Taylor, Stephen D.

STRIPED BASS MONITORING

QL638.M678T39 1994
#30329359

By

Stephen D. Taylor
and
H. Craig Hardy

North Carolina Department of Environment,
Health, and Natural Resources

Division of Marine Fisheries
Morehead City, NC 28557

Final Report, Project F-53

March 1994

QL
638
.M678
T39
1994

ct was conducted under the Federal Aid in Sport Fish Restoration Act
ohnson Act) through the Wallop-Breaux Amendment, and funded, in part, by
epartment of Interior, Fish and Wildlife Service, under Project No. F-53.

ABSTRACT

Project F-53 updates and compliments the historical long-term monitoring database for the Albemarle Sound/Roanoke River stock of striped bass (*Morone saxatilis*). Annual juvenile striped bass sampling was conducted at seven trawl stations in western Albemarle Sound July-October, 1992-1993. Nine seine stations in the western sound were initiated in 1993. The 1992 index remained low while the 1993 index was the highest ever (44.5). The Albemarle Sound commercial fishery was sampled for the 1992-1993 season, to determine size, age and composition. The catch was dominated by the age IV (1989 year class) fish. In 1993, a cooperative effort to assess the age composition of the Atlantic migratory stock overwintering off North Carolina and Virginia was conducted in which a total of 530 striped bass was tagged. The percentage of year class composition was equally distributed with the 1984, 1985 and 1988 year classes each contributing approximately 20% of the total. Sampled fish of the Atlantic Ocean commercial catch was dominated by the 1983, 1984, and 1985 (age X, IX, and VIII) year classes with each contributing over 20% of the total catch. Five hundred and sixty seven adult striped bass were tagged in the Albemarle, Croatan and Roanoke sounds from October 1992 through April 1993 to determine resource utilization and migration. A return rate of 4.6% has been determined. During spring 1993, 2,452 adult striped bass participating in the spawning migration in the Roanoke River area were tagged. A return rate of 2.7% has been determined, with recreational anglers accounting for 39.2% of the returns. During the project, 209,876 Phase II striped bass were released in coastal North Carolina. Of the total, 14,971 were tagged prior to stocking, and 317 (2.1%) have been returned.

TABLE OF CONTENTS

ABSTRACT ii

TABLE OF CONTENTS iii

NEED 1

JOB 1: JUVENILE ABUNDANCE 1
Procedures 3
Discussion 3
Western Albemarle Sound Survey - 1992 3
Central Albemarle Sound Survey - 1992 6
Albemarle Sound Seine Survey - 1993 6
Western Albemarle Sound Survey - 1993 6
Central Albemarle Sound Survey - 1993 6

JOB 2: ASSESSMENT OF ADULT STRIPED BASS 9
Procedures 9
Albemarle Sound Area Commercial Harvest 9
Contribution of Year Class 9
Atlantic Ocean Migratory Stock 10
Discussion 10
Albemarle Sound Area Commercial Harvest 10
Contribution of Year Class 12
Atlantic Ocean Migratory Stock 17
Commercial Harvest-Winter 1992-1993 17
Recreational Harvest 1992-1993 17
North Carolina Cooperative Tagging Surveys 17

JOB 3: ADULT STRIPED BASS CONTRIBUTION AND UTILIZATION 22
Procedures 22
Adult Striped Bass-Albemarle and Croatan Sound Areas 22
Adult Striped Bass-Roanoke River Delta Area 22
Roanoke River Spawning Run 24
Discussion 25
Albemarle and Croatan Sound Areas - 1990 Tagging/Returns 25
Albemarle and Croatan Sound Areas - 1991 Tagging/Returns 25
Albemarle and Croatan Sound Areas - 1992 Tagging/Returns 25
Albemarle Sound Independent Gill Net Survey 1990-1991-Tagging/Returns 27
Albemarle Sound Independent Gill Net Survey 1991-1992-Tagging/Returns 27
Albemarle Sound Independent Gill Net Survey 1992-1993-Tagging/Returns 27
Roanoke River Spawning Run - 1991 Tagging/Returns 29
Roanoke River Spawning Run - 1992 Tagging/Returns 29
Roanoke River Spawning Run - 1993 Tagging/Returns 29
Batchelor Bay Area - 1990 Pound Net Tagging/Returns 32
Fall-Winter 1992-1993 Hook and Line Tagging in Albemarle Sound 32
Summary of Adult Tagging, September 1992-August 1993 32

JOB 4: EVALUATION OF COASTAL STRIPED BASS STOCKING 34
Procedures 35
Discussion 35
Albemarle Sound Area-1990 Through 1992 35
Neuse River Area - 1990 and 1992 38
Pamlico River Area - 1991 41

RECOMMENDATIONS 43

ACKNOWLEDGEMENTS 43

LITERATURE CITED 44

STATE: North Carolina

PROJECT NO: F-53

SEGMENT NO: 1

TITLE: Striped Bass Monitoring

PERIOD: 1 Sep 1992 - 31 Aug 1993

OBJECTIVE: To monitor the status of striped bass stocks in North Carolina and to provide annual comprehensive recommendations for management through 1995.

NEED: Based on conclusions and recommendations of Project AFS-26 North Carolina Striped Bass (Taylor and Hardy 1993) and the North Carolina Striped Bass Study Management Board (NCSBSMB) Report to Congress (1991), continuation of some specific components of these prior projects in the form of Project F-53, North Carolina Striped Bass Monitoring provided the biological data necessary for monitoring the status of striped bass in North Carolina, as well as along the Atlantic Coast. Long-term size, age, sex composition, and juvenile abundance databases for striped bass have allowed the North Carolina Division of Marine Fisheries (DMF) to monitor changes in population levels and age composition as well as monitor the relative commercial and recreational utilization of the harvestable stock. This information was essential in establishing and evaluating rules and regulations such as area or seasonal closures, fishing means and methods, minimum size limits, and catch limits that were implemented to maximize the potential for restoring the striped bass stock(s).

JOB 1: JUVENILE ABUNDANCE INDEX

OBJECTIVE: Establish a juvenile abundance index (JAI) by conducting standardized bi-weekly trawl sampling at 19 established stations in western and central Albemarle Sound that are supplemented with weekly seine sampling one month prior to the trawl work.

PROCEDURES

Biological staff conducted weekly seine samples at nine previously established locations in the western Albemarle Sound area (Figure 1). A 60 foot bag seine with a 6.35 mm (0.25 inch) stretched mesh body and 3.1 mm (0.125 inch) stretched mesh bag was employed. Seine sampling started 9 June 1993 and continued weekly until the second week of July, at which time, trawl sampling began.

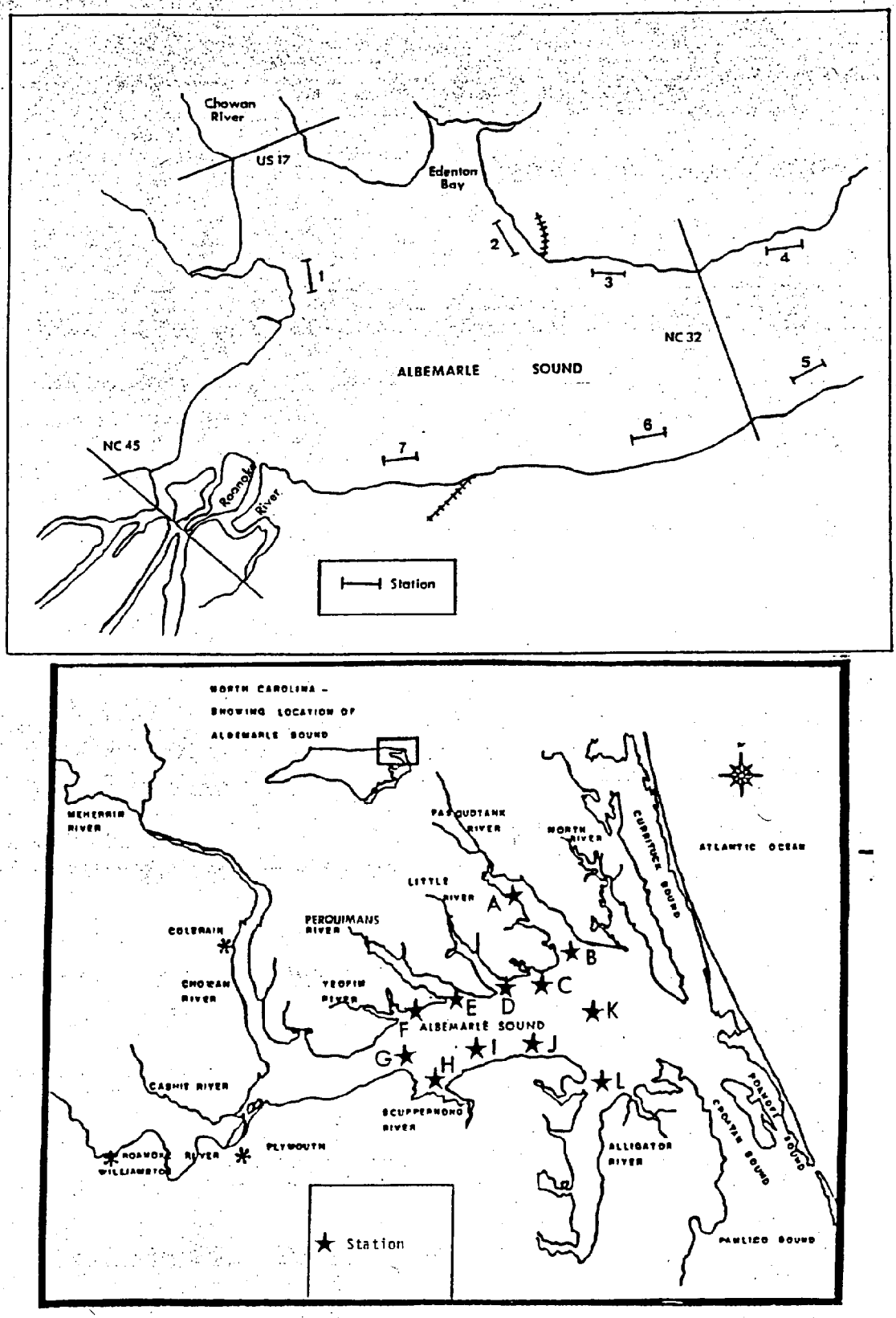

Figure 1. Station locations for young-of-year striped bass sampling utilizing a trawl in the western Albemarle Sound (top) and the central Albemarle Sound (bottom) areas, NC, 1992-1993

Bi-weekly trawl samples were conducted at seven established locations in the western Albemarle Sound area and 12 established locations in the central sound area, annually July through October (Figure 2). An 18 ft semi-balloon trawl with a 38.1 mm (1.5 inch) stretched mesh body and 12.7 mm (0.5 inch) stretched mesh cod end was employed and tow times were 15 minutes in the western sound and 10 minutes in the central sound.

All captured striped bass were counted and measured to the nearest mm fork length (FL) and total length (TL); other species were also counted and measured. Water temperature and salinity were recorded for each sample.

Relative abundance was determined from the seine samples. An index of juvenile abundance was calculated for the trawl surveys in the western and central areas. These indices were compared with previous years. Data from this study was entered into the DMF Biological Database.

DISCUSSION

The objectives of all jobs in this section for both 1992 and 1993 have been met and completed. The results of 1992 and 1993 data are discussed below.

Western Albemarle Sound Survey - 1992

During the July-October 1992 sampling period, 56 samples were taken at seven sites in western Albemarle Sound (Table 1). One hundred forty-four young-of-year striped bass were captured in these samples yielding a JAI of 2.57, the third highest recorded since 1982 (Table 2). Since 1982, only two year classes (1988 and 1989) were higher than the 1992 year class. Continuous efforts to adhere to the flow regime recommended by the Roanoke River Water Flow Committee (RRWFC) in 1988 seem to have aided in this relatively high JAI. During May when the majority of the egg production occurred, Roanoke River flows were within the negotiated water flow regime (Rulifson and Manooch, 1991). High flows, both early and late in the flow augmentation period, may have hampered the establishment of a productive nursery area and subsequent juvenile survival.

