FINAL REPORT

Delaware Bay 1996 Random Sampling of Oyster Seed Beds

by

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Summary of the 1996 Random Sampling of the Delaware Bay Seed Beds

Attached is a summary of the 1996 seed bed sampling data with similar data for 1995 and 1994. All data were collected between November 18, 1996 and November 20, 1996 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 strata, and no more than two samples were taken from the marginal strata 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.

We have eliminated the yearling classification and added - to the left of the Percent Oyster 1996 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:

- There was a direct harvest of market oysters from the seed beds (Apr - June and Sept.- Oct.) last year. Most were removed from Bennies (11,214 bu.) and New Beds (41,940 bu.) with additional oysters being removed from Bennies Sand (4,869 bu.) and Hog Shoal (1,022 bu.), and miscellaneous beds (1,584 bu.).

- The number of oysters (older than yearlings) per bushel has generally increased. This is due to the relatively good sets on some beds in 1994 and 1995. Beadons is a good example of this increase.

o The number of oysters in market size categories (>2.5") on most Middle Bay beds has increased. Numbers of oysters in the market size categories in the upper bay may have decreased and those in the lower bay beds remain about the same.

o Mortalities based on box counts were generally the same or lower on all beds than last year.

o Spat setting was uniformly poor. The highest average spat set was 44 spat per bushel.

o Prevalence of Dermo remains about the same as last year.

o Weighted Prevalence indices have declined slightly in beds above and including Shell Rock. Beds below this point have about the same weighted prevalence as last year.

o Beadons is a good example of a bed a number of marketable oysters, 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.

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 1995 and 1996 data for selected beds is provided in Table 2 below.

Numbers of oysters per bushel on seed beds increased in 1996, as did the number market sized oysters per bushel. This is particularly true of the oysters in the middle of the seed bed area (Cohansey, Ship John and Shell Rock). Numbers increased on Middle, but the number in the market size categories did not. This, with the declines in Arnolds and Round Island suggests poor growing conditions in the upper portion of the seed beds. In spite of the harvest there was little or no change in numbers of market size oysters per bushel on Bennies or New Beds.

The extremely poor spat set this year, the worst since 1992, means that we expect fewer oysters to be available for market in 1999 or 2000 depending on their survival and growth. A good set next year may help to compensate in 2000 and 2001.

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.

Table 2. Average number of oysters per bushel based on samples from selected seed beds in 1995 and 1996. 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			1995		
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	139	51	203
Middle	42	17	244	45	15	132
Cohansey	71	27	322	29	14	154
Ship John	68	24	345	42	17	151
Shell Rock	92	46	323	11	24	114
Bennies	55	25	123	36	18	79
New Beds	40	24	87	36	20	92

Dermo Prevalence and Weighted Prevalence

Salinities on the seed beds were depressed in 1996 as a result of abundant precipitation in the water shed. Temperatures were below average for much of the year. Although prevalences of Dermo disease remained high in the Bay, both mortality and weighted prevalences were reduced, especially on the upper seed beds. A comparison of Dermo weighted prevalences observed during the fall surveys of 1996 and 1997, showed marked differences between the upper and lower seed beds. The weighted prevalences for three age classes (spat, yearlings, and older oysters) on beds including and below Bennies were statistically the same in 1996 as in 1995 (Figure 1). The same comparison for beds including and above Shell Rock, however, showed that weighted prevalences were statistically different in the two years: each age class had a lower Dermo level this year compared to last year. Overall, the weighted prevalence on the upper seed beds in 1996 was about half that in 1995. The fact that the reduction in Dermo levels occurred only on the upper beds argues that the major contributing factor was the high river flow, rather than low temperatures. High river flow could have lowered Dermo intensities by reducing salinities to the point that the Dermo parasite could no longer survive or by diluting and flushing infective particles from the upper bay, or both. The lower intensities would have translated directly into lower mortalities.

Although survival improved in 1996, there is much evidence showing that high disease and mortalities levels can return quickly if we enter another warm, dry year.

