1991

Distribution Of Striped Bass Morone-Saxatilis (Walbaum) Eggs And Larvae In Major Virginia Rivers

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Abstract.–Spring ichthyoplankton surveys in the tidal freshwater reaches of Virginia rivers were used to document the temporal and spatial occurrence of spawning by striped bass *Morone saxatilis* (Walbaum). Single river systems were intensively surveyed in 1980 (York River system), 1981 (James River system), and 1982 (Rappahannock River). In spring 1983, all three river systems were sampled at approximately weekly intervals. Some spawning occurred in all years, including those yielding poor year-classes (1980 and 1981). Spawning occurred largely within the first 40 km of tidal freshwater in major rivers, except when drought conditions displaced spawning upstream in advance of encroaching saltwater. Eggs appeared in sharp, brief peaks of abundance, usually between the third week in April and the first week in May. Peak densities coincided with rapidly rising water temperatures in the range 13.7–19.5°C.

Manuscript accepted 19 October 1990.
Fishery Bulletin, U.S. 89:187–193 (1991).

Distribution of Striped Bass *Morone saxatilis* (Walbaum) Eggs and Larvae in Major Virginia Rivers*

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The importance of Chesapeake Bay spawning grounds to Atlantic coast stocks of striped bass *Morone saxatilis* (Walbaum) has long been recognized (Merriman 1941; Raney 1952; Briggs 1962; Alperin 1966; Schaefer 1967, 1968, 1972; Berggren and Lieberman 1978; Kohlenstein 1981; Fabrizio 1987a, 1987b). Striped bass spawning in Chesapeake Bay and its tributaries has been documented from collections of eggs and larvae (Tresselt 1952, Rinaldo 1971, Johnson and Koo 1975, Polgar et al. 1976, Conte et al. 1979, Kernehan et al. 1981, Setzler-Hamilton et al. 1981), and survey data on the distribution of juveniles or presence of ripe adults (Vladykov and Wallace 1952, Grant and Joseph 1969, Markle and Grant 1970, Grant 1974).

Direct documentation of striped bass spawning in Virginia rivers based on plankton collections of eggs and larvae was provided by consecutive single surveys of five rivers in April and May 1950 (Tresselt 1952); a single river survey during the entire 1966 spawning season (Rinaldo 1971); and a single river survey during the entire 1985 spawning season (McGovern and Olney 1988). This paper documents temporal and spatial occurrence of striped bass eggs and larvae in Virginia's major river systems. The York, James, and Rappahannock river systems, respectively, were surveyed in the years 1980–82; all three rivers were sampled in 1983.

Methods and materials

Lower tidal freshwater portions of the James, Chickahominy, Pamunkey, Mattaponi, and Rappahannock Rivers were divided into 3-mile (5-km) strata, from which single stations were randomly selected prior to each sampling trip. Number of strata (in parentheses) and cruise dates were: the Pamunkey River (10), 16 April–13 June 1980 and 5 April–11 May 1983; Mattaponi River (6), 18 April–14 June 1980; James River (10), 22 April–19 June 1981 and 8 April–8 May 1983; Chickahominy River (7), 21 April–18 June 1981; and Rappahannock River (9), 5 April–6 June 1982 and 9 April–13 May 1983.

Stations were sampled semi-weekly to weekly within strata extending upstream from the limits of brackish water (~0.5‰) to beyond the observed occurrence of striped bass eggs. Collections at each station were stepped-oblique, daylight tows of a 60-cm bongo sampler, equipped with 333-μm mesh nets and flowmeters. Length of tows were 2–6 minutes; tows in deep water were of longer duration and tows encountering excessive detritus loads were shortened. Catches from the paired nets

*Contribution no. 1626 of the Virginia Institute of Marine Science and School of Marine Science, College of William and Mary.

