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Status of the Major Oyster Diseases in Virginia 1994 A Summary of the Annual Monitoring Program

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STATUS OF THE MAJOR OYSTER DISEASES IN VIRGINIA—1994.

A SUMMARY OF THE ANNUAL MONITORING PROGRAM.

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EXECUTIVE SUMMARY

Weather. The winter of 1994 was very cold and wet and this was reflected in water temperatures which remained below 5°C for a period of 8 weeks and in James River streamflow which was well above the long-term average in February and March. Temperatures in spring and summer were periodically above and below average. Streamflows were average in April, May and July, below average in June, and above average in August. The fall was dry and water temperatures were consistently above average.

***Haplosporidium nelsoni* (MSX).** *Haplosporidium nelsoni* was present in oysters from four James River beds—Horsehead Rock, Wreck Shoal, Thomas Rock, and Nansemond Ridge. Prevalence at Horsehead Rock was relatively low and varied from 8-17% during the months of January through April, 0% from May through November and 4% in December. Prevalences and intensities of *H. nelsoni* were much higher in the high salinity (>12-15 ppt) areas of the James River. In October prevalence was 44% at Thomas Rock and 56% at Nansemond Ridge. At Wreck Shoal prevalence varied from 8-60% during the months of January through April, 0% from May through July, and 12-60% from August through December. On average, *H. nelsoni* prevalence at Wreck Shoal and Horsehead Rock was higher than in previous years.

High prevalences and infection intensities of *H. nelsoni* were also observed in VIMS monitoring tray oysters. In late July prevalence was 84%, equivalent to the highest prevalence ever recorded in VIMS monitoring trays. Cumulative mortality of the tray oysters was 90% in mid-October. Mortality may be attributed to heavy infections of both *H. nelsoni* and *P. marinus*.

Haplosporidium nelsoni was not abundant in oyster beds outside of the James River. Only two cases of MSX were detected in our fall survey of oysters from the Rappahannock, Piankatank, Corrotoman, and Great Wicomico Rivers. One case was observed at Broad Creek in the Rappahannock River and the other case was observed at Burton's Point in the Piankatank River. Prevalence at both locations was 4%.

***Perkinsus marinus* (Dermo).** This parasite continued to be present on all oyster bars in Virginia, with the exception of Ross' Rock in the Rappahannock River. The unusually cold winter and high streamflows in February and March had little impact on the subsequent abundance of *P. marinus* during the summer and fall. *Perkinsus marinus* prevalence at Wreck Shoal in the James River was 92-100% for a period of 5 months, August through December. The parasite was also abundant in the fall at Horsehead Rock and Deepwater Shoal in the James River; prevalences were respectively 96 and 56%. Advanced infections were restricted to higher salinity (>12 ppt) areas and were common in the lower portions of the Piankatank, Rappahannock, Corrotoman, and James (at and below Wreck Shoal) Rivers and throughout seaside waters of the Eastern Shore. It is probable that *P. marinus* caused some mortality in these areas. There is no indication that *P. marinus* is being eradicated from low salinity areas as prevalences and infection intensities in 1994 were very similar to 1992-1993 levels.

INTRODUCTION

The protozoan parasites *Haplosporidium nelsoni*, popularly known as MSX, and *Perkinsus marinus*, popularly known as Dermo, are serious pathogens of oysters in the Chesapeake Bay. MSX first appeared in Chesapeake Bay in 1959 and in the early 1960s killed millions of bushels of oysters on lower Bay oyster grounds. The continued presence of the parasite has discouraged use of these prime growing areas since that time.

The infection period for *H. nelsoni* begins in early May each year with peak mortality in the lower Bay from these early summer infections during August and September. However, infections acquired during late summer and fall may overwinter if salinity remains high and develop as soon as water temperature increases in early spring. These overwintering infections may cause oyster mortality as early as June. In the major tributaries, normal spring runoff usually causes expulsion of overwintering *H. nelsoni* infections by May, but the pathogen may reinvade an area by fall if salinity is favorable during summer. Oyster mortality is reduced under these circumstances because *H. nelsoni* is present mainly during winter when cold water temperature slows development of the parasite.

Historically, *P. marinus* has been present at low levels in the lower portions of all Virginia rivers, but the parasite increased in abundance and spread throughout all public oyster beds during the late 1980s. Until that time *P. marinus* was not as serious a pathogen as *H. nelsoni* because *P. marinus* spread slowly within an oyster bed and between adjacent beds, and required three years to cause significant mortality. However, because of the increase in the distribution and abundance of *Perkinsus*, this parasite is now more important than *H. nelsoni* as an oyster pathogen in the Bay. The population dynamics of *P. marinus* are complex and not entirely understood. Most mortality occurs during late summer and early fall, but it may begin as early as June following warm winters that allow more overwintering infections.