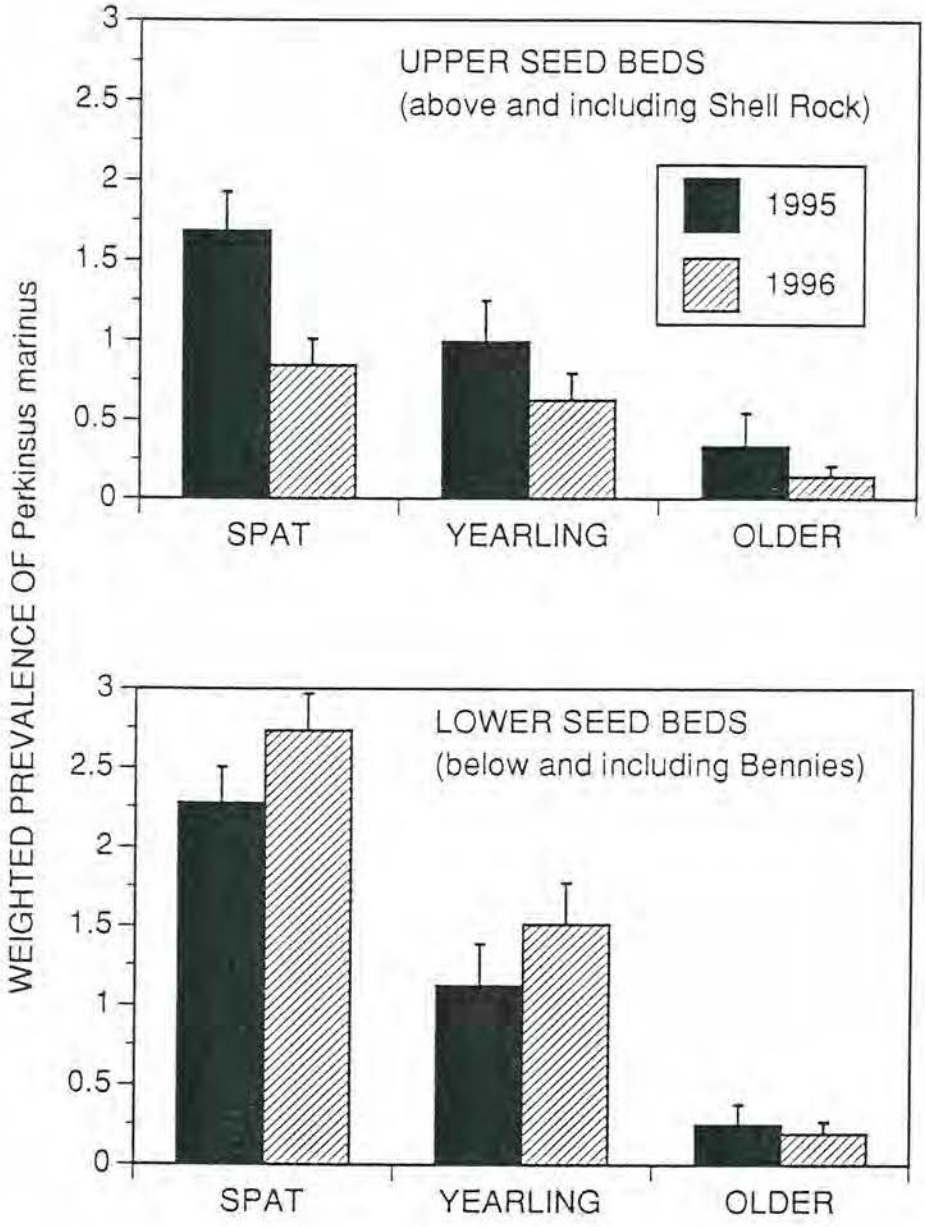

Figure 1. Weighted prevalence of the Dermo disease parasite, *Perkinsus marinus* on upper and lower Delaware Bay oyster seed beds as measured during the fall surveys of 1995 and 1996. Error bars are the standard error of the mean. N = 40 - 60 for each sample. A 2-way ANOVA (age and year) showed a significant effect ($p<0.05$) of age in both areas of the bay, was was significant for year only in the upper bay.

