ANNUAL PROGRESS REPORT

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

U. S. Fish and Wildlife Service

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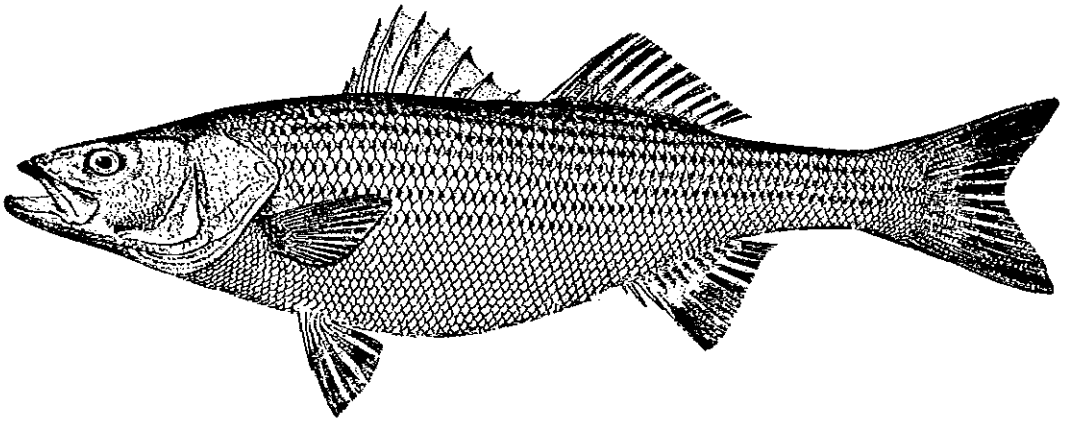

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PREFACE

The Virginia Institute of Marine Science (VIMS) has conducted a juvenile striped bass seine survey from 1967 through 1973 and from 1980 through the present. The primary objective has been the monitoring of the relative annual recruitment success of juvenile striped bass in the spawning and to the nursery areas of Lower Chesapeake Bay. Initially (1967-1973), the survey was funded by the U.S. Fish and Wildlife Service and when reinstated in 1980 with funding from the National Marine Fisheries Service under the Emergency Striped Bass Study program. Commencing with the 1988 annual survey, support of the program has been jointly made through the Sportfish Restoration Program (Wallop-Breaux Act), administered through the U.S. Fish and Wildlife Service and the Virginia Marine Resources Commission. This report summarizes the results of the 1996 sampling period and compares these results with the previous work.

Specific objectives planned for the 1996 program were to:

1. Measure the relative abundance of the 1996 year class of striped bass from the James, York and Rappahannock river systems.
2. Quantify environmental conditions at the time of collection.
3. Examine relationships between juvenile striped bass abundance and measured or proxy environmental and biological data.

INTRODUCTION

The estimation of juvenile striped bass abundance in Virginia waters, funded by the U.S. Fish and Wildlife Service, is part of a coast-wide sampling program of striped bass recruitment conducted from New England to North Carolina under the coordination of the Atlantic States Marine Fisheries Commission (ASMFC). Virginia'a efforts started in 1967 with funding from the Commercial Fisheries Development Act of 1965 (PL88-309) and continued until 1973 when the program was terminated. It was instituted in 1980 with 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 Sportfish Restoration and Enhancement Act of 1988 (PL 100-448 known as the Dingle-Johnson Act).

The Atlantic Coast Striped Bass Interstate Fisheries Management Plan was adopted by ASMFC, in 1981, then adopted by the Virginia Marine Resources Commission (VMRC) in March 1982 (Regulation 450-01-0034). Amendment IV to the plan requires "producing states" (e.g. Virginia, Maryland, Delaware and New York) to develop and support monitoring programs of recruitment levels. This became a mandate when Congress passed the Atlantic Striped Bass Conservation Act in 1984 (reauthorization 1991, PL102-130). To remain in compliance with the Act, each state must adhere to all provisions in the interstate FMP (ESBS 1993). Virginia has done this through December 1996.

Originally, the Virginia program used a 6' x 100' (2m x 30.5m) x 0.25" (6.4mm) mesh bag

seine, but after comparison tows with Maryland gear , 4' x 100' x 0.25" mesh (1.2m x 30.5m x 6.4mm) showed virtually no statistical differences in catch, Virginia adopted the "Maryland seine" (Colvocoresses 1984). The original purpose of the gear comparison studies was to standardize methods thereby allowing a Bay-wide examination of recruitment success (Colvocoresses and Austin 1987). This was never realized however, for various differences in data handling (MD: arithmetic index, VA: geometric index) and state politics. A Bay-wide index using a weighted (by river spawning area) geometric mean was finally developed in 1993 (Austin, Colvocoresses and Mosca 1993).

METHODS

Field sampling was conducted during five approximately biweekly sampling periods from July through mid-September of 1996. During each sampling period beach seine hauls were conducted at eighteen historically sampled sites (index stations) and twenty-two auxiliary stations along the shores of the James, York and Rappahannock river systems (Fig. 1). Addition of the auxiliary sites was made to provide better geographic coverage and, once a sufficient time series of data is developed, create larger within-river-system sample sizes so that trends in juvenile abundance can be meaningfully monitored on a system by system basis.

One seine haul was made at each auxiliary station, and two replicate hauls made at each index station during each sampling round. Collections were made by deploying a 100' (30.5m) long, 4' (1.22m) deep, 1/4" (0.64cm) bar mesh minnow seine perpendicular to the shoreline (either until

the net was fully extended or a depth of approximately four feet was encountered) and then leaving the onshore brail in a fixed position while pulling the offshore end downcurrent and back to the shore, resulting in the sweeping of a quarter circle quadrant. In the case of index stations, all fish taken during the first tow were removed from the net and held in water-filled buckets until after the second tow. All fish collected were identified and counted, and all striped bass and all individuals or a subsample of at least 25 individuals of other species measured to the nearest mm fork length (or total length if appropriate). Salinity, water temperature, pH and dissolved oxygen concentrations were measured after the first haul using a Hydrolab Reporter® water quality instrument. Sampling time, tidal stage and weather conditions were recorded at the time of each haul. When two hauls were made, an intervening period of 30 minutes was allowed between hauls and the first sample was processed in the period between the two hauls. All fishes captured, excepting those preserved for life history studies, were returned to the water at the conclusion of sampling.

In the present report, comparisons with prior years will be made on the basis of the 'primary nursery' standardized data set (Colvocoresses 1984), i.e. only the data collected from the months and areas covered during all surveys will be included in the analyses. Data from the auxiliary stations will not be included since there is no direct basis for comparison. Since the frequency distribution of catch size of these collections is extremely skewed and approximates a negative binomial distribution (Colvocoresses 1984), a logarithmic transformation ($\ln(x+1)$) was applied in order to normalize the data (Sokal and Rohlf 1981) prior to analyses. Subsequently computed mean values were retransformed (i.e. the geometric mean), but because the geometric means of such a strongly

skewed distribution are much smaller than the arithmetic means, for comparative purposes (particularly with respect to the results of the Maryland survey, wherein arithmetic means are reported) the geometric means have been scaled up to the arithmetic means by multiplication by the ratio of the overall arithmetic to geometric means to give adjusted means as of the 1984 survey (2.28).

Mean catch rates are contrasted by comparing 95% confidence intervals as estimated by $\pm$ two standard errors (square root of the variance divided by n) of the mean. Reference to "significant" differences between means in this context will be restricted to cases of non-overlap by these confidence intervals. Because the standard errors are calculated using the transformed (logarithmic) values, confidence intervals on the retransformed and adjusted scale are non-symmetrical.

RESULTS

Objective 1: Measure the relative abundance of the 1996 year class of juvenile striped bass from the James, York and Rappahannock river systems.

A total of 3759 young-of-the-year striped bass were collected from 180 seine hauls during the 1996 index station sampling, and an additional 1661 age 0 striped bass were collected in 102 hauls at the auxiliary sites (Fig. 1, Table 1). The adjusted overall mean catch per seine haul (CPUE) for the index stations was 23.00 which was approximately four times the 1995 value of 5.45 and represented a significant increase in the index from the 1995 value (Table 2,Fig. 2). This value was nearly three and one-half times the overall average index of 6.05 and was the highest index

recorded in the Virginia portion of Chesapeake Bay. The 1996 index (23.00) exceeded the previous record (1993) index (18.12) by twenty-seven percent. Indices for individual drainages were all more than twice as large as their respective historical average with the James system nearly six times its historical average.

The 1996 catch rate in the James drainage (42.33) was nearly six times higher than the historical average (7.24)(Table 3, Fig. 3) and both the mainstem James (34.52) and the Chickahominy (63.27) were both significantly higher than their respective historical average. The James River index reversed a downward pattern of recruitment observed for that river since the prior record year of 1993. Both the James and Chickahominy rebounded from average indices to record numbers. Juvenile striped bass were abundant throughout the James system during 1996 (Table 3, Fig. 4) and only seine hauls at the lowest auxiliary site (J12) during rounds two, three and four produced no striped bass. Striped bass were most abundant in the center of the index region although consistent catches were made at all stations. The greatest number of fish were captured at station C1, the lower Chickahominy site, while in the James, sites near the center of the sampling area produced the highest catches. These sites included two index (J36 and J46) and one auxiliary (J51) station.

The 1996 index in the York drainage (15.79) was significantly higher than the historical average (5.15)(Table 3, Fig. 3).Catch rates in both the Pamunkey (18.19) and the Mattaponi (14.17) were near or greater than three times their respective historical average (Table 3, Fig. 3). The Pamunkey River index was over five times the 1995 index (3.26) and was the highest index

recorded on the Pamunkey. The 1996 index reversed a two year decline seen since the previous record set in 1993. The Mattaponi index (14.17) was also the highest index recorded for that river and continued a three year trend of indices that were significantly higher than the historical averages.

In both rivers, highest catches were made in the lower regions and at Y28, an auxiliary station just downriver of the confluence of the Pamunkey and Mattaponi rivers (Figs.1,5,6) On the Pamunkey, the most productive site was P36, an auxiliary station just downriver of the index area (Fig.6). Within the defined index area of the Pamunkey, highest catches were recorded at the two uppermost sites. Catches upriver of the index area were not significant. Highest catches on the Mattaponi (Fig.5) also occurred at the lowest site (M33) on the river. However, on the Mattaponi, this was an index site and it alone accounted for 65.6% of all fish captured from the Mattaponi River (632 of 963 fish)(Table 1). Generally, catches of striped bass decreased as sampling progressed upstream in both rivers.

The 1996 index in the Rappahannock River (18.18) was three times the historical average (6.02)(Table 3) and almost eight times the value seen in 1995 (2.41)(Austin et al, 1996).This reversed a three year decline(1993-1995) and represented the third highest index recorded for the Rappahannock River (Fig.3). Juveniles were caught throughout the river and in all tows except rounds three and four at R12, the lowest station (Fig. 7). Stations R60 through R76 were not sampled during round four due to higher than normal tides from a coastal storm. During the early sampling rounds, significant numbers of striped bass were captured at the lower sites, a pattern that had never been seen in the past (Table 1,Fig. 7). Even in later rounds, fish were being

captured at R21, an auxiliary site that had only produced one striped bass in the past. Within the index area, the upper sites (R44, 50,55) were the highest producers.

Because the number and precise timing of sampling rounds has varied throughout the history of the sampling program, results by sampling period cannot be directly compared. However, temporal usage of the nursery area can be evaluated by comparing round by round results with historical monthly averages. Generally, catch rates are highest during July and into early-August and taper off in the later rounds of August and September. Results from 1996 follow this pattern quite precisely with a twenty to thirty percent decrease between each successive round (Table 4).

Objective 2: Quantify environmental conditions at the time of collection.

Collection information and pertinent environmental variables recorded at the time of each collection in 1996 are given in Tables 5 through 8.

Generally, salinities were somewhat lower in 1996 than in 1995 and 1994 (Table 5)(Austin et al, 1996). Though not excessively so, 1996 was a cooler, wetter summer than those in the last few years. Streamflow for the summer months was above average thereby reducing observed salinities in the rivers (USDOI 1997).

Water temperatures also averaged slightly lower in 1996 (Table 6) than in 1995 (Austin et al, 1996). Though direct round by round comparisons are difficult because of local site conditions and variations, generally rounds one through four had cooler water temperatures than in 1995.

Dissolved oxygen levels were generally within the norms experienced during this sampling period (Table 7). Some readings of less than four mg/l were recorded but did not seem to affect catches. During round two, at station J62, an unusually high dissolved oxygen reading (13.0 mg/l) was observed. pH values were also higher than normal (9.2) (Table 8), as was water temperature (29.6^{0}C)(Table 6) and salinity (0.2)(Table 5).

pH levels during the 1996 sampling were generally within normal limits with all stations registering neutral to slightly alkaline qualities except for the Mattaponi River which was slightly acidic (Table 8).

Higher than normal tides from a coastal storm caused the loss of available beach at R60, R65, R69, and R76 in round four. All index sites were completed without interruption during all five sampling rounds, however some data were not collected due to a malfunction of the Hydrolab water quality instrument.

Objective 3: Examine relationships between juvenile striped bass abundance and measured or proxy environmental and biological data.

Overall distribution of catch rates with respect to salinity in 1996 followed the normally observed pattern i.e. a definitive trend towards higher catches at lower salinities (Table 9). Overall mean catches were highest in the areas of lowest salinities (0-4.9ppt), however there were some exceptions, notably R12, R21 and R28 (Fig.7) where catch rates were generally higher than at

stations just upriver from these sites. These stations were intermediate (5.0-9.9) to higher salinity stations (10.0-14.9ppt).

Catch rates with respect to water temperature in 1996 clearly adhered to the pattern seen in most years, i.e. catch rates varied directly with water temperature (Table 10). As noted in previous reports, this relationship is considered to be largely the result of a coincident downward progression of both catch rates and temperature as the survey season progresses (at least after the second sampling round) rather than any causative effect of water temperature on juvenile distribution. The growth and thus increased gear escapement or avoidance usually play a larger role in this trend. Generally, catches within the sampling season are not noticeably governed by water temperatures and the overall relationship between catch and water temperature within the sampling season is probably coincidental.

Data on pH, dissolved oxygen concentrations and secchi disc visibility depth readings have only been recorded with the seine collections since the expansion of the sampling program in 1989. Dissolved oxygen concentrations generally exceeded 5mg/l outside of the York system, and should have little or no effect on juvenile striped bass distributions. The lowest dissolved oxygen concentrations observed during 1996 sampling occurred during the last sampling round in the York system, generally in the lower Mattaponi and Pamunkey down to their confluence where concentrations were less than 4 ppm (Table 7). Juvenile striped bass were collected during the visits to these sites so low dissolved oxygen should not have been a factor. Low pH values (<6.5) were not observed at any sampling sites in 1996 (Table 8). However, at station J62 in the second

system, generally in the lower Mattaponi and Pamunkey down to their confluence where concentrations were less than 4 ppm (Table 7). Juvenile striped bass were collected during the visits to these sites so low dissolved oxygen should not have been a factor. Low pH values (<6.5) were not observed at any sampling sites in 1996 (Table 8). However, at station J62 in the second round, a combination of high pH (9.2), elevated water temperature (29.6), high dissolved oxygen (13.0), and a slightly elevated salinity (0.2 vs 0.1) may have contributed to a reduced catch of juvenile striped bass. While not conclusive and hardly significant statistically, a small catch in this seine haul appears suspect. Obviously, some factor or factors influenced the water quality parameters and it seems likely that it may have affected striped bass abundance at that particular site at that time, however we have no definitive data to project. All of these parameters, as well as those previously discussed and undoubtedly others which are not currently measured, probably exert complex and interrelated effects on juvenile striped bass distribution, catchability and survival.

