FINAL REPORT

Delaware Bay 1997 Random Sampling of Oyster Seed Beds

by

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February 10, 1998

Summary of the 1997 Random Sampling of the Delaware Bay Seed Beds

Attached is a summary of the 1997 seed bed sampling data with similar data for 1996 and 1995. All data were collected between October 27, 1997 and October 29, 1997 using a boat and captain donated by Bivalve Packing. This information is provided based on a stratified random sampling of grids from the seed beds. The strata (groups) from which the samples were selected are: Test area, general bed, marginal areas. One sample was taken from one of the test area grids, and no more than two samples were taken from the marginal grids of the beds. The remainder of the samples were from the general bed. All data were adjusted to a 37 quart bushel.

The data format is the same as in the past years. Data are displayed from the farthest up bay beds to those down bay. For each bed the percentage of oysters for each sample is presented, with rankings from highest to lowest. Percentage of oyster is based on volume of oyster in the sample divided by the total volume of the shell, oyster and debris in the sample. Those samples that have over 40% oyster are underlined. The test area is a small area of grids that has been sampled consistently as representative of the better areas of the bed. The test area sample is indicated by an *. Oysters per bushel and spat per bushel are based on actual counts adjusted to 37 quarts.

As with last year, we have eliminated the yearling classification and added - to the left of the Percent Oyster 1997 Column - a new set of information called Bushels/haul. This indicates the **average** number of bushels brought up by the 3 dredge hauls from each grid. The dredge was estimated to hold 7 bushels so if 7 is in the column all dredges were full. If -- appears in the column it means that at least one dredge haul volume was not recorded, and we have not included an average for this sample.

Due to the influence of Dermo on the industry we have continued the set of columns for Percentage Mortality and data on Percent Prevalence and Weighted Prevalence of Dermo. The Percentage Mortality figure is based on the number of boxes that were counted in the samples. Prevalence is the percentage of oysters with detectable infections. Weighted Prevalence is the average infection intensity (scored from 0 to 5) of all infected and uninfected oysters.

The major points of interest this year are:

o There was a direct harvest of market oysters from the seed beds (Apr - June and Sept.- Dec.) this year. Some of this harvest took place **AFTER** we sampled the seed beds. The spring effort removed 27,479 bu and the fall 87, 667 bu for a total harvest of 115,146 bu. The beds making more than 5% of the total harvest were New Beds (48,423 bu; 42%), Bennies (28,726 bu; 25%), Shell Rock (13,837 bu; 12%), Vexton (10,183 bu; 9%) and Hog Shoal (7,374 bu; 6%). Data from Vexton was adjusted to increase harvest by 6369 bu that were formerly allotted to Egg Island. Other beds that were harvested include: Bennies Sand, Egg Island, Ledge, Middle and Ship John.

o The number of oysters (older than yearlings) per bushel has generally remained the same or increased slightly on beds above Shell Rock. Below that point there may be a general decline in the number of oysters per

bushel. Beadons, which we cited last year as an example of a bed with increasing numbers of oysters has shown a drop this year probably reflecting the continuing mortality and low recruitment last year.

- o The number of oysters per bushel in market size categories (>2.5") on most Middle Bay beds remained about the same as last year or increased slightly. The numbers of oysters on Bennies, New Beds and Beadons may have declined somewhat. Numbers of 2.5" oysters on New Beds also appear to have declined.

- o Mortalities based on box counts were generally the same as last year.

- o Spat set improved markedly from last year throughout the bay. The highest average bed spat set was 553 spat per bushel and that occurred on Beadons. In general, spat set appeared to be greater in the Lower Bay and inshore.

- o On New Beds the random sampling program sampled one of the sites that received cultch. This one sample increased the overall bed average spat count by a factor of 10. There were over 1500 spat/bushel in this sample while the remainder of the bed averaged about 15. These data are provided in Table 2. as an indication of the type of enhancement that might be expected (in years of good set) if efforts were made to improve seed bed conditions.

- o Prevalence of Dermo was spotty, but remained about the same as last year.

- o Weighted Prevalence indices appear to have declined slightly in most beds. Beadons and Nantuxent Point Beds have had weighted prevalence increased slightly.

- o Nantuxent Point and Beadons are examples of beds with significant numbers of marketable oysters per bushel, but relatively high Dermo levels. Unless these levels decline significantly this winter and spring these oysters would be useful for direct market, but risky to transplant.

