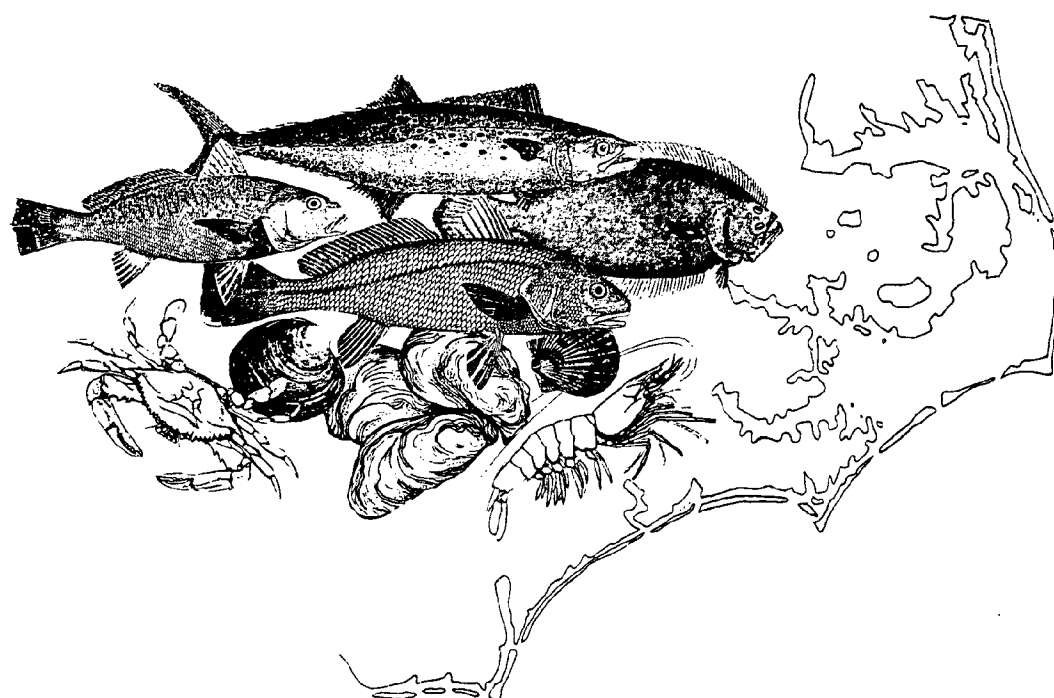


ASSESSMENT OF THE SINK NET FISHERY
ALONG NORTH CAROLINA'S OUTER BANKS,
FALL 1982 THROUGH SPRING 1987,
WITH NOTES ON OTHER COASTAL GILL NET FISHERIES



North Carolina Department of Environment,
Health, and Natural Resources

Division of Marine Fisheries
Morehead City, North Carolina 28557

SPECIAL SCIENTIFIC REPORT NO. 50

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1989

October 1989

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by

Jeffrey L. Ross

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ABSTRACT

The coastal gill net fishery along the Outer Banks, which is active from late fall through early spring, accounted for 9.5 - 22.3% of North Carolina's marketable finfish harvest from 1982 through 1987, the percentage increasing throughout the period. The sink net fishery had its beginnings in the 1930's, expanded dramatically during the 1980's in terms of fishing effort and finfish landings, and currently dominates other winter ocean gill net fisheries.

From Fall 1982 through Spring 1987, 316 sink net, 42 anchored gill net and 44 floating gill net catches were sampled. Sink nets were by far the most prevalent and productive gill net employed. Sink net catches were dominated by Cynoscion regalis, Pomatomus saltatrix and Micropogonias undulatus. Anchored gill net catches were more diverse and composed predominantly of P. saltatrix, Euthynnus alletteratus, Scomberomorus cavalla, Mustelus canis, C. regalis, and M. undulatus. Floating gill nets were fished for Morone saxatilis only during the first two seasons of this study due to the closure of the ocean fishery for the species in 1984.

Sink net catches of C. regalis increased from 558 to 1094 kg/trip, and total landings steadily increased during the study. Most fish were ages 1 and 2, and the percent of age 3-10 fish has declined. P. saltatrix catches fluctuated between 400 and 848 kg/trip, and landings increased during the 1985-86 and 1986-87 fishing seasons. Catches included fish age 0 to age 10, with ages 0, 1, 4 and 5 dominating. M. undulatus catches have increased from <1 kg to 120.7 kg/trip, ages 2 and 3 fish dominated the catches, and landings have generally increased.

While the sink net fishery has expanded and CPUEs and landings have risen, inter- and intra-fishery gear conflicts and fluctuating market prices have become increasingly problematical.

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INTRODUCTION

The sink net fishery of North Carolina's Outer Banks is a revived fishery that has expanded dramatically in recent years. Sink nets are gill nets weighted to fish just above the bottom. Fishing takes place from just beyond the surf zone's outer bars to depths of 27-37 m (15-20 fathoms) from late fall through early spring. During the last five fishing seasons (Fall 1982 through Spring 1987), the value of finfish landings by this fishery has increased from 2.3 to 3.8 million dollars.

Sink netting had its beginnings at Hatteras, N.C. in the 1920s¹. Several crews fished out of Hatteras Inlet in 7.6-7.9 m (25-26 ft) round-sterned boats with displacement hulls between the Inlet and Cape Hatteras during the winter months. They set 274-365 m (300-400 yds) of 6.3-7.6 cm (2.5-3 in) stretched mesh cotton sink nets for weakfish (Cynoscion regalis) and Atlantic croaker (Micropogonias undulatus). During the 1930s, 30-35 boats fished out of Hatteras, including three or four 10.7-12.2 m (35-40 ft) class vessels built locally for the fishery.¹ Several of these, including the Albatross I and Jackie Faye, were still fishing in 1987. These boats were low-sided, round-sterned craft with no cabin, so fouled nets could be lifted up over the boat. Crews of 3-5 men fished 1097-1372 m (1200-1500 yds) of net. Stretched mesh as small as 3.7 cm (2.5 in) was used for Atlantic croaker and weakfish. After World War II, fishing was good for a few years, but with declining prices, landings also declined. Little sink netting occurred in the 1950s and 1960s because of the lack of available weakfish and Atlantic croaker.¹

The resurgence of sink netting off Cape Hatteras began in 1977-78 and was enhanced by two factors: 1) the increased abundance of weakfish and bluefish (Pomatomus saltatrix) and (2) the availability of hydraulically powered net reels. The successful use of hydraulically powered systems for net reels by a crew of two led to their use by the entire

¹ Pers. commun. Captain Ernal Foster, Albatross Fleet, Hatteras, N.C., June 1988.

fleet fishing off the Outer Banks (Lebovitz 1982). The net reels were initially suggested by Sea Grant agents to assist fishermen with their striped bass nets.

The use of net reels allowed a reduction in crew size and speeded up the net handling process. Today, vessels most commonly used in the fishery are 10.7-13.7 m (35-45 ft) with low-sides and large cockpits to hold fish on deck. New England lobster type boats, Chesapeake Bay rigs, and Wanchese-built, high-prowed, large cockpit craft are prevalent. Most are versatile and used during other seasons offshore for tuna, king mackerel, and grouper-snapper fishing, or inshore for long haul seining.

In a typical day of sink net fishing, the two-man crew left the dock at 0400 h, arrived on the fishing grounds by 0430, and began searching for concentrations of weakfish with fish finders (chromoscopes, depth recorders) or by sighting surface feeding birds. Often the first sets of the day were the best, before the fish were scattered by vessel and net activity later in the day. Several 274-731 m (300-800 yd) lengths of gill net were set over fish concentrations depending on movements of fish and the operations of other vessels on the grounds. Depending on local conditions, nets were either retrieved immediately or allowed to fish for up to several hours. Nets were retrieved onto net reels with the webbing directed through vertical guides which are mounted over the transom. Fish were picked during net retrieval and stored (loose and/or in boxes) on deck. The rest of the day is spent alternately setting the nets, picking up their webbing, and searching for more fish. Most vessels headed for port by sunset and unloaded their catch that evening at one of 6-8 fish houses, several of which were active only during the sink net season. When the fishing was good, boats often had to wait into the early morning hours to get packed out.

The fishery's primary gear is a heavily weighted monofilament gill net assembled in 91-273 m (100-300 yard) sections (shots). The lead line is weighted with 27.2-45.3 kg (60-100 lbs) of lead per 91 m (100 yds) of net to assure it fishes directly over the bottom; most nets are

3.6-4.6 m (12-15 ft) deep. Large buoys (balls) or high flyers are attached to one or both ends of the net by enough line to allow the net to sink freely. Anchors are usually not used, and nets are retrieved at the end of the day. Vessels remain in the vicinity while the nets are fishing. The mesh sizes most prevalent in the fishery have been 7.6-8.9 cm (3-3.5 in) stretched mesh for weakfish, Atlantic croaker, and small bluefish, and 11.4-15.2 cm (4.5-6 in) stretched mesh for large bluefish and weakfish. In 1986-87, 9.5 cm (3.7 in) stretched mesh was very productive (larger fish, better price, and less picking) and was becoming more prevalent through the fishery².

The sink net fishery on the Outer Banks is most active from December through April, though some vessels target large bluefish when they arrive in November. Most vessels begin sink net fishing in December or early January, after the king mackerel (Scombermorous regalis) and yellowfin tuna (Thunnus albacares) season and several inshore fisheries conclude.

Vessels fish out of two primary ports and inlets. Those landing fish in Wanchese, N.C. use Oregon Inlet, while those landing in Hatteras, N.C. use Hatteras Inlet (Figure 1). The fleet is usually concentrated in Hatteras from January through March, and split between the two ports early and late in the season. Several vessels from Ocracoke, N.C. utilize Ocracoke Inlet, and a few boats run across the Pamlico Sound from Englehard and Stumpy Point, N.C.

Two smaller gill net fisheries take place along the Outer Banks' beaches from Fall through Spring for weakfish, bluefish, spotted seatrout (Cynoscion nebulosus), king mackerel (Scombermorous regalis), and red drum (Sciaenops ocellatus). Several two-man crews fish anchored gill nets from beach-launched dories. These daily sets are made just beyond the outer sand bars from Corolla to Ocracoke. This fishery is ongoing today scattered throughout the area though effort has been

²Pers. commun. Captain Fred Fox, F/V Apparition, Wanchese, N.C., October, 1988.

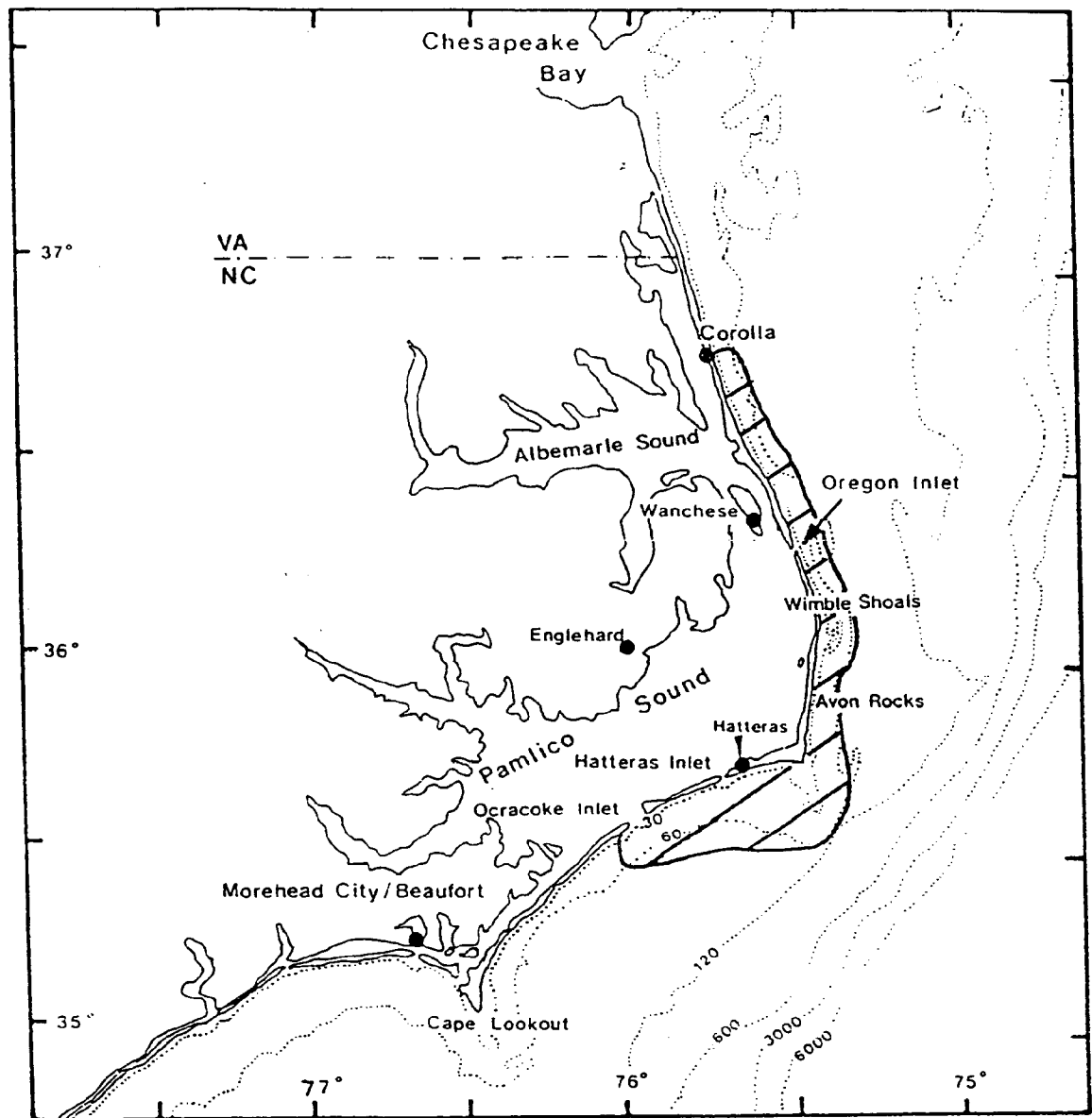


Figure 1. Sink net fishing grounds off the Outer Banks of North Carolina.

reduced in recent years, as most of the crews have entered the sink net fishery. Second, a floating gill net fishery for striped bass took place in the late 1970s and early 1980s from January through mid-March and included crews from the beach-launched dory fleet and part of the sink net fleet. During the last few seasons, they used 25.4 cm (10 in) stretched mesh monofilament nets that were rigged to float just below the surface and fish to depths of 3.0-4.6 m (10-15 ft). The nets were anchored on one or both ends, fished daily, and left in the water throughout the fishing season. Fishing effort was concentrated on the edge of Diamond Shoals in 12.2-19.8 m (40-65 ft) of water, as well as on the shoals off Ocracoke Inlet and Portsmouth Island. This fishery continued through the 1983-84 season after which the waters of the Atlantic Ocean off North Carolina were closed to the taking of striped bass (Regulation NCAC 3B .1504(b)--North Carolina Dept. of Nat. Resour. and Community Develop., DMF 1988).

The North Carolina Division of Marine Fisheries (DMF) has sampled all three gill net fisheries operating in the Atlantic Ocean off the Outer Banks since Fall 1982. The objective of this report is to characterize these fisheries for the five fishing seasons from Fall 1982 through Spring 1987. Data are presented on trends in species catch/effort (CPUE), landings, seasonality, and size and age composition of the target species for the three different gears. Since the preponderance of the gill net fishery landings and catches sampled were from sink nets, this fishery will be the emphasis of the discussion.

METHODS AND MATERIALS

The sink net fishery catches were sampled monthly and analyzed on a seasonal basis (December through April) from 1982 through 1987. Samples were taken at fish packing houses in Hatteras and Wanchese while the catches were being offloaded. Anchored gill net catches were sampled from September through April and floating gill net catches were sampled from February through March. Culled samples were taken on the beach as crews offloaded dories into trucks for transport to fish markets. For all gear types, captain or crew members were interviewed, when available, to obtain information including: area and depth fished, days

at sea, and gear(s) used including mesh size and length of gill nets. Two or more sink net catches were sampled each week, when possible.

Random stratified samples of the graded catch were taken to insure adequate coverage of all sizes and species landed. This involved sampling one or more 22.7 kg (50 lb) cartons for each species and market grade (small, medium, large, jumbo, etc.) for each gill net catch sampled. More cartons of the larger grades were sampled to compensate for the fewer fish contained in them. 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 individual fish recorded. The total weight of each market category for each species was obtained from the fish dealer's records with the permission of the captain and fish dealer. Total weight of the scrap fish was estimated if not available from the dealer; only total scrap fish >50 kg was recorded and sampled. If the scrap fish was <50 kg, a list of all associated species was kept. Occasionally, a species' market grade was included on the trip ticket, but time did not permit sampling. Typically, these were incidental market species. In these instances, the number of fish landed for this species grade was estimated from the mean weights of the same grade from another catch sampled that evening.

Length frequencies for each catch were derived by expanding the sample length frequencies for each market category (grade) by a raising factor (RF) where:

$$RF = \frac{\text{Total species market grade weight}}{\text{Total sample weight of species market grade}}$$

Species market grade weights were obtained from trip tickets. Species length frequencies were developed by combining those expanded for the respective species market grades.

Approximately 30-60 scale samples were taken monthly, when available, from weakfish, Atlantic croaker, and bluefish over the entire size range of individuals captured. Length (mm) and weight (0.01 kg) were recorded for each fish sampled; samples were not always taken for

each species from each catch. Scales were aged using criteria for determining annuli given by Wilk (1977) for bluefish, Ross, S. (1988) for Atlantic croaker, and Massmann (1963), Merriner (1973) and Hawkins (1988) for weakfish.

Depending on the species, semi-annual or quarterly age-length keys were generated for each 20-mm size interval. Age data from the North Carolina sink net fishery and the winter trawl fishery were pooled to generate age-length keys. These were 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 an age-length key from fish caught in 1979-1981 (Ross, S. 1988). Bluefish and weakfish age length keys were developed from fish caught from Fall 1982 through Spring 1985 and from January 1982 through December 1983, respectively.

Average catches and landings were determined for trend analysis. Average catch(kg)/trip (CPUE) was defined as the total catch/species/one day trip; a trip may consist of one or more gill net sets. Landings refer to commercial landings (kg) derived from the North Carolina General Canvas Data File compiled through the DMF and the National Marine Fisheries Service (NMFS) cooperative data collection program.