DISCUSSION AND CONCLUSIONS

The striped bass juvenile indices recorded in the Virginia Chesapeake Bay nursery areas in 1996 were significantly higher than the historical average and over four times the 1995 index (Table 2). It is the highest index recorded for the Virginia portion of Chesapeake Bay, surpassing the previous high by nearly twenty-seven percent. This index was not unduly influenced by any one or two rivers but the index was strong and above average in all systems making 1996 a truly dominant year class. Each individual river index was at least three times higher than the historical

we do not have enough data to link these environmental conditions directly contributed to a dominant yearclass, we can theorize that conditions in 1996 must certainly have been favorable to survival of eggs, larvae, and juveniles of striped bass.

The size of the 1996 yearclass certainly influenced the distribution patterns observed in 1996. Fish were captured at every station sampled, even some where no juvenile striped bass had previously been captured during this study. Other projects (VIMS Juvenile Finfish Trawl Survey, Juvenile Bluefish Seine Survey) captured juvenile stripers in the higher salinity waters of lower Chesapeake Bay and into the Atlantic Ocean. Clearly the magnitude of the yearclass influenced the widespread distributions observed in 1996.

The strong year classes of late are probably a product of a substantial increase in spawning stocks due to stringent harvest regulations in place since implementation of the ASMFC Interstate Fisheries Management Plan. Refinements of our sampling program whereby we have zeroed in on the spatial and temporal usage of the nursery areas and thereby become more efficient in our sampling have also probably served to give us a more precise estimate of yearclass strength.

While striped bass recruitment success in the Virginia portion of Chesapeake Bay clearly remains highly variable between years and between the different nursery areas within years, it is evident that these fluctuations have been bracketing a much higher average over the past ten years. This pattern is consistent with an increase in spawning stock size resulting from the

stringent harvest regulations in place over the period since 1985.

The addition of auxiliary stations in 1989 was done to provide a better areal coverage of the nursery areas. These additional areas of coverage have revealed that in years of high or low salinities and abundances there may be a shift in the traditional nursery areas (salinities) either up or downriver or there may be a dispersion of fish up and/or downriver (abundance). The 1996 yearclass was dispersed over the entire range of index and auxiliary stations during most rounds. Only twenty-two of two-hundred-eighty-two (7.8%) hauls caught no striped bass. Of those twenty-two, nine (40.9%) were index stations and of those nine, five (55.5%) were from M44 in the Mattaponi River. In some cases, notably Y28, P36, J51 and this year R12 and R21, auxiliary sites seem to outproduce index sites (Figs. 4-7), however only one haul is made at each auxiliary site and two are made at index sites. Figures 4-7 represent average catch per haul and past analyses have demonstrated that catches are consistently higher in the first haul of any given set of seine hauls. Therefore, the figures tend to overemphasize the relative contribution of the auxiliary sites. They are included only to demonstrate the spatial distribution of the yearclass. They are important in that they allow us to see a shift in distribution that could be affecting catches at the index sites. Reducing hauls at index sites to one per site and including some of the auxiliary sites in the index may lead to a more precise estimate of relative year- class strength but it will undoubtedly elevate the recalculated indices. This change was recommended in 1992 at a juvenile abundance workshop at Kent Island, MD (Rago et al, 1995). However, in order to achieve this, all past indices must be recalculated using this formula and suitable complementary auxiliary sampling sites were probably not sampled adequately to make those indices comparable. Further, any change must be

approved by the stock assessment sub-committee of the Striped Bass Technical Committee of ASMFC.

Utilization of auxiliary sites since the inception of sampling at them will be examined in the near future. Large yearclasses and salinity abnormalities have occurred in this time frame and some analyses of the utilization of these areas will help determine if continued sampling of all of these sites is warranted.

The 1996 yearclass of juvenile striped bass was of such a magnitude that distribution patterns due to hydrological or environmental parameters were overshadowed and fish were found all the way from the highest freshwater reaches sampled to the Atlantic Ocean.

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Table 1. Catch of young-of-the-year striped bass per seine haul during the 1996 survey. Two hauls were made per sampling round at each of the historical index stations (bold).

Drainage														
JAMES														
Station	J12	J22	**J29**	**J36**	**C1**	**C3**	**J46**	J51	**J56**	J62	J68	J74	J78	TOT.
Round														
1	61	14	8/7	59/70	138/96	65/10	34/9	30	20/12	48	6	5	1	693
2	0	6	7/19	36/21	33/100	36/22	60/23	14	3/5	2	11	29	18	445
3	0	16	12/23	19/45	78/36	62/3	17/63	33	1/2	32	1	17	ns	460
4	0	18	13/18	30/38	65/20	6/3	31/55	61	4/5	9	2	7	7	392
5	5	3	24/15	12/10	62/36	12/5	16/21	25	6/2	6	0	5	3	268
														2258
YORK														
Station	Y15	Y21	Y28	P36	**P42**		**P45**	**P50**	P55	P61				
Round														
1	7	14	37	20	44/3		41/27	7/10	16	2				228
2	36	3	30	112	6/1		51/23	47/41	9	1				360
3	1	2	22	15	4/2		10/11	18/10	3	0				98
4	0	1	30	33	0/3		11/9	8/5	2	2				104
5	0	0	37	51	1/0		15/7	10/1	ns	ns				122
Station				**M33**	M37	**M41**	**M44**	**M47**	M52					
Round														
1				173/50	55	61/43	0/0	3/4	2					391
2				150/18	12	44/13	11/3	12/3	1					267
3				111/12	6	2/1	6/0	3/2	0					143
4				79/9	16	3/7	1/1	5/3	0					124
5				27/3	ns	1/3	0/0	1/2	1					38
														1875
RAPPAHANNOCK														
Station	R12	R21	**R28**	**R37**		R41	**R44**	**R50**	**R55**	R60	R65	R69	R76	
Round														
1	206	19	79/34	2/4		3	31/32	7/2	31/42	79	51	14	14	650
2	50	47	0/5	1/1		17	14/16	32/17	23/24	4	7	4	3	265
3	4	13	22/3	2/0		2	21/16	5/12	17/46	6	0	8	1	178
4	0	16	3/4	2/3		4	13/8	6/3	12/10	ns	ns	ns	ns	84
5	0	6	4/1	1/1		2	25/7	9/3	27/17	1	3	1	2	110
														1287
														5420

Table 2. Catch of young-of-the-year striped bass per seine haul in the primary nursery area summarized by year (adjusted mean = retransformed mean of ln(x+1) * 2.28, the ratio of the overall arithmetic and geometric means through 1984).

Year	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N
1967	209	1.07	0.977	4.40	2.82-6.45	53
1968	208	0.93	0.900	3.50	2.35-4.94	66
1969	207	0.78	0.890	2.71	1.80-3.84	77
1970	461	1.31	1.121	6.17	4.27-8.63	77
1971	178	0.76	0.857	2.61	1.76-3.64	80
1972	96	0.39	0.575	1.07	0.73-1.45	117
1973	139	0.53	0.790	1.59	0.98-2.32	84
1980	228	0.74	0.900	2.52	1.68-3.53	89
1981	165	0.52	0.691	1.57	1.10-2.09	116
1982	323	0.78	0.967	2.71	1.85-3.74	106
1983	296	0.91	0.833	3.40	2.53-4.42	102
1984	597	1.09	1.059	4.47	3.22-6.02	106
1985	322	0.72	0.859	2.41	1.78-3.14	142
1986	669	1.12	1.036	4.74	3.62-6.06	144
1987	2191	2.07	1.228	15.74	12.4-19.8	144
1988	1348	1.47	1.127	7.64	6.10-9.45	180
1989	1978	1.78	1.119	11.23	9.15-13.7	180
1990	1249	1.44	1.096	7.34	5.89-9.05	180
1991	667	0.97	0.951	3.76	2.96-4.68	180
1992	1769	1.44	1.247	7.32	5.69-9.28	180
1993	2323	2.19	0.975	18.12	15.4-21.3	180
1994	1510	1.72	1.034	10.48	8.66-12.6	180
1995	926	1.22	1.045	5.45	4.33-6.75	180
1996	3759	2.41	1.227	23.00	18.8-28.1	180
Overall	21818	1.30	1.157	6.05	5.71-6.4 0	3123
Unweighted Annual Mean				6.42		24

Table 3. Catch of young-of-the-year striped bass per seine haul in the primary nursery area in 1996 summarized by drainage and river.

	1996						All Years Combined					
Drainage River	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N
James	1763	2.97	1.006	42.33	32.12-55.56	60	8335	1.43	1.201	7.24	6.55-7.98	1031
James	875	2.78	0.905	34.52	25.36-46.71	40	4536	1.31	1.147	6.13	5.43-6.90	693
Chickahom.	888	3.36	1.108	63.27	37.65-105.3	20	3799	1.68	1.269	9.97	8.39-11.78	338
York	1296	2.07	1.330	15.79	10.86-22.55	70	6437	1.18	1.033	5.15	4.71-5.61	1173
Pamunkey	426	2.19	1.118	18.19	11.33-28.52	30	2879	1.22	1.064	5.47	4.77-6.25	497
Mattaponi	870	1.98	1.477	14.17	8.03-23.96	40	3558	1.15	1.009	4.91	4.38-5.49	676
Rappahannock	700	2.19	1.088	18.18	12.76-25.55	50	7046	1.29	1.238	6.02	5.37-6.73	919
Overall	3759	2.41	1.227	23.00	18.77-28.07	180	21818	1.30	1.157	6.05	5.71-6.40	3123

Table 4. Catch of young-of-the-year striped bass per seine haul in the primary nursery area in 1996 summarized by sampling period and month.

Month	1996 Total	1996 Mean ln(x+1)	1996 Std. Dev.	1996 Adjust. Mean	1996 C.I. (± 2 SE)	1996 N	All Years Combined Total	All Years Combined Mean ln(x+1)	All Years Combined Std. Dev.	All Years Combined Adjust. Mean	All Years Combined C.I. (± 2 SE)	All Years Combined N
July (1st)	1258	2.92	1.326	39.79	24.8-63.2	36	7490	1.47	1.153	7.61	6.89-8.38	944
(2nd)	921	2.73	1.170	32.64	21.4-49.3	36						
Aug. (3rd)	697	2.33	1.242	21.23	13.3-33.3	36	6798	1.27	1.108	5.86	5.33-6.42	1084
(4th)	496	2.16	1.011	17.42	11.8-25.3	36						
Sept. (5th)	387	1.89	1.137	12.88	8.10-19.9	36	3771	0.93	1.019	3.49	3.11-3.89	915
Overall	3759	2.41	1.227	23.00	18.8-28.1	180	21818	1.30	1.157	6.05	5.71-6.40	3123

Table 5. Salinity (parts per thousand) recorded at 1995 seine survey stations.

Drainage														
JAMES														
Station	J12	J22	J29	J36	C1	C3	J46	J51	J56	J62	J68	J74	J78	MEAN
Round														
1	10.7	4.7	2.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	1.4
2	11.1	4.1	1.8	0.4	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	1.4
3	ns	ns	2.7	0.6	0.0	0.3	0.1	0.1	0.1	0.2	0.1	0.1	ns	0.4
4	11.4	5.2	2.4	0.6	0.3	0.3	0.1	0.1	0.1	0.1	0.0	0.0	0.0	1.6
5	5.5	1.1	3.0	1.3	0.5	0.4	0.1	0.1	0.0	0.1	0.1	0.1	0.1	1.0
														1.2
YORK														
Station	Y15	Y21	Y28	P36	P42		P45	P50	P55	P61				
Round														
1	12.7	10.6	7.8	1.8	0.2		0.1	0.0	0.0	0.0				2.4
2	18.0	13.2	5.6	0.7	0.1		0.1	0.0	0.0	0.0				2.5
3	ns	ns	5.9	0.9	0.1		0.1	0.0	0.0	0.0				0.8
4	12.3	8.6	5.4	0.3	0.1		0.0	0.0	0.0	0.0				1.8
5	10.8	8.2	7.2	2.7	0.6		0.1	0.0	ns	ns				2.6
														2.0
Station				M33	M37	M41	M44	M47	M52					
Round														
1				2.0	0.5	0.2	0.0	0.0	0.0					
2				0.4	0.1	0.0	0.0	0.0	0.0					(included
3				ns	ns	0.0	ns	0.0	ns					above)
4				0.3	0.1	0.0	0.0	0.0	0.0					
5				1.7	ns	0.3	0.0	0.0	0.0					
RAPPAHANNOCK														
Station	R12	R21	R28	R37		R41	R44	R50	R55	R60	R65	R69	R76	
Round														
1	9.1	8.0	6.2	1.7		0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.1
2	9.9	8.6	5.4	1.4		0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.2
3	10.1	9.6	7.2	2.0		0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	2.5
4	9.8	8.7	5.2	0.5		0.1	0.1	ns	0.0	ns	ns	ns	ns	3.5
5	9.6	8.7	6.4	1.7		0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.2
														2.5
														1.9

Table 6. Water temperature (°C) recorded at 1996 seine survey stations.

Drainage														
JAMES														
Station	J12	J22	J29	J36	C1	C3	J46	J51	J56	J62	J68	J74	J78	MEAN
Round														
1	28.0	23.8	27.8	24.4	28.6	24.2	27.5	28.2	27.9	29.2	29.7	28.7	ns	27.3
2	28.1	29.2	30.0	27.7	28.5	28.5	29.3	26.7	26.9	29.6	28.7	28.9	26.5	28.4
3	ns	ns	28.6	25.4	26.5	26.6	28.3	27.8	27.8	29.1	29.9	28.6	ns	27.9
4	25.4	25.9	28.5	26.0	28.2	27.2	27.7	25.9	25.2	28.5	26.9	26.3	27.2	26.8
5	27.3	28.4	27.8	26.3	27.1	27.1	27.0	27.6	24.1	28.5	29.9	29.5	28.7	27.6
														27.6
YORK														
Station	Y15	Y21	Y28	P36	P42		P45	P50	P55	P61				
Round														
1	30.5	32.5	24.1	26.4	26.8		27.2	27.2	27.2	27.9				27.9
2	25.4	25.5	26.3	27.5	25.9		28.0	28.2	28.5	27.5				27.0
3	ns	ns	26.0	26.9	27.0		27.2	27.3	29.1	27.3				27.2
4	28.6	27.4	25.9	26.8	26.9		27.1	27.1	28.1	26.1				27.0
5	29.9	27.9	26.1	26.2	26.6		27.0	26.8	ns	ns				26.9
														27.2
Station				M33	M37	M41	M44	M47	M52					
Round														
1				27.3	27.5	27.8	28.1	28.6	29.4					
2				27.2	27.3	27.3	27.4	27.0	26.4					(included
3				ns	ns	26.8	ns	27.5	ns					above)
4				26.5	26.4	26.3	26.8	27.4	ns					
5				26.5	ns	26.2	26.6	26.8	26.3					
RAPPAHANNOCK														
Station	R12	R21	R28	R37		R41	R44	R50	R55	R60	R65	R69	R76	
Round														
1	24.8	28.1	25.2	26.0		27.5	28.9	27.1	27.1	27.0	27.2	27.5	28.8	27.1
2	26.4	29.6	27.9	28.8		31.2	31.8	27.0	27.7	26.3	24.9	27.7	27.5	28.1
3	25.0	28.3	25.1	25.6		25.8	26.9	26.5	26.7	26.6	26.3	26.8	25.9	26.3
4	24.5	27.5	25.5	26.7		27.3	27.9	25.4	24.7	ns	ns	ns	ns	26.2
5	25.9	26.5	28.8	27.8		28.1	29.0	27.2	27.5	27.5	26.9	27.5	27.4	27.5
														27.0
														27.3

Table 7. Dissolved oxygen (milligrams per liter) recorded at 1996 seine survey stations.

