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STATUS OF THE MAJOR OYSTER DISEASES IN VIRGINIA - 1989. A SUMMARY OF THE ANNUAL MONITORING PROGRAM.

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EXECUTIVE SUMMARY

After four drought years in a row, 1989 was a year of above average rainfall. May was the wettest on record and James River flow was above average every month from May through October. The low salinity in the James River resulting from the high runoff caused the elimination of MSX from oysters at Wreck Shoal and from beds above Wreck Shoal. Continuing low salinity during summer and fall prevented reinfection of oysters at these locations. All other harvesting areas also had relatively low prevalence of MSX during summer compared to the previous four years and this parasite was not a source of significant oyster mortality during summer and fall of 1989. However, during April 1989 prevalence of MSX was relatively high, especially on the seaside of the Eastern Shore, and some mortality may have occurred there during that time as well as at Wreck Shoal in the James River, in the lower Piankatank River, the lower Rappahannock River and the Great Wicomico River.

Unfortunately, the decreasing salinity appeared to have little effect on the prevalence or intensity of *Perkinsus*. This parasite had spread to all public oyster grounds in Virgnia during 1988. During winter of 1989 prevalence and intensity of *Perkinsus* decreased gradually in the James River seed area, but as soon as water warmed in the spring prevalence rapidly increased to 100% with a high proportion of heavy and moderate infections. This was in direct contrast to MSX, which was completely eliminated from the same areas during May. It is now clear that *Perkinsus* persists tenaciously at low salinity, even though it may not cause mortality below 10ppt., and in future droughts it may intensify rapidly. Prolonged above-average rainfall may gradually reduce the distribution of *Perkinsus*, but a single year has not been sufficient for remission to occur. The abundance of *Perkinsus* appears to be controlled more by winter temperature than by salinity.

Most other areas in the Bay had similar high prevalence and intensity of *Perkinsus*, except for the uppermost grounds in the Rappahannock and James Rivers, and mortality from this parasite was probably high during 1989. *Perkinsus* was consistently present on the seaside of the Eastern Shore, but prevalence and intensity were not as high as in the Bay and little mortality occurred from this parasite on the Eastern Shore.

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 prevented use of these prime growing areas since that time.

The infection period for MSX begins in early May each year with peak mortality from these early summer infections during August and September. However, infections acquired during late summer and fall may overwinter and develop as soon as water temperature increases in early spring. These overwintering infections may cause oyster mortality as early as June.

Historically, *Perkinsus* has been present at low levels in the lower portions of all Virginia rivers, but the parasite has recently increased in abundance and has spread throughout all public oyster beds. Until recently, *Perkinsus* was not as serious a pathogen as MSX because *Perkinsus* spread slowly within an oyster bed and between adjacent beds, and required three years to cause significant mortality. However, because of the recent increase in the abundance of *Perkinsus*, this parasite is now more important than MSX as an oyster pathogen in the Bay. The population dynamics of *Perkinsus* 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. MSX seems to be eliminated from oysters after about 10 days below 10ppt; however, *Perkinsus* 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.

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 either Horsehead Rock or Deep Water Shoal in the upper portion of the James River seed area and placed in 2-foot by 4-foot legged trays in the York River at Gloucester Point and at Wachapreague, Virginia on the seaside of the Eastern Shore. Oysters from the upper James River are known to be highly susceptible to MSX and thus they serve as excellent indicators of annual MSX abundance when placed in an endemic areas such as the lower York River. Historically, *Perkinsus* 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 *Perkinsus* abundance since 1987, oysters in the monitoring trays have become infected with *Perkinsus* in recent years and this has made interpretation of the cause of mortality difficult. Prior to establishing trays, a sample of 25 oysters is analyzed for MSX and *Perkinsus* to determine the level of existing infections at the dredge site. No infections have ever been encountered at these sites during April. At least 400 oysters are placed in each of two trays at each location on 1 May each year. Trays are cleaned every week and counts are made of live and dead oysters in each tray. Samples of 25 oysters are removed on about 1 July, 1 August, 1 September, and 1 October for disease determination; final counts are made about 1 December and trays are removed from the river at that time. New trays are established each May to provide a record of disease prevalence and intensity for each year. Because oysters from the same source have been held at the same location each year since 1960 we have a long-term data base on MSX abundance and it is possible to compare years and to relate disease abundance and distribution to various environmental parameters.

Oysters are also usually dredged from the upper James River during August and placed in trays in the lower York River. Mortality and disease prevalence are followed in these trays throughout winter and spring to determine the severity of late summer infections.

