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Assessment of the North Carolina Winter Trawl Fishery

September 1982-April 1985

by

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Special Scientific Report No. 53

April 1990

This work was conducted under the Commercial Fisheries Research and Development Act (PL 88-309, as amended) and funded, in part, by the U.S. Department of Commerce, National Oceanic and Atmospheric Agency, National Marine Fisheries Service, under Project 2-386-R.

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Two hundred copies of this report were printed at a cost of $688.50, or $3.44 a copy

SH222
.N8N67
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ABSTRACT

The winter trawl fishery produced one-third of all finfish (excluding menhaden) commercially landed in North Carolina during the study period. From Fall 1982 through Spring 1985, 43, 67 and 84 catches were sampled during the respective fishing seasons. Catches were partitioned by gear (nearshore flounder trawl, deepwater trawls, flynet), and area (north of Cape Hatteras, Cape Hatteras to Cape Lookout, west of Cape Lookout) to facilitate analyses of seasonal fishing patterns and catches.

The nearshore flounder fishery occurred from late November through January and accounted for 18.6 to 37.3% of the catches sampled. Summer flounder (Paralichthys dentatus) dominated these catches, although their relative abundance declined from 93.7 to 88.6% during the study. The CPUE (mean weight/trip) was highest in 1983-84 (9,687 kg) and lowest in 1982-83 (5,584 kg). Fish <300 mm TL accounted for 9.8-14.6% of the catches, while fish >400 mm TL comprised 21.4-26.0%, with no dramatic changes noted during the three-year period.

Deepwater trawling occurred from December through April, accounting for 18.6-31.3% of the samples. This fishery was dominated (94.0-98.0%) by scup (Stenotomus chrysops), summer flounder, black sea bass (Centropristis striata), and squids (Loligo sp.). The CPUE of S. chrysops declined from 9,708 kg in 1982-83 to 2,003 kg in 1984-85 as did the percent of fish >200 mm FL, from 58.5 to 18.8%. The CPUE of P. dentatus increased from 1,377 kg to 4,431 kg from 1982-83 to 1984-85; their size composition did not change significantly during the study; smaller summer flounder were captured in the deepwater than the nearshore fishery. The CPUE of C. striata increased from 1,314 kg to 3,449 kg, and the proportion of large fish increased during the study.

Flynet fishing occurred from September through April and comprised 31.3-62.8% of the samples. Catches were dominated by weakfish (Cynoscion regalis) in 1982-83 (52.8%) and 1983-84 (61.9%) and by Atlantic croaker (Micropogonias undulatus) (38.6%) and C. regalis (35.6%) in 1984-85. Bluefish (Pomatomus saltatrix), spot (Leiostomus xanthurus), and butterfish (Peprilus triacanthus) were also regularly captured. The CPUE of C. regalis was highest in 1983-84 (7,598 kg) and lowest in 1984-85 (4,780 kg). C. regalis of age 0-XI were landed, but ages 0 and I comprised 90% of the catches. The CPUE of M. undulatus increased from 2,344 kg in 1982-83 to 5,190 kg/catch. Age 0-V M. undulatus were landed, though fish ages I-III constituted 98.9-99.9% of the catches. A declining trend in CPUE and landings of P. saltatrix was indicated; age 0-XI individuals were sampled, but fish age 0-I comprised 87.7-88.8% of the catches in 1982-84 and 57.9% in 1984-85. Flynets produced the greatest relative percentage of scrapfish and inshore flounder trawls the lowest percentage.

INTRODUCTION

The inception of the winter trawl fishery off North Carolina and Virginia occurred around 1920 when New Jersey flounder trawlers began looking southward for the schools of Atlantic croaker (Micropogonias undulatus) they captured further north during March and April (Pearson 1932; Nesbit 1935). They used converted shallow draft oyster and crab dredge boats from Hampton and Portsmouth, Virginia, rigged with otter trawls, and fished out of Ocracoke Inlet, North Carolina within 10-20 mi of land. In 1930, the North Carolina legislature prohibited all trawling in state waters. In spite of this and similar regulations in Virginia waters, nearly 20 small vessels continued to fish outside of three mi when conditions were favorable (Eldridge 1962).

By 1928, several large New England draggers were fishing along the North Carolina-Virginia coasts, centering their efforts around Cape Hatteras and selling their catches in Hampton Roads. Their success on scup (Stenotomus chrysops), black sea bass (Centropristis striata), Atlantic croaker and summer flounder (Paralichthys dentatus) led to an expansion in the winter of 1930-31 to approximately 25 northern vessels and 20 local Chesapeake Bay boats. Although croaker and flounder were initially targeted, the 1930-31 season produced catches of other species similar to what we see today. This was due to the expansion of the fishery offshore to depths of 20-50 fathoms off southern Virginia and northern North Carolina, as well as into the Hatteras Bight. Atlantic croaker, spot (Leiostomus xanthurus), weakfish (Cynoscion regalis), and bluefish (Pomatomus saltatrix) dominated landings on the southern fishing grounds, and black sea bass, scup, hake (Urophycis spp.), and flounder were caught north of Cape Hatteras (Eldridge 1962; Pearson 1932).

The larger vessels used during the 1930s were ketch-rigged, 60-100 ft in length (16-20 ft beam), powered with 100-150 hp crude oil auxiliary engines, with 50,000-80,000 lb holding capacities (Eldridge 1962). They were rigged for side trawling and pulled otter trawls with 6 ft x 4 ft x 2-1/2 in. non-reinforced wooden doors. The trawls were 70-90 ft wide, 75 ft long, made of cotton twine with 2-1/2 in stretched mesh cod ends and 2-3/4 in stretched mesh bodies. These vessels were crewed by 6-10 men. Two vessels that fished in the 1930s, the SEA RAMBLER (in winter 1986, this vessel caught fire and was lost at sea) and the MITZI KAY were still in use during this study.

The winter trawl fishery changed little through the 1930s and then effort dropped sharply during World War II. Since World War II, several developments modified and modernized the fishery. War surplus diesel engines (6-71; 350 hp) became available. Today, vessels with up to 920 hp engines facilitate the pulling of bigger nets (Etheridge).[1] Corps of Engineers' maintenance of Oregon Inlet's channel, beginning in the mid-1950s, facilitated the development of Wanchese, North Carolina as a major fish processing port. Eastern North Carolina ports such as Englehard, Belhaven, and Bayboro were also used by trawlers fishing out of Oregon Inlet.

Vessel sizes have generally increased, with most ranging from 60 to

[1] Captain Will Etheridge, Jr., Wanchese, North Carolina, personal communication 1986.

95 ft, widths of 15-23 ft, tonnages from 33 to 200, and engines of 200-920 hp. Steel vessels, first used in the mid-1960s, increased in number in the 1970s, and now predominate. Most vessels are stern trawlers, with net reels further increasing efficiency, although a few side trawlers are still in use. Modern electronics facilitate fishing different locations and locating fish concentrations. Crew sizes are smaller today (4-5 men) since powerheads, winches and net reels have made gear handling much less arduous.

Nets have also changed in type as well as materials used. Early nets were cotton, less durable, and deteriorated sooner than today's nylon and polypropylene nets which are lighter, more durable and less prone to deterioration. Use of wider wing mesh has reduced drag while not reducing catch, allowing larger nets to be used. High rising flynets, low profile flounder trawls, nets with rollers or "cookies" for rough bottoms, combination nets, and others have increased gear efficiency over the range of bottom types and for a variety of species (Etheridge[1]).

The North Carolina trawl fishery is a multispecies-multigear fishery which takes place from September through April, during which time effort is shifted depending on seasonal distribution, availability, catchability and marketability. Fishing grounds extend from as far north as Maryland to south and west of Cape Lookout and from just off the beach to the 50 fathom curve (Figure 1). Target species include butterfish (September-November), croaker (September-April), weakfish (November-April), summer flounder (November-April), scup and black sea bass (December-April) and bluefish (December-April).

Catches are landed at ports from Wanchese to Morehead City-Beaufort, and throughout the Pamlico Sound. The primary processing facilities in North Carolina are located in Wanchese, where 30-40 vessels offload at six fish houses. During the late 1970 and prior to the severe shoaling around Oregon Inlet (which often makes passage difficult), up to 100 vessels landed fish there. Morehead City-Beaufort is the second largest processing center for trawlers, with 5-6 fish houses servicing 10-15 full-time trawlers. The ports of Hobucken, Vandemere, Bayboro, and Oriental pack fish for 4-8 trawlers which fish out of both Oregon and Ocracoke inlets. Other ports included in this study which have 1-3 vessels (45-65 ft class) include Englehard, Swan Quarter, Belhaven, and Wrights Creek.

The winter trawl fishery accounted for 32-36% of all finfish (excluding menhaden) landed in North Carolina during the 1982-85 fishing seasons. In one or more seasons, it accounted for >50% of the landings of weakfish, bluefish, flounder, butterfish, black sea bass, and scup (Table 1). Total landings of marketable food fish during September 1982 - April 1985 ranged from 19.8 to 22.4 million lb each season.

At least three different types of trawls were utilized in this fishery, with modifications of each in use (Etheridge[1]). Flynets are a high-rise (high profile) net which fishes 10-12 ft off the bottom. Headropes range from 80 to 120 ft, and mesh sizes taper from 16 to 64 in. in the wings to 2 in. in the cod end. The basic trawl used in the directed flounder fishery has a 65-82 ft headrope, shallow wings, 2 or 4 seams; these are low profile nets which fish only a foot or two off the bottom. Mesh sizes are generally 5-6 in. in the wings and 2-4-1/2 in. in the tailbags. In deepwater, combination nets similar to a Yankee trawl are used with headropes of 72-80 ft and mesh sizes

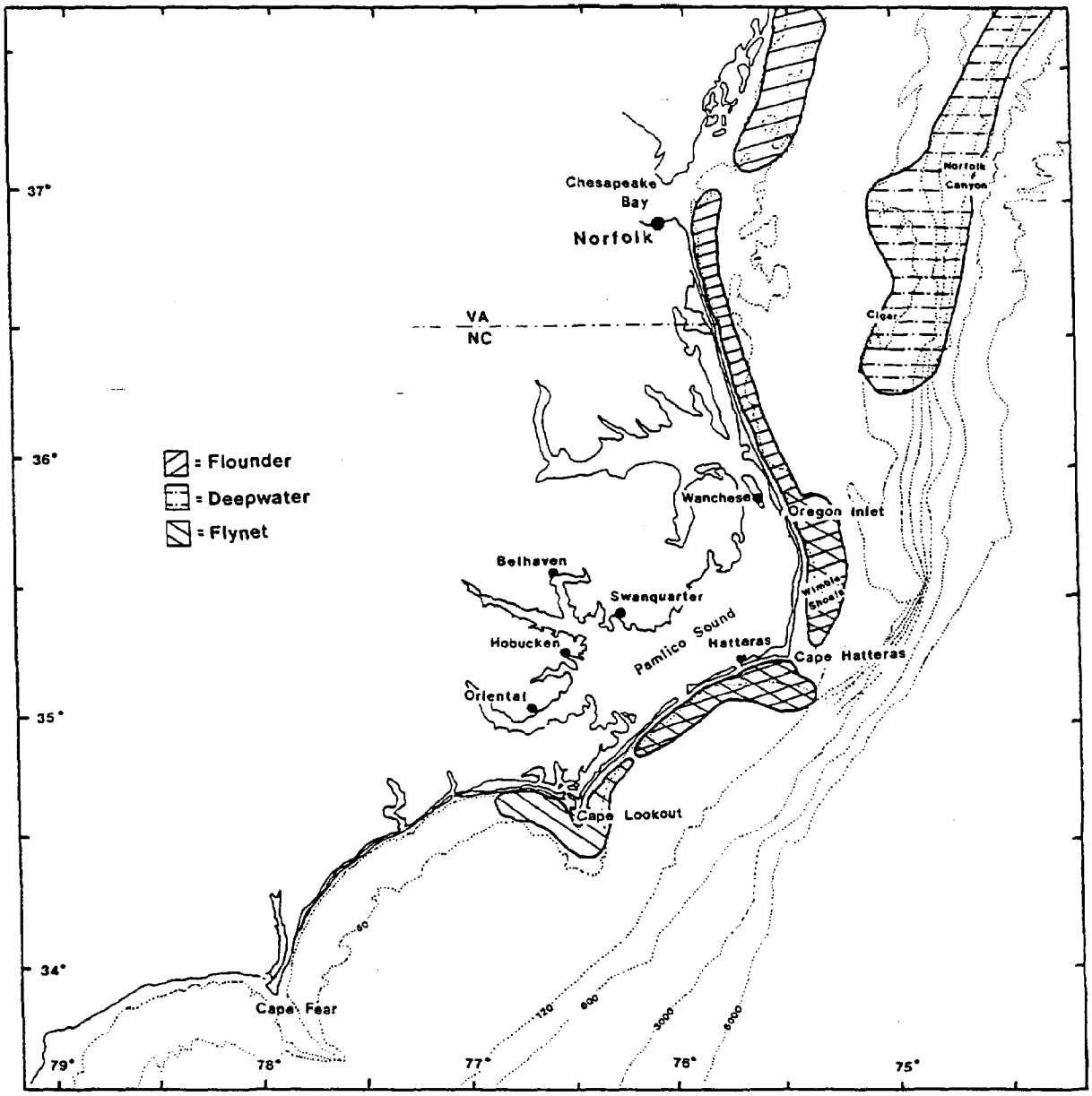

Figure 1. Fishing grounds of North Carolina winter trawl fishery.

Table 1. Seasonal commercial landings of the pound net[1], long haul[2], ocean gill net (gill net)[3] and winter trawler[4] fisheries in North Carolina for 1982-1985 (year = May-April), including total landings/species (pounds), total value of state landings/species (value in dollars) and relative contribution of the three fisheries/species (percent).

Species	May 82-April 83		May 83-April 84		May 84-April 85	
	Pounds	Value/percent	Pounds	Value/percent	Pounds	Value/percent
Atlantic croaker	9,866,141	3,572,225	8,149,494	3,099,117	10,376,614	3,277,669
Pound net	1,902,215	19.31	644,560	7.91	975,762	9.40
Long haul	4,549,326	46.11	4,151,140	50.94	2,951,449	28.45
Trawler	1,205,872	12.22	1,054,312	12.94	2,996,638	28.88
Gill net	833,236	8.45	1,153,007	14.15	2,615,006	25.20
Weakfish	11,382,336	4,694,631	12,094,801	3,936,466	10,422,617	3,873,849
Pound net	278,438	2.45	161,494	1.34	368,337	3.53
Long haul	1,624,525	14.27	1,552,367	12.84	1,680,145	16.12
Trawler	6,733,559	59.46	6,040,467	49.94	3,879,464	37.22
Gill net	1,842,995	16.19	3,380,165	27.95	3,389,223	32.52
Bluefish	7,649,633	914,334	3,567,772	565,016	2,963,934	509,375
Pound net	195,560	2,56	69,163	1.94	84,782	2.86
Long haul	427,246	5,58	337,461	9.46	245,300	11.65
Trawler	3,914,922	51.18	1,024,513	28.71	791,896	26.72
Gill net	2,122,837	27.75	1,395,109	39.10	1,216,539	41.04
Spot	4,881,153	1,063,275	3,059,581	699,276	3,443,161	808,613
Pound net	330,801	6.78	65,525	2.14	195,775	5.69
Long haul	3,430,237	70.28	1,950,733	62.29	2,067,525	60.05
Trawler	78,806	1.61	152,545	4.99	109,817	3.19
Gill net	76,135	1.56	128,352	4.20	262,124	7.61
Flounders	8,751,842	5,486,386	13,288,085	7,292,754	14,115,181	10,132,192
Pound net	121,321	1.39	75,267	0.57	117,160	0.83
Long haul	62,433	0.71	79,810	0.60	58,727	0.42
Trawler	6,367,909	72.76	10,513,594	79.12	11,430,499	80.98
Butterfish[4]	298,057	75,641	116,347	42,742	176,570	63,785
Pound net	24,078	8.08	3,185	2.74	15,117	8.56
Long haul	8,090	2.71	9,006	8.37	5,148	2.92
Trawler	163,887	54.99	83,392	71.68	114,113	64.63
Gill net	84,486	28.35	11,506	9.89	25,405	14.39
Harvestfish[4]	437,720	123,419	221,748	59,970	242,613	96,992
Pound net	75,290	17.20	37,153	16.75	70,008	28.86
Long haul	90,101	20.58	43,019	19.40	47,213	19.46
Trawler	75,429	17.23	15,703	7.08	11,338	4.67
Gill net	90,206	20.61	12.789	5.77	10,609	4.37
Spanish mackerel	189,217	61,268	41,336	15,221	127,467	42,043
Pound net	6,857	3.62	5,850	14.15	13,935	10.93
Trawler	824	0.44	14	0.03	-	
Gill net	63,297	33.45	8,371	20.25	31,073	24.38
Spotted Seatrout	93,381	71,764	159,066	120,497	150,780	122,505
Pound net	10,847	11.62	10,802	6.79	9,014	5.98
Long haul	33,222	35.58	41,199	25.90	33,543	22.25
Trawler	900	0.96	625	0.39	954	0.63
Gill net	5,003	5.36	9,294	5.84	8,158	5.41
Red drum	48,717	11,238	321,853	81,232	199,739	59,570
Pound net	718	1.47	3,533	1.10	1,758	0.88
Long haul	9,947	20.42	20,865	6.48	15,444	7.73
Trawler	13,496	27.70	28,802	8.95	14,144	7.08
Gill net	11,005	22.59	75,748	23.53	41,894	20.97

Table 1. (continued).

Species	May 82-April 83 Pounds	May 82-April 83 Value/percent	May 83-April 84 Pounds	May 83-April 84 Value/percent	May 84-April 85 Pounds	May 84-April 85 Value/percent
Striped bass	241,687	451,330	408,632	356,001	466,354	365,232
Pound net	-	-	-	-	-	-
Long haul	228	0.09	19	0.01	47	0.01
Trawler	3,619	1.50	13,633	3.34	132	0.03
Gill net	49,152	20.34	685	0.17	-	-
Black sea bass	468,963	342,656	982,197	681,794	1,199,375	976,068
Trawler	156,648	33.50	586,101	59.67	799,469	71.42
Scup or porgies	1,451,219	840,315	1,840,452	997,463	1,113,225	758,760
Trawler	670,491	46.20	1,051,734	57.15	588,542	52.87
Bait	9,483,722	353,653	9,767,200	375,892	10,350,279	380,999
Pound net	770,299	8.12	442,355	4.53	928,158	8.97
Long haul	4,141,819	43.67	4,190,474	42.90	4,153,578	40.13
Trawler	3,007,459	31.71	3,555,923	36.41	3,796,043	36.68
Gill net	137,536	1.45	95,944	0.98	220,218	2.13
Total finfish (w/out menhaden)	70,034,744	23,446,020	72,260,108	23,638,834	81,638,670	28,220,020
Pound net	3,746,504	5.35	1,556,540	2.15	2,832,346	3.47
Long haul	14,503,469	20.71	12,453,982	17.23	11,408,674	13.97
Trawler	22,855,221	32.63	25,968,070	35.94	26,232,641	32.13
Gill net	5,822,047	8.31	6,422,844	8.89	8,172,358	10.01
Total marketable finfish (w/out menhaden)	60,551,022	23,092,367	62,492,908	23,262,942	71,288,391	27,839,021
Pound net	2,976,205	4.92	1,114,185	1.78	1,094,388	2.67
Long haul	10,361,650	17.11	8,263,508	13.22	7,255,096	10.18
Trawler	19,847,726	32.78	22,412,147	35.86	22,436,598	31.47
Gill net	5,684,561	9.39	6,326,900	10.12	7,952,140	11.15

[1]Pound net landings include Dare County.

[2]Long haul landings include: Dare, Hyde, Carteret, Craven, Pamlico and Beaufort counties.

[3]Winter trawl and ocean gill net landings include: Dare, Hyde, Pamlico Beaufort, Craven, Carteret, Brunswick and Onslow counties.

[4]North Carolina commercial landings combined harvestfish and butterfish landings in 1985 as harvestfish; for the purpose of this presentation, we extrapolated out butterfish landings based on monthly relative proportions of the two species in our samples.

tapering from 5 in. in the wings to 3 in. in the tailbag. These nets are designed to fish 3-4 ft off the bottom. Flounder trawls and flynets are also used in deepwater.

In 1978, the North Carolina Division of Marine Fisheries (DMF) initiated a statewide sampling program of the dominant commercial fisheries. The overall objective was to obtain biological and fisheries data on economically important fishes for use in management programs in estuarine waters and the territorial sea. Because of its importance to the state, the winter trawl fishery was included and is described with regard to species composition, relative abundance, distribution, and seasonality. Age and/or size composition of the dominant species are presented. The discussion will include a partitioning of the fishery into three components: flynets, nearshore flounder, and deepwater trawling.

METHODS AND MATERIALS

Winter trawl catches were sampled and analyzed by "fishing seasons," which included October 1982-April 1983, November 1983-April 1984, and September 1984-April 1985. Samples were obtained from fish packing houses while the catches were being offloaded, primarily in Wanchese and Morehead City-Beaufort, and to a lesser extent from Hatteras, Oriental, Vandemere, Hobucken, Swan Quarter, and Belhaven. Captains or crew members were interviewed when available to obtain information on: area and depth fished, number and duration of tows, days at sea, and gear(s) used including size of headrope and cod end mesh. Six or more catches were sampled monthly when possible. Two sampling methods, graded and ungraded, were employed, although 98% were graded random stratified samples.

Graded Random Stratified Sampling

To insure adequate coverage of all sizes and species in the catches, and since culling does occur offshore, random stratified samples of the graded catch were taken. This process involved randomly sampling one or more 50 lb cartons of each species market category or grade (small, medium, large, jumbo, etc.). More cartons of the larger grades were sampled since they contained fewer fish. Each sample was weighed to the nearest 0.1 kg, the individual fish measured to the nearest millimeter (FL or TL), and the total number of individuals recorded. If the individuals in a fish box were too numerous to measure, at least 30 were measured, and the remainder counted. The total catch weight of each market category for each species was obtained from the fish dealer's records.

Scrap is defined as the part of the catch not marketed for human consumption, but rather sold for bait or industrial fish, or discarded. To describe the species and size composition of the scrap fish landed, at least one-half of the fish basket (about 12 kg) from this portion of the catch was treated as an ungraded sample when scrap was a significant (>5%) component of the catch. Total catch weight of the (scrap fish) was estimated if not available from the dealer unless it was <50 kg, in which case it was considered negligible and not recorded. If the scrap was not sampled, component species were noted.

In cases where a particular species' market grades were included on the trip ticket but time did not permit their being sampled, an estimate of the number of fish landed for the grade was made based on a recent sample of that species and grade from another recent catch.

Total length frequencies for each catch were derived by expanding the sample length frequencies for each market category (grade) by an expansion factor to represent the species market grade weight. Species market grade weight was obtained from trip tickets and species length frequencies were a combination of those expanded for the respective species market grades. Species length frequencies from the scrap fish component of catch were included after they were calculated by the methods described in "Ungraded Samples."

Species numerical abundance/catch was calculated similarly by determining the number of individuals/market grade and then merging all market grades/species. The number of individuals/species from the scrap component of the catch was determined by calculations described in "Ungraded Samples."

Ungraded Sampling

For ungraded samples, several (∿30 kg baskets) from throughout the catch were taken. Each sample was sorted and weighed (kg) by species, and all individuals measured to the nearest millimeter (TL or FL). If a particular species was too numerous, a random subsample of at least 30 individuals was measured and the remaining fish counted. However, if a species had two or more distinct size classes, then each size class was treated like a separate species when subsampled. The total weight of each species or the entire catch was obtained, preferably from the trip ticket, and if not, it was estimated.

Length-frequencies for ungraded catches were derived by expanding the sample length frequencies to represent the total weight of the species in the respective catch. Total weight of a species in a catch was calculated by determining the proportion of a species in the samples, and expanding that to the respective species proportional weight in the total catch. The total weight of the catch was obtained from the trip ticket. The number of individuals/species in a catch was calculated by expanding the number of individuals in the samples to represent the total weight of the species in the total catch.

Scale samples from 30-60 weakfish, summer flounder, croaker, bluefish, and spot were taken monthly when available, representing the entire size range of individuals captured. Both length and weight data were taken for each fish sampled. Ageing was done using criteria for determining annuli given by Wilk (1977) for bluefish, Ross (in press) for croaker, DeVries (1981) for spot, and Massmann (1963) and Merriner (1973) for weakfish.

Semi-annual or quarterly age frequency distributions were generated for each 20 mm size interval, then merged with expanded length frequency data from the same time period to produce the overall annual age composition. Atlantic croaker age composition was determined using age/length keys from 1979-81 age data (Ross in press). Age data from individuals collected from the North Carolina winter sink net fishery were pooled with the winter trawler data to increase the sample size and size range of individuals aged.

Landings and catch-per-unit-of effort (CPUE) are compared throughout the report. CPUE is defined as the total weight (kg)/species/trip. A trip (= catch) may consist of one or more tows and one or more days of fishing. Landings refer to commercial landings (lb) data collected through the North Carolina Division of Marine Fisheries and the National Marine Fisheries Service cooperative program. Landings during

the 1982-85 study period were reported based on a May through April fishing season (i.e., Table 1); however, when considering historical landings data prior to 1982, annual refers to January through December.

RESULTS

North Carolina's winter trawl fishery will be described in four sections. First, a broad overview of the fishery, considering catches sampled by fishing season and month. The subsequent sections will describe the catches based on fishing gear used and geographical area fished.

Species Composition - Overview

Species Composition, 1982-1985

During the 1982-83 fishing season, 43 catches were sampled (Table 2), including 27 flynet, 8 inshore flounder trawl, and 8 deepwater catches. Geographically, 42% of these catches were made north of Cape Hatteras, 51% between Cape Hatteras and Cape Lookout and 7% west of Cape Lookout. Weakfish accounted for 36.6% of the weight and 34.8% of the number of fish sampled (Table 3). Scup, bluefish, summer flounder and Atlantic croaker each accounted for >12% of the catches while black sea bass, spot and squid accounted for <1%. At least 68 species of fish and 6 species of invertebrates were observed. Monthly dominant species and catch compositions are presented in Table 4.

During the 1983-84 fishing season, 67 catches were sampled (Table 2), including 21 flynet, 25 inshore flounder trawl, and 21 deepwater catches. Geographically, 60% of these catches were made north of Cape Hatteras, 39% between Cape Hatteras and Cape Lookout, and 1% west of Cape Lookout. Summer flounder (43.0%), weakfish (23.1%) and scup (11.6%) were the dominant species. Atlantic croaker, black sea bass and squid accounted for >3% of the catches and Atlantic mackerel (Scomber scombrus), spot and bluefish contributed >1% (Table 5). At least 75 species of fish and 13 species of invertebrates were observed. Monthly dominant species and catch compositions are presented in Table 4.

During the 1984-85 fishing season, 84 catches were sampled (Table 2), including 38 flynet, 27 inshore flounder trawl and 19 deepwater trawl catches. Geographically, 74% of these catches were made north of Cape Hatteras, 14% between Cape Hatteras and Cape Lookout, and 12% west of Cape Lookout. Summer flounder (31.6%), Atlantic croaker (20.0%) and weakfish (19.8%) dominated the catches (Table 6). Black sea bass, bluefish, spot and scup accounted for 3.9-6.8%, while squid and butterfish contributed >1% of the overall weight of the catches sampled. At least 74 species of fish and 17 species of invertebrates were observed. Monthly dominant species and catch compositions are presented in Table 4.

Components of the Winter Trawl Fishery

The winter trawl fishery is a diverse fishery in terms of species caught and fluctuations within and between months and years based on the information in the previous section; however, this is somewhat misleading. The winter trawl fishery, when partitioned by gear and/or area fished, in fact is consistently dominated by specific species or species groups. The fishery is ultimately controlled by spatial-temporal distributions of the species targeted.

Partitioning the catches by gears resulted in the clear dominance of just a few species by each gear (Table 7). Flynet catches accounted for >90%

Table 2. Monthly sampling effort of winter trawl fishery from October 1982 through April 1985, by area fished (North = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, South = west of Cape Lookout) and gear (Flounder denotes flounder net fishing in depths generally <20 fathoms; deepwater denotes use of flounder nets or roller rigs fishing in deep water generally >20 fathoms; n = number of catches sampled).

Season	Month	Area	Gear	n	Catch weight (kg) Mean	Catch weight (kg) Range	Sample weight (kg) Mean	Sample weight (kg) Range
1982-83	Oct	N	Flynet	1	7,257.0		109.1	
	Nov	N	Flynet	3	15,372.2	5,612-23,154	210.9	109.9- 307.0
		C	Flynet	3	16,002.2	6,532-28,865	163.0	88.3- 224.0
		C	Flounder	1	9,167.0		181.6	
	Dec	N	Flounder	3	9,032.3	7,688-10,685	352.3	162.0- 491.7
		N	Deepwater	1	3,379.0		264.8	
		C	Flynet	2	12,226.5	6,917-17,536	293.0	266.7- 319.2
		C	Flounder	3	2,699.7	1,923- 3,269	185.5	75.0- 298.5
	Jan	N	Flynet	3	16,469.7	12,744-22,810	251.2	248.0- 254.4
		N	Deepwater	1	26,111.0		267.7	
		C	Flynet	2	14,790.5	6,771-22,810	251.2	248.0- 254.4
		C	Flounder	1	3,528.0		157.2	
		S	Flynet	2	14,796.5	11,675-17,918	142.3	126.6- 158.0
	Feb	C	Flynet	7	14,607.9	5,248-32,427	568.9	177.4- 971.4
		S	Flynet	1	11,818.0		84.1	
	Mar	N	Deepwater	4	14,294.1	10,051-21,355	276.4	172.7- 373.7
		C	Flynet	2	1,001.3	251- 1,751	150.7	144.3- 157.0
	Apr	N	Deepwater	2	9,984.9	5,234-14,736	197.7	194.8- 200.6
		C	Flynet	1	5,081.2			280.8
1983-84	Nov	N	Flynet	4	9,534.3	3,858-11,773	394.4	243.0- 781.4
		N	Flounder	2	10,302.0	7,480-13,124	318.1	227.0- 409.1
		C	Flynet	1	20,567.0		255.2	
	Dec	N	Flounder	9	12,929.6	3,947-22,433	453.5	176.8- 886.0
		C	Flounder	3	4,337.3	1,750- 8,339	166.5	90.8- 227.0
	Jan	N	Deepwater	4	13,393.3	2,592-21,079	245.7	113.5- 331.7
		C	Flynet	5	13,317.4	5,566-18,306	281.1	128.9- 484.7
		C	Flounder	11	10,157.0	1,038-29,432	206.7	90.8- 485.4
		S	Flynet	1	6,554.6		48.0	
	Feb	N	Deepwater	8	9,129.5	4,039-16,337	468.7	226.9- 607.0
		C	Flynet	3	18,479.7	10,682-27,289	155.0	134.5- 166.2
	Mar	N	Flynet	4	6,674.9	1,308-13,838	672.1	145.0-1,477.4
		N	Deepwater	3	9,081.3	4,436-17,503	333.3	174.1- 481.4
		C	Flynet	3	14,738.1	9,313-21,741	119.9	77.4- 180.3

Table 2. (continued)

Season	Month	Area	Gear	n	Catch weight (kg) Mean	Catch weight (kg) Range	Sample weight (kg) Mean	Sample weight (kg) Range
	Apr	N	Deepwater	6	8,672.3	6,383-11,281	251.8	113.5- 458.0
	Sept	N	Flynet	1	2,554.0		125.2	
	Oct	N	Flynet	4	14,795.7	11,114-18,939	267.4	170.9- 511.8
1984-85	Nov	N	Flynet	1	16,255.0			159.6
		N	Flounder	6	8,764.2	1,976-18,140	306.1	128.9- 589.8
		C	Flynet	3	18,821.7	15,372-21,747	178.3	151.4- 222.9
		S	Flynet	1	17,053.0			136.7
	Dec	N	Flynet	1	2,744.0		124.7	
		N	Flounder	11	13,107.0	6,164-25,542	364.7	249.7- 731.4
		C	Flynet	1	5,293.0		111.4	
		S	Flynet	1	23,227.0		209.9	
	Jan	N	Flynet	3	14,783.0	4,802-32,223	143.6	126.2- 161.0
		N	Flounder	7	6,610.2	3,058-11,902	326.1	
		C	Flynet	1	1,066.4		68.1	
		S	Flynet	5	16,299.3	9,525-18,965	135.6	91.6- 182.9
	Feb	N	Flynet	2	6,032.2	5,417- 6,647	161.6	107.4- 215.7
		N	Flounder	1	3,564.9		181.6	
		N	Deepwater	8	10,634.3	3,282-13,935	361.0	249.7- 522.1
		C	Flynet	3	17,011.5	3,113-38,601	169.5	136.8- 223.4
	Mar	N	Flounder	1	4,055.0		113.5	
		N	Deepwater	8	13,857.4	4,678-39,444	235.2	189.6- 308.2
		C	Flynet	4	11,790.4	1,198-29,464	131.4	67.3- 268.5
		S	Flynet	3	11,400.0	9,329-12,816	116.3	97.6- 131.6
	Apr	N	Flynet	4	14,108.0	6,595-19,562	340.1	208.9- 470.8
		N	Flounder	1	3,725.8		227.4	
		N	Deepwater	3	8,157.3	3,513-11,638	347.9	287.8- 424.9

Table 3. Overall species composition of 43 winter trawl fishery catches sampled from October 1982 through April 1983 by weight, including CPUE, percentage of the total weight of the catch, cumulative percentage of catch weight (Cum. %), number of fish, percentage of total number of fish, and the percentage of catches in which a species occurred (% Freq. occur.).

Species	Weight (kg)			Number		% Freq.
	Mean	%	Cum. %	Mean	%	occur.
Cynoscion regalis	4,229.7	36.59	36.59	14,485	34.50	72.7
Stenotomus chrysops	1,806.6	15.63	52.24	6,525	15.67	22.7
Pomatomus saltatrix	1,682.7	14.56	66.78	2,133	5.12	81.8
Paralichthys dentatus	1,500.1	12.98	79.76	2,980	7.16	65.9
Micropogonias undulatus	1,450.4	12.55	92.31	8,303	19.95	40.9
Centropristis striata	244.9	2.12	94.43	889	2.14	29.5
Leiostomus xanthurus	230.4	1.99	96.42	3,250	7.81	38.6
Cephalopoda	149.0	1.29	97.71	-		45.5
Peprilus triacanthus	130.4	1.13	98.84	1,850	4.45	68.2
Urophycis regia	13.2	0.11	98.95	113	0.27	25.0
Menticirrhus spp.	11.7	0.10	99.06	40	0.10	13.6
Prionotus evolans	9.5	0.08	99.14	336	0.81	27.3
Menticirrhus saxatilis	8.6	0.07	99.21	30	0.07	25.0
Carcharhinidae	7.3	0.06	99.28	-	-	4.5
Acipenser oxyrhynchus	6.8	0.06	99.33	1	0.01	13.6
Lophius americanus	6.6	0.06	99.39	-	-	13.6
Sphoeroides maculatus	6.1	0.05	99.44	56	0.14	25.0
Scomberomorus cavalla	6.1	0.05	99.49	-	-	15.9
Menticirrhus americanus	5.2	0.05	99.54	33	0.08	22.7
Paralichthys spp.	4.8	0.04	99.58	-	-	4.5
Bairdiella chrysoura	4.7	0.04	99.62	97	0.23	9.1
Paralichthys lethostigma	4.4	0.04	99.66	4	0.01	18.2
Orthopristis chrysoptera	4.3	0.04	99.70	73	0.18	13.6
Brevoortia tyrannus	3.7	0.03	99.73	28	0.07	6.8
Merluccius bilinearis	3.5	0.03	99.76	3	0.01	13.6
Isurus oxyrinchus	2.3	0.02	99.78	1	0.01	2.3
Stenotomus caprinus	2.1	0.02	99.80	60	0.15	6.8
Calamus leucosteus	2.0	0.02	99.81	46	0.11	2.3
Carangidae	1.9	0.02	99.83	2	0.01	4.5
Rachycentron canadum	1.8	0.02	99.85	1	0.01	4.5
Anchoa hepsetus	1.8	0.02	99.86	92	0.22	6.8
Trichiurus lepturus	1.4	0.01	99.87	17	0.04	13.6
Chaetodipterus faber	1.3	0.01	99.88	29	0.07	11.4
Prionotus scitulus	1.2	0.01	99.89	40	0.10	4.5
Priacanthus spp.	1.2	0.01	99.90	9	0.02	4.5
Uraspis secunda	1.1	0.01	99.91	2	0.01	2.3
Seriola dumerili	0.9	0.01	99.92	1	0.01	6.8
Raja eglanteria	0.8	0.01	99.93	12	0.03	9.1
Scomberomorus spp.	0.8	0.01	99.93	-	-	2.3
Porichthys plectrodon	0.8	0.01	99.94	21	0.05	6.8
Tautoga onitis	0.7	0.01	99.95	1	0.01	2.3
Lagodon rhomboides	0.7	0.01	99.96	9	0.02	9.1

Table 3. (continued).

Species	Weight (kg) Mean	%	Cum. %	Number Mean	%	% Freq. occur.
Cynoscion nebulosus	0.6	0.01	99.96	1	0.01	6.8
Loligo pealii	0.5	0.01	99.97	-	-	4.5
Stenotomus spp.	0.5	0.01	99.97	12	0.03	2.3
Scomberomorus maculatus	0.4	0.01	99.97	1	0.01	4.5
Prionotus salmonicolor	0.4	0.01	99.98	11	0.03	4.5
Euthynnus alletteratus	0.4	0.01	99.98	1	0.01	4.5
Penaeus duorarum	0.4	0.01	99.98	-	-	9.1
Peprilus alepidotus	0.3	0.01	99.98	6	0.01	4.5
Prionotus carolinus	0.3	0.01	99.99	13	0.03	9.1
Monacanthus hispidus	0.3	0.01	99.99	9	0.02	2.3
Morone saxatilis	0.3	0.01	99.99	1	0.01	2.3
Priacanthus arenatus	0.2	0.01	99.99	2	0.01	2.3
Pagrus pagrus	0.1	0.01	99.99	1	0.01	2.3
Pseudopleuronectes americanus	0.1	0.01	99.99	1	0.01	2.3
Etropus crossotus	0.1	0.01	100.00	2	0.01	2.3
Euthynnus pelamis	0.1	0.01	100.00	1	0.01	2.3
Squilla empusa	0.1	0.01	100.00	2	0.01	4.5
Penaeus aztecus	0.1	0.01	100.00	2	0.01	4.5
Malacanthus plumieri	0.1	0.01	100.00	1	0.01	2.3
Alosa sapidissima	0.1	0.01	100.00	1	0.01	2.3
Urophycis floridana	0.1	0.01	100.00	-	0.01	2.3
Pollachius virens	0.1	0.01	100.00	1	0.01	4.5

Observed species

Mustelus canis	Rhinoptera bonasus	Sciaenops ocellatus
Squalus acanthias	Dasyatis sayi	Lutjanus spp.
Ovalipes ocellatus	Dasyatis sabina	Urophycis chuss
Archosargus probatocephalus	Scomber scombrus	Synodus foetens
		Callinectes similis

Table 4. Monthly and seasonal comparison of the species that accounted for the top 99.5% by weight of the winter trawl fishery 1982-85, all gears combined, including their percent contribution to the total weight of the catches sampled (%TW) and the number of catches sampled (n).

