Food and Feeding of Young
Striped Bass in Western
Albemarle Sound, NC

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FOOD AND FEEDING OF YOUNG STRIPED BASS IN WESTERN ALBEMARLE SOUND, NORTH CAROLINA

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By

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ABSTRACT

Spatial and temporal distribution and abundance of larval and early juvenile striped bass (Morone saxatilis) and zooplankton were determined for nursery areas of western Albemarle Sound, North Carolina, during 1982 and 1983. Gut contents of young striped bass were examined to determine food and feeding habits. In 1982, striped bass larvae were most abundant in inshore areas of western Albemarle Sound in mid-May, concentrated in the region where the Roanoke and Cashie Rivers empty into Batchelor Bay. Zooplankton densities were greatest in inshore areas and were dominated by copepods, averaging 1410/m^3 and comprising 75% of the zooplankton population. Larval striped bass abundance was correlated with several of the more abundant zooplankton groups in inshore areas: cladocerans, amphipods, and ostracods. There was little correlation between numbers of larvae and copepod densities in inshore areas. Offshore densities of striped bass larvae and zooplankton were considerably less than inshore areas during 1982. Copepods dominated offshore zooplankton, averaging 970.15/m^3 and comprising 80% of total zooplankton. Density of larval striped bass was correlated with several zooplankton groups in offshore waters (amphipods, cladocerans, and ostracods), although none of the correlations was consistent. Few striped bass larvae were collected in 1983; no correlations between concentrations of larvae and zooplankton were attempted. In 1982, 32% of inshore Morone larvae had empty stomachs, 15% had ingested food items, and 61% ingested detritus only. No significant differences were evident in the number of empty stomachs per location or over time. Inshore larvae ingested only two food groups: copepods and cladocerans. No significant differences were found between the percentage of copepods in the gut and the percentage present in the zooplankton, indicating that inshore larvae were opportunistic feeders during 1982. Stomachs examined from offshore larvae were empty in 35% of the cases. Approximately one-fourth of the larval stomachs contained food items, and 39% contained detritus only. Statistical analyses indicated that feeding of offshore Morone larvae was independent of food (zooplankton) concentration in 1982. No food items were present in stomachs of the 10 striped bass larvae caught in western Albemarle Sound in 1983. Detritus was common in stomachs of

Roanoke striped bass larvae, but is not commonly ingested by striped bass larvae in other estuarine systems. Zooplankton concentrations in Albemarle Sound are considerably lower than in other estuaries inhabited by striped bass stocks, suggesting that food quantity and/or quality may be a factor controlling larval striped bass survival in western Albemarle Sound.

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INTRODUCTION

The striped bass (Morone saxatilis) population inhabiting Albemarle Sound and its tributaries supports important commercial and recreational fisheries in coastal North Carolina. The major spawning area for Albemarle Sound striped bass is the Roanoke River, a swiftly-flowing coastal stream that empties into the extreme western end of the Sound. Adult striped bass spawn in the Roanoke River upstream of Hamilton, North Carolina (River Mile 120), from late April through early June (Hassler et al. 1981). Historical spawning areas further upstream are blocked by the Roanoke Rapids Dam at River Mile 137 (McCoy 1959). Eggs develop to the hatching stage as they drift downstream with the currents. After hatching, the larvae continue to drift downstream through the Roanoke River delta on their journey to the nursery grounds in the western Sound (Street 1975). Additional spawning areas are located in the Nottoway and Meherrin Rivers, which are tributaries of the Chowan River. During years of high abundance, striped bass larvae from both the Roanoke and Chowan systems may be distributed throughout most of Albemarle Sound (Street 1975).

In recent years the commercial and recreational striped bass fisheries in the Albemarle Sound area have suffered due to reduced numbers of harvestable adults (Hassler et al. 1981). During the period 1955 through 1958, various State, Federal and private agencies entered into a cooperative agreement known as the "Roanoke River Studies", the purpose of which was to examine multiple use problems of the Roanoke River system and monitor changes in the striped bass population. Other studies since the late 1970's have documented the decline of the Roanoke striped bass population. Results of these studies indicate that several factors may be responsible for stock decline. Reduced egg viability was suspected as the initial cause for the decline of the adult population (Guier et al. 1980, Hassler et al. 1981). Another potential problem may be poor survival of juvenile striped bass on the nursery grounds of the western Sound (Hassler et al. 1981). Poor survivability may be the result of changes in water quality and lack of food. Recent studies indicate that predation by other finfish on the nursery grounds is of minor importance to survivability (Rulifson 1984a).

An additional factor that may contribute to stock decline is the rate of survival of pre-juvenile life stages during transport from the spawning grounds in the Roanoke River to the nursery areas of the western Sound. Studies by Kornegay (1981, 1983) indicate that "adequate" numbers of viable striped bass eggs are spawned each year to sustain the Albemarle stock at an adult population size greater than that observed in recent years. However, the juvenile trawl index survey conducted each year in the Sound suggests that numbers of juvenile striped bass are too low to produce adequate recruitment to the population (Hassler et al. 1981). A survey of larvae and early juvenile striped bass abundance conducted in 1982 indicated low recruitment of these early life stages to the nursery grounds (Rulifson 1984b). Reduced survival of pre-juvenile life stages may be due to interruption of the food chain, which may cause low food abundance during critical periods of larval development. Food quality and quantity could be altered by food chain interruption, resulting in starvation of striped bass larvae before they reach the juvenile life stage.

The objective of the present study was to determine the spatial and temporal distribution of larval and juvenile striped bass in western Albemarle Sound, and to relate this distribution pattern to zooplankton species composition and abundance in the same area. Gut contents of young striped bass were examined to determine food and feeding habits on the nursery grounds of the western Sound. The study was conducted in 1982 and 1983; results of the 1982 distribution and abundance survey were presented previously (Rulifson 1984b). However, all data for both years will be included in this report for comparative purposes.

STUDY SITE DESCRIPTION

Albemarle Sound is a shallow coastal estuary in northeastern North Carolina that comprises an area of approximately 1295 km^2 (Figure 1). Oriented in an east-west direction, the Sound extends approximately 97 km from the mouth of the Roanoke River to the Outer Banks, where it is connected to the Atlantic Ocean via Croatan and Roanoke Sounds and Oregon Inlet. Eight rivers drain into Albemarle Sound; the two principal tributaries are the Roanoke and Chowan

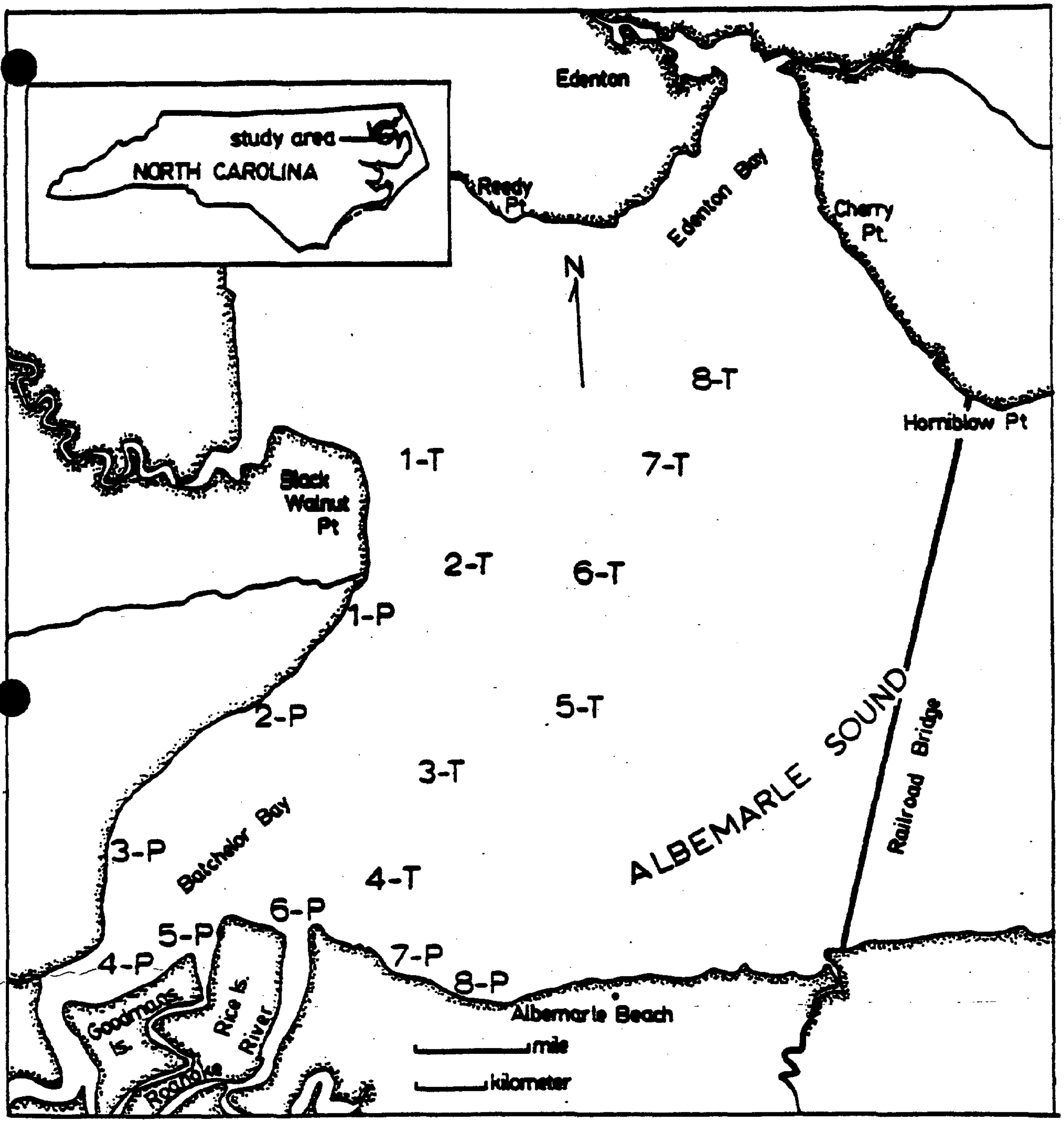

Figure 1. Inshore (P = pushnet) and offshore (T = Tucker trawl) sampling stations for the striped bass nursery grounds study conducted in western Albemarle Sound, North Carolina, during 1982-1983.

Rivers, which enter the Sound at the western extremity. Salinities range from 0 parts per thousand (ppt) at the western end to 28 ppt near Oregon Inlet. Tides and water flow patterns in Albemarle Sound are influenced to a great extent by wind action due to the large expanse of open water.

METHODS

1982 Survey

Sampling was conducted in two phases to determine the presence, distribution, and abundance of striped bass larvae and early juveniles in western Albemarle Sound. Phase I sampling was focused on striped bass larvae and Phase II sampling was for early juveniles. Both phases included sampling for possible finfish predators of young striped bass. Results of the finfish predator study were presented elsewhere (Rulifson 1984a).

Phase I sampling in western Albemarle Sound began approximately 72 hours after major (peak) spawning activity was reported (Kornegay 1983) in the Roanoke River (Figure 2). Sixteen stations, eight within the shallows (1-8P) and eight open, deep-water stations (1-8T), were sampled on alternate days for a two week period from 17 May to 4 June 1982 (Figure 1). Sampling during the initial week was conducted during both day and night on alternate sampling days. During the second week (25 May to 4 June), sampling for larvae was conducted only at night to minimize gear avoidance. The time during the evening at which each station was sampled varied to reduce the possibility of sampling any one station more than once during peak diurnal larval activity. Larvae were collected from the offshore stations with a 1 m^2 Tucker trawl containing a 505 um mesh liner towed from the stern in an oblique manner. Zooplankton were collected with a 0.5 m diameter Wisconsin net of 250 um mesh, which was towed from the stern approximately 1 m below the surface. Young-of-the-year striped bass and other predatory fishes were collected with a 6.3 mm (1/4 inch) bar mesh otter trawl with a 3.2 m (10.5 foot) head rope and 3.2 mm (1/8 inch) bar mesh tail bag. Inshore stations were sampled approximately 1 m below the surface with two 0.5 m diameter Wisconsin push nets, one fitted with 505 um mesh and the other with 250 um mesh. All nets except the trawl were equipped with General Oceanics (model 2030) flowmeters. Flowmeter calibration was conducted in the field by mounting the meters in round metal frames and towing the frames at constant speed over known distances.

Samples were collected by towing the nets for six minutes. After each tow the catch was washed to the end of the net and emptied into glass jars. Each sample was placed on ice to minimize regurgitation of stomach contents by the larvae. A five percent buffered solution was used to fix samples for storage. Water temperature (^{o}C), dissolved oxygen (mg/l), conductivity, salinity (ppt), sample depth (m), and weather conditions were recorded for each sample.

Phase II sampling for early juvenile striped bass was conducted from 9 June to 14 July 1982 only at offshore stations. Samples were collected weekly during daylight hours with an otter trawl and a 250 um mesh Wisconsin net. The techniques and information recorded for each station were the same as for Phase I samples.

1983 Survey

Sampling for striped bass larvae and early juveniles in western Albemarle Sound was initiated considerably later in the spring of 1983 compared to the 1982 study. Heavy rainfall throughout the 1983 spring season resulted in increased water flow in the Roanoke River (Figure 2). At the time, it appeared that the major (peak) spawning activity of striped bass above Halifax, North Carolina, was delayed by the increased runoff. However, as the spawning season progressed it became apparent that no clearly-defined peak of spawning activity had occurred or was going to occur before spawning activity ceased altogether. Therefore, sampling for striped bass larvae and early juveniles on the nursery grounds was not initiated until June 1983.

