The Status Of Virginia's Public Oyster Fishery 1994

Reinaldo Morales-Alamo
Roger Mann, Ph.D.

Virginia Institute of Marine Science
School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

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Status of the Public Oyster Resource Of Virginia in 1994

Summary

1. There was a considerable decline in spatfall on shell-string collectors at almost every station monitored in Virginia in 1994 from levels recorded in 1993. With one exception (Willis Wharf in the Eastern Shore) total spatfall in 1994 was light. No spatfall was recorded on shellstrings in the Potomac and Great Wicomico rivers. As a result, recruitment into oyster populations will be minimal in most Virginia tributaries of western Chesapeake Bay and on the seaside of the Eastern Shore.

2. Total count of oysters of all sizes per bushel of bottom material approached the count traditionally considered good for transplantation (700) only at Horsehead bar in the James River. Elsewhere, the counts were far below that level.

3. From 1986 to the spring of 1993, there was a continuous decline in abundance of market oysters in the productive public grounds (those in low-salinity areas) in the James and Rappahannock rivers. The decline continued through the fall of 1994 in the Rappahannock River, but a slight recovery detected in the Burwell Bay bars of the James River in the fall of 1993 appeared to have held on through the fall of 1994; those numbers, however, are still low.

4. Number of market oysters were very low in the Rappahannock River. Their numbers were extremely low or absent in the York, Piankatank and Great Wicomico rivers and in Mobjack Bay.

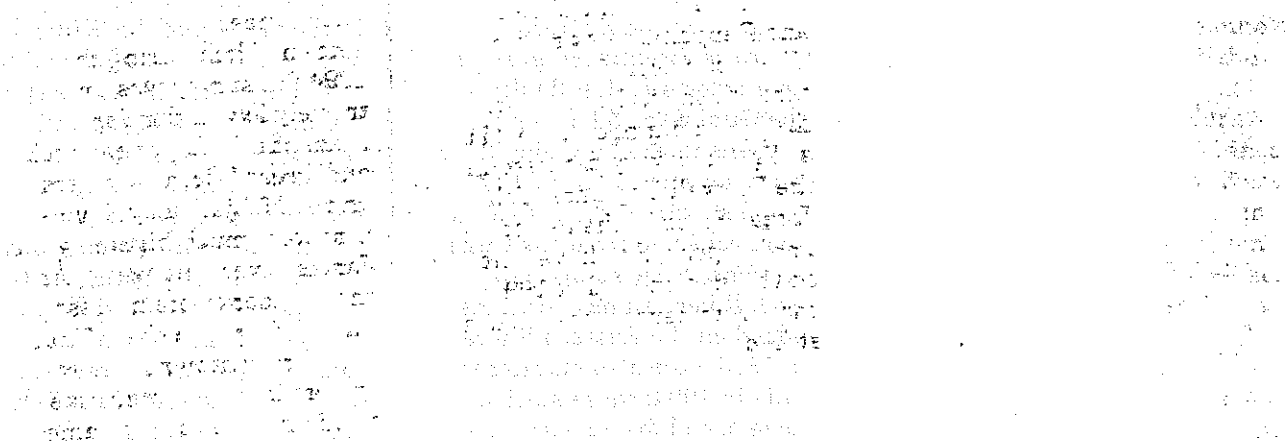
5. Oyster bars above Wreck Shoal in the James River are presently the only ones in Virginia tributaries of western Chesapeake Bay with abundant numbers of small oysters (those 1-year or older but under 3 inches). From 1992 through the fall of 1994, however, there has been a declining trend in their numbers. This trend should be of concern to managers of the resource and should be monitored carefully.

6. Average number of small oysters in the Rappahannock, Piankatank and Great Wicomico rivers remained low (under 100 per bushel) through the fall of 1994. They were very scarce in the York River and absent in Mobjack Bay.

7. The number of spat found on bottom cultch during the 1994 fall survey was extremely low in the York, Piankatank, Rappahannock, and Great Wicomico rivers and in Mobjack Bay. Numbers were much higher in the James River, but even there the numbers were modest, under 200 per bushel. Thus, recent recruitment of new oysters into the productive public grounds of the James

River has been low and management strategies to enhance recruitment should be encouraged.

8. Recent mortality of oysters was low at almost all bars sampled in the fall of 1994. Only Aberdeen Rock in the York River (with 16.7%) and Thomas Rock in the James River (with 14.5%) had a mortality higher than 10%.



Part I. Oyster Spatfall in Virginia in 1994

Introduction

The Virginia Institute of Marine Science (VIMS) conducts surveys of oyster spatfall (or "setting") in Virginia waters throughout the summer reproductive period. This survey provides an estimate of the *potential* of a particular area for receiving a "strike" or set of oysters on the bottom and helps define the timing of setting events. Information obtained from this monitoring effort is added to a data base that provides an overview of long-term trends in spatfall in the lower Chesapeake Bay and contributes to assessment of the current condition of the oyster resource and the general health of the bay system. The data are also valuable to the Virginia Marine Resources Commission for its shell repletion program, and to private oyster growers interested in potential timing and location of shell plantings.

Results from the shellstring survey are reflective of the abundance of ready-to-set oyster larvae present in an area, and thus an indication of the reproductive activity of oyster populations in an estuary and of successful development and survival of the larvae to the settlement stage. Environmental factors affecting those parameters cause seasonal and annual fluctuations in spatfall which are evident in the data from the shellstring program.

Data from the shellstring surveys are also an indicator of the *potential* for recruitment into oyster populations in a particular estuary. However, settlement and subsequent survival of spat on bottom cultch is affected by many factors, including physical and chemical environmental conditions, the physiological condition of the larvae when they set, predators, disease and the timing of those factors. Abundance and condition of the bottom cultch also affect survival of spat on the bottom. Thus, settlement on shellstrings may not correspond directly with recruitment on bottom cultch at all times or places. Under most circumstances, however, the relationship between the two is expected to be commensurate.

This report summarizes data collected during the 1994 setting season.

Methods

Spatfall in 1994 was monitored from June through the first week of October at a total of 32 stations in the Virginia tributaries of the Chesapeake Bay, 10 stations in the Potomac River, and 15 stations on the Eastern Shore of Virginia. (Figure 1). Due to logistical difficulties, the Gum Bar and Yates Bar stations in the Potomac River were not monitored in 1994 and only three weeks of data were collected from the three stations in the Rappahannock River. All new stations added on the Eastern Shore in 1993 were also monitored fully in 1994; those stations have been labeled with geographic names and are listed within each transect in Table 1 in the same order listed in the 1993 report (offshore, middle, inshore). Two additional stations were monitored for 4-5 weeks in August in the vicinity of the Willis Wharf station to acquire additional information on the spatial distribution of spatfall in that area.

We continue to use the shellstring as the standard monitoring tool. Throughout the monitoring period, shellstrings were deployed 0.5 m off the bottom at each station. A shellstring consisted of 12 oyster shells of similar size (about 3 inches) drilled

through the center and strung (inside of shell down) on heavy gauge wire. Shell-strings were replaced after a one-week exposure (with some occasional deviations), and the number of spat that attached to the smooth surface (underside) of the central 10 shells was counted with the aid of a dissection microscope. This number was then divided by 10 to get the number of spat-per-shell for the corresponding time interval. A computer program was used to calculate the number of spat-per-shell-per-week with corrections that standardize the various exposure periods to the 7-day period specified in Table 1; thus. the weekly periods in Table 1 are not necessarily the actual time periods during which the string at a specific station was exposed, but they approximate those periods closely. The standardized weekly periods allow comparison of spatfall trends over the course of the summer between the various locations, as well as between data for different years. Total annual spatfall was computed by adding the weekly values of spat-per-shell for the entire season.

Spat-per-shell-per-week values were categorized for comparison purposes as follows: less than 0.1, *none*; 0.1-1.0, *light*; 1.1-10.0, *moderate*; and more than 10.0, *heavy*.

Results

❖ *James River*

No spat settlement was recorded in the James River in June, but there was a relatively consistent set between the first week in July and the first week in September (Table 1). Settlement was recorded on at least one station on 13 of the 18 weeks monitored in that interval; however, the set was light on two-thirds of those weekly periods. Heavy sets occurred only at three stations (Dog Shoal, Days Point, and Dry Shoal), simultaneously on the week of July 27. Those same three stations and those at Point of Shoals and Rock Wharf, all on the south-side of the river and above the James River Bridge, received good sets with consistency between the second week in July and the second week in August.

Spatfall was recorded at the farthest station downriver, Nansemond Ridge, on seven of the nine weeks between the first week of July and the first week of September; spat set was light on all but one of those seven weeks. No set was recorded at Deep Water Shoal, on the upper end of the river area monitored, until the third week in July, but from then on spat were found on six of the following eight weeks (a light set each time). Settlement was very intermittent at Wreck Shoal with spatfall recorded on only four of the nine weeks between July and the first week of September. Settlement was recorded as late as the last week in September at one station (Point of Shoals) but spatfall was generally very low and scattered after the first week in September.

Total annual spatfall was much lower in 1994 than in 1993 at all stations in the James River (Table 2, Figs. 2 and 3). It was also much lower than the average for the previous 10 years. At some of the stations, however, total annual spatfall in 1994 was considerably higher than in 1992 (Dog Shoal, Days Point, Dry Shoal and Point of Shoals); at the other stations, spatfall was similar in 1992 and 1994.

❖ *Mobjack Bay*

1994 spatfall in Mobjack Bay was lower than in 1993 except at Tow Stake where it was similar to 1993. Most of the set was confined to the month of July except at the station off Pepper Creek, where it extended into the last week in August. In contrast, most of the spatfall in 1993 occurred between mid-July and the first week in September. Spatfall in 1994 was very light (0.5 or less) on every week. Total annual spatfall in 1994 was also much lower than the 10-year average at all stations.

❖ *York River*

The only shellstring in the York River was located at the VIMS oyster pier. Settlement was lower than in 1993 and much lower than the 10-year average; it was essentially absent throughout the season since setting was recorded only on the last week in July.

❖ *Rappahannock River*

Monitoring of our three stations in the lower Rappahannock River was limited to three weeks between the end of August and the middle of September because of logistical difficulties. No spatfall was recorded during that time period.

❖ *Piankatank River*

This has traditionally been a site of good spatfall, as shown by the 10-year record on Table 2. However, in 1994 spatfall was nearly absent at all stations and was the lowest recorded in the last 15 years.

❖ *Great Wicomico River*

No spatfall was recorded at any of the six stations in the Great Wicomico River in 1994.

❖ *Little Wicomico River*

No spatfall was recorded at the only station in the Little Wicomico River.

❖ *Potomac River*

There was essentially a complete spatfall failure in the Potomac River in 1994. A single spat was found on two occasions during the whole season. This is very similar to what was found in 1993 and 1992. Spatfall at Cornfield in the last three years has been considerably lower than the average for the preceding 10 years.

❖ *Eastern Shore*

With the exception of the Willis Wharf station, spatfall at the Eastern Shore seaside stations was considerably lower in 1994 than in 1993. Spatfall at Willis Wharf was four times higher in 1994 than in 1993. At the two Hog Island Bay stations (Egging Marsh and Crab Hook), spatfall was also lower than the 5-year average, although it was much higher than in 1992 and similar to that recorded in 1990. Spatfall in 1993 was observed with consistency between the middle of July and the end of September at all but one of the stations, The Four Mouths (Chincoteague Middle). Neither that consistency, nor the protracted setting period, was evident in 1994, except at the Willis Wharf station. Spatfall at the two additional stations near Willis Wharf was lower than at Willis Wharf, suggesting that conditions at the Willis Wharf station are conducive to unusually high settlement of oyster larvae.

Discussion

There was a considerable decline in spatfall at almost every station monitored in Virginia in 1994 from what was recorded in 1993. With one exception, total annual spatfall was categorized as light at all stations where any spatfall occurred; the exception was Willis Wharf in the Eastern Shore, where total spatfall was very heavy. At many of the stations, however, particularly those in the Potomac and Great Wicomico rivers, no spatfall was recorded on shellstrings. Spatfall on shellstrings was extremely low, very close to zero, in the Piankatank River.

Those results suggest that there will be minimal recruitment into oyster populations in most Virginia tributaries of the Chesapeake Bay or on the Eastern Shore seaside. The levels of spatfall recorded at many of the stations in the James River and in the Eastern Shore seaside (and to a lesser extent in Mobjack Bay), however, could support a modest recruitment into those oyster populations, if other factors do not subsequently affect adversely survival of spat on the oyster beds. Unusual mortalities or excessive harvesting may easily override the recruitment potential of the 1994 spatfall.

Spatfall on shellstrings has been characterized by significant fluctuations from year to year (Figures 2 and 3). The values recorded in 1994 rank close to the lowest recorded since 1960 for stations monitored since then and those recorded since 1984 at stations with shorter data records. The complex combination of factors that affects spatfall makes it very difficult to explain annual variations, especially when many of the factors are not monitored. However, variations in standing stock of market-size oysters and others close to market size should have a noticeable impact on spatfall because they are the principal storehouse of reproductive material in the population.