RESULTS

Seasonal Catch Composition

Sink Nets

A total of 27 sink net catches were sampled between January 1982 and April 1983, with all but two catches made south of Cape Hatteras (Table 1). CPUE ranged from 47 to 3,814 kg/trip and averaged 1,418 kg/trip. Bluefish dominated the catches by weight (59.8%) and weakfish dominated by number (69.3%). Together, these species accounted for 99.1% of the catches sampled (Table 2a).

A total of 69 sink net catches were sampled from December 1983 through April 1984, with all but 9 catches made from Cape Hatteras to off Ocracoke (Table 1). CPUE ranged from 68 to 7,589 kg and averaged

Table 1. Monthly summary of sampling of ocean gill net fisheries from September 1982 through April 1987, by area fished (N=north of Cape Hatteras; C=Cape Hatteras to Cape Lookout) and gear (sink nets, anchored nets, floating nets); n=number of catches samples.

Season	Month	Gear	Area	n	Catch weight (kg)		Sample weight (kg)	
					Mean	Range	Mean	Range
1982-83	Sep	Anchored	C	2	61.5	51- 72	61	5- 72
		Anchored	N	3	194.1	68- 393	194	68-393
	Oct	Anchored	C	1	134.0		134	
		Anchored	N	3	86.8	12- 170	78	12-170
	Nov	Anchored	C	4	68.2	37- 138	68.2	37-138
		Anchored	N	1	484.0		287.6	
	Dec	Anchored	C	5	278.2	88- 645	188.2	88-352
		Anchored	N	1	65.6		65.6	
	Jan	Sink	C	11	734.1	47-2,895	90.4	24-318
		Anchored	C	2	513.4	417- 609	234.3	168-300
	Feb	Sink	C	10	1,556.6	144-3,595	201.7	53-377
		Anchored	C	3	243.4	67- 475	164.7	67-239
		Floating	C	26	163.8	15-1,025	137.3	15-727
	Mar	Sink	C	2	2,521.9	1,529-3,515	119.7	81-159
		Floating	C	14	99.4	12- 291	81.5	12-205
	Apr	Sink	C	2	2,712.9	1,612-3,814	219.1	208-230
		Sink	N	2	2,056.3	401-3,712	350.4	300-401
		Anchored	N	5	2,047.9	65-9,072	203.8	38-654
Total		Sink	C	25	1,364.1	47-3,813		
		Sink	N	2	2,056.3	401-3,712		
		Anchored	C	17	202.2	37- 645		
		Anchored	N	13	894.8	12-9,072		
		Floating	C	40	141.3	12-1,025		
1983-84	Dec	Sink	C	6	365.8	68- 753	53.9	35- 88
		Sink	N	4	470.2	84- 897	225.3	84-355
	Jan	Sink	C	18	918.3	108-2,358	140.3	54-320
	Feb	Sink	C	19	1,168.7	107-4,431	132.0	56-259
		Floating	C	4	27.9	15- 65	27.9	15- 65
	Mar	Sink	C	14	1,094.9	146-3,589	143.2	50-306
		Anchored	N	1	257.2		95.8	
	Apr	Sink	C	3	1,263.4	290-1,884	130.1	34-251
		Sink	N	5	3,524.5	1,218-7,589	299.0	126-485
		Anchored	N	1	1,717.4		1,717.4	
Total		Sink	C	60	1,000.8	68-4,431		
		Sink	N	9	2,167.0	84-7,590		
		Anchored	N	2	987.3	257-1,717		
		Floating	C	4	27.9	15- 65		

Table 1. (continued)

Season	Month	Gear	Area	n	Catch weight (kg)		Sample weight (kg)	
					Mean	Range	Mean	Range
1984-85	Oct	Anchored	C	6	292.5	156- 420	156.7	66-236
	Dec	Sink	C	7	1,030.6	565-2,051	83.5	0-141
	Jan	Sink	C	16	837.8	176-2,169	80.5	0-183
	Feb	Sink	C	14	2,570.2	151-8,137	280.6	0-782
	Mar	Sink	C	11	1,630.4	527-3,759	100.4	57-185
		Sink	N	3	1,709.0	237-4,540	333.8	237-420
	Apr	Sink	N	7	1,511.3	273-5,029	150.6	0-252
Total		Sink	C	48	1,552.8	151-8,137		
		Sink	N	10	1,570.6	237-5,029		
		Anchored	C	6	292.5	156- 420		
1985-86	Dec	Sink	C	6	780.3	553-1,087	145.8	0-282
	Jan	Sink	C	10	1,513.6	763-3,040	110.0	0-252
		Sink	N	10	1,500.7	14-2,931	28.3	0-192
		Anchored	C	1	738.4		88.5	
	Feb	Sink	C	15	1,967.1	630-4,349	79.2	0-181
		Sink	N	5	719.5	516-1,247	56.6	0- 72
	Mar	Sink	C	19	2,197.8	518-5,968	111.6	0-436
		Anchored	C	2	309.4	300- 318	24.5	0- 49
	Apr	Sink	C	3	632.0	425- 813	58.8	47- 78
		Anchored	C	1	208.7		57.4	
Total		Sink	C	53	1,754.3	425-5,968		
		Sink	N	15	1,240.3	14-2,931		
		Anchored	C	4	391.5	209- 738		
1986-87	Dec	Sink	C	3	768.9	496-1,193	96.6	45-148
		Sink	N	4	1,022.5	555-1,570	115.8	69-148
	Jan	Sink	C	6	1,143.1	238-2,117	83.4	47-115
		Sink	N	9	1,237.6	500-1,777	108.3	72-134
	Feb	Sink	C	21	2,146.1	262-5,986	141.0	23-421
	Mar	Sink	C	32	2,029.4	530-4,532	165.5	71-307
	Apr	Sink	N	19	1,366.9	54-4,330	139.0	46-281
	Total	Sink	C	62	1,922.2	238-5,986		
		Sink	N	32	1,287.5	54-4,330		

1,151 kg/trip. Weakfish dominated catches by weight (62.2%) and number (78.4%). Together with bluefish, they accounted for 96.8% of the weight and 92% by number (Table 2b).

Of the 58 sink net catches sampled from December 1984 through April 1985, all but 10 catches were from below Cape Hatteras to off Ocracoke (Table 1). CPUE ranged from 151 to 8,137 kg/trip and averaged 1556 kg/trip. Weakfish and bluefish were co-dominant by weight (47%), though weakfish were more numerous (65%). Collectively, bluefish, weakfish, and Atlantic croaker comprised 99% of the weight (Table 2c).

Of the 68 sink net catches sampled from December 1985 through April 1986, 53 were from south of Cape Hatteras and 15 were north of Cape Hatteras (Table 1). CPUE ranged from 14 to 5,968 kg/trip and averaged 1,641 kg/trip. Weakfish were dominant by weight (61.1%) and number (78%). Together with bluefish, they accounted for 94% of the catch weight, and with Atlantic mackerel (Scomber scombrus) and Atlantic croaker, represented 98% of the catch (Table 2d).

During the 1986-87 fishing season, a total of 94 sink net catches were sampled, including 62 from Cape Hatteras to Ocracoke Inlet and 32 from north of Cape Hatteras (Table 1). CPUE catches ranged from 54 to 5,986 kg/trip and averaged 1,726 kg/trip. Weakfish dominated catches by weight (64%) and number (76%). Together with bluefish and Atlantic croaker, they accounted for 98% of the catches sampled (Table 2e).

Species composition of the sink net catches has remained constant through the five year period (Table 3). Weakfish and bluefish have dominated catches every year; in 1982-84, they accounted for 96.8 and 98.2% of the weight, respectively. Since then, Atlantic croaker have become more prevalent in the catches (3.8-6.9%). Collectively, these three species accounted for 96.3 to 99.0% of the total weight seasonally. The fishery demonstrated the ability to target bluefish and weakfish as market conditions permit.

Table 2. Species composition of sink net catches sampled from October 1982 through April 1987; n=number of catches sampled; OBS=species observed in catches but not occurring in samples.

Species	Weight (kg)		Number		Mean fish weight (kg)	Percent freq. occur
	Mean	Percent	Mean	Percent		
a) 1982-83 (n=27)						
<u>Pomatomus saltatrix</u>	848.4	59.82	377	28.9	2.520	92.5
<u>Cynoscion regalis</u>	558.3	39.36	905	69.3	0.617	88.8
<u>Mustelus canis</u>	5.0	0.35	-	-	-	7.4
<u>Brevoortia tyrannus</u>	3.6	0.25	16	1.2	0.222	11.1
<u>Euthynnus alletteratus</u>	1.8	0.12	<1	<0.1	5.950	18.5
<u>Peprilus triacanthus</u>	0.7	0.05	7	0.6	0.102	37.0
<u>Micropogonias undulatus</u>	0.2	0.01	<1	<0.1	0.354	11.1
<u>Alosa mediocris</u>	0.1	0.01	<1	<0.1	0.345	11.1
<u>Alosa sapidissima</u>	0.1	<0.01	<1	<0.1	1.800	3.7
<u>Paralichthys dentatus</u>	0.1	<0.01	<1	<0.1	0.700	3.7
<u>Menticirrhus americanus</u>	<0.1	<0.01	<1	<0.1	0.243	7.4
<u>Urophycis floridana</u>	<0.1	<0.01	<1	<0.1	0.500	3.7
<u>Urophycis regia</u>	<0.1	<0.01	<1	<0.1	0.300	3.7
<u>Peprilus alepidotus</u>	<0.1	<0.01	<1	<0.1	0.010	3.7
<u>Alosa aestivalis</u>	OBS					3.7
b) 1983-84 (n=69)						
<u>Cynoscion regalis</u>	716.5	62.18	812	78.48	0.883	85.5
<u>Pomatomus saltatrix</u>	399.7	34.68	139	13.48	2.670	88.4
<u>Euthynnus alletteratus</u>	12.3	1.07	3	0.27	4.410	36.2
<u>Micropogonias undulatus</u>	11.6	1.00	51	4.88	0.229	44.9
<u>Brevoortia tyrannus</u>	8.7	0.76	24	2.28	0.370	8.7
<u>Sciaenops ocellatus</u>	1.8	0.16	<1	0.01	2.330	2.9
<u>Peprilus triacanthus</u>	0.5	0.04	<1	0.42	0.119	34.8
<u>Lophius americanus</u>	0.3	0.02	<1	0.02	1.264	13.0
<u>Cynoscion nebulosus</u>	0.2	0.02	<1	0.03	0.811	15.9
<u>Scomberomorus cavalla</u>	0.2	0.01	<1	<0.01	5.450	1.4
<u>Menticirrhus americanus</u>	0.1	0.01	<1	0.03	0.406	14.5
<u>Paralichthys dentatus</u>	0.1	0.01	<1	0.01	0.753	7.2
<u>Alosa mediocris</u>	0.1	0.01	<1	0.04	0.227	2.9
<u>Alosa sapidissima</u>	<0.1	0.01	<1	<0.01	1.150	1.4
<u>Urophycis earlii</u>	<0.1	<0.01	<1	<0.01	1.360	1.4
<u>Centropristis striata</u>	<0.1	<0.01	<1	0.01	0.272	1.4
<u>Leiostomus xanthurus</u>	<0.1	<0.01	<1	<0.01	0.670	2.9
<u>Alosa pseudoharengus</u>	<0.1	<0.01	<1	0.01	0.325	2.9
<u>Urophycis regia</u>	<0.1	<0.01	<1	0.01	0.300	2.9
<u>Menticirrhus sp.</u>	<0.1	<0.01	<1	<0.01	0.333	2.9
<u>Alosa aestivalis</u>	<0.1	<0.01	<1	<0.01	0.250	1.4
<u>Urophycis chuss</u>	<0.1	<0.01	<1	<0.01	0.500	1.4
<u>Caranx hippos</u>	<0.1	<0.01	<1	<0.01	0.500	1.4
<u>Prionotus evolans</u>	<0.1	<0.01	<1	<0.01	0.350	1.4
<u>Orthopristis chrysoptera</u>	<0.1	<0.01	<1	<0.01	0.050	1.4
<u>Loligo pealii</u>	OBS					1.4
<u>Merluccius bilinearis</u>	OBS					2.9
<u>Sphoeroides maculatus</u>	OBS					1.4
c) 1984-85 (n=58)						
<u>Cynoscion regalis</u>	730.5	46.95	1,203	64.65	0.607	91.4
<u>Pomatomus saltatrix</u>	726.2	46.67	265	14.23	2.743	84.5
<u>Micropogonias undulatus</u>	84.3	5.42	352	18.92	0.240	55.2
<u>Euthynnus alletteratus</u>	5.7	0.36	1	0.06	4.699	34.5
<u>Peprilus triacanthus</u>	3.4	0.22	29	1.56	0.116	37.9
<u>Menticirrhus americanus</u>	2.1	0.14	5	0.28	0.411	20.7
<u>Mustelus canis</u>	1.1	0.07	-	-	-	19.0
<u>Alosa mediocris</u>	0.9	0.06	2	0.12	0.427	13.8
<u>Lophius americanus</u>	0.2	0.02	<1	0.01	1.611	12.1
<u>Menticirrhus sp.</u>	0.2	0.01	1	0.03	0.433	19.0
<u>Centropristis striata</u>	0.2	0.01	1	0.03	0.331	3.4
<u>Scomberomorus cavalla</u>	0.2	0.01	<1	<0.01	3.033	1.7
<u>Menticirrhus saxatilis</u>	0.1	0.01	<1	0.01	0.507	3.4
<u>Leiostomus xanthurus</u>	0.1	0.01	1	0.03	0.218	10.3
<u>Cynoscion nebulosus</u>	0.1	0.01	<1	0.01	0.756	6.9

Table 2. (Continued)

Species	Weight (kg)		Number		Mean fish weight (kg)	Percent freq. occur
	Mean	Percent	Mean	Percent		
<u>Merluccius bilinearis</u>	0.1	0.01	<1	0.01	0.550	3.4
<u>Paralichthys dentatus</u>	0.1	0.01	<1	0.01	0.522	10.3
<u>Alosa sapidissima</u>	<0.1	<0.01	<1	<0.01	0.540	5.2
<u>Tautoga onitis</u>	<0.1	<0.01	<1	0.01	0.400	1.7
<u>Alosa pseudoharengus</u>	<0.1	<0.01	<1	0.01	0.287	3.4
<u>Urophycis regia</u>	<0.1	<0.01	<1	0.01	0.317	6.9
<u>Urophycis sp.</u>	<0.1	<0.01	<1	0.01	0.233	3.4
<u>Urophycis earlii</u>	<0.1	<0.01	<1	<0.01	0.250	1.7
<u>Orthopristis chrysoptera</u>	<0.1	<0.01	<1	<0.01	0.250	1.7
<u>Alosa sp.</u>	<0.1	<0.01	<1	<0.01	0.450	1.7
<u>Scomberomorus maculatus</u>	<0.1	<0.01	<1	<0.01	0.450	1.7
<u>Callinectes sapidus</u>	OBS					1.7
<u>Brevoortia tyrannus</u>	OBS					70.7
<u>Larimus fasciatus</u>	OBS					1.7
<u>Trichiurus lepturus</u>	OBS					1.7

d) 1985-86 (n=68)

<u>Cynoscion regalis</u>	1,003.7	61.17	1,688	77.60	0.595	82.4
<u>Pomatomus saltatrix</u>	539.6	32.89	197	9.07	2.734	91.2
<u>Micropogonias undulatus</u>	37.4	2.28	163	7.51	0.229	51.5
<u>Scomber scombrus</u>	28.6	1.74	36	1.65	0.796	5.9
<u>Euthynnus alletteratus</u>	11.9	0.72	2	0.11	5.018	41.2
<u>Menticirrhus americanus</u>	7.2	0.44	17	0.79	0.419	36.8
<u>Peprilus triacanthus</u>	6.0	0.36	63	2.88	0.095	48.5
<u>Alopias vulpinus</u>	1.9	0.12	<1	<0.01	43.100	2.9
<u>Mustelus canis</u>	1.3	0.08	1	0.02	2.509	19.1
<u>Menticirrhus sp.</u>	0.6	0.04	1	0.07	0.400	11.8
<u>Urophycis regia</u>	0.5	0.03	1	0.06	0.365	20.6
<u>Alosa sapidissima</u>	0.3	0.02	<1	0.01	1.700	10.3
<u>Leiostomus xanthurus</u>	0.3	0.02	2	0.10	0.132	13.2
<u>Scomberomorus maculatus</u>	0.3	0.02	<1	0.01	1.657	1.5
<u>Acipenser oxyrhynchus</u>	0.2	0.01	<1	<0.01	15.900	1.5
<u>Lophius americanus</u>	0.2	0.01	<1	0.01	0.873	4.4
<u>Alosa sp.</u>	0.2	0.01	<1	0.02	0.397	2.9
<u>Menticirrhus saxatilis</u>	0.2	0.01	<1	0.02	0.345	5.9
<u>Alosa mediocris</u>	0.1	0.01	1	0.02	0.271	14.7
<u>Carcharhinidae</u>	0.1	0.01	-	-	-	1.5
<u>Paralichthys dentatus</u>	0.1	0.01	<1	0.01	0.800	8.8
<u>Cynoscion nebulosus</u>	0.1	0.01	<1	0.01	0.678	11.8
<u>Centropristis striata</u>	0.1	<0.01	<1	0.01	0.315	8.8
<u>Orthopristis chrysoptera</u>	0.1	<0.01	<1	0.01	0.183	5.9
<u>Merluccius bilinearis</u>	0.1	<0.01	<1	<0.01	0.457	2.9
<u>Scomberomorus cavalla</u>	<0.1	<0.01	<1	<0.01	3.180	1.5
<u>Archosargus probatocephalus</u>	<0.1	<0.01	<1	<0.01	0.700	1.5
<u>Trichiurus lepturus</u>	<0.1	<0.01	<1	<0.01	0.500	1.5
<u>Paralichthys sp.</u>	<0.1	<0.01	<1	<0.01	0.500	1.5
<u>Alosa aestivalis</u>	OBS					1.5
<u>Brevoortia tyrannus</u>	OBS					35.3
<u>Opisthonema oglinum</u>	OBS					5.9
<u>Priacanthus arenatus</u>	OBS					1.5
<u>Bairdiella chrysoura</u>	OBS					1.5
<u>Larimus fasciatus</u>	OBS					1.5

e) 1986-87 (n=94)