From 1 June to 29 June 1983, eight inshore and eight offshore stations were sampled (all at night) by methods used in the 1982 study. Gear used to collect the samples was different from those used in 1982. Ichthyoplankton were collected at offshore stations by towing a 1 m^2 Tucker trawl equipped with 505 um mesh in an oblique manner. Zooplankton were collected in a similar manner

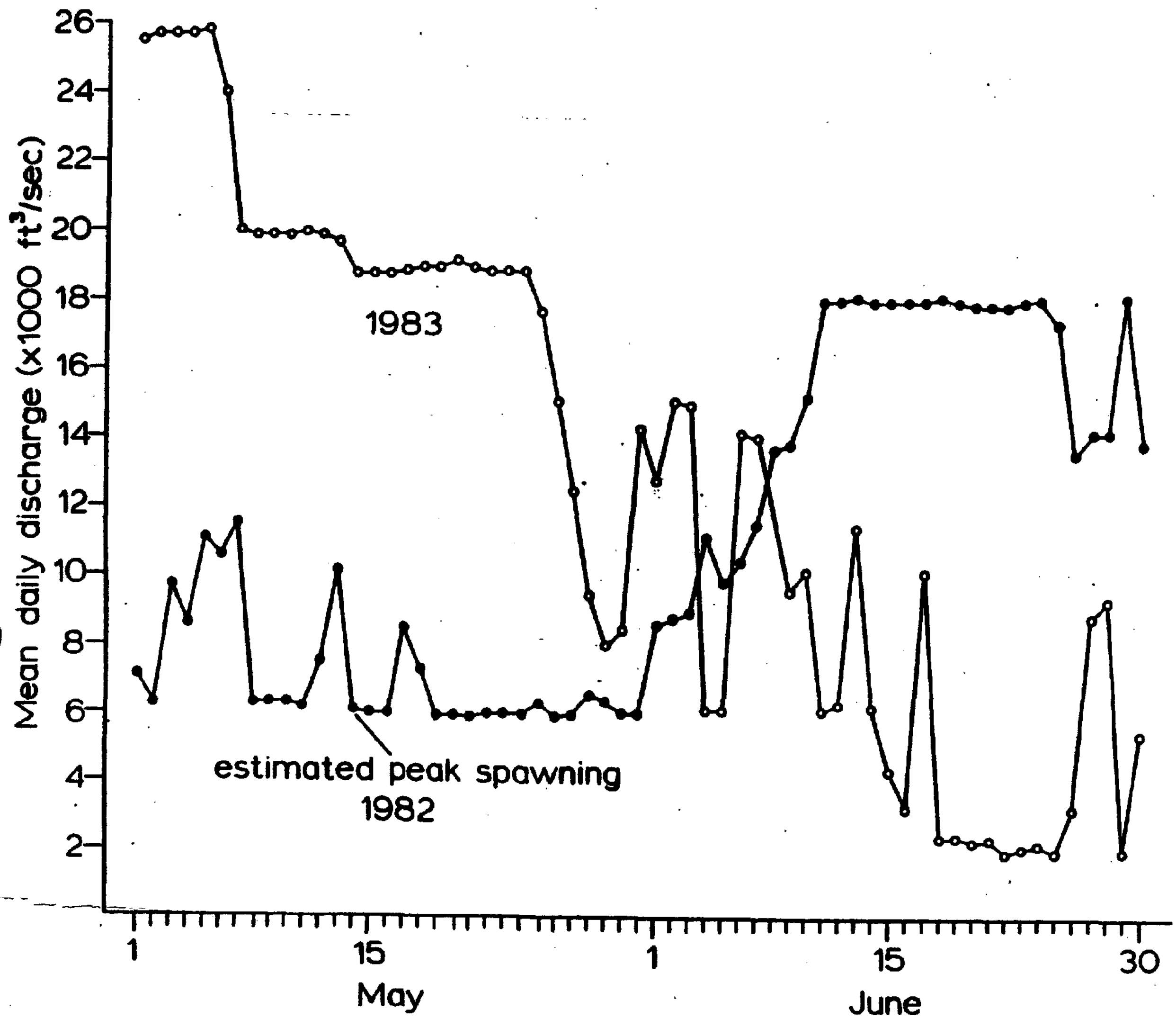

Figure 2. Estimated peak spawning activity of striped bass adults in relation to mean daily discharge of water (1000 ft^3/sec) through the Roanoke Rapids Dam at Roanoke Rapids, North Carolina (data from U.S. Geological Survey).

with a 1 m^2 Tucker trawl equipped with 250 um mesh. No otter trawl samples were collected at offshore stations in 1983. Inshore stations were sampled with two Wisconsin push nets. Ichthyoplankton samples were taken with a 0.50 m diameter net containing 505 um mesh, and zooplankton were collected with a 0.25 m diameter net of 250 um mesh. All nets were equipped with General Oceanics (model 2030) flowmeters, which were calibrated by towing weighted nets containing the flowmeters at constant speed over known distances.

Laboratory Sample Workup

During laboratory workup of the 1982 ichthyoplankton (505 um mesh) samples, a number of inshore and offshore samples having the same station number were combined inadvertently. This action prevented making statistical comparisons between larval and zooplankton distributions and abundance. However, the 1982 zooplankton (250 um mesh) samples were re-examined and all fish larvae were removed from each sample so that some statistical comparisons could be made.

In the laboratory, all larval and early juvenile fish were removed from the ichthyoplankton samples. Striped bass were separated from white perch (Morone americana), when possible, and enumerated. Several criteria were used in combination to identify striped bass from white perch: size of the yolk sac, length of the body at a specific stage of development, fin ray counts, examination of dorsal fin ray development, and anal fin ray development at later developmental stages (Mansueti 1964, Lippson and Moran 1974). Up to 30 striped bass larvae from each sample were measured (0.1 mm) with an ocular micrometer. Stomachs from up to 10 striped bass larvae were dissected and the contents removed to determine food items present. Food items were identified to the lowest taxon possible and enumerated. The percent occurrence of each food item, relative to total content of the gut, was estimated.

Zooplankton samples were subsampled by removing aliquots and counting the most abundant group until 100 or more of the group were enumerated. Then all remaining organisms from the aliquot were identified to the lowest taxon possible and enumerated. Larval fish from the 1983 zooplankton samples were counted by the aliquot method; therefore, no comparisons were made of larval fish catches between gear types.

RESULTS

Initially, data were analyzed to determine the effects of sampling time and water quality factors on larval striped bass and zooplankton densities. However, abundance of larvae and zooplankton fluctuated greatly throughout the study, in both 1982 and 1983. This fluctuation reduced chances of detecting effects of collection time and water quality on organism abundance. Stepwise linear regression of the 1982 data produced no correlation between water quality variables and density of larval striped bass. Water temperatures fluctuated most during the study, ranging from 23.0 to 34.2 C. Dissolved oxygen ranged from 7.2 to 12.6 mg/l in offshore waters. No statistical analysis was performed on 1983 data due to the few numbers of striped bass larvae collected.

1982 Survey

Inshore Areas, 1982

Striped bass larvae and early juveniles were most abundant in the inshore areas of western Albemarle Sound throughout the study (Figure 3, Table 1). Greatest abundance occurred on 19 May and again on 23 May at stations 4-P, 5-P, and 6-P, which are the inshore areas where the Roanoke and Cashie Rivers discharge into the western Sound (Figure 1). Striped bass larvae were less abundant at stations 7-P and 8-P (toward Albemarle Beach), and few larvae were collected along the western shore from Batchelor Bay to Black Walnut Point. Chi-square analysis of inshore stations 4-8 indicated significant changes in abundance (X^2=559.92, P<0.001, df=12) during the study (dates of May 19, 23, 25, and 29).

Inshore zooplankton abundance was greatest along the southwest shore between the Roanoke River and Albemarle Beach (stations 7-P and 8-P) from 19 May to 25 May (Table 2). Although the inshore zooplankton concentrations appeared

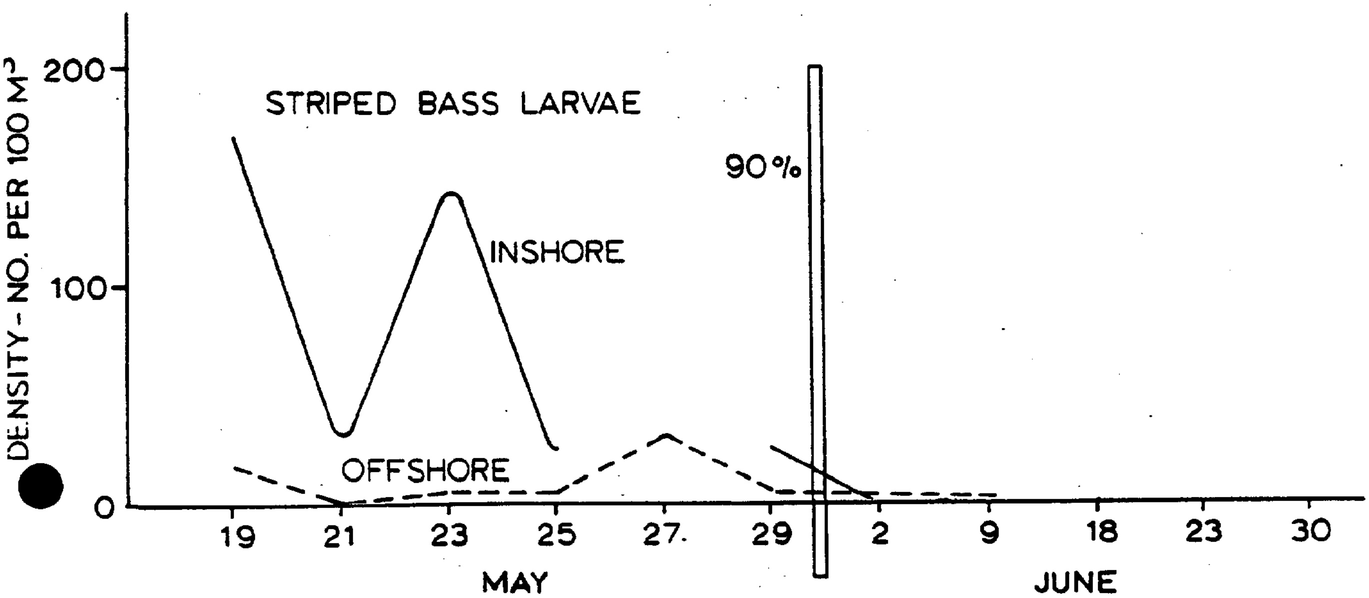

Figure 3. Abundance of striped bass larvae in inshore and offshore areas of western Albemarle Sound, North Carolina, during spring of 1982.

Table 1. Density (number/100 m^3) of striped bass larvae in inshore and offshore areas of western Albemarle Sound during 1982 based on Wisconsin push net (250 um) tows of six minutes. Dashed line (-) indicates no sample collected.

Date	Stations 1	2	3	4	5	6	7	8	Average density
					Inshore Stations				
5-19	0	17.93	0	97.97	641.61	361.39	185.23	73.21	172.17
5-21	-	-	-	-	61.58	-	0	-	30.79
5-23	20.49	0	0	272.63	474.36	340.51	32.91	0	142.61
5-25	0	0	0	85.57	44.33	9.25	57.26	8.24	25.58
5-27	-	-	-	-	-	-	-	-	-
5-29	0	0	0	8.52	67.11	111.76	10.55	0	24.74
5-31	0	-	-	-	-	-	-	-	0
6-02	0	0	0	-	-	-	-	-	0
Average density	3.41	3.59	0	116.17	257.80	205.73	57.19	20.36	78.48
					Offshore Stations				
5-19	0	0	-	-	10.21	35.49	20.04	36.14	16.98
5-21	-	-	-	-	10.51	-	0	-	0
5-23	0	0	0	40.54	0	0	6.09	0	5.83
5-25	0	0	0	23.86	10.51	0	-	-	5.76
5-27	10.10	22.56	43.47	95.26	47.42	0	0	0	27.35
5-29	0	0	5.19	25.66	7.93	4.06	0	5.36	6.02
5-31	-	-	-	-	-	-	-	-	-
6-02	-	-	-	-	-	-	-	-	-
6-04	-	-	-	-	-	-	0	-	0
6-09	33.31	0	0	0	0	0	0	0	4.16
Average density	7.24	3.76	9.73	37.06	12.37	6.59	3.73	8.30	10.50

similar over time, the patterns were significantly different ($P<0.001$) between sampling dates: between 19 May and 23 May (X^2=2666.18, df=7), between 23 May and 25 May (X^2=601.20, df=7), and between 25 May and 29 May (X^2=12538.92, df=7).

Total zooplankton densities were examined in greater detail by subdividing the potential food items into groups (Table 2). Densities of each group were averaged for all stations sampled on each date so that the relative contribution of each group could be determined. Leptodora, a species of cladoceran, were classified separately from other cladocerans due to their size and abundance.

During the spring and early summer of 1982, copepods comprised the most abundant group of the inshore zooplankton in western Albemarle Sound. Copepods averaged 1410 animals per cubic meter of water filtered by the plankton nets (Table 3), or 75% of all zooplankton organisms collected during the study (Table 4). Only four other groups comprised more than 1% of total zooplankton collected in inshore areas: cladocerans (17.05%), leptodorans (3.68%), amphipods (1.58%), and ostracods (1.57%).

Abundance of larval striped bass was correlated with several of the most abundant species groups in inshore areas. Concentrations of larvae and cladocerans were highly correlated (df=31, r=0.89) on 23 May 1982, with a ratio of 1:192 among inshore stations (Table 5). Positive correlations between striped bass larvae and concentrations of amphipods (df=31, r=0.52) and ostracods (df=31, r=0.40) were observed on 29 May. Very little correlation was observed between larval abundance and either copepod or total zooplankton densities. Correlation coefficients between Leptodora and striped bass larvae were always negative in inshore areas (Table 5). This relationship may indicate active avoidance of leptodorans by striped bass larvae, or may indicate differences in habitat preferences. Leptodora kindti, an active carnivorous cladoceran, is large enough to prey upon small fish larvae.

Offshore Areas, 1982

Offshore densities of striped bass larvae and early juveniles were considerably less than inshore densities during the 1982 study (Table 1, Figure 3). Many of the offshore samples could not be taken due to inclement

Table 2. Distribution and abundance of zooplankton in inshore areas of western Albemarle Sound during spring of 1982. Stations as in Figure 1.

