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The Status of Virginia's Public Oyster Resource 1993

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Marine Resource Special Report

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Status of the Public Oyster Resource Of Virginia in 1993

Summary

- Spatfall was very low in most of the tributaries of the lower Chesapeake Bay in the summer of 1993. It was heavy, however, at all but one of the stations in the James River and at most of the stations on the seaside of the Eastern Shore. Total spatfall for the season exceeded the average for the previous 9-10 years at four of the James River stations (Days Point, Dry Shoal, Point of Shoals, and Horsehead).
- Spatfall was a complete failure in the Potomac River in 1993.
- The number of living oysters on Virginia's Public Oyster Grounds was as low in 1993 as in most previous years. Only one shoal sampled (Horsehead Reef in the James River) had over 1,000 living oysters per bushel of bottom material, and only two more (Point of Shoals and Long Rock, also in the James River) had over 500 living oysters per bushel. Number of oysters in rivers other than the James River was very low.
- Oyster bars in the Horsehead-Point of Shoals area of the James River showed slight increases in numbers of 3-inch market oysters and spat, but with the exception of spat numbers at Horsehead, those increases may not be great enough to have a significant impact on populations in the area in 1994. A sharp decrease in the number of small oysters (under 3 inches) at Horsehead, where their abundance was very high in the fall of 1992, will become a serious concern if it continues in 1994.
- As predicted in the 1992 report, the number of market oysters at Bowlers Rock in the Rappahannock River declined significantly in 1993.
- Recruitment of spat was low at most bars sampled in 1993. Only at Horsehead and Dry Shoal in the James River and at Haynie Point in the Great Wicomico River were more than 100 spat per bushel recorded, and only at Horsehead did the number exceed 200.
- Mortality of oysters was low at almost all bars sampled. Only three bars (Tow Stake in Mobjack Bay, and Smokey Point and Hog House in the Rappahannock River) had a mortality higher than 13% and in those three, mortality was no higher than 49%. Prevalence of MSX (*Haplosporidium nelsoni*) ranged from absent to low in 1993 and intensity of infection was mostly light. *Perkinsus (Perkinsus marinus,* previously known as "Dermo") was present at all bars sampled, except Ross Rock in the Rappahannock River, and prevalence ranged from moderate to high but intensity of infection was mostly light.

Part I. Oyster Spatfall in Virginia, 1993

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 effort is valuable to the Virginia Marine Resources Commission (VMRC) for its shell repletion program, and to private oyster growers, both of which are interested in maximizing the timing of shell planting. In addition, by maintaining a long-term data base, trends in spatfall throughout the lower Chesapeake Bay can be monitored. This in turn provides an index of the general health of the Bay.

This report summarizes data collected during the entire 1993 setting season.

Methods

Spatfall in 1993 was monitored from June through the first week of October at a total of 32 stations in the Virginia tributaries of the Chesapeake Bay, 12 stations in the Potomac River, and 15 stations on the Eastern Shore of Virginia. (Figure 1). The four stations added in 1992 to the Potomac River portion of the survey (Nomini Bay, Currioman Bay, Lower Machodoc River, and Ragged Point) were again examined; two new stations were added in 1993 (Gum Bar and Yates Bar). A significant number of new stations were added on the Eastern Shore, approximating inshore to offshore transects from Chincoteague, Wachapreague, Quinby, and Willis Wharf (Willis Wharf was the inshore station and the 1992 stations labeled Hog Island South and Hog Island North completed the transect).

We continue to use the shellstring as the standard monitoring tool. Throughout this period shellstrings were deployed 0.5m off the bottom at each bar. 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. Shellstrings were replaced after a one week exposure, and the number of spat that attached to the smooth surface (underside) of the center 10 shells was counted with the aid of a dissecting microscope. This number was then divided by 10 to get the number of spat per shell for that time interval. A computer program was used to calculate the number of spat per shell per week for standardized weekly periods. These values were categorized as follows: less than 0.1, *none*; 0.1-1.0, *light*; 1.1-10.0, *moderate*; and more than 10.0, *heavy*.

Weekly sampling allowed setting trends over the course of the summer to be compared between the various locations. Comparisons of setting intensity between years were made by adding the weekly values of spat per shell for the entire setting season.

SHELLSTRING SURVEY STATIONS

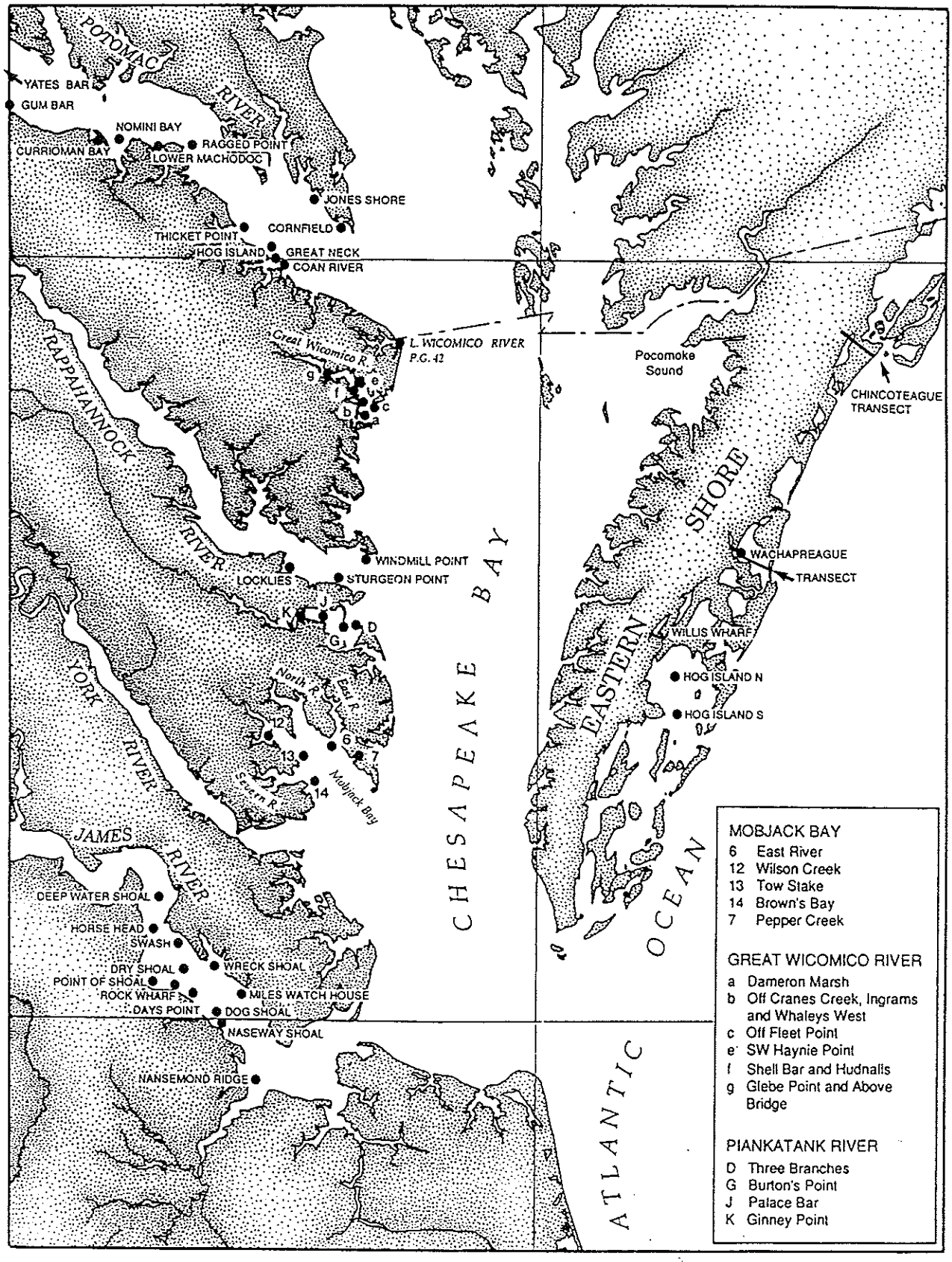

Figure 1. Location of shellstring stations.

Results

Weekly spat/shell values and annual spatfall totals (sums of weekly values) for 1993 are given in Table 1 and summarized below:

❖ James River

Twelve stations were monitored in the James River. Spat settlement began the week of July 6 and continued through the week of September 28. Moderate spatfall was observed at a number of stations by the third week in July, with a heavy set at Rock Wharf. Further heavy sets were observed at several of the stations through the middle of August with the highest set recorded on the first week of August. Moderate sets occurred at most of the stations throughout August. Bars with the highest sets ranged from Dog Shoal at the James River Bridge, through Days Point, Rock Wharf, Dry Shoal, Point of Shoals, and Horsehead upriver on the southern side of the river and at Swash on the north side of the navigation channel. It is notable that no heavy spatfall occurred in the James River in 1992. In 1992, cumulative spatfall totals ranged from 0.7 spat/shell at Deepwater Shoal to 15.7 spat/shell at Days Point. By comparison, 1993 values were much higher, ranging up to 131.6 shell/spat. Dog Shoal, Dry Shoal, and Days Point received the greatest spatfall in both years.

❖ Mobjack Bay

Spat settlement was followed at five locations in Mobjack Bay and was consistently low throughout the summer. Cumulative values were lower than in 1992.

❖ York River

The only shellstring in the York River was located at the VIMS oyster pier. Settlement was essentially absent there throughout the season.

❖ Piankatank River

This has traditionally been a site of good spatfall. In 1992 moderate spatfall was seen at all locations in the first three weeks of July with a heavy set at Palace Bar the weeks of July 6 and 13. Spatfall was generally lighter at all stations in 1993 and occurred later, mostly in August. Cumulative values were low, all below 6.5 spat/shell.

❖ Great Wicomico River

Spat settlement was consistently light or absent at all six stations in the Great Wicomico River, and consistently lower than 1992 values.