1982-1983		1983-1984		1984-1985	
Species	%TW	Species	%TW	Species	%TW
September				**(n=1)**	
				Micropogonias undulatus	96.75
October (n=1)				**(n=4)**	
Peprilus triacanthus	43.13			Micropogonias undulatus	58.97
Cynoscion regalis	41.62			Cynoscion regalis	32.68
Micropogonias undulatus	7.46			Leiostomus xanthurus	1.93
Pomatomus saltatrix	4.69			Peprilus triacanthus	1.87
November (n=7)		**(n=7)**		**(n=11)**	
Micropogonias undulatus	41.91	Paralichthys dentatus	32.69	Micropogonias undulatus	36.56
Cynoscion regalis	37.22	Cynoscion regalis	31.86	Paralichthys dentatus	35.19
Paralichthys dentatus	10.16	Micropogonias undulatus	24.60	Cynoscion regalis	13.36
Pomatomus saltatrix	4.29	Leiostomus xanthurus	5.70	Leiostomus xanthurus	9.55
Leiostomus xanthurus	2.40	Pomatomus saltatrix	1.42	Pomatomus saltatrix	1.01
December (n=12)		**(n=9)**		**(n=14)**	
Paralichthys dentatus	52.11	Paralichthys dentatus	91.41	Paralichthys dentatus	73.49
Cynoscion regalis	32.70	Cynoscion regalis	3.50	Micropogonias undulatus	10.80
Pomatomus saltatrix	7.55	Pomatomus saltatrix	2.21	Cynoscion regalis	7.60
Stenotomus chrysops	4.07			Pomatomus saltatrix	2.50
				Loligo pealii	1.44
January (n=9)		**(n=21)**		**(n=16)**	
Cynoscion regalis	40.95	Paralichthys dentatus	53.50	Cynoscion regalis	33.38
Stenotomus chrysops	19.58	Cynoscion regalis	23.59	Micropogonias undulatus	28.14
Pomatomus saltatrix	16.26	Stenotomus chrysops	10.94	Paralichthys dentatus	23.10
Micropogonias undulatus	10.50	Micropogonias undulatus	3.57	Leiostomus xanthurus	9.00
Paralichthys dentatus	8.20	Loligo pealii	1.78	Pomatomus saltatrix	1.15
		Leiostomus xanthurus	1.68	Loligo pealii	1.13
February (n=8)		**(n=11)**		**(n=14)**	
Cynoscion regalis	58.44	Cynoscion regalis	41.25	Paralichthys dentatus	23.79
Pomatomus saltatrix	31.56	Stenotomus chrysops	20.80	Centropristis striata	21.92
Micropogonias undulatus	5.61	Centropristis striata	15.14	Cynoscion regalis	20.36
		Paralichthys dentatus	12.49	Micropogonias undulatus	11.53
		Loligo pealii	3.81	Cephalopoda	8.03

Table 4. (continued)

1982-1983		1983-1984		1984-1985	
Species	%TW	Species	%TW	Species	%TW
		Peprilus triacanthus	2.42	Leiostomus xanthurus	4.67
				Pomatomus saltatrix	3.06
				Peprilus triacanthus	2.59
March (n=6)		**(n=10)**		**(n=16)**	
Stenotomus chrysops	60.95	Cynoscion regalis	29.60	Cynoscion regalis	20.36
Paralichthys dentatus	18.49	Stenotomus chrysops	13.76	Paralichthys dentatus	19.58
Centropristis striata	9.36	Micropogonias undulatus	13.47	Stenotomus chrysops	16.85
Cephalopoda	6.16	Scomber scombrus	11.23	Centropristis striata	14.40
Cynoscion regalis	2.88	Paralichthys dentatus	7.21	Micropogonias undulatus	9.51
		Merluccius bilinearis	5.60	Pomatomus saltatrix	6.26
		Morone saxatilis	3.65	Leiostomus xanthurus	5.98
		Alosa pseudoharengus	2.65	Cephalopoda	3.10
		Loligo pealii	1.98		
		Alosa sapidissima	1.71		
		Peprilus triacanthus	1.54		
		Alosa aestivalis	1.50		
		Leiostomus xanthurus	1.25		
April (n=3)		**(n=6)**		**(n=8)**	
Stenotomus chrysops	54.56	Stenotomus chrysops	33.36	Pomatomus saltatrix	42.70
Pomatomus saltatrix	20.42	Paralichthys dentatus	32.32	Paralichthys dentatus	20.45
Centropristis striata	19.29	Centropristis striata	16.44	Cynoscion regalis	17.43
Cephlopoda	5.03	Loligo pealii	16.26	Centropristis striata	5.23
				Micropogonias undulatus	5.04
				Stenotomus chrysops	3.81
				Leiostomus xanthurus	1.68

Table 5. Overall species composition of 67 winter trawl fishery catches sampled November 1983-April 1984 by weight, including CPUE, percentage of total catch weight, cumulative percentage of catch weight (Cum. %), number of fish, percentage of total number of fish and the percentage of catches in which a species occurred (% Freq. occur).

Species	Weight (kg)			Number		% Freq.
	Mean	%	Cum. %	Mean	%	occur.
Paralichthys dentatus	4,606.8	42.98	42.98	9,146	25.31	85.1
Cynoscion regalis	2,477.9	23.12	66.10	10,632	29.42	77.6
Stenotomus chrysops	1,244.4	11.61	77.71	4,819	13.34	31.3
Micropogonias undulatus	609.8	5.70	83.40	5,256	14.54	40.3
Centropristis striata	467.6	4.37	87.75	1,592	4.41	62.7
Loligo pealii	331.8	3.10	90.85	-	-	49.3
Scomber scombrus	166.1	1.55	92.40	363	1.01	16.4
Leiostomus xanthurus	151.3	1.41	93.81	2,053	5.75	25.4
Pomatomus saltatrix	143.9	1.34	95.16	160	0.44	71.6
Peprilus triacanthus	101.4	0.95	96.10	985	2.73	74.6
Merluccius bilinearis	95.3	0.89	96.99	32	0.50	28.4
Lophius americanus	49.8	0.47	97.95	5	0.02	49.3
Morone saxatilis	53.5	0.50	97.50	7	0.02	6.0
Alosa pseudoharengus	38.9	0.36	98.32	181	0.50	3.0
Alosa sapidissima	25.3	0.24	98.56	59	0.16	10.4
Alosa aestivalis	22.0	0.21	98.76	208	0.58	6.0
Archosargus probatocephalus	16.2	0.15	98.91	-	-	14.9
Menticirrhus americanus	10.7	0.10	99.01	85	0.23	17.9
Acipenser oxyrhynchus	10.5	0.10	99.11	1	0.01	14.9
Urophycis chuss	9.8	0.09	99.20	17	0.05	14.9
Prionotus evolans	7.4	0.07	99.27	19	0.05	22.4
Cephalopoda	7.4	0.07	99.34	-	-	22.4
Paralichthys oblongus	6.2	0.06	99.40	12	0.03	11.9
Bairdiella chrysoura	5.9	0.06	99.45	77	0.21	9.0
Busycon spp.	5.0	0.05	99.50	-	-	6.0
Trichiurus lepturus	5.0	0.05	99.55	31	0.09	7.5
Prionotus carolinus	4.8	0.05	99.59	71	0.20	11.9
Menticirrhus spp.	4.8	0.04	99.64	17	0.01	11.9
Brevoortia tyrannus	4.4	0.04	99.68	40	0.11	14.9
Urophycis regia	4.3	0.04	99.72	30	0.08	25.4
Menticirrhus saxatilis	3.4	0.03	99.75	15	0.04	25.4
Conger oceanicus	3.3	0.03	99.78	4	0.01	10.4
Scomberomorus cavalla	3.3	0.03	99.81	1	0.01	3.0
Sphoeroides maculatus	2.8	0.03	99.83	2	0.01	13.4
Glyptocephalus cynoglossus	2.2	0.02	99.85	5	0.01	10.4
Cynoscion nebulosus	1.9	0.02	99.87	6	0.02	14.9
Urophycis floridana	1.7	0.02	99.89	6	0.02	3.0
Carcharhinus spp.	1.6	0.01	99.90	-	-	1.5
Orthopristis chrysoptera	1.3	0.01	99.91	11	0.03	7.5
Lopholatilus chamaeleonticeps	1.0	0.01	99.92	1	0.01	1.5
Scomberomorus maculatus	0.9	0.01	99.93	3	0.01	1.5
Urophycis spp.	0.8	0.01	99.95	2	0.01	4.5
Lagodon rhomboides	0.8	0.01	99.94	14	0.04	1.5
Rajiformes	0.6	0.01	99.95	-	-	1.5
Euthynnus alletteratus	0.6	0.01	99.96	1	0.01	4.5

Table 5. (continued).

Species	Weight (kg) Mean	%	Cum. %	Number Mean	%	% Freq. occur.
Pseudopleuronectes americanus	0.5	0.01	99.96	2	0.01	1.5
Squalus acanthias	0.5	0.01	99.97	7	0.02	7.5
Tautoga onitis	0.5	0.01	99.97	1	0.01	3.0
Pogonias cromis	0.4	0.01	99.98	-	-	3.0
Tautogolabrus adspersus	0.4	0.01	99.98	1	0.01	3.0
Caulolatilus microps	0.3	0.01	99.98	1	0.01	1.5
Peprilus alepidotus	0.3	0.01	99.98	12	0.03	4.5
Seriola dumerilli	0.3	0.01	99.99	-	-	4.5
Sciaenops ocellatus	0.2	0.01	99.99	1	0.01	14.9
Centropristis philadelphica	0.2	0.01	99.99	-	-	1.5
Anthias nicholsi	0.2	0.01	99.99	2	0.01	1.5
Pleuronectidae	0.1	0.01	99.99	-	-	1.5
Rachycentron canadum	0.1	0.01	100.00	1	0.01	1.5
Chaetodipterus faber	0.1	0.01	100.00	3	0.01	1.5
Larimus fasciatus	0.1	0.01	100.00	1	0.01	1.5
Mustelus canis	0.1	0.01	100.00	1	0.01	3.0
Neomerinthe hemingwayi	0.1	0.01	100.00	1	0.01	1.5
Trinectes maculatus	0.1	0.01	100.00	1	0.01	1.5
Anchoa hepsetus	0.1	0.01	100.00	2	0.01	4.5
Scyliorhinus retifer	0.1	0.01	100.00	1	0.01	1.5
Stenotomus caprinus	0.1	0.01	100.00	1	0.01	1.5
Synodus foetens	0.1	0.01	100.00	1	0.01	1.5
Morone americana	0.1	0.01	100.00	1	0.01	1.5
Balistes capriscus	0.1	0.01	100.00	1	0.01	1.5

Observed species

Scophthalmus aquosus	Prionotus scitulus
Ovalipes ocellatus	Squatina dumerili
Callinectes spp.	Gerreidae
Limulus polyphemus	Selene vomer
Penaeus duorarum	Urophycis tenuis
Raja eglanteria	Menippe mercenaria
Cancer irroratus	Callinectes similis
Callinectes sapidus	Libinia spp.
Dasyatis spp.	Calappa flammea
Raja garmani	Octopus spp.

Table 6. Overall species composition of 84 winter trawl fishery catches sampled September 1984 through April 1985 by weight, including CPUE, percentage of the total weight of the catch, cumulative percentage of catch weight (Cum. %), number of fish, percentage of total number of fish, and the percentage of catches in which a species occurred (% Freq occur.).

Species	Weight (kg)			Number		% Freq.
	Mean	%	Cum. %	Mean	%	occur.
Paralichthys dentatus	3,706.3	31.62	31.62	6,481	12.05	73.8
Micropogonias undulatus	2,350.1	20.05	51.66	19,106	34.89	51.2
Cynoscion regalis	2,322.0	19.81	71.49	11,497	21.00	91.7
Centropristis striata	802.1	6.84	78.31	2,497	4.56	29.8
Pomatomus saltatrix	727.1	6.20	84.51	429	0.78	83.3
Leiostomus xanthurus	629.4	5.40	89.88	8,948	16.35	47.6
Stenotomus chrysops	457.6	3.90	93.79	2,568	4.68	28.6
Loligo pealii	327.4	2.79	96.58	-	-	71.4
Peprilus triacanthus	127.3	1.09	97.67	1,495	2.73	64.3
Lophius americanus	60.5	0.52	98.19	49	0.05	35.7
Merluccius bilinearis	30.6	0.25	98.44	94	0.17	15.5
Bairdiella chrysoura	18.1	0.16	98.60	203	0.37	20.2
Lagodon rhomboides	16.1	0.14	98.73	458	0.84	10.7
Menticirrhus americanus	16.1	0.14	98.87	79	0.15	29.8
Larimus fasciatus	14.3	0.12	98.99	139	0.25	21.4
Urophycis regia	13.5	0.12	99.11	57	0.10	29.8
Carcharhinidae	12.7	0.11	99.22	-	-	7.1
Brevoortia tyrannus	11.7	0.10	99.32	155	0.28	14.3
Menticirrhus spp.	9.7	0.08	99.40	48	0.09	21.4
Acipenser oxyrhynchus	7.8	0.07	99.47	1	0.01	21.4
Orthopristis chrysoptera	6.9	0.06	99.52	130	0.24	10.7
Busycon spp.	5.8	0.05	99.57	-	-	13.1
Menticirrhus saxatilis	5.2	0.04	99.61	21	0.04	20.2
Paralichthys lethostigma	4.7	0.04	99.65	4	0.01	10.7
Mustelus canis	4.7	0.04	99.69	7	0.01	19.0
Urophycis spp.	4.4	0.04	99.73	-	-	4.8
Paralichthys spp.	3.5	0.03	99.76	4	0.01	1.2
Prionotus evolans	3.3	0.03	99.79	46	0.08	19.0
Pogonias cromis	3.0	0.03	99.82	1	0.01	3.6
Glyptocephalus cynoglossus	2.2	0.02	99.84	6	0.01	8.3
Synodus foetens	2.1	0.02	99.85	7	0.02	3.6
Conger oceanicus	2.1	0.02	99.87	2	0.01	8.3
Urophycis chuss	2.0	0.02	99.89	7	0.01	4.8
Scomberomorus cavalla	1.9	0.02	99.91	1	0.01	6.0
Sphoeroides maculatus	1.5	0.01	99.92	-	-	15.5
Stronglura marina	1.2	0.01	99.93	9	0.02	1.2
Scomber scombrus	1.1	0.01	99.94	4	0.01	9.5
Archosargus probatocephalus	0.8	0.01	99.94	1	0.01	6.0
Paralichthys oblongus	0.8	0.01	99.96	6	0.01	16.7
Prionotus scitulus	0.8	0.01	99.96	20	0.04	9.5
Cynoscion nebulosus	0.5	0.01	99.96	2	0.01	9.5
Citharichthys spp.	0.5	0.01	99.97	4	0.01	1.2
Centropristis philadelphica	0.5	0.01	99.98	7	0.01	4.8
Chaetodipterus faber	0.5	0.01	99.98	9	0.02	3.6
Tautoga onitis	0.5	0.01	99.98	1	0.01	1.2
Tautogolabrus adspersus	0.4	0.01	99.99	1	0.01	3.6

Table 6. (continued)

Species	Weight (kg) Mean	%	Cum. %	Number Mean	%	% Freq. occur.
Sciaenops ocellatus	0.3	0.01	99.99	1	0.01	7.1
Prionotus carolinus	0.3	0.01	99.99	13	0.02	22.6
Peprilus alepidotus	0.3	0.01	99.99	3	0.01	3.6
Euthynnus alletteratus	0.2	0.01	99.99	1	0.01	2.4
Seriola dumerili	0.2	0.01	99.99	1	0.01	2.4
Caulolatilus microps	0.2	0.01	99.99	1	0.01	1.2
Chilomycterus schoepfi	0.2	0.01	100.00	6	0.01	2.4
Alosa aestivalis	0.1	0.01	100.00	1	0.01	1.2
Anchoa hepsetus	0.1	0.01	100.00	5	0.01	1.2
Monacanthus hispidus	0.1	0.01	100.00	2	0.01	2.4
Raja eglanteria	0.1	0.01	100.00	1	0.01	20.2
Squalus acanthias	0.1	0.01	100.00	1	0.01	7.1
Scophthalmus aquosus	0.1	0.01	100.00	1	0.01	29.8
Pseudopleuronectes americanus	0.1	0.01	100.00	1	0.01	1.2
Anthias nicholsi	0.1	0.01	100.00	1	0.01	1.2

Observed species

Ovalipes ocellatus	Hepatus epheliticus	Citharichthys spilopterus
Cancer irroratus	Sicyonia brevirostris	Uraspis seconda
Dasyatis spp.	Penaeus duorarum	Prionotus tribulus
Callinectes sapidus	Rhinoptera bonasus	Macrorhamphosus scolopax
Dasyatis sabina	Calappa flammea	Ophidion marginatum
Libinia emarginata	Homarus americanus	Porichthys plectrodon
Trichiurus lepturus	Penaeus aztecus	Alosa pseudoharengus
Ovalipes spp.	Octopus	Squilla empusa
Limulus polyphemus	Raja garmani	Portunus spinimanus
Priacanthus arenatus	Squatina dumerili	Portunidae
Portunus gibbessi	Symphurus plagiusa	Ilex illecebrosus
Callinectes spp.	Ancylopsetta quadrocellata	Placopecten magellanicus

Table 7. Percent of the weight of the dominant species (or species groups) sampled in the winter trawl fishery 1982-1985 captured by the 3 major gear groupings (flynets; flounder = inshore flounder trawl fishery; deepwater = multigear offshore, generally 25 fathoms), including number of catches sampled (n).

	1982-83			1983-84			1984-85		
Species	Flynet	Flounder	Deep-water	Flynet	Flounder	Deep-water	Flynet	Flounder	Deep-water
	n=27	n=8	n=8	n=21	n=25	n=21	n=38	n=27	n=19
Cynoscion regalis	99.11	0.88	0.01	95.75	3.72	0.53	92.91	4.76	2.33
Micropogonias undulatus	99.98	0.02	-	99.79	0.21	-	99.90	0.10	-
Leiostomus xanthurus	100.00	-	-	100.00	-	-	100.0	-	-
Pomatomus saltatrix	97.65	0.33	2.02	42.41	32.34	25.24	85.07	8.93	6.00
Menticirrhus sp.	78.69	21.31	-	90.99	9.01	-	90.43	9.57	-
Peprilus triacanthus	96.38	0.55	3.07	11.73	10.79	77.47	88.11	2.10	9.79
Paralichthys dentatus	13.58	69.35	17.07	2.18	78.68	19.14	0.59	72.34	27.06
Stenotomus chrysops	0.01	-	99.99	0.01	0.01	99.99	0.98	0.01	99.01
Centropristis striata	0.08	0.06	99.86	0.06	0.27	99.67	0.50	2.23	97.27
Lophius americanus	8.97	2.47	88.56	10.38	74.18	15.44	2.37	48.20	49.43
Cephalopods	5.78	10.59	83.63	4.62	14.20	81.18	6.49	20.69	72.83

of the weakfish, Atlantic croaker, and spot, and >85% of the catches of bluefish and kingfishes (Menticirrhus spp.) during at least two of the fishing seasons. Deepwater trawling produced >97% of the scup and black sea bass and 72.8-83.6% of the squid. Summer flounder were landed by the inshore directed flounder fishery (69.4-78.7%) and also captured in the deepwater segment (17.1-27.1%), together accounting for 86.5-99.4% of the summer flounder sampled. The high percentage of summer flounder in 1982-83 flynet catches is likely due to catches in which two gears were used, but only one was reported. Butterfish were captured primarily in flynets in 1982-83 (96.4%) and 1984-85 (88.1%) and in deepwater trawls in 1983-84 (78.7%). Bluefish were generally captured in flynets (97.7% in 1982-83 and 85.1% in 1984-85), but were more evenly distributed between the gears in 1983-84, the year overall bluefish catches were smallest.

Trawler catches also showed differences by area fished (Figure 2), although gear type more clearly defined these differences. West of Cape Lookout, the 14 catches sampled were all flynet catches dominated by croaker, spot, and weakfish each year. Between Cape Hatteras and Cape Lookout, both nearshore flounder and flynet trawling occurred (Table 2). Croaker, weakfish, spot, and bluefish dominated, since flynets accounted for 77.2%, 46.2%, and 100.0% of the catches sampled during the three fishing seasons. Flounder trawl catches from Cape Hatteras to Cape Lookout were sampled only in 1982-84 and thus, summer flounder were important only during these two fishing seasons. North of Cape Hatteras, all three gears were regularly used (Table 2), and thus, more species dominated the catches, including weakfish, bluefish, summer flounder, croaker, black sea bass, scup, and squid.

Nearshore Summer Flounder Fishery

The nearshore summer flounder fishery occurred primarily from November through January, although catches were sampled through April in 1985. In 1982-83, 19% of the catches sampled were nearshore flounder catches, while these accounted for 37% and 32% the next two seasons (Table 2). Boats landing fish in North Carolina fished from Chincoteague, Virginia to Ocracoke, and generally inshore of the 10 fathom curve (Figure 1), although most catches sampled were made from Corolla to Wimble Shoals.

Nearshore flounder fishing occurred south of Cape Hatteras to off Ocracoke during the 1982-83 and 1983-84 seasons, but no flounder catches from that area were sampled in 1984-85. The seasonal percentage of summer flounder, in terms of weight, caught nearshore north of Cape Hatteras, based on our samples was 54.2%, 50.5%, 100.0% during the respective fishing seasons. The average catch of flounder was 9,023 and 13,335 kg north and 4,159 and 8,910 kg south of Cape Hatteras during the 1982-83 and 1983-84 seasons.

Summer flounder dominated these catches, accounting for 88.6-93.7% of the total weight of the catches sampled each fishing season (Table 8). Weakfish, squid, and bluefish were the next three most important species landed, although together they accounted for only 5.3%, 4.9%, and 8.1% of the catches during the respective fishing seasons. Weakfish were more important in the catches during November and December, while goosefish (Lophius americanus) and squids (primarily Loligo sp.) were important from January through April (Table 9).

The overall CPUE of summer flounder was greatest in 1983-84 (9,689 kg), intermediate in 1984-85

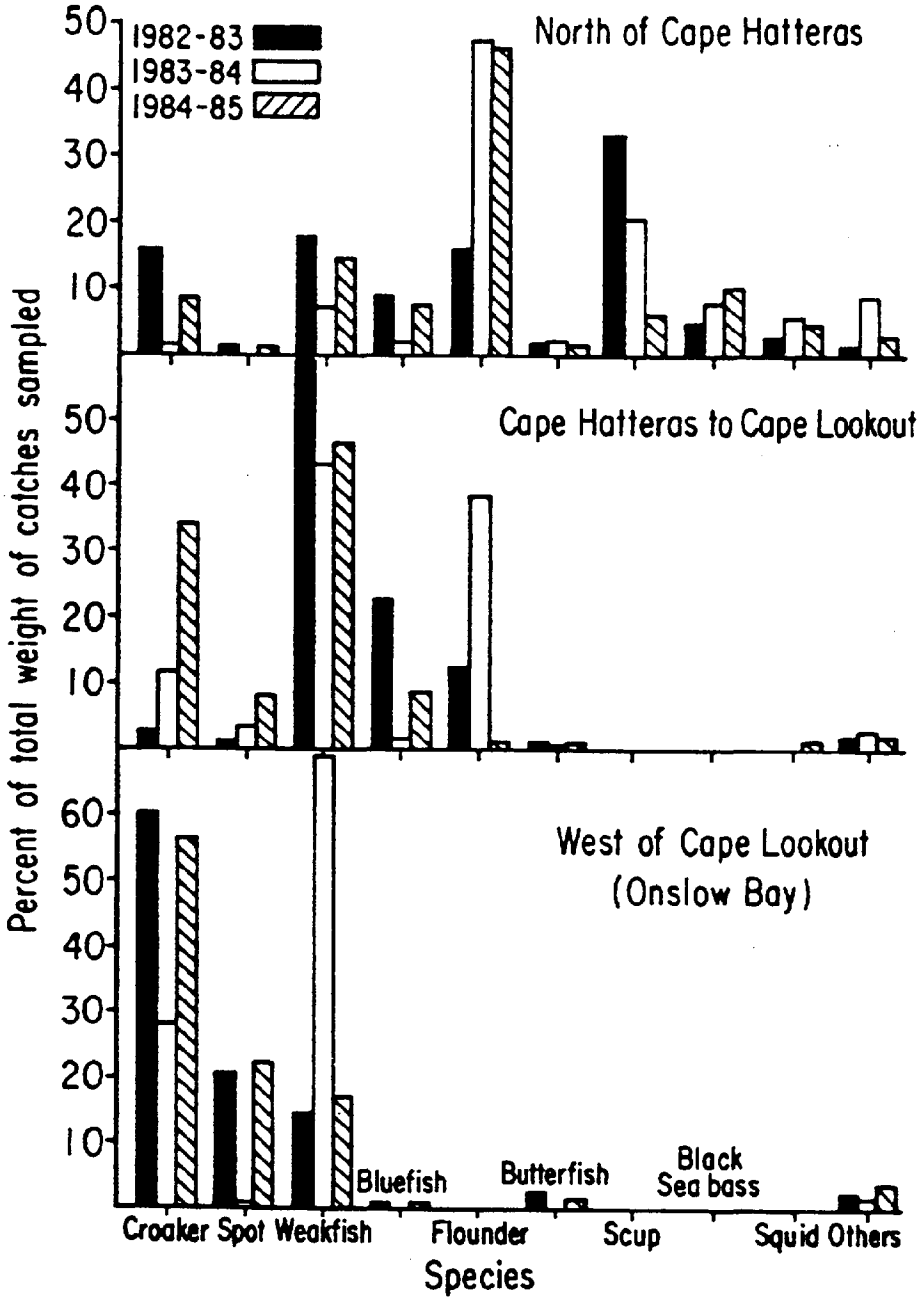

Figure 2. Dominant species composition of trawler catches sampled during 1982-1985 fishing seasons by geographical areas fished.

Table 8. Mean weight and number of fish per trip for the top 99.9% (by weight) of the nearshore flounder catches by season for October 1982 through April 1985, including number of catches sampled (n) and species percent of the total weight of the catches sampled (%TW).

Species	Mean weight (kg)	%TW	Mean number of fish
1982-83 (n=8)			
Paralichthys dentatus	5,584.0	93.7	10,154
Cynoscion regalis	202.7	3.4	301
Cephalopods	84.8	1.4	-
Pomatomus saltatrix	30.1	0.5	23
Menticirrhus saxatilis	17.2	0.3	11
Paralichthys lethostigma	11.9	0.2	9
Menticirrhus spp.	11.9	0.2	-
Acipenser oxyrhynchus	6.7	0.1	1
Peprilus triacanthus	3.9	0.1	20
1983-84 (n=25)			
Paralichthys dentatus	9,686.8	93.3	18,229
Cynoscion regalis	248.1	2.4	212
Loligo pealii	130.6	1.3	-
Pomatomus saltatrix	124.7	1.2	19
Lophius americanus	99.6	1.0	-
Peprilus triacanthus	29.8	0.3	-
Busycon spp.	13.3	0.1	-
Menticirrhus spp.	10.2	0.1	-
Sphoeroides maculatus	7.0	0.1	-
Acipenser oxyrhynchus	7.0	0.1	1
Scomberomorus cavalla	5.2	0.1	1
1984-85 (n=27)			
Paralichthys dentatus	8,341.8	88.6	13,983
Cynoscion regalis	344.9	3.7	442
Loligo pealii	208.5	2.3	-
Pomatomus saltatrix	202.1	2.1	75
Lophius americanus	90.7	1.0	82
Centropristis striata	55.7	0.6	118
Carcharhinidae	36.5	0.4	-
Urophycis regia	33.4	0.4	110
Busycon spp.	18.0	0.2	-
Acipenser oxyrhynchus	17.4	0.2	1
Urophycis spp.	12.6	0.1	-
Paralichthys lethostigma	12.3	0.1	10
Peprilus triacanthus	8.3	0.1	75
Menticirrhus spp.	7.7	0.1	22
Micropogonias undulatus	7.6	0.1	-
Urophycis chuss	4.8	0.1	11

Table 9. Monthly mean weight per trip ($\bar{x}$ TW) of the top 99.0% of the species in the nearshore flounder trawl catches sampled during 1982-85, including (kg) percent contribution to the total weight (% TW) and number of catches sampled (n).

1982-83			1983-84			1984-85		
Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW
November (n=1)			**(n=2)**			**n=6**		
Paralichthys dentatus	9,028.0	98.5	Paralichthys dentatus	10,018.0	97.2	Paralichthys dentatus	8,237.5	94.4
Menticirrhus spp.	95.0	1.0	Busycon spp.	167.2	1.6	Cynoscion regalis	198.5	2.3
Paralichthys lethostigma	44.0	0.5	Cynoscion regalis	43.1	0.4	Pomatomus saltatrix	68.5	0.8
						Loligo pealii	100.7	1.2
						Busycon spp.	58.2	0.7
December (n=6)			**(n=12)**			**(n=11)**		
Paralichthys dentatus	5,367.8	91.8	Paralichthys dentatus	9,855.4	91.4	Paralichthys dentatus	11,689.2	89.2
Cynoscion regalis	270.3	4.6	Cynoscion regalis	377.4	3.5	Cynoscion regalis	658.9	5.0
Cephalopoda	113.1	1.9	Pomatomus saltatrix	238.6	2.0	Pomatomus saltatrix	374.9	2.9
Pomatomus saltatrix	40.1	0.7	Loligo pealii	222.6	2.2	Loligo pealii	166.8	1.3
			Peprilus triacanthus	44.7	0.4	Carcharhinidae	68.4	0.5
January (n=1)			**(n=11)**			**(n=7)**		
Paralichthys dentatus	3,527.8	100.0	Paralichthys dentatus	9,422.5	94.8	Paralichthys dentatus	5,669.4	85.8
			Lophius americanus	223.3	2.2	Loligo pealii	383.7	5.8
			Cynoscion regalis	144.3	1.4	Pomatomus saltatrix	130.7	2.0
			Loligo pealii	54.2	0.5	Urophycis regia	128.8	1.9
						Cynoscion regalis	113.1	1.7
						Centropristis striata	105.8	1.6
						Acipenser oxyrhynchus	29.2	0.4
February (n=0)			**(n=0)**			**(n=1)**		
						Paralichthys dentatus	2,478.4	69.5
						Cephalopods	408.6	11.5
						Centropristis striata	378.2	10.6
						Urophycis chuss	130.8	3.7
						Cynoscion regalis	82.6	2.3
						Lophius americanus	70.4	2.0
March (n=0)			**(n=0)**			**(n=1)**		
						Paralichthys dentatus	2,063.5	50.9
						Lophius americanus	1,810.3	44.6
						Cephalopods	88.4	2.2
						Busycon spp.	70.3	1.7
April (n=0)			**(n=0)**			**(n=1)**		
						Paralichthys dentatus	2,995.1	80.4
						Lophius americanus	503.5	13.5
						Carcharhinidae	204.1	5.5

(8,342 kg) and smallest in 1982-83 (5,584 kg) (Table 8). This was, in part, reflected in the landings data. Lowest landings were recorded in 1982-83 (6.4 million lb), although 1984-85 (11.4 million lb) exceeded 1983-84 (10.5 million lb).

Catches of summer flounder in the nearshore fishery were largest in November of 1982 (only one catch sampled) and 1983, then decreased through January, at which point the fishery ceased both seasons (Table 9, Figure 3). Commercial landings for those seasons corresponded, increasing from November, a period of initial but limited effort, to a peak in December in 1982 and January in 1984, then falling off through April; the February-April landings were primarily from the deepwater fishery (discussed in the next section). In 1984-85, CPUE was greatest in December, with some fishing continuing through April, primarily around the Cigar off Virginia and Wimble Shoals. Commercial landings correspondingly increased in November, were highest in December and January, and declined through April.

Scrap landings in the nearshore flounder fishery, generally <100 kg/trip, were consistently the lowest of the three component fisheries (Table 10). Most boats sampled reported using 4-1/2" stretched mesh tail bags which eliminated most undersized flounder (Gillikin, et al. 1981) and reduced the bycatch.

Size frequencies of summer flounder in the nearshore flounder fishery changed little during this study (Table 11a, Figures 4 and 5). Catches were dominated by fish 301-400 mm TL (62.5-66.7% seasonally) with fish >400 mm TL accounting for 20.4-26.0% seasonally. Fish less than the legal size of 11 in (280 mm) constituted 3.1, 2.4 and 2.5% of those sampled during the respective seasons, while fish <300 mm (∿12") comprised 9.8-14.6% of the catches.

Summer flounder caught north of Cape Hatteras were larger than those south of the Cape (Table 11d). North of Cape Hatteras, 20.9-24.3% of the summer flounder were >400 mm TL, and 49.0-53.4% were <350 mm TL; South of Cape Hatteras, only 12.7-14.7% were >400 mm TL, and 59.6-65.3% were <350 mm TL. This difference may reflect the use of smaller mesh tailbags (2 in -vs- 4-1/2 in stretched mesh) south of Cape Hatteras.

Deepwater Fishery

The deepwater component of the North Carolina winter trawl fishery follows nearshore flounder fishing and occurs with the latter part of the flynet season. The target species, black sea bass, scup, and summer flounder, maintain stable and higher prices than weakfish and bluefish. Since greater travelling time is required to capture these species, this fishery became more active when flynet fishing was not productive or market prices for sciaenids and bluefish were low.

Deepwater catches accounted for 19% (n=8) of the winter trawl catches sampled in 1982-83, 31% (n=21) in 1983-84, and 23% (n=19) in 1984-85 (Table 2). Fishing occurred primarily from January through April.

Deepwater trawling accounted for 27, 44, and 35% of the catches sampled during January through April, and 35, 63, and 50% of the catches sampled from February through April during 1983-85.

Fish landed in North Carolina by this fishery were caught in 20-50+ fathoms, as far north as Wilmington and Washington canyons and south to the edge of the shelf off Oregon Inlet (Figure 1). Fishing occurred inshore

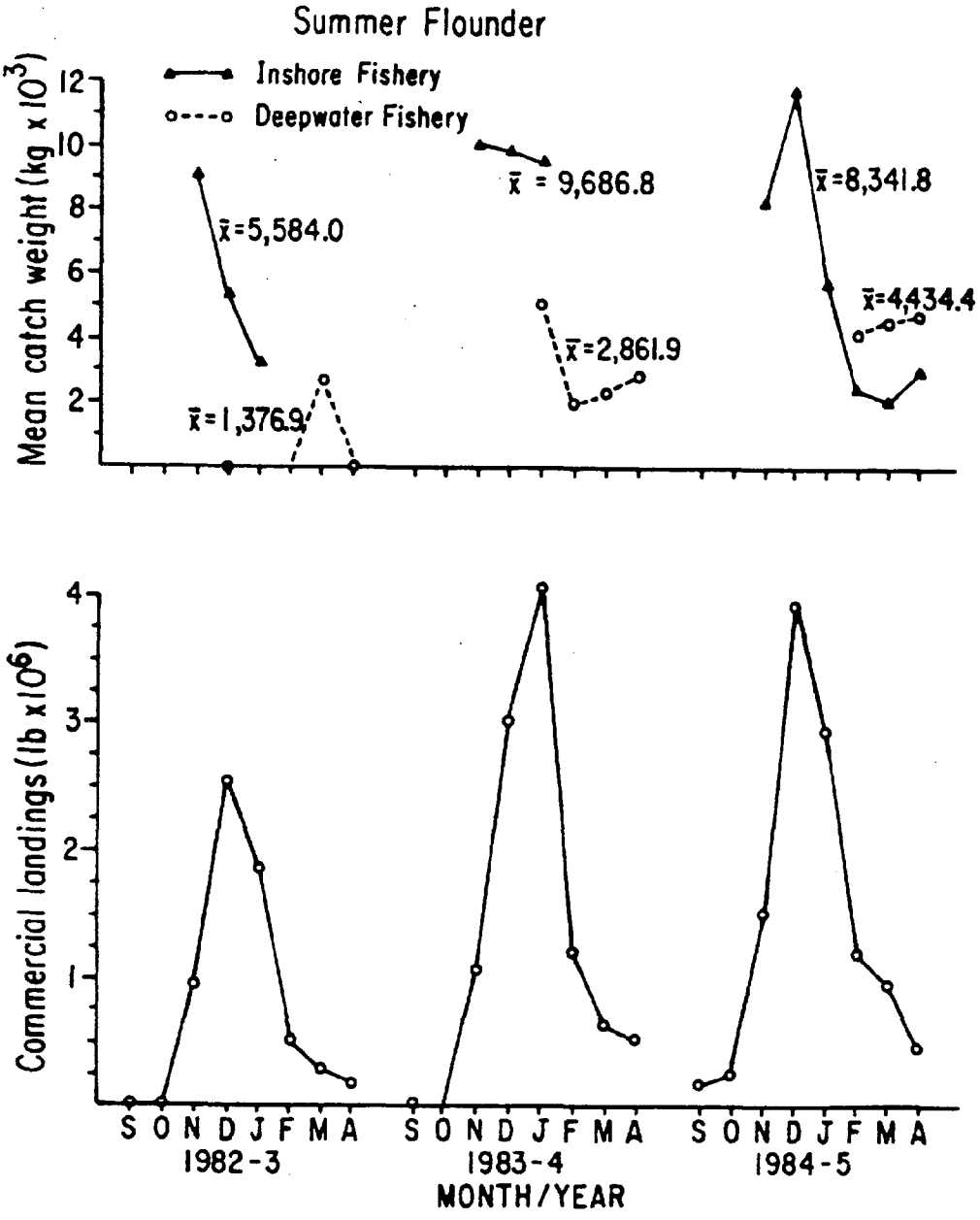

Figure 3. Monthly mean total weight/trip sampled of summer flounder, Paralichthys dentatus, for inshore flounder and deepwater trawl fisheries and commercial landings data for winter trawl fishery, September 1982-April 1985.

Table 10. Scrap component of winter trawl catches from October 1982 through April 1985 by gear and area fished (North = north of Cape Hatteras; Central = Cape Hatteras to Cape Lookout; South = west of Cape Lookout), including: number of catches in which scrap weight was obtained (N), mean total weight ($\bar{x}$ TW), mean weight of marketed fish ($\bar{x}$ market), mean total weight of scrap ($\bar{x}$ scrap) and percent of scrap (% scrap) in these catches. All weights are in kg.

