S. IAN HARTWELL D)ECENNE

DELAWARE BAY AND ADJACENT WATERS BENTHIC COMMUNITY ASSESSMENT

SUBMITTED TO

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U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL OCEAN SERVICE OFFICE OF OCEAN RESOURCES CONSERVATION AND ASSESSMENT SLIVER SPRING, MARYLAND 20910

PREPARED BY

BARRY A. VITTOR & ASSOCIATES, INC. 8060 COTTAGE HILL RD. MOBILE, ALABAMA (334) 633-6100

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INTRODUCTION

The Delaware River, Delaware Bay and adjacent waters were sampled during September, 1997. One goal of this sampling effort was benthic community characterization. National Oceanic and Atmospheric Administration (NOAA) personnel collected the samples and laboratory and data analysis were performed by Barry A. Vittor & Associates, Inc. (BVA).

METHODS

Sample Collection And Handling

A Young dredge (area = 0.04 m^2) was used to collect bottom samples at each of 81 steps in the Delaware River, Delaware Bay and adjacent waters. Macroinfaunal samples were sieved through a 0.5-mm mesh screen and preserved with 10% formalin on ship. Macroinfaunal samples were transported to the BVA laboratory in Mobile, Alabama.

Sediment Analysis

Sediment texture was determined at half-phi intervals using the hydrometer technique for fractions smaller than 44 µm and nested sieves for larger particle fractions. Texture parameters computed included percent gravel, sand, silt and clay. Total organic carbon (TOC) content was measured as ash-free dry weight expressed as a percentage.

Macroinfaunal Sample Analysis

In the laboratory of BVA, benthic samples were inventoried, rinsed gently through a 0.5 mm mesh sieve to remove preservatives and sediment, stained with Rose Bengal, and stored in 70% isopropanol solution until processing. Sample material (sediment, detritus, organisms) was placed in white enamel trays for sorting under Wild M-5A dissecting microscopes. All macroinvertebrates were carefully removed with forceps and placed in labelled glass vials containing 70% isopropanol. Each vial represented a major taxonomic group (e.g. Polychaeta, Mollusca, Arthropoda). All sorted macroinvertebrates were identified to the lowest practical

identification level (LPIL), which in most cases was to species level unless the specimen was a juvenile, damaged, or otherwise unidentifiable. The number of individuals of each taxon, excluding fragments, was recorded. A voucher collection was prepared, composed of representative individuals of each taxa not previously encountered from the region.

DATA ANALYSIS

All data generated as a result of laboratory analysis of macroinfauna samples were first coded on data sheets. Enumeration data were entered for each species according to site and strata. These data were reduced to a data summary report for each site, which included a taxonomic species list and benthic community parameters information. Archive data files of species identification and enumeration were prepared.

The QA/QCs report for the Delaware Bay and adjacent waters samples is given in the Appendix.

The analytical methodologies utilized for this study were similar to those used in other benthic community characterization reports prepared for NOAA. Macroinfaunal characterization involves an evaluation of several biological community structure parameters (e.g., taxa abundance, taxa composition and taxa diversity indices) during initial data reduction, followed by pattern and classification analysis for delineation of taxa assemblages. Since taxa are distributed along environmental gradients, there are generally no distinct boundaries between communities. However, the relationships between habitats and taxa assemblages often reflect the interactions of physical and biological factors and indicate major ecological trends.

Assemblage Structure

Several numerical indices were chosen for analysis and interpretation of the macroinfaunal data. Selection was based primarily on the ability of the index to provide a meaningful summary of data, as well as the applicability of the index to the characterization of the benthic community. Infaunal abundance is reported as the total number of individuals per site and the total number of

individuals per square meter (= density). Taxa richness is reported as the total number of taxa represented in a given site collection.

$$\mathbf{H'} = -\sum_{i=1}^{3} \mathbf{p}_i (ln \mathbf{p}_i)$$

where, S = is the number of taxa in the sample,

i = is the i'th taxa in the sample, and

 p_i = is the number of individuals of the i'th taxa divided by the total number of individuals in the sample.