Acknowledgments

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TABLE 1

Average number of spat/shell (10 shells) for a ' period starting with the date shown.
(- indicates that no data were obtained for the week)

STATION	Sta. No.	June					July				August					September				October	Total
		1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	
JAMES RIVER																					
Nansemond Ridge	S131	0.0	0.0	0.0	0.0	0.0	0.1	1.4	-	0.0	0.0	0.8	0.2	0.4	0.1	0.1	0.0	0.0	0.0		3.1
Naseway Shoal	S098	0.0	0.0	0.0	0.0	0.0	-	-	0.0	2.5	0.4	0.0	0.2	0.3	0.0	0.0	0.0				3.4
Dog Shoal	S194	0.0	0.0	0.0	0.0	0.0	0.0	2.5	3.6	20.9	1.0	1.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0		30.4
Miles Watch House	S089	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.8	0.0	1.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0		2.2
Days Point	S040	0.0	0.0	0.0	0.0	0.0	0.2	2.0	9.1	24.1	9.0	3.1	1.1	0.4	0.1	0.1	0.0	0.0	0.0		49.2
Rock Wharf	S199	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.9	5.8	2.5	0.7	0.0	0.2	0.0	0.0	0.2	0.0			12.0
Wreck Shoal (Middle)	S274	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.3	-	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0		2.2
Dry Shoal	S195	0.0	0.0	0.0	0.0	0.0	0.2	3.3	6.1	15.3	15.3	-	0.0	0.6	0.2	0.2	0.0	0.1	0.0		41.3
Point of Shoals	S123	0.0	0.0	0.0	0.0	0.0	0.5	1.0	3.5	6.8	1.9	2.4	0.0	0.4	0.3	0.3	0.0	0.0	0.1		17.2
Swash	S096	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.2	1.1	0.5	1.3	0.0	1.1	0.1	0.1					5.5
Horsehead	S073	0.0	0.0	0.0	0.0	0.0	0.2	0.3	1.0	1.1	0.3	0.1	0.0	0.3	0.2	0.2	0.1	0.0	0.0		3.8
Deep Water Shoal	S043	-	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0		0.8
MOBJACK BAY																					
Off Brown's Bay	S017	-	-	-	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.2
Tow Stake	S151	-	-	-	0.0	0.1	0.5	0.1	0.1	0.2	0.3	0.0	0.0	0.1	0.2	0.1	0.0	0.0			1.7
Wilson Creek	S171	-	-	-	0.0	0.0	0.0	0.2	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			1.2
Pultz Bar(East R.)	S046	-	-	-	0.0	0.0	0.1	0.4	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			1.2
Off Pepper Creek	S113	-	-	-	0.0	0.1	0.4	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0			2.1
YORK RIVER																					
VIMS Oyster Pier	S106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.2
PIANKATANK RIVER																					
Three Branches	S150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.1
Burton's Point	S020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0			0.1
Palace Bar	S110	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.9
Ginney Point	S050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
GREAT WICOMICO RIVER																					
Dameron Marsh	S039	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.0
Cranes Creek	S037	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
Hudnall's Dock	S074	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
Haynie Point	S064	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
Glebe Point	S051	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
Fleet Point	S048	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.0
LITTLE WICOMICO RIVER																					
P.G. No. 42	S207	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0

TABLE 1(Continued)

Average number of spat/shell (10 shells) for a 7 day period starting with the date shown.
(- indicates that no data were obtained for the week)

STATION	Sta. No.	June					July				August					September				October	TOTAL
		1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	
RAPPAHANNOCK RIVER																					
Sturgeon Creek	S200	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0				0.0
Locklies Creek	S208	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0				0.0
Windmill Point	S217	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0				0.0
POTOMAC RIVER																					
Gum Bar	S058	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Yates Bar	S246	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Jones Shore	S080	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hog Island	S066	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coan River	S030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Great Neck	S053	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Thicket Point	S149	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cornfield	S035	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Nomini Bay	S101	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Currioman Bay	S224	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Ragged Point	S130	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Lower Machodoc	S225	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
EASTERN SHORE																					
Chincoteague Transect:																					
Willis Point	S237	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0			0.1
The Four Mouths	S238	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Powells Bay	S239	-	-	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.4
Wachapreague Transect:																					
Off Little Wye Ch.	S240	-	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0			0.4
Hummocks Light	S241	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.1
Wachapreague	S156	-	0.0	0.0	0.1	0.1	0.7	2.0	2.8	1.0	0.4	0.0	0.1	0.2	0.3	0.0	0.0	0.0			7.7
Quinby Transect:																					
Mouth Sandy I. Ch.	S231	-	0.0	0.0	0.0	0.0	0.0	0.2	1.2	1.7	0.1	0.1	0.0	0.5	0.1	0.0	0.0	0.0			3.9
Great Gap Ch.	S232	-	0.0	0.0	0.0	0.0	0.1	0.8	0.9	1.9	0.1	0.0	0.1	2.2	0.4	0.2	0.0	0.0			6.7
Off Quinby Marina	S233	-	0.0	0.0	0.0	0.2	0.8	1.3	4.0	5.9	3.8	0.0	0.9	1.1	0.7	0.1	0.0	0.0			18.8
Willis Wharf Transect:																					
Egging Msh(Hog I.N)	S221	-	0.0	0.0	0.0	-	0.4	2.4	2.8	3.5	1.4	0.5	0.1	2.1	1.2	0.2	0.0	0.0			14.6
Crab Hook(Hog I.S)	S222	-	0.0	0.0	0.1	0.0	2.6	6.7	4.0	2.9	0.8	0.3	0.1	1.9	0.1	0.0	0.0	0.0			19.5
Willis Wharf	S228	-	1.1	1.5	5.5	13.8	103.0	94.2	58.5	48.8	103.3	23.5	16.1	13.6	3.6	0.0	0.3	0.6			487.4
Parting Creek	S244	-	-	-	-	-	-	-	-	5.2	4.8	2.2	0.9	2.0							15.1
Mouth Machipongo R.	S245	-	-	-	-	-	-	-	-	-	38.5	3.9	1.9	12.7							57.0
Oyster Transect:																					
N off Man-Boy Ch.	S234	-	0.1	0.1	0.0	0.0	0.1	0.7	0.6	0.2	0.4	0.0	0.1	2.3	0.4	0.1	0.1	0.0			5.2
N off Running Ch.	S235	-	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.6	0.4	0.0	0.0	0.1			1.8
Off Oyster Slip	S236	-	0.0	0.0	0.0	0.1	0.1	0.5	0.6	1.0	0.3	0.2	0.2	1.1	2.4	0.0	0.0	0.2			6.7

TABLE 2

SPATFALL TOTALS FOR YEARS 1984-1994 AND MEAN FOR 1984-1993

Presented as the sum of weekly spat-per-shell values for each year.

(+ and - indicate direction of change in 1994 in reference to 1993 and to 10-Yr Mean; nc = no change)

Location	STA ID.	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Mean 84-93	1994	Change Ref. 1993	Change Ref. Mean
JAMES RIVER															
Nansemond Ridge	S131	15.1	69.7	8.8	18.4	8.9	26.0	40.6	56.5	7.0	13.7	*26.5*	**3.1**	-	-
Naseway Shoal	S098	41.0	465.9	40.0	296.6	18.5	59.4	20.6	179.0	1.9	11.3	*113.4*	**3.4**	-	-
Dog Shoal	S194	38.3	568.8	32.1	356.9	27.5	73.0	34.4	274.8	11.6	58.6	*147.6*	**30.4**	-	-
Miles Watch House	S089	16.7	20.9	9.8	33.7	3.2	4.2	2.4	18.7	3.5	5.2	*11.8*	**2.2**	-	-
Days Point	S040	24.4	120.3	22.3	481.6	17.3	25.9	28.6	146.6	15.7	131.6	*101.4*	**49.2**	-	-
Rock Wharf	S199	38.7	163.5	11.4	285.7	40.9	3.5	17.1	--	11.7	34.4	*60.7*	**12.0**	-	-
Wreck Shoal (Middle*)	S274	21.2	26.3	7.9	35.1	10.0	10.5	5.9	35.4	3.2	15 5	*17.1*	**2.2**	-	-
Dry Shoal	S195	24.0	87.1	16.8	241.5	13.2	10.1	45.8	217.2	14.2	119.0	*78.9*	**41.3**	-	-
Point of Shoals	S123	23.5	31 2	4.6	75.4	9.9	2.1	2.9	21.4	5.4	73.5	*25.0*	**17.2**	-	-
Swash	S096	37.2	38 1	9.2	79.5	7.6	3.8	3.9	68.6		46.2	*32.7*	**5.5**	-	-
Horsehead	S073	28.1	36.0	7.3	100.0	3.7	1.5	1.0	24.6	3.6	43.7	*25.0*	**3.8**	-	-
Deepwater Shoal	S043	2.7	1.1	2.0	30.6	4.3	2.1	3.8	10.8	0.7	15.6	*7.4*	**0.8**	-	-
MOBJACK BAY															
Off Brown's Bay	S017	4.6	7.1	241.1	8.0	2.2	29.9	44.7	40.2	6.3	2.7	*38.7*	**0.2**	-	-
Tow Stake	S151	14.3	2.5	15.7	1.9	5.3	28.8	64.7	16.1	7.7	1.5	*15.9*	**1.7**	+	-
Wilson Creek	S171	39.3	1.7	5.7	2.6	4.8	42.8	101.9	12.1	29.7	5.1	*24.6*	**1.2**	-	-
Pultz Bar (East R.)	S046	14.1	9.4	29.2	8.9	13.1	37.8	64.0	32.0	7.2	3.3	*21.9*	**1.2**	-	-
Off Pepper Creek	S113	18.3	112.5	264.6	40.7	4.7	18.0	74.2	70.1	4.0	3.3	*61.0*	**2.1**	-	-
YORK RIVER															
VIMS Oyster Pier	S106	2.2	20.5	165.2	25.0	7.1	5.4	14.4	18.7	2.2	1.1	*26.2*	**0.2**	-	-

TABLE 2 (Continued)

Location	STA ID.	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Mean	1994	Change Ref. 1993	Change Ref. Mean
PIANKATANK RIVER															
Three Branches	S150	17.6		97.9	64.9	1.7	22.5	55.7	19.7	4.6	1.5	*31.8*	**0.1**	-	-
Burton Point	S020	38.8	85.7	252.8	43.9	4.7	31.6	102.1	16.3	4.3	6.5	*58.7*	**0.1**	-	-
Palace Bar	S110	59.7	124.5	376.5	243.9	9.1	42.3	139.9	39.1	24.9	5.9	*106.6*	**0.9**	-	-
Ginney Point	S050	126.6	82.7	204.2	133.3	5.6	30.0	85.6	25.2	11.9	1.7	*70.7*	**0.0**	-	-
GREAT WICOMICO RIVER															
Dameron Marsh	S039	0.9	8.6	43.3	29.1	59.3	6.1	29.2	11.0	0.7	1.2	*18.9*	**(0.0)** **	****	
Cranes Creek	S037	1.3	6.3	121.6	30.5	17.4	11.7	39.1	10.7	0.3	0.2	*23.9*	**0.0**	-	-
Hudnall's Dock	S074	3.3	14.2	237.6	50.8	61.8	28.4	119.6	7.0	1.2	0.9	*52.5*	**0.0**	-	-
Haynie Point	S064	0.7	7.6	170.8	10.5	57.4	20.1	67.9	13.6	1.5	1.6	*35.2*	**0.0**	-	-
Glebe Point	S051	2.2	10.9	364.6	23.6	27.1	9.1	19.8	3.8	0.9	0.2	*46.2*	**0.0**	-	-
Fleet Point	S048	1.7	78.4	42.8	157.9	10.1	9.0	18.1	10.1	7.4	2.4	*33.8*	**0.0**	-	-
LITTLE WICOMICO RIVER															
P.G. No. 42	S207						0.2	5.2	4.8	0.0	0.3	*2.1*	**0.0**	-	-
RAPPAHANNOCK RIVER															
Sturgeon Creek	S200			21.6	1.1	1.7	1.7	--	12.7	0.4	0.6	*4.9*	**(0.0)** **	****	
Locklies Creek	S208			27.7	2.8	3.3	2.4	4.6	25.5	0.3	0.5	*8.4*	**(0.0)** **	****	
Windmill Point	S217				45.9	1.4	1.0	98.5	23.4	0.4	0.0	*24.3*	**(0.0)** **	****	

TABLE 2 (Continued)