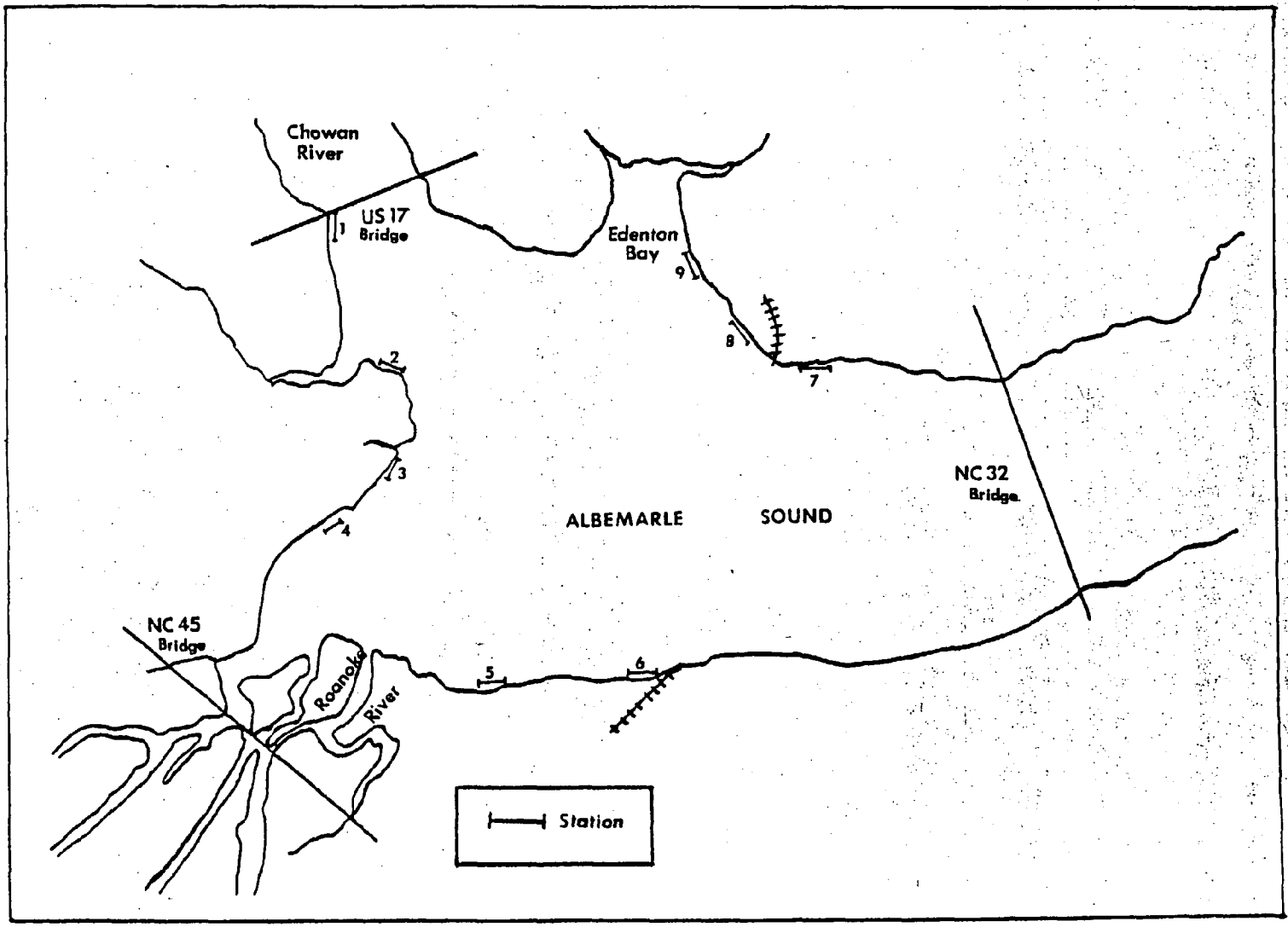

Figure 2. Station locations for young-of-year striped bass utilizing bag seine in the western Albemarle Sound area, NC, 1993.

Table 1. Number of young-of-year striped bass captured by semi-balloon trawl in western Albemarle Sound, NC, by station, July-October 1992.

	Station number							
Date	1	2	3	4	5	6	7	Total
15 Jul	2	3	0	1	1	0	0	7
28 Jul	0	15	10	6	0	0	0	31
10 Aug	0	45	0	6	0	1	0	52
27 Aug	1	3	6	8	0	0	1	19
08 Sep	0	0	24	0	0	0	0	24
22 Sep	0	0	2	0	3	1	0	6
08 Oct	0	0	0	1	0	0	1	2
22 Oct	0	0	0	0	1	1	1	3
Total	3	66	42	22	5	3	3	144

Table 2. JAI catch matrix for seven stations in western Albemarle Sound, NC, 1992.

Date	Stations	Fish	JAI
15 Jul	7	7	1.0
28 Jul	7	31	4.4
Monthly Subtotal	14	38	2.7
10 Aug	7	52	7.4
27 Aug	7	19	2.7
Monthly Subtotal	14	71	5.1
08 Sep	7	24	3.4
22 Sep	7	6	.86
Monthly Subtotal	14	30	2.1
08 Oct	7	2	.29
22 Oct	7	3	.43
Monthly Subtotal	14	5	.36
Total	56	144	2.57

Central Albemarle Sound Survey - 1992

During July-October 1992, a total of 84 trawl samples was taken in the central survey area. Thirty-six young-of-year striped bass were captured producing a CPUE of 0.43. The central sound survey continued to yield few juveniles compared to the western area.

Albemarle Sound Seine Survey - 1993

A total of 1,129 young-of-year striped bass was caught in 54 samples for a CPUE of 20.9 (Figure 3). The 1993 seine sampling accurately forecasted the number of young-of-year striped bass captured during the trawl sampling. The 1993 spring flow seemed extremely high on the Roanoke River to produce a favorable spawn, but despite this fact, a record year for egg (estimated 24 billion) and juvenile production took place (R. Rulifson, ECU ICMR, pers. comm.). Apparently, adults from the 1988 and 1989 year classes were a supportive factor in these numbers.

Western Albemarle Sound Survey - 1993

The JAI for 1993 was 44.5 based on 2,494 striped bass caught in 56 samples (Table 3). This JAI was the highest ever recorded in the Albemarle Sound area. In only two other years, 1959 and 1967, has the JAI exceeded 20.

The monthly JAIs for 1993 are shown in Table 4. The increased JAI could be attributed to both the beneficial effects of water flow modification of the Roanoke River reservoir system and favorable water quality conditions. Despite the flows being high, they remained stable throughout the peak spawning period. This parallels the conditions in 1989 when a high index (4.3 JAI), was recorded. Olsen and Rulifson (1991), reported that 95% of five year old females, 93% of four year old females, and 44% of three year old females were sexually mature at these ages. This suggests that a rather large number of females could be contributing to the large number of eggs this year, as witnessed by Rulifson's egg study on the Roanoke River. The 1993 JAI has also been attributed to stable Roanoke River flows, striped bass harvest limitations, and favorable water quality.

Central Albemarle Sound Survey - 1993

During July-October 1993, 84 trawl samples were taken in the central Albemarle Sound survey area. One thousand and forty three young-of-year striped bass were captured

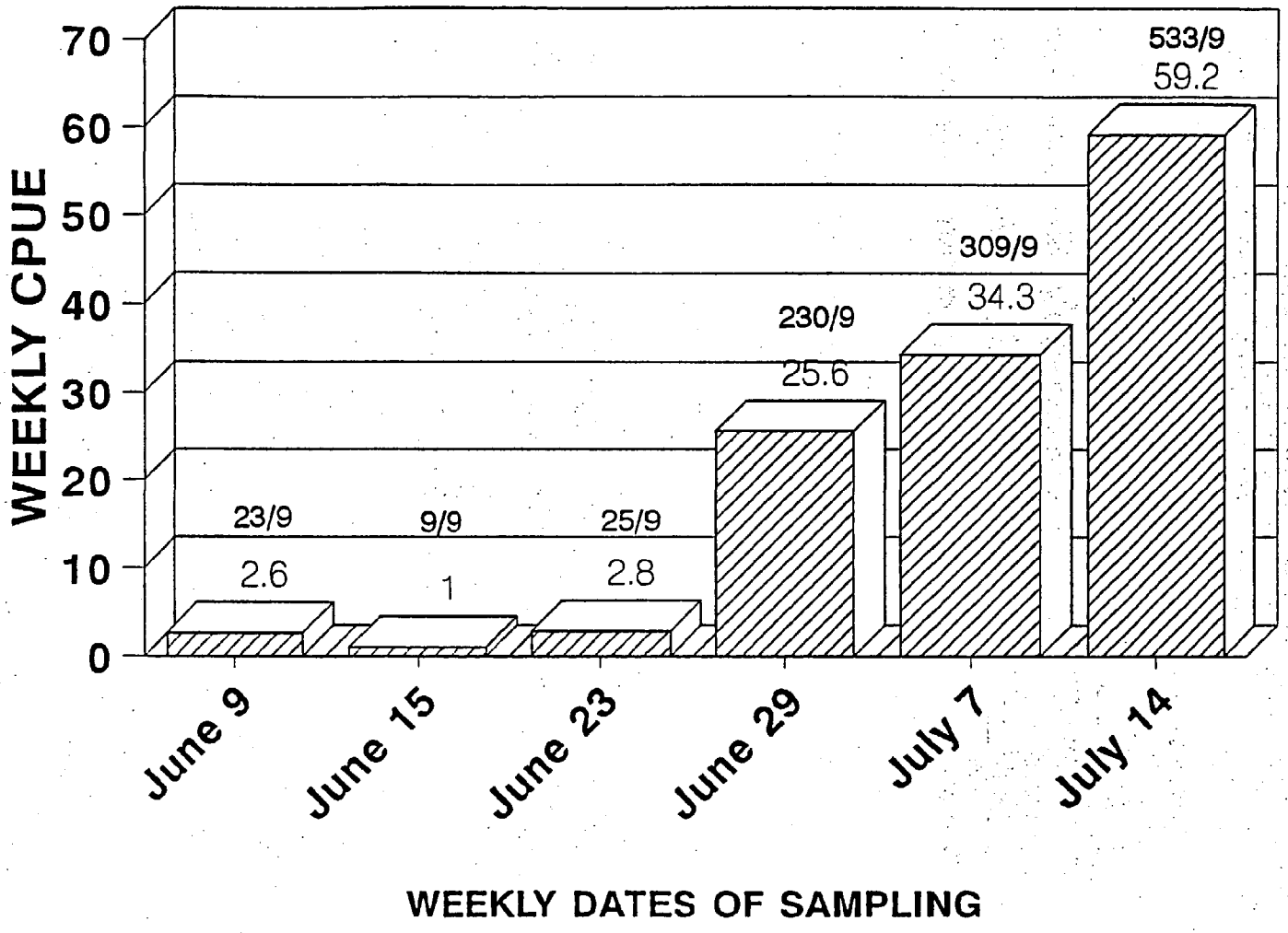

Figure 3. Catch-per-unit-effort values by week of young-of-year striped bass captured during seine sampling in the western Albemarle Sound area, NC, 1993. Bold numbers are number of fish per nine stations sampled, numbers below bold are the weekly CPUEs.

Table 3. Number of young-of-year striped bass captured by semi-balloon trawl in western Albemarle Sound, NC, by station, July-October 1993.

	Station number							
Date	1	2	3	4	5	6	7	Total
13 Jul	1	0	244	15	37	8	136	441
27 Jul	60	15	6	30	19	38	471	639
11 Aug	20	18	83	5	2	43	17	188
23 Aug	28	4	38	102	0	11	4	187
07 Sep	13	27	51	60	2	23	7	183
23 Sep	13	14	65	278	2	27	6	405
05 Oct	1	49	84	148	7	11	1	301
19 Oct	3	16	16	24	6	19	66	150
Total	139	143	587	662	75	180	708	2494

Table 4. JAI catch matrix for seven stations in western Albemarle Sound, NC, 1993.

Date	Stations	Fish	JAI
13 Jul	7	441	63.0
27 Jul	7	639	91.3
Monthly Subtotal	14	1080	77.1
11 Aug	7	188	26.9
23 Aug	7	187	26.7
Monthly Subtotal	14	375	26.8
07 Sep	7	183	26.1
23 Sep	7	405	57.9
Monthly Subtotal	14	588	42.0
05 Oct	7	301	43.0
19 Oct	7	150	21.4
Monthly Subtotal	14	451	32.2
Total	56	2494	44.5

producing a CPUE of 12.4. The 1993 central sound survey produced the highest CPUE since DMF started this survey in 1984. The 1989 CPUE of 3.65 (307 fish/84 samples) was the only other year in which a significant number of juveniles was captured. Flow into the Albemarle Sound, principally from the Roanoke River affects the striped bass nursery area location and distribution of larvae within the sound on a yearly basis (Rulifson and Manooch, 1991, Taylor and Hardy 1993). For 1993, the increase in abundance of juveniles observed in the central sound was an overflow of the juvenile production and survival observed in the western Albemarle Sound nursery area.

JOB 2: ASSESSMENT OF ADULT STRIPED BASS HARVEST

OBJECTIVE: Assess the adult striped bass harvest by examining up to 300 fish (90 per month randomly collected during the season) from three Albemarle Sound fishhouses, from various gears used in the ocean fishery (as practical), and from an interagency cooperative oceanic tagging study in order to determine the age/sex composition of those portions of the exploited stock.

PROCEDURES

Albemarle Sound Area Commercial Harvest

A total of ninety randomly selected striped bass was obtained monthly during the commercial season from three or more commercial fishhouses in the Albemarle Sound area. A target of 300 fish was sampled per year. The fish were measured to the nearest mm TL and weighed to the nearest 0.01 kg. Scale samples were removed from the left side of the body above the lateral line and below the gap between the spinous and soft dorsal fins. Sex was determined by the Sykes (1958) method. Aging methods utilized during this study were employed to update the database (Harriss et al. 1985).

Contribution of Year Class (Number of Individuals) to Harvest

Striped bass from the Albemarle Sound commercial harvest, for which age, sex, and weight data were available, were placed in the appropriate year class for each month sampled from November 1992 through April 1993. The number of individuals of each year class were followed monthly through the sampling period. The number (N) of striped bass landed by month of each sex and age class was calculated by multiplying the landings (kg) by the percent weight of the landings made up of that sex and age class divided by mean weight of

that sex for that year class during the month. To obtain the estimated number of individuals, the following calculations were performed:

$$\text{Number of individuals landed} = \frac{\text{Landings (kg) X \% of wt of sex of year class}}{\text{wt of sex of year class}}$$

$$\text{To obtain \% wt of sex, year class} = \frac{\text{wt of sex of each year class}}{\text{wt of all year classes, both sexes}}$$

Atlantic Ocean Migratory Stock

North Carolina's ocean striped bass fishery is currently very limited, based on the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan for Striped Bass, Amendment 4 (1990). Striped bass were sampled when available from the various ocean fisheries (winter trawl, beach seine, gill net, and hook-and-line) as directed in Amendment 4. Fish were obtained from fishhouses or directly from fishermen. Striped bass were measured to the nearest mm TL, weighed to the nearest 0.01 kg, and sexed utilizing the Sykes (1958) method. Lengths and scales were also obtained from oceanic migratory striped bass captured during the Cooperative Tagging Survey conducted offshore North Carolina and Virginia through the joint efforts of the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), Maryland Department of Natural Resources (MDNR), and DMF utilizing National Oceanic and Atmospheric Administration (NOAA) vessels. Scale samples were taken in the same manner as described in the Albemarle Sound commercial harvest section.