<u>Cynoscion regalis</u>	1,094.4	63.39	2,118	75.92	0.517	91.5
<u>Pomatomus saltatrix</u>	479.0	27.74	163	5.85	2.934	74.5
<u>Micropogonias undulatus</u>	120.7	6.99	472	16.94	0.255	68.1
<u>Euthynnus alletteratus</u>	20.6	1.19	4	0.14	5.365	52.1
<u>Carcharhinus sp.</u>	4.3	0.25	-	-	-	9.6
<u>Peprilus triacanthus</u>	2.7	0.16	23	0.83	0.118	51.1
<u>Mustelus canis</u>	1.0	0.06	-	-	-	4.3
<u>Menticirrhus americanus</u>	0.7	0.04	2	0.06	0.371	35.1
<u>Brevoortia tyrannus</u>	0.5	0.03	3	0.10	0.184	19.1
<u>Lophius americanus</u>	0.5	0.03	<1	0.01	1.181	18.1

Table 2. (Continued)

Species	Weight (kg)		Number		Mean fish weight (kg)	Percent freq. occur
	Mean	Percent	Mean	Percent		
<u>Alosa sapidissima</u>	0.4	0.02	<1	0.01	1.235	7.4
<u>Cynoscion nebulosus</u>	0.3	0.02	<1	0.01	1.740	9.6
<u>Acipenser oxyrinchus</u>	0.3	0.02	<1	<0.01	25.400	1.1
<u>Menticirrhus</u> sp.	0.2	0.01	1	0.02	0.361	9.6
<u>Carcharhinus limbatus</u>	0.2	0.01	<1	<0.01	18.100	1.1
<u>Alosa mediocris</u>	0.2	0.01	<1	0.01	0.762	10.6
<u>Peprilus alepidotus</u>	0.1	0.01	2	0.06	0.057	2.1
<u>Thunnus alalunga</u>	0.1	0.01	<1	<0.01	4.300	2.1
<u>Urophycis regia</u>	0.0	0.00	<1	0.01	0.301	9.6
<u>Leiostomus xanthurus</u>	0.0	0.00	<1	0.01	0.152	7.4
<u>Alosa pseudoharengus</u>	0.0	0.00	<1	<0.01	0.533	2.1
<u>Urophycis</u> sp.	0.0	0.00	<1	<0.01	0.242	5.3
<u>Centropristis striata</u>	0.0	0.00	<1	<0.01	2.900	5.3
<u>Scomber scombrus</u>	0.0	0.00	<1	<0.01	0.500	9.6
<u>Pogonias cromis</u>	0.0	0.00	<1	<0.01	1.400	1.1
<u>Urophycis floridana</u>	0.0	0.00	<1	<0.01	0.500	2.1
<u>Paralichthys dentatus</u>	0.0	0.00	<1	<0.01	0.250	2.1
<u>Urophycis chuss</u>	0.0	0.00	<1	<0.01	0.400	2.1
<u>Alosa</u> sp.	0.0	0.00	<1	<0.01	0.500	1.1
<u>Pollachius virens</u>	0.0	0.00	<1	<0.01	0.500	1.1
<u>Percidae</u>	0.0	0.00	<1	<0.01	0.500	1.1
<u>Menticirrhus saxatilis</u>	0.0	0.00	<1	<0.01	0.320	1.1
<u>Prionotus evolans</u>	-	-	-	-	-	-
<u>Larimus fasciatus</u>	-	-	-	-	-	-

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Species	1982-83				1983-84				1984-85				1985-86				1986-87			
	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt
SINK NETS																				
<i>Cynoscion regalis</i>	558.3	(n=27)	39.4	69.3	0.617	(n=69)	716.5	62.2	78.5	0.833	(n=58)	730.5	46.9	64.7	0.607	(n=68)	1,003.7	61.2	77.6	0.595
<i>Pomatomus saltatrix</i>	848.4	59.8	28.9	2.252	399.7	34.7	13.5	2.867	726.2	46.7	14.2	2.743	539.6	32.9	9.1	2.734	479.0	27.7	5.8	2.934
<i>Micropogonias undulatus</i>					11.6	1.00	4.88	0.229	84.3	5.4	18.9	0.240	37.4	2.3	7.5	0.224	120.7	7.0	16.9	0.255
<i>Euthynnus alletteratus</i>					12.3	1.07	0.27	4.410	5.7	0.3	0.1	4.699					11.9	0.7	0.1	5.018
<i>Brevoortia tyrannus</i>					8.7	0.8	2.3	0.370									28.6	1.7	1.6	0.796
<i>Scomber scombrus</i>																	7.2	0.4	0.8	0.419
<i>Menticirrhus americanus</i>																				
ANCHORED NETS																				
<i>Pomatomus saltatrix</i>	378.1	(n=30)	62.9	79.6	2.933	(n=2)	531.2	53.8	30.5	4.024	(n=6)						50.6	12.9	14.3	0.504
<i>Cynoscion regalis</i>	3.5	0.6	1.5	1.462	90.9	9.2	10.0	2.091									318.7	81.4	77.7	0.586
<i>Euthynnus alletteratus</i>	66.4	10.8	7.0	5.823					124.3	42.5	48.4	5.524								
<i>Squalus acanthias</i>	50.0	8.3																		
<i>Mustelus canis</i>	46.4	7.6							211.4	21.4										
<i>Scomberomorus cavalla</i>	33.8	5.7	2.9	7.291					134.4	46.0	31.9	9.063								
<i>Carcharhinidae</i>	12.0	2.0	0.7	10.214					4.9	1.7										
<i>Alosa sapidissima</i>	4.8	0.8	1.6	1.860																
<i>Scomber scombrus</i>									7.7	0.8	1.2	1.540								
<i>Scomberomorus maculatus</i>	1.4	0.2	0.3	2.950					63.9	6.5	18.3	0.804								
<i>Clupea harengus</i>									57.5	5.8	34.0	0.390								
<i>Acipenser oxyrinchus</i>									17.7	1.8	1.1	3.550								
<i>Alosa aestivialis</i>									5.3	0.5	4.3	0.286								
<i>Sciaenops ocellatus</i>																				
<i>Alosa mediocris</i>																				
<i>Cynoscion nebulosus</i>																				
<i>Menticirrhus</i> spp.																				
<i>Micropogonias undulatus</i>																				
<i>Menticirrhus americanus</i>																				
<i>Menticirrhus saxatilis</i>																				
<i>Centropristis striata</i>																				
FLIGHTING GILL NET																				
<i>Norone saxatilis</i>	133.8	(n=40)	94.7	83.2	16.624	(n=4)	55.8	100.0	100.0	18.617										
<i>Euthynnus alletteratus</i>	5.4	3.8	8.8	6.324																
<i>Lophius americanus</i>	1.4	1.0	6.5	2.192																
<i>Acipenser oxyrinchus</i>		0.5	0.4	10.650																
<i>Alosa sapidissima</i>	0.2	0.1	0.8	2.033																
																	72.6	30.2	43.2	0.162
																	26.5	11.0	17.4	0.147
																	4.2	1.7	1.2	0.341
																	2.1	0.9	1.1	0.180

Anchored and Floating Gill Nets and Gear Comparisons

From September 1982 through April 1983, 30 anchored gill net catches were sampled (Table 1). This reflected the greater effort by fishermen at that time using dories off the beach. Anchored gill nets were fished from September through April. They were directed towards king mackerel through November, weakfish and bluefish December through April, and American shad (Alosa sapidissima) in February and March. In declining rank by weight, the catches were composed primarily of bluefish, weakfish, little tunny (Euthynnus alleteratus), spiny dogfish (Squalus acanthias), smooth dogfish (Mustelus canis), and king mackerel (Table 3).

After 1983, sample sizes for anchor gill nets were much smaller (Table 1) because of both reduced fishing activity and redirected sampling effort. The dominant species in 1983-84 samples were bluefish, smooth dogfish, and weakfish; in 1984-85, king mackerel, little tunny, and red drum; in 1985-86, weakfish and bluefish, and in 1986-87, weakfish, Atlantic croaker, and sea mullet (Menticirrhus spp.).

Floating gill net catches of striped bass were sampled during the 1982-83 (n=40) and 1983-84 (n=4) fishing seasons (Table 1). In 1982-83, the average catch sampled was 134 kg (8 fish); catches ranged from 123 to 1,025 kg/trip (Table 3). In February and March, 258 and 64 fish were sampled, averaging 16.3 and 17.8 kg, respectively. In 1983-84, floating nets were set in February and March, but the 12 fish sampled represented nearly the entire catch. The four catches in which fish were caught averaged 56 kg and individual striped bass averaged 18.6 kg.

Since the 1982-83 season, sampling efforts focused more on sink net catches and less on anchored and floating gill nets (Table 1). This reflected the increased fishing effort within the sink net fishery, the decline of the less effective anchor gill net, and the prohibition of ocean fishing for striped bass.

Monthly Catch Composition

Sink Nets

Paralleling the annual species composition, monthly catches in each season were dominated by weakfish and bluefish, with good catches of Atlantic croaker during the beginning or end of several seasons (Tables 4 and 5).

In December, large bluefish were caught from Oregon Inlet to Avon Rocks, Atlantic croaker were caught in the Hatteras Bight and weakfish were scattered throughout both areas (Table 4). Within a season, the largest catches of Atlantic croaker generally occurred in December (Table 5).

By January, most of the fleet had located in Hatteras although some fishing occurred north of Diamond Shoals to off Avon Rocks when water temperatures were warm (January 1986 and 1987). In the 1982-1985 seasons, bluefish and weakfish dominated January catches and no effort was observed north of Cape Hatteras (Tables 4 and 5). The 1985-1987 seasons had warmer water conditions in January and Atlantic croaker catches were higher in the Hatteras Bight than in the earlier three seasons. Weakfish were available north and south of Diamond Shoals, whereas in the earlier three seasons, they were caught only south of the Shoals.

From February through March, the fishing fleet was concentrated in Hatteras, N.C., and fishing was spread from Diamond Shoals to the south end of Ocracoke Island (Tables 4 and 5). Weakfish were the target species, though bluefish catches were occasionally landed when favorable market conditions existed. Weakfish catches generally reached their seasonal highs during this period (Tables 4 and 5).

In April, bluefish, weakfish, and Atlantic croaker stocks begin moving north across Diamond Shoals and inshore towards the various inlets. The sink net fleet was split between the ports of Wanchese and Hatteras and fished north and south of Diamond Shoals. During the 1982-85 fishing seasons, large weakfish ("sow" trout) were targeted and

Table 4. Monthly comparison of dominant species (top 99%) average catch/trip (CPUE) in sink net catches sampled September 1982 through April 1987, including percent of the weight (% Wt) and number (% Num) of fish caught, and mean fish weight (Mean fish wt.); Note: all weights in kilograms; n=number of catches sampled.

Species	1982-83				1983-84				1984-85				1985-86				1986-87			
	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt
<i>Cynoscion regalis</i>	(n=0)				(n=10)				(n=7)				(n=6)				(n=7)			
<i>Pomatomus saltatrix</i>					94.0	23.4	19.5	0.642	577.6	56.0	42.1	0.478	268.5	34.4	24.8	0.414	618.1	67.6	79.6	0.501
<i>Micropononias undulatus</i>					130.7	32.6	13.1	1.326	119.5	11.6	11.1	0.376	231.0	29.6	23.1	0.383	265.0	29.0	13.4	1.277
<i>Brevoortia tyrannus</i>					70.1	17.5	41.3	0.226	291.4	28.3	41.3	0.246	147.2	18.9	25.7	0.219	19.2	2.1	5.6	0.219
<i>Euthynnus alletteratus</i>					59.8	14.9	21.5	0.371					34.3	4.4	0.3	4.680	6.0	0.7	0.1	4.644
<i>Peprilus triacanthus</i>					41.9	10.4	1.3	4.361	14.7	1.4	4.3	0.119	51.8	6.6	21.7	0.092				
<i>Menticirrhus americanus</i>									11.6	1.1	0.9	0.461	33.3	4.3	3.2	0.395				
<i>Cynoscion regalis</i>	(n=11)				(n=18)				(n=16)				(n=20)				(n=15)			
<i>Pomatomus saltatrix</i>	164.5	22.3	48.7	0.360	278.0	30.3	68.2	0.703	727.2	86.8	83.0	0.448	1,404.8	93.2	89.3	0.487	1,217.1	92.2	87.8	0.473
<i>Brevoortia tyrannus</i>	561.8	76.0	46.5	1.287	619.0	67.4	29.3	3.645	62.6	7.5	8.8	0.364	22.7	1.5	1.5	0.463				
<i>Euthynnus alletteratus</i>	8.7	1.2	4.2	0.222	18.0	1.9	0.8	4.151	8.6	1.0	0.1	4.613	55.3	3.7	7.1	0.242	22.5	1.7	0.1	5.352
<i>Micropononias undulatus</i>									22.3	2.6	4.5	0.252					60.5	4.6	8.7	0.236
<i>Peprilus triacanthus</i>									5.5	0.7	2.5	0.113					7.5	0.6	2.2	0.117
<i>Alosa mediocriis</i>									3.4	0.4	0.4	0.429								
<i>Menticirrhus americanus</i>													12.8	0.8	0.9	0.437				
<i>Cynoscion regalis</i>	(n=10)				(n=19)				(n=14)				(n=20)				(n=21)			
<i>Pomatomus saltatrix</i>	428.5	27.5	66.6	0.524	821.2	70.2	86.7	0.731	350.1	13.6	32.6	0.537	982.6	59.4	84.0	0.729	1,613.0	75.2	93.7	0.520
<i>Micropononias undulatus</i>	1,112.6	71.4	31.9	2.839	343.3	29.4	12.8	2.072	2,039.8	79.4	26.8	3.914	564.5	34.1	8.0	4.376	494.6	23.0	3.5	4.260
<i>Mustelus canis</i>	12.4	0.8															20.2	0.9	2.3	0.268
<i>Scomber scombrus</i>													97.1	5.8	7.6	0.796				
<i>Cynoscion regalis</i>	(n=2)				(n=14)				(n=14)				(n=19)				(n=32)			
<i>Pomatomus saltatrix</i>	2,521.1	100.0	100.0	0.495	761.4	69.5	91.9	0.704	1,274.5	77.4	95.0	0.714	905.7	41.2	71.9	0.748	1,242.7	61.2	83.6	0.529
<i>Micropononias undulatus</i>					327.8	29.9	7.5	3.706	365.9	22.2	4.8	4.037	1,239.3	56.4	19.4	3.789	710.5	35.0	9.6	2.629
<i>Euthynnus alletteratus</i>													27.4	1.2	7.3	0.224	41.8	2.0	6.2	0.241
													19.7	0.9	0.2	5.844	31.1	1.5	0.2	5.620
<i>Cynoscion regalis</i>	(n=4)				(n=8)				(n=7)				(n=3)				(n=19)			
<i>Pomatomus saltatrix</i>	984.3	41.3	41.9	3.768	2,154.1	80.5	88.9	1.576	563.9	37.3	40.2	3.201	560.8	88.7	90.5	0.529	350.1	25.5	24.0	0.578
<i>Alipias vulpinus</i>	1,400.4	58.7	58.1	3.866	502.2	18.8	9.7	3.376	943.0	62.4	59.6	3.611	5.3	0.8	0.9	0.497	526.3	38.4	5.6	3.739
<i>Micropononias undulatus</i>													34.0	5.4	<0.1	102.1				
<i>Euthynnus alletteratus</i>													10.9	1.7	5.4	0.172	449.7	32.8	68.6	0.260
<i>Alosa spp.</i>													9.8	1.5	0.2	3.675	14.9	1.1	0.1	4.654
<i>Carcharias spp.</i>													4.2	0.7	0.9	0.397	17.9	1.3		

Table 5. Catch/trip (CPUE, kg/trip) for weakfish (*Cynoscion regalis*, bluefish (*Pomatomus saltatrix*), and Atlantic croaker (*Micropogonias undulatus*) for sink nets by area fished from September 1982 through April 1987.

Season	North of Cape Hatteras					Cape Hatteras to Cape Lookout				
	CPUE (kg/trip)					CPUE (kg/trip)				
	Dec	Jan	Feb	Mar	Apr	Dec	Jan	Feb	Mar	Apr
Weakfish	1982-83				1,946.3		164.5	428.5	2,521.1	19.3
	1983-84	92.5			2,722.2	95.1	278.0	821.2	761.4	905.3
	1984-85			0.5	563.9	577.6	727.2	350.1	1,622.0	
	1985-86		1,457.4	5.1		268.5	1,352.3	1,308.5	905.8	560.8
	1986-87	590.0	1,176.1		350.1	655.6	1,278.5	1,613.0	1,242.7	-
Bluefish	1982-83	-		-	107.1	-	561.8	1,112.6	0	2,693.6
	1983-84	257.9		-	802.3	45.9	618.9	343.2	327.8	1.6
	1984-85	-		1,707	943.0	119.6	62.6	2,039.9	0.2	
	1985-86		19.8	325.3		231.0	25.6	644.3	1,239.3	5.3
	1986-87	418.3	3.7		526.3	60.6	2.2	494.6	710.5	-
Atlantic croaker	1982-83	-			0	-	0	0.5	-	-
	1983-84	0			0	116.8	1.99	1.5	0.1	7.8
	1984-85	-		0	0	291.5	22.3	177.9	0.5	-
	1985-86	-	14.2	0	-	147.2	96.4	0.1	27.4	10.9
	1986-87	0	7.1		449.7	44.8	140.7	20.2	41.8	-

caught as they moved north from Wimble Shoals to Corolla, N.C. (Tables 4 and 5). Good catches of large bluefish were taken in April as they moved inshore and north around Oregon Inlet, and also off Hatteras in 1983 (Tables 4 and 5). Bluefish were often caught with or while searching for large weakfish. During the last two fishing seasons, good catches of medium weakfish occurred above (1987) or below (1986) Cape Hatteras. Good catches of Atlantic croaker were made for the first time during this study in April 1987 around Avon Rocks (Table 5).

Comparison of Sink Net Catches North and South of Cape Hatteras

Most sampling effort in this study was south of Cape Hatteras and roughly reflected the distribution of fishing activity. The increasingly larger percentage of samples from northern waters each year, from 7% in 1982-83 to 34% in 1986-87 (Table 6), reflected increased sampling effort, as well as increased size and expanded range of the sink net fleet. In recent seasons, more boats stayed north and fished out of Wanchese for longer periods of time.