Year	Area	N	$\bar{x}$ TW	$\bar{x}$ market	$\bar{x}$ scrap	% scrap
FLYNETS						
1982-3	North	4	17,029	16,689	340	2.0
	Central	17	12,761	11,505	1,255	9.8
	South	3	13,804	6,697	7,107	51.5
1983-4	North	4	9,542	8,008	1,534	16.1
	Central	12	15,566	12,864	2,702	17.4
	South	1		6,555		
1984-5	North	16	14,094	10,962	3,132	22.2
	Central	11	11,126	7,927	3,199	28.8
	South	9	15,603	7,290	8,312	53.3
FLOUNDER TRAWLS						
1982-3	North	3	9,023	8,986	37	0.4
	Central	5	4,159	4,159	0	0.0
1983-4	North	11	13,335	13,335	0	0.0
	Central	14	8,910	8,910	0	0.0
1984-5	North	27	9,165	9,158	7	0.1
DEEPWATER TRAWLS						
1982-3	North	8	13,248	13,184	64	0.48
1983-4	North	20	9,585	9,405	180	1.88
1984-5	North	19	12,050	11,275	775	6.43

Table 11. Size composition of summer flounder, Paralichthys dentatus captured by North Carolina winter trawlers, 1982-1985.

a. Nearshore only

	Percent frequency/size class							
TL (mm)	<300	301-350	351-400	401-450	451-500	501-600	601-700	>700
1982-83	14.6	38.6	23.9	15.4	4.9	2.3	0.3	
1983-84	12.9	39.8	26.9	13.4	5.2	2.7	0.1	<0.1
1984-85	9.8	39.2	25.0	15.7	7.3	2.8	0.2	<0.1

b. Deepwater only

1982-83	8.9	50.1	28.0	9.1	2.2	1.5	0.2	<0.1
1983-84	26.5	37.3	12.9	9.4	2.2	1.5	0.2	<0.1
1984-85	9.8	52.0	23.0	10.4	2.8	1.5	0.5	<0.1

c. All catches combined

1982-83	16.7	40.3	24.4	12.7	3.8	1.9	0.1	<0.1
1983-84	16.7	39.1	25.7	12.3	4.4	1.7	0.1	<0.1
1984-85	9.9	43.3	24.3	13.9	4.9	2.4	0.3	<0.1

d. North vs south of Cape Hatteras - All gears

		Percent frequency/size class							
TL (mm)		<300	301 350	351-400	401-450	451-500	501-600	601-700	>700
1982-83	North	8.7	40.3	26.7	16.1	4.9	2.9	0.4	<0.1
	South	33.8	31.5	22.0	9.3	2.6	0.8	<0.1	
1983-84	North	18.5	34.9	25.7	13.5	5.3	1.9	0.2	<0.1
	South	13.8	45.8	25.7	10.2	3.0	1.4	0.1	<0.1

e. All gears combined by month

	Nov	Dec	Jan	Feb	Mar	Apr
1982-83						
<300 mm	18.5	14.9	26.6		8.9	
301-400 mm	62.8	60.1	63.4		78.2	
>400 mm	18.7	25.0	10.0		12.9	
1983-84						
<300 mm	18.0	11.5	14.3	22.2	23.9	42.4
301-400 mm	57.8	63.1	70.0	65.7	59.4	53.7
>400 mm	24.2	25.4	15.7	12.1	16.7	3.9
1984-85						
<300 mm	10.1	8.8	8.7	8.4	10.3	19.6
301-400	59.3	64.6	69.8	77.0	72.8	68.7
>400 mm	30.6	26.6	21.5	14.6	16.9	11.7

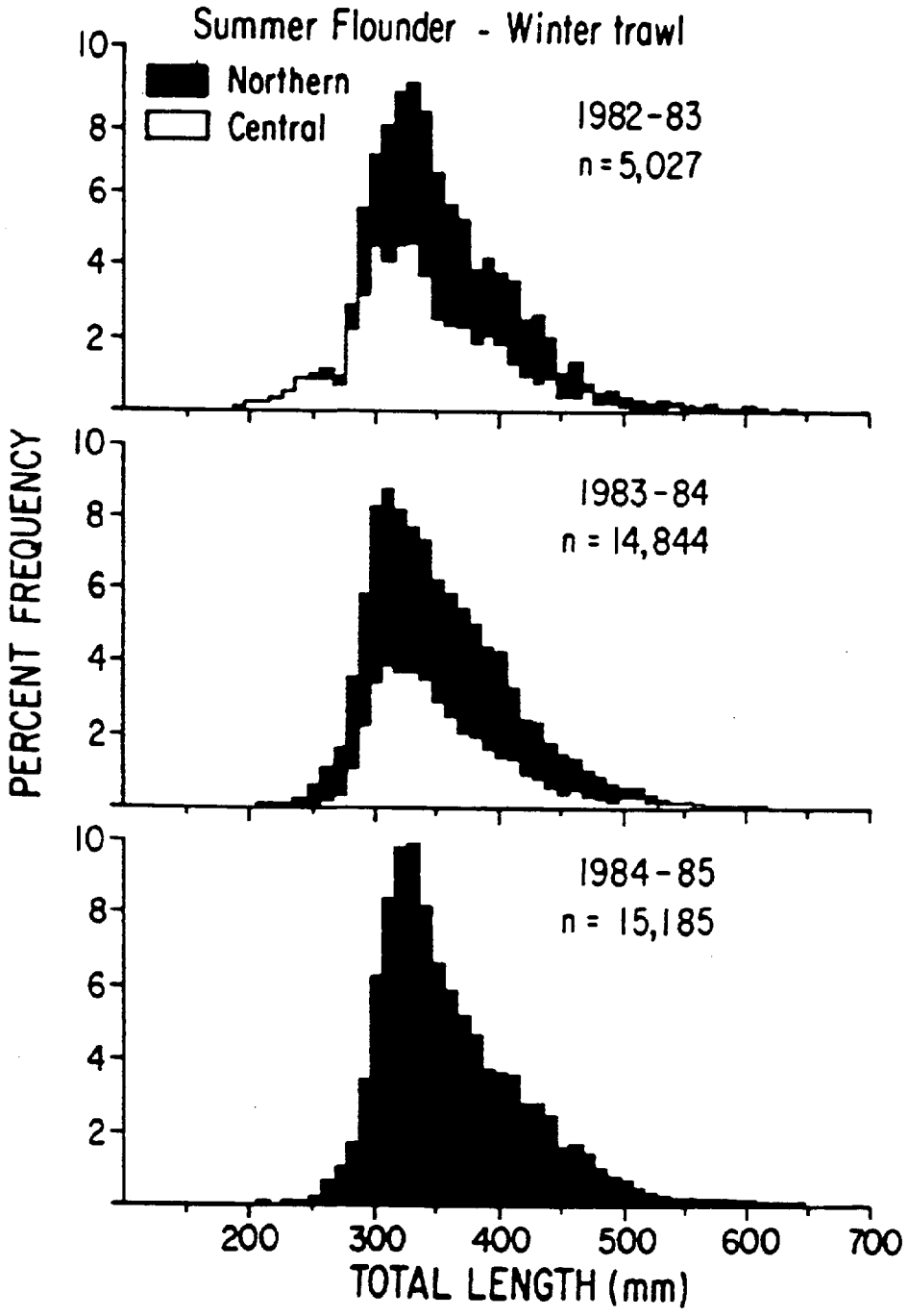

Figure 4. Expanded length-frequencies for summer flounder, Paralichthys dentatus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout); n = number of fish measured.

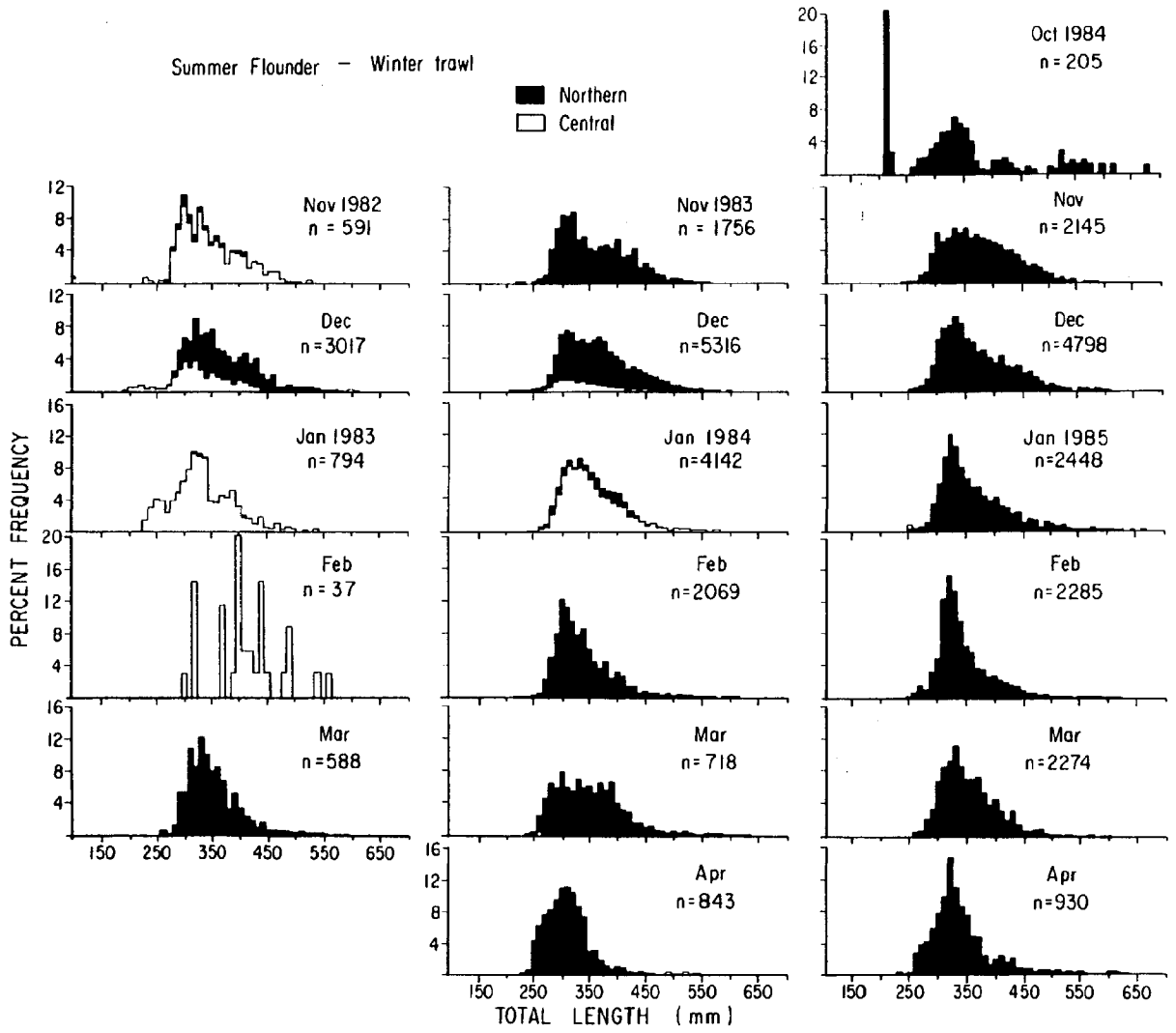

Figure 5. Monthly expanded length-frequencies for summer flounder, Paralichthys dentatus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout); n = number of fish measured.

to areas like the Cigar off Virginia, where the bottom type is favorable. Based on interviews, Norfolk Canyon was the most frequently fished area.

Scup, summer flounder and black sea bass accounted for 85-93% of the deepwater catches sampled, and with squid (approximately 9.0% each year) totaled 94-98% (Table 12). Species that accounted for >1.0% of the catches in at least one season included bluefish, butterfish, weakfish and goosefish. Scup dominated deepwater catches during the 1982-83 and 1983-84 fishing seasons, while summer flounder dominated each month of the 1984-85 season (Table 13).

Generally, this fishery landed small amounts of scrap fish; only 0.48 to 6.43% of the catches sampled were unmarketable (Table 10). However, several large catches of small scup, with 1/3-1/2 of the catch unmarketable even as "pin porgies," were observed but not sampled.

Scup

Scup was the dominant species captured in deepwater the first two seasons but ranked behind flounder and black sea bass in weight/trip in 1984-85 (Table 12). The CPUE of scup declined from 9,709 kg/trip in 1982-83 to 2,003 kg/trip in 1984-85. Commercial landings, however, were highest in 1983-84 (>1.0 million lb) and lowest in 1984-85 (0.6 million lb) (Table 1). No specific monthly pattern in CPUE can be discerned from our samples, except that scup were caught during January-April (Table 12). Commercial landings peaked each year in March and were substantial January through April (Figure 6).

Coincident with the declining catch rates was an increase in the proportion of small scup in 1984-85 (See Table below and Figure 7).

In 1982-83, scup ranged from 144 to 405 mm FL, and 82.4% were <250 mm. In 1983-84, they ranged from 86 to 407 mm FL, and 84.2% were <250 mm. This situation changed in 1984-85 when fish ranged from 109 to 421 mm FL, but 97.1% were <250 mm.

Summer Flounder

Summer flounder were the second most important species in these samples during 1982-84 and dominated in 1984-85. The CPUE was lowest in 1982-83 (1,377 kg/trip) and highest in 1984-85 (4,434 kg/trip) (Table 12). Landings of flounder for the entire winter trawl fishery were lowest in 1982-83 and highest in 1984-85 (Table 1).

	Percent frequency/fork length class (mm)					
Season	<150	151-200	201-250	251-300	301-350	>350
1982-83	0.2	41.3	40.9	13.2	3.8	0.6
1983-84	0.7	42.4	41.1	11.9	3.2	0.7
1984-85	4.6	76.6	15.9	2.6	0.2	0.1

Table 12. Mean weight and number of fish ($\bar{x}$ no. fish) per trip for the top 99.9% (by weight) of the deepwater catches by season for October 1982 through April 1985, including number of catches sampled (n) and species percent of the total weight of the catches sampled (%TW).

Species	Mean weight (kg)	%TW	$\bar{x}$ no. fish
1982-83 (n=8)			
Stenotomus chrysops	9,708.8	72.8	35,069
Paralichthys dentatus	1,376.9	10.3	3,099
Centropristis striata	1,314.0	9.9	4,780
Cephalopods	669.0	5.0	-
Pomatomus saltatrix	184.2	1.4	200
Lophius americanus	31.4	0.2	-
Peprilus triacanthus	20.7	0.2	202
Merluccius bilinearis	16.7	0.1	-
1983-84 (n=21)			
Stenotomus chrysops	3,970.3	40.5	15,374
Paralichthys dentatus	2,861.9	29.2	6,924
Centropristis striata	1,487.2	15.2	5,070
Loligo pealii	889.2	9.1	-
Peprilus triacanthus	254.6	2.6	2,483
Pomatomus saltatrix	115.8	1.2	61
Merluccius bilinearis	62.3	0.6	265
Cynoscion regalis	42.3	0.4	24
Lophius americanus	24.5	0.3	-
Prionotus evolans	22.8	0.2	50
Paralichthys oblongus	19.5	0.2	38
Conger oceanicus	10.5	0.1	12
Urophycis regia	9.3	0.1	34
Prionotus carolinus	7.2	0.1	117
Glyptocephalus cynoglossus	7.1	0.1	17
Scomber scombrus	4.9	0.1	-
1984-85 (n=19)			
Paralichthys dentatus	4,434.4	38.2	9,116
Centropristis striata	3,449.3	29.7	10,807
Stenotomus chrysops	2,003.3	17.3	11,857
Cephalopods	1,043.2	9.0	-
Cynoscion regalis	239.6	2.1	442
Pomatomus saltatrix	192.7	1.7	84
Lophius americanus	132.2	1.1	97
Peprilus triacanthus	55.1	0.5	443
Merluccius bilinearis	23.0	0.2	82
Glyptocephalus cynoglossus	9.5	0.1	26
Conger oceanicus	9.3	0.1	8

Table 13. Monthly mean weight per trip ($\bar{x}$ TW) of the top 99.0% (by weight) of the species in the deepwater trawl catches sampled during 1982-1985, including percent contribution to the total weight (% TW) and number of catches sampled (n). All weights are in kg.

1982-83			1983-84			1984-85		
Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW
December (n=1)						**(n=0)**		
Stenotomus chrysops	2,558.7	75.7						
Cephalopods	317.5	9.4						
Pomatomus saltatrix	260.3	7.7						
Centropristis striata	142.0	4.2						
Paralichthys dentatus	60.3	1.8						
Tautoga onitis	29.0	0.3						
January (n=1)			**(n=4)**			**(n=0)**		
Stenotomus chrysops	25,377.6	97.2	Stenotomus chrysops	6,448.1	48.1			
Pomatomus saltatrix	592.8	2.3	Paralichthys dentatus	5,063.5	37.8			
			Loligo pealii	847.9	6.3			
			Centropristis striata	590.6	4.4			
			Merluccius bilinearis	149.4	1.1			
			Peprilus triacanthus	108.9	0.8			
			Paralichthys oblongus	90.3	0.7			
February (n=0)			**(n=8)**			**(n=8)**		
			Stenotomus chrysops	3,339.5	36.6	Paralichthys dentatus	4,197.9	39.5
			Centropristis striata	2,432.1	26.6	Centropristis striata	4,111.1	38.7
			Paralichthys dentatus	2,003.2	21.9	Cephalopods	1,435.9	13.5
			Loligo pealii	612.2	6.7	Pomatomus saltatrix	351.3	3.3
			Peprilus triacanthus	387.2	4.2	Stenotomus chrysops	220.6	2.1
			Pomatomus saltatrix	198.7	2.2	Lophius americanus	178.3	1.7
			Lophius americanus	48.4	0.5	Cynoscion regalis	73.0	0.7
			Cynoscion regalis	28.1	0.3			
March (n=4)			**(n=3)**			**(n=8)**		
Stenotomus chrysops	9,016.5	63.1	Stenotomus chrysops	4,502.7	49.6	Paralichthys dentatus	4,545.1	32.8
Paralichthys dentatus	2,735.3	19.1	Paralichthys dentatus	2,334.6	25.7	Stenotomus chrysops	4,133.8	29.8
Centropristis striata	1,383.9	9.7	Loligo pealii	641.8	7.1	Centropristis striata	3,528.9	25.5
Cephalopods	911.1	6.4	Peprilus triacanthus	493.6	5.4	Loligo pealii	885.7	5.4
Pomatomus saltatrix	138.7	1.0	Centropristis striata	286.2	3.2	Cynoscion regalis	475.4	3.4
			Pomatomus saltatrix	271.1	3.0	Lophius americanus	102.2	1.0
			Cynoscion regalis	166.6	1.8	Peprilus triacanthus	74.5	0.7
			Prionotus evolans	159.6	1.8			
			Merluccius bilinearis	141.6	1.6			
April (n=2)			**(n=6)**			**(n=3)**		
Stenotomus chrysops	6,834.5	68.4	Stenotomus chrysops	2,893.0	33.4	Paralichthys dentatus	4,769.9	58.5
Centropristis striata	2,416.7	24.2	Paralichthys dentatus	2,802.8	32.3	Centropristis striata	1,472.5	18.1
Cephalopods	629.3	6.3	Centropristis striata	1,425.5	16.4	Stenotomus chrysops	1,075.6	13.2
			Loligo pealii	1,409.9	16.3	Loligo pealii	276.0	3.4
			Peprilus triacanthus	55.6	0.6	Merluccius bilinearis	139.9	1.7
						Pomatomus saltatrix	109.6	1.3
						Lophius americanus	91.3	1.1
						Cynoscion regalis	89.2	1.1

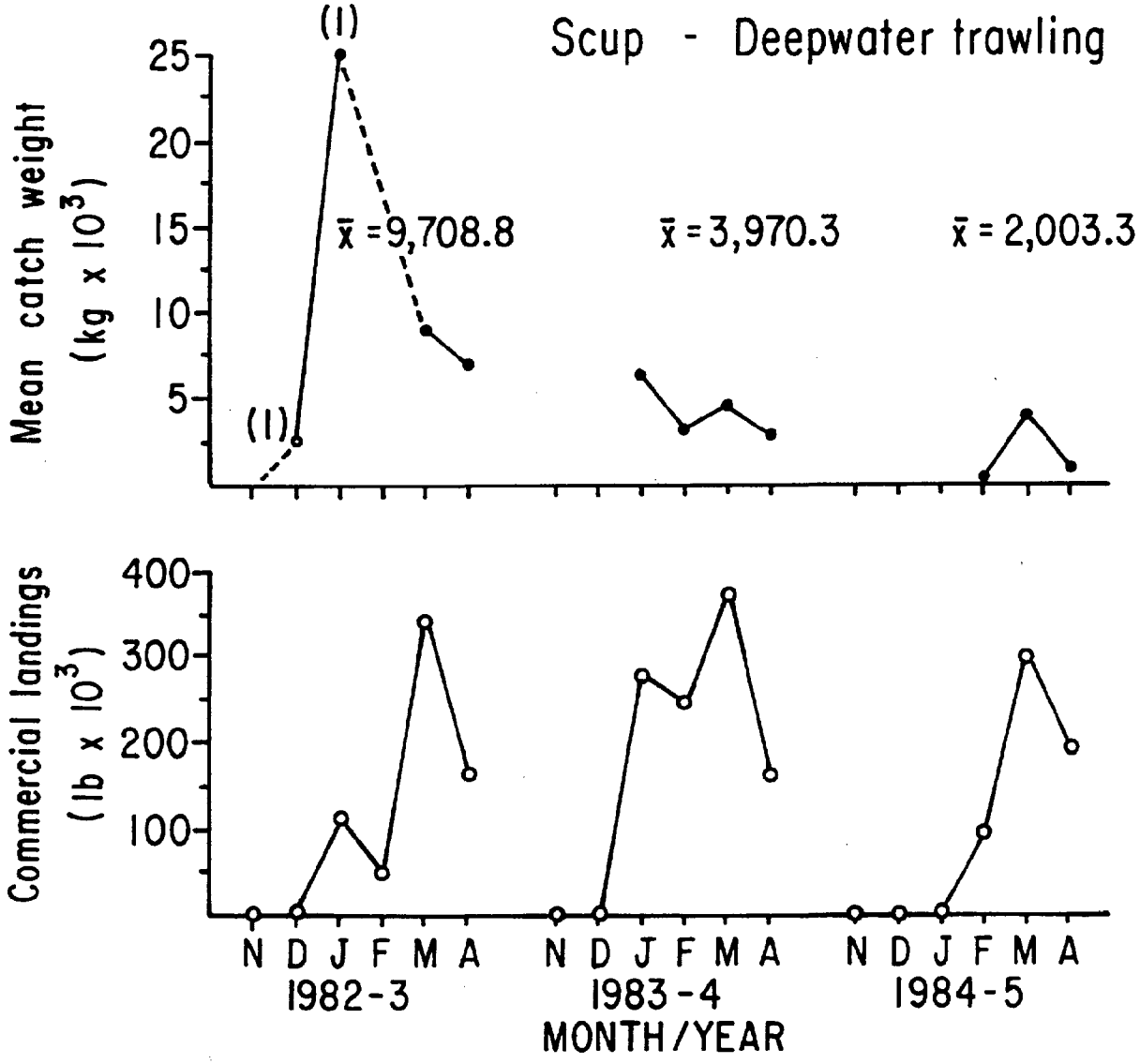

Figure 6. Monthly mean total weight/trip sampled of scup, Stenotomus chrysops, by deepwater trawling and commercial landings data for North Carolina winter trawl fishery September 1982-April 1985.

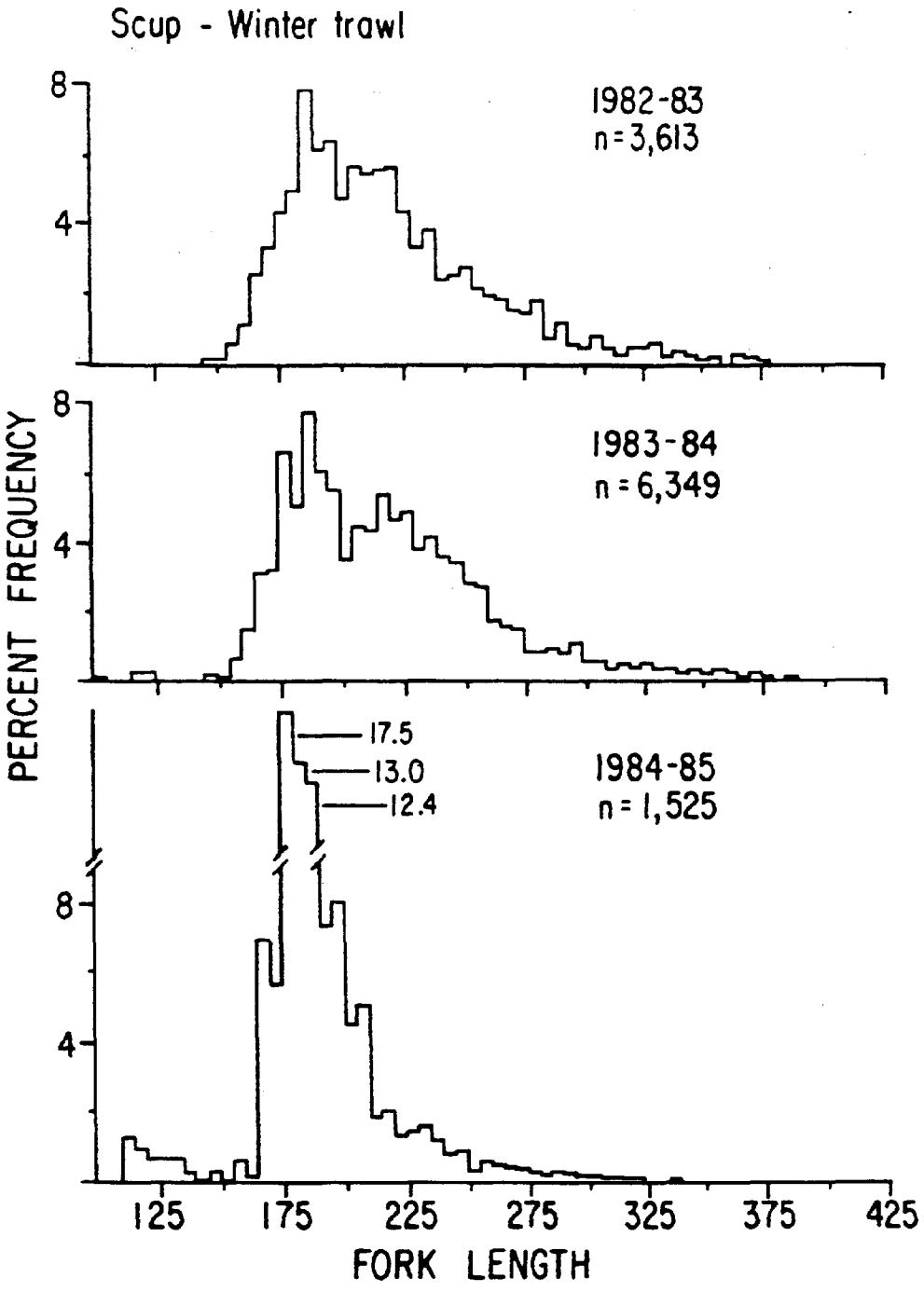

Figure 7. Expanded length-frequencies for scup, Stenotomus chrysops, from samples of September 1981-April 1985 winter trawl fishery; n = number of fish measured.

The CPUE of summer flounder increased offshore as the nearshore fishing declined. Catches increased slightly from February to April in 1984 and 1985 (Figure 3, Table 13). Landings do not reflect this increase as they are low and fall off from February through April; effort is less in this fishery than the nearshore flounder fishery.

Size frequencies of summer flounder caught offshore were similar all three fishing seasons (Table 11). Although more small fish (<300 mm TL) were caught in 1983-84 (26.5%), the percent of fish <350 mm TL was consistent, ranging from 59.0 to 63.8% during the three seasons. Fish exceeding 400 mm comprised 13.0-15.2% of the catches. No severe decline in large fish or increased relative abundance of small fish was observed.

Summer flounder captured in deepwater were generally smaller than those captured in the nearshore fishery. Seasonally, summer flounder >400 mm accounted for 13.0-15.2% of the deepwater catches and 21.4-26.0% of the nearshore catches (Table 11a, b). This is, at least in part, attributable to smaller mesh used in the tailbags in deepwater to retain small scup, black sea bass, and squid.

Combining all gears and areas, the size composition of summer flounder in the winter trawl fishery remained very consistent during this study, with the possible exception of a slight increase in proportions of larger fish in 1984-85 (Table 11c). In 1982-84, fish <300 mm comprised 16.7% of the catches, and in 1984-85 only 9.9%, while fish >400 mm accounted for 18.5% the first two seasons and 22.5% the last season.

The proportion of larger summer flounder in the catches decreased during the season when considering all gears and areas combined (Figure 5, Table 11e). The percent of fish >400 mm decreased each season from 18.7 to 30.6% during the peak months of the inshore fishery (November-December) to <17% after January. Likewise, the percent of fish <300 mm increased during December-April in 1983-84, while the percent of fish 300-400 mm was highest in March in 1982 and during February in 1985.

Black Sea Bass

Black sea bass catches increased from 1,314 kg/trip in 1982-83 to 3,449 kg/trip in 1984-85 (Table 12). Landings also increased from 156,648 lb in 1982-83 to 799,469 lb in 1984-85. Trawlers accounted for only 33.4% of the state's landings in 1982-83 but 71.4% in 1984-85 (Table 1).

The average catch/trip was highest for black sea bass in April in 1983, February and April in 1984, and in February-March in 1985. Trends in landings corresponded with CPUEs each fishing season (Figure 8, Table 13).

Corresponding with increased catches of black sea bass, the proportions of fish >300 mm FL also increased (Table below and Figure 9).

	Percent frequency/total length class (mm)					
Season	<200	201-250	251-300	301-400	401-500	>500
1982-83	3.1	45.3	32.7	16.9	1.8	0.2
1983-84	2.2	36.4	37.0	23.3	1.1	<0.1
1984-85	8.9	32.3	28.3	26.9	3.4	0.2

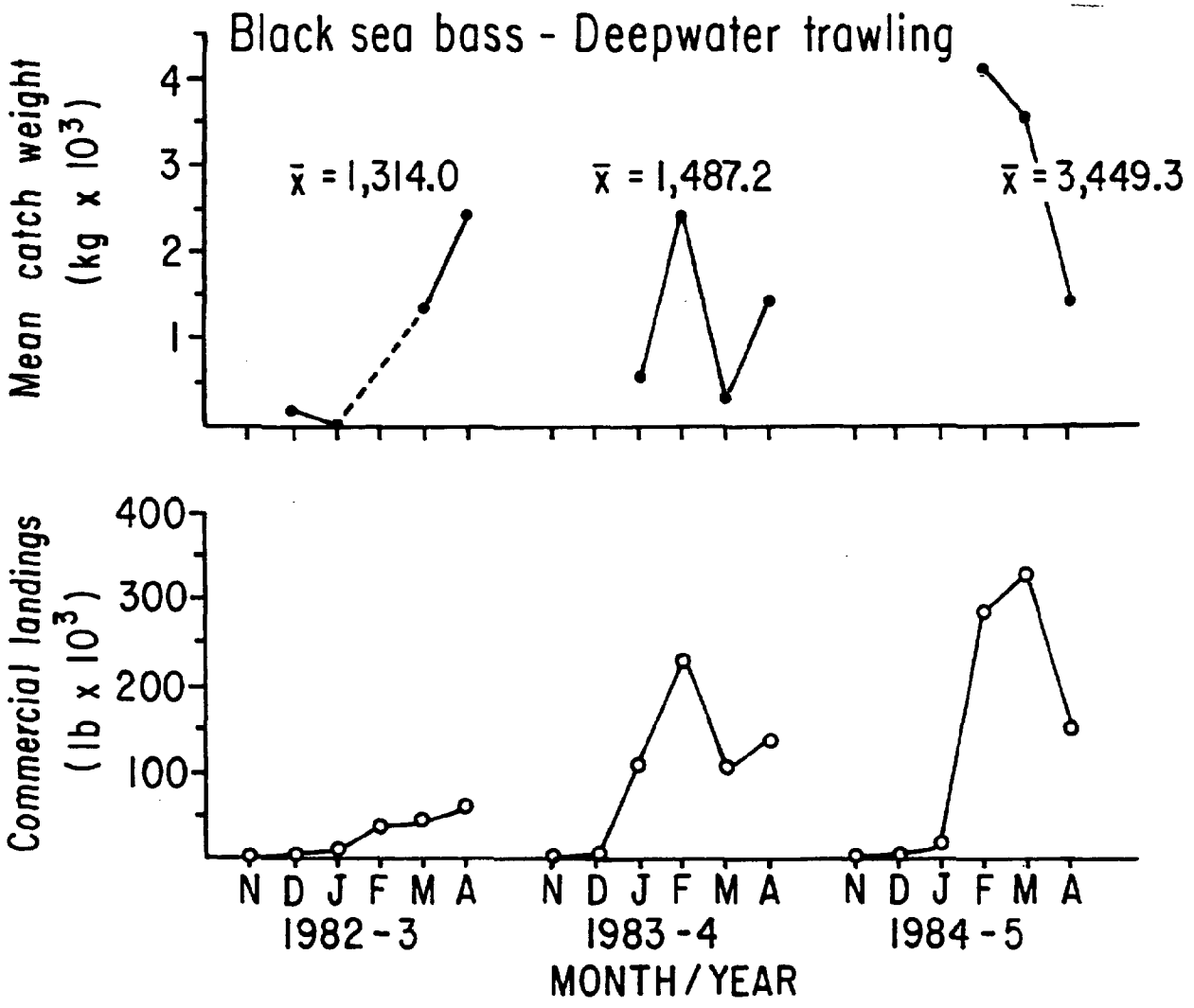

Figure 8. Monthly mean total weight/trip sampled of black sea bass, Centropristis striata, by deepwater trawling and commercial landings data for North Carolina winter trawl fishery September 1982-April 1985.

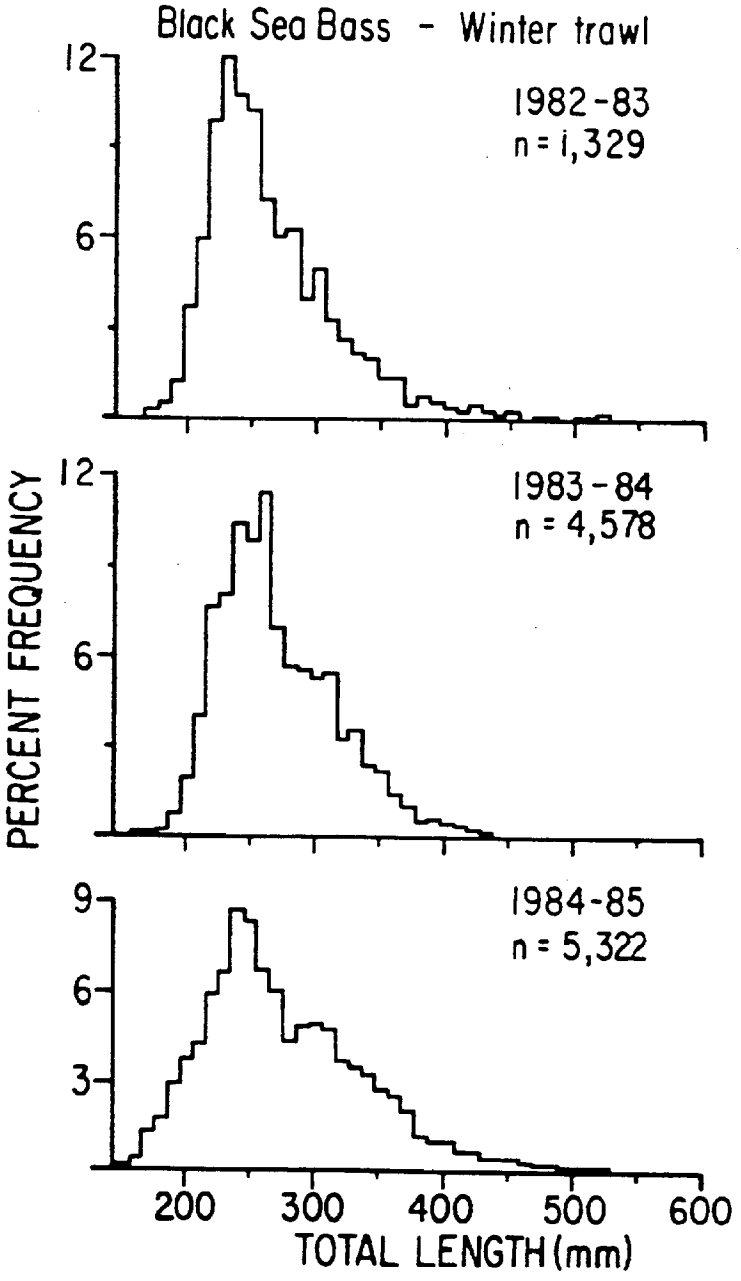

Figure 9. Expanded length-frequencies for black sea bass, Centropristis striata, from samples of September 1982-April 1985 winter trawl fishery; n = number of fish measured.

Black sea bass ranged from 166 to 582 mm FL with 18.9% >300 mm in 1982-83, from 165 to 585 mm FL with 24.4% >300 mm in 1983-84, and from 125 to 605 mm with 30.5% >300 mm in 1984-85.

Flynet Fishery

Flynet trawling was the second most important component of the winter trawl fishery in terms of total value of target species (Atlantic croaker, spot, weakfish, bluefish; Table 1). It was the most frequently sampled gear in 1982-83 (n=27, 62.8%) and 1984-85 (n=38, 45.2%) and tied with deepwater catches behind inshore flounder trawling in 1983-84 (n=21, 31.3%) (Table 2). This fishery generally took place in water <20 fathoms in depth.

The primary species sought by this fishery were available December through April, particularly off Cape Hatteras. The periodic large catches brought in by several boats at the same time, combined with concurrent Wanchese and Hatteras ocean gill net landings, often resulted in rapid price fluctuations. Trawlers switched to alternatives such as trawling in deepwater or for other species when prices dropped below $0.10/lb.

Flynet Catch Composition - (All Areas)

In 1982-83, weakfish comprised 52.8% of the weight and averaged 6,782 kg/trip (Table 14). Bluefish (20.5%) and croaker (18.2%) were also abundant, and together with weakfish accounted for 91.5% of the weight. Spot, butterfish and summer flounder each accounted for >1.5% of the catches.

In 1983-84 weakfish accounted for 61.9% of the weight and averaged 7,597 kg/trip (Table 14). Atlantic croaker averaged 2,114 kg/trip and accounted for 17.2% of the weight. Atlantic mackerel, spot, summer flounder, silver hake (Merluccius bilinearis), bluefish and striped bass (Morone saxatilis) all accounted for >1.5% of the weight.

In 1984-85 Atlantic croaker (5,190 kg/trip) and weakfish (4,780 kg/trip) accounted for 39% and 36% of the weight, respectively (Table 14). Spot (10.4%) and bluefish (10.2%) were also important, while butterfish accounted for 1.8%. The increased importance of Atlantic croaker in the 1984-85 season reflects, in part, increased sampling effort in the southern region.

The flynet fishery targeted weakfish, Atlantic croaker, and occasionally bluefish. These species, together with butterfish and spot, accounted for 85.0-96.6% of the flynet catches sampled each season. Consequently, the emphasis of the succeeding discussion will be on these five species.

Monthly Flynet Catches - (All Areas)

Weakfish, Atlantic croaker, butterfish, spot, and bluefish accounted for >89.1% of the weight in flynet catches sampled during every month, except March, 1984.

Flynet catches in 1982-83 were dominated by weakfish, though periodically several other species were abundant (Table 15). During the first half of the fishing season, butterfish and Atlantic croaker dominated, with weakfish nearly as abundant each month. Weakfish comprised 53.1-85.1% of the catches during December through March, and bluefish accounted for 13.8-31.6%. In April, one flynet catch of large bluefish was sampled.