❖ Little Wicomico River

The only spatfall recorded at Public Ground 42 in the Little Wicomico River in 1993 was a light set during the second week in July

TABLE 1

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)

Week of:	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	12	
JAMES RIVER																					
Nansemond Ridge	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	1.9	4.9	2.8	1.5	0.7	0.1	0.3	0.1	0.0	0.0			13.7
Naseway Shoal	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	4.2	3.3	0.4	0.3	1.3	1.0	0.2	0.1	0.0	0.0			11.3
Dog Shoal	0.0	0.0	0.0	0.0	0.0	0.1	0.4	2.2	17.6	20.4	8.5	6.5	0.9	0.4	1.0	0.2	0.2	0.2			58.6
Miles Watch House	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	0.5	0.3	0.1	0.0	0.1	0.0	0.5	0.6			5.2
Days Point	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.4	39.8	46.1	17.1	8.6	9.9	3.7	0.8	0.8	0.1	0.0			131.6
Rock Wharf	0.0	0.0	0.0	0.0	0.0	0.0	1.5	20.6	7.8	1.6	0.4	1.1	1.2	0.2	0.0	-					34.4
Wreck Shoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.1	7.9	1.8	0.5	0.6	0.5	0.1	0.0	0.0	0.0			15.5
Dry Shoal	0.0	0.0	0.0	0.0	0.0	0.4	0.8	3.4	21.5	68.5	12.6	2.4	5.8	1.7	1.2	0.5	0.1	0.1			119.0
Point of Shoals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	8.9	45.0	9.9	2.2	1.8	2.3	0.4	0.6	0.1	0.0			73.5
Swash	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.9	26.8	6.7	1.6	2.0	1.5	0.9	0.1	0.0	0.0			46.2
Horsehead	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.8	4.2	28.6	6.2	1.3	1.1	0.2	0.0	0.0	0.0	0.0			43.7
Deep Water Shoals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.6	8.0	2.4	0.4	0.6	0.6	1.0	0.3	0.0	0.0			15.6
MOBJACK BAY																					
Brown's Bay	0.0	0.0	0.0	-	0.1	0.1	0.1	0.1	0.3	0.5	0.5	0.6	0.3	0.1	0.0	0.0	0.0	0.0			2.7
Tow Stake	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.3	0.3	0.1	0.0	0.0			1.5
Wilson Creek	0.0	0.0	0.0	0.0	0.3	0.3	0.5	0.7	1.8	0.1	0.1	0.5	0.6	0.1	0.1	0.0	0.0	0.0			5.1
Pultz Bar(East R.)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.2	1.5	0.8	0.3	0.1	0.0	0.0	0.0			3.3
Pepper Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	0.8	0.8	0.3	0.3	0.3	0.0	0.0	0.0	0.0			3.3
YORK RIVER																					
VIMS Oyster Pier	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.2	0.0	0.0				1.1
PIANKATANK RIVER																					
Three Branches	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.3	0.5	0.1	0.1	0.0	0.0				1.5
Burton's Point	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.8	0.7	1.2	1.0	1.1	0.4	0.0	0.0	0.0				6.5
Palace Bar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	2.2	1.1	1.3	0.5	0.2	0.1	0.0				5.9
Ginney Point	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.2	0.0	0.0	0.0				1.7
GREAT WICOMICO RIVER																					
Dameron Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.5	0.5	0.0	0.0	-	0.0	0.0	0.0	0.0		1.2
Cranes Creek	0.0	0.0	0.0	0.0	0.0	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			0.2
Hudnall's Dock	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.7	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.9
Haynie Point	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.0	0.0	0.0	0.3	0.3	0.0	0.1	0.0						1.6
Glebe Point	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0			0.2
Fleet Point	0.0	0.0	0.0	-	0.0	0.4	0.4	0.1	0.0	0.6	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0			2.4
LITTLE WICOMICO RIVER																					
P.G. No. 42	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	0.1	0.0	0.0				0.3

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Week of:	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	12	
RAPPAHANNOCK RIVER																					
Sturgeon Creek	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0							0.6
Locklies Creek	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0							0.5
Windmill Point	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
POTOMAC RIVER																					
Gum Bar	-	-	-	-	-	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0						0.0
Yates Bar	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
Jones Shore	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	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	0.1	0.0				0.1
Coan River	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	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
Thicket Point	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	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
Nomini Bay	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2				0.2
Currioman Bay	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.0
Ragged Point	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-			0.0
Lower Machodoc	-	-	-	-	-	-	-	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(Off.)	-	-	-	-	0.0	0.1	0.5	0.1	0.0	-	0.2	0.0	0.7	1.7	0.6	0.1	0.1	0.0	0.0		4.1
Chincoteague(Mid.)	-	-	-	-	0.0	0.0	-	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.3	0.2	0.1	0.5	0.1		1.7
Chincoteague(Ins.)	-	-	-	-	0.0	0.0	3.8	0.0	0.7	0.8	3.6	2.0	0.5	0.3	1.0	1.0	0.2	0.0	0.0		13.9
Wachapreague(Off.)	-	-	-	-	0.0	0.0	0.6	1.0	0.4	0.4	0.3	0.4	2.3	1.9	0.9	0.1	0.1	1.2	0.3		9.9
Wachapreague(Mid.)	-	-	-	-	0.0	0.0	0.0	0.4	0.1	0.0	0.3	0.0	0.7	1.4	0.6	0.2	0.2	0.1	0.0		4.0
Wachapreague(Ins.)	-	-	-	-	0.0	0.7	12.3	15.3	8.0	6.7	5.8	3.1	15.4	19.8	13.0	3.0	2.0	0.6	0.0		105.7
Quinby (Off.)	-	-	-	-	-	0.0	0.7	1.6	2.4	5.4	4.4	1.0	8.1	3.8	0.7	0.1	0.0	0.0	0.1		28.3
Quinby (Mid.)	-	-	-	-	0.0	0.0	1.7	0.0	1.6	2.7	1.0	0.1	3.7	3.0	1.7	0.2	0.3	0.1	0.0		16.1
Quinby (Ins.)	-	-	-	-	0.0	0.4	5.0	1.4	4.4	16.7	10.6	2.5	9.8	17.5	7.4	1.2	0.1	0.0	0.0		77.0
Oyster (Off.)	-	-	-	-	0.1	0.0	0.1	0.3	15.2	0.6	3.1	0.6	1.4	2.0	1.0	0.1	0.3	0.1			24.9
Oyster (Mid.)	-	-	-	-	0.0	0.0	0.2	0.2	5.0	0.4	0.8	0.1	0.6	0.3	0.1	0.0	0.1	0.1			7.9
Oyster (Ins.)	-	-	-	-	0.0	0.0	0.7	0.4	14.7	3.4	33.1	10.8	18.0	5.4	1.6	1.0	0.2	0.0			89.3
Hog Island No.(Off	-	-	0.8	0.2	0.4	0.2	1.7	1.4	5.5	6.2	12.9	4.6	0.6	2.2	2.6	0.4	0.1	0.1	0.0		39.9
Hog Island So.(Mid	-	-	0.0	0.0	0.0	1.5	3.3	1.6	7.0	1.1	24.5	8.2	0.1	1.4	3.7	0.7	0.2	0.2	0.0		53.5
Willis Wharf (Ins)	-	-	0.2	1.0	0.2	1.8	23.6	6.2	13.3	7.2	29.9	9.7	8.9	3.7	1.7	0.4	0.3	0.4	0.1		108.6

and the first week in September.

❖ *Rappahannock River*

Three stations were monitored in the Rappahannock River. At Sturgeon Creek and at Locklies Creek spatfall was very light in July. With this exception there was a complete spatfall failure at the monitored bars. This is consistent with 1992 observations of very light and sporadic spatfall throughout the summer.

❖ *Potomac River*

Spatfall was monitored at 12 stations in the Potomac River in 1993. There was essentially a complete spat settlement failure in the Potomac in 1993. This is a repetition of 1992 observations at 10 monitored bars.

❖ *Eastern Shore*

Spatfall on seaside Eastern Shore stations is a source of optimism in the 1993 survey. Spatfall was recorded throughout the summer at most of the stations monitored. The inshore bars at Wachapreague, Quinby, Oyster and Willis Wharf all had consistent moderate or heavy settlement. Cumulative spatfall totals in 1993 were high at most of the stations, ranging between 13.9 and 108.6 at 10 of the 15 stations.

Discussion

Results from the shellstring survey are reflective of the abundance of oyster larvae present in an area, and thus an indication of reproductive activity and the *potential* for recruitment. However, settlement, recruitment, and subsequent survival of oysters on bottom cultch is affected by many factors, including environmental conditions, the physiological condition of the larvae when they set, predators, and disease. A decline in overall water quality and food availability can reduce the reproductive capability of oysters and affect larval survival. Lower-than-normal temperature and salinity in spring may also interfere with gonad maturation in oysters and affect spatfall adversely. Abundance and condition of the bottom cultch, which is influenced by the extent and intensity of harvesting activity, also affects recruitment and survival of spat on the bottom. Thus, high spat counts on shellstrings may not be accompanied by a good set on bottom cultch and conversely, good setting on bottom shell may occur even though setting on shellstrings was light.

Spatfall in Virginia was as poor in 1993 as it was in 1992 at most of the river stations monitored on the western shore of Chesapeake Bay. In spite of the low spatfall at most other stations, there is the likelihood of some recruitment at Mobjack Bay and the Piankatank River. Spatfall and potential recruitment of oysters was a complete failure in the Potomac River in 1993. Total spatfall was substantially higher in 1993 than in 1992 at the three stations monitored on both years at the seaside of the Eastern Shore. High total spatfall levels were also recorded at many of the other stations monitored there for the first time in 1993. Those levels forecast an encouraging potential recruitment of oysters on seaside bars of the Eastern Shore.

Spatfall in 1993 was considerably higher in the James River than at the other tributaries on the western shore of the Bay and also much higher than in 1992 (Table 2). Total spatfall at five of the James River stations (Days Point, Dry Shoal, Point of Shoals, Horsehead and Deepwater Shoal) also exceeded the average for the previous 9 or 10 years. Overall spatfall in the James River in 1993 forecasts the potential for a significant recruitment of new individuals into the oyster populations in the James River.

The general decline in spatfall in Virginia since 1959 can be attributed to several factors which include the acute effect of the oyster diseases MSX (*Haplosporidium nelsoni*) and *Perkinsus* (*Perkinsus marinus*, formerly known as "Dermo"). These diseases caused widespread mortality in many areas of the state particularly in the higher salinity portions of the rivers, resulting in a drastic reduction in the numbers of adult oysters available for reproduction. Thus, spatfall

in the James River fluctuated between poor and light from 1960 to 1978 (Figure 2). Since 1979, however, annual spatfall reached significantly higher levels at several stations near or above the bridge (Figures 2 and 3). Although spatfall was light to moderate in most of those years, in six of them (1981, 1983, 1985, 1987, 1991 and 1993) moderate-to-heavy spatfall levels that match pre-1960 levels were recorded at several shellstring stations, all of them on the south side of the river. Even at Nansemond Ridge, 4 miles below the James River Bridge, annual spatfall reached moderate levels in 1983, 1985, 1990 and 1991 (Table 2).

In spite of the encouraging occurrence of moderate-to-heavy spatfall in the James River in some recent years, there appears to be a declining trend in the last fifteen years, as shown when the annual data for stations with the longest data sets are grouped into 5-year averages (Figure 4).

The complex combination of factors that affects spatfall makes it very difficult to explain annual variations. Thus, no explanation was forthcoming for the extremely light spatfall recorded in 1992 following a heavy spatfall in 1990 and 1991. Likewise, it is difficult to explain the occurrence of heavy spatfall only in the James River and the seaside of the Eastern Shore in 1993 when heavy spatfall was recorded throughout Virginia in 1990 and 1991 (except for the Potomac River). However, the fluctuations observed in the James River may be associated with variations in standing stock of market and sub-market (those close to market size) which are influenced by variations in intensity of harvesting from year to year. The high peaks in spatfall recorded several times since 1979 point to the persistence of a moderate-to-high recruitment potential in populations of oysters in the upper James River. In the absence of extreme deviations from normal environmental conditions, proper management of the resource in the Burwell Bay area should help maintain that potential at a relatively high and stable level through control of the harvesting pressure.

