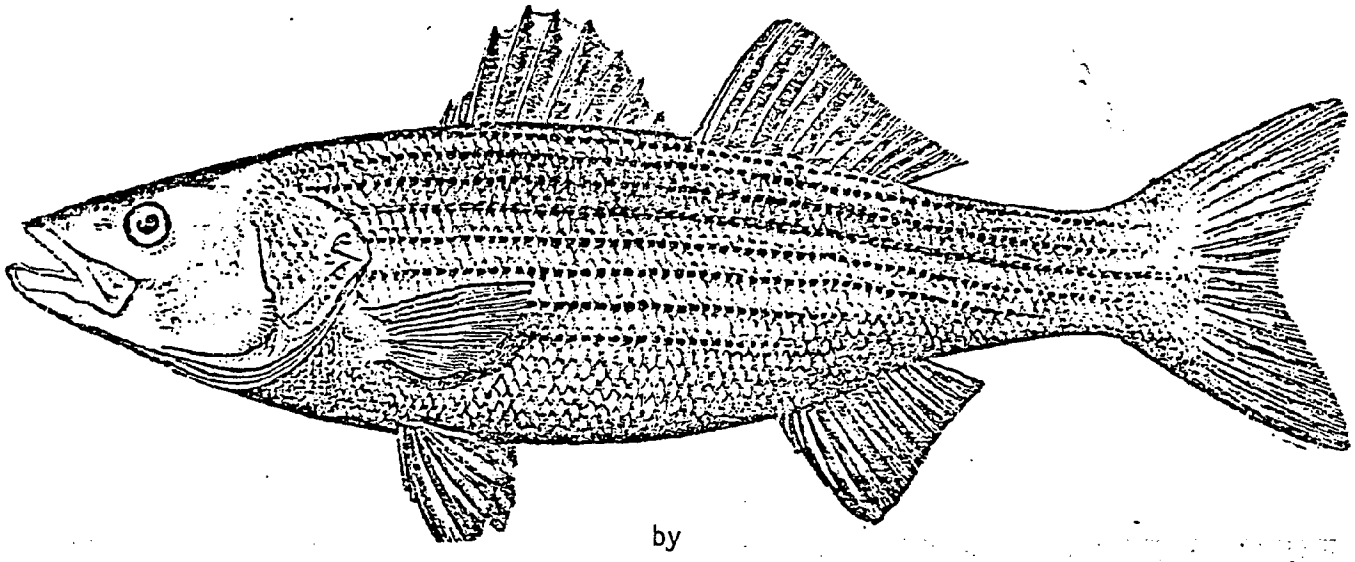
THE STATUS AND ABUNDANCE OF STRIPED BASS, MORONE SAXATILIS, IN THE ROANOKE RIVER AND ALBEMARLE SOUND, NORTH CAROLINA, 1977-1981



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ABSTRACT

Several aspects of the life history and fisheries for striped bass, Morone saxatilis, were investigated during 1977-81 in Roanoke River and Albemarle Sound, North Carolina. Commercial and recreational harvests declined sharply to extremely low levels. Estimated egg production during 1981 was the lowest on record. Egg viability was extremely low during 1977-80, but improved in 1981. Juvenile abundance declined to the lowest level on record in 1981. The number of fish tagged declined during the study period as did the exploitation rate. Estimates of the spawning population, based on the tagging work, were the lowest on record during 1980 and 1981.

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INTRODUCTION

The Roanoke River is a major coastal stream of North Carolina. It originates in Virginia on the eastern slopes of the Appalachian Ridge, traverses the rolling Piedmont Plateau, descends the Atlantic Coastal Plain and discharges into Albemarle Sound through several channels (Figure 1). A descent of 2,900 feet occurs in the 410 miles from the headwaters to the estuary. The drainage basin of the Roanoke covers approximately 9,600 square miles, of which two-thirds are in Virginia and one-third in North Carolina. The average annual discharge of the Roanoke River at Weldon, North Carolina is approximately 8,500 cubic feet per second. Carnes (1965) presented a general description of the chemical, physical, and biological features of the Roanoke River Basin.

Albemarle Sound is a shallow coastal estuary which extends about 60 mi in an east-west direction from the mouth of the Roanoke River. It averages about 7 mi in width (range 3.5 to 15 mi), and its area is about 500 square miles. Eight rivers drain into Albemarle Sound, which empties into the Atlantic Ocean via Oregon Inlet. Salinities vary from 0 parts per thousand (ppt) in the western end to approximately 10 ppt at the eastern extremity.

Hydroelectric Impoundments

The record flood which occurred in 1940 instigated the construction of hydroelectric impoundments on the Roanoke River by the Corps of Engineers, U. S. Army and the Virginia Electric and Power Company. The John H. Kerr Dam was completed in 1952 at river mile 179.5. It is a multipurpose impoundment for flood control and hydroelectric power and covers an area of about 49,000 acres at normal elevation. The Gaston Dam was constructed downstream (river mile 145.5) from the John H. Kerr Dam. It was completed in 1963 and serves primarily for hydroelectric power. It has a surface area of 20,300 acres. The Roanoke Rapids Dam, located at river mile 137.5, was completed in 1955. It impounds approximately 4,900 acres (Figure 1).