Catches in the two regions were basically the same for the three dominant species, although the relative abundance varied seasonally (Table 6). Most secondary species, including kingfish (Menticirrhus spp.) and little tunny, were caught in both areas. In the 1986-87 season, Atlantic mackerel occurred in several catches north of Cape Hatteras.

The average catch of weakfish increased for the area south and decreased for the area north of Cape Hatteras during this study (Table 6). South of Cape Hatteras, CPUEs increased steadily from 447 to 1,343 kg/trip from 1982-83 to 1987-88; mean fish weight remained between 0.48 and 0.68 kg. North of Cape Hatteras, CPUE declined from 1,949 kg/trip to 612 kg/trip and mean fish weight also declined, from 3.6-3.8 kg to 0.5-0.6 kg during the same period. Although availability and/or species targeting may both contribute to these trends, weakfish were the species targeted by this fishery, when available.

Table 6. Comparison of average catches (CPUE) of dominant species (top 99%) in sink net catches by area fished from catches sampled September 1982 through April 1987, including percent of the weight (% Wt) and number (% Num) of fish caught, and average fish weight; Note: all weights are in kilograms; n=number of catches sampled.

Species	Cape Hatteras to Cape Lookout				North of Cape Hatteras			
	CPUE	% Wt	% Num	Mean fish wt	CPUE	% Wt	% Num	Mean fish wt
1982-83	(n=25)				(n=2)			
<u>Cynoscion regalis</u>	447.0	32.7	68.5	0.478	1,949.3	94.8	94.0	3.763
<u>Pomatomus saltatrix</u>	907.7	66.4	29.6	2.246	107.1	5.2	6.0	3.244
1983-84	(n=60)				(n=9)			
<u>Cynoscion regalis</u>	591.0	59.0	79.0	0.680	1,553.5	71.9	72.6	3.618
<u>Pomatomus saltatrix</u>	375.6	37.5	12.5	2.728	560.4	26.0	25.5	3.708
<u>Micropogonias undulatus</u>	13.3	1.3	5.3	0.229	45.8	2.1	1.8	4.340
<u>Brevoortia tyrannus</u>	10.1	1.0	2.5	0.370				
<u>Euthynnus alletteratus</u>	7.3	0.7	0.2	4.477				
1984-85	(n=48)				(n=10)			
<u>Cynoscion regalis</u>	800.4	51.5	66.2	0.561	1,172.2	74.6	71.3	3.790
<u>Pomatomus saltatrix</u>	633.3	40.8	11.8	2.419	394.9	25.1	28.5	3.200
<u>Micropogonias undulatus</u>	101.9	6.6	19.2	0.240				
<u>Euthynnus alletteratus</u>	6.8	0.4	0.1	4.701				
<u>Peprilus triacanthus</u>	4.1	0.3	1.6	0.116				
<u>Menticirrhus americanus</u>	2.6	0.2	0.3	0.411				
1985-86	(n=53)				(n=15)			
<u>Cynoscion regalis</u>	1,012.3	57.7	75.8	0.591	973.3	78.5	85.2	0.610
<u>Pomatomus saltatrix</u>	657.9	37.5	10.5	2.782	121.6	9.8	3.2	2.056
<u>Micropogonias undulatus</u>	45.3	2.6	8.7	0.230	9.5	0.8	2.3	0.291
<u>Euthynnus alletteratus</u>	14.4	0.8	0.1	5.065	2.9	0.2	0.4	4.310
<u>Menticirrhus americanus</u>	9.2	0.5	1.0	0.419				
<u>Peprilus triacanthus</u>	7.5	0.4	3.5	0.095				
<u>Scomber scombrus</u>					129.5	10.4	8.7	0.796
1986-87	(n=62)				(n=32)			
<u>Cynoscion regalis</u>	1,343.2	68.8	86.7	0.521	612.4	47.5	50.5	0.498
<u>Pomatomus saltatrix</u>	537.4	27.5	6.2	2.922	365.8	28.4	5.1	2.469
<u>Micropogonias undulatus</u>	44.2	2.3	6.2	0.242	269.0	20.8	42.5	0.260
<u>Euthynnus alletteratus</u>	20.8	1.1	0.1	5.571	20.1	1.6	0.2	4.997
<u>Carcharhinus sp.</u>					12.4	1.0		

Bluefish catches were generally larger south of Cape Hatteras, but the average weight of the fish was greater north of Cape Hatteras (Table 6). However, several substantial catches of large bluefish were reported early in the season north of Hatteras by boats fishing out of Wanchese that were not sampled. CPUEs fluctuated seasonally, particularly north of Cape Hatteras where large bluefish catches occurred sporadically, but were often not sampled.

Atlantic croaker have taken on increased importance in the catches since 1984 (Table 6). Atlantic croaker were more abundant south of Cape Hatteras from 1982-83 through 1985-86, and virtually absent from catches north of Cape Hatteras. However, some of the largest catches of Atlantic croaker by sink netters were made from Avon rocks to Wimble Shoals in April 1987.

Species Trends

Landings, CPUE, and Size-Age Composition of Sink Net Catches

Weakfish

During this study, weakfish catches by Dare County sink nets increased and closely paralleled seasonal commercial landings. CPUE rose from 558 to 1,094 kg/trip between 1982 and 1987 (Figure 2, Table 2). Seasonal landings increased from 0.8 million kg in 1982-83 to 2.7 and 2.3 million kg in the 1985-86 and 1986-87 fishing seasons, respectively (Table 7). During this period, weakfish landings by the winter trawl and long haul fisheries generally declined (Figure 3).

Weakfish were caught by sink nets from December through April. The highest monthly CPUEs varied among years of the project (January through April), but catches were generally larger in February and March (Tables 4 and 5). CPUEs were greater south of Cape Hatteras during the last three fishing seasons and increased (800-1,012-1,343 kg/trip); however, during the 1982-84 seasons, CPUE was greater north of Cape Hatteras (1,553-1,949 kg/trip). The northern and southern areas contrast with each other as CPUEs increased in the south and decreased in the north.

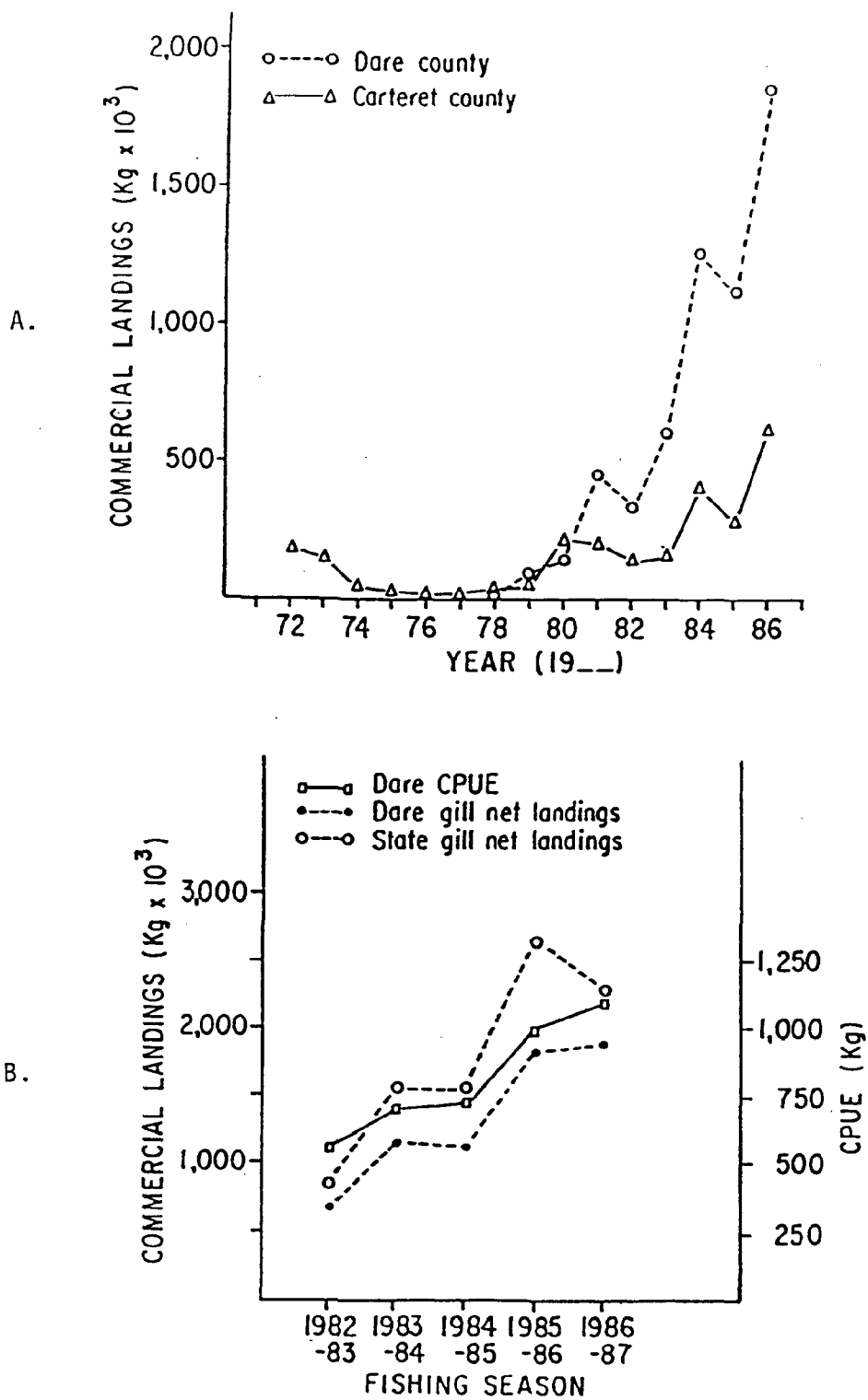


Figure 2. A) Annual commercial landings of weakfish, Cynoscion regalis, in Dare and Carteret counties from ocean-fished gill nets 1972 through 1987.

B) Mean catch-per-trip (CPUE) and total commercial landings for Dare County ocean-fished gill nets, and total state ocean-fished gill net landings of weakfish, Cynoscion regalis, for 1982 through 1987 fishing season.

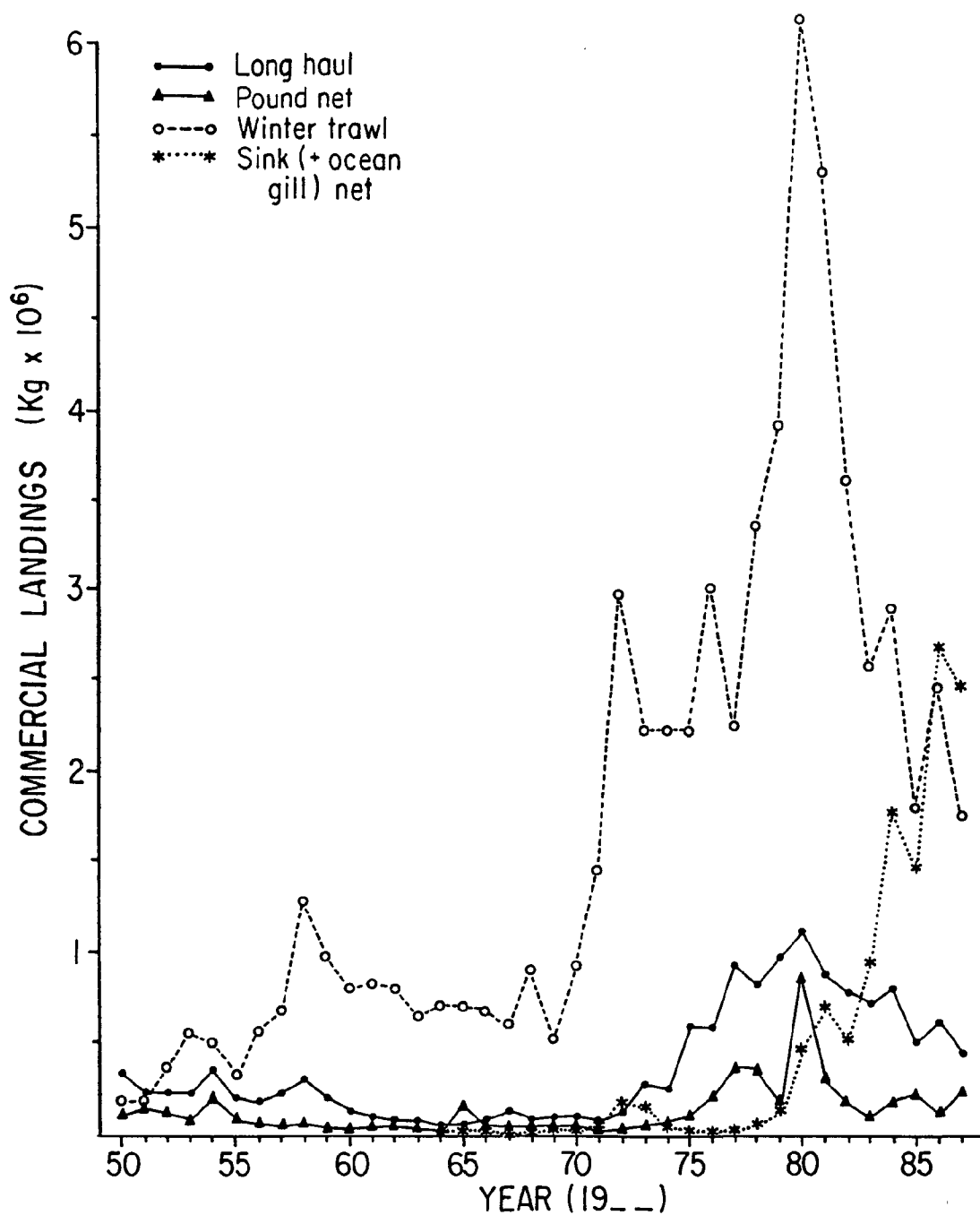


Figure 3. Annual commercial landings of weakfish, *Cynoscion regalis*, in North Carolina by long hauls, pound nets, winter trawls, and sink nets from 1950-1987.

Weakfish captured by sink nets ranged from 160 to 925 mm FL, though the relative number of large fish declined since the 1984-85 season (Figure 4). Throughout the period, 330-380 mm FL encompassed the predominant modal length classes and fish from 300 to 400 mm FL accounted for 53.5-82.1% of the samples. During the 1983-86 seasons, fish 400-600 mm FL made up approximately 33% of the catches; in 1986-87, they fell to only 14.8%. In the 1982-83 season, they were also less abundant in the samples (6.2%), reflecting apparent swings in stock abundance.

The decline of large fish was most dramatic in the 600+ mm FL class. This group comprised 4.3-8.0% of the weakfish caught in 1982-84; by the 1984-85 season, they were reduced to only 1.3%, and since then have fallen to less than 0.2%. Historically, these large fish were targeted in March and April as they moved northward across Diamond Shoals and along the beaches. In April of the 1982-84 fishing seasons, catches of large fish were frequent, and on one day in 1983-84, 8-10 boats landed 100-200 boxes (100 lb boxes) of 600+ mm FL weakfish, all caught in one set per boat. In 1984-85, a catch of 250-500 kg of these large weakfish was a significant catch, and since then, virtually none have been caught.

Sink net catches were composed mainly of ages 1 and 2 weakfish, though fish up to age 10 were captured (Figure 5). Age 1 fish, which ranged from 210 to 495 mm FL, and age 2 fish, which ranged from 241 to 561 mm FL, accounted for 80.2-92.9% annually of the fish landed. From 1983-84 to 1986-87, age 1 fish increased from 32.8 to 48.9% of the catch. During this time, the relative abundance of age 2 and 3 fish declined 4%/age class. More dramatic, and corresponding with the reduced catch of 600+ mm FL fish, was the decline in fish age 5 and older, down from 3.6-7.2% during the 1982-84 seasons to <0.1% during the 1985-87 fishing seasons. Fred Fox (pers. commun. *ibid*) attributes this local decline to warmer winters, i.e., the larger fish not migrating as far south. However, the winter trawl fleet has not caught these older fish in more northern waters since 1985 (Ross et al. 1989; Ross 1989).

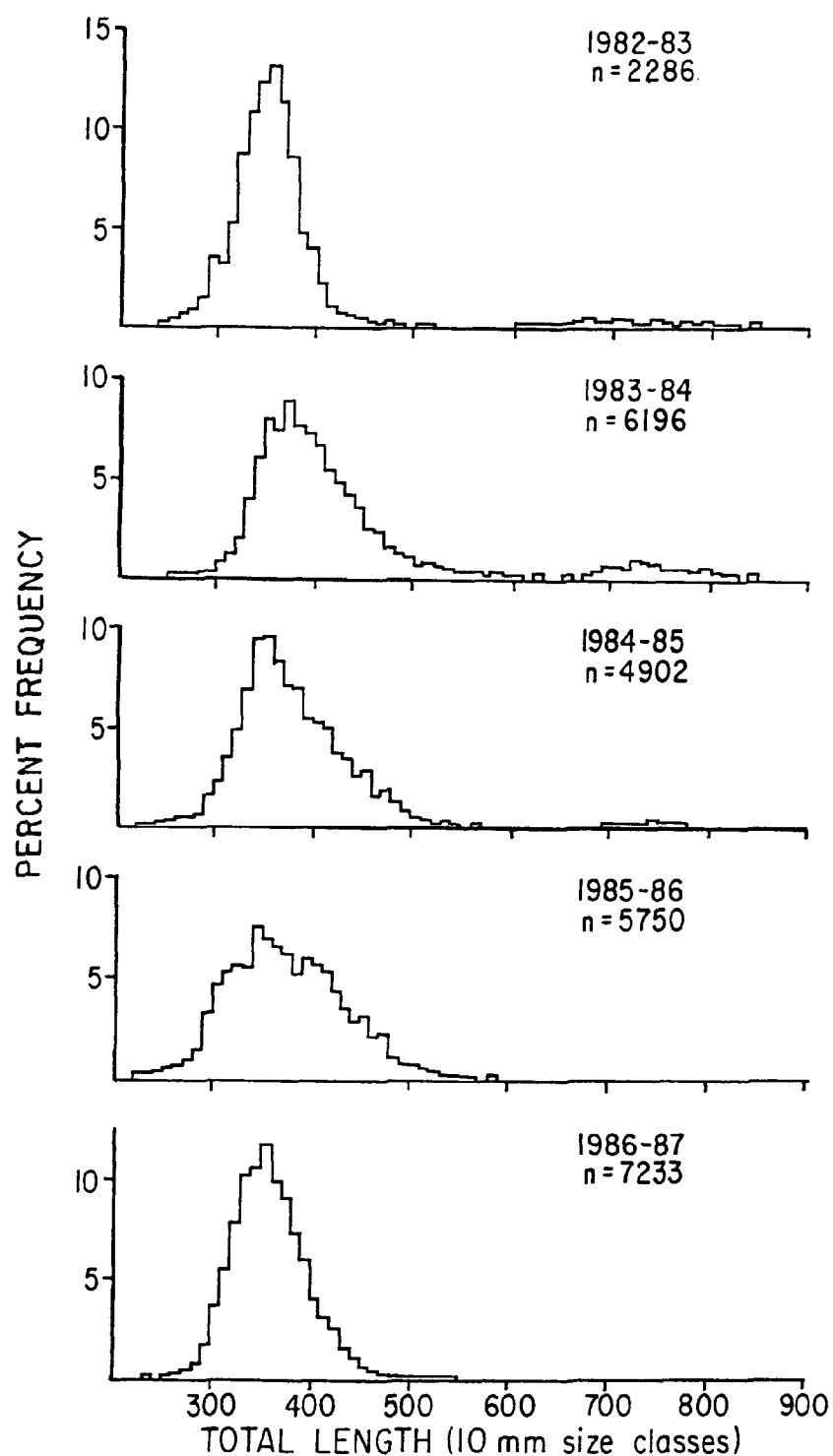


Figure 4. Expanded length frequencies of weakfish, Cynoscion regalis, from January 1983 through April 1987 sink net catches; n=number of fish measured.