Date	Location	Station	Water volume filtered (m^3)	Aliquot size	Striped bass larvae (#/100m^3)	Other fish larvae (#/100m^3)	Zooplankton species groups (#/m^3): Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Clam	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Mosquito adults	Mosquito larvae	Mosquito pupae	Ostracods	Polychaetes	Unidentified	Total zooplankton
519	1	1	9.91	0.0200	0.00	30.26	0.00	0.00	0.00	0.00	0.00	60.52	0.00	408.51	5.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	474.08
519	1	2	11.15	0.0250	17.93	44.83	3.59	0.00	0.00	0.00	0.00	154.20	0.00	537.92	0.00	0.00	0.00	3.59	0.00	0.00	0.00	0.00	0.00	0.00	699.30
519	1	3	10.67	0.0800	0.00	140.65	0.00	0.00	0.00	0.00	0.00	69.15	0.00	76.18	0.00	0.00	0.00	7.03	0.00	0.00	0.00	0.00	0.00	0.00	152.37
519	1	4	10.21	0.0180	97.97	146.96	0.00	0.00	10.89	5.44	16.33	522.52	0.00	571.50	0.00	0.00	0.00	5.44	0.00	0.00	5.44	32.66	10.89	0.00	1181.11
519	1	5	12.00	0.0080	641.61	91.66	10.42	0.00	0.00	20.83	52.08	1104.07	0.00	239.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.74	20.83	0.00	1541.54
519	1	6	10.52	0.0130	361.39	190.20	51.21	0.00	21.95	7.32	7.32	124.36	0.00	534.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.32	0.00	753.50
519	1	7	11.34	0.0020	185.23	44.10	88.21	0.00	0.00	0.00	0.00	1234.89	0.00	5953.96	0.00	0.00	0.00	308.72	0.00	0.00	0.00	0.00	0.00	0.00	7585.78
519	1	8	12.29	0.0010	73.21	0.00	81.35	0.00	0.00	0.00	0.00	813.47	0.00	14967.87	0.00	0.00	0.00	162.69	0.00	0.00	0.00	162.69	0.00	0.00	16188.07
521	1	5	11.37	0.2000	61.58	140.76	0.00	0.00	0.00	0.44	0.00	43.56	0.00	6.16	0.00	0.88	0.00	0.44	0.00	0.00	0.00	3.08	0.00	0.00	54.54
521	1	7	12.14	0.0300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.22	0.00	71.39	0.00	0.00	0.00	32.95	0.00	0.00	0.00	0.00	0.00	0.00	123.56
523	1	1	9.76	0.0330	20.49	81.97	0.00	0.00	0.00	0.00	3.10	65.20	0.00	226.65	3.10	0.00	0.00	0.00	0.00	0.00	3.10	0.00	0.00	0.00	301.17
523	1	2	11.29	0.1330	0.00	70.87	0.00	0.00	0.00	2.66	0.00	10.66	0.00	49.29	0.00	0.00	0.00	2.66	0.00	0.00	0.00	0.00	0.00	0.00	65.28
523	1	3	10.27	0.0130	0.00	194.74	7.49	0.00	14.98	0.00	0.00	239.68	0.00	352.03	0.00	0.00	0.00	22.47	0.00	0.00	0.00	7.49	0.00	0.00	644.15
523	1	4	10.64	0.0200	272.63	310.24	0.00	0.00	4.70	0.00	4.70	451.26	0.00	502.96	0.00	0.00	0.00	4.70	0.00	0.00	0.00	37.60	4.70	0.00	1010.62
523	1	5	11.17	0.0170	474.36	277.45	10.53	0.00	0.00	26.32	0.00	794.98	0.00	131.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.85	0.00	0.00	1000.31
523	1	6	11.76	0.0250	340.51	59.59	57.89	3.41	3.41	10.22	6.81	371.16	0.00	146.42	0.00	0.00	0.00	3.41	0.00	0.00	0.00	10.22	3.41	0.00	616.33
523	1	7	12.15	0.0060	32.91	24.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2344.91	0.00	0.00	0.00	452.53	0.00	0.00	0.00	13.71	0.00	0.00	2811.15
523	1	8	12.38	0.0030	0.00	16.16	80.80	0.00	0.00	0.00	0.00	242.40	0.00	3716.87	0.00	0.00	0.00	26.93	0.00	0.00	0.00	161.60	0.00	0.00	4228.61
525	1	1	11.22	0.0500	0.00	115.83	0.00	0.00	0.00	0.00	0.00	181.77	1.78	153.26	3.56	0.00	0.00	24.95	0.00	0.00	0.00	14.26	0.00	0.00	379.58
525	1	2	12.00	0.0250	0.00	74.99	0.00	0.00	3.33	0.00	6.67	629.90	0.00	513.25	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1163.14
525	1	3	13.42	0.0050	0.00	59.63	0.00	0.00	0.00	0.00	0.00	178.90	0.00	2161.76	0.00	0.00	29.82	0.00	0.00	0.00	0.00	14.91	0.00	0.00	2385.39
525	1	4	11.69	0.0100	85.57	154.02	17.11	0.00	8.56	17.11	8.56	256.70	0.00	1035.34	0.00	0.00	0.00	17.11	0.00	0.00	0.00	59.90	0.00	0.00	1420.38
525	1	5	11.28	0.0070	44.33	124.14	0.00	0.00	12.67	25.33	0.00	1127.35	0.00	101.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	126.67	0.00	0.00	1393.36
525	1	6	10.81	0.0100	9.25	37.01	64.77	0.00	9.25	18.51	0.00	619.97	0.00	166.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.52	0.00	0.00	934.58
525	1	7	10.48	0.0020	57.26	57.26	334.03	0.00	0.00	47.72	0.00	572.63	0.00	4819.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5774.00
525	1	8	12.14	0.0030	8.24	16.47	137.29	0.00	0.00	0.00	0.00	192.20	0.00	5271.83	0.00	0.00	0.00	27.46	0.00	0.00	0.00	0.00	0.00	0.00	5628.78

Table 2 (continued).

Date	Location	Station	Water volume filtered (m^3)	Aliquot size	Striped bass larvae (#/100m^3)	Other fish larvae (#/100m^3)	Zooplankton species groups (#/m^3): Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Clam	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Mosquito adults	Mosquito larvae	Mosquito pupae	Ostracods	Polychaetes	Unidentified	Total zooplankton
529	1	1	11.08	0.1000	0.00	18.05	0.00	0.90	0.00	0.00	0.00	20.76	0.00	46.93	1.80	0.00	0.00	100.17	0.00	0.00	0.00	0.00	0.00	0.00	170.56
529	1	2	12.93	0.0750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.69	0.00	0.00	0.00	138.18	0.00	0.00	0.00	0.00	0.00	0.00	160.87
529	1	3	11.81	0.0250	0.00	93.13	0.00	0.00	0.00	0.00	0.00	10.16	0.00	94.82	0.00	0.00	0.00	555.37	0.00	0.00	0.00	0.00	0.00	0.00	660.35
529	1	4	11.74	0.0020	8.52	42.58	0.00	0.00	0.00	42.58	0.00	1234.88	0.00	4684.04	42.58	0.00	0.00	127.75	0.00	0.00	0.00	85.16	42.58	0.00	6259.58
529	1	5	11.92	0.0500	67.11	92.27	1.68	3.36	1.68	11.74	1.68	174.48	0.00	53.69	0.00	0.00	0.00	0.00	1.68	0.00	1.68	115.76	10.07	0.00	377.49
529	1	6	11.63	0.0500	111.76	8.60	67.06	5.16	0.00	3.44	6.88	161.62	0.00	51.58	0.00	0.00	0.00	3.44	0.00	0.00	0.00	22.35	0.00	0.00	321.53
529	1	7	9.48	0.0750	10.55	94.99	52.07	0.00	1.41	5.63	4.22	92.88	0.00	154.79	0.00	1.41	1.41	112.58	0.00	0.00	0.00	0.00	0.00	0.00	426.39
529	1	8	10.45	0.0500	0.00	9.57	36.35	1.91	1.91	13.39	15.31	80.35	0.00	120.53	0.00	1.91	0.00	252.53	0.00	0.00	1.91	1.91	1.91	0.00	529.94
531	1	1	11.37	0.0300	0.00	17.59	2.93	0.00	5.86	14.66	11.73	0.00	0.00	287.31	5.86	0.00	0.00	2.93	0.00	0.00	0.00	14.66	0.00	0.00	345.94
602	1	1	10.93	0.0250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66	0.00	333.06	0.00	3.66	0.00	102.48	0.00	0.00	0.00	25.62	3.66	3.66	475.80
602	1	2	11.90	0.0100	0.00	8.40	0.00	8.40	0.00	0.00	8.40	8.40	0.00	1016.98	8.40	0.00	0.00	8.40	0.00	0.00	0.00	8.40	0.00	0.00	1067.41
602	1	3	12.85	0.0200	0.00	0.00	0.00	0.00	3.89	3.89	0.00	0.00	0.00	540.90	3.89	0.00	0.00	15.57	0.00	0.00	0.00	3.89	0.00	0.00	572.03

weather and equipment failures. The available data indicated that the greatest larval striped bass abundance in offshore waters occurred on 27 May. On 19 May, larval abundance was centered near the middle of western Albemarle Sound at stations 6-T, 7-T, and 8-T. Less than one week later, larval abundance had shifted to areas closer to the mouth of the Roanoke River (stations 3-T, 4-T, and 5-T). This shift in abundance corresponded to the highest inshore densities of striped bass observed in the same general area (stations 6-P and 7-P) at approximately the same time (Table 1). Very few larvae were collected at offshore stations east of Black Walnut Point (1-T, 2-T), a phenomenon also exhibited in the inshore data. Statistical analysis of larval densities by station and date was not attempted due to the large number of null densities and missing data.

Total zooplankton concentration fluctuated significantly ($P<0.001$, chi-square) among the stations and dates throughout the study. Offshore zooplankton was most abundant on 19 May in the middle of the western sound (stations 5-T, 6-T, 7-T and 8-T, Table 6). Copepoda was the most abundant group in offshore waters, averaging 970.15 individuals per cubic meter of water filtered (Table 7) and comprising approximately 80% of all offshore zooplankton (Table 8). Three additional groups each comprised more than 1% of all offshore zooplankton: cladocerans (8.14%), leptodorans (7.04%), and amphipods (3.15%).

Densities of larval and early juvenile striped bass in offshore waters were highly correlated with concentrations of five major species groups. Amphipod and striped bass densities ranged in correlation from $r=0.10$ at a ratio of 270:1 to a high of $r=0.97$ at densities of 256:1 (Table 9). Occasionally, cladocerans and ostracods also exhibited high correlations with striped bass abundance. No consistent relationship between striped bass and total zooplankton or leptodoran densities was observed (Table 9).

1983 Survey

Few striped bass larvae were collected in the 1983 survey. Therefore, no correlations or statistical analyses on distribution and abundance were possible.

Table 3. Average densities (number/m^3) of zooplankton species groups in inshore areas of western Albemarle Sound during 1982.

Species group	Inshore densities by date 5-19	5-21	5-23	5-25	5-29	6-02	Average density
Amphipod	29.35	0.00	19.59	69.15	19.65	0.00	29.78
Arachnid	0.00	0.00	0.43	0.00	1.42	2.80	0.63
Chaoborus larvae	4.11	0.00	2.89	4.23	0.63	1.30	2.67
Chaoborus pupae	4.20	0.22	4.90	13.58	9.60	1.30	7.10
Chironomid	9.47	0.00	1.83	1.90	3.51	2.80	3.84
Cladoceran	510.40	31.39	271.92	469.93	221.89	4.02	320.75
Clam	0.00	0.00	0.00	0.22	0.00	0.00	0.05
Copepod	2911.19	38.78	933.84	1777.87	653.63	630.31	1410.29
Insect adult	0.63	0.00	0.39	0.45	5.55	4.10	1.85
Insect larvae	0.00	0.44	0.00	0.00	0.42	1.22	0.21
Isopod	0.00	0.00	0.00	4.98	0.18	0.00	1.11
Leptodoran	60.93	16.70	64.09	8.69	161.25	42.15	68.10
Ostracod	36.14	1.54	33.43	33.91	28.15	12.64	29.57
Polychaete	4.88	0.00	1.01	0.00	6.82	1.22	2.85
Mosquito adult	0.00	0.00	0.00	0.00	0.21	0.00	0.05
Mosquito larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mosquito pupae	0.68	0.00	0.39	0.00	0.45	0.00	0.33
Unidentified	0.00	0.00	0.00	0.00	0.00	1.22	0.10
Average zooplankton density	3571.97	89.06	1334.70	2384.90	1113.34	705.07	1879.26
Mean aliquot size	0.02	0.12	0.03	0.01	0.05	0.02	0.03
Number of stations	8	2	8	8	8	3	

Table 4. Relative composition (%) of zooplankton in inshore areas of western Albemarle Sound during 1982.

Species group	Inshore composition (%) by date						Overall contribution
	5-19	5-21	5-23	5-25	5-29	6-02	
Amphipod	0.82	0.00	1.47	2.90	1.76	0.00	1.58
Arachnid	0.00	0.00	0.03	0.00	0.13	0.40	0.03
Chaoborus larvae	0.11	0.00	0.22	0.18	0.06	0.18	0.14
Chaoborus pupae	0.12	0.25	0.37	0.57	0.86	0.18	0.38
Chironomid	0.27	0.00	0.14	0.08	0.32	0.40	0.20
Cladoceran	14.29	35.24	20.37	19.70	19.93	0.57	17.07
Clam	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Copepod	81.50	43.54	69.97	74.55	58.71	89.40	75.05
Insect adult	0.02	0.00	0.03	0.02	0.50	0.58	0.10
Insect larvae	0.00	0.49	0.00	0.00	0.04	0.17	0.01
Isopod	0.00	0.00	0.00	0.21	0.02	0.00	0.06
Leptodoran	1.71	18.75	4.80	0.36	14.48	5.98	3.62
Ostracod	1.01	1.73	2.50	1.42	2.53	1.79	1.57
Polychaete	0.14	0.00	0.08	0.00	0.61	0.17	0.15
~~Mosquito adult~~	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Mosquito larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mosquito pupae	0.02	0.00	0.03	0.00	0.04	0.00	0.02
Unidentified	0.00	0.00	0.00	0.00	0.00	0.17	0.01
Total zooplankton	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 5. Concentration of the most abundant species groups relative to densities of larval striped bass in inshore areas of western Albemarle Sound during 1982. Correlation coefficients were calculated by simple linear regression using striped bass density as the dependent (y) variable.

Species group	Dates			
	5-19	5-23	5-25	5-29
Total zooplankton				
number/striped bass larva	1429	909	>10000	5000
corr. coef. (r)	-0.18	-0.24	0.17	-0.17
no. of obs. (n)	8	8	8	8
Copepoda				
number/striped bass larva	1667	145	714	2500
corr. coef. (r)	-0.17	0.09	0.10	-0.16
no. of obs. (n)	8	8	8	8
Cladocera				
number/striped bass larva	294	192	2000	909
corr. coef. (r)	0.51	0.89	0.21	0.11
no. of obs. (n)	8	8	8	8
Leptodora				
number/striped bass larva	35	45	34	667
corr. coef. (r)	-0.08	-0.27	-0.03	-0.56
no. of obs. (n)	8	8	8	8
Amphipoda				
number/striped bass larva	17	14	270	79
corr. coef. (r)	0.12	0.06	0.30	0.52
no. of obs. (n)	8	8	8	8
Ostracoda				
number/striped bass larva	21	23	133	114
corr. coef. (r)	0.27	-0.09	0.42	0.40
no. of obs. (n)	8	8	8	8

Table 6. Distribution and abundance of zooplankton in offshore areas of western Albemarle Sound during spring of 1982. Stations as in Figure 1.