Native Oyster Samples. In order to determine the annual distribution and severity of both MSX and *Perkinsus*, samples of native oysters are collected periodically from most major public harvesting areas in Virginia. Samples of 25 oysters are collected approximately 1 June, 1 August and 1 October from many sites in Mobjack Bay, the Rappahannock River, the Great Wicomico River, Pocomoke Sound, and from the seaside of the Eastern Shore. Because of the intense fishing pressure in the James River, samples are collected monthly at Wreck Shoal and periodically at other sites upriver from Wreck Shoal.

Private Oyster Grounds. Private oyster planters submit samples for disease diagnosis and the results are used to make planting and harvesting decisions. In this report these samples are identified by location only and cannot be separated from native oyster samples.

DIAGNOSTIC TECHNIQUES

Prevalence of MSX is determined by histological analysis of paraffin-embedded tissue sectioned at 6µm and stained with hematoxylin and eosin; prevalence of *Perkinsus* is determined by thioglycollate culture.

Monthly mortality in tray samples is determined by dividing the number of dead oysters by the number of live and dead oysters in the tray. This result is divided by the period in days since the last count to yield percent dead per day. This value is then multiplied by 30 to yield monthly mortality.

RESULTS - 1989

Native Oyster Samples.

MSX. The distribution and prevalence of MSX was greatly reduced during the summer of 1989, especially in the rivers with large drainage systems (Table 1), and may have been the result of decreased salinity caused by high rainfall during May, 1989 (the wettest May on record, see Discussion). For example, monthly samples at Wreck Shoal in the James River (Table 1) revealed a slight increase in MSX prevalence from January (28.0%) through April (40.0%), but prevalence was greatly reduced during May (8.0%) and no MSX was found at Wreck Shoal from June through December, normally the period of maximum abundance. MSX prevalence was also reduced after May in other areas that have had high levels of the disease in recent years. For example, MSX prevalence was only 4% at Fleeton Point in the Great Wicomico River and only 12% at Parrot's Rock in the lower Rappahannock River. Considering this low prevalence in all areas sampled, MSX was not a source of significant oyster mortality in the lower Chesapeake Bay during summer of 1989.

The prevalence of MSX was much higher on the seaside of the Eastern Shore, especially during spring. Prevalence ranged from 28% to 60% in oyster samples from North Channel, Hog Island Bay and a high proportion of the infections were heavy or moderate in intensity indicating ongoing mortality (Table 1). There were also heavy infections at Burton's Bay and Brant Hill, although prevalence was lower at these locations than at North Channel. On the basis of the few samples obtained during fall, it appears that MSX prevalence decreased after the spring/early summer mortality.

Perkinsus. Unfortunately, during 1989 *Perkinsus marinus* was again present on all major harvesting areas and caused serious oyster mortality in most areas except the uppermost beds in the major rivers. For the second year in a row the high runoff in May had no effect on the distribution of *Perkinsus*. In the James River *Perkinsus* was present during early winter on the three beds sampled routinely—Deepwater Shoal, Horsehead Rock and Wreck Shoal (Table 1). Prevalence and intensity declined each month at all three stations and the parasite became undetectable at Deepwater Shoal and Horsehead Rock in April. At Wreck Shoal the prevalence and intensity began to increase again in May and by August prevalence had reached 100% with a high proportion of heavy and moderate infections. Prevalence remained at 100% through October and then began to decline; intensity followed a similar pattern. *Perkinsus* reappeared at Horsehead Rock in July and at Deepwater Shoal in September, but prevalence and intensity remained relatively low, especially at Deepwater Shoal. Most other growing areas in the Bay also had high levels of *Perkinsus* during summer and fall of 1989. These areas included Mobjack Bay, the Piankatank River, the Rappahannock River below Bowler's Rock, the Great Wicomico River, the Little Wicomico River, and tributaries of the Potomac River. Prevalence of *Perkinsus* was relatively low on the seaside of the Eastern Shore, but it was consistently present for the second year in a row.

Tray Samples.

May (Spring) Imports. Counts of live and dead oysters and prevalence of MSX and *Perkinsus* in the duplicate trays established 1 May 1989 at Gloucester Point are listed in Table 2. Total mortality in the second tray through early December was 77.2%; mortality for the first tray (only through September) was 64.6%. For the second year in a row *Perkinsus* invaded the trays and was a source of significant mortality. Historically, *Perkinsus* has been slow to invade oysters in these monitoring trays and has not been a source of mortality during the first year of exposure. However, during 1988, and again during 1989, *Perkinsus* rapidly invaded the trays and during 1989 was much more prevalent than MSX. Maximum mortality in the trays occurred during September and October when *Perkinsus* prevalence was 100% and MSX prevalence was about 50%; intensity of both parasites was high (Table 2).