Scale samples from the North Carolina Cooperative Tagging Survey were processed and aged. Coded data from all scale samples was entered into the DMF Biological Database.

DISCUSSION

Albemarle Sound Area Commercial Harvest

A total of 477 striped bass was sampled from six fish dealers in the Albemarle Sound area (Figure 4) from November 1992 and February through April 1993. One hundred and seventy two were male and 305 were female for a sex ratio of 0.56:1. Scales from 464 fish were suitable for age determination.

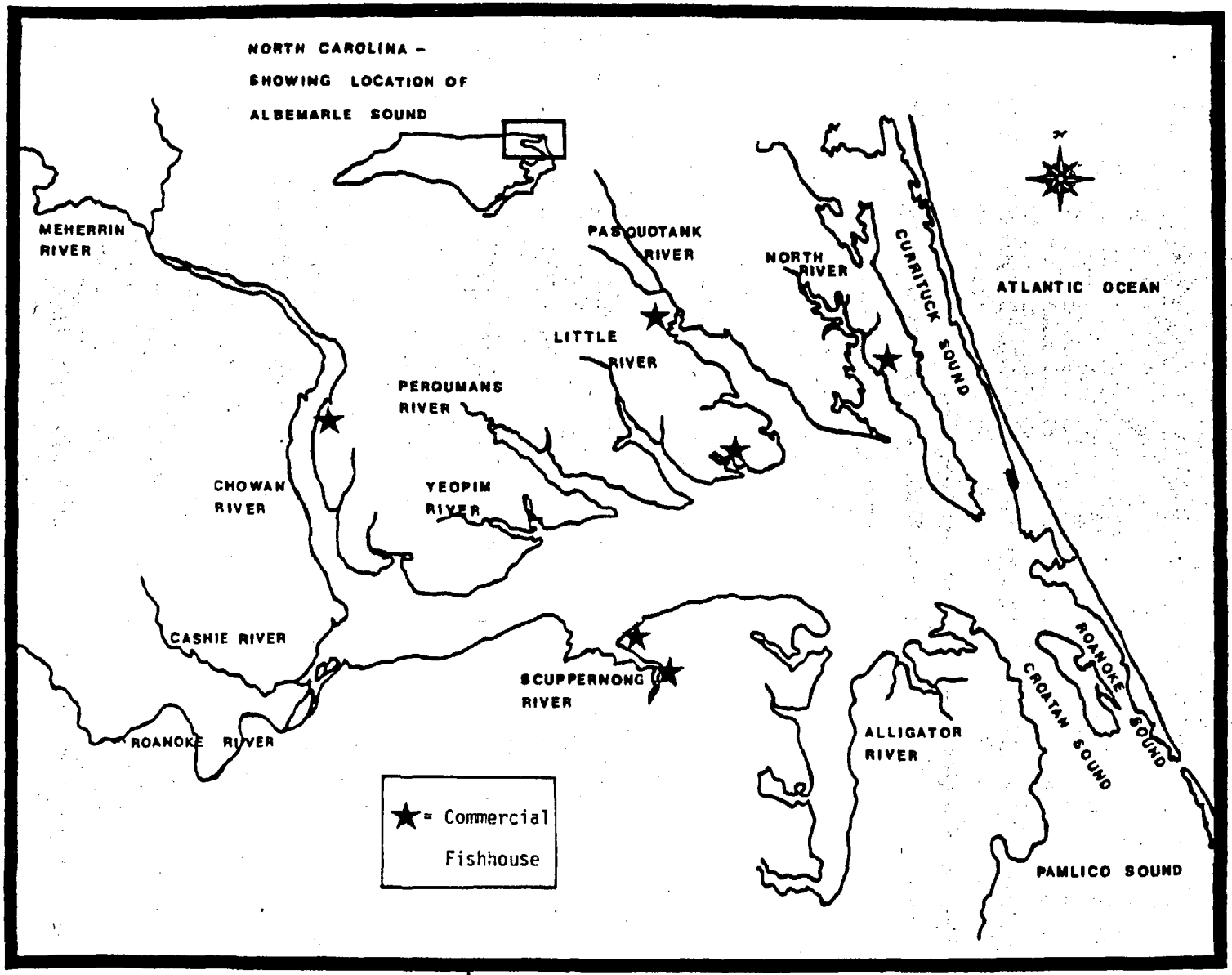

Figure 4. Locations of Albemarle Sound area commercial fishhouses sampled November 1992 through April 1993.

Male striped bass ranged in length from 448 to 757 mm (17 to 29 in) and weight from 1.07 to 5.45 kg (2 to 12 lb). Female striped bass ranged in length and weight from 461 to 940 mm (18 to 37 in) and 1.1 to 7.04 kg (2 to 15 lb). Length-frequency distributions by sex for the 4-month period are presented in Figure 5. Males in the 451-500 mm size group and females in the 501-550 mm size group dominated the samples. A portion of the commercial catch was subsampled for age according to Ketchen (1950) and Harriss et al. (1985).

Table 5 summarizes the year class, age, and size data for striped bass, by sex, from the Albemarle Sound commercial fishery during November 1992 and February through April 1993. Striped bass from the 1989 year class (age IV) were most abundant, comprising approximately 54.3% of the total sample. The 1988 year class (age V) fish was 37.3% of the sample. These two year classes represent 91.6% of the commercial sample.

The commercial fishhouse survey does evaluate size, age, and sex composition of the commercial harvest, meeting the objective of this job. However this evaluation is not representative of the composition of the entire Albemarle-Roanoke stock.

Contribution of Year Class (Number of Individuals) to Harvest

The Albemarle Sound striped bass age and weight data for November 1992 and February through April of 1993 were used to estimate the number of individuals in the commercial harvest from each year class by month (Table 6). The 1989 year class dominated the striped bass harvest, contributing 51.9% of the individuals sampled from the commercial harvest (Table 7). The estimated percentage contribution of the 1988 (34.5%) and 1989 (51.9%) year classes (age V and IV) was 86.4%. The 1987 (age VI) and older year classes contributed 9.9% to the commercial harvest. The percentage of age VI and older fish was higher than that reported by Henry et al. (1992a) for 1986-1990 (0.6 to 8.5%). The above data combined with the low contribution of the 1990 year class (3.7%) reflects the directed effort on the 1989 and older year classes due to mesh size requirements and minimum size limits. In addition, the percentage contribution by year class of the commercial harvest is affected by fishermen culling for larger fish due to daily harvest restrictions limiting the number of fish which may be landed. A comparison of data from the Striped Bass Independent Survey, Project F-48 (Henry et. al 1992b) for the same period reflects the effects

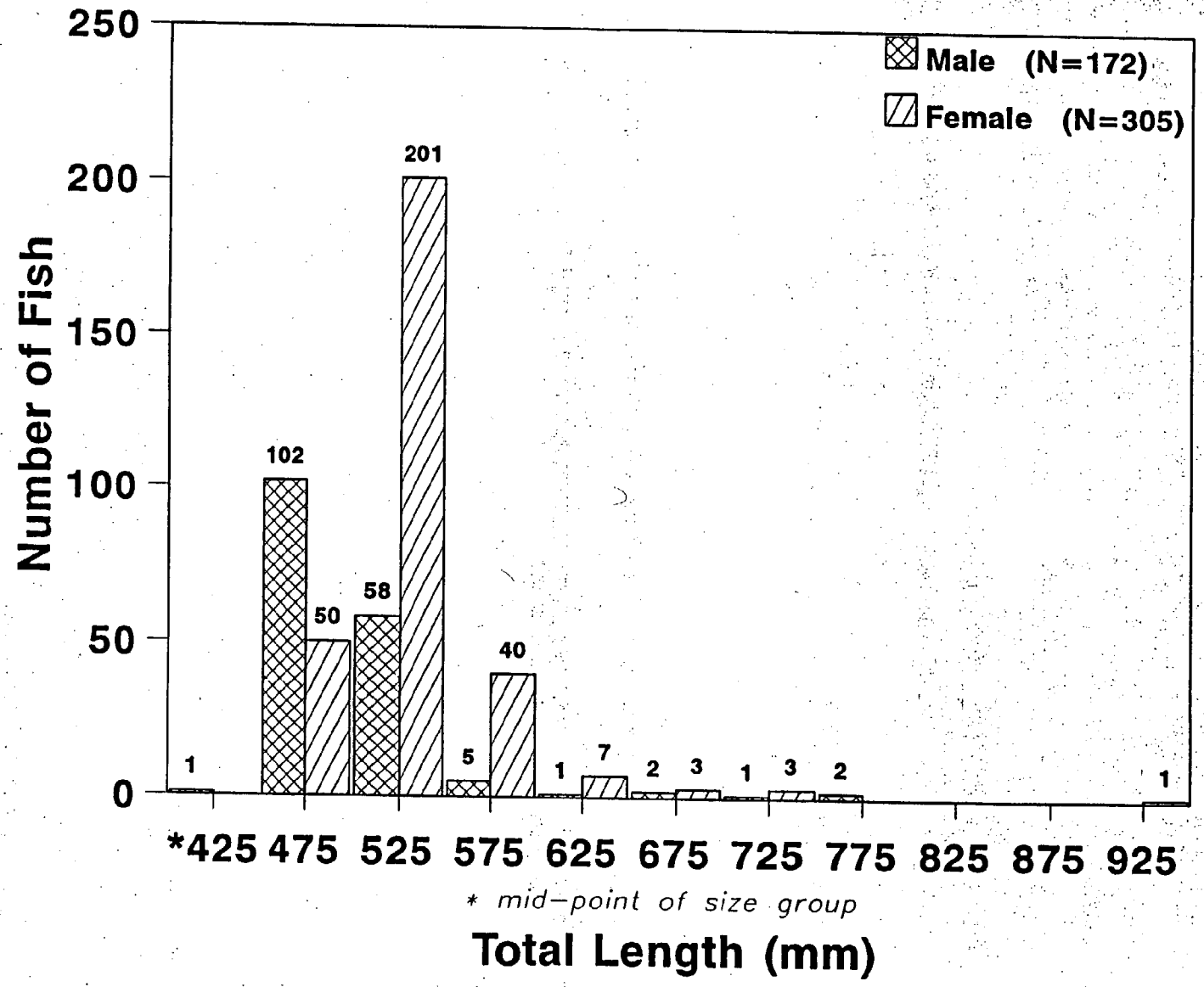

Figure 5. Length-frequency distribution of striped bass, by sex, from commercial dealers, Albemarle Sound, NC, November 1992 through April 1993.

Table 5. Number, percent, mean length, mean weight, and standard deviation at age, by sex, for striped bass sampled from North Carolina commercial catch, Albemarle Sound, November 1992 and February through April 1993.

						Total length (mm)				Total weight (kg)			
		Number		Percent of total		Mean		SD		Mean		SD	
Year class	Age	M	F	M	F	M	F	M	F	M	F	M	F
1990	III	15	2	3.2	0.5	469.4*	478.5	6.06*	24.75	1.28*	1.35	0.11*	0.35
1989	IV	125	127	27.2	27.1	495.7*	503.4*	22.73*	25.49*	1.51*	1.50*	0.23*	0.23*
1988	V	22	153	4.7	33.0	543.0	547.5*	27.00	35.72*	1.91	1.90*	0.30	0.43*
1987	VI	3	9	0.6	2.0	645.6	636.7	52.73	37.42	3.47	2.69	0.45	0.39
1986	VII	1	3	0.2	0.7	723.0	668.0	-	36.37	4.35	3.46	-	1.46
1985	VIII	1	1	0.2	0.2	757	729	-	-	5.15	4.65	-	-
1984	IX	1	1	0.2	0.2	753	941	-	-	5.45	7.04	-	-
Subtotal		168	296										
Total		464											

* Mean and standard deviation calculated from subsample.

Table 6. Estimated contribution by year class of the striped bass harvest from the Albemarle Sound, NC commercial fishery by sex, by month, November 1992 and February through April 1993.

		Male		Female		
Month	Year class	Percent	Number of individuals	Percent	Number of individuals	Total number of individuals
November	1990	16.7	48	-	0	48
	1989	66.2	190	6.3	49	239
	1988	17.1	49	56.2	440	489
	1987	-	0	25.0	196	196
	1986	-	0	12.5	98	98
February	1990	7.7	283	1.9	134	417
	1989	53.8	1,978	51.0	3,675	5,653
	1988	23.2	852	37.3	2,688	3,540
	1987	3.8	140	5.9	429	569
	1986	3.8	141	1.9	135	276
	1985	3.8	139	2.0	141	280
	1984	3.9	143	-	0	143
March	1990	8.9	217	2.0	108	325
	1989	68.3	1,660	45.9	2,546	4,206
	1988	13.8	335	46.1	2,559	2,894
	1987	9.0	219	4.0	219	438
	1984	-	0	2.0	110	110
April	1989	84.9	722	46.2	255	977
	1988	15.1	128	53.8	297	425
Total			7,244		14,079	21,323

December 1992, January 1993, and May through August 1993 fishery closed, no samples taken.