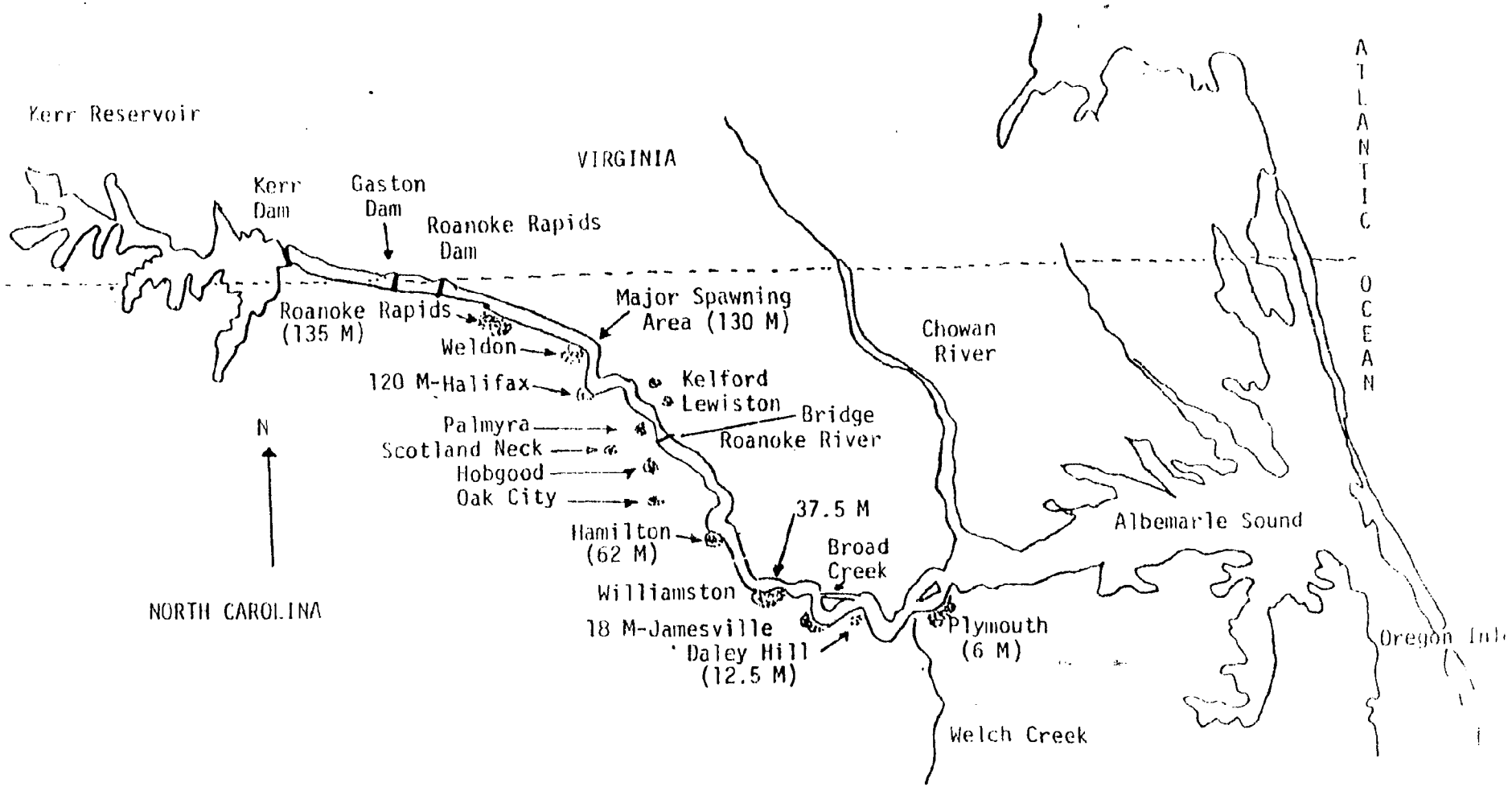

Figure 1. Map of the Roanoke River and Albemarle Sound, N. C.

The waters of the Roanoke River serve three major users--hydroelectric power, industrial, and fisheries, both sport and commercial. Other important users include agriculture, lumbering, transportation, and recreation.

The conflicting uses of the Roanoke River necessitated the formation of a Steering Committee for Roanoke River Studies in 1955. This organization, composed of state , federal, and private agencies and interests, made a comprehensive study of the river in order to adjudicate conflicting interests and maintain river conditions to permit multiple use. The results of this study were presented in detail by Fish (1959).

The cooperative Roanoke-Albemarle Striped Bass Studies originated in 1955 as part of the Steering Committee studies. Our studies were originally supported by the National Council for Stream Improvement, Weyerhaeuser Company, and Albemarle Paper Manufacturing Company. The Steering Committee Studies were terminated in 1958, but the Weyerhaeuser Company continued its support in an endeavor to be a concerned and responsible corporate neighbor. However, cooperative field work was resumed in 1975 with the U. S. Fish and Wildlife Service and the North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, under the Anadromous Fish Act (PL 89-304).

These studies have been conducted annually since 1955 to provide long term information on the status and abundance of the striped bass which is the most valuable sport and commercial fish in the Roanoke River and Albemarle Sound. This annual study provides a continuing source of data on the status of the striped bass population. The data are utilized by state agencies for current management information and decisions.

The long term objectives of the striped bass studies are as follows: (1) to determine the striped bass catch and rate of exploitation by commercial fishermen; (2) to determine the catch and rate of exploitation by sport fishermen; (3) to record the prevailing ecological conditions during the spawning season in the Weldon area; (4) to collect striped bass eggs during the spawning season in order to estimate the number of eggs spawned and the viability of the eggs; (5) to estimate the size of the spawning population; (6) to detect changes in the size of the spawning population; (7) to determine the ecological conditions prevailing in Albemarle Sound when the striped bass larvae reach the estuary; (8) to make periodic

trawl collections in Albemarle Sound during the summer and fall to determine the relative abundance and growth of striped bass young-of-year; (9) to detect variations in recruitment of striped bass in the Albemarle Sound population; (10) to observe and recommend fishery management practices which might provide the best sustained yield for the present and future purposes; and (11) to develop methods of predicting future commercial catches.

The data acquired during these studies have been available to graduate students for special problems and thesis material and also to biologists in other areas.

This report was prepared in compliance with the agreement for Project AFS-14 funded, in part, by the Fish and Wildlife Service, U. S. Department of Interior under the Anadromous Fish Conservation Act, PL-89-304 (as amended). Additional funding was provided by the Weyerhaeuser Company.

COMMERCIAL FISHING

Commercial Catch of Striped Bass in North Carolina

The commercial fish landings in North Carolina have been recorded since 1887 by various federal agencies, including the U. S. Fish Commission, the U. S. Bureau of Commercial Fisheries, and the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration. Since 1978, data have been collected by the North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries in cooperation with NMFS. In 1980 the North Carolina Division of Marine Fisheries took over the publication of these data.

From 1967 to 1976 the commercial striped bass catch exceeded 1,000,000 pounds annually. The peak year was 1970, and a total of 2,318,000 pounds was landed during that year. However, by 1977 the commercial striped bass landings had declined to approximately 572,000 pounds, and decreased landings were reported for the five consecutive years extending from 1977 through 1981. These data are listed in Table 1.

Decreased striped bass landings have been reported throughout the United States since the mid 1970's, and this decline is generally attributed to long-term cyclic fluctuations and short-term meterological conditions. These reduced catches have instigated considerable criticisms of striped bass management policies from

Table 1. Commercial catch and monetary value of striped bass in North Carolina, 1977-1981

Year	Quantity in Pounds x 1000	Value in dollars x 1000
1977	572	405
1978	698	623
1979	614	577
1980	473	435
1981	417	452

commercial fishermen and sport fishermen. However, in my opinion the advent of favorable meterological conditions should result in a gradual improvement in striped bass catches.

The monthly commercial catch records for striped bass for the years 1977, 1978, 1979, 1980, and 1981 are tabulated in Table 2. The most productive month for commercial striped bass was March with a cumulative total of 541,220 pounds. February accounted for 398,764 pounds, while November landings totalled 380,813 pounds. Generally, the striped bass landings for this 5-year period were in excess of 200,000 pounds for the months extending from October through April. May and September were in excess of 100,000 pounds, and the summer months of June, July, and August were less than 100,000 pounds. Generally, the cool and cold weather months predominated the striped bass commercial landings.

Commercial Catch of Striped Bass in the Roanoke River

Commercial fishing extends 102 miles from the mouth of the Roanoke River upstream to the Scotland Neck bridge (Figure 1). Striped bass are caught by various types of commercial gear which include anchor gill nets, "rock" drift gill nets (drift gill nets designed to catch striped bass), trotlines, fishing machines or wheels, hoop and fyke nets, rod and reel, and haul seines. A small number of striped bass are captured in herring nets and perch traps.

A complete census of the striped bass commercial fishery in the Roanoke River has been conducted by the Roanoke-Albemarle Project personnel since 1958. Each commercial fisherman was contacted prior to the fishing season and the commercial creel census was discussed with him. A log book was given to each fisherman to record the daily catch and effort for striped bass. During the season field biologists contacted each fisherman weekly to obtain the records. Some of the more active commercial fishermen are contacted daily. Also, the field biologists maintained records for other fishermen in the operation of a striped bass tagging program. Additional records are obtained from daily receipts of commercial fishermen and from fish houses in the area. The most complete records were obtained from the more experienced and successful fishermen. Records were not received with much accuracy from some intermittent and irregular commercial fishermen. However, the striped bass catch of these individuals constituted a negligible percentage. A local fisherman

Table 2. Commercial catch of striped bass in North Carolina, 1977-1981, by months, quantity in pounds

	Year					
Month	1977	1978	1979	1980	1981	Total
January	49,291	58,515	47,179	34,339	34,446	223,770
February	47,500	185,743	82,779	48,949	33,793	398,764
March	63,713	141,487	246,854	44,848	44,318	541,220
April	32,886	79,667	63,777	27,248	29,746	233,324
May	22,182	22,509	32,446	17,399	18,949	113,485
June	18,395	12,316	11,293	12,027	15,807	69,838
July	6,165	9,058	5,148	14,955	11,581	46,907
August	13,841	8,170	4,610	15,819	13,749	56,189
September	22,243	17,007	13,480	26,839	42,170	121,739
October	62,912	73,652	41,750	85,291	80,268	343,873
November	118,631	57,231	33,399	102,250	69,302	380,813
December	113,892	32,507	31,469	42,539	23,195	243,602
Total	571,651	697,862	614,184	472,503	417,324	2,773,524

was also employed to maintain records of the catches of "sport-commercial" fishermen who fish mainly weekends and at night. This group has competed for fishing areas with the traditional resident commercial fishermen, and some conflict has ensued from the competitive and crowded conditions.

