Estimation of Juvenile Striped Bass Relative Abundance in the Virginia Portion of Chesapeake Bay

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Leonard S. Machut
Mary C. Fabrizio

Department of Fisheries Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia

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EXECUTIVE SUMMARY

The 2012 Striped Bass juvenile abundance index is 2.68 and is significantly lower than the historic average of 6.96. Recruitment failure, as defined by Addendum II to Amendment 6 of the FMP, occurred during 2012. All individual watershed JAI values were below their historic mean. The Rappahannock, Pamunkey and Chickahominy River JAI values were significantly lower than their respective historic averages. Although lower JAI values were reported for the James and Mattaponi rivers, annual JAI confidence intervals overlapped with historic confidence intervals suggesting juvenile abundance in these two rivers was not significantly different from the long-term average abundance. Based on our sampling of auxiliary stations juvenile Striped Bass generally did not occupy sites outside of the core nursery zone during 2012.

Pilot sampling prior to the 2012 field season revealed that juvenile Striped Bass and White Perch of the size commonly encountered in early July were available to the seine in early June. Therefore, seine survey sampling commenced one week earlier than the traditional start period to ensure sampling of similar sized individuals. The historic average is now properly reported as the geometric mean of annual juvenile abundance estimates in this report and that for 2011. Previous to 2011, the historic average was calculated as the mean abundance across all stations sampled over all years; this method effectively weighted the mean by the number of stations sampled in any given year, and because the survey sampled fewer stations prior to 1988, positively biased the historic mean towards recent abundance estimates. A JAI has been provided for Atlantic Croaker for 2012. Also new to the 2012 report is the use of the revised naming convention for common names of fishes recently adopted by the American Fisheries Society and the American Society of Ichthyologists and Herpetologists.

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PREFACE

The primary objective of the Virginia Institute of Marine Science juvenile Striped Bass survey is to monitor the relative annual recruitment success of juvenile Striped Bass in the major Virginia nursery areas of lower Chesapeake Bay. The U.S. Fish and Wildlife Service initially funded the survey from 1967 to 1973. Beginning in 1980, funds were provided by the National Marine Fisheries Service under the Emergency Striped Bass Study program. Commencing with the 1989 annual survey, the work was jointly supported by Wallop-Breaux funds (Sport Fish Restoration Act), administered through the U.S. Fish and Wildlife Service, and the Virginia Marine Resources Commission. This report summarizes the results of the 2012 sampling period and compares these results with previous years.

INTRODUCTION

Striped Bass (*Morone saxatilis*) is one of the most commercially and recreationally sought-after fish species on the east coast of the United States. Decreases in the commercial harvest of Striped Bass in the 1970s paralleled the steady decline in abundance of Striped Bass along the east coast; Chesapeake Bay stock abundances were particularly depressed. Declines in commercial harvest mirrored declines in juvenile recruitment (Goodyear 1985). Because the tributaries of Chesapeake Bay had been identified as primary spawning and nursery areas, fishery managers enacted regulations intended to halt and reverse the decline of Striped Bass in Chesapeake Bay and elsewhere within its native range (ASMFC 2003).

In 1981, the Atlantic States Marine Fisheries Commission (ASMFC) developed the Atlantic Coast Striped Bass Interstate Fisheries Management Plan (FMP), which included recommendations aimed to improve the stock status. The Virginia Marine Resources Commission (VMRC) adopted this plan in March 1982 (Regulation 450-01-0034), but the ASMFC did not have regulatory authority for fisheries management in individual states at that time. As Striped Bass populations continued to decline, in 1984 Congress passed the Atlantic Striped Bass Conservation Act (PL 98-613), which required states to follow and enforce management measures in the FMP or face a moratorium on Striped Bass harvests. Since 1981 the FMP has been amended six times to address changes in the management of the stocks. Amendment VI to the plan, adopted in February 2003, requires "producing states" (i.e., Virginia, Maryland, Delaware and New York) to develop and support programs monitoring Striped Bass recruitment.

In 1967, before the FMP requirement, Virginia began monitoring the annual recruitment of juvenile Striped Bass using funding from the Commercial Fisheries Development Act of 1965 (PL88-309). This monitoring continued until 1973 when funding was discontinued. Monitoring of striped bass recruitment was re-instituted in 1980 using Emergency Striped Bass Study funds (PL 96-118, 16 U.S.C. 767g, the "Chafee Amendment"), and since 1989 has been funded by the Wallop-Breaux expansion of the Sport Fish Restoration and Enhancement Act of 1988 (PL 100-448, “the Dingle-Johnson Act”). Funds are administered through the VMRC.

Initially, the Virginia program used a 6 ft. x 100 ft. x 0.25 in. mesh (2 m x 30.5 m x 6.4 mm) bag seine, but comparison tows with Maryland gear (4 ft. x 100 ft. x 0.25 in. mesh; 1.2m x 30.5m x 6.4mm mesh) showed virtually no statistical differences in catch, and Virginia adopted the "Maryland seine" after 1987 (Colvocoresses 1987). The gear comparison study aimed to standardize methods and promote a bay-wide recruitment estimate (Colvocoresses and Austin 1987). This was never realized due to remaining differences in the methods of estimation of means (MD: arithmetic index; VA: geometric index). A bay-wide index using a geometric mean weighted by spawning area in each river was proposed in 1993 (Austin et al. 1993) but has not been used. Recent computations of a bay-wide geometric mean juvenile abundance index (JAI) were used to correlate young-of-the-year recruitment to fishery-independent monitoring (Woodward 2009).

Objectives for the 2012 program were to:

1. estimate the relative abundance of the 2012 year class of Striped Bass in the James, York and Rappahannock river systems,
2. quantify environmental conditions at the time of collection, and
3. examine relationships between juvenile Striped Bass abundance and environmental and biological data.

METHODS

Field sampling was conducted during five biweekly periods (rounds) from 25 June through 10 September 2012. During each round, seine hauls were conducted at 18 index stations and 21 auxiliary stations in the James, York and Rappahannock river systems (Figure 1). Auxiliary sites were added to the survey in 1989 to provide better geographic coverage and increase sample sizes within each river system. Such monitoring was desirable in light of increases in stock size during the 1980s and hypothesized expansion of the nursery ground.

Collections were made by deploying a 100 ft. (30.5 m) long, 4 ft. (1.2 m) deep, 0.25 in (6.4 mm) mesh minnow seine perpendicular to the shoreline until either the net was fully extended or a depth of approximately 4 ft. (1.2 m) was encountered and then pulling the offshore end down-current and back to the shore. During each round a single haul was made at each auxiliary station and duplicate hauls, with a 30-minute interlude, were made at each index station. Every fish collected during a haul was removed from the net and placed into water-filled buckets. All Striped Bass were measured to the nearest mm fork length (FL), and for all other species a sub-sample of up to 25 individuals was measured to the nearest mm FL (or total length if appropriate). At index stations, fish collected during the first haul were held until the second haul was completed. All captured fish, except those preserved for life history studies, were returned to the water at the conclusion of sampling. Sampling time, tidal stage, and weather conditions were recorded at each sampling location. Salinity, water temperature and dissolved oxygen concentrations were measured after the first haul using a YSI water quality sampler.

In this report, comparisons of Striped Bass recruitment indices with prior years are made for the "primary nursery" area only (Colvocoresses 1984), using data collected from months and areas sampled during all years (i.e., index stations). Catch data from auxiliary stations are not included in the calculation of the annual indices. The index of relative abundance for young-of-the-year Striped Bass is calculated as the adjusted overall mean catch per seine haul such that

$$\text{Index} = (\exp(\ln(\text{totnum} + 1)) - 1) \times 2.28$$

where *totnum* is the total number of Striped Bass per seine haul (includes catches from the first and second seine haul at each station). Because the frequency distribution of the catch is skewed (Colvocoresses 1984), a logarithmic transformation (ln(*totnum*+1)) was applied to the data prior to analysis (Sokal and Rohlf 1981). Mean values are back-transformed and scaled up arithmetically ($\times$2.28) to allow comparisons with Maryland data. Thus, a "scaled" index refers to an index that is directly comparable with the Maryland index.

In accordance with suggestions made by Rago et al. (1995), the Virginia juvenile Striped Bass index has also been recomputed using only the first haul at each index station. Additionally, the rehabilitation of Chesapeake Bay Striped Bass stocks, and subsequent relaxation of commercial and recreational fisheries regulations in Chesapeake Bay in 1990 (ASMFC 2003) allows examination of the recruitment of Striped Bass during three distinct periods:

- 1967 – 1973: an early period of monitoring;
- 1980 – 1989: a decade reflecting severe population depression during which temporary fishing moratoria were in place; and,
- 1990 – Present: a period of post-recovery and regulation targeting the development of a sustainable fishery.

An average index value for 1990 – 2012 was calculated using only the first haul at each index site and was compared with the annual index value to provide a benchmark for interpreting recruitment strength during the post-recovery period.

In previous years, the historic average was calculated as the geometric mean across all stations. However, survey effort has not been equal through time. The number of hauls completed annually ranged from 42 (1967) to 180 (post-1988) resulting in an estimate of the historic average that was biased by recruitment years with higher effort (i.e., more recent years). The historic average should instead be calculated as the mean of the annual abundance estimates (n = 40, one estimate per year). Equal weight is thus given to years of lower sampling effort (which in this time series happen to be years of low abundance), and years with higher sampling effort (which occurred during the latter part of the time series and represent years of higher abundance).

Throughout this report mean catch rates are compared using 95% confidence intervals. Reference to “significant” differences between geometric means in this context will be restricted to cases of non-overlapping confidence intervals. Because standard errors are calculated from transformed (logarithmic) values, confidence intervals on the back-transformed and scaled indices are non-symmetrical.

RESULTS AND DISCUSSION

Juvenile Index of Abundance for Virginia

In 2012, 408 young-of-the-year Striped Bass were collected from 179 seine hauls at index stations and 94 individuals were collected from 100 hauls at auxiliary stations (Table 1). Using index station data from both hauls, the estimated Striped Bass recruitment index in 2012 is 2.68 (LCI = 2.10, UCI =3.33; Table 2), which is significantly lower than the historic average of 6.96 (LCI = 5.46, UCI = 8.74; Figure 3). The 2012 index represents the lowest JAI recorded since 2002. As defined by Addendum II of the FMP (ASMFC 2010), recruitment failure occurred in 2012. Striped Bass recruitment failure also occurred in the Maryland portion of Chesapeake Bay during 2012 (Durell and Weedon 2012).

Even with a 30-minute interlude between hauls at index stations, second hauls are not independent samples and their use violates a key assumption necessary for making inferences from a sample mean (Rago et al. 1995). Previous reports consistently documented fewer catches in the second haul (e.g. Hewitt et al. 2007, 2008), a result which artificially lowers the geometric mean when data from both hauls are included in the index computation. Thus, the annual and historic indices were recalculated using only the first haul at each index station. In 2012, 265 young-of-the-year Striped Bass were collected in the first haul resulting in an index of 3.47 (LCI = 2.50, UCI = 4.63, Table 3), which is significantly lower than the recomputed first-haul historic index of 8.29 (LCI = 6.47, UCI =10.48). All annual Striped Bass abundance estimates presented in Table 3 are based on single hauls. The 2012 Virginia-wide index of 3.47 (LCI = 2.50, UCI = 4.63) is also significantly lower than the mean index estimated for the post-recovery period (index = 11.91; LCI = 9.25, UCI = 15.17) further supporting the conclusion that recruitment failure occurred during 2012.

Prior to 2011, annual recruitment indices were derived from all collections made during a sampling year. From 1967 to 1973, seine sampling extended into October and occasionally into December (1973). Current sampling concludes in mid-September because after this time, sampling efficiency decreases due to mortality of juveniles, increased avoidance of the sampling gear, and the dispersal of juveniles into deeper waters. Indices calculated from data that include catches after mid-September are therefore biased low. Starting in 2011, recruitment calculations were made using catch data from the currently established sampling season (July through mid-September) to permit uniform comparisons of annual recruitment (Tables 2– 4).

Striped Bass recruitment success in the Virginia portion of Chesapeake Bay is variable among years and among nursery areas within years. Average to above-average recruitment years occurred between 2003 and 2011 (Figure 3). The highest recruitment index observed by the Virginia seine survey occurred in 2011. Since the termination of the Striped Bass fishing moratorium in 1990, strong year classes have been observed approximately every decade (1993, 2003 and 2011). Similarly, single years of low recruitment have occurred approximately every ten years (1991, 1999 and 2002). Poor recruitment in 2012 is therefore consistent with past observations. Individual years of recruitment failure post-moratorium (i.e., since 1990) were followed by years of average or above-average recruitment (Figure 3). Under current ASMFC regulations (ASMFC 2010), management action is triggered after three consecutive years of recruitment failure in producing states.

During 2012, sampling was initiated prior to the traditional seine season (early July) due to the apparent early spawning of Striped Bass. When sampling sites were examined for over-winter damage in mid-June, the seine was also hauled at several sites and the presence of young-of-the-year Striped Bass was noted; these fish had already recruited to the gear (avg. FL = 45 mm, range 31 mm – 55 mm) and were already the size typically encountered in early July. Round 1 sampling commenced on June 25, a week earlier than scheduled; and Round 2 began on July 9, originally scheduled to start on July 18. Examination of length-frequency distributions from Striped Bass collected during round 1 in 2012 showed a similar distribution to that observed for Striped Bass collected in previous years for this round (Figure 4). That is, advancing round 1 sampling dates in 2012 allowed survey personnel to capture the same relative size class of fish normally captured during round 1 (early July). Low JAI values for 2012 are therefore likely not the result of a temporal mismatch between sample collection and availability of small young-of-the-year fish.

Continued monitoring of regional recruitment success will be important in identifying management strategies to protect the spawning stock of Chesapeake Bay Striped Bass. Research suggests that a Chesapeake Bay-wide index, computed from Virginia and Maryland data combined, will provide a better estimate of recruitment strength and serve as a better predictor of subsequent adult Striped Bass abundance within the Bay (Woodward 2009; Fabrizio et al. in review). This may be particularly appropriate in years when individual state JAIs provide divergent estimates of year-class strength; such divergences may arise due to annual changes in the spatial distribution and contribution of nursery areas throughout Chesapeake Bay.

Juvenile Index of Abundance for Individual Watersheds

Recruitment indices observed in the three Virginia watersheds during 2012 were significantly depressed when compared with their respective historic averages. The 2012 JAI for the James River drainage is 3.77 (LCI = 2.49, UCI = 5.40), compared with the historic James River index of 8.85 (LCI = 6.69, UCI = 11.54; Table 4). The 2012 JAI value for the York River drainage is 2.26 (LCI = 1.51, UCI = 3.15), compared with the historic York River index of 5.27 (LCI = 4.06, UCI = 6.72). The 2012 JAI value for the Rappahannock River is 2.15 (LCI = 1.27, UCI = 3.25), compared with the historic Rappahannock River index of 7.13 (LCI = 4.06, UCI = 6.72).

River-specific JAIs show some variation among rivers within the same watershed. In particular, the 2012 James River main stem index of 6.29 (LCI = 4.14, UCI = 9.16) is not significantly different from the historic index of 8.11 (LCI = 5.91, UCI = 10.89); however, the 2012 Chickahominy River index of 0.79 (LCI = 0.24, UCI = 1.47) is significantly lower than the historic index of 10.94 (LCI = 8.17, UCI = 14.44). The source of this variation within the James River watershed is unclear.

Throughout the James River watershed, four of six index sites were characterized by lower-than-average relative abundances when compared to their respective historic means (Table 5). The exceptions, J29 and JA56, were comparable to their historic average. Unlike recent years, when catches at mid-river index stations dominated the catches in the James River watershed (Machut and Fabrizio 2011, 2012), in 2012, 60% of all young-of-the-year Striped Bass were from two downstream stations, J29 and J36. The furthest upstream station, J56, contributed 22% of the catch, and the core nursery zone (C1, C3, and J46) contributed only 18% combined in 2012. Since 2002, J46 has been among the top two most productive James River watershed stations in 7 out of 10 years (based on ranks).

In 2011, due to the construction of a breakwater before our sampling began, station J36 was relocated 100 m upstream of the traditional site (Figure 2b). It is unclear how this shift in sampling location may have affected fish distribution and abundance at this site; also unclear is the relationship of current and past catches at J36. Compared with their respective historic averages, lower-than-average catches were observed in 2012 at J36 and at 4 of the 5 remaining James River index stations. During 2011, J36 exhibited higher-than-average catches compared with the historic average for this site, and this pattern was consistent for all other James River index stations.

Through two years of collections at the relocated J36 site, catches have trended with those at other index stations. It is therefore assumed that shifting J36 upstream approximately 100 m has not significantly altered JAI computations for the James River.

The 2012 York River JAI interrupts a three-year increasing trend in relative abundance for this river (Figure 5). No index sites are located along the main stem of the York River although three auxiliary stations are sampled; the watershed JAI is compiled from sites located within the two principle York River tributaries, the Mattaponi and Pamunkey Rivers. The 2012 Pamunkey River JAI of 0.70 (LCI = 0.29, UCI = 1.18) is significantly lower than the historic index of 5.94 (LCI = 4.22, UCI = 8.11), but the 2012 Mattaponi River index (3.93; LCI = 2.55, UCI = 5.75) is not significantly different from the historic average (4.81; LCI = 3.82, UCI = 5.96). The thirteen total young-of-the-year Striped Bass collected from the Pamunkey River reflect the lowest total number of individuals collected since 2002. About 90% of York River Striped Bass were collected from the Mattaponi River and most were concentrated primarily at two upper-river index stations, M44 and M47. Catches peaked in late July and early August (Table 1).