Flynet catches in 1983-84 (Table 15) were dominated by weakfish and Atlantic croaker in November, and

Table 14. Mean weight (kg) and number of fish ($\bar{x}$ no. fish) per trip for the top 99.9% (by weight) of the flynet catches by season for October 1982 through April 1985, including number of catches sampled (n) and species percent of the total weight of the catches sampled (%TW).

Species	Mean weight (kg)	%TW	$\bar{x}$ no. fish	Species	Mean weight (kg)	%TW	$\bar{x}$ no. fish	Species	Mean weight (kg)	%TW	$\bar{x}$ no. fish
1982-83 (n=27)				1983-84 (n=21)				1984-85 (n=38)			
Cynoscion regalis	6,782.7	52.8	23,607	Cynoscion regalis	7,597.5	61.9	33,783	Micropogonias undulatus	5,190.6	38.6	42,236
Pomatomus saltatrix	2,635.0	20.5	3,416	Micropogonias undulatus	2,114.5	17.2	17,721	Cynoscion regalis	4,780.1	35.6	24,976
Micropogonias undulatus	2,343.8	18.2	13,439	Scomber scombrus	525.1	4.3	1,150	Leiostomus xanthurus	1,391.2	10.4	19,789
Leiostomus xanthurus	369.1	2.9	5,214	Leiostomus xanthurus	490.7	4.0	6,612	Pomatomus saltatrix	1,367.4	10.2	852
Paralichthys dentatus	324.6	2.5	821	Paralichthys dentatus	326.0	2.7	667	Peprilus triacanthus	247.8	1.8	3,031
Peprilus triacanthus	201.8	1.6	2,901	Merluccius bilinearis	241.8	2.1	314	Merluccius bilinearis	55.9	0.4	165
Urophycis regia	21.2	0.2	182	Pomatomus saltatrix	197.6	1.6	437	Loligo pealii	54.0	0.4	-
Prionotus evolans	15.1	0.1	535	Morone saxatilis	170.7	1.5	22	Paralichthys dentatus	48.6	0.4	97
Menticirrhus spp.	15.1	0.1	64	Alosa pseudoharengus	124.1	1.1	577	Bairdiella chrysoura	40.1	0.3	450
Cephalopods	13.7	0.1	-	Alosa sapidissima	80.2	0.7	187	Lagodon rhomboides	35.7	0.3	1,013
Carcharhinidae	11.7	0.1	-	Alosa aestivalis	70.3	0.6	663	Menticirrhus americanus	34.7	0.3	171
Scomberomorus cavalla	9.3	0.1	-	Archosargus probatocephalus	49.0	0.4	-	Larimus fasciatus	31.6	0.2	307
Sphoeroides maculatus	9.1	0.1	92	Peprilus triacanthus	38.6	0.3	703	Brevoortia tyrannus	25.8	0.2	343
Acipenser oxyrhynchus	8.8	0.1	1	Menticirrhus americanus	35.4	0.3	274	Menticirrhus spp.	15.9	0.1	90
Menticirrhus saxatilis	8.5	0.1	44	Loligo pealii	34.0	0.3	-	Orthopristis chrysoptera	15.1	0.1	288
Menticirrhus americanus	8.3	0.1	53	Urophycis chuss	29.6	0.3	51	Menticirrhus saxatilis	10.5	0.1	44
Paralichthys spp.	7.6	0.1	-	Acipenser oxyrhynchus	25.1	0.2	1	Mustelus canis	10.4	0.1	16
Bairdiella chrysoura	7.5	0.1	154	Bairdiella chrysoura	18.7	0.2	244	Stenotomus chrysops	9.9	0.1	239
Orthopristis chrysoptera	6.9	0.1	119	Lophius americanus	16.5	0.1	9	Centropristis striata	8.8	0.1	32
				Trichiurus lepturus	15.8	0.1	98	Paralichthys spp.	7.8	0.1	10
				Brevoortia tyrannus	13.4	0.1	124	Prionotus evolans	7.3	0.1	101
				Prionotus carolinus	8.1	0.1	109				
				Menticirrhus saxatilis	9.8	0.1	45				

Table 15. Monthly mean weight/trip ($\bar{x}$TW) of Micropogonias undulatus, Cynoscion regalis, Pomatomus saltatrix, Peprilus triacanthus, and Leiostomus xanthurus in the flynet catches sampled from October 1982 through April 1985 (all areas combined), including the number of catches sampled (n).

1982-83		1983-84		1984-85		1982-83		1983-84		1984-85	
Species	$\bar{x}$ TW	Species	$\bar{x}$ TW	Species	$\bar{x}$ TW	Species	$\bar{x}$ TW	Species	$\bar{x}$ TW	Species	$\bar{x}$ TW
September				**(n=1)**		**January (n=7)**		**(n=6)**		**(n=9)**	
				M. undulatus	2,466.9	C. regalis	7,581.4	C. regalis	9,007.9	C. regalis	6,335.4
				L. xanthurus	62.8	P. saltatrix	2,926.2	M. undulatus	1,422.5	M. undulatus	5,397.7
				P. saltatrix	4.5	M. undulatus	1,943.8	L. xanthurus	660.4	L. xanthurus	1,731.0
				C. regalis	0	L. xanthurus	421.6	P. saltatrix	495.1	P. saltatrix	119.9
				P. triacanthus	0	P. triacanthus	167.4	P. triacanthus	8.0	P. triacanthus	75.4
October (n=1)				**(n=4)**		**February (n=8)**		**(n=3)**		**(n=5)**	
P. triacanthus	3,130.0			M. undulatus	8,725.5	C. regalis	8,332.8	C. regalis	17,592	C. regalis	6,045.3
C. regalis	3,020.0			C. regalis	4,835.4	P. saltatrix	4,499.5	M. undulatus	312.0	M. undulatus	3,500.4
M. undulatus	541.0			L. xanthurus	286.4	M. undulatus	799.6	L. xanthurus	238.7	L. xanthurus	1,417.3
P. saltatrix	340.0			P. triacanthus	276.8	L. xanthurus	541.3	P. triacanthus	0	P. triacanthus	724.1
L. xanthurus	85.0			P. saltatrix	51.1	P. triacanthus	8.2	P. saltatrix	0	P. saltatrix	367.0
November (n=6)		**(n=5)**		**(n=5)**		**March (n=2)**		**(n=7)**		**(n=7)**	
M. undulatus	7,064.8	C. regalis	4,710.6	M. undulatus	10,394.1	C. regalis	852.1	C. regalis	4,079.5	C. regalis	5,166.6
C. regalis	6,617.9	M. undulatus	3,649.4	C. regalis	3,561.1	P. saltatrix	138.3	M. undulatus	1,888.7	M. undulatus	2,667.0
P. saltatrix	792.0	L. xanthurus	846.4	L. xanthurus	2,714.0	P. triacanthus	0.7	L. xanthurus	175.9	L. xanthurus	1,677.7
L. xanthurus	405.3	P. saltatrix	211.0	P. triacanthus	237.9	M. undulatus	0	P. saltatrix	5.6	P. saltatrix	1,671.4
P. triacanthus	172.4	P. triacanthus	121.8	P. saltatrix	205.2	L. xanthurus	0	P. triacanthus	0	P. triacanthus	171.3
December (n=2)				**(n=3)**		**April (n=1)**				**(n=4)**	
C. regalis	9,469.4			M. undulatus	6,283.1	P. saltatrix	5,049.9			P. saltatrix	8,964.6
P. saltatrix	2,123.8			C. regalis	2,168.8	C. regalis	31.6			C. regalis	3,644.8
M. undulatus	174.6			L. xanthurus	751.3	M. undulatus	0			M. undulatus	1,065.6
L. xanthurus	84.2			P. triacanthus	528.2	P. triacanthus	0			L. xanthurus	356.2
P. triacanthus	22.9			P. saltatrix	85.1	L. xanthurus	0			P. triacanthus	9.5

weakfish, with a smaller contribution by Atlantic croaker, in January and February. March catches were dominated by weakfish, but also included Atlantic mackerel, (15.5%, 1,575 kg/trip), silver hake (7.1%, 724 kg/trip), striped bass (5.1%, 512 kg/trip), and Alosa sp. (8.2%, 822 kg/trip), the latter were all captured north of Oregon Inlet.

Atlantic croaker accounted for 57.9%-96.6% of the catches during the first half of the 1984-85 fishing season, with weakfish accounting for 19.8-32.7%. Weakfish comprised 44.5-47.9% and Atlantic croaker 22.9-38.3% of the January-March catches, with spot providing >10% each month. Bluefish accounted for 14.4% in March, then dominated April catches (63.5%) together with weakfish (25.8%).

Flynet Catches - North of Cape Hatteras

Most flynet catches north of Cape Hatteras came from Wimble Shoals or off Oregon Inlet and in <20 fathoms. Overall, 36% (n=31) of the flynet catches sampled were from this area, including 26%, 38%, and 42% during the 1982-83 to 1984-85 seasons (Table 2). The CPUE was highest in 1982-83 (17,029 kg) and lowest in 1983-84 (9,542 kg) (Table 10). Catches of scrap ranged from 2.0% in 1982-83 to 22.2% in 1985-85, and were lower than the two southern regions (Table 10).

Weakfish dominated catches north of Cape Hatteras each fishing season, accounting for 35.8%-41.8% and averaging 2,900 to 5,746 kg/trip (Table 16). Atlantic croaker and bluefish were abundant in 1982-83 and 1984-85, with butterfish and spot also important. The 1983-84 season differed in catch composition. Atlantic mackerel comprised 17% of the catches, followed by Atlantic croaker, summer flounder, striped bass, blueback herring (Alosa aestivalis), American shad (A. sapidissima), and alewife (A. pseudoharengus).

Flynet catches north of Cape Hatteras were sequentially dominated by croaker, weakfish, and bluefish (Table 17) within a fishing season. Atlantic croaker were the target species during October through December when concentrated off Hatteras Island, having recently migrated from Chesapeake Bay and Pamlico Sound (DeVries 1986). Weakfish were the only other dominant species during this period, except for a catch of spot in November 1984 and butterfish in October 1982. The trawler fleet shifted from flynetting to flounder fishing during late November through January. Large weakfish dominated the flynet catches in January 1983, and together with large bluefish, dominated the catches made around Wimble Shoals in January-April 1985. Generally, effort for weakfish after December was concentrated south of Cape Hatteras. However, trawlers searching for Atlantic mackerel and striped bass north of Hatteras in March 1984 caught species other than those generally targeted by this fishery. The mean CPUEs for the dominant species (top 99%) in four catches were: Atlantic mackerel (Scomber scombrus) - 2,756.6 kg; silver hake (Merluccius bilinearis) - 1,267.6 kg; striped bass (Morone saxatilis) - 896.3 kg; alewife (Alosa pseudoharengus) - 651.3 kg; American shad (Alosa sapidissima) - 419.4 kg; blueback herring (Alosa aestivalis) - 363.5 kg; red hake (Urophycis chuss) - 148.9 kg; Atlantic sturgeon (Acipenser oxyrhynchus) - 101.9 kg; and goosefish (Lophius americanus) - 46.5 kg.

Flynet Catches - Cape Hatteras to Cape Lookout

Most catches sampled from this area were inshore of 15 fathoms, and

Table 16. Mean weight(kg)/trip ($\bar{x}$ TW) of the species comprising the top 99.0% of the flynet catches sampled from October 1982 through April 1985, by area and season, including number of catches sampled (n) and species percent contribution to the total weight of the catches (% TW).

1982-83			1983-84			1984-85		
Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW
			NORTH OF CAPE HATTERAS					
(n=7)			**(n=8)**			**(n=16)**		
C. regalis	5,746.4	39.1	C. regalis	2,900.3	35.8	C. regalis	5,053.6	41.8
M. undulatus	5,253.1	35.8	S. scombrus	1,378.2	17.0	M. undulatus	3,432.0	28.4
P. saltatrix	2,593.1	17.7	M. undulatus	900.9	11.1	P. saltatrix	2,336.9	19.3
P. triacanthus	500.3	3.4	M. bilinearis	633.8	7.8	P. triacanthus	400.6	3.3
L. xanthurus	192.0	1.3	P. dentatus	592.7	7.3	L. xanthurus	355.9	2.9
P. dentatus	167.4	1.1	M. saxatilis	448.2	5.5	M. bilinearis	132.7	1.1
Cephalopods	41.7	0.3	A. pseudoharengus	325.6	4.0	L. pealii	120.7	1.0
Carcharhinidae	38.8	0.3	A. sapidissima	210.5	2.6	P. dentatus	74.4	0.6
			A. aestivalis	181.8	2.2	M. canis	24.7	0.2
			P. saltatrix	137.8	1.7	M. americanus	18.4	0.2
			P. triacanthus	85.2	1.1	S. chrysops	16.8	0.1
			L. xanthurus	80.4	1.0	C. striata	15.2	0.1
			U. chuss	74.3	0.9			
			A. oxyrhynchus	51.0	0.6			
			L. americanus	23.2	0.3			
			A. probatocephalus	21.8	0.3			
			CAPE HATTERAS TO CAPE LOOKOUT					
(n=17			**(n=12)**			**(n=12)**		
C. regalis	8,131.0	65.4	C. regalis	8,712.0	70.7	C. regalis	6,217.3	46.3
P. saltatrix	3,100.7	24.9	M. undulatus	2,946.6	19.0	M. undulatus	4,588.3	34.0
P. dentatus	446.4	3.6	L. xanthurus	803.3	5.2	P. saltatrix	1,225.6	8.7
M. undulatus	399.5	3.2	P. saltatrix	254.0	1.6	L. xanthurus	1,061.9	7.9
L. xanthurus	112.4	0.9	P. dentatus	173.9	1.1	P. triacanthus	96.1	0.7
P. triacanthus	65.1	0.5	A. probatocephalus	71.3	0.5	P. dentatus	75.6	0.6
U. regia	32.8	0.3	M. americanus	56.1	0.4	L. fasciatus	46.5	0.3
P. evolans	24.0	0.2	L. pealii	56.0	0.4	O. chrysoptera	46.1	0.3
			B. chrysoura	32.8	0.2	M. saxatilis	21.2	0.2
			WEST OF CAPE LOOKOUT					
(n=3)			**(n=1)**			**(n=10)**		
M. undulatus	6,573.0	60.1	C. regalis	4,589.8	70.0	M. undulatus	8,758.8	56.2
L. xanthurus	2,237.0	20.5	M. undulatus	1,837.1	28.0	L. xanthurus	3,442.8	22.1
C. regalis	1,560.7	14.3	Menticirrhus spp.	68.0	1.0	C. regalis	2,617.7	16.8
P. triacanthus	279.7	2.6	C. nebulosus	36.9	0.6	P. triacanthus	185.6	1.2
Menticirrhus spp.	109.3	1.0	L. xanthurus	22.7	0.3	B. chrysoura	131.8	0.8
P. saltatrix	94.0	0.9				L. rhomboides	125.8	0.8
						M. americanus	91.9	0.6
						B. tyrannus	76.8	0.5
						L. fasciatus	64.5	0.4

Table 17. Monthly mean weight/trip ($\bar{x}$ TW) and percent contribution to the total weight of the flynet catches sampled (% TW) of Micropogonias undulatus, Cynoscion regalis, Pomatomus saltatrix, Peprilus triacanthus and Leiostomus xanthurus from October 1982 through April 1985, including the number of catches sampled (n). Tables are partitioned by areas where catches were made.

1982-83			1983-84			1984-85		
Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW
NORTH OF CAPE HATTERAS								
September (n=0)			**(n=0)**			**(n=1)**		
						M. undulatus	2,467.0	96.6
						L. xanthurus	62.8	2.5
						P. saltatrix	4.5	0.2
October (n=1)			**(n=0)**			**(n=4)**		
P. triacanthus	3,130.0	43.1				M. undulatus	8,775.2	59.0
C. regalis	3,020.0	41.6				C. regalis	4,835.4	32.7
M. undulatus	541.0	7.5				L. xanthurus	286.4	1.9
P. saltatrix	340.0	4.7				P. triacanthus	276.8	1.9
L. xanthurus	85.0	1.2				P. saltatrix	61.1	0.3
November (n=3)			**(n=4)**			**(n=1)**		
M. undulatus	12,070.1	75.8	C. regalis	5,796.8	60.8	M. undulatus	10,251.2	63.1
C. regalis	1,792.9	11.7	M. undulatus	1,801.8	18.9	C. regalis	2,509.8	15.4
L. xanthurus	419.7	2.7	P. saltatrix	252.7	2.9	L. xanthurus	2,502.3	15.4
P. saltatrix	333.4	2.2	P. triacanthus	170.7	1.8	P. saltatrix	99.3	0.6
P. triacanthus	113.8	0.7	L. xanthurus	160.9	1.7	P. triacanthus	76.2	0.5
December (n=0)			**(n=0)**			**(n=1)**		
						P. triacanthus	1,559.3	56.8
						P. saltatrix	40.8	1.5
January (n=3)			**(n=0)**			**(n=3)**		
C. regalis	10,608.8	64.4				C. regalis	12,988.5	87.9
P. saltatrix	5,603.8	34.0				M. undulatus	985.4	6.7
P. triacanthus	10.3	0.1				P. saltatrix	337.4	2.3
M. undulatus	6.8	0.1				L. xanthurus	158.9	1.1
						P. triacanthus	9.1	0.1
February (n=0)			**(n=0)**			**(n=2)**		
						C. regalis	2,731.4	45.3
						P. triacanthus	1,800.9	29.9
						P. saltatrix	95.1	1.4
						L. xanthurus	41.5	0.7
						M. undulatus	37.4	0.6
March (n=0)			**(n=4)**			**(n=0)**		
			C. regalis	3.9	0.1			
			P. saltatrix	0.2	0.1			
April (n=0)			**(n=0)**			**(n=4)**		
						P. saltatrix	8,964.6	63.5
						C. regalis	3,644.8	25.8
						M. undulatus	1,065.6	7.6
						L. xanthurus	356.2	2.5
						P. triacanthus	9.5	0.1
CAPE HATTERAS TO CAPE LOOKOUT								
November (n=3)			**(n=1)**			**(n=3)**		
C. regalis	11,442.9	71.3	M. undulatus	14,684.8	71.4	M. undulatus	10,613.5	56.4
M. undulatus	2,059.4	12.8	L. xanthurus	3,752.9	18.2	C. regalis	4,767.0	25.3
P. saltatrix	1,250.7	7.8	C. regalis	980.9	4.8	L. xanthurus	1,782.0	9.5
L. xanthurus	390.9	2.4	P. triacanthus	34.4	0.2	P. triacanthus	358.4	1.9
P. triacanthus	230.9	1.4	P. saltatrix	15.9	0.1	P. saltatrix	237.3	1.3

Table 17. (continued)

1982-83			1983-84			1984-85		
Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW	Species	$\bar{x}$ TW	% TW
December (n=2)			**(n=0)**			**(n=1)**		
C. regalis	9,469.4	77.4				M. undulatus	3,527.5	66.6
P. saltatrix	2,123.8	17.4				C. regalis	1,644.6	31.1
M. undulatus	174.6	1.4				L. xanthurus	84.5	1.6
L. xanthurus	84.2	0.7				P. triacanthus	26.2	0.5
P. triacanthus	22.9	0.2						
January (n=2)			**(n=5)**			**(n=1)**		
C. regalis	8,810.6	59.6	C. regalis	9,891.5	74.7	C. regalis	934.3	87.6
P. saltatrix	1,694.9	11.5	M. undulatus	1,303.6	9.8	M. undulatus	55.4	5.2
L. xanthurus	251.5	1.7	L. xanthurus	787.8	5.9	L. xanthurus	1.4	0.1
P. triacanthus	151.0	1.0	P. saltatrix	594.1	4.5			
M. undulatus	115.0	0.8	P. triacanthus	9.6	0.1			
February (n=7)			**(n=3)**			**(n=3)**		
C. regalis	9,371.8	64.2	C. regalis	17,592.8	95.2	C. regalis	8,254.6	48.5
P. saltatrix	5,142.3	35.2	M. undulatus	312.0	1.7	M. undulatus	5,809.1	34.1
L. xanthurus	9.6	0.1	L. xanthurus	238.7	1.3	L. xanthurus	2,334.6	13.7
P. triacanthus	9.4	0.1	P. saltatrix	7.8	0.1	P. saltatrix	554.9	3.3
M. undulatus	4.8	0.1	P. triacanthus	3.8	0.1	P. triacanthus	6.2	0.0
March (n=2)			**(n=3)**			**(n=4)**		
C. regalis	852.1	85.1	C. regalis	9,513.7	64.4	C. regalis	8,241.1	69.9
P. saltatrix	138.3	13.8	M. undulatus	4,407.0	29.9	P. saltatrix	2,925.0	24.8
P. triacanthus	0.7	0.1	L. xanthurus	410.3	2.8	M. undulatus	462.3	3.9
L. xanthurus	0.1	0.1	P. saltatrix	12.7	0.1	L. xanthurus	77.3	0.7
			P. triacanthus	11.4	0.1	P. triacanthus	7.9	0.1
April (n=1)								
P. saltatrix	**5,049.9**	**99.4**						
C. regalis	**31.3**	**0.6**						
WEST OF CAPE LOOKOUT								
November (n=0)			**(n=0)**			**(n=1)**		
						M. undulatus	9,878.7	57.9
						L. xanthurus	5,721.4	33.6
						C. regalis	994.4	5.8
						P. saltatrix	214.7	1.3
						P. triacanthus	38.4	0.2
December (n=0)			**(n=0)**			**(n=2)**		
						M. undulatus	7,660.9	66.0
						C. regalis	2,430.9	20.9
						L. xanthurus	1,084.7	9.3
						P. saltatrix	107.3	0.9
January (n=2)			**(n=1)**			**(n=5)**		
M. undulatus	6,678.0	63.6	C. regalis	4,589.8	70.0	M. undulatus	9,113.5	55.9
C. regalis	1,811.0	17.3	M. undulatus	1,837.1	28.0	C. regalis	3,423.7	21.0
L. xanthurus	1,224.0	11.7	L. xanthurus	22.7	0.3	L. xanthurus	3,020.5	18.5
P. triacanthus	419.5	4.0				P. triacanthus	130.0	0.8
P. saltatrix	141.0	1.3				P. saltatrix	13.4	0.1
February (n=1)			**(n=0)**			**(n=0)**		
M. undulatus	6,363.0	53.8						
L. xanthurus	4,263.0	36.1						
C. regalis	1,060.0	9.0						
March (n=0)			**(n=0)**			**(n=3)**		
						M. undulatus	3,237.9	49.2
						L. xanthurus	2,286.9	33.4
						C. regalis	640.4	9.4
						P. triacanthus	233.6	3.4

in the Hatteras Bight around Diamond Shoals or just south and/or west of the shoals. All the Wanchese boats fished this area; vessels from Englehard, Morehead City-Beaufort, and other ports fished further south as well, to just off the beaches of Core Banks, Drum Inlet and the eastern side of Cape Lookout Shoals. Overall, 48% of the flynet catches sampled were from Cape Hatteras to Cape Lookout, with 63.%, 57%, and 32% during respective seasons (Table 2).

The average total catch/trip of fish (Table 10) was highest in 1983-84 (15,566 kg) and lowest in 1984-85 (11,126 kg). The proportion of scrap in these catches ranged seasonally from 9.8 to 28.8%.

Weakfish comprised 46.3-70.7% of the catches from Cape Lookout to Cape Hatteras and averaged 8,131 kg/trip, 8,712 kg/trip and 6,217 kg/trip during the 1982/83 seasons, respectively (Table 16). Bluefish constituted 24.9% in 1982-83, averaging 3,101 kg/trip, but averaged only 254 kg/trip (1.6%) in 1983-84 and 1,225 kg/trip (8.7%) in 1984-85. Atlantic croaker were relatively unimportant in 1982-83 (400 kg/trip, 3.2%) but second to weakfish in 1983/84-1984/85, averaging 2,947 and 4,588 kg/trip and accounting for 19.0 and 34.0%, respectively. Spot accounted for 7.9% of the 1984-85 catches and averaged 1,061 kg/trip.

Weakfish dominated the catches almost every month through March each season, except during November, 1983 and 1984, and December, 1984, when Atlantic croaker ranked first, and in April, 1985, when bluefish were dominant (Table 17).

In 1982-83, weakfish accounted for 59.6-85.1% of the flynet catches between Cape Hatteras and Cape Lookout during November through March, with CPUE highest in November (11,443 kg) and lowest in March (852 kg, n=1 catch). Atlantic croaker were only important in November (12.8%, 2,059 kg/catch). Bluefish were second to weakfish after November, accounting for from 7.8% (1,251 kg/trip) in November to 35.2% (5,142 kg/trip) in February; they constituted essentially all of the single catch sampled in April.

In 1983-84, Atlantic croaker (71.4%, 14,685 kg) and spot (18.2%, 3,753 kg) dominated the single catch sampled in November. Weakfish comprised 64.4-95.2% of the flynet catches January-March, with monthly mean CPUEs from 9,513 to 17,952 kg/trip. Atlantic croaker accounted for 9.8 and 29.9% of the catches in January and March and averaged 1,304 and 4,407 kg/trip during those months.

In 1984-85, Atlantic croaker and weakfish dominated the catches. Atlantic croaker accounted for 56.4-66.6% of the catches sampled and averaged 10,613.5 and 3,527 kg/trip in November and December. Atlantic croaker in January and February were second in importance, averaging 55 and 5,809 kg/catch. Weakfish composed 25.3-31.1% of November and December catches, but dominated catches during January-March, averaging 934-8,255 kg/catch/month. Spot were only important in November (9.5%) and February (13.7% of catches). Bluefish accounted for 28.4% (2,925 kg/catch) in March.

Flynet Catches - West of Cape Lookout

Flynetting west of Cape Lookout occurred around or just west of Cape Lookout Shoals, off Beaufort Bar, along Shackelford and Bogue Banks, and generally in <15 fathoms of water. Effort was not as great as in the northern areas, primarily because large fish were not as abundant. Catches averaged from 13,804 kg/trip

in 1982-83 to 15,603 kg/trip in 1984-85 with scrap composing 51.5-53.3%, respectively (Table 10).

Atlantic croaker, weakfish, and spot accounted for 94.9-98.3% of the flynet catches west of Cape Lookout (Table 16). Atlantic croaker accounted for 56.2% (8,759 kg/trip) to 60.1% (6,573 kg/trip) in 1982-83 and 1984-85, respectively. Spot made up 20 and 22% and averaged 2,237 and 3,443 kg/trip in 1982-83 and 1984-85, respectively, while weakfish accounted for 14.3-16.8%. The one catch sampled in 1983-84 was 70% weakfish (4,589 kg) and 28.0% Atlantic croaker (1,837 kg).

Monthly trends cannot be described since only in 1984-85 were sampled obtained in more than two months (Table 17). This fishery generally occurs from November through April, with greatest activity during January-March. Atlantic croaker were the dominant fish in all months sampled (49.2-66.0%) in 1982-83 and 1984-85. Weakfish and spot were the next two most important species in all catches west of Cape Lookout during this study.

Weakfish

Winter trawl landings of weakfish declined during the three fishing seasons while overall state landings were highest in 1983-84 and lowest in 1984-85 (Table 1). The fishery's contribution to total state weakfish landings decreased from 59.2% to 37.2% (6.7 to 3.9 million lb) during this period, while at the same time, ocean gill net landings steadily increased. Landings in northern ports declined from 3.8 million lb in 1982-83 to 2.3 million lb in 1984-85, while in southern ports landings were highest in 1983-84 (3.7 million lb) and lowest in 1984-85 (1.5 million lb) (Table 18).

The CPUE of weakfish in flynets was highest in 1983-84 (7,598 kg/trip) and lowest in 1984-85 (4,780 kg/trip) (Table 14). The CPUE north of Cape Hatteras was highest in 1982-83 (5,746 kg) and lowest in 1983-84 (2,900 kg) (Table 16). Catches from Cape Lookout to Cape Hatteras were high in both 1982-83 and 1983-84 (8,131-8,712 kg/trip), but declined in 1984-85 (6,217 kg/trip). West of Cape Lookout, catches were higher during 1984-85 than 1982-83; however, sample sizes during the first two seasons were limited. The weighted seasonal mean catch of weakfish for flynet catches north of Cape Lookout averaged 7,435 kg in 1982-83, 6,387 kg in 1983-84, and 5,552 kg in 1984-85, and corresponded with reduced trawler landings in northern ports (Table 18). The reduced landings are, to an unknown but considerable extent, a result of reduced flynet effort the last two seasons, due to decreased prices/lb ($0.40 in 1982-83; $0.27 in 1983-84; $0.33 in 1984-85) and gear conflicts with ocean gill nets in the Cape Hatteras area.

The seasonal availability of weakfish was similar in each region (Figure 10). North of Cape Hatteras, catches were generally small (about 1,800-5,700 kg/trip) in October and November, peaked in January (10,608 kg in 1983; 12,988 kg/trip in 1985) and declined thereafter. Catches of large "sow" trout (weakfish >600 mm TL) and bluefish occurred in April 1985. Fishing effort and catches between Cape Hatteras and Cape Lookout were greatest during November through March, with declines (1984-85) likely related, in part, to shifting effort (ie., to flounder in December). Weakfish landings in the northern ports peaked in December-March in 1982-83, January-March in 1984, and January-March in 1985 (Figure 10). Landings in southern ports, which included catches north of Cape Lookout, were greatest during January-

Table 18. Predominant marketed fish captured in the 1982-1985 winter trawl fishery, including total landings (Pounds) percent of total state landings (Percent) and value in dollars. These data are partitioned by areas where fish were landed with: North including Dare (Wanchese and Hatteras), Hyde (Englehard), Beaufort (Belhaven), and Pamlico (Bayboro) counties; and South including Craven, Carteret (Morehead-Beaufort), Onslow and Brunswick counties.

Species		1982-83			1983-84			1984-85		
		Pounds	Percent	Value	Pounds	Percent	Value	Pounds	Percent	Value
Croaker	North	604,888	6.13	$ 235,824	221,826	2.72	$ 88,065	1,202,975	11.59	$ 260,420
	South	600,984	6.10	213,008	832,486	10.21	284,128	1,793,663	17.29	478,234
	Total	1,205,872	12.23	$ 498,832	1,054,312	12.93	$ 372,193	2,996,638	28.88	$ 738,654
Spot	North	15,775	0.32	$ 3,879	12,793	0.42	$ 1,832	16,992	0.49	$ 2,959
	South	63,031	1.29	$ 14,645	139,752	4,57	$ 26,760	92,825	2.70	$ 20,591
	Total	78,806	1.61	$ 18,524	152,545	4.99	$ 28,592	109,817	3.18	$ 23,550
Weakfish	North	3,849,455	33,82	$1,680,359	2,404,519	19.88	$ 771,821	2,307,627	22.14	864,583
	South	2,923,404	25.68	1,058,710	3,635,948	30.06	388,118	1,571,837	15.08	432,205
	Total	6,772,859	59.50	$2,739,069	6,040,467	49.94	$1,659,939	3,879,464	37.22	$ 1,296,788
Bluefish	North	1,275,668	16.68	$ 150,601	635,032	17.80	$ 95,480	595,583	20.09	$ 95,507
	South	2,639,254	34.50	241,953	389,281	10.91	39,892	196,313	6.62	18,853
	Total	3,914,922	51.18	$ 392,554	1,024,313	28.71	$ 135,392	791,896	26.71	$ 114,410
Flounder	North	4,559,884	52.10	$2,799,136	9,499,033	71.49	$4,993,132	10,100,341	71.56	$ 7,207,215
	South	1,841,429	21.04	1,012,903	1,027,851	7.74	540,613	1,330,078	9.42	884,977
	Total	6,401,313	73.14	$3,812,039	10,510,526	79.23	$5,533,795	11,430,419	80.98	$ 8,092,192
Kingfish	North	34,054	7.68	$ 9,939	20,954	5.09	$ 7,004	35,037	6.06	$ 10,716
	South	82,428	18.59	28,187	35,974	8.73	12,472	136,175	23.56	53,651
	Total	116,482	26.27	$ 38,126	56,928	13.82	$ 19,476	171,212	29.62	$ 64,367
Seabass	North	156,004	33.27	$ 125,962	585,195	59.58	$ 382,102	788,846	76.77	$ 564,687
	South	644	0.14	550	906	0.09	544	10,623	0.89	9,466
	Total	156,648	33.41	$ 126,512	586,101	59.67	$ 382,646	799,469	66.66	$ 514,153

Table 18. (continued).

Species		1982-83 Pounds	1982-83 Percent	1982-83 Value	1983-84 Pounds	1983-84 Percent	1983-84 Value	1984-85 Pounds	1984-85 Percent	1984-85 Value
Scup (porgies)	North	670,410	46.20	$ 287,330	1,051,486	57.14	$ 474,428	586,509	62.69	$ 329,752
	South	81	0.01	34	148	0.01	44	2,003	0.18	1,387
	Total	670,491	46.21	$ 287,364	1,061,734	57.15	$ 474,472	588,512	52.87	$ 331,139
Squid	North	161,772	92.28	$ 58,158	628,449	97.52	$ 92,001	758,588	83.83	$ 153,798
	South	4,024	2.30	1,210	13,268	2.08	4,067	28,673	3.17	7,945
	Total	165,796	94.58	$ 59,368	641,717	99.60	$ 96,968	787,261	87.00	$ 161,743
Butterfish	North	116,490	39.08	$ 27,831	73,265	62.97	$ 27,812	87,019	49.28	$ 35,123
	South	47,397	15,90	8,015	10,127	8.70	2,668	27,094	15.34	5,693
	Total	163,887	54.98	$ 35,846	83,392	71.67	$ 30,480	114,113	64.42	$ 40,816
Harvestfish	North	10,296	2.35	$ 1,990	6,816	3.07	$ 1,023	-		-
	South	65,133	14.88	11,106	8,887	4.01	1,338	11,338	4.67	$ 2,002
	Total	75,429	17.23	$ 13,096	15,703	7.08	$ 2,361	11,338	4.67	$ 2,002
Scrap/bait	North	302,450	3.19	$ 11,125	560,183	5.74	$ 26,4455	449,323	4.34	$ 12,742
	South	2,704,509	28.52	85,748	2,995,740	30.67	104,546	3,346,720	32.33	101,930
	Total	3,007,459	31.71	$ 96,873	3,555,923	36.41	$ 131,001	3,796,043	36.67	$ 114,672
Totals	North	11,912,673	17.01	$5,464,240	16,837,457	23.30	$7,260,636	17,629,679	21.59	$ 9,729,162
	South	10,942,548	15.62	2,744,891	9,130,613	12.64	1,921,804	8,602,962	10.54	2,036,540
	Total	22,855,221	32.63	$8,209,131	25,968,070	35.94	$9,182,440	26,232,641	32.13	$11,765,702

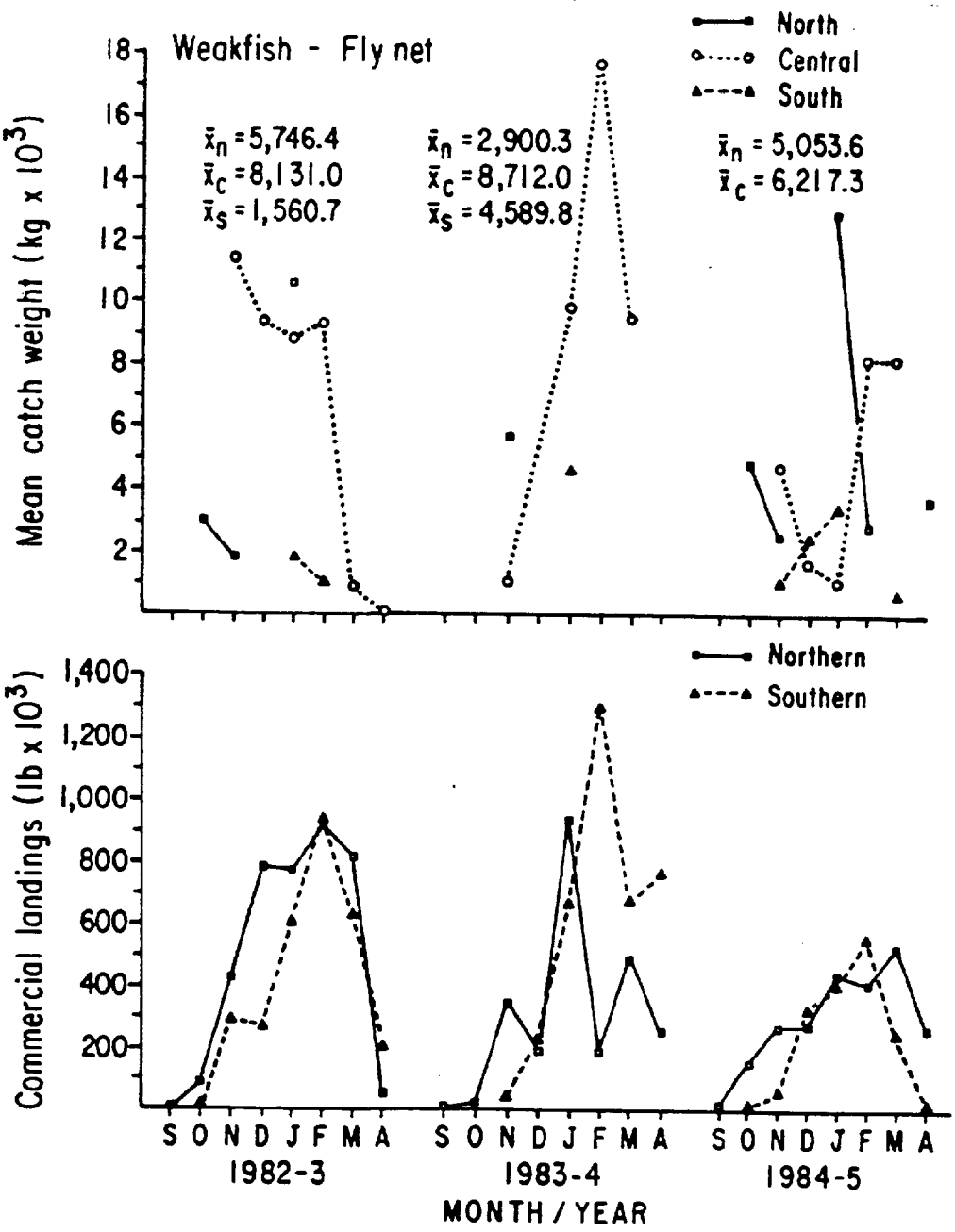

Figure 10. Top: Monthly mean total weight/trip of weakfish, Cynoscion regalis, in flynets by area fished (North = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, South = west of Cape Lookout; $\bar{x}$ = mean weight/catch/season/area).

Bottom: Commercial landings data for North Carolina winter trawl fishery, September 1982-April 1985, by ports where fish were landed (Northern = Dare, Hyde, Beaufort, Pamlico counties; Southern = Craven, Carteret, Onslow counties).

March 1983, January-April 1984, and December-March 1985.

Most of the weakfish sampled during 1982-84 (76.8-85.2%) were captured between Cape Hatteras and Cape Lookout. In 1984-85, 48.5% were captured north of Cape Hatteras, 38.2% from Hatteras to Lookout and 13.3% west of Cape Lookout.