Acknowledgements

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TABLE 2

SPATFALL TOTALS FOR YEARS 1983-1993 (WHERE AVAILABLE) AND MEAN FOR UP TO 10 YEARS
(+ and - indicate change in 1993 in reference to 1992 and Mean)

Location	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	1993	Change Ref. 1992	Change Ref. Mean
JAMES RIVER														
Nansemond Ridge	46.7	15.1	69.7	8.8	18.4	8.9	26.0	40.6	56.5	7.0	*29.8*	**13.7**	+	-
Naseway Shoal	224.7	41.0	465.9	40.0	296.6	18.5	59.4	20.6	179.0	1.9	*134.8*	**11.3**	+	-
Dog Shoal		38.3	568.8	32.1	356.9	27.5	73.0	34.4	274.8	11.6	*157.5*	**58.6**	+	-
Miles Watch House	46.8	16.7	20.9	9.8	33.7	3.2	4.2	2.4	18.7	3.5	*16.0*	**5.2**	+	-
Days Point		24.4	120.3	22.3	481.6	17.3	25.9	28.6	146.6	15.7	*98.1*	**131.6**	+	+
Rock Wharf		38.7	163.5	11.4	285.7	40.9	3.5	17.1		11.7	*71.6*	**34.4**	+	-
Wreck Shoal	104.8	21.2	26.3	7.9	35.1	10.0	10.5	5.9	35.4	3.2	*26.0*	**15.5**	+	-
Dry Shoal		24.0	87.1	16.8	241.5	13.2	10.1	45.8	217.2	14.2	*74.4*	**119.0**	+	+
Point of Shoals	77.4	23.5	31.2	4.6	75.4	9.9	2.1	2.9	21.4	5.4	*25.4*	**73.5**	+	+
Swash	333.8	37.2	38.1	9.2	79.5	7.6	3.8	3.9	68.6		*64.6*	**46.2**		-
Horsehead	96.6	28.1	36.0	7.3	100.0	3.7	1.5	1.0	24.6	3.6	*30.2*	**43.7**	+	+
Deepwater Shoal	62.0	2.7	1.1	2.0	30.6	4.3	2.1	3.8	10.8	0.7	*12.0*	**15.6**	+	+
MOBJACK BAY														
Brown's Bay	71.1	4.6	7.1	241.1	8.0	2.2	29.9	44.7	40.2	6.3	*45.5*	**2.7**	-	-
Tow Stake	18.8	14.3	2.5	15.7	1.9	5.3	28.8	64.7	16.1	7.7	*17.6*	**1.5**	-	-
Wilson Creek	11.0	39.3	1.7	5.7	2.6	4.8	42.8	101.9	12.1	29.7	*25.2*	**5.1**	-	-
East River	26.8	14.1	9.4	29.2	8.9	13.1	37.8	64.0	32.0	7.2	*24.3*	**3.3**	-	-
Pepper Creek	87.5	18.3	112.5	264.6	40.7	4.7	18.0	74.2	70.1	4.0	*69.5*	**3.3**	-	-
YORK RIVER														
VIMS Pier	6.2	2.2	20.5	165.2	25.0	7.1	5.4	14.4	18.7	2.2	*26.7*	**1.1**	-	-

TABLE 2 (Continued)

Location	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	1993	Change Ref. 1992	Change Ref. Mean
PIANKATANK RIVER														
Three Branches	27.2	17.6		97.9	64.9	1.7	22.5	55.7	19.7	4.6	*34.6*	**1.5**	-	-
Burton Point	27.1	38.8	85.7	252.8	43.9	4.7	31.6	102.1	16.3	4.3	*60.7*	**6.5**	+	-
Palace Bar	146.2	59.7	124.5	376.5	243.9	9.1	42.3	139.9	39.1	24.9	*120.6*	**5.9**	-	-
Ginney Point	171.7	126.6	82.7	204.2	133.3	5.6	30.0	85.6	25.2	11.9	*87.7*	**1.7**	-	-
GREAT WICOMICO RIVER														
Dameron Marsh	12.7	0.9	8.6	43.3	29.1	59.3	6.1	29.2	11.0	0.7	*20.1*	**1.2**	+	-
Cranes Creek	6.7	1.3	6.3	121.6	30.5	17.4	11.7	39.1	10.7	0.3	*24.6*	**0.2**	-	-
Hudnall's Dock	16.3	3.3	14.2	237.6	50.8	61.8	28.4	119.6	7.0	1.2	*54.0*	**0.9**	-	-
Haynie Point	12.9	0.7	7.6	170.8	10.5	57.4	20.1	67.9	13.6	1.5	*36.3*	**1.6**	+	-
Glebe Point	0.6	2.2	10.9	364.6	23.6	27.1	9.1	19.8	3.8	0.9	*46.3*	**0.2**	-	-
Fleet Point	42.7	1.7	78.4	42.8	157.9	10.1	9.0	18.1	10.1	7.4	*37.8*	**2.4**	-	-
LITTLE WICOMICO RIVER														
P.G. No. 42							0.2	5.2	4.8	0.0	*2.6*	**0.3**	+	-
RAPPAHANNOCK RIVER														
Sturgeon Creek				21.6	1.1	1.7	1.7		12.7	0.4	*6.5*	**0.6**	-	-
Locklies Creek				27.7	2.8	3.3	2.4	4.6	25.5	0.3	*9.5*	**0.5**	-	-
Windmill Point					45.9	1.4	1.0	98.5	23.4	0.4	*28.4*	**0.0**	-	-

TABLE 2 (Continued)

Location	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	1993	Change Ref. 1992	Change Ref. Mean
POTOMAC RIVER														
Jones Shore	14.5	0.7	20.6	16.2	27.2	3.8	0.1	0.4	8.2	0.3	*9.2*	**0.0**	-	-
Hog Island	1.5	0.3	1.7	4.8	1.8	0.0	0.1	0.2	0.4	0.1	*1.1*	**0.1**		-
Coan River	0.9	0.0	0.0	10.8	0.0	0.4	0.0	0.1	0.3	0.0	*1.3*	**0.0**	-	-
Great Neck	1.9	0.0	5.2	6.4	1.9	1.4	0.0	0.2	1.1	0.1	*1.8*	**0.0**	-	-
Thicket Point	1.1	0.1	0.2	5.0	0.3	0.6	0.0	0.2	1.4	0.1	*0.9*	**0.0**	-	-
Cornfield	22.9	0.2	29.5	3.6	49.6	6.7	1.8	8.9	50.5	0.3	*17.4*	**0.2**	-	-
EASTERN SHORE														
Wachapreague	121.0	56.4	31.9	66.7	29.7	47.1	144.1	211.4	287.4	61.1	*105.7*	**105.7**	+	+
Hog Island N.							49.9	21.2	109.7	0.4	*45.3*	**39.9**	+	-
Hog Island S.							48.7	14.2	67.4	1.7	*33.0*	**53.5**	+	+

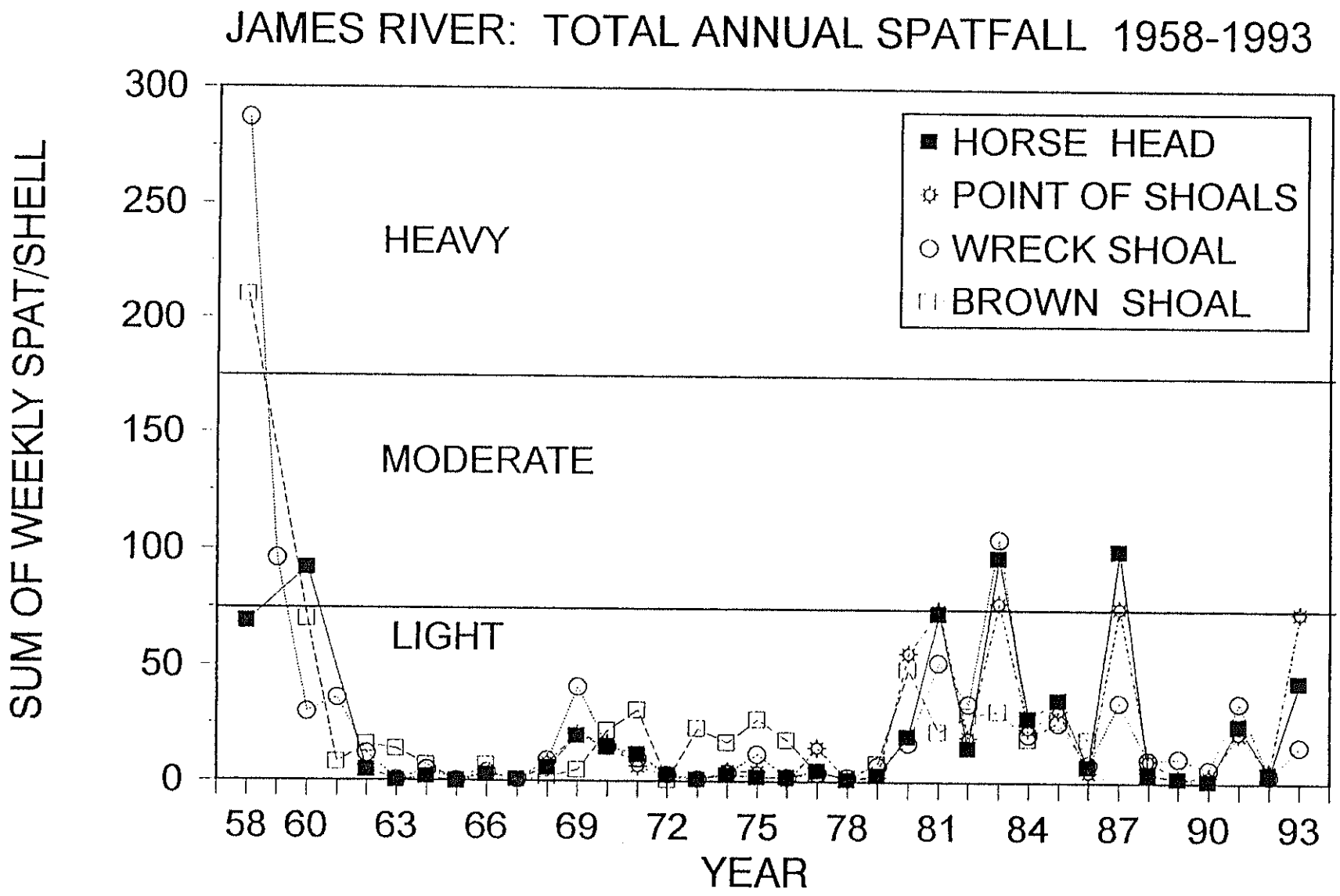

Figure 2. Total annual spatfall (expressed as the sum of weekly spat/shell values) at four shellstring stations in the James River, 1958-1993. Stations selected for the length of their data records. Spatfall intensity categories created for comparative purposes.