Similar to other Virginia nursery grounds, the 2012 Rappahannock River index of 2.15 (LCI = 1.27, UCI = 3.25) is significantly lower than the historic average of 7.13 (LCI = 5.31, UCI = 9.38). This represents the lowest catch observed since 1995 in the Rappahannock River. Collections at individual index stations are depressed at four of the five stations compared with their historic average (Table 5). In 2012, 80% of the total Rappahannock River catch was taken from the two uppermost index sites (R50 and

R55; Table 1); these two sites have dominated the catches in this drainage for several years.

Weak year classes in 2012 and in 1991, 1999 and 2002 share some similarities. In 1991, 1999, and 2012, recruitment in the James River was average whereas recruitment in the Chickahominy River was significantly below average. Poor recruitment in 2002 was attributed to recruitment failure within the York River watershed. Recruitment in 1999 was similarly poor in the York River. The 2012 JAI may be unique in that recruitment failure occurred in all three watersheds simultaneously. In previous years of recruitment failure, relative abundance in at least one watershed was not significantly different from the historic average: in 1991 the York River produced an average abundance, and in 1999 and 2002 recruitment in both the Rappahannock and James River watersheds were considered average.

Catches of young-of-the-year Striped Bass from individual watersheds in Virginia during 2012 indicate a weak year class was produced throughout Virginia waters. After the moratorium was lifted in 1990, individual years of poor recruitment have occurred sporadically and were usually driven by recruitment failures within a single watershed. In contrast, 2012, was unique in that recruitment was poor in all three watersheds. However, because the 2012 year class followed the strong 2011 year class, regional production of juvenile Striped Bass in Chesapeake Bay and along the Atlantic coast is not presently of concern. Continued monitoring of individual watersheds will provide additional insight into management strategies specific to each nursery zone.

Striped Bass Collections from Auxiliary Stations

Figures 6 – 9 illustrate the spatial distribution of the 2012 year class throughout the nursery area. Note that scaling is not constant across figures. The 1989 addition of auxiliary stations has provided increased spatial coverage for the James, York and Rappahannock drainages and the upriver and downriver auxiliary sites allow delineation of the upper and lower limits of the nursery. These auxiliary stations reveal spatial changes in the nursery areas that occur due to annual changes in river flow. Additionally, in years of low or high juvenile abundance, the nursery area spatially contracts or expands. This inter-annual flux in the collection of young-of-the-year Striped Bass at auxiliary sites is particularly evident in 2012 with decreased catches at upriver and downriver auxiliary stations suggesting a contraction in Striped Bass nursery grounds.

The only upstream auxiliary stations that contributed juvenile Striped Bass during 2012 were those in the James River. Although collections were made at each sampling site throughout the season, geometric means at the three upper James River auxiliary sites were lower than the historic average for each site (Table 5). The nursery grounds also extended downstream in 2012 (to J22), but geometric means were lower than the historic average (Table 5). No young-of-the-year Striped Bass were collected at J12.

No Striped Bass were collected from upriver auxiliary sites in the Pamunkey (P55) or Mattaponi rivers (M52). Striped Bass were collected from only two auxiliary stations within the York River watershed, Y28 and M37 (Table 1); M37 is an auxiliary station between index stations in the lower Mattaponi River and is within the core nursery area; Y28 is the uppermost station on the main stem York River, and has the highest historic average index among York River stations (Table 5). No Striped Bass were collected from P36 during any round.

We previously suggested that the lack of Striped Bass at upriver auxiliary stations in the York River watershed may have been due to the inability to accurately sample in dense hydrilla vegetation that occurs at these sites (Machut and Fabrizio 2010). Although low catches in downstream core nursery grounds suggest limited presence of Striped Bass throughout the watershed, it is possible that juveniles may have been present within the upstream portions of these rivers but may not have been detected due to low capture efficiencies associated with hauling a seine net through dense aquatic vegetation. It is plausible that recent catches at P55, and to a lesser extent M52, were affected by the altered state of the near-shore zone. Striped Bass may have been forced into deeper waters by the dense hydrilla beds; alternatively, Striped Bass may preferentially use hydrilla habitats but remain unavailable to the sampling gear. The continued sampling difficulties at these stations suggest a need to examine alternative collection methods within this region to determine the abundance of juvenile Striped Bass in near-shore areas where hydrilla is present.

No Striped Bass were collected at Rappahannock River auxiliary stations during 2012. In recent years, few fish were collected at the lower auxiliary stations in the Rappahannock River (R10, R21) even though these sites have favorable substrate and no obstructions that would compromise seining. The consistent low capture rates at R10 and R21 suggest these sites may have lower value as nursery areas in the Rappahannock River. The same is not true for upstream auxiliary locations. Historic JAI values at auxiliary stations upstream of Tappahannock (near R37) are comparable to JAIs at index stations R28, R37, and R44 (Table 5). The consistent absence of Striped Bass from these upriver auxiliary locations in 2012 suggests that nursery grounds were contracted to areas sampled by the index stations (e.g., R50 and R55).

The evident decrease in occurrence of young-of-the-year Striped Bass at downstream and upstream auxiliary sites throughout tidal tributaries in Virginia further supports the observation of a poor recruitment year during 2012. Furthermore, catches were zero at some of the auxiliary stations that have historically supported production. Direct comparisons between auxiliary and index sites are problematic due to slightly different sampling protocols (index station catches are reported as an average of two hauls, whereas only a single haul is made at auxiliary stations). Past analyses demonstrate that catches are consistently greater in the first of two hauls at a given site. Because only one haul is completed at auxiliary sites, abundance estimates at these sites may be biased high relative to abundances estimated at index sites.

Comparison among Sampling Rounds

Considerably fewer young-of-the-year Striped Bass were collected during each round in 2012 than in comparable rounds dating back to 2002. In late June 2012 (round 1), 144 young-of-the-year Striped Bass were collected and in mid-July (round 2), 83 fish were collected; this represents a decrease of over 40% between rounds 1 and 2 (Table 6). This decline was greater than the historic decrease in catches observed between rounds 1 and 2 (21%). Although twelve days separated late July and early August sampling (rounds 2 and 3), compared with an average of 7 days in previous years, it is thought that this time lapse between rounds did not disproportionately impact sample results. Typically, catches decrease by 26% between rounds 2 and 3, but in 2012, catches increased by more than 25%. The increase in catches between rounds 2 and 3 in 2012 was largely driven by catches at M47 and J36 (Table 1). Generally, raw catch values are highest during July and early August (rounds 1, 2, and 3) and taper off in late August and September (rounds 4 and 5) as fish disperse to deeper water and grow large enough to avoid seine capture. In 2012, we observed a decline in catches of 60% between rounds 3 and 4 (early August to late August), compared with the historic average decrease of 15%.

Environmental Conditions and Potential Relationships to Juvenile Striped Bass Abundance

The distribution and abundance of juveniles within the nursery area may be affected by water quality parameters. Although variation in local site conditions preclude direct round-by-round comparisons of environmental and water quality parameters, broad scale patterns may occur.

Historically, a well-defined pattern exists with high water temperatures observed during July followed by a decline towards the end of the sampling season in mid September. In 2012, water temperatures peaked during July (round 2), but remained above 25^{o}C throughout August (round 3 and 4) and into early September (round 5; Table 7). A more traditional temperature pattern occurred in 2009 and 2010 (Machut and Fabrizio 2010, 2011) when temperatures in September were below 25°C. In September 2012 (round 5), only 5% (2 of 38) of sampled sites exhibited water temperatures below 25.0°C compared with about 50% of sites in 2010. Catch rates in 2012 followed the historic pattern with respect to water temperature: most fish (99%) were captured at temperatures between 25.0 and 34.9°C (Table 8). Water temperatures in tidal tributaries reflect not only long-term, regional climate patterns, but also significant day-to-day and local variation. Shallow shoreline areas are easily affected by local events such as thunderstorms and small-scale spatial and temporal variations associated with time of sampling (e.g., morning versus afternoon, riparian shading, tidal stage). As noted in previous reports, the relationship between declining catches and decreasing temperature is considered to be largely the result of a coincident downward decline in catch rates and water temperatures as the season progresses (beyond early August) rather than any direct effect of water temperature on juvenile fish distribution.

In 2012, as in the past, greater catches of young-of-the-year Striped Bass were observed at sites exhibiting lower salinities within the primary nursery area (Table 9). No index station exceeded 12.9 ppt salinity although salinity was as high as 20.0 ppt at one auxiliary site in the York River (Table 10). This gradient was comparable to previous years when salinity approached or exceeded 20 ppt only at downstream sites (Table 5). In 2012, the percentage of catch observed in low salinities (0.0 – 4.9 ppt) was similar to that observed historically (88% in 2012 vs. 93% all years; Table 9). Similarly, the catch in mid-range salinities (5.0 – 9.9 ppt) was similar to the historic average (6% in 2012 vs. 6%

all years). Although juvenile Striped Bass were captured at downstream sites with average salinities up to 12 ppt, catches were distinctly lower than those observed in lower salinity areas.

Dissolved oxygen (DO) concentrations were lower in 2012 than those measured during 2010 or 2011 (Machut and Fabrizio 2011, 2012). Within the primary nursery area, approximately half of the measurements (93 of 190 measurements) exhibited DO levels that were more than one standard error (SE) less than the site's historic average (Table 11). Three DO levels measured during 2012 (M33 in late July and early August, and M37 during late August) were particularly depressed. DO measures at these two stations approached the range considered to be hypoxic (less than 2-3 mg/L) for certain species. Correlations between DO and juvenile Striped Bass catches are difficult to ascertain. Lower-than-average values occurred inconsistently through time and across sampling sites. DO values more than one SE less than the mean at a given station (shaded values in Table 11) do not necessarily correspond with low catches at that station (Table 1). For example, juvenile Striped Bass were captured at M33 during periods approaching hypoxia and in normoxic conditions. Farther upriver, high seasonal catches at index stations occurred during periods when DO was more than one SE below the historic average and when DO measures were within one SE of the historic average. Similarly, lower than average DO conditions were prevalent throughout the Rappahannock River in 2012 and catches varied greatly between sites.

Striped Bass recruitment variability may be partially explained by regional climate patterns during winter and spring (Wood 2000). Furthermore, abundance of young Striped Bass has been positively associated with high river flows during the preceding winter (Wingate and Secor 2008). One of the strongest Striped Bass year classes was produced in 2011, which was characterized by above normal precipitation in winter and spring (Machut and Fabrizio 2012). Precipitation in the winter of 2012 (December 2011 - February 2012) was “below normal” in Maryland and Virginia (NCDC 2013). Spring precipitation (March -May 2012) was “near normal” in Virginia but remained “below normal” in Maryland. These regional precipitation conditions resulted in our observation that salinities exceeded the historic averages at most Virginia seine sites (Table 5). The Bay-wide below normal precipitation during the winter and spring of 2012 may have contributed to the 2012 Striped Bass year-class failure in Chesapeake Bay. It is still unclear if fine-scale climate patterns or other factors exert effects on variations in recruitment of juvenile Striped Bass.

Additional Abundance Indices Calculated from the Seine Survey

Due to a sampling regime that spans from euryhaline to freshwater zones, a variety of species are collected by the juvenile Striped Bass seine survey annually (Table 12). The five most common species encountered in 2012 were Mummichog (*Fundulus heteroclitus*), White Perch (*Morone americana*), Spottail Shiner (*Notropis hudsonius*), Bay Anchovy (*Anchoa mitchilli*), and Banded Killifish (*Fundulus diaphanous*). Juvenile Striped Bass were the 17th most common species, a drop from second in 2011. In 2012, slightly more than 53,000 individuals comprising 70 species were collected (Table 12). This represents a nearly 40% decrease in the number of total fish observed relative to 2011 collections. Nearly 40% of the total number of fish captured during 2012 is attributed to a single Y21 haul in which 20,959 Mummichog were captured; this single haul represents 88% of the total yearly Mummichog catch. Removing this atypical haul, 32,318 fish were captured during the 2012 seine survey which represents a 60% decrease in total catch compared with 2011. Despite lower catch rates in 2012, several species that occupy the near-shore zone were consistently encountered and their catches allow for the calculation of additional abundance indices.

To fulfill commonwealth compliance requirements to the ASMFC, several annual indices are reported for species of management importance which are presently derived from seine survey collections. These species include American Shad (Watkins et al. 2011) and Atlantic Menhaden (VMRC 2010). Abundance estimates for juvenile American Shad from the seine survey were highly correlated with those from push-net sampling (Wilhite et al. 2003), providing validation for this seine survey-based index. Additionally, requests for an index of abundance or raw catch data occur throughout the year on an *ad hoc* basis. During the summer of 2012, the ASMFC Spot Technical Committee requested an age-0 Spot (*Leiostomus xanthurus*) abundance index from the seine survey to compliment fishery-dependent and fishery-independent data currently reported (Figure 10).

One of the most common species annually captured by the seine survey, White Perch, supports important recreational and commercial fisheries in Chesapeake Bay (Murdy et al. 1997, NMFS 2012). The general overlap in spawning time and use of nursery grounds by White Perch and Striped Bass suggest that the seine survey may adequately sample juvenile White Perch and that calculation of a recruitment index for this species is appropriate. Colvocoresses (1988) found a strong correlation between a young-of-the-year geometric mean calculated from seine survey sampling and a trawl survey estimate of White Perch fishable stock. However, examination of raw catch data suggests high annual variability in White Perch catches. In years of low abundance (e.g., 1985) the proportion of hauls containing White Perch may be as low as 40%; whereas in years of high abundance (e.g., 2011), White Perch may be found in 95% of hauls. A delta-lognormal index was developed to address this inter-annual variation and to accommodate data with a high proportion of zero hauls. We used Cox's method (Fletcher 2008) to estimate the mean abundance based on the delta-lognormal distribution, and calculated 95% confidence intervals from 1,000 bootstrap samples as described by Fletcher (2008). This approach remains under development, so we report only the means here.

From June through September 2012, 1,618 young-of-the-year White Perch were collected from 30 sampling stations during five sampling rounds. Because White Perch movement among Virginia tributaries is unlikely (Mulligan and Chapman 1989), we presume each tributary supports a distinct stock and report juvenile abundance for each river separately (Figures 11 - 15). Generally, 2012 river-specific JAIs for White Perch suggest poor recruitment for this species throughout Virginia. Numerically, the highest 2012 JAI values for White Perch were observed in the James and Rappahannock rivers although these values were only 30% (Rappahannock) to 50% (James) of their historic average. Near complete recruitment failure occurred in the Pamunkey and Mattaponi rivers; 2012 collections were between 3% (Pamunkey) and 6% (Mattaponi) of each river's historic average. At present, development of river-specific indices for White Perch is incomplete. Although we feel confident in the estimation of annual mean relative abundance, alternative approaches for estimating confidence intervals should be examined. The White Perch JAI developed by the seine survey compliments the juvenile White Perch index currently reported by the Juvenile Fish Trawl Survey (Tuckey and Fabrizio 2011); however, unlike the index reported by the trawl survey, the seine survey index is based on catches from tidal brackish and freshwater zones.

Atlantic Croaker (*Micropogonias undulatus*) are another commercially and recreationally important fish (Murdy et al. 1997, NMFS 2012) regularly collected by the seine survey. Young-of-the-year Atlantic Croaker are collected at predominately mesohaline sampling sites during July and early August (rounds 1, 2 and 3) before growth increases net avoidance and reduces detection probabilities (Williams and Fabrizio 2011). Murdy et al. (1997) report peak spawning of Atlantic Croaker from August – October; thus, young-of-the-year fish collected during 2012 were spawned during the fall of 2011. Similar to White Perch, Atlantic Croaker raw catch data exhibit high annual variability in the proportion of non-zero hauls. To address this variation and accommodate data with a high proportion of zero hauls we developed a delta-lognormal index for Atlantic Croaker. The delta-lognormal approach remains under development, so only means are currently reported. Alternative approaches for estimating confidence intervals should be examined.