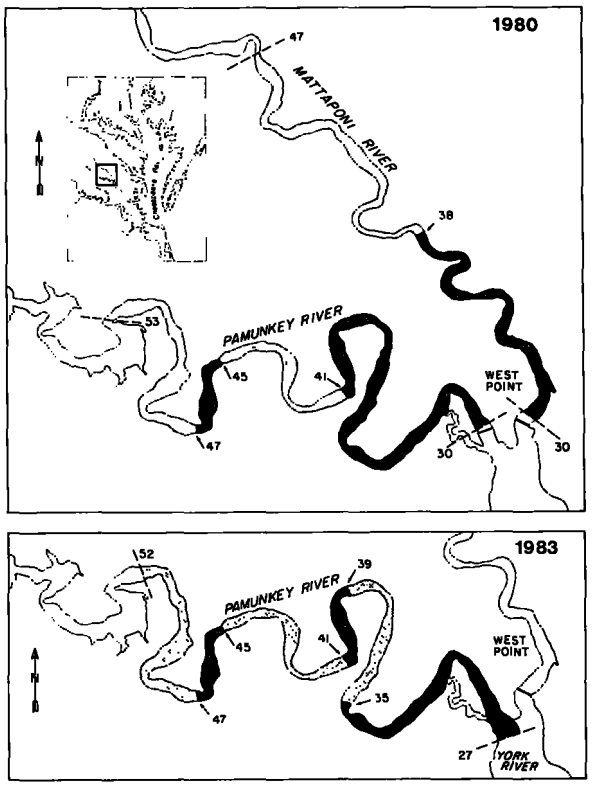

Figure 1
Spatial extent of observed striped bass egg occurrence, Pamunkey and Mattaponi rivers, 1980 and 1983. Over 80% of eggs occurred in solid black areas. Inset shows location in Chesapeake Bay region.

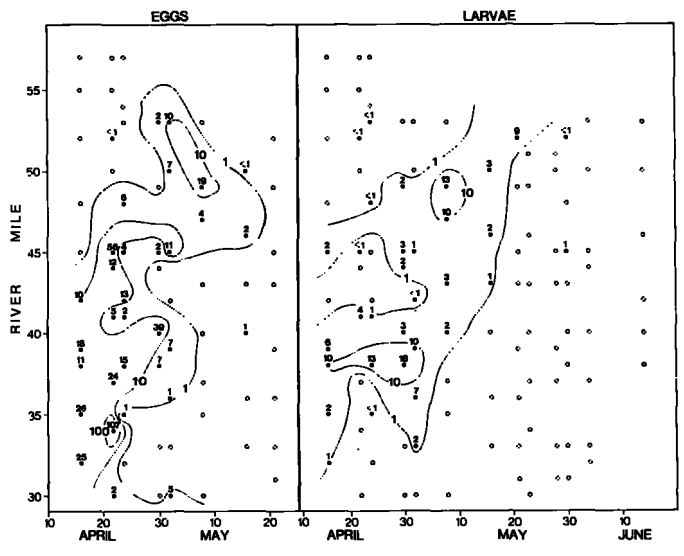

Figure 2
Spatial and temporal abundance (numbers/100 m^3) of striped bass eggs and larvae in the Pamunkey River, 1980. River miles are nautical miles above the York River mouth.

were combined and preserved in 5–8% buffered formalin. Sampling in 1983 was intended to document only egg occurrence; however, surveys on 4 and 11 May 1983 yielded some larval data. Surface and bottom measurements of temperature, salinity, and dissolved oxygen were made at each station.

Whole collections were sorted for striped bass eggs and *Morone* spp. larvae, except where large amounts of detritus necessitated examining only one-half of the collection. When bits and pieces of striped bass eggs were found, only intact eggs and separated embryos were counted. The area of peak spawning was defined as those strata that cumulatively contributed >80% of all eggs collected. *Morone* larvae lacking yolk material and larger than 8.5mm standard length were cleared and stained for positive identification (Fritzsche and Johnson 1980, Olney et al. 1983).

Results

York River System, 1980 and 1983

Spawning extended approximately 40km upstream from the limit of brackish water in the Pamunkey River in 1980 and 1983 and 27km in the Mattaponi River in 1980. Peak spawning was recorded over 13km on the Mattaponi River, while on the Pamunkey River it was observed in two disjunct regions (miles 27–41 and 45–47) in both years (Fig. 1). In 1980, eggs were found on initial surveys (April 16 and 18), indicating that spawning activity had already begun (Figs. 2, 3). Peak egg densities (>1/m^3) occurred on 22 and 25 April in the Pamunkey and Mattaponi rivers, respectively. In 1983 (Fig. 4), sampling on the Pamunkey River was initiated on 5 April, but few eggs were collected until 27 April, when peak densities for the season were encountered.

Abundance of larval striped bass was centered somewhat further upstream than eggs on the initial 1980 surveys, and all were yolksac larvae. Peaks in egg and larval abundance coincided more closely on subsequent sampling dates (Figs. 2, 3). Few larvae were collected after the 8 and 9 May surveys of the Pamunkey and Mattaponi rivers, none after 31 May.