Location	STA ID.	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Mean	1994	Change Ref. 1993	Change Ref. Mean
POTOMAC RIVER															
Gum Bar	S058										0.0	***	—		
Yates Bar	S246										0.0	***	—		
Jones Shore	S080	0.7	20.6	16.2	27.2	3.8	0.1	0.4	8.2	0.3	0.0	*7.8*	**0.0**	nc	-
Hog Island	S066	0.3	1.7	4.8	1.8	0.0	0.1	0.2	0.4	0.1	0.1	*1.0*	**0.0**	-	-
Coan River	S030	0.0	0.0	10.8	0.0	0.4	0.0	0.1	0.3	0.0	0.0	*1.2*	**0.0**	nc	-
Great Neck	S053	0.0	5.2	6.4	1.9	1.4	0.0	0.2	1.1	0.1	0.0	*1.6*	**0.1**	+	-
Thicket Point	S149	0.1	0.2	5.0	0.3	0.6	0.0	0.2	1.4	0.1	0.0	*0.8*	**0.0**	nc	-
Cornfield	S035	0.2	29.5	3.6	49.6	6.7	1.8	8.9	50.5	0.3	0.2	*15.1*	**0.1**	-	-
Nomini Bay	S101									0.0	0.0	***	**0.0**	nc	
Currioman Bay	S224									0.0	0.0	***	**0.0**	nc	
Ragged Point	S130									0.0	0.0	***	**0.0**	nc	
Lower Machodoc	S225									0.0	0.0	***	**0.0**	nc	
EASTERN SHORE SEASIDE															
Chincoteague Transect:															
Willis Point	S237										4.1	***	**0.1**	-	
The Four Mouths	S238										1.7	***	**0.0**	-	
Powells Bay	S239										13.9	***	**0.4**	-	

TABLE 2 (Continued)

Location	STA ID.	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Mean	1994	Change Ref. 1993	Change Ref. Mean
EASTERN SHORE (Continued)															
Wachapreague Transect:															
Off Little Wye Channel	S240										9.9	***	0.4	-	
Hummocks Light	S241										4.0	***	0.1	-	
Wachapreague	S156	56.4	31.9	66.7	29.7	47.1	144 1	211.4	287.4	61.1	105.7	*104.2*	7.7	-	
Quinby Transect:															
Mouth Sandy I. Channel	S231										28.3	***	3.9	-	
Great Gap Channel	S232										16.1	***	6.7	-	
Off Quinby Marina	S233										77.0	***	18.8	-	
Willis Wharf Transect:															
Egging Marsh (Hog Is. N)	S221						49 9	21 2	109.7	0.4	39.9	*44.2*	14.6	-	-
Crab Hook (Hog Is. S)	S222						48.7	14.2	67.4	1.7	53.5	*37.1*	19.5	-	-
Willis Wharf	S228										108.6	***	487.4	+	
Parting Creek	S244										--	***	(15.1) **	****	
Mouth Machipongo R.	S245										--	***	(57) **	****	
Oyster Transect:															
N off Man-Boy Channel	S234										24.9	***	5.2	-	
N off Running Channel	S235										7.9	***	1.8	-	
Off Oyster Slip	S236										89.3	***	6.7	-	

* Wreck Shoal station located between Wreck Shoal Inshore and Wreck Shoal Offshore since 1982.

** Parentheses indicate that few weekly data were collected in 1994.

*** Mean not computed for fewer than 5 years.

**** Comparisons not made because few weekly data were collected in 1994.

SHELLSTRING SURVEY STATIONS

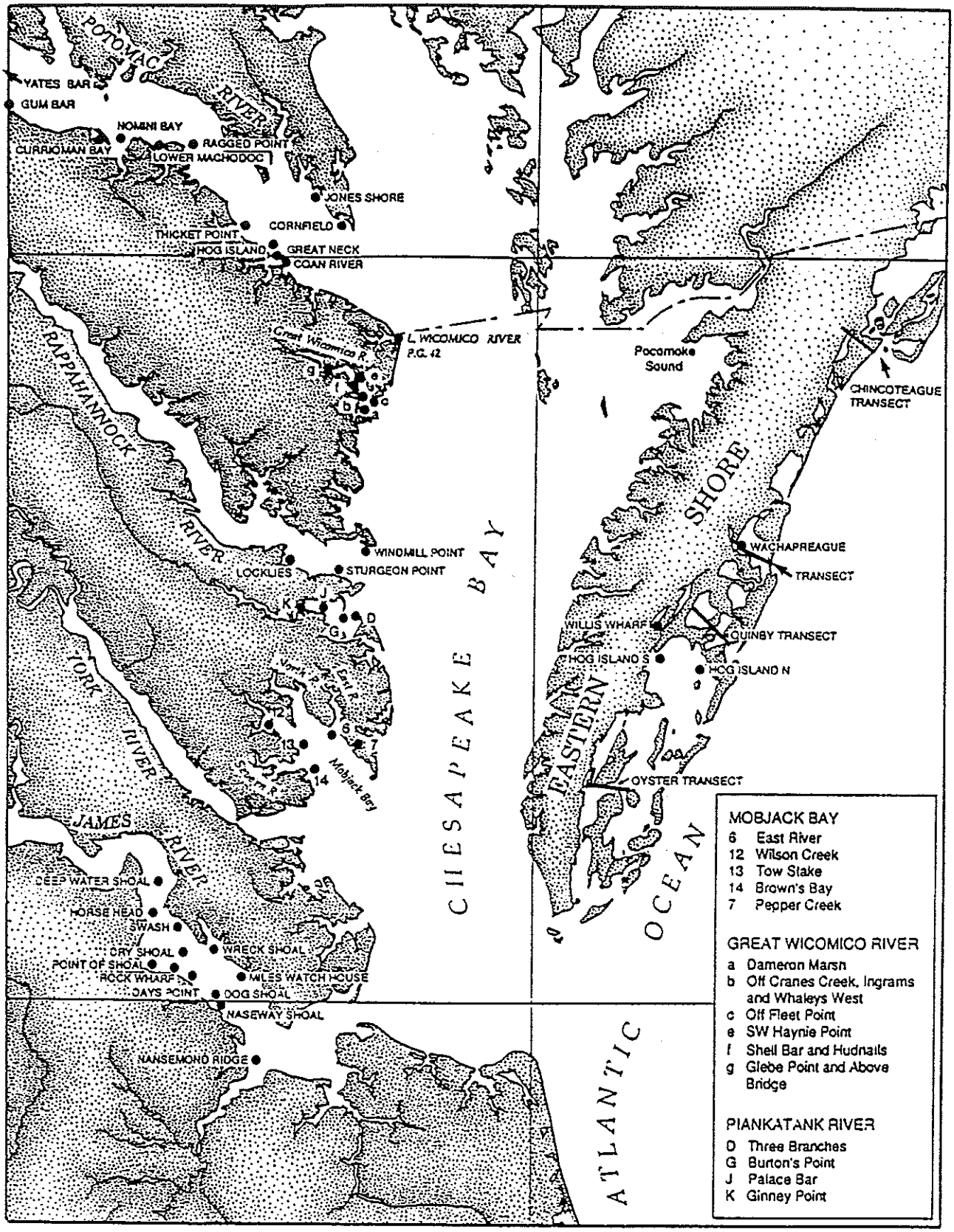

Figure 1. Location of shellstring stations.

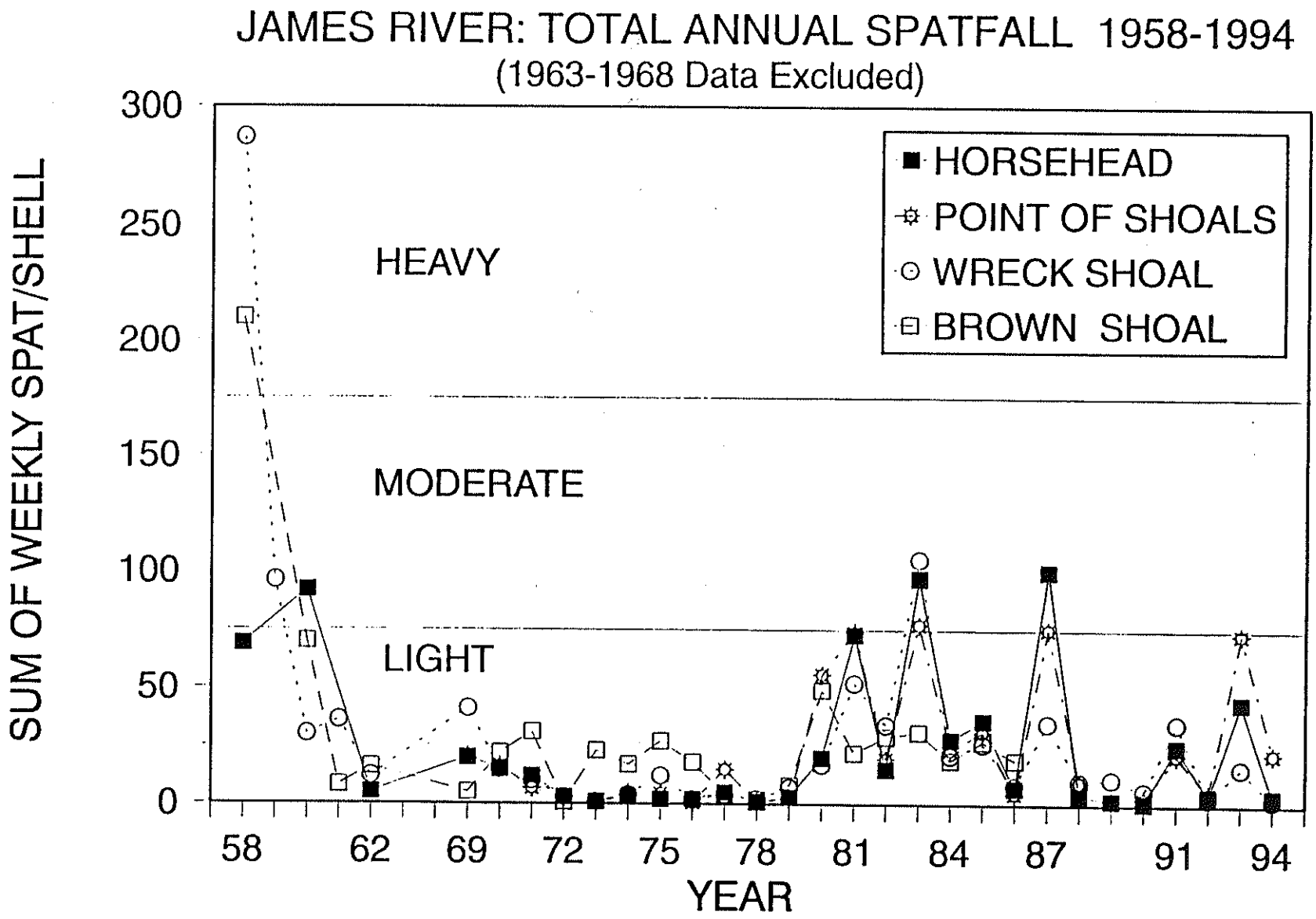

Figure 2. Total annual spatfall (expressed as the sum of weekly spat/shell values) at four shellstring stations in the James River, 1958-1993. Stations selected for the length of their data records. Spatfall intensity categories created for comparative purposes. Values for 1963-1968 omitted; may be obtained from 1993 report.