Declining striped bass populations in recent years (1977-1980) necessitated a review of commercial fishing methods employed in the Roanoke River during the striped bass spawning run. The North Carolina Marine Fisheries Commission conducted public hearings during the winter of 1980-1981 and amended the fisheries regulations for the Roanoke, Cashie, Middle, and Eastmost Rivers as follows:

(1) No fixed or stationary gill net of any size shall be used during the period April 1 to May 31 from the mouth of the Roanoke River to Highway 258 bridge.

(2) No drift gill net with a mesh length of less than two and one-fourth inches or greater than three inches stretch mesh shall be used during the period April 1 to May 31 from the mouth of the Roanoke River to Highway 258 bridge.

Also, the North Carolina Wildlife Resources Commission was instrumental in the rescinding of a local regulation permitting the use of special devices such as drift bow nets and fight bow nets in the Weldon area of the Roanoke River.

The commercial striped bass catch in the Roanoke River is recorded by number and weight for 1977, 1978, 1979, 1980, and 1981 in Table 3. These data indicate an acceptable decline in catches for 1977, 1978 and 1979 but a sharp decline occurred in 1980. A precipitous drop occurred in 1981, but this was the result of the ban on set gill nets for striped bass. It is also necessary to point out that the highest total of 16,253 striped bass was caught in a high water year. The sharp decline to 2,286 striped bass occurred in 1980 which was one of the lowest years on record in respect to river flow during the spring spawning run.

Examination of the data presented in Table 4 shows that anchor gill nets were the most proficient gear in catching striped bass, with a total catch of 29,450 fish over the 5-year period, 1977-1981. This gear caught the highest total of striped bass

Table 3. Commercial catch of striped bass by number and weight (lbs), Roanoke River, N. C., 1977-1981

Year	Number caught	Total weight in pounds
1977	10,465	36,620
1978	16,253	56,886
1979	9,798	34,293
1980	2,286	8,001
1981	349	1,468

in the Roanoke River in 1978 when 12,085 fish were taken. This peak catch declined to 8,511 striped bass in 1979, and the fishery was severely curtailed in 1980 when anchor gill nets captured only 1,935 striped bass. However, fishing conditions in the Roanoke River were very poor during 1980 because of a prolonged drought and consequent low river flows.

The 1981 striped bass commercial catches were completely curtailed in 1981 by the ban on anchor gill nets. However, low water levels limited the catch from the use of other gear.

Roanoke River striped bass catch and effort data are presented in Table 5 by gear for the years 1977-1981. The greatest effort was expended by hoop net fishermen with a total of 17,339 net days. However, this gear is very inefficient in catching striped bass,and only 290 fish were caught despite the effort expended. The second largest effort was expended by anchor gill nets with 15,600 net days, and a capture of 29,450 fish. Again, we mention that the anchor gill net has been banned by regulation commencing in the 1981 season. Herring-drift gill nets are used considerably on the Roanoke River,but this gear catches few striped bass. An effort of 3,684 net days over the 5-year period caught only 211 striped bass. Drift gill nets for striped bass (now banned) caught the most striped bass in relation to effort with a total of 6,911 striped bass caught during 1,066 net days. However, the use of this gear is governed closely by river flow conditions. Trotlines, fishing machines, rod and reel, and herring-set gill nets account for lesser numbers of striped bass.

Table 4. Roanoke River commercial catch of striped bass by gear, 1977-1981

Year	Anchor gill net	Drift gill net	Trotline	Hoop net	Fishing machine	Rod & reel	Herring set gill net	Herring drift gill net	Total catch
1977	6,597	3,134	59	155	220	164	-	136	10,465
1978	12,085	3,278	4	48	698	94	14	32	16,253
1979	8,511	433	3	81	571	142	20	37	9,798
1980	1,935	66	0	5	138	138	0	4	2,286
1981	322	0	9	1	14	0	1	2	349
Total	29,450	6,911	75	290	1,641	538	35	211	39,151

Table 5. Roanoke River commercial catch of striped bass by gear and effort, 1977-1981

Year	Anchor gill net		Drift gill net		Trotline		Hoop net		Fishing machine		Rod & reel		Herring-set gill net		Herring-drift gill net	
	Fish	Days	Fish	Days	Fish	Days	Fish	Days	Fish	Days	Fish	Days	Fish	Days	Fish	Days
1977	6,597	2,615	3,134	359	59	345	155	4,374	220	148	164	104	-	-	136	908
1978	12,085	4,241	3,278	433	4	17	48	3,623	698	136	94	79	14	266	32	1,007
1979	8,511	6,112	433	210	3	70	81	2,019	571	148	142	79	20	371	37	1,008
1980	1,935	2,441	66	64	0	0	5	430	138	95	138	63	0	56	4	83
1981	322	191	0	0	9	188	1	6,893	14	30	0	0	1	42	2	678
Total	29,450	15,600	6,911	1,066	75	620	290	17,339	1,641	557	538	325	35	735	211	3,684
C.U.E.	1.89		6.48		0.12		0.02		2.95		1.66		0.05		0.06	
Percent of Total Catch	75.22		17.65		0.19		0.74		4.19		1.37		0.09		0.54	

The 1977-1981 commercial catch of striped bass from the Roanoke River is listed by weeks in Table 6. The five-week period from April 1 to May 5 accounted for approximately 77% of the season's catch. The season extends over a 16-week span, but the majority of landings are concentrated over a 5-7-week period.

The commercial catch of striped bass by location along the Roanoke River is presented in Table 7 for the years 1977-1981. These data show that the commercial fishery is (was) concentrated in the Jamesville and Williamston areas where 92.42% of the striped bass were landed.

The catch per unit effort of striped bass by various commercial methods in the Roanoke River is tabulated in Table 8 for the years 1977-1981. These data indicate the most efficient gear is drift gill nets with a catch of 6.48 striped bass per unit effort. The second most efficient is the fishing machine which lands 2.95 striped bass per gear day but is limited in effort by river conditions. The anchor gill net lands 1.89 fish per net day, rod and reel lands 1.66 striped bass per unit effort, and the catches by trotlines, hoop nets, and herring nets (drift and set) are all negligible.

Commercial Catch of Striped Bass in Albemarle Sound

The commercial catch of striped bass in Albemarle Sound is presented in Table 9. These data indicate a considerable decline in striped bass landings in 1977 and subsequent years. The previous striped bass landings for 1975 and 1976 were 625,005 and 610,385 pounds, respectively. The five-year (1977-1981) commercial catch of striped bass is the lowest for any similar period over the past 22 years.