The distribution and pathogenicity of both diseases are limited by salinity and, in a very general sense, neither parasite causes serious mortality in areas where the salinity remains below about 12-15ppt. *Haplosporidium nelsoni* is eliminated from oysters after about 10 days below 10ppt; however, *P. marinus* may persist for years at low salinity although it is not pathogenic.

Because of the detrimental effect of these diseases on the Virginia oyster industry, the Virginia Institute of Marine Science has been monitoring the prevalence of both parasites since 1960. Information on disease severity and distribution each year is provided to management agencies and the oyster industry through publications and special advisories of the Marine Advisory Service office. The results of disease monitoring for the calendar year 1994 are presented in this report.

SAMPLING METHODS

The oyster disease monitoring program consists of three different sample types—tray samples, native oyster samples and samples provided from private oyster grounds.

Tray Samples. In late April each year, oysters are dredged from Ross' Rock in the upper Rappahannock River, and placed in 2-foot by 4-foot legged trays in the York River at Gloucester Point. Oysters from the upper Rappahannock River are known to be highly susceptible to *H. nelsoni* and thus they serve as excellent indicators of annual abundance of this parasite when placed in an endemic areas such as the lower York River just prior to the normal infection period for *H. nelsoni* that begins in May and continues through July. Historically, *P. marinus* has never invaded the trays during the first year of monitoring so the trays were a good measure of mortality resulting from MSX alone. However, because of the dramatic increase in *P. marinus* abundance since 1987, oysters in the monitoring trays have become infected with this pathogen in recent years. The presence of both *H. nelsoni* and *P. marinus* in the trays has made interpretation of the cause of mortality difficult. In addition, because of its widespread distribution, oysters from the upper Rappahannock Rivers may now be infected

RESULTS

Temperature and streamflow/salinity.

Water temperature in 1994 was characterized by alternating periods of above average temperatures and below average temperatures (Figure 1). The winter of 1994 was atypically cold and water temperature reflected the unusually cold air temperature as weekly means were generally less than long-term averages. Weekly water temperature averages were below 5°C for a period of eight weeks, the longest period since 1988. The months of April, June and July were relatively warm as temperatures were 1-2°C above average while water temperatures during May, and August through October were lower than long-term averages. The end of the year was relatively warm and weekly temperature averages were 1-3°C above average during November and December (Figure 1). A comparison of 1990-1994 temperature anomalies (deviations from long-term average temperatures) is shown in Figure 3.

James River streamflow during 1994 was well above average in January, February, March and August, average in April, May, July, and September, and below average during June and from October through December (Figure 1). Streamflow in the James River reflected monthly mean streamflow for the entire Chesapeake Bay system as shown in Figure 2. A comparison of 1990-1994 streamflow anomalies (deviations from long-term means) is shown in Figure 3. The above average streamflow during February and March of 1994 resulted in yearly salinity minimums of 5-6 ppt at Wreck Shoal (Figure 5), and 0 ppt at Horsehead Rock and Deepwater Shoal during February, March and April (Figure 6 and 7). Salinity at Wreck Shoal increased to 12 ppt by late April while salinity at Horsehead Rock and Deepwater Shoal increased from the spring minimum more slowly following the onset of drier conditions in May and June. June-August salinity ranged from 10-20 ppt at Wreck Shoal, 4-12 ppt at Horsehead Rock, and 3-10 ppt at Deepwater Shoal (Figures 5-7). The relatively dry conditions occurring during September-December caused elevated salinities and created conditions conducive to *P. marinus* development at all three locations. September-December salinity ranged from 14-19 ppt at Wreck Shoal, 10-15 ppt at Horsehead Rock, and 6-13 ppt at Deepwater Shoal (Figures 5-7).

Native Oyster Samples.

***Haplosporidium nelsoni* (MSX).** This parasite was present at relatively high levels in 1994 in several James River oyster beds. Prevalence in oysters sampled in October from Wreck Shoal, Thomas Rock, and Nansemond Ridge ranged from 40-56% (Table 1) and heavy infections were numerous. At Wreck Shoal *H. nelsoni* prevalence in the winter declined from 60 to 8% in response to low salinities as a result of high streamflow in February and March (Figure 5). The parasite was absent from oysters sampled in May through July, but with the return of favorable salinities prevalence increased to 12% in August and continued to rise to 60% in December. *Haplosporidium nelsoni* also infected oysters at Horsehead Rock. Infections originating in the fall of 1993 persisted at Horsehead Rock at a prevalence of 8-21% during the months of January through April. The parasite was not observed in oysters sampled in May through November, but it did reappear at 4% prevalence in December (Figure 6). *Haplosporidium nelsoni* was generally rare in oysters sampled from other public oyster beds. Low prevalences (4%) of MSX were observed in the Piankatank River at Burton's Point, in the Rappahannock River at Broad Creek, and on the Eastern Shore at Burton Bay (Table 1).