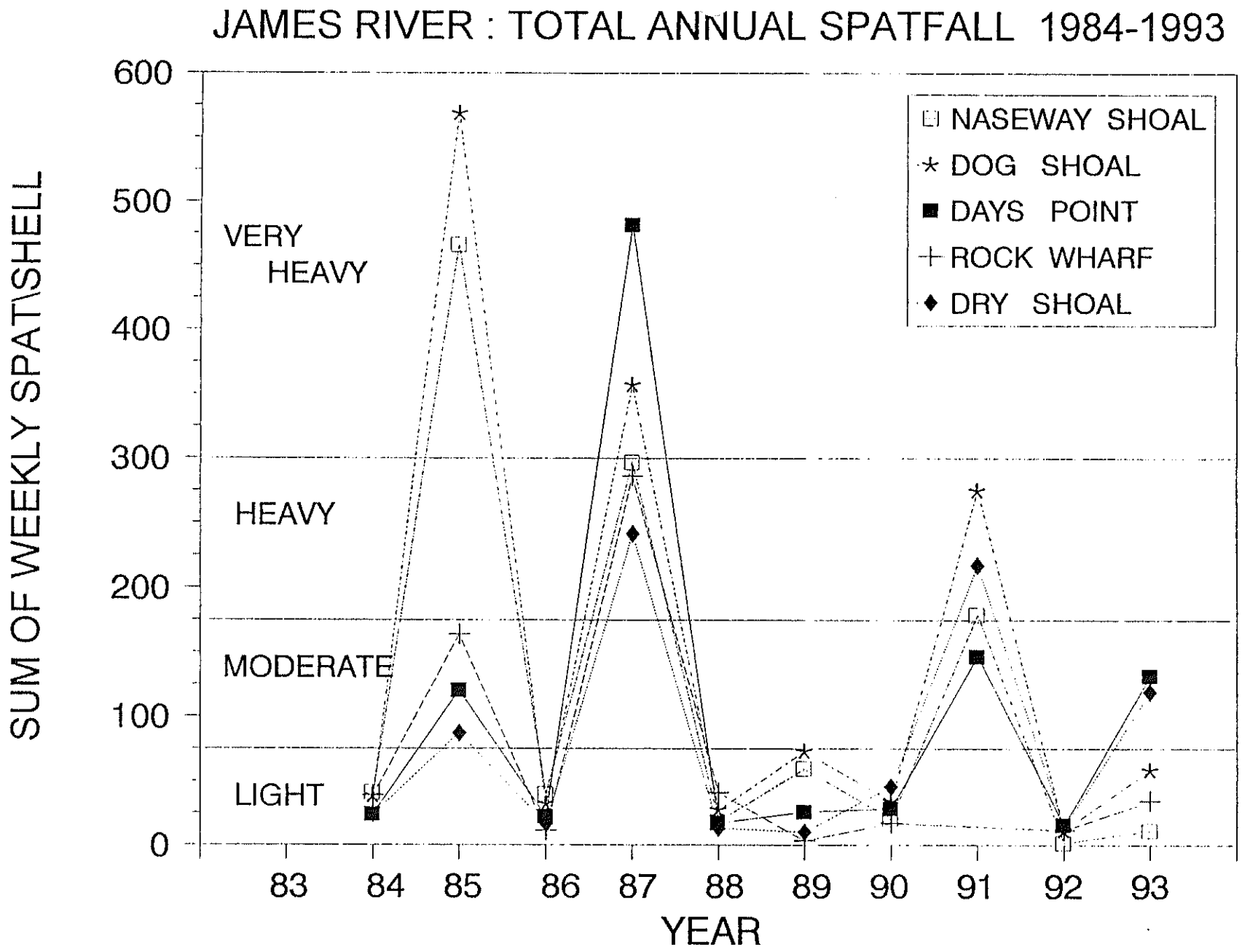

Figure 3. Total annual spatfall (expressed as the sum of weekly spat/shell values) at five shellstring stations on the south side of the James River, between Point of Shoals and naseway Shoal (downriver at the bridge), 1984-1993. Spatfall intensity categories created for comparative purposes.

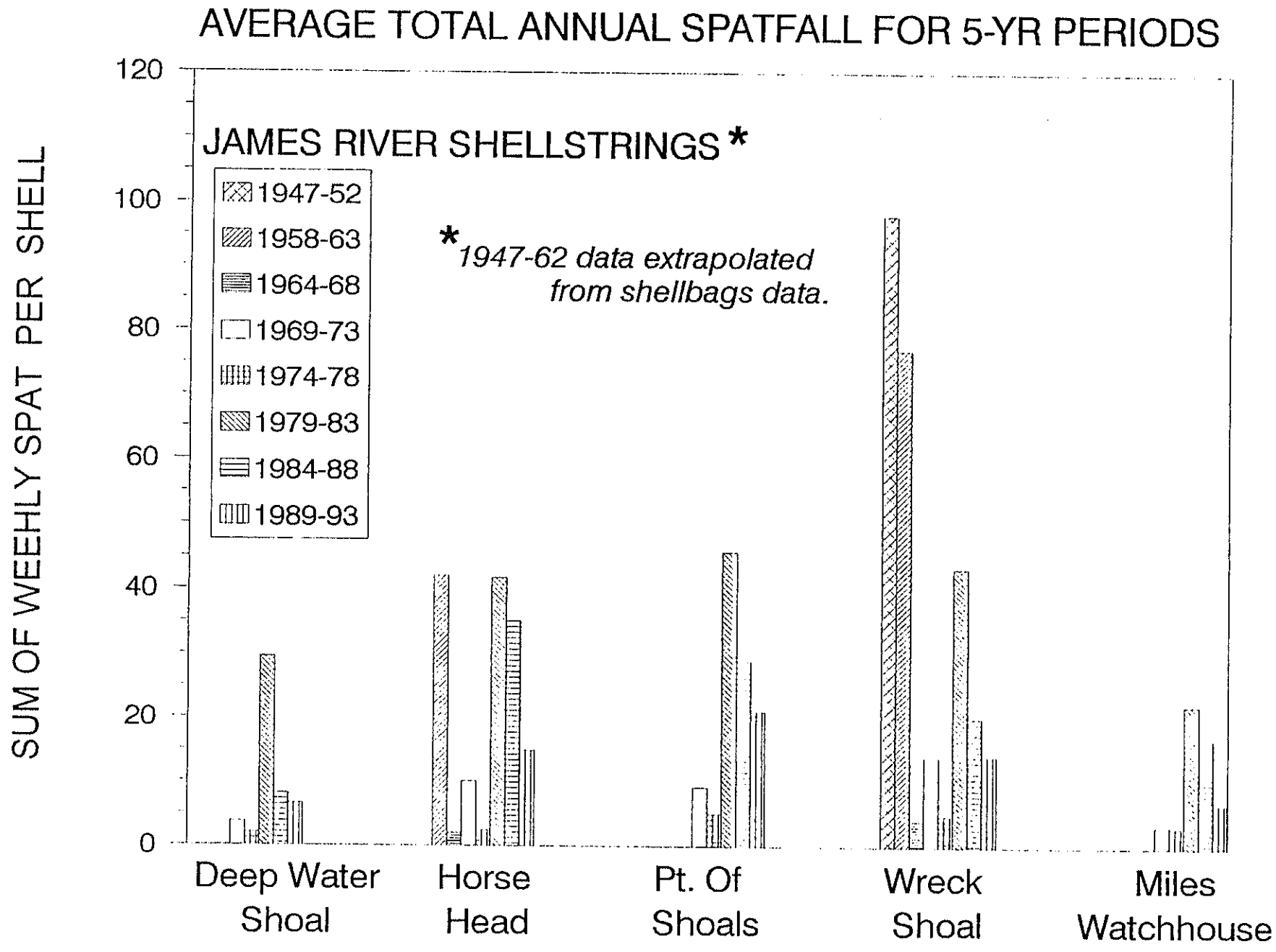

Figure 4. Average total annual spatfall (expressed as the sum of weekly spat/shell values) for 5-year periods regressing from 1993, at five shellstring stations in the James River, 1947-1993. Stations selected for the length of their data records in VIMS files.

Part II. Survey of Selected Oyster Bars In Virginia — Fall 1993

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. J. B. Baylor, United States Navy. 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 the Virginia Institute of Marine Science (VIMS) conducts a survey of selected public oyster bars in Virginia waters for the purpose of assessing the status of the resource. Surveys conducted in the spring provide information about over-winter mortality and relative fishing pressure from the current harvesting season[1]. Surveys conducted in the fall provide information about spatfall or recruitment, summer (disease) mortality, and the status of each shoal as a source of seed or market oysters prior to the beginning of the harvesting season.

This report summarizes the findings of the Fall 1993 Oyster Bars Survey, conducted between September 13 and September 28, 1993.

Methods

Three 0.5 bushel (25 quart) samples of bottom material were taken at each bar using a 24-inch dredge with 4-inch teeth. The bars sampled are shown in Figure 1. Sampling dates, times, and 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 approximately a month or more). Surface water samples were obtained at each location for temperature (°C) and salinity (ppt) determination. Where possible, 20-25 oysters were collected for disease analysis (prevalence of *Perkinsus marinus*).[2]

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

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[1]Oysters are usually harvested from public grounds in Virginia between October 1 and June 1 with the exception of the seaside of the Eastern Shore, where harvesting is usually restricted to the period from November 1 to April 1.

[2] Complete disease data, including prevalence and intensity of both MSX and *Perkinsus* in Virginia waters, are available from Dr. Eugene M. Burreson of the VIMS disease monitoring program.

OYSTER BAR SURVEY STATIONS

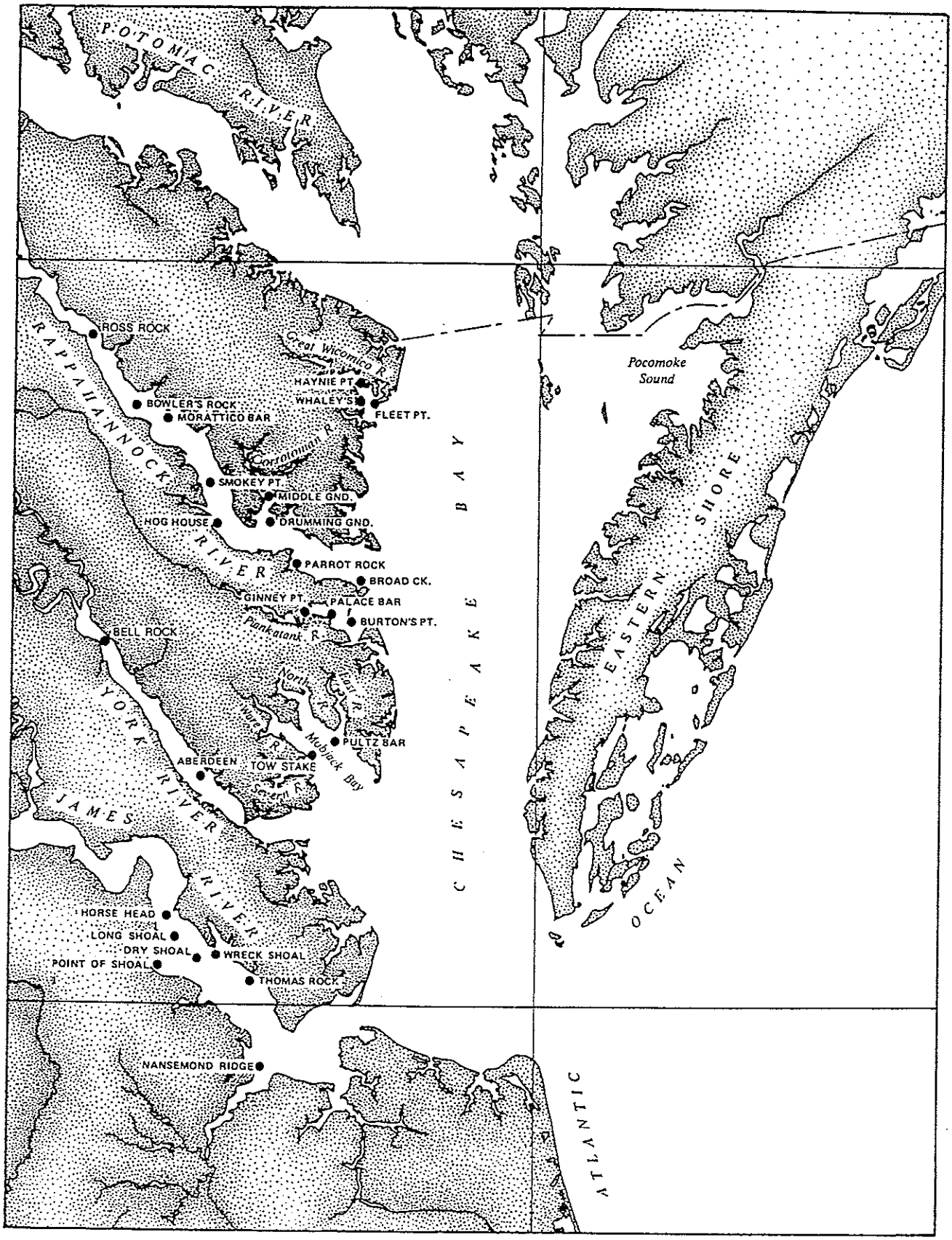

Figure 1. Location of oyster bars sampled.