From late-June through early August 2012, 953 young-of-the-year Atlantic Croaker were collected from 21 sampling locations. Because Atlantic Croaker are coastal shelf spawners with larval migration into Chesapeake Bay, we report a Virginia-wide estimate of juvenile abundance (Figure 16). A strong year class for Atlantic Croaker appears to have occurred during 2012. A warmer-than-average 2011 – 2012 winter may have allowed for higher juvenile overwinter survival. Periods of strong recruitment from 1991 – 1995, 1997 – 1998, and 2008 – 2009 correspond with patterns observed by the VIMS Juvenile Fish Trawl Survey (Tuckey and Fabrizio 2011). The spatial overlap of sampling sites between the seine and trawl surveys provides a more complete picture of fish distribution in estuarine areas. Near-shore shallow zones are sampled by the seine survey whereas the trawl survey samples adjacent benthic main stem sections. Indices of abundance for common forage species within the tidal near-shore zone have been computed for: Spottail Shiner (*Notropis hudsonius*; Table 13), Atlantic Silverside (*Menidia menidia*; Table 14), Inland Silverside (*Menidia beryllina*; Table 15), and Banded Killifish (*Fundulus diaphanus*; Table 16). The 2012 Spottail Shiner geometric mean of 10.03 (LCI = 7.27, UCI = 13.71) was not significantly different from the historic average (Index = 8.88, LCI = 7.24, UCI = 10.85). Although the 2012 Atlantic Silverside index of 5.42 (LCI = 3.43, UCI = 8.31) was low compared with the historic average of 10.13 (LCI = 7.99, UCI 12.78), it was not significantly different due to overlapping confidence intervals. The 2012 Inland Silverside abundance index of 3.26 (LCI = 2.47, UCI = 4.25) was significantly higher than the historic geometric mean of 1.70 (LCI = 1.35, UCI = 2.09). Similarly, the 2012 Banded Killifish abundance index of 7.22 (LCI = 5.32, UCI = 9.70) was significantly higher than the historic average of 2.01 (LCI = 1.42, UCI = 2.73). The high catches of Banded Killifish continue a trend of higher-than-average abundances observed from 2004 through 2012 and suggest a sustained increase in the abundance of banded killifish populations. Average to above-average indices for these four species suggest that there is a stable population of forage fishes in Virginia waters for commercially and recreationally important piscivores.

Perhaps due to the warmer 2011-2012 winter, species for which Chesapeake Bay is considered the northern limit of their range were more commonly observed in seine catches during 2012. For instance, Red Drum (*Sciaenops ocellatus*) was collected more frequently during 2012 than in any year since 1989. Unlike previous years when a single school of Red Drum may have disproportionately contributed to combined yearly catches (e.g., in 2003, 25 of 39 fish were captured in one haul), during 2012, Red Drum were consistently collected throughout all rounds and across a broad spatial range. Examining catches from the first hauls during 2012, we collected 25 Red Drum in 19 hauls (range: 1 – 3 fish/haul). In previous years, Red Drum were generally collected at only downriver locations, i.e., within approximately 20 miles of the river mouth. Red Drum were more broadly distributed in 2012: from Fort Eustis (J22) upstream to the Chickahominy River in the James River watershed (C1); from Clay Bank (Y15) upstream to Sweet Hall Marsh (P42) and Sandy Point (M47) in the York River watershed; and, from Punchbowl Point (R21) upstream to Mulberry Point (R41) in the Rappahannock River watershed. Large catches reported by the game-fish tagging program in 2012 (Susanna Musick, VIMS, personal communication) support our conclusion that small Red Drum were much more prevalent in 2012 than in previous years. Additionally, nine Southern Flounder (*Paralichthys lethostigma*) were collected during 2012. Only two records exist in the seine survey database: single fish were collected in 1989 and 2009. While Southern Flounder may occasionally be mistaken for Summer Flounder (*Paralichthys dentatus*), it is unlikely that persistent Southern Flounder presence would have been continually misidentified by seine survey personnel.

CONCLUSION

The 2012 juvenile abundance index (JAI) for Striped Bass (2.68) is significantly lower than the historic average (6.96) for Virginia waters. Abundance indices from individual rivers were significantly lower than their respective historic averages except for the James and Mattaponi rivers which were not significantly different from the historic average. This suggests that Striped Bass in Virginia waters produced a weak year class in 2012. Continued calculation of the JAI is critical for predicting recruitment to the commercial and recreational Striped Bass fisheries in the Chesapeake Bay and along the Atlantic coast. A critical characteristic of the long-term annual seine survey conducted in the Chesapeake Bay is the ability to identify years of recruitment failure which, if persistent, serve as an early warning to managers of potential declines in Striped Bass standing stock biomass. Similar to Striped Bass, the juvenile White Perch abundance index in 2012 was considerably lower than the historic average. Unlike previous years, Red Drum was consistently captured throughout the entire season at numerous locations suggesting ubiquitous presence of small Red Drum throughout Virginia tributaries to Chesapeake Bay in 2012. Forage fish abundance index values reported by the seine survey were average or significantly above average in 2012.

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Table 1. Catch of young-of-the-year Striped Bass per seine haul in 2012. Two hauls were completed at each index station (bold). Sampling was completed in June (round 1), July (round 2), August (rounds 3 and 4), and September (round 5).

Drainage																Round Total
JAMES		Station	J12	J22	**J29**	**J36**	J42	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J77	
	Round	1	0	5	13/9	11/2	5	0/1	2/0	9/6	5	3/0	2	3	ns	76
		2	0	0	6/6	2/0	ns	1/3	1/0	4/ns	5	5/11	0	4	3	51
		3	0	27	7/3	15/12	2	0/0	0/0	0/0	1	10/7	6	5	0	95
		4	0	3	1/8	2/3	0	0/0	1/1	0/1	0	2/0	0	0	0	22
		5	0	1	1/1	4/3	5	0/0	0/0	1/0	2	0/2	1	0	0	21
															James Total	**265**
YORK		Station	Y15	Y21	Y28	P36	**P42**	**P45**	**P50**	P55						
	Round	1	0	0	1	0	1/0	0/0	0/0	0						2
		2	0	ns*	3	0	1/0	1/0	2/1	0						8
		3	0	0	1	0	1/1	0/0	0/0	ns						3
		4	0	0	0	0	0/0	0/0	0/3	0						3
		5	0	0	0	0	0/0	0/1	0/1	0						2
		Station				**M33**	M37	**M41**	**M44**	**M47**	M52					
	Round	1				2/0	0	1/2	4/1	3/1	0					14
		2				2/0	4	2/0	10/5	7/2	0					32
		3				2/0	0	5/1	2/5	22/7	ns					44
		4				0/0	0	4/2	7/1	1/0	0					15
		5				0/0	0	1/1	3/0	6/1	0					12
															York Total	**135**
RAPPAHANNOCK		Station	R10	R21	**R28**	**R37**	R41	**R44**	**R50**	**R55**	R60	R65	R69	R75		
	Round	1	0	0	6/3	1/1	0	1/1	16/8	30/6	0	0	0	0		73
		2	0	0	2/0	0/0	0	1/0	2/1	4/1	0	0	0	0		11
		3	0	0	0/0	1/0	0	0/0	1/0	2/1	0	0	0	0		5
		4	0	0	1/1	0/0	0	0/0	1/1	3/0	0	0	0	0		7
		5	0	0	0/1	0/0	0	0/0	1/0	1/3	0	0	0	0		6
															Rappahannock Total	**102**
ns = not sampled (*=mechanical)															2012 Catch	**502**

Table 2. Catch of young-of-the-year Striped Bass in the primary nursery areas of Virginia (index stations) summarized by year, where x = total fish, Index = $(\exp(\ln(x+1)) - 1) \times 2.28$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1967	191	1.18	1.00	5.17	3.20-7.86	42
1968	184	1.04	0.92	4.15	2.68-6.06	50
1969	193	0.97	0.94	3.73	2.39-5.46	55
1970	345	1.39	1.11	6.88	4.52-10.06	56
1971	165	0.90	0.90	3.34	2.17-4.81	60
1972	84	0.45	0.59	1.28	0.87-1.75	90
1973	133	0.60	0.82	1.86	1.12-2.76	70
1980	228	0.74	0.90	2.52	1.68-3.53	89
1981	165	0.52	0.69	1.56	1.10-2.09	116
1982	323	0.78	0.97	2.71	1.85-3.74	106
1983	296	0.91	0.83	3.40	2.53-4.42	102
1984	597	1.09	1.06	4.47	3.22-6.02	106
1985	322	0.72	0.86	2.41	1.78-3.14	142
1986	669	1.12	1.04	4.74	3.62-6.06	144
1987	2191	2.07	1.23	15.74	12.40-19.80	144
1988	1348	1.47	1.13	7.64	6.10-9.45	180
1989	1978	1.78	1.12	11.23	9.15-13.70	180
1990	1249	1.44	1.10	7.34	5.89-9.05	180
1991	667	0.97	0.95	3.76	2.96-4.68	180
1992	1769	1.44	1.24	7.35	5.72-9.31	180
1993	2323	2.19	0.98	18.11	15.35-21.30	180
1994	1510	1.72	1.03	10.48	8.66-12.60	180
1995	926	1.22	1.05	5.45	4.33-6.75	180
1996	3759	2.41	1.23	23.00	18.80-28.10	180
1997	1484	1.63	1.10	9.35	7.59-11.40	180
1998	2084	1.92	1.14	13.25	10.80-16.10	180
1999	442	0.80	0.86	2.80	2.19-3.50	180
2000	2741	2.09	1.24	16.18	13.06-19.92	180
2001	2624	1.98	1.27	14.17	11.33-17.60	180
2002	813	1.01	1.09	3.98	3.05-5.08	180
2003	3406	2.40	1.18	22.89	18.84-27.71	180
2004	1928	1.88	1.04	12.70	10.54-15.22	180
2005	1352	1.61	1.05	9.09	7.45-11.02	180
2006	1408	1.69	1.04	10.10	8.31-12.18	180
2007	1999	1.83	1.18	11.96	9.66-14.70	180
2008	1518	1.50	1.17	7.97	6.33-9.93	180
2009	1408	1.55	1.10	8.42	6.80-10.32	180
2010	1721	1.61	1.25	9.07	7.14-11.40	180
2011	4189	2.56	1.19	27.09	22.30-32.80	178
2012	408	0.78	0.83	2.68	2.10-3.33	179
Overall (1967-2012)	51140	1.40	0.56	6.96	5.46-8.74	40 (years)

Table 3. Catch of young-of-the-year Striped Bass in the primary nursery areas of Virginia using only the 1st haul (Rago et al. 1995) summarized by year, Index = $(\exp(\ln(x+1)) - 1) \times 2.28$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1967	191	1.18	1.00	5.17	3.20-7.86	42
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1969	193	0.97	0.94	3.73	2.39-5.46	55
1970	345	1.39	1.11	6.88	4.52-10.06	56
1971	165	0.90	0.90	3.34	2.17-4.81	60
1972	84	0.45	0.59	1.28	0.87-1.75	90
1973	133	0.60	0.82	1.86	1.12-2.76	70
1980	216	0.82	0.96	2.90	1.85-4.21	72
1981	112	0.64	0.74	2.05	1.28-2.99	58
1982	172	0.86	0.96	3.10	1.86-4.71	54
1983	185	0.99	0.94	3.86	2.44-5.71	51
1984	377	1.27	1.09	5.81	3.72-8.63	53
1985	216	0.94	0.92	3.54	2.4-4.97	71
1986	449	1.35	1.07	6.53	4.56-9.06	72
1987	1314	2.27	1.22	19.77	14.25-27.13	72
1988	820	1.57	1.21	8.66	6.2-11.85	90
1989	1427	2.06	1.18	15.68	11.71-20.77	90
1990	720	1.58	1.12	8.76	6.44-11.7	90
1991	462	1.17	1.05	5.04	3.59-6.85	90
1992	1143	1.65	1.31	9.63	6.76-13.41	90
1993	1241	2.34	0.89	21.36	17.31-26.25	90
1994	969	1.93	1.09	13.37	10.17-17.4	90
1995	559	1.37	1.07	6.71	4.89-8.99	90
1996	2326	2.60	1.27	28.29	21.11-37.69	90
1997	931	1.83	1.14	11.92	8.9-15.76	90
1998	1365	2.12	1.22	16.66	12.35-22.23	90
1999	274	0.92	0.91	3.43	2.43-4.64	90
2000	1528	2.22	1.23	18.70	13.91-24.9	90
2001	1671	2.16	1.32	17.52	12.7-23.89	90
2002	486	1.17	1.13	5.03	3.48-7.01	90
2003	2042	2.50	1.26	25.61	19.09-34.13	90
2004	1129	2.07	1.04	15.75	12.19-20.19	90
2005	835	1.79	1.07	11.42	8.64-14.9	90
2006	767	1.76	1.06	11.02	8.34-14.36	90
2007	1271	2.09	1.21	16.07	11.95-21.39	90
2008	867	1.70	1.11	10.15	7.56-13.42	90
2009	861	1.72	1.11	10.47	7.81-13.83	90
2010	994	1.75	1.26	10.83	7.78-14.82	90
2011	2397	2.70	1.17	31.69	24.29-41.16	90
2012	265	0.92	0.87	3.47	2.50-4.63	90
Overall (1967-2012)	31686	1.53	0.60	8.29	6.47-10.48	40 (years)
Overall (1990-2012)	25103	1.83	0.50	11.91	9.25-15.17	23 (years)

Table 4. Catch of young-of-the-year Striped Bass per seine haul in the primary nursery area in 2012 summarized by drainage and river.

	2012				All Years Combined (1967-2012)			
Drainage River	Total Fish	Index	C.I. (±2 SE)	N (hauls)	Total Fish	Index	C.I. (±2 SE)	N (years)
JAMES	180	3.77	2.49 – 5.40	59	20484	8.85	6.69 – 11.54	40
James	170	6.29	4.14 – 9.16	39	12657	8.11	5.91 – 10.89	40
Chickahominy	10	0.79	0.24 – 1.47	20	7827	10.94	8.17 – 14.44	40
YORK	126	2.26	1.51 – 3.15	70	14871	5.27	4.06 – 6.72	40
Pamunkey	13	0.70	0.29 – 1.18	30	7379	5.94	4.22 – 8.11	40
Mattaponi	113	3.93	2.55 – 5.72	40	7492	4.81	3.82 – 5.96	40
RAPPAHANNOCK	102	2.15	1.27 – 3.25	50	15785	7.13	5.31 – 9.38	40
Overall	408	2.68	2.10 – 3.32	179	51140	6.96	5.46 – 8.74	40

Table 5. Site specific Striped Bass indices and average site salinity during 2012 compared to historic (1967 – 2012) index values with corresponding average salinities (Avg. Sal., ppt). The York drainage includes Pamunkey and Mattaponi rivers. Index stations are indicated by bold font.

Drainage															
JAMES		Station	J12	J22	**J29**	**J36**	J42	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J77
	1967-2012	Avg. Sal.	14.5	7.9	4.8	2.6	1.7	1.5	1.4	0.6	0.3	0.2	0.2	0.1	0.2
		Index	1.8	14.5	7.4	12.7	13.1	16.1	7.4	20.3	16.3	6.2	9.3	7.1	2.5
	2012	Avg. Sal.	14.9	8.7	5.4	3.1	1.5	1.6	1.4	0.5	0.2	0.1	0.2	0.2	0.2
		Index	0.0	7.4	9.7	8.5	5.1	0.7	0.9	2.8	4.4	5.6	2.5	3.7	0.9
YORK		Station	Y15	Y21	Y28	P36	**P42**	**P45**	**P50**	P55					
	1967-2012	Avg. Sal.	16.6	13.8	10.7	4.3	1.7	0.7	0.4	0.3					
		Index	1.3	1.8	5.1	10.9	4.1	8.6	12.4	4.5					
	2012	Avg. Sal.	17.4	15.2	11.7	5.1	2.4	0.6	0.4	0.2					
		Index	0.0	0.0	1.7	0.0	0.7	0.3	1.1	0.0					
		Station				**M33**	M37	**M41**	**M44**	**M47**	M52				
	1967-2012	Avg. Sal.				4.6	2.5	1.2	0.4	0.3	0.1				
		Index				5.9	8.0	6.5	5.5	4.6	1.4				
	2012	Avg. Sal.				6.3	3.4	1.8	0.5	0.4	0.1				
		Index				0.9	0.9	3.6	6.6	6.8	0.0				
RAPPAHANNOCK		Station	R10	R21	**R28**	**R37**	R41	**R44**	**R50**	**R55**	R60	R65	R69	R75	
	1967-2012	Avg. Sal.	14.3	12.9	10.0	5.4	3.3	2.1	1.0	0.6	0.2	0.2	0.1	0.1	
		Index	0.5	0.8	2.7	3.4	5.5	8.0	12.7	39.5	5.7	3.9	3.0	2.1	
	2012	Avg. Sal.	15.2	14.2	11.8	7.2	4.5	2.9	1.4	0.8	0.3	0.2	0.1	0.1	
		Index	0.0	0.0	2.1	0.5	0.0	0.5	3.7	6.0	0.0	0.0	0.0	0.0	

Table 6. Catch of young-of-the-year Striped Bass in the primary nursery areas of Virginia in 2012 summarized by sampling round and month.

	2012					All Years Combined (1967-2012)				
Month (Round)	N (hauls)	Total Fish	Scaled Mean	C.I. (± 2 SE)	Decrease From Previous Round	N (years)	Total Fish	Scaled Mean	C.I. (± 2 SE)	Decrease From Previous Round
June (1st)	36	144	4.73	2.82 – 7.35		40	15860	11.05	8.58 – 14.08	
(2nd)	35	83	3.45	2.15 – 5.14	42.4 %	40	12557	8.20	6.28 – 10.54	20.8%
Aug. (3rd)	36	105	2.90	1.46 – 4.89	- 26.5%*	40	9243	6.46	4.97 – 8.27	26.4%
(4th)	36	44	1.72	0.95 – 2.68	58.1%	36	7914	6.03	4.58 – 7.79	14.4%
Sept. (5th)	36	32	1.32	0.70 – 2.06	27.3%	33	5566	4.92	3.76 – 6.29	29.7%

* - a negative value denotes an increase in catch from the previous round

Table 7. Water temperature (^oC) recorded at seine survey stations in 2012. The York drainage includes the Pamunkey and Mattaponi rivers. Index stations are indicated by bold font. Red colors denote temperatures over 30^oC; blue colors denote temperatures below 25^oC.