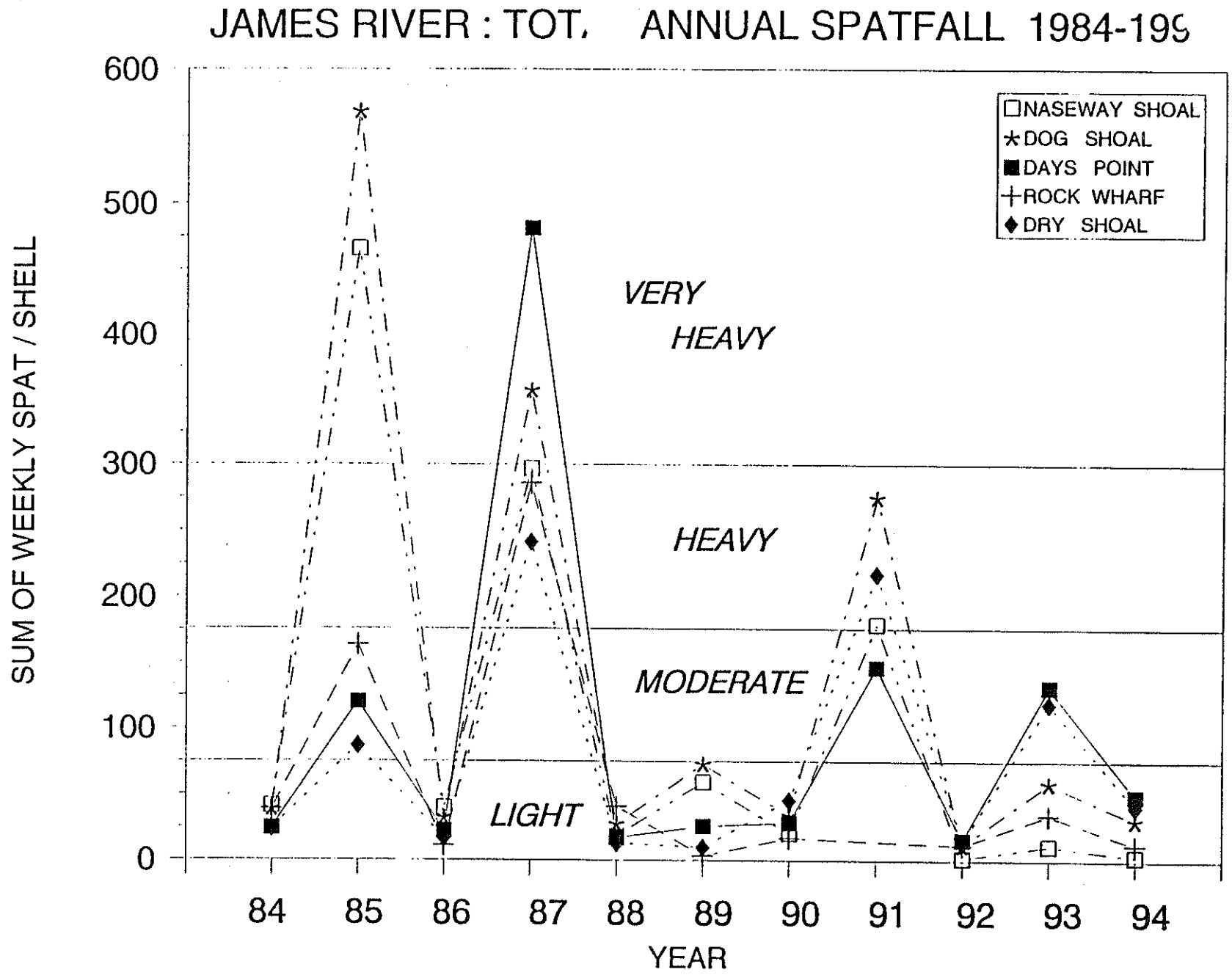

Figure 3. Total annual spatfall (expressed as the sum of weekly spat/shell values) at five shellstring stations with the highest values in the past 10 years, all on the south side of the James River and upriver from the James River bridge. Spatfall intensity categories created for comparative purposes. No data collected for Rock Wharf in 1991.

Part II. Survey of Selected Oyster Bars In Virginia — 1994

Introduction

Oysters have been harvested from Virginia waters as long as humans have inhabited the area. Depletion of natural stocks in the late 1880s led to the establishment of regulations by public fisheries agencies. A survey of bottom areas in which oysters grew naturally was completed in 1896 under the direction of Lt. Baylor, USN. These areas (over 243,000 acres) were set aside by legislative action for public use and have come to be known as the Baylor Survey Grounds or Public Oyster Grounds of Virginia, and are presently under management by the Virginia Marine Resources Commission (VMRC).

Twice a year, in May and October, the Virginia Institute of Marine Science (VIMS) conducts a survey of selected public oyster bars in Virginia tributaries of the western Chesapeake Bay for the purpose of assessing the status of the resource. Surveys conducted in the spring concentrate on grounds that are currently productive and provide information about over-winter mortality and relative fishing pressure from the previous harvesting season.[1] Surveys conducted in the fall provide information about spatfall and recruitment, summer (disease) mortality,[2] and the status of each shoal as a source of seed or market oysters at the start of the harvesting season.

This section summarizes the findings of the bar surveys conducted in 1994, between 18 and 24 May, and between 30 September and 28 October.

Methods

Three 0.5 bushel (25 quart) samples of bottom material were taken at each bar using a 24-inch dredge having 4-inch teeth. The bars sampled are shown in Figure 1. Geographic coordinates are given in Table 1.

The following data were obtained for each sample: number of market oysters (greater than 3 inches in shell height), number of small oysters (submarket size), number of spat (1993 recruits), number of recent boxes (inside of shells relatively clean; dead for approximately a month or less), and number of old boxes (inside of shells dirty; dead for longer than a month). The data are presented as the average for the three or four samples collected at each station; those averages were rounded off to the nearest whole number and because of that the total number of oysters given does not always match the sum of the averages. Water samples were obtained just off the bottom at each location for temperature and salinity determination.

Data were summarized for each bar as the average number of market, small, spat, and total oysters per bushel of bottom material dredged up. Percent recent mortality was calculated as: [recent boxes and gapers / live oysters + recent boxes and gapers] x 100.

[1]Oysters are usually harvested from public grounds in Virginia between 1 October and 1 June with the exception of the seaside of the Eastern Shore, where harvesting is usually restricted to the period from 1 November to 1 April.
[2]Complete disease data, including prevalence and intensity of both MSX (*Haplosporidium nelsoni*) and Perkinsus (*Perkinsus marinus*) in Virginia waters, are available from Eugene M. Burreson of the VIMS disease monitoring program.

Results

A. Spring Survey

Spring survey sampling stations were located in the primary harvesting areas of the public grounds in the upper James River and the upper Rappahannock River.

Results of this survey are summarized in Table 2.

❖ *James River*

Eight oyster bars were sampled in the James River on May 18 and 19, 1994. Bottom temperature at stations sampled on May 18 ranged between 18.0 and 19.0°C and bottom salinity ranged between 18 and 19 ppt; at stations sampled on May 19 temperature ranged between 16.9 and 17.5°C and salinity ranged between 16.9 and 17.5 ppt.

The average number of market oysters at Mulberry Point (69) was significantly higher than at any of the other stations but not different from the number at Deep Water Shoal (66). Numbers at Horsehead, Point of Shoals, Long Rock and Swash ranged from 29 and 45 per bushel. The average number at Dry Shoal and Wreck Shoal (3 and 8) was significantly lower than at any of the other stations.

The highest concentration of submarket oysters ("small oysters") were found at Deep Water Shoal, Mulberry Point, Horsehead and Point of Shoals where the average number per bushel ranged from 469 and 686. The average number at Long Rock and the Swash was lower than at the above four stations (361 and 273). Dry Shoal and Wreck Shoal had considerably fewer small oysters (78 and 63) than any of the other stations.

A large variability between samples collected at Long Rock made the average number of spat at that station (284) statistically indistinguishable from the average at all the other stations. Apart from that, the highest average number of spat from the 1993 set was found at Deep Water Shoal (510). The average number at Mulberry Point, Horsehead, Long Rock, Dry Shoal and Wreck Shoal ranged from 200 to 296; it was slightly lower at the Swash (123). The lowest average number of spat per bushel was recorded at Point of Shoals (62).

Average number of new boxes per bushel was highest at Long Rock (76) and ranged from 18 to 54 at six of the other seven bars; average number was lowest at Point of Shoals (7). Recent (new) mortality (based on the average density of new boxes and of the average number of oysters, including spat) was very low at all bars sampled in the James River; it ranged from 1.3 percent at Point of Shoals to 10.0 percent at Long Rock.

Average number of old boxes was highest at Wreck Shoal (85 per bushel); it ranged from 41 to 55 at Horsehead, Long Rock and Dry Shoal and was lowest at Swash, Point of Shoals, Deep Water Shoal and Mulberry Point (16 to 23 per bushel).

❖ *Rappahannock River*

Five oyster bars in the upper part of the Rappahannock River estuary were surveyed on May 24, 1994.

Bottom water temperature ranged from 19.9 to 22.5°C. Water salinity ranged between 4 ppt at Ross Rock and 7 ppt at Morattico Bar and Smokey Point.

Average number of oysters in all three size categories were much lower at the Rappahannock River bars than at most of the bars in the James River. The highest densities of market oysters found in the Rappahannock were 19 and 15 per bushel at Bowlers Rock and Long Rock; 9 per bushel were found at Morattico Bar and only 3 and 1, respectively, at Smokey Point and Ross Rock.

Average number of small oysters was highest (33 and 27 per bushel) at Bowlers Rock and Ross Rock and lowest (6 and 9 per bushel) at Morattico Bar and Smokey point; the number at Long Rock was intermediate (13 per bushel).

No oyster spat were found at four of the five bars sampled and the average number per bushel at Ross Rock was very low (8).

No new boxes were found at three of the five bars sampled. Average number was very low at Bowlers Rock (2 per bushel) and relatively low at Ross Rock (16 per bushel). Recent (new) mortality was likewise non-existent or very low (3.7 percent) at four of the stations. At Ross Rock, recent mortality was fairly high (30.8 percent).

Average number of old boxes per bushel was also low at all bars, but at some, the numbers represented a substantial percentage when compared with the average total number of live oysters (45 percent at Smokey Point and 29 percent at Ross Rock).

B. Fall Survey

Twenty-seven oyster bars were sampled from six of the major tributaries of the western Chesapeake Bay in Virginia between 30 September and 28 October 1994.

Results of this survey are summarized in Table 3.

❖ *James River*

Seven bars were sampled in the James River, between Nansemond Ridge at the lower end of the river and Horsehead in Burwell Bay.

Total count per bushel of oysters of all sizes approached the count traditionally considered good for seed transplantation (700) only at Horsehead where it was 617. At all other stations, total counts were far below that level: they ranged from 221 to 399 at Long Rock, Point of Shoals, Dry Shoal and Wreck Shoal and from 51 to 73 at Thomas Rock and Nansemond Ridge.

The number of market oysters per bushel of bottom cultch was generally low throughout the river. The highest average number of market oysters (56) was found at Point of Shoals. Average number at the other stations were much lower and well below desired levels for harvest. They ranged from 8 to 26 at Wreck Shoal, Long Rock and Horsehead, and from 0 and 1 at Dry Shoal, Thomas Rock and Nansemond Ridge.

The number of small oysters per bushel exceeded 300 only at Horsehead (449). Counts at Long Rock and Point of Shoals were just below 300 at 272 and 245. At Wreck Shoal and Dry Shoal, counts averaged between 100 and 200 and at Thomas Rock and Nansemond Ridge average counts were very low (23 and 10).

Average number of spat per bushel was also low at all stations. They ranged from 111 to 143 at Horsehead, Dry Shoal, Long Rock and Wreck Shoal, and from 40 to 49 at Point of Shoals, Thomas Rock and Nansemond Ridge.

The average number of new boxes per bushel of bottom material was low at all stations, ranging from 12 at Thomas Rock to 3 at Horsehead and Nansemond Ridge. The number of old boxes was also relatively low; it ranged from 20 to 35 per bushel at Thomas Rock, Dry Shoal, Long Rock and Wreck Shoal, and from 8 to 10 at Point of Shoals, Nansemond Ridge and Horsehead.

❖ *York River*

The total number of oysters at the two bars sampled in the middle and upper parts of the York River on October 25 ranged from 3 to 6 with no market oysters found. Only one new box was found at each station and no old boxes were recorded.

❖ *Mobjack Bay*

The only oysters found at the two bars sampled in Mobjack Bay on October 24, 1994 were one market and one small at Pultz Bar and two spat at Tow Stake resulting in fractional averages which rounded off to 1 for the average total in each case. No new boxes were found at either bar and only two old

boxes were found at Pultz Bar, averaging a fraction which rounded off to 1.

❖ *Piankatank River*

The average total number of oysters per bushel at the three bars sampled in the Piankatank River on October 28, 1994 ranged from 38 to 92 and consisted of mostly small oysters. Only three market oysters were found (at Burton's Point) and the average number of spat ranged from 2 to 23. The average number of small oysters ranged from 36 to 78.

The average number of new boxes was low at the three bars; the number of old boxes was also low at Ginney Point and Burton's Point but it was moderately high at Palace Bar.

❖ *Rappahannock River*

Ten oyster bars were sampled in the Rappahannock River (including one in the Corrotoman River) between October 12 and 17, 1994. They extended from off Broad Creek near the mouth of the river to Ross Rock near the upriver limit of oysters. Bar locations are given in Table 1.

Very few oysters were found at any of the bars sampled. The only significant number of oysters was found at the public ground off the mouth of Broad Creek (a total of 104). At the other stations, the average total number ranged between 2 and 30. The bars with the lowest total numbers were Morattico Bar, Smokey Point and Hog House (2 to 5).

The average number of market oysters off Broad Creek was 19. At the other bars it ranged from 0 to 9 per bushel. The highest average number of small oysters was 74 off Broad Creek and at all other bars it ranged from 0 to 24. The average number of spat per bushel was very low at all bars, ranging from 0 to 11.

The number of new and old boxes was low at all bars. No new boxes were found at nine of the ten bars sampled and the number of old boxes ranged from 2 to 8.

❖ *Great Wicomico River*

The average number of oysters per bushel was low at the three bars sampled in the Great Wicomico River on October 21, 1994. It consisted mostly of small oysters with average counts between 50 and 77. Average number of market oysters ranged from 0 to 3 and the number for spat was between 3 and 4 per bushel.