Drainage														
JAMES														
Station	J12	J22	J29	J36	C1	C3	J46	J51	J56	J62	J68	J74	J78	MEAN
Round														
1	6.2	7.7	6.4	6.7	7.3	6.0	8.3	7.3	7.4	9.1	5.3	6.4	ns	7.0
2	9.6	7.8	8.4	6.3	8.9	6.4	8.5	7.7	9.6	13.0	6.3	6.0	5.8	8.0
3	ns	ns	7.4	6.7	7.7	5.4	6.0	5.5	7.4	8.2	5.9	6.4	ns	6.7
4	3.4	5.3	6.5	4.2	5.9	4.7	5.8	7.4	5.1	7.4	5.1	5.8	5.3	5.5
5	ns	ns	4.2	3.9	4.2	5.0	3.9	3.4	4.4	4.4	4.0	4.3	5.9	4.3
														6.3
YORK														
Station	Y15	Y21	Y28	P36	P42		P45	P50	P55	P61				
Round														
1	9.5	7.2	6.1	4.1	5.8		6.1	6.1	5.3	5.2				5.7
2	5.8	4.7	6.0	5.9	6.3		6.2	5.5	4.9	4.1				5.3
3	ns	ns	4.6	4.7	5.3		5.4	4.7	4.6	5.5				4.9
4	7.9	4.2	4.3	4.1	6.1		4.6	4.2	4.4	4.6				4.7
5	ns	ns	3.6	3.5	3.6		4.0	4.1	ns	ns				3.9
														4.9
Station				M33	M37	M41	M44	M47	M52					
Round														
1				5.0	5.1	5.1	5.3	5.3	5.0					
2				5.0	5.0	5.4	5.3	5.0	4.4					(included
3				ns	ns	4.4	ns	4.5	ns					above)
4				5.0	3.7	3.4	4.6	4.5	4.5					
5				3.9	ns	3.1	4.0	4.3	5.2					
RAPPAHANNOCK														
Station	R12	R21	R28	R37		R41	R44	R50	R55	R60	R65	R69	R76	
Round														
1	5.9	6.9	6.4	6.4		5.9	7.3	6.7	7.1	6.0	6.1	5.3	4.6	6.2
2	7.1	8.1	8.4	8.1		6.8	8.5	7.3	8.0	7.5	9.6	7.0	5.9	7.7
3	5.0	6.5	6.1	7.1		7.1	8.0	5.8	6.0	6.3	7.8	6.4	6.1	6.5
4	4.2	5.6	4.9	5.3		6.8	6.2	5.9	5.2	ns	ns	ns	ns	5.5
5	4.4	3.4	7.0	7.6		6.1	6.7	4.4	6.6	5.9	4.2	6.4	4.0	5.6
														6.3
														5.8

Table 8. pH recorded at 1996 seine survey stations.

Drainage														
JAMES														
Station	J12	J22	J29	J36	C1	C3	J46	J51	J56	J62	J68	J74	J78	MEAN
Round														
1	7.3	7.5	7.7	8.0	8.2	7.7	8.6	8.5	8.8	8.7	7.6	8.0	ns	8.1
2	7.6	7.9	8.1	7.6	8.3	7.5	8.5	8.3	8.6	9.2	7.3	7.5	7.1	8.0
3	ns	ns	7.9	7.4	7.4	7.4	7.6	7.2	7.8	7.8	7.5	7.6	ns	7.6
4	7.5	7.8	8.1	7.8	8.5	7.5	7.9	7.6	8.0	7.8	7.5	7.8	7.9	7.8
5	7.9	8.9	7.7	7.4	8.0	7.4	7.6	7.1	8.1	8.0	7.4	7.9	7.5	7.8
														7.9
YORK														
Station	Y15	Y21	Y28	P36	P42		P45	P50	P55	P61				
Round														
1	7.7	7.4	7.3	7.0	7.4		7.5	7.5	7.1	7.1				7.1
2	7.1	7.1	7.0	7.0	7.2		7.3	7.1	7.0	6.9				6.9
3	ns	ns	7.0	6.9	7.1		7.2	6.9	7.0	7.0				6.9
4	7.9	7.5	7.2	7.0	7.1		7.1	7.0	6.8	7.7				7.1
5	8.2	7.2	7.0	6.9	7.1		7.0	7.0	ns	ns				6.9
														7.0
Station				M33	M37	M41	M44	M47	M52					
Round														
1				6.7	6.7	6.8	6.8	6.6	6.5					
2				6.8	6.8	6.9	6.7	6.5	6.5					(included
3				ns	ns	6.7	ns	6.7	ns					above)
4				6.8	6.9	7.4	6.9	6.8	7.1					
5				6.6	ns	6.6	6.6	6.5	6.5					
RAPPAHANNOCK														
Station	R12	R21	R28	R37		R41	R44	R50	R55	R60	R65	R69	R76	
Round														
1	7.5	7.9	7.5	7.5		7.3	8.1	7.6	7.6	7.6	7.7	7.3	7.1	7.6
2	7.7	7.8	7.8	7.7		7.0	8.6	7.6	7.9	7.5	8.4	7.2	7.2	7.7
3	7.3	7.6	7.3	7.4		7.4	7.7	7.1	7.2	7.2	7.6	7.0	7.1	7.3
4	7.8	8.0	7.9	8.2		7.8	8.7	7.3	7.3	ns	ns	ns	ns	7.9
5	7.6	7.3	7.8	7.7		7.3	8.0	7.3	7.1	7.1	7.0	7.0	6.9	7.3
														7.6
														7.5

Table 9. Catch of young-of-the-year striped bass per seine haul in the primary nursery area in 1996 summarized by salinity.

	1996						All Years Combined					
Salinity (ppt.)	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N
0-4.9	3604	2.43	1.219	23.67	19.25-29.01	170	20157	1.38	1.159	6.82	6.42-7.23	2663
5-9.9	155	1.95	1.340	13.82	4.62-35.32	10	1567	0.97	1.078	3.72	3.05-4.48	328
10-14.9							102	0.38	0.599	1.04	0.69-1.44	113
15-19.9							2	0.07	0.219	0.17	-0.06-0.43	19
Overall	3759	2.41	1.227	23.00	18.77-28.07	180	21828	1.30	1.157	6.05	5.71-6.40	3123

Table 10. Catch of young-of-the-year striped bass per seine haul in the primary nursery area in 1996 summarized by water temperature.

	1996						All Years Combined					
Temp. (deg. C)	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N	Total	Mean ln(x+1)	Std. Dev.	Adjust. Mean	C.I. (± 2 SE)	N
15-19.9							79	0.81	0.908	2.85	1.40-4.86	30
20-24.9	234	2.87	1.178	37.89	15.19-90.11	8	1475	0.81	0.938	2.86	2.43-3.33	467
25-29.9	3340	2.38	1.228	22.34	18.04-27.54	164	15512	1.39	1.158	6.88	6.42-7.37	2040
30-34.9	56	2.65	0.401	30.12	19.42-46.10	4	4374	1.48	1.209	7.72	6.70-8.86	500
Overall	3759	2.41	1.227	23.00	18.77-28.07	180	21818	1.30	1.157	6.05	5.71-6.40	3123

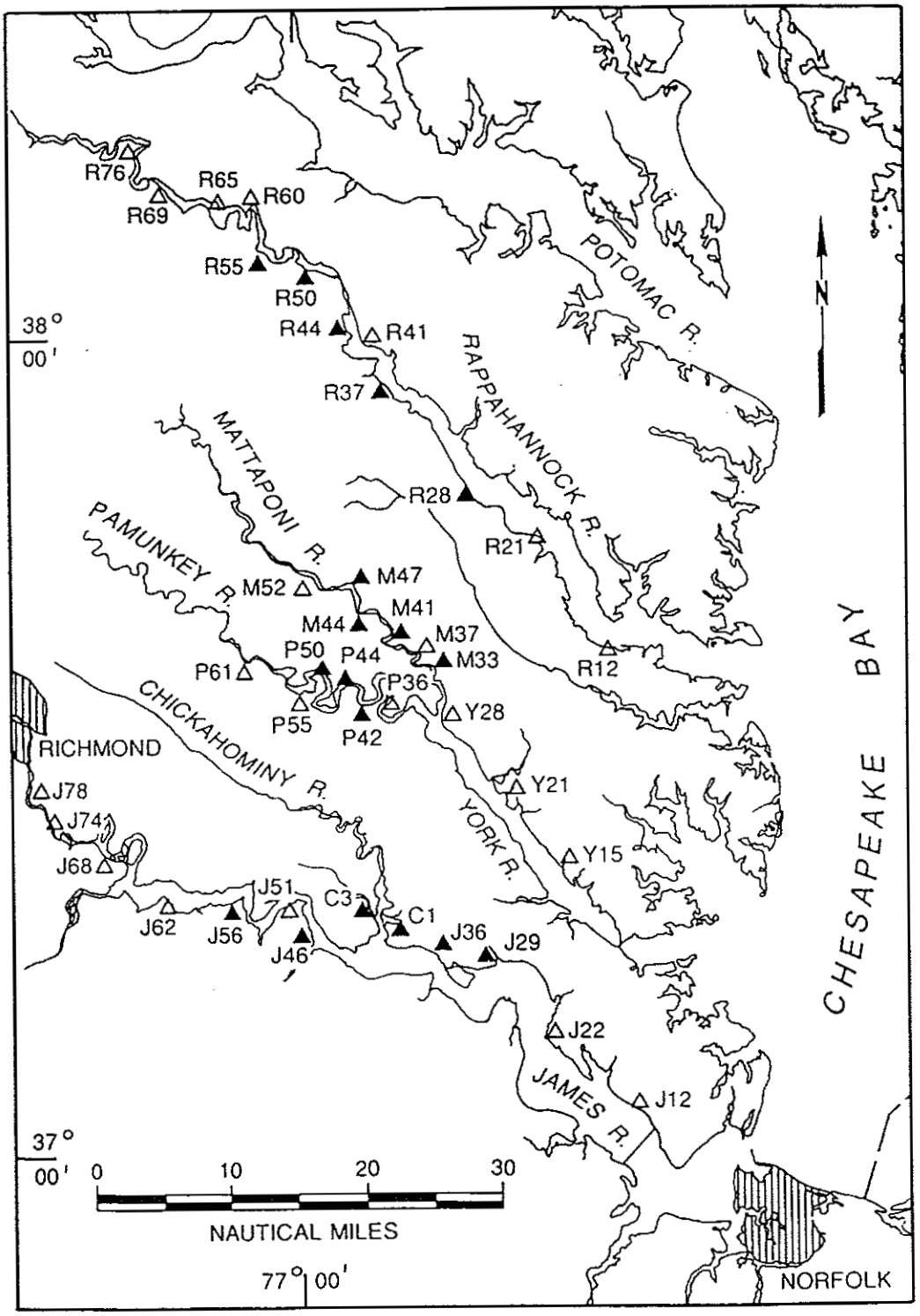

Figure 1. Juvenile striped bass seine survey sampling locations. Numeric portion of station designations indicate river mile from mouth. Solid triangles are index stations, open ones, auxiliary stations.

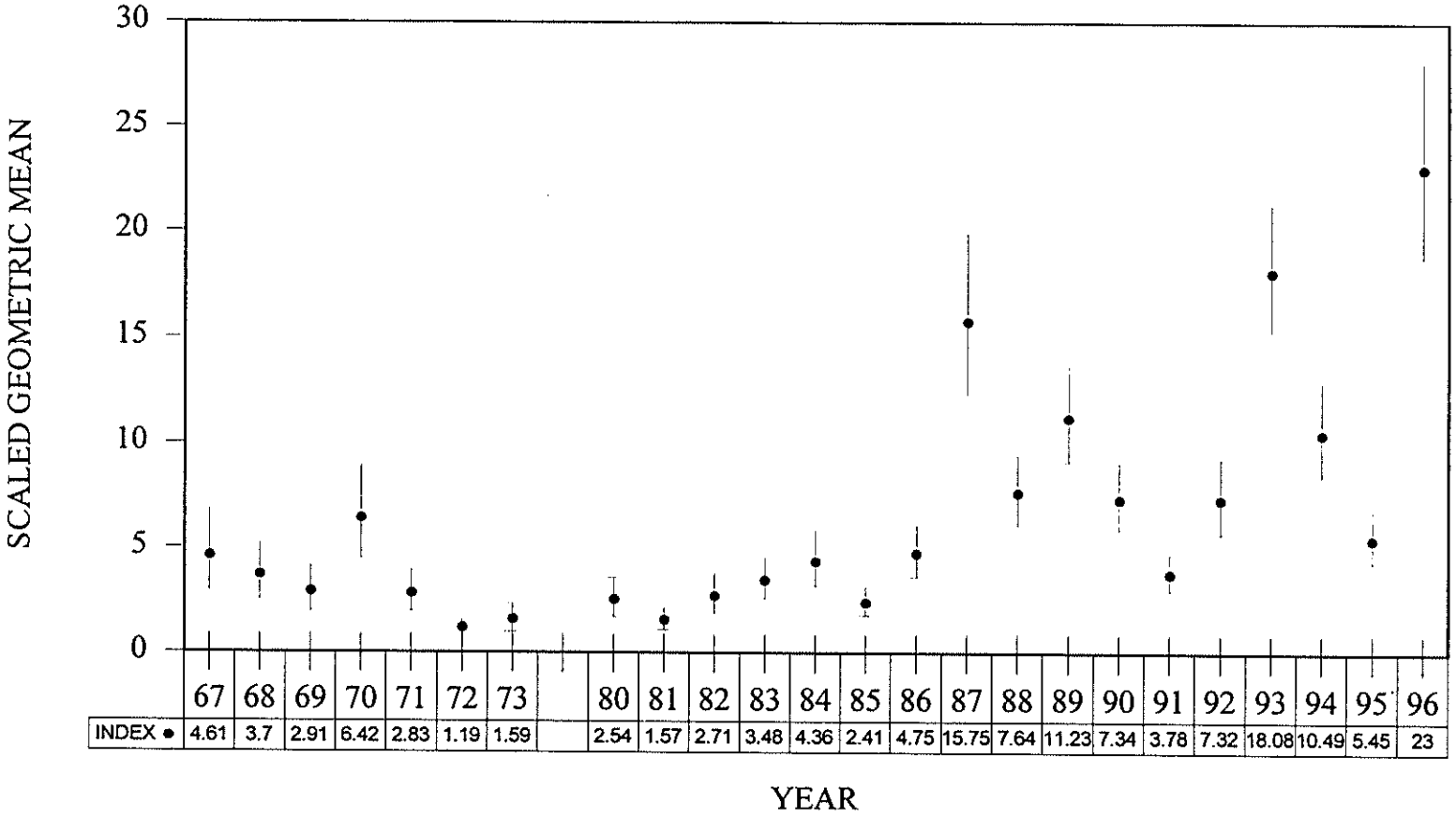

Figure 2. Scaled average catch of young-of-the-year striped bass per seine haul in the primary nursery area (index stations) by year.Vertical bars are 95% confidence intervals as estimated by ± 2 standard errors of the mean.