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Taxa diversity within a given community is dependent upon the number of taxa present (taxa richness) and the distribution of all individuals among those taxa (equitability or evenness). In order to quantify and compare faunal equitability to taxa diversity for a given area, Pielou's Index J' (Pielou, 1966) was calculated as J' = H'/ln S, where $ln S = H'_{max}$, or the maximum possible diversity, when all taxa are represented by the same number of individuals; thus, $J' = H'/H'_{max}$.

Macroinfaunal data were graphically and statistically analyzed to identify any differences in density between strata. Data for total density were variously transformed and tested for normality (Shapiro-Wilk W; SAS Institute, 1995). Data which could not be normalized with standard transformations [e.g. ln(x+1), $\sqrt{(x+1)}$] were analyzed using non-parametric methods (SAS Institute, 1995).

Faunal Similarities

Cluster analysis was performed on the faunal data to examine between-site differences at the Delaware Bay sites and to compare faunal composition of each site within the study area. Both normal and inverse cluster analyses were used in this study. Normal analysis (sometimes called Q-analysis) treats samples as individual observations, each being composed of a number of attributes

(i.e. the various taxa from a given sample). Normal analysis is instructive in helping to ascertain community-structure and to infer specific ecological conditions between sampling stations from the relative distributions of species. Inverse clustering (termed R-analysis) is based on taxa as individuals, each of which is characterized by its relative abundance in the various samples. This type of analysis is commonly used to identify species groupings with particular habitats or environmental conditions.

Cluster analysis of both station collections (normal analysis) and taxa (inverse analysis) was performed using the average linkage method (SAS Institute 1997). In this method, the distance between two clusters is the average distance between pairs of observations, one in each cluster. Taxa used in these analyses were selected according to their percent abundance in the assemblage. Total densities for each of the selected taxa at a given station were ln transformed [x=ln(x+1)] before the analyses.

HABITAT CHARACTERISTICS

Sediment data for the 81 sites and 22 strata are given in Table 1 and Figures 1, 2, 3 and 4. Sediment composition of the 81 sites varied considerably from 73% silt (sandy silt) at Site 3 to greater than 99% sand at nine sites with Site 47 at 99.97% (Table 1; Figures 1 and 2); however, the sediment at the majority of sites was predominantly silty sand (Figures 1 and 2). The total organic carbon (TOC) fraction of the sediment ranged from 0.09% at site 62 to 20.5% at site 89 (Table 1; Figures 3 and 4). In terms of strata, sand again dominated with 14 of the 22 strata composed of greater than 50% (Figure 5) however, the variability of sediment components of the sites within each stratum is high (Figures 6, 7, 8 and 9). Stratum 3 contained the highest percentage of sand at 94.45% (Table 1). Strata 21 and 22 contained the highest percentages of silt, 61.17% and 53.96% respectively and, conversely, the lowest percentages of sand, 6.41% and 4.55% (Table 2; Figure 5). Mean % TOC for all strata is displayed in Figure 10.