Table 6. Commercial catch of striped bass by weekly intervals, 1977-1981

Weeks	Number striped bass caught — Year 1977	1978	1979	1980	1981	Total catch	Percent of total catch
Prior to March 25	396	89	70	2	1	558	1.43
March 25-31	1,245	137	269	13	4	1,668	4.26
April 1-7	2,243	1,099	751	78	30	4,201	10.73
April 8-14	2,439	3,232	1,666	353	105	7,795	19.91
April 15-21	1,757	3,389	1,898	385	145	7,574	19.35
April 22-28	1,054	2,333	2,445	553	45	6,430	16.42
April 29-May 5	642	1,555	1,412	340	1	3,950	10.09
May 6-12	328	1,134	757	322	14	2,555	6.53
May 13-19	208	871	337	196	3	1,615	4.13
May 20-26	117	625	136	44	1	923	2.36
May 27-June 2	30	518	52	-	-	600	1.53
June 3-9	6	454	5	-	-	465	1.19
June 10-16	-	374	-	-	-	374	0.96
June 17-23	-	275	-	-	-	275	0.70
June 24-30	-	140	-	-	-	140	0.36
July 1-2	-	28	-	-	-	28	0.07
Total	10,465	16,253	9,798	2,286	349	39,151	100.00
Percent of total catch	26,73	41.51	25.03	5.84	0.89		

Table 7. Roanoke River commercial catch of striped bass (in number of fish) by location, 1977-1981

Year	Plymouth Daley Hill Broad Creek	Jamesville	Williamston	Hamilton	Oak City Hobgood Palmyra Kelford Lewiston	Scotland Neck	Total
1977	538	5,900	3,519	298	85	125	10,465
1978	283	4,458	11,469	39	4	-	16,253
1979	1,057	1,375	6,957	409	-	-	9,798
1980	83	147	2,007	49	-	-	2,286
1981	0	1	348	0	0	0	349
Total	1,961	11,881	24,300	795	89	125	39,151
Percent of total catch	5.00	30.35	62.07	2.03	0.23	0.32	100.00

Table 8. Catch per unit effort for striped bass caught by commercial gear on the Roanoke River, 1977-1981

Year	Anchor gill net	Drift gill net	Trot-line	Hoop net	Fishing machine	Rod & reel	Herring-set gill net	Herring-drift gill net
1977	2.52	8.73	0.17	0.04	1.49	1.58	-	0.15
1978	2.85	7.57	0.24	0.01	5.13	1.19	0.05	0.03
1979	1.39	2.06	0.04	0.04	3.86	1.80	0.05	0.04
1980	0.79	1.03	0.00	0.01	1.45	2.19	0.00	0.05
1981	1.69	0.00	0.05	0.0001	0.47	0.00	0.02	0.003
Weighted mean	1.89	6.48	0.12	0.02	2.95	1.66	0.05	0.06

Table 9. Commercial landings of striped bass from the Albemarle Sound area, 1977-1981 *

Year	Landings (lb)
1977	422,144
1978	475,913
1979	243,744
1980	376,510
1981	333,484

* - From National Marine Fisheries Service and North Carolina Division of Marine Fisheries.

SPORT FISHING

Sport fishing for striped bass in the Roanoke River occurs over a 140-mile area from the mouth of the river to the Roanoke Rapids dam. The Weldon area is the most popular site for striped bass anglers. Consequently, our creel census effort is concentrated in the Weldon area, although catch records are maintained for the entire 140-mile stretch. We strive to collect complete creel census data at Weldon during the spawning season and maintain personnel at the access site approximately 18 hours per day.

The striped bass catch and effort for rod and reel fishermen in the Weldon area of the Roanoke River, 1977-1981, is presented in Table 10. These data show that the most fish were caught in 1977 and 1979 with 10,898 and 11,126 striped bass respectively. The catch per unit effort for these years of 3.98 and 3.16 striped bass were also the highest achieved during the five-year period. It should be stressed that 1977 and 1979 were years of more normal river flows. High river discharges occurred during the spawning season in 1978, and record low flows occurred in 1980 and 1981. A similar striped bass catch distribution also occurred in 1977 and 1979 for bow nets (drifting) when a total of 2,054 and 835 fish were taken respectively (Table 11). Again river flows disrupted the fishing in 1978 (high water) and in 1980 (low water), and bow netting was banned in 1981.

The striped bass bow net catch from "fights" is listed in Table 12. These data show that the most striped bass were landed by this method in 1977 (8,769). In second place was 1979 (5,957), and 1980 ranked third (5,451). The fewest fish were caught in 1978 (1,051) when high water releases interferred with this type of fishing. In 1981 the regulation banning bow netting precluded the catch of striped bass. It should be noted that the catch of striped bass did not decline appreciably in 1980 (a low water year) since this type of fishing harvests the fish at the surface while spawning, when they are easily exploited.

The estimated sport catch and effort for all areas of the Roanoke River is presented in Table 13. These data show the decline in sport catch and effort from 1977 (10,074 trips and 32,983 striped bass) to 1981 (2,706 trips and 3,905 fish caught). The 1981 decline in the size of the spawning run of striped bass was aggravated by the low water flow during the migratory period. The 1981 sport catch of 3,905 striped bass was the lowest recorded during the 26-year tenure of the study.

Table 10. Catch and effort data for striped bass caught by rod and reel fishery in the Weldon area of the Roanoke River, 1977-1981

Year	Boat days	Total catch	C.U.E. ± S.E.
1977	2,739	10,898	3.98 ± 0.11
1978	1,450	3,500	2.41 ± 0.14
1979	3,525	11,126	3.16 ± 0.11
1980	2,518	7,279	2.89 ± 0.18
1981	2,128	3,427	1.61 ± 0.11
Total	12,360	36,230	2.93

Table 11. Catch and effort data for striped bass caught by bow nets (drifting) in the Roanoke River, N. C., 1977-1981

Year	No. boats	No. nets	No. fishermen	Total catch	Mean no. fish/boat ± S.E.	$\Sigma\chi^2$
1977	253	257	483	2,054	8.12 ± 0.76	53,134
1978	83	83	173	286	3.45 ± 0.63	3,582
1979	190	190	383	835	4.39 ± 0.46	11,111
1980	85	85	170	415	4.88 ± 0.66	5,217
1981	No bow nets allowed in the Weldon area in 1981					
Total	611	615	1,209	3,590	5.88	

Table 12. Catch and effort data for striped bass caught by bow nets (fight) in the Roanoke River, N. C., 1977-1981

Year	No. boats	No. nets	No. fishermen	Total catch	Mean no. fish/boat ± S.E.	$\Sigma\chi^2$
1977	986	987	2,028	8,769	8.89 ± 0.56	384,537
1978	328	328	690	1,051	3.20 ± 0.42	22,499
1979	719	720	1,404	5,957	8.29 ± 0.57	215,807
1980	437	437		5,451	5.90 ± 0.71	463,725
1981	No bow nets allowed in the Weldon area in 1981					
Total	2,470	2,472	4,122	21,228	8.59	

Table 13. Estimated sport catch and effort of striped bass in the Roanoke River, N. C. 1977-1981

Year	No. fishing units	No. striped bass	C.U.E.
1977	10,074	32,983	3.27
1978	10,161	28,016	2.76
1979	9,048	29,419	3.25
1980	4,189	15,239	3.64
1981	2,706	3,905	1.44
Total	36,178	109,562	3.03

QUANTITATIVE SAMPLING OF STRIPED BASS EGGS

The Roanoke-Albemarle project striped bass egg sampling station was located at Barnhill's Landing from 1977 through 1981. Barnhill's Landing is located approximately nine miles downstream from the major spawning grounds at Weldon, North Carolina. Some striped bass spawning occurs below the sampling station, but it is relatively insignificant.

The river's contour at Barnhill's Landing was surveyed, and a nomagraph was drawn indicating the cross-sectional area in square feet of the river for each river stage. A river stage gauge was constructed at the sampling station.

The samples were taken by a standard 10-inch net from each side of the stern of a small aluminum outboard motorboat. The nets were adjusted according to river flow to remain approximately six inches under the surface. Five-minute samples were collected eight times daily at three-hour intervals. The river stage, surface water temperature, and air temperature were recorded as each sample was taken. The number of striped bass eggs collected by each net was counted, the number of non-viable eggs determined, and the stage determined for the viable eggs. For each day the estimated number of eggs spawned was calculated by using the following equation:

$$N = 514.29\ XY$$

where N = estimated number of eggs spawned in 24-hour period

X = average number of eggs collected per net during 24-hour period

Y = cross-sectional area of river for average river stage during 24-hour period,

and 514.29 = constant for 10-inch net.