Modal length of larvae in both rivers was 5mm NL (notochord length) and most were yolksac larvae. All larvae captured after 16 May were 12mm SL (standard length) or larger. In 1983, all larvae from the surveys of 4 and 11 May (the only collections examined for larvae) were yolksac larvae less than 6mm in length.

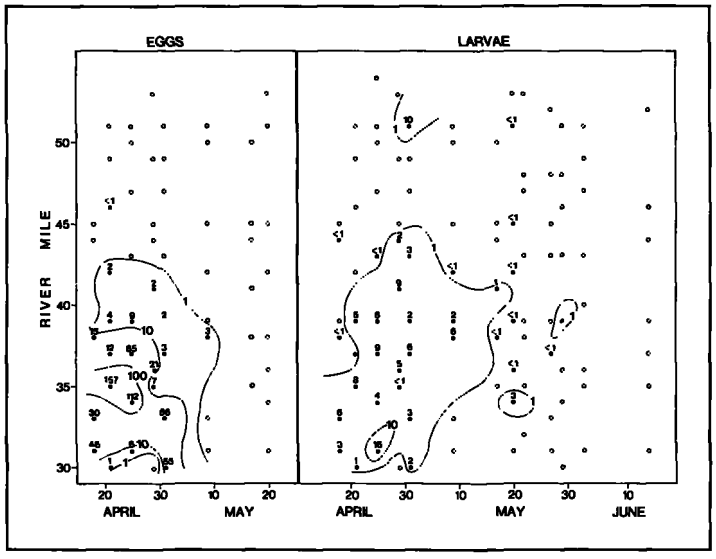

Figure 3
Spatial and temporal abundance (numbers/100 m^3) of striped bass eggs and larvae in the Mattaponi River, 1980. River miles are nautical miles above the York River mouth.

James River System, 1981 and 1983

Location of peak spawning and maximum densities of eggs differed considerably between 1981 and 1983 (Fig. 5). Occurrence of eggs much farther upstream in 1981 was probably related to drought and intrusion of saltwater in winter and spring, 1980–81. Spawning extended over 35 km in 1981, and over 40 km in 1983. In both years

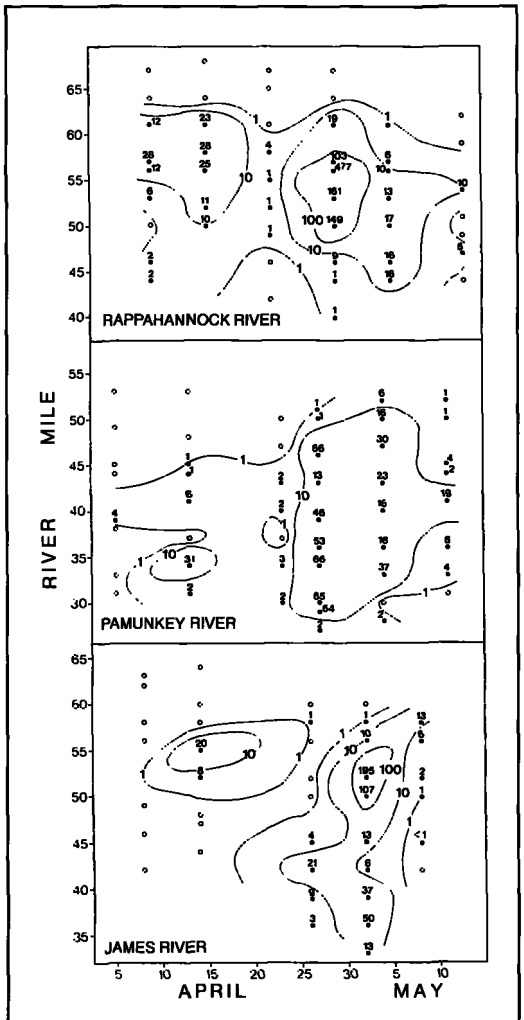

Figure 4
Spatial and temporal abundance (numbers/100 m^3) of striped bass eggs in three Virginia rivers, 1983. River miles are nautical miles.