Table 7. Estimated contribution by year class of the striped bass harvest from the Albemarle Sound, NC commercial fishery by sex, November 1992 and February through April 1993.

Year class	Age	Male	Female	Total number	Percent of total
1990	III	548	242	790	3.7
1989	IV	4,550	6,535	11,075	51.9
1988	V	1,364	5,984	7,348	34.5
1987	VI	359	844	1,203	5.6
1986	VII	141	233	374	1.8
1985	VIII	139	141	280	1.3
1984	IX	143	110	253	1.2
Total		7,244	14,079	21,323	

Table 8. Year class composition of striped bass sampled from the Striped Bass Independent Survey in the Albemarle Sound, NC, November 1992 and February through April 1993.

Year Class	Age	Total number	Percent of total
1991	II	103	14.8
1990	III	127	18.2
1989	IV	430	61.7
1988	V	30	4.3
1987	VI	3	.4
1986	VII	2	.3
1985	VIII	2	.3
		697	100.0

of these restrictions and fishing practices (Table 8). The fishery independent data is more representative of the Albemarle Sound year class composition.

ATLANTIC OCEAN MIGRATORY STOCK

Commercial Harvest-Winter 1992-1993

The Atlantic Ocean commercial season opened 15 December 1992 and continued through 31 March 1993. Two hundred and eighty-eight fish were sampled to determine the size, age, and sex composition of the harvest (Table 9). The 1983 (age X), 1984 (age IX), and 1985 (age VIII) year classes, sexes combined, each contributed over 20%, to a total of 70.8% (Table 9). These data reflect the broad range of available year classes and reconfirms the abundance of the 1982-1986 year classes. This abundance is the result of the ongoing implementation of coastwide striped bass conservation efforts. Length-frequency distributions for male and female fish sampled during the 1992-1993 season are presented in Figure 6. A sex ratio of 0.85:1, male to female was determined. The distribution reflect harvested fish in excess of the 28 in (711 mm) minimum size limit. Striped bass in the 701-750 mm size interval were the most abundant males, while females were most abundant in the 751-800 mm size interval. Males ranged in length from 601-971 mm (23.6 to 38.2 in) and weighed 2.6 to 12.6 kg (5.7 to 27.8 lb). Female fish ranged in length and weight from 706 to 1,299 mm (27.6 to 56.1 in) and 3.9 to 26.8 kg (8.6 to 59.1 lb).

Recreational Harvest 1992-1993

The Atlantic Ocean recreational season, was open 15 December 1992 through 31 March 1993, with a 28 inch TL minimum size limit and a one fish/day creel limit. The minimum size limit and creel were based on guidelines established by ASMFC Amendment No. 4. An insignificant number of striped bass were landed in the recreational fishery, of which only one fish was sampled.

North Carolina Cooperative Tagging Surveys

During the 1-9 February 1993 Cooperative Tagging Survey, 581 striped bass were measured and released from Cape Henry, VA to Cape Hatteras, NC (Figure 7). Five hundred and thirty (91%) of these fish were tagged with USFWS internal anchor tags. Fish ranged in size from 439 to 995 mm TL (17.3 to 39.1 in) (Figure 8). Two fish, tagged on previous cruises were recaptured and 34 fish scanned Coded Wire Tag positive. Scale samples from 227 striped

Table 9. Number, percent, mean length, mean weight, and standard deviation at age, by sex, for striped bass sampled commercially, from the Atlantic Ocean, December 1992 and January through March 1993.

		Number		Percent of total		Total length (mm) Mean		Total length (mm) SD		Total weight (kg) Mean		Total weight (kg) SD	
Year class	Age	M	F	M	F	M	F	M	F	M	F	M	F
1987	VI	10	4	7.5	2.6	688	747	48	10.8	3.93	4.51	0.85	0.07
1986	VII	17	20	12.8	12.9	735	763	41.7	56.7	4.91	5.08	0.51	1.0
1985	VIII	36	33	27.1	21.3	762	790	46.1	53.8	5.80	5.80	1.01	1.27
1984	IX	28	44	21.0	28.4	774	831	49.7	68.4	6.04	6.81	1.18	1.63
1983	X	33	30	24.8	19.4	812	884	72.7	78.4	6.93	8.29	1.57	2.20
1982	XI	7	14	5.3	9.0	842	956	117	70.2	9.37	9.66	2.35	2.70
1981	XII	2	4	1.5	2.6	926	893	1.41	112	9.54	8.54	0.46	2.49
1980	XIII	0	1	-	0.6	-	1076	-	-	17.5	-	-	-
1979	XIV	0	1	-	0.6	-	1117	-	-	16.6	-	-	-
1977	XVI	0	1	-	0.6	-	1162	-	-	18.1	-	-	-
1976	XVII	0	3	-	1.9	-	1228	-	62.4	-	23.3	-	2.53
Total		133	155										

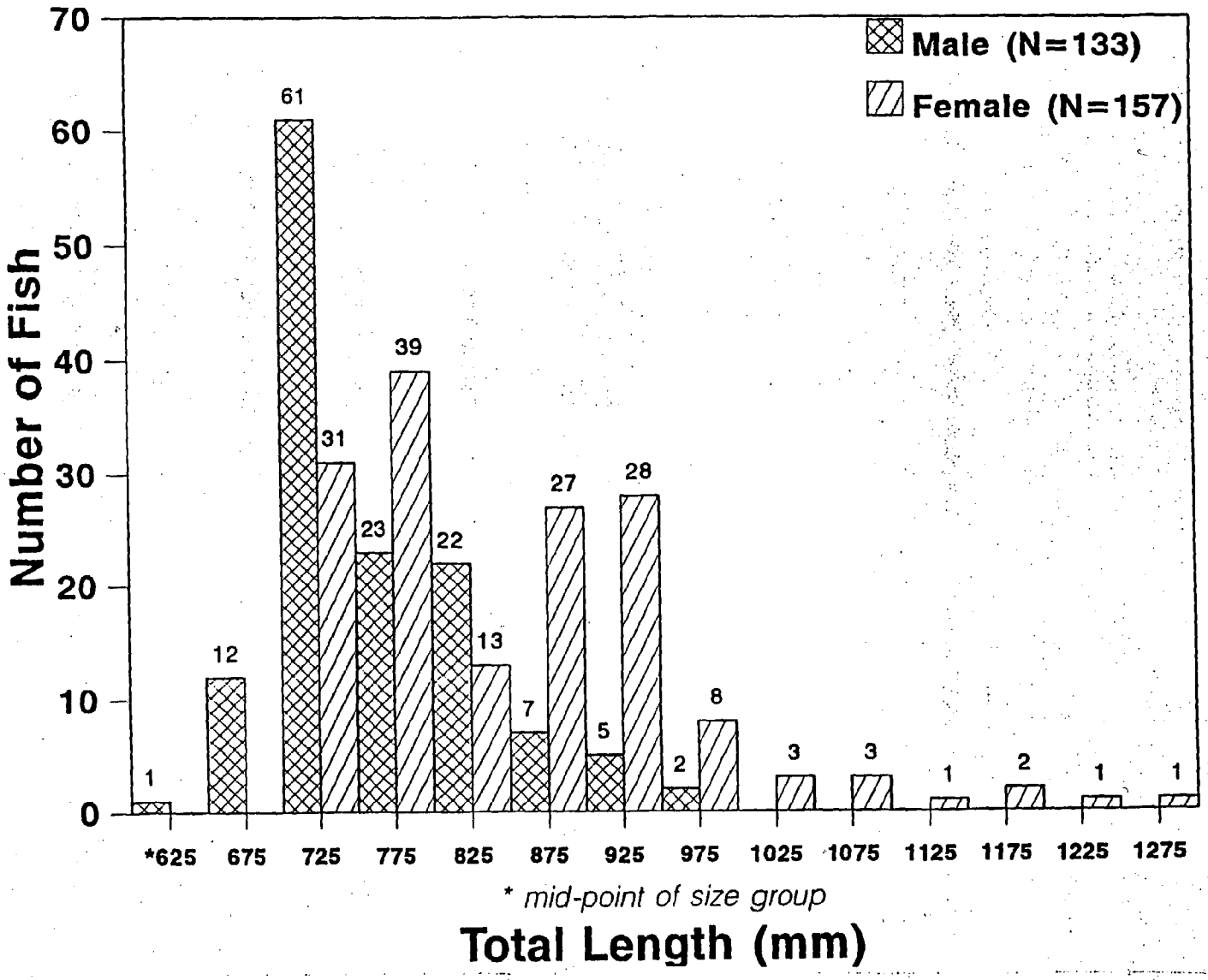

Figure 6. Length-frequency distribution of striped bass sampled during the North Carolina Atlantic Ocean commercial season, December 1992 through March 1993.

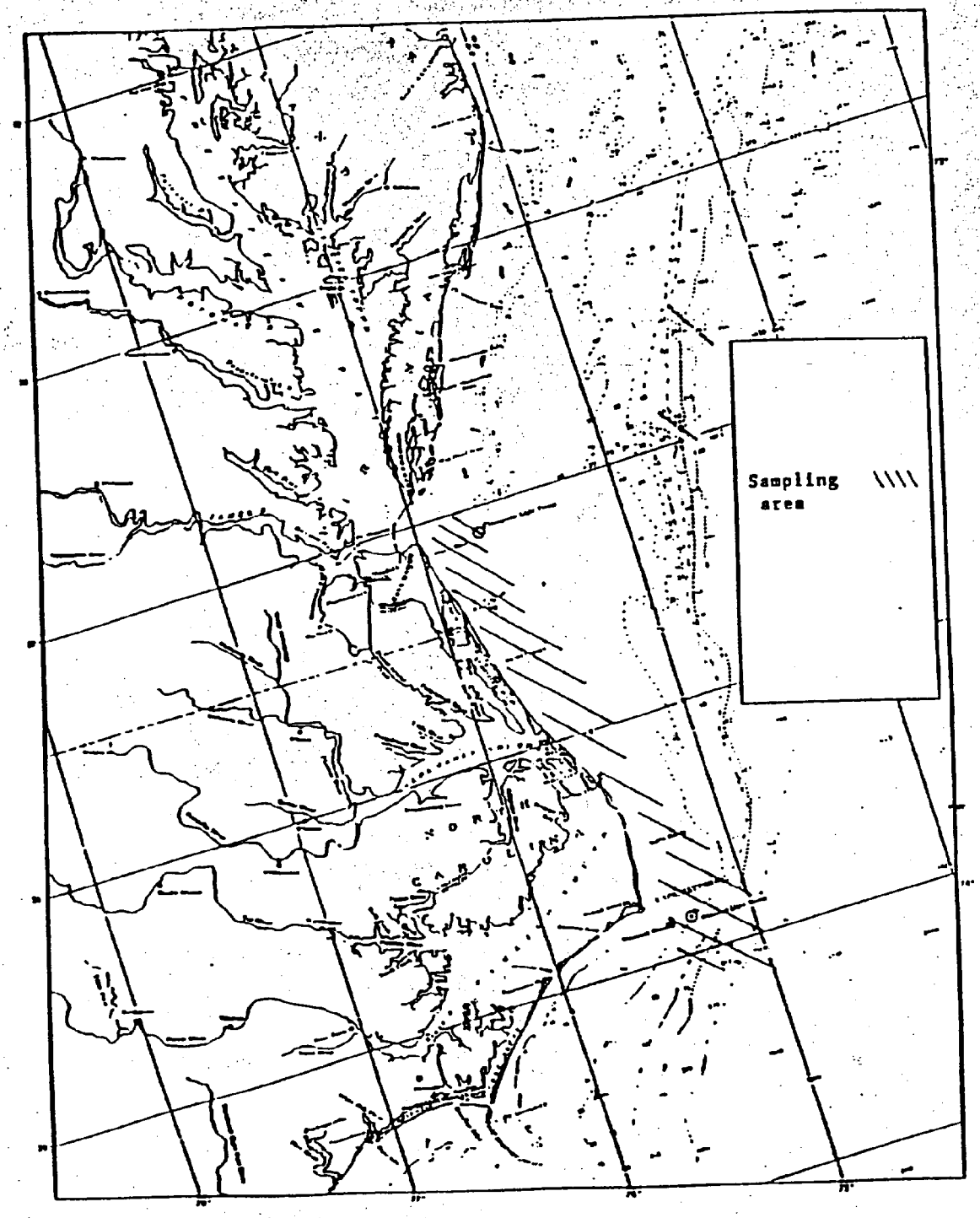

Figure 7. Map showing location where striped bass were tagged and released during the 1993 North Carolina Cooperative Tagging Survey off Virginia and North Carolina.