TABLE 1

STATION LOCATIONS AND SAMPLING DATES - FALL 1993

STATION	DATE	TIME	LATITUDE	LONGITUDE
JAMES RIVER				
Horsehead	13 Sept	1710	37 06.3	76 37.9
Point of Shoals	13 Sept	1605	37 04.5	76 38.7
Long Rock	13 Sept	1005	37 04.6	76 37.1
Dry Shoal	13 Sept	1045	37 03.5	76 36.1
Wreck Shoal	13 Sept	1520	37 03.7	76 34.3
Thomas Rock	13 Sept	1420	37 01.5	76 29.5
Nansemond Ridge	13 Sept	1315	36 55.5	76 27.2
MOBJACK BAY				
Pultz Bar	24 Sept.	1045	37 21.1	76 21.1
Tow Stake	24 Sept.	940	37 20.2	76 23.7
PIANKATANK RIVER				
Ginney Point	24 Sept.	1405	37 32.0	76 24.2
Burton's Point	24 Sept.	1310	37 30.9	76 19.7
RAPPAHANNOCK RIVER				
Ross Rock	28 Sept.	1315	37 54.0	76 47.5
Bowlers Rock	28 Sept.	1200	37 49.5	76 44.0
Morattico Bar	28 Sept.	1105	37 46.9	76 39.3
Smokey Point	28 Sept.	1005	37 43.2	76 34.8
Hog House Bar	20 Sept.	1525	37 38.4	76 33.2
Drumming Ground	20 Sept.	1335	37 38.7	76 27.5
Parrot Rock	20 Sept.	1200	37 36.4	76 25.2
Off Broad Creek	20 Sept.	1030	37 34.6	76 18.4
CORROTOMAN RIVER				
Middle Ground	20 Sept.	1435	37 41	76 28.4
GREAT WICOMICO RIVER				
Haynie Point	14 Sept.	1250	37 49.8	76 18.7
Whaley's East	14 Sept.	1140	37 48.3	76 17.8
Fleet Point	14 Sept.	1015	37 48.6	76 17.3

Results

(Refer to Table 2)

❖ *James River*

Seven bars were sampled in the James River. Bottom temperature ranged from 24.5°C at Nansemond Ridge to 25.8°C at Point of Shoals. Temperature data are missing for Horsehead and Long Rock, but may be presumed to be in the vicinity of 25°C. Salinity was lowest at Horsehead (12 ppt) and highest at Nansemond Ridge (20 ppt).

Market oysters (3 inches and larger) were most numerous at Point of Shoals and Long Rock where 46 and 34 per bushel were found, respectively. Average counts of market oysters per bushel were substantially lower at Horsehead (16), and even lower at Dry Shoal, Wreck Shoal, and Thomas Rock (range: 2-9). No market oysters were found at Nansemond Ridge. The number of small oysters was greatest at Horsehead, where 791 per bushel were recovered. At Point of Shoals and Long Rock, the average number was similar (528 and 441); the average number at Dry Shoal and Wreck Shoal was significantly lower than at the three bars already mentioned (143 and 97). Average number of small oysters per bushel was extremely low at Thomas Rock and Nansemond Ridge (15 and 9). Recruitment was greatest at Horsehead and Dry Shoal where 229 and 103 spat per bushel, respectively, were found. Average number of spat per bushel was of a similar magnitude at the other five bars, ranging between 41 and 74.

The average number of old boxes per bushel ranged from 36 to 60 at four of the bars (Dry Shoal, Wreck Shoal, Horsehead, and Long Rock); the number of new boxes at those same bars ranged from 19 to 25. The number of old boxes at Nansemond Ridge, Thomas Rock and Point of Shoals ranged from 7 to 17 and the number of new boxes ranged from 2 to 7.

Recent mortality was low at all bars, ranging from 1.8% at Horsehead to 12.2% at Wreck Shoal.

❖ *York River*

No bottom samples were collected from the York River in 1993.

❖ *Mobjack Bay*

Bottom temperature was 22.9°C at Tow Stake and 22.8°C at Pultz Bar; bottom salinity was 22 ppt at both bars.

No oysters or spat and only an average of 6 old boxes per bushel were found at Pultz Bar. No market oysters and only 9 small oysters and 7 spat were found at Tow Stake. An average of 16 old and 7 new boxes per bushel were found at Tow Stake for a 36% recent mortality.

❖ *Piankatank River*

In the Piankatank River, surface temperature was 23.2°C at Burton Point and 23.4°C at Ginney Point. Salinity was 19 ppt at both bars.

No market oysters were found at either of the bars.

TABLE 2

RESULTS OF PUBLIC OYSTER GROUNDS SURVEY - FALL 1993

STATION	TEMP. (C)	SAL. (ppt)	AVERAGE NUMBER OYSTERS PER BUSHEL				BOXES		PCT. RECENT MORT.	MSX		*Perkinsus*	
			Market	Small	Spat	Total	Old	New		Pct. Infect.	Intensity H-M-L	Pct. Infect.	Intensity H-M-L
JAMES RIVER													
Horsehead	-	12	16	791	229	1036	47	19	1.8	0	- - -	96	0-1-23
Point of Shoals	25.8	12	46	528	41	615	17	7	1.2			80	0-3-17
Long Rock	-	-	34	441	74	549	60	25	4.3				
Dry Shoal	25.1	18	2	143	103	248	36	25	9.3				
Wreck Shoal	25.0	18	9	97	57	163	37	23	12.2	24	1-0-5	100	3-5-17
Thomas Rock	25.2	19	3	15	61	79	14	2	2.5				
Nansemond Ridge	24.5	20	0	9	53	62	7	2	2.8				
MOBJACK BAY													
Pultz Bar	22.8	22	0	0	0	0	6	0	-				
Tow Stake	22.9	22	0	9	7	16	16	7	36.0	0	- - -	93	0-2-12
PIANKATANK RIVER													
Ginney Point	23.4	19	0	45	55	100	11	4	3.7			88	2-3-17
Burton's Point	23.2	19	0	101	55	156	5	7	4.1			96	0-4-20
RAPPAHANNOCK RIVER													
Ross Rock	22.2	11	5	21	5	31	10	3	9.0			0	- - -
Bowlers Rock	22.0	14	17	9	0	26	10	1	1.6			12	0-0-3
Morattico Bar	22.6	16	2	2	0	4	12	0	0.0			33	0-0-8
Smokey Point	22.1	17	2	1	0	3	12	2	30.6	0	- - -	44	0-0-11
Hog House Bar	24.1	18	1	4	1	6	8	4	48.4				
Drumming Ground	24.8	19	0	33	17	50	3	1	1.0			28	1-0-6
Parrot Rock	24.1	19	2	39	35	76	6	3	3.5	0	- - -	96	3-1-20
Off Broad Creek	23.8	20	1	95	80	176	7	5	2.6	4	0-0-1	88	0-1-21
CORROTOMAN RIVER													
Middle Ground	24.7	19	0	17	51	68	26	9	12.3			63	1-0-11
GREAT WICOMICO RIVER													
Haynie Point	25.2	16	0	91	147	238	33	8	3.6			20	0-0-5
Whaley's East	24.2	18	1	188	47	236	52	14	5.8			64	0-0-16
Fleet Point	24.7	17	3	67	62	132	88	9	6.8	4	1-0-0	76	0-1-18

An average of 45 small oysters per bushel was found at Ginney Point and 101 per bushel at Burton Point. Spat counts per bushel averaged 55 at both bars.

There were 11 old boxes and 4 new boxes per bushel at Ginney Point and 5 old boxes and 7 new boxes at Burton Point. Recent mortality was very low at both bars (3.7% at Ginney Point and 4.1 at Burton Point).

❖ *Rappahannock River*

At the eight bars surveyed in the Rappahannock River, bottom water temperature ranged from 22.0°C at Bowlers Rock to 24.8°C at Drumming Ground. Salinity generally increased in a downriver direction, from 11 ppt at Ross Rock to 20 ppt off Broad Creek.

Counts of market oysters per bushel averaged 17 at Bowlers Rock. They ranged from 0 to 5 at the other bars. The average count of small oysters was highest off Broad Creek (95 per bushel); it ranged from 21 to 39 at Ross Rock, Drumming Ground and Parrot Rock and was very low at Bowlers Rock, Morattico Bar and Smokey Point (range: 1-9). The average number of spat per bushel was highest off Broad Creek (80) followed by the other two downriver bars, 35 at Parrot Creek, and 17 at Drumming Ground. No spat were found at Morattico Bar, Smokey Point or Bowlers Rock, and 1 spat per bushel was recorded at Hog House and 5 at Ross Rock.

The number of old boxes per bushel averaged between 3 and 12 per bushel, and the number of new boxes ranged from 0 to 5 per bushel. Recent mortality was moderately high at Smokey Bar and Hog House Bar (30.6% and 48.4%), but was low at all other bars, ranging from 0 to 9.0%.

❖ *Corrotoman River*

At the Middle Ground bar in the Corrotoman River, bottom temperature was 24.7°C and salinity 19 ppt. No market oysters were found and small oysters averaged 17 per bushel; there were 51 spat per bushel. An average of 67 old boxes and 26 new boxes per bushel were found. Recent mortality was 12.3%.

❖ *Great Wicomico River*

Bottom temperature ranged from 24.2°C to 25.2°C at the three bars sampled in the Great Wicomico River. Salinity ranged from 16 to 18 ppt.

Market oyster counts averaged between 0 and 3 at the three bars sampled. The number of small oysters per bushel ranged from 188 at Whaley's East to 67 at Fleet Point. Average spat counts were 47 per bushel at Whaley's East, 67 per bushel at Fleet Point, and 147 per bushel at Haynie Point.

The average number of old boxes per bushel was 33 at Haynie Point, 52 at Whaley's East, and 88 at Fleet Point. The average number of new boxes per bushel was 8 at Haynie Point, 9 at Fleet Point, and 14 at Whaley's East. Recent mortality was 3.6% at Haynie Point, 5.8% at Whaley's East, and 6.8% at Fleet Point.

Disease Prevalence and Intensity

The information on disease prevalence and intensity of infection was provided by Dr. Eugene M. Burreson of the VIMS disease monitoring program, to whom inquiries for further information should be addressed.

Seven stations were sampled for MSX and 17 were sampled for *Perkinsus* (Table 2). In the James River, no oysters were infected with MSX at Horsehead and the prevalence (percent infection) of MSX was 24 at Wreck Shoal. Only 1 of the 25 oysters sampled from Wreck Shoal had moderate-to-heavy intensity of infection. Prevalence was very low (4%) off Broad Creek in the Rappahannock River and at Fleet Point in the Great Wicomico River. MSX was absent from Tow Stake in Mobjack Bay, and from Morattico Bar and Parrot Rock in the Rappahannock.

Perkinsus was found at all stations sampled except for Ross Rock in the Rappahannock River. Prevalence was low-to-moderate at Bowlers Rock (12%) at Drumming Ground (28%), at Morattico Bar (33%) and at Smokey Point (44%) in the Rappahannock River and at Haynie Point in the Great Wicomico River (20%). Prevalence at all other stations sampled was high, ranging from 63% at Middle Ground in the Corrotoman River to 100% at Wreck Shoal in the James. Intensity of infection by *Perkinsus*, however, was light in most of the oysters sampled. The highest number of oysters with either high or moderate intensity of infection was found at Wreck Shoal (8 or 32%).

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 in Virginia in recent years has been found in the upper limits of oyster distribution (lower salinity areas) in the James River and the Rappahannock River. Those concentrations have declined to very low levels (20 per bushel or less) since 1989. The quantity of 3-inch-and-larger market oysters in Virginia waters is at present negligible. This is an indication of a natural population stressed by a number of factors which include the effect of diseases and harvesting pressure.

