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Prevalence of the Major Oyster Diseases in Virginia Waters 1988 A Summary of the Annual Monitoring Program.

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Executive Summary

1988 was the fourth drought year in a row and the distribution and abundance of Perkinsus marinus continued to increase. This parasite spread to the upper Rappahannock River and to the upper James River and it is now present on all public oyster grounds in Virginia. During late summer, prevalence of Perkinsus was over 90% on most oyster beds in the Virginia portion of the Bay except those in the uppermost portions of major tributaries. In addition, Perkinsus was more abundant than usual on the Eastern Shore, although the prevalence was still relatively low compared to Bay values. Unusually high over-wintering levels of Perkinsus resulted in parasite development and oyster mortality as early as the first week in June, rather than late summer as is more typical. The prolonged infection period probably greatly increased the number of infective zoospores in the water during summer of 1988 and greatly enhanced transmission and spread of the parasite.

The record widespread distribution of Perkinsus is a serious threat to the oyster industry because this parasite is apparently not rapidly eliminated by low salinity based upon samples collected during winter and spring of 1988. The salinity and time period needed for elimination of established Perkinsus infections is not known, but it may require a long period even after salinity returns to more normal levels. If so, additional high oyster mortality from this disease can be expected during summer of 1989.

The distribution of MSX was greatly reduced during summer of 1988. Low salinity during early June resulting from the above average rainfall during May apparently eliminated this parasite from most oyster beds except those in the normal endemic area in the lower Bay. MSX was not a source of significant oyster mortality during 1988.

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 develop as soon as water temperature increases in early spring and may cause oyster mortality in 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 spread throughout all public oyster beds. Until recently Perkinsus was not as serious a pathogen as MSX because Perkinsus spread slowly from oyster bed to oyster bed and also spread slowly within beds. However, because of the recent increase in the abundance of Perkinsus, this parasite is now more important than MSX as an oyster pathogen. 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 to 15 ppt.

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.

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' by 4' legged trays in the York River at Gloucester Point and at Wachapreague, Virginia. 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 area such as the lower York River. 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 two weeks and counts are made of live and dead oysters in each tray. Samples of 25 oysters are removed on about 1 August, 1 September, and 1 October for disease determination. Historically, only the October sample has been analyzed for Perkinsus because it usually takes six months or longer for this parasite to infect tray oysters in significant numbers. New trays are established each May to provide a record of MSX 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 to various environmental parameters.

Oysters are also dredged from the upper James River during August and placed in trays in the lower York River. Mortality and MSX prevalence are followed in these trays throughout winter and spring to determine the severity of late summer MSX 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 Horsehead Rock and periodically at many other sites above 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.

Prevalence of MSX is determined by histological analysis of stained slides; 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 - 1988

Native Oyster Samples.

MSX. The distribution and prevalence of MSX was greatly reduced during the summer of 1988 (Table 1) and may have been the result of decreased salinity caused by high rainfall during May, 1988 (see Discussion). For example, monthly samples at Wreck Shoal in the James River (Table 1) from January through April show MSX prevalence of about 50% with at least some heavy infections each month. However, in early June prevalence had decreased to 36%, and during July and August, the usual period of maximum abundance, the prevalence was only about 10%. MSX prevalence was also greatly reduced after May in other areas of Virginia (Table 1). For example, there was little MSX in the Great Wicomico River during early June, and no MSX was found there during October. This river has had moderately high levels of MSX during recent years. There was no MSX above Wreck Shoal in the James River, and only low prevalence in Mobjack Bay. The lower Rappahannock River was not sampled during summer because of the scarcity of oysters resulting from high mortality during 1987. There was no MSX during summer at Morattico Bar in the upper Rappahannock River, or in tributaries of the Potomac River.