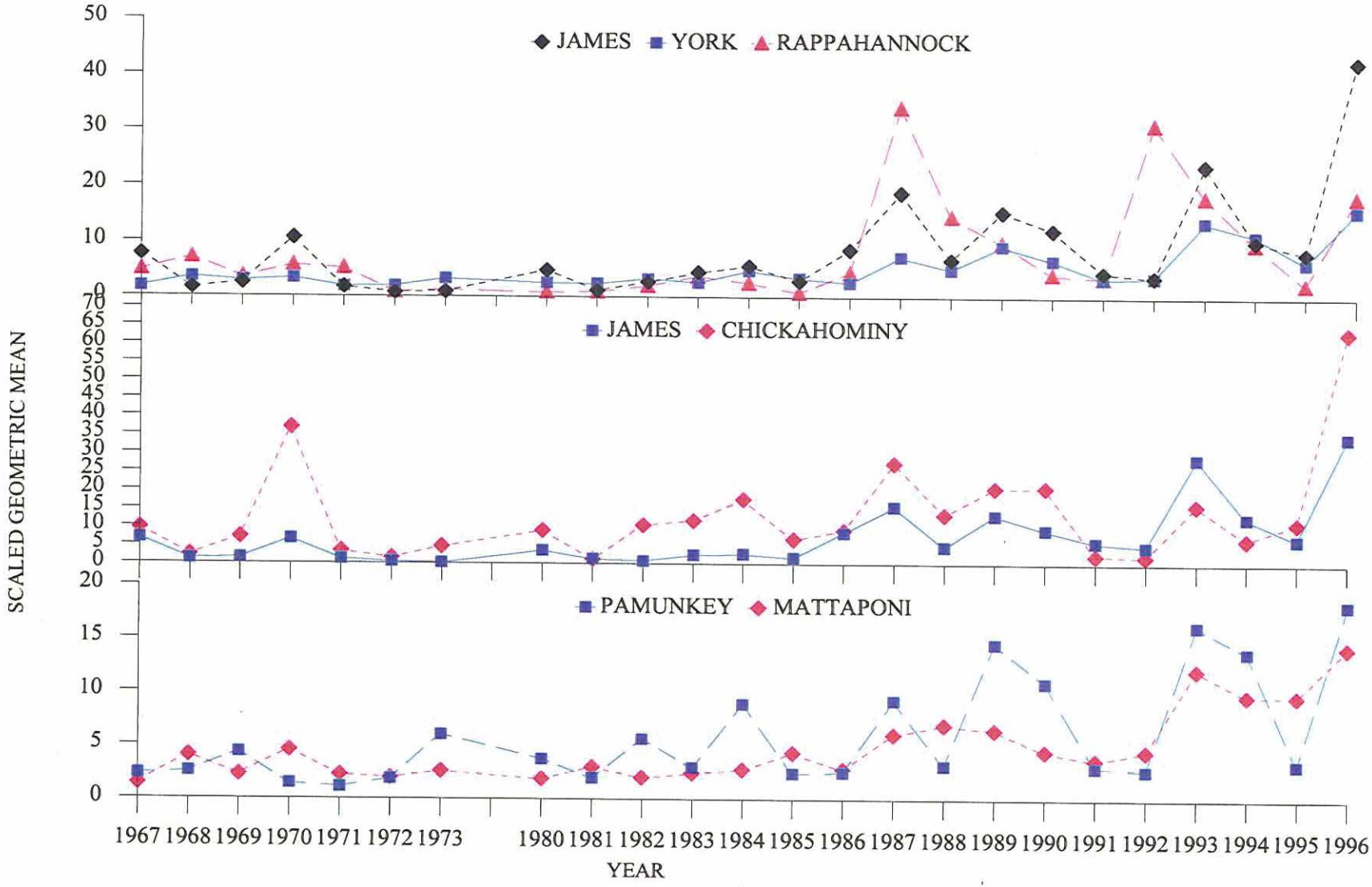

Figure 3. Adjusted average annual catch of young-of-the-year striped bass per seine haul in the primary nursery area by drainage and river.

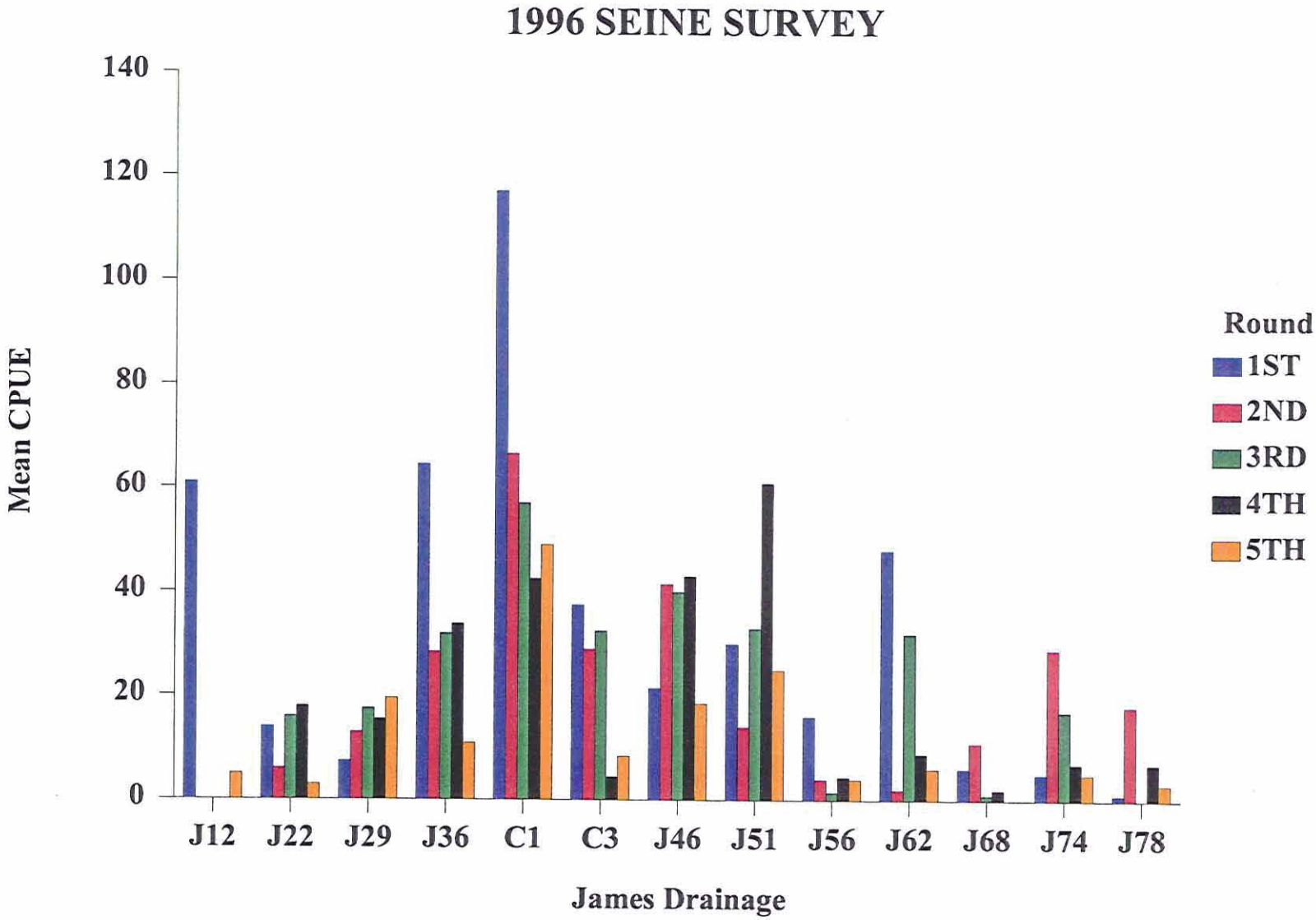

Figure 4. Average catch of young-of-the-year striped bass per seine haul by station in the James drainage in 1996.

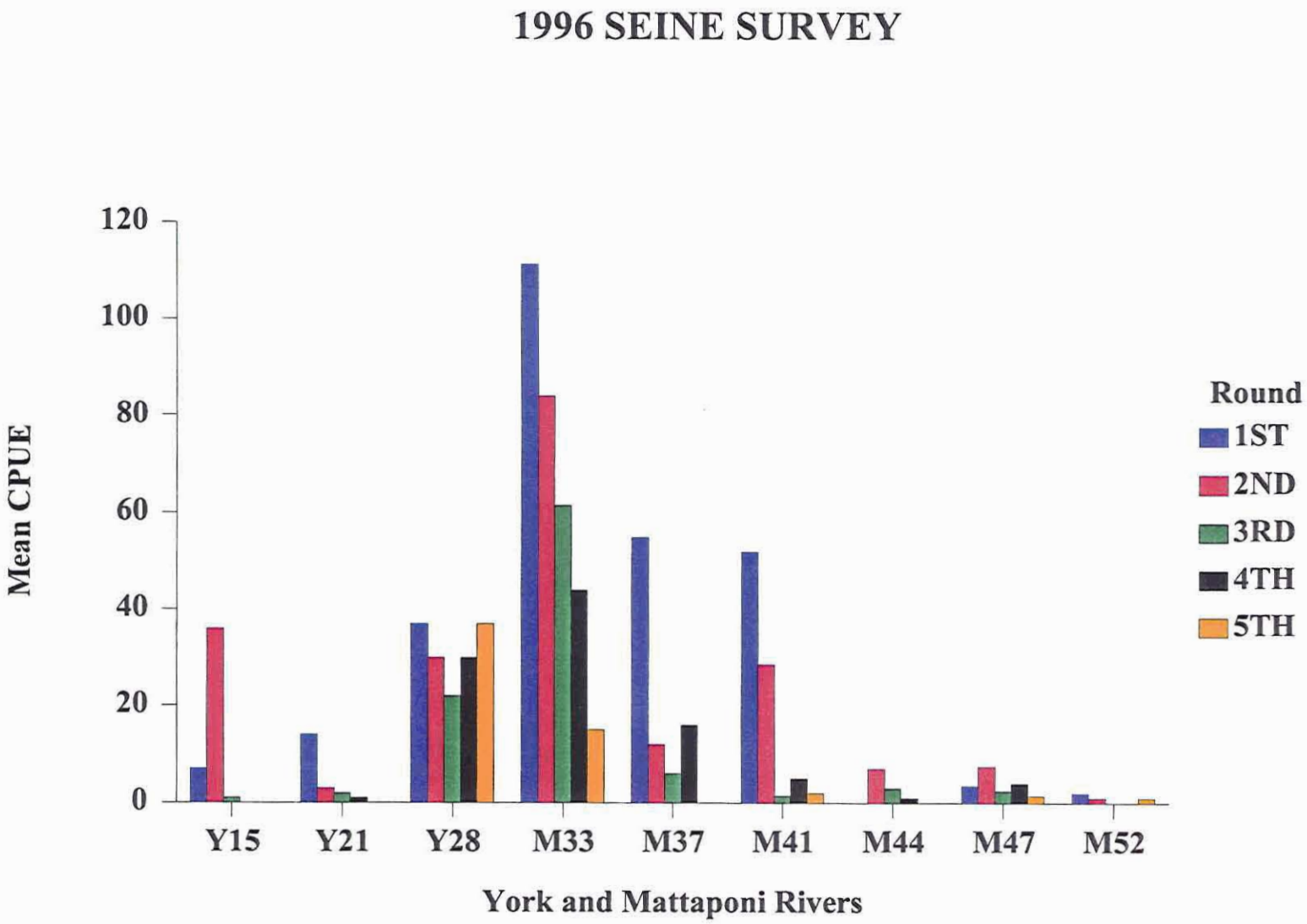

Figure 5. Average catch of young-of-the-year striped bass per seine haul by station in the Mattaponi and York rivers in 1996.

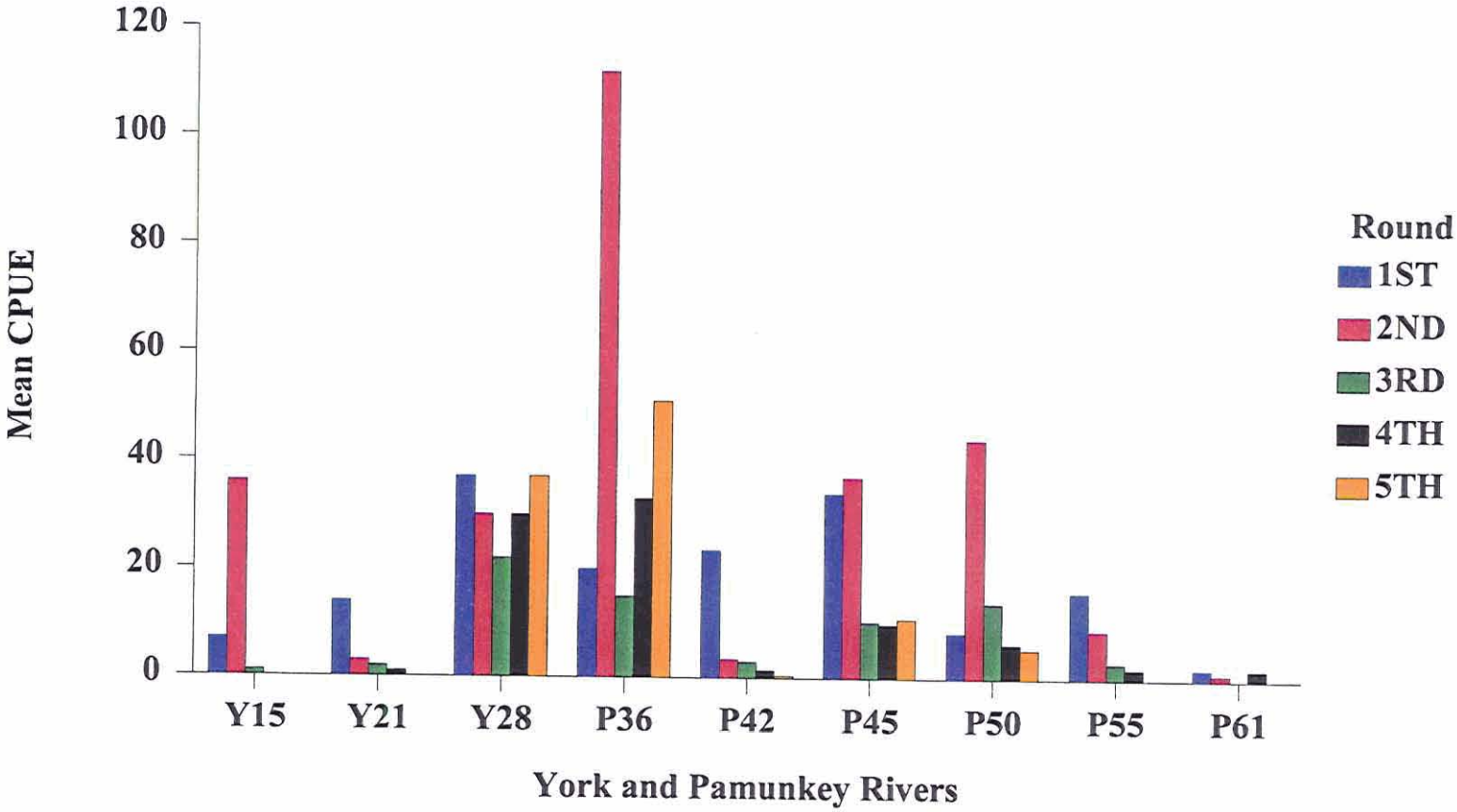

Figure 6. Average catch of young-of-the-year striped bass per seine haul by station in the Pamunkey and York rivers in 1996.