The annual striped bass egg sampling program commences at the first significant indication of spawning and continues until it is virtually negligible.

The estimated number of striped bass eggs spawned annually in the Roanoke River for the period 1977-1981 is tabulated in Table 14. These data show a continual decline in the number of eggs spawned, and this decline is the most acute ever recorded during the past 20 years. This decrease in the total number of eggs spawned is attributed to the reduction in number of spawners, decreased egg viability (1977-1981) and low river flows in 1980 and 1981.

Table 14. Estimated number of striped bass eggs spawned in the Roanoke River, N. C., 1977-1981

Year	Estimated number of striped bass eggs spawned
1977	1,775,957,318
1978	1,691,227,585
1979	1,613,382,382
1980	870,322,832
1981	344,364,065

Viability of Striped Bass Eggs

The viability of the striped bass eggs is determined immediately following collection of each sample. Non-viable eggs have been classified into the following categories:

1. Milky-white and opaque
2. Yolk disintegrated and perivitellene space cloudy
3. Yolk disintegrated and perivitellene space clear
4. Yolk and oil globule disintegrated
5. Oil globule broken or disintegrated
6. Embryo disintegrated
7. Post larvae dead upon collection
8. Embryo normal but yolk subnormal in size
9. Embryo abnormal

Striped bass egg viability was determined over the five-year period from 1977 to 1981. These data are presented in Table 15. These data indicate that striped bass egg viability, which first declined in 1975 (55.69%) and 1976 (50.73%) reached its lowest point in 1978 (37.72%). The viability continued poor in 1979 and 1980 with 43.62 and 43.39% respectively. However, a resurgence in viability occurred in 1981 with an increase to 73.70%.

Table 15. Striped bass egg viability during the spawning season in the Roanoke River, N. C., 1977-1981

Year	Number of non-viable eggs	Number of viable eggs	Percent viable eggs
1977	6,332	7,061	52.72
1978	2,942	1,782	37.72
1979	4,448	3,442	43.62
1980	3,025	2,319	43.39
1981	911	2,554	73.70
Total	17,658	17,158	49.28

The striped bass egg viability as related to water temperatures is tabulated in Table 16. These data indicate a considerable range of temperatures with similar viabilities and are not in agreement with previous Roanoke River studies showing optimum egg viabilities in the 17-20° C range.

Table 16. Striped bass spawning and egg viability related to water temperature during spawning season, Roanoke River, N. C., 1977-1981

Temperature Range °C	Number of non-viable eggs	Number of viable eggs	Percent viable eggs
10.3-11.9	1	0	0.00
12.0-13.6	98	53	35.09
13.7-15.3	1,736	1,138	39.60
15.4-17.0	7,465	6,158	45.21
17.1-18.7	3,826	4,385	53.40
18.8-20.4	3,516	4,414	55.66
20.5-22.1	761	743	49.40
22.2-23.8	255	267	51.15
Total	17,658	17,158	49.28

SAMPLING OF YOUNG-OF-YEAR STRIPED BASS IN ALBEMARLE SOUND

Annual sampling to determine the survival and relative abundance of young-of-year striped bass has been conducted in Albemarle Sound from 1955 to 1981. The sampling area is located in western Albemarle Sound extending eastward approximately 12 miles. Seven permanent sampling stations have been selected and demarcated by some fixed land feature. These locations are as follows:

Station No. 1 - Black Walnut Point
Station No. 2 - East of Edenton Bay
Station No. 3 - North side between bridges
Station No. 4 - North side east of N. C. 32 bridge
Station No. 5 - South side east of N. C. 32 bridge
Station No. 6 - South side between bridges
Station No. 7 - Albemarle Beach

The sampling area and station locations are illustrated in Figure 2.

A 5.49 m balloon trawl is used to collect the samples. The samples collected early in the sampling period are taken with a 6.35 mm stretched mesh cod end, while later samples are collected with a 12.7 mm stretched mesh cod end. Each trawl sample is of 15 minutes duration at a towing speed of approximately 2.75 mi per hour. The trawling depth varies between 6 and 10 feet. Wind direction and velocity, depth, air and water temperatures, and the time started and stopped are recorded for each sample. All striped bass are retained for growth information. Other species captured are identified, counted, measured (a sub-sample of 30 if the total number exceeds that), and released.

The mean number of young-of-year striped bass per 15-minute trawl in Albemarle Sound is listed by year (1977-1981) and station in Table 17. These data show that there has been a severe decline in the number of young-of-year striped bass collected over the 1977-1981 time period. Previously, in 1975 and 1976 the mean catches of 10.80 and 10.52 specimens per trawl were considered average in abundance. The drop to 3.63 young-of-year striped bass per trawl in 1977 indicates below average recruitment for this year class. The next four years, 1978, 1979, 1980, and 1981 have been the