Drainage															
JAMES		Station	J12	J22	**J29**	**J36**	J42	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J77
	Round	1	31.9	33.3	27.2	25.9	29.5	28.8	25.3	28.2	29.6	31.1	34.1	31.3	ns
		2	30.2	29.9	28.5	30.1	ns	31.7	31.1	31.4	31.4	33.2	35.0	34.2	34.1
		3	29.9	29.5	26.6	27.1	29.5	29.3	29.3	32.0	28.9	29.2	30.0	32.2	32.1
		4	27.1	26.5	25.7	25.1	28.8	26.3	26.0	28.0	28.0	27.1	28.5	30.5	30.0
		5	27.7	25.2	25.7	26.4	30.1	27.2	27.7	29.3	26.1	26.7	28.1	29.1	27.9
YORK		Station	Y15	Y21	Y28	P36	**P42**	**P45**	**P50**	P55					
	Round	1	30.7	30.3	26.7	27.3	27.5	27.9	28.1	29.2					
		2	27.3	ns	28.8	30.0	30.0	30.9	31.4	32.3					
		3	28.2	28.4	27.7	28.5	29.2	30.3	30.3	ns					
		4	25.8	25.8	25.7	26.7	26.8	27.9	28.5	29.4					
		5	24.7	24.8	26.6	27.7	28.1	27.3	27.5	27.7					
		Station				**M33**	M37	**M41**	**M44**	**M47**	M52				
	Round	1				27.1	28.1	26.2	29.1	29.7	30.4				
		2				29.9	30.2	29.0	30.7	31.4	31.6				
		3				29.3	30.0	29.1	29.9	31.3	ns				
		4				27.0	27.0	26.6	27.1	27.7	28.8				
		5				27.3	27.7	27.0	28.1	29.3	29.2				
RAPPAHANNOCK		Station	R10	R21	**R28**	**R37**	R41	**R44**	**R50**	**R55**	R60	R65	R69	R75	
	Round	1	32.0	30.8	28.6	30.1	32.4	32.3	28.4	29.3	27.9	31.6	30.8	30.5	
		2	32.1	30.2	29.0	29.8	29.8	30.4	31.3	31.9	32.7	33.8	33.0	34.3	
		3	32.5	31.5	28.0	28.3	30.4	29.9	27.8	29.8	29.0	27.7	29.5	30.7	
		4	28.4	26.2	24.6	24.9	26.2	25.5	28.1	28.5	28.5	27.7	29.4	30.1	
		5	30.0	29.3	26.9	28.3	29.4	29.7	26.5	27.4	27.3	29.3	28.9	28.8	

ns = no sample taken

Table 8. Catch of young-of-the-year Striped Bass per seine haul in the primary nursery areas of Virginia in 2012 summarized by water temperature.

	2012				All Years Combined (1967-2012)			
Temp. (°C)	Total Fish	Scaled Mean	C.I. (± 2 SE)	N (sites)	Total Fish	Scaled Mean	C.I. (± 2 SE)	N (sites)
15.0 - 19.9	N/A			0	54	2.30	0.66 – 4.85	20
20.0 - 24.9	2	0.94	0.00 – 2.53	4	2587	3.93	3.46 – 4.44	641
25.0 - 29.9	305	2.59	1.94 – 3.33	136	38648	8.52	8.13 – 8.93	4227
30.0 - 34.9	101	3.24	1.95 – 4.91	39	9476	9.58	8.65 – 10.58	917
Overall	408	2.68	2.10 – 3.33	179	51140	7.94	8.18 – 8.86	5870

Table 9. Catch of young-of-the-year Striped Bass per seine haul in the primary nursery areas of Virginia in 2012 summarized by salinity.

	2012				All Years Combined (1967-2012)			
Salinity (ppt)	Total Fish	Scaled Mean	C.I. (± 2 SE)	N (sites)	Total Fish	Scaled Mean	C.I. (± 2 SE)	N (sites)
0.0 - 4.9	359	2.91	2.22 – 3.70	143	47459	9.21	8.82 – 9.61	4855
5.0 - 9.9	26	1.77	0.80 – 3.05	26	3275	4.35	3.88 – 4.86	749
10.0 - 14.9	14	2.09	0.57 – 4.43	10	238	2.11	1.70 – 2.56	238
15.0 - 19.9	N/A			0	2	0.12	0.00 – 0.29	28
Overall	408	2.68	2.10 – 3.33	179	51140	7.94	7.63 – 8.27	5870

Table 10. Salinity (ppt) recorded at seine survey stations in 2012. The York drainage includes the Pamunkey and Mattaponi rivers. Index stations are indicated by bold font.

Drainage															
JAMES		Station	J12	J22	**J29**	**J36**	J42	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J77
	Round	1	13.5	6.6	3.9	1.2	0.2	0.3	0.3	0.1	0.1	0.1	0.2	0.2	ns
		2	11.3	7.9	5.1	3.1	ns	1.2	0.9	0.3	0.1	0.1	0.2	0.1	0.2
		3	14.2	8.5	4.6	2.4	1.3	1.6	1.4	0.4	0.2	0.1	0.2	0.2	0.2
		4	18.9	11.7	7.8	5.1	2.4	2.7	2.3	1.0	0.3	0.2	0.2	0.2	0.2
		5	16.7	8.6	5.6	3.6	1.9	2.4	2.2	0.6	0.3	0.2	0.2	0.2	0.1
YORK		Station	Y15	Y21	Y28	P36	**P42**	**P45**	**P50**	P55					
	Round	1	15.3	13.2	9.5	2.6	0.7	0.2	0.1	0.1					
		2	16.1	ns	11.3	5.2	2.2	0.4	0.2	0.1					
		3	17.4	14.8	11.5	5.3	2.3	0.5	0.3	ns					
		4	20.0	17.1	14.2	7.0	4.1	1.2	0.6	0.4					
		5	18.4	15.6	11.8	5.4	2.8	0.9	0.6	0.3					
		Station				**M33**	M37	**M41**	**M44**	**M47**	M52				
	Round	1				3.5	1.1	0.4	0.0	0.0	0.0				
		2				5.7	2.7	1.1	0.2	0.1	0.0				
		3				6.9	3.8	2.0	0.6	0.5	ns				
		4				8.2	5.2	3.0	0.8	0.6	0.1				
		5				7.1	4.4	2.4	0.8	0.7	0.1				
RAPPAHANNOCK		Station	R10	R21	**R28**	**R37**	R41	**R44**	**R50**	**R55**	R60	R65	R69	R75	
	Round	1	13.9	12.9	10.7	6.2	3.1	1.8	0.3	0.1	0.1	0.1	0.1	0.1	
		2	13.1	13.3	11.0	6.9	3.6	2.4	0.9	0.4	0.1	0.1	0.1	0.1	
		3	15.5	14.3	11.8	7.0	5.0	3.4	1.9	1.1	0.6	0.2	0.1	0.1	
		4	16.8	15.3	12.9	7.6	5.4	3.4	1.8	1.1	0.3	0.3	0.1	0.1	
		5	16.5	15.1	12.7	8.1	5.4	3.7	2.1	1.4	0.6	0.3	0.1	0.1	

ns = no sample taken; * = sampling site directly downstream from Lake Maury outflow after heavy rain event

Table 11. Dissolved oxygen concentrations (mg/L) at seine survey stations in 2012. The York drainage includes the Pamunkey and Mattaponi rivers. Blue shaded values are more than one standard error (SE) less than the mean dissolved oxygen concentrations recorded at that station from 1989 to 2012. Yellow shaded values denote particularly low dissolved oxygen values (also more than 1 SE below the long-term mean). Index stations are indicated by bold font.

Drainage															
JAMES		Station	J12	J22	**J29**	**J36**	J42	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J77
	Round	1	9.8	7.6	6.5	7.1	9.6	10.0	7.7	8.8	7.7	8.1	15.2	15.9	ns
		2	6.7	7.2	5.8	5.7	ns	8.4	5.7	7.4	7.5	8.8	14.4	5.4	5.2
		3	7.5	7.0	6.0	6.4	7.1	7.4	4.8	6.7	5.4	5.7	8.8	4.7	5.2
		4	6.1	6.0	4.3	4.4	8.4	5.4	4.7	5.0	5.2	4.8	7.9	6.2	5.9
		5	6.6	8.1	6.8	6.4	8.6	6.5	5.2	6.4	4.7	4.6	7.0	7.0	5.5
YORK		Station	Y15	Y21	Y28	P36	**P42**	**P45**	**P50**	P55					
	Round	1	9.3	7.3	6.5	5.8	7.1	5.1	5.6	8.1					
		2	5.9	ns	5.6	4.0	5.2	5.3	4.3	9.2					
		3	4.6	4.6	4.8	5.0	4.7	4.6	5.4	ns					
		4	5.1	4.8	4.7	3.6	3.8	5.6	5.6	8.0					
		5	6.5	6.1	6.6	4.8	5.7	7.9	5.8	7.1					
		Station				**M33**	M37	**M41**	**M44**	**M47**	M52				
	Round	1				4.4	3.5	4.5	5.1	5.8	5.9				
		2				3.3	3.8	4.6	5.2	6.0	8.2				
		3				3.0	7.3	4.2	4.3	6.4	ns				
		4				3.6	2.4	4.3	5.6	5.6	4.4				
		5				4.2	4.2	4.7	4.7	6.2	5.1				
RAPPAHANNOCK		Station	R10	R21	**R28**	**R37**	R41	**R44**	**R50**	**R55**	R60	R65	R69	R75	
	Round	1	7.6	6.5	5.1	4.7	5.8	6.4	6.9	6.3	4.5	7.6	6.7	5.8	
		2	6.3	6.3	5.3	4.3	5.4	5.3	6.1	7.5	6.0	8.3	6.8	6.5	
		3	6.5	6.8	5.0	5.4	6.6	5.6	5.6	6.3	4.3	5.4	5.7	5.7	
		4	7.0	6.1	5.6	5.2	5.2	5.6	5.5	6.1	4.9	6.1	5.9	6.0	
		5	7.0	6.5	5.6	6.1	6.7	7.3	5.5	6.8	5.1	6.1	6.3	6.6	

ns = no sample taken

Table 12. Species collected during the 2012 seine survey (index and auxiliary stations).

Scientific Name	Common Name	Total Caught
Fundulus heteroclitus	Mummichog	23840
Morone americana	White Perch	5029
Notropis hudsonius	Spottail Shiner	4315
Anchoa mitchilli	Bay Anchovy	2430
Fundulus diaphanus	Banded Killifish	2335
Dorosoma cepedianum	Gizzard Shad	2245
Menidia menidia	Atlantic Silverside	1664
Dorosoma petenense	Threadfin Shad	1437
Menidia beryllina	Inland Silverside	1325
Micropogonias undulatus	Atlantic Croaker	1254
Ictalurus furcatus	Blue Catfish	851
Notropis analostanus	Satinfin Shiner	802
Leiostomus xanthurus	Spot	744
Trinectes maculatus	Hogchoker	666
Membras martinica	Rough Silverside	594
Menticirrhus saxatilis	Northern Kingfish	558
Morone saxatilis	Striped Bass	502
Fundulus majalis	Striped Killifish	341
Alosa aestivalis	Blueback Herring	285
Brevoortia tyrannus	Atlantic Menhaden	191
Hybognathus regius	Eastern Silvery Minnow	183
Bairdiella chrysoura	Silver Perch	180
Etheostoma olmstedi	Tessellated Darter	167
Lepomis macrochirus	Bluegill	118
Menidia spp.	Silverside spp.	112
Lepomis gibbosus	Pumpkinseed	108
Gambusia affinis	Mosquitofish	100
Cynoscion regalis	Weakfish	95
Anchoa hepsetus	Striped Anchovy	94
Mugil curema	White Mullet	83
Ictalurus punctatus	Channel Catfish	71
Enneacanthus gloriosus	Bluespotted Sunfish	68
Lepomis auritus	Redbreast Sunfish	46
Notemigonus crysoleucas	Golden Shiner	41
Anguilla rostrata	American Eel	38
Cynoscion nebulosus	Spotted Seatrout	37
Sciaenops ocellatus	Red Drum	35

Table 12 (cont'd.)

Scientific Name	Common Name	Total Caught
Pomatomus saltatrix	Bluefish	27
Perca flavescens	Yellow Perch	24
Micropterus punctulatus	Spotted Bass	24
Menticirrhus americanus	Southern Kingfish	22
Alosa sapidissima	American Shad	20
Micropterus salmoides	Largemouth Bass	20
Symphurus plagiusa	Blackcheek Tonguefish	17
Ictalurus catus	White Catfish	12
Strongylura marina	Atlantic Needlefish	12
Mugil cephalus	Striped Mullet	12
Ictalurus nebulosus	Brown Bullhead	10
Morone saxatilis age 1+	Striped Bass - age 1+	10
Paralichthys lethostigma	Southern Flounder	9
Paralichthys dentatus	Summer Flounder	8
Syngnathus fuscus	Northern Pipefish	8
Alosa pseudoharengus	Alewife	7
Lepisosteus osseus	Longnose Gar	7
Alosa mediocris	Hickory Shad	5
Micropterus dolomieui	Smallmouth Bass	5
Cyprinus carpio	Common Carp	3
Chaetodipterus faber	Atlantic Spadefish	3
Notropis bifrenatus	Bridle Shiner	3
Cyprinodon variegatus	Sheepshead Minnow	3
Lepomis spp	Sunfishes	3
Pogonius cromis	Black Drum	2
Mugil spp.	Mullet spp.	2
Gobiosoma bosci	Naked Goby	2
Caranax latus	Horse-eye Jack	2
Syngnathus louisianae	Chain Pipefish	2
Hyporhamphus meeki	False-Stripe Halfbeak	2
Scomberomorus maculatus	Spanish Mackerel	1
Trachinotus carolinus	Florida Pompano	1
Carpiodes cyprinus	Quillback	1
	Total	**53277**

Table 13. Preliminary catch of Spottail Shiner from select juvenile Striped Bass seine survey stations using only the 1st haul (Rago et al. 1995) summarized by year, where x = total fish, Index = $(\exp(\ln(x+1)) - 1)$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1989	2940	2.64	1.15	12.99	10.34-16.25	121
1990	2068	2.12	1.30	7.35	5.62-9.54	124
1991	1429	1.87	1.24	5.49	4.17-7.14	119
1992	2357	2.02	1.40	6.50	4.83-8.65	123
1993	1713	1.96	1.27	6.13	4.65-8.01	118
1994	2498	2.29	1.34	8.91	6.77-11.66	120
1995	2216	2.10	1.36	7.16	5.37-9.46	120
1996	2280	2.28	1.27	8.74	6.72-11.29	119
1997	3605	2.17	1.53	7.77	5.67-10.53	125
1998	2092	2.12	1.32	7.36	5.53-9.72	114
1999	1252	1.48	1.30	3.38	2.48-4.52	126
2000	4882	2.73	1.43	14.39	10.92-18.86	125
2001	2848	2.39	1.33	9.92	7.64-12.82	128
2002	1541	1.30	1.40	2.67	1.86-3.70	128
2003	2972	2.42	1.40	10.21	7.76-13.34	129
2004	5113	3.25	1.13	24.72	19.98-30.54	123
2005	3585	2.63	1.40	12.85	9.71-16.91	119
2006	3451	2.47	1.51	10.85	7.96-14.68	117
2007	3823	2.58	1.47	12.22	9.09-16.33	118
2008	2152	1.97	1.46	6.16	4.51-8.31	124
2009	3033	2.21	1.54	8.10	5.89-11.02	122
2010	3983	2.38	1.54	9.79	7.16-13.26	121
2011	6194	3.20	1.41	23.50	17.84-30.85	117
2012	3997	2.40	1.58	10.03	7.27-13.71	121
Overall (1989-2012)	72024	2.29	0.45	8.88	7.24-10.85	24 (years)

Table 14. Preliminary catch of Atlantic Silverside from select juvenile Striped Bass seine survey stations using only the 1st haul (Rago et al. 1995) summarized by year, where x = total fish, Index = $(\exp(\ln(x+1)) - 1)$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1989	881	1.49	1.57	3.42	1.93-5.68	58
1990	1430	1.47	1.46	3.33	1.97-5.31	60
1991	2532	2.53	1.71	11.51	6.89-18.84	55
1992	5564	2.88	2.08	16.79	9.39-29.45	60
1993	2166	2.21	1.80	8.12	4.71-13.56	59
1994	2174	1.98	1.73	6.26	3.64-10.35	60
1995	2701	2.43	1.81	10.39	6.11-17.26	59
1996	4666	2.50	2.17	11.24	5.96-20.52	59
1997	973	1.83	1.48	5.26	3.24-8.23	58
1998	2182	2.61	1.60	12.64	8.02-19.64	60
1999	6227	3.37	1.50	28.03	18.49-42.23	57
2000	2936	2.83	1.72	15.99	9.81-25.71	58
2001	3487	2.92	1.69	17.48	11.02-27.41	62
2002	4582	3.48	1.53	31.38	20.82-47.04	60
2003	3470	2.16	2.15	7.63	3.95-14.04	60
2004	1473	1.76	1.79	4.78	2.64-8.19	60
2005	1843	2.48	1.50	10.97	7.18-16.52	62
2006	2613	2.56	1.68	11.96	7.52-18.72	64
2007	2021	2.68	1.51	13.61	8.84-20.70	58
2008	3107	2.04	1.78	6.71	3.93-11.06	63
2009	2618	2.76	1.68	14.80	9.35-23.13	63
2010	1347	2.38	1.26	9.78	6.87-13.78	64
2011	2953	2.63	1.80	12.94	7.87-20.92	63
2012	1079	1.86	1.46	5.42	3.43-8.31	62
Overall (1989-2012)	65025	2.41	0.52	10.13	7.99-12.78	24 (years)