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalenc		
			1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994
Round Island		2	**54.7**	78.9	69.3															
Round Island	*	2	**50.4**	63.4	40.4															
Round Island		--	**43**	61.5	34.8	**225**	372	253	**37**	62	57	**10**	12	8	**50**	--	60	**0.3**	--	0.5
Round Island		1	**35.7**	60.8	28.3															
Round Island		0.5	**26.8**	51.8	19.1															
Round Island		2	**6.8**	4.7	11.3															
Up. Arnolds		--	--	72.3	--															
Up. Arnolds		--	--	65.1	--	--	422	--	--	109	--	--	15	--	--	60	--	--	1.2	--
Up. Arnolds		--	--	63.6	--															
Arnolds		5	**75.2**	57.1	81.7															
Arnolds	*	7	**63**	50	58.3															
Arnolds		3	**41.3**	44.8	58	**194**	203	301	**44**	55	78	**20**	18	7	**10**	90	100	**0.5**	1.7	1.9
Arnolds		1	**17.1**	0	47.6															
Arnolds		0.5	**15.6**	0	22.6															
Arnolds		0	**0**	0	0															
Up. Middle	*	0	**0**	--	25															
Up. Middle		0	**0**	--	0.6	**0**	--	47	**0**	--	47	**0**	--	4	--	--	--	--	--	--
Middle		1	**80**	44.8	51.2															
Middle	*	3	**78.4**	43.4	43.2															
Middle		4	**77.4**	41.4	40.5															
Middle		0.3	**57.9**	39.7	37.1															
Middle		1	**32.8**	39.5	35.6	**244**	132	138	**42**	162	142	**10**	38	30	--	--	80	--	--	2.3
Middle		--	**13.8**	0.9	33.3															
Middle		0.5	**13.4**	0	26.7															
Middle		0.3	**0**	0	13.2															
Middle		0	**0**	0	6															
Cohansey	*	5	**72.9**	50.9	43.1															
Cohansey		5	**70.2**	47.4	42.5															
Cohansey		6	**66.4**	35.7	40	**322**	154	152	**36**	160	302	**12**	32	22	**90**	70	95	**1.9**	2.1	2.7
Cohansey		4	**40.7**	22.4	39.9															
Cohansey		0.2	**21.4**	14.8	37.5															
Ship John		5	**78.6**	49	58.5															
Ship John		2	**72.7**	39.9	45.9															
Ship John		4	**70.9**	37.3	37.8	**345**	151	149	**40**	198	123	**13**	36	24	**100**	--	100	**1.2**	--	3.4
Ship John	*	6	**61**	34.1	30.3															
Ship John		0.8	**8.8**	33	20.6															
Ship John		--	**--**	25.1	--															
Shell Rock		2	**76.8**	45.4	47.5															
Shell Rock		7	**71.5**	40.3	46.7															
Shell Rock		3	**69.6**	35.7	43.6															
Shell Rock	*	3	**67**	34.8	40.6	**323**	114	134	**24**	197	88	**12**	36	22	**80**	100	90	**0.9**	2.3	2.9
Shell Rock		6	**66.7**	20.3	36.3															
Shell Rock		3	**13.7**	12.9	3.1															
Shell Rock		1	**4.9**	2.8	0.4															

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalence		
			1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994
Bennies Sand	*	6	72.8	38.2	9.4															
Bennies Sand		3	11.3	15.1	3.3															
Bennies Sand		4	4.1	9	1.2	152	47	14	6	117	55	8	39	28	--	--	100	--	--	2.7
Bennies Sand		0.3	2	2.1	0.3															
Bennies	*	7	73.7	75.2	42.3															
Bennies		6	52.5	39.5	40.5															
Bennies		6	33.5	28.9	40															
Bennies		7	30.2	20.8	39															
Bennies		7	18.6	12.8	34.4															
Bennies		6	17.8	3.2	17.1															
Bennies		4	13.7	0.8	5.9	123	79	75	10	110	68	19	31	30	90	100	90	1.7	1.7	2.9
Bennies		0.3	9.8	0.8	3.7															
Bennies		4	6.3	0.8	2.6															
Bennies		2	3.2	0.6	0.3															
Bennies		0.8	1.6	0	0.3															
Bennies		0.1	0	0	0.3															
Nantuxent Pt		--	--	34.6	--															
Nantuxent Pt		--	--	25	--															
Nantuxent Pt		--	--	24.8	--	--	120	--	--	113	--	--	39	--	--	50	--	--	1	--
Nantuxent Pt		--	--	17.4	--															
Nantuxent Pt		--	--	6.3	--															
Nantuxent Pt		--	--	3.7	--															
Hog Shoal		--	--	61.1	--															
Hog Shoal		--	--	37.6	--															
Hog Shoal		--	--	29.7	--	--	124	--	--	117	--	--	28	--	--	--	--	--	--	--
Hog Shoal		--	--	9.3	--															
Hog Shoal		--	--	6.3	--															
Hog Shoal		--	--	0	--															
New Beds		5	77.1	45.3	66.7															
New Beds		2	37.4	43.5	55.3															
New Beds		2	16.6	41	45															
New Beds	*	1	12.5	24.2	44.7															
New Beds		3	11.9	21.8	32.9	87	92	124	8	81	248	22	49	24	100	100	100	3.1	1.4	3.3
New Beds		2	5.2	16.1	18.8															
New Beds		1	3.1	15	0.3															
New Beds		2	1.4	9.7	0.3															
New Beds		1	0.73	7.1	0															
New Beds		--	--	1.4	--															