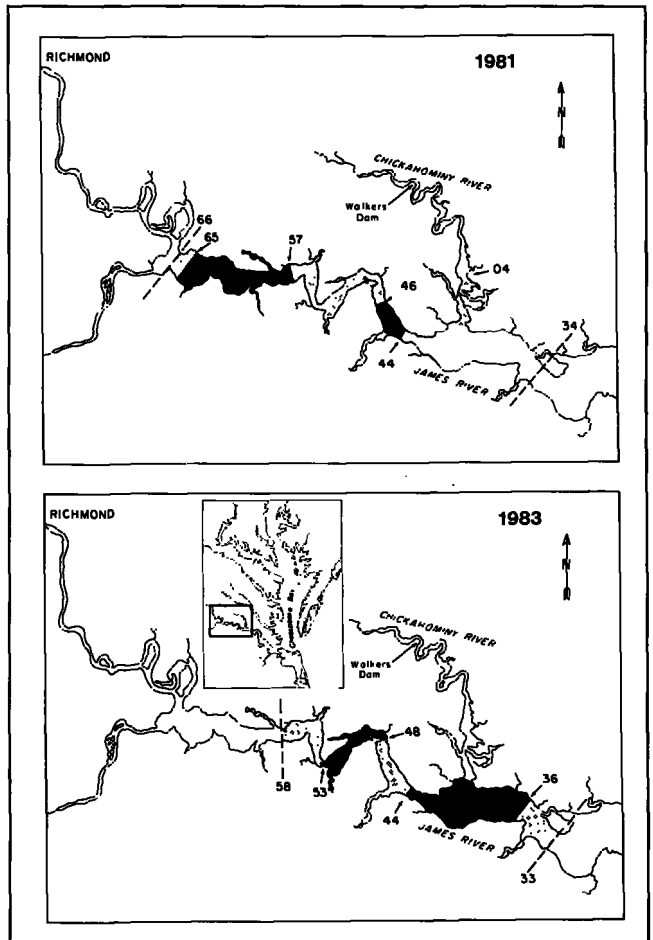

Figure 5
Spatial extent of observed striped bass egg occurrence, James River, 1981 and 1983. Over 80% of eggs occurred in solid black areas. Inset shows location in Chesapeake Bay region.

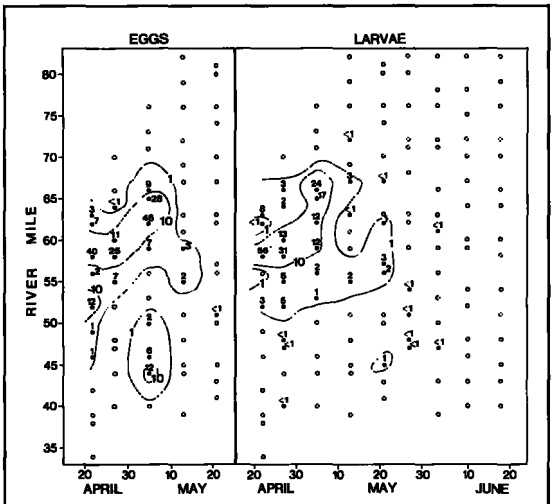

Figure 6
Spatial and temporal abundance (numbers/100 m^3) of striped bass eggs and larvae in the James River, 1981. River miles are nautical miles above the river mouth.

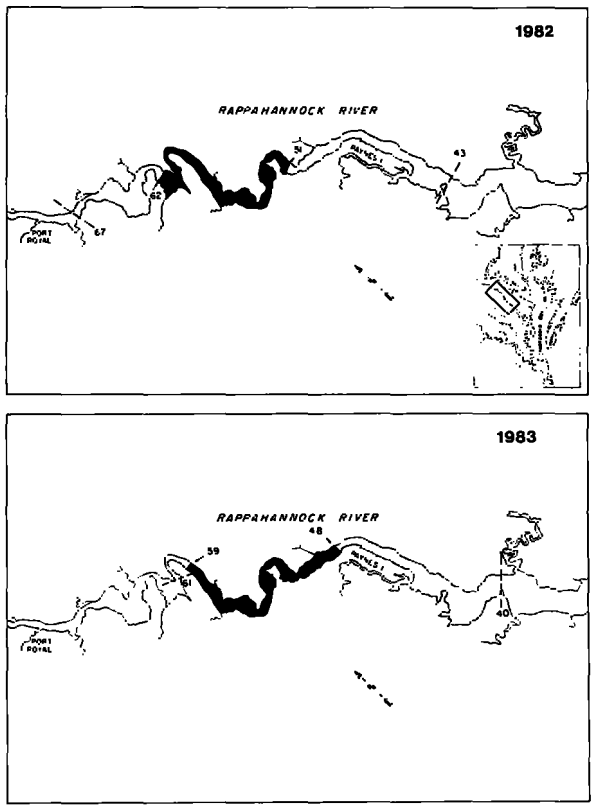

Figure 7
Spatial extent of observed striped bass egg occurrence, Rappahannock River, 1982 and 1983. Over 80% of eggs occurred in solid black areas. Inset shows location in Chesapeake Bay region.