Perkinsus. Unfortunately, during 1988 Perkinsus marinus continued to spread up tributaries and to increase in abundance (Table 1). The high runoff during May had no effect on this disease. At Wreck Shoal in the James River for example (Table 1), prevalence and intensity of Perkinsus declined during April, but as soon as water temperature increased during June, both prevalence and intensity increased dramatically and remained high through November. The upstream spread of Perkinsus is apparent by examining data from Horsehead Rock in the upper James River. Oysters at this location have had only occasional

Perkinsus infections in the past. There was no Perkinsus at Horsehead Rock from early April through early July, but prevalence was 8% in late August and had increased to 52% by late fall. This is the first year since records have been kept that Perkinsus has consistently been present at Horsehead Rock. Perkinsus was also present at Deepwater shoal and one infected oyster was found near Bouy 34A, the uppermost oyster bed in the James River. Most other growing areas around the Bay also had high levels of Perkinsus during summer and fall (Table 1). These included Pocomoke Sound, all tributaries of the Potomac River except Nomini Creek, all areas of the Rappahannock River, the Great Wicomico River, and Mobjack Bay. In addition, Perkinsus was relatively common in samples from the seaside of the Eastern Shore (Table 1).

Tray Samples.

May (Spring) Imports. Counts of live and dead oysters and prevalence of MSX and Perkinsus in the duplicate trays at Gloucester Point are listed in Table 2. Total mortality in the first tray was 86.8%, the highest value ever recorded. However, for the first time since trays began being used in 1960, Perkinsus was a source of significant mortality. Historically, Perkinsus has been slow to invade trays and has not been a source of measurable mortality during the first year. However, during 1988 Perkinsus was as prevalent as MSX at least by 17 August and had a higher proportion of heavy and moderate infections suggesting that at least half of the mortality in the trays was caused by Perkinsus. Maximum mortality in the trays occurred between mid-July and the end of September.

Counts of live and dead oysters and prevalence of MSX and Perkinsus in duplicate trays at Wachapreague are listed in Table 3. Total mortality in each tray was 28%. Based upon prevalence and intensity of MSX and Perkinsus in the trays, most of the mortality can be attributed to MSX, although prevalence of Perkinsus was unusually high for Wachapreague trays. For example, during 1987 Perkinsus was not found in trays at Wachapreague.

August (Fall) Imports. MSX first appeared in these trays in early December, but prevalence and intensity remained low through April (Table 4). On 1 June, MSX prevalence was 36% with over half the infections rated either heavy or moderate, but mortality remained below 10% through June. Mortality increased during July, but by that time MSX infections acquired since May were probably responsible for most of the mortality (Table 2).

Discussion

Somewhat surprisingly, MSX retreated from its record 1987 invasion when it was found farther into the Maryland portion of the Bay and farther up Virginia tributaries than ever before. This retreat may have been caused by above average rainfall during May that decreased salinity during early June and eliminated MSX from oysters except in the normal endemic area in the lower Bay. May was the only month during 1988 in which river flow input to the Bay was above the long term average, and during early June salinity at Wreck Shoal was 10ppt for about 2 weeks. It is well documented that salinity below 10ppt will cause elimination of MSX from oysters in about 10 days, so it is probable that the high rainfall in May was responsible for the reduced distribution of MSX during summer. In the endemic area monitoring trays maximum MSX prevalence during 1988 was higher than during 1987 (72% versus 64%). Total mortality in the trays was also higher in 1988 than in 1987 but, unlike 1987,

Perkinsus was abundant in the trays during 1988. The high prevalence of both diseases in the trays makes precise allocation of the mortality difficult.

1988 was the fourth drought year in a row and the resulting high salinities in the Bay apparently allowed continued spread and intensification of Perkinsus. The present distribution of Perkinsus and the unusually rapid spread of the disease and unusually high overwintering levels during recent years have serious implications for the oyster industry. Historically, Perkinsus overwintered in very low numbers and gradually increased in abundance throughout the summer causing mortality during late August and September. In 1988, for the second year in a row, Perkinsus was abundant in early June and many of the infections were already heavy in intensity. Thus, the mortality period for Perkinsus started at least two months earlier than normal, resulting in greatly increased oyster mortality. For example, see data for Wreck Shoal in the James River (Table 1) or various locations in the Great Wicomico River. Perkinsus takes about four weeks to undergo a developmental cycle, kill an oyster and release infective zoospores. The two or more additional developmental cycles resulting from high overwintering levels has probably greatly increased the number of infective zoospores in the water and greatly enhanced transmission of the parasite.