Bed		Bushels/ Haul	Percent Oyster			Oysters/Bushel			Spat/ Bushel			Percent Mortality			Dermo Percent Prevalence			Dermo Weighted Prevalenc		
			1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994	1996	1995	1994
Strawberry		4	43.1	--	30.8															
Strawberry	*	4	40	--	5.3															
Strawberry		2	31.4	--	0.3	105	--	19	13	--	164	27	--	24	--	--	80	--	--	2.7
Strawberry		5	17.2	--	0.3															
Strawberry		3	3.7	--	0															
Strawberry		2	1.5	--	0															
Hawks Nest		7	75.2	--	28.6															
Hawks Nest		5	74.3	--	22.5															
Hawks Nest		5	56.6	--	12.8															
Hawks Nest	*	7	44	--	8.1	300	--	50	29	--	193	17	--	24	100	--	80	3.4	--	3.3
Hawks Nest		3	3.7	--	5.5															
Hawks Nest		5	0.8	--	0															
Beadons		7	60.3	48.9	26.5															
Beadons		7	48.1	46.5	12.1															
Beadons		6	44.7	44.1	9.7															
Beadons		7	43.7	41.2	8.8															
Beadons		6	41.2	18.8	6	153	135	28	32	241	270	40	30	17	90	90	30	2.3	2.1	1.1
Beadons		7	40.7	18.6	3.2															
Beadons	*	5	30.1	3.1	3.1															
Beadons		4	9.3	1.7	0.4															
Beadons		3	6.7	0.7	0.4															
Beadons		3	1.2	0	0.3															
Vexton		--	--	43.3	--															
Vexton		--	--	34.8	--															
Vexton		--	--	32.7	--															
Vexton		--	--	24.8	--															
Vexton		--	--	4.7	--	--	71	--	--	183	--	--	46	--	--	--	--	--	--	--
Vexton		--	--	3.3	--															
Vexton		--	--	3	--															
Egg Island		5	22.2	9.1	30.6															
Egg Island		5	11.9	4.9	16															
Egg Island	*	7	2.2	3.2	3.6															
Egg Island		4	2	1.6	2.9															
Egg Island		4	1.3	1.3	2.8	10	8	16	4	3	26	52	80	51	100	100	100	2.8	3.1	3.9
Egg Island		3	1	1.1	0.3															
Egg Island		2	1	0	0.3															
Egg Island		3	0.9	0	0															
Egg Island		2	0.6	0	0															
Egg Island		0.5	0	0	0															
Ledge		2	1.5	--	43.1															
Ledge		0.6	1.1	--	0.4															
Ledge	*	2	0.7	--	0.3															
Ledge		1	0.6	--	0.3	0.6	--	18	0.6	--	5	79	--	35	--	--	100	--	--	3.8
Ledge		1	0.6	--	0															
Ledge		1	0	--	0															
Ledge		3	0	--	0															
Ledge		2	0	--	0															

Table 3. Size frequency of oysters on New Jersey's Delaware Bay seed beds in 1996. All data have been adjusted to numbers of oysters collected in an average bushel of unculled material. Oysters approximately 3 inches in length and larger are indicated in bold.

	Round Is.	Arnolds	Middle	Cohansey	Ship John	Shell Rock	Ben Sand	Bennies	New Bed	Strawberry	Hawks Nst.	Beadons	Ledge
Size (mm)													
10	1	0	0	0	0	0	0	0	0	0	0	0	0
15	5	0	0	0	0	0	0	0	0	0	0	0	0
20	4	0	1	0	0	0	0	0	0	0	0	0	0
25	7	3	3	1	1	1	2	0	0	0	0	0	0
30	12	10	19	12	6	3	0	1	0	0	3	1	0
35	11	17	35	36	29	17	3	1	1	4	12	4	0
40	16	22	37	54	53	46	8	7	5	8	26	8	0
45	17	20	34	49	55	52	19	11	10	15	44	16	0
50	25	26	31	46	49	47	24	15	10	16	58	19	0
55	30	23	26	25	48	44	27	18	9	11	47	21	0
60	33	20	16	28	36	21	11	15	12	13	41	25	0
65	31	20	15	24	25	26	16	14	7	14	28	19	0
70	14	13	10	20	19	20	15	16	9	11	20	13	0
75	**10**	**9**	**6**	**14**	**7**	**15**	**6**	**10**	**7**	**6**	**13**	**10**	**0**
80	**5**	**4**	**5**	**6**	**13**	**11**	**5**	**5**	**4**	**4**	**4**	**8**	**1**
85	**2**	**3**	**3**	**4**	**2**	**5**	**5**	**4**	**4**	**2**	**2**	**4**	**0**
90	**1**	**3**	**1**	**2**	**1**	**10**	**2**	**2**	**4**	**1**	**1**	**3**	**0**
95	**0**	**1**	**2**	**1**	**1**	**1**	**5**	**1**	**2**	**0**	**1**	**1**	**0**
100	**1**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**1**	**0**	**0**	**1**	**0**
105	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**
110	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**
115	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
120	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total/Bushel	225	194	244	322	345	323	152	123	87	105	300	153	1
No. Measured	523	422	596	443	429	591	183	641	383	387	412	658	4
Greater than 3"	**19**	**20**	**17**	**27**	**24**	**46**	**27**	**25**	**24**	**13**	**21**	**27**	**1**
Greater than 2.5"	64	53	42	71	68	92	58	55	40	38	69	59	1
Average Size	53	53	49	51	52	55	60	62	64	57	54	60	80