Discussion

❖ *Market Oysters*

Only oysters larger than 3 inches are counted as market oysters in VIMS bar surveys. This maintains consistency in the data collected because VIMS data pre-date the current 2-1/2-inch standard by many years. The 3-inch standard is, therefore, the only valid comparative measure of changes in abundance of market-size oysters over an extended number of years.

The greatest concentration of market oysters on the public grounds of the western side of the Chesapeake Bay in Virginia in recent years has been found at the upper limits of oyster distribution (lower salinity areas) in the James River and the Rappahannock River. Since 1986, there has been a continuous decline in abundance of market oysters in those areas to levels of 20 per bushel or less which can be considered commercially negligible (Figures 2 and 3). That is an indication of natural populations adversely affected by factors such as diseases and harvesting pressure.

In the Rappahannock River, the decline has continued to the present. In the James River, however, there was a slight recovery in the fall of 1993 and the spring of 1994, but no statistically detectable change is evident from our surveys in the fall of 1994 at the stations sampled in those three surveys (Horsehead Point of Shoals, Long Rock, Dry Shoal, and Wreck Shoal; Figure 4). Market oysters were absent or their numbers extremely low in the York, Piankatank and Great Wicomico rivers and in Mobjack Bay.

Thus, the James River bars above Wreck Shoal continue to be the only public grounds in Virginia, on the western side of the Chesapeake Bay, where oysters can survive the effect of diseases to reach market size in substantial numbers and, consequently, those bars also constitute the primary repository of potential oyster reproduction and recruitment in Virginia. The number of market oysters found there at present are still low; they represent on the average only 4% of the total number of oysters present (with a maximum of 16% at Point of Shoals). Natural mortality of oysters on those bars, attributable to diseases or low salinity, has been negligible in recent years (see VIMS annual reports on status of the resource). That leaves harvesting pressure as the factor most likely to limit the number of oysters that reach market size in the James River bars above Wreck Shoal.

❖ *Small Oysters*

Oyster bars above Wreck Shoal in the James River are also presently the only ones in Virginia public grounds on the western side of the Chesapeake Bay with abundant numbers of small oysters (Figure 5). Average numbers above 400 per bushel (a level traditionally considered attractive to industry concerns) have been recorded frequently in recent years and at Horsehead they have been as high as 1100. Since 1992, however, there has been a declining trend in

small oyster numbers in the James River. The average number at some of the most productive bars, such as Horsehead, Point of Shoals and Long Rock, was statistically lower in the fall of 1994 than in the spring of 1994 and the fall of 1993 (Figure 6). The decline is likely due to increased harvesting of seed from those bars and should be of concern in development of management strategies.

No small oysters were found in Mobjack Bay in the fall of 1994 and they were very scarce in the York River. Average numbers in the Rappahannock River have been very low since 1986, averaging less than 100 per bushel or slightly more (Figure 7). Although the number of small oysters in the Piankatank and Great Wicomico rivers has reached a 300 per bushel average several times since 1986 (500 at Haynie Point in the Great Wicomico in 1986), they have been around 100 per bushel since 1992 (Figure 7).

❖ *Oyster Spat*

Spat are juvenile oysters that have been recruited into the population within the few months included in the summer spawning season. They are important as potential seed oysters (in 1-3 years) and market oysters (in 3-5 years), depending on growth rates and survival.

The number of spat found on bottom cultch from the James River in the fall of 1994 was much higher than at any of the other rivers surveyed on the western side of the Chesapeake Bay, and reflects the greater abundance of oysters on James River bars. Nevertheless, the numbers found in the James River approach the lowest numbers recorded at Burwell Bay stations in the last 30 years (Figure 9). It is evident from these data that recruitment of new oysters into the remaining productive bars in the James River has been low in the last three years and that active management strategies may be helpful in enhancing future recruitment. Numbers of spat on bottom cultch in the Piankatank and Great Wicomico rivers were also the lowest recorded since 1986 at the stations sampled (Figures 9 and 10).

❖ *Mortality*

Recent mortalities observed at all stations sampled in the fall of 1994 were low, the highest being under 17%.

TABLE 1

STATION LOCATIONS FOR SPRING AND FALL SURVEYS

STATION	LATITUDE	LONGITUDE
JAMES RIVER		
Deep Water Shoal	37 08.8	76 38.1
Horsehead	37 06.3	76 37.9
Point of Shoals	37 04.5	76 38.7
Long Rock	37 04.6	76 37.1
Dry Shoal	37 03.5	76 36.1
Wreck Shoal	37 03.7	76 34.3
Thomas Rock	37 01.5	76 29.5
Nansemond Ridge	36 55.5	76 27.2
MOBJACK BAY		
Pultz Bar	37 21.1	76 21.1
Tow Stake	37 20.2	76 23.7
PIANKATANK RIVER		
Ginney Point	37 32.0	76 24.2
Burton's Point	37 30.9	76 19.7
RAPPAHANNOCK RIVER		
Ross Rock	37 54.0	76 47.5
Bowlers Rock	37 49.5	76 44.0
Long Rock	37 48.9	76 42.9
Morattico Bar	37 46.9	76 39.3
Smokey Point	37 43.2	76 34.8
Hog House Bar	37 38.4	76 33.2
Drumming Ground	37 38.7	76 27.5
Parrot Rock	37 36.4	76 25.2
Off Broad Creek	37 34.6	76 18.4
CORROTOMAN RIVER		
Middle Ground	37 41.0	76 28.4
GREAT WICOMICO RIVER		
Haynie Point	37 49.8	76 18.7
Whaley's East	37 48.3	76 17.8
Fleet Point	37 48.6	76 17.3

TABLE 2

RESULTS OF PUBLIC OYSTER GROUNDS SURVEY - SPRING 1994

STATION	COLL DATE	TEMP. (C)	SAL (ppt)	AVERAGE NUMBER OYSTERS PER BUSHEL				BOXES PER BUSHEL		PCT. NEW MORT
				Market	Small	Spat	Total	New	Old	
JAMES RIVER										
Deep Water Shoal	5/19	17.5	4	66	566	510	1142	54	18	4.5
Mulberry Point	5/19	17.5	4	69	522	229	819	29	23	3.4
Horsehead	5/19	17.1	5	34	686	289	1009	35	41	3.3
Point of Shoals	5/19	16.9	6	45	469	62	577	7	16	1.3
Long Rock	5/18	19.0	5	36	361	284	681	76	49	10.0
Dry Shoal	5/18	19.0	6	3	78	296	377	26	55	6.5
Swash	5/18	19.0	7	29	273	123	425	34	16	7.4
Wreck Shoal	5/18	18.0	8	8	63	200	270	18	85	6.3
RAPPAHANNOCK R.										
Ross Rock	5/24	22.5	4	1	27	8	36	16	15	30.8
Bowlers Rock	5/24	20.5	5	19	33	0	53	2	7	3.7
Long Rock	5/24	19.9	6	15	13	0	27	0	6	0.0
Morattico Bar	5/24	19.9	7	9	6	0	15	0	9	0.0
Smokey Point	5/24	19.9	7	3	9	0	12	0	10	0.0

Discrepancies in Total Oysters per Bushel due to rounding off decimal averages to whole numbers.

TABLE 3

RESULTS OF PUBLIC OYSTER GROUNDS SURVEY - FALL 1994

STATION	COLL DATE	TEMP. (C)	SAL. (ppt)	AVERAGE NUMBER OYSTERS PER BUSHEL				BOXES		PCT. NEW MORT
				Markt	Small	Spat	Total	New	Old	
JAMES RIVER										
Horsehead	9/14	25.0	10							
	9/30	21.9	10.3	26	449	143	617	3	10	0.4
	10/18	18.0	15							
Long Rock	9/30	21.8	12.3	17	272	110	399	10	27	2.4
Wreck Shoal	9/14	25.0	14							
	9/30	21.6	16.8	8	101	111	221	14	35	5.8
	10/18	17.0	18							
Point of Shoals	9/14	24.0	11							
	10/7	13.6	15.9	56	245	49	351	5	8	1.4
	10/18	17.9	14							
Dry Shoal	10/7	18.8	17.4	1	163	111	275	10	26	3.5
Thomas Rock	10/5	19.5	21							
	10/7	–	–	1	23	49	73	12	20	14.5
Nansemond Ridge	10/7	17.7	20.7	0	10	40	51	3	9	5.0
YORK RIVER										
Bell Rock	10/25	16.1	12.5	0	3	3	6	1	0	10.0
Aberdeen Rock	10/25	15.3	17.8	0	3	1	3	1	0	16.7
MOBJACK BAY										
Pultz Bar	10/24	14.6	21.7	0	0	0	1	0	1	0.0
Tow Stake	10/24	15.8	20.0	0	0	1	1	0	0	0.0
PIANKATANK R.										
Ginney Point	10/28	–	15	0	36	2	38	0	0	0.0
Palace Bar	10/28	–	16	0	78	14	92	5	20	4.8
Burton's Point	10/28	–	17	1	64	23	88	5	7	5.0
RAPPAHANNOCK R.										
Ross Rock	10/12	13.8	10.4	0	12	0	12	0	8	0.0
Bowlers Rock	10/12	15.0	11.3	9	13	0	21	0	5	0.0
Long Rock	10/12	17.0	11.8	9	6	0	14	0	2	0.0
Morattico Bar	10/13	17.7	13.5	2	0	0	2	0	4	0.0
Smokey Point	10/13	12.3	15.8	2	2	1	4	0	3	0.0
Hog House Bar	10/17	12.0	15.6	1	4	0	5	0	2	5.9
Drumming Ground	10/17	17.5	15.3	0	8	3	11	0	2	0.0
Parrot Rock	10/17	17.0	15.2	0	24	6	30	0	5	1.1
Off Broad Creek	10/17	15.8	15.7	19	74	11	104	2	6	1.6
CORROTOMAN R.										
Middle Ground	10/17	16.8	14.7	0	12	2	14	0	3	0.0
GREAT WICOMICO R.										
Haynie Point	10/21	16.3	17.5	0	77	4	81	1	4	0.8
Whaley's East	10/21	13.8	16.8	1	54	3	58	5	16	7.4
Fleet Point	10/21	15.0	17.3	3	50	3	56	1	12	1.8

Discrepancies in Total Oysters per Bushel due to rounding off of fractional averages.

OYSTER BAR SURVEY STATIONS

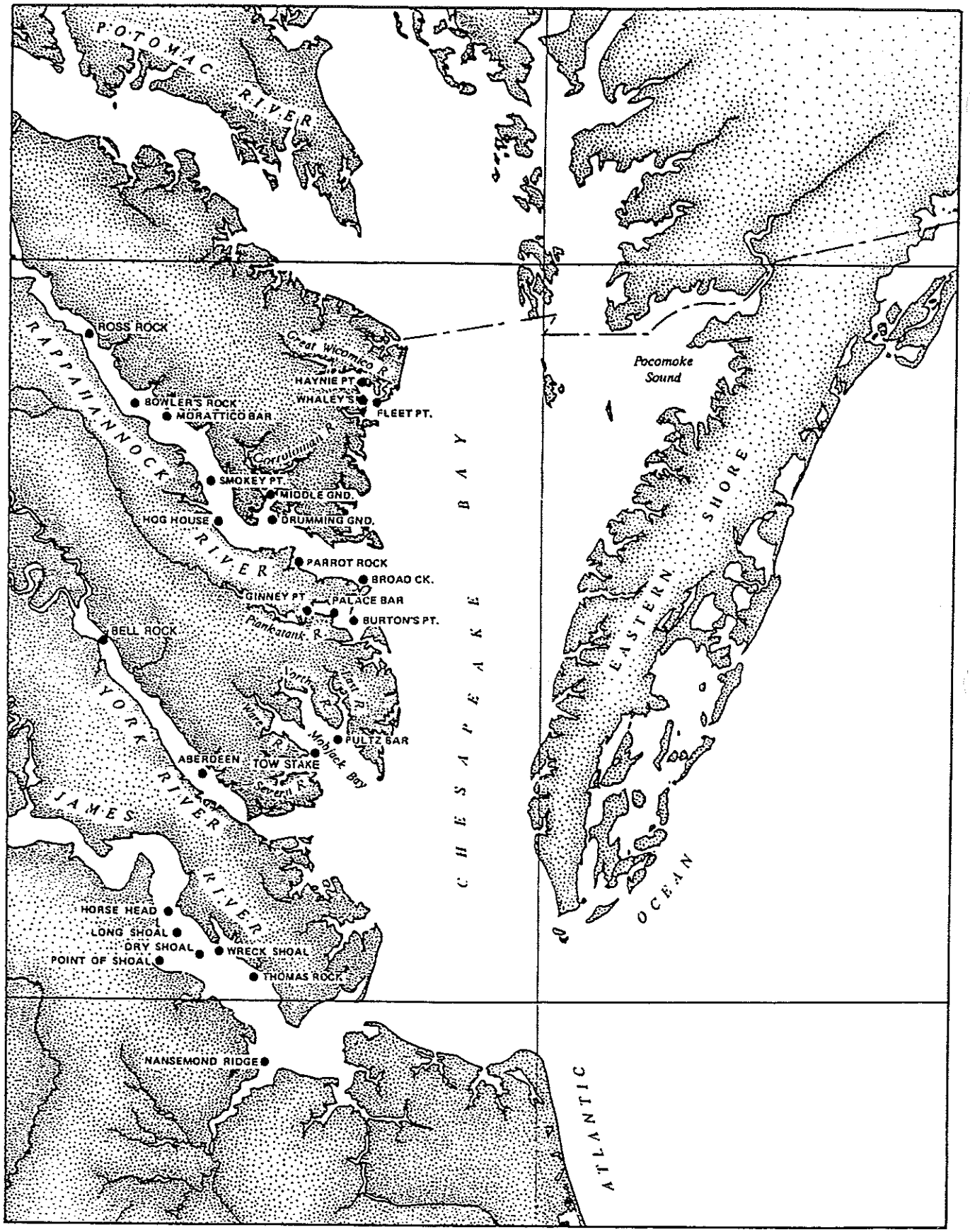

Figure 1. Location of oyster bars sampled.