The record widespread distribution of Perkinsus is a serious threat to the oyster industry because this parasite is apparently not rapidly eliminated by low salinity based upon samples from Wreck Shoal during winter and spring of 1988. The prevalence of MSX decreased sharply after the low salinity period in early June, but the prevalence of Perkinsus actually increased in June. The salinity and time period needed for elimination of established Perkinsus infections is not known, but it may require a long period even after salinity returns to more normal levels. If so, additional high oyster mortality from this disease can be expected during summer of 1989.

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 analysis for both MXS and Perkinsus. Judy Meyers and Beth McGovern assisted with sample processing and with cleaning and sampling the trays at Gloucester Point; Mike Castagna and his staff maintained the trays at Wachapreague. Dr. Roger Mann's field team, especially Jim Whitcomb and Kenny Walker, often interrupted their own work to collect samples. Mike Oesterling of the Marine Advisory Service staff coordinated much of the sample collection from private oyster growers and communicated results of analyses. Special thanks to Dr. Jay Andrews for his continued interest in the program and for sharing his extensive knowledge of oyster diseases.

Table 1. Prevalence and intensity of MSX and Perkinsus in oysters from Virginia harvesting areas in 1988. See accompanying figures for station locations.

LOCATION	DATE	MSX INF./EXAM.	MSX - %	MSX H-M-L*	Perkinsus INF./EXAM.	Perkinsus - %	Perkinsus H-M-L*
James River							
Bouy 34A	09 Nov	0/25	0		1/25	4	0-0-1
Deepwtr Shoal	31 Aug	0/25	0		0/25	0	
	03 Nov	0/25	0		2/20	10	1-0-1
Horsehead Rk.	02 Mar	0/25	0		2/25	8	0-0-2
	06 Apr	0/25	0		0/10	0	
	27 Apr	0/25	0		0/25	0	
	06 Jul	0/25	0		0/25	0	
	24 Aug	0/25	0		2/25	8	0-1-1
	31 Aug	0/25	0		9/25	36	1-0-8
	03 Nov	0/25	0		13/25	52	0-2-11
Mulberry Pt.	15 Aug	0/25	0		8/25	32	0-0-8
	09 Nov	Not sampled			15/25	60	2-1-12
Swash #1	08 Nov	0/25	0		25/25	100	7-4-14
#2	08 Nov	0/25	0		25/25	100	8-7-10
Mulberry Isl.	18 Apr	0/25	0		2/25	8	0-0-2
	30 Jun	0/25	0		6/26	24	1-0-5
	04 Aug	0/25	0		21/25	84	9-0-12
	15 Aug	0/25	0		16/25	64	2-3-11
Pt. of Shoal #1	27 Jul	0/25	0		3/25	12	1-1-1
Pt. of Shoal #2	27 Jul	0/25	0		4/25	16	0-0-4
Pt. of Shoal #2	28 Sep	0/25	0		18/25	72	1-0-17
Burrells upr	08 Nov	Not sampled			5/25	20	1-0-4
Burrells lwr	08 Nov	Not sampled			20/25	80	3-3-14
Long Rock	27 Jul	0/25	0		3/25	12	1-1-1
Wreck Shoal	07 Jan	10/25	40	4-1-5	20/25	80	1-1-18
	04 Feb	13/25	52	2-1-10	17/25	68	0-1-16
	02 Mar	14/25	56	2-0-12	17/25	68	1-2-14
	23 Mar	13/25	52	4-1-8	15/27	56	2-3-10
	06 Apr	14/25	56	1-0-13	12/25	48	0-0-12
	27 Apr	13/25	52	1-0-12	4/25	16	0-0-4
	08 Jun	9/25	36	3-2-4	14/25	56	3-3-8
	06 Jul	3/25	12	0-0-3	21/25	84	2-6-13
	27 Jul	3/25	12	0-0-3	22/25	88	10-3-9
	31 Aug	2/25	8	0-0-2	24/25	96	7-8-9
	28 Sep	9/25	36	0-2-7	25/25	100	7-5-13
	03 Nov	2/25	8	0-0-2	20/25	80	8-2-10
Goosehouse #1	24 Aug	10/25	40	0-1-9	21/25	84	7-6-8
#2	24 Aug	16/25	64	1-3-12	23/25	92	8-4-11
Nansemond Riv.	24 Aug	1/25	4	0-0-1	14/25	56	2-0-12

Table 1. (continued).