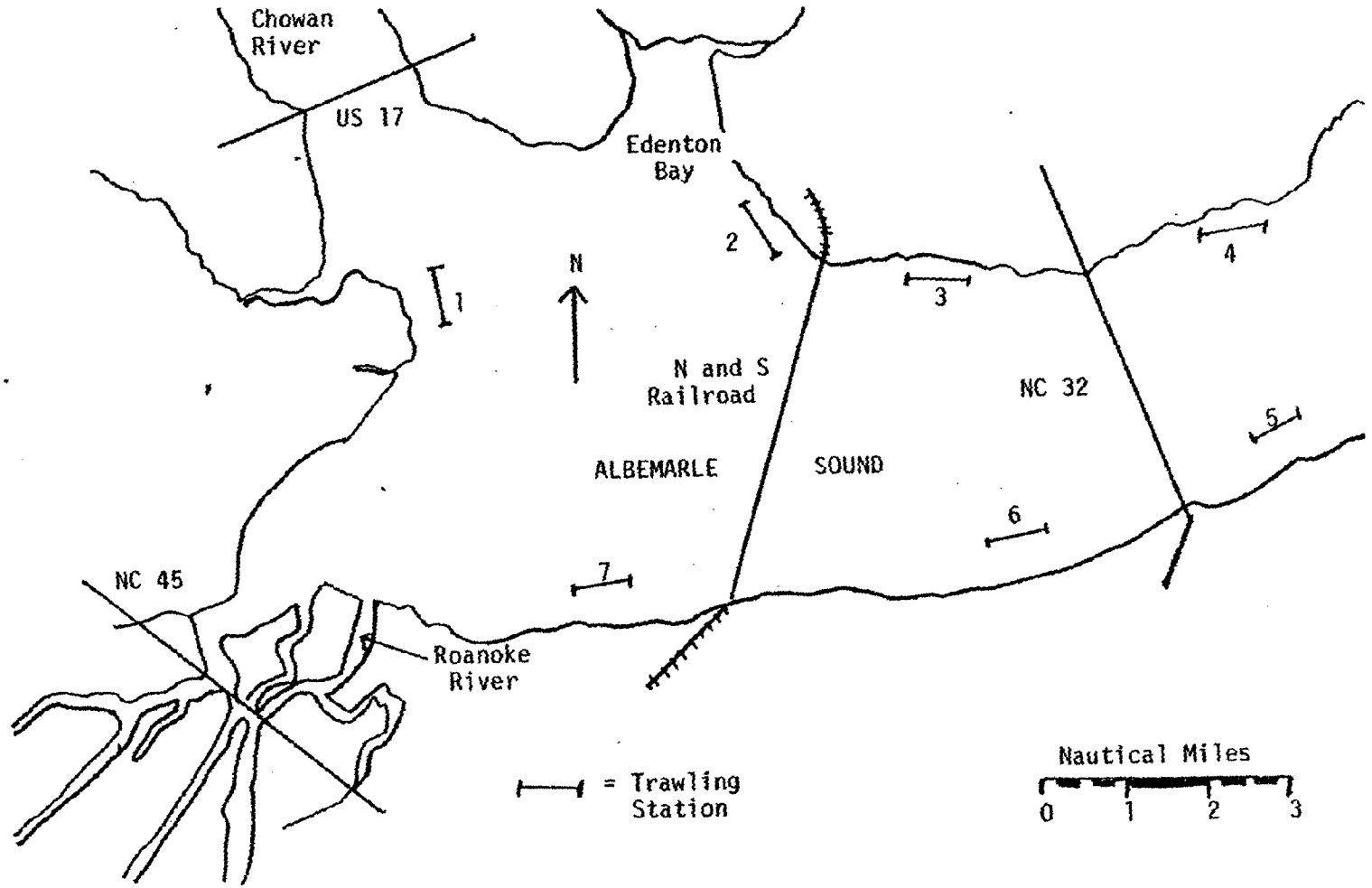

Figure 2. Map of the sampling area and station locations for young-of-year striped bass in the western end of Albemarle Sound, N. C.

Table 17. Mean number of young-of-year striped bass caught per 15-minute trawl by year and station in Albemarle Sound, N. C., 1977-1981

Year	Station							Total
	I	II	III	IV	V	VI	VII	
1977	5.62	2.38	4.50	0.43	4.43	4.50	3.25	3.63
1978	0.25	1.88	0.75	0.29	0.00	0.25	0.62	0.59
1979	0.57	2.29	0.00	0.29	0.14	0.00	0.57	0.55
1980	1.63	0.75	0.38	0.00	0.00	0.38	0.50	0.46
1981	0.00	0.04	0.00	0.04	0.00	0.00	0.02	0.09
Mean	0.24	0.22	0.17	0.03	0.12	0.14	0.14	1.06

poorest four-year span of recruitment recorded over the 27-year duration of the project. These four years (1978-1981) averaged 0.59, 0.55, 0.46, and 0.09 young-of-year striped bass per trawl. The only other year in which the mean number of young-of-year striped bass occurred in this low range was 1958 when the mean number per trawl was 0.15. This low level of recruitment in 1958 was attributed to a very high rate of river discharge which persisted throughout the entire spawning season.

The data in Table 17 also indicate that Stations I and II were the most productive areas from 1977 to 1981 for the collection of young-of-year striped bass. Station I (Black Walnut Point) has been the most productive trawling station for young-of-year striped bass throughout the duration of the project. Since this station is located at the mouth of the Chowan River, the influence of the discharge from this river on young-of-year striped bass should be investigated.

Trawl Data for Other Species Collected with Striped Bass in Albemarle Sound

In Table 18 the number of fishes collected by bottom trawl in Albemarle Sound, N. C. are listed by species and year from 1977 through 1981. The species most commonly collected in the balloon trawl for this five-year period has been the white perch, with 32,868 specimens. The spot has ranked second in abundance with a catch of 5,463 fish while the blueback herring ranked third with a catch of 3,949 specimens. Anchovies were the fourth most abundant species with 1,658 specimens, and croakers were ranked fifth with 1,025 landed.

Table 18. Numbers of fishes collected by bottom trawl in Albemarle Sound, N. C. by species and year, 1977-1981

No. trawls	54	54	49	56	56	
Year	1977	1978	1979	1980	1981	Total
Species						
Morone saxatilis (y-o-y)	196	32	27	26	5	286
Acipenser oxyrhynchus	2			3		5
Alosa aestivalis	635	2,320	98	896		3,949
Alosa mediocris			30	16		46
Alosa pseudoharengus	278	319	130	82		809
Alosa sapidissima			63	4		67
Anchoa hepsetus					3	3
Anchoa mitchilli	325	170	48	201	914	1,658
Anguilla rostrata	20	15	7			42
Brevoortia tyrannus	7			31	4	42
Citharichthys spilopterus	1		1			2
Cyprinus carpio	4	9	5		9	27
Dorosoma cepedianum		5		2	4	11
Esox americanus americanus				2		2
Esox niger		2				2
Etheostoma nigrum		51	42	8		101
Etheostoma olmstedi	5	19				24
Eucinostomus gula	1					1
Ictalurus catus	159	142	308	64	13	686
Ictalurus furcatus			8			8
Ictalurus melas			2			2
Ictalurus nebulosus			1	1		2
Ictalurus punctatus	75	65	406	134	88	768
Lagodon rhomboides	2					2
Leiostomus xanthurus	4,238	38	242	43	902	5,463
Lepomis gibbosus		16	52	12		80
Lepomis macrochirus		16		2		18
Lepomis sp.		3				3
Micropogonias undulatus	623	70	83	11	238	1,025
Micropterus salmoides		1				1
Morone americana	3,565	12,938	8,607	4,230	3,528	32,868
Morone saxatilis (yearling)	22	5		5	5	37
Moxostoma coregonus			3			3
Moxostoma sp.	1	2				3
Mugil curema	1					1
Notropis hudsonius	16	212	232	26		486
Notropis sp.		2				2
Paralichthys lethostigma	15		4	5	17	41
Perca flavescens	51	275	429	111	12	878
Pomatomus saltatrix					1	1
Pomoxis nigromaculatus			3			3
Trinectes maculatus	219	116	287	70	15	707
Total finfish						50,165
Callinectes sapidus	485	28	73		544	1,130
Grand Total						51,295

The bottom trawl catch by species and mean number per trawl are contained in Table 19 for long-term comparisons with data collected before 1977.

Also, Table 20 lists the percentage of total catch in the balloon trawl for each species, and white perch composed 65.52% of the total fish catch. Spot accounted for 10.89% of the catch, blueback herring were 7.87%, anchovies were 3.31%, and croaker were 2.04% of the fish caught. These five species accounted for almost 90% of the total number of fish collected in the balloon trawl.

BALLOON TRAWL COLLECTIONS IN THE ROANOKE RIVER AND MIDDLE RIVER, N. C., 1978

During 1978, bottom trawling, day surface trawling, and night surface trawling were conducted in the Roanoke River and in the Middle River which is a delta tributary of the Roanoke River. A total of 98 six-minute bottom trawls were taken in the Roanoke River, and 17 six-minute bottom trawls were pulled in Middle River. These data are contained in Table 21, and confirm earlier trawling observations that young-of-year striped bass are not present in the delta river areas during the first summer of life. White perch was the most abundant species collected, and a total of 7,354 white perch were caught. The spot-tail shiner (*Notropis hudsonius)* ranked second in abundance (3,358), and the white catfish rated third in abundance, totalling 3,201 specimens.

A total of 72 day surface trawl collections were taken in the Roanoke River, and 12 day surface trawl collections were made in the Middle River. The blueback herring was the most abundant species collected (246), while spot-tail shiners (*Notropis hudsonius)* and silvery minnows (*Hybognathus nuchalis)* ranked second and third, with 135 and 122 specimens respectively (Table 22).

Twenty-four night surface trawls were taken in the Roanoke River. Alewives predominated in the catch with 338 specimens, while silvery minnows and blueback herring followed with 239 and 159 fish respectively (Table 23).