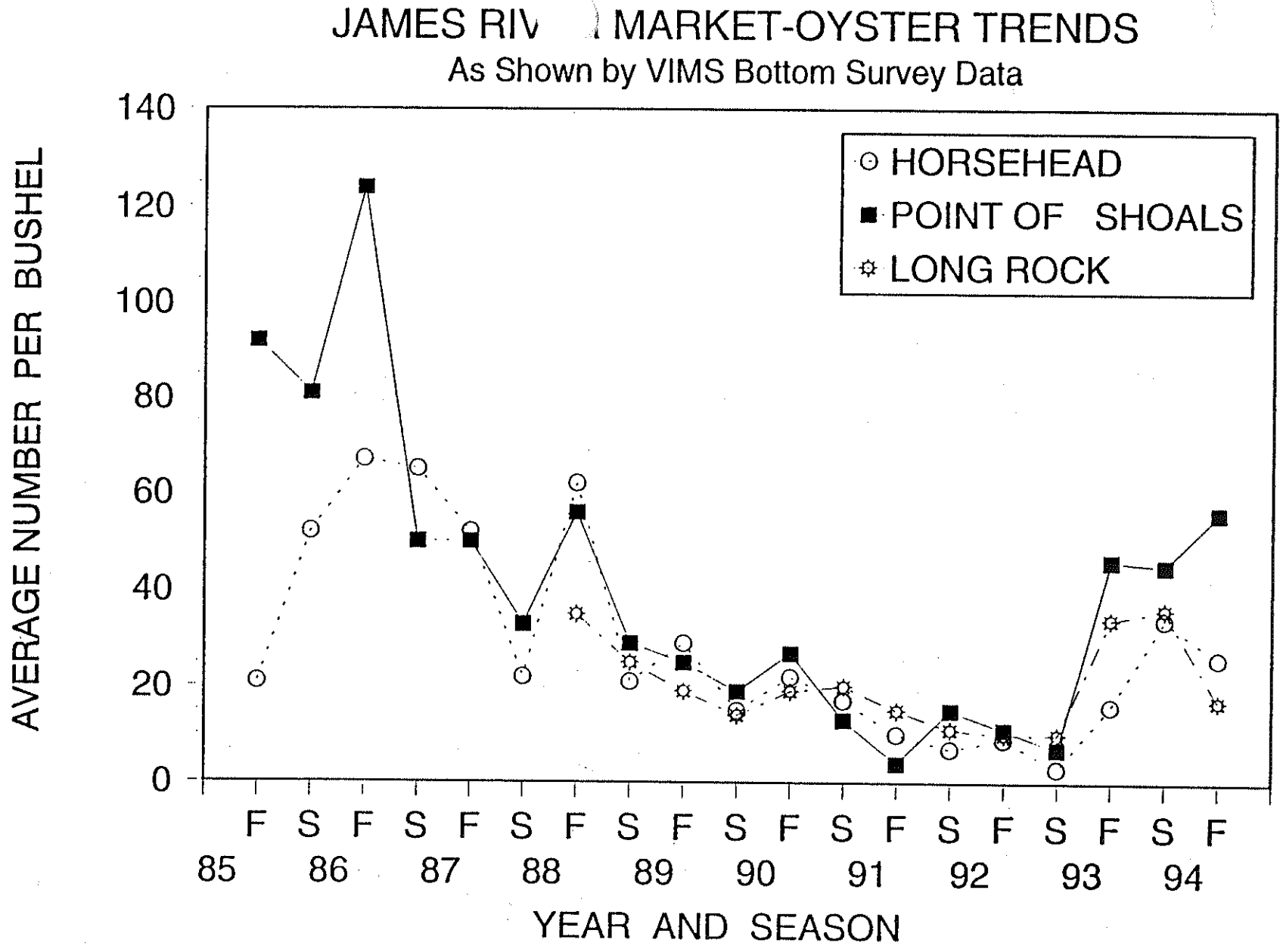

Figure 2. Trend in abundance of market oysters at three stations in the James River sampled during VIMS oyster bottom surveys in the spring and fall of successive years between 1985 and 1994. Spring samples usually collected in May and fall samples usually collected in October. F=Fall, S=Spring.

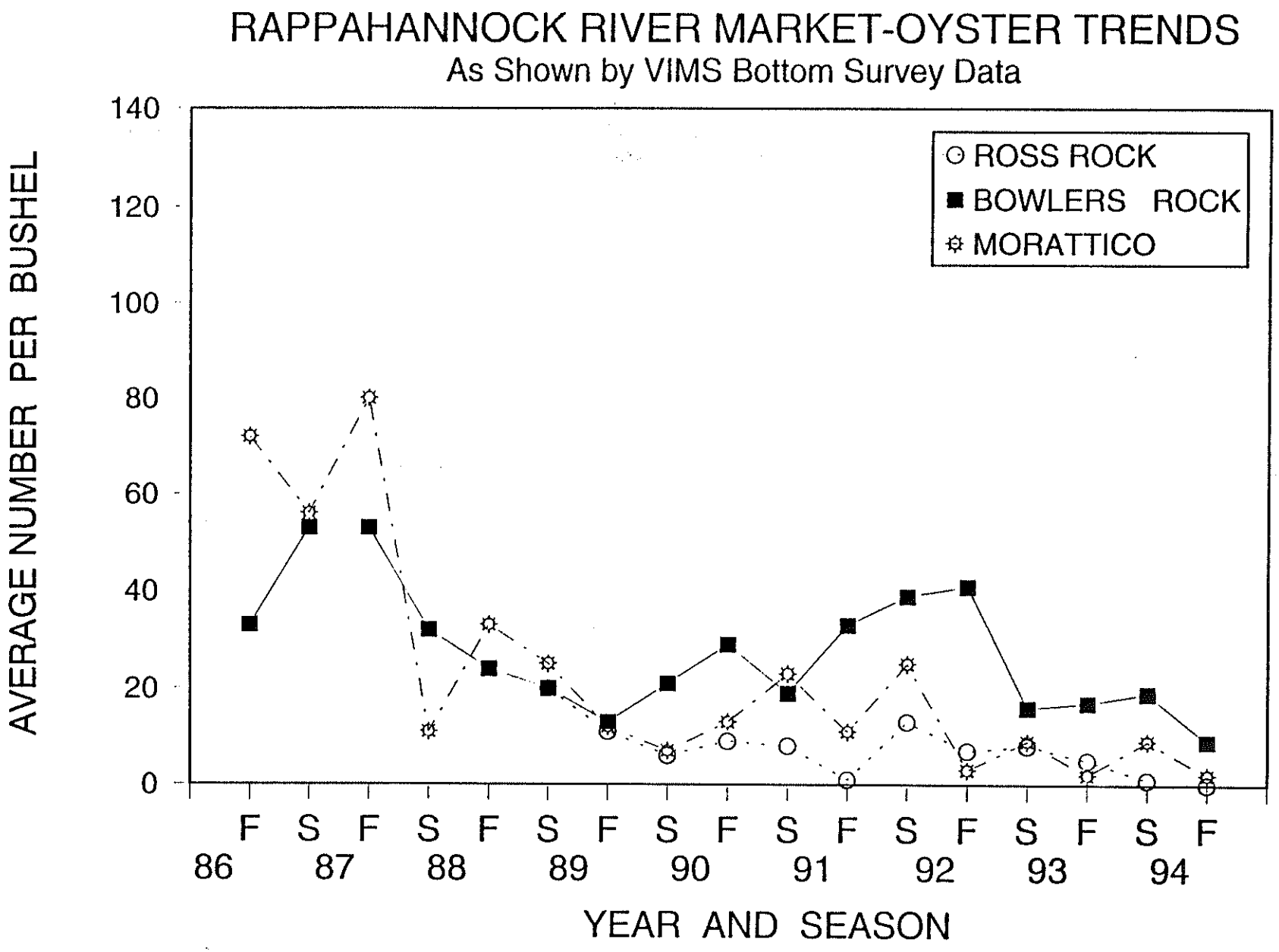

Figure 3. Trend in abundance of market oysters at three stations in the Rappahannock River sampled during VIMS oyster bottom surveys in the spring and fall of successive years between 1986 and 1994. Spring samples usually collected in May and fall samples usually collected in October. F=Fall, S=Spring.

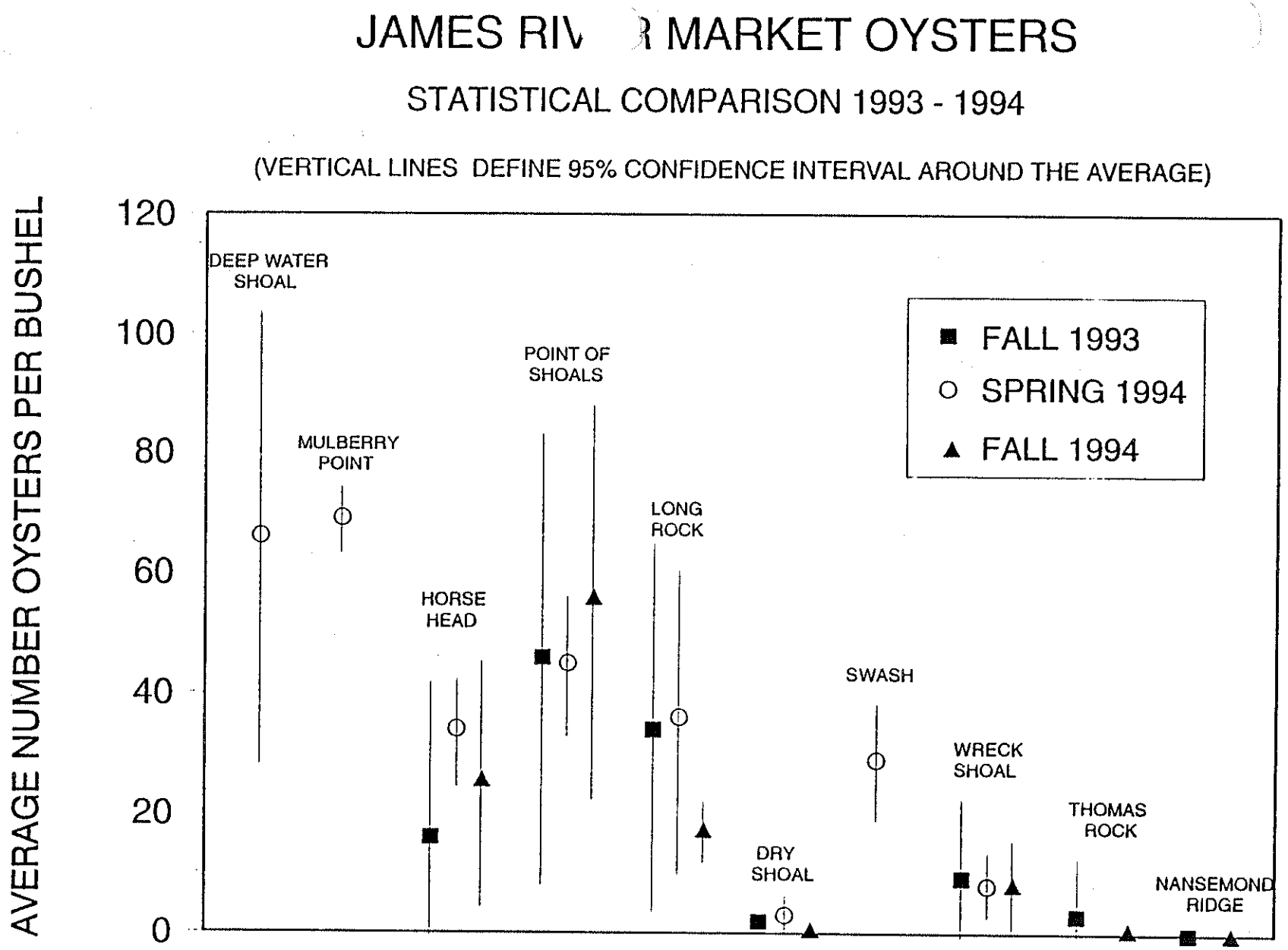

Figure 4. Statistical comparison between the average number of market-size oysters (3-in and larger) collected during oyster bar surveys in the fall of 1993, spring of 1994 and fall of 1994 at selected oyster bars on the public grounds of the James River, Virginia. A 95% probability exists that two averages are significantly different when the vertical line representing the confidence interval around one sample's average does not overlap the symbol for the average of another sample.