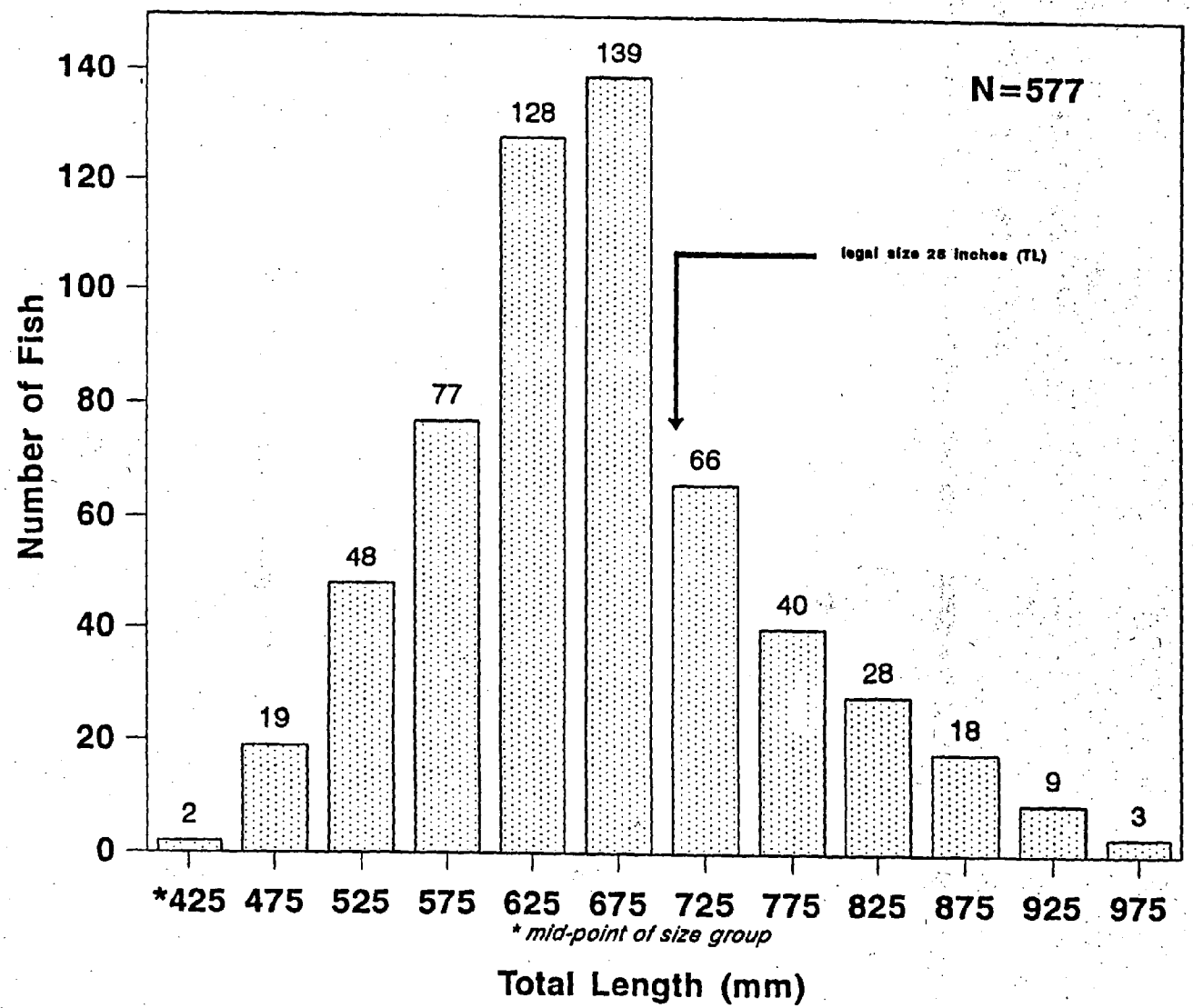

Figure 8. Length-frequency distribution of striped bass sampled off North Carolina and Virginia during the North Carolina Cooperative Tagging Survey, February 1993.

bass were suitable for age determination. The year class composition from these fish are presented in Table 10. The 1984, 1985, and 1988 (ages IX, VIII, and V) year classes comprised 59% of the total. Information on stock composition, migration, and growth rates gained from this survey is utilized in the coastwide striped bass management and restoration efforts coordinated by the ASMFC.

DMF data on age distribution from the 1992-1993 commercial harvest is similar to the 1993 Cooperative Tagging Survey data. Both surveys found the majority of the fish to be from the 1983 through 1985 year classes. These data reflect the broad range of available year classes and continues to confirm the abundance of the 1982-1986 year classes.

JOB 3: ADULT STRIPED BASS CONTRIBUTION AND UTILIZATION

OBJECTIVE: Assess the utilization and contribution to the ocean migratory stock of striped bass which overwinter in Croatan and Albemarle sounds and participate in the Roanoke River spawning run by tagging some 1,000 total fish annually and analyzing the returns.

PROCEDURES

Adult Striped Bass - Albemarle and Croatan Sound Areas

During November - March, adult striped bass were captured for tagging. The primary capture methods were pound nets, hook-and-line, and gill nets. Lengths (mm, TL) were recorded from all striped bass tagged. Water temperature and salinity were recorded each fishing day. Fish which appeared healthy were marked with individually applied internal anchor tags. Tags were inserted in the abdominal cavity on the left side just behind the pectoral fin. Fish were released immediately upon tagging. A target of up to 500 fish was to be marked and released annually from the Albemarle and Croatan sound areas.

Adult Striped Bass - Roanoke River Delta Area

During April - June, adult striped bass which were perceived to be participating in the spring spawning migration were to be captured and tagged in the Batchelor Bay area of western Albemarle Sound near the mouth of Roanoke River.

Fish were to be captured by pound net and hook-and-line, with pound nets being the primary capture method. Length (mm, TL) was to be collected from all tagged fish. Water

Table 10. Percent year class composition of striped bass collected along the North Carolina and Virginia coast, February 1993 during the Cooperative Tagging Survey.

Year class	N	Percent of total
1990	1	0.4
1989	19	8.4
1988	45	19.8
1987	27	11.9
1986	27	11.9
1985	44	19.4
1984	45	19.8
1983	16	7.0
1982	3	1.3
Total	227	

temperature was to be recorded each fishing day. Fish which appear healthy were to be marked with individually applied internal anchor tags. Tags were to be inserted in the abdominal cavity as previously described. Fish were to be released immediately upon tagging. A target of 600 fish were to be marked and released annually from the Roanoke River delta area.

All data was to be coded and entered in the DMF Biological Database and analyzed to determine utilization by the various fisheries, direction, distance and seasonality of movement.

DEVIATIONS: Due to the extreme high river flow on the Roanoke River and its tributaries, a contracted pound net fishermen was unable to set the pound nets for DMF use. No fish were tagged from any pound nets in the delta area and no data was collected.

Roanoke River Spawning Run

The North Carolina Wildlife Resources Commission (WRC), through Project F-22 is currently assessing (length, age, and sex) the Roanoke River spawning population through a fishery independent survey utilizing electroshocking. DMF assisted the WRC by recording data such as length (mm, TL), sex, and release location on captured striped bass. These captured fish were marked with internal anchor tags inserted in the abdominal cavity as previously described, and released immediately upon tagging. Data from this project was utilized by the WRC in assessing the population and DMF stored the same data for tag return purposes.

A letter stating the release date, location, days at large, estimated distance traveled, and length at release were sent to each person returning a tag along with a reward. The current reward system is a choice of $5.00 per tag or a tagging cap and a random drawing at years end for three (3) $100.00 rewards. Tagging activity was publicized in the media, through presentations to various organizations, and by distributing posters at marinas, ramps, tackle stores, and fishhouses.

All data was coded and entered in the DMF Biological Database and analyzed to determine utilization by various fisheries, direction, distance, and seasonality of movement.

DISCUSSION

This discussion is for tag recaptures which occurred from September 1992 through August 1993. Roanoke River returns will be reported separately from the Albemarle Sound Management Area which includes Albemarle, Croatan, Roanoke and Currituck sounds and their tributaries, excluding the Roanoke River.

Albemarle and Croatan Sound Areas - 1990 Tagging/Returns

Eleven tags were returned from September 1992 through August 1993 from 420 striped bass tagged during November 1990. Seven (63.6%) were recaptured by hook-and-line and four (36.4%) from pound nets. Release and recapture information by quarter, mean days at large, and distance from the release site (miles) are presented in Table 11. Six of the returns (54.5%) were recaptured from Albemarle Sound and its tributaries, four (36.4%) were caught in the Roanoke River, and one (9.1%) from the Neuse River.

Albemarle and Croatan Sound Areas - 1991 Tagging/Returns

A total of 183 striped bass was tagged and released during October and November 1991. Eleven tags were returned during this reporting period, from the 1991 tagging, of which five (45.5%) were from hook-and-line, four (36.4%) from commercial gill nets, one (9.1%) from a pound net, and one (9.1%) from electroshocking sampling. Of these returns, 63.6% (N=7) came from the Albemarle Sound area and tributaries, while the remaining 36.4% (N=4) came from the Roanoke River. Recapture information by quarter are presented in Table 12.

Albemarle and Croatan Sound Areas - 1992 Tagging/Returns

The 1992 eastern Albemarle and Croatan sound tagging from pound nets resulted in 88 striped bass being tagged and released. Ten tags have been returned of which four (40%) were from hook-and-line, three from pound nets (30%), and three from gill nets (30%). The Albemarle Sound area had the highest percentage of returns with 60% (N=6), followed by Roanoke River (20%, N=2), with one return each from Neuse River (10%) and Pamlico Sound (10%). The returns are presented by quarter in Table 13.

Table 11. Striped bass tag return summary, by quarter, for tagging from pound nets in Albemarle, Croatan and Roanoke sounds, November 1990.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Sept-Nov 1992	3	726.3	694-742	16.7	0-32
Mar-May 1993	6	907.2	868-1013	166.2	59-284
June-Aug 1993	2	982.5	959-1006	22.0	22
Total	11				

Table 12. Striped bass tag return summary, by quarter, for tagging from pound nets in Albemarle, Croatan and Roanoke sounds, November 1991.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Sept-Nov 1992	2	356.5	353-360	4.5	1-8
Dec 1992-Feb 1993	1	438.0	-	42.0	-
Mar-May 1993	7	510.9	477-544	81.4	37-202
June-Aug 1993	1	609.0	-	9.0	-
Total	11				

Table 13. Striped bass tag return summary, by quarter, for tagging from pound nets in Albemarle, Croatan and Roanoke sounds, November 1992.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Sept-Nov 1992	2	10	4-16	0	0
Dec 1992-Feb 1993	1	54	-	2.0	-
Mar-May 1993	6	158.2	132-181	79.8	25-196
June-Aug 1993	1	250	-	24.0	-
Total	10				

Albemarle Sound Independent Gill Net Survey 1990-1991 - Tagging/Returns

The Albemarle Sound Independent Gill Net Survey (ASIGNS) was initiated in October 1990 with 282 striped bass being tagged from December 1990 through March 1991. This year seven returns were received from the 1990-1991 ASIGNS tagging efforts. Of these seven returns, hook-and-line accounted for 71.4% (N=5), pound nets 14.3% (N=1) and one by electroshocking sampling (14.3%). The returns are presented in Table 14. Four (57.1%) were returned from the Roanoke River while three fish (42.9%) came from Albemarle Sound and its tributaries.

Albemarle Sound Independent Gill Net Survey 1991-1992 - Tagging/Returns

Three hundred and twenty eight striped bass were tagged and released during the period November 1991 through February 1992 by Division personnel. All fish were tagged in the Albemarle and Croatan sounds.

A total of sixteen tags have been returned from the Fall-Winter 1991-1992 tagging. Of these 16 returns, hook-and-line accounted for 56.3% (N=9), gill nets 37.5% (N=6) and pound nets 6.2% (N=1). The returns are presented in Table 15. The Albemarle Sound area accounted for 75.0% (N=12) of the returns, with the remaining 25.0% (N=4) coming from the Roanoke River.

Albemarle Sound Independent Gill Net Survey 1992-1993 - Tagging/Returns

Three hundred and seventy striped bass were tagged and released during the November 1992 through February 1993 sampling period in the Albemarle and Croatan Sound areas.

A total of fifteen (4.1%) tags have been returned from the Fall-Winter 1992-1993 taggings. Hook-and-line recaptures accounted for 60.0% (N=9), gill nets 33.3% (N=5) and pound nets 6.7% (N=1) of the fifteen returns. The returns are presented by quarter in Table 16.

Seven tags (46.7%) were returned from the Roanoke River, six (40.0%) from the Albemarle Sound area, one (13.3%) from the Stumpy Point area of Pamlico - Croatan sounds and one (13.3%) from the Potomac River above Washington DC (13.3%). The striped bass recaptured in the Potomac River just northwest of Washington DC by hook-and-line was tagged 23

Table 14. Striped bass tag return summary, by quarter, for tagging in Albemarle and Croatan sounds by the fishery independent gill net study, November 1990 through February 1991.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Sept-Nov 1992	2	677	662-692	20	36
Dec 1992-Feb 1993	0	0		0	
Mar-May 1993	5	848-6	807-875	108.2	30-166
Total	7				

Table 15. Striped bass tag return summary, by quarter, for tagging in Albemarle and Croatan sounds by the fishery independent gill net study, November 1991 through February 1992.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Sept-Nov 1992	5	342.4	317-363	10	1-38
Dec 1992-Feb 1993	2	439.0	437-441	7	2-12
Mar-May 1993	7	506	476-518	55.4	2-166
June-Aug 1993	2	541	519-564	20.0	14-26
Total	16				

Table 16. Striped bass tag return summary, by quarter, for tagging in Albemarle and Croatan sounds by the fishery independent gill net study, November 1992 through February 1993.

		Days at large		Distance from release site miles	
Quarter	Number returned	Mean	Range	Mean	Range
Dec 1992-Feb 1993	3	44	10-70	29.2	8.5-52
Mar-May 1993	9	76.1	1-186	73.2	0-193.5
June-Aug 1993	3	151.7	81-201	146.7	8-294
Total	15				

January 1993 off of Durant's Island in Albemarle Sound. The recapture occurred 173 days later on 15 July 1993, 294 miles from the release site.