- o Some consideration should be given to preserving the spat on those beds with relatively high set this year. These would include Ship John, Beadons and Vexton

The size distribution data (Table 3) have been used to estimate the numbers of oysters in each size group for a 37 quart bushel dredge sample for all sampled beds. These size/frequency data can provide an estimate of the numbers of oysters in each size class. We have highlighted (bold) and summed the number of 3 inch long oysters per average bushel of material expected from each of the beds. We have also included information on 2.5" oysters. A summary of 1996 and 1995 data for selected beds is provided in Table 4.

Numbers of oysters per bushel on upper and upper middle seed bed areas remained about the same as in 1996, but in the lower bay areas the numbers appear to have declined slightly. This is particularly true on Bennies Sand, Bennies, Beadons and New Beds. On these beds we may be seeing the combined result of harvesting coupled with the lack of additions to the adult oysters stocks due to the poor spat set of 1996.

During the sampling program in the lower bay we noted a number of stations that had significant numbers of large oysters. These appeared to occur most often when the amount of material coming up in

the dredge varied greatly from one haul to the other. This suggests that we were on lumps or near the edge of a bed, and that harvesting had not yet taken place. When we were on uniform areas, the number of large oysters in the dredge haul appeared to decrease.

If they are allowed to grow the good spat set this year should stabilize conditions on the lower inshore seed beds. On some beds drills have already consumed a significant number of the spat. For instance on one Egg Island grid there were 686 live spat/bu. and 332 drilled spat/bu., while on another grid there were 122 spat/bu., and 104 drilled spat/bu. Predation can still be an important factor in overall recruitment success.

Please remember that these data **do not** provide an estimate of the numbers of oysters on the seed beds, but provide a relative assessment of what could be expected from a dredge haul on a particular bed. Disease continues to be a dominant factor in the survival of oysters, and all decisions must be interpreted in conjunction with the analysis of the diseases on the seed beds.

Dermo Prevalence and Weighted Prevalence

Seed bed samples analyzed for prevalence and intensity of *Perkinsus marinus* (Dermo) in October 1997 continued to show a trend toward lower infection intensities, although prevalences remained at or near 100% on the beds including and below Bennies. The trend was evident in the weighted prevalence measure, which combines infection prevalence and intensity. It persisted despite a very dry summer that increased salinities in the upper bay. Also, temperatures over the winter of 1996-1997 were well above normal. The relatively low weighted prevalences after a warm winter is atypical as warm winters have been previously correlated with the northward spread of Dermo disease since 1990.

An examination of autumn weighted prevalences in "adult" oysters (>two years old) on the upper (including and above Shell Rock/Bennies Sand) and the lower (including and below Bennies) seed beds over the eight years from 1990, when the Dermo epizootic began, through 1997 shows an interesting pattern. In both regions, infection levels increased to a peak in 1993-4 as the Dermo parasite spread upbay (Fig. 1). Since then, Dermo levels have been declining, especially on the upper beds and the main offshore lower beds. High levels persist the lower inshore beds represented by Nantuxent and Beadons.

Beginning in 1995, we began to analyze approximately equal numbers of spat, yearlings, and older oysters in each sample so that we could observe the speed with which infections were acquired and developed in each year class. Again, we see an interesting pattern. In both 1995 and 1996 on the lower seed beds, there was a clear increase in weighted prevalence with age (Fig. 2). In 1997, that pattern changed: infection levels in yearlings were equal to or higher than those in older oysters. This change was

most obvious on the inshore beds of Nantuxent and Beadons, where infection levels in all ages were higher in 1997 than in 1996.

It is likely that the high levels of Dermo on the inshore lower beds is due to the relatively high density of oysters there. These beds typically receive heavier sets than the offshore beds and are less likely to be dredged for market or planting. (Note that the numbers of oysters per bushel given in this report are not a measure of the absolute abundance of oysters on the beds).