The size composition of weakfish in the winter trawl fishery varied slightly during the study (Figure 11; Table 19). Weakfish were exploited over a wide range of sizes (111-871 mm TL), although fish 201-400 mm dominated catches, and their proportion increased from 85% to 94%. Correspondingly, the number of medium and large weakfish (>400 mm) declined from 5.2% to 1.1%. Weakfish were marketable food fish at 220-230 mm TL (Sholar 1979). The percentages of unmarketable weakfish did not vary greatly from 1982-85 (12-16% <221 mm TL).

Weakfish size composition differed noticeably by region, although the majority in all areas were 201 to 300 mm TL. Fewer large weakfish were caught west of Cape Lookout (Table 19; Figure 12) as individuals <301 mm TL constituted 86-99% of the catches, including 28-46% unmarketable-sized fish. Fish 301-400 mm TL made up larger proportions of the weakfish in the northern and central regions. Weakfish caught in northern and central waters were similar except that waters north of Cape Hatteras produced more large (>600 mm TL) weakfish, especially in 1982-83. The percentages of unmarketable weakfish were 2-17% and 11-16% in the north and central areas, respectively.

Fish 201-300 mm TL dominated catches during most months (Table 20), the exceptions being February and March 1983 when 301-400 mm TL fish predominated, and December 1983 when a large number of fish 401-500 mm TL and >600 mm TL were caught. The highest proportions of unmarketable fish were caught in November coinciding with the fall migration of age 0 weakfish out of estuaries. Percentages of fish <221 mm TL were lowest during December when trawlers used flounder gear with larger tailbag mesh sizes. Larger fish (>301 mm TL) usually did not comprise a significant portion of catches until after November.

Small weakfish were caught earlier and south of larger weakfish within a fishing season. Weakfish <300 mm TL were caught north of Cape Hatteras in October, and in all areas in November (Figure 12). During December, northern catches were consistently dominated (79-100%) by fish >300 mm TL, perhaps indicating the arrival of migratory stocks from northern states, while 201-300 mm TL weakfish predominated in the central and southern areas. A large portion (40%) of the weakfish caught north of Hatteras in December 1983 were >600 mm TL. Weakfish 201-300 mm TL predominated catches January through March, although occasionally fish >300 mm TL would dominate north of Cape Lookout. Weakfish >600 mm TL were abundant (18%) during January 1983 north of Hatteras and in central area catches one month later (10%). A high percentage of unmarketable-sized weakfish (>25%) characterized catches west of Cape Lookout during January-March.

Weakfish ranged from age 0 to age XI, although age I fish composed 72-77% of the catches. Age 0 weakfish contributed 14-16% of winter trawl catches (Figure 13). Age II weakfish constituted 8-11% of the catches, while age III fish made up about 1%. Weakfish $\geq$ age IV generally constituted <1% of samples. The relative abundance of age 0 through age IV weakfish varied little each season (Figure 13). However, almost 2% of

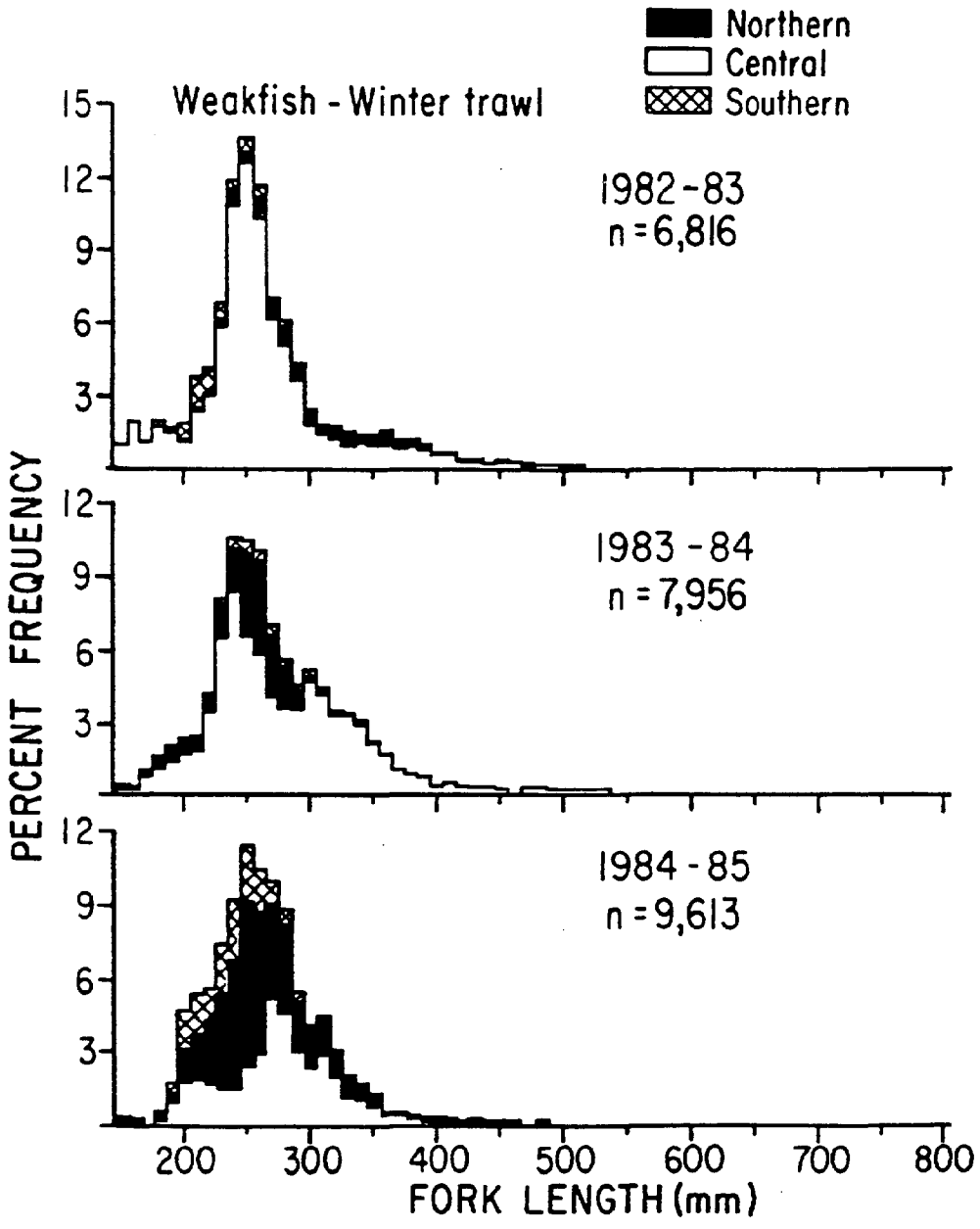

Figure 11. Expanded length-frequencies for weakfish, Cynoscion regalis, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

Table 19. Size composition, overall and by geographic region, of weakfish, Cynoscion regalis, from 1982-1985 winter trawl samples.

	Percent frequency/size class (TL, mm)/fishing season																	
	101-200			201-300			301-400			401-500			501-600			>600		
Area	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85
North of Cape Hatteras	0.0	11.6	3.6	47.2	84.3	81.4	37.9	2.9	13.0	7.5	0.6	1.3	0.6	0.1	0.3	6.8	0.5	0.4
Cape Hatteras-Cape Lookout	10.8	5.7	4.8	72.3	61.7	69.9	12.6	29.7	24.9	2.6	2.5	0.3	0.1	0.4	0.1	1.6	0.0	0.0
West of Cape Lookout	8.5	0.0	5.8	90.9	86.2	91.4	0.6	13.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall (areas combined)	9.4	6.7	4.4	70.7	66.9	78.6	14.7	23.9	15.9	2.9	2.0	0.7	0.2	0.4	0.2	2.1	0.1	0.2

Table 20. Monthly size composition of weakfish, Cynoscion regalis, from 1982-85 winter trawl samples.

	Percent frequency/size class (TL, mm)/fishing season																				
	101-200			201-300			301-400			401-500			501-600			>600			Unmarketable		
Month	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-85	82-83	83-84	84-84
Oct	0.0	-	0.2	98.1	-	91.1	1.9	-	8.4	0.0	-	0.1	0.0	-	0.1	0.0	-	0.1	10.4	-	0.9
Nov	16.0	11.3	3.5	81.2	86.4	69.2	2.8	2.1	26.8	0.1	0.1	0.4	0.0	0.1	0.1	0.0	0.1	0.1	22.2	16.9	14.7
Dec	0.3	0.0	0.4	83.4	0.2	88.8	13.8	6.2	5.4	1.8	44.0	3.6	0.3	9.8	1.4	0.4	39.8	0.4	1.5	0.0	3.6
Jan	6.9	0.6	4.2	73.7	51.4	84.2	13.8	38.8	11.4	2.8	7.7	0.2	0.1	1.4	0.1	2.7	0.1	0.1	17.6	2.9	19.4
Feb	4.7	11.6	4.6	20.0	52.3	65.0	62.6	36.1	29.2	12.9	0.1	1.0	.0.8	0.1	0.1	9.0	0.1	0.1	9.9	20.0	6.5
Mar	0.0	2.0	8.6	12.2	85.9	73.1	73.4	11.3	16.6	14.3	0.7	1.4	0.0	0.1	0.3	0.1	0.1	0.1	0.0	6.6	27.7
Apr	-	-	0.3	-	-	82.5	-	-	14.1	-	-	0.3	-	-	0.2	-	-	2.6	-	-	3.3

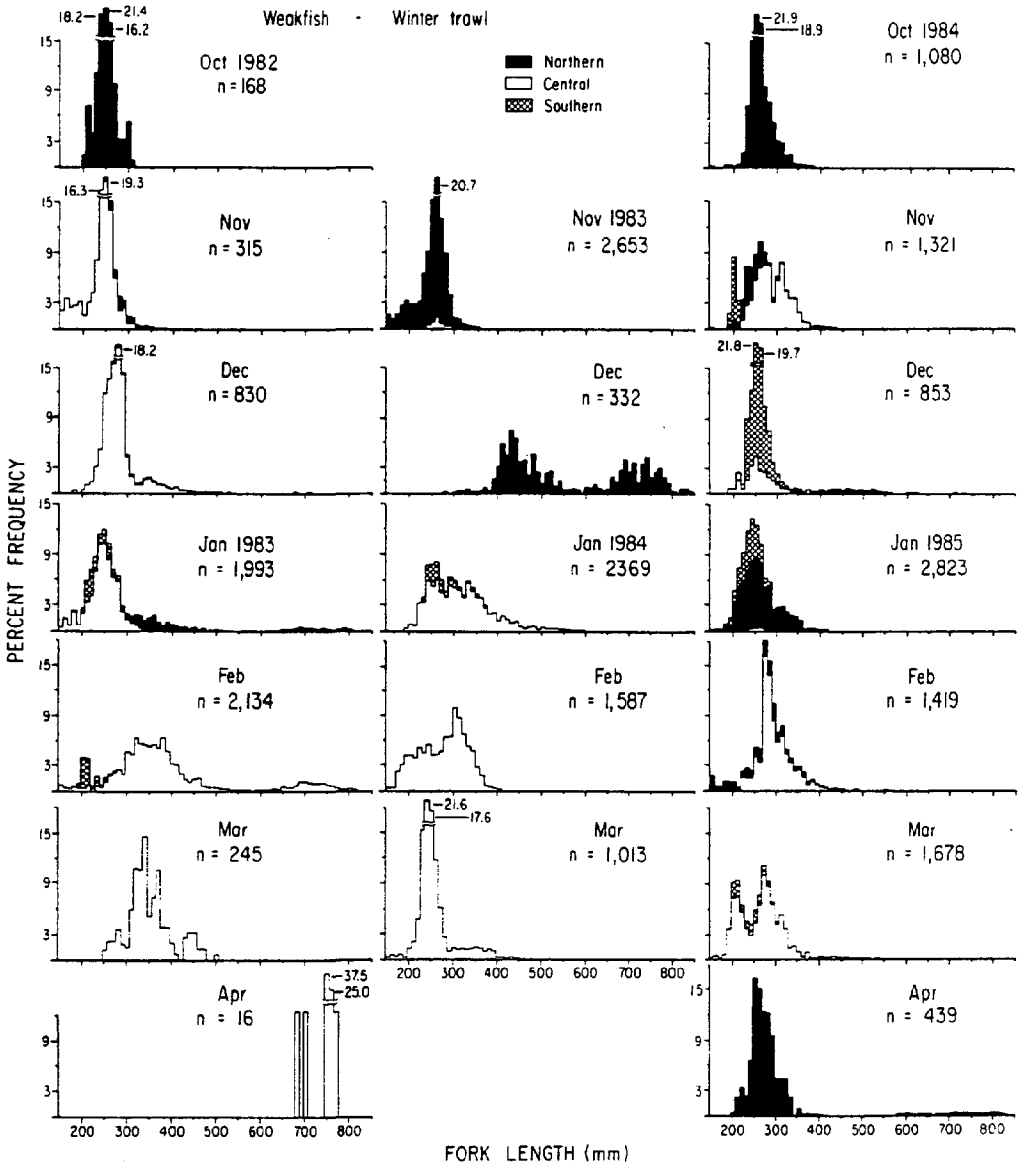

Figure 12. Monthly expanded length-frequencies for weakfish, Cynoscion regalis, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

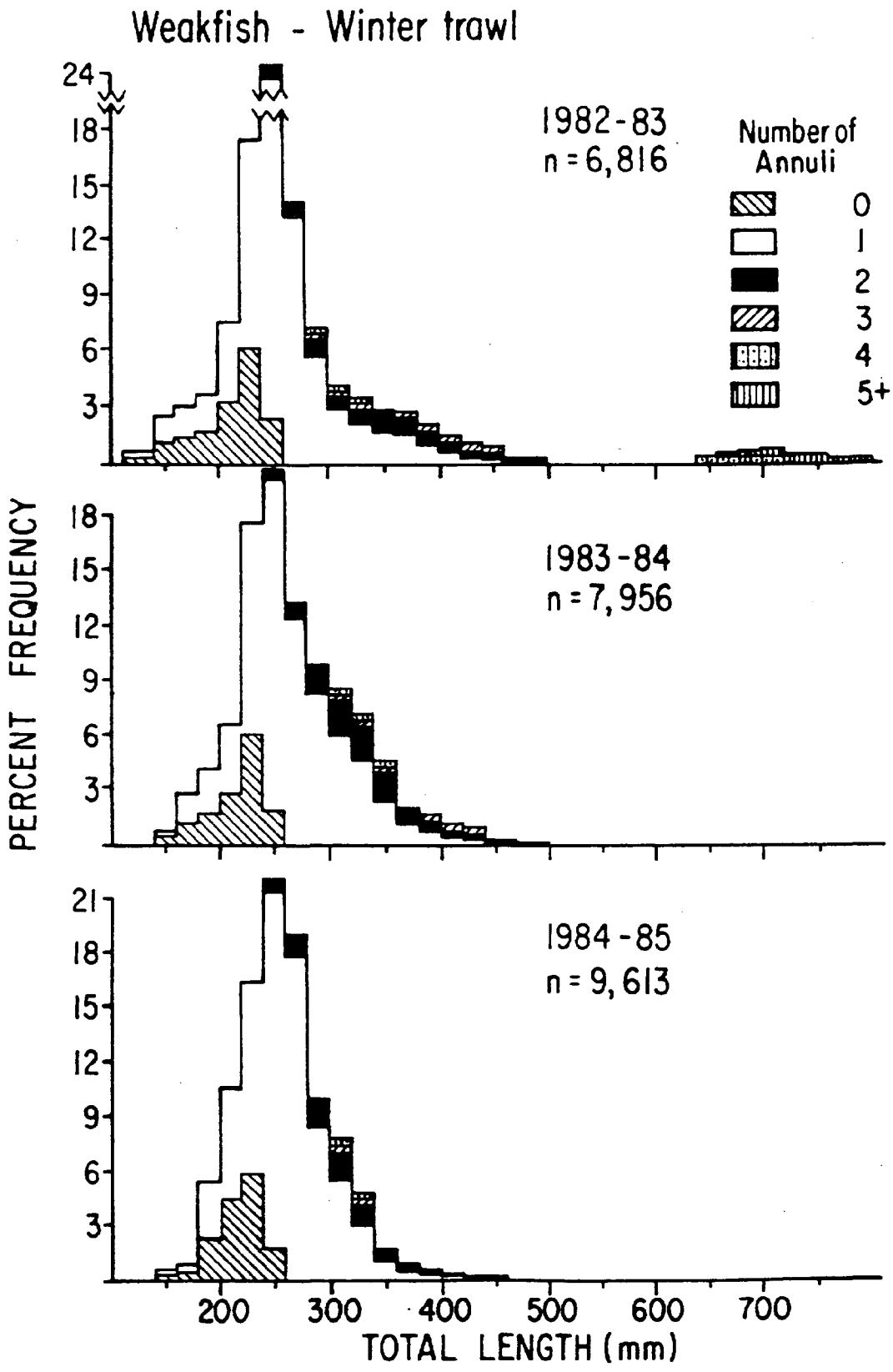

Figure 13. Expanded age composition of weakfish, Cynoscion regalis, in winter trawl catches sampled September 1982-April 1985.

the weakfish in 1982-83 were age 5 or older, whereas the next two seasons <0.2% of the weakfish were age V or older.

Age groups overlapped considerably in size. Age 0 weakfish ranged from 110 to 259 mm TL, with most being 190-259 mm TL (Figure 13). Age I fish ranged from 110 to 519 mm TL, with the majority 230-289 mm TL, and those age II ranged from 250 to 599 mm TL, but most were 280-369 mm TL. Age III weakfish were 310-699 mm TL, with most 320-419 mm TL. The ranges for the remaining age groups were: Age IV - 310-739 mm TL; age V - 610-819 mm TL; age VI - 650-819 mm TL; age VII - 690-819 mm TL; age VIII - 710-859 mm TL; age IX - 600-871 mm TL; age X - 710-819 mm TL; and age XI - 810-871 mm TL.

Atlantic Croaker

The winter trawl fishery accounted for 12.2 and 12.9% of the Atlantic croaker landings in 1982-83 and 1983-84 and 28.9% in 1984-85; landings increased from around one million lb the first two seasons to nearly three million lb in 1984-85, corresponding with higher overall state landings (Table 1). Landings in the northern ports were lowest during 1983-84 (221,826 lb) and highest in 1984-85 (1.2 million lb); landings increased from 0.6 to 1.8 million lb in the southern ports during the study (Table 18).

The average catch of Atlantic croaker by flynets (all areas combined) increased from 2,343 kg/trip in 1982-83 to 5,190 kg in 1984-85 (Table 14), corresponding with state landings. Catches were largest north of Hatteras in 1982-83 and between Cape Hatteras and Cape Lookout in 1984-85 (Figure 14, Table 16). The seasonal mean CPUE north of Cape Lookout was 1,815 kg in 1982-83, 2,128 kg in 1983-84, and 3,927 kg in 1984-85. This corresponded with increased catches overall in Chesapeake Bay which likely contributed a significant component of the fish available to this fishery (DeVries 1986). Similarly, catches west of Cape Lookout were greatest in 1984-85.

Seasonal patterns in catches of Atlantic croaker varied among areas (Figure 14, Table 17). North of Cape Hatteras, catches were largest in October and November; between Cape Hatteras and Cape Lookout, catches were largest in November each year but exceeded 1,300 kg/trip in January, March and December 1984 and February 1985. In general, catches in the northern area occurred before those south of Cape Hatteras. Landings in northern ports were highest in October and November when this was the primary target species, and low the remainder of the season. West of Cape Lookout catches of Atlantic croaker occurred in February and March 1983 and November-January and March 1984-85. Landings in southern ports generally increased through December-February, then declined.

Atlantic croaker in the winter trawl samples ranged from 120 to 475 mm TL and annually, from 154-475 mm, 138-420 mm and 120-373 mm during the successive 1982/83-1984-85 seasons with modes around 245-255 mm, 205-220 mm, and 220-230 mm, respectively (Figure 15). The mode declined considerably after the 1982-83 season, as evidenced by the annual proportions of unmarketable-size croaker (<225 mm TL)--24.5% in 1982-83, 63.1% in 1983-84, and 57.2% in 1984-85.

Monthly length frequency distributions of Atlantic croaker were unimodal every month except November and December 1982 and February 1985, when they were bimodal (Figure 16). Through November, most fish were about 200-275 mm TL, after which some as small as 150 mm were common and modes tended to

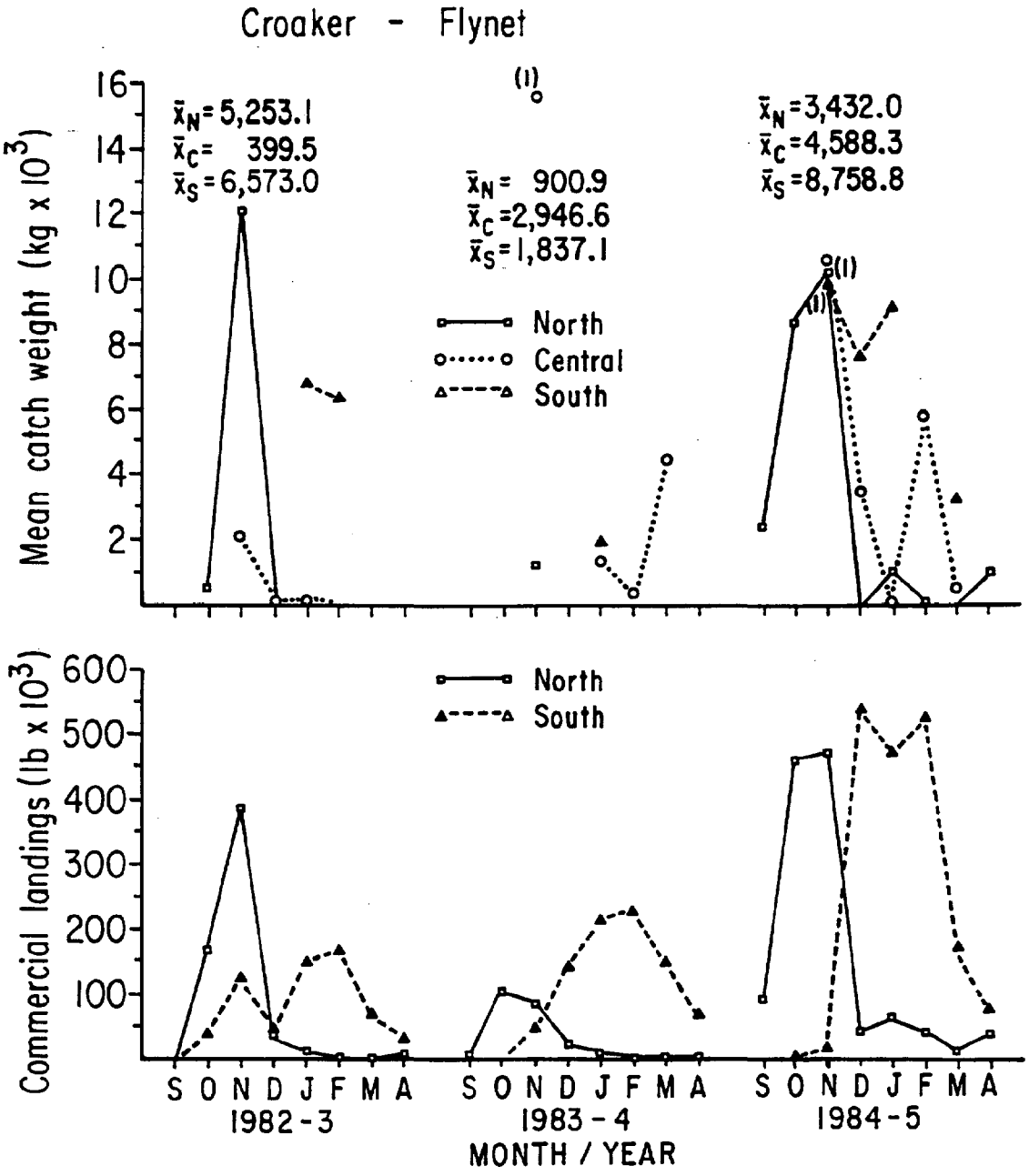

Figure 14. Monthly mean total weight/trip of Atlantic croaker, Micropogonias undulatus, in flynets by area fished and commercial landings data for North Carolina winter trawl fishery, September 1982-April 1985, by ports where fish were landed. Area fished and ports landed designations are the same as in Figure 10.

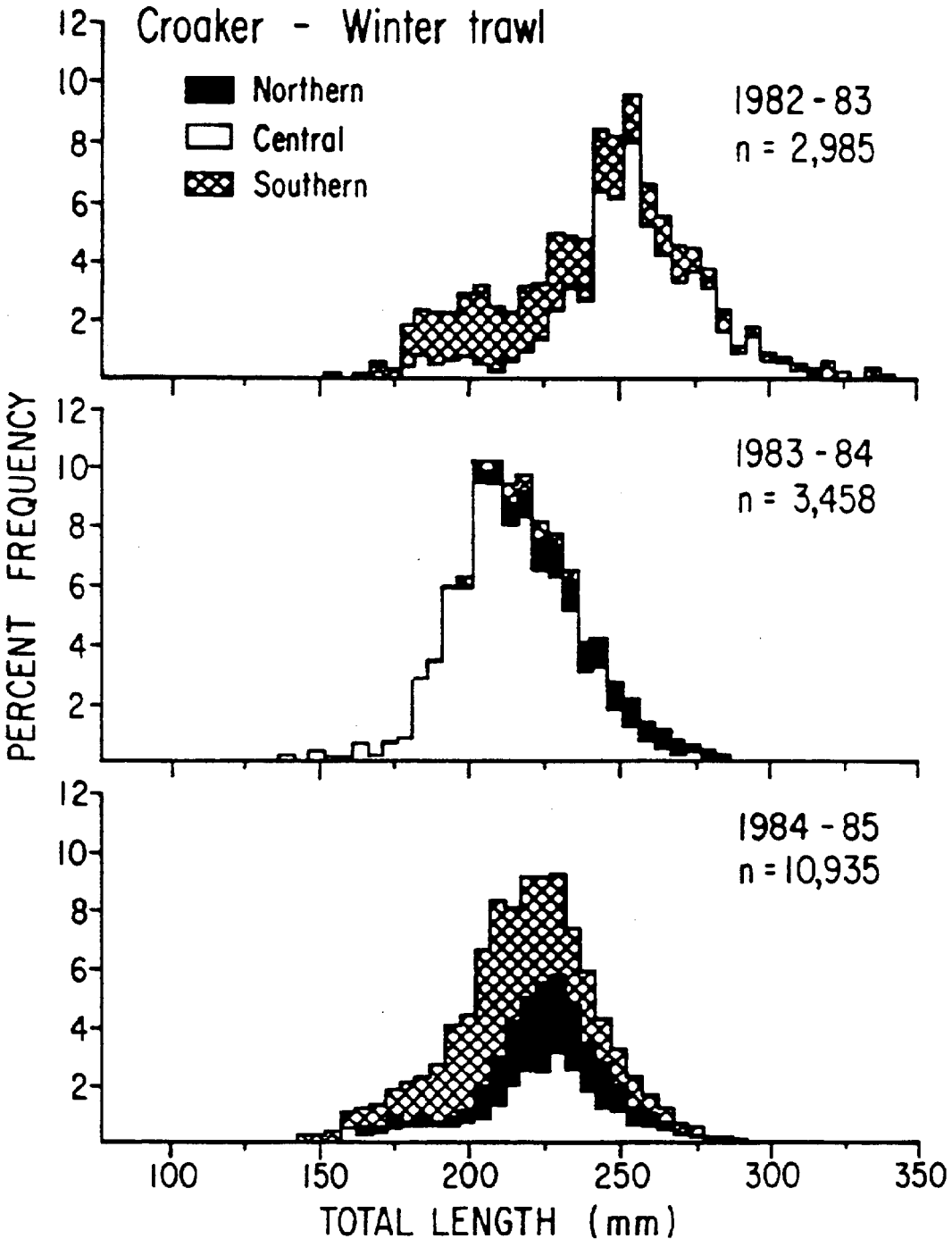

Figure 15. Expanded length-frequencies for Atlantic croaker, Micropogonias undulatus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

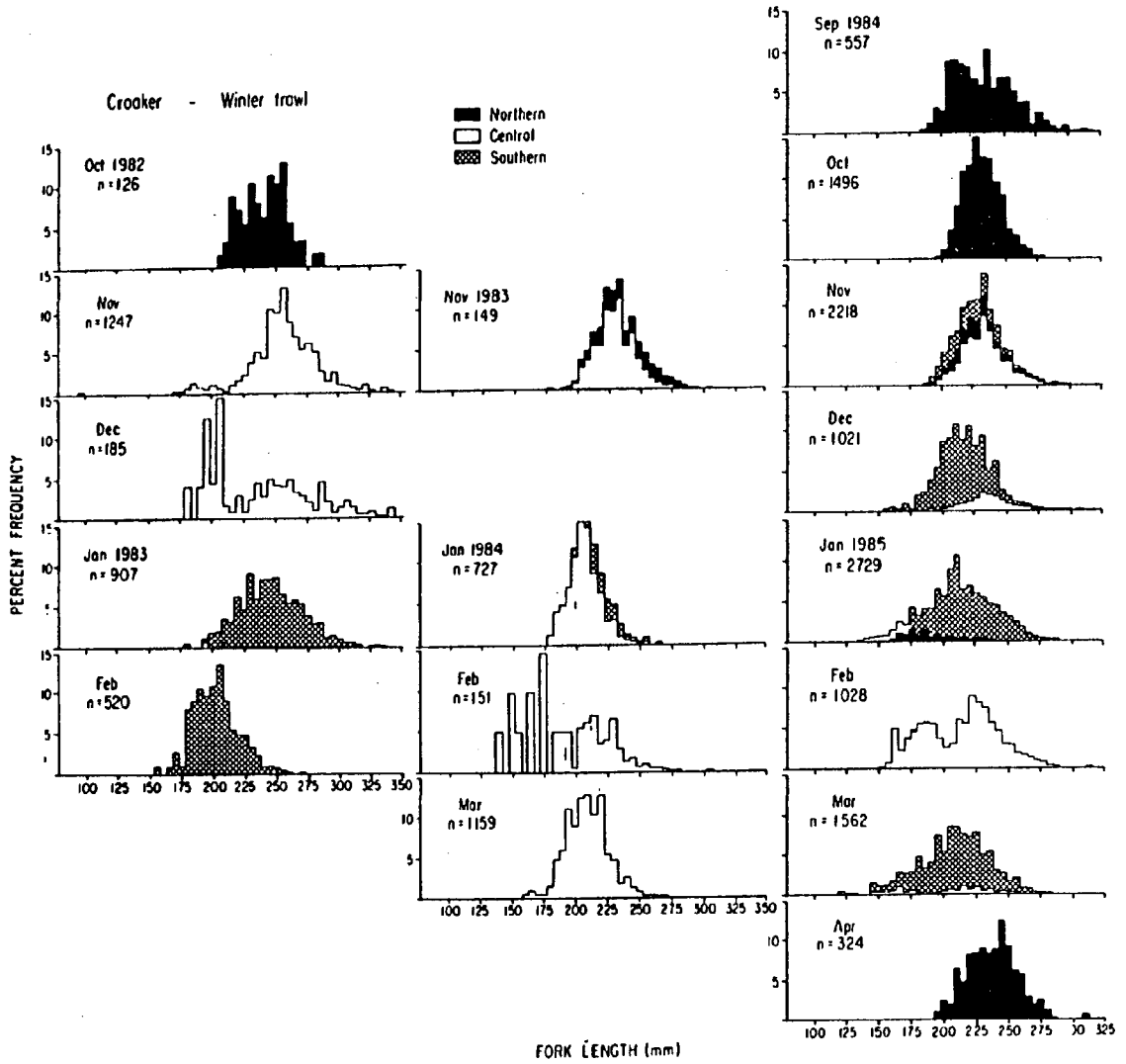

Figure 16. Monthly expanded length-frequencies for Atlantic croaker, Micropogonias undulatus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

decrease. For instance, croaker caught north of Cape Hatteras in September and October included very few fish <200 mm TL. This decrease in the lower limit of the size distribution in December or January may reflect a later migration of the smaller fish from the estuaries. The monthly length frequencies from the long haul fishery, which show the larger croaker disappearing after August or September and the smaller, presumably age 0 fish still present in October, add credence to this hypothesis.

Age/length relationships indicated that Atlantic croaker in the winter trawl fishery ranged from ages 0 to V in the 1982-83 season and 0 to IV the following two seasons (Figure 17). Ages I-III croaker comprised 99% of the samples, with age II fish dominating in 1982-83 and age I fish more prevalent the next two seasons. The almost complete absence of age 0 fish is a result of the October birthdate (Ross 1989), so that age I fish in winter trawl samples are the same group identified as age 0 in the long haul and pound net samples from the previous summer and fall (Ross et al. 1986). The age composition data also suggested that a substantial shift in age structure occurred in 1982, as evidenced by the large declines in proportions of age II and age III croaker and the doubling in the proportion of age I fish between the 1982-83 and 1983-84 seasons. This shift probably resulted from the recruitment of a very large 1983 year class seen during Spring 1983 in the DMF estuarine trawl survey (DeVries 1986) and as indicated in landings during January-April 1984, which were double the previous year's landings each month.

Bluefish

Trawler landings of bluefish declined from 3.9 million lb in 1982-83 to 0.8 million lb in 1984-85; their contribution to the total state bluefish landings decreased from 51.2% to 26.7%. Landings of bluefish statewide decreased from 7.6 million lb in 1982-83 (the highest on record) to 3.0 million lb in 1984-85 (Table 1). Landings in northern and southern ports declined considerably, particularly between the first two fishing seasons; landings in southern ports exceeded northern ports in 1982-83 but were less than half that of northern ports the last two seasons (Table 18).

The CPUE of bluefish was highest in 1982-83 (2,635 kg) and lowest in 1983-84 (198 kg) (Table 14). Catches were considerably greater north of Cape Lookout than south, where they averaged <100 kg/trip (Table 16; Figure 18). The CPUE of bluefish were greatest in both areas north of Cape Lookout in 1982-83 (north: 2,593 kg/trip; central: 1,225 kg/trip) and lowest in 1983-84 (north: 138 kg; central: 254 kg).

Flynet catches of bluefish were sporadic even during their peak season due to the schooling nature of the fish and its fluctuating marketability (Table 17; Figure 18). This was, in part, the reason that no "bluefish catches" were sampled in 1983-84. During 1982-83, the average catch north of Cape Hatteras was highest in January, while south of Hatteras it was highest in February and April (Figure 18). In 1984-85, catches were highest south of Hatteras in March and north of Hatteras in April. Generally, large bluefish were caught between Cape Hatteras and Cape Lookout through the winter, around Diamond Shoals in March and north to Wimble Shoals and off Oregon Inlet in April. Commercial landings in both areas generally increased through the fishing season, with landings greatest from February through April (Figure 18).

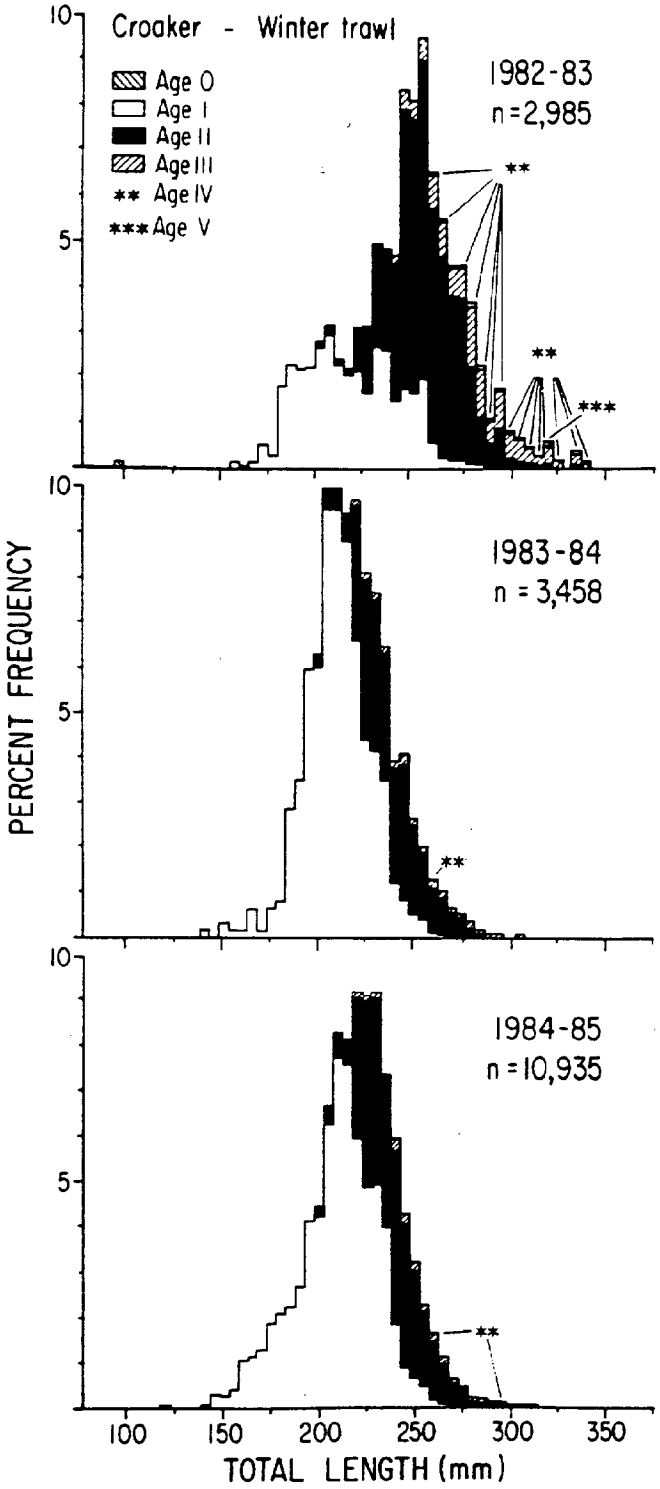

Figure 17. Expanded age composition of Atlantic croaker, Micropogonias undulatus, in winter trawl catches sampled September 1982- April 1985.