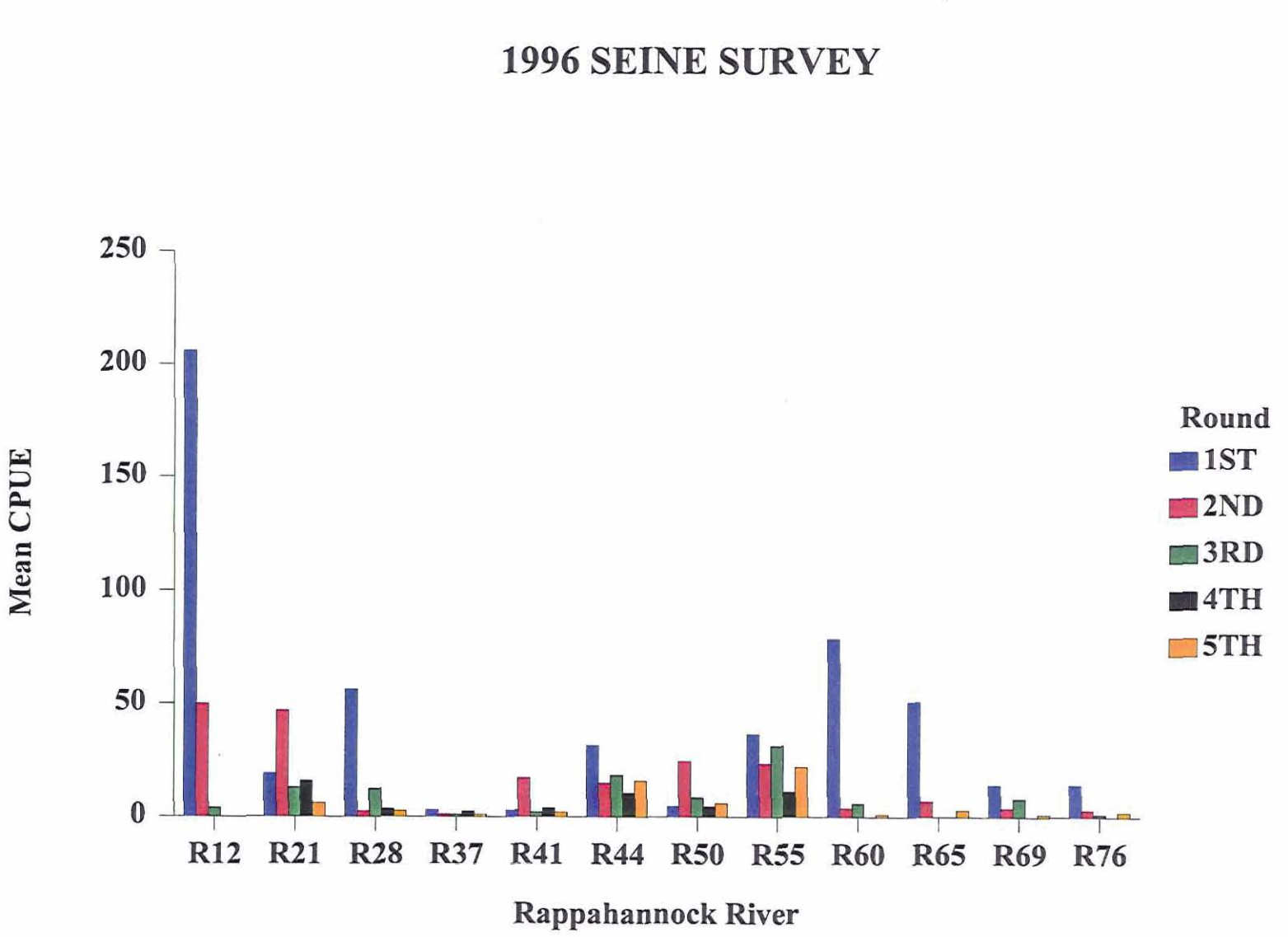

Figure 7. Average catch of young-of-the-year striped bass per seine haul by station in the Rappahannock River in 1996.

Appendix

An Analysis of Finfish Species Taken in the Juvenile Striped Bass Seine Survey

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Executive Summary

The Virginia Institute of Marine Science (VIMS) has conducted a striped bass juvenile abundance beach seine survey since 1967, except the period 1974-1979 when funding was suspended. In the 1996 segment of this study, sixty-three species in addition to striped bass were captured when all sites were examined with fifty-one being taken at the index sites. When all stations are examined for all years, one-hundred-thirty-five species have been captured with one-hundred-ten of those species being captured at index sites. Some of these species are ecologically and/or economically important to the Chesapeake Bay system. Number of species reported in this text varies from the tables because young-of-the-year striped bass are separated from older bass for the purposes of this study and in one year, coded wire tagged fish were being released into the Mattaponi River by another agency and those fish were separated from wild fish when encountered. Those fish are reported in these tables as separate species.

Indices for some of the most abundant species and several of the ecologically and/or economically important species were calculated using only the index sites to remain consistent with the content of the striped bass report.

When all years and all sites were combined and examined, Atlantic menhaden was the most abundant species captured; however their numbers peaked in the early to mid-eighties and have fallen to low levels in recent years (Fig. A-1). Menhaden were also most abundant when only index stations were examined for all years. In 1996, menhaden were the fourth most abundant species captured at index sites.

The 1996 index for white perch was the highest that has been recorded at the index sites, doubling or nearly doubling every index since 1980 with the exception of the 1987 index which is only slightly less than the 1996 index (Fig. A-2). White perch were three times more abundant than striped bass, the second most abundant species at the index sites in 1996. White perch are of particular interest as they are a cohabitant species with striped bass and are probably the chief competitor for the same food source as that of striped bass. With both species at all time high abundances, one might have thought survival and growth of both species might have been affected. We saw no visual indications of such in either species. White perch became the most abundant species when only 1996 was examined (Tables A-1 and A-2).

When all sites were considered Atlantic silversides were the second most abundant species (Tables A-1 through A- 4) but when only the index stations were examined silversides fell to fourth in all years and seventh in 1996. Atlantic silverside indices seem cyclic but since the late eighties their indicies have been at somewhat lower levels than those of the earlier years (Fig. A-3)

Spottail shiner was one of the top five species when examining any combination of years and stations(Tables A-1 through A-4). They mostly cohabit the same areas as striped bass and white perch but are more of a pelagic feeder though they sometimes probably do compete for like foods. However, as stripers grow and become pisciverous spottail shiners probably become a striped bass food item. Spottail shiner indices have been erratic through this study.

Another abundant species was the hogchoker (Tables A-1 through A-4). Hogchokers are ubiquitous and generally plentiful therefore their numbers were usually high. The hogchoker indices seem to have been at a generally higher level since 1986 (Fig. A-5).

Though in the top ten species when all years were examined, spot were not abundant in 1996 (Tables A-1 through A- 4). Spot indicies were erratic in the early to mid-eighties but in 1989 the index dropped to below one fish per haul and has essentially remained low since that time (Fig. A-6).

Bay anchovy was another species that was in the top ten when looking at all years but was at low levels in 1996 (Tables A-1through A-4). Anchovy levels were highest in the early to mid-eighties but in 1988 dropped to significantly lower levels where they have remained (Fig. A-7).

Tidewater silverside was usually one of the top ten speciesbut fell out of the top ten when looking at all stations in 1996 (Tables A-1 through A-4). It usually cohabitates the freshwater nursery areas of striped bass and is probably a food source for larger juvenile and adult striped bass. Its indices peaked in the early to mid-eighties but have dropped off to low levels since 1988 (Fig. A-8).

Several other species have occupied a spot in the top ten most abundant species. If looking at all stations, the mummichog, a species more abundant downriver of the index area, is always there (Tables A-1 through A-4). Though not extremely abundant, the mummichog index has become somewhat higher since 1991 (Fig. A-9).

Blueback herring, eastern silvery minnow, American shad, banded killifish and other freshwater species have at one time or another been in or near the top ten in abundance (Tables A-1 through A-4). Herring and shad are anadromus species of some interest while the minnows and killifish are freshwater species that occur in the striped bass nursery area. Blueback herring and American shad indices have been at low levels since the restart of sampling in 1980, however both species exhibited a small increase in their respective indices in 1996 (Figs. A-10 and A-11).

Table A-1. Juvenile striped bass seine survey species abundance at index sites in 1996.

	SPECIES	TOTAL
1	white perch	10140
2	striped bass	3759
3	spottail shiner	1764
4	Atlantic menhaden	1611
5	American shad	1489
6	hogchoker	1454
7	Atlantic silverside	1172
8	eastern silvery minnow	749
9	inland silverside	742
10	banded killifish	598
11	blueback herring	486
12	threadfin shad	479
13	mummichog	448
14	gizzard shad	349
15	satinfin shiner	282
16	rough silverside	248
17	channel catfish	195
18	tessellated darter	156
19	white catfish	141
20	bay anchovy	115
21	striped killifish	101
22	yellow perch	98
23	alewife	53
24	golden shiner	47
25	spot	34
26	Atlantic croaker	18
27	bluegill	16

Table A-1 (con't).

28	American eel	13
29	pumpkinseed	12
30	striped bass - age 1+	12
31	shorthead redhorse	11
32	striped anchovy	8
33	blue catfish	7
34	brown bullhead	6
35	largemouth bass	6
36	redbreast sunfish	6
37	common carp	3
38	creek chub	3
39	black drum	2
40	longnose gar	2
41	swallowtail shiner	2
42	northern pipefish	2
43	Atlantic needlefish	2
44	striped mullet	2
45	creek chubsucker	2
46	bluespotted sunfish	2
47	redear sunfish	2
48	bluefish	1
49	hickory shad	1
50	mosquitofish	1
51	black crappie	1
52	pinfish	1
		=====
		26854

Table A-2. Juvenile striped bass seine survey species abundance at all sites for 1996.

	SPECIES	TOTAL
1	white perch	14079
2	Atlantic silverside	5571
3	striped bass	5420
4	hogchoker	5381
5	spottail shiner	2913
6	American shad	2015
7	threadfin shad	1862
8	Atlantic menhaden	1854
9	blueback herring	1611
10	mummichog	1514
11	eastern silvery minnow	1138
12	inland silverside	917
13	banded killifish	913
14	spot	741
15	gizzard shad	717
16	satinfin shiner	511
17	striped killifish	447
18	channel catfish	343
19	rough silverside	303
20	bay anchovy	263
21	tessellated darter	246
22	yellow perch	246
23	alewife	225
24	white catfish	152
25	golden shiner	64
26	creek chubsucker	53
27	bluegill	50

Table A-2 (con't).

28	blue catfish	48
29	bluespotted sunfish	41
30	Atlantic croaker	40
31	American eel	37
32	striped anchovy	37
33	weakfish	35
34	redbreast sunfish	33
35	silver perch	28
36	pumpkinseed	26
37	creek chub	24
38	largemouth bass	20
39	striped bass - age 1+	17
40	shorthead redhorse	16
41	Atlantic needlefish	12
42	brown bullhead	9
43	smallmouth bass	8
44	common carp	5
45	mosquitofish	5
46	black drum	4
47	quillback	4
48	skilletfish	4
49	inshore lizardfish	4
50	longnose gar	3
51	northern pipefish	3
52	bluefish	2
53	red drum	2
54	southern kingfish	2
55	swallowtail shiner	2

Table A-2 (con't).

56	striped mullet	2
57	white mullet	2
58	redear sunfish	2
59	hickory shad	1
60	bighead searobin	1
61	tadpole madtom	1
62	black crappie	1
63	cownose ray	1
64	pinfish	1
		=====
		50032

Table A-3. Juvenile striped bass seine survey species abundance at index sites for all years.

	SPECIES	TOTAL
1	Atlantic menhaden	101908
2	white perch	48469
3	spottail shiner	32354
4	Atlantic silverside	30344
5	striped bass	21685
6	bay anchovy	14658
7	spot	13865
8	hogchoker	12821
9	inland silverside	12273
10	eastern silvery minnow	11970
11	blueback herring	11643
12	American shad	7060
13	banded killifish	6665
14	gizzard shad	5861
15	threadfin shad	5515
16	Atlantic croaker	4370
17	mummichog	4047
18	satinfin shiner	3997
19	tessellated darter	3076
20	channel catfish	3010
21	rough silverside	2226
22	white catfish	2063
23	alewife	1592
24	golden shiner	1247
25	striped killifish	1101
26	pumpkinseed	1067
27	yellow perch	612

Table A-3 (con't).

28	striped mullet	488
29	striped bass - age 1+	444
30	Atlantic needlefish	332
31	American eel	310
32	bluegill	289
33	white mullet	284
34	redbreast sunfish	267
35	silversides	260
36	bluefish	228
37	bridle shiner	216
38	minnow	214
39	silver perch	201
40	striped anchovy	132
41	largemouth bass	120
42	Atlantic thread herring	114
43	blackcheek tonguefish	98
44	blue catfish	87
45	mosquitofish	84
46	brown bullhead	80
47	rainwater killifish	54
48	summer flounder	45
49	common carp	44
50	spotted seatrout	44
51	crevalle jack	43
52	bluespotted sunfish	37
53	herring	36
54	flier	28
55	hickory shad	27
56	harvestfish	26

Table A-3 (con't).

57	Spanish mackerel	25
58	longnose gar	23
59	shorthead redhorse	23
60	striped bass - hatchery	23
61	redear sunfish	21
62	northern pipefish	17
63	naked goby	15
64	sunfishes	15
65	weakfish	10
66	tadpole madtom	9
67	skilletfish	9
68	chain pickerel	8
69	smallmouth bass	8
70	scup	7
71	sheepshead minnow	7
72	spotfin shiner	7
73	river chub	6
74	margined madtom	6
75	green sunfish	6
76	ladyfish	5
77	spotted sunfish	5
78	bluehead chub	5
79	black drum	4
80	blue runner	4
81	chubs	4
82	southern kingfish	3
83	inshore lizardfish	3
84	bowfin	3
85	creek chub	3

Table A-3 (con't).

86	quillback	2
87	swallowtail shiner	2
88	black crappie	2
89	banded rudderfish	2
90	pinfish	2
91	creek chubsucker	2
92	common shiner	2
93	Lepomis spp	2
94	Atlantic herring	1
95	red drum	1
96	winter flounder	1
97	catfishes	1
98	northern puffer	1
99	northern kingfish	1
100	fourspine stickleback	1
101	green goby	1
102	oyster toadfish	1
103	pipefish	1
104	eastern mudminnow	1
105	horse-eye jack	1
106	longear sunfish	1
107	spotfin mojarra	1
108	pirate perch	1
109	gray snapper	1
110	silver jenny	1
111	Noturus spp	1
		370449

Table A-4. Juvenile striped bass seine survey species abundance all sites for all years.