The continued trend toward lower infection intensities on the seed beds is intriguing. Last year, we attributed the lower infection levels on the upper beds to a cold, wet year, particularly the latter. This year, the trend has continued, despite a warm winter and a dry summer. Although the decline is much more obvious on the upper beds, it is worth noting that infection levels on the lower beds did not increase in response to the "stimulus" of a warm winter/dry summer as might be expected. We may be seeing evidence of resistance to Dermo disease in the older oysters, many of which set after the initial incursion of Dermo up the bay in 1991-1993 caused severe mortalities. Consequently, they would be the offspring of survivors of this epizootic, which probably had some innate resistance to the disease. Also, these older oysters themselves have survived two or more years of Dermo disease pressure - a good sign that they have some inherent resistance. Although there may be other factors contributing to the lower Dermo levels, we have solid evidence from our genetics and breeding program that resistance to Dermo disease is heritable and can be improved through selective breeding. Thus, development of increased resistance to the disease through natural selection of wild stocks is likely - just as happened for MSX disease in Delaware Bay after the 1957-59 epizootic.

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalence		
			1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995
Round Island		1.4	**74.2**	54.7	78.9															
Round Island	*	2.3	**57.9**	50.4	63.4															
Round Island		1.3	**40.3**	43	61.5	**239**	225	372	**51**	37	62	**15**	10	12	**10**	50	--	**0.1**	0.3	--
Round Island		0.5	**27.5**	35.7	60.8															
Round Island		0.1	**14.7**	26.8	51.8															
Round Island		1	**14.3**	6.8	4.7															
Up. Arnolds	*	0.1	**28.1**	--	72.3															
Up. Arnolds		0.2	5.7	--	65.1	**109**	--	422	**41**	--	109	**12**	--	15	--	--	60	--	--	1.2
Up. Arnolds			--	--	63.6															
Arnolds		3	**60.4**	75.2	57.1															
Arnolds		1.5	**39.7**	63	50															
Arnolds		0.5	**33.6**	41.3	44.8	**237**	194	203	**40**	44	55	**11**	20	18	**40**	10	90	**0.3**	0.5	1.7
Arnolds	*	2.8	**24.8**	17.1	0															
Arnolds		6	**20.6**	15.6	0															
Arnolds		2.6	**0**	0	0															
Up. Middle			--	0	--															
Up. Middle			--	0	--	--	0	--	--	0	--	--	0	--	--	--	--	--	--	--
Middle		3.7	**73.9**	80	44.8															
Middle		2.5	**72.1**	78.4	43.4															
Middle	*	4	**70.5**	77.4	41.4															
Middle		2.7	**57.5**	57.9	39.7															
Middle		4.3	**48.3**	32.8	39.5	**262**	244	132	**52**	42	162	**8**	10	38	**10**	--	--	**0.2**	--	--
Middle		4.3	**44.3**	13.8	0.9															
Middle		0.3	**16.4**	13.4	0															
Middle		0.1	**16**	0	0															
Middle		5	**7.3**	0	0															
Cohansey	*	7	**78.3**	72.9	50.9															
Cohansey		2.3	**57.5**	70.2	47.4															
Cohansey		4.2	**55.2**	66.4	35.7	**262**	322	154	**72**	36	160	**12**	12	32	**80**	90	70	**0.8**	1.9	2.1
Cohansey		5	**34**	40.7	22.4															
Cohansey		2.5	**26.3**	21.4	14.8															
Ship John		7	**83.9**	78.6	49															
Ship John	*	7	**83**	72.7	39.9															
Ship John		7	**80**	70.9	37.3	**344**	345	151	**234**	40	198	**14**	13	36	--	100	--	--	1.2	--
Ship John		7	**76.5**	61	34.1															
Ship John		3.3	**28.3**	8.8	33															
Ship John		4.2	**0.5**	--	25.1															