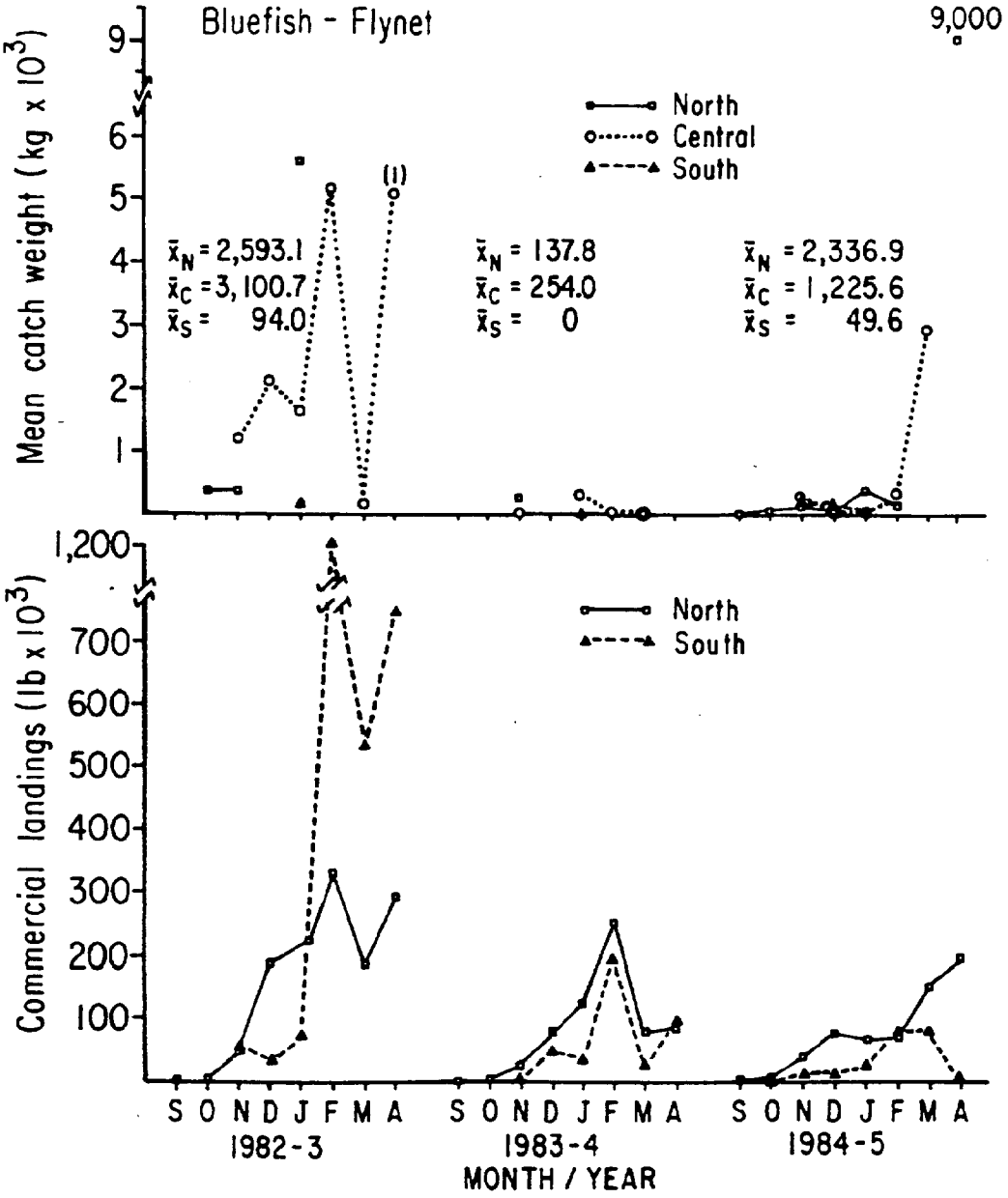

Figure 18. Monthly mean total weight/trip of bluefish, Pomatomus saltatrix, in flynets by area fished and commercial landings data for North Carolina winter trawl fishery, September 1982-April 1985, by ports where fish were landed. Area fished and ports landed designations are the same as in Figure 10.

Catches north of Cape Hatteras accounted for the greatest proportion (63.6-76.1%) of bluefish during the 1983/84 and 1984/85 seasons, while more were observed in catches from Hatteras to Lookout (72.6%) in 1982-83. Less that 1.0% of the bluefish in the catches sampled were caught west of Cape Lookout. The decline in flynetting activity after 1982-83 in the central area was probably responsible for the decline in catches of bluefish sampled the latter two seasons.

Although captured by all trawl gears off North Carolina, flynets generally produced the preponderance of bluefish. North of Cape Hatteras 91.4 and 80.4% of the bluefish sampled in 1982-83 and 1984-85 were caught in flynets, while in 1983-84 58.7 and 32.7% were caught in deepwater and nearshore flounder trawls, respectively. From Cape Hatteras south, 90.7-100% were caught in flynets. Only in 1983-84 were more bluefish sampled from a gear other than flynets in any one area.

Bluefish captured by winter trawlers encompassed a broad range of sizes reflecting the importance of the Cape Hatteras area as a wintering ground (Wilk 1977). They ranged from 170 to 831 mm FL in 1982-83, 155-844 mm FL in 1983-84 and 161-861 mm FL in 1984-85 (Figure 19). Small fish (201-400 mm FL) dominated (82.2%) 1982-83 catches with large fish (>600 mm FL) contributing 8.7% of the fish sampled (Table 21). Bluefish 101-400 mm FL dominated the catches (79.2%) in 1983-84, while fish >600 mm FL contributed 8.0%. Large bluefish were more prevalent in 1984-85; fish <400 mm accounted for only 60.2% and fish >600 mm FL accounted for 30.7%; the relative abundance of fish 301-400 mm FL decreased.

Small bluefish (200-450 mm FL) were captured throughout the fishing season, with larger fish (>500 mm FL) first appearing in late November-December and most abundant in March-April (Figure 20, Table 22). In 1982-83 small fish (200-400 mm) were dominant from October to March, with the smallest of these caught south of Cape Hatteras; larger fish (>400 mm FL) were caught in December, and were dominant south of Hatteras in February and April. In 1983-84, fish 150-350 mm FL dominated catches north of Hatteras in November, after which fish 250-450 mm FL occurred in catches north and south of Cape Hatteras. Fish >500 mm first appeared in November and were prevalent in December, February and March catches. Similarly in 1984-85 small bluefish (200-350 mm FL) dominated catches north and south of Cape Hatteras through February. Large bluefish (500-850 mm FL) first appeared in catches in November, were abundant north of Hatteras in December, and dominated catches south of Hatteras in March and north of Hatteras in April.

Several seasonally persistent spatial-temporal patterns in bluefish size distribution were observed (Figure 20, Table 22). First, the occurrence of fish 101-400 mm in all areas; second, fish >400 mm were caught north of Cape Lookout each year; and finally, large fish (>600 mm) accounted for the largest proportion of the catches north of Cape Hatteras. The fluctuations in relative abundance of the different size classes in the different areas from year to year, together with varying fishing patterns in search of the more lucrative croaker and trout, will influence the size distribution of bluefish captured. In the past few years, the only consistent flynetting specifically aimed at bluefish occurred each year in March-April north of Hatteras and in mid-winter south of Cape Hatteras in 1982-83.

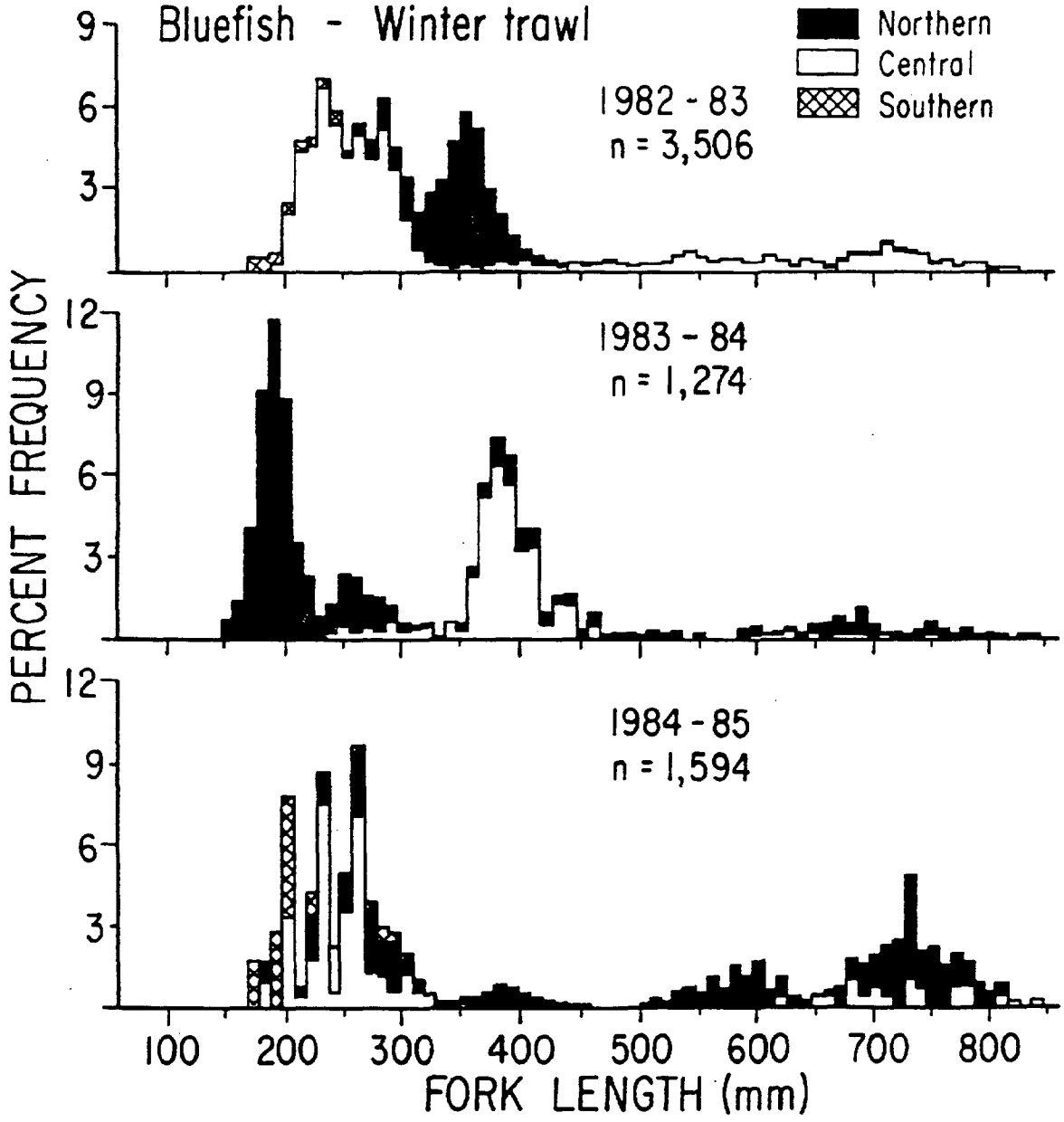

Figure 19. Expanded length-frequencies for bluefish, Pomatomus saltatrix, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

Table 21. Size composition of bluefish, Pomatomus saltatrix captured by North Carolina winter trawlers, 1982-1985 in all areas combined.

	Percent frequency/size class						
Season	101-200	201-300	301-400	401-500	501-600	601-700	>700
1982-83	2.2	49.7	32.5	3.0	3.9	4.0	4.7
1983-84	31.8	20.5	26.9	11.3	1.5	5.3	2.7
1984-85	8.9	45.3	6.0	1.2	7.9	8.0	22.7

Table 22. Size composition of bluefish, Pomatomus saltatrix, sampled from the winter trawl fishery north of Cape Hatteras (North), Cape Hatteras to Cape Lookout (Central), and west of Cape Lookout (South) during the 1982/83 - 1984/85 seasons.

			Percent frequency/size class (FL, mm)						
Season	Area	Catches sampled	101-200	201-300	301-400	401-500	501-600	601-700	>700
1982-83	North	4		12.5	82.0	3.5	0.4	0.6	1.0
	Central	17	1.2	71.6	4.9	2.9	6.1	6.2	7.1
	South	13	50.0	50.0					
1983-84	North	4	48.0	27.6	6.0	5.8	2.2	6.8	3.6
	Central	12		6.5	68.2	21.9	0.1	2.3	1.0
	South	1							
1984-85	North	16	1.3	27.0	7.9	2.3	15.4	10.1	36.0
	Central	11	10.3	65.8	5.0	0.1		7.4	11.4
	South	9	38.9	60.8	0.6				

Table 23. Mean fork length (mm) at age for bluefish, Pomatomus saltatrix sampled during the 1982/83 -1984/85 winter trawl fishery seasons, including number of fish aged (N) and range of FL/age class.

	1982-83			1983-84			1984-85		
		Mean			Mean			Mean	
Age	N	FL	Range	N	FL	Range	N	FL	Range
0	122	269.7	194-346	71	255.6	152-312	62	275.4	216-350
I	83	389.1	274-508	50	396.2	273-461	97	403.7	333-488
II	41	543.9	481-607	16	484.4	341-355	24	538.5	475-591
III	12	614.8	569-652	17	620.7	523-655	20	595.8	527-667
IV	26	684.2	635-725	25	672.4	631-710	11	682.0	564-744
V	15	720.0	685-753	9	721.8	698-758	38	720.9	658-778
VI	3	745.0	720-769	9	760.6	728-792	24	759.7	730-815
VII	5	791.8	777-813	6	794.8	732-819	23	771.4	728-811
VIII	2	844.5	820-869	3	813.3	795-831	8	812.5	772-845
IX							1	840.0	
X				1	842.0		1	805.0	
XI							2	839.0	823-855

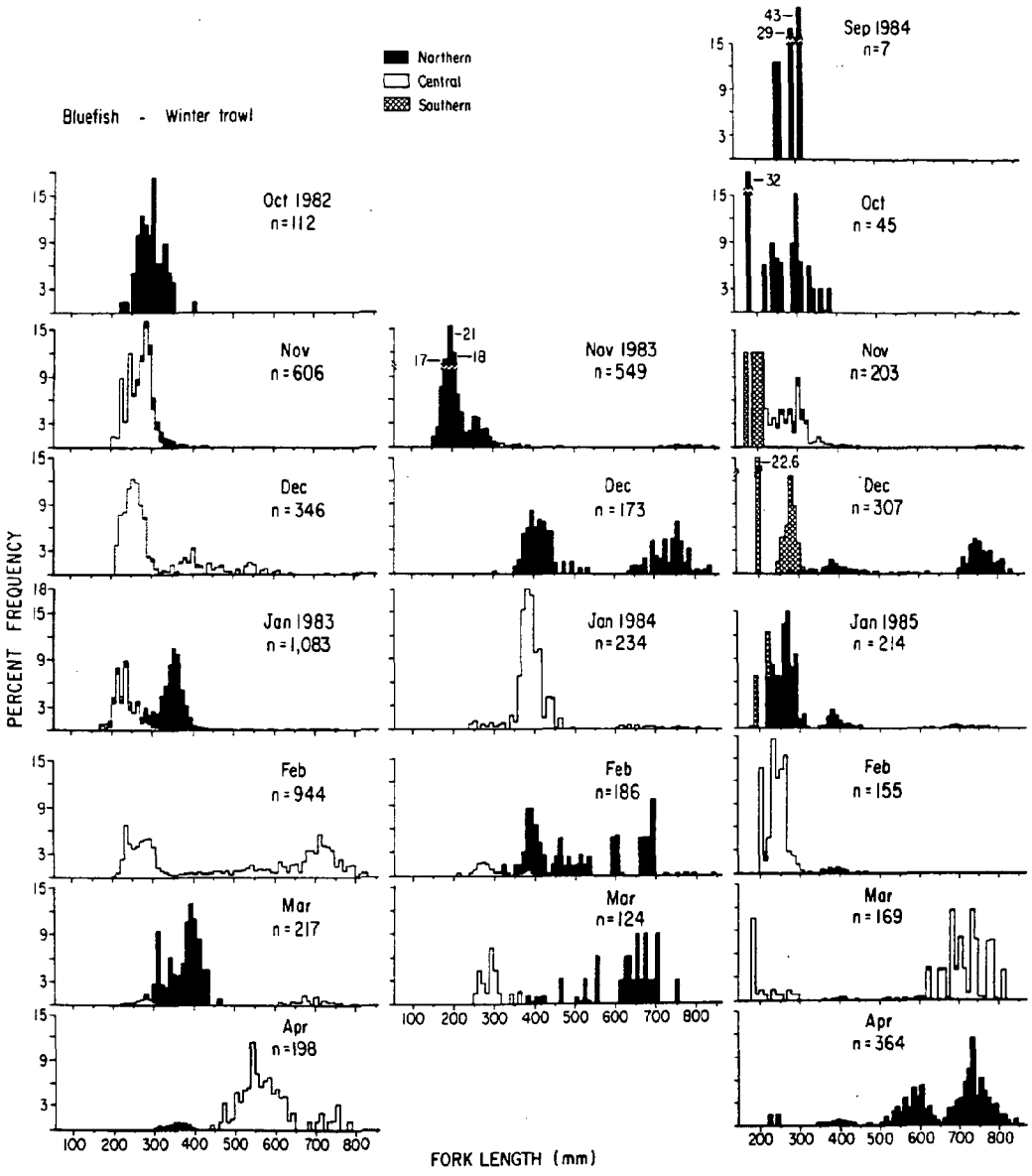

Figure 20. Monthly expanded length-frequencies for bluefish, Pomatomus saltatrix, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

Winter trawlers captured bluefish age 0 to XI although age 0 fish constituted 52.7-58.5% of the catches (Figure 21; Table 22). Age 0 and I fish dominated catches in 1982-84 (87.7%-88.8%) with only a few age IV or older fish (7.0% and 5.6%). In 1984-85 age 0 fish were still dominant (52.7%), but age I fish were much less abundant and fish age IV or older bluefish accounted for 30.7% of the fish sampled. Table 23 presents the average size/age of bluefish in the winter trawl fishery.

Spot

Trawlers account for only a small fraction (1.6-5.0%) of the state's spot landings, and southern ports account for the greatest portion. Trawler landings were highest in 1983-84 and lowest in 1982-83, while overall state landings were highest in 1982-83 (4.9 million lb) and lowest in 1983-84 (3.1 million lb) (Table 1). Landings in northern ports ranged from 12,000 to 17,000 lb/season, while southern ports ranged from 63,000 to 139,000 lb/season (Table 18).

CPUE of spot ranged from 369 kg/trip in 1982-83 to 1,391 kg/trip in 1984-85 (Table 14). This increase was seen in all areas. North of Cape Hatteras catches were lowest in 1983-84 (80 kg) and highest in 1984-85 (356 kg); Cape Hatteras to Cape Lookout catches increased from 112 kg/trip in 1982-83 to 1,062 kg/trip in 1984-85; catches west of Cape Lookout were lower in 1982-83 (2,237 kg) than 1984-85 (3,443 kg) (Table 16, Figure 22).

North of Cape Hatteras and from Cape Hatteras to Cape Lookout, catches of spot were largest in November and February, respectively. Landings in northern ports were highest in October and November and March and April (Table 17, Figure 22). West of Cape Lookout catches were sampled too infrequently to determine any patterns. Landings from southern ports were high in November and during January to April in 1982-83, December to April in 1983-84, and November to February in 1984-85.

Spot ranged from 93 to 308 mm FL, although most were 135 to 195 mm; annual modes were between 155-180 mm (Figure 23). Annually, spot were 124-252 mm FL during the 1982-83 season, 118-242 mm during 1983-84, and 93-308 mm during 1984-85. Very large proportions--84.8, 67.6, and 78.2%--were less than the minimum marketable size of 180 mm FL during the respective seasons; almost all the remainder --14.5, 31.3, and 20.9%--were in the sometimes-marketable 180-199 mm size range. During the same seasons spot $\geq$200 mm FL made up only 0.7, 1.1, and 1.0% of the catches.

Monthly size distributions of spot were singularly unimodal every month during all three fishing seasons in all three areas (Figure 24). Ranges and modes of the size distributions were very similar every month, with no indication of recruitment of different sizes or growth of the original fish occurring from September through April. The only exception to this uniformity was a slight (about 15 mm) decrease in the mode between October and November in 1982 and 1984 and between November and December in 1983.

Although the length frequency distributions were unimodal over a narrow range of sizes, suggesting the dominance of one age group, analysis of scale data indicated that two age classes, 0 and I, comprised the vast majority of the samples (Figure 25). These two respective age groups made up 47.7 and 49.6% of the samples in 1982-83, 16.9 and 74.5% in 1983-84, and 65.5 and 28.5% in 1984-85. Two year olds were a minor component, comprising 2.6, 8.6, and 7.0% of the fish sampled during those same sea-

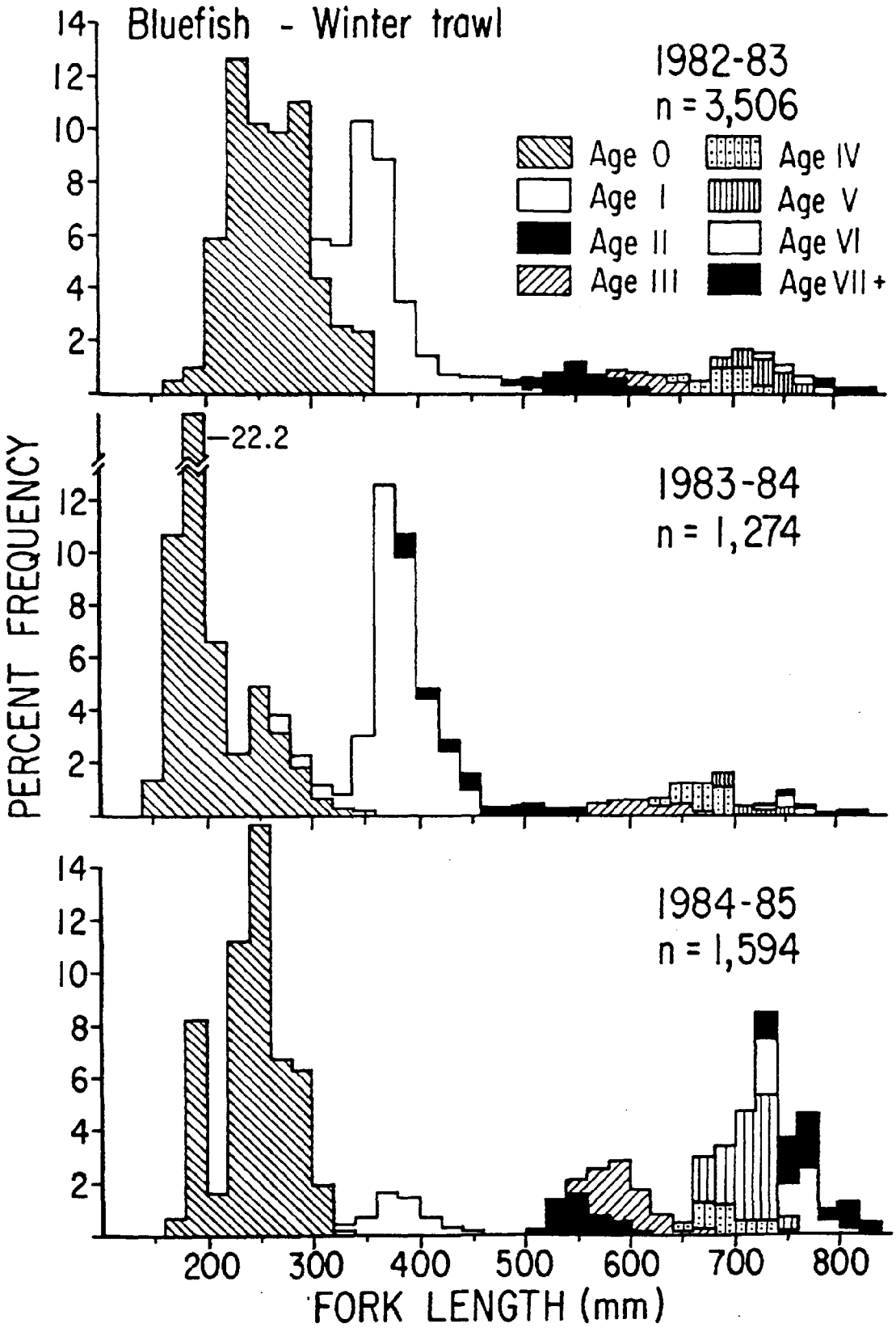

Figure 21. Expanded age composition (20 mm TL size class) of bluefish, Pomatomus saltatrix, in winter trawl catches sampled September 1982-April 1985.

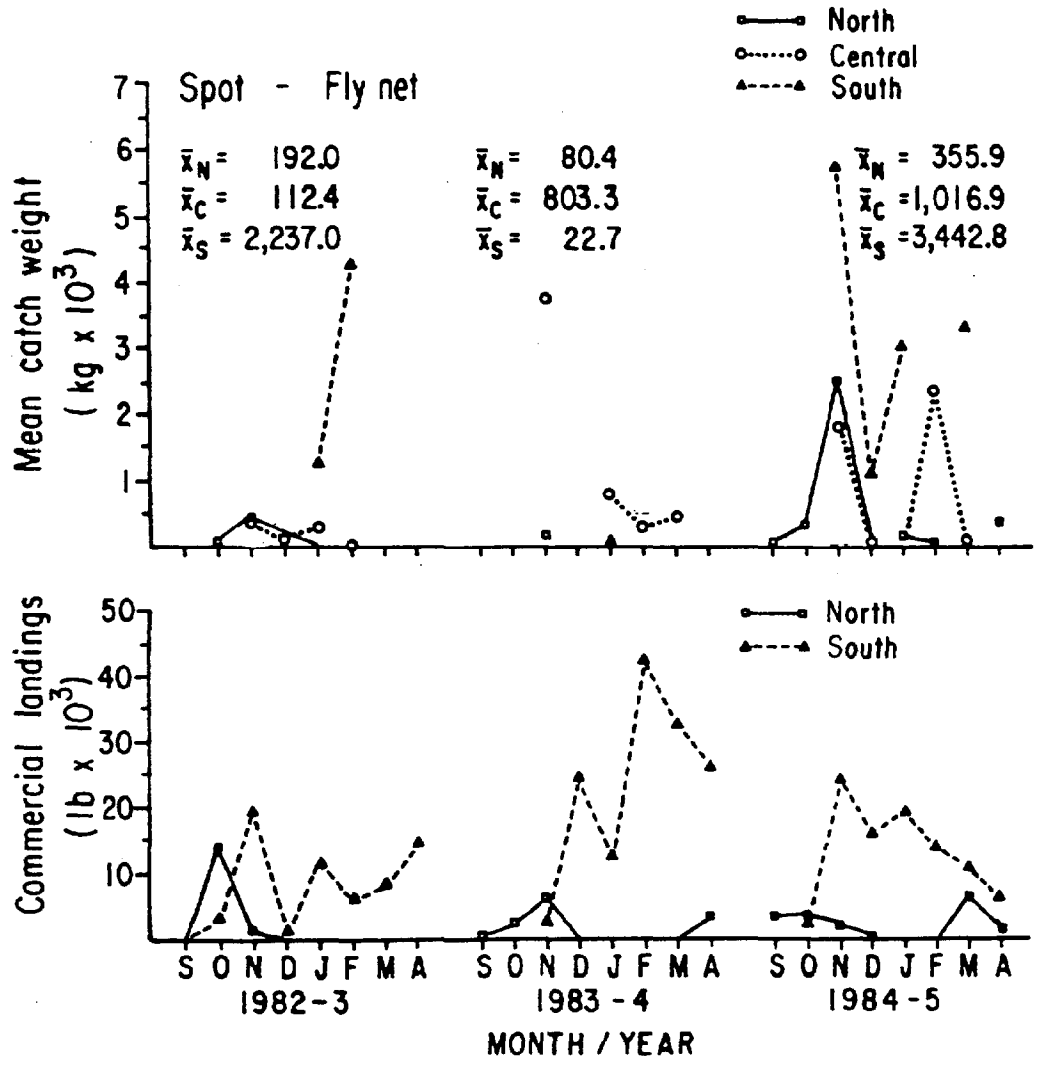

Figure 22. Monthly mean total weight/trip of spot, Leiostomus xanthurus, in flynets by area fished and commercial landings data for North Carolina winter trawl fishery, September 1982-April 1985, by ports where fish were landed. Area fished and ports landed designations are the same as in Figure 10.

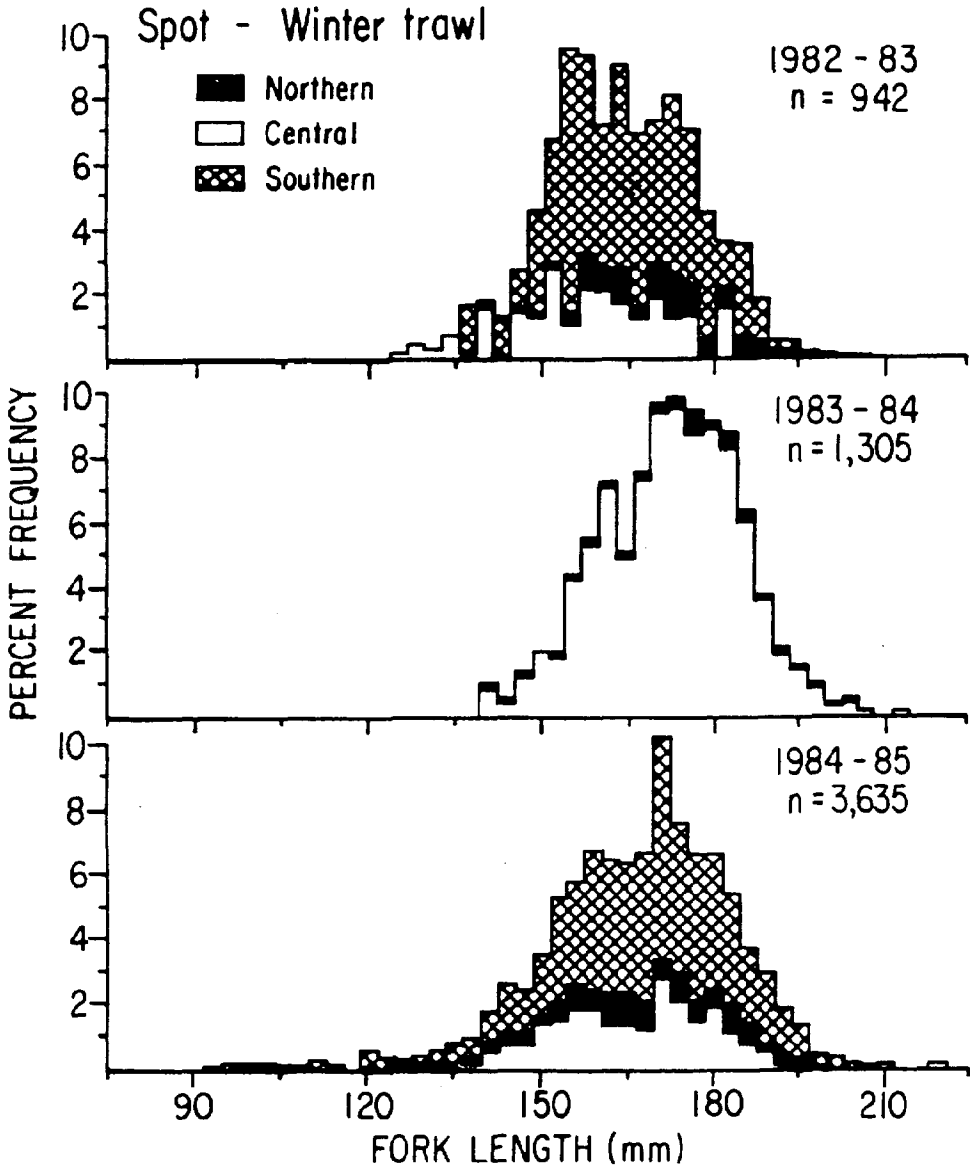

Figure 23. Expanded length-frequencies for spot, Leiostomus xanthurus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

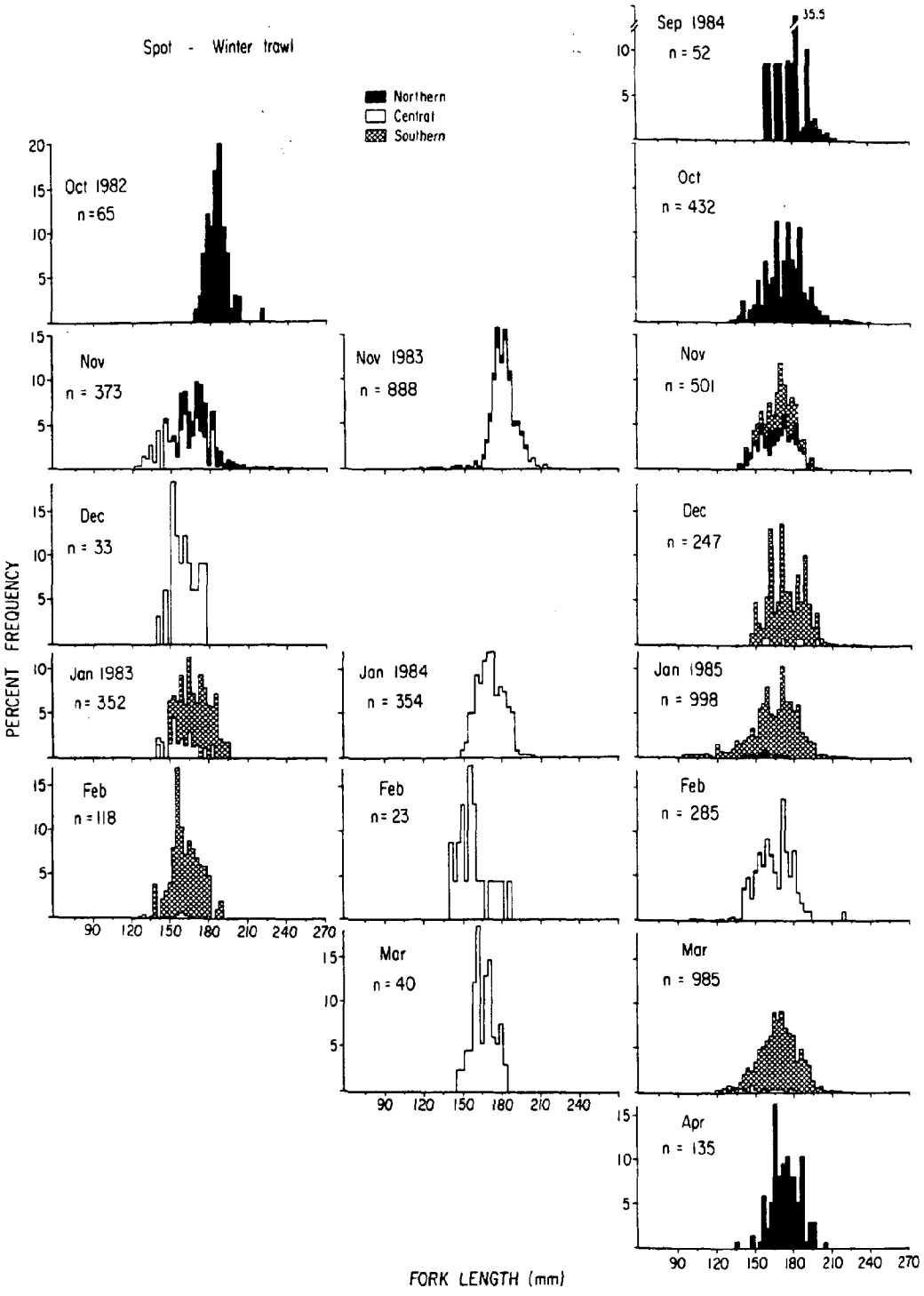

Figure 24. Monthly expanded length-frequencies for spot, Leiostomus xanthurus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

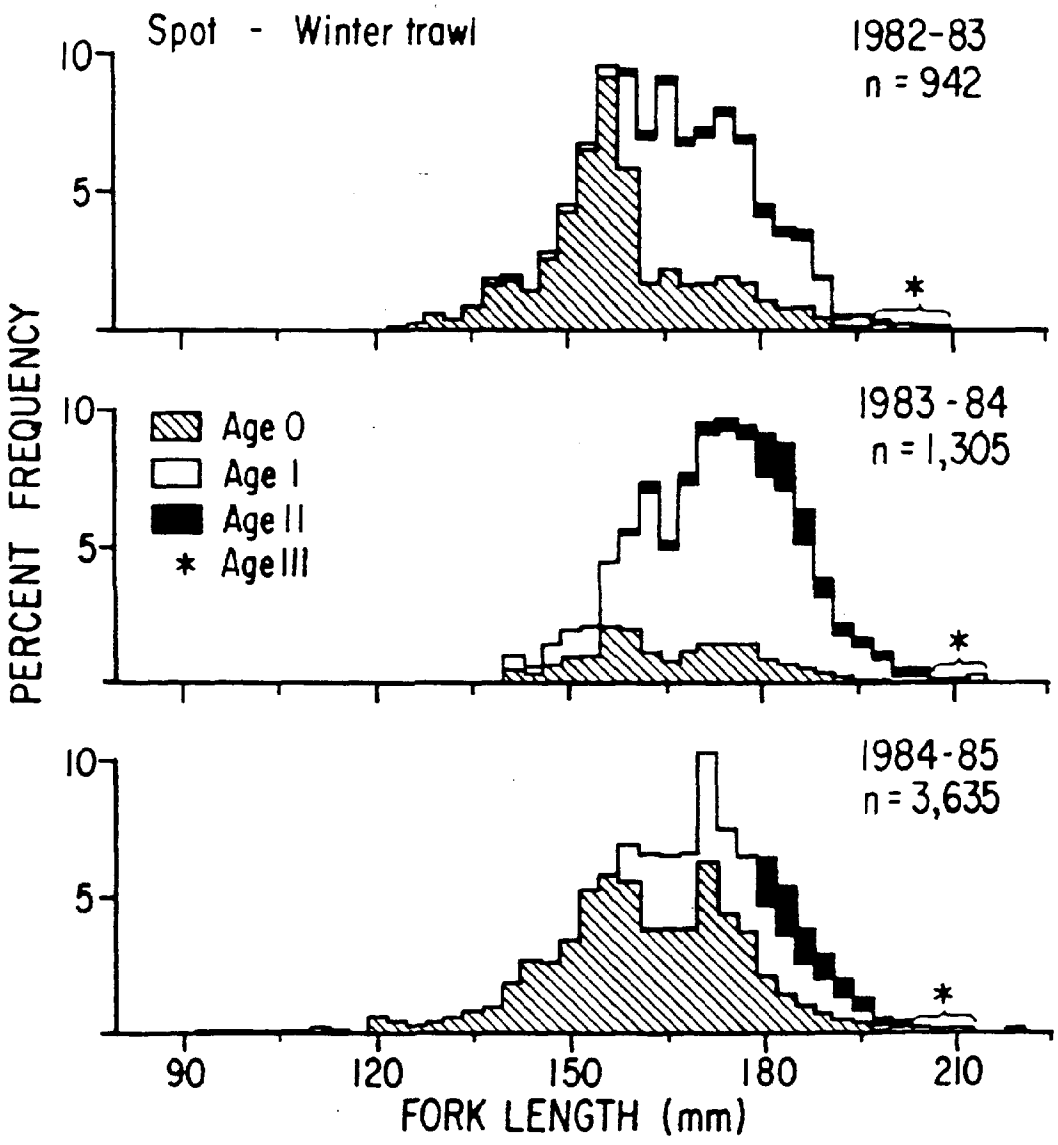

Figure 25. Expanded age composition of spot, Leiostomus xanthurus, in winter trawl catches sampled September 1982-April 1985.

sons, while age III spot were almost nonexistent, comprising only 0.01-0.03%. Because all winter trawl age compositions were calculated using fall (August-December) age-length data, and because January 1 is considered the birthday for spot in North Carolina (DeVries 1986), all ages in the above discussion could be advanced one year for fish taken after December, although it would still be dealing with the same year classes.