	SPECIES	TOTAL
1	Atlantic menhaden	141235
2	Atlantic silverside	93403
3	white perch	66456
4	spottail shiner	43337
5	bay anchovy	28800
6	hogchoker	27989
7	striped bass	27013
8	spot	25665
9	mummichog	20181
10	inland silverside	17627
11	blueback herring	16570
12	eastern silvery minnow	14714
13	gizzard shad	14118
14	threadfin shad	12218
15	banded killifish	10209
16	American shad	8562
17	striped killifish	8188
18	Atlantic croaker	8116
19	satinfin shiner	6222
20	channel catfish	4178
21	tessellated darter	4075
22	white catfish	3292
23	rough silverside	2712
24	alewife	2364
25	white mullet	1922
26	pumpkinseed	1568
27	golden shiner	1502

Table A-4 (con't).

28	yellow perch	1461
29	striped mullet	1142
30	silver perch	864
31	Atlantic needlefish	729
32	bluegill	684
33	redbreast sunfish	674
34	striped anchovy	666
35	sheepshead minnow	654
36	American eel	604
37	striped bass - age 1+	553
38	blue catfish	548
39	silversides	510
40	Atlantic thread herring	354
41	bluefish	327
42	largemouth bass	313
43	bridle shiner	273
44	fourspine stickleback	265
45	blackcheek tonguefish	253
46	rainwater killifish	244
47	weakfish	233
48	minnow	220
49	southern kingfish	206
50	inshore lizardfish	173
51	bluespotted sunfish	154
52	naked goby	132
53	summer flounder	131
54	mosquitofish	128
55	brown bullhead	119
56	northern pipefish	119

Table A-4 (con't).

57	skilletfish	98
58	smallmouth bass	96
59	spotted seatrout	95
60	crevalle jack	94
61	halfbeak	93
62	common carp	79
63	oyster toadfish	67
64	creek chubsucker	64
65	harvestfish	61
66	shorthead redhorse	48
67	red drum	45
68	Spanish mackerel	45
69	herring	39
70	redear sunfish	36
71	longnose gar	30
72	flier	29
73	hickory shad	28
74	striped blenny	28
75	creek chub	24
76	striped bass - hatchery	24
77	quillback	23
78	black drum	18
79	sunfishes	17
80	northern kingfish	16
81	margined madtom	15
82	ladyfish	14
83	bluehead chub	14
84	northern puffer	11
85	tadpole madtom	11

Table A-4 (con't).

86	black crappie	11
87	chubs	11
88	Atlantic spadefish	10
89	northern searobin	10
90	chain pickerel	8
91	spotfin shiner	8
92	scup	7
93	river chub	7
94	chub mackerel	7
95	cownose ray	6
96	blue runner	6
97	permit	6
98	spotted sunfish	6
99	green sunfish	6
100	pigfish	5
101	bighead searobin	5
102	green goby	5
103	common shiner	5
104	bull chub	5
105	Atlantic mackerel	4
106	Florida pompano	4
107	winter flounder	3
108	striped searobin	3
109	pipefish	3
110	bowfin	3
111	fallfish	3
112	kingfish	2
113	catfishes	2
114	swallowtail shiner	2

Table A-4 (con't).

115	banded rudderfish	2
116	pinfish	2
117	horse-eye jack	2
118	silver jenny	2
119	Lepomis spp	2
120	Atlantic herring	1
121	cobia	1
122	warmouth	1
123	banded sunfish	1
124	roughtail stingray	1
125	eastern mudminnow	1
126	northern stargazer	1
127	longear sunfish	1
128	spotfin mojarra	1
129	comely shiner	1
130	pirate perch	1
131	chain pipefish	1
132	white crappie	1
133	gray snapper	1
134	Atlantic threadfin	1
135	southern flounder	1
136	Noturus spp	1
		======
		626421

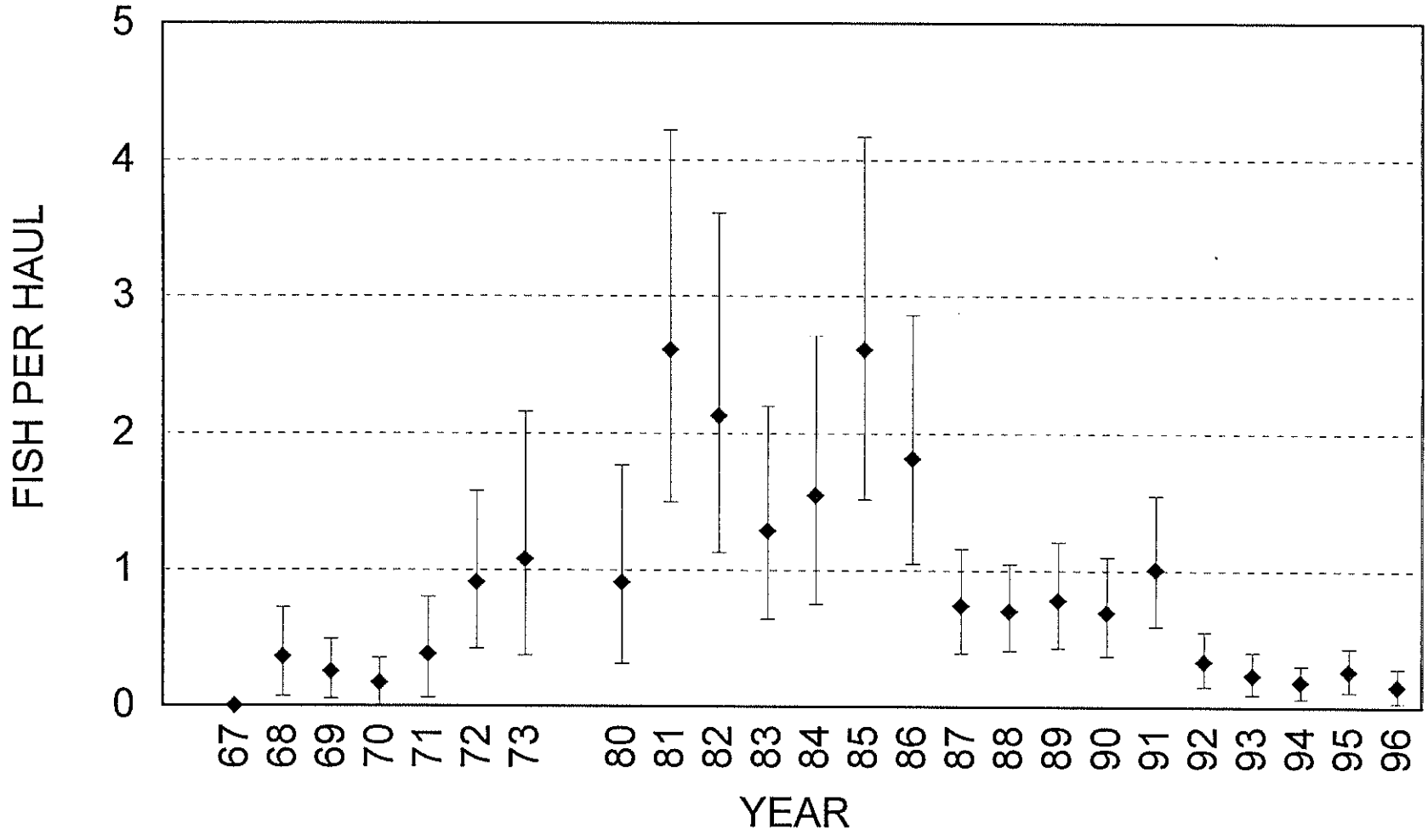

Figure A-1. Catch per seine haul of Atlantic Menhaden at index sites in the striped bass seine survey

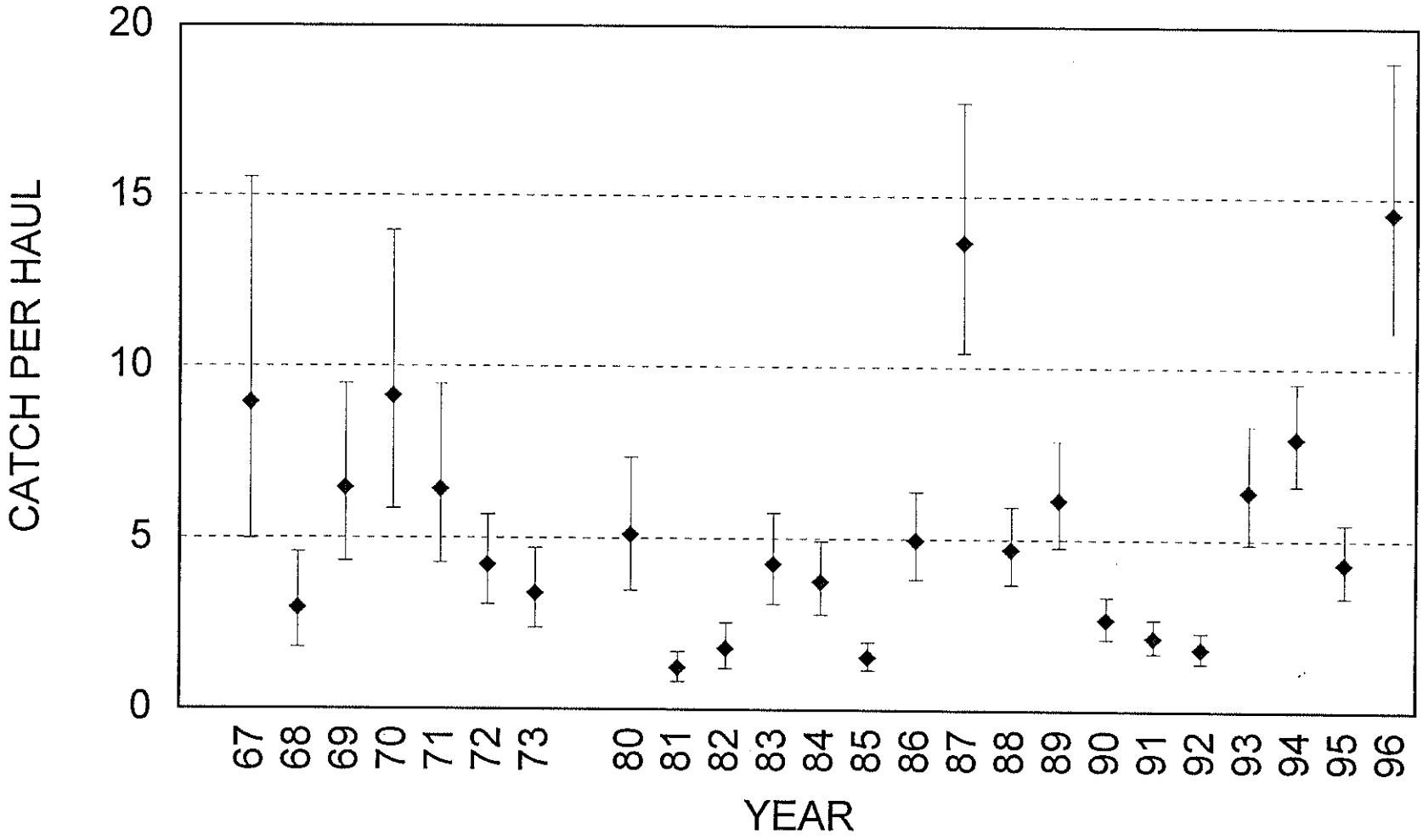

Figure A-2. Catch per seine haul of White Perch at index sites in the striped bass seine survey.

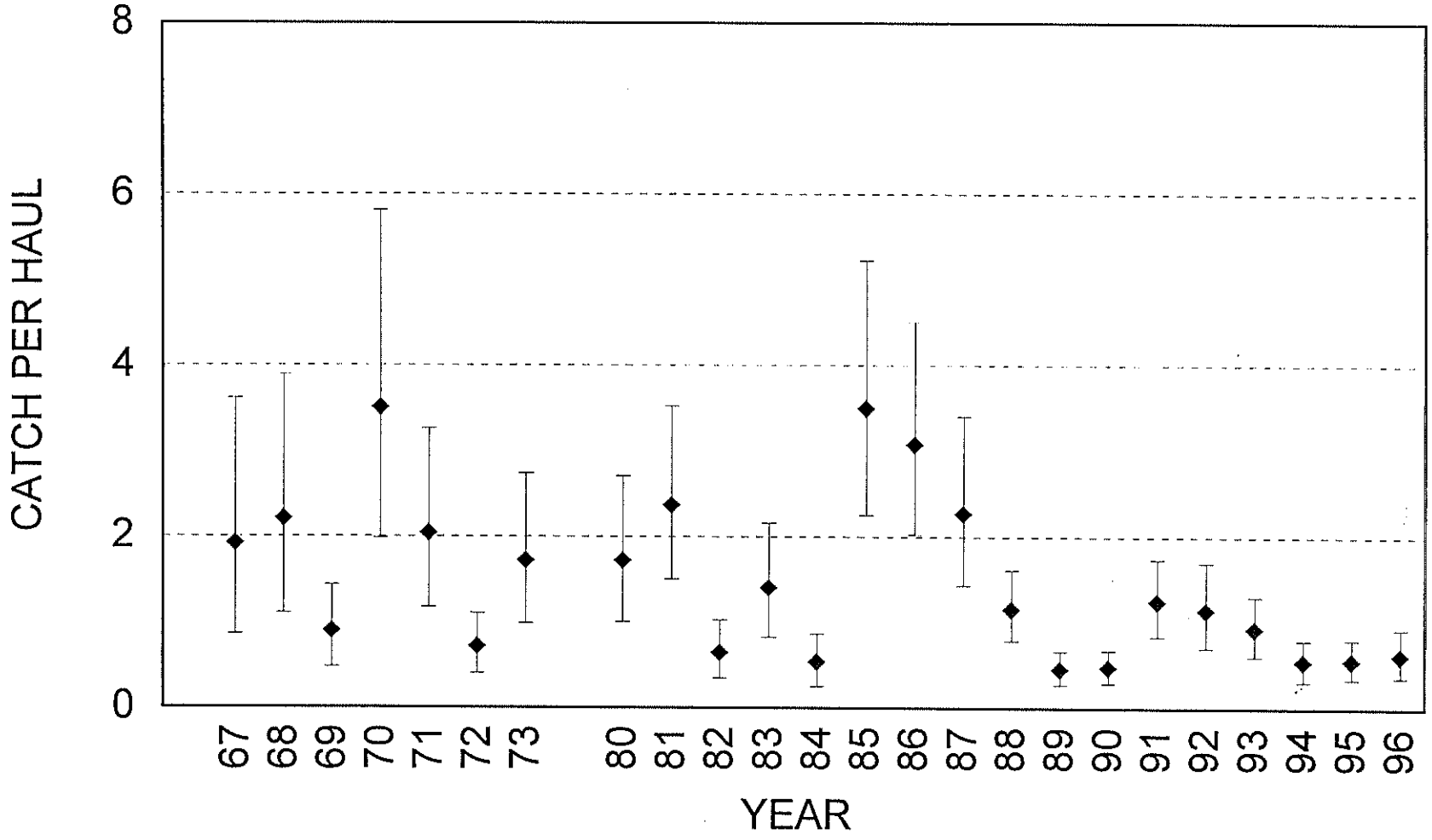

Figure A-3. Catch per seine haul of Atlantic Silversides at index sites in the striped bass seine survey.