LOCATION	DATE	MSX INF./EXAM.	MSX - %	MSX H-M-L*	Perkinsus INF./EXAM.	Perkinsus - %	Perkinsus H-M-L*
Mobjack Bay							
Mobjack Bay	02 May	2/7	29	1-0-1	1/7	14	0-0-1
East River	11 May	1/25	4	0-0-1	5/25	20	0-0-5
	11 May	1/25	4	1-0-0	3/25	12	0-0-3
	05 Aug	0/25	0		22/25	88	2-5-15
	05 Aug	1/25	4	0-0-1	24/25	96	3-5-16
	05 Aug	2/25		0-0-2	22/25	88	3-1-18
Piankatank River							
Freeport	17 Oct	0/25			0/14	0	
Rappahannock River							
Sharps	11 May	0/12	0		0/12	0	
	11 May	0/17	0		0/17	0	
	11 May	0/9	0		0/9	0	
	11 May	0/18	0		3/18	17	0-0-3
	11 May	0/25	0		3/25	12	0-0-3
	04 Aug	Not sampled			19/25	76	4-3-12
	04 Aug	Not sampled			19/25	76	2-3-14
	04 Aug	Not sampled			17/25	68	1-1-16
	07 Sep	Not sampled			23/25	92	2-6-15
	14 Sep	0/24	0		24/24	100	5-8-11
Morattico	11 May	0/15	0		1/15	7	0-0-1
	04 Aug	0/25	0		16/25	64	2-2-12
Piney Isl.	17 Feb	7/25	28	1-1-5	11/25	44	0-2-9
Wicks	17 Feb	1/25	4	0-0-1	12/25	48	0-0-12
	13 May	6/25	24	1-0-5	6/25	24	0-2-4
Great Wicomico River							
Haynie Pt.	08 Jun	0/25	0		10/25	40	0-3-7
	06 Oct	0/25	0		14/25	56	0-0-14
Spat	06 Oct	0/25	0		0/25	0	
Cranes Crk.	08 Jun	3/25	12	1-0-2	19/25	76	1-3-15
	06 Oct	1/25	4	1-0-0	6/25	24	0-3-3
Spat	06 Oct	0/25	0		5/25	20	1-1-3
Fleeton Pt.	08 Jun	2/25	8	0-0-2	16/25	64	0-2-15
Spat	06 Oct	0/25	0		0/25	0	
	06 Oct	0/25	0		17/25	68	0-0-17
Spat	06 Oct	0/25	0		18/25	72	4-1-13
Potomac River							
Colonial Pt.	11 Mar	0/25	0		0/25	0	
Nomini Crk.	12 May	0/24	0		2/24	8	0-0-2
	12 May	0/25	0		4/25	16	0-0-4

Table 1. (continued).

LOCATION	DATE	MSX INF./EXAM.	MSX - %	MSX H-M-L*	Perkinsus INF./EXAM.	Perkinsus - %	Perkinsus H-M-L*
Potomac River							
Machodoc R.	12 May	2/25	8	1-0-1	2/25	8	0-0-2
	12 May	0/25	0		1/25	4	0-0-1
	12 May	0/25	0		1/25	4	0-0-1
	12 May	0/25	0		5/25	20	0-1-4
	22 Aug	0/25	0		11/25	44	0-3-8
	22 Aug	Not sampled			12/24	50	0-2-10
	22 Aug	Not sampled			16/25	64	2-2-12
Yeocomico R.	05 May	0/25	0		4/25	16	1-1-2
	05 May	0/25	0		1/25	4	0-0-1
	13 Jul	0/25	0		22/25	88	1-4-17
	13 Jul	0/25	0		20/25	80	2-5-13
	13 Jul	0/24	0		7/24	29	0-1-6
	04 Aug	Not sampled			17/25	68	1-3-13
	04 Aug	Not sampled			21/25	84	0-5-16
Coan R.	05 May	0/25	0		0/25	12	0-1-2
	04 Aug	Not sampled			24/25	96	8-3-13
Pocomoke Sound							
Sample #1	12 May	8/25	32	4-0-4	13/25	52	3-2-8
Eastern Shore - Seaside							
Burtons Bay	29 Jul	1/25	4	0-1-0	6/25	24	0-0-6
	02 Sep	0/25	0		9/25	36	1-0-8
	01 Nov	0/25	0		4/25	16	0-2-2
Hog Isl. Bay	31 May	0/25	0		1/25	4	0-0-1
	31 May	0/25	0		Not sampled		
	16 Jun	0/25	0		5/25	20	0-2-3
	16 Jun	1/25	4	0-0-1	0/25	0	
	02 Aug	Not sampled			0/25	0	
	02 Aug	Not sampled			0/25	0	
	03 Aug	0/25	0		14/25	56	3-3-8
	03 Aug	0/25	0		1/25	4	1-0-0
Willis Wharf	06 Jul	2/25	8	0-0-2	4/25	16	0-1-3
	06 Jul	1/25	4	0-1-0	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, 1988.