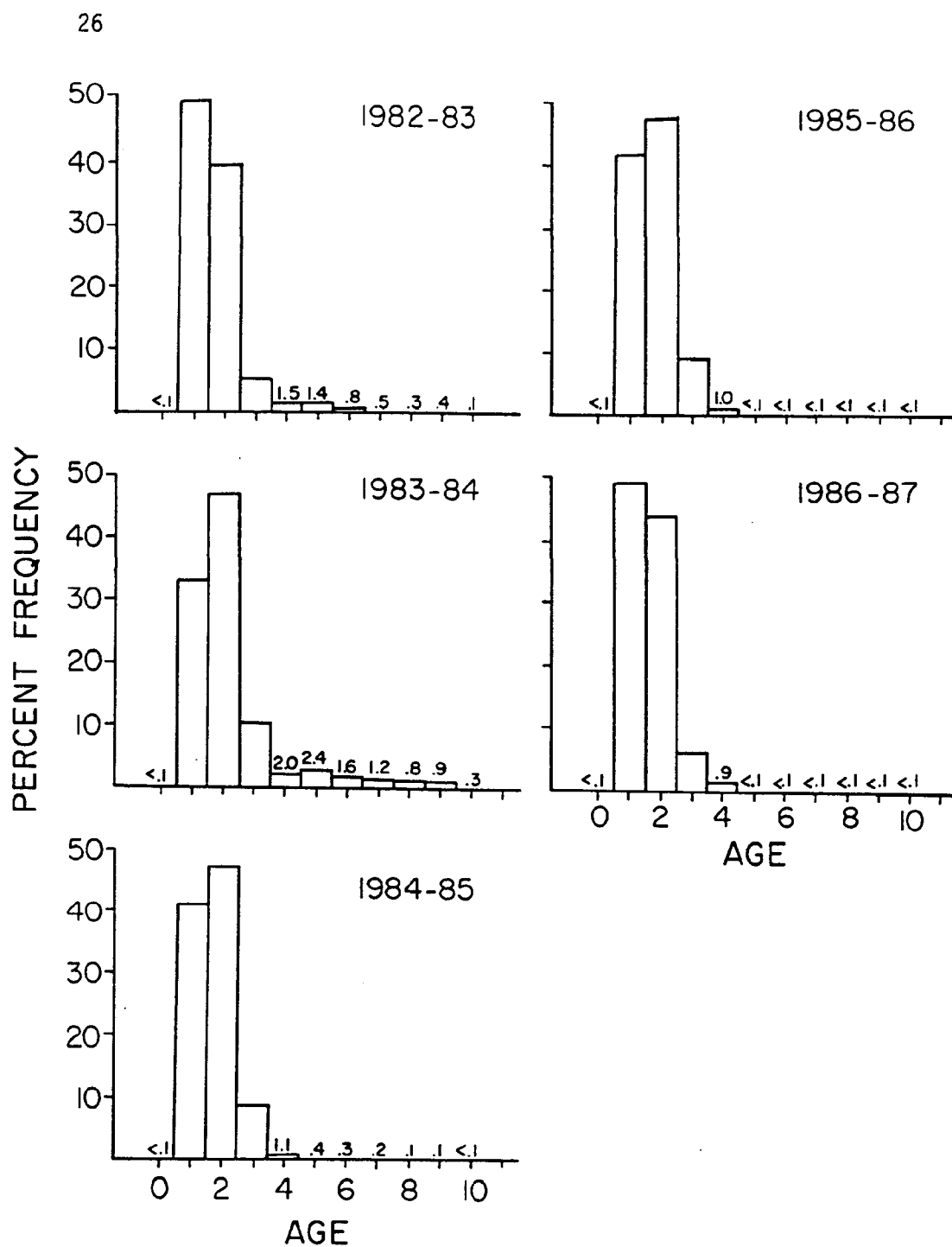


Figure 5. Annual age composition of weakfish, Cynoscion regalis, in sink net catches, 1982-87.

Bluefish

As with weakfish, the trend toward increased bluefish landings since 1978 reflected the pattern of fishing effort in Dare County and its abundance off the Outer Banks in the winter months (Figure 6a). The increase in landings from virtually 0 in 1978 to 0.8 million kg in 1983 coincided with the expanded activity of the sink net fishery on the Outer Banks as well as increased availability of the species along the entire east coast (ASMFC 1987). Landings of bluefish by trawlers similarly rose dramatically during the late 1970s - early 1980s (Figure 7).

Seasonal CPUEs of bluefish by sink nets have ranged between 400 and 848 kg/trip during the study period, with no trend apparent (Table 3). The inconsistency of CPUE and landings data (Figure 6b) might result from the sporadic nature of bluefish catches and our sampling effort, which, together with increased fishing effort since 1985, could explain the increased sink net landings of bluefish.

Catches of bluefish fluctuated monthly with no pattern (Tables 4 and 5). Good catches of large bluefish occurred in November and December, but were not sampled. Large bluefish typically occur off Oregon Inlet to Cape Hatteras in late November through December, from Cape Hatteras to off Portsmouth Island December through early April, and again north of Cape Hatteras in late March through early May. Basically, the market price, demand, and the availability of higher priced species dictated bluefish catches.

Bluefish were harvested by sink nets both north and south of Cape Hatteras. Annually, CPUE averaged from 375 to 908 kg/trip south of Cape Hatteras, and 107 to 1,172 kg/trip north of Cape Hatteras; CPUEs were larger south of Cape Hatteras during three of the last five fishing seasons (Table 6b).

A broad size range of bluefish (220-850 mm FL) were captured by the sink net fishery. During the first four seasons, two or three primary length frequency modes were represented (Figure 8). The smaller fish

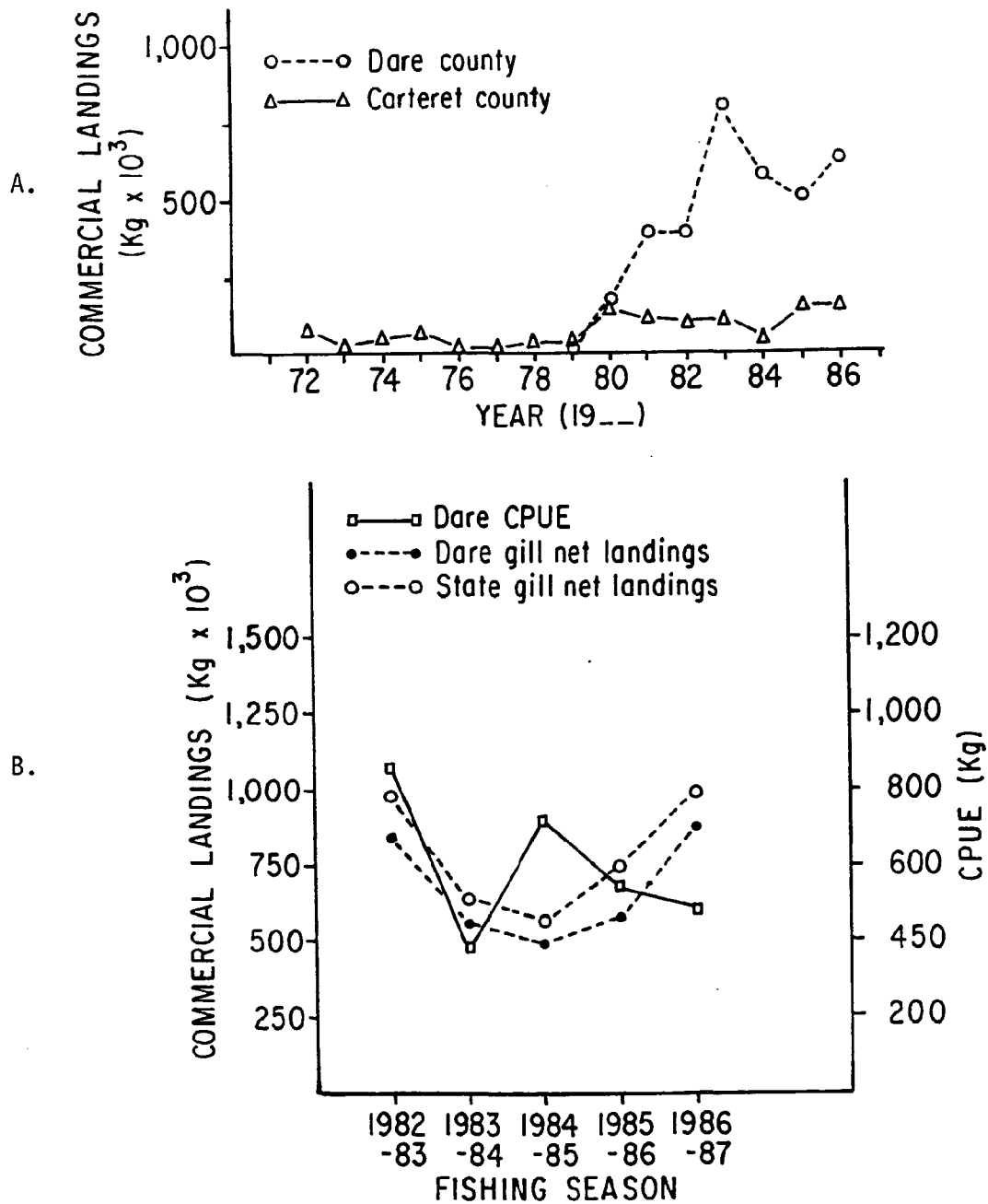


Figure 6. A) Annual commercial landings of bluefish, Pomatomus saltatrix, in Dare and Carteret counties from ocean-fished gill nets 1972-1987.

B) Mean catch per trip (CPUE) and total commercial landings for Dare County ocean-fished gill nets, and total state ocean-fished gill net landings of bluefish, Pomatomus saltatrix, for 1982 through 1987 fishing seasons.

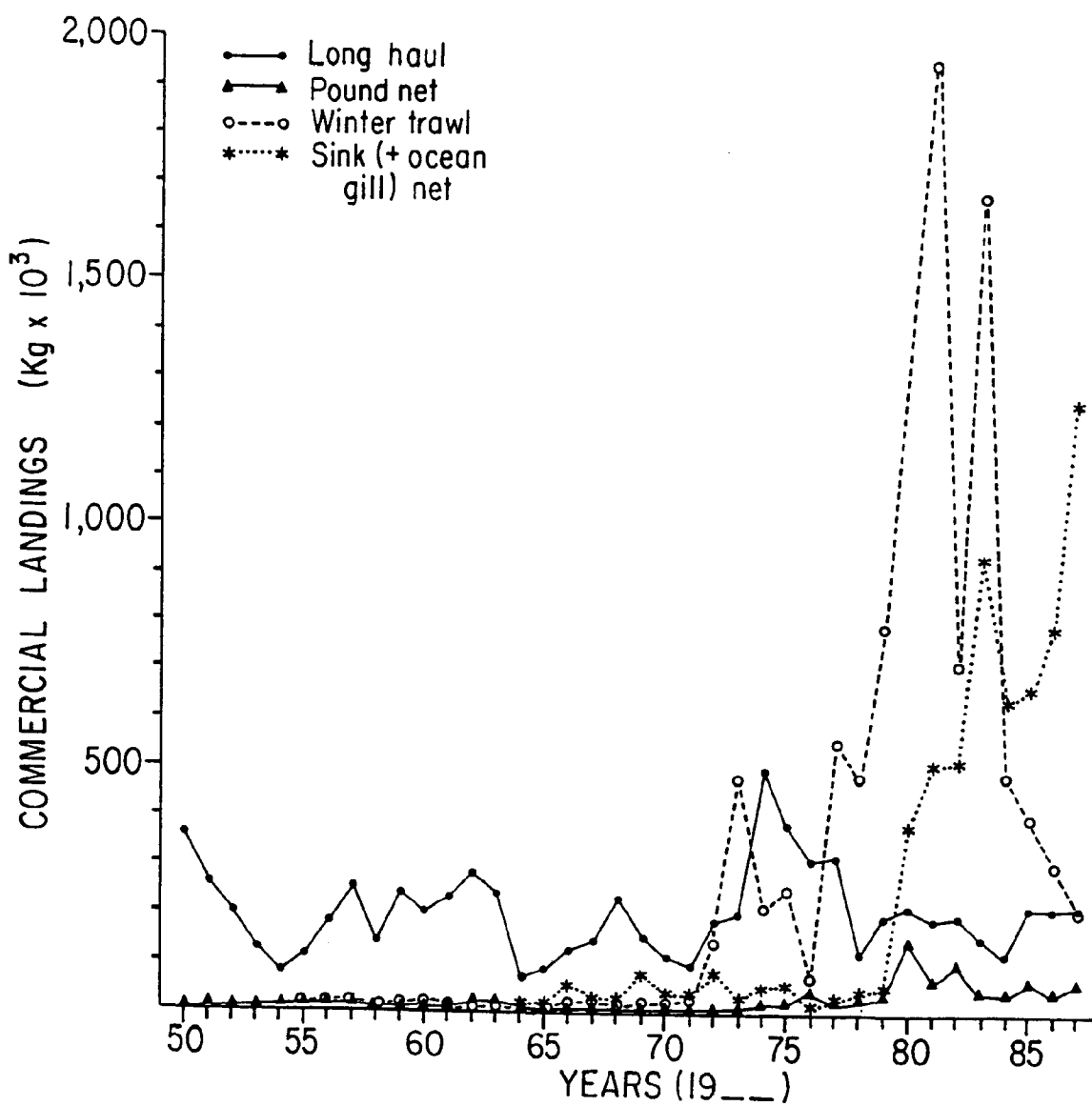


Figure 7. Annual commercial landings of bluefish, *Pomatomus saltatrix*, in North Carolina by long hauls, pound nets, winter trawls, and sink nets from 1950-1987.

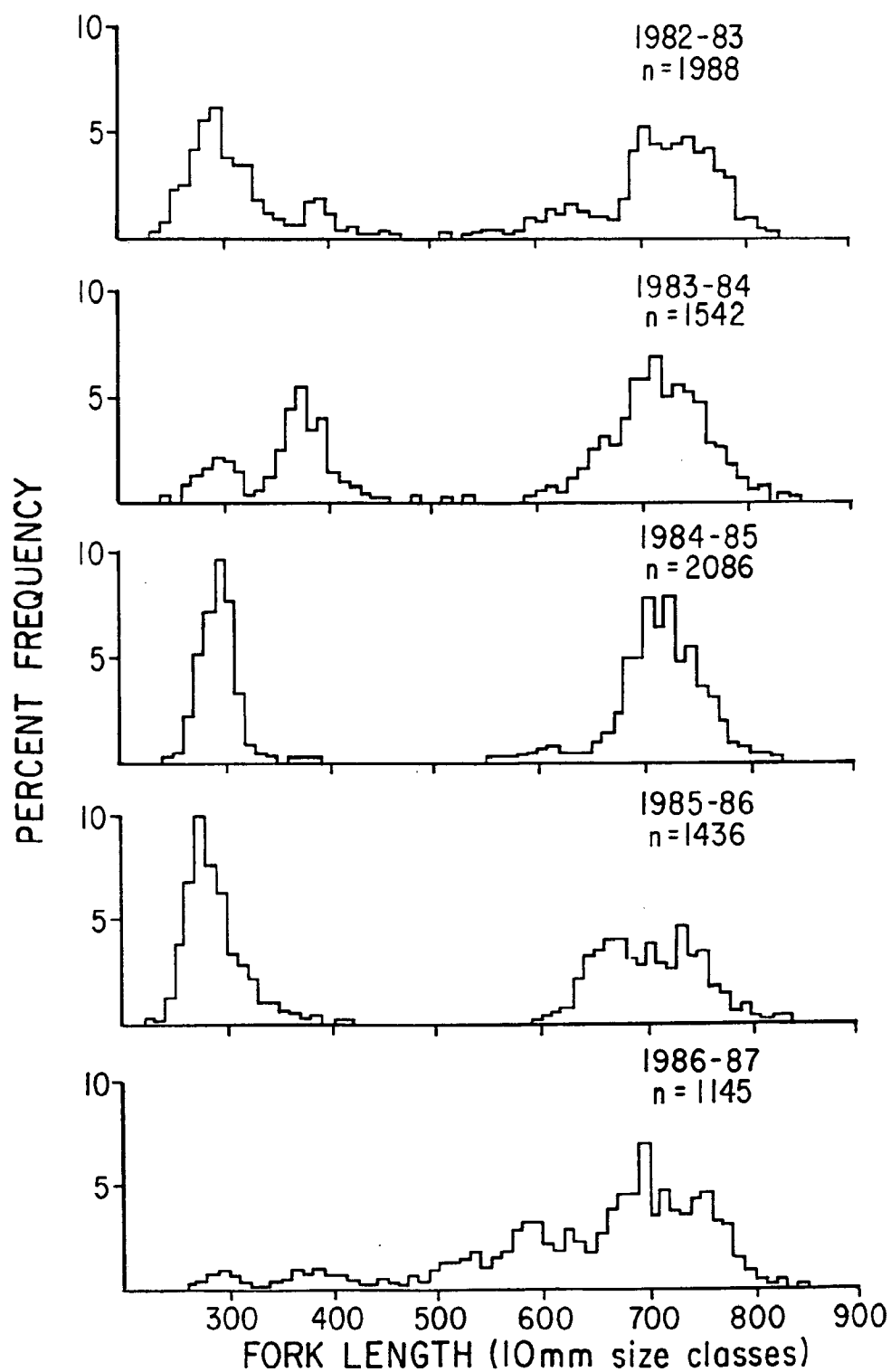


Figure 8. Expanded length frequencies of bluefish, *Pomatomus saltatrix*, from January 1983 through April 1987 sink net catches; n=number of fish measured.