Roanoke River Spawning Run - 1991 Tagging/Returns

A total of forty five recaptures (2.7%) occurred from September 1992 through August 1993 from 1,657 fish tagged during the 1991 electro-shock sampling on Roanoke River. Hook-and-line fishing accounted for 66.7% (N=30) of the recaptures, gill nets 22.2% (N=10), and pound nets 11.1% (N=5). Of these 45 fish, 23 (51.1%) were recaptured from the Roanoke River. Twenty two (48.9%) striped bass were caught in the Albemarle Sound area. The returns are presented by quarter in Table 17.

Roanoke River Spawning Run - 1992 Tagging/Returns

Tagging efforts for 1992 were concentrated in the upper Roanoke River near Gaston and Weldon (Figure 9). With the aid of the WRC staff and electroshocking boats, project personnel tagged and released 2,433 fish between 21 April and 15 June 1992.

Of the 2,433 tagged fish, 142 tags (5.8%) were returned during the reporting period. Seventy seven (54.2%) striped bass came from the Roanoke River, while 62 fish (43.7%) were caught from the Albemarle Sound area. Returns from other areas accounted for 2.1% (N=3). These three tags were returned from the Belhaven - Pungo River area of North Carolina. Hook-and-line returns have accounted for 62.7% (N=89), gill nets (19.7% (N=28), electro-shocking sampling 4.9% (N=7), and 2.1% (N=3) from pound nets. The returns by quarter are presented in Table 18.

In addition to the electro-shocking tagging, DMF personnel tagged and released 22 striped bass captured below Weldon by hook-and-line. The fish ranged in length from 372 to 502 mm TL (14.6 to 19.8 in). One tag has been returned. The recapture occurred 338 days after release, 6 miles up river at the Roanoke Rapids Dam.

Roanoke River Spawning Run - 1993 Taggings/Returns

Tagging during the 1993 spawning run on the upper Roanoke River concentrated near Gaston and Weldon (Figure 9). A cooperative effort with the WRC staff resulted in the capture and release of 2,452 striped bass of which 2,338 were released with DMF internal anchor tags.

Table 17. Striped bass tag return summary, by quarter, for tagging on Roanoke River during the spawning run April - June 1991.

Quarter	Number returned	Days at large		Distance from release site (miles)	
		Mean	Range	Mean	Range
Sept-Nov 1992	7	536.7	510-556	164.3	145-180
Dec 1992-Feb 1993	5	617.2	561-641	159.6	153-168
Mar-May 1993	29	696.6	645-741	71.6	0-165
Jun-Aug 1993	4	767.5	755-774	162.8	157-169
Total	45				

Table 18. Striped bass tag return summary, by quarter, for tagging on Roanoke River during the spawning run April through June 1992.

Quarter	Number returned	Days at large		Distance from release site (miles)	
		Mean	Range	Mean	Range
Sept-Nov 1992	23	170.8	114-204	159.2	15-182
Dec 1992-Feb 1993	16	271.1	221-300	164.4	132-220
Mar-May 1993	78	334.3	278-389	83.4	0-219
Jun-Aug 1993	25	397.5	304-447	62.8	0-164
Total	142				

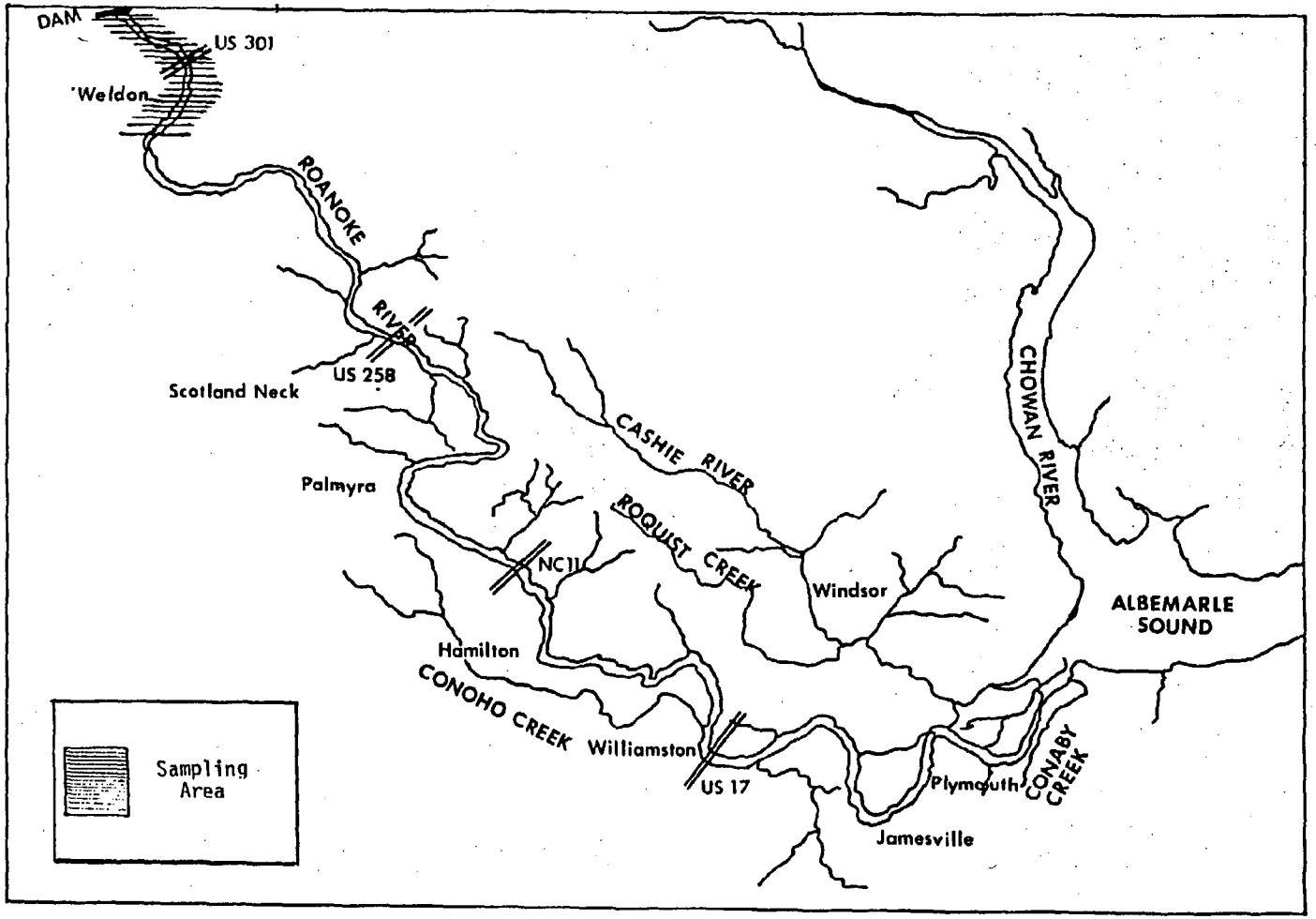

Figure 9. Sampling area for adult striped bass tagging, upper Roanoke River area, NC, 1991-1993.

Male striped bass numbered 1687, (68.8%) while the number of females was 735, (30.0%). The sex of 30 fish (1.2%) could not be determined.

Of the 2,338 tagged fish, 74 tags (3.2%) have been returned (3.2%). Forty three (58.1%) tag returns came from the Roanoke River, with 31 (41.9%) being returned from the Albemarle Sound area. Hook-and-line has been the most productive recapture gear accounting for 39.2% (N=29) of the returns, followed by pound nets with 33.8% (N=25), electro-shocking sampling 13.5% (N=10), gill nets 4.0% (N=3), and 9.5% (N=7) of the returns from tagging mortalities found floating downstream of the tagging area on Roanoke River. Tag returns are presented by quarter in Table 19.

Batchelor Bay Area - 1990 Pound Net Tagging/Returns

Henry et al. (1992a) reported that 289 striped bass were tagged and released in the spring of 1990 in the Batchelor Bay area of Albemarle Sound. During this 1992-1993 segment three recaptures occurred from that tagging. Two fish (66.7%) were recaptured on the spawning grounds of the Roanoke River. One striped bass (33.3%) was caught in the Albemarle Sound. Hook-and-line accounted for 66.7% (N=2) of the recaptures and gill nets 33.3% (N=1). The three recaptures occurred during the March through May quarter. The mean days at large was 1,074 with a range of 1,061 to 1,094 days. The mean distance from the release site was 57.4 miles with a range of 6 to 135 miles.

Fall-Winter 1992-1993 Hook-and-Line Tagging in Albemarle Sound

One hundred and nine striped bass were caught, tagged, and released by Division staff using hook-and-line during the fall-winter of 1992-1993. One recapture occurred on Roanoke River by hook-and-line after 165 days at large and 54 miles from the release site.

Summary of Adult Tagging, September 1992-August 1993

A total of 2,905 adult striped bass was tagged by various methods (electroshocking, gill nets, and pound nets) from September 1992 through August 1993. To date, 100 returns have been received as well as 233 returns from prior year's tagging efforts for a total of 333 recaptures. Recapture methods were hook-and-line which accounted for 56.8% (N=189), gill nets 17.7% (N=59), pound nets 16.8% (N=56), electro-shocking 5.7% (N=19), haul

Table 19. Striped bass tag return summary, by quarter, for tagging on Roanoke River during the spawning run April through June 1993.

Quarter	Number Returned	Days at large		Distance from release site (miles)	
		Mean	Range	Mean	Range
Mar-May 1993	34	7.6	0-34	15.8	0-169
Jun-Aug 1993	40	42.2	10-78	117.7	0-174
Total	74				

seine .9% (N=3) and seven fish found on Roanoke River, attributed to tagging mortality (2.1%).

Approximately half the recaptures (51%, N = 170) occurred from the Roanoke River. This high percentage of returns from the spawning grounds by hook-and-line is a result of the fish being concentrated in a relatively small area with a large amount of directed effort. Forty seven percent (N = 156) of the recaptures occurred mainly from Albemarle, Croatan, and Currituck sounds and their tributaries. Seven returns came from the Pamlico Sound - Neuse and Pungo river area. The only return from outside the internal waters of North Carolina came from the Potomac River above Washington, DC. These returns show the Albemarle/Roanoke striped bass population is distributed throughout the Albemarle and Croatan sounds and tributaries during the fall-winter (September - February). A migration into the western Albemarle Sound and up the Roanoke River occurs in the spring (March - May), with a migration down the river and a dispersal throughout the Albemarle and Croatan sounds and tributaries in the summer (June - August).

All but one recovery was from within the North Carolina internal waters showing very little contribution to the Atlantic Migratory stock. Historical adult tag recovery databases (Street et al. 1975; Johnson et al. 1977; Hassler et al. 1981; Hassler and Taylor 1986) suggest that the Albemarle/Roanoke striped bass stock is composed principally of a discrete resident population which contribute insignificantly to the Atlantic migratory stocks.

The tag return data shows that the tagged fish have contributed to the commercial and recreational harvest and participated in the spawning population. The return rate by gear type for the period indicates that 56.8% were captured by recreational angers and 35.4% by commercial harvesters. This recreationally dominated utilization is a combination of extensive regulatory measures implemented on the Albemarle area commercial fisheries and the concentrated recreational effort on the spawning grounds.

JOB 4: EVALUATION OF COASTAL STRIPED BASS STOCKING

OBJECTIVE: Evaluate the influence of stocking striped bass on both the exploited and reproducing portion of the population by tagging approximately 2,500 Phase II fish reared at

the Edenton National Fish Hatchery prior to their release in various coastal systems and analyzing the returns.

PROCEDURES

Prior to scheduled stocking, project personnel tagged Phase II striped bass at the Edenton National Fish Hatchery, Edenton, NC. The Cooperative Stocking Agreement Development Work Plan indicates two stocking groups per year. All striped bass stocked in Albemarle Sound were tagged with internal anchor tags prior to release and approximately 2,500 striped bass were tagged for the other systems. Internal anchor tags were inserted in the abdominal cavity on the left side just behind the pectoral fin. Cinch-up tags, when used in other systems, were to be inserted between the soft and hard dorsal. All stocked fish were released in the natural striped bass nursery area in the various coastal systems. Rewards will be processed as previously discussed in Job 3. All data was coded and entered in the DMF Biological Database.

DISCUSSION

During the 1990-1992 winter stockings, 209,876 Phase II striped bass were released in coastal North Carolina. Of the total, 14,971 were tagged prior to stocking, and 317 (2.1%) have been returned (Table 20). Only one of the tag returns have occurred from outside the internal waters of North Carolina, indicating a very insignificant amount of contribution to the Atlantic Ocean migratory stock.

Phase II striped bass were released in the Albemarle Sound area annually during 1990-1992, in the Neuse River in 1990 and 1992, and in the Pamlico River area in 1991 (Figure 10). All of these stockings occurred in the natural striped bass nursery areas in each system (Street et al. 1975, Marshall 1976, Johnson et al. 1977, Sholar 1977, Hawkins 1979 and 1980, and Winslow et al. 1983 and 1985).

Albemarle Sound Area - 1990-1992

A total of 7,459 tagged Phase II striped bass was released in the Albemarle Sound area in December 1990-92 (Figure 10). Since the stockings occurred, 2.4% of the tags have been returned. Table 20 presents the annual stocking figures, number of returns, and the methods of recapture. No recaptures from the December 1992 stockings have occurred.

Table 20. Summary of Phase II striped bass stockings, returns, and recapture gears from coastal North Carolina, 1990-1992.