Date	Location	Station	Water volume filtered (m^3)	Aliquot size	Striped bass larvae (#/100m^3)	Other fish larvae (#/100m^3)	Zooplankton species groups (#/m^3): Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Clam	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Mosquito adults	Mosquito larvae	Mosquito pupae	Ostracods	Polychaetes	Unidentified	Total zooplankton
519	2	1	20.03	0.0600	0.00	9.98	3.33	0.00	0.00	0.00	0.00	1.66	0.00	59.07	0.83	0.00	0.00	6.66	0.00	0.00	0.00	0.00	0.00	0.83	72.38
519	2	2	19.03	0.0750	0.00	15.77	0.00	0.00	0.70	0.00	0.00	12.61	0.00	42.05	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	56.76
519	2	5	19.59	0.0080	10.21	0.00	12.76	0.00	6.38	0.00	0.00	63.81	0.00	1320.96	0.00	0.00	0.00	312.69	0.00	0.00	0.00	12.76	6.38	0.00	1735.76
519	2	6	19.72	0.0030	35.49	0.00	67.60	0.00	16.90	0.00	0.00	50.70	0.00	3870.27	0.00	0.00	0.00	50.70	0.00	0.00	0.00	0.00	33.80	0.00	4089.98
519	2	7	19.96	0.0010	20.04	0.00	0.00	0.00	150.29	0.00	0.00	1252.44	0.00	6963.58	0.00	50.10	0.00	450.88	0.00	0.00	0.00	0.00	0.00	0.00	8867.29
519	2	8	19.37	0.0010	36.14	10.33	0.00	0.00	0.00	0.00	51.63	103.25	0.00	7485.80	0.00	0.00	0.00	361.38	0.00	0.00	0.00	51.63	0.00	0.00	8053.69
521	2	5	19.02	0.1000	10.51	42.06	0.00	1.05	1.58	0.00	0.00	56.25	0.00	29.97	0.00	0.00	0.00	9.99	0.00	0.00	0.00	2.10	0.00	0.00	100.94
521	2	7	18.23	0.1500	0.00	5.49	0.00	0.00	0.00	0.00	0.00	1.46	0.00	29.99	0.00	0.00	0.00	24.87	0.00	0.00	0.00	0.00	0.00	0.00	56.32
523	2	1	18.80	0.0500	0.00	15.96	4.26	0.00	0.00	0.00	0.00	22.34	0.00	45.74	5.32	0.00	0.00	38.30	0.00	1.06	0.00	0.00	1.06	0.00	118.09
523	2	2	17.42	0.0500	0.00	11.48	1.15	0.00	0.00	2.30	0.00	36.74	0.00	75.77	0.00	0.00	0.00	35.59	0.00	0.00	0.00	1.15	0.00	0.00	152.69
523	2	3	17.33	0.0040	0.00	0.00	0.00	0.00	14.43	0.00	0.00	28.85	0.00	1341.60	0.00	0.00	0.00	115.41	0.00	0.00	0.00	14.43	0.00	0.00	1514.71
523	2	4	19.73	0.0040	40.54	182.44	25.34	0.00	0.00	0.00	0.00	76.02	0.00	1571.05	0.00	0.00	12.67	63.35	0.00	0.00	0.00	0.00	0.00	0.00	1748.43
523	2	5	18.32	0.0040	0.00	0.00	81.87	0.00	13.65	0.00	0.00	13.65	0.00	1964.96	0.00	0.00	0.00	204.68	0.00	0.00	0.00	0.00	13.65	0.00	2292.45
523	2	6	18.60	0.0120	0.00	0.00	13.44	0.00	0.00	0.00	13.44	44.79	0.00	949.62	0.00	0.00	0.00	215.01	0.00	0.00	0.00	0.00	8.96	0.00	1245.25
523	2	7	16.42	0.0030	6.09	0.00	0.00	0.00	0.00	0.00	0.00	812.22	0.00	2152.37	0.00	0.00	20.31	446.72	0.00	0.00	0.00	0.00	20.31	0.00	3451.92
523	2	8	28.31	0.0070	0.00	0.00	0.00	0.00	20.18	0.00	0.00	232.12	0.00	1140.39	0.00	0.00	0.00	55.51	0.00	0.00	0.00	0.00	5.05	0.00	1453.25
525	2	1	18.32	0.3000	0.00	0.00	0.00	0.18	0.73	0.00	0.00	6.91	0.00	19.47	1.46	0.00	0.00	6.91	0.00	0.00	0.00	0.00	0.00	0.00	35.67
525	2	2	18.34	0.0250	0.00	10.90	8.72	0.00	0.00	0.00	2.18	41.43	0.00	307.47	2.18	0.00	0.00	133.02	0.00	0.00	0.00	0.00	0.00	0.00	495.01
525	2	3	18.50	0.0200	0.00	5.41	278.36	0.00	0.00	0.00	0.00	16.22	0.00	97.29	2.70	0.00	0.00	2.70	0.00	0.00	0.00	5.41	0.00	0.00	402.68
525	2	4	20.96	0.0060	23.86	0.00	238.56	0.00	0.00	0.00	7.95	111.33	0.00	842.92	0.00	0.00	0.00	15.90	0.00	0.00	0.00	0.00	15.90	0.00	1232.57
525	2	5	19.03	0.0100	10.51	10.51	68.30	0.00	0.00	0.00	0.00	21.02	0.00	803.82	0.00	0.00	0.00	10.51	0.00	0.00	0.00	0.00	5.25	0.00	908.90
525	2	6	22.57	0.0020	0.00	4.43	0.00	0.00	0.00	0.00	0.00	44.30	0.00	2525.36	0.00	0.00	0.00	44.30	0.00	0.00	0.00	0.00	22.15	0.00	2636.13
527	2	1	19.80	0.0250	10.10	10.10	2.02	2.02	0.00	0.00	0.00	52.53	0.00	264.65	0.00	0.00	0.00	250.51	0.00	0.00	0.00	4.04	0.00	0.00	575.76
527	2	2	26.59	0.0070	22.56	52.65	5.37	0.00	0.00	0.00	0.00	32.23	0.00	827.32	0.00	0.00	0.00	85.95	0.00	0.00	0.00	10.74	0.00	0.00	961.62
527	2	3	18.40	0.0100	43.47	32.60	380.35	0.00	0.00	5.43	0.00	16.30	0.00	396.65	5.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	804.17
527	2	4	22.04	0.0060	95.26	22.68	370.47	0.00	0.00	7.56	7.56	181.46	0.00	1073.61	0.00	15.12	0.00	22.68	0.00	0.00	0.00	22.68	0.00	0.00	1701.14

Table 6 (continued).

Date	Location	Station	Water volume filtered (m^3)	Aliquot size	Striped bass larvae (#/100m^3)	Other fish larvae (#/100m^3)	Zooplankton species groups (#/m^3): Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Clam	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Mosquito adults	Mosquito larvae	Mosquito pupae	Ostracods	Polychaetes	Unidentified	Total zooplankton
527	2	5	21.09	0.0170	47.42	42.67	66.94	0.00	2.79	0.00	0.00	25.10	0.00	348.65	0.00	2.79	0.00	44.63	0.00	0.00	0.00	2.79	0.00	0.00	493.68
527	2	6	25.61	0.0070	0.00	19.53	5.58	0.00	16.74	0.00	0.00	27.90	0.00	1082.38	0.00	0.00	0.00	22.32	0.00	0.00	0.00	0.00	5.58	0.00	1160.49
527	2	7	13.42	0.0100	0.00	29.80	0.00	0.00	14.90	0.00	0.00	22.35	0.00	1959.47	0.00	0.00	0.00	37.25	0.00	0.00	0.00	0.00	7.45	0.00	2041.42
527	2	8	17.21	0.0070	0.00	17.43	0.00	0.00	16.60	8.30	0.00	0.00	0.00	1311.68	0.00	0.00	0.00	91.32	0.00	0.00	0.00	0.00	8.30	0.00	1436.21
529	2	1	20.90	0.0750	0.00	4.78	0.00	0.00	0.00	0.00	0.00	1.91	0.00	15.31	0.00	0.00	0.00	112.28	0.00	0.00	0.00	0.00	0.00	0.00	129.50
529	2	2	21.87	0.0500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.49	0.00	15.54	0.00	0.00	0.00	82.30	0.00	0.00	0.00	0.91	0.00	0.00	104.24
529	2	3	19.28	0.1000	6.19	20.75	5.19	0.00	0.00	0.00	1.56	38.91	0.00	55.51	0.00	0.00	0.00	35.28	0.00	0.00	0.00	0.52	0.52	0.00	137.48
529	2	4	19.49	0.0250	25.66	20.53	84.15	0.00	2.05	10.26	0.00	53.37	0.00	160.10	0.00	0.00	0.00	59.52	0.00	0.00	0.00	2.05	0.00	0.00	371.51
529	2	5	25.21	0.0330	7.93	23.80	25.24	1.20	0.00	1.20	2.40	42.07	0.00	119.00	2.40	1.20	2.40	66.11	0.00	0.00	0.00	1.20	0.00	0.00	264.43
529	2	6	24.62	0.0200	4.06	8.12	6.09	0.00	8.12	0.00	0.00	160.41	0.00	207.12	0.00	2.03	0.00	79.19	0.00	0.00	0.00	4.06	12.18	0.00	479.21
529	2	7	20.49	0.0150	0.00	4.88	3.25	0.00	3.25	39.05	0.00	224.52	0.00	325.39	0.00	0.00	0.00	182.22	0.00	0.00	0.00	3.25	0.00	0.00	780.94
529	2	8	18.66	0.0020	5.36	10.72	0.00	0.00	80.39	0.00	0.00	535.93	0.00	2760.06	0.00	0.00	0.00	107.19	0.00	0.00	0.00	26.80	0.00	0.00	3510.37
604	2	7	15.66	0.1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.83	0.00	0.00	0.00	51.10	0.00	0.00	0.00	0.00	0.00	0.00	54.93
609	2	1	15.01	1.0000	33.31	0.00	0.00	0.00	0.00	0.00	0.00	3.40	0.00	1.73	1.13	0.00	0.07	4.47	0.00	0.00	0.13	0.00	0.00	0.00	10.94
609	2	2	17.04	1.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	2.47	0.47	0.06	0.00	5.41	0.00	0.00	0.00	0.12	0.00	0.00	8.93
609	2	3	10.26	1.0000	0.00	0.00	0.00	0.20	0.00	0.00	0.00	2.34	0.00	6.73	0.59	0.10	0.00	1.85	0.00	0.00	0.00	0.68	0.00	0.00	12.48
609	2	4	15.78	1.0000	0.00	12.68	0.00	0.06	0.00	0.00	0.00	2.09	0.00	7.23	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	9.71
609	2	5	12.63	1.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14	0.00	14.99	0.08	0.08	0.00	16.02	0.00	0.00	0.00	0.00	0.00	0.00	33.30
609	2	6	15.23	0.5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	10.38	0.39	0.00	0.00	11.95	0.00	0.00	0.00	0.00	0.00	0.00	24.30
609	2	7	16.66	0.5000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.22	0.00	12.01	0.00	0.00	0.00	5.37	0.00	0.00	0.00	1.02	0.00	0.00	34.62
609	2	8	16.01	0.5000	0.00	0.00	0.00	0.00	0.00	0.00	0.12	2.26	0.00	9.50	0.00	0.00	0.00	2.87	0.00	0.00	0.00	0.50	0.00	0.00	15.25

Table 7. Average densities (number/m^3) of zooplankton species groups in offshore areas o western Albemarle Sound during 1982.

Species group	Offshore densities by date							Averag densit
	5-19	5-21	5-23	5-25	5-27	5-29	6-09	
Amphipod	13.95	0.00	15.76	98.99	103.84	15.49	0.00	38.2
Arachnid	0.00	0.53	0.00	0.03	0.25	0.15	0.03	0.1
Chaoborus larvae	29.05	0.79	6.03	0.12	6.38	11.73	0.00	8.0
Chaoborus pupae	0.00	0.00	0.29	0.00	2.66	6.31	0.00	1.6
Chironomid	8.60	0.00	1.68	1.69	0.94	0.49	0.02	1.8
Cladoceran	247.41	28.86	158.34	40.20	44.73	138.83	3.80	98.8
Clam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Copepod	3290.29	29.98	1155.19	766.06	908.05	457.25	8.13	970.1
Insect adult	0.14	0.00	0.66	1.06	0.68	0.30	0.36	0.5
Insect larvae	8.35	0.00	0.00	0.00	2.24	0.40	0.03	1.5
Isopod	0.00	0.00	4.12	0.00	0.00	0.30	0.01	0.7
Leptodoran	197.29	17.43	146.82	35.56	69.33	90.51	5.99	85.5
Ostracod	10.73	1.05	1.95	0.90	5.03	4.85	0.30	3.6
Polychaete	6.70	0.00	6.13	7.22	2.67	1.59	0.00	3.6
Mosquito adult	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Mosquito larvae	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.0
Mosquito pupae	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.0
Unidentified	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Average zooplankton density	3812.65	78.64	1497.10	951.83	1146.80	728.20	18.69	1214.
Mean aliquot size	0.02	0.12	0.02	0.06	0.01	0.04	0.81	0.1
Number of stations	6	2	8	6	8	8	8	

Table 8. Relative composition (%) of zooplankton in offshore areas of western Albemarle Sound during 1982.

Species group	Offshore composition (%) by date							Over cont buti
	5-19	5-21	5-23	5-25	5-27	5-29	6-09	
Amphipod	0.37	0.00	1.05	10.40	9.05	2.13	0.00	3.
Arachnid	0.00	0.67	0.00	0.00	0.02	0.02	0.16	0.
Chaoborus larvae	0.76	1.00	0.40	0.01	0.56	1.61	0.00	0.
Chaoborus pupae	0.00	0.00	0.02	0.00	0.23	0.87	0.00	0.
Chironomid	0.23	0.00	0.11	0.18	0.08	0.07	0.11	0.
Cladoceran	6.49	36.70	10.58	4.22	3.90	19.06	20.33	8.
Clam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Copepod	86.30	38.12	77.16	80.48	79.18	62.79	43.50	79.
Insect adult	0.00	0.00	0.04	0.11	0.06	0.04	1.93	0.
Insect larvae	0.22	0.00	0.00	0.00	0.20	0.05	0.16	0.
Isopod	0.00	0.00	0.28	0.00	0.00	0.04	0.05	0.
Leptodoran	5.17	22.16	9.81	3.74	6.05	12.43	32.05	7.
Ostracod	0.28	1.34	0.13	0.09	0.44	0.67	1.61	0.
Polychaete	0.18	0.00	0.41	0.76	0.23	0.22	0.00	0.
Mosquito adult	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Mosquito larvae	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.
Mosquito pupae	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.
Unidentified	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Total zooplankton	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.

Table 9. Concentration of the most abundant species groups relative to densities of larval striped bass in offshore areas of western Albemarle Sound during 1982. Correlation coefficients were calculated by simple linear regression using striped bass density as the dependent (y) variable.

Species group	Dates				
	5-19	5-23	5-25	5-27	5-29
Total zooplankton					
number/striped bass larva	>10000	>10000	>10000	5000	>10000
corr. coef. (r)	0.76	0.20	0.14	-0.02	-0.03
no. of obs. (n)	6	8	6	8	8
Copepoda					
number/striped bass larva	>10000	>10000	>10000	3330	>10000
corr. coef. (r)	0.82	0.29	0.05	-0.31	-0.02
no. of obs. (n)	6	8	6	8	8
Cladocera					
number/striped bass larva	1429	2500	714	164	2000
corr. coef. (r)	0.15	0.02	0.81	0.80	-0.09
no. of obs. (n)	6	8	6	8	8
Leptodora					
number/striped bass larva	1110	2500	625	256	1429
corr. coef. (r)	0.43	0.11	-0.30	-0.34	-0.46
no. of obs. (n)	6	8	6	8	8
Amphipoda					
number/striped bass larva	82	270	1667	385	256
corr. coef. (r)	0.51	0.10	0.48	0.82	0.97
no. of obs. (n)	6	8	6	8	8
Ostracoda					
number/striped bass larva	63	33	16	18	81
corr. coef. (r)	0.53	0.18	-0.29	0.78	-0.02
no. of obs. (n)	6	8	6	8	8

Inshore Areas, 1983

Only one striped bass larva was captured in inshore areas of western Albemarle Sound during June 1983, representing a density of 0.92 larvae per cubic meter of water (Table 10). Total fish density was highest on June 3, when 189.53/ m^3 were collected near the mouth of the Cashie River (4-P) and 135.33/m^3 were captured at the mouth of the Roanoke River (6-P). Larvae of Clupeidae were the most abundant fish group throughout the study (Table 10).

Zooplankton concentrations were highest in inshore areas of western Albemarle Sound during June 1983 (Table 11). Inshore zooplankton abundance fluctuated greatly throughout June; greatest concentrations occurred on 1 June and after 23 June (Table 12). Copepoda was the most abundant zooplankton group in inshore areas, averaging approximately 180/m^3 by date (Table 12) or nearly 48% of all inshore zooplankton. Cladocera was the second most abundant group, averaging nearly 120 individuals/m^3, or 31.7% of inshore zooplankton by date. Leptodorans comprised 12.7% of inshore zooplankton.

Inshore zooplankton were most numerous between the Roanoke River mouth and Albemarle Beach (stations 7-T and 8-T, Table 13). Copepods and leptodorans were most abundant at station 7-P, and cladocerans were concentrated at station 8-P (Table 13).