The number of market oysters per bushel was higher in the fall of 1993 than in the fall of 1991 and 1992 at Point of Shoals and Long Rock (Figure 2). The average number at those two bars in the fall of 1993 (46 and 34 per bushel) was also the highest recorded since 1988 at either bar. However, those averages are at best commercially marginal and the overall abundance of market oysters is still low in the James River (at Point of Shoals it is three times lower than the number recorded in 1986). The potential for a substantial increase in number of 3-inch market oysters in the Horsehead-Point of Shoals area of the James River is highlighted by the numbers recorded in 1986. That potential may only be attained or exceeded if good spat settlement and favorable environmental conditions are combined with wise management policies.

In the Rappahannock River, following gradual increases between 1989 and 1992, the average number of market oysters found at Bowlers Rock in the fall of 1993 was much lower than what was recorded in the fall of 1992; that decrease, first observed in the spring of 1992, represented a retreat to the lower numbers recorded in the fall of 1989 (Figure 3). Numbers of market oysters at Morattico Bar, Long Rock and Ross Rock have been extremely low since the fall of 1992.

Market oysters were absent from bars sampled in Mobjack Bay, the Piankatank River and the Corrotoman River and were very scarce in the Great Wicomico River bars.

Recent mortality was very low at most of the bars sampled (Table 2). Mortality higher than 13% was only recorded from three bars (Tow Stake in Mobjack Bay, and Smokey Point and Hog House in the Rappahannock River). The highest mortality did not exceed 49%.

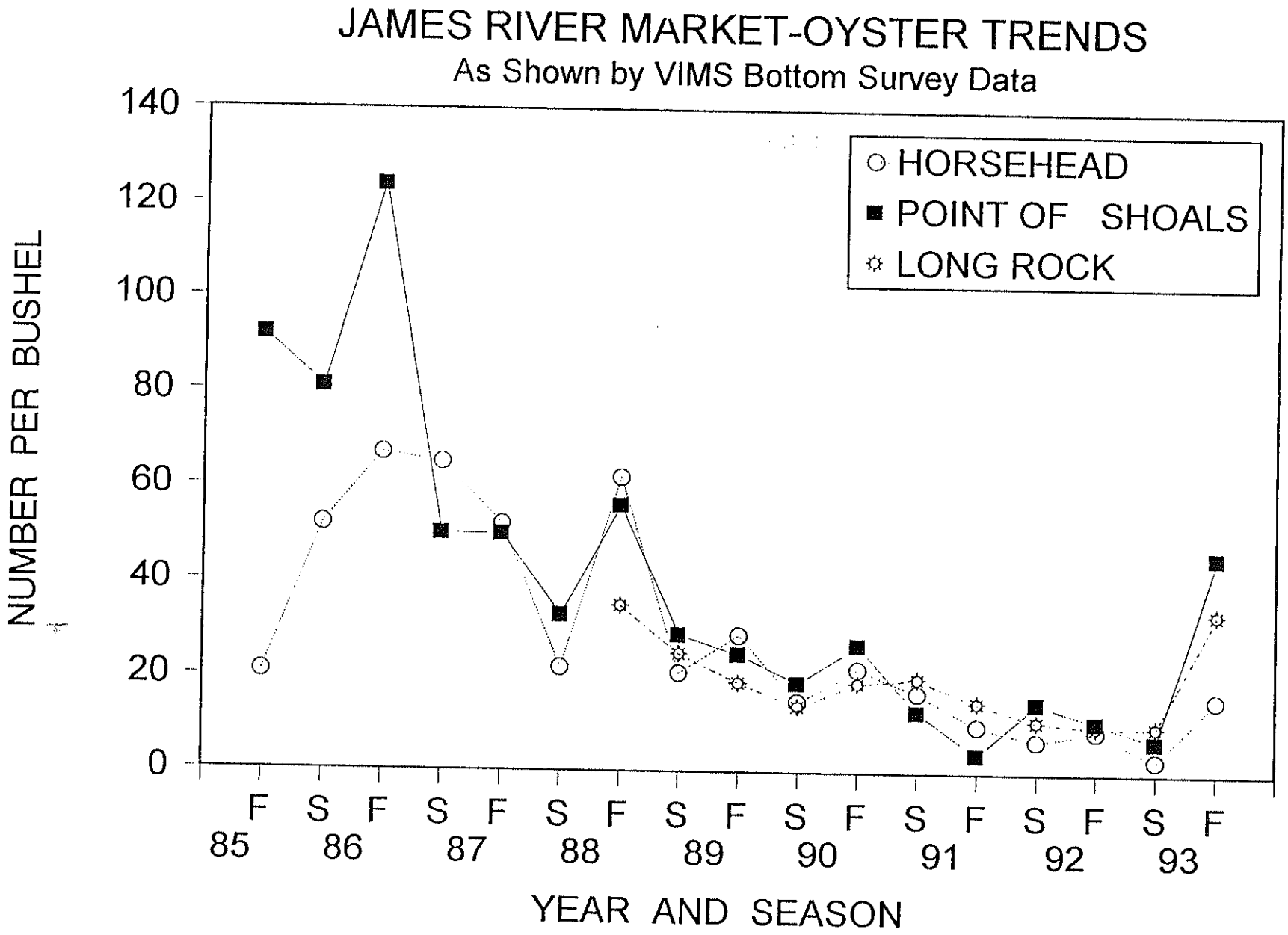

Figure 2. Trend in abundance of market oysters at three stations in the James River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

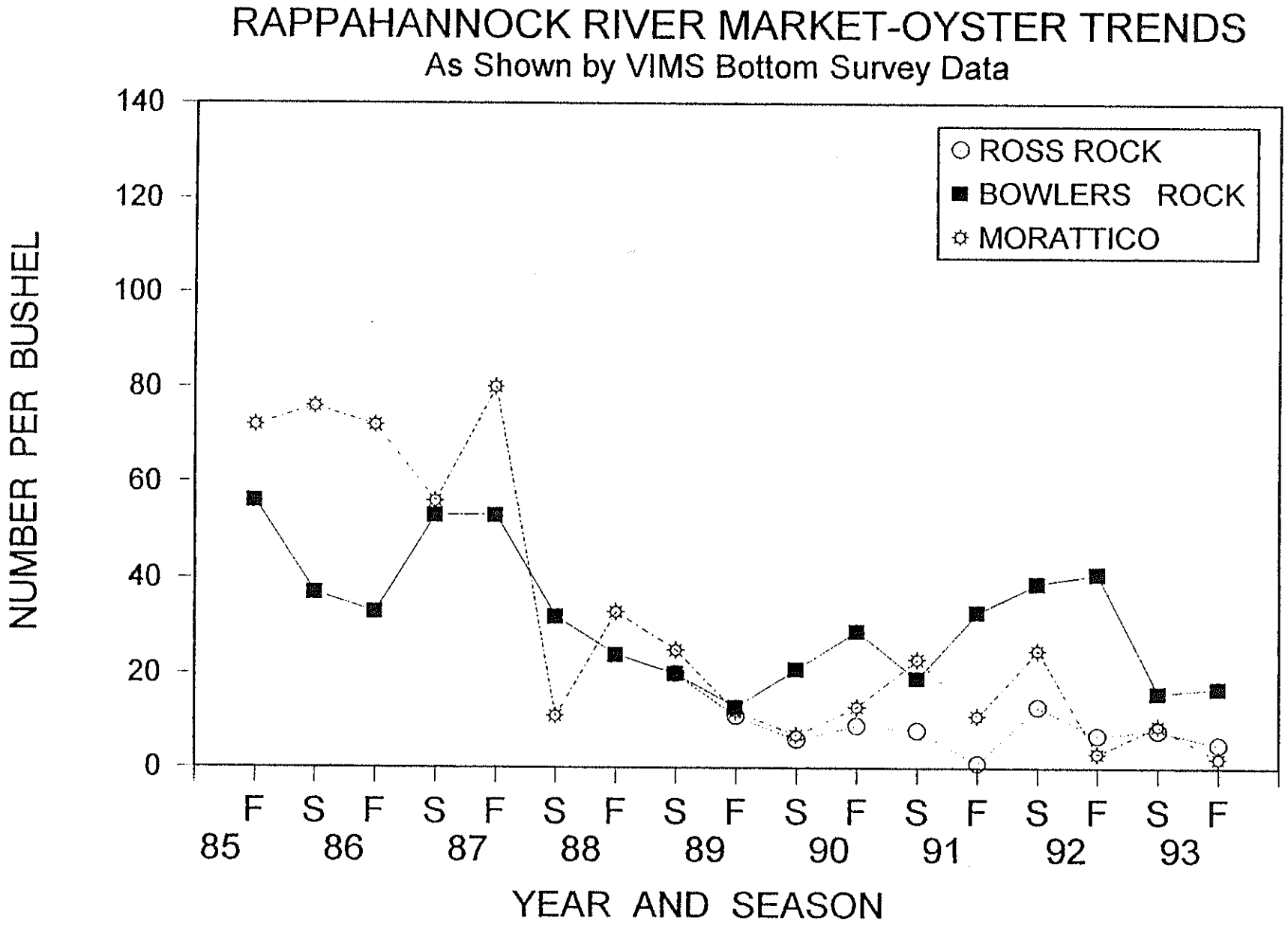

Figure 3. Trend in abundance of market oysters at three stations in the Rappahannock River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

❖ *Small Oysters*

Oysters classified as small (seed oysters) in VIMS surveys are over one-year old but under 3 inches in size. They can reach market size within one or two more years, depending on survival and growth rates.

There were fewer small oysters per bushel of bottom material in the James River in the spring of 1993 than in the fall of 1992 (Figure 4). Although there was a slight rebound at Point of Shoals and Dry Shoal from numbers recorded in the spring of 1993, the numbers were still lower than in the fall of 1992. The difference between fall 1993 and fall 1992 was small-to-moderate at bars in the lower salinity area on the south side of the river: 14-18% at Long Rock and Point of Shoals, and 30-39% at Horsehead and Dry Shoal; however, the difference was large in the higher salinity areas of the river: 84% at Nansemond Ridge, 68% at Wreck Shoal and 57% at Thomas Rock. Horsehead is the only bar among those sampled in the James River, or elsewhere in this survey, with a count of small oysters that approximates what could be termed as a "good" seed count of 700 per bushel.

Establishment of a 2 1/2-inch cull law in 1986 has undoubtedly contributed to the sharp decrease in the number of small oysters (under 3 inches) in the James River, especially at Horsehead (Figure 4). The subsequent large increase in 1991 at Horsehead was due primarily to a very high spat set at the same location in 1990 (Figure 7). Numbers of small oysters at Horsehead remained high through the fall of 1992 (assisted by another good spat set in 1991) but started to decrease in 1993. The decline in 1993 may be attributable to a combination of a low spat set in 1992 and harvesting pressure during the 1992-93 season. The 1993 data do not show unusual mortalities that could be attributed to high freshwater flows in the spring of that year.

In the Rappahannock River, the most significant change in the average number of small oysters between fall of 1992 and fall of 1993 was recorded at Ross Rock: a decrease of 81%, from 111 to 21 per bushel. There was very little change in numbers between 1992 and 1993 at five of the other seven bars. A decrease of 87% at Hog House Bar and an increase of 72% at Drumming Ground Bar are at this time considered anomalous and probably related to the small number of oysters in the samples. Number of small oysters also remain very low in the Corrotoman River.