Date - 1988	Counts live/dead	Monthly mortality-%	No. examined	No. infected(%)	Intensity H-M-L*
1 May	400/0	0.0	25	MSX 0	
				PRK 0	
	400/0	0.0			
1 June	398/2	0.5			
	399/1	0.3			
28 June	397/1	0.3			
	348/51**	14.1			
19 July	358/15	5.1	25	MSX 11 (44)	4-0-7
				PRK No sample	
	No sample				
17 August	158/175	50.4	25	MSX 18 (72)	1-3-14
				PRK 17 (68)	3-5-9
	150/198	47.1			
21 September	71/87	47.1			
	41/84	48.0	25	MSX 12 (48)	3-0-9
				PRK 14 (56)	3-3-8
24 October	49/22	27.9			
	34/7	15.3			
21 November	43/6	13.5			
	30/4	12.9			

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

**, Tray on its side in the mud; mortality probably a result of smothering.

Total mortality for tray number one from 1 May 1988 through 21 November 1988 was 86.8%. Both MSX and Perkinsus contributed approximately equally to this mortality based upon the prevalence of each disease in the tray. Mortality for tray number two was not calculated because of the potential confounding smothering mortality.

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, 1988. PRK = *Perkinsus marinus*.

Date - 1988	Counts live/dead	Monthly mortality-%	No. examined	No. infected(%)		Intensity H-M-L*
1 May	300/0	0.0	25	MSX	0	
				PRK	0	
	300/0	0.0				
1 June	295/5	1.7				
	296/4	1.6				
1 July	291/4	1.4				
	291/5	1.7				
29 July	287/4	1.2				
	262/4	1.2	25	MSX	0	
				PRK	Not sampled	
2 September	244/18	5.1	25	MSX	7(28)	1-1-5
				PRK	4(16)	0-0-4
	246/16	5.1				
4 October	210/34	12.9				
	221/25	9.3				
31 October	175/10	5.1	25	MSX	11(44)	2-3-6
				PRK	13(52)	1-1-11
	202/19	9.3				
30 November	170/5	2.9				
	196/6	3.0				

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

Total mortality from 1 May 1988 through 30 Novermber 1988 for the two trays was 28.6% and 28.3% respectively.