Counts of live and dead oysters and prevalence of MSX and *Perkinsus* in duplicate trays established 1 May 1989 at Wachapreague are listed in Table 3. Total mortality in each tray was about 84%. By early August prevalence of both parasites was about 50%, but intensity of MSX was much higher than for *Perkinsus* and MSX was responsible for most of the mortality at that time. By late October prevalence of *Perkinsus* was over twice as great as prevalence of MSX and intensity of *Perkinsus* was also higher. Prevalence of *Perkinsus* was unusually high in these trays, especially when considering the low prevalence of this parasite in native oyster samples from the Eastern Shore.

August (Fall) Imports. MSX first appeared in these trays in late November and prevalence increased to 28% by mid-April (Table 4). Moderate and heavy infections were present in the trays by mid-April suggesting the possibility for mortality, but little mortality had actually occurred by that time. On the basis of these observations there may have been some mortality from MSX during spring of 1989.

Perkinsus was present in the oysters when they were placed in the trays, but prevalence of this parasite did not increase dramatically during winter.

DISCUSSION

On the basis of prevalence and intensity, MSX may have caused some mortality in many harvesting areas, including the seaside of the Eastern Shore, during April and May; these infections were probably acquired the previous summer. Fortunately, for the second year in a row, heavy rainfall during May, resulting in salinity below 10ppt., caused the elimination of MSX from the James River seed area. Continued above average runoff through November prevented reinfection of oysters during summer at Wreck Shoal and at beds above Wreck Shoal in the James River. Summer prevalence of MSX was also low in all other oyster harvesting areas in the Bay after May, including the coastal plain estuaries such as the Great Wicomico River. These small rivers do not receive much fresh water input, but tend to reflect salinity of the main stem of the Bay. These results suggest that the return to more normal rainfall patterns during 1989 reduced the prevalence of MSX in all oyster harvesting areas in the Bay. This reduced prevalence was also reflected in the monitoring trays where MSX prevalence reached only 56% in 1989 compared to 72% during 1988. The higher prevalence in the trays compared to native oyster samples probably reflects the high susceptibility of upper James River (Horsehead Rock) oysters used for monitoring.

River discharge was above average during 1989 after four years of drought conditions and important data were gained on the response of *Perkinsus* to decreased salinity. During the drought years 1985-1988 *Perkinsus* had spread to all oyster beds in Virginia and the intensity of infections had increased dramatically. Rapid expulsion of MSX at salinity below 10ppt. is well documented, but comparable data for *Perkinsus* are lacking. Data from the James River during 1989 indicate that temperature is more important than salinity as a factor controlling abundance of *Perkinsus*. For example, at Wreck Shoal in the James River *Perkinsus* prevalence and intensity declined from January through May, but both parameters increased rapidly when water temperature increased in early summer even though salinity remained low. In contrast, MSX disappeared after May and no infections were seen for the remainder of the year in the James River seed area (Table 1). High overwintering levels of *Perkinsus* also allow early development of the parasite and resulted in heavy infections, and mortality, as early as 15 June at Wreck Shoal.

During summer and fall, *Perkinsus* was abundant on most oyster beds except the uppermost locations in the James and Rappahannock Rivers. The high prevalence of this parasite at some locations in the upper Rappahannock River, for example at Sharps and Morattico, may be the result of transplanting infected seed oysters from other areas. The widespread distribution of *Perkinsus* in the Bay, even after a year of normal, if not above average, rainfall is cause for continuing concern. It is now clear that the prevalence and intensity of this parasite is not affected by a return to more normal salinity, at least not within a single year. Continuing normal rainfall may gradually reduce the abundance of *Perkinsus*, but it is clear that *Perkinsus* can persist tenaciously at low salinity for at least one year and another drought year in 1990 would allow it to intensify rapidly.

The high prevalence and intensity of *Perkinsus* in monitoring trays at Wachapreague is unprecedented and not consistent with the low prevalence in native oyster samples and the low prevalence in trays during previous years. The high prevalence in trays during 1989 cannot be explained at this time.

ACKNOWLEDGMENTS

The oyster disease monitoring program could not be conducted without the help of many VIMS scientists and staff. Nita Walker was responsible for sample processing and diagnoses for both MSX and *Perkinsus*. Judy Meyers and Beth McGovern assisted with sample processing and with cleaning and sampling monitoring trays at Gloucester Point; Mike Castagna and his staff maintained the trays at Wachapreague. Judy Meyers and Kenny Walker collected the monthly James River samples; Dr. Bruce Barber and his field staff assisted with sample collection from other areas. Mike Oesterling of the Marine Advisory Service staff coordinated much of the sample collection from private oyster growers and communicated results of analyses.