Table 15. Preliminary catch of Inland Silverside from select juvenile Striped Bass seine survey stations using only the 1st haul (Rago et al. 1995) summarized by year, where x = total fish, Index = $(\exp(\ln(x+1)) - 1)$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1989	471	1.15	0.96	2.17	1.63-2.81	107
1990	574	1.09	1.14	1.97	1.39-2.70	110
1991	285	0.86	0.87	1.37	1.00-1.81	105
1992	326	0.67	0.90	0.96	0.65-1.33	110
1993	368	0.76	0.97	1.14	0.77-1.59	106
1994	166	0.53	0.76	0.70	0.46-0.97	106
1995	104	0.44	0.62	0.56	0.38-0.75	107
1996	772	0.82	1.13	1.27	0.83-1.83	107
1997	175	0.54	0.76	0.71	0.48-0.98	110
1998	204	0.69	0.80	0.99	0.70-1.33	104
1999	298	0.72	0.93	1.06	0.73-1.45	113
2000	718	1.06	1.19	1.89	1.31-2.62	113
2001	626	0.96	1.15	1.61	1.10-2.24	115
2002	447	0.78	1.04	1.18	0.80-1.66	114
2003	545	1.21	0.99	2.37	1.80-3.06	113
2004	753	1.23	1.17	2.44	1.75-3.29	113
2005	368	0.93	0.94	1.53	1.11-2.03	110
2006	1161	1.32	1.32	2.73	1.90-3.79	112
2007	807	1.06	1.20	1.88	1.29-2.62	111
2008	658	1.15	1.11	2.14	1.56-2.87	114
2009	1691	1.88	1.29	5.56	4.16-7.35	114
2010	908	1.19	1.30	2.29	1.57-3.21	111
2011	1334	1.32	1.27	2.76	1.95-3.79	110
2012	901	1.45	1.10	3.26	2.49-4.25	113
Overall (1989-2012)	14660	0.99	0.33	1.70	1.35-2.09	24 (years)

Table 16. Preliminary catch of Banded Killifish from select juvenile Striped Bass seine survey stations using only the 1st haul (Rago et al. 1995) summarized by year, where x = total fish, Index = $(\exp(\ln(x+1)) - 1)$, SD = Standard Deviation, and SE = Standard Error.

Year	Total Fish (x)	Mean ln (x+1)	SD	Index	C.I. (± 2 SE)	N (hauls)
1989	231	0.56	0.82	0.75	0.49 - 1.05	106
1990	235	0.65	0.88	0.92	0.63 - 1.28	109
1991	247	0.59	0.93	0.80	0.50 - 1.16	104
1992	153	0.46	0.77	0.59	0.37 - 0.84	108
1993	258	0.59	0.95	0.80	0.49 - 1.17	103
1994	200	0.53	0.84	0.70	0.44 - 1.01	105
1995	287	0.66	1.01	0.93	0.59 - 1.35	105
1996	600	1.14	1.20	2.12	1.46 - 2.94	104
1997	365	0.88	1.00	1.41	0.99 - 1.92	110
1998	304	0.92	0.94	1.52	1.07 - 2.05	95
1999	335	0.79	1.01	1.20	0.81 - 1.68	107
2000	312	0.81	0.95	1.24	0.86 - 1.69	105
2001	374	0.99	0.95	1.68	1.23 - 2.22	108
2002	478	0.82	1.12	1.26	0.83 - 1.80	109
2003	841	1.16	1.24	2.18	1.50 - 3.03	109
2004	1388	1.79	1.31	5.00	3.63 - 6.77	103
2005	721	1.29	1.22	2.64	1.86 - 3.65	100
2006	498	0.93	1.18	1.53	0.99 - 2.21	97
2007	677	1.32	1.18	2.73	1.94 - 3.74	98
2008	1017	1.62	1.19	4.05	3.00 - 5.37	105
2009	1202	1.74	1.29	4.72	3.43 - 6.39	102
2010	1927	2.15	1.37	7.63	5.57 - 10.34	101
2011	1920	1.95	1.95	6.00	4.25-8.32	97
2012	1831	2.11	1.33	7.22	5.32-9.70	102
Overall (1989-2012)	16401	1.10	0.52	2.01	1.42-2.73	24 (years)

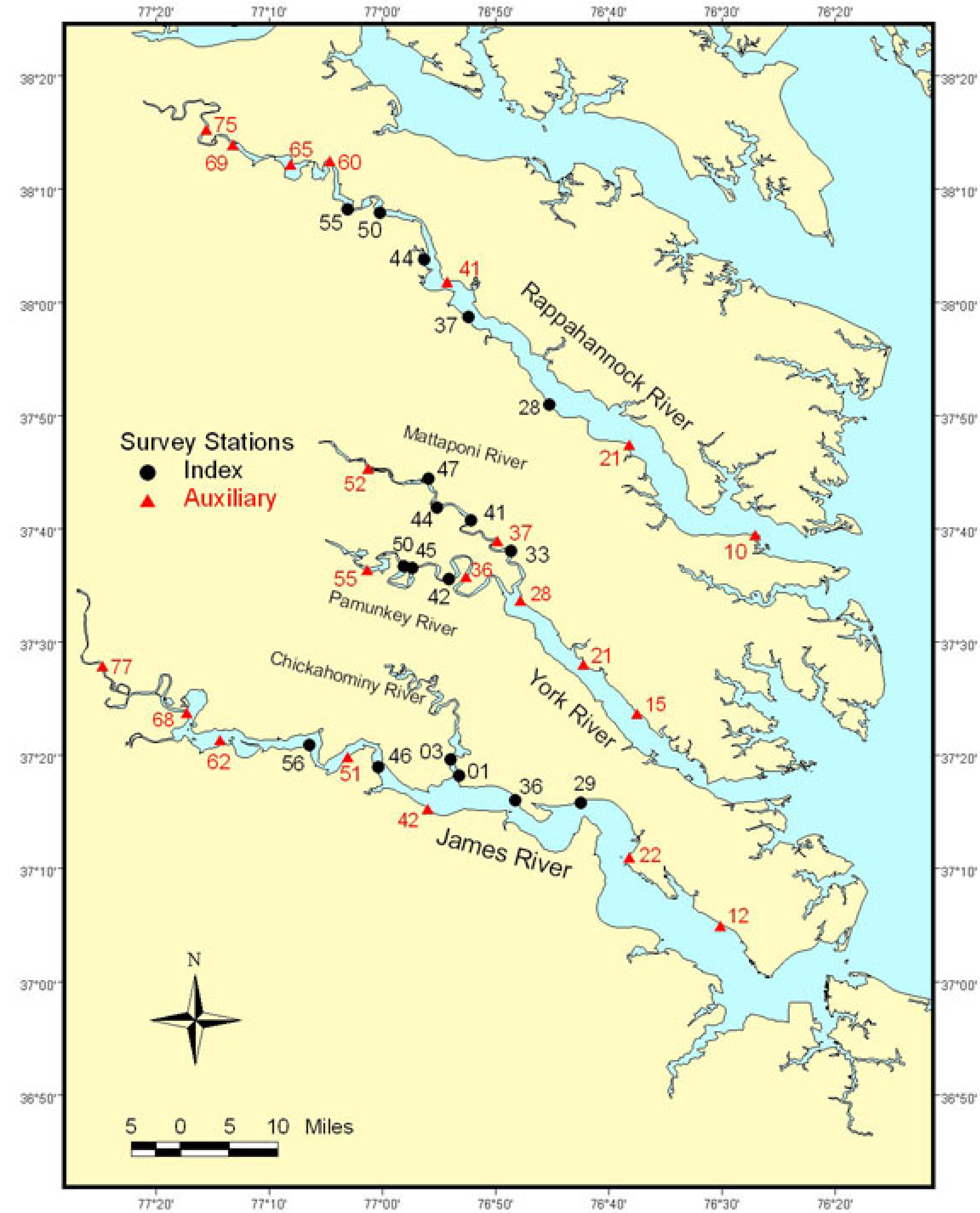

Figure 1. Juvenile Striped Bass seine survey stations. Numeric portion of station designation indicates approximate mile from mouth of river.

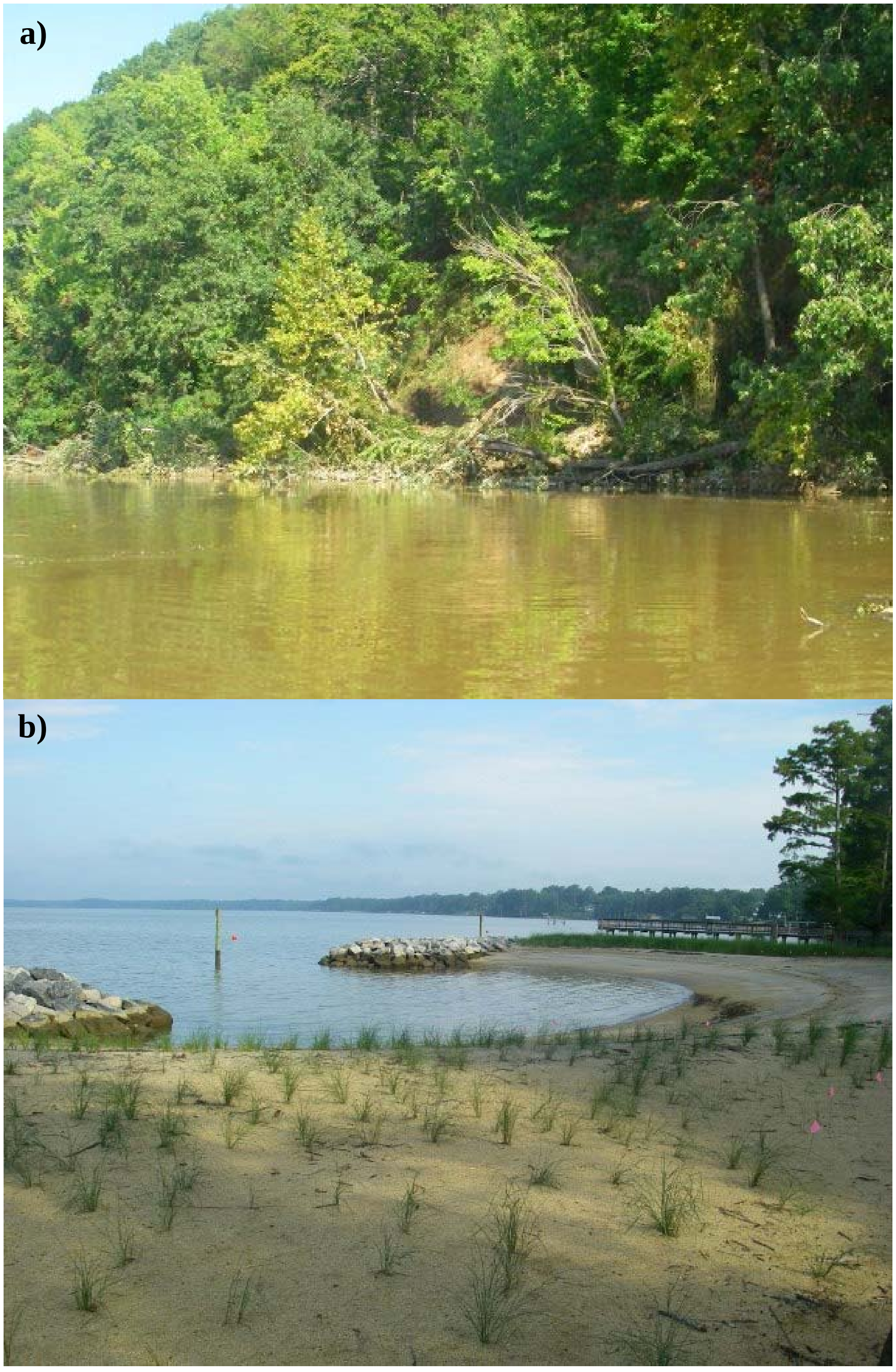

Figure 2. **a**) Landslide at R60 caused by Hurricane Irene and Tropical Storm Lee in 2011. An alternative location was selected approximately 0.5 miles downstream for 2012.
b) New breakwaters constructed at J36 in 2011 overlaying the historic sampling location. The seine site was moved ~100m upstream, just beyond the dock in the right background (relocated during the 2011 seine season).

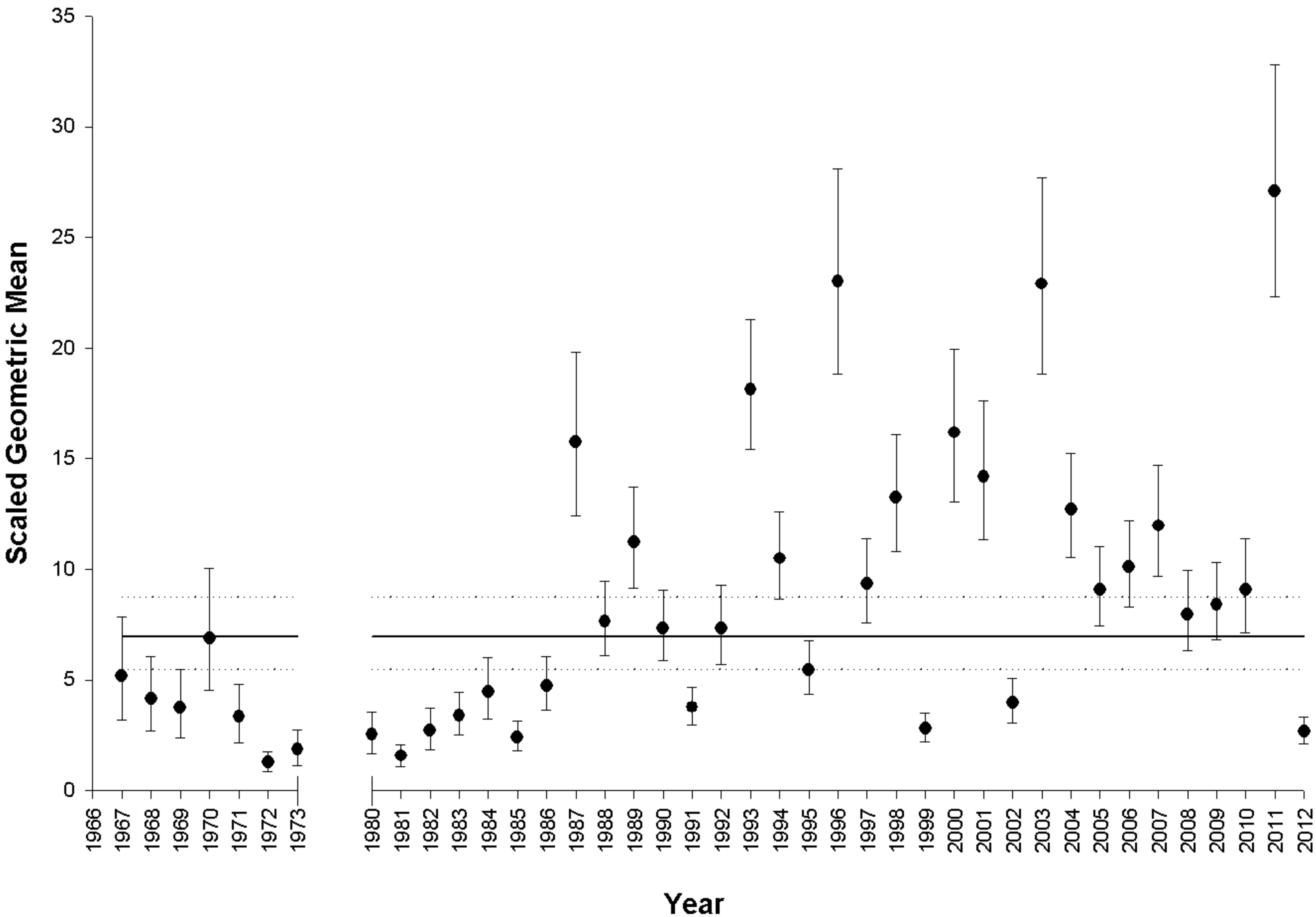

Figure 3. Scaled geometric mean of young-of-the-year Striped Bass in the primary nursery areas of Virginia (index stations) by year. Vertical bars are 95% confidence intervals as estimated by $\pm$ 2 standard errors of the mean. Horizontal lines indicate the historical geometric mean (solid) and confidence intervals (dotted) for 1967-2012.