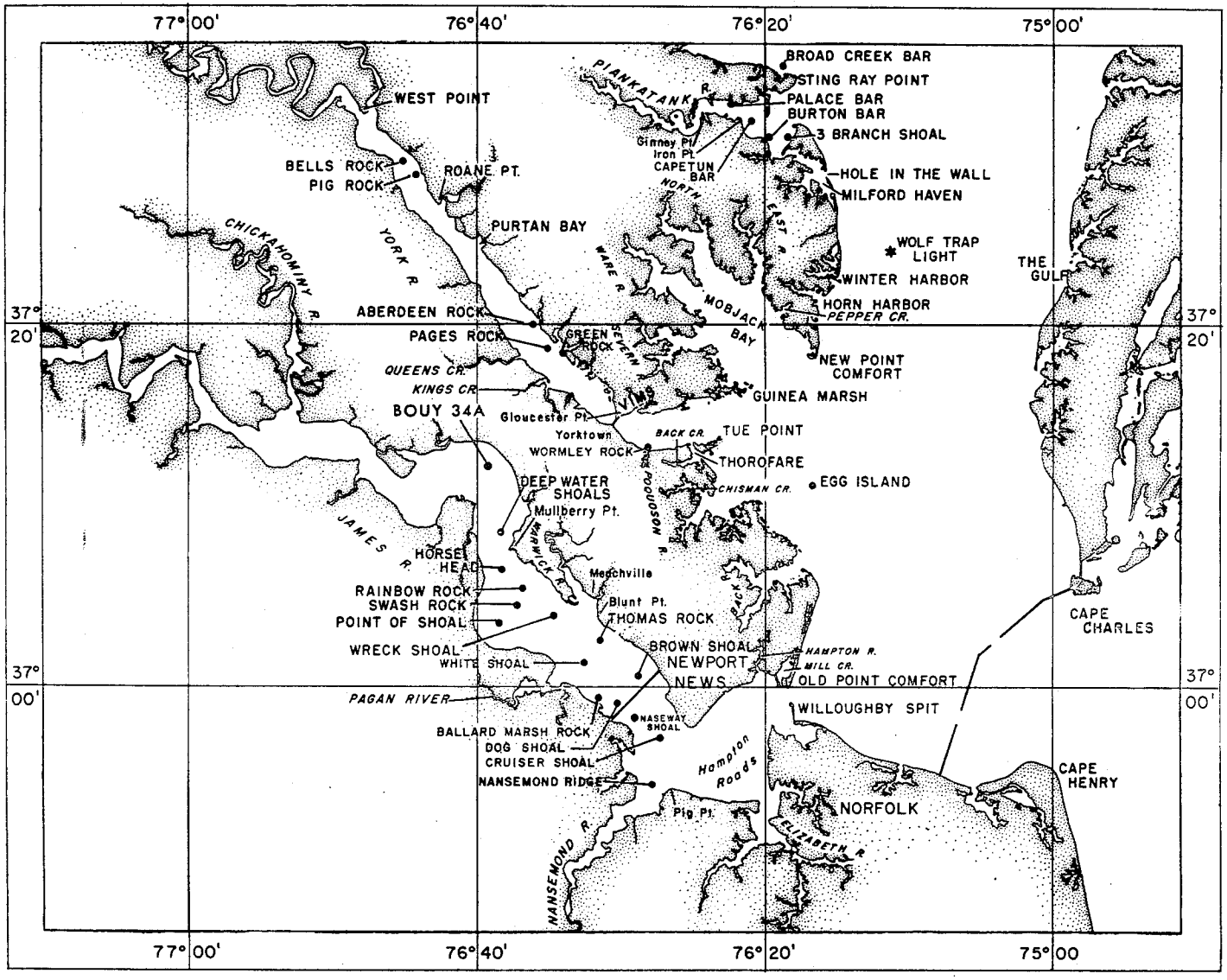
Table 4. Mortality and disease prevalence in James River seed oysters placed in replicate trays at Gloucester Point in August, 1987. PRK = *Perkinsus marinus*.

Date	Counts live/dead	Monthly mortality-%	No. examined	No. infected(%)	Intensity H-M-L*
20 Aug 87	329/0	0.0	25	MSX 0 PRK 0	
	327/0	0.0			
26 Aug 87	328/1	1.5			
	324/3	4.5			
16 Sep 87	328/0	0.0			
	324/0	0.0			
02 Oct 87	302/1	0.3	25	MSX 0 PRK Not sampled	
	321/3	1.5			
30 Oct 87	302/0	0.0			
	296/0	0.0	25	MSX 0 PRK Not sampled	
02 Dec 87	276/0	0.0	26	MSX 2(8)	0-0-2
				PRK Not sampled	
	292/4	1.2			
13 Jan 88	276/0	0.0			
	267/0	0.0	25	MSX 3(12)	0-0-3
				PRK Not sampled	
05 Feb 88	251/0	0.0	25	MSX 0 PRK Not sampled	
	266/1	0.3			
29 Feb 88	250/1	0.3			
	224/1	0.3	25	MSX 2(8)	0-0-2
				PRK	
07 Apr 88	225/0	0.0	25	MSX 4(16)	0-0-4
				PRK Not sampled	
	222/2	0.6			
06 May 88	225/0	0.0			
	196/1	0.3	25	MSX 7(28)	0-1-6
				PRK Not sampled	
01 Jun 88	199/1	0.3	25	MSX 9(36)	3-2-4
				PRK Not sampled	
	194/2	0.9			
28 Jun 88	182/17	9.3			
	179/15	8.4			