Butterfish

Winter trawlers produced greater than half of North Carolina's butterfish landings in 1982-83 (163,887 lb), 1983-84 (83,000 lb), and 1984-85 (114,000 lb) (Table 1). Northern ports accounted for 39.1-63.0% of these landings (Table 18). State landings of butterfish were highest in 1982-83 (298,000 lb) and lowest in 1983-84 (116,000 lb) (Table 1).

The average CPUE of butterfish by flynets was greatest in 1984-85 (248 kg/trip), slightly less in 1982-83 (202 kg/trip) and least in 1983-84 (37 kg/trip). Catches by flynets north of Hatteras exceeded the other areas sampled each year, and were greatest in 1982-83 (500 kg/catch) and 1984-85 (401 kg) (Figure 26, Table 16). Catches of butterfish in deepwater (Table 12) were greatest in 1983-84 (254.6 kg/catch) and low in 1984-85 (55 kg) and 1982-83 (21 kg). Catches in the flounder fishery (Table 8) were generally <30 kg/trip each season.

Seasonal trends based on CPUE were difficult to discern. Catches were high in October 1982 (n=1) and December-January 1984-85 (Figure 26). Landings were high during September-November 1982, January to April 1983-84 and October, November, February and April 1984-85. The early and late season peaks in landings correspond with inshore flynetting and deepwater trawling, respectively.

Butterfish were somewhat larger the last two fishing seasons than in 1982-83. Butterfish ranged from 53 to 224 mm FL, 93 to 228 mm FL and 82 to 229 mm FL during the three seasons, respectively (Figure 27). The percent of fish exceeding 120 mm, which is approximately marketable size, increased from 75.1% in 1982-83 to 91.8% in 1983-84 and 83.8% in 1984-85. Fish >180 mm FL accounted for 1.8, 24.6 and 17.3% of the butterfish sampled during the respective fishing seasons.

DISCUSSION

Overall landings of edible finfish in North Carolina have declined from a peak in 1980 (Table 24). Annual landings from winter trawlers in North Carolina which were less than 10 million lbs prior to 1971, increased to more than 30 million lb annually from 1978 through 1981; since then they have ranged between 18 and 25 million lb (Table 25).

The winter trawl fishery accounted for 31.5-35.9% of the state's edible finfish, and landings increased from 19.8 million lb during the 1982-83 fishing season to 22.4 million lb the next two seasons (Table 1). The diversity of species harvested by this fishery buffered it from decline, while long haul and pound net landings decreased each fishing season, largely because of diminished catches of croaker. Landings of edible finfish by long hauls decreased 30% from 1982 to 1984; pound net landings declined 62% from 1982 to 1983, then rebounded in 1984 to 65% of the 1982 landings (Ross et al. 1986).

The species composition and seasonality of the North Carolina winter trawl fishery is currently very similar to the fishery during its inception. In 1930-31, scup, croaker, summer flounder, black sea bass, hake

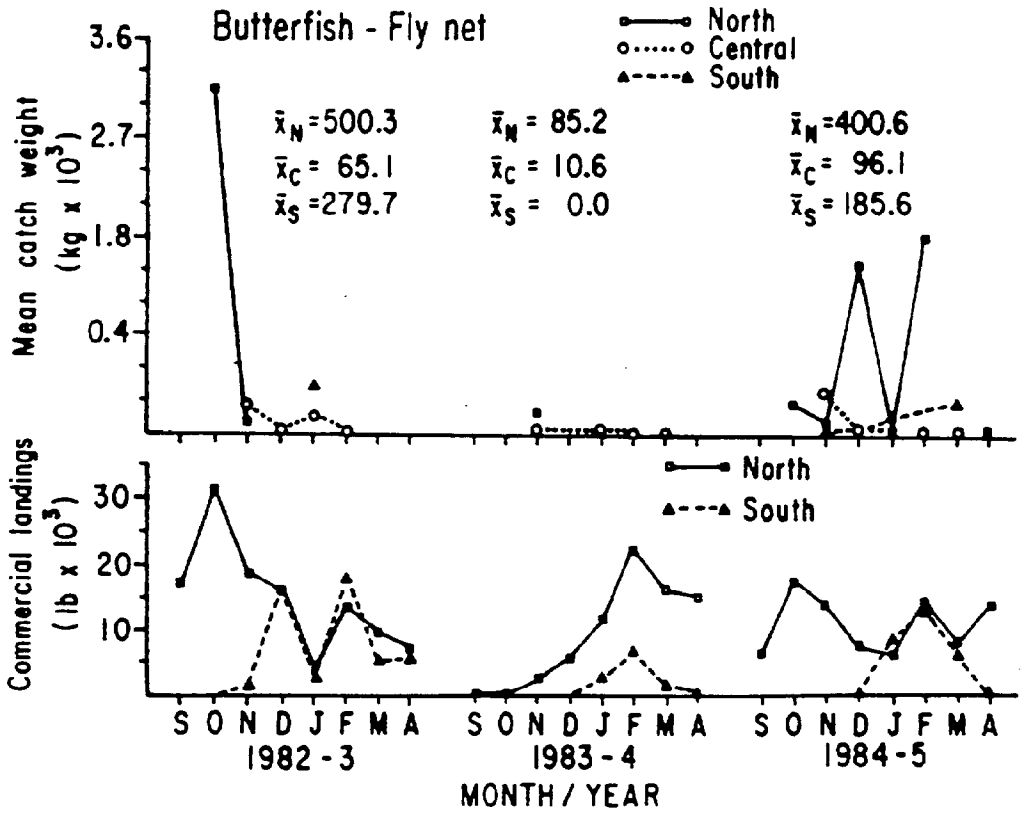

Figure 26. Monthly mean total weight/trip of butterfish, Peprilus triacanthus, in flynets by area fished and commercial landings data for North Carolina winter trawl fishery, September 1982-April 1985, by ports where fish were landed. Area fished and ports landed designations are the same as in Figure 10.

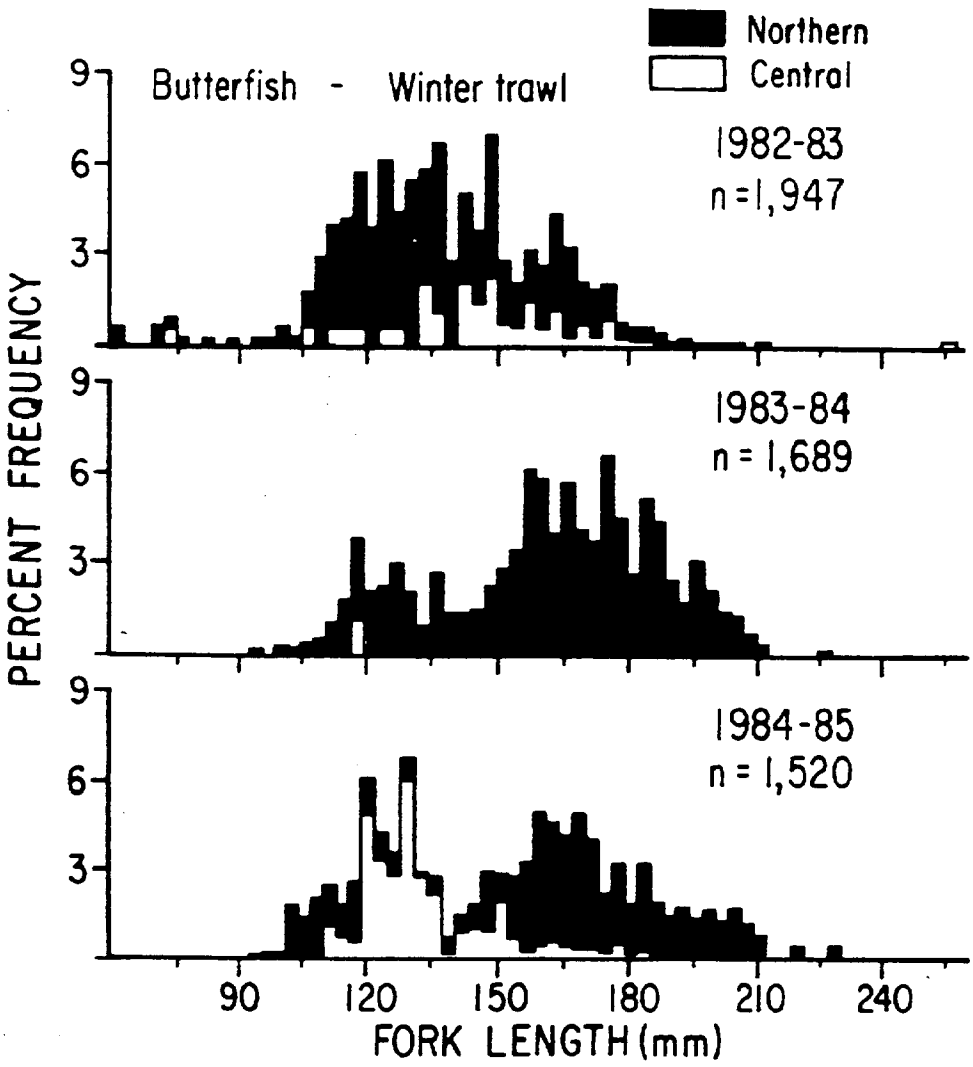

Figure 27. Expanded length-frequencies for butterfish, Peprilus triacanthus, from samples of September 1982-April 1985 winter trawl fishery by area (Northern = north of Cape Hatteras, Central = Cape Hatteras to Cape Lookout, Southern = west of Cape Lookout); n = number of fish measured.

Table 24. Total commercial landings (thousands of pounds) in North Carolina during 1965-1985 of finfish that are important components of the winter trawl fishery, with total weight of nine major species and their percent of the state's total edible finfish landings.

	Total edible finfish	Croaker	Flounder[+]	Weakfish	Bluefish	Spot	Black sea bass	Scup[*]	Butter-fish	Harvest-fish	Total weight of dominant species	Percent of state landings
1965	33,638	1,754	4,721	1,959	704	913	1,090	975	367	125	10,051	29.9
1966	32,567	1,267	4,017	1,896	821	1,091	1,267	1,923	503	72	8,001	24.6
1967	40,880	1,283	4,391	1,769	888	3,048	1,994	452	383	146	11,379	27.8
1968	33,378	1,201	2,602	2,286	872	1,575	1,193	171	107	70	8,536	25.6
1969	36,658	1,369	2,766	1,539	871	1,488	1,947	252	130	25	8,033	21.9
1970	29,833	807	3,163	2,441	495	1,529	1,178	199	132	27	8,435	28.3
1971	31,380	948	4,011	3,645	578	1,190	748	203	58	48	10,372	33.1
1972	40,733	4,109	4,655	7,373	1,167	3,902	635	37	88	51	21,206	52.1
1973	41,034	4,324	7,365	6,222	2,008	5,398	684	17	40	64	25,317	61.7
1974	47,241	6,082	11,812	6,056	2,183	5,607	1,317	33	76	17	31,740	67.2
1975	53,679	10,252	11,510	6,725	1,975	8,300	1,148	112	127	41	38,762	72.2
1976	53,771	15,038	11,452	8,714	1,356	2,674	573	204	54	25	39,234	73.0
1977	61,755	18,995	11,137	8,671	2,331	3,805	1,465	118	47	48	44,939	72.8
1978	67,072	19,945	12,311	10,849	1,948	4,878	1,149	1,054	111	95	49,931	74.4
1979	82,248	20,558	18,457	14,759	3,406	7,303	1,375	1,298	181	31	64,483	78.4
1980	91,528	21,147	16,923	20,344	5,444	7,100	1,531	1,322	149	275	70,958	77.5
1981	68,826	11,205	9,795	16,894	6,610	3,512	1,197	1,503	281	150	48,016	69.8
1982	63,909	10,825	8,469	12,052	4,291	4,919	810	1,473	264	456	40,556	63.5
1983	53,634	7,250	9,820	10,234	6,747	2,952	533	666	108	244	37,003	69.0
1984	64,706	9,171	15,133	12,991	3,560	3,482	990	1,054	172	233	44,337	68.5
1985	64,470	8,714	10,965	9,825	3,604	4,044	1,219	588	159	350	39,468	61.2

[+] 1973-1986 data include all Paralichthys, not just P. dentatus. Actual landings of P. dentatus would be 15-20% lower.

[*] Scup landings for winter trawl fishery only to preclude inclusion of significant amount of porgy (Pagrus pagrus) landings together with scup, Stenotomus chrysops.

Table 25. Commercial landings (thousands of pounds) reported for winter trawlers landing fish in North Carolina, 1934 - 1985.

Year	Croaker	Spot	Blue-fish	Weak-fish	Flounder	Butter-fish	Harvest-fish	Black sea bass	Scup	Total edible finfish	Total scrap (bait)
34	-	-	-	-	6	-	-	-	-		
36	172	-	-	33	623	-	-	-	-		
37	28	-	-	8	80	-	-	-	-		
38	20	-	-	-	153	-	-	-	-		
39	17	5	2	4	302	5	-	1	11		
40	-	-	-	-	118	-	-	-	-		
45	315	6	-	146	250	-	42	7	84		
50	322	28	<1	394	1,222	2	103	10	30		
51	780	20	-	396	1,016	1	140	53	127		
52	621	79	-	809	1,654	38	116	35	74		
53	1,062	44	-	1,222	1,445	-	250	39	45		
54	774	102	-	1,116	1,311	-	123	30	41		
55	707	42	8	704	935	-	58	5	15		
56	4,135	79	10	1,250	788	30	65	43	95		
57	2,198	107	8	1,494	784	80	-	7	15		
58	5,694	63	5	2,828	518	68	3	10	20		
59	2,185	157	10	2,148	1,156	188	10	21	25		
60	1,538	329	8	1,744	909	107	9	37	135		
61	1,227	366	15	1,829	1,535	193	7	297	234		
62	1,152	212	5	1,765	1,550	64	1	971	271		
63	1,548	125	4	1,411	2,277	111	-	526	179		
64	1,285	92	3	1,559	1,861	61	-	613	479		
65	1,269	71	3	1,527	3,667	204	41	629	975	9,848	3,947
66	1,030	39	18	1,502	3,416	384	8	637	1,923	9,835	3,786
67	914	301	12	1,323	3,771	362	2	634	452	8,815	4,631
68	922	181	11	1,963	1,838	61	2	627	171	6,542	2,534
69	1,174	229	16	1,151	2,044	112	1	478	252	6,314	943
70	596	3	23	2,030	2,579	132	-	424	199	6,999	1,345
71	636	<1	50	3,214	3,573	49	-	254	203	9,037	1,053
72	3,127	226	320	6,563	3,761	72	-	-	37	14,776	
73	1,278	876	1,062	5,030	6,314	27	-	106	17	15,273	
74	1,887	368	479	4,942	10,028	57	-	126	33	18,185	
75	3,117	348	549	4,935	9,539	88	-	481	112	19,661	
76	8,228	145	164	6,787	9,627	48	-	294	204	26,200	
77	9,758	564	1,227	5,562	10,336	31	-	1,189	118	29,286	
78	10,898	1,230	1,078	7,388	10,820	77	8	<1	1,054	34,028	2,098
79	8,074	849	1,752	10,830	16,084	111	-	806	1,297	41,573	8,992
80	5,534	639	2,883	13,550	13,646	93	16	760	1,322	39,434	4,200
81	1,972	96	4,338	11,706	7,459	161	15	647	1,502	32,239	3,128
82	1,834	80	1,594	7,942	6,315	143	106	426	1,473	21,099	2,016
83	215	75	3,717	5,675	7,057	73	27	158	666	18,530	3,035
84	2,273	169	1,089	6,393	12,510	121	7	594	1,054	25,525	3,858
85	2,194	166	888	3,968	8,657	113	27	817	598	18,373	3,540

and weakfish were the top six species landed (Pearson 1932). During that season, Atlantic croaker dominated catches in November (88%) and December (76%) when trawlers were fishing between Bodie Island and Ocracoke Inlet. Summer flounder increased in relative importance from November (4%) to December (12%). Scup (46%) and summer flounder (22-28%) dominated in January and February while croaker catches declined (23% to 6%) and black sea bass increased (2% to 14%) (Pearson 1932). Total landings were greatest in March when scup (43%), black sea bass (30%), and summer flounder (19%) were dominant. Eldridge (1962) described the trawl fishery for summer flounder through 1962. The pattern of fishing has changed very little from his description. In 1962 flounder were caught near shore (<25 fathoms) in November, and in deeper waters during the winter through April. Then, as today, the trawler fleet fished further offshore as the season progressed and by February was fishing close to the 100 fathom curve (Eldridge 1962).

The number of vessels in the winter trawl fishery has steadily increased since its inception. Eldridge (1962) reported an increase from 50 to nearly 100 from 1931-32 to the 1934-35 season, one-half of which were equipped to fish in deep water; after 1935 many of the smaller vessels left the fishery. During the 1961-62 season, 30 Hampton (VA)-based vessels fished the winter stocks. The landings reported by these trawlers (Eldridge 1962) were higher than current landings by North Carolina vessels during the last three seasons for scup (4.9-10.6 million lb) and black sea bass (2.7-9.2 million lb) but much lower for flounder (0.5-1.8 million lb). From 1982 through 1985, 96 to 145 trawlers were reported fishing out of North Carolina ports. [2]

The most significant change since the 1960s, besides general modernization of vessels is the use of the flynet, which has increased the catches of weakfish and bluefish. These species, together with croaker, are now caught throughout the fishing season, particularly south of Cape Hatteras.

The percent of scrap fish in the landings and catches sampled generally increased during this study. This could indicate some degree of growth overfishing, since the relative abundance of the species has not dramatically changed, and three species (croaker, spot, and weakfish) make up the bulk of the scrap fish landed. The reported landings of scrap fish were highest for trawls in 1984-85. The predominance of spot and croaker in the scrap portion of trawler catches corresponded with their dominance in the industrial fish fishery from 1962 to 1964 reported by Fahy (1966). Weakfish, which are currently prevalent in the scrap, were less abundant in the early 1960s while butterfish, longspine porgies and pigfish were more abundant among the scrap fish. Since the late 1960s, a directed industrial fishery has been illegal in North Carolina.

Weakfish

Commercial landings of weakfish along the east coast during the past 40 years have attained two peaks, one in the 1940s and the other during the 1970s (Wilk 1981, Mercer 1983). Most recently, Atlantic coast landings peaked in 1980 (third highest year in 104-year records). North Carolina's overall weakfish landings have sim-

[2] West, Katy H. 1988. personal communication, N.C. Div. Mar. Fish, Morehead City, N.C. 28557

ilarly fluctuated (Table 24), most recently reaching peak landings in 1980 (20.3 million lbs), the year east coast landings were also highest (Mercer 1983). All weakfish landings, however, have steadily declined since then (Boreman and Seagraves 1984).

Trawlers have landed most of the weakfish along the east coast in recent years, with North Carolina landings driving east coast commercial landings trends. During the 1940s, pound nets, haul seines, gill nets, and trawls took 63, 11, 3, and 23%, respectively. The same gears still dominated during the 1970s, accounting for 20, 11, 9, and 60%, respectively, but trawlers became the dominant gear (Wilk 1981; Mercer 1983). North Carolina trawl landings accounted for 35-44% of the weakfish caught during the peak years of 1979-1981 (Figure 28). From 1982 to 1985 their contribution declined from 45% to 24%. During this period however, North Carolina's sink net contribution to east coast weakfish landings increased from 7% to 22%, thus perpetuating North Carolina's dominance in overall weakfish landings (Table 1).

During this study, North Carolina trawler catches of weakfish declined from 6.7 to 3.9 million lb annually. Their proportion of the state landings declined from 59.5 to 37.2% and of east coast landings declined from 32.3-23.9%. Average flynet catches increased from 1982-83 to 1983-84, although landings declined. This discrepancy is partially attributable to decreased effort by trawlers in the Hatteras Bight area because of gear conflicts with sink nets; this reduced overall landings, although large catches still occurred. Landings continued to decline in 1984-85, corresponding with decreased average catches, as well.

Small weakfish (age 1+) dominated trawl catches (67-79%) annually, although ages I-XI were represented in the catches. Merriner (1973) similarly reported that weakfish were fully recruited to the fishery at age I. However, older weakfish were found in catches sampled during this study than were reported off North Carolina in 1916 (maximum age = VIII; Taylor 1916), 1967-1969 (maximum age = VI; Merriner 1973), and 1979-1981 (maximum age = IV Shepard 1982). Although fish age V or older never accounted for more than 2% of annual landings, several large catches of large weakfish (600 mm+ fish) were sampled. Sink net catches similarly evidenced concentrations of these fish working their way north from below Diamond Shoals in March and along Nags Head beaches in April (Ross 1989).

Reports of larger weakfish captured further north are consistent with our findings, not only between states, but within state waters. Shepard (1982) reported that landings from the spring mid-water trawl fishery out of Cape May caught fish predominantly greater than 550 mm TL and age V. The fall fishery from that port, however, harvested primarily one year old weakfish, but included fish up to age VII, and thus, similar to North Carolina catches. Within North Carolina waters, trawl catches west of Cape Lookout were generally composed of smaller fish than north of Cape Lookout and Cape Hatteras.

The exploitation of overwintering small weakfish in North Carolina waters will likely be an important management issue. Boreman and Seagraves (1984) stated that the recent declines in weakfish landings along the east coast coupled with declines in available recruitment indices suggested that landings would continue to decline. Yield-per-recruit and egg-per-recruit analyses indicated that weakfish from Maryland to North Carolina have been experiencing growth

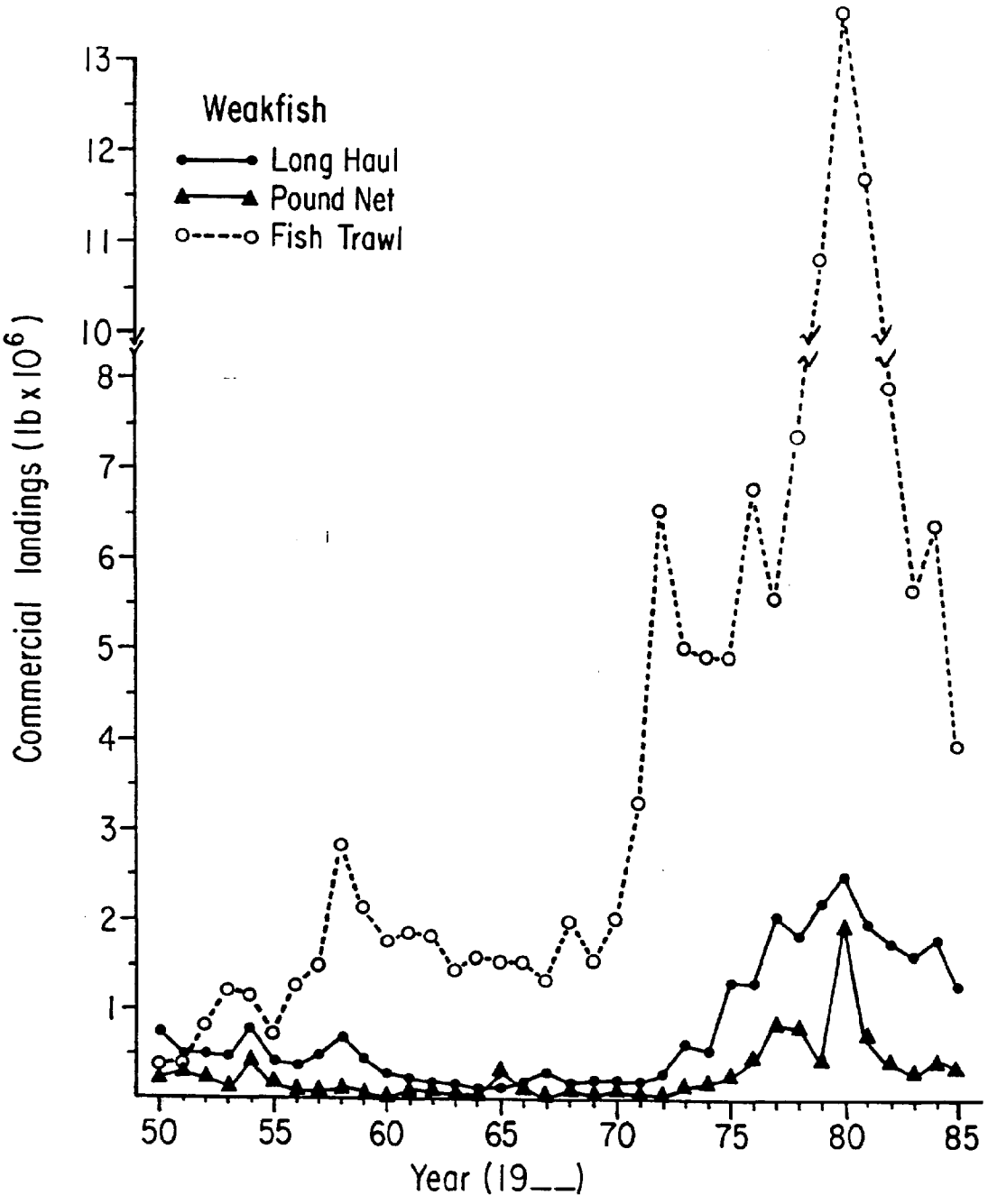

Figure 28. Annual commercial landings of weakfish, Cynoscion regalis, in North Carolina by long hauls, pound nets, and winter trawls from 1950-1985.

overfishing and recruitment overfishing in recent years, and North Carolina data may support these conclusions.

Summer Flounder

Trends in commercial landings of summer flounder and the exploitation by winter trawls in North Carolina parallel trends for the Mid-Atlantic region. Total U.S. commercial landings of summer flounder peaked in 1979 at nearly 42 million lbs. The reported landings in 1984 of slightly over 40 million lbs were the second highest on record. Even though landings decreased in 1985 by 5 million lbs, they were still among the five highest annual landings (MAFMC 1987). Ninety percent of these landings came from otter trawls (MAFMC 1987). Similarly, North Carolina's winter trawl landings of flounder peaked in 1979 and 1984 (Table 24), and the winter trawl fishery dominated these catches (Table 25, Figure 29).

The average CPUE of summer flounder and the reported landings for the trawl fishery both increased during this study. Nearshore flounder catches increased from 5,584 to 9,686 kg/trip, then declined in 1984-85 to 8,341 kg/trip; however, offshore flounder catches rose through the entire period (1,377 to 4,434 kg/catch). Summer flounder dominated the trawler catches sampled in 1983-84 and 1984-85, accounting for 43.0 and 31.6% of the weight, respectively, but ranked behind weakfish, scup and bluefish in 1982-83, accounting for 7.2%. Southern flounder accounted for <0.3% of the flounder sampled in the trawler catches.

Summer flounder have traditionally dominated the winter trawl fishery catches from late November through January during the "directed nearshore flounder fishery." This fishery encompasses depths of <10-25 fathoms from Chincoteague, VA to Ocracoke, NC and includes was the fishing grounds covered during the 1950s by the trawlers (Eldridge 1962). As the water temperature cools, summer flounder are caught in deeper waters (40-100 fathoms) near the shelf edge. They were harvested in this area, along with scup and black sea bass by the deepwater fishery; their contribution to this fishery increased from 10.3 to 38.2% during this study. Eldridge (1962) noted that trawlers did not fish any further south as this season advanced, suggesting the offshore movement followed the southerly migration.

Summer flounder caught during this study were smaller than those harvested in earlier years. Pearson (1932) reported a modal length of 400 mm during December-February catches and 350 mm during March-April catches. Eldridge (1962) found mean lengths increasing in catches from 389 to 445 mm for November through March. Modal lengths during this study were 320-340 mm FL with 64.7-67.6% between 301 and 400 mm.

We observed the pattern of smaller fish caught later in the fishing season noted by Pearson (1932). Eldridge (1962) attributed the increasing mean size to fishing in offshore waters. We noted comparatively more smaller fish captured offshore each season. This could be the result of fishing effort having reduced the relative abundance of larger fish through the season; captains claim they try to fish on concentrations of larger flounder during the earlier nearshore fishery. This situation could also reflect differential size distribution since most catches late in the season come from the deepwater fishery; larger fish may also migrate north earlier. It could also reflect the existence of two stocks in the Mid-Atlantic region (Delaney 1986).

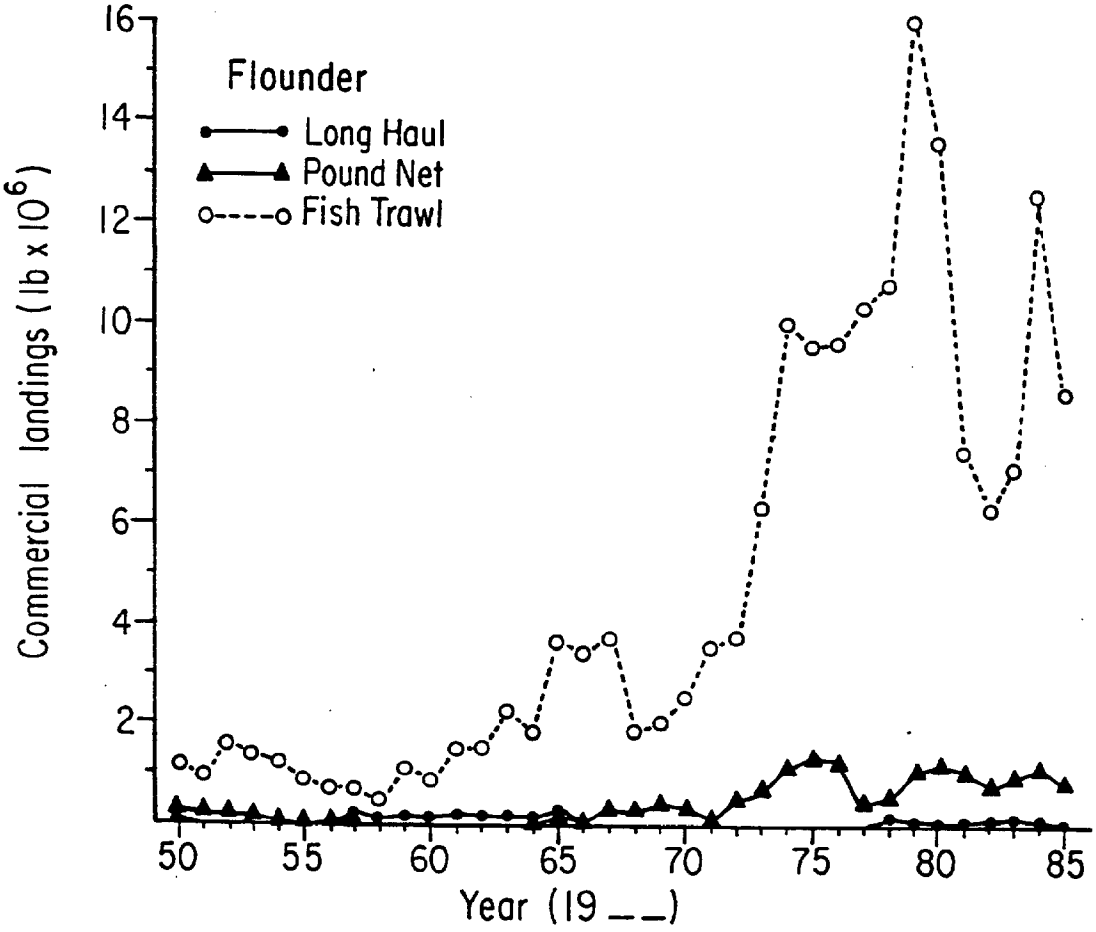

Figure 29. Annual commercial landings of flounder, Paralichthys spp., in North Carolina by long hauls, pound nets, and winter trawl from 1950-1985.

Reduced fish size (age) in the commercial catches was noted from 1976 to 1983 (MAFMC 1987). Estimates of catch at age for commercial landings from 1976 to 1983 indicated age I-IV fish comprised 94% of the landings, but that since 1980, the contribution of ages III and IV fish had declined from 49% to 28%, and age I and II increased from 46% to 66% (MAFMC 1987). The ranges of mean calculated total lengths of successive annuli are reported to be: II = 228-330; III = 330-381; IV = 355-431 for males and II = 228-381; III = 355-457; IV = 431-457 for females. This distribution would indicate that at least 53-57% of the fish we sampled were less than age II (<359 mm) each season. This would be consistent with the trend in the 1980s of fish of only ages I or II dominating the trawler fisheries (MAFMC 1987).

Recent stock assessment analyses have indicated that current harvesting is at or near the all time high and age composition of the stock is greatly compressed. Yield/recruit and long term yield can be increased by increasing the minimum size of fish caught and reducing fishing mortality (Fogerty 1981; MAFMC 1987).

Bluefish

Overall bluefish landings in North Carolina have generally increased during the last twenty years (Table 24, Figure 30). Landings rose to record levels in 1981 and 1983 (6.6-6.7 million lb), and then declined to 3.6 million lb in 1984 and 1985. During this study, bluefish accounted for 5.5 (1984) to 12.6% (1983) of the state's edible finfish landings (Table 1). North Carolina has dominated total Atlantic coast commercial bluefish landings (27-43%) from 1979 to 1985 (ASMFC 1987).

The most productive commercial gear for bluefish in North Carolina has shifted in the last two decades (Table 1, Figure 30). Long hauls landed most of the bluefish until 1977. From 1977 to 1983, trawlers dominated landings due to the development of the flynet and increased effort below Cape Hatteras. Sink nets replaced long hauls as the second most productive gear in 1979; in 1984, sink nets caught more bluefish than any other gear (Table 1).

Trawler landings in North Carolina have followed Atlantic coast bluefish commercial landings (Boreman and Seagraves 1984). Through 1971 trawler landings were less than 50,000 lb annually, while east coast landings were generally less than 6 million pounds. In 1973, both North Carolina winter trawl (1 million lb) and east coast commercial (8.5 million lb) landings increased. Since 1973, North Carolina winter trawl and east coast commercial landings have tracked similarly, both generally increasing through 1983, then declining. Winter trawl landings exceeded 1 million pounds from 1977 through 1984, while east coast landings exceeded 8 million pounds (Boreman 1983). Winter trawl (4.3 and 3.7 million lb) and east coast (15.8 and 16.1 million lb) landings both peaked in 1981 and 1983.

Trawl landings and CPUEs both declined during this study. Trawl landings fell from 3.9 to 0.8 million lb and their contribution to the state's landings dropped from over half to 26.7% in 1984-85. Likewise the average catch of bluefish in flynets was highest in 1982-83 and approximately half that in 1984-85. Long haul and pound net landings and CPUEs also declined during this period (Ross et al. 1986).

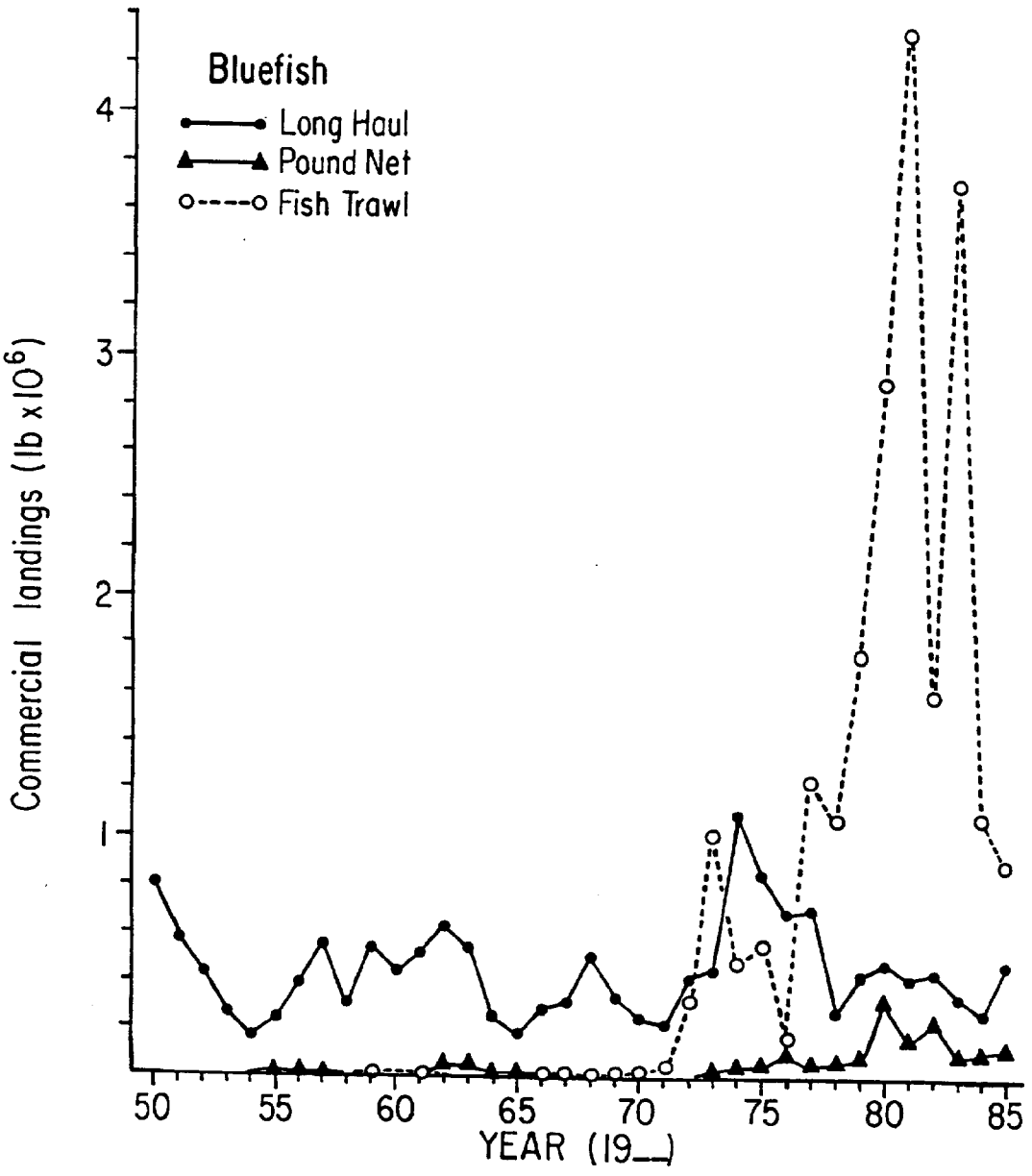

Figure 30. Annual commercial landings of bluefish, Pomatomus saltatrix, in North Carolina by long hauls, pound nets, and winter trawls from 1950-1985.

The two critical aspects of bluefish and their role in the winter trawl fishery are availability and marketability. Bluefish of all sizes and age groups (0-XI) were harvested by the trawl fishery from October through April. They were, for the most part, caught incidentally by gears not designed and/or targeted on their capture in nearly all catches sampled--deepwater rigs off Norfolk Canyon, flounder trawls off Oregon Inlet, and flynets from Wimble Shoals to west of Cape Lookout. They are ubiquitous throughout the range of the trawler fleet. Historical studies suggest major wintering grounds occur along the outer edge of the continental shelf (Hamer 1955; Lund and Maltezos 1970). Their occurrence in deepwater catches targeted on flounder and black sea bass confirms this distribution. The area from Cape Hatteras to Cape Lookout is also an important wintering ground. Age 0 and I bluefish dominate flynet catches, although all winter trawl gears and sink nets frequently catch large fish from just off the beach to 20 fathoms, as well as in deeper waters near the continental shelf edge (Ross 1989). Were the marketability of bluefish better, the prices higher and more stable, the fisheries could easily harvest many more. Currently however, they are only occasionally targeted, by the sink net (Ross 1989) and less frequently by the trawler fisheries. This aspect can be an important factor driving the trends in CPUEs, particularly for larger fish (age II+).