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalence		
			1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995
Shell Rock	*	7	**82.9**	76.8	45.4															
Shell Rock		7	**76**	71.5	40.3															
Shell Rock		7	**75.7**	69.6	35.7															
Shell Rock		5.3	**57.1**	67	34.8	**190**	323	114	**95**	24	197	**19**	12	36	**50**	80	100	**0.6**	0.9	2.3
Shell Rock		0.6	**38.3**	66.7	20.3															
Shell Rock		4.3	**23.7**	13.7	12.9															
Shell Rock		4.2	**22.6**	4.9	2.8															
Bennies Sand		5.3	**57.5**	72.8	38.2															
Bennies Sand	*	5.3	**56.2**	11.3	15.1															
Bennies Sand		0.6	**17.5**	4.1	9	**94**	152	47	**109**	6	117	**23**	8	39	**30**	--	--	**0.6**	--	--
Bennies Sand		4.7	**4.7**	2	2.1															
Bennies	*	5.3	**86.1**	73.7	75.2															
Bennies		5.7	**63.3**	52.5	39.5															
Bennies		7	**36.8**	33.5	28.9															
Bennies		2.8	**29.6**	30.2	20.8															
Bennies		6.7	**28.1**	18.6	12.8															
Bennies		0.1	**14.5**	17.8	3.2															
Bennies		4.7	**11.1**	13.7	0.8	**77**	123	79	**150**	10	110	**22**	19	31	**90**	90	100	**1.3**	1.7	1.7
Bennies		0.3	**10.9**	9.8	0.8															
Bennies		4.7	**6.2**	6.3	0.8															
Bennies		1.2	**5.7**	3.2	0.6															
Bennies		0.4	**3.6**	1.6	0															
Bennies		3.7	**0.8**	0	0															
Nantuxent Pt		4.8	**45.9**	--	34.6															
Nantuxent Pt		7	**39.4**	--	25															
Nantuxent Pt	*	6	**34.1**	--	24.8	**109**	--	120	**99**	--	113	**25**	--	39	**100**	--	50	**3**	--	1
Nantuxent Pt		7	**31.4**	--	17.4															
Nantuxent Pt		0.3	**9.9**	--	6.3															
Nantuxent Pt		0.6	**2.5**	--	3.7															
Hog Shoal		5	**76.3**	--	61.1															
Hog Shoal		1.7	**75.2**	--	37.6															
Hog Shoal	*	4.3	**57.1**	--	29.7	**142**	--	124	**162**	--	117	**29**	--	28	--	--	--	--	--	--
Hog Shoal		3.7	**53.3**	--	9.3															
Hog Shoal		3.5	**38.6**	--	6.3															
Hog Shoal		7	**16.8**	--	0															
New Beds		5	**75.2**	77.1	45.3															
New Beds		3.3	**16.5**	37.4	43.5															
New Beds		1.3	**15.9**	16.6	41															
New Beds		4.3	**12.8**	12.5	24.2															
New Beds	*	4.3	**7.9**	11.9	21.8	**23**	87	92	**165**	8	81	**39**	22	49	**60**	100	100	**1.1**	3.1	1.4
New Beds		1.2	**7**	5.2	16.1															
New Beds		5.3	**4.7**	3.1	15															
New Beds		1.2	**4.7**	1.4	9.7															
New Beds		0.4	**1.1**	0.73	7.1															
New Beds		0.7	**1**	--	1.4															

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalence		
			1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995	1997	1996	1995
Strawberry			--	43.1	--															
Strawberry			--	40	--															
Strawberry			--	31.4	--	--	105	--	--	13	--	--	27	--	--	--	--	--	--	--
Strawberry			--	17.2	--															
Strawberry			--	3.7	--															
Strawberry			--	1.5	--															
Hawks Nest			--	75.2	--															
Hawks Nest			--	74.3	--															
Hawks Nest			--	56.6	--															
Hawks Nest			--	44	--	--	300	--	--	29	--	--	17	--	--	100	--	--	3.4	--
Hawks Nest			--	3.7	--															
Hawks Nest			--	0.8	--															
Beadons		5	**79.5**	60.3	48.9															
Beadons		5.3	**68**	48.1	46.5															
Beadons		6.7	**58**	44.7	44.1															
Beadons	*	4.6	**57.6**	43.7	41.2															
Beadons		0.5	**30.6**	41.2	18.8	**89**	153	135	**553**	32	241	**34**	40	30	**100**	90	90	**2.9**	2.3	2.1
Beadons		0.8	**18.6**	40.7	18.6															
Beadons		4.3	**14**	30.1	3.1															
Beadons		2	**12**	9.3	1.7															
Beadons		6.3	**5.1**	6.7	0.7															
Beadons		2.3	**1.5**	1.2	0															
Vexton		5.3	**66.7**	--	43.3															
Vexton		3.7	**56.9**	--	34.8															
Vexton	*	3.5	**56.1**	--	32.7															
Vexton		7	**53.9**	--	24.8															
Vexton		4.3	**41**	--	4.7	**100**	--	71	**307**	--	183	**28**	--	46	--	--	--	--	--	--
Vexton		0.3	**24**	--	3.3															
Vexton		6.3	**7.4**	--	3															
Egg Island		3.8	**38.2**	22.2	9.1															
Egg Island		3.5	**21**	11.9	4.9															
Egg Island		6	**12**	2.2	3.2															
Egg Island		2.1	**11.1**	2	1.6															
Egg Island		0.4	**3.2**	1.3	1.3	**8**	10	8	**130**	4	3	**41**	52	80	**80**	100	100	**1.4**	2.8	3.1
Egg Island		0.3	**2.7**	1	1.1															
Egg Island		5	**1.6**	1	0															
Egg Island		?	**0.6**	0.9	0															
Egg Island		0.2	**0**	0.6	0															
Egg Island	*	0.5	**0**	0	0															
Ledge			--	1.5	--															
Ledge			--	1.1	--															
Ledge			--	0.7	--															
Ledge			--	0.6	--	--	0.6	--	--	0.6	--	--	79	--	--	--	--	--	--	--
Ledge			--	0.6	--															
Ledge			--	0	--															
Ledge			--	0	--															
Ledge			--	0	--															