Offshore Areas, 1983

Few larval striped bass were collected in offshore areas of western Albemarle Sound during June 1983. Striped bass larvae were found at less than 1/m^3 on 11 June off Black Walnut Point (Table 14); two days later larvae were found farther east at stations 7-T and 8-T (Figure 1). On 21 and 23 June, striped bass larvae occurred near the middle of the western Sound at approximately 0.3/m^3. Larvae of the Clupeidae were dominant numerically in offshore waters during June (Table 14).

Three groups comprised 97% of the offshore zooplankton community: copepods (%), cladocerans (23%), and leptodorans (10%). Zooplankton in offshore areas

Table 10. Distribution and abundance of larval fishes in inshore areas of western Albemarle Sound during June of 1983. Asterisk (*) indicates volume filtered was estimated by averaging all volumes of water filtered.

Date (yr/mo/dy)	Station/location	Volume filtered (m^3)	Larval density (no./100 m^3)					
			Striped bass	White perch	Clupeid species	Morone species	Unidentified larvae	Total fish density
830601	11	90.40	0.00	0.00	5.53	0.00	0.00	5.53
830601	21	87.40	0.00	1.14	3.43	0.00	0.00	4.58
830601	31	89.14	0.00	0.00	0.00	0.00	0.00	0.00
830601	41	97.95	0.00	2.04	42.88	0.00	11.23	56.15
830601	51	76.57	0.00	0.00	9.14	0.00	20.90	30.04
830601	61	81.57	0.00	0.00	2.45	0.00	11.03	13.48
830601	71	94.22	0.00	0.00	3.18	0.00	3.18	6.37
830601	81	100.19	0.00	0.00	4.99	0.00	2.00	6.99
								0.00
830603	11	80.68						
830603	21	77.92	0.00	1.28	17.97	0.00	10.27	29.52
830603	31	79.82	0.00	1.25	6.26	0.00	1.25	8.77
830603	41	92.86	0.00	0.00	185.22	0.00	4.31	189.53
830603	51	97.52	0.00	0.00	0.00	0.00	0.00	0.00
830603	61	96.80	0.00	0.00	12.40	0.00	122.93	135.33
830603	71	91.00	0.00	3.30	2.20	0.00	1.10	6.59
830603	81	92.27	0.00	3.25	19.51	0.00	5.42	28.18
830607	11	90.15	0.00	0.00	1.11	0.00	0.00	1.11
830607	21	92.17*	0.00	1.08	0.00	0.00	1.08	2.17
830607	31	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830607	41	92.17*	0.00	0.00	2.17	0.00	1.08	3.25
830607	51	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830607	61	92.17*	0.00	0.00	36.89	0.00	79.20	116.09
830607	71	92.17*	0.00	0.00	44.48	0.00	13.02	57.50
830607	81	92.17*	0.00	1.08	2.17	0.00	11.93	15.19
830613	11	94.44	0.00	0.00	2.12	0.00	2.12	4.24
830613	21	82.11	0.00	0.00	10.96	0.00	8.53	19.49
830613	31	91.76	0.00	0.00	1.09	0.00	0.00	1.09
830613	41	84.36	0.00	0.00	0.00	0.00	0.00	0.00
830613	51	88.60	0.00	0.00	1.13	0.00	4.51	5.64
830613	61	90.47	0.00	0.00	0.00	0.00	1.11	1.11
830613	71	82.62	0.00	0.00	26.63	0.00	10.89	37.52
830613	81	91.59	0.00	0.00	0.00	0.00	0.00	0.00
830614	11	91.91	0.00	0.00	2.18	0.00	2.18	4.35
830614	21	95.85	0.00	0.00	12.52	0.00	10.43	22.95
830614	31	88.11	0.00	1.13	19.29	0.00	5.67	26.10
830614	41	86.69	0.00	0.00	18.46	0.00	0.00	18.46

Table 10 (continued).

Date (yr/mo/dy)	Station/location	Volume filtered (m^3)	Larval density (no./100 m^3)					
			Striped bass	White perch	Clupeid species	*Morone* species	Unidentified larvae	Total fish density
830615	11	86.84	0.00	1.15	5.76	1.15	5.76	13.82
830615	21	96.71	0.00	0.00	2.07	0.00	5.17	7.24
830615	31	91.11	0.00	0.00	1.10	0.00	14.27	15.37
830615	41	96.19	0.00	0.00	3.12	1.04	0.00	4.16
830615	51	91.18	0.00	0.00	1.10	0.00	0.00	1.10
830615	61	87.95	0.00	0.00	1.14	0.00	4.55	5.69
830615	71	97.52	0.00	0.00	5.13	1.03	13.33	19.48
830615	81	104.20	0.00	0.00	0.96	0.00	11.52	12.48
830617	11	92.24	0.00	0.00	4.34	0.00	3.25	7.59
830617	21	95.04	0.00	0.00	2.10	1.05	4.21	7.37
830617	31	92.69	0.00	0.00	4.32	0.00	4.32	8.63
830617	51	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830617	61	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830621	11	91.74	0.00	0.00	1.09	0.00	3.27	4.36
830621	21	90.56	0.00	0.00	0.00	0.00	2.21	2.21
830621	31	103.94	0.00	0.00	0.96	0.00	13.47	14.43
830621	41	103.15	0.00	0.00	3.88	0.00	1.94	5.82
830621	51	102.05	0.00	0.00	0.00	0.00	0.98	0.98
830621	61	101.65	0.00	0.00	4.92	0.00	3.94	8.85
830621	71	98.29	0.00	0.00	0.00	0.00	20.35	20.35
830621	81	108.22	0.00	0.00	0.00	0.00	1.85	1.85
830623	11	94.24	0.00	0.00	16.98	0.00	6.37	23.34
830623	21	92.20	0.00	0.00	1.08	0.00	1.08	2.17
830623	31	90.85	0.00	2.20	105.67	0.00	17.61	125.48
830623	41	87.66	0.00	0.00	7.99	0.00	2.28	10.27
830623	51	87.12	0.00	0.00	1.15	0.00	0.00	1.15
830623	61	85.92	0.00	0.00	6.98	0.00	4.66	11.64
830623	71	91.77	0.00	0.00	0.00	0.00	0.00	0.00
830623	81	90.08	0.00	0.00	13.32	0.00	2.22	15.54
830627	11	86.89	0.00	0.00	1.15	0.00	1.15	2.30
830627	21	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830627	31	92.17*	0.00	0.00	0.00	0.00	0.00	0.00
830627	41	98.17	0.00	0.00	1.02	0.00	0.00	1.02
830627	51	100.15	0.00	2.00	13.98	0.00	0.00	15.98
830627	61	108.14	0.92	0.00	0.00	0.00	1.85	2.77
830627	71	90.79	0.00	0.00	3.30	1.10	2.20	6.61
830627	81	94.19	0.00	0.00	0.00	0.00	1.06	1.06

Table ●. Distribution and abundance of zooplankton in inshore areas of western Albemarle sound during June of 1983. Volumes with an asterisk (*) were estimated from the average volume of water filtered at all inshore stations.

Date (yr/mo/dy)	Station/location	Aliquot size	Water volume filtered (m^3)	Zooplankton density: Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Nematodes	Ostracods	Polychaetes	Mosquito larvae	Mosquito pupae	Clam	Unidentified	Total zooplankton
830601	11	.01	22.82	0.00	8.77	0.00	0.00	0.00	521.53	56.97	0.00	4.38	0.00	8.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	600.42
830601	21	.02	22.52	0.00	4.44	0.00	0.00	0.00	472.93	22.20	0.00	0.00	0.00	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	501.79
830601	31	.01	22.94	0.00	0.00	0.00	0.00	0.00	671.28	156.92	0.00	0.00	0.00	0.00	0.00	8.72	0.00	0.00	0.00	0.00	0.00	836.92
830601	41	.0067	24.75	0.00	0.00	12.06	18.09	6.03	643.38	192.98	6.03	12.06	0.00	0.00	12.06	24.12	0.00	0.00	0.00	0.00	0.00	946.83
830601	51	.0182	19.25	0.00	0.00	2.85	11.42	2.85	319.66	128.44	0.00	0.00	0.00	0.00	0.00	0.00	19.98	0.00	0.00	0.00	0.00	485.21
830601	61	.015	18.26	0.00	0.00	0.00	3.65	3.65	511.13	91.27	0.00	3.65	0.00	0.00	3.65	3.65	0.00	0.00	0.00	0.00	0.00	620.66
830601	71	.02	23.91	2.09	0.00	0.00	0.00	4.18	242.56	138.01	0.00	2.09	0.00	0.00	2.09	2.09	0.00	0.00	2.09	0.00	0.00	395.19
830601	81	.02	25.37	7.88	0.00	0.00	0.00	3.94	191.17	130.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	333.06
830603	11	.04	16.57	1.51	0.00	0.00	0.00	0.00	203.72	13.58	0.00	0.00	1.51	4.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	224.85
830603	21	.25	18.74	0.00	0.00	0.21	0.00	0.00	20.70	1.49	0.21	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.84
830603	31	.15	20.16	0.00	0.99	0.00	0.00	0.00	40.68	5.62	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	47.63
830603	41	.08	23.66	0.00	1.06	0.00	0.00	0.00	59.18	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.41
830603	51	.1	24.24	0.00	1.65	0.00	0.00	1.24	37.96	11.14	0.00	0.00	0.00	0.00	0.00	1.65	1.24	0.00	0.00	0.00	0.00	54.87
830603	61	.08	23.79	1.58	0.00	0.00	0.00	0.53	78.29	35.20	0.00	0.00	0.00	2.10	0.00	3.68	0.00	0.00	0.00	0.00	0.00	121.37
830603	71	.0333	22.77	3.96	0.00	0.00	0.00	0.00	145.09	36.93	0.00	0.00	1.32	0.00	0.00	5.28	0.00	0.00	0.00	0.00	0.00	192.58
830607	11	.3	22.03	0.00	0.00	0.00	0.00	0.00	16.94	2.77	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	20.00
830607	21	.2	21.47	0.23	0.23	0.00	0.00	0.00	23.53	1.86	0.00	0.00	0.00	0.00	0.23	0.23	0.23	0.00	0.00	0.00	0.00	26.56
830607	31	1	22.35*	0.00	0.76	0.04	0.00	0.00	4.34	1.25	0.00	0.04	0.00	0.00	0.09	0.22	0.09	0.00	0.00	0.00	0.00	6.85
830607	41	.1	22.35*	0.00	0.45	0.00	0.00	0.00	48.76	8.95	0.00	0.00	0.00	0.00	1.34	1.79	0.09	0.00	0.00	0.09	0.00	63.07
830607	51	.1	22.35*	0.00	0.45	0.00	0.00	0.45	56.36	20.58	0.09	0.00	0.00	0.00	12.53	4.92	0.00	0.00	0.00	0.00	0.00	96.18
830607	61	.12	22.35*	0.00	0.00	0.00	0.00	0.00	37.28	4.85	0.37	0.00	0.00	1.49	1.86	2.61	0.37	0.00	0.00	0.00	0.00	48.83
830607	71	.56	22.35*	0.00	1.12	0.08	0.00	0.08	7.91	5.35	0.08	0.00	0.00	4.07	0.00	0.00	0.08	0.00	0.00	0.00	0.00	18.77
830607	81	.005	22.35*	0.00	0.00	0.00	0.00	0.00	1467.25	1118.33	0.00	0.00	0.00	8.95	0.00	8.95	0.00	0.00	0.00	0.00	0.00	2603.48
830613	11	.5	22.35*	0.00	0.45	0.00	0.09	0.00	7.96	10.91	0.00	0.00	0.00	3.49	0.00	1.97	0.00	0.00	0.00	0.00	0.00	24.07
830613	21	1	21.00	0.00	0.62	0.05	0.00	0.10	4.10	6.38	0.24	0.10	0.00	1.24	0.00	3.62	0.05	0.00	0.00	0.00	0.00	16.48
830613	31	1	23.31	0.00	0.09	0.00	0.00	0.00	0.94	2.87	0.00	0.04	0.00	0.99	0.00	1.29	0.00	0.00	0.00	0.00	0.04	6.26
830613	41	1	19.74	0.00	0.20	0.00	0.00	0.00	4.15	1.57	0.05	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	6.94
830613	51	1	21.70	0.00	0.28	0.05	0.00	0.00	4.79	1.47	0.05	0.00	0.00	0.00	0.23	1.52	0.14	0.00	0.00	0.00	0.00	8.53
830613	61	.4	22.00	0.00	0.23	0.00	0.00	0.00	12.39	6.25	0.00	0.00	0.00	0.00	0.45	3.18	0.00	0.00	0.00	0.11	0.00	22.61
830613	71	1	22.37	0.00	0.36	0.00	0.00	0.09	2.91	3.71	0.09	0.13	0.00	1.12	0.13	1.65	0.00	0.00	0.00	0.00	0.00	10.19
830613	81	.06	23.52	0.00	0.71	0.71	0.00	0.00	29.05	26.93	0.00	0.00	0.00	73.70	0.00	10.63	0.71	0.00	0.00	0.00	0.71	143.14
830614	11	1	23.08	0.04	0.00	0.00	0.00	0.13	4.46	3.73	0.09	0.04	0.00	0.22	0.00	0.09	0.00	0.00	0.00	0.00	0.00	8.79
830614	21	.3	24.51	0.14	0.00	0.00	0.00	0.41	12.24	13.19	0.14	0.41	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.00	0.00	28.70
830614	31	.4	22.63	0.00	0.55	0.00	0.11	0.00	10.38	10.05	0.33	0.22	0.00	0.88	0.00	4.53	0.11	0.00	0.00	0.00	0.00	27.18
830615	11	.075	22.02	0.00	1.21	0.00	0.00	0.00	31.49	70.24	0.00	0.00	0.00	29.07	0.61	10.29	0.00	0.00	0.61	0.00	0.00	143.52
830615	21	.04	24.29	0.00	0.00	3.09	1.03	1.03	57.63	235.68	1.03	1.03	0.00	30.88	0.00	21.61	0.00	0.00	1.03	0.00	0.00	354.04
830615	31	.02	22.76	0.00	2.20	0.00	2.20	6.59	32.96	388.89	0.00	0.00	0.00	19.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	452.61
830615	41	.05	23.73	0.00	0.00	0.00	0.84	0.00	37.92	77.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.30
830615	51	1	21.52	0.00	0.00	0.05	0.00	0.14	2.28	3.67	0.00	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	6.87
830615	61	.08	21.28	0.00	0.00	0.00	0.00	0.00	56.38	38.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	94.56
830615	71	.15	24.75	0.27	0.00	0.00	0.00	0.00	8.08	21.01	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	29.63
830615	81	.0222	26.62	0.00	0.00	1.69	1.69	3.38	109.99	208.14	1.69	3.38	0.00	10.15	0.00	13.54	0.00	0.00	0.00	0.00	0.00	353.67

Table 11 (continued).