***Perkinsus marinus* (Dermo).** This parasite was found on all beds sampled in the fall (the period of maximum abundance) except for Ross' Rock in the upper Rappahannock River (Table 1). *Perkinsus marinus* prevalence and infection intensity varied with location, generally decreasing with decreasing salinities as one moves up river. Moderate to heavy infections were only observed in oysters from areas having salinities greater than 9 ppt. Prevalences of *P. marinus* at the various sampling locations were very consistent with levels observed in 1993.

Shoal increased to 12-20 ppt and *H. nelsoni* reappeared. Prevalence was only 12% in August but continued to rise during the fall months. In December prevalence was 60% which was unusually high. Infection intensities were high during the fall and some oyster mortality probably occurred. Prevalence at Horsehead Rock was much lower than at Wreck Shoal, but relatively high for this location, ranging from 8-17% during January through April. Consistently low salinity allowed expulsion of the parasite in May and it did not reappear at this location until December, following a two month dry period in which salinity was consistently greater than 11 ppt.

Oysters in the monitoring tray at VIMS were infected with *H. nelsoni* at relatively high levels indicating that the abundance of the parasite was high in high salinity (18-20 ppt) areas and that oysters transplanted into endemic high salinity areas are likely to acquire high levels of infection. Prevalence and intensity of *H. nelsoni* in oysters maintained at VIMS in 1994 were equivalent to record high levels and undoubtedly contributed to the observed mortality of tray oysters. By late July *H. nelsoni* prevalence was 84% and 14 out of the 25 oysters examined had heavy or moderate infections. Prevalence declined in subsequent samples but advanced infections continued to be numerous. The rate of oyster mortality was high in August and September and by mid-October cumulative mortality was 91%. *Perkinsus marinus* was also present in the tray oysters at high intensities and probably also contributed to the observed mortality.

***Perkinsus marinus* (Dermo).** The harsh winter temperatures and wet conditions occurring in the early months of 1994 had little impact on the summer and fall abundances of *P. marinus*. While spring prevalence and intensities of *P. marinus* were as low as 0% for several months in some areas the parasite reappeared during the summer months and was present in the fall on all sampled oyster grounds, except for Ross' Rock, Rappahannock River. Prevalences and infection intensities of the parasite were very similar to levels observed in 1993—which had a much warmer winter than 1994 but like 1994 also had relatively high winter/spring streamflows. While prevalence and infection intensities in 1992-1994 have been consistently lower than in 1991, there seems to be little evidence of eradication of the parasite from the upper tributary bars. *Perkinsus marinus* still poses a serious threat to oyster survival in areas having salinities greater than 12-15 ppt.

Typical of the annual cycle of *P. marinus*, in 1994 infection intensity declined during the winter reaching an annual low in the spring. This decline was followed by an increase during the summer months as warm water temperatures allowed proliferation of the parasite. Peak prevalences were observed in September in areas having higher salinities (>12 ppt) and in October at lower salinity (<12 ppt) areas. The relatively warm dry fall allowed high infection levels to be sustained through December. *Perkinsus marinus* abundance decreased in an upriver direction in all tributaries surveyed and heavy-moderate infections were only observed in oysters inhabiting areas with salinities above 9-12 ppt.

It has become apparent in recent years that standard diagnostic methods fail to detect many cases of overwintering *P. marinus* infections because they are usually very light in intensity. In March 1994 utilization of a new diagnostic technique revealed light intensity infections in all Wreck Shoal oysters that were analyzed. These overwintering infections serve as a reservoir and are probably responsible for the continued resurgence of the disease during the summer and fall months, particularly in upper river areas where transmission of new infections is believed to be limited by low salinity.

Table 1. Prevalence and intensity of MSX and *Perkinsus marinus* in oysters from Virginia harvesting areas in 1994. See accompanying figures for station locations.