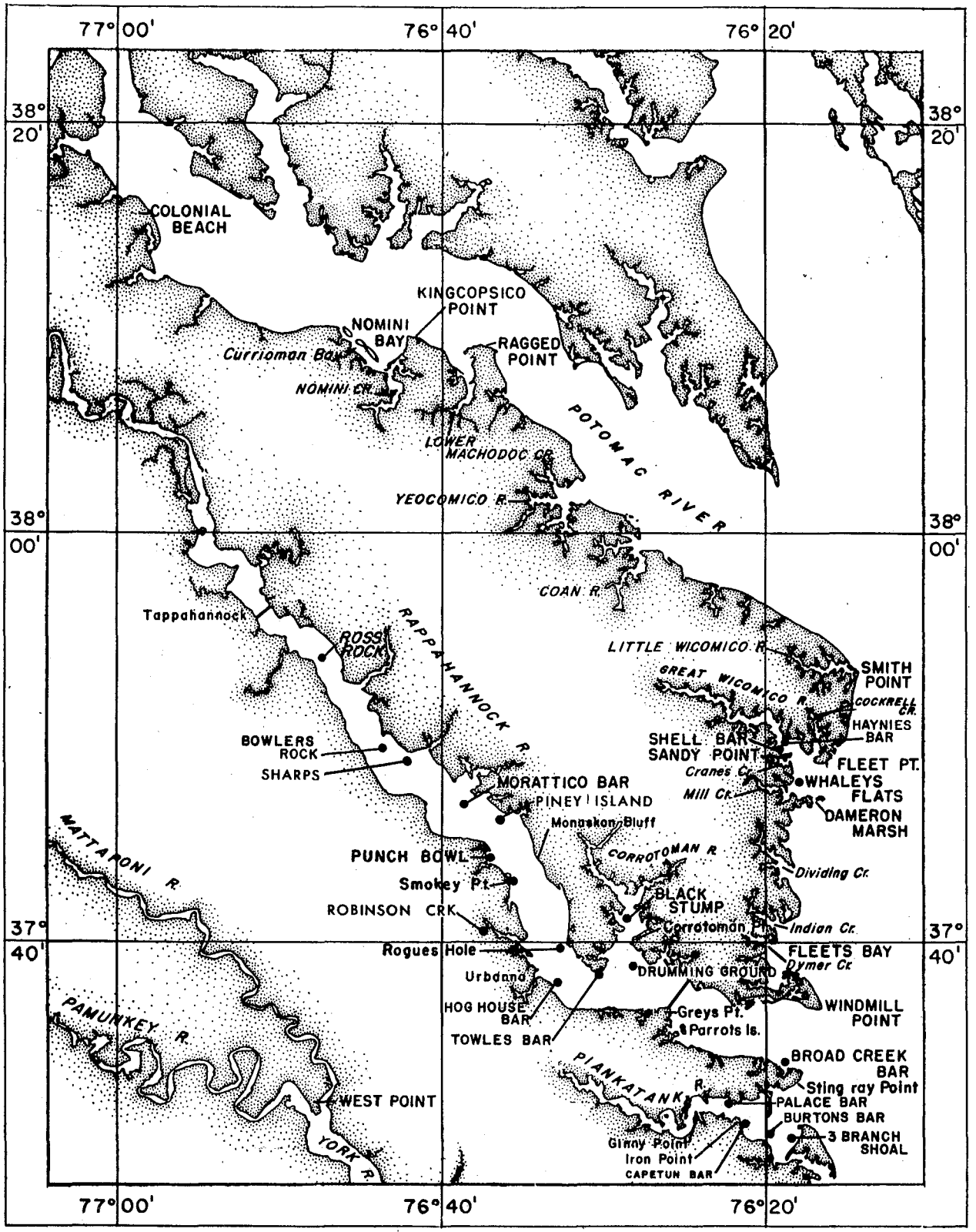
Table 4. (continued).