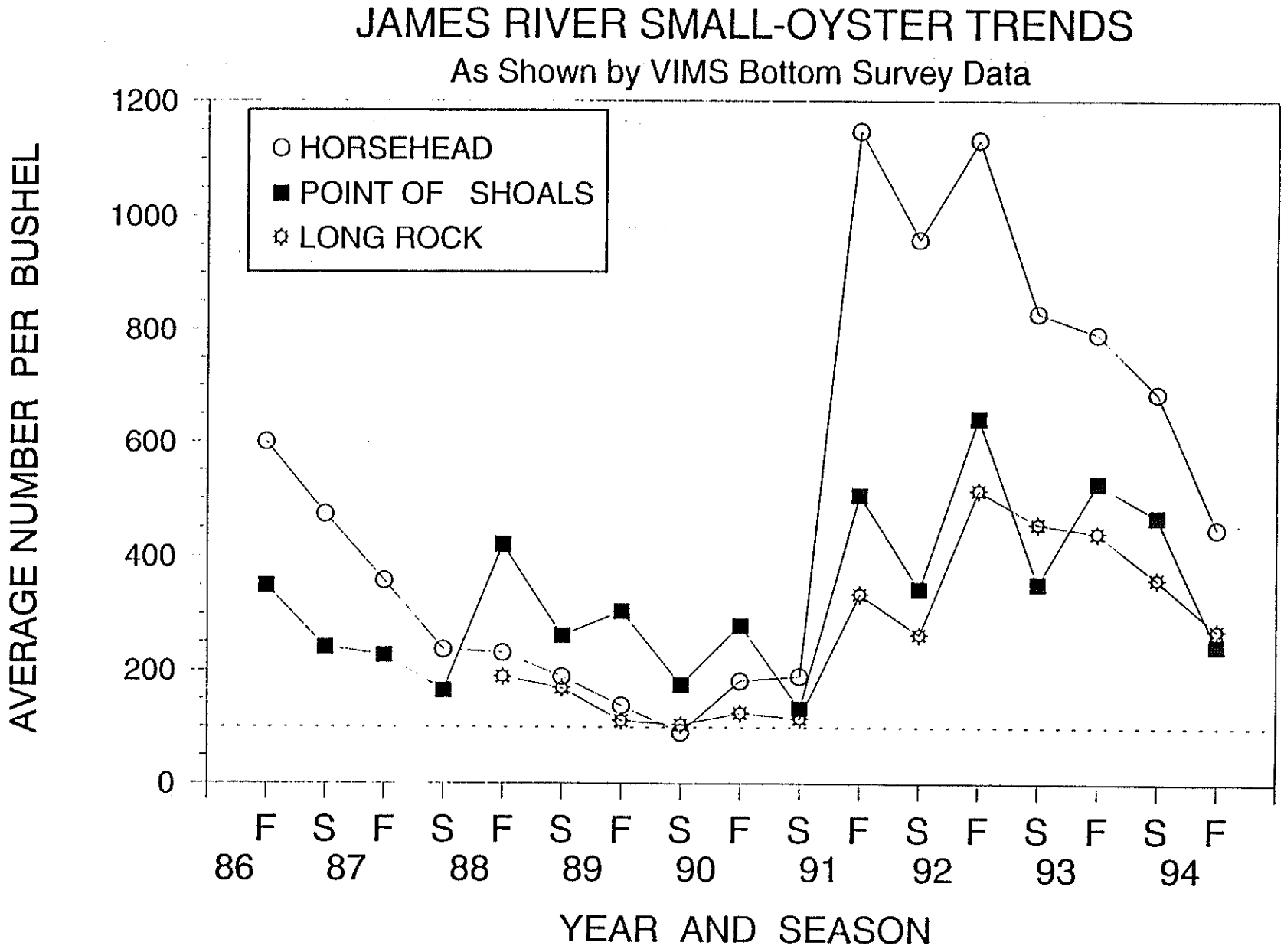

Figure 5. Trend in abundance of small oysters at three stations in the James River sampled during VIMS oyster bottom surveys in the spring and fall of successive years between 1986 and 1994. Spring samples usually collected in May and fall samples usually collected in October. The 100 per bushel level is highlighted with a broken line to ease comparison with other figures. F=Fall, S=Spring.

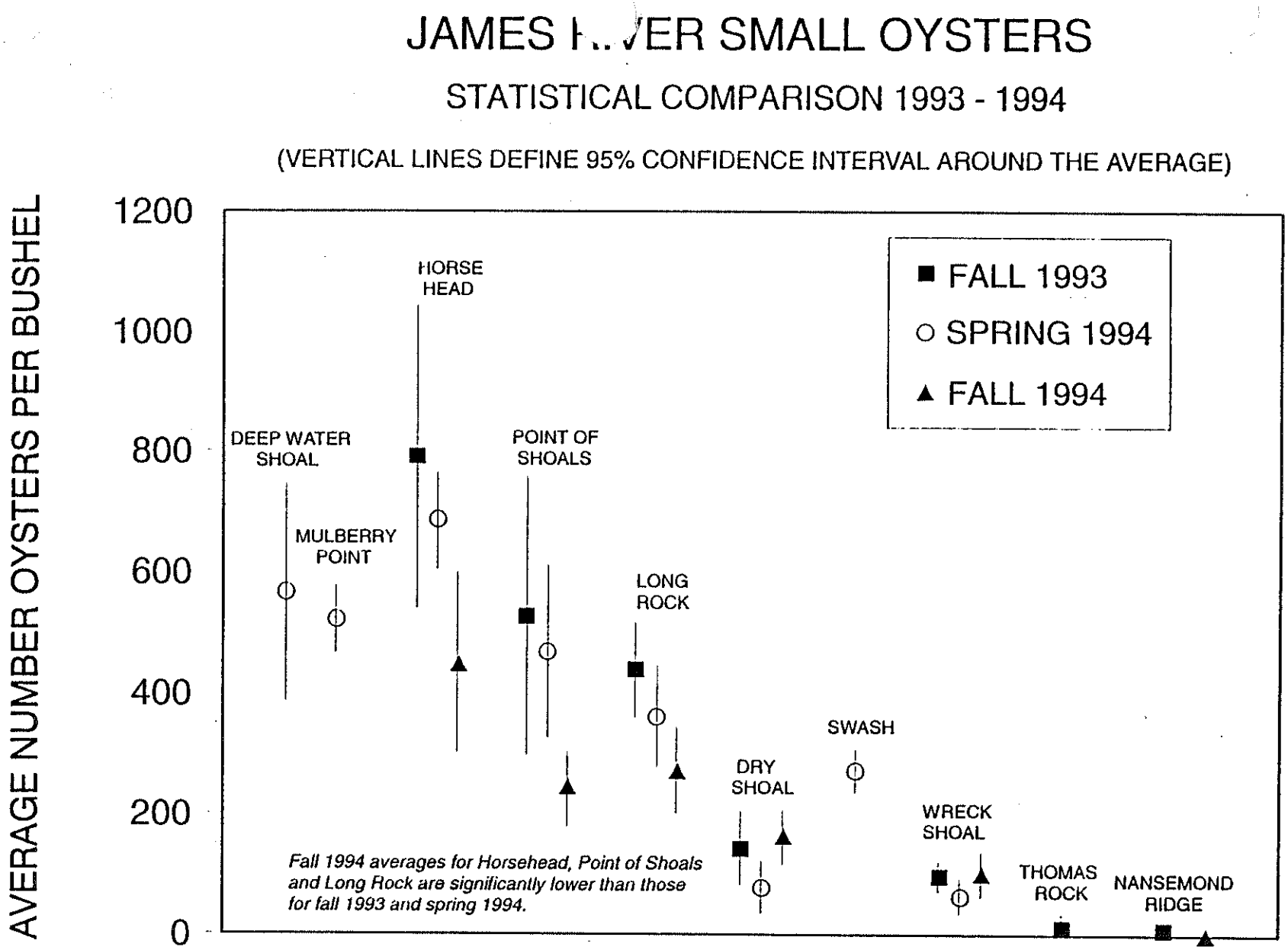

Figure 6. Statistical comparison between the average number of small oysters (under 3 in.) collected during oyster bar surveys in the fall of 1993, spring of 1994 and fall of 1994 at selected oyster bars on the public grounds of the James River, Virginia. A 95% probability exists that two averages are significantly different when the vertical line representing the confidence interval around one sample's average does not overlap the symbol for the average of another sample.

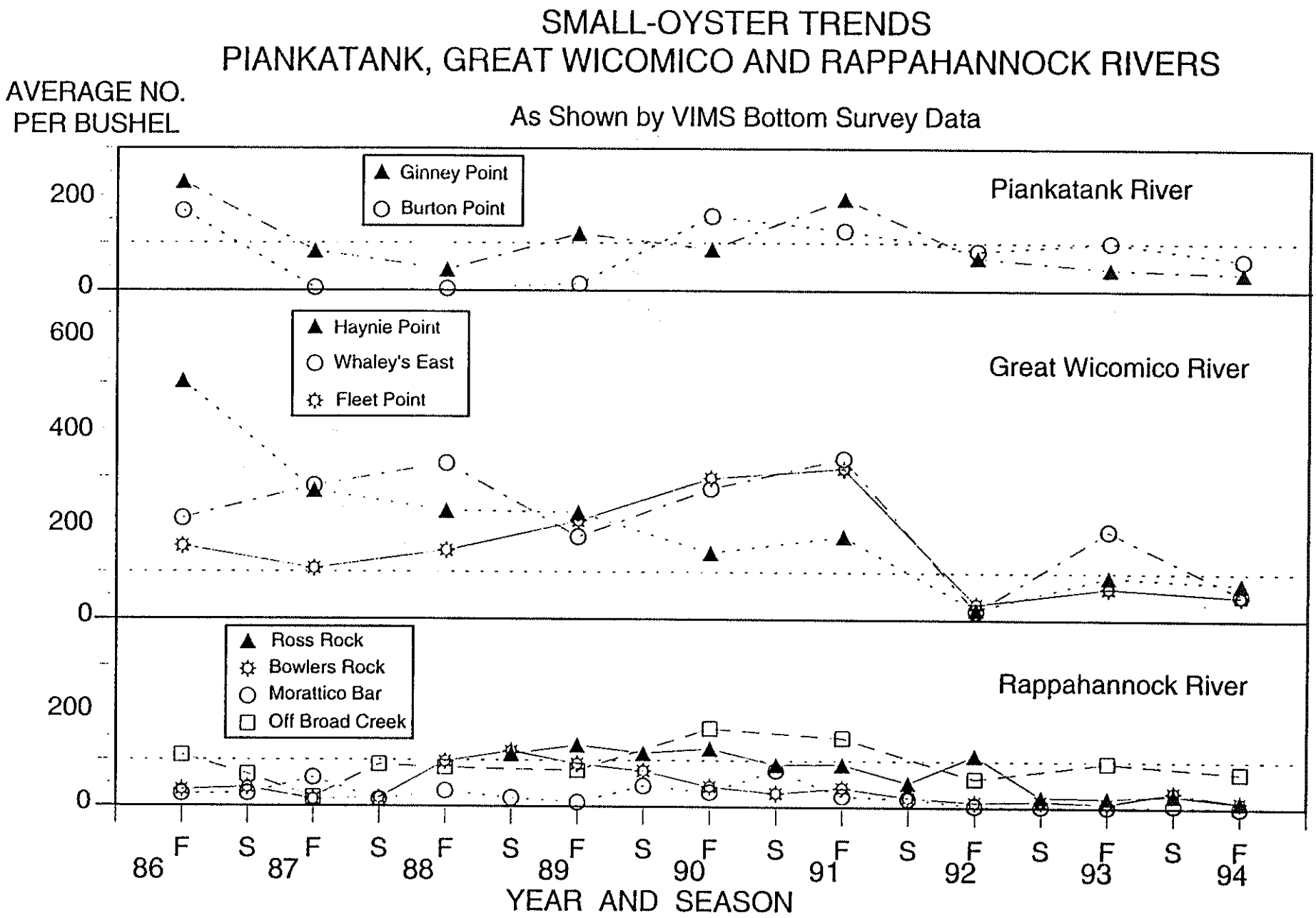

Figure 7. Trend in abundance of small oysters at stations in the Piankatank, Great Wicomico, and Rappahannock Rivers sampled during VIMS oyster bottom surveys in the spring and fall of successive years between 1986 and 1994. Spring samples usually collected in May and fall samples usually collected in October. The 100 per bushel level is highlighted with a broken line to ease comparison with other figures. F=Fall, S=Spring.