Site No.	Strata	No. of Taxa	Density (nos./m2)	H' Diversity	J' Evenness	Temp (°C) Surface	Temp (°C) Bottom	DO (mg/l) Surface	DO (mg/l) Bottom	Salinity (ppt) Surface	Salinity (ppt) Bottom	% Gravel	% Sand	% Silt	% Clay	% TOC	Textural Description
	19	17	6900	1.74	0.62	22.8	22.7	6.7	6.3	0.1	0.1	0	11.76	55.99	32.24	1.42	silty clay
2	19	11	4100	1.49	0.62	21.7	21.7	7.0	5.3	0.1	0.1	1.24	96.18	1.56	0	1 47	sand
3	19	15	7650	1.79	0.66	22.3	22.3	5.7	4./	0.1	0.1	U	14.99	/3.05	11.90	1.47	sandy sill
		14.33	6216.67	1 67	0.63	27 3	72 7	Mean a. 170	5 4	A i	R1	0.41	An og	47 53	14 73	1 90 1	υ.
		5D	SD.	,	0.0.	S D	5 D	S.D	śp.	S.D.	Š.D.	S.D.	S.D.	S.n.	S.D.	S.D.	
		3.06	1871.05			0.55	0.50	0.67	0.82	0	0	0.72	47.83	37.34	16.30	0.26	
4	20	16	19525	0.96	0.35	22.5	22.5	6.0	5.9	0.2	0.1	0	78.05	18.22	3.72	2,27	silty sand
5	20	6	1425	0.78	0.44	22.9	22.9	7.1	5.3	0.2	0.1	0.15	99.04	0	0	2.12	sand
6	20	10	3325	1.87	0.81	22.5	22.5	8.6	9.0	0.1	0.1	0.09	99.26	0	0	1.98	sand
		Mean No. Taxa	Mean D	Mean H'	Mean J	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B. DO	Mean S. Sal	Mean B. Sal	Mean % G	Mean % Sand	Mean %Silt	Mean % Clay	Mean % 10	C
		10.67	8091.07	1.20	0.53	220	22.6	1.4	0.1	U.1 C D	U.J	0.08	92.12 E D	0.U/ 5 D	1.24 c n	212 E D	
		5.02	0047.03			S.D. 0.10	3.0.0	3.12	5D.	3.0.	5.D. 0.07	5.D.	3.0.	5.0.	2.15	G 15	
7	1	18	13250	1 36	047 1			63	65	01	0.04	0	42.38	53 13	4 49	217	sandy silt
8	i	7	11150	0.42	0.22	23.4	23.3	5.6	4.3	0.2	0.2	ŏ	31.35	62.49	6.16	2.03	sandy silt
9	i	ż	4700	1.41	0.73	22.8	22.7	5.8	5.7	0.1	0.1	11.81	84.56	2.25	0	0.99	gravelly sand
		Mean No. Taxa	Mean D	Mean H'	Mean J'	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B, DO	Mean S. Sal	Mean B. Sal	Mean % G	Mean % Sand	Mean %Silt	Mean % Clay	Mean % TO	C .
		10.67	9700	1.07	0,47	23.2	23.i	5.9	5.5	0.1	0.1	3.94	52.76	39.29	3.55	1.73	
		S.D.	\$.D.			S.D.	\$.D.	S.D.	S,D,	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	
		6.35	4455.61			0.33	0.35	0.35	1,10	0.04	0.04	6.82	28.08	32.42	3.19	0.64	
10	2	12	6975	1.95	0.78	23.5	23.3	5.6	5.4	0.2	0.2	0	13.24	70.48	16.28	3.13	sandy sill
11	2	11	3775	1.89	0.79	23.5	23.3	5.2	4.8	0.2	0.2	0.85	74.72	18.54	5.89	0.74	silly sand
12	4	12	08/5	1.74	0.70						0000 0. JANNAA (200/ 1.200	15,80	24.08	32.93	27.12	5.01	graveny muu
		11.67	4975	1 86	interit J	mean S. Temp	nean b. temp	Mean S. DO	4 1 mean b. DO	0.7	0.7	4 47	3735	do 54	16.43	2 20	C .
		50	5075 S.D	1250	0.70	S D	<u>Sn</u>	Ś.D	5 D	S.D.	S.D	5.D	\$D	5.D.	S.D.	Ŝ.D.	
		0.58	1819.34			0	0	0.28	0.43	0	0	8.92	32.82	26,82	10.62	1.35	
13	3	5	1875	1.07	0.67	23.6	23.6	5.3	5.3	0.2	0.2					1.02	
14	3	9	1425	1.72	0.78	23.4	23.3	4.0	5.6	0.2	0.2	1.53	89.81	5.51	0	2.62	sand
15	3	7	1475	1.29	0.66	23.5	23.6	5.4	5.3	0.3	0.2	0	99.08	0	0	0.34	sand
		Mean No. Taxa	Mean D	Mean H'	Mean J	Mean S. Temp	Meau B. Temp	Mean S. DO	Mean B. DO	Mean S. Sul	Mean B. Sal	Mean % G	Mean % Sand	Mean %Silt	Mean % Clay	Mean % IU	C
		c'a	1591.67	1.36	0.70	23.5	23.5	4,9	5.4	0.2 C D	0.2 C D	0.11	94.45	2.70 E D	0 5 D	1.33	
		s.p.	5.0.			5.11.	5.D.	5.0.	S.D.	5. <i>D</i> ,	5.µ.	5.D.	a.u. 6.sr	3.0.	3.D. 0	a.u. 117	
16	4	12	200,04	1.54	0.60	0,09	0,10	0.70	U. 2U	040	0.01	0	43.03	26.65	3032	1 98	sandy clay
17	4	8	3300	1.48	0.00							1.09	95.98	2 05	0	0.32	sand
1 18	4	8	2325	1.25	0.60	23.9	23.7	6.4	6.4	0.7	0.7	0.07	84.57	12.2	õ	0.46	sand
		Mean No. Taxa	Mean D	Mean H'	Mean J	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B, DO	Mean S. Sal	Mean B. Sal	Mean % G	Mean % Sand	Mean %Silt	Mean % Clay	Mean % TO	C
		9.67	6141,67	1.42	0,64	23.9	23.7	6.4	6.4	0.7	0.7	0.39	74,53	13.63	10,11	0.92	
		S.D.	S.D.			S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D,	
		2.89	5786.86			0	0	Ð	0	0	0	0.61	27.87	12.36	17,51	0.92	