Date (yr/mo/dy)	Station/location	Aliquot size	Water volume filtered (m^3)	Zooplankton density: Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Nematodes	Ostracods	Polychaetes	Mosquito larvae	Mosquito pupae	Clam	Unidentified	Total zooplankton
830617	11	.01	23.85	0.00	8.46	4.23	0.00	12.69	160.70	114.18	0.00	0.00	0.00	42.29	0.00	12.49	0.00	0.00	0.00	744.29	0.00	1099.52
830617	21	.07	24.25	0.00	2.36	0.00	0.59	5.09	55.96	60.08	2.36	1.18	0.00	37.11	1.77	2.36	1.77	0.00	0.00	10.01	0.00	181.41
830617	31	.06	24.14	0.00	0.69	0.69	0.00	4.83	38.66	75.26	0.69	1.38	0.00	36.59	11.74	2.07	0.69	0.00	0.00	0.00	0.00	173.29
830617	51	1	22.35	0.00	0.13	0.04	0.00	0.13	8.86	1.48	0.00	0.00	0.00	0.00	0.13	0.27	0.13	0.00	0.00	0.00	0.04	11.23
830617	61	.4	22.35	0.00	0.34	0.11	0.00	0.56	10.18	7.27	0.45	0.00	0.00	0.34	0.00	1.23	0.45	0.00	0.00	4.03	0.00	24.94
830621	11	.03	23.58	0.00	1.41	0.00	0.00	0.00	145.60	97.54	0.00	0.00	0.00	16.96	1.41	4.24	0.00	0.00	0.00	0.00	0.00	267.17
830621	21	.06	22.35	0.00	2.24	0.75	0.00	0.75	18.64	86.48	0.00	0.75	0.00	26.09	0.00	1.49	0.00	0.00	0.00	8.95	0.00	146.13
830623	11	.06	24.17	0.00	0.69	0.00	0.69	0.69	42.75	75.16	0.00	0.00	0.00	31.72	0.00	4.83	0.69	0.00	0.00	0.00	0.00	157.22
830623	21	.06	23.56	0.00	0.00	0.00	0.00	0.71	21.93	130.90	0.00	0.71	0.00	38.91	0.71	2.12	0.00	0.00	0.00	0.00	1.42	197.41
830623	31	.02	23.37	0.00	8.56	0.00	0.00	0.00	53.49	218.24	0.00	0.00	0.00	162.61	0.00	4.28	0.00	0.00	0.00	0.00	0.00	447.18
830623	41	.05	22.91	0.00	0.00	5.24	0.00	0.00	49.77	33.18	0.00	0.00	0.00	78.58	1.75	9.60	0.00	0.00	0.00	0.00	0.00	178.12
530623	51	.12	22.32	0.00	0.00	0.37	0.00	0.00	38.08	40.32	0.00	0.00	0.00	10.45	0.00	2.61	3.36	0.00	0.00	0.00	0.00	95.21
830623	61	.05	22.34	0.00	1.79	1.79	0.00	0.00	63.57	98.49	0.00	0.00	0.00	2.69	0.00	11.64	0.90	0.00	0.00	0.00	0.00	180.86
830623	71	.0014	23.10	0.00	0.00	0.00	92.76	0.00	30.92	5689.39	0.00	0.00	0.00	61.84	0.00	30.92	0.00	0.00	0.00	0.00	0.00	5905.83
830623	81	.01	23.23	4.30	0.00	0.00	4.30	0.00	38.74	792.09	0.00	0.00	0.00	469.23	0.00	8.61	0.00	0.00	0.00	0.00	0.00	1317.29
830627	11	.2	20.88	0.00	0.72	0.96	1.20	0.96	9.58	27.06	0.00	0.72	0.24	0.24	0.00	4.31	0.00	0.00	0.00	0.00	0.00	45.98
830627	41	.03	24.64	0.00	1.35	0.00	0.00	1.35	166.91	74.40	0.00	2.71	0.00	12.17	0.00	1.35	0.00	0.00	0.00	0.00	0.00	250.24
830627	51	.01	24.51	0.00	0.00	12.24	0.00	0.00	469.27	179.55	0.00	0.00	0.00	32.64	0.00	65.29	0.00	0.00	4.08	0.00	0.00	763.07
830627	61	.0067	26.86	11.20	5.60	16.80	0.00	0.00	106.37	772.59	0.00	0.00	0.00	766.99	0.00	78.38	0.00	0.00	0.00	0.00	0.00	1757.92
930627	71	.005	22.52	8.88	0.00	26.64	0.00	0.00	222.03	222.03	0.00	0.00	0.00	870.37	0.00	17.76	0.00	0.00	0.00	0.00	0.00	1367.72
830627	81	.01	23.29	0.00	4.29	0.00	0.00	0.00	352.08	824.38	0.00	0.00	4.29	128.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1313.85

Table 12. Inshore distribution and abundance (number/m^3) of zooplankton species groups in 1983 by date.

Species group	Date										Average density
	6-1	6-3	6-7	6-13	6-14	6-15	6-17	6-21	6-23	6-27	
Amhipods	1.25	1.01	0.03	0.00	0.06	0.03	0.00	0.00	0.54	3.35	0.63
Arachnids	1.65	0.53	0.38	0.37	0.18	0.43	2.40	1.82	1.38	1.99	1.11
Chaoborus larv.	1.86	0.03	0.02	0.10	0.00	0.60	1.01	0.38	0.92	9.44	1.44
Chaoborus pupae	4.14	0.00	0.00	0.01	0.04	0.72	0.12	0.00	12.22	0.20	1.74
Chironomids	2.58	0.25	0.07	0.02	0.18	1.39	4.82	0.38	0.18	0.38	1.02
Cladocerans	449.21	83.66	207.80	8.29	9.03	42.09	54.87	82.12	42.41	219.37	119.88
Copepods	114.61	15.30	145.49	7.51	8.99	130.42	51.65	92.01	884.72	350.00	180.07
Insect adults	0.75	0.03	0.17	0.05	0.19	0.34	0.70	0.00	0.00	0.00	0.22
Insect larvae	2.77	0.00	<0.01	0.03	0.22	0.55	0.51	0.38	0.09	0.57	0.51
Isopods	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.12
Leptodorans	1.37	0.98	1.81	10.07	0.37	11.23	23.27	21.52	107.00	301.87	47.95
Nematodes	2.22	0.00	2.01	0.10	0.00	0.08	2.73	0.70	0.31	0.00	0.81
Ostracods	4.82	1.52	2.38	3.10	2.27	5.77	3.72	2.86	9.33	27.85	6.36
Polychaetes	2.50	0.22	0.21	0.11	0.04	0.03	0.61	0.00	0.62	0.00	0.43
Mosquito larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mosquito pupae	0.26	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.68	0.11
Clam	0.00	0.00	0.11	0.01	0.00	0.00	151.66	4.48	0.00	0.00	15.63
Unidentified	0.00	0.00	0.00	0.09	0.00	0.00	0.01	0.00	0.18	0.00	0.03
Average zooplankton density	590.01	103.94	360.47	29.88	21.56	193.90	298.08	206.65	1059.89	916.46	378.08
Average aliquot size	0.015	0.105	0.298	0.745	0.567	0.180	0.308	0.045	0.046	0.044	
No. of stations	8	7	8	8	3	8	5	2	8	6	

Table 13. Inshore distribution and abundance (number/m^3) of zooplankton species groups in 1983 by location.

Species group	Inshore Station 1	2	3	4	5	6	7	8	Average density
Amhipods	0.16	0.04	0.00	0.00	0.00	0.21	2.17	2.03	0.58
Arachnids	2.17	1.32	1.73	0.44	0.56	0.43	0.21	0.83	0.96
Chaoborus larv.	0.52	0.53	0.09	2.47	2.03	0.33	3.82	0.40	1.27
Chaoborus pupae	0.20	0.18	0.29	2.71	1.43	0.46	13.25	1.00	2.44
Chironomids	1.45	1.06	1.43	1.05	0.84	0.95	0.62	1.22	1.08
Cladocerans	114.47	78.27	106.59	145.73	133.14	102.87	94.21	364.71	142.50
Copepods	47.22	70.64	107.39	55.97	50.99	40.86	873.78	516.66	220.44
Insect adults	0.01	0.44	0.13	0.87	0.12	0.10	0.02	0.28	0.25
Insect larvae	0.51	0.46	0.21	2.11	0.00	0.46	0.02	0.56	0.54
Isopods	0.17	0.00	0.00	0.00	0.00	0.00	0.19	0.72	0.14
Leptodorans	13.73	15.19	27.61	12.97	5.39	96.70	133.91	115.14	52.58
Nematodes	0.20	0.30	1.48	2.16	1.61	0.75	0.02	0.00	0.82
Ostracods	3.87	3.73	2.64	5.40	9.63	13.05	7.94	6.95	6.65
Polychaetes	0.07	0.23	0.15	0.13	3.11	0.21	0.05	0.12	0.51
Mosquito larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mosquito pupae	0.06	0.11	0.00	0.00	0.51	0.00	0.30	0.00	0.12
Clam	74.43	2.11	0.00	0.13	0.00	0.52	0.00	0.00	9.65
Unidentified	0.00	0.16	0.01	0.00	0.01	0.00	0.00	0.12	0.04
Average zooplankton density	259.23	174.77	249.75	232.14	209.37	257.90	1130.51	1010.74	440.57
Average aliquot size									
No. of stations	10	9	8	7	8	8	7	6	

Table 14. Distribution and abundance of larval fishes in offshore areas of western Albemarle Sound during June of 1983.

Date (yr/mo/dy)	Station/location	Volume filtered (m^3)	Larval density (no./100 m^3)					
			Striped bass	White perch	Clupeid species	*Morone* species	Unidentified larvae	Total fish density
830601	12	356.57	0.00	1.12	1.40	0.28	3.65	6.45
830601	22	342.27	0.00	3.80	11.39	0.00	5.84	21.04
830601	32	347.26	0.00	1.73	3.74	0.58	4.32	10.37
830601	42	347.01	0.00	1.73	8.65	0.00	2.02	12.39
830601	52	313.61	0.00	2.55	5.10	0.00	1.28	8.93
830601	62	323.01	0.00	28.17	18.27	0.00	0.62	47.06
830601	72	290.43	0.00	18.59	13.08	0.00	2.41	34.09
830601	82	368.13	0.00	0.27	1.09	0.00	0.27	1.63
830603	12	328.31	0.00	2.74	4.87	0.00	3.66	11.27
830603	22	360.14	0.00	0.28	0.56	0.00	0.00	0.83
830603	32	344.52	0.00	0.00	0.58	0.00	0.29	0.87
830603	42	377.36	0.00	0.00	0.00	0.00	0.00	0.00
830603	52	363.01	0.00	0.83	0.28	0.00	1.38	2.48
830603	62	407.91	0.00	0.00	0.00	0.00	0.00	0.00
830603	72	374.27	0.00	1.60	1.34	0.00	2.40	5.34
830603	82	399.48	0.00	0.50	3.75	1.00	0.75	6.01
830605	12	346.28	0.00	2.02	3.18	0.29	0.58	6.06
830605	22	353.94	0.00	2.83	3.67	0.00	0.85	7.35
830605	32	377.54	0.00	0.26	1.59	0.00	0.79	2.65
830605	42	377.99	0.00	0.26	25.93	0.00	0.00	26.19
830605	52	331.33	0.00	1.51	0.60	0.00	0.30	2.41
830605	62	346.49	0.00	2.02	0.58	0.00	0.29	2.89
830605	72	374.25	0.00	3.21	1.60	0.00	0.27	5.08
830605	82	360.67	0.00	7.21	0.55	0.00	0.00	7.76
830607	12	296.08	0.00	0.68	1.69	0.00	0.34	2.70
830607	22	343.02	0.00	0.87	2.04	0.00	0.29	3.21
830607	32	302.70	0.00	0.99	0.00	0.00	0.99	1.98
830607	42	348.95	0.00	2.01	2.29	0.00	0.00	4.30
830607	52	351.47	0.00	1.99	1.14	0.00	0.00	3.13
830607	62	348.64	0.00	1.43	1.15	0.00	0.86	3.44
830607	72	344.53	0.00	2.03	3.77	0.00	1.74	7.55
830607	82	324.62	0.00	0.92	0.62	0.00	0.92	2.46

Table 14 (continued).

Date (yr/mo/dy)	Station/location	Volume filtered (m^3)	Larval density (no./100 m^3) Striped bass	White perch	Clupeid species	*Morone* species	Unidentified larvae	Total fish density
830611	12	307.31	0.98	3.90	3.25	0.98	1.63	9.76
830611	22	347.06	0.86	1.73	14.41	0.00	4.61	20.75
830611	32	318.39	0.00	0.00	21.67	0.00	1.57	23.24
830611	42	343.33	0.00	0.00	9.90	0.00	1.17	11.07
830611	52	406.61	0.00	0.25	5.66	0.25	1.48	7.62
830611	62	331.76	0.00	0.90	5.43	0.00	1.21	7.54
830611	82	318.42	0.00	0.31	4.08	0.94	0.31	5.65
830613	12	358.43	0.00	0.00	3.63	0.00	0.00	3.63
830613	22	305.03	0.00	0.33	0.98	0.00	0.66	1.97
830613	32	323.87	0.00	0.00	0.31	0.00	0.31	0.62
830613	42	342.08	0.00	0.00	1.17	0.00	0.00	1.17
830613	52	330.78	0.00	0.00	0.60	0.00	0.30	0.91
830613	62	339.81	0.00	0.29	2.65	0.00	2.06	5.00
830613	72	318.72	0.63	0.31	4.08	0.31	2.51	7.22
830613	82	323.67	0.62	2.78	2.78	0.00	0.93	6.49
830621	12	334.67	0.00	0.00	2.69	0.00	0.30	2.99
830621	22	327.84	0.00	0.00	0.00	0.00	0.92	0.92
830621	32	339.67	0.00	0.59	0.88	0.00	2.36	3.83
830621	42	346.97	0.00	0.29	1.73	0.00	2.59	4.61
830621	52	324.67	0.31	0.00	0.00	0.00	0.62	0.62
830621	62	330.45	0.00	0.00	3.03	0.00	0.00	3.03
830621	72	328.00	0.00	0.30	1.83	0.00	2.13	4.27
830621	82	330.33	0.00	0.30	8.17	0.00	0.00	8.48
830623	12	416.60	0.00	0.00	0.48	0.00	0.00	0.48
830623	22	262.82	0.00	0.00	0.76	0.00	0.00	0.76
830623	32	323.33	0.00	0.62	3.09	0.00	1.86	5.57
830623	42	320.56	0.00	0.00	11.23	0.00	0.94	12.17
830623	52	304.69	0.33	0.00	3.94	0.00	0.00	3.94
830623	72	360.80	0.00	0.00	0.83	0.00	0.00	0.83
830623	82	341.25	0.00	0.00	1.47	0.00	0.88	2.34
830627	12	296.59	0.00	0.00	0.34	0.00	0.00	0.34
830627	22	338.40	0.00	0.00	0.30	0.00	0.00	0.30
830627	32	361.79	0.00	0.00	0.00	0.00	0.00	0.00
830627	42	398.91	0.00	0.00	6.52	0.00	1.00	7.52
830627	52	349.84	0.00	0.00	1.72	0.00	0.29	2.00
830627	62	373.91						
830627	72	211.62						
830627	82	407.16						

were not as abundant as zooplankton in inshore habitats (Table 15, Table 11). Offshore concentrations were highest after 20 June (Table 16). In early June, zooplankton densities were highest at stations off Black Walnut Point (1-T, 7-T, and 8-T); station 8-T had the highest average zooplankton concentrations throughout the study (Table 17).