(220-450 mm FL) were captured incidentally, but on a regular basis by fishermen in pursuit of weakfish. Fish 500+ mm FL were caught in 12.7-15.2 mm (5-6 in) stretched mesh; these were occasionally targeted for or caught by crews in pursuit of large weakfish.

A noticeable change in length-frequency distribution occurred in 1986-87: considerably fewer small bluefish (220-450 mm FL) were captured and large bluefish dominated (Figure 8). The decline in small bluefish could reflect reduced year class strength. Numbers of bluefish <450 mm FL from 1982-83 through 1985-86 were 45.5 to 69.6 fish/trip, while in 1986-87, this declined to 9.6 fish/trip. Through the 1985-86 season, large bluefish (>600 mm FL) dominated catches north of Hatteras, and accounted for 67.1 to 95.1% of the fish sampled. South of Hatteras, the catches were more evenly divided in sizes: fish 201-400 mm FL accounted for 37.3 to 49.3% and fish >600 mm FL accounted for 48.3 to 57.2%. In 1986-87, large bluefish dominated catches in northern (87%) and southern (66%) areas. Atypically, small bluefish only accounted for 3.8% of the catches below Hatteras. Fish in the 500-600 mm FL range, which through 1985-86 made up less than 10.6% of the catch north of Hatteras and 2.7% south of Hatteras, represented 26.7% of the fish sampled in 1986-87.

Bluefish caught in sink nets ranged from age 0 through age 9. Age 0 fish were predominant during three fishing seasons, whereas ages 1, 4, and 5 fish in 1983-84 and ages 2, 4, and 5 fish in 1986-87 were co-dominant age groups (Figure 9). Bluefish ages 4 (650-710 mm FL) and 5 (680-750 mm FL) were the predominant age classes for bluefish >600 mm FL. The major decline in age 0 and age 1 fish in 1986-87 corresponded with the reduced numbers of fish <500 mm FL in the length frequency distributions (Figures 8 and 9). Also of note, 1986-87 was the first season where substantial numbers of age 2 and 3 fish (450-650 mm FL) were caught in sink nets.

Atlantic Croaker

Sink net landings of Atlantic croaker off the Outer Banks were higher from 1984 to 1987 than any of the preceding six years, this followed the pattern displayed by weakfish and bluefish (Figure 10).

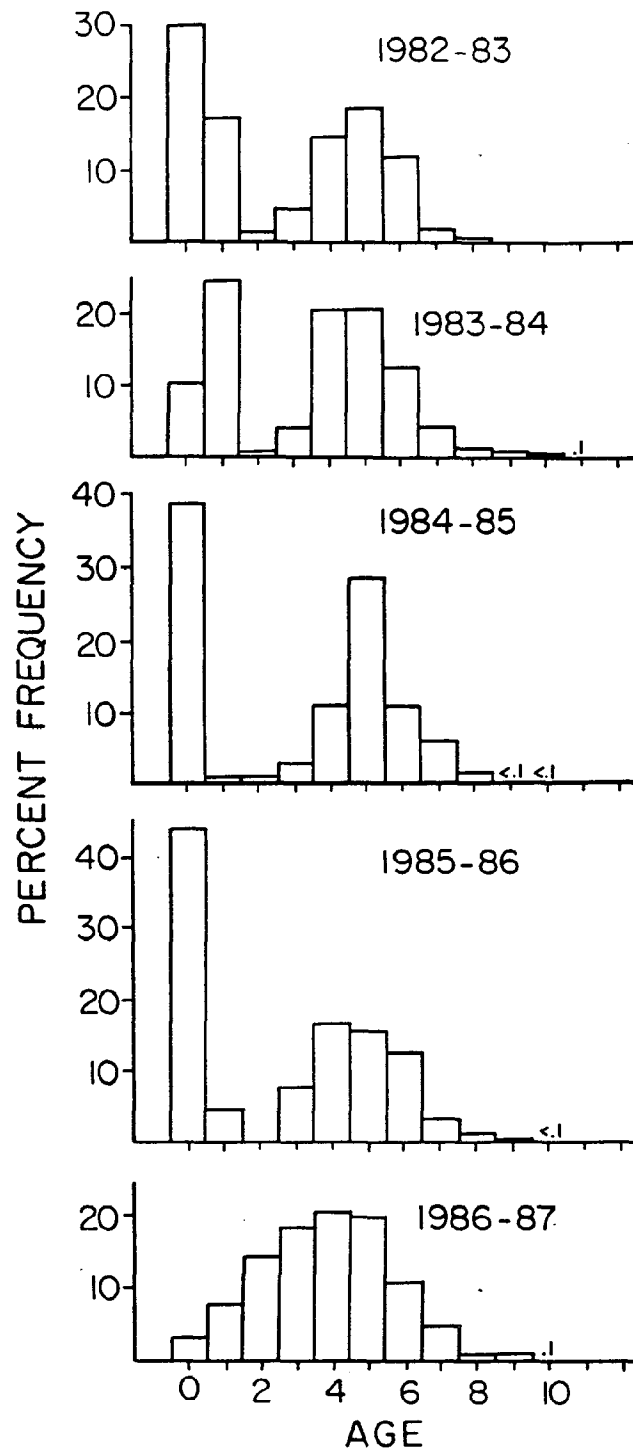


Figure 9. Annual age composition of bluefish, *Pomatomus saltatrix*, in sink net catches, 1982-87.

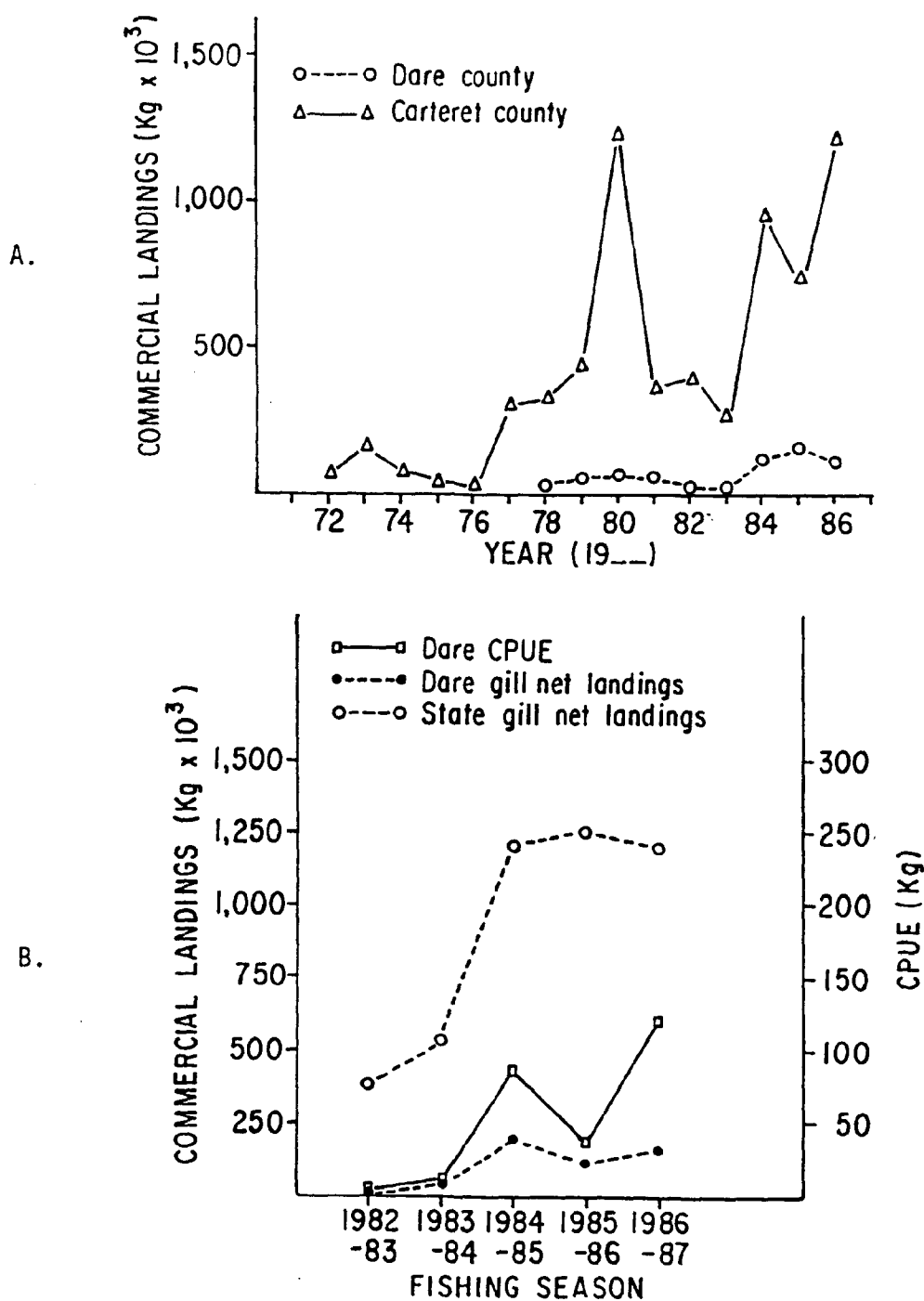


Figure 10. A) Annual commercial landings of croaker, *Micropogonias undulatus*, in Dare and Carteret counties from ocean-fished gill nets 1972-1987.

B) Mean catch-per-trip (CPUE) and total commercial landings for Dare County ocean-fished gill nets, and total state ocean-fished gill net landings of croaker, *Micropogonias undulatus*, for 1982 through 1987 fishing seasons.

Atlantic croaker dominated (70%) sink net landings in 1978 and were second to weakfish in 1979 (29%). Since then, Atlantic croaker have been the third most important species in the sink net fishery. After 1984, ocean-fished gill nets were the second most productive gear for landings of Atlantic croaker in North Carolina (Figure 11).

Sink net catches and landings of Atlantic croaker generally increased during the 1982-83 to 1986-87 fishing seasons (Figure 10); average CPUEs ranged from 0.2 kg/trip (1982-83) to 120 kg/trip (1986-87). Similarly, ocean gill net landings increased in Dare County and statewide. Atlantic croaker CPUEs were higher (13.3-101.9 kg/trip) south of Cape Hatteras throughout the 1985-86 season, though in 1986-87 larger CPUEs (269 kg/trip) were made north of Cape Hatteras (Table 6). CPUEs of Atlantic croaker were largest in December during the 1983-84 through 1985-86 seasons south of Cape Hatteras, although good catches occurred in February 1985 (Table 5). The 1986-87 catches were small from December through March, but catches of 450 kg/trip in April were the highest monthly CPUEs for the entire study; these catches were made north of Cape Hatteras off Avon Rocks as fish migrated northward.

The length frequency distributions of Atlantic croaker captured in sink nets were unimodal; modes of 260-275 mm TL existed annually, except in 1982-83 when few fish were measured (Figure 12). Atlantic croaker ranged from just under 200 mm to 366 mm TL. During the last 4 seasons, most of the fish were 250-300 mm TL (64.7-81.4%). Large Atlantic croaker (>300 mm TL) accounted for 4.9% (1985-86) to 21.9% (1986-87). The percentage of unmarketable (<225 mm TL) fish ranged from 0.4 to 2.1%.

Atlantic croaker caught in sink nets were predominantly age 2 and 3, even though the size frequency distribution was unimodal (Figure 13). Ages 1 through 6 croaker were caught, but ages 2 and 3 accounted for 91.6% (1986-87) to 93.5% (1985-86) of the catches seasonally (excluding 1982-83, when few croaker were sampled). The relative abundance of age 2 and age 3 fish has remained comparatively consistent since 1983-84. Older Atlantic croaker (age 4+) ranged from 3.2 to 6.5% from 1983 to 1987.

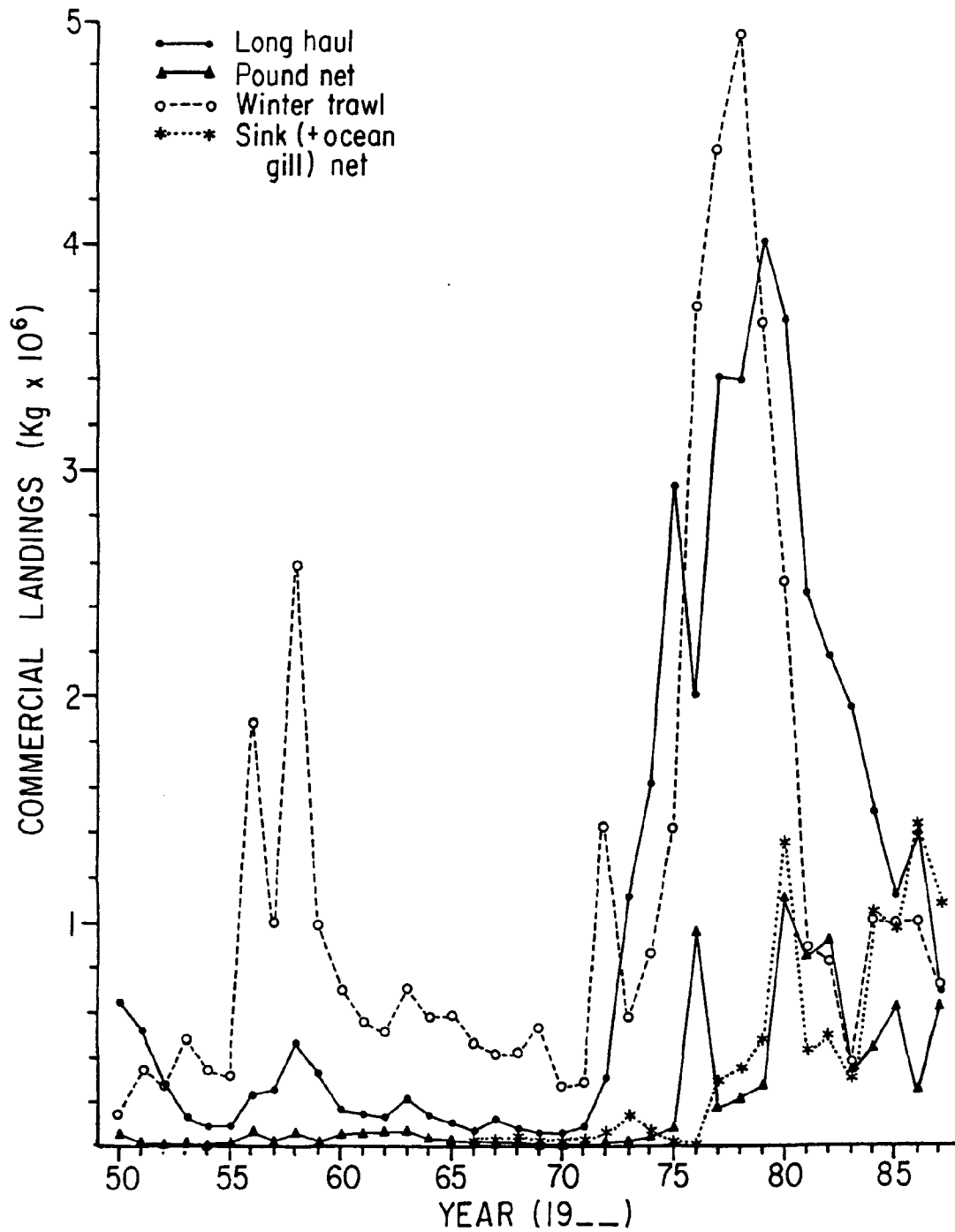


Figure 11. Annual commercial landings of croaker, *Micropogonias undulatus*, in North Carolina by long hauls, pound nets, winter trawls, and sink nets from 1950-1987.

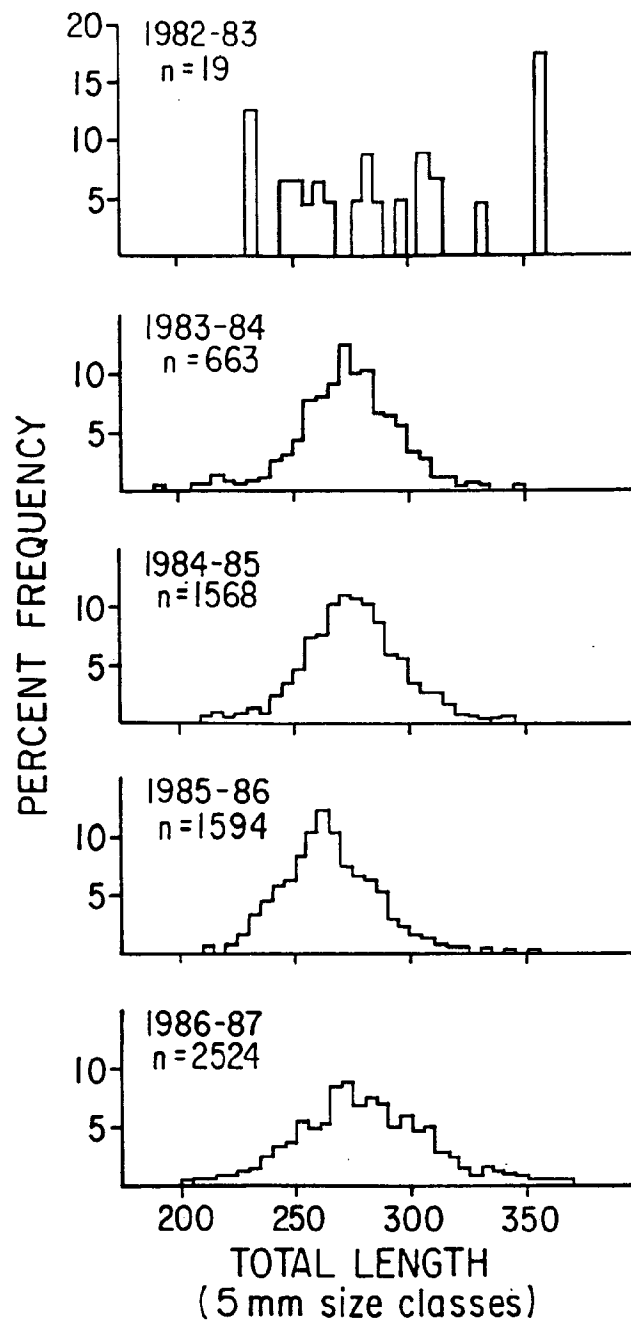


Figure 12. Expanded length frequencies of Atlantic croaker, *Micropogonias undulatus*, from January 1983 through April 1987 sink net catches; n = number of fish measured.