Table 1. Summary of water parameters and benthic macroinfaunal data for the Delaware Bay and adjacent waters sites and eorresponding strata, September 1997.

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Site No.	Strata	No. of Taxa	Density (nos/m2)	H' Diversity	J' Evenness	Temp (°C) Surface	Temp (°C) Bottom	DO (mg/l) Surface	DO (mg/l) Bottom	Salinity (ppt) Surface	Salinity (ppt) Bottom	% Gravel	% Sand	% Silt	% Clay	% TOC	Textural Description
19 20 21	5 5 5	8 7 2	2550 5075 400	1.01 0.83 0.48	0.49 0.43 0.70	23.1 23.7	23.2 23.2	5.8 6.8	5.4 6.4	-0.8 1.4	2.1 1.6	0.41	59.38 62.87 34.42	25.14 27.83 40.11	15.07 9.3 25.48	2.67 2.97 0.96	silty sand silty sand
		Mean No. Taxa 5.67	Mean D 2675	Mean H' 0,77	Mean J 0,54	Mean S. Temp 23.4	Mean B. Temp 23.2	Mean S. DO 6.3	Mean B. DO 5.9	Mean S. Sal	Mean B. Sal 1.9	Mean % G 0,14	Mean % Sun 52.22	d Mean %Sili 31.03	Mean % Clay 16.62	Mean % TC 2.2	C I
22	6	3.21 7	5.D. 2340.01	1 17	0.60	5.D. 0.42	8.D. 0 23.1	S.D. 0.75	S.D. 0.71	S.D. 0.42	S.D. 0.35	5.D. 0.24	S.D. 15.52	S.D. 7.98	S.D. 8.20	S.D. 1.08	
23 24	6 6	2 2	2900 75	0.55 0.64	0.80 0.92	23.2 23.2 23.2	23.2 23.1	6.3 7.0	6.2 6.5	3.4 3.1	3.5	0	4.01	44.5 48.87	51.49 39.64	3.23 3.11	clay silty clay
		Mean Na, Taxa 3.67 S D	Mean D 1591.67 S D	Mean H' 0.79	Mean J' 0.77	Mean S. Temp 23.2 S D	Mean B. Temp 23.1 5 D	Mean S. DO 6.6 S D	Mean B. DO 5.3 S D	Mean S, Sal 3.D S D	Menn B. Sal 3.2 S D	Mean % C	Mean % San 32.38 S D	d Mean %Sili 34.92 S D	Mean % Clay 32.7	Mean % TC 2.24 S D	NC
25	7	2.89	1423.98 125	1.33	0.96	0.06	0.06	0.35	1.83	0.40	0.23	0	42.83 29.28	20.49 42.06	23.06 28.66	1.61 2.23	clayey silt
26 27	7	5 4 Mean No Taxa	4550 150 Mean D	0.21 1.24 Menn H	0.13 0.90	19.4 19.9 Mean S. Temn	19.2 19.5 Mean B. Tama	7.3 7.4	7.0 7.3	4.5 4.7 Mean S Sal	4.5 5.1 Magan B. Sol	1.83	54.53	20.1	23.54	1,98 0.6	clayey sand
		4.33 S.D.	1608.33 S.D.	0.93	0.66	19.7 S.D.	19.4 S.D.	7,3 S.D.	7.2 S.D.	4.6 S.D.	4.8 S.D.	0.92 S.D.	41 91 5.D,	31.08 S.D.	26.1 S.D.	1.60 S.D.	n.
28 29	8	0.58	2547.59 1650 1800	1.36	0.57	0.35	0.21	0.05 7.5 7.2	0.19 7.5 7.1	0.14 6.0 7.5	0.42	0	17.85 61.65 18.63	15.53 24.18 52.03	3.62 14.17 20.34	0.88	silty sand