Food Habit Analyses

Stomachs of *Morone* larvae were examined to identify and quantify ingested material. A total of 185 *Morone* larvae were examined from those collected in 1982, and 10 striped bass larvae were analyzed from the 1983 survey. Fish were classified as having empty stomachs, stomachs with detritus only, and stomachs containing food items. Food items were identified and quantified by estimating the volume of each food category as a percentage of the total stomach content. Detritus appeared to be small particles of plant debris, but may have contained very small quantities of undefined, partially-digested food items. For purposes of this investigation an assumption was made that detritus was of little nutritional value to *Morone* larvae.

Comparisons of the number of larvae falling into each category were made to determine significant differences by location and date of collection (Table 18). The 1982 survey data was analyzed by Kruskal Wallis H Test, a nonparametric test for determining equality of means among samples (Walpole and Myers 1979). Analysis of the 1983 data was not possible due to the small number of striped bass larvae collected.

Inshore Areas

Morone larvae collected from inshore stations showed significant ($P<0.025$) differences in gut contents (Table 18). Inshore larvae were summed by gut content category. Of the 114 larvae examined, only 15% of *Morone* larvae captured inshore contained food items in stomachs; an additional 61% contained detritus only. Thirty-two percent (32%) of the larvae had empty stomachs. There was no significant difference ($P>0.05$) in the number of larvae in each gut

Table 13. Distribution and abundance of zooplankton in offshore areas of western Albemarle Sound during June of 1982.

Date (yr/mo/dy)	Station/location	Aliquot size	Water volume filtered (m^3)	Zooplankton density: Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Nematodes	Ostracods	Polychaetes	Mosquito larvae	Mosquito pupae	Clam	Unidentified	Total zooplankton
830601	12	.0033	442.83	0.68	0.00	0.00	0.00	0.00	48.59	133.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	182.71
830601	22	.01	357.92	0.28	0.00	0.00	0.00	0.00	43.03	13.41	0.00	0.00	0.00	0.56	0.00	1.68	0.00	0.00	0.00	0.00	0.00	58.95
830601	32	.01	267.46	0.00	0.00	0.00	0.00	0.00	48.23	28.04	0.00	0.00	0.00	0.00	0.00	1.12	1.50	0.00	0.00	0.75	0.00	79.64
830601	42	.01	373.93	1.60	0.27	0.00	0.00	0.80	41.99	13.91	0.00	0.00	0.00	0.27	0.00	1.07	0.27	0.00	0.27	0.00	0.00	60.44
830601	52	.005	576.43	2.43	0.69	0.00	0.00	0.35	48.92	15.27	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00	68.35
830601	62	.01	326.61	3.37	0.00	0.61	0.92	0.31	51.74	23.58	0.00	0.00	0.00	0.00	0.00	1.22	0.00	0.00	0.31	0.00	0.00	82.06
830601	72	.03	358.99	0.56	0.09	0.84	0.00	0.00	6.31	9.38	0.00	0.00	0.00	0.00	0.09	0.28	0.09	0.00	0.00	0.00	0.00	17.64
830601	82	.005	332.19	0.00	0.00	1.20	1.81	0.00	45.76	66.83	0.60	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	116.80
830605	12	.005	336.73	0.59	0.00	0.59	0.00	1.78	65.93	12.47	0.59	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	82.56
830605	22	.02	353.95	1.70	0.00	0.00	0.14	0.14	22.04	12.29	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.45
830605	32	.01	408.82	4.65	0.24	0.00	0.24	0.49	26.91	7.09	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	40.36
830605	42	.2	402.65	0.01	0.02	0.01	0.17	0.00	1.25	0.10	0.02	0.00	0.00	0.01	0.01	0.01	0.11	0.00	0.01	0.00	0.00	1.76
830605	52	.03	325.00	0.00	0.21	0.31	0.00	0.10	12.10	4.31	0.00	0.21	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	17.54
830605	62	.05	375.93	0.00	0.11	0.00	0.00	0.11	13.51	4.15	0.16	0.00	0.00	0.27	0.00	0.37	0.00	0.00	0.00	0.00	0.00	18.67
830605	72	.01	389.73	0.26	0.77	0.00	0.00	0.00	35.67	14.88	0.26	0.00	0.00	2.05	0.00	1.28	0.00	0.00	0.00	0.00	0.00	55.17
830605	82	.005	363.32	0.00	0.00	0.00	0.00	0.00	80.92	17.06	0.55	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.09
830607	12	.01	309.07	0.00	0.00	0.00	0.00	0.00	37.21	5.50	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.36
830607	22	.02	332.27	0.00	0.15	0.15	0.00	0.00	45.45	4.21	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.62
830607	32	.02	286.40	0.00	0.00	0.00	0.00	0.00	20.60	2.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.39
830607	42	.02	340.49	0.00	0.00	0.00	0.00	0.00	20.26	18.21	0.15	0.00	0.00	2.20	0.00	1.32	0.00	0.00	0.00	0.00	0.00	42.15
830607	52	.02	332.06	1.20	0.00	0.15	0.00	0.00	26.35	6.32	0.15	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.00	34.48
830607	62	.01	315.74	1.27	0.32	0.32	0.00	0.00	33.57	12.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.82
830607	72	.005	333.59	0.60	0.00	1.80	0.00	0.00	95.93	22.18	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	121.71
830607	82	.00125	289.46	2.76	0.00	0.00	5.53	0.00	290.19	121.60	0.00	0.00	0.00	2.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	422.85
830611	12	.0033	327.73	0.00	0.00	2.77	0.00	0.00	38.84	257.05	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	302.36
830611	22	.005	345.81	0.58	0.00	0.00	0.00	0.00	37.59	76.34	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	115.09
830611	32	.0067	340.02	0.88	0.44	0.88	0.00	0.88	12.73	44.77	0.00	0.00	0.00	0.88	0.00	1.32	0.44	0.00	0.00	0.00	0.00	63.21
830611	42	.0075	365.03	0.00	0.73	1.10	0.73	0.00	23.74	38.72	0.73	0.00	0.37	0.37	0.00	1.46	0.00	0.00	0.00	0.00	0.00	67.94
830611	52	.01	352.42	0.00	0.00	0.57	0.28	0.28	30.08	29.79	0.28	0.00	0.00	0.28	0.85	0.57	0.00	0.00	0.00	0.00	0.00	62.99
830611	62	.005	353.46	0.00	0.57	0.00	0.57	0.57	45.27	58.28	0.00	0.00	0.00	4.53	0.00	2.83	0.00	0.00	0.00	0.00	0.00	112.60
830611	72	.0025	346.98	0.00	0.00	0.00	0.00	0.00	51.88	229.41	0.00	0.00	0.00	3.46	0.00	2.31	0.00	0.00	0.00	0.00	0.00	287.05
830611	82	.00125	380.96	0.00	0.00	0.00	0.00	0.00	163.80	398.99	2.10	0.00	0.00	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	585.89
830613	12	.0167	339.89	0.00	0.00	0.00	0.00	0.18	7.75	23.78	0.00	0.00	0.00	21.49	0.00	0.18	0.00	0.00	0.00	0.00	0.00	53.38
830613	22	.005	307.49	0.00	1.30	0.65	0.00	0.00	65.04	14.31	0.00	0.00	0.00	1.30	0.00	0.65	0.00	0.00	0.00	0.00	0.00	83.25
830613	32	.02	318.88	0.00	0.00	0.00	0.00	0.16	16.93	2.67	0.00	0.00	0.00	8.94	0.00	0.63	0.00	0.00	0.00	0.00	0.00	29.32
830613	42	.02	322.51	0.00	0.93	0.16	0.00	0.00	8.06	4.19	1.09	0.00	0.00	20.93	0.00	1.24	0.00	0.00	0.00	0.00	0.00	36.59
830613	52	.0167	334.70	0.00	0.00	1.25	0.00	0.00	21.47	30.77	0.00	0.00	0.00	6.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.75
830613	62	.0033	321.58	0.00	0.00	0.94	0.00	0.00	59.37	203.54	0.00	0.00	0.00	3.77	0.00	2.83	0.00	0.00	0.00	0.00	0.00	270.45
830613	72	.0067	302.07	0.00	0.00	0.99	0.00	0.00	50.89	74.12	0.00	0.00	0.00	5.93	0.00	4.45	0.00	0.00	0.00	0.00	0.00	136.37

Table 15 (continued).

Date (yr/mo/dy)	Station/location	Aliquot size	Water volume filtered (m^3)	Amphipods	Arachnids	*Chaoborus* larvae	*Chaoborus* pupae	Chironomids	Cladocerans	Copepods	Insect adults	Insect larvae	Isopods	Leptodorans	Nematodes	Ostracods	Polychaetes	Mosquito larvae	Mosquito pupae	Clam	Unidentified	Total zooplankton
				Zooplankton density																		
830621	12	.02	326.41	0.00	0.00	0.31	0.00	0.00	15.77	9.49	0.00	0.15	0.00	2.91	0.00	0.15	0.00	0.00	0.00	0.00	0.00	28.78
830621	22	.0133	328.69	0.00	0.46	0.23	0.00	0.00	13.73	5.72	0.23	0.00	0.00	24.93	0.00	0.23	0.00	0.00	0.00	0.00	0.00	45.52
830621	32	.0133	332.99	0.00	0.00	0.45	0.00	0.00	20.32	19.19	0.00	0.00	0.00	12.87	0.00	1.58	0.00	0.00	0.00	0.00	0.00	54.42
830621	42	.0067	354.21	0.00	0.00	1.26	0.00	0.00	34.13	19.80	0.00	0.00	0.00	45.93	0.00	1.26	0.00	0.00	0.00	0.00	0.00	102.39
830621	52	.0033	332.86	0.00	0.00	0.91	0.00	0.00	39.15	52.80	0.00	0.00	0.00	86.58	0.00	4.55	0.00	0.00	0.00	0.00	0.00	183.99
830621	62	.004	296.75	0.00	0.84	1.68	0.00	0.00	26.96	100.25	0.00	0.00	0.00	25.27	0.00	2.53	0.00	0.00	0.00	0.00	0.00	157.54
830621	72	.0011	323.03	0.00	0.00	0.00	0.00	0.00	42.21	436.21	0.00	0.00	0.00	14.07	0.00	2.81	0.00	0.00	0.00	0.00	0.00	495.31
830621	82	.0006	319.40	0.00	0.00	15.65	0.00	5.22	83.49	1654.15	0.00	0.00	0.00	26.09	0.00	31.31	0.00	0.00	0.00	0.00	0.00	1815.91
830623	12	.0167	345.42	0.17	0.00	0.00	0.00	0.00	19.07	6.76	0.00	0.00	0.00	31.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.38
830623	22	.0029	342.38	0.00	0.00	0.00	0.00	0.00	2.01	41.29	0.00	0.00	0.00	122.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	166.18
830623	32	.0031	317.87	0.00	0.00	0.00	0.00	0.00	0.00	145.12	0.00	0.00	0.00	128.88	0.00	10.15	0.00	0.00	0.00	0.00	0.00	284.15
830623	42	.005	325.94	1.84	0.61	1.84	0.00	0.00	3.07	62.59	0.00	0.00	0.00	35.59	0.00	5.52	0.00	0.61	0.00	0.00	0.00	111.68
830623	52	.006	278.10	0.60	0.00	1.20	0.00	0.00	6.59	70.72	0.00	0.00	0.00	57.53	0.00	2.40	0.00	0.00	0.00	0.00	0.00	139.04
830623	62	.0033	332.06	3.65	0.00	0.00	0.00	0.00	4.56	125.02	0.00	0.00	0.00	107.68	0.00	2.74	0.00	0.00	0.00	0.00	0.00	243.66
830623	72	.0013	369.18	0.00	0.00	2.08	0.00	0.00	43.76	479.23	0.00	0.00	0.00	47.92	0.00	6.25	2.08	0.00	0.00	0.00	0.00	581.33
830623	82	.0011	337.92	0.00	2.69	6.38	0.00	2.69	26.90	529.98	0.00	0.00	0.00	40.35	0.00	0.00	0.00	2.69	0.00	0.00	0.00	611.68
830627	12	.0067	301.60	0.00	0.00	0.00	0.00	0.00	4.95	46.02	0.00	0.00	0.00	1.48	0.00	0.99	0.00	0.00	0.00	0.00	0.00	53.45
830627	22	.012	330.40	0.00	0.00	0.50	0.00	0.00	2.52	23.71	0.00	0.00	0.00	28.50	0.00	1.51	0.00	0.00	0.00	0.00	0.00	56.75
830627	32	.016	373.00	0.00	0.00	0.50	0.00	0.00	0.67	19.44	0.17	0.00	0.00	16.25	0.00	1.68	0.00	0.00	0.00	0.00	0.00	38.71
830627	42	.016	391.73	0.00	0.00	0.00	0.00	0.51	0.68	20.59	0.00	0.00	0.00	9.70	0.00	1.02	0.00	0.00	0.00	0.00	0.00	32.51
830627	52	.0182	330.63	0.00	0.00	0.00	0.00	0.00	0.00	17.62	0.00	0.00	0.00	0.33	0.00	0.83	0.00	0.00	0.00	0.00	0.17	18.94
830627	62	.0073	354.58	3.09	0.00	1.16	0.00	0.00	14.68	54.86	0.00	0.00	0.00	13.52	0.00	0.00	0.39	0.00	0.39	0.00	0.00	88.09
830627	72	.0036	273.09	3.05	0.00	16.27	2.03	0.00	19.33	191.23	0.00	0.00	0.00	18.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	250.22
830627	82	.0036	209.66	3.97	0.00	27.82	0.00	2.65	25.17	243.78	0.00	0.00	0.00	5.30	0.00	1.32	0.00	0.00	0.00	0.00	0.00	310.02

Table 16. Offshore distribution and abundance (number/m^3) of zooplankton species groups in 1983 by date.

Species group	Date 1	2	3	4	5	6	7	8	Average density
Amhipods	1.12	0.90	0.73	0.18	0.00	0.00	0.78	1.26	0.62
Arachnids	0.13	0.17	0.06	0.22	0.32	0.16	0.41	0.00	0.18
Chaoborus larv.	0.33	0.11	0.30	0.66	0.57	2.56	1.31	5.78	1.45
Chaoborus pupae	0.34	0.07	0.69	0.20	0.00	0.00	0.00	0.25	0.19
Chironomids	0.18	0.33	0.00	0.22	0.05	0.65	0.34	0.40	0.27
Cladocerans	41.82	32.29	71.20	50.49	32.79	34.47	13.25	8.50	35.60
Copepods	37.98	9.05	24.15	141.67	50.48	287.20	182.59	77.15	101.28
Insect adults	0.08	0.20	0.24	0.39	0.16	0.03	0.00	0.02	0.14
Insect larvae	0.00	0.03	0.00	0.00	0.00	0.02	0.00	0.00	<0.01
Isopods	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	<0.01
Leptodorans	0.18	0.38	0.70	4.28	9.80	29.71	71.53	11.68	16.03
Nematodes	0.01	<0.01	0.00	0.11	0.00	0.00	0.00	0.00	<0.01
Ostracods	0.67	0.41	0.33	1.33	1.43	5.55	3.38	0.92	1.97
Polychaetes	0.32	0.01	0.02	0.06	0.00	0.00	0.26	0.05	0.09
Mosquito larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.05
Mosquito pupae	0.07	<0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.01
Clam	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Unidentified	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	<0.01
Average zooplankton density	83.32	43.96	98.42	199.86	95.60	360.35	274.26	106.08	157.73
Average aliquot size	0.009	0.041	0.013	0.005	0.011	0.062	0.005	0.010	
No. of stations	8	8	8	8	7	8	8	8	

Table 17. Offshore distribution and abundance (number/m^3) of zooplankton species groups in 1983 by location.