Table 1. Prevalence and intensity of MSX and *Perkinsus* in oysters from Virginia harvesting areas in 1989. See accompanying figures for station locations. Stations are listed in order from upper river (low salinity) to lower river (higher salinity).

LOCATION	DATE	MSX INF/EXAM-	%	H-M-L	*Perkinsus* INF/EXAM-	%	H-M-L*
James River							
Deepwater Shoal	09 Feb	0/25	0		1/25	4	0-0-1
	24 Apr	0/25	0		0/25	0	
	18 May	0/25	0		0/25	0	
	19 Jul	0/22	0		0/22	0	
	14 Sep	0/25	0		2/25	8	0-1-1
	20 Oct	0/25	0		1/24	4	0-0-1
	14 Nov	0/25	0		0/25	0	
	11 Dec	0/25	0		1/25	4	0-0-1
Parker's Island	19 Aug	0/25	0		21/25	84	3-3-15
Horsehead Rock	11 Jan	1/25	4	0-0-1	14/25	56	1-1-12
	08 Feb	0/25	0		9/25	36	0-0-9
	13 Mar	0/25	0		3/25	12	0-0-3
	10 Apr	0/25	0		0/25	0	
	18 May	0/25	0		0/25	0	
	10 Jun	0/25	0		0/25	0	
	13 Jul	0/25	0		1/25	4	0-0-1
	17 Aug	0/25	0		9/25	36	0-2-7
	14 Sep	0/25	0		5/25	20	1-1-3
	20 Oct	0/25	0		5/25	20	1-0-4
	14 Nov	0/25	0		12/25	48	0-0-12
	11 Dec	0/25	0		3/25	12	0-0-3
Mulberry Island	18 Apr				2/25	8	0-0-2
	18 Oct				7/22	32	0-0-7
Point of Shoal	18 May	0/25	0		1/25	4	0-0-1
	17 Aug	0/25	0		5/25	20	2-0-3
Wreck Shoal	11 Jan	7/25	28	2-1-4	25/25	100	5-5-15
	08 Feb	7/25	28	0-1-6	22/25	88	3-2-17
	13 Mar	9/25	36	1-1-7	11/25	44	0-0-11
	10 Apr	10/25	40	2-1-7	5/25	20	0-0-5
	18 May	2/25	8	0-0-2	9/24	38	0-1-8
	15 Jun	0/25	0		17/25	68	2-2-13
	13 Jul	0/25	0		23/25	92	1-4-18
	17 Aug	0/25	0		25/25	100	5-4-16
	21 Sep	0/24	0		25/25	100	3-5-16
	20 Oct	0/25	0		25/25	100	3-4-18
	14 Nov	0/25	0		23/25	92	3-2-18
	11 Dec	0/25	0		18/25	72	1-1-16
Mobjack Bay							
Tow Stake	26 Sep	0/25	0		22/25	88	2-7-13
East River #1	28 Jun	2/25	8	0-1-1	24/25	96	3-4-17
East River #2	28 Jun	2/25	8	0-2-0	22/24	91	2-2-18

Table 1. (continued).