30	8	14 Mean No, Taxa	2500 Mean D	1.99 Mean H	0.76 Mean J	20.0 Mean S. Temp	19.9 Mean B. Temp	7.4 Mean S. DO	7.4 Mean B, DO	7.1 Mean S. Sal	7.1 Mean B. Sal	0.22 Mean % G	61.24 Mean % Sam	21.16 d Mean %Sili	29.54 17.37 Mean % Clay	2.44 Mean % TO	silty sand
		10.67 S.D.	1983.33 S.D. 453.69	1.52	0.65	19.8 S.D. 0.71	19.6 S.D.	7.4 S.D.	7.3 S.D.	6.9 S.D.	6.9 S.D. 0.78	0.07 S.D.	47.17 S.D.	32.46 S.D.	20.29 S.D.	2.15 S.D.	
31 32	9 9	3 10	300 2925	0.82 1.27	0.75 0.55	20.4	19.7	6.9	6.4	7.6	7.8	0.51 0	44.44 5.77	33.78 50.81	21.27 43.42	0.52 2.21	clayey sand silty clay
33 34	9 9	5 13 Maan No 2 avo	625 1800	0.95 2.25	0.59 0.88	20.1	19.8	6.8	6.7	11.2	11.7	0 0.16	39.91 36.04	43.89 44.01	16.2 19.79	1.98 1.32	sandy silt sandy silt
		7.75 S.D.	1412.50 S.D.	1.32	0.69	20.3 S.D.	19.8 S.D.	6.8 S.D.	6.6 S.D.	9.4 S.D.	98 S.D.	0.17 S.D.	31.54 S.D.	43.12 S.D.	25.17 S.D.	1.51 S.D.	n.
35 36	10	4.57	1196.61 300 1450	1,20	0.86	0.21	0.1 19.7 21.3	0.09 7.0 7.3	0.21 6.9 7.0	2.55 8.3 12.0	2,76	0.24	17.52 86.76 43.36	7,02 8,76 33,06	12.35 3.92 73.58	0.76	sand
37 38	10 10	16 15	4275 2200	2.02	0.73 0.72	20.1 19.7	19.5 19.4	7.0 7.2	7.0 7.0 7.0	13.6 14.9	13.7	0 0.25	30.26 66.08	50.72 13.47	19.02 20.2	0.84 0.75	sandy silt clayey sand
		Mean No. Taxa 12.5 S.D.	Mean D 2056.25 S.D.	Mean H 1.85	Mean J 0.78	Mean S. Temp 20.2 S.D.	Mean B. Temp 20.0 S.D.	Mean S. DO 71 S.D.	Mean B. DO 7.0 5.D.	Mean S. Sal 12.2 S D	Mean B. Sal 12,3 S D	Mean % G 0.21 S D	Mean % San 56.62 S D	d Mean %Silt 26.50 S D	. Mean % Clay 0.21 S D	Mean % TO 0.84 S D	ю
39	11	5.69	1672.87 1250	1.12	0.57	0.76	0.89 22.7	0.15 7.1	0.05	2.86 13.1	2.87 13.8	0.27 2.98	24 96 95.22	19.27 0	0.27	0.51 1.07	sand
40 41 42	11 11 11	16 19 27	7225 3525 22400	1.37 2.30 1.25	0.49 0.78 0.38	21.9 28.5	21.9	7.2 7.3	7.1	20.0 20.2	20.2 20.4	1.26 1.96 1.2	61.92 90.59 52.59	17.37 6.18 23.02	19.45 0 23.19	1.08 0.42 0.6	silty sand sand clayey sand
		Mean No. Taxa 17.25	Mean D 8600	Mean H' 1.51	Mean J 0.56	Mean S. Temp 24,37	Mean B. Temp 22.13	Mean S. DO 7.22	Mean B. DO 7.39	Mean 5, 5nl 17,77	Mean B. Sal 18.13	Mean % G 1.85	Mean % Sunt 75.08	I Mean %Silt 11.64	Mean % Clay 10.66	Mean % TO 0.79	C
		5.D. 8.26	5.D. 9523.81			5.D. 3.60	S.D. 0.49	S.D. 0.11	S.D. 0.49	S.D. 4.04	5.D. 3.75	5.D. 0.83	8.D. 21.02	S.D. 10.45	S.D. 12,40	S.D. 0.33	