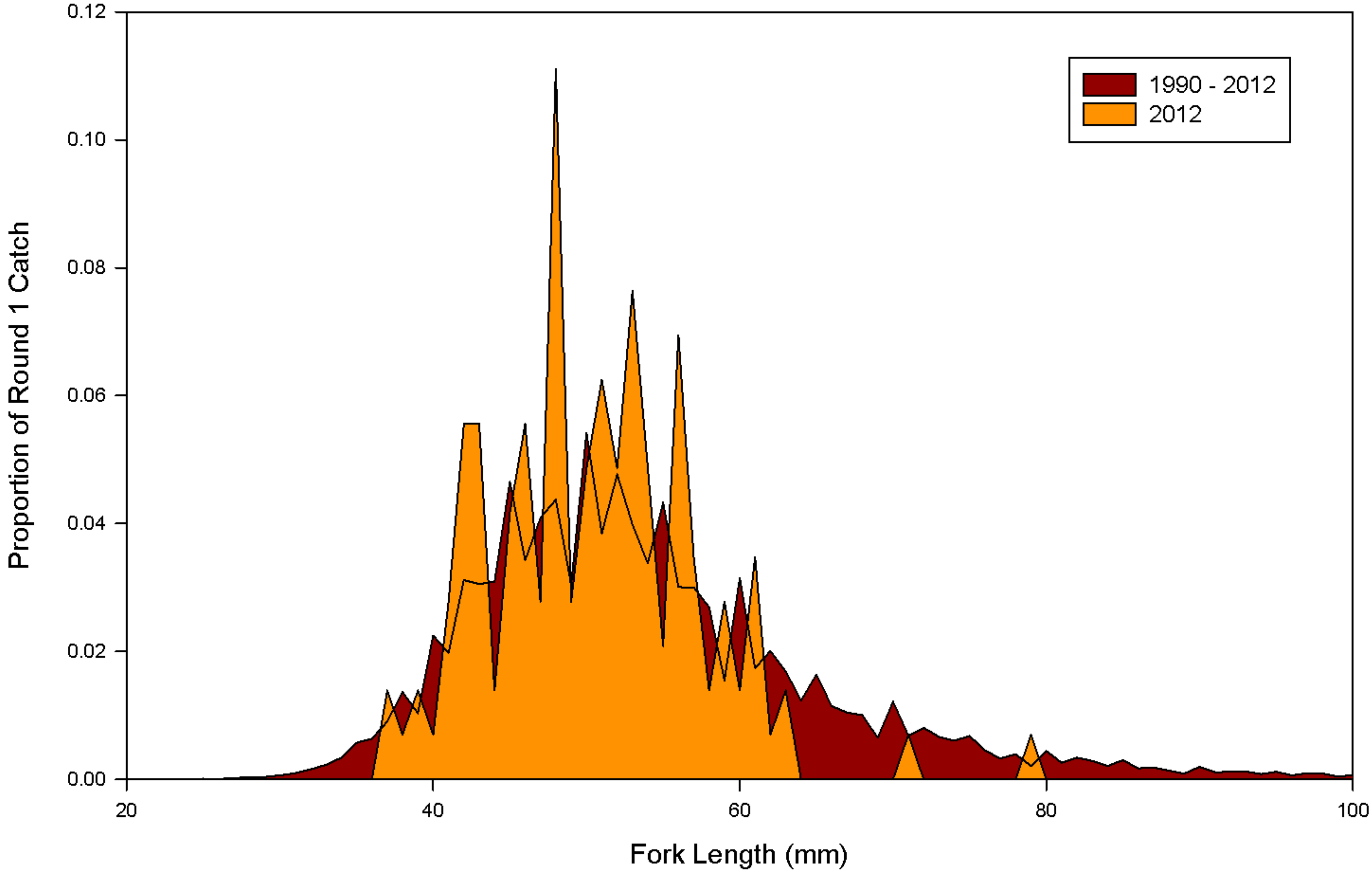

Figure 4: Length-frequency distribution of young-of-the-year Striped Bass captured during late-June (round 1). Although sampling was initiated one week earlier than previous years, a similar size range of Striped Bass were captured.

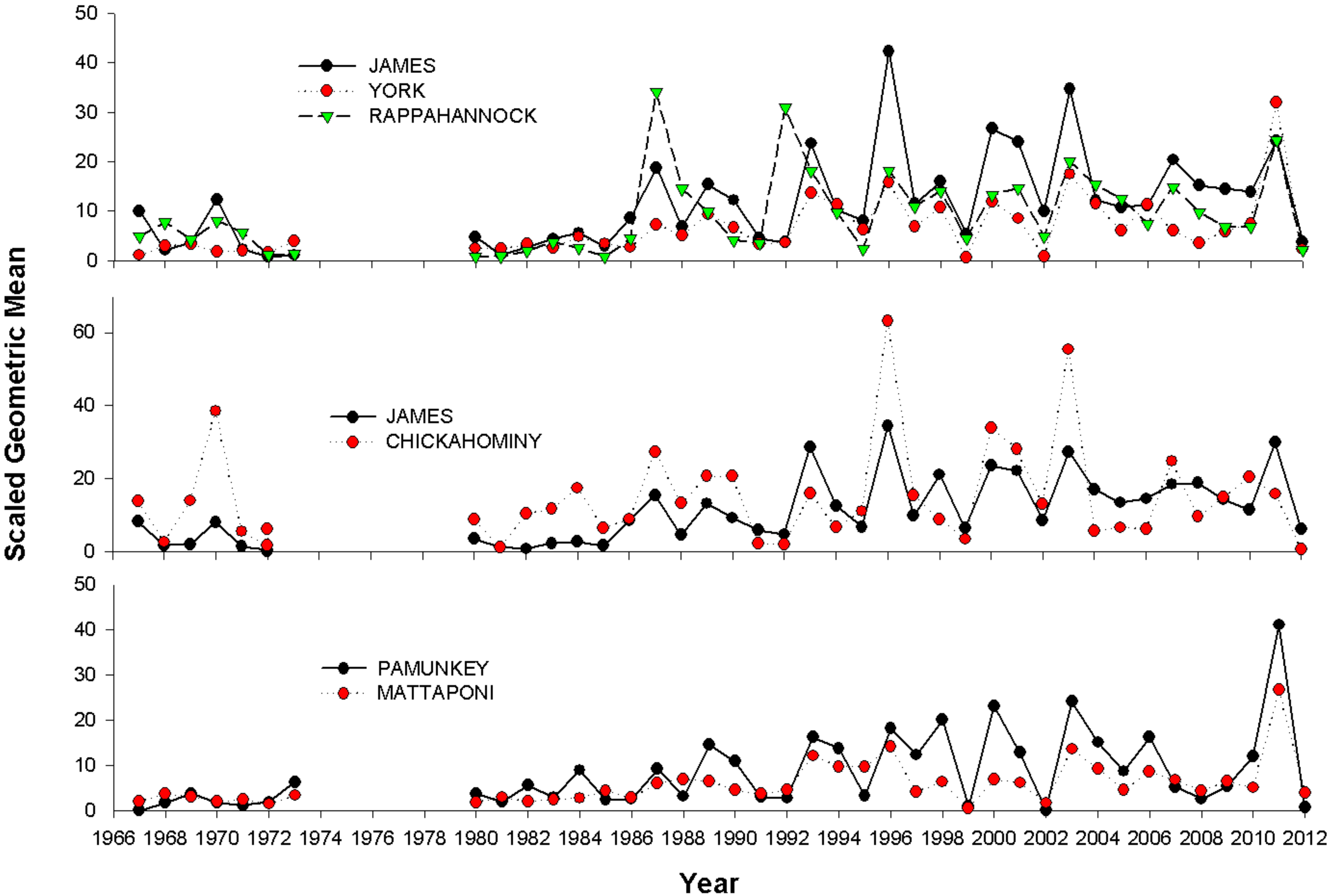

Figure 5. Scaled geometric mean of young-of-the-year Striped Bass in the primary nursery areas of Virginia (index stations) by drainage and river.

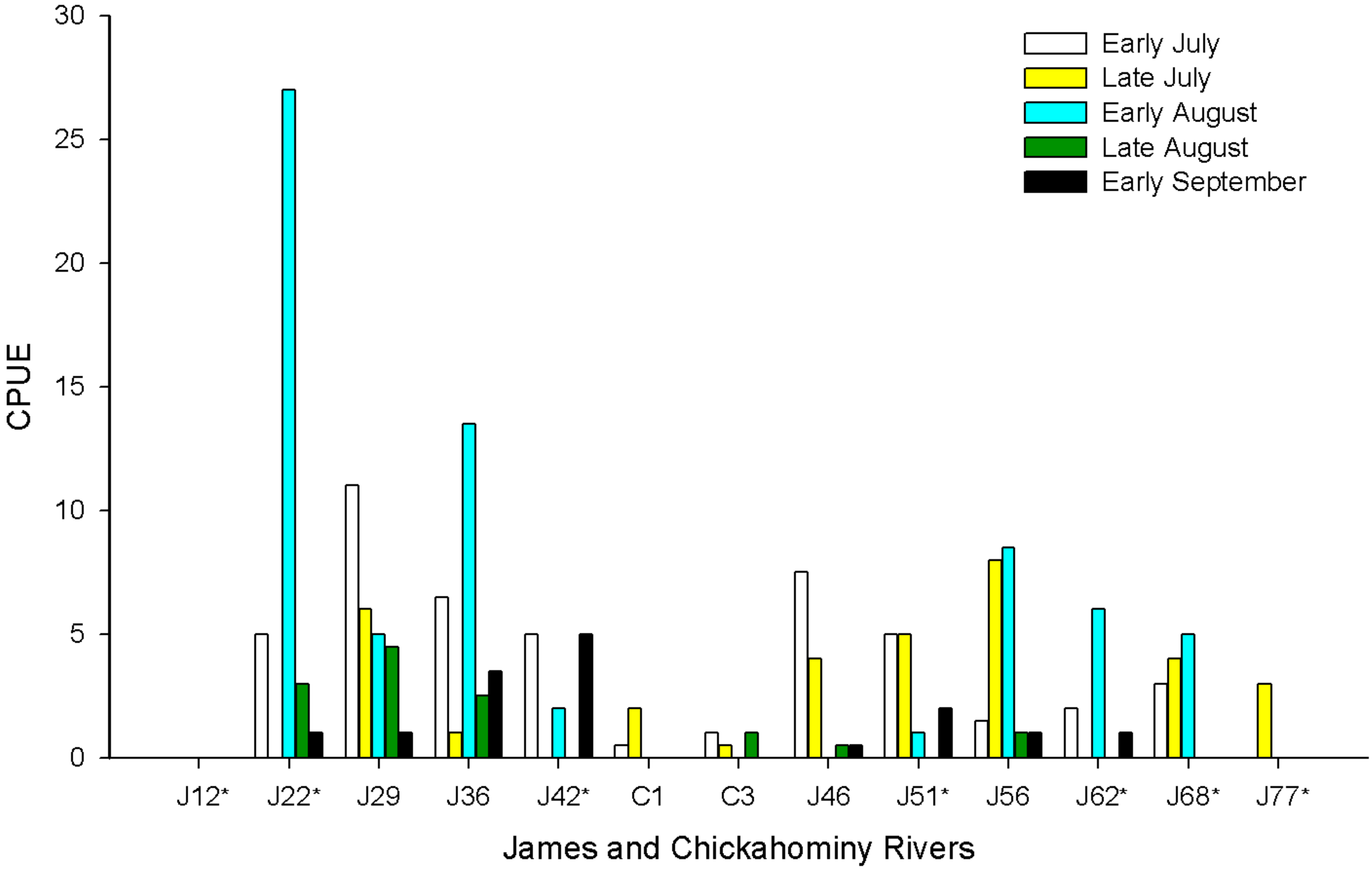

Figure 6. Catch of young-of-the-year Striped Bass by station in the James River drainage in 2012. Index station catch represents an average of two hauls; auxiliary station (starred) catch represents one haul. No sampling occured at J77 during late June.

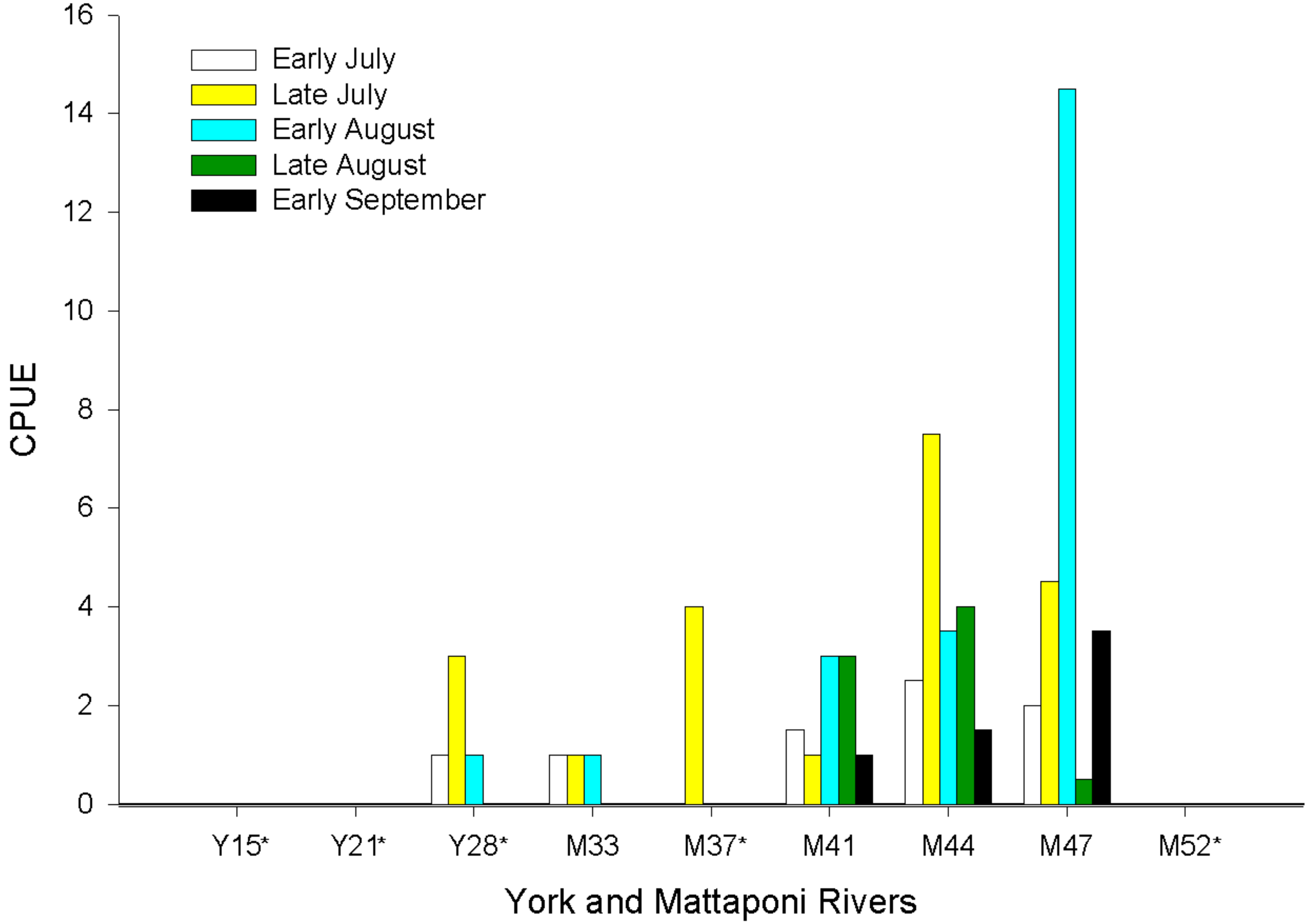

Figure 7. Catch of young-of-the-year Striped Bass by station in the York and Mattaponi rivers in 2012. Index station catch represents an average of two hauls; auxiliary station (starred) catch represents one haul. No sampling occured at M52 during early August.