Table 2. Spat set on New Beds, 1997, indicating the effect of addition of clean cultch to an area that included grid number 26.

Grid	Percent Oyster	Oyster/bu.	Spat/bu.	Drilled Spat/bu.
5	5	15	11	0
6	17	32	21	9
8	16	41	41	8
20	7	7	23	1
51	8	14	14	1
68	13	33	10	2
69	5	11	2	6
88	1	0	11	0
89	1	6	6	0
26	75	70	1510	66

Table 4. Average number of oysters per bushel based on samples from selected seed beds in 1996 and 1997. The values indicate the numbers of oysters greater than 2.5 and 3 inches in length that could be expected if a bushel of oyster and shell was removed directly from the dredge (no pre-sorting).

	1996			1997		
Bed	greater than 2.5 inches (63.5mm)	greater than 3 inches (76.2mm)	Number/Bu.	greater than 2.5 inches (63.5mm)	greater than 3 inches (76.2mm)	Number/Bu.
Arnolds	53	20	194	62	12	237
Middle	42	17	244	56	21	262
Cohansey	71	27	322	98	39	262
Ship John	68	24	345	105	44	344
Shell Rock	92	46	323	103	45	190
Bennies	55	25	123	55	17	77
New Beds	40	24	87	16	11	23

Table 3. Size Frequency of oysters on New Jersey's Delaware Bay seed beds, 1997. All data have been adjusted to numbers of oysters collected from an average bushel of unculled material. Oysters approximately 3 inches in length and larger are indicated in bold.

	Round Is	Up Arn	Arnolds	Middle	Cohansey	Ship Jn	Shell Rk	Ben Snd	Bennies	Nantux	Hog Sh.	New Beds	Beadons	Vexton	Egg Is
Size (mm)															
20	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
25	2	0	2	0	0	1	0	0	0	1	1	0	0	1	0
30	6	0	6	9	2	5	1	0	0	0	0	0	1	2	0
35	12	0	16	18	12	8	2	1	1	1	0	0	2	2	0
40	17	0	17	27	16	24	4	1	1	3	1	1	4	2	0
45	22	2	32	33	25	24	7	2	2	5	2	0	6	2	0
50	26	36	33	45	32	53	14	4	3	9	6	1	7	4	0
55	40	51	37	40	46	65	22	14	4	16	8	1	10	7	0
60	46	7	33	33	31	59	37	15	11	24	15	2	10	13	0
65	25	0	20	19	35	38	32	15	12	18	18	3	11	13	0
70	15	0	20	16	25	24	25	13	14	13	21	3	11	15	1
75	**10**	**0**	**10**	**10**	**15**	**19**	**20**	**12**	**12**	**8**	**22**	**2**	**11**	**12**	**1**
80	**9**	**0**	**5**	**4**	**13**	**12**	**12**	**9**	**7**	**4**	**19**	**4**	**7**	**8**	**1**
85	**5**	**0**	**4**	**4**	**6**	**7**	**5**	**4**	**5**	**2**	**12**	**2**	**4**	**7**	**1**
90	**4**	**0**	**2**	**1**	**3**	**4**	**4**	**3**	**2**	**2**	**9**	**1**	**3**	**5**	**1**
95	**1**	**9**	**1**	**1**	**2**	**0**	**3**	**0**	**1**	**2**	**4**	**1**	**2**	**3**	**0**
100	**0**	**3**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**2**	**0**	**1**	**2**	**1**
105	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**
110	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
115	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
120	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
125	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
130	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
135	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
140	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total/Bu.	239	109	237	262	262	344	190	94	77	109	142	23	89	100	8
No. Measured	472	123	237	709	481	592	619	244	483	381	531	188	89	528	65
Greater than 3"	**29**	**13**	**12**	**21**	**39**	**44**	**45**	**30**	**17**	**18**	**70**	**11**	**17**	**39**	**5**
Greater than 2.5"	69	13	62	56	98	105	103	57	55	49	109	16	49	67	6
Average Size	57	55	55	53	59	58	64	67	69	62	72	70	64	69	78