Date	Counts live/dead	Monthly mortality-%	No. examined	No. infected(%)		Intensity H-M-L*
12 Jul 88	159/23	27.0				
	136/18	21.3	25	MSX	11(44)	2-3-6
				PRK	Not sampled	
19 Jul 88	144/15	40.2				
	117/19	59.7				
02 Aug 88	118/26	38.4				
09 Aug 88	84/33	40.2				

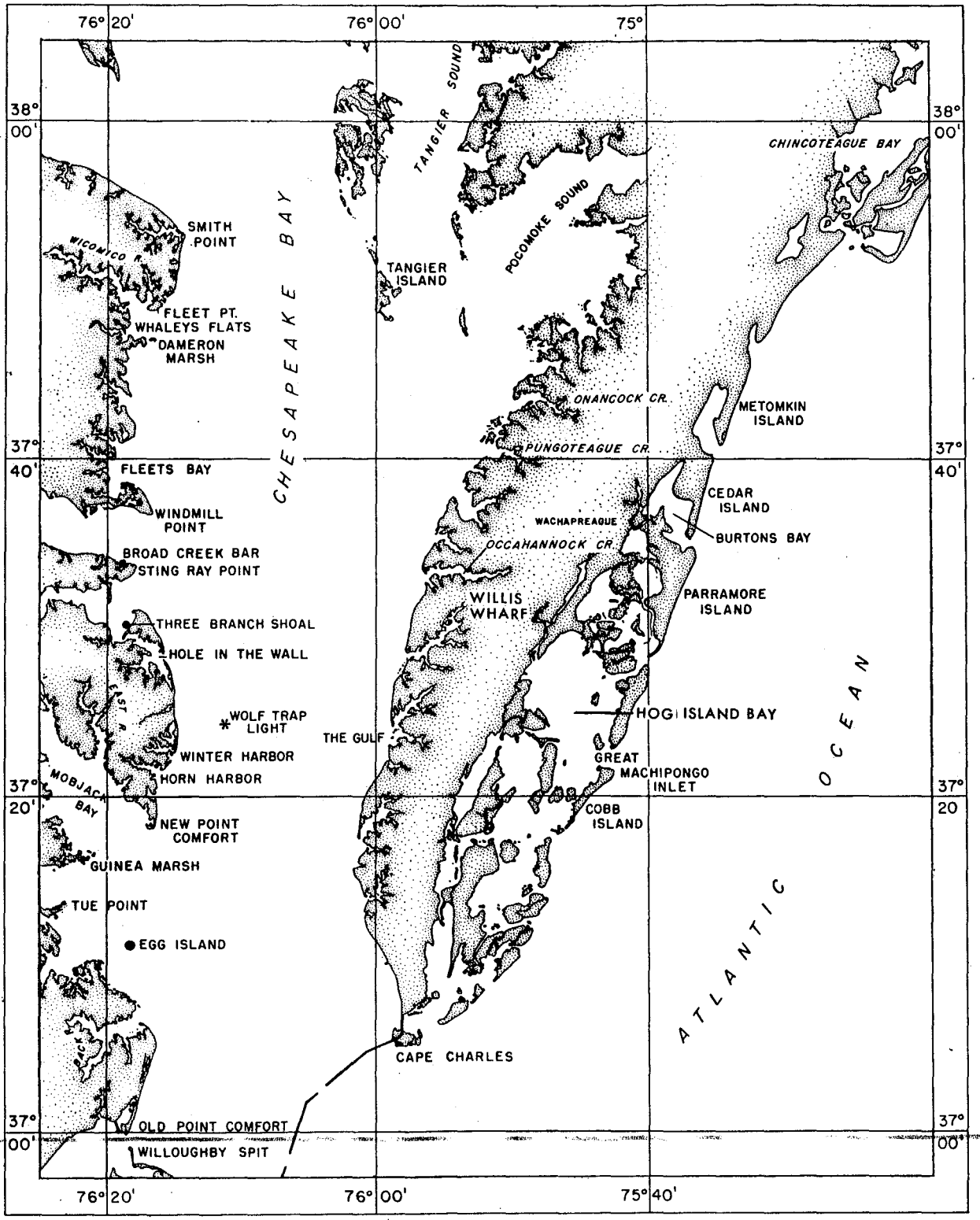
*H=Number of heavy infections, M=moderate infections, L=light infections.



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.