Species group	Offshore Station 1	2	3	4	5	6	7	8	Average density
Amhipods	0.18	0.32	0.69	0.43	0.53	1.42	0.56	0.96	0.64
Arachnids	0.00	0.24	0.09	0.32	0.11	0.23	0.11	0.38	0.18
Chaoborus larv.	0.46	0.19	0.23	0.55	0.55	0.59	2.75	7.15	1.56
Chaoborus pupae	0.00	0.18	0.03	0.11	0.04	0.19	0.25	1.05	0.23
Chironomids	0.24	0.02	0.19	0.16	0.09	0.12	0.00	1.51	0.29
Cladocerans	29.76	28.93	18.30	16.65	23.08	31.21	43.25	102.32	36.69
Copepods	61.82	23.91	33.64	22.26	28.45	72.25	182.08	433.20	107.26
Insect adults	0.07	0.24	0.02	0.25	0.05	0.02	0.03	0.46	0.14
Insect larvae	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.01
Isopods	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	<0.01
Leptodorans	7.70	22.29	20.98	14.37	18.25	19.38	11.47	18.75	16.65
Nematodes	0.00	0.00	0.00	<0.01	0.11	0.00	0.01	0.11	0.03
Ostracods	0.24	0.58	2.15	1.61	1.10	1.56	2.32	1.10	1.33
Polychaetes	0.00	0.00	0.24	0.05	0.11	0.05	0.27	0.11	0.10
Mosquito larvae	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.38	0.06
Mosquito pupae	0.00	0.00	0.00	0.04	0.00	0.09	0.00	0.00	0.02
Clam	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.01
Unidentified	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Average zooplankton density	100.49	76.90	76.65	56.93	73.02	127.61	243.10	568.11	165.35
Average aliquot size	0.010	0.011	0.012	0.036	0.014	0.012	0.008	0.003	
No. of stations	8	8	8	8	8	8	8	7	

Table 18. Statistical comparisons, by date and location, of the number of *Morone* larvae with empty stomachs, stomachs with food items, or stomachs with detritus only, using Kruskal-Wallis H Test for significance. Category refers to status of the stomach (empty, food, detritus only).

Location	Comparison	No. of fish	No. of cells	df	h	$X^2_{.05}$	P
Inshore	category by station	110	15	2	7.835	6.0	<0.025
	station by category	110	15	4	0.600	9.5	>0.05
	category by date	114	12	2	8.769	6.0	<0.025
	date by category	114	12	3	0.064	7.8	>0.05
Offshore	category by station	64	21	2	0.036	6.0	>0.05
	station by category	64	21	6	0.515	12.6	>0.05
	category by date	69	15	2	1.865	6.0	>0.05
	date by category	69	15	4	0.375	9.5	>0.05

content category when summed by date (n=114) or by station (n=110) (Table 18). There was no correlation (i.e., a significant difference; F=7.49, P<0.01, n=35) between total inshore zooplankton density and the percentage of inshore larvae with food present in stomachs, indicating that Morone larvae were feeding at rates or levels unrelated to total zooplankton density.

Copepods and cladocerans were the only food groups found in stomachs of Morone larvae collected in 1982 (Table 19). The relationship between food items in stomachs and the zooplankton density available was analyzed by assuming that copepods and cladocerans are the only groups fed upon by Morone larvae. By date and location, the percentage of total edible zooplankton (copepods + cladocerans) that were copepods was compared to the percentage of copepods found in fish stomachs. The relationship was not statistically significant (F=0.14, P>0.05, n=19) for inshore larvae when analyzed by analysis of variance; this means that the percentage of copepods in stomachs increased as the number of copepods in the population increased (r=0.50). Thus, the data suggest that Morone larvae were opportunistic feeders in the inshore areas of western Albemarle Sound in 1982.

Offshore Areas

The numbers of offshore larvae in each gut content category did not change significantly (P>0.05) by station (n=64) or date (n=69) (Table 18). Even though there were no significant differences in the number of larvae present in each category, the occurrence of empty stomachs in offshore areas was slightly higher (35%) than those collected from inshore areas. Approximately one-fourth (26%) of offshore larvae examined contained food, and 39% of the stomachs contained detritus only. The was no correlation between the percentage of copepods in stomachs and percentage of copepods in the offshore zooplankton population (F=5.89, P=0.03, df=13). Furthermore, significant differences (F=9.47, P=0.004, df=35) were evident between the percentage of offshore larvae with food in stomachs and the concentration of total edible zooplankton. Thus, it appears that feeding of offshore Morone larvae was independent of food concentration.

Table 19. Stomach contents of *Morone* larvae collected from western Albemarle Sound, North Carolina, during May 1982. Location 1 = inshore; 2 = offshore. Volume of ingested items was estimated as a percentage of total stomach contents.

Date	Stat/loc		Number of larvae examined	Average length (mm)	Min. length (mm)	Max. length (mm)	% with empty stomachs	% with detritus only	% with food items	Stomach contents (% volume)		
										Cope-poda	Clado-cera	Detri-tus
5-23	1	1	2	3.40	3.06	3.74	100	0	0			
5-19	2	1	2	4.36	3.92	4.80	0	0	100	97.5	0.0	2.5
5-19	4	1	9	6.23	5.44	7.14	33	67	0			
5-23	4	1	8	4.63	3.57	5.61	50	50	0			
5-25	4	1	10	6.10	4.76	11.05	40	50	10	95.0	0.0	5.0
5-19	5	1	10	6.32	5.10	9.86	60	30	10	0.0	40.0	60.0
5-25	5	1	4	5.91	5.61	6.29	0	75	25	0.0	15.0	85.0
5-29	5	1	8	6.40	5.95	6.63	38	38	24	45.0	50.0	5.0
5-19	6	1	10	5.05	3.57	6.63	0	60	40	59.7	0.8	39.5
5-23	6	1	10	5.97	5.27	6.80	20	80	0			
5-25	6	1	1	6.29	-	-	0	100	0			
5-29	6	1	11	6.10	5.78	6.46	27	64	9	80.0	0.0	20.0
5-19	7	1	10	4.40	3.74	5.44	80	20	0			
5-23	7	1	4	7.65	5.95	11.39	25	75	0			
5-25	7	1	6	7.82	6.46	9.52	0	50	50	66.7	0.0	33.3
5-29	7	1	1	7.16	-	-	0	0	100	95.0	0.0	5.0
5-19	8	1	7	6.22	5.10	7.99	14	86	0			
5-25	8	1	1	8.84	-	-	0	0	100	100.0	0.0	0.0
5-27	1	2	2	5.10	4.59	5.61	50	50	0			
5-27	2	2	6	5.92	4.08	8.50	0	33	67	48.8	12.5	38.7

Table 19 (continued).

Date	Stat/loc		Number of larvae examined	Average length (mm)	Min. length (mm)	Max. length (mm)	% with empty stomachs	% with detritus only	% with food items	Stomach contents (% volume) Cope-poda	Clado-cera	Detri-tus
5-27	3	2	6	4.90	3.40	6.29	67	33	0			
5-29	3	2	1	5.78	-	-	0	100	0			
5-23	4	2	10	6.49	5.44	11.05	20	70	10	60.0	0.0	40.0
5-27	4	2	8	5.27	4.25	5.78	50	25	25	100.0	0.0	0.0
5-29	4	2	4	6.12	5.78	6.46	0	100	0			
5-19	5	2	1	1.96	-	-	0	100	0			
5-21	5	2	2	5.01	4.08	5.95	50	50	0			
5-21	5	2	7	5.54	4.76	6.29	71	29	0			
5-25	5	2	2	7.06	5.95	8.16	0	100	0			
5-29	5	2	2	5.14	4.90	5.39	0	100	0			
5-19	6	2	8	7.23	5.61	12.24	0	0	100	90.8	0.0	9.2
5-29	6	2	1	9.31	-	-	0	0	100	10.0	0.0	90.0
5-19	7	2	4	5.86	5.27	6.29	75	25	0			
5-23	7	2	1	7.48	-	-	0	0	100	0.0	2.0	98.0
5-19	8	2	5	6.53	5.78	8.16	80	0	20	25.0	0.0	75.0
5-29	8	2	1	10.20	-	-	0	100	0			

No food items were found in stomachs of striped bass larvae examined from the 1983 survey (n=10). Offshore larvae either had empty stomachs (44%) or stomachs containing only detritus (56%). Only one striped bass larvae was caught in inshore waters, and its gut was empty (Table 20).

DISCUSSION

Many of the striped bass larvae collected from western Albemarle Sound in 1982 and 1983 had empty stomachs, which could have been caused by aberrations in feeding behavior or inadequate food supply. Empty stomachs could be a result of aberrations in feeding behavior caused by pollutants in the water column, which might inhibit the ability of striped bass larvae to make successful feeding strikes on zooplankton. An alternate explanation is that feeding strategies may have changed in response to changes in zooplankton species composition or abundance. Unfortunately, little is known about the historical abundance and species composition of zooplankton in the Roanoke River and Albemarle Sound, and less about the types and strengths of pollutants that may adversely affect larval fish and zooplankton. However, many of the larvae are "successful" feeders in that some material is present in stomachs.

Many stomachs of striped bass larvae contained, or were filled with, detritus. Researchers studying larval striped bass in other estuarine areas have not observed detritus in gut contents, specifically in the Potomac River (F.D. Martin and E.M. Setzler-Hamilton, Chesapeake Biological Laboratory, Solomons, MD, personal communications), or the Sacramento River (M.B. Eldridge, National Marine Fisheries Service, Southwest Fisheries Center, Tiburon, CA, personal communication). Detritus appeared to be comprised of small particles of plant debris, although some of the material could have been unrecognizable digested animal matter. Regardless of the potential for food items to have gone unrecognized, the fact remains that small particles of plant debris are commonly found in Roanoke larval striped bass stomachs. It was assumed that striped bass larvae could derive little, if any, nutritional value from consuming plant debris, although juvenile Atlantic menhaden (*Brevoortia tyrannus*) can digest cellulose with 75% efficiency (Lewis and Peters 1984).

Table 20. Stomach contents of striped bass larvae collected from western Albemarle Sound, North Carolina, during June 1983. Location 1 = inshore; 2 = offshore. Station numbers as in Figure 1.

Date	Station/location		Number of larvae examined	Larva length (mm)	Stomach content	Percent of stomach contents
6-11	2	2	3	6.80	detritus	100
				7.14	empty	-
				6.80	detritus	100
6-13	7	2	2	6.97	detritus	100
				6.80	detritus	100
6-13	8	2	2	5.61	empty	-
				6.80	empty	-
6-21	5	2	1	5.61	detritus	100
6-23	5	2	1	7.74	empty	-
6-27	6	1	1	7.10	empty	-

Zooplankton concentrations in western Albemarle Sound are lower (Table 21) than those observed in the Potomac River (Setzler-Hamilton et al. 1981; F.D. Martin, personal communication) and the Sacramento River (Eldridge et al. 1981), systems containing large -- but declining -- stocks of striped bass. Zooplankton in all three systems are dominated by several species of copepods, which appear to be the preferred food items of larval striped bass in estuarine areas. Low concentrations of zooplankton in Albemarle Sound are not unreasonable, since similar oligohaline estuaries typically have low concentrations of zooplankton (Copeland et al. 1983). Low numbers of edible zooplankton, combined with high concentrations of suspended organic matter (Heath 1975) and sediment, may cause larval striped bass to make some feeding strikes on plant debris rather than the less abundant edible zooplankton. If no successful feeding on zooplankters is accomplished, and if no nutritional value is gained from ingesting the plant debris, larval striped bass will starve. Thus, year-class strength in the Roanoke River striped bass population may be controlled or affected to a great extent by zooplankton concentrations on the nursery grounds.

Histological studies indicate that starvation can be detected by the appearance of lesions in various organs and tissues of striped bass larvae (Martin and Malloy 1981). In laboratory studies, Eldridge et al. (1981) reported that some striped bass larvae can live without food for up to 18 days and yet remain capable of making successful feeding strikes on Artemia nauplii. However, histological studies show that degeneration of the optic nerves in starving larvae can begin as early as six days after feeding should have been initated (Joel Bodammer, National Marine Fisheries Service, Oxford Laboratory, MD, personal communication), thus decreasing the chances of successful feeding strikes.

Work in Chesapeake Bay indicates that high densities of zooplankton at the time of first larval feeding is one factor contributing to survival of striped bass larvae in the Potomac Estuary (Mihursky et al. 1981). Zooplankton concentration in the Potomac Estuary is related to river flow. Higher flow results in higher zooplankton concentrations, but the mechanisms involved for producing a successful year-class remain unclear. Position of the spawning

Table 21. Comparison of total zooplankton concentrations and larval striped bass status for several estuaries within the continental United States. Percentages of larval stomach contents refer to those stomachs examined that contained food items, were empty, or contained detritus only.

River system	Year	Plankton net size	Total zooplankton (no./m^3)	Larval status	Source
Sacramento	1980	75 um, pumped	100,000	"some" mortality	Eldridge et al. (1981)
Potomac	1981	75 um, pumped	200,000-500,000	10-15% of larvae starving	F.D. Martin (personal communication)
Potomac	1982	75 um, pumped	1,000,000-2,000,000	growth, stomachs full of <u>Bosmina</u>	F.D. Martin (personal communication)
Albemarle Sound (western end)	1982	inshore: 250 um, pushed	54-16,188	larval stomachs (n=114): Food - 14% Empty - 36% Detritus - 50%	present study
		offshore: 250 um, towed	8-8,867	larval stomachs (n=69): Food - 28% Empty - 30% Detritus - 42%	
Albemarle Sound (western end)	1983	inshore: 250 um, pushed	6-5,905	larval stomachs (n=1): Empty - 100%	present study
		offshore: 250 um, towed	1-1,815	larval stomachs (n=9): Food - 0% Empty - 44% Detritus - 56%	

stock as well as timing of spawning activity were also listed as crucial factors in determining survival of striped bass larvae in the Potomac Estuary.

RECOMMENDATIONS

From work conducted on larval striped bass in western Albemarle Sound in 1982 and 1983, it is evident that inadequate food supply -- quantity and/or quality -- may be a contributing factor to poor year-class success. However, few larvae were collected from western Albemarle Sound, suggesting that the factors controlling larval survival may be in the Roanoke River, not in western Albemarle Sound. Therefore, recommendations for future study are:

1. Examine the distribution and abundance of striped bass yolk-sac larvae and early juveniles in the lower Roanoke River, delta, and extreme western sound after peak spawning activity of adult striped bass is observed at Weldon, North Carolina.
2. Determine the location at which feeding by Roanoke larvae is first initiated.
3. Determine the distribution and abundance of zooplankton in the lower Roanoke River, delta, and extreme western sound, in relation to larval striped bass abundance.
4. Examine the density and species composition of phytoplankton algae available in these areas to support zooplankton production.
5. Determine food items ingested by Roanoke striped bass larvae in the lower Roanoke River using gut analysis techniques.
6. Determine the incidence of starvation in Roanoke striped bass larvae using histological techniques.

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