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Table 1. c	ontinued																
Site No.	Strata	No. of Taxa	Density (nos./m2)	H' Diversity	J' Evenness	Temp (°C) Surface	Temp (°C) Bottom	DO (mg/l) Surface	DO (mg/l) Bottom	Salinity (ppt) Surface	Salinity (ppt) Bottom	% Gravel	% Sand	% Silt	% Clay	% TOC	Textural Description
43 44	12 12	31 42	9275 31625	2.16 1.94	0.63 0.52							2.46 12.89	59.41 76.95	18.65	19.47 0	0.65	silty sand gravelly sand
45 46	12	15	2100	2.41 2.01	0.89							0.09	99.09	0	0	0.78	sand
		Mean No. Taxa 26.25	Mean D 10925.00	Mean H' 2.13	Mean J' 0.69	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B. DO	Mean S. Sal	Mean B. Sal	Mean % G 3,86	Меан % 5ан 83.61	d Mean %Sill 6.77	Mean % Clay 4.87	Mean % 10 0.72	C
		S.D. 12.69	S.D. 14302.02			\$.D.	S.D.	S.D.	S.D.	S.D.	\$.D.	S.D. 6.13	S.D. 19.20	S.D. 8.86	S.D. 9.74	S.D. + 0.05	
47 48	13 13	13 14	2300 1075	1.46 2.21	0.57 0.84	21.8	21.8	7.2	7.5	27.1	27.1	0 0.03	99.97 61.18	0 6.97	0 31.82	0.24 0.37	sand sandy clay
49	13	10	1425	1.50	0.65	22.2	21.6	10.2	8.3	27.5	29.0	1.93 3.15	97.94 72.78	0 14.8	0 9.27	0.23 0.67	sand silty sand
51	13	9	3725	1.01	0.46	21.5	21.5	9.6	9.6	26.0	25.9	0	99.78	0	0	0.12	sand
53	13	10	275	2.33	0.92	22.0	21.4	10.2	6.8	29.0	29,4	0.57	96.25	Ö	0	0.32	sand
54	13 13	15 18	2000 3550	2.22 1.56	0.82 0.54							0.03	97.52 97.35	0	0	0.26	sand
56	13	15 Mean No. Taxu	8100 Mean D	2.07 Mean H	0.77 Mean J	20.6 Mean S. Temp	20.9 Mean B. Tenn	9.8 Mean S. DO	6.9 Mean B. DO	30.4 Mean 5, 5al	30.1 Mean B. Sal	0 Mean % G	31.93 Меан % Sum	43.07 d Mean %Sili	25 Mean % Clay	2.97 Mean % TO	clayey silt C
		14.30 S D	4205.00	1.81	0,70	21.64 5 D	21.45 S D	9.40 S D	7.83 S D	27.98 S D	28.30 S.D	0.57 S D	85.33 S D	6.48 S D	6.61 S D	0.582 S D	
		4.22	5578,78			0.66	0.36	1.24	1,17	1.72	1.74	1.09	23.00	13.75	11.96	0.85	
57	14 14	14 29	39175 59700	1.49	0.56	22.0	22.0	10.7	10.4	20.9	20.8	0.35	90.34 91.07	6.6	0	2.03	sand