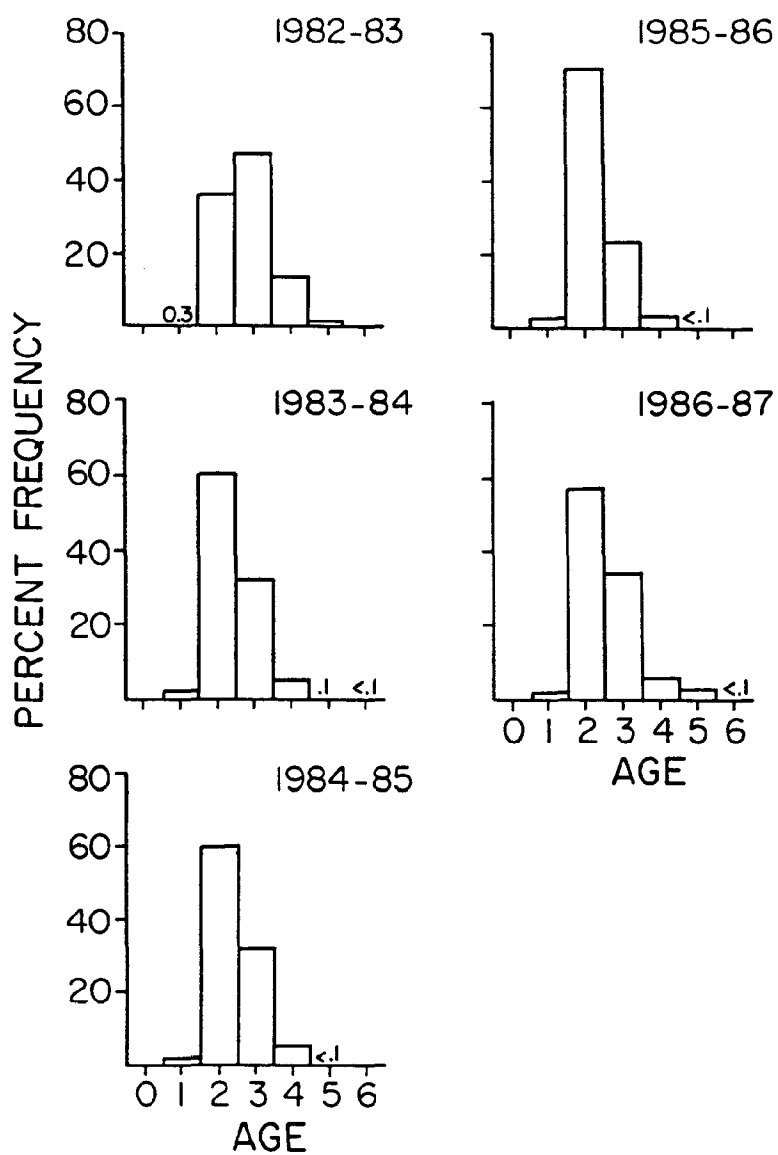


Figure 13. Annual age composition of Atlantic croaker, *Micropogonias undulatus*, from 1982-1987 sink net catches.

DISCUSSION

Since 1978, sink nets have increasingly become the dominant type of gill net used in the coastal ocean waters along the Outer Banks of North Carolina from late fall through early spring. During the first year of this study (1982), considerable effort was exerted by fishermen using dories and fishing anchored and/or floating gill nets just off the beach. However, the closure of North Carolina coastal ocean waters to the taking of striped bass in 1984 ended the floating gill net fishery. The success of the sink net was a strong inducement to many other fishermen and thereby greatly reduced fishing effort in the anchored gill net fishery.

The sink net and floating gill net fisheries are directed fisheries while anchored gill nets are a more generalized gear. Though mesh sizes used in the sink net fishery (7.6-15.2 cm stretched mesh) catch a variety of fish, they are, in fact, set for short periods on predetermined concentrations of fish and targeted for weakfish, bluefish, or Atlantic croaker. This results in catches totally dominated by one or two species and usually by one or two specific market grades of that species. The floating gill net was selective for striped bass with its 25.4 cm (10 in) stretched mesh when fished in very specific locations, left in the water overnight, and set off the bottom to avoid catching dogfish. Anchored gill nets, on the other hand, produced catches of greater species diversity. They were fished overnight close to the surf zone and had mesh sizes capable of catching a variety of species. Though ostensibly directed by season and location on either weakfish, king mackerel, bluefish, or spot, their catches were often dominated by species other than those intentionally sought. This parallels anchored gill net catches ("set nets") which occur in the inside waters of North Carolina's sounds and rivers.

The sink net fishery along the Outer Banks has expanded during the last 10 years (Figure 14). Marketable finfish landings have doubled from 1982 to 1987 and accounted for 51-67% of North Carolina's marketable finfish landings from ocean gill nets (Table 7). The fishery's expansion was also in fishing effort. The number of boats

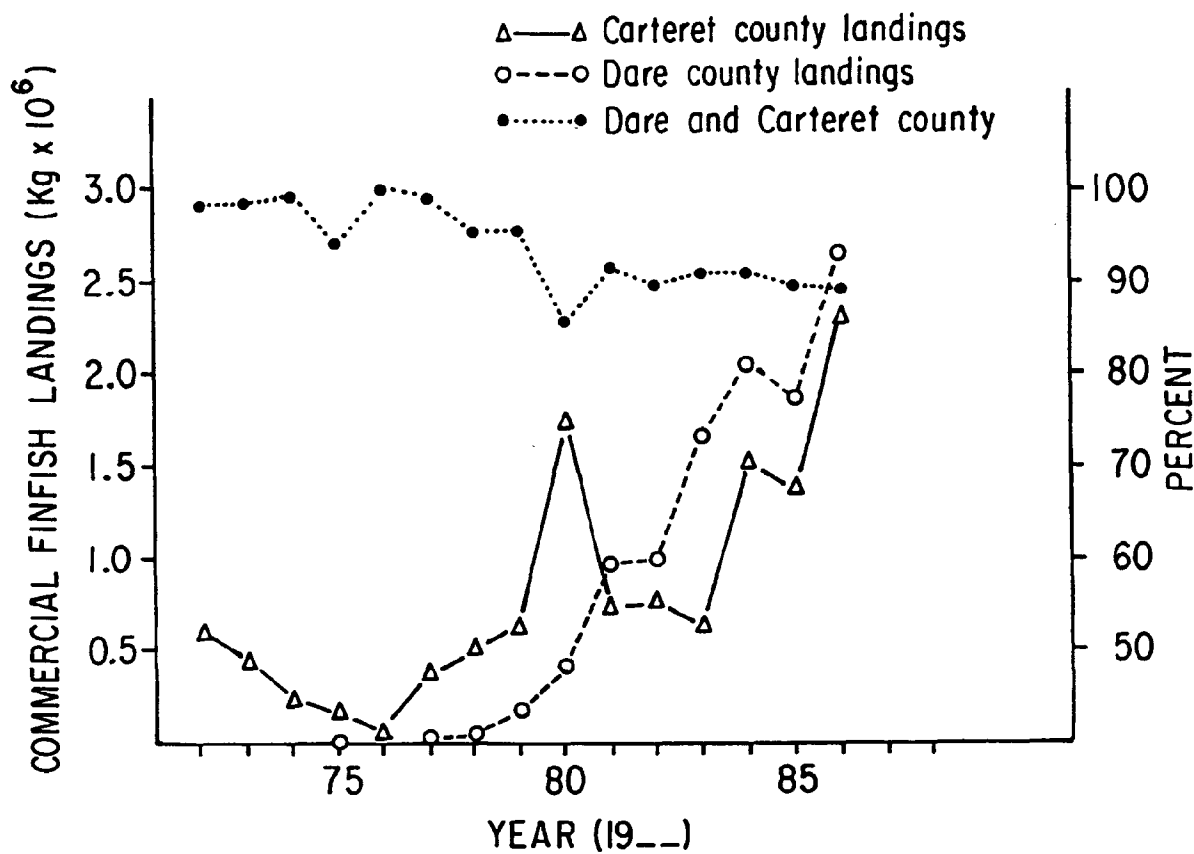


Figure 14. Total annual commercial finfish landings for Dare and Carteret County ocean-fished gill nets from 1972 through 1987 and the percent of all North Carolina ocean-fished gill net landings from Dare and Carteret counties.

Table 7. Seasonal commercial landings (weight; kg) from gill nets fished in the ocean during 1982-1987 fishing seasons (September-April) for North Carolina, Dare County, Carteret County, and other areas combined, including total value of state's landings and relative contribution of each area grouping (percent).

	September 1982-April 1983		September 1983-April 1984		September 1984-April 1985		September 1985-April 1986		September 1986-April 1987	
	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent
Bluefish	970,078	310,219	637,343	252,096	561,535	248,853	744,247	227,478	979,257	469,839
Dare	845,923	87.2	550,490	86.4	493,718	87.9	577,778	77.6	876,126	89.5
Carteret	76,077	7.8	70,057	11.0	27,377	7.2	118,593	15.9	80,542	8.2
Others	48,078	5.0	16,796	2.6	40,440	4.9	47,876	6.4	22,589	2.3
Weakfish	846,337	944,277	1,555,217	1,303,129	1,564,657	1,423,014	2,653,582	1,812,703	2,277,279	1,903,189
Dare	673,946	79.6	1,159,298	74.5	1,138,650	72.8	1,830,121	69.0	1,871,054	82.2
Carteret	112,686	13.3	315,765	20.3	337,709	21.6	635,852	24.0	254,009	11.2
Others	59,705	7.1	80,154	5.2	88,298	5.6	187,609	7.1	152,216	6.6
Croaker	384,986	396,676	539,698	477,841	1,218,711	823,714	1,252,499	1,065,779	1,203,675	980,102
Dare	8,769	2.3	35,755	6.6	199,276	16.4	114,982	9.2	161,070	13.4
Carteret	325,659	84.6	442,121	81.9	901,761	74.0	1,028,564	82.1	977,212	81.2
Others	50,568	13.1	61,822	11.4	117,674	9.6	108,842	8.7	65,393	5.4
Red drum	5,309	2,642	36,683	21,058	20,692	13,915	18,758	15,350	8,730	8,926
Dare	109	2.1	7,062	19.3	2,026	9.8	2,903	15.5	470	5.4
Carteret	3,074	57.9	22,465	61.2	13,465	65.1	12,338	65.8	4,731	54.6
Others	2,126	40.0	7,156	19.5	5,201	25.1	3,517	18.7	3,489	40.0
King mackerel	168,143	355,595	52,614	74,797	24,247	40,477	7,373	20,579	8,114	14,812
Dare	166,005	98.7	52,527	99.7	23,988	98.9	5,531	75.0	3,950	48.6
Carteret	536	0.3	79	0.3	176	0.7	1,842	25.0	1,409	17.4
Others	1,602	1.0	8	<0.1	83	0.4	0	0	2,755	34.0
Kingfish	29,933	23,304	26,046	22,974	76,221	66,242	118,297	106,802	109,501	104,845
Dare	498	1.7	566	2.1	4,288	5.6	13,186	11.1	4,744	4.3
Carteret	9,547	31.9	12,803	49.2	32,495	42.6	71,060	60.1	37,061	33.8
Others	19,888	66.4	12,677	48.7	39,438	51.7	34,051	28.8	67,696	61.8
Butterfish	38,322	14,961	5,605	3,845	12,613	8,180	9,044	6,643	11,122	8,833
Dare	3,156	8.4	1,837	32.8	4,682	37.1	6,059	67.0	6,885	61.9
Carteret	35,101	91.6	2,006	35.8	5,077	40.3	636	7.0	2,194	19.7
Others	65	<0.1	1,762	31.4	2,854	22.6	2,349	26.0	2,043	18.4
Spotted seatrout	2,273	3,950	4,216	9,294	4,188	7,230	15,902	27,767	9,827	15,954
Dare	663	29.2	418	9.9	487	11.6	3,219	20.2	801	8.1
Carteret	1,606	70.7	3,644	86.4	2,864	68.4	10,287	64.7	6,914	70.4
Others	4	0.1	154	3.7	837	20.0	2,396	15.1	2,112	21.5
Spanish mackerel	29,794	22,756	3,797	2,738	14,094	10,401	26,784	22,577	40,985	35,897
Dare	3,746	12.6	985	25.9	3,158	22.4	5,403	20.2	3,670	9.0
Carteret	21,892	73.5	2,812	74.1	10,254	72.8	19,933	74.4	22,943	56.0
Others	4,156	13.9	0		682	4.8	1,448	5.4	14,372	35.0

Table 7. (continued).

	September 1982-April 1983		September 1983-April 1984		September 1984-April 1985		September 1985-April 1986		September 1986-April 1987	
	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent	Weight (kg)	Value/ percent
Spot	37,154	23,026	65,025	36,524	131,436	71,345	150,445	94,101	212,972	126,589
Dare	954	2.6	510	0.8	1,091	0.8	12,824	8.5	9,574	4.5
Carteret	18,695	50.6	43,155	66.4	92,126	70.1	72,154	48.0	141,503	66.4
Others	17,406	46.8	21,360	32.8	38,219	29.1	65,467	43.5	61,895	29.1
Striped bass	22,295	137,150	311	2,327	11	56	0	0	0	0
Dare	21,575	96.8	295	94.9	0	0	0	0	0	0
Carteret	0	0	0	0	0	0	0	0	0	0
Others	720	3.2	16	5.1	11	100.0	0	0	0	0
Bait (scrap)	66,498	5,760	43,519	3,266	100,138	6,628	13,019	1,035	23,467	1,646
Dare	5,799	9.2	24,756	56.9	4,688	4.7	1,896	14.6	199	0.8
Carteret	51,043	81.7	18,763	43.1	95,200	95.1	11,123	85.4	23,101	98.5
Others	5,656	9.1	0	0	250	0.2	0	0	167	0.7
Marketable finfish	2,613,259	2,263,418	3,027,583	2,228,161	3,725,283	2,760,354	5,144,289	3,495,581	5,043,405	3,791,425
Dare	1,748,478	66.9	1,849,980	61.1	1,914,415	51.4	2,621,917	51.0	3,005,025	59.6
Carteret	643,360	24.6	932,483	30.8	1,460,052	39.2	2,014,984	39.1	1,557,718	30.9
Others	221,413	8.5	245,120	8.1	351,116	9.4	507,388	9.9	480,662	9.5
Total finfish	2,675,756	2,269,178	3,071,102	2,231,427	3,825,422	2,766,982	5,157,308	3,496,616	5,066,872	3,793,071
Dare	1,754,277	65.6	1,874,736	61.0	1,918,803	50.2	2,623,813	50.9	3,005,224	59.3
Carteret	694,411	26.0	951,246	31.0	1,555,252	40.7	2,026,107	39.3	1,580,820	31.2
Others	227,068	8.4	245,120	8.0	351,367	9.1	507,388	9.8	480,828	9.5

doubled with 100-110 boats fishing out of Hatteras during the height of the 1986-87 season. Since the 1982-83 fishing season, the mean length of net fished daily/boat for weakfish increased each of the last three seasons from 509 to 1,105 m (1,658 to 3,600 ft). The fleet fished roughly 110 km (68 miles) of net on any one day (100 boats x 1,105 m/boat). The average vessel size and speed increased, so more fishing days occurred with more hours on the fishing grounds.

Although the Dare and Carteret County fisheries dominated North Carolina ocean gill net landings, which steadily increased during the last decade (Figure 14), there were some differences between them. Dare County catches were dominated by weakfish, while Carteret County catches were predominantly Atlantic croaker. Bluefish were much more important in Dare County catches (Table 7). Dare County vessels fished out of Oregon and Hatteras Inlets, covering waters from Corolla to Ocracoke Inlet, whereas Carteret County vessels fished out of Bardens and Beaufort Inlets, covering waters from Beaufort Inlet to east of Cape Lookout Shoals and north to Drum Inlet. The fish caught in the Carteret County fishery were smaller³, which is consistent with observed geographic differences in winter trawl catches (Ross et al. 1989, Ross 1989).

The Outer Banks sink net fleet fished primarily on the concentrations of schooling fish located off Cape Hatteras in the late fall through early spring. The area is the primary wintering grounds for a large portion of the bluefish and weakfish populations occurring on the east coast, due to the proximity and warming influence of the Gulf Stream (Mercer 1983, Wilk 1977, ASMFC 1987).

When stock size is large, the species tends to expand in spatial distribution to reduce interspecific competition, whereas when reduced in size, it will usually inhabit the most favorable areas within the species' seasonal distributional range (Moermond 1979). Assuming the

³ Pers. commun. Rick Monaghan, N.C. Division of Marine Fisheries, Morehead City, N.C.

Hatteras area is the primary wintering grounds for these species, CPUEs from the winter fisheries may be misleading because of the limited spatial coverage of the fishery and the fact that bluefish, weakfish, and Atlantic croaker will always be concentrated in this area.

Weakfish were generally targeted by sink nets and dominated catches in all but the first year of this study. They were captured north of Cape Hatteras in December and early January. As water temperatures declined weakfish become concentrated in the Hatteras Bight, where the largest catches occurred from January through March. As water temperatures warm in late March-April, the fish moved northward across Diamond Shoals or very close to the beach and into Hatteras Inlet; during this period catches were made north and south of Cape Hatteras.