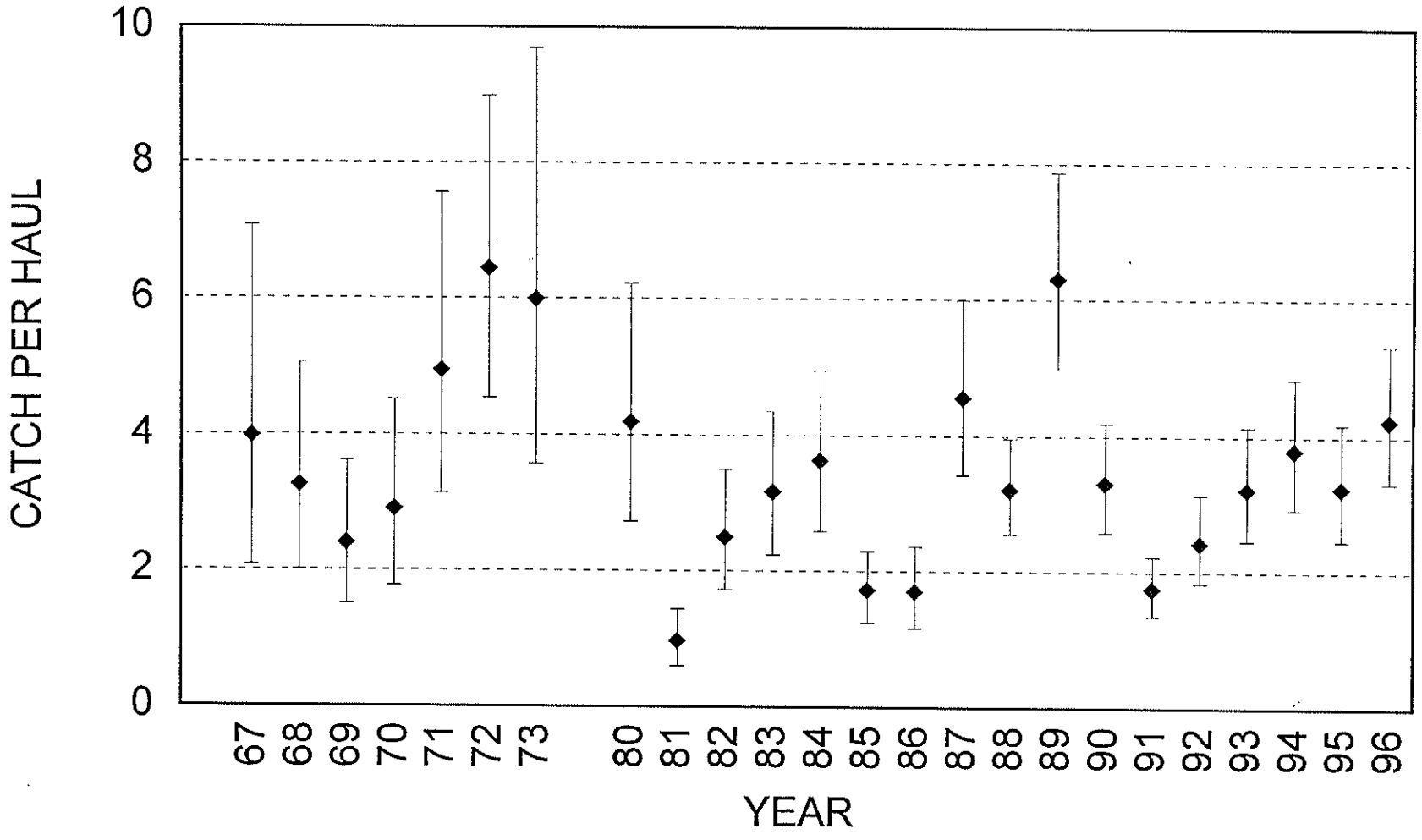

Figure A-4. Catch per haul of Spottail Shiner at index sites in the striped bass seine survey.

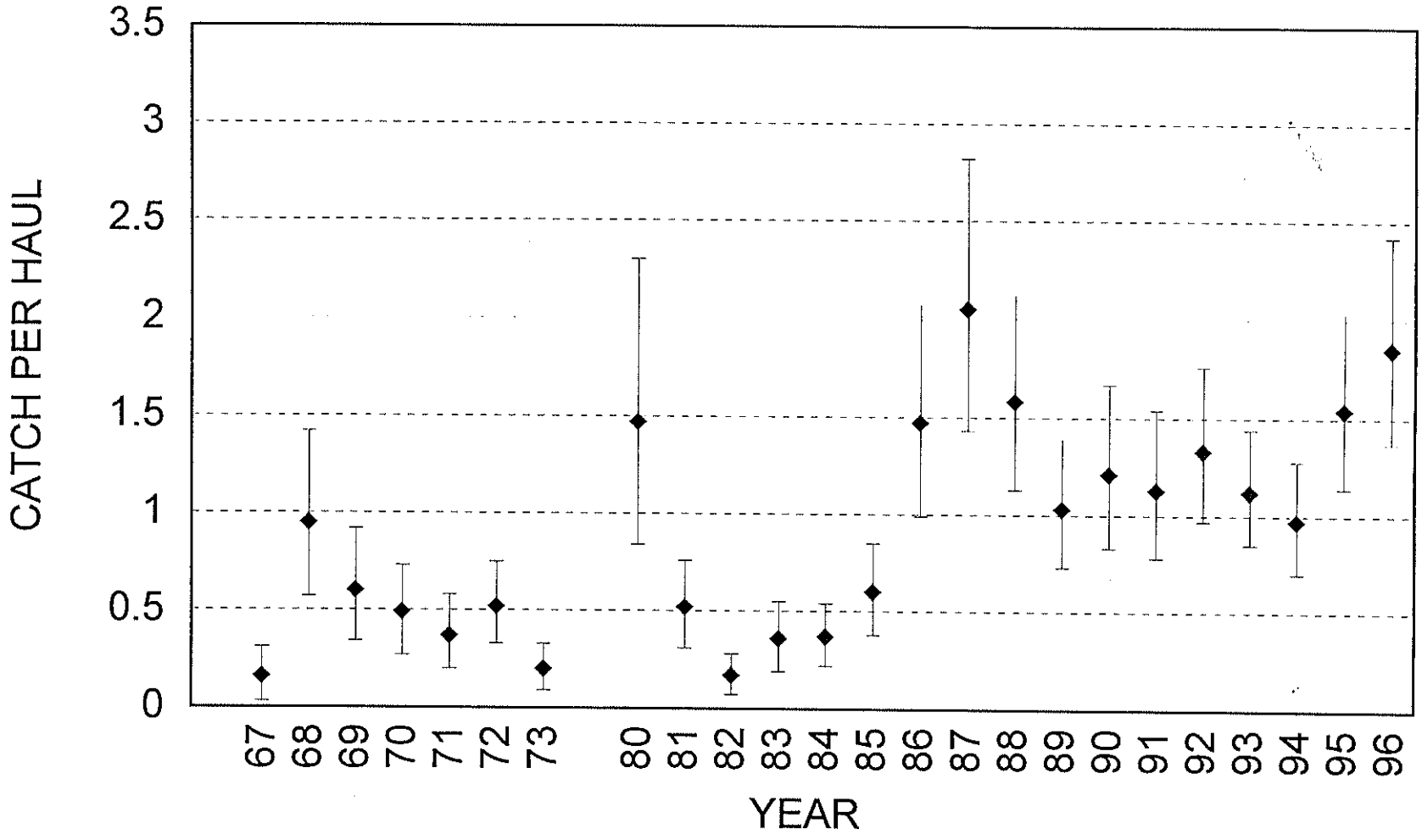

Figure A-5. Catch per haul of Hogchoker at index sites in the striped bass seine survey.

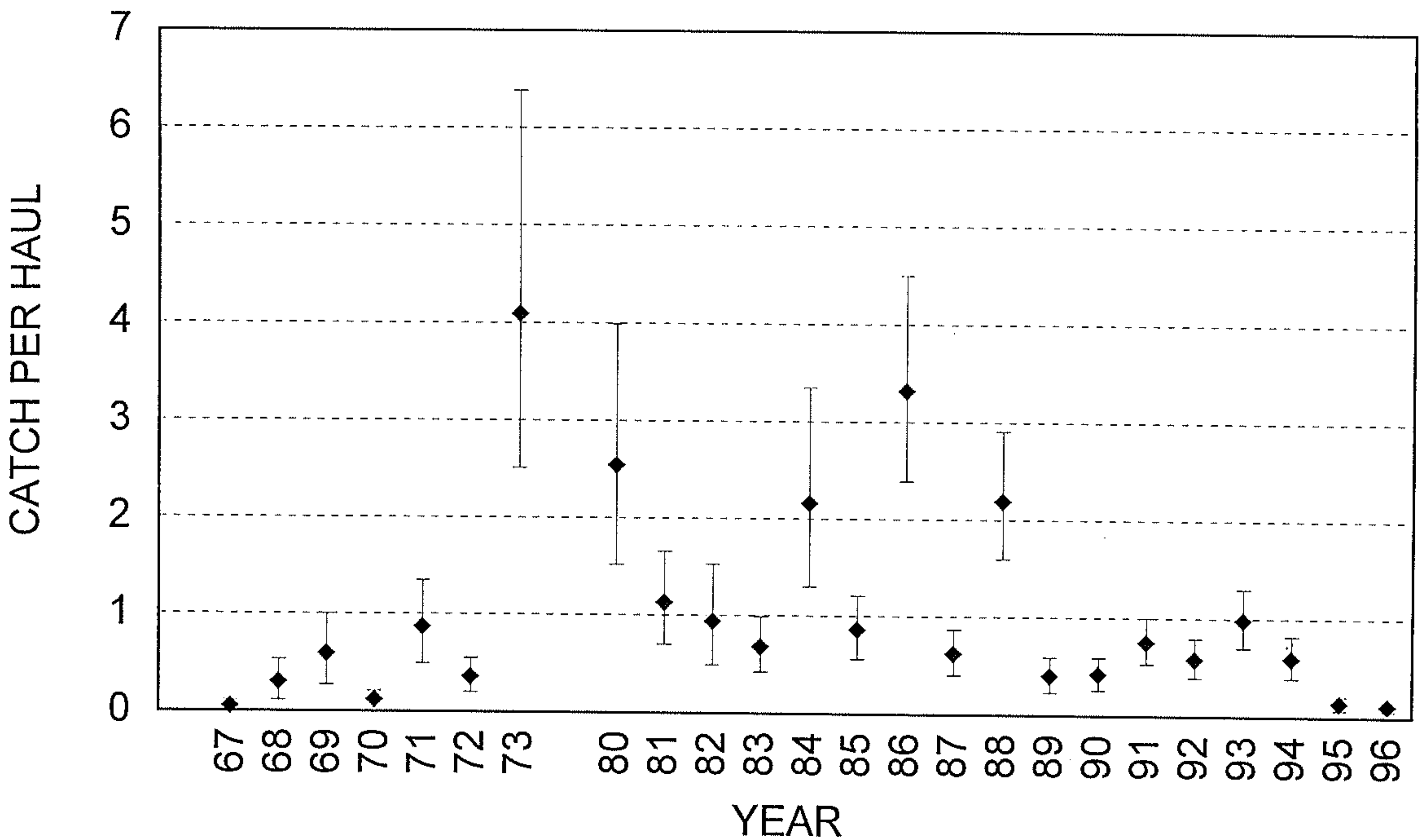

Figure A-6. Catch per haul of Spot at index sites in the striped bass seine survey.

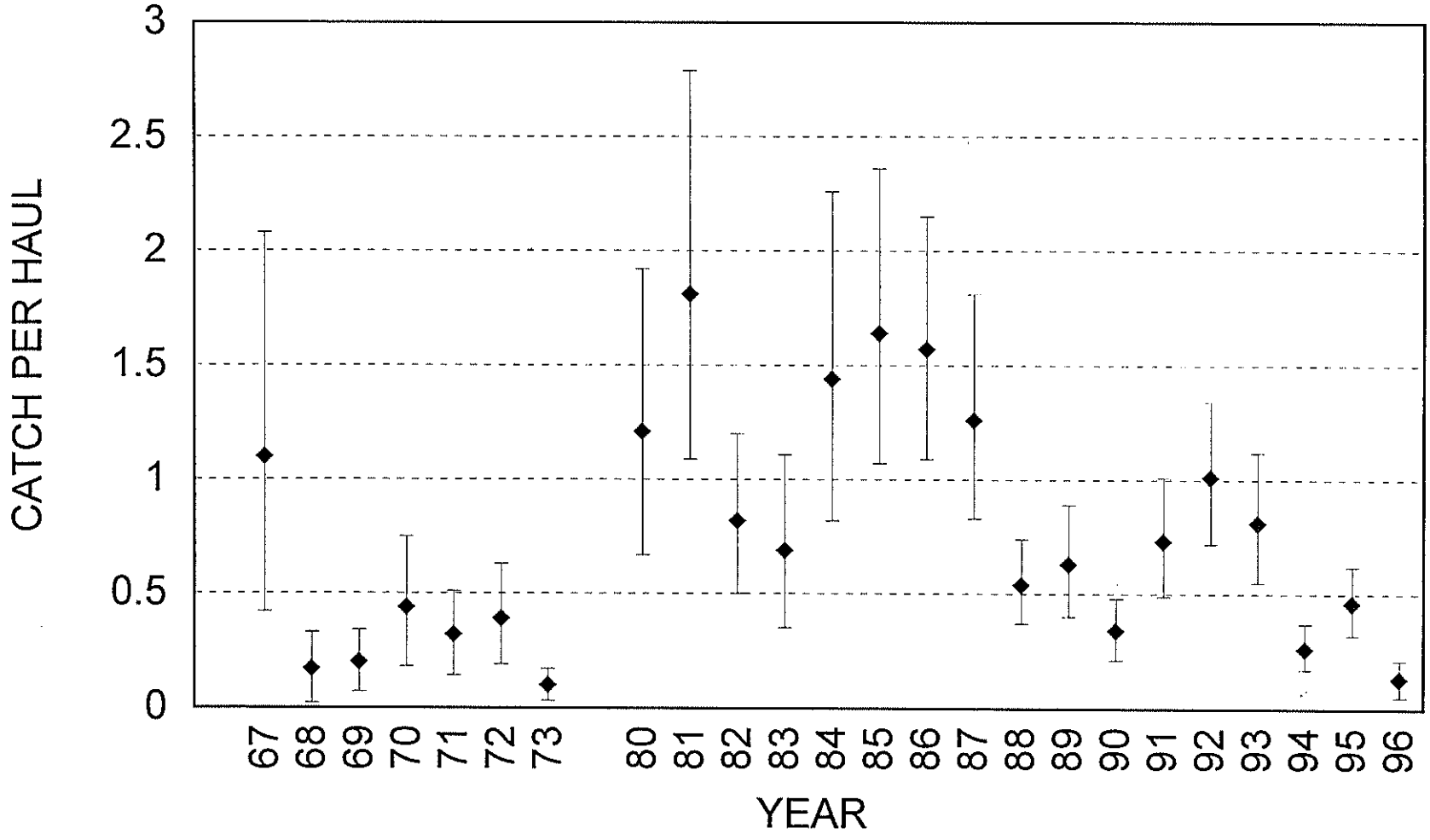

Figure A-7. Catch per haul of Bay Anchovy at index sites in the striped bass seine survey.