Location	Date	Temp. (°C)	Sal. (ppt)	MSX Infect./exam. -%infected	H–M–L*	*Perkinsus* Infect./exam. -%infected	H–M–L*
James River							
Deep Water Shoal	13 Jan	4.0	5.0	NA**		3/25 - 12%	0–0–3
	15 Feb	4.0	0	NA		2/25 - 8%	0–0–2
	14 Mar	9.0	0	NA		0/25 - 0%	
	12 Apr	17.0	0	NA		0/25 - 0%	
	16 May	17.5	3.9	NA		0/25 - 0%	
	16 Jun	27.2	4.0	NA		0/25 - 0%	
	13 Jul	29.0	8.0	NA		0/25 - 0%	
	17 Aug	26.7	10.0	NA		1/25 - 4%	0–0–1
	14 Sep	25.5	8.0	NA		4/25 - 16%	0-0-4
	18 Oct	18.1	13.0	NA		14/25 - 56%	0-0-14
	15 Nov	16.8	11.0	NA		6/25 - 24%	0-0-6
	13 Dec	8.9	10.5	NA		4/25 - 16%	0-0-4
Horsehead Rock	13 Jan	4.0	6.5	2/25 - 8%	0-0-2	11/25 - 44%	0–0–11
	15 Feb	4.0	0	2/25 - 8%	0-0-2	5/25 - 20%	0–0–5
	14 Mar	9.0	0	0/25 - 0%		2/25 - 8%	0–0–2
	12 Apr	16.0	0	4/24 - 17%	0-0-4	0/25 - 0%	
	16 May	17.1	5.0	0/25 - 0%		0/25 - 0%	
	16 Jun	26.8	5.0	0/25 - 0%		2/25 - 8%	0-0-2
	13 Jul	28.8	10.0	0/25 - 0%		0/25 - 0%	
	17 Aug	25.5	12.0	0/25 - 0%		7/25 - 28%	0–0–7
	14 Sep	25.0	10.0	0/25 - 0%		11/25 - 44%	1-1-9
	18 Oct	18.0	15.0	0/25 - 0%		24/25 - 96%	1-0-23
	15 Nov	17.0	13.0	0/25 - 0%		24/25 - 96%	0-1-23
	13 Dec	9.0	13.5	1/25 - 4%	0-0-1	15/25 - 60%	0-0-15
Point of Shoals	13 Jan	4.0	8.5	NA		8/25 - 32%	0–0–8
	15 Feb	5.0	0	NA		6/25 - 24%	0–0–6
	14 Mar	9.0	0	NA		0/25 - 0%	
	12 Apr	15.8	1.0	NA		0/25 - 0%	
	16 May	16.9	5.1	NA		0/25 - 0%	
	16 Jun	26.8	6.0	NA		0/25 - 0%	
	13 Jul	28.8	10.0	NA		2/25 - 8%	0-0-2
	17 Aug	25.5	13.0	NA		10/25 - 40%	2-1-7
	14 Sep	24.0	10.0	NA		17/25 - 68%	1-1-15
	18 Oct	17.9	14.0	NA		23/25 - 92%	3-0-20
	15 Nov	16.2	13.5	NA		22/25 - 88%	0-2-20
	13 Dec	8.5	13.0	NA		21/25 - 84%	0-0-21
Wreck Shoal	13 Jan	4.0	14.0	15/25 - 60%	4-2-9	19/25 - 76%	2-1-16
	15 Feb	4.0	5.0	7/25 - 28%	1-1-5	14/25 - 56%	2-2-10
	14 Mar	9.0	5.0	2/25 - 8%	0-0-2	2/25 - 8%	0-0-2
	12 Apr	15.0	6.5	10/25 - 40%	0–0–10	2/25 - 8%	0-0-2
	16 May	19.5	8.0	0/25 - 0%		2/25 - 8%	0-0-2
	16 Jun	26.8	12.2	0/25 - 0%		12/25 - 48%	0–2–10
	13 Jul	27.8	17.0	0/25 - 0%		19/25 - 76%	0–3–16
	17 Aug	25.5	18.0	3/25 - 12%	0-0-3	24/24 - 100%	3-7-14
	14 Sep	25.0	13.0	3/25 - 12%	0-1-2	25/25 - 100%	4-6-15
	18 Oct	17.0	18.0	10/25 - 40%	1-1-8	24/25 - 96%	1-9-14
	15 Nov	16.4	17.0	11/25 - 44%	2-2-7	25/25 - 100%	6-6-13
	13 Dec	9.0	16.0	15/25 - 60%	2-3-10	23/25 - 92%	4-4-15

*H=number of heavy infections, M=moderate infections, L=light infections.
**NA=not analyzed for MSX.

Table 2. Mean mortality and disease prevalence in upper Rappahannock River seed oysters placed in replicate trays at Gloucester Point, VA in May, 1994.

Date–1994	Monthly mortality–%	Cumulative mortality-%	*H. nelsoni* prevalence	Intensity H-M-L*	*P. marinus* prevalence	Intensity H–M–L*
5 May	0%	0%				
6 Jun	1.29%	1.38%				
7 Jul	0.37%	1.75%				
29 Jul	3.29%	4.12%	21/25 - 84%	9-5-7	1/25 - 4%	0-0-1
9 Sep	39.70%	47.2%	16/25 - 64%	8-3-5	23/25 - 92%	7-4-12
17 Oct	53.50%	90.5%	11/25 - 44%	3-4-4	25/25 - 100%	11-1-13

*H = number of heavy infections, M = moderate infections, L = light infections.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in Cooperation with
STATES OF MARYLAND, PENNSYLVANIA, AND VIRGINIA
ESTIMATED STREAMFLOW ENTERING CHESAPEAKE BAY

A monthly summary of cumulative streamflow into the Chesapeake Bay designed to aid those concerned with studying and managing the Bay's resources. For additional information, contact the District Chief, U.S. Geological Survey, 208 Carroll Building, 8600 LaSalle Road, Towson, Maryland 21286, Phone 410–512–4800.

December 31, 1994.