Table 19. Mean catch per trawl by species in western Albemarle Sound, 1977-1981

Year	1977	1978	1979	1980	1981
No trawls	54	54	49	56	56
Species					
Morone saxatilis (y-o-y)	3.63	0.59	0.55	0.46	0.09
Acipenser oxyrhynchus	0.04			0.05	
Alosa aestivalis	11.76	42.96	2.00	16.00	
Alosa mediocris			0.61	0.29	
Alosa pseudoharengus	5.15	5.91	2.65	1.46	
Alosa sapidissima			1.29	0.07	
Anchoa hepsetus					0.05
Anchoa mitchilli	6.02	3.15	0.98	3.59	16.32
Anguilla rostrata	0.37	0.28	0.14		
Brevoortia tyrannus	0.13			0.55	0.07
Citharichthys spilopterus	0.02		0.02		
Cyprinus carpio	0.07	0.17	0.10		0.16
Dorosoma cepedianum		0.09		0.04	0.07
Esox americanus americanus				0.04	
Esox niger		0.04			
Etheostoma nigrum		0.94	0.86	0.14	
Etheostoma olmstedi	0.09	0.35			
Eucinostomus gula	0.02				
Ictalurus catus	2.94	2.63	6.29	1.14	0.23
Ictalurus furcatus			0.16		
Ictalurus melas			0.04		
Ictalurus nebulosus			0.02	0.02	
Ictalurus punctatus	1.39	1.20	8.29	2.39	1.57
Lagodon rhomboides	0.94				
Leiostomus xanthurus	78.48	0.70	4.94	0.77	16.11
Lepomis gibbosus		0.30	1.06	0.21	
Lepomis macrochirus		0.30		0.04	
Lepomis sp.		0.06			

Table 19. (continued)

Year	1977	1978	1979	1980	1981
No.trawls	54	54	49	56	56
Species					
Micropogonias undulatus	11.54	1.30	1.69	0.20	4.25
Micropterus salmoides		0.02			
Morone americana	66.02	239.59	175.65	75.54	63.00
Morone saxatilis (yearling)	0.41	0.09		0.09	0.09
Moxostoma coregonus			0.06		
Moxostoma sp.	0.02	0.04			
Mugil curema	0.02				
Notropis hudsonius	0.30	3.03	4.73	0.46	
Notropis sp.		0.04			
Paralichthys lethostigma	0.28		0.08	0.09	0.30
Perca flavescens	0.94	5.09	8.76	1.98	0.21
Pomatomus saltatrix					0.02
Pomoxis nigromaculatus			0.06		
Trinectes maculatus	4.06	2.15	5.86	1.25	0.27
Callinectes sapidus	8.98	0.52	1.49		9.71

Table 20. Catch composition by species and mean catch per trawl in Albemarle Sound, N. C., 1977-1981 (269 trawls)

Species	Total number collected	Mean catch per trawl	Percentage of total catch
Morone saxatilis (y-o-y)	286	1.06	0.57
Morone americana	32,868	122.19	65.52
Leiostomus xanthurus	5,463	20.31	10.89
Alosa aestivalis	3,949	14.68	7.87
Anchoa mitchilli	1,658	6.16	3.31
Micropogonias undulatus	1,025	3.81	2.04
Perca flavescens	878	3.26	1.75
Alosa pseudoharengus	809	3.01	1.61
Ictalurus punctatus	768	2.86	1.53
Trinectes maculatus	707	2.63	1.41
Ictalurus catus	686	2.55	1.37
Notropis hudsonius	486	1.81	0.97
Etheostoma nigrum	101	0.38	0.20
Lepomis gibbosus	80	0.30	0.16
Alosa sapidissima	67	0.25	0.13
Alosa mediocris	46	0.17	0.09
Anguilla rostrata	42	0.16	0.08
Brevoortia tyrannus	42	0.16	0.08
Paralichthys lethostigma	41	0.15	0.08
Morone saxatilis (yearling)	37	0.14	0.07
Cyprinus carpio	27	0.10	0.05
Etheostoma olmstedi	24	0.09	0.05
Lepomis macrochirus	18	0.07	0.04
Dorosoma cepedianum	11	0.04	0.02
Ictalurus furcatus	8	0.03	0.02
Acipenser oxyrhynchus	5	0.02	0.01
Anchoa hepsetus	3	0.01	0.006
Lepomis sp.	3	0.01	0.006
Moxostoma coregonus	3	0.01	0.006

Table 20 (continued)

Species	Total number collected	Mean catch per trawl	Percentage of total catch
Moxostoma sp.	3	0.01	0.006
Pomoxis nigromaculatus	3	0.01	0.006
Citharichthys spilopterus	2	0.007	0.004
Esox americanus americanus	2	0.007	0.004
Esox niger	2	0.007	0.004
Ictalurus melas	2	0.007	0.004
Ictalurus nebulosus	2	0.007	0.004
Logodon rhomboides	2	0.007	0.004
Notropis sp.	2	0.007	0.004
Encinostomus gula	1	0.004	0.002
Micropterus salmoides	1	0.004	0.002
Mugil curema	1	0.004	0.002
Pomatomus saltatrix	1	0.004	0.002
Total finfish	50,165		
Callinectes sapidus	1,130	4.20	

Table 21. Species and numbers of fish collected by bottom trawl in the Roanoke River and Middle River, N. C., 1978

River	Roanoke River	Middle River	
No. trawls	98	17	
Species	No. fish caught	No. fish caught	Total
Alosa aestivalis	2	7	9
Alosa pseudoharengus	189	155	344
Anguilla rostrata	3		3
Cyprinus carpio	34	3	37
Dorosoma cepedianum	17		17
Esox niger	1	1	2
Etheostoma nigrum	213	256	469
Etheostoma olmstedi	3	1	4
Hybognathus nuchalis	504	36	540
Ictalurus catus	3,109	92	3,201
Ictalurus melas	3	4	7
Ictalurus natalis	5	1	6
Ictalurus nebulosus	52		52
Ictalurus punctatus	452	5	457
Lepisosteus osseus	9	2	11
Lepomis gibbosus	33	2	35
Lepomis gulosus	2		2
Lepomis macrochirus	160	15	175
Micropterus salmoides	26	3	29
Morone americana	7,058	296	7,354
Moxostoma anisurum	64	9	73
Moxostoma coregonus	47	14	61
Moxostoma sp.	2	1	3
Notropis hudsonius	2,840	518	3,358
Noturus insignis	4		4
Perca flavescens	28	13	41
Pomoxis nigromaculatus	115	11	126
Trinectes maculatus	22	12	34
Total	14,997	1,457	16,454

Table 22. Species and number of fish collected by day surface trawl in the Roanoke River and Middle River, N. C., 1978

River	Roanoke River	Middle River	
No. trawls	72	12	
Species	No. fish caught	No. fish caught	Total
Alosa aestivalis	200	46	246
Alosa pseudoharengus	39	7	46
Brevoortia tyrannus	1		1
Dorosoma cepedianum	4		4
Etheostoma nigrum		1	1
Hybognathus nuchalis	111	11	122
Ictalurus catus	5		5
Lepisosteus osseus	1		1
Lepomis gibbosus	2		2
Lepomis macrochirus		1	1
Morone americana	6	3	9
Moxostoma anisurum	3	2	5
Notemigonus crysoleucas	2		2
Notropis analostanus	1		1
Notropis hudsonius	29	106	135
Unidentified species	20	3	23
Total	424	180	604

Table 23. Species and number of fish collected by night surface trawl in the Roanoke River, N. C., 1978 (24 trawls)

Species	Number fish caught
Alosa aestivalis	159
Alosa pseudoharengus	338
Brevoortia tyrannus	13
Dorosoma cepedianum	66
Hybognathus nuchalis	239
Ictalurus catus	5
Morone americana	7
Notropis hudsonius	5
Total	832

STRIPED BASS TAGGING STUDIES

Since 1956 striped bass have been tagged in the Roanoke River to provide information pertaining to population size, rate of capture by commercial and sport fishermen, survival and mortality estimates, movements and migrations, and growth. Most of the tagging is performed in the lower section of the Roanoke River, and the fish are obtained by working in cooperation with commercial fishermen. Striped bass have been tagged from a variety of commercial gear such as set gill nets, drift gill nets, trotlines, and a large haul seine. In recent years the set gill net has been the principal gear utilized. The tagging has also been conducted from a number of locations such as Daley Hill, Jamesville, Williamston, and Hamilton. In recent years the majority of the tagging has been concentrated above Williamston, between river miles 41 and 50.