Weakfish landings in the sink net fishery have risen dramatically since 1982 (Table 8, Figure 3) and CPUEs have steadily increased, though growth overfishing may be indicated. East coast landings, which peaked in 1978-1981 (11,946-16,394 mt), have since declined to 8,132 mt in 1987. North Carolina winter trawls, pound net, and long haul landings have also declined following 1980 peak landings (Table 8, Figure 3). The increased effort and fishing power of the sink net fishery has led to the virtual abandonment of the area by a portion of the winter trawl fleet. These factors facilitated the fishery's increased landings and concurrent decreased landings by winter trawls. Since the area fished is the primary wintering grounds for weakfish, the rising CPUEs may be an unreliable indicator of stock size. The decline in large weakfish age 3 and older suggests that the stock may not be able to sustain itself with increased fishing pressure.

The sink net fishery has become the dominant commercial weakfish fishery, not only among North Carolina fisheries, but on the U.S. Atlantic coast, having increased from 10% to 18% of the entire east coast catch from 1982 to 1987. In fact, Dare County sink net landings alone for the 1985-86 and 1986-87 fishing seasons exceeded the annual commercial landings of any individual state during 1986 and 1987.

Table 8. Seasonal commercial landings (Weight; kg) of the pound net,¹ long haul,² winter trawl,³ and ocean gill net (gill net)⁴ fisheries in North Carolina for 1982-1987 (year = May-April), including total landings/species, 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			May 85-April 86			May 86-April 87		
	Weight	Value/percent		Weight	Value/percent		Weight	Value/percent		Weight	Value/percent		Weight	Value/percent	
Atlantic croaker	4,475,183	3,572,225		3,696,529	3,099,117		4,706,728	3,277,669		4,211,368	3,203,918		3,757,338	2,908,579	
Pound net	862,826	19.31		232,366	7.91		442,596	9.40		567,300	13.47		234,416	6.24	
Long haul	2,063,529	46.11		1,882,916	50.94		1,338,748	28.45		1,113,946	26.45		1,391,870	37.04	
Trawler	546,971	12.22		478,225	12.94		1,359,245	28.88		1,068,981	25.38		720,638	19.18	
Gill net	384,986	8.60		539,698	13.29		1,218,712	25.89		1,252,499	29.74		1,203,675	32.04	
Weakfish	5,162,914	4,694,631		5,486,081	3,936,466		4,727,595	3,873,849		6,626,487	4,458,011		5,276,438	4,151,890	
Pound net	126,297	2.45		73,252	1.34		167,074	3.53		191,738	2.89		87,785	1.66	
Long haul	736,868	14.27		704,138	12.84		762,097	16.12		507,797	7.66		586,247	11.11	
Trawler	3,054,275	59.46		2,739,895	49.94		1,759,686	37.22		2,569,774	38.79		1,970,830	37.35	
Gill net	846,333	16.39		1,555,298	28.35		1,564,658	33.10		2,653,583	40.05		2,277,279	43.16	
Bluefish	3,469,797	914,334		1,618,306	565,016		1,344,411	509,375		1,734,020	513,017		1,712,022	731,837	
Pound net	68,704	2.56		31,372	1.94		38,456	2.86		51,388	2.96		30,272	1.77	
Long haul	193,795	5.58		153,069	9.46		111,266	11.65		216,208	12.47		211,585	12.36	
Trawler	1,775,769	51.18		464,709	28.71		359,196	26.72		352,673	20.34		185,401	10.83	
Gill net	970,078	27.96		637,344	39.38		561,535	41.77		744,247	42.92		979,257	51.20	
Spot	2,214,042	1,063,275		1,387,795	699,276		1,561,783	808,613		1,843,424	899,891		1,472,840	9,351,218	
Pound net	150,048	6.78		29,721	2.14		88,802	5.69		56,318	3.06		22,012	1.49	
Long haul	1,555,921	70.28		884,833	62.29		937,809	60.05		1,125,779	61.14		865,454	58.76	
Trawler	35,746	1.61		69,193	4.99		49,812	3.19		75,033	4.07		38,395	2.61	
Gill net	37,154	1.68		65,025	4.69		131,436	8.42		150,445	8.16		212,972	14.46	
Butterfish	135,196	75,641		52,774	42,742		80,090	63,785		62,727	47,189		78,890	72,270	
Pound net	10,922	8.08		1,445	2.74		6,857	8.56		13,949	22.24		9,969	12.62	
Long haul	3,670	2.71		4,085	8.37		2,335	2.92		210	0.34		12,834	16.25	
Trawler	74,338	54.99		37,826	71.68		51,761	64.63		33,594	53.56		36,961	49.22	
Gill net	38,322	28.35		5,605	10.61		12,613	15.74		9,044	14.42		11,122	14.08	
Harvestfish	198,545	123,419		100,583	59,970		110,047	96,992		18,716	200,423		137,138	167,224	
Pound net	34,151	17.20		16,852	16.75		31,755	28.86		86,322	46.48		33,770	24.63	
Long haul	50,869	20.58		19,513	19.40		21,415	19.46		16,361	8.81		32,791	23.91	
Trawler	34,214	17.23		7,123	7.08		5,141	4.67		42,716	23.00		6,563	4.79	
Gill net	41,955	21.13		6,084	6.04		5,141	4.67		17,174	9.54		11,333	8.26	
Spanish mackerel	85,827	61,268		18,750	15,221		57,818	42,043		78,543	56,113		105,326	81,196	
Pound net	3,110	3.62		2,654	14.15		6,321	10.93		9,759	12.43		16,027	15.22	
Long haul	925	1.07		1,480	7.89		2,578	4.46		4,952	6.31		13,057	12.40	
Trawler	374	0.44		6	0.03		0	0		273	0.35		332	0.32	
Gill net	29,794	34.71		3,797	20.25		14,095	24.38		26,784	34.10		40,995	38.91	

Table 8. (continued).

Species	May 82-April 83		May 83-April 84		May 84-April 85		May 85-April 86		May 86-April 87	
	Weight	Value/ percent	Weight	Value/ percent	Weight	Value/ percent	Weight	Value/ percent	Weight	Value/ percent
Spotted seatrout	42,357	71,764	72,151	120,497	68,392	122,505	65,092	171,346	85,448	156,623
Pound net	4,920	11.62	4,900	6.79	4,089	5.98	229	0.35	260	0.30
Long haul	15,069	35.58	18,687	25.90	15,215	22.25	9,352	14.87	10,079	11.80
Trawler	408	0.96	283	0.39	433	0.63	1,845	2.83	5,698	6.67
Gill net	2,269	5.36	4,216	5.84	4,188	6.12	15,902	24.42	9,837	11.51
Red drum	22,098	11,238	145,989	81,232	90,600	59,570	76,829	113,247	104,466	339,535
Pound net	326	1.47	1,603	1.10	797	0.88	373	0.49	508	0.49
Long haul	4,512	20.42	9,464	6.48	7,005	7.73	2,124	2.76	32,229	30.85
Trawler	6,122	27.70	13,064	8.95	6,416	7.08	1,624	2.11	1,613	1.54
Gill net	5,309	24.02	36,683	25.13	20,692	22.83	18,753	24.41	8,730	8.36
Striped bass	109,627	451,330	185,351	356,001	211,534	365,232	100,642	169,542	134,547	297,433
Pound net	-	-	-	-	-	-	-	-	239	0.18
Long haul	103	0.09	9	0.01	21	0.01	-	-	-	-
Trawler	1,642	1.50	6,184	3.34	60	0.03	-	-	-	-
Gill net	22,295	20.34	311	0.17	11	<0.01	-	-	-	-
Bait	4,301,721	353,653	4,430,304	375,892	4,694,783	380,999	3,437,035	229,952	2,836,315	201,473
Pound net	349,400	8.12	200,648	4.53	421,003	8.97	549,316	15.98	123,088	4.34
Long haul	1,878,688	43.56	1,900,757	42.90	1,884,021	40.13	1,148,202	33.41	1,385,669	48.85
Trawler	1,364,153	31.71	1,612,931	36.41	11,721,847	36.68	1,619,860	47.13	904,971	31.91
Gill net	62,498	1.45	43,519	0.98	100,138	2.13	13,019	0.38	23,467	0.83
Total finfish	31,767,060	23,446,020	32,776,462	23,638,834	37,030,484	28,220,020	32,319,039	27,182,009	25,462,043	25,398,740
(w/out menhaden)	1,669,377	5.35	706,031	2.15	1,284,724	3.47	1,552,521	4.80	684,065	2.69
Pound net	6,478,629	20.71	5,649,002	17.23	5,174,860	13.97	4,249,956	13.15	4,713,560	18.51
Long haul	10,336,900	32.63	11,778,857	35.94	11,898,864	32.13	9,850,153	30.48	6,492,565	25.50
Trawler	2,671,221	8.42	3,071,102	9.36	3,825,422	10.33	5,157,317	15.96	5,066,872	19.90
Gill net										

¹ Pound net landings include Dare County.

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

³ Winter trawl landings include: Dare, Hyde, Pamlico, Beaufort, Craven, Carteret, Brunswick, and Onslow counties.

⁴ Ocean gill net landings include all state landings September through April

⁵ North Carolina commercial landings combined harvestfish and butterflyfish landings in 1985 as harvestfish; we extrapolated out butterflyfish landings from harvestfish landings based on monthly relative proportions of the two species in our samples.

Sink nets have also become the dominant commercial fishing gear harvesting bluefish both in North Carolina and for the U.S. Atlantic coast. Sink net landings in the last five years exceeded catches by the winter trawl fleet and all other gears in North Carolina; their contribution increased from 28 to 51% (Table 8, Figure 7), of which Dare County accounted for 78% (1985-86) to 89% (1986-87)(Table 7). Since 1979, bluefish landings in North Carolina have exceeded any other east coast state and in 1983 and 1986, sink net landings alone exceeded the catch of any east coast state.

Landings of bluefish followed east coast trends, but there was no relationship between sink net CPUEs and landings. CPUEs fluctuated between 500 and 1,075 kg/trip, but tended to decline the last three seasons whereas landings increased. The increased fishing effort coupled with sporadic large catches often missed by once a week sampling were likely responsible for the lack of correlation. Both sets of landings were high in 1983, declined in 1984, and rose in 1985 and 1986. In spite of lowered CPUEs, sink net landings rose to their highest level in 1986-87, reflecting, in part, increased effort.

Noteworthy changes in age composition of the bluefish catches occurred in the 1986-87 fishing season. The substantial decline in age 0 fish suggests a poor year class, since this age class was predominant in the catches the four previous seasons. The NMFS Southeast Fisheries Center young-of-the-year bluefish index in 1987 was the lowest on record.⁴ The increased contribution of ages 2 and 3 in 1986-87 was unique; earlier, they were rarely caught in sink nets as well as winter trawls off North Carolina (Ross 1989; Ross et al. 1989). This could represent a differential seasonal distribution by age (size) group. Ages 4 and 5 bluefish (650-750 mm FL) predominated catches of large fish each season because of their susceptibility to capture by 14-15.2 mm (5.5-6 in) stretched mesh net as well as their availability; similarly, they were the dominant ages in winter trawl catches of large bluefish off North Carolina (Ross 1989, Ross et al. 1989).

⁴ Pers. commun. Chris Moore, Mid-Atlantic Fishery Management Council, Annapolis, MD.

North Carolina has dominated east coast Atlantic croaker landings since 1966 (Mercer 1989), and sink nets have become an increasingly important gear. Historically, long haul seine and winter trawl catches produced most of these landings, but have declined since the late 1970s (Ross et al. 1986, Moyer and Strasser 1989, Ross et al. 1989). On the other hand, sink net landings declined from 1980 to 1983 and then increased in recent years to become the co-dominant gear for croaker along with long haul seines (Figure 14, Table 8). Sink nets produced only 8.6% of the Atlantic croaker landed in 1982-83, but 29.7% and 32.0% of the landings during the 1985-87 fishing seasons. The majority of the Atlantic croaker were landed in Carteret County (74-85%), although the contribution of Dare County has increased the last three seasons. Croaker caught by sink nets were consistently a larger, older class of fish than were harvested by other North Carolina fisheries. Whereas sink net catches were predominantly age 2 and 3 croaker, the winter trawl, pound net, and long haul fisheries were all dominated by age 1 and 2 fish (Ross 1989, Moyer and Strasser 1989, Burns and Ross 1989).

In the 1980s, the North Carolina sink net fishery experienced a tremendous increase in finfish landings. Sink nets became the dominant gear landing weakfish, bluefish, and Atlantic croaker not only in North Carolina (Table 8), but along the entire U.S. Atlantic coast. While other fisheries landings of these species have declined, sink net landings have risen.

The amount of unmarketable finfish landed by sink nets in Dare County was negligible in spite of the increased effort and landings. In Carteret County, where 85-98% of the scrap fish were landed during the last three seasons (Table 7), these fish made up <2% of the sink net landings. The amount of discarded fish at Hatteras fish houses was always <25 kg/trip for gill net catches. Obviously, the size selectivity of the gill nets and the selective targeting of key market species such as weakfish (7.6-9.5 cm stretched mesh), Atlantic croaker (7.0-8.3 cm stretched mesh), or bluefish (7.6-15.2 cm stretched mesh) precluded an abundance of undersized fish. From 1982 to 1987, 12-36% of the

weakfish in long hauls, 18-29% in pound nets, and 12-16% in winter trawl catches were unmarketable-size fish, while even greater amounts of Atlantic croaker were undersized in these fisheries (Ross et al. 1986, Ross and Moye 1989).

The future of the Hatteras sink net fishery is uncertain, although catches and landings have increased, and profits have allowed crews to purchase larger and faster vessels. Weakfish landings peaked in the late 1970s, but have declined recently coastwide (Mercer 1983b). They are still abundant compared to the 1950 and 1960s landings, but weakfish can decline dramatically and remain at low population levels (Mercer 1983b). It is possible that the stock has recently experienced growth overfishing, indicated by the lack of age 5 and older fish. The disappearance of large weakfish has also been observed in North Carolina winter trawl fishery catches during the same period, and this fishery covers grounds from New Jersey to Cape Lookout, N.C. (Ross 1989). Bluefish landings have also decreased since the peak landings in the late 1970s. Population levels may have declined in recent years (Crecco et al. 1987). However, both weakfish and bluefish are notorious for wide swings in abundance, and local conditions i.e. North Carolina sink nets, may not be reflective of the total east coast population.

Inter-fishery gear conflicts will continue to be a problem in North Carolina waters. Until the 1983-84 season, there were less than 50 sink net crews, and trawlers fished flynets for weakfish in the Hatteras Bight from January through March (Ross et al. 1989). As the sink net fleet expanded, the trawler fleet was reluctantly forced out of the area, finding it impossible in daylight hours to fish around the increasing miles of gill net. Since 1986, virtually no trawlers based in Wanchese fished flynets in the Hatteras Bight. Trawlers from the Morehead City-Beaufort area and inland ports still fish in Hatteras Bight, but usually only at night after sink net crews have departed (Ross 1989). If the trawler fleet experiences declines in flounder, sea bass, and scup abundance in the future, they may be forced to redirect their efforts to weakfish, Atlantic croaker, and bluefish, resulting in gear and spatial conflicts with sink net fishermen.

More insidious are the intra-fishery problems relating to overcapitalization of equipment and sheer numbers of operators in a confined area. One hundred vessels each fishing over 3,600 feet of net/day in a small area, often on the same body of fish, frequently results in crossed nets. Vessels leave the dock at 4:00 a.m. to locate fish and get the first set since early sets are usually the best before fish get "run hard" or "scattered"; aggressive and rapid setting of nets displaces any semblance of courtesy. With good catches of 100 mt (more than 2,000 boxes) of weakfish/day, east coast markets are rapidly flooded, sending the prices to \$0.05 or \$0.10/lb, a low price for top quality 1-4 lb. weakfish. This has become a more frequent occurrence in the sink net fishery and, in part, was responsible for the trend towards larger boats with greater capacity, more speed, more net, more fishing days, and larger boat payments. Further compounding the situation, declining inshore shellfish resources, reduced water quality (open shellfish areas), and catastrophe (red tide in 1987-88) have prompted fishermen from other ports to enter this fishery.

The author and sink net fishermen have discussed ways to stabilize the fishery, such as actions to control total catch (to reduce glut conditions) or limit effort; no clear consensus exists. A reduced fishing week (weekdays or not on Sundays) could reduce effort while allowing the market time to clear itself; this option is favored by fish dealers while others fear it would allow a window for opportunistic trawlers. However, sink netters could then gear up to catch the same amount of fish in the shorter period of time, thus producing even more exaggerated market swings. Limiting net size (914 m (1,000 yds)/vessel) could reduce gear conflicts and stabilize daily catches but individuals with larger vessels and investments are reluctant to equalize fishing power throughout the fleet. Minimum mesh sizes could reduce total catch and stabilize market prices. This change could reduce potential growth overfishing, but it would not reduce gear conflicts and could even exacerbate them.

Another option is limited entry. Controlling the size of the fleet would allow some security to those involved, while not immediately

regulating their fishing effort or power. Limited entry introduces direct control over fishing effort itself, i.e., limiting the number of fishing vessels, tonnage of vessels, etc. (Bell 1980). The salmon and herring fisheries of Alaska and British Columbia have had favorable experiences with limited entry in the form of limited licenses to individuals using specific types of gears (Adasiak 1980). Productive and profitable fisheries exist in Australia that are managed by limited entry, including the rock lobster fishery in which vessels licences and pots/vessel are limited, and the shrimp fishery where vessel licenses are limited (Meany 1980). However, the difficulty in controlling effort by restricting licenses was revealed in the northeastern Pacific halibut fishery of British Columbia. The replacement of traditional hooks with circle hooks doubled CPUE (Royce 1987). Modifications of sink net gear or vessels within a limited entry regulated sink net fishery could result in similar increased CPUEs and thus, fishing mortality. However, subsequent regulations on mesh size or net length might then be more palatable to fishermen if it was determined that reduced fishing effort or mortality was needed.

ACKNOWLEDGEMENTS

This report would not have been possible without the field work and data processing of Beth Burns, Mark Rockett, Tonya Stevens, Steve Strasser, and John Zuaboni (N.C. DMF biological staff). John Gillikin, Terry Henley, and Katy West provided valuable help with computer processing. Tonya Stevens and Dee Willis typed and helped organize the manuscript; the late Val Page and Meg Foward drafted the figures. Chris Moore (MAFMC), John Merriner (SEFC, NMFS), Jess Hawkins (DMF), Sara Winslow (DMF), Beth Burns (DMF), Paul Phalen (DMF), and Fred Fox (commercial fisherman) provided constructive comments on the manuscript. Finally, I am especially grateful to the many commercial fishermen and fish dealers in Wanchese and Hatteras who cooperated with this project.

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