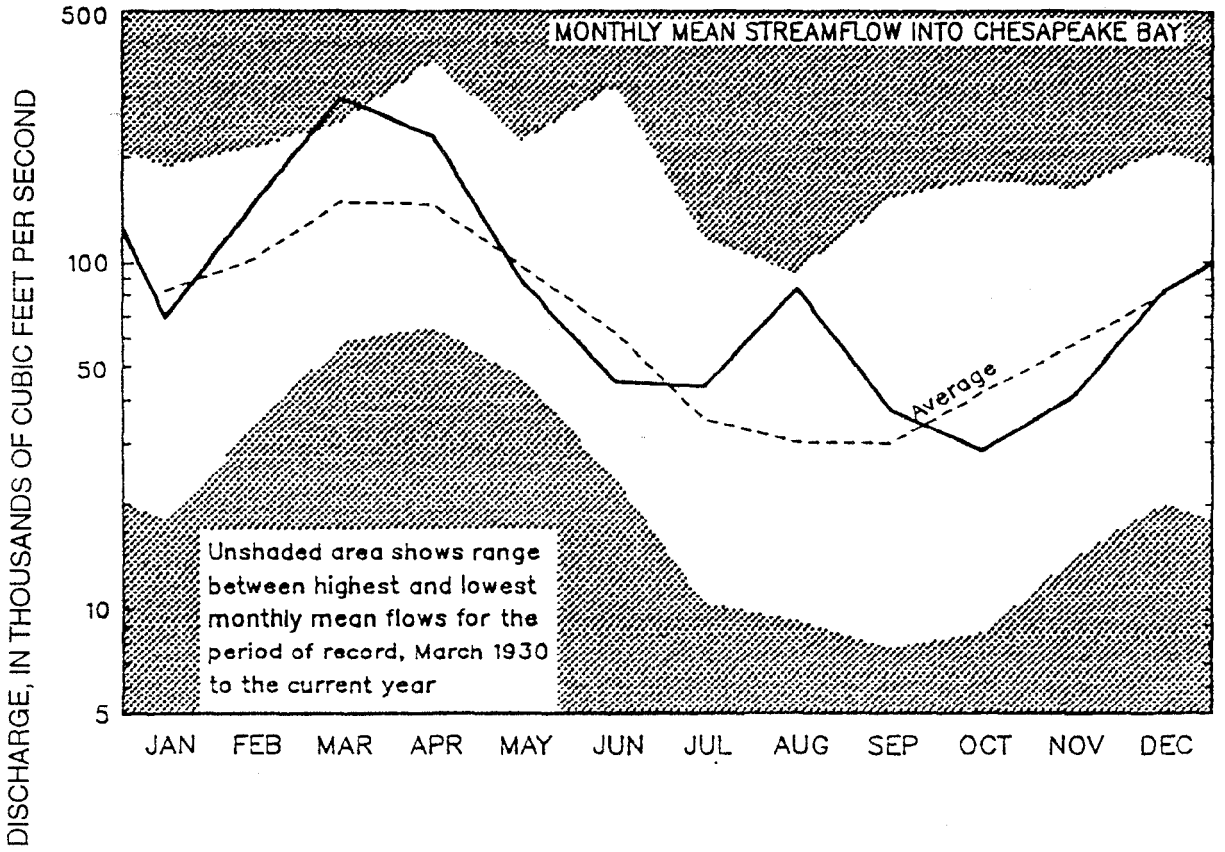


Figure 2. Monthly mean streamflow into Chesapeake Bay during 1994 (solid line) compared with average monthly streamflow for the period 1951-1993 (dashed line).