LOCATION	DATE	MSX INF/EXAM-	%	H-M-L	*Perkinsus* INF/EXAM-	%	H-M-L*
Piankatank River							
Ginny Point	27 Sep	1/25	4	0-0-1	23/25	92	4-5-14
Palace Bar	27 Sep				22/25	88	3-4-15
Gwynn's Island	21 Apr	7/25	28	2-2-3	0/25	0	
Rappahannock Riv.							
Ross' Rock	22 May				0/25	0	
	08 Sep				0/25	0	
Ross' Rock #2	06 Dec				0/25	0	
Ross' Rock #3	06 Dec				0/25	0	
Ware Wharf	03 Feb				0/25	0	
Bowler's Rock	22 May				0/25	0	
	03 Oct				10/25	40	0-0-10
Sharps #1	21 Jun				22/25	88	0-0-22
Sharps #2	21 Jun				11/25	44	0-1-10
Farnham Creek	29 Jun				21/25	84	0-1-20
Morattico Bar	22 May	2/25	8	0-0-2	2/25	8	0-0-2
	03 Oct				25/25	100	3-7-15
Morattico Bar #2	13 Oct				20/25	80	3-2-15
Morattico Bar #3	13 Oct				13/15	87	0-0-13
McKan's Bay	06 Dec				13/23	57	0-2-11
Smokey Point	22 May	3/25	12	2-0-1	12/25	48	1-1-10
	03 Oct				11/25	44	1-1-9
Corrotoman River	02 Oct	1/23	4	1-0-0	17/23	74	2-2-13
Parrot's Rock	02 Oct	3/25	12	0-0-3	14/25	56	0-2-12
Broad Creek	02 Oct	0/25	0		11/25	44	0-3-8
Great Wicomico R.							
Haynie's Creek	21 Jun	0/25	0		10/25	40	0-1-9
	05 Oct				22/25	88	0-0-22
Crane's Creek	21 Jun	0/25	0		9/25	36	1-0-8
Whaley's Flats	06 Oct				21/25	84	1-0-20
Fleeton Point	21 Jun	1/25	4	1-0-0	19/25	76	0-1-18
	05 Oct	1/25	4	0-1-0	22/25	88	1-2-19
Little Wicomico R							
Sunny Bank	05 Jun	0/25	0		22/25	88	0-2-20
Little Wicomico #2	28 Jun				24/25	96	2-2-20
Little Wicomico #3	03 Aug				23/25	92	2-3-18
Little Wicomico #4	22 Aug				22/25	88	2-3-17
Little Wicomico #5	07 Sep				24/25	96	2-4-18
Little Wicomico #6	07 Sep				25/25	100	2-2-21
Potomac River							
Yeocomoco River #1	13 Jun				12/23	52	0-1-11
Yeocomico River #2	14 Jun				23/24	96	6-5-13
Yeocomico River #3	14 Jun				20/24	83	0-0-20
Coan River #1	21 Jun				15/25	60	1-1-13
Coan River #2	21 Jun	0/25	0		12/25	48	0-1-11
Coan River #3	21 Jun				18/25	72	2-0-16

Table 1. (continued).

LOCATION	DATE	MSX INF/EXAM-	%	H-M-L	*Perkinsus* INF/EXAM-	%	H-M-L*
Potomac River							
Jones Shore #1	03 Feb				14/25	56	0-0-14
Jones Shore #2	03 Feb				5/25	20	0-0-5
Eastern Shore							
Burton's Bay	18 Apr	4/20	20	2-1-1	2/20	10	0-0-2
Burton's Bay	12 Aug				2/25	8	0-1-1
Willis Wharf	27 Oct	1/25	4	0-0-1	3/25	12	0-0-3
Brant Hill	02 May	4/25	16	2-0-2	0/25	0	
North Channel #1	18 Apr	15/25	60	9-0-6	0/25	0	
North Channel #2	18 Apr	7/25	28	3-1-3	0/25	0	
North Channel #3	18 Apr	14/25	56	5-4-5	0/25	0	
Machipongo River	15 Nov	2/25	8	1-0-1	6/25	24	0-0-6
Rosier Creek	08 Jun				0/25	0	

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

Table 2. Mortality and disease prevalence in James River seed oysters placed in replicate trays at Gloucester Point in May, 1989. PRK = *Perkinsus marinus*.

Date-1989	Counts live/dead	Monthly mortality %	Infected/examined-%			Intensity H-M-L *
24 Apr	400/0	0.0				
	400/0	0.0	MSX	0/25	0	
			PRK	0/25	0	
13 Jun	395/5	0.75				
	395/5	0.75				
05 Jul	389/6	2.07				
	367/3	1.04	MSX	5/25	20	0-1-4
			PRK	1/25	4	0-0-1
02 Aug	316/48	13.22	MSX	8/25	32	2-0-6
			PRK	5/25	20	0-1-4
	331/36	10.50				
24 Aug	266/50	21.57				
	285/46	18.94				
7 Sep	222/44	35.44				
	217/44	33.09	MSX	13/24	54	1-2-10
			PRK	23/24	96	2-4-17
20 Sep	165/57	59.24				
	173/44	46.79				
02 Oct	106/34	51.53	MSX	14/25	56	3-3-8
			PRK	25/25	100	8-9-8
	142/31	44.80				
15 Nov	No sample					
	58/59	28.33	MSX	11/25	44	2-2-7
			PRK	25/25	100	6-8-11
07 Dec	No sample					
	54/4	9.40				

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

Total mortality for tray number two from 1 May through 7 December was 77.2%. On the basis of prevalence and intensity, *Perkinsus* was probably responsible for twice as much mortality as MSX. Total mortality for tray number one from 1 May through 2 October was 64.6%.

Table 3. Mortality and disease prevalence in James River seed oysters placed in replicate trays at Wachapreague on the Eastern Shore of Virginia in May, 1989. PRK = *Perkinsus marinus*.