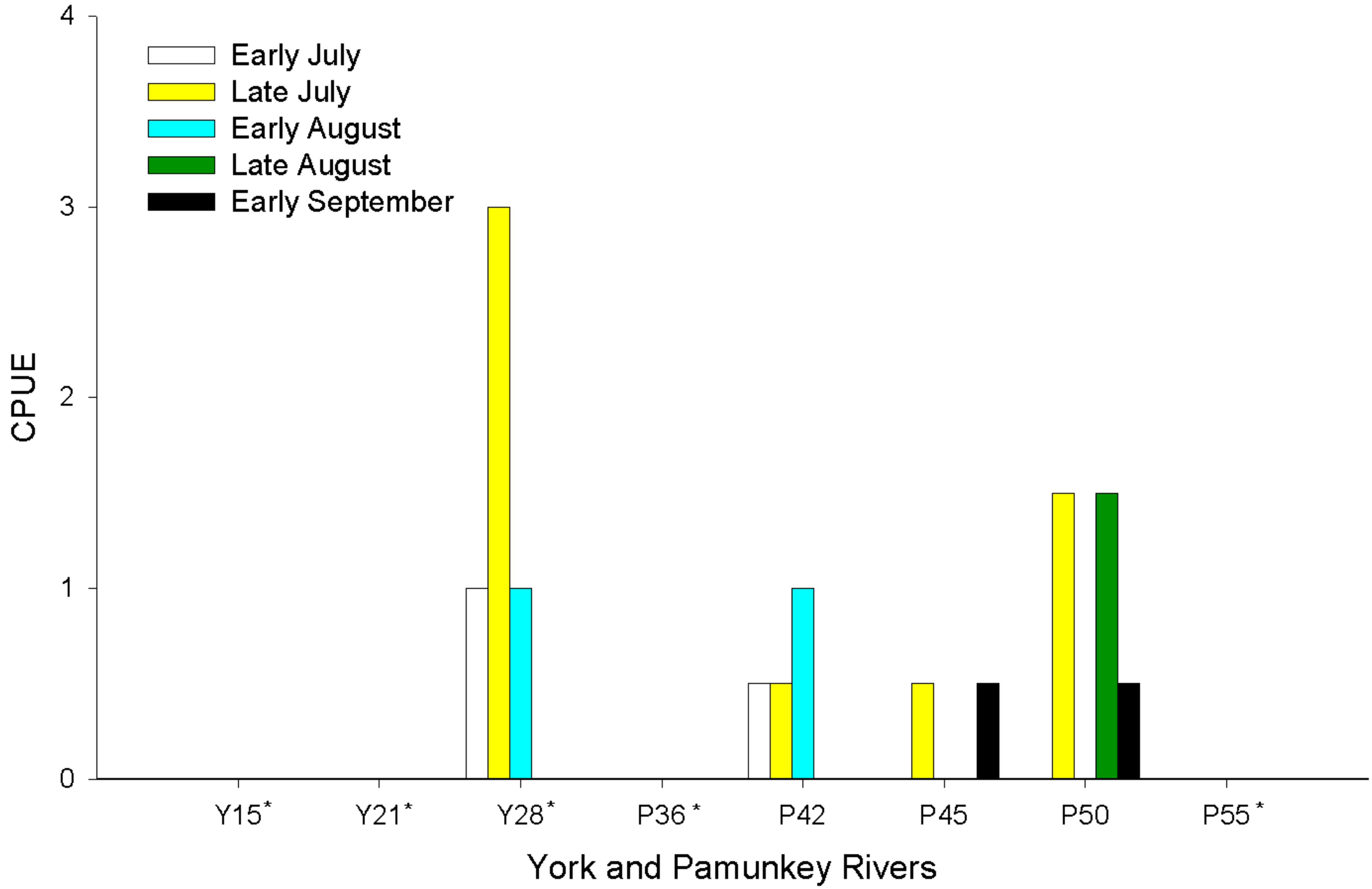

Figure 8. Catch of young-of-the-year Striped Bass by station in the York and Pamunkey rivers in 2012. Index station catch represents an average of two hauls; auxiliary station (starred) catch represents one haul. No sampling occured at P55 in early August.

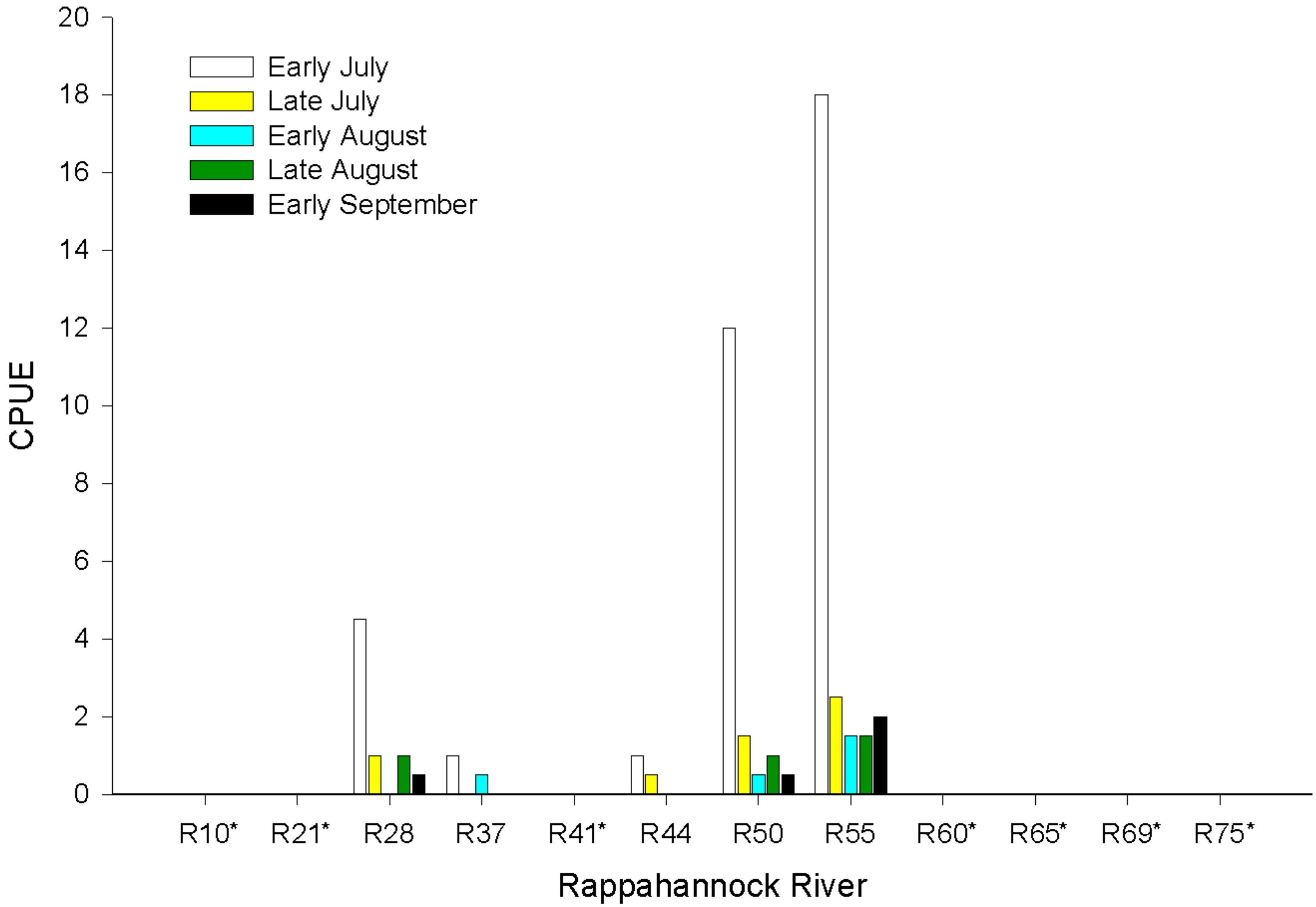

Figure 9. Catch of young-of-the-year Striped Bass by station in the Rappahannock River in 2012. Index station catch represents an average of two hauls; auxiliary station (starred) catch represents one haul. Hauls were completed at all stations during all rounds in 2012.

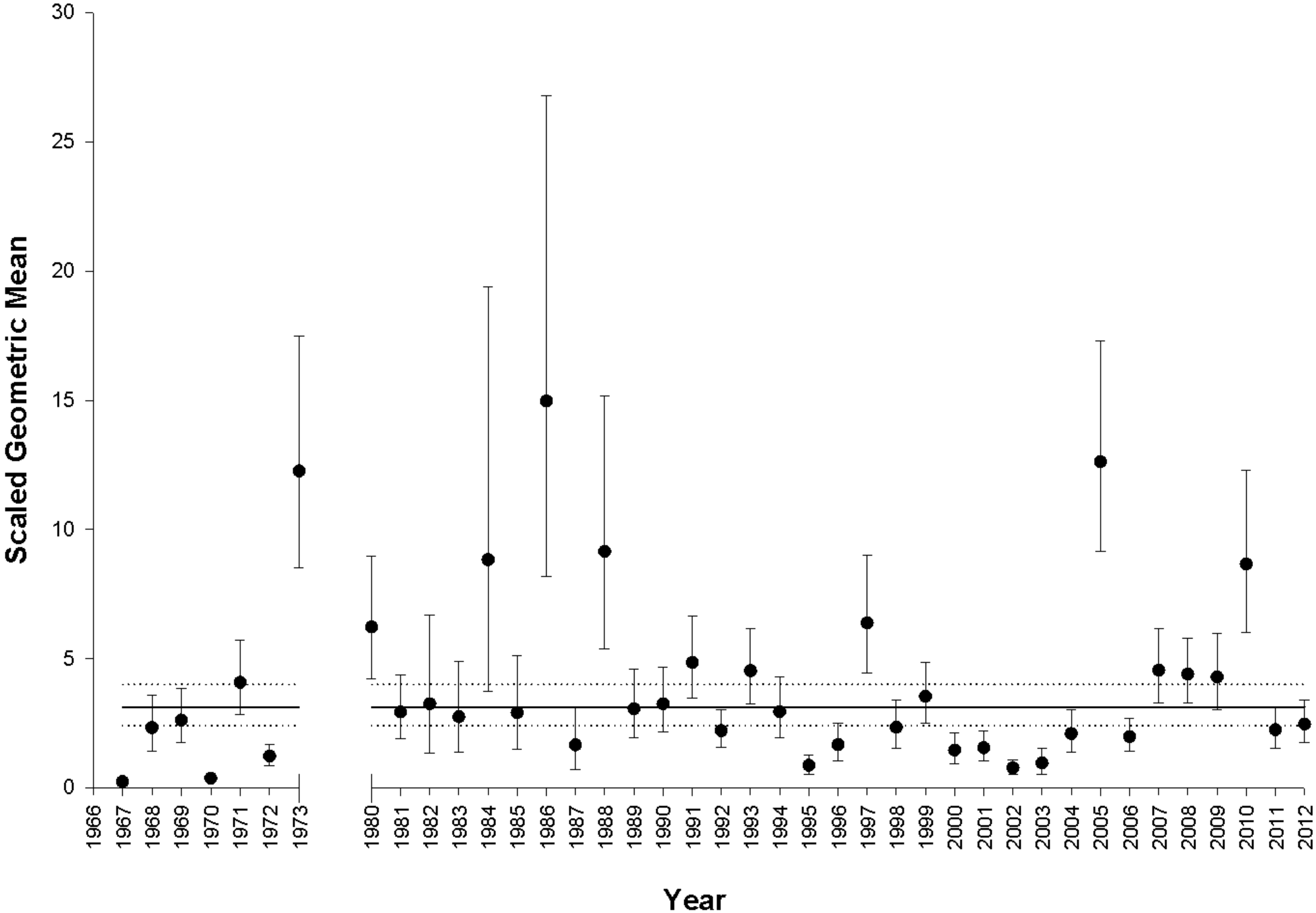

Figure 10. Scaled geometric mean of young-of-the-year Spot by year from select seine survey stations in Virginia tributaries of Chesapeake Bay. Vertical bars are 95% confidence intervals as estimated by ± 2 standard errors of the mean. Horizontal lines indicate the historical geometric mean (solid) and confidence intervals (dotted) for 1967-2012.

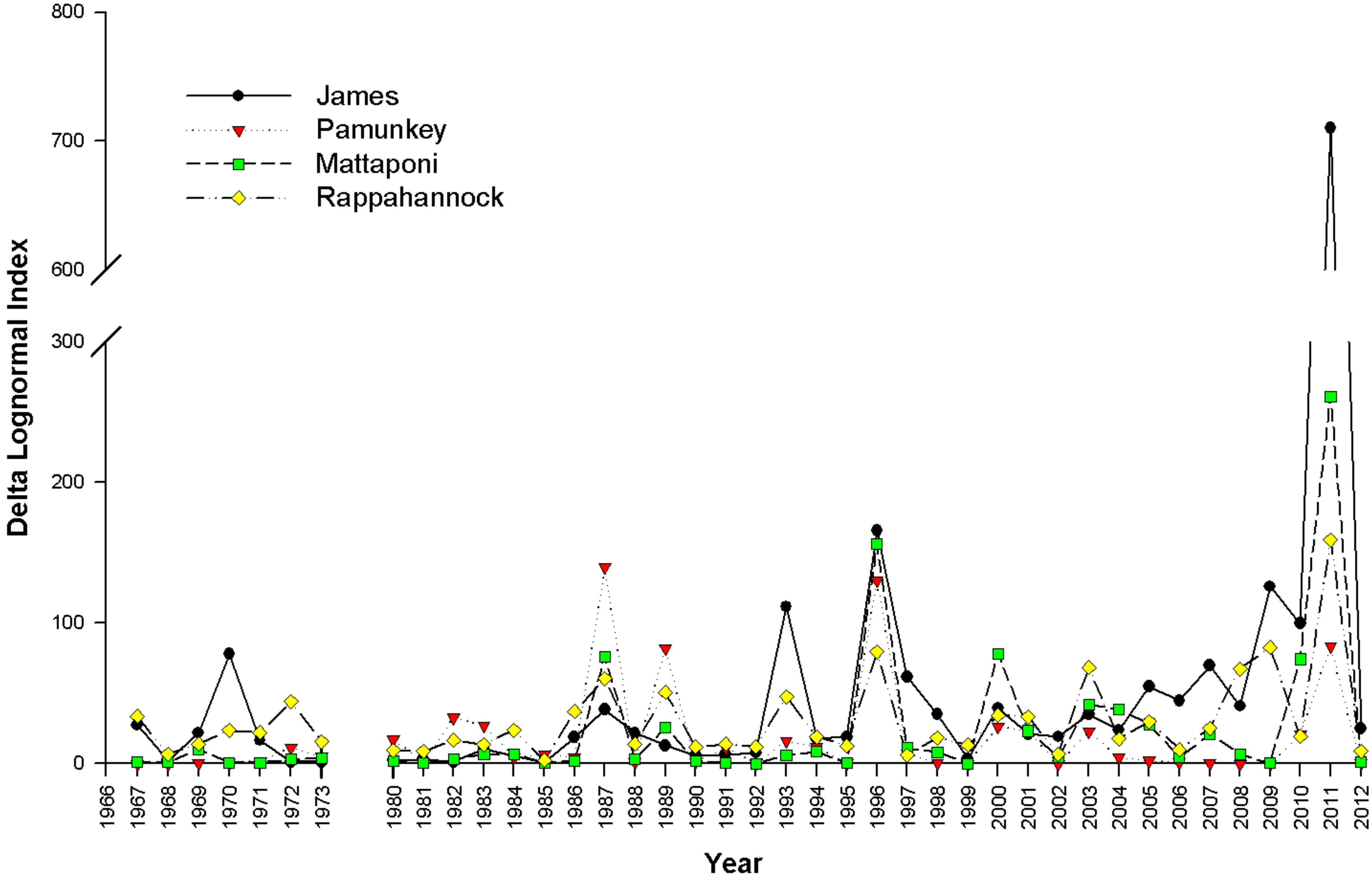

Figure 11. Delta-lognormal mean of young-of-the-year White Perch from select seine survey stations by river and year.

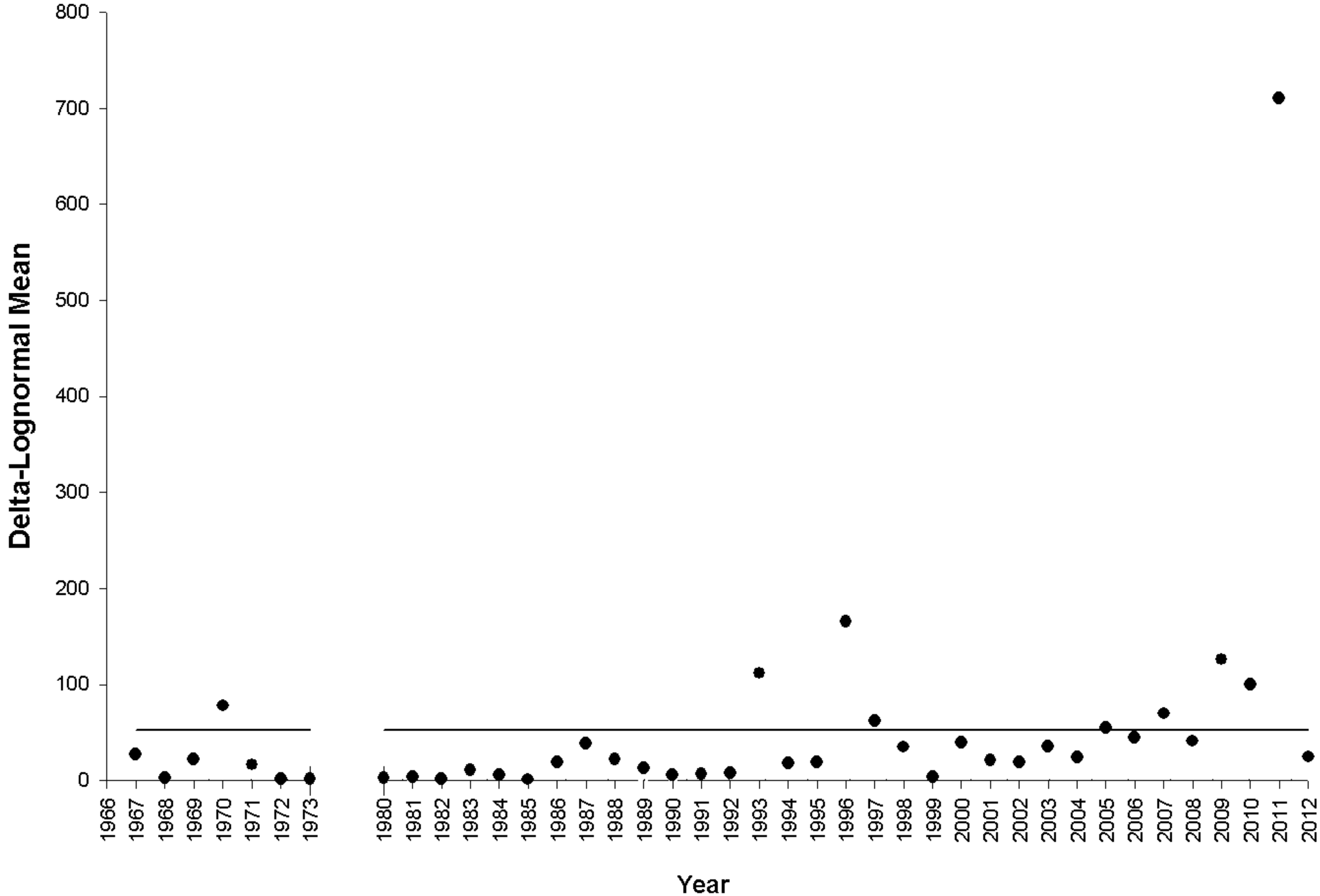

Figure 12. Delta-lognormal mean of young-of-the-year White Perch from the James River nursery area by year. The horizontal line indicates the historical mean for 1967-2012.