System stocked	Total number stocked	Number tagged	Returns No.	Returns %	Percent returns after recruitment	Recapture gear: Gill nets No.	Gill nets %	Pound nets No.	Pound nets %	Hook and line No.	Hook and line %	Other No.	Other %
Neuse River area-December 1990	61,877	2,992	75	2.5	50.0	65	86.7	0	-	9	12.0	1	1.3
Albemarle Sound area-December 1990	2,000	2,000	39	2.0	43.6	10	25.6	4	10.3	24	61.5	1	2.6
Pamlico River area-December 1991	2,000	1,993	59	3.0	0	33	56.0	0	-	26	44.0	0	-
Albemarle Sound area-December 1991	2,994	2,994	142	4.7	0	65	45.8	65	45.8	12	8.4	0	-
Neuse River area-December 1992	138,540	2,527	2	.08	0	0	-	0	-	2	-	0	-
Albemarle Sound area-December 1992	2,465	2,465	0	0	0	0	-	0	-	0	-	0	-
Totals	209,876	14,971	317	2.1									

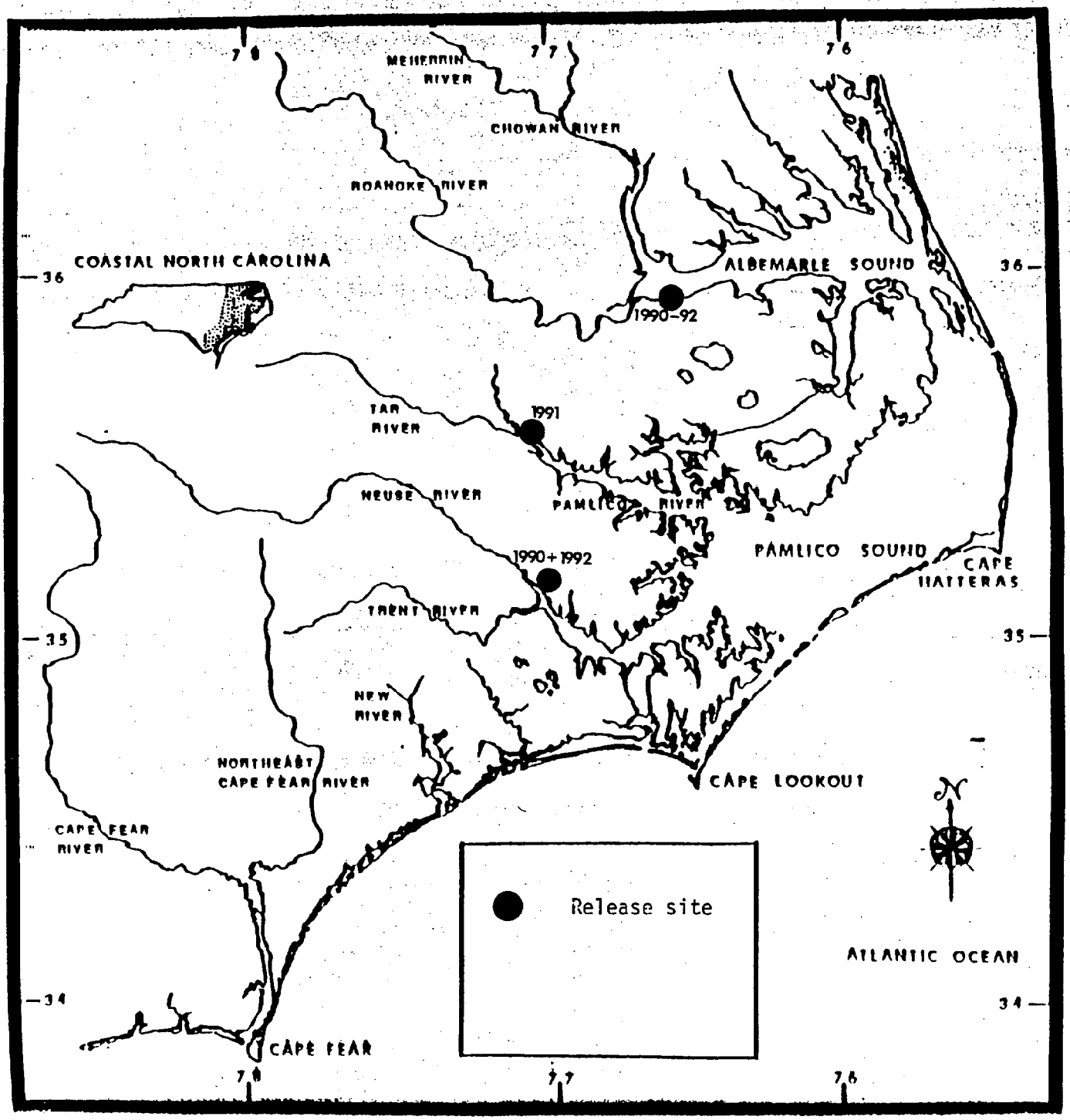

Figure 10. Release sites of Phase II striped bass stockings, 1990-1992.

The pre-recruit striped bass movements were the same for each stocking regardless of the release site and similar to those reported by Taylor et al. (1992). This was especially true along the southeastern shore of Albemarle Sound and the Alligator River during the winter. During the spring, a general movement to the western sound was observed. As the winter months approached, the returns again were from the eastern sound area (Figure 11).

The majority of the returns from the Albemarle Sound area have been from gill nets (41.2%) followed by pound nets (37.9%) with hook-and-line accounting for the remainder (19.8%). Many of the early returns prior to recruitment into the fisheries were a result of cinch-up tags setting entangled in the gill net webbing. However, since the switch to internal anchor tags, whose streamer tag protrudes smoothly from the side, this situation has been eliminated. The percentage of return from all gear has ranged from 19.8% to 41.2%. These data confirm that stocked fish continue to contribute to the commercial and recreational fisheries in the area.

During May of 1993, three returns (Phase II fish released in December of 1990) were recaptured from the spawning grounds on the Roanoke River. The mean number of days at large was 874 and the mean distance of recapture from release site was 141 miles. One additional tag was returned from the lower Roanoke River in May 1993. These fish may have been participating in the spawning migration. Returns from the spawning grounds continue to indicate that the stocked fish contribute to the spawning population. This continued contribution from stocked fish substantiates earlier reports (Henry et. al 1992b, Taylor and Hardy, 1993).

Neuse River Area - 1990 and 1992

The Neuse River was stocked with 5,519 tagged Phase II fish during the project (Figure 12) and 77 tags (1.4%) have been returned. The stocking numbers, returns, and recapture gears are shown in Table 20.

The movements of Phase II striped bass from the various stockings were similar to that reported for the Neuse River by Taylor et al. (1992) and Henry et al. (1992a). Two returns occurred during the reporting time. They were recaptured by hook-and-line between the release site and the mouth of Goose Creek (Figure 12).

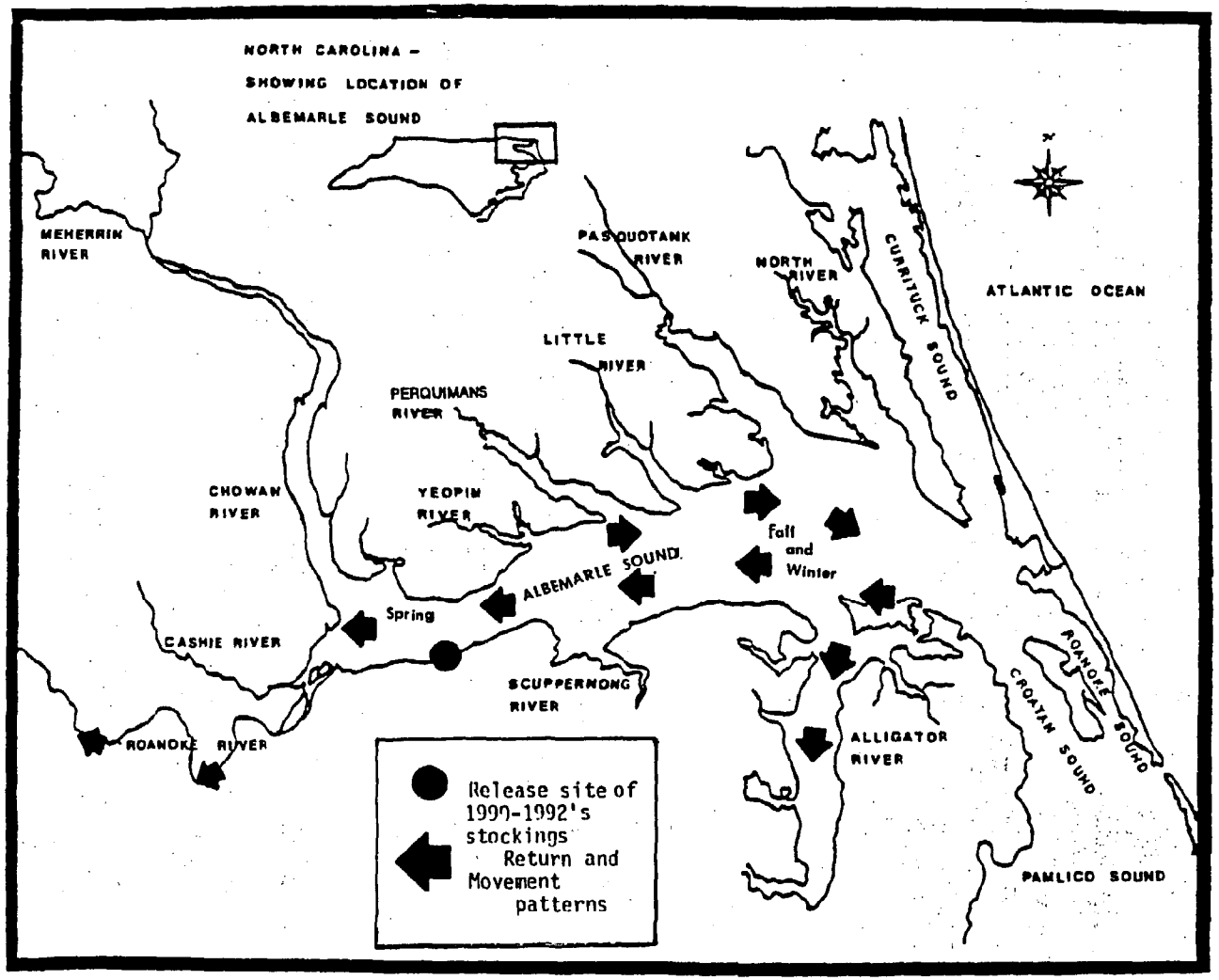

Figure 11. General return and movement patterns of Phase II striped bass stocked, Albemarle Sound area, NC, 1990-1992.

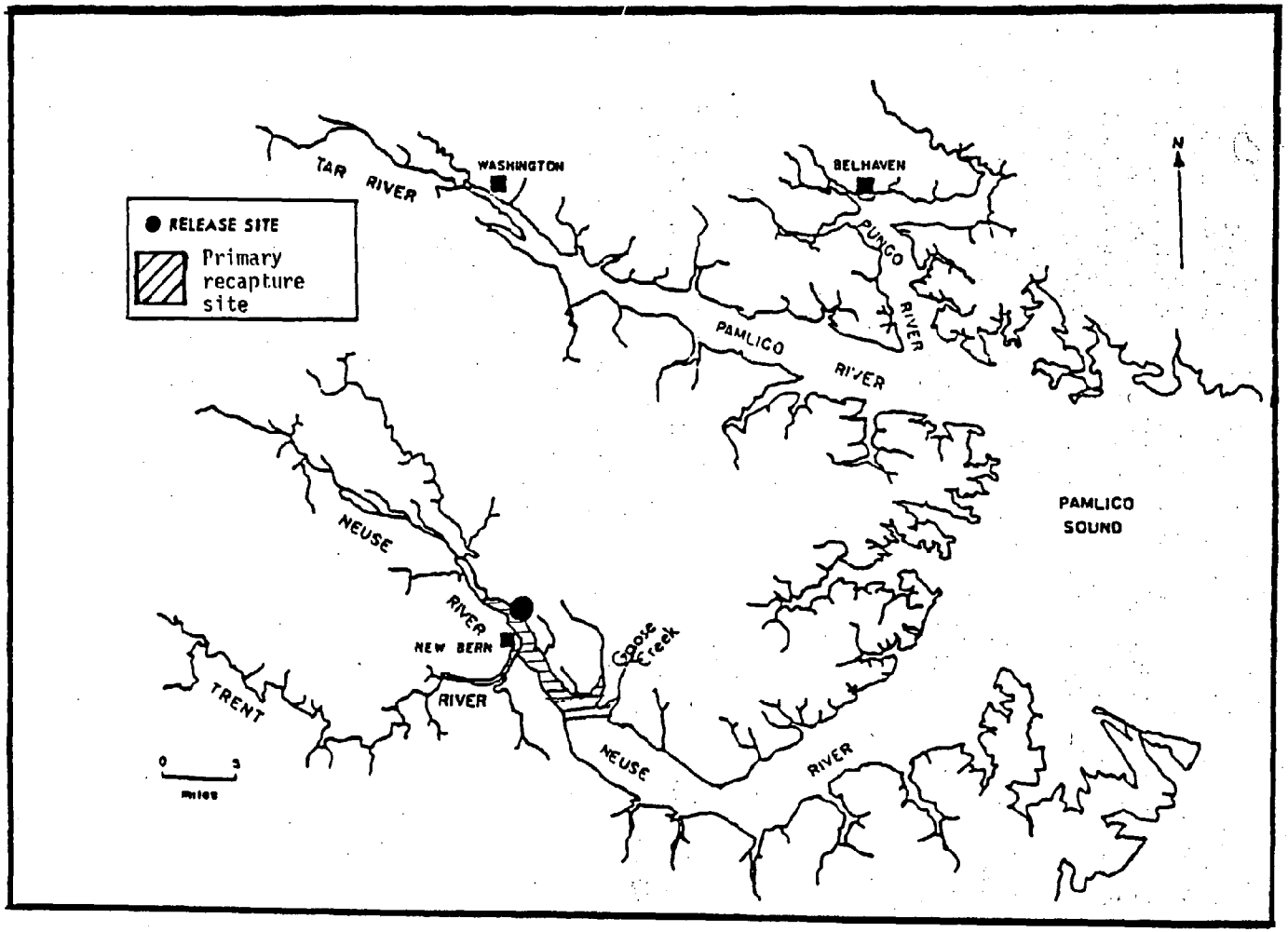

Figure 12. Primary recapture location of Phase II striped bass released in Neuse River, NC, 1990 and 1992.