59 60	14 14	15 21	1175 34200	2,10 0,70	0.78 0.23	21.5	21.5	10.5	6.8	26.1	25.8	0.62	95.71 80.67	0 13.94	0 5.39	0.63	sand sand
61	14	9 Mean No Tavo	675	1.85 Mean H!	0.84 Mean 1	21.7 Mean S. Temn	21.7 Mean B. Terrin	IU.5 Mean S DO	7.7 Mean H. DO	26.2 Mean S. Sal	26.6 Mean B. Sal	0.24 Menn % G	98.42 Mean % San	0 d Mean %Sill	0 Mean % Clay	0.57 Mean % TO	sand C
		17.6	26985.00	1,43	0.54	21.74	21.75	10.58	8.29 6 D	24.37	24,38	0.61 S D	91.24 6 D	5.26 S D	1.08	1.28 S D	
		5.D. 7.67	25638.33			0.23	<u>0.2i</u>	0.13	<u>1.87</u>	3.04	3.16	0.73	6.78	5.76	2.41	0.69	
62 63	15	20 32	1275 4575	2.56 2.56	0.85 0.74	22.2	21.9	7.0	7.0	31.2	51.2	11.75	87.87	0	0	0.09	gravelly sand
64	15	4 Mean No. Taxa	350 Mean D	0.90 Mean H	0.65 Mean	23.6 Mean S. Temp	23.5 Mean B. Temn	7.1 Mean S. DO	6.9 Mean B. DO	26.6 Mean S. Sal	27.7 Mean B. Sal	0 Mean % G	99.07 Mean % Sam	0 d Mean %Sil(0 Mean % Clay	0.07 Mean % TO	sand
		18.67 S D	2066.67 S D	2.00	0.75	22.9 5 D	22.7 S D	7.0 S D	6.9 S D	23.9 S D	29.5 S D	5.88 S D	93.47 S D	0 S.D	0 S D	0.25 S.D.	
		14.05	2220.97			1.01	1.13	0.09	0.10	3.27	2,50	8.31	7.92	0	0	0.29	cand
65 66	16	4	975	2.53	0.65	23	22.8	6.79	0.9	21.2	27.0	24.12	73.51	1.93	0	0.13	gravelly sand
		Mean No. Taxa 22.50	Mean D 9287,50	Mean H' 1.72	Mean J' 0,67	Mean S. Temp 23	Mean B. Femp 22.8	Mean 8, DO 6.79	Mean B. DO 6.9	Mean S. Sal 27.2	Mean B. Sal 27,6	Mean % G 14,45	меза % Sam 84.10	d Mean %Sill (1.97	. Mean % Clay 0	Mean % 10 0.33	i.
		S.D. 26.16	S.D. 11755.65			S.D.	S.D.	S.D.	S.D.	S.D.	S.D.	S.D. 13.68	S.D. 14.97	S.D. 136	S.D. 0	S.D. 0.25	
67	17	34	7225	2.77	0.79							35.81	61.99	1.45	0	0.42	sandy gravel
69	17	14	1125	2,20	0.83							0	99.53	0	Ő	0.22	sand
70	17	9 Mean No. Taxa	1125 Меан D	1.34 Mean H	Mean J	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B. DO	Mean S. Sul	Mean B. Sal	Mean % G	Mean % Sun	d Mean %Sili	Mean % Clay	Mean % TO	C
		18,75 S D	2881.25 S.D.	2,08	0,73	5.D.	S.D.	S.D.	S.D.	S.D.	S.D.	9.03 S.D.	90.02 S.D.	0.36 S.D.	0 S.D.	0.25 S.D,	
		10.81	2928,48									17.85	18.69	0,73	0	0.12	