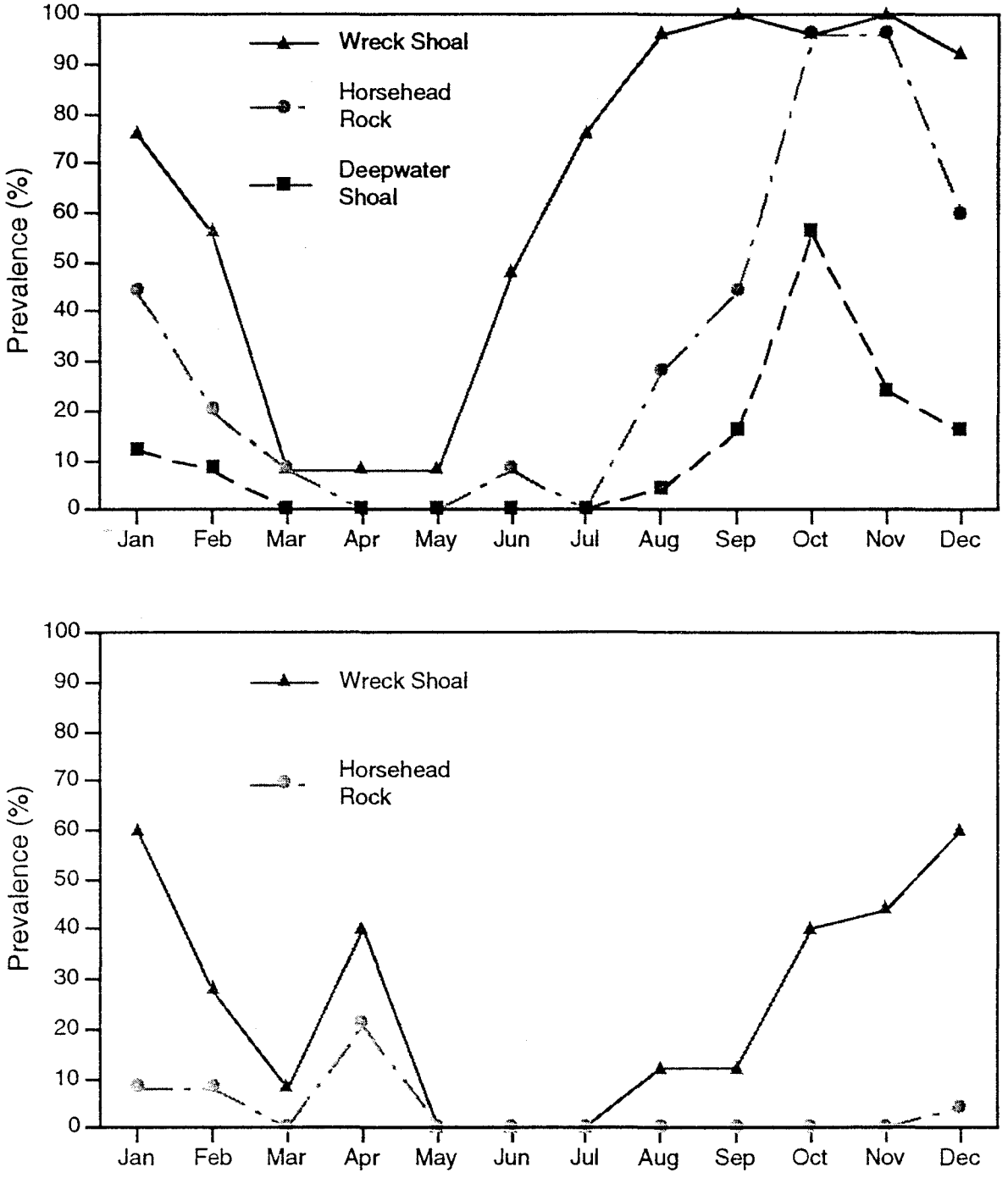


Figure 4. Prevalence of *P. marinus* (top) and *H. nelsoni* (MSX) (bottom) in James River oysters from Wreck Shoal, Horsehead Rock and Deepwater Shoal in 1994.