The average number of small oysters per bushel in the Piankatank River was slightly lower at Ginney Point and slightly higher at Burton Point in 1993 than in the fall survey of 1992, but the numbers at both bars represent the continuation of low or very low numbers evident in our surveys since 1985 and 1986 (Figure 5).

In the Great Wicomico River, the number of small oysters per bushel in 1992 was the lowest recorded in our surveys since 1985, between 18 and 33 at the three bars sampled (Figure 6). There was a substantial increase in those numbers in 1993, between 51% and 90%; however, those values are still the lowest since 1985.

❖ *Spat*

Spat are juvenile oysters that have been recruited into the population within the few months included in the last spawning season. They are important as potential seed oysters (in 1-3 years) and market oysters (in 3-5 years), depending on growth and survival. Overall, recruitment on bottom cultch was very poor in 1993, when compared to 1990 and 1991 (and 1989 in the Piankatank River) (Figures 5, 7, and 8). Only three bars (Horsehead and Dry Shoal in the James and Haynie Point in the great Wicomico) had more than 100 spat per bushel (Table 2).

❖ ❖ ❖

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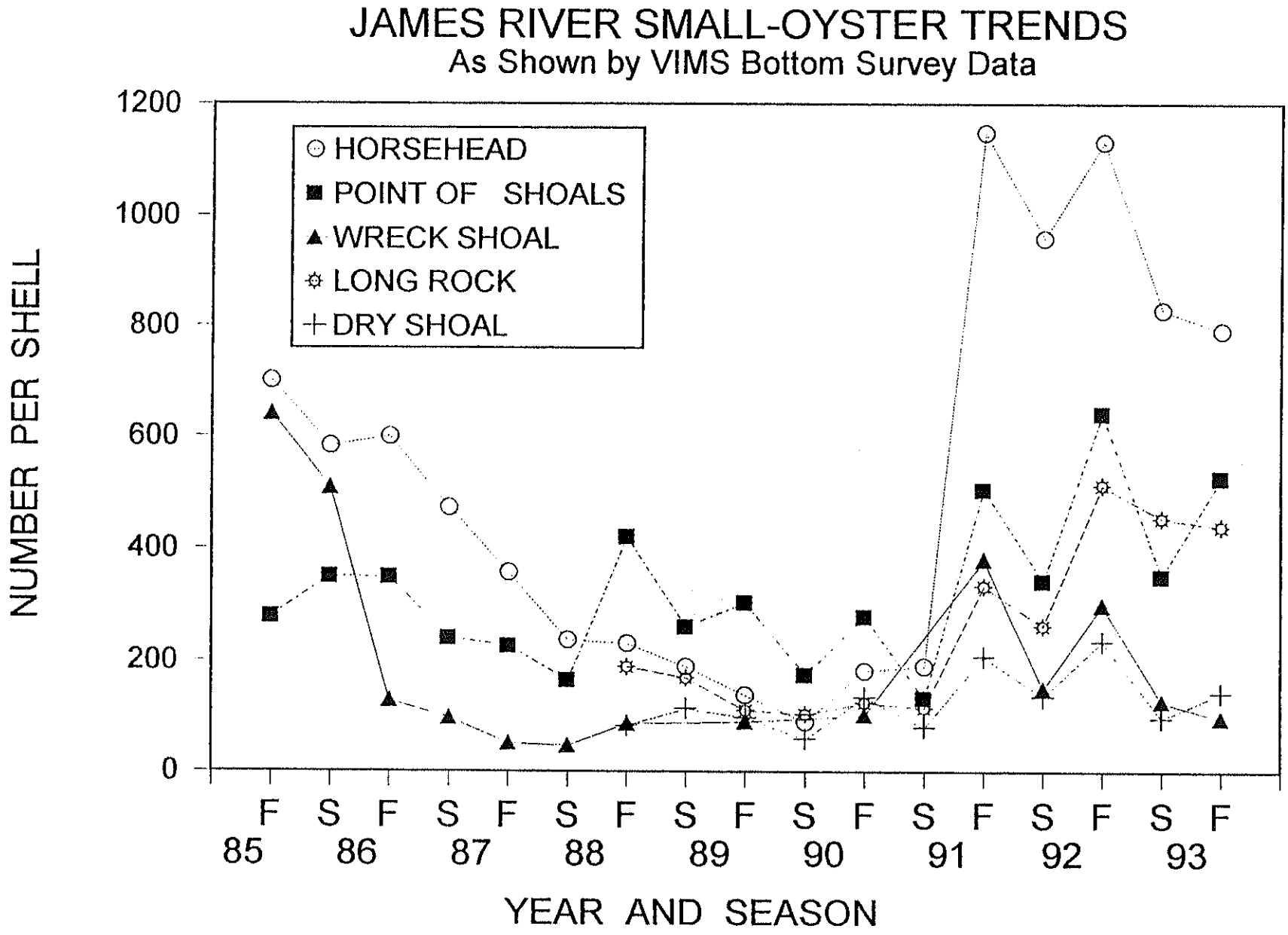

Figure 4. Trend in abundance of small oysters at three stations in the James River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

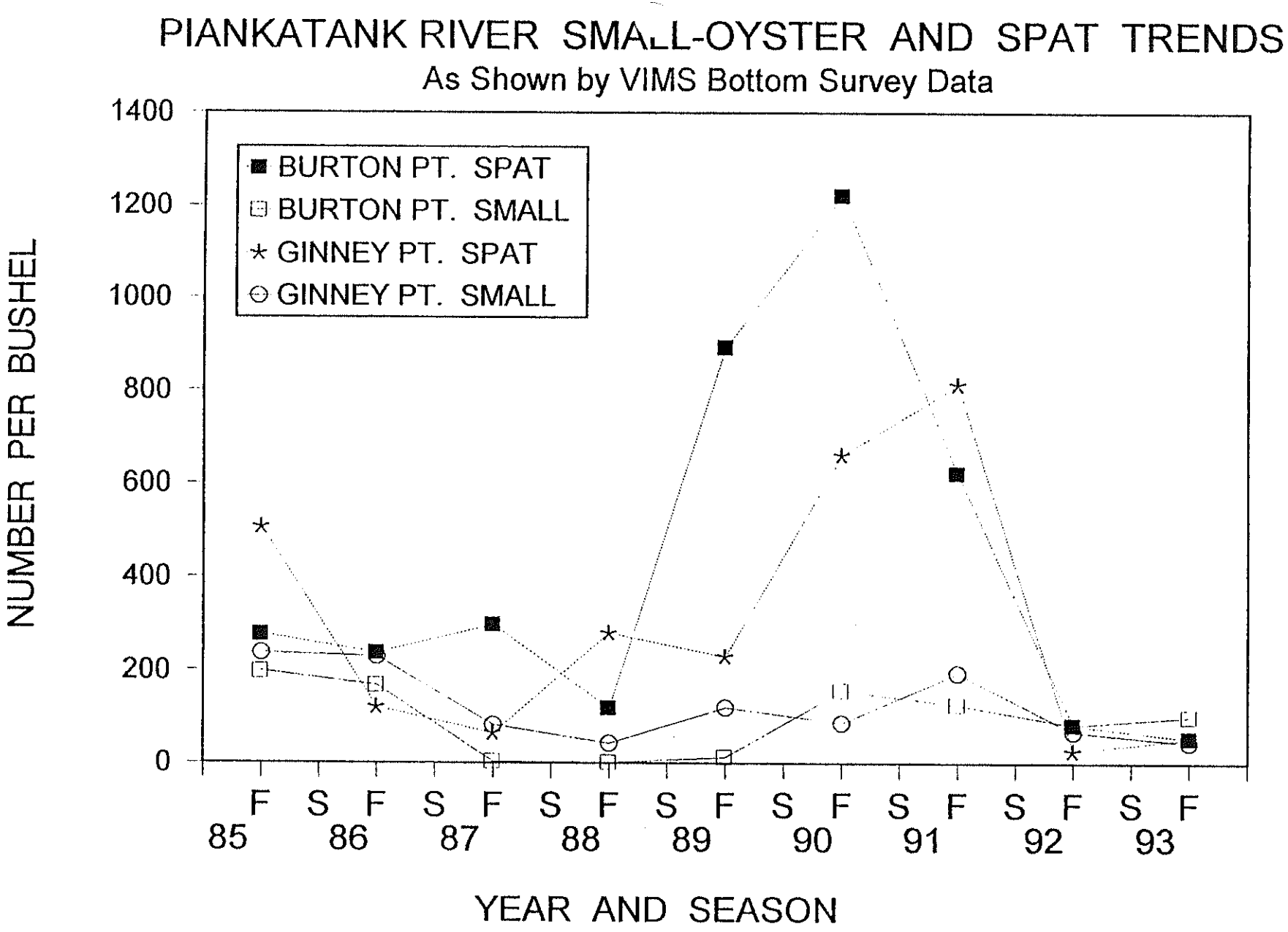

FIgure 5. Trend in abundance of small oysters and spat at three stations in the Piankatank River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

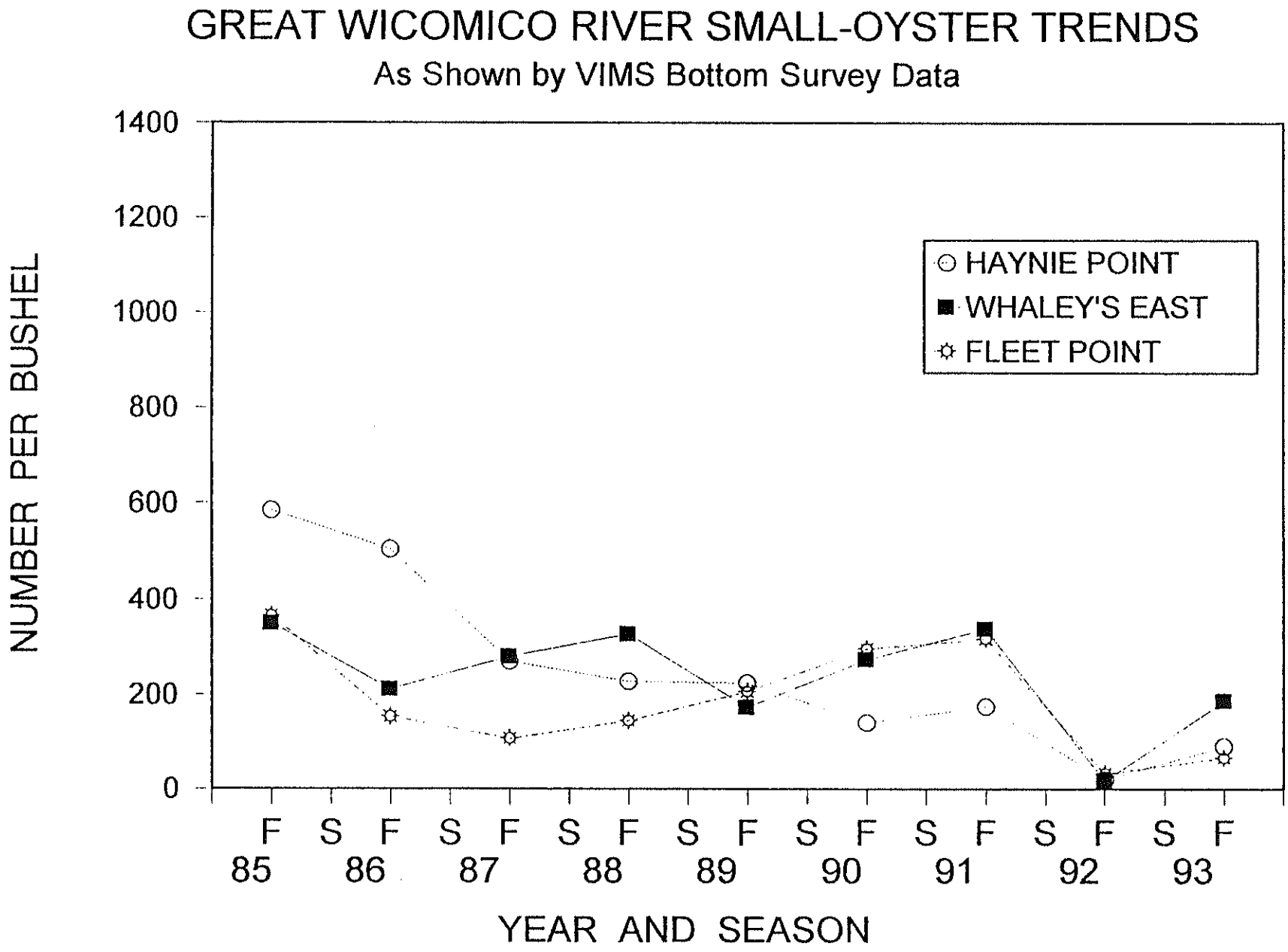

FIgure 6. Trend in abundance of small oysters at three stations in the Great Wicomico River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