Atlantic Croaker

Peak landings of Atlantic croaker by trawlers in 1978 were followed by declines which only in 1984 and 1985 showed any sign of leveling off (Table 25, Figure 31). During this study, CPUE and landings of croaker both declined by 10% in 1983-84, then doubled in 1984-85. The fluctuations in North Carolina trawler landings followed croaker landings for the combined Atlantic and Gulf coasts for 1950 through 1979 with peak years between 1955 and 1958 and between 1974 and 1979 (Wilk 1981). Total state croaker landings reached 21.1 million lb in 1980, and thereafter have declined 50% (Table 24).

Trawlers accounted for most of the croaker landed prior to 1973 in North Carolina; since then, trawls and long hauls have been the dominant gears. During this study, long hauls landed more croaker the first two seasons and shared the lead with trawlers in 1984-85 (Table 1).

Croakers were abundant in trawl catches from offshore of Oregon Inlet south to Wimble Shoals and Avon rocks in the fall. This distribution parallels trawler activity in 1930-31 when they followed the croaker migration southward (Pearson 1932). Croaker were also captured in flynets south of Cape Hatteras and west of Cape Lookout during mid-winter months on what are apparently their wintering grounds.

The seasonal length-frequency distributions of croaker in trawl catches were unimodal and similar to pound net and long haul caught croaker in Pamlico Sound (Ross et al. 1986). We observed an increase in the proportion of small unmarketable fish (<225 mm) that was more pronounced in trawler catches (83%) than long haul and pound net catches (21-44%) (ibid). The proportion of large croaker (>250 mm TL) declined from 45.9% in 1982-83 to 7.8 and 8.0% the next two seasons; similar, though not as dramatic, were the declines observed in the inshore fisheries (ibid). It is not clear why the proportion of large fish declined more in the offshore than in the estuarine fisheries. A possible explanation may be that the offshore

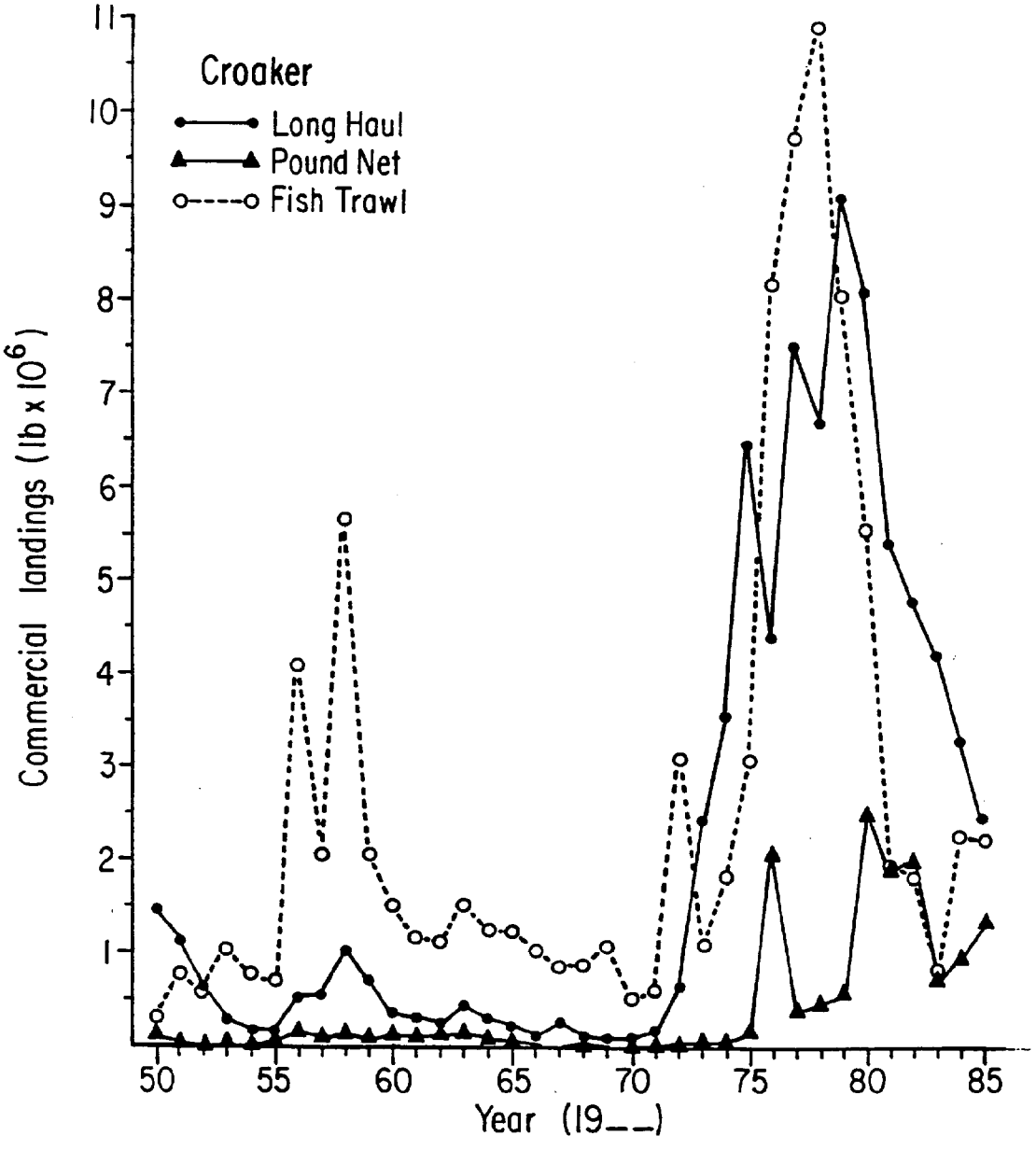

Figure 31. Annual commercial landings of Atlantic croaker, Micropogonias undulatus, in North Carolina by long hauls, pound nets, and winter trawls from 1950-1985.

winter fishery depended more on a different, perhaps northern (Chesapeake Bay) stock of croaker which declined in abundance more than the stock utilized by the estuarine fisheries (ibid).

Pearson (1932) reported croaker 220-470 mm TL with a unimodal distribution centered around 260-360 mm; during three of the five months, most fish were greater than 300 mm TL. Thus, the current fishery is harvesting much smaller croaker from the same fishing grounds.

One-year-olds dominated all three fisheries each year except during the 1982-83 winter trawl fishery when >50% were two-year-olds. Croaker ranged from ages 0 to V in the long haul and winter trawl fisheries and 0 to VI in the pound net fishery. In all three fisheries over 99.9% were ages 0-III, and at least 97.7% were ages 0-II (except during the 1982-83 winter trawl fishery, when 88.6% were ages 0-II) (Ross et al. 1986).

Spot

Recent landings of spot in North Carolina have fluctuated with no definite trend indicated (Table 24; Figure 32). Landings increased from 0.9 million lb in 1965 to 8.3 million lb in 1975 and have since exceeded 7 million lb only in 1979 and 1980. During this study, annual spot landings ranged between 2.9 and 4.9 million lb and accounted for 5.4-7.7% of the state's edible finfish landings.

Long hauls have traditionally landed most of the marketable spot in North Carolina (Figure 9). During this study, long hauls accounted for 60.1 (1984) to 70.3% (1982) of the landings, while pound nets accounted for 2.1-6.8% and trawlers 1.6-5.2%.

Although spot ranked high in the flynet caches, they were not a target species. They were most prevalent west of Cape Lookout where they comprised 20.5-22.1% of the catches, although most were too small to be marketed (<180 mm TL).

Spot were an unimportant by-catch of the fisheries described by Pearson (1932) and Eldridge (1962) likely because the area covered by those studies did not include catches west of Cape Lookout. Spot were the second most important species captured in the industrial fish trawl fishery from Hatteras to west of Cape Lookout (Fahy 1966, Wolff 1972), a similar ranking in relative importance in catches west of Cape Lookout during this study.

Butterfish

North Carolina butterfish landings have shown no persistent trend during the last 20 years (Table 24) with peak landings (0.5 million lb) in 1966. During this study, landings ranged from 0.11 to 0.29 million lb (Table 1), and averaged 0.18 million lb seasonally, which is slightly above the 20 yr average of 0.16 million lb/yr. Commercial landings from Cape Hatteras to Maine have ranged between 10 and 45 million lb since 1962, with North Carolina contributing less than 4% (Waring and Anderson 1983).

Butterfish have been landed primarily by trawls in North Carolina since 1965, although pound nets were productive in 1979-81, as well as prior to 1967 (Figure 33). Long hauls have not produced many butterfish since at least 1966. During this study trawlers accounted for 55.0-71.6% of North Carolina's landings, with both long hauls and pound nets annually contributing <9% (Table 1).

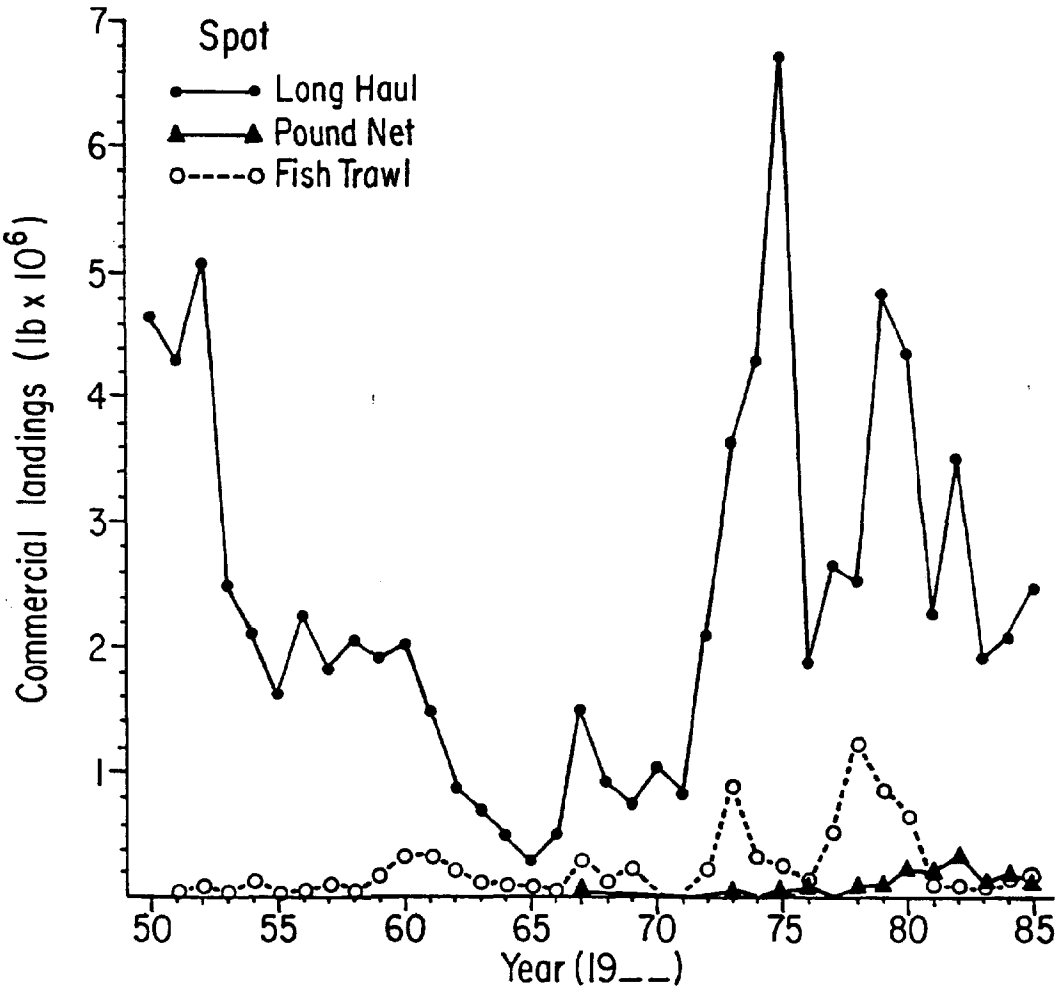

Figure 32. Annual commercial landings of spot, Leiostomus xanthurus, in North Carolina by long hauls, pound nets, and winter trawls from 1950-1985.

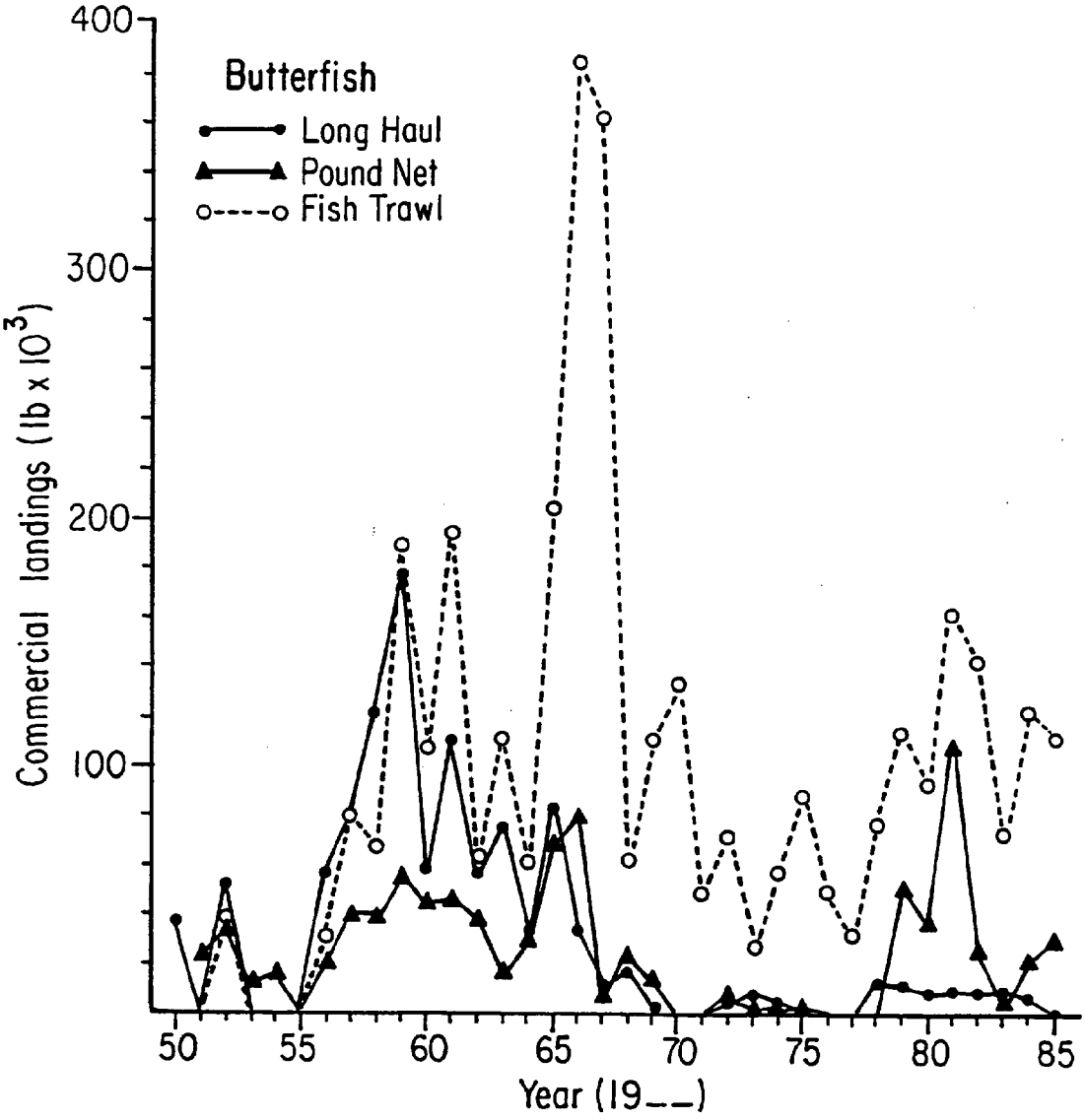

Figure 33. Annual commercial landings of butterfish, Peprilus triacanthus, in North Carolina by long hauls, pound nets, and winter trawls from 1950-1985.

Trends in commercial landings and average catch/trip of butterfish corresponded during this study. Trawl CPUE and commercial landings both declined in 1983 and increased in 1984, but not to 1982 levels.

North Carolina trawlers generally landed butterfish as an incidental species within the targeted fisheries, although they were captured regularly by each component fishery or by all gears in all areas. Consequently, the overall landings of butterfish in North Carolina are not comparatively high. During the study period only one fall flynet catch was dominated by butterfish (together with croaker).

Scup

Scup are available to North Carolina trawlers while on their wintering grounds in offshore waters (35-100 fathoms) north of Cape Hatteras. Scup were the leading species in the trawl fishery during the 1930-31 season, with most catches reported from 20-50 fathoms between Cape Henry and Oregon Inlet (Pearson 1932). The fishing grounds were similar to those used by the fleet today, though recent fishing activity was generally around and north of Norfolk Canyon. During both periods, no scup catches were reported south of Cape Hatteras. In 1930-31, they were the dominant species in January, February, and March (Pearson 1932); during this study this was the period their catches were largest.

Scup reported in 1930-31 were larger fish than were harvested in 1982-1985. Modal lengths of 180 and 280 mm FL were reported in 1930-31 with the larger mode much more pronounced. During this study, 180 mm FL was the only significant mode and relatively few fish >250 mm FL were captured, particularly during the 1984-85 season.

Nominal commercial catches by USA vessels fluctuated between 39 and 48 million lb from 1953 to 1963 and then declined to 9-11 million lb during the early 1970s. Distant water fleet catches peaked in 1963 (12.8 million lbs), but declined to less than 100 mt/year after 1975 (Mayo 1982). During this period, North Carolina trawl landings peaked in 1966 (1.9 million lbs), then fell steadily through 1973 (Table 25; Figure 34). With the reduction of distant water catches, U.S. nominal and North Carolina landings increased steadily to peaks in 1981 (21 and 1.5 million, respectively). Since then, landings have declined dramatically (NEFC 1987). Stock abundance appears to be considerably lower in the Mid-Atlantic area than in Southern New England waters. The resource was being fully exploited, particularly in the Mid-Atlantic region based on commercial landings trends and NEFC trawl surveys (NEFC 1986; NEFC 1987). The Virginia winter trawl fishery, which through 1981 had produced greater than 10 million pounds annually, has steadily declined since then and recently yielded less than 0.2 million pounds per year (Mayo 1982). Correspondingly, commercial landings of scup in North Carolina reached an eight-year low in 1985 (Figure 34), and CPUEs a three year low during the 1984-85 fishing season.

Black Sea Bass

Landings of black sea bass in North Carolina since 1961 have exceeded 0.5 million lb, ranging from 0.6 million in 1976 to 1.5 million in 1980 (Table 24, Figure 35). During this study they increased from 0.47 to 1.20 million pounds (Table 1). Trawlers have accounted for approximately half of the black sea bass landings in North Carolina since 1950 and during this study accounted for an increasing portion, from 33.5% in

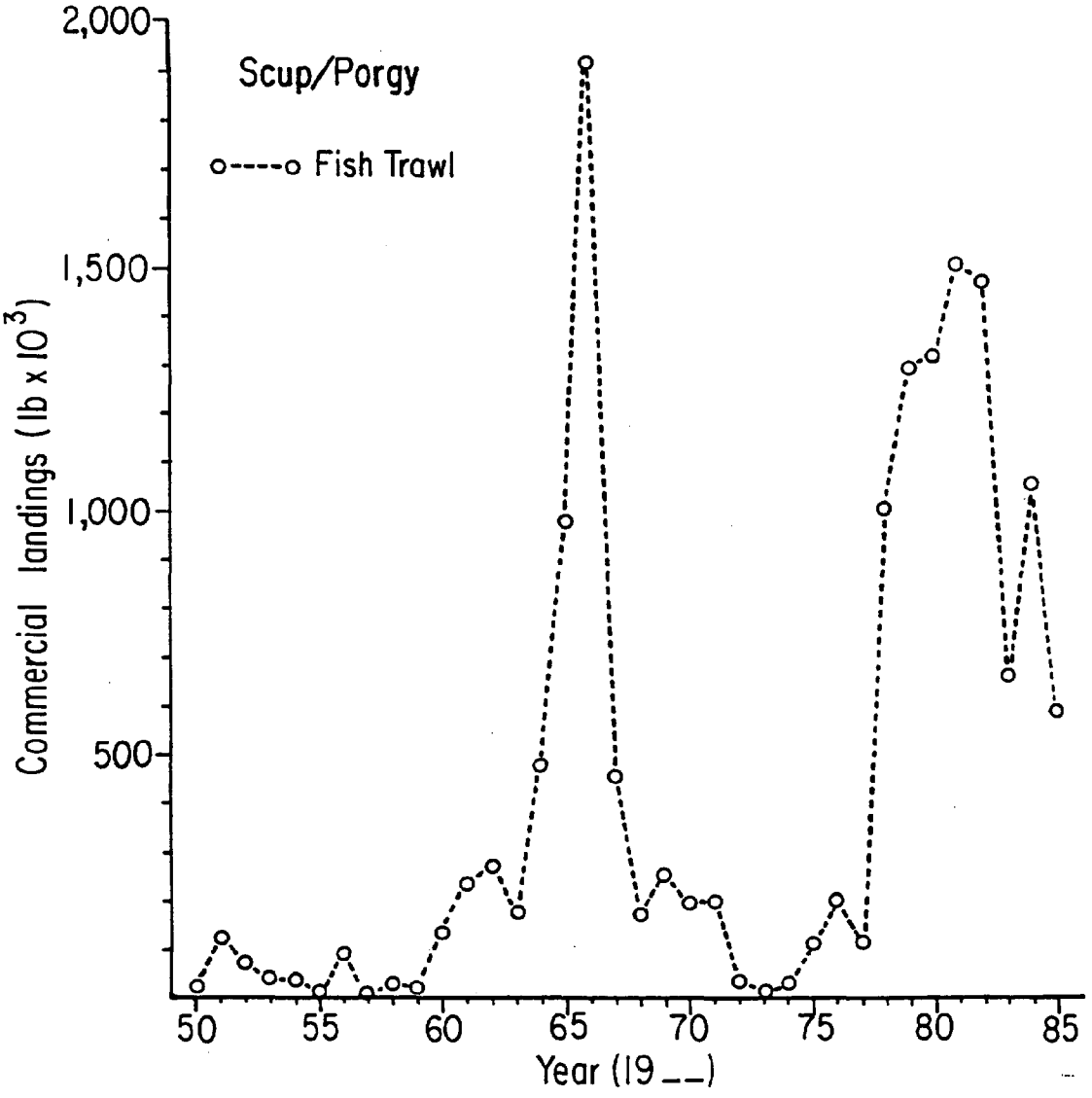

Figure 34. Annual commercial landings of scup, Stenotomus chrysops, in North Carolina by winter trawls from 1950-1985.

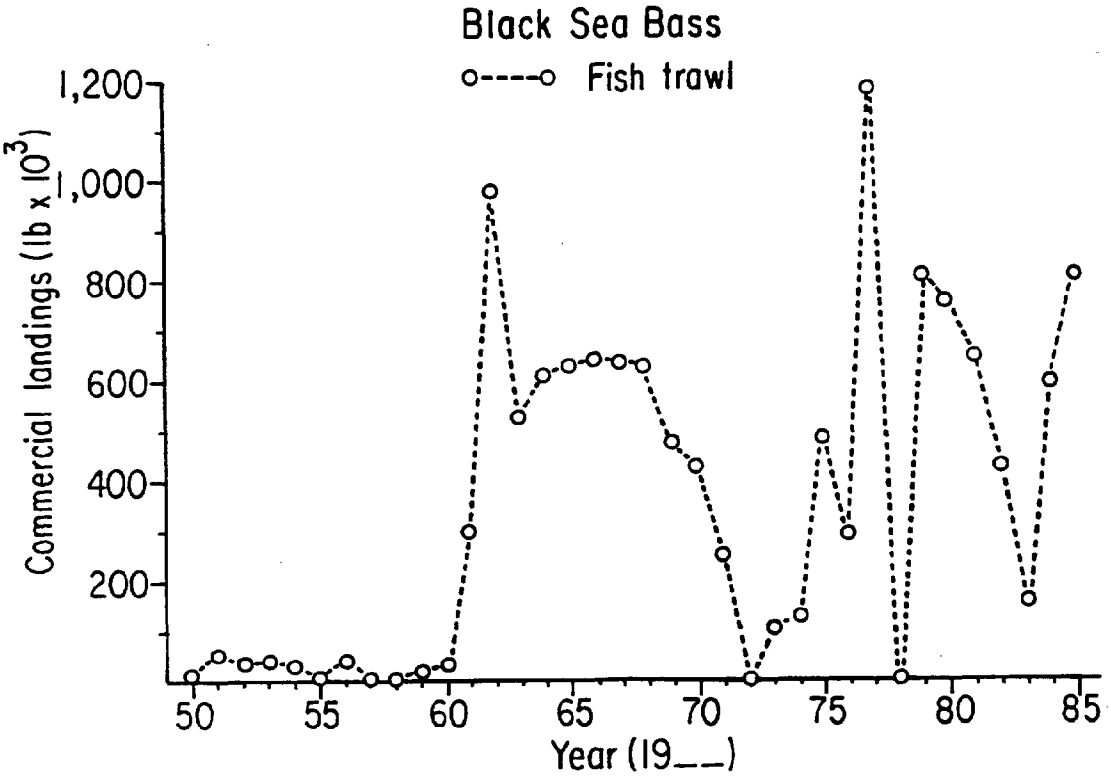

Figure 35. Annual commercial landings of black sea bass, Centropristis striatus, in North Carolina by winter trawls from 1950-1985.

1982-83 to 71.4% in 1984-85 (Table 25).

Consistent with that reported by Pearson (1932), the catch of black sea bass by trawlers was greatest from January through April. Although not observed during this study, black sea bass were the dominant species in April offshore trawl catches in 1930-31. Commercial landing trends from the Gulf of Maine to the mid-Atlantic region and those by North Carolina trawlers have paralleled one another. Both peaked in 1952 (21.8 million and 1.9 million lbs, respectively), declined through the early 1970s, then peaked again in 1977 (5.3 and 1.2 million lbs, respectively). Since 1978, total U.S. commercial landings have ranged from 2.4 to 4.6 million lbs, with North Carolina trawlers accounting for 20-63% of these landings.

The catches of black sea bass consisted of larger fish in 1930-31 than were observed during this study. Modal lengths of 260-360 mm FL, with most fish 230 to 460 mm TL, were reported by Pearson (1932). We found modal lengths of 240 to 260 mm TL with most fish 200 to 380 mm TL.

Size composition data from commercial landings indicate that black sea bass are recruited to the trawl fishery by age III, although the optimum age for harvesting, based on yield-per-recruit analysis is age VI (NEFC 1986).

SUMMARY

The North Carolina winter trawl fishery is a complex fishery in terms of geographic areas fished, fishes sought and captured, and gears used. Although within a fishing season (September-April) the spatial distribution of fishing activity varies temporally from year to year, the fleet's seasonal fishing pattern is consistent. North Carolina trawlers fish out of Oregon, Ocracoke, and Beaufort inlets, as well as Chesapeake Bay. Initially, Atlantic croaker, weakfish, and butterfish are targeted (September-October) with flynets or combination nets from False Cape to Wimble Shoals; summer flounder catches are occasionally landed from fishing efforts north of Delaware Bay. From November through January, nearshore flounder fishing with flounder or combination nets dominated from off Chincoteague, VA to Ocracoke Inlet. From January through April, flynets are used nearshore for weakfish, bluefish, Atlantic croaker, and spot from Wimble Shoals to Cape Lookout to west of Beaufort Inlet; also, flounder nets, combination nets, and flynets are used in deep water (20-60 fathoms) for summer flounder, black sea bass, scup, and squid from Baltimore Canyon to Norfolk Canyon, off the Cigar and offshore of Oregon Inlet. Fishing effort is determined by fish availability, marketability, gear conflicts (flynets-vs-sink nets off Cape Hatteras), and Oregon Inlet shoaling and channel conditions, among other things.

Today's fishery retains many characteristics of the winter trawl fishery during its inception in the early 1930s, although several important changes are apparent. The primary species sought then and now include Atlantic croaker, summer flounder, scup, and black sea bass. Spatial-temporal patterns of fishing activity during the early 1980s were also characteristic of the 1930s fishery. The development of flynets and other high profile trawls, coupled with increased availability during of the 1970s and 1980s, resulted in the addition of bluefish and weakfish to the list of dominant species landed. The average sizes of the scup, black sea bass, summer flounder, and Atlantic croaker landed during this study

were smaller than were reported in the 1930s (Pearson 1932).

A persistent problem for this fishery since its inception has been the excessive scrap or bycatch due to the non-selective nature of most trawls used. The areas fished are not only wintering grounds for adults, but also for juveniles and small individuals of each species. Large catches of small weakfish, Atlantic croaker, spot, scup, and black sea bass have been observed at the docks regularly. Even during the early years of the fishery, this was a perceived problem:

"Wasteful and destructive practices are obviously fully as damaging to their own interests.... It is generally doubted if the present practices of capturing and marketing small sizes of scup and sea bass is profitable in the long run." (Nesbit 1935).

One persistent change observed in the fishery today is the smaller average sizes of fish captured. Scup, black sea bass, summer flounder, and Atlantic croaker caught during the 1930s were larger than those observed in this study (Pearson 1932). Not only is the scrapfish that is landed a perceived problem, but also the bycatch that is discarded at sea. This quantity is unknown for the North Carolina winter trawl fishery and all other east coast trawl fisheries, as well. Once again, during the fisheries' early years, this problem was noted. Nesbit (1935) estimated that "by volume 20% and by numbers 40% of the scup caught were destroyed and discarded at sea."

The flynet fishery further complicates the bycatch issue. Harvesting primarily weakfish and Atlantic croaker, the southern part of this fishery markets fish for industrial uses and bait as well as for human consumption. The nets used have small mesh tail bags (2" stretched mesh) and often catch large volumes in short tow times. Culling by hand is virtually impossible, so all fish are kept and brought to the dock. Catches consist of more scrap as one progresses south from Oregon Inlet to off Beaufort Inlet. Age 0 and I Atlantic croaker, spot, and weakfish predominate these catches.

The current fisheries management strategy for regulating this fishery (at least one segment of it) is increased tailbag mesh size to reduce the capture of small summer flounder (MAFMC 1987). Even at the fishery's inception, "it is virtually certain that changes in mesh of the cod end of trawls in the winter fishery would eliminate the present waste" (Nesbit 1935). The multispecies nature of the fishery however, complicates this management strategy, and at least initially, is perceived by the fishermen as "lost dollars." The proposed increased mesh sizes (to 4-1/2") for flounder trawls would eliminate undesirable small summer flounder (MAFMC 1987), but also marketable "pan trout," squid, small bluefish and butterfish in the nearshore directed flounder fishery and "pan" and "small" porgies, "mice and small" black sea bass, and squid in the deepwater fishery. The management communities' assertion of future gains with reduced growth overfishing of fish stocks cannot, however, be assured due to natural population abundance cycles and is, thus, greeted with much skepticism by many fishermen.

The winter trawl fishery is a critical segment of U.S. Atlantic coast fisheries, driving trends in landings for several species. North Carolina trawlers dominate east coast commercial landings of summer flounder, black sea bass, and bluefish; together with sink nets, they accounted for roughly half of the weakfish landings. This fishery is

possible because these species migrate to wintering grounds off the Virginia and North Carolina coasts. Stocks inhabiting wintering grounds are often compressed spatially where hydrographic conditions are suitable. This situation offers opportunities for trawlers to harvest species that during other seasons may not be available to trawl gears. Harvesting fish on these wintering grounds can be a management problem. Fishermen perceive that species are abundant when fishing on aggregations of fish in the wintering grounds. What they may not realize is that though fish are concentrated in certain areas, the overall spatial distribution of the stock may be reduced. Careful definition of CPUE to include searching as well as fishing time may better define this situation at least to the scientific community.

The importance of the North Carolina winter trawl fishery, not only to North Carolina commercial fishery landings, but the entire east coast fisheries, necessitates the continued monitoring of this fishery. Continued and improved analyses and definition of CPUE will be useful to understand population fluctuations. A study of at-sea discard practices for qualitative and quantitative information would be very useful. The inclusion of Virginia CPUE and landings data would be advantageous since the two fisheries are interrelated, both by species sought and vessels fishing out of both ports.

ACKNOWLEDGMENTS

This report would not have been possible without the field and technical assistance of Beth Burns, Mark Rockett, Steve Strasser, Lele Tison, Cliff Harvell, Greg Judy, Manley Gaskill, Jack Guthrie, and Paul Moore. John Gillikin and Katy West provided invaluable help with computer processing and data retrieval. We wish to thank Tom Hoff (Mid-Atlantic Fishery Management Council) and Steve Ross (North Carolina State University) for suggestions and constructive reviews of the manuscript; Sara Winslow, Rick Monaghan, and Linda Mercer also provided useful comments on the manuscript. We are sincerely appreciative of D. Willis, S. Russell and D. Tootle who provided much more than a first-class job of typing and organizing the manuscript. Finally, we are especially grateful to the many commercial fishermen and dealers who cooperated with this project.

LITERATURE CITED

Atlantic States Marine Fisheries Commission.
1987. Draft fishery management plan for bluefish. ASMFC, Washington, D.C., 49 p.

Boreman, J., and R.J. Seagraves.
1984. Status of weakfish along the Atlantic coast, 1984. NMFS, NEFC, Woods Hole Lab.,Ref. Doc. No. 84-19, 43 p.

Boreman, J.
1983. Status of bluefish along the Atlantic coast, 1982. NMFS, NEFC, Woods Hole Lab.,Ref. Doc. No. 28.

DeVries, D.A.
1981. Description and catch composition of North Carolina's long haul seine fishery. Proc. Annu. Conf. S.E. Assoc. Fish. Wildl. Comm. 34:234-247.

DeVries, D.A.
1986. Inshore Atlantic croaker tagging study, p. 331-394, In: Ross, J.L., D .A. DeVries, J.H. Hawkins, III, and J.B. Sullivan. Assessment of North Carolina commercial finfisheries. Compl. Rep., Proj. 2-386-R, NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish.

Eldridge, P.J.
1962. Observations on the winter trawl fishery for summer flounder, Paralichthys dentatus. M.S. thesis. College of William and Mary, Williamsburg, VA.

Fahy, W.E.
1966. Species composition of the North Carolina industrial fish fishery. Commercial Fisheries Review, 28(7):1-8.

Fogarty, M.J.
1981. Review and assessment of summer flounder, (Paralichthys dentatus) in the Northwest Atlantic. NMFS, NEFC, Woods Hole Lab., Ref. Doc. No. 80-22, 57 p.

Gilliken, J.W., B.F. Holland, and R.O. Guthrie.
1981. Net mesh selectivity in North Carolina's winter trawl fishery. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish. SSR No. 37, 69 p.

Hamer, P.E.
1956. Age and growth studies of the bluefish (Pomatomus saltatrix Linnaeus) of the New York Bight. M.S. Thesis, Rutgers Univ., New Brunswick, NJ.

Lund, W.A., and G.C. Maltezos.
1970. Movements and migrations of the bluefish, Pomatomus saltatrix, tagged in waters of New York and southern New England. Trans. Am. Fish. Soc. 99(4):719-725.

Massman, W.H.
1963. Age and size composition of weakfish, Cynoscion regalis, from pound nets in Chesapeake Bay, Virginia 1954-1958. Chesapeake Sci. 4:43-51.

Mayo, R.K.
1982. An assessment of the scup, Stenotomus chrysops (L.), population in southern New England and Mid-Atlantic regions. NMFS, NEFC, Woods Hole Lab., Ref. Doc. No. 82-46, 59 p.

Mercer, L.P.
1983. A biological and fisheries profile of weakfish, Cynoscion regalis. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., Spec. Sci. Rep. No. 39, 107 p.

Merriner, J.V.
1973. Assessment of the weakfish resource, a suggested management plan, and aspects of life history in North Carolina. Ph.D. Diss. North Carolina State Univ., Raleigh, 201 p.

Mid-Atlantic Fishery Management Council (MAFMC).
1987. Fishery management plan for the summer flounder fishery. MAFMC, Hearing Draft 11.9.87, 160 p.

Northeast Fisheries Center, Conservation and Utilization Division (NEFC).
1986. Status of the fishery resources off the northeastern United States for 1986. NOAA, Tech. Memo. NMFS-F/NEC-43, 130 p.

Northeast Fisheries Center, Conservation and Utilization division (NEFC).
1987. Status of the fishery resources off the Northeastern United States for 1987. NOAA Tech. Memo NMFS-F/NEC-80, 132 p.

Nesbit, R.A.
1935. Conditions affecting the southern winter trawl fishery. U.S. Bur. Fish. Circ. 18, 12 p.

Pearson, J.C.
1932. Winter trawl fishery off Virginia and North Carolina coasts. U.S. Bur. Fish., Invest. Rep. 10, 31 p.

Ross, J.L., D.A. DeVries, J.H. Hawkins, III, and J.B. Sullivan.
1986. Assessment of North Carolina commercial fisheries. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., Compl. Rep. Proj. 2-386-R, 418 p.

Ross, J.L.
1989. Assessment of the sink net fishery along North Carolina's Outer Banks, Fall 1982 through Spring 1987, with notes on other coastal gill net fisheries. NC Dept. Environ., Health, and Nat. Resour., Div. Mar. Fish., Spec. Sci. Rep. No. 50, 54 p.

Ross, S.W.
In press. Age, growth and mortality of the Atlantic croaker, Micropogonias undulatus, in North Carolina with comments on population dynamics. Trans. Am. Fish. Soc.

Shepard, G.R.
1982. Growth, reproduction, and mortality of weakfish, Cynoscion regalis, and size/age structure of the fisheries in the Middle Atlantic region. M.S. Thesis, Rutgers Univ., New Brunswick, NJ, 69 p.

Sholar, T.M.
1979. Adult stock assessment, p. 11-27 In: A plan for management of North Carolina's estuarine fisheries--phase I. Semi-annual rep. for NC Off. Coast. Zone Mgmt. Fish. Asses. Prog. Grant, Oct. 1978 - Feb. 1979. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish.

Taylor, N.E.
1916. The structure and growth of the scales of the squeteague and the pigfish as indicative of life history. Bull. U.S. Bur. Fish. 34:285-330.

Waring, G.T., and E.D. Anderson.
1983. Status of northwestern Atlantic butterfish stock - 1983. NMFS, NEFC, Woods Hole Lab., Ref. Doc. No. 83-41, 39 p.

Wilk, S.J.
1977. Biological and fisheries data on bluefish, Pomatomus saltatrix (Linnaeus). NMFS, NEFC, Sandy Hook Lab., Tech. Ser. Rept. No. 11, 56 p.

Wilk, S.J.
1981. The fisheries for Atlantic croaker, spot, and weakfish. pp. 59-68 In: Marine Recreational Fisheries 6, Sport Fishing Institute, Wash., D.C.

Wolff, M.
1972. A study of the North Carolina scrap fishery. NC Dept. Nat. and Econ. Resour., NC Div. Commercial and Sport Fish., Spec. Sci. Rep. No. 20, 29 p.

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