In 1981 the use of anchor gill nets to catch striped bass in the Roanoke River during April and May was banned by the North Carolina Marine Fisheries Commission. Consequently, the Division of Marine Fisheries has permitted our personnel to set gill nets in the Roanoke River at Williamston for the purposes of the mark and recapture study. The number of striped bass tagged in the Roanoke River for the years 1977 to 1981 are listed below in Table 24:

Table 24. Number of striped bass tagged in the Roanoke River, 1977-1981

Year	Number of striped bass tagged
1977	334
1978	452
1979	385
1980	77
1981	156

These data in Table 24 indicate a decrease in the number of striped bass tagged during the 1980 and 1981 seasons. The reasons for this decline is that very low water flows prevailed during both of these years, and these low water discharges limited the number of migrating fish and also made gill netting less productive. A reduced number of spawning fish could have also limited the catch of striped bass.

The cumulative rate of exploitation for striped bass in Albemarle Sound and the Roanoke River, N. C. for the years 1977-1981 is presented in Table 25. This rate of return for the past five years has been less than the long term average, and the low rates of tag returns for 1980 and 1981 have contributed considerably to this decline. Both of these years were characterized by small numbers of fish tagged, and decreased recovery effort.

Table 25. Cumulative rate of exploitation for striped bass in Roanoke River and Albemarle Sound, N. C. 1977-1981

Year	No. striped bass tagged	Number recovered	Percent recovered
1977	334	45	13.47
1978	452	96	21.24
1979	385	63	16.36
1980	77	9	11.69
1981	156	10	6.41

POPULATION ABUNDANCE

The estimated number of striped bass in the spawning migration up the Roanoke River has been made annually since 1955. Both the Petersen (1896) and Ricker (1940) methods have been used to derive the population estimation. However the Petersen (1896) method has been used for the 1977-1981 data. The population estimation for the five-year period from 1977 through 1981 is given in Table 26.

Table 26. Estimated number of striped bass in the spawning population in the Roanoke River, N. C., 1977-1981

Year	Estimated number of striped bass
1977	347,584
1978	354,152
1979	313,736
1980	100,192
1981	34,032
5-year average = 229,939	

These data indicate that the striped bass spawning population was estimated to be fairly abundant in 1977, 1978, and 1979 when the estimations were in excess of 300,000 fish per year. However, the spawning estimation declined considerably to 100,192 striped bass in 1980 and to 34,032 striped bass in 1981. Two possible reasons for these declines are decreased numbers of striped bass in the spawning run, and the adverse effects of low river discharges on the migration behavior of these fish.

SUMMARY

1. The North Carolina striped bass commercial landings exceeded 1,000,000 pounds for 10 years (1967-1976). In 1977 the catch declined to 572,000 pounds, increased to 698,000 pounds in 1978, 614,000 pounds in 1979, and then dropped to 473,000 and 417,000 pounds respectively in 1980 and 1981.
2. North Carolina commercial striped bass landings from 1977-1981 showed the greatest cumulative monthly totals during March, followed by February and November. Generally, striped bass landings are concentrated from October through April with decreased catches in May and September. The landings during the summer months are minimal.
3. Roanoke River commercial striped bass landings were approximately average in abundance in 1977 (10,465), above average in 1978 (16,753), and then declined in 1979, 1980, and 1981 to 9,798, 2,286, and 349 fish respectively. The 1981 decreased landings resulted from a change in commercial fishing regulations.
4. The commercial striped bass season in the Roanoke River in 1977-1981 was concentrated from the last week in March through the first week in May.
5. The 1977-1980 Roanoke River striped bass commercial catch was landed mainly by anchor gill nets and striped bass drift gill nets. Both of these devices were prohibited by regulations enacted in 1981. Catch and effort data for other gears are presented.
6. The Roanoke River commercial striped bass fishery was concentrated in the Jamesville and Williamston areas of the Roanoke River during the 1977-1981 time period.
7. Albemarle Sound striped bass catches declined in 1977, and the successive landings during the 5-year period, 1977-1981, were the lowest recorded for the past 20 years.
8. Rod and reel striped bass catches at Weldon, N. C. during the 1977-1981 interval declined from the long-term average. High water discharge in 1978 and low water flows in 1980 and 1981 may have contributed to the reduced rod and reel catches.
9. The catch and effort data for striped bass caught by bow nets (drifting) indicated 2,054 fish caught in 1977 for a c.u.e. of 8.12. The drift bow net

catches were reduced in 1978, 1979, and 1980 (286, 835, and 415 fish caught respectively). The use of the bow net was prohibited in 1981.

10. The catch and effort data for striped bass caught by bow nets (fights) in the Roanoke River indicated that 1977 had the highest catch (8,769 fish). The catch was reduced considerably in 1978 (1,051 fish) because of high water, and further reduction occurred in 1979 and 1980 (5,957 and 5,451 fish respectively). The use of bow nets to capture striped bass in "fights" was prohibited in 1981.
11. The estimated sport catch of striped bass by all methods in the entire Roanoke River declined from 32,983 fish in 1977 to only 3,905 fish in 1981. Low river flows in 1980 and 1981 were associated with a considerable reduction in the sport catch to 15,239 and 3,905 fish respectively.
12. The estimated number of striped bass eggs spawned in the Roanoke River was considered to be in an acceptable range during 1977, 1978, and 1979 (1.776; 1.691; 1.613 billion respectively). However, during 1980 and 1981 the estimates declined to the lowest totals since 1965 (0.87 and 0.34 billion).
13. Striped bass egg viability which decreased in 1975 and 1976 continued in this decline from 1976 to 1980. The egg viability increased to 73.70% in 1981.
14. The 1977-1981 egg viability and water temperatures were not indicative of the relationship existing in prior years.
15. The mean number of young-of-year striped bass caught by trawling in Albemarle Sound nursery areas declined in 1977 to 3.63 fish per trawl. Young-of-year striped bass were conspicuously scarce in 1978, 1979, 1980, and 1981 when the c.u.e. was only 0.59, 0.55, 0.46, and 0.09 fish respectively. These were the lowest averages (with one exception) attained during the 27-year history of the study.
16. Trawling data for other fish species were tabulated for Albemarle Sound from 1977 to 1981. White perch was the most abundant species, composing 65% of the total catch. Other abundant species were spot, blueback herring, bay anchovies, and croaker.
17. Day bottom trawls, day surface trawls, and night surface trawls were taken in the Roanoke and Middle Rivers to determine distribution of fishes in the delta area. Striped bass were not collected. The bottom trawls collected numerous white perch, spot-tail shiners, and white catfish. The day surface trawl collections were mainly composed of blueback herring, spot-tail shiners, and silvery

minnows, and blueback herring.

18. Striped bass tagging studies were conducted in the Roanoke River during 1977 to 1981. A total of 334, 452, 385, 77, and 156 fish were tagged. The reduced numbers tagged in 1980 and 1981 were probably the result of record low water flows.
19. The cumulative rate of exploitation of striped bass in the Roanoke River and Albemarle Sound from 1977 to 1981 was 13.47, 21.24, 16.36, 11.69, and 6.41 percent respectively.
20. The estimated number of striped bass in the Roanoke River spawning migration was 347,584; 354,152; 313,736; 100,192; and 34,032 fish for the respective years 1977-1981.

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