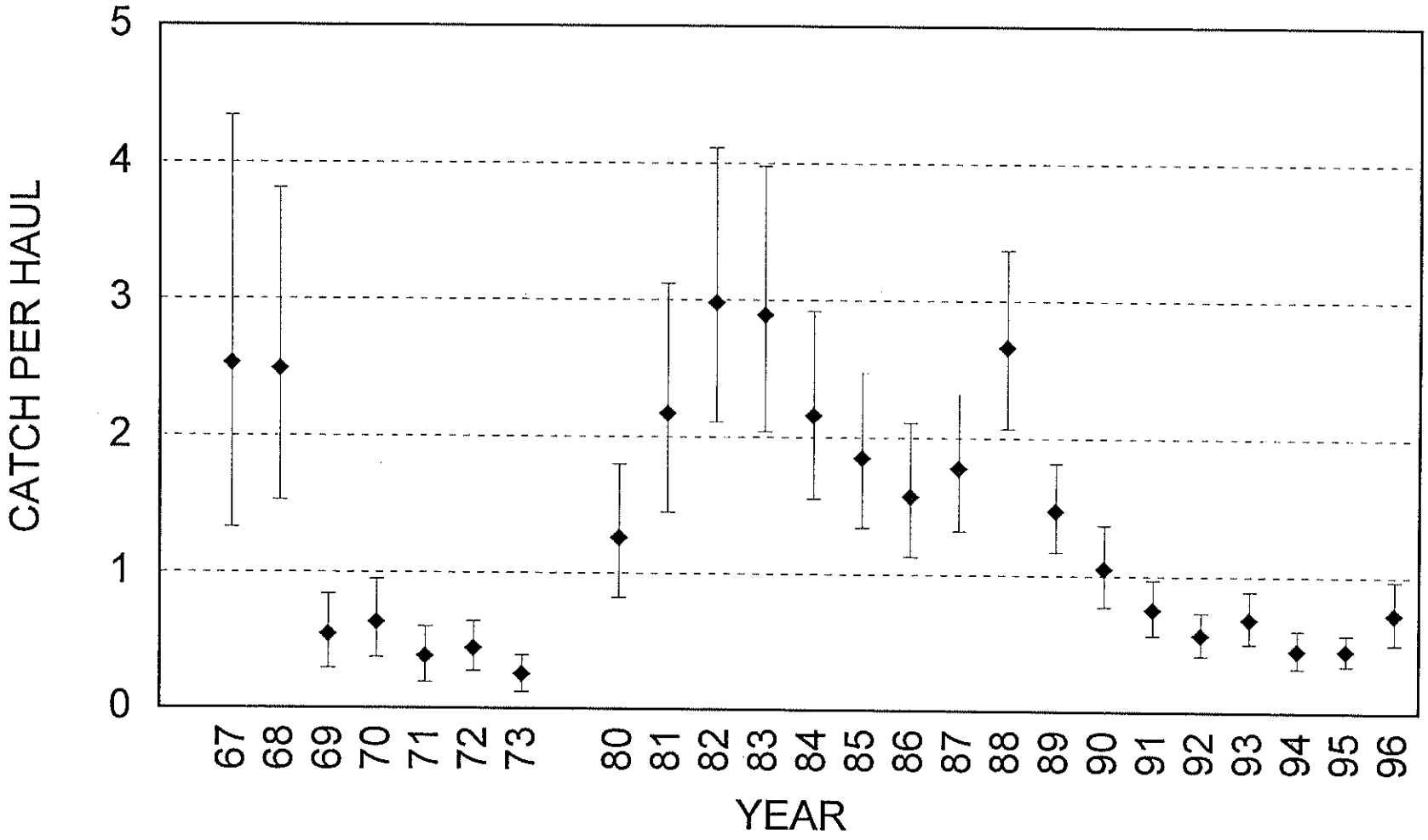

Figure A-8. Catch per seine haul of Tidewater Silversides at index sites in the striped bass seine survey.

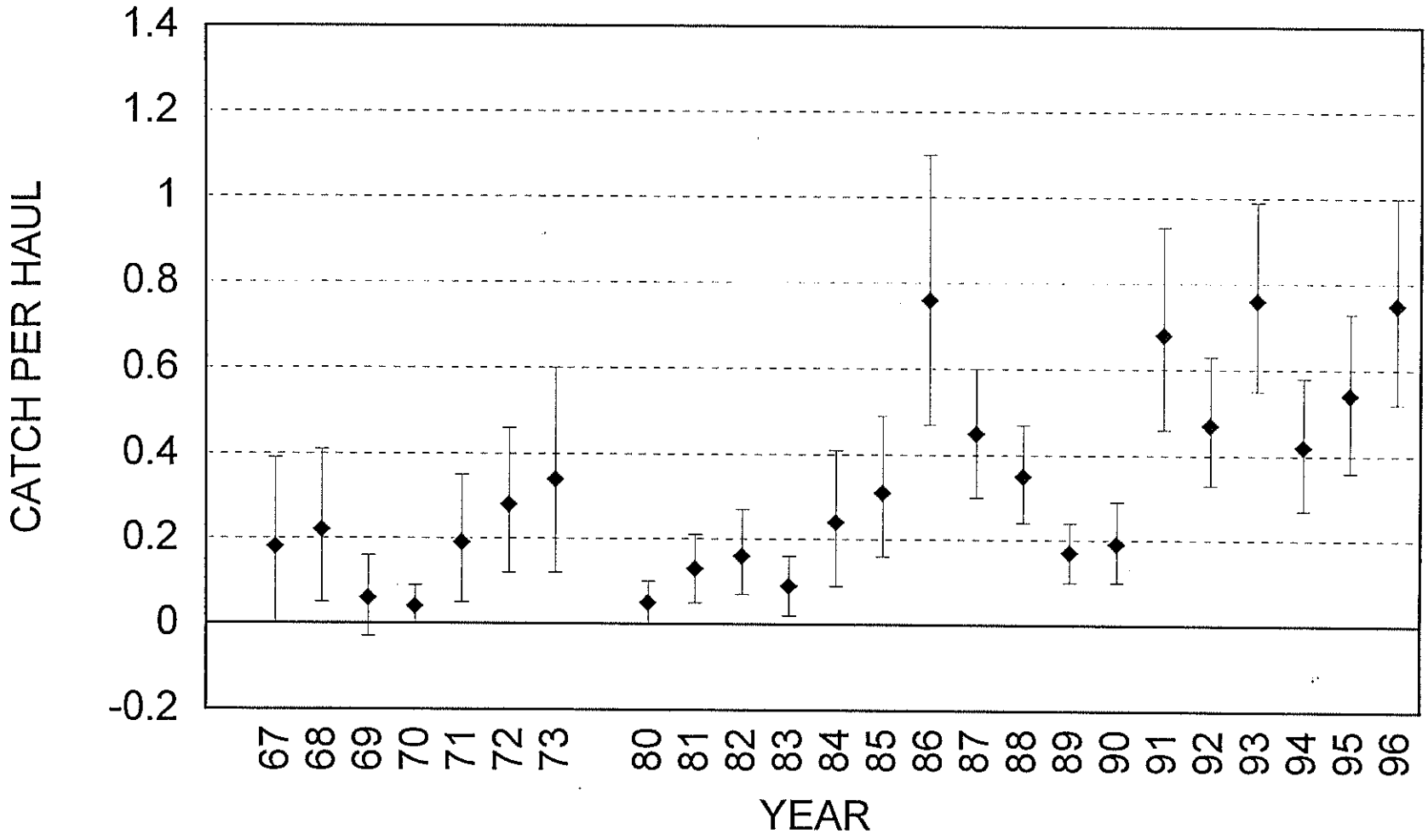

Figure A-9. Catch per seine haul of Mummichog at index sites in the striped bass seine survey.

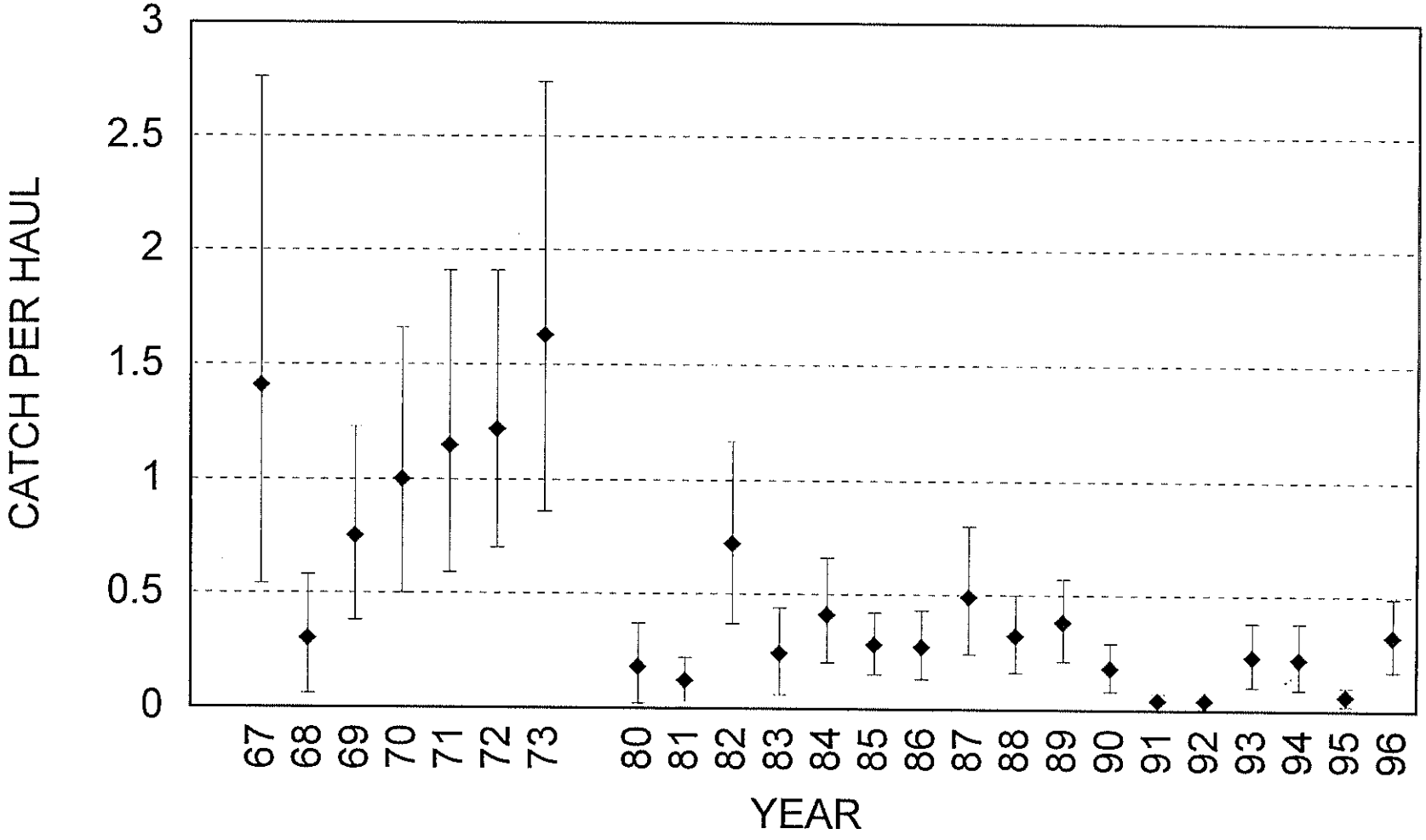

Figure A-10. Catch per seine haul of Blueback herring at index sites in the striped bass seine survey.

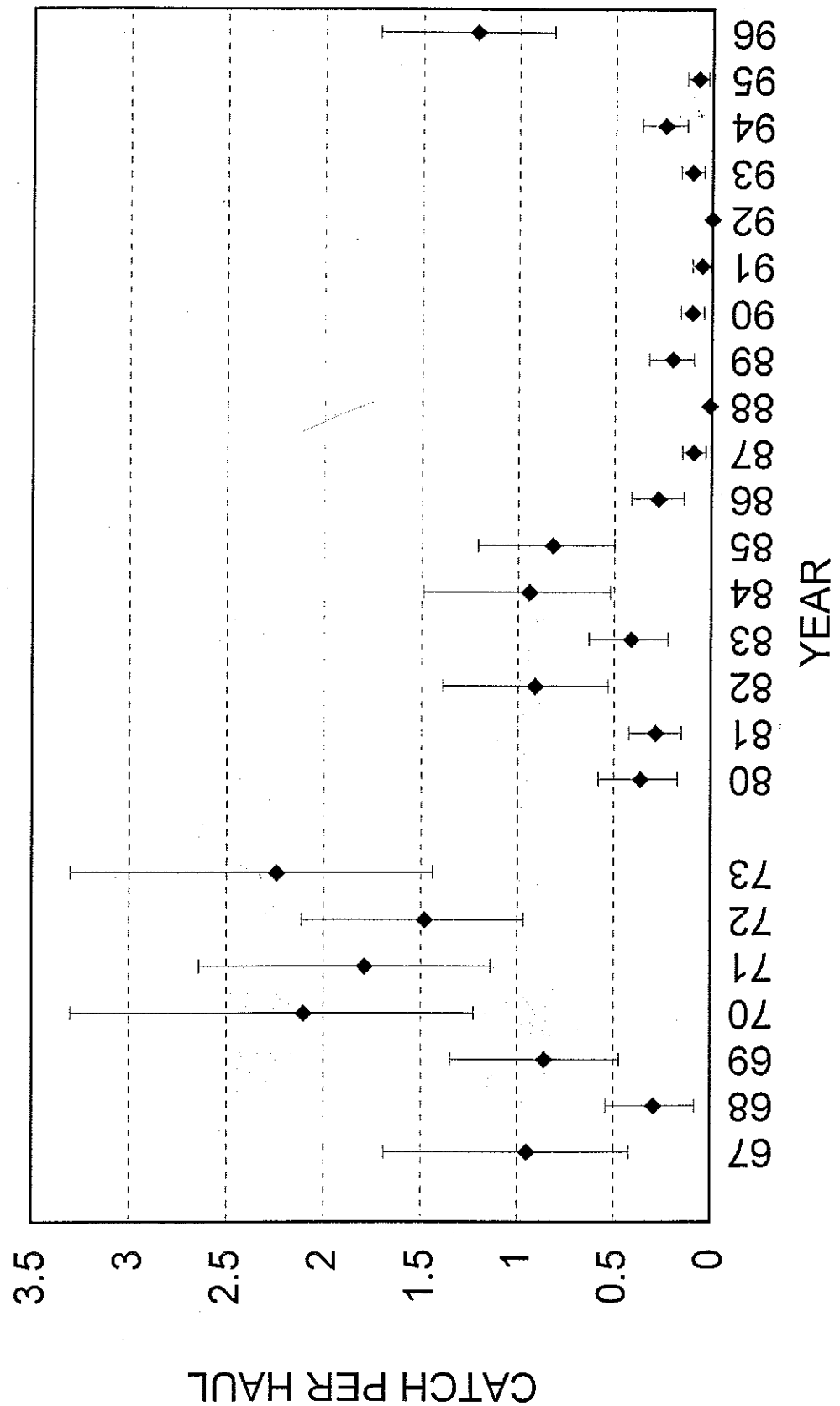

Figure A-11. Catch per seine haul of American shad at index sites in the striped bass seine survey.