Date-1989	Counts live/dead	Monthly mortality %	Infected/examined-%			Intensity H-M-L *
05 May	400/0	0.0				
	400/0	0.0	MSX	0/25	0	
			PRK	0/25	0	
20 Jun	370/30	4.89				
	360/40	6.52				
17 Jul	329/41	12.31				
	320/40	12.34				
07 Aug	195/109	47.33	MSX	11/25	44	4-2-5
			PRK	13/25	52	1-0-12
	213/107	47.77				
14 Sep	91/104	42.10				
	90/123	45.59				
23 Oct	58/33	27.89				
	36/29	24.79	MSX	8/25	32	1-1-6
			PRK	21/25	84	4-2-15

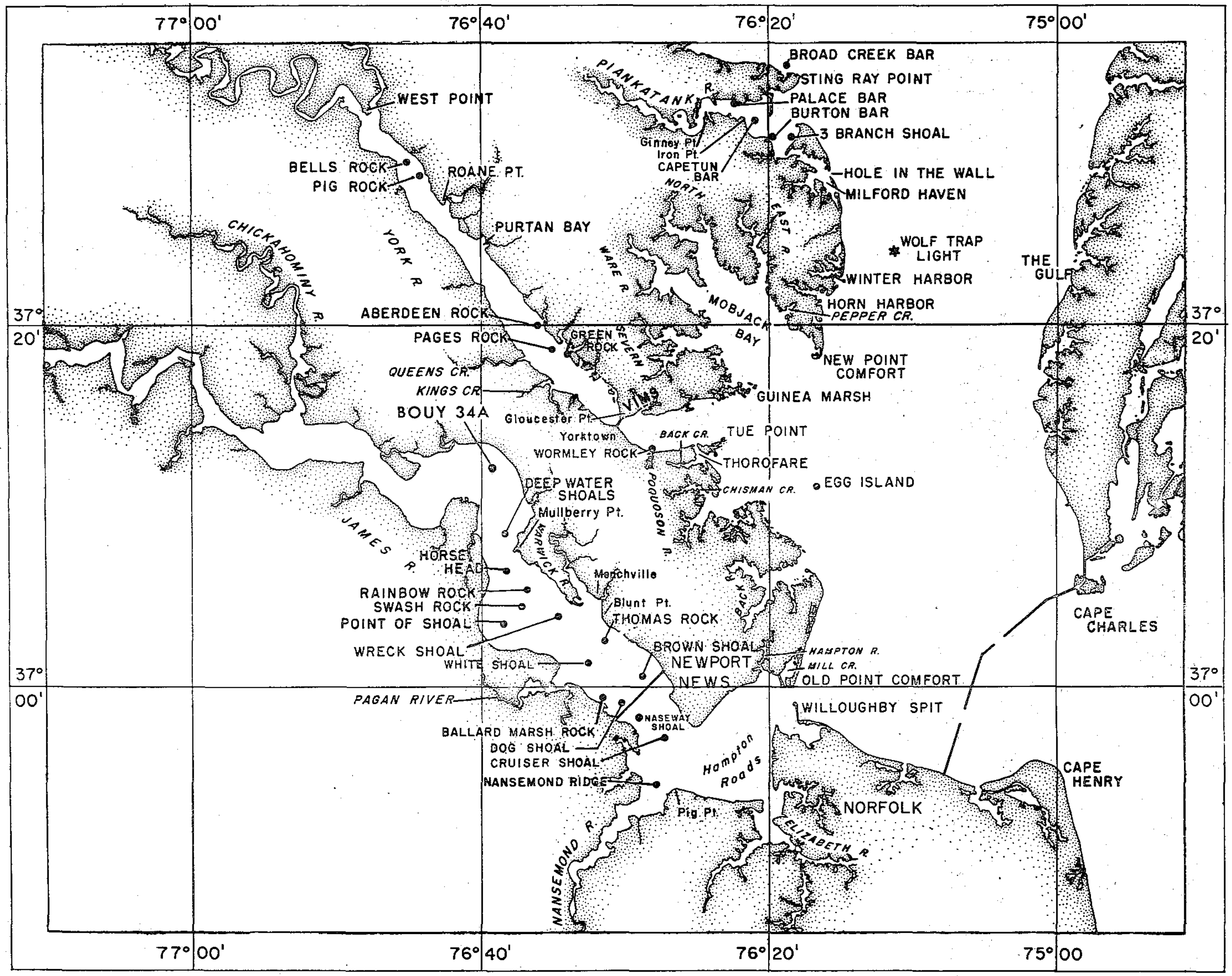
* H=number of heavy infections, M=moderate infections L=light infections.