peak spawning appeared to be bimodally distributed along the river channel. Eggs were present in both rivers on initial surveys of 1981 (21 April in the Chickahominy River and 22 April in the James River) in fresh to slightly brackish water and temperatures of 15.6–18.7°C. Maximum egg densities in the James River were only 46/100 m^3 in 1981 (13/100 m^3 in the Chickahominy), compared with 195/100 m^3 in 1983. These maxima occurred in both years during the first week in May, in tidal freshwater and similar temperatures (18.5–19.5°C), but at sites separated by 16 km (Fig. 6). In the Chickahominy River, eggs were restricted to the river's junction with the James and found on only two surveys, suggesting that eggs could have been spawned in the James River and tidally advected into the Chickahominy.

Larval striped bass were not present in collections from the Chickahominy River in 1981, and the river was not sampled in 1983. James River collections in 1981 yielded primarily yolksac larvae, found in maximum densities similar to those of eggs (Fig. 6). The modal length of larvae during the first 3 weeks of surveys in 1981 was 5.0–5.9 mm, but a few smaller larvae (4.0–4.9 mm) were hatched as late as 21–22 May. The maximum size of larvae increased from 7.0–7.9 mm in late April to over 13 mm on 4–5 June, the last survey in which striped bass larvae were captured. Only a dozen larvae larger than 9 mm were collected. In 1983, larvae from the early-May surveys attained densities of 31/100 m^3.

Rappahannock River, 1982 and 1983

Eggs were found within the first 40 km of tidal freshwater in both 1982 and 1983 (Fig. 7). Peak spawning was observed between river miles 51 and 62 in 1982 and miles 48 and 59 in 1983. Eggs occurred in densities ranging between 1.4–330/100 m^3 during April 1982 and 0.7–50/100 m^3 in May of that year. None were found after the 11 May survey, and the maximum density occurred on 21 April in temperatures 15.7–16.6°C. In 1983, eggs were collected in all weekly surveys from 9 April to 13 May, but increasing densities were reversed by a cold snap in the third week of April, when only scattered eggs were found (water temperatures had declined from 13–14°C to 11–12°C). Egg densities peaked once water temperature rose in the last week of April, when a maximum of 477 eggs/100 m^3 was recorded. Eggs were rare by the final sampling date (May 13).

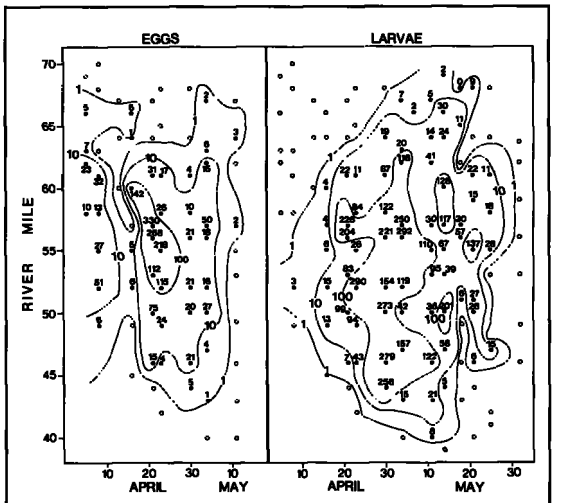

Figure 8
Spatial and temporal abundance (numbers/100 m^3) of striped bass eggs and larvae in the Rappahannock River, 1982. River miles are nautical miles above the river mouth.

Peak larval densities were recorded on the Rappahannock River in 1982 during late April and early May (Fig. 8). These densities were the highest observed in our 3-year study of Virginia rivers. Modal lengths of larvae were 5–6 mm NL until mid-May; all larvae from 21 May to the conclusion of sampling in June were at least 8 mm in length. In 1983, larvae from the early May surveys were all less than 8 mm in length and attained a maximum density of 103 larvae/100 m^3.

Discussion

Tresselt (1952), Rinaldo (1971), McGovern and Olney (1988), and this study constitute the only direct observations on striped bass eggs and larvae in major Virginia rivers. Striped bass spawning in Virginia rivers occurred from early April through the first week or two in May 1980–83, and within the first 40 km of tidal freshwater, generally confirming earlier observations of Tresselt (1952) and Rinaldo (1971).