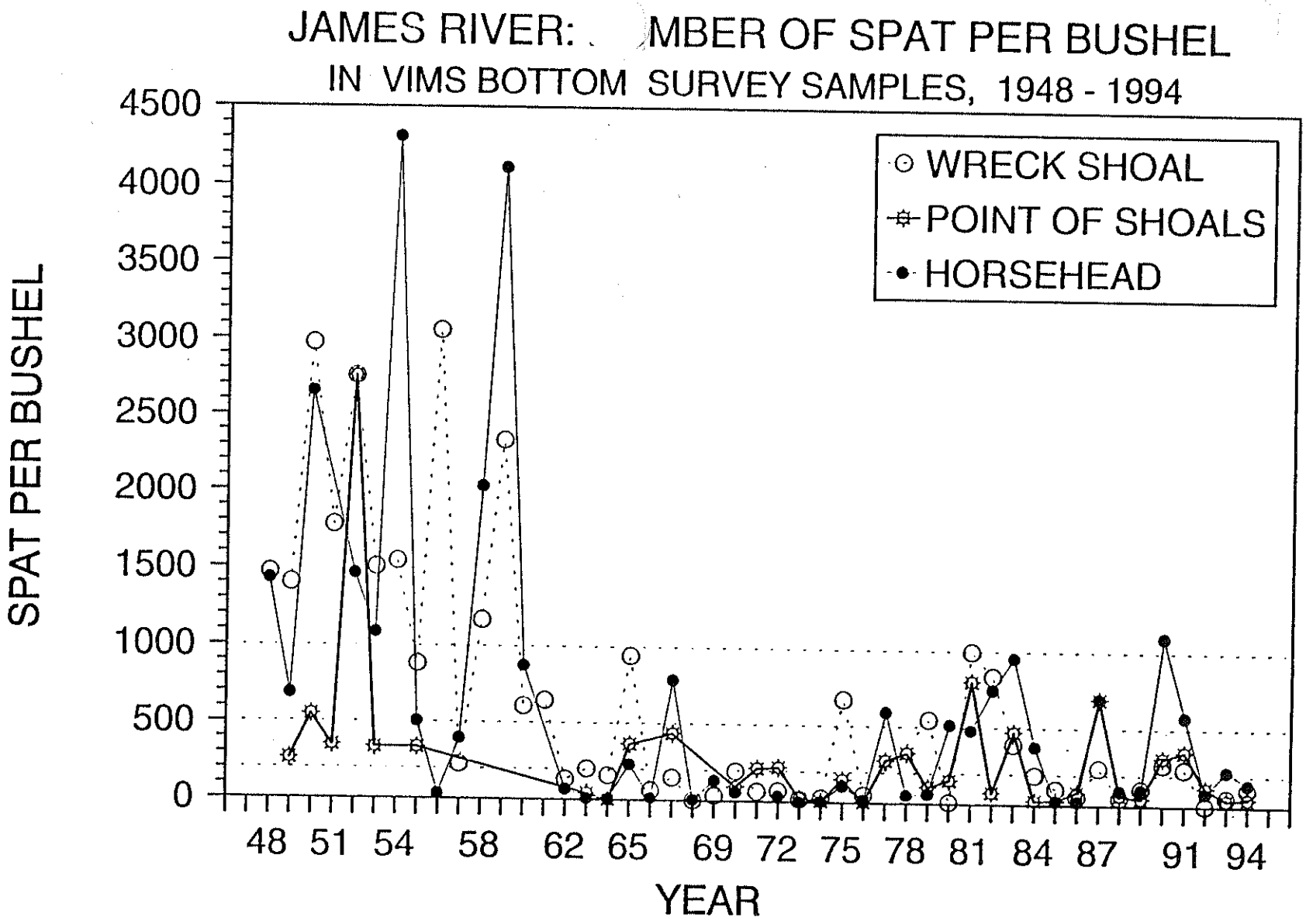

Figure 8. Average number of spat per bushel of natural cultch collected at three oyster bars in the James River during annual fall surveys, 1948-1994. Bars selected for the length of their data records. Data for Point of Shoals missing between 1955 and 1963.

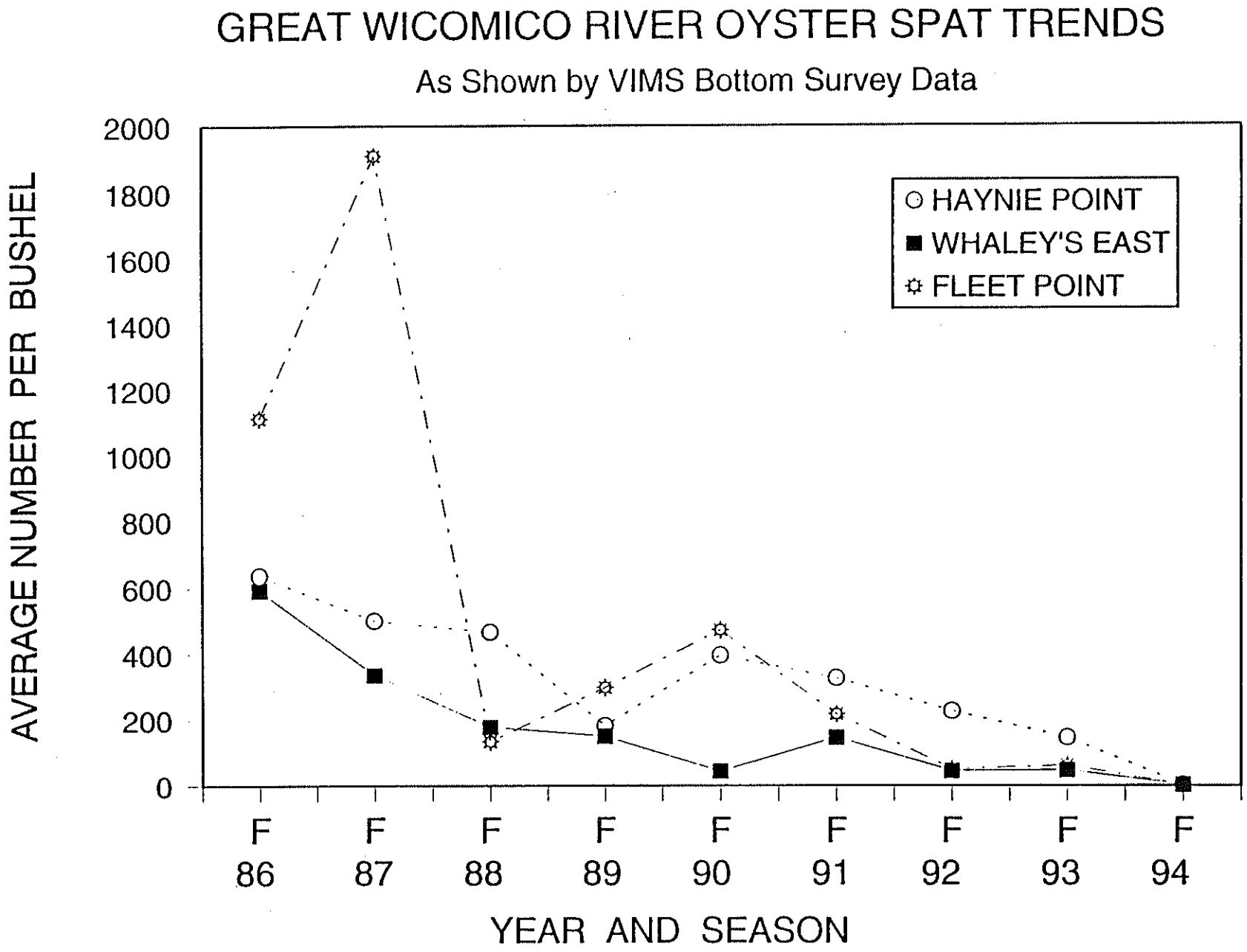

Figure 9. Trend in abundance of oyster spat at three stations in the Great Wicomico River sampled during VIMS bottom oyster surveys in the fall of successive years between 1986 and 1994. Samples usually collected in October. F=Fall.

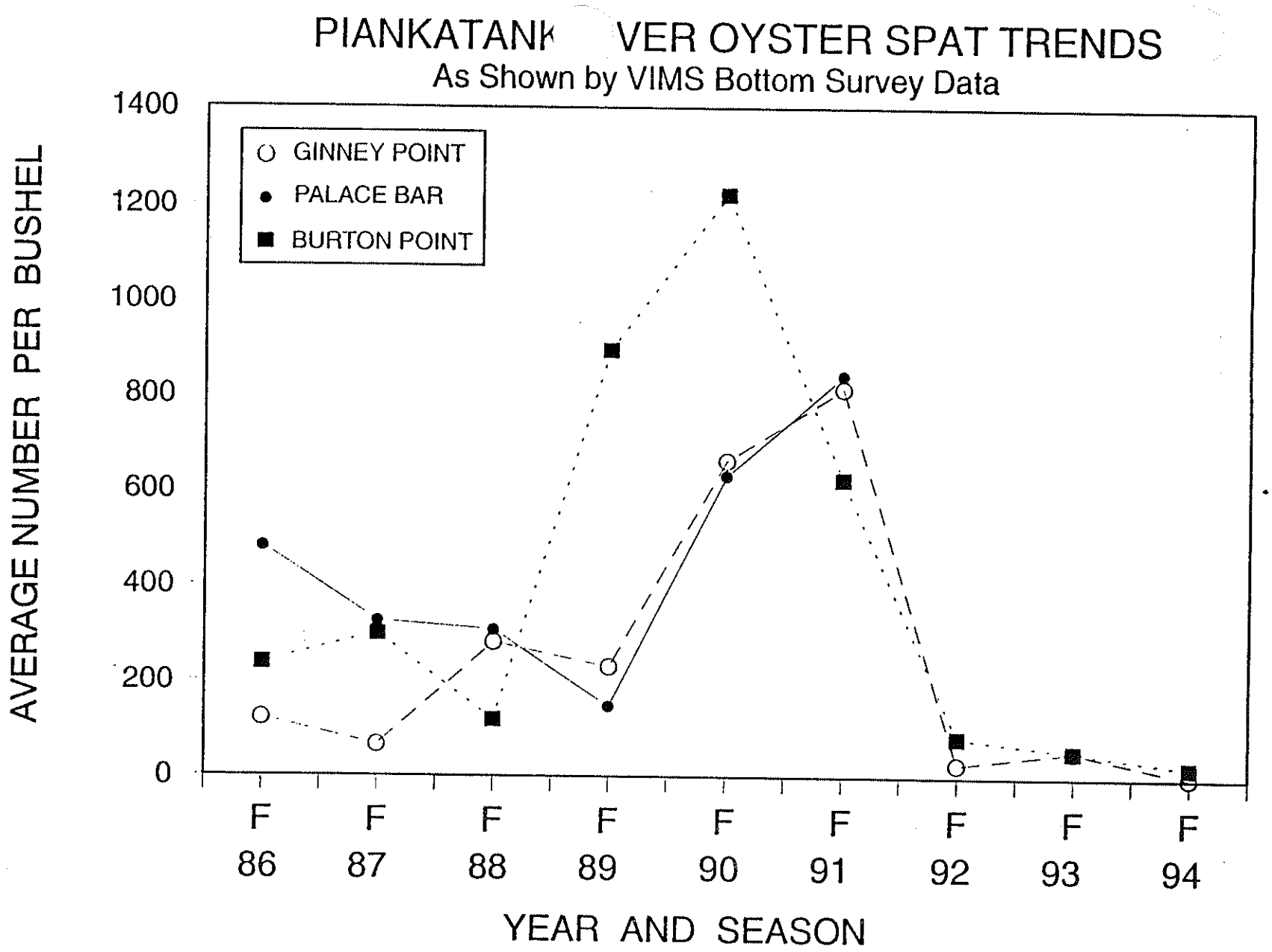

Figure 10. Trend in abundance of oyster spat at three stations in the Piankatank River sampled during VIMS oyster bottom surveys in the fall of successive years between 1986 and 1994. Samples usually collected in October. F=Fall.

Dr. Roger Mann
VIMS
Gloucester Point, VA 23062

Virginia Sea Grant College Program
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA 23062

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