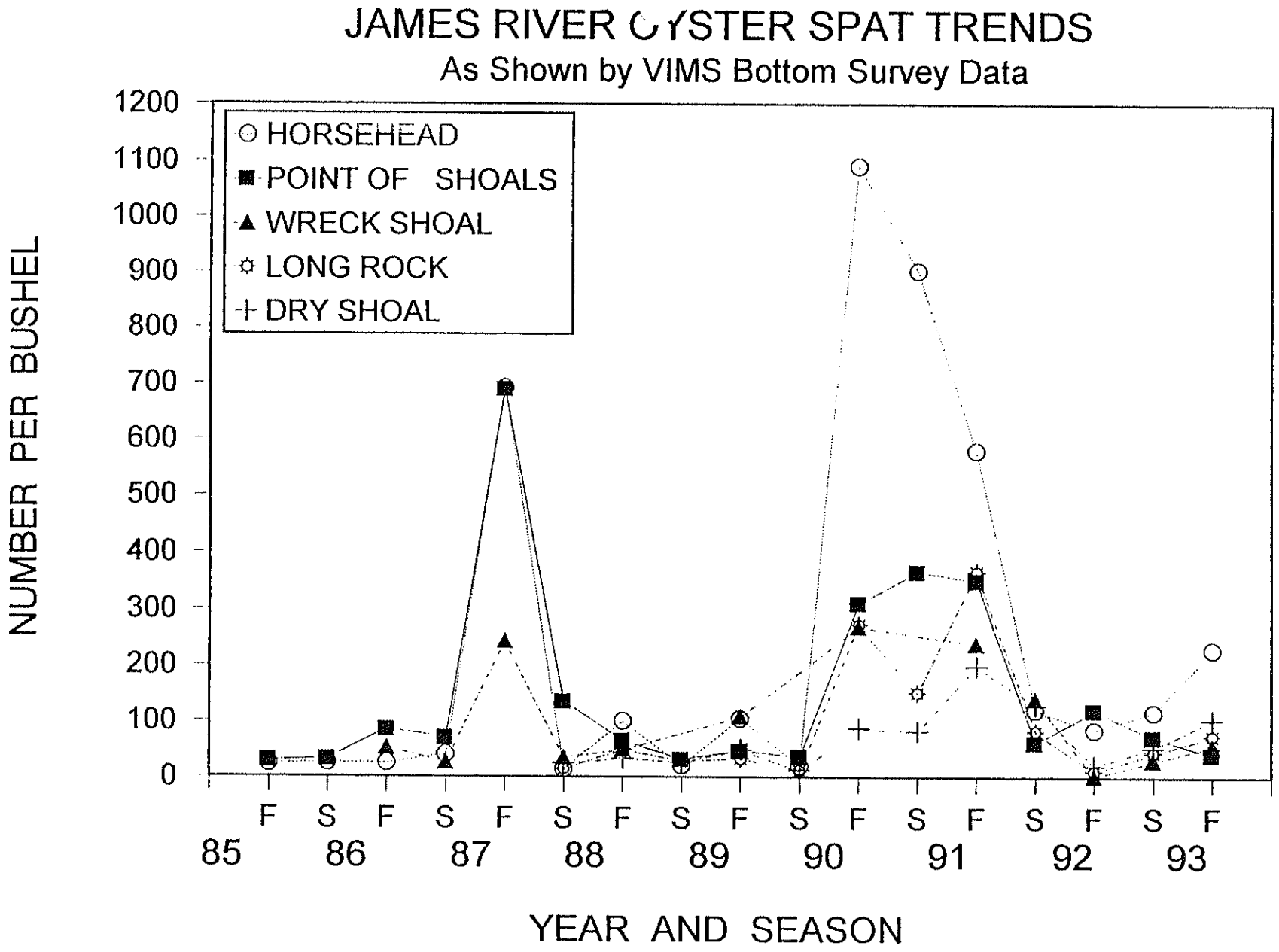

FIgure 7. Trend in abundance of oyster spat at five stations in the James River sampled during VIMS oyster bottom surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

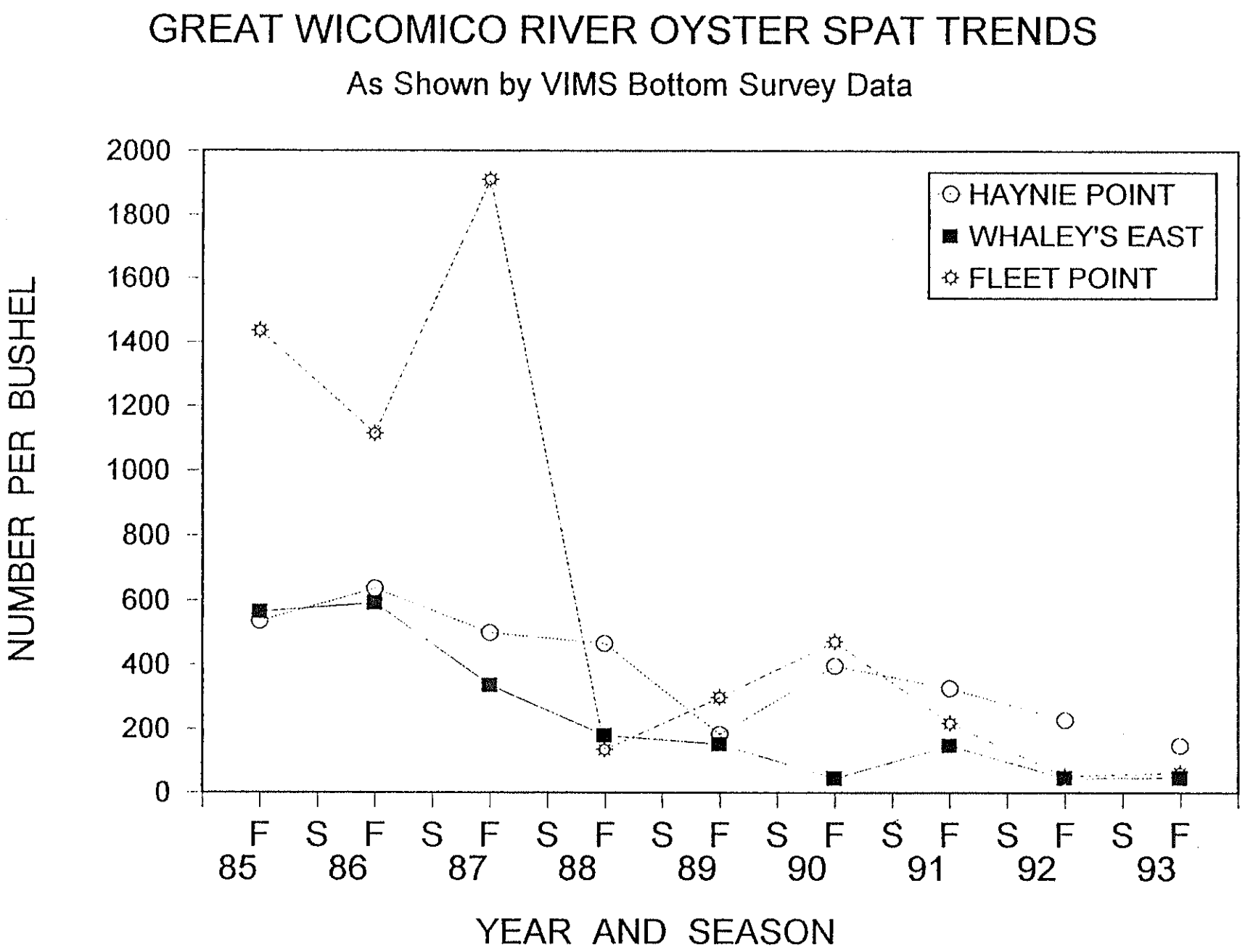

FIgure 8. Trend in abundance of oyster spat at three stations in the Great Wicomico River sampled during VIMS bottom oyster surveys in the Spring and Fall of successive years between 1985 and 1993. F=Fall, S=Spring.

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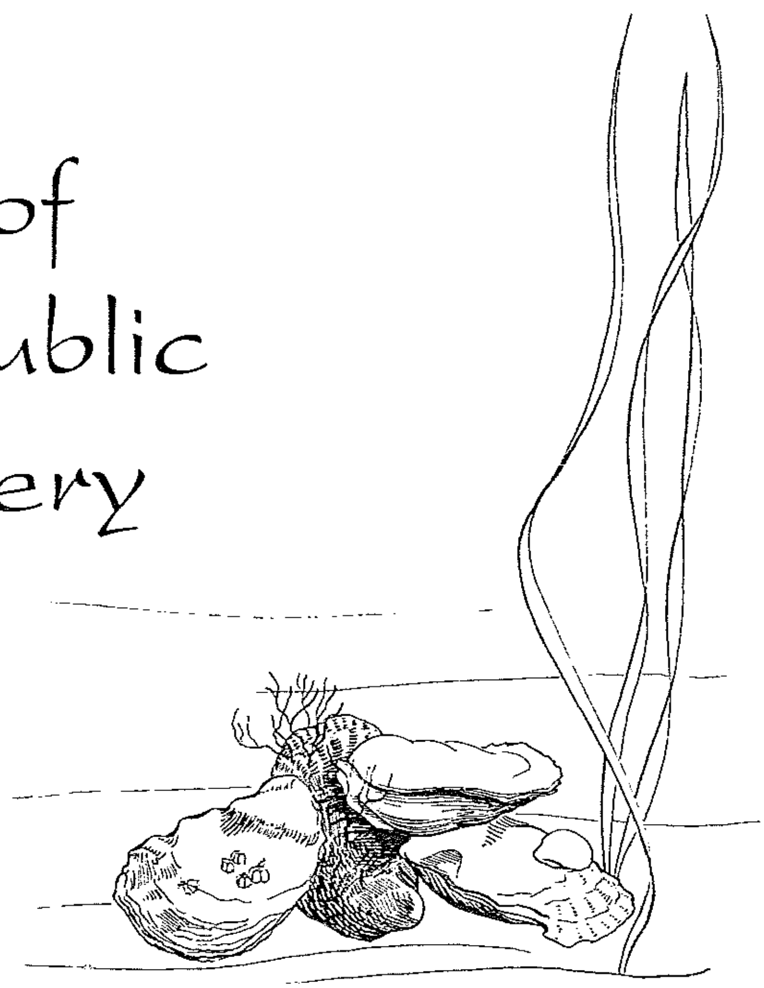

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