Tresselt (1952) observed spawning on the two major rivers of the York River system, the Pamunkey River (4–13 April 1950) and the Mattaponi River (13–30 April 1950). He found largest numbers of eggs 27 km above the mouth of the Pamunkey and 14 km above the mouth of the Mattaponi. Historic centers of successful spring fishing for striped bass were in these tidal freshwater rivers. Spawning in the Pamunkey River in 1966 occurred 8–48 km above West Point during 24 April–13 May 1966 (Rinaldo 1971). Surveys of Virginia striped bass spawning grounds in 1950 (Tresselt 1952) were inadvertently somewhat late in the Chickahominy and James rivers, but provide the only direct documentation of striped bass spawning prior to the present study. He found only three eggs in 30 collections in the Chickahominy River, 5–8 May 1950, and 57 eggs in 38 collections from the James River during 9–10 May. No direct observations on striped bass larvae were made prior to the present study. Use of the Rappahannock River as a spawning site by striped bass was also documented by Tresselt (1952), although his limited survey (four sampling dates in May 1950) yielded only five eggs.

Temporal occurrence of striped bass spawning is similar throughout Chesapeake Bay. In Virginia rivers, peaks in spawning were sharp and of limited duration. They occurred in the fourth week of April in York River tributaries in both surveyed years (1980 and 1983) and in the Rappahannock River in 1983; peak spawning was a week earlier in the Rappahannock River in 1982. Spawning in the James River was somewhat later, peaking in the first week of May in both 1981 and 1983. Peak spawning in this time-period is also typical for the Potomac River (Setzler-Hamilton et al. 1981) and in the upper Chesapeake Bay and Chesapeake and Delaware Canal (Johnson and Koo 1975, Kernehan et al. 1981). Although striped bass eggs were found in a wide range of temperatures (8.0–21.2°C), peak densities were limited to rapidly rising temperatures in the range 13.7–19.5°C and nearly always to freshwater. Annual differences in time of spawning within a given river system are most likely a result of differences in temperature and the rate of vernal warming.

Areas of peak spawning and the spatial extent of the spawn are remarkably similar among years and river systems, but differences can occur in years of drought. The present data from the James River contrasted a year of severe drought (1981) with one of near-average rainfall (1983). The estimated streamflow from the James River system into Chesapeake Bay during March, April, and May averaged only 69,000 cfs in 1981 compared with 180,000 cfs in 1983 (monthly summary reports of estimated streamflows entering Chesapeake Bay, 12/30/81 and 12/30/83, U.S. Geol. Surv., Towson, MD). Peak egg production was displaced 15 km upriver in 1981, in advance of encroaching saltwater, whereas interannual differences in location of peak spawning in the other river systems where drought was not a factor were insignificant (<2 km).

The tidal freshwaters of the Rappahannock River were surveyed for striped bass eggs and larvae in the spring of 1982, during production of what later was determined to be the strongest year-class measured in Virginia during the period 1971–82 (Colvocoresses

1989). The observed high density of eggs and larvae in 1982 and subsequent success of the 1982 year-class support the concept that attributes strong year-classes to exceptional survival of eggs and larvae on the spawning grounds, rather than absolute size of spawning stock (management actions designed to prevent overfishing and to increase size of spawning stock were not yet in effect). After 10 years of poor year-classes, i.e., 1972–81, the stock producing this 1982 year-class must necessarily have been small. Chapman's (1987, 1989, 1990) discovery of differences between genotype frequencies of 1982 year-class males and those of older Chesapeake Bay females is more direct evidence that strong year-classes can stem from successful spawning by relatively few females. Unfortunately, we have yet to determine which factors govern survival and growth of striped bass eggs and larvae on Chesapeake Bay spawning grounds, although recent research efforts are addressing this important question (e.g., McGovern and Olney 1988, Chesney 1989, Uphoff 1989).

Acknowledgments

This research was supported in part by the National Marine Fisheries Service (NOAA) grants NA80FAD-VA1B, NA81FAD-VA3B, NA81FAD-VA5B, and contract AFC-14-1, and by NOAA Office of Sea Grant, grant no. 5-29346. We particularly owe thanks to Bruce H. Comyns, James E. Price, Cathy J. Womack, and Patricia A. Crewe for their assistance in the study, and to Daniel W. Sved, James A. Colvocoresses, and John C. McGovern for early manuscript reviews.

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