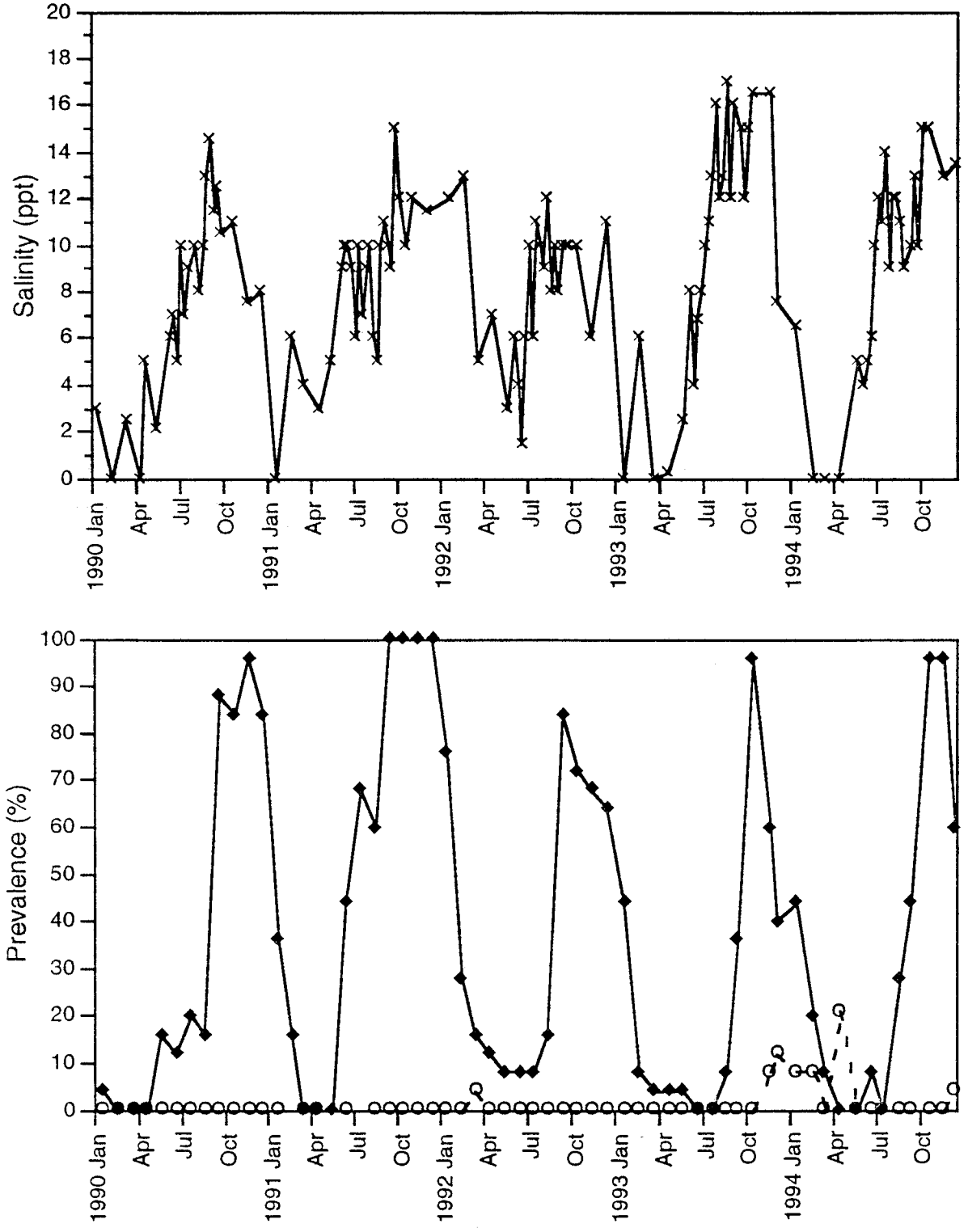
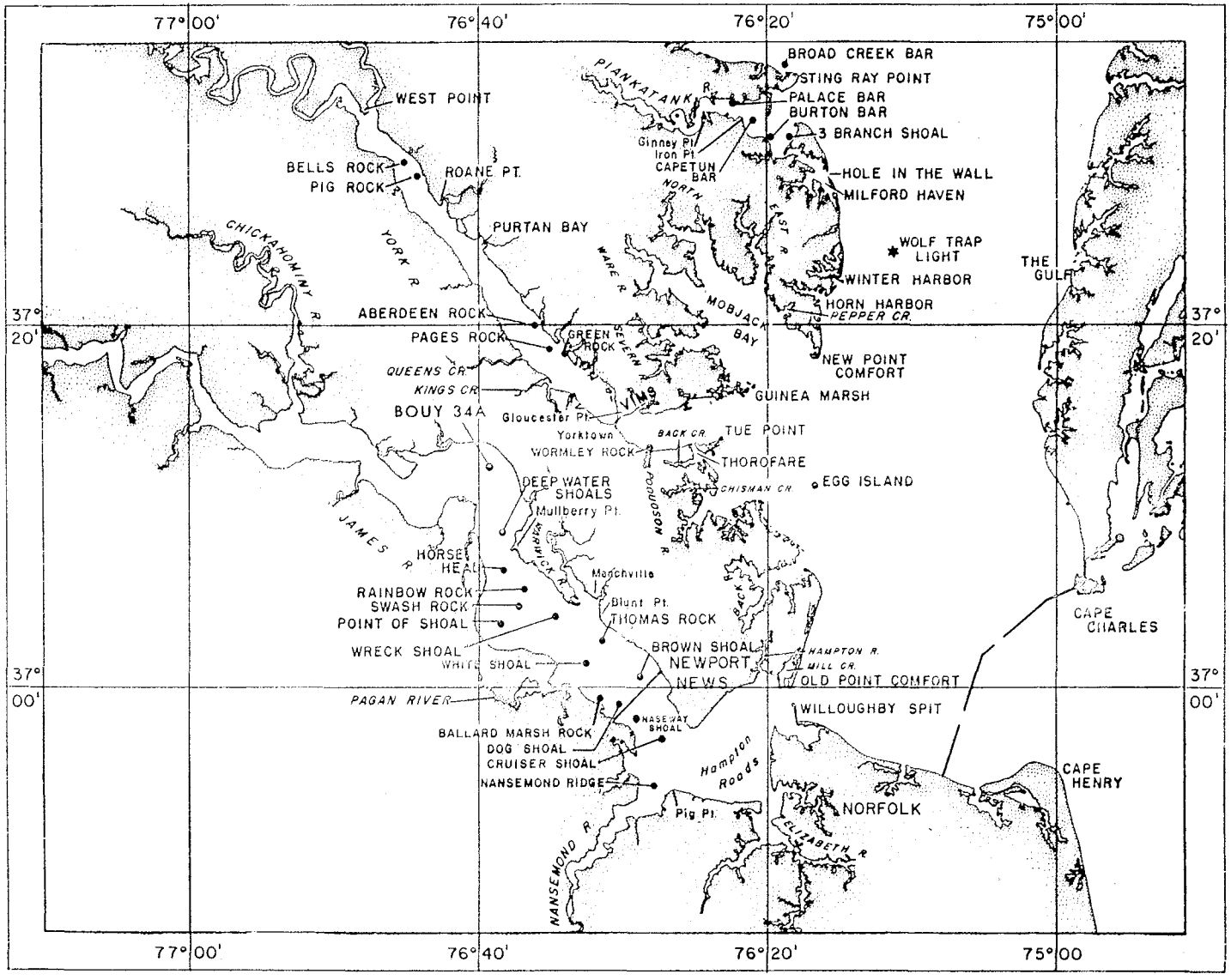
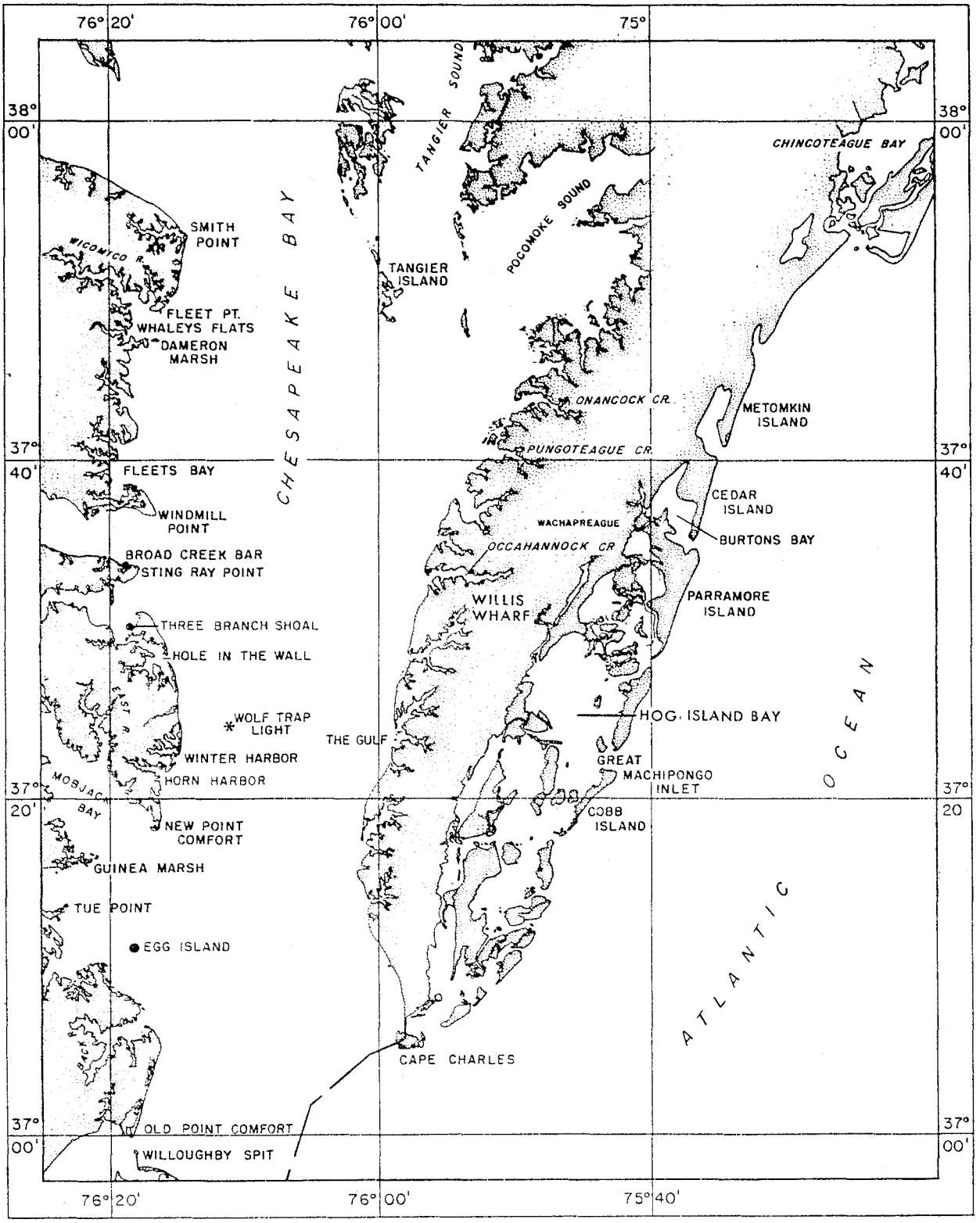


Figure 6. Salinity (top) and prevalence (bottom) of *P. marinus* (solid line) and *H. nelsoni* (dashed line) at Horsehead Rock, VA for the years 1990-1994.



Names of oyster rocks, geographical points, towns and bodies of water in James and York rivers.



Names of oyster rocks, geographical points, towns and bodies of water on Eastern Shore of Virginia.