Total mortality for tray number one from 5 May through 23 October was 83.7%; total mortality for tray number two for the same period was 84.8%. On the basis of prevalence and intensity, *Perkinsus* was probably responsible for more of the mortality than MSX.

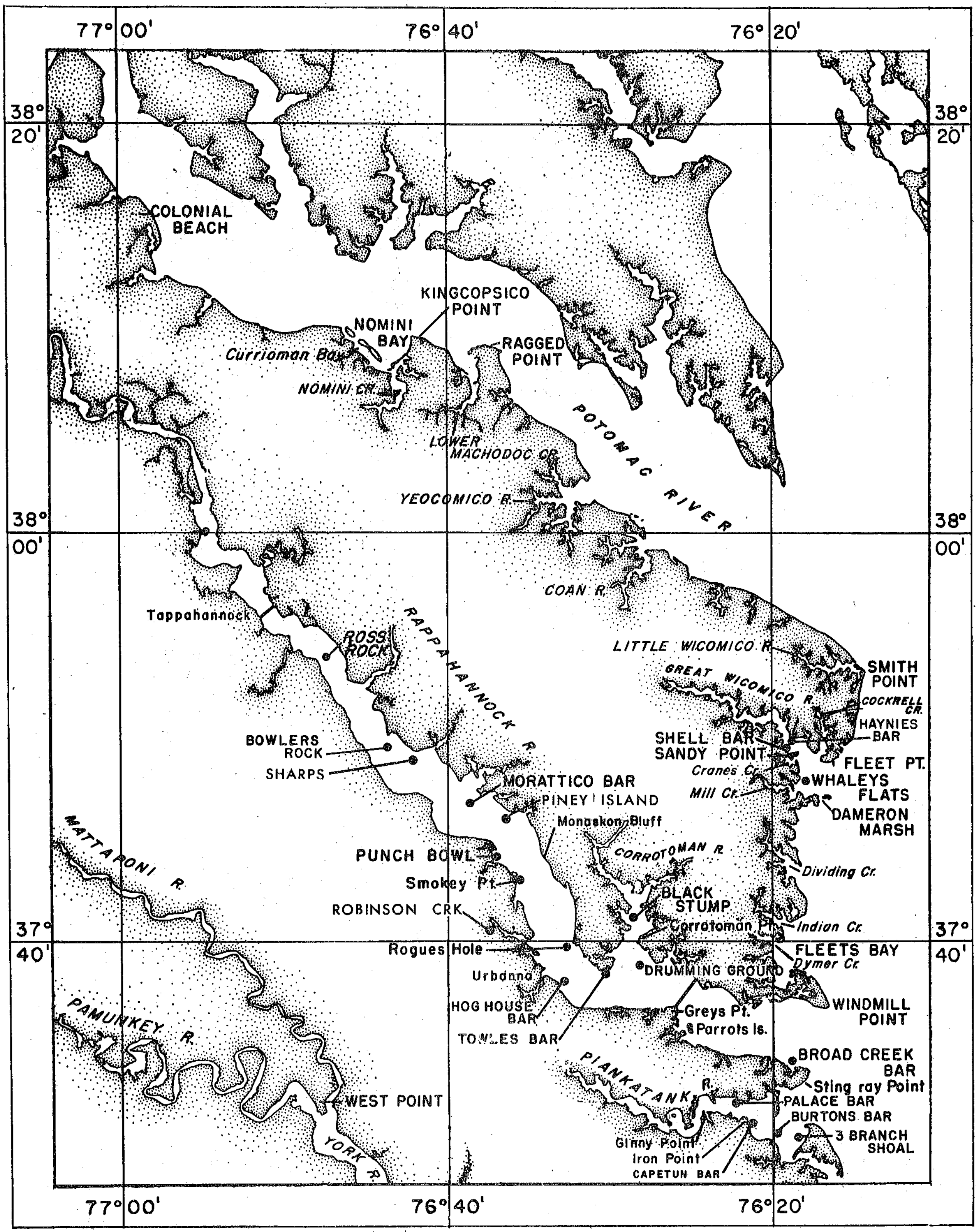
Table 4. Mortality and disease prevalence in James River seed oysters placed in replicate trays at Gloucester Point in August, 1988. PRK = *Perkinsus marinus*.