Gill nets have accounted for the majority (84.4%) of the returns from the Neuse River area (Table 20). The percentage of hook-and-line returns was 14.3%. Returns have occurred from both sectors of the fishery despite only 50% of the fish from the 1990 stocking being legal size.

Pamlico River Area - 1991

A total of 1,993 tagged Phase II striped bass was released in the Pamlico River area during December 1991 (Figure 13). Fifty-nine tags (3.0%) have been returned (Table 20). Eighteen tags (one from a gill net and 17 from hook-and-line) of the total were returned during this reporting period.

Sixty-seven percent of the returns occurred from the area between Washington and Goose Creek (Figure 13). This percentage is lower than that reported by Henry et al. (1992a) for the 1987 stocking (82%) and Winslow et al. (1985) for the 1984 stocking (76%), but was higher than the 48% reported by Winslow and Johnson (1984) for the 1983 stocking. The reason for the low percentage was because six recaptures were returned from the upper regions of the Tar River during early spring and summer. No returns occurred from outside the Tar-Pamlico River drainage from the 1991 stocking.

The majority (56.0%) of tag returns were from gill nets prior to recruitment into the fishery. Hook-and-line returns have accounted for 44.0% . Only 5.9% of the returns have occurred from the commercial and recreational fisheries since the fish attained legal size (Table 20).

The results of these Phase II stocking programs have shown that stocking can be used as a management tool. The data indicate that the stocked fish do contribute to the commercial and recreational harvest in each system. Tag returns from the Roanoke River spawning grounds show that these fish continue to augment the spawning population.

Tagging a portion of Phase II fish will continue to provide data for determining exploitation rates and survival to first spawning. These stocking programs will help sustain a striped bass population during low levels of abundance. However, stocking at these levels will not be effective in restoring populations to self-sustaining levels in the face of fishing pressure prior to sexual maturity and poor environmental conditions.

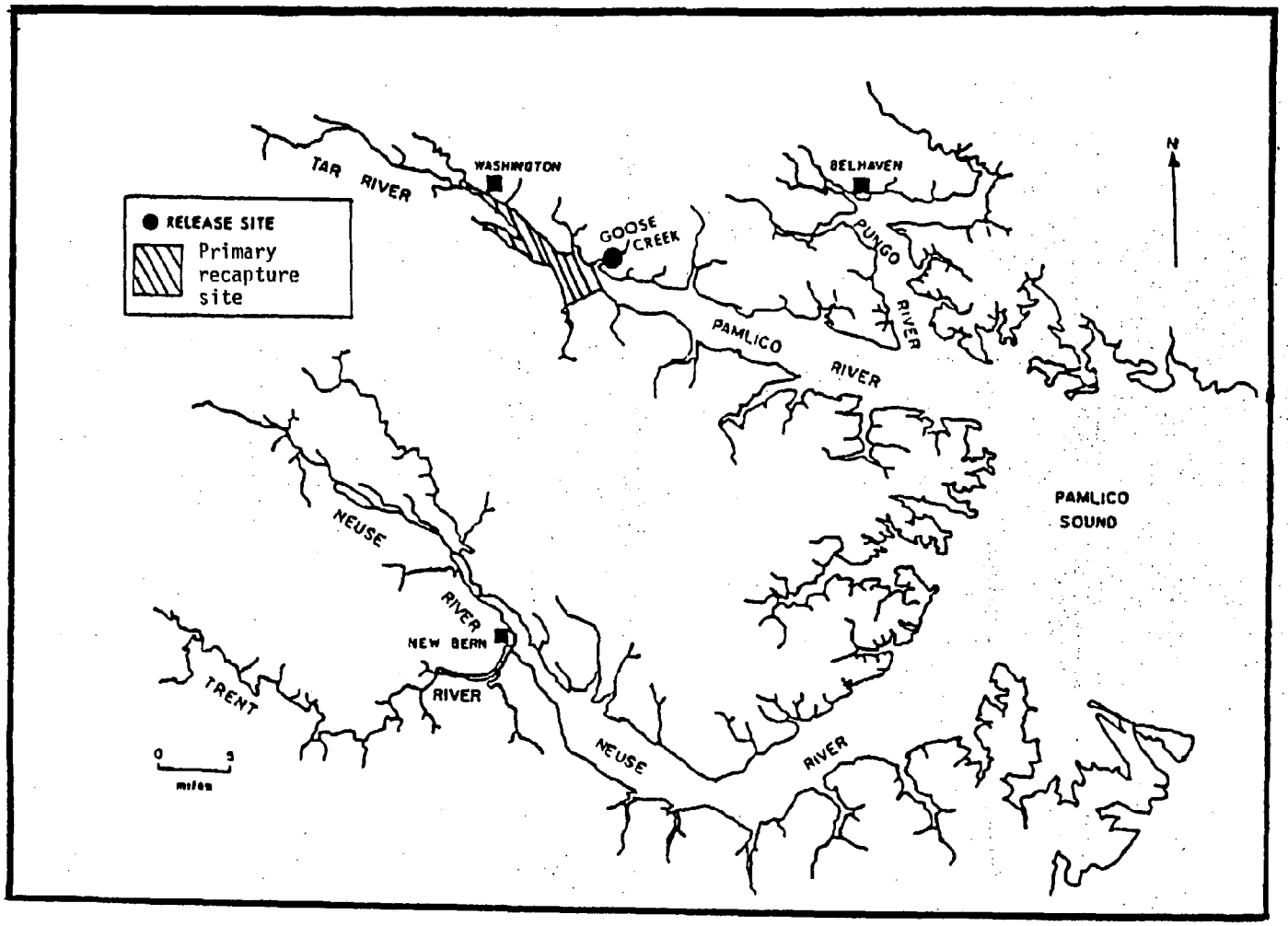

Figure 13. Primary recapture location of Phase II striped bass released in Pamlico/Tar River, NC, 1991.

RECOMMENDATIONS

This agency recommends:

- Continuation of both the western and eastern Albemarle Sound juvenile abundance databases.
- Validation of the juvenile abundance indices be conducted to meet the ASMFC Striped Bass Study Management Board requirements through review of the Technical Committee.
- The North Carolina Cooperative for Anadromous Species Restoration, which includes the USFWS, WRC, and DMF should continue to pool available resources.
- Specific investigations need to be developed on seasonal gear-related mortality such as cold water vs. warm water by-catch mortality.
- Continued Phase II stocking programs to help sustain striped bass populations during low levels of abundance.
- Consideration should be given for a 24 inch TL size limit to allow more fish to reach sexual maturity. The Albemarle Sound gill net fishery must be managed to minimize the bycatch wastage of striped bass, as the losses may negate the potential gains from the increased size limit.
- Harvest quota management is recommended as the principal management component to control fishing mortality for the Albemarle/Roanoke striped bass population.

ACKNOWLEDGEMENTS

This project would not have been possible without funding from the U.S. Fish and Wildlife Service. We thank B. Burns, S. Cooper, L. Henry, R. Marsh, K. Rawls, A. Saunders, S. Trowell, C. Teague, and J. Zuaboni for their field and technical assistance. T. Gillikin, S. McLeod, P. Phalen, and A. Schmidt in the data management and commercial statistics section provided useful products for our data requests. We especially thank S. Winslow and M. Wolff for their constructive review and comments on the manuscript. We are appreciative of the skills of K. Winslow who typed the manuscript and D. Willis who helped type and organize the final drafts of this report. Finally, we are grateful to the many commercial fish dealers and commercial and recreational fishermen who allowed us to sample their catches.

LITERATURE CITED

Atlantic States Marine Fisheries Commission (ASMFC).
1990. Source document for the supplement to the Striped Bass Fisheries Management Plan - Amendment #4. Versar Inc., Columbia, MD.

Harriss, R.C., Jr., B.L. Burns, and H.B. Johnson.
1985. An investigation of size, age, and sex of North Carolina striped bass. Comp. Rep. Proj. AFC-18. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., 136 p.

Hassler, W.W., H.S. Hill, and J.T. Brown.
1981. Status and abundance of striped bass, *Morone saxatilis*, in the Roanoke River and Albemarle Sound, NC, 1956-1980. Spec. Sci. Rep. No. 38, NC Dept. Nat. Resour., and Community Develop., Div. Mar. Fish., 156 p.

Hassler, W.W. and S.D. Taylor.
1986. Status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1984. Dept. Zool., NCSU, Raleigh, 47 p.

Hawkins, J.H.
1979. Anadromous fisheries research program - Neuse River. Compl. Rep., Proj. AFCS 13-2. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., 67 p. + Append.

Hawkins, J.H.
1980. Investigations of anadromous fishes of the Neuse River, North Carolina. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., Spec. Scie. Rep. No. 34, 111 p.

Henry, L.T., S.D. Taylor, and S.E. Winslow.
1992a. North Carolina Striped Bass, Final Rep. Proj. AFS-26-2-6, NC Dept. Environ., Health, and Nat. Resour., Div. Mar. Fish., Morehead City, NC 60.p

Henry, L.T., H.C. Hardy, and S.D. Taylor.
1992b. Fishery independent gill net surveys for Albemarle Sound striped bass: A characterization of the Albemarle/Roanoke population. Report to the North Carolina Striped Bass Study Management Board, Work Order No. 91-1. NC Dept. Environ., Health, and Nat. Resour., Div. Mar. Fish. Morehead City, NC, 32 p. + Append.

Johnson, H.B., B.F. Holland, Jr., and S.G. Keefe.
1977. Anadromous fisheries research program, northern coastal area. Compl. Rep., Proj. AFCS-11. NC Dept. Nat. Resour. Community Develop., Div. Mar. Fish., 138 p.

Ketchen, J.S.
1950. Stratified subsampling for determining age distribution. Trans. Am. Fish. Soc. 79: 205-212.

Marshall, M.D.
1976. Anadromous fisheries research program - Tar River, Pamlico River, and northern Pamlico Sound. Compl. Rep., Proj. AFCS-10, NC Dept. Nat. Econ. Resour., Div. Mar. Fish., 90 p.

NC Striped Bass Study Management Board.
1991. Report on the Albemarle Sound-Roanoke River stock of striped bass. NC Striped Bass Study Management Board, U.S. Fish and Wildlife Service, Atlanta, GA. 56 p + appendices.

Olsen, E.J., and R.A. Rulifson.
1991. Maturation and fecundity of Roanoke River/Albemarle Sound striped bass (*Morone saxatilis*). Work Order No. 90-02, N.C. Striped Bass Res. Mgmt. Bd. ECU, Inst. for Coast. and Mar. Res., Greenville, NC, 39 p.

Rulifson, R.A., and C.S. Manooch, III (eds.).
1991 Roanoke River Water Flow Committee Report for 1990. NOAA Technical Memorandum NMFS-SEFC-291, 433 p.

Sholar, T.M.
1977. Anadromous fisheries research program, Cape Fear River System, Phase I. Prog. Rep. Proj. AFCS-12. NC Dept. Nat. Econ. Resour., Div. Mar. Fish., 60 p.

Street, M.W., P. P. Pate, Jr., B.F. Holland, and A.B. Powell.
1975. Anadromous fisheries research program, northern coastal region, North Carolina Compl. Rep. Proj. AFCS-8, NC Dept. Nat. Econ. Resour., Div. Mar. Fish., 210 p.

Sykes, J.E.
1958. A method of determining the sex of the striped bass *Roccus saxatilis* (Walbaum). Trans. Am. Fish. Soc. 87: 104-107.

Taylor, S.D. and H.C. Hardy.
1993. North Carolina Striped Bass (September 1991-August 1992), Annual Report, Project AFS-26, Segment 7, NC Dept. Environ., Health and Nat. Resour., Div. Mar. Fish., Morehead City, NC, 55 p.

Winslow, S.E., and H.B. Johnson.
1984. North Carolina coastal striped bass stocking. Report given at meeting of Northeastern Div. Am. Fish. Soc. 1984. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., 74 p.

Winslow, S.E., S.C. Mozley, and R.A. Rulifson.
1985. North Carolina anadromous fisheries. Compl. Rep., Proj. AFCS-22, NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., 207 p.

Winslow, S.E., N.S. Sanderlin, G.W. Judy, J.H. Hawkins, B.F. Holland, Jr., C.A. Fischer, and R.A. Rulifson.
1983. North Carolina anadromous fisheries management program. Compl. Rep., Proj. AFCS-17. NC Dept. Nat. Resour. and Community Develop., Div. Mar. Fish., 402 p.

NOAA COASTAL SERVICES CENTER LIBRARY
3 6668 14101 3088