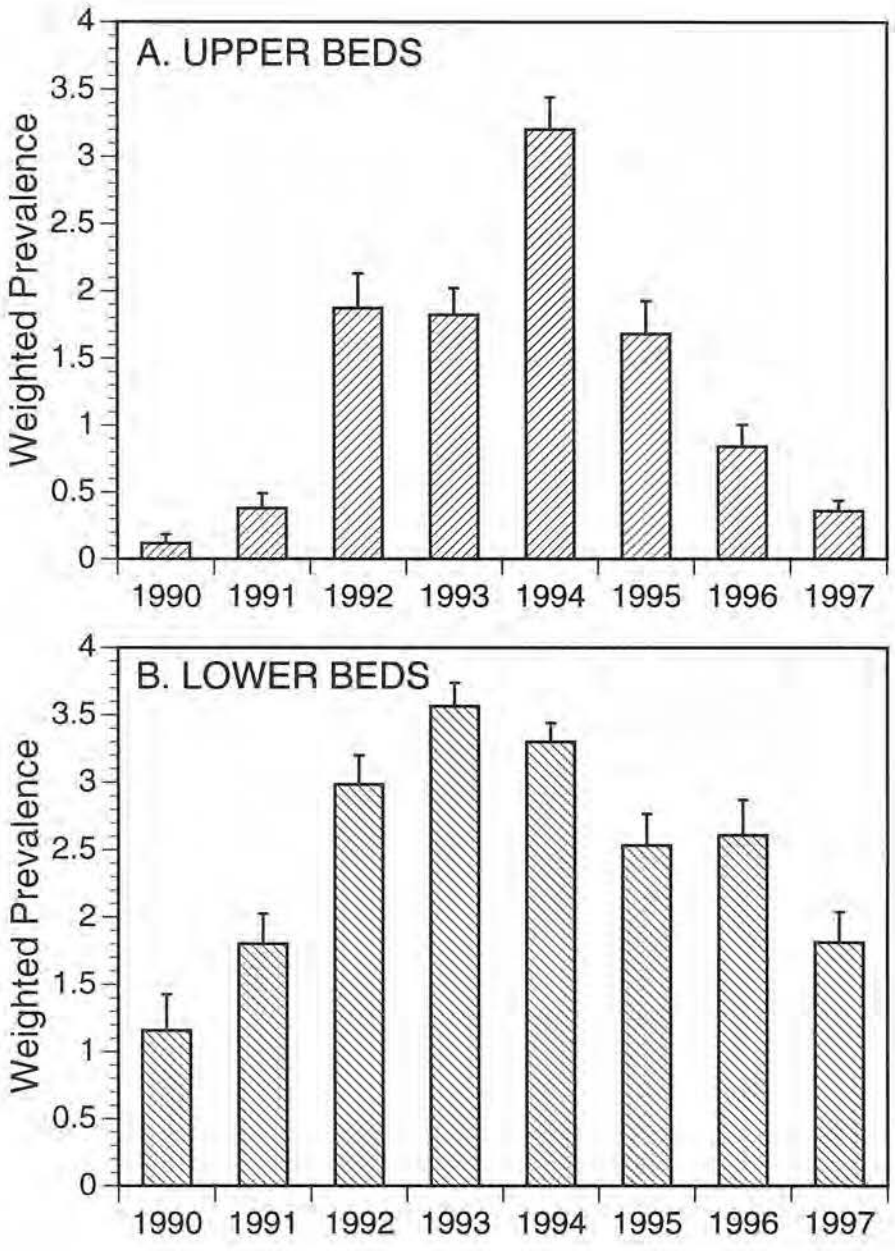

Figure 1. Weighted prevalence of *Perkinsus marinus* (Dermo) in oysters two years and older on Delaware Bay, NJ seed beds during fall surveys from 1990 through 1997. Upper Beds include Shell Rock/Bennies and above; Lower Beds include Bennies and below. Beadons and Nantuxent Beds are excluded.