Date	Counts live/dead	Monthly mortality %	Infected/examined-%			Intensity H-M-L *
25 Aug 88	400/0	0.0				
	400/0	0.0	MSX	0/25	0	
			PRK	2/25	8	0-1-1
21 Sep 88	373/27	7.50				
	393/7	1.94				
24 Oct 88	355/18	4.39				
	393/0	0.0				
21 Nov 88	328/2	0.60	MSX	1/25	4	0-0-1
			PRK	No sample		
	379/14	3.82				
17 Jan 89	326/2	0.32				
	376/3	0.42				
15 Mar 89	301/0	0.0	MSX	2/25	8	0-0-2
			PRK	9/25	36	0-0-9
	376/0	0.0				
19 Apr 89	298/3	0.85				
	351/0	0.0	MSX	7/25	28	1-1-5
			PRK	4/25	16	1-0-3

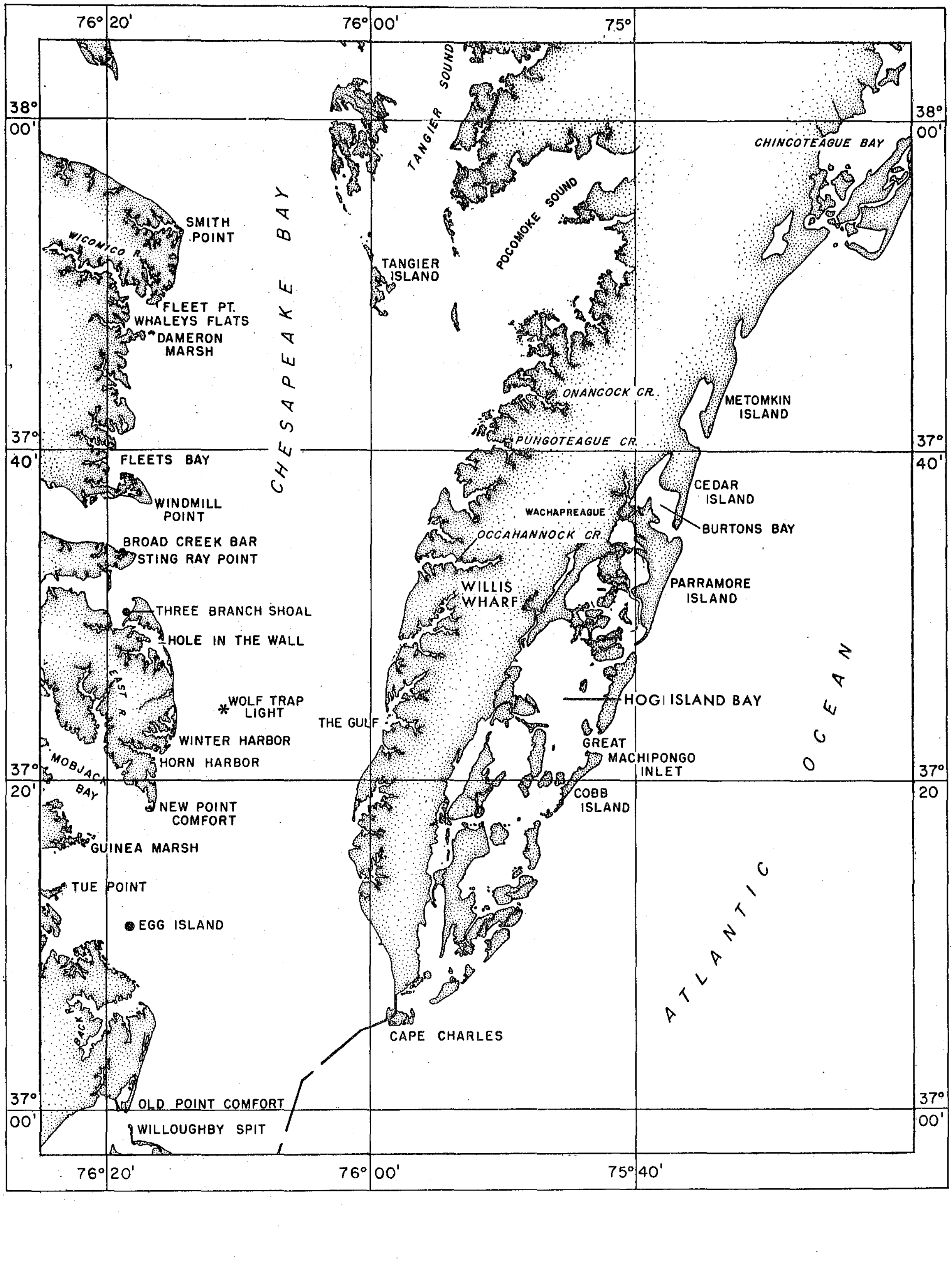
* H=number of heavy infections, M=moderate infections, L=light infections.



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 in Rappahannock and Potomac rivers.



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