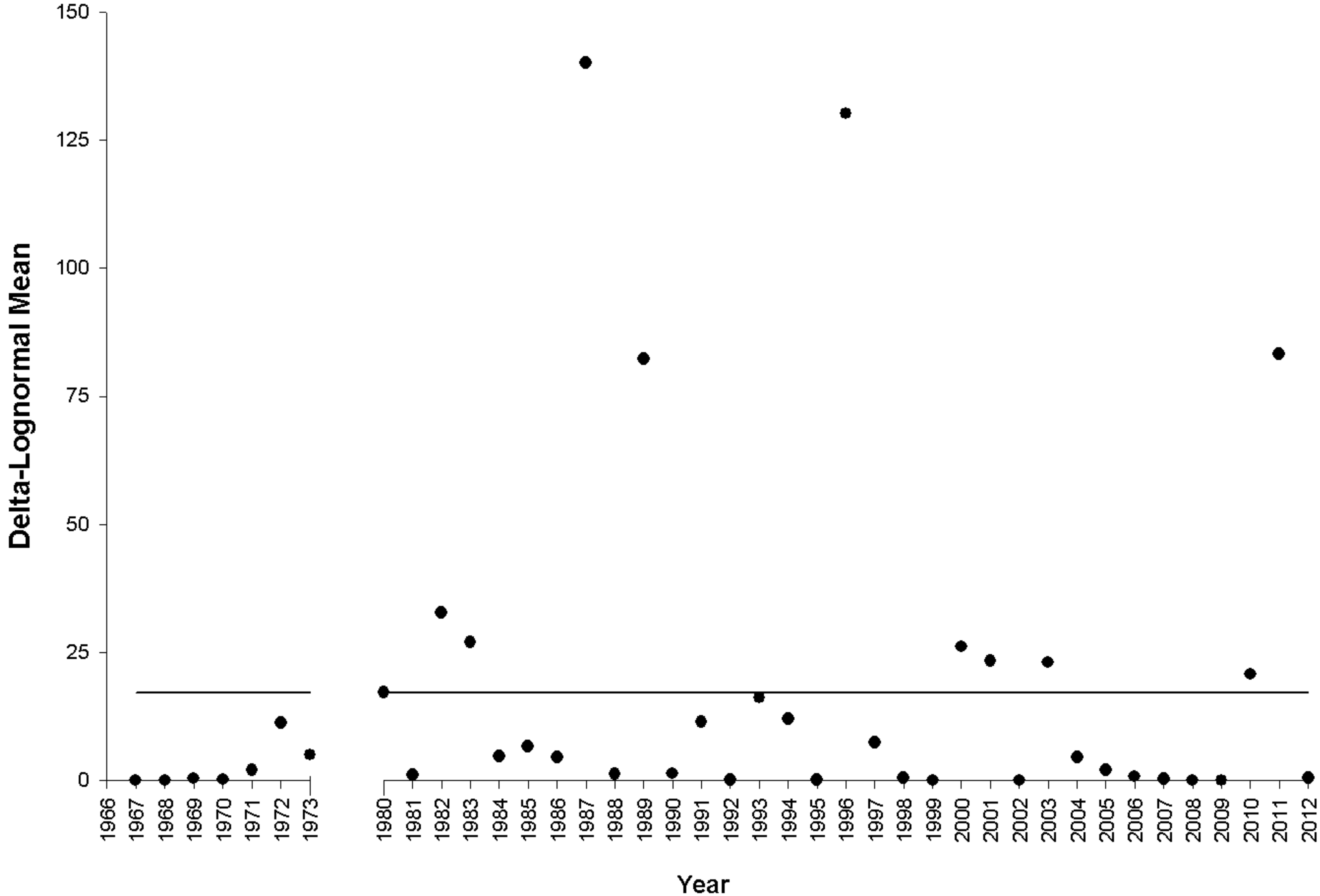

Figure 13. Delta-lognormal mean of young-of-the-year White Perch from the Pamunkey River nursery area by year. The horizontal line indicates the historical mean for 1967-2012.

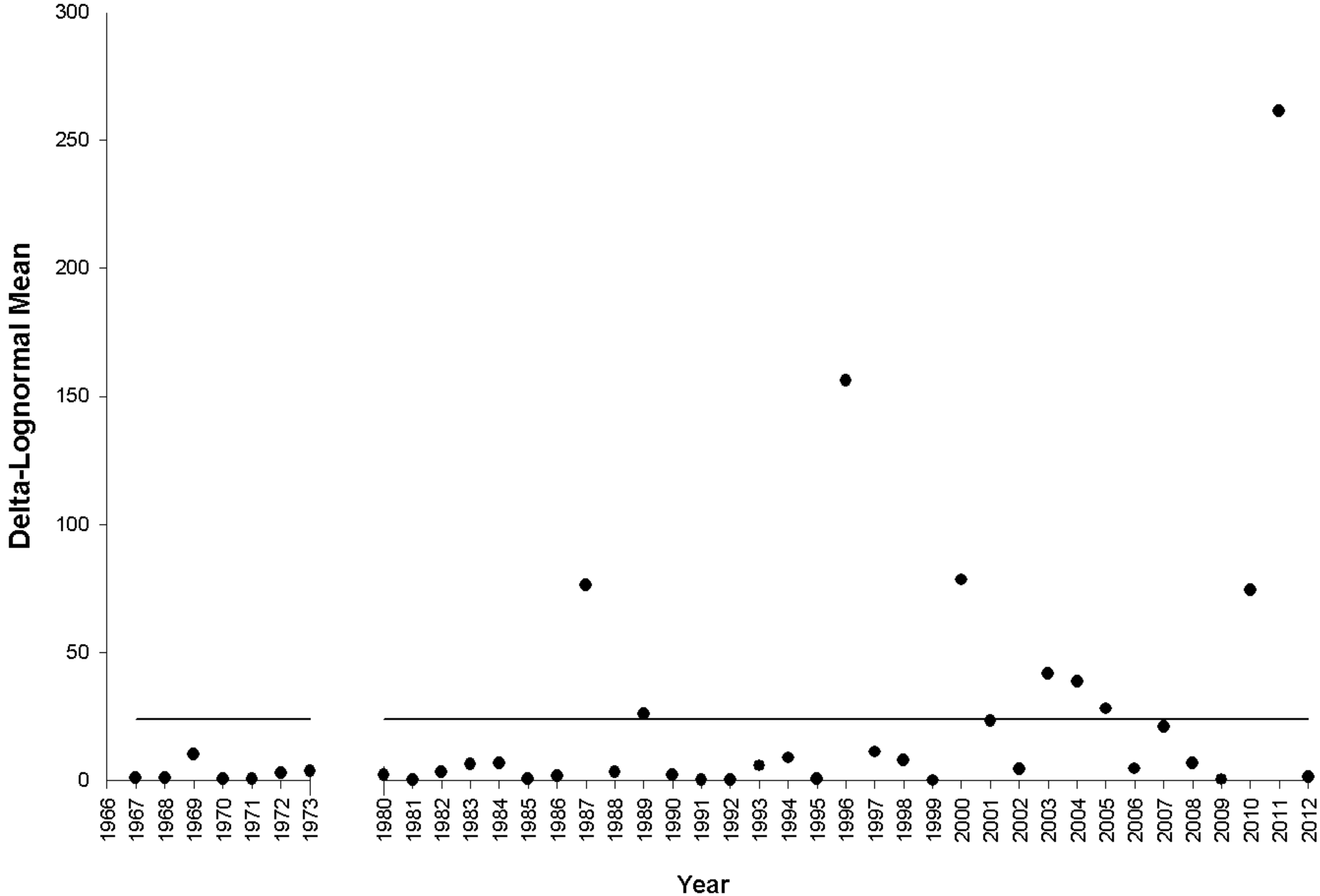

Figure 14. Delta-lognormal mean of young-of-the-year White Perch from the Mattaponi River nursery area by year. The horizontal line indicates the historical mean for 1967-2012.

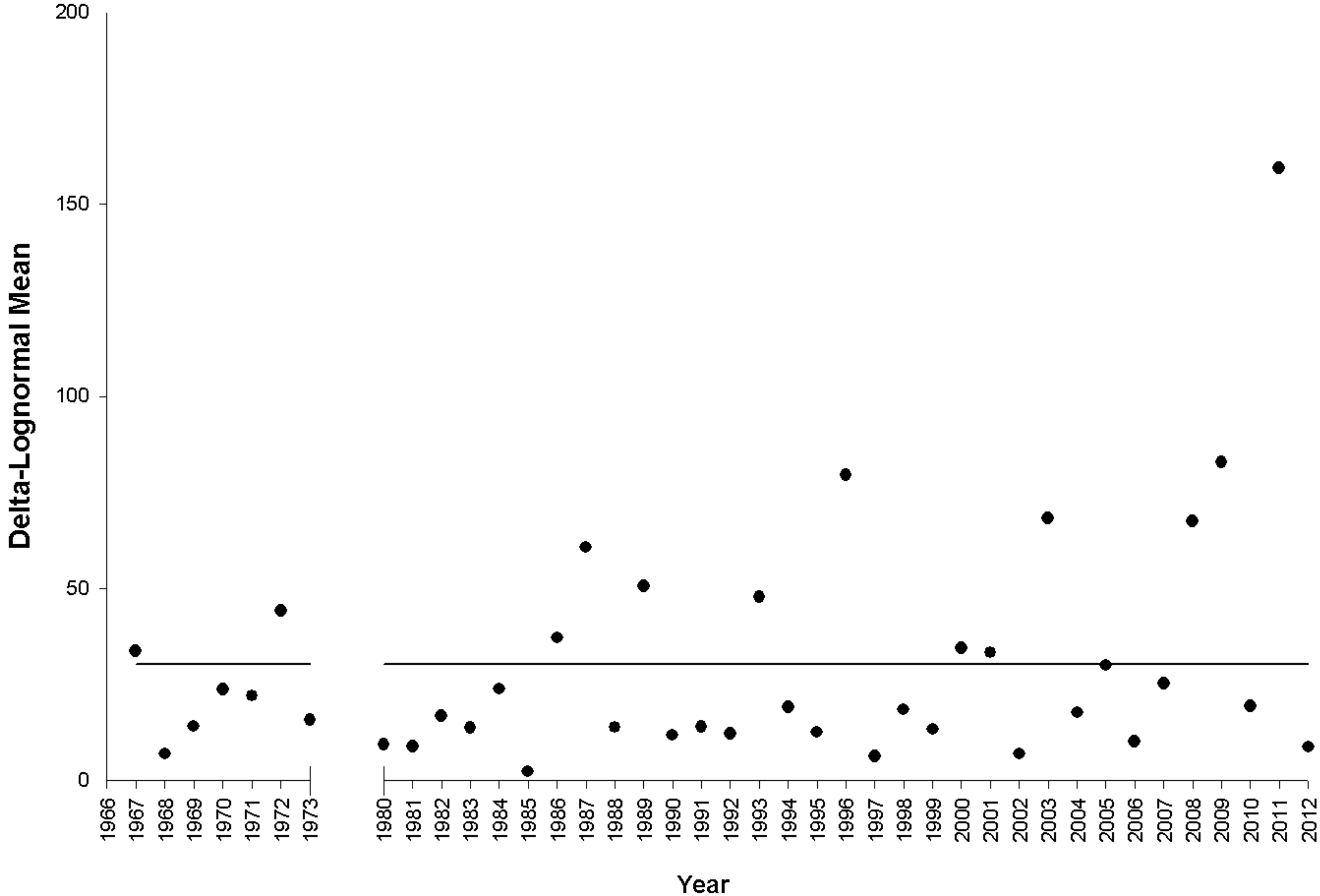

Figure 15. Delta-lognormal mean of young-of-the-year White Perch from the Rappahannock River nursery area by year. The horizontal line indicates the historical mean for 1967-2012.

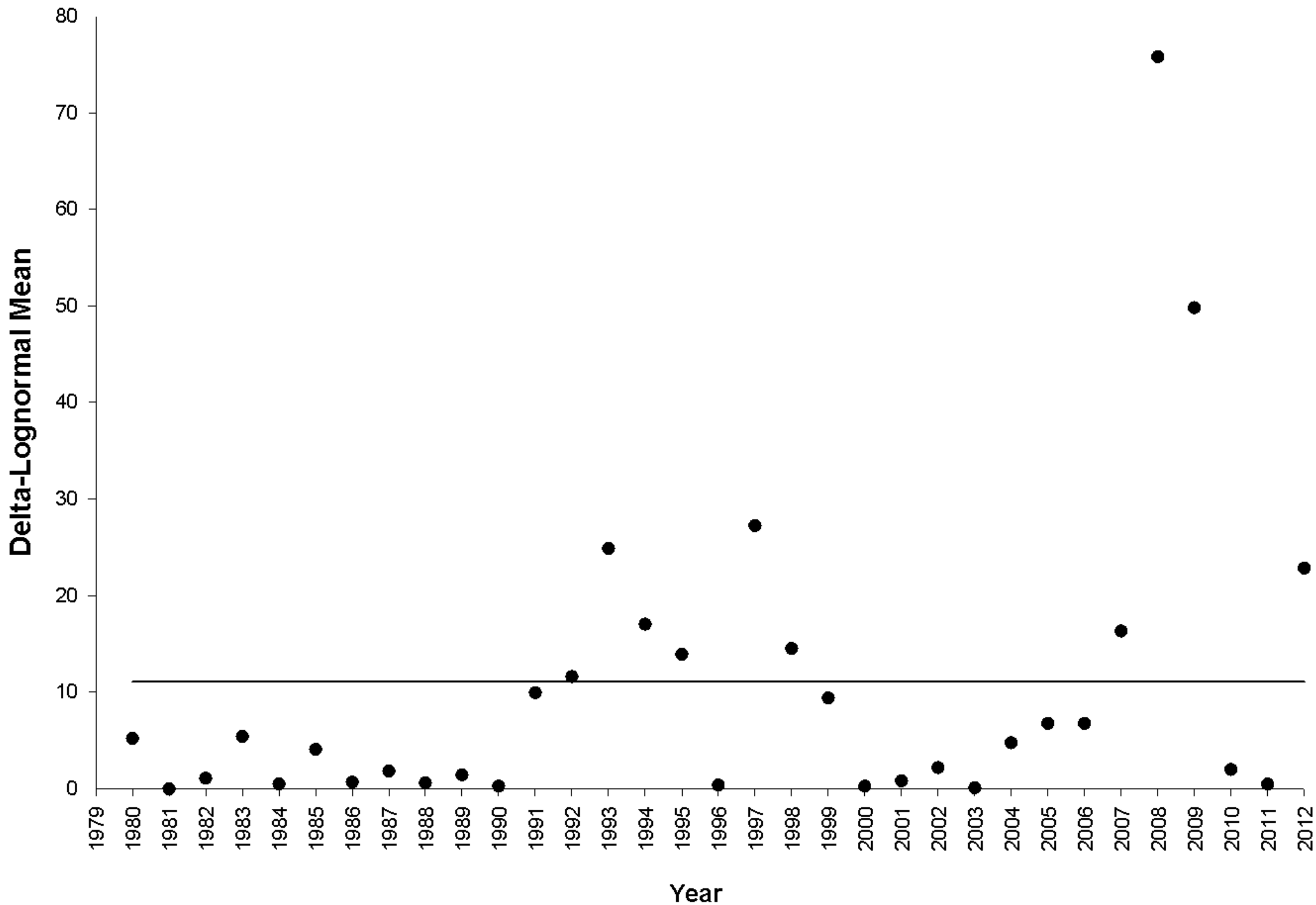

Figure 16. Delta-lognormal mean for young-of-the-year Atlantic Croaker from select seine survey stations in Virginia tributaries of Chesapeake Bay by year. The horizontal line indicates the historical mean for 1967-2012.