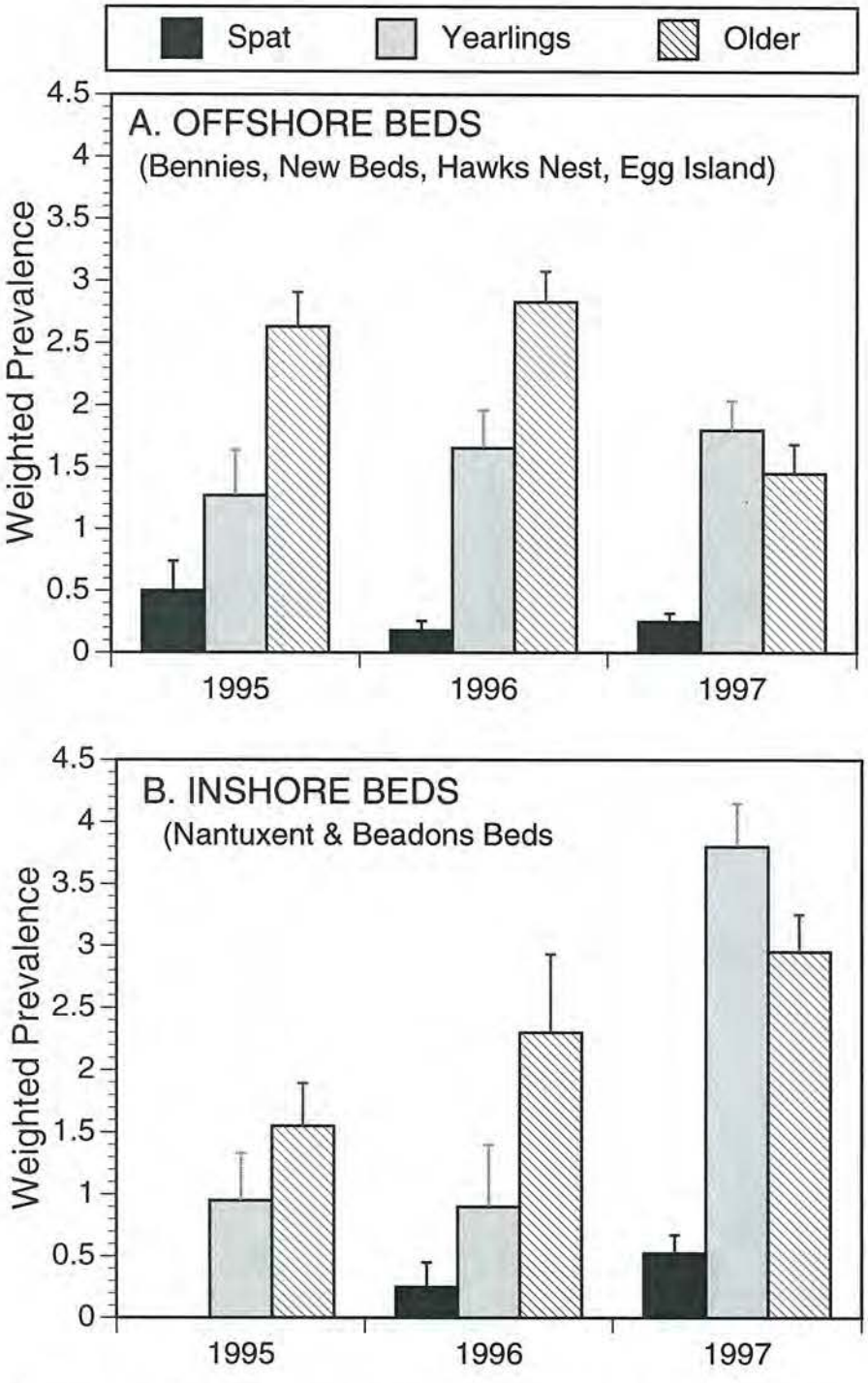

Figure 2. Weighted prevalence of *Perkinsus marinus* (Dermo) in three age classes of oysters on offshore (A) and inshore (B) lower Delaware Bay, NJ seed beds during fall surveys of 1995-1997.