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Table 1. Co	ontinued																
		No. of	Density	H	r	Temp (°C)	Temp ("C)	DO (mg/l)	DO (mg/l)	Salinity (ppt)	Salinity (ppt)	%	%	%	%	%	Textural
Site No.	Strata	Taxa	(nos/m2)	Diversity	Evenness	Surface	Bottom	Surface	Bottom	Surface	Bottom	Gravel	Sand	Silt	Clay	TOC	Description
71	18	16	3550	1.79	0.65							0.76	98.45	0	0	0.11	sand
72	18	30	3675	2.67	0.79							20.25	79.57	0	0	0.1	gravelly sand
73	18	24	1675	2.90	0.91						A Francis De Cost	Mann. 44.10	Mann 4 Sun	d Mana GSU	Maan Pe Clar	Meun Se TC	r.
		Mean No. Taxa	Mean D	Mean H	Mean J	mean S. Temp	wiego is. reinp	mean 3. DO	Mean 0. DO	wicki o. oai	NICAU D. OM	10.51	89 D1			0.47	Ĭ.
		23.33 8 D	2906.07	2,40	0.76	S D	S D	S D	S.D.	S.D.	5.D.	S.D.	S.D.	S.D.	S.D.	S.D.	
		7 (12	1120 36			L.L.A	500.	2121				13,78	13.35	0	0	0.64	
84	21	10	2150	1.92	0.83	20,4	20.4	6.0	5.9	8.0	8.1	0	12.64	65.21	22.16	2.36	clayey silt
85	21	9	1000	0.99	0.45	20.6	20.5	6.6	6.6	7.4	7.4	0	0.17	57.13	42.7	5.85	silty clay
		Mean No, Taxa	Mean D	Mean H	Mean J'	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B, DO	Mean S, Sal	Mean B. Sal	Mean % G	Mean % 5an	id Mean %Sill	Mean % Clay	Mean % IC	il.
		9.50	1575.00	1.46	0.64	20.5	20.5	0.3 6 N	0.2 S D	ś'n	/.8 S D	s n	0.41 S D	S D	52.45 S D	\$.105 S.D	
		5D.	5.D.			5.D. 6.1	3.D. 01	0.5	05	0, 9 . ∩4	0.5	0	8 82	5.71	14.52	2.47	
		14	29500	111	0.42	20.0	19.9	5.0	4.8	19.4	19.8	0.1	9.2	55.39	35.32	5.07	silty clay
89	22	8	1850	1.44	0.69	19.6	19.6	10.6	9.6	4.4	4.4	0	1.45	39.14	59.42	20.5	clay
90	22	16	3825	1.34	0.48	20.3	20.1	4.1	4.1	19.1	19.2	0	3.01	67.36	29.63	3.9	clayey silt
		Mean No. Taxa	Mean D	Mean H	Mean J	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B. DO	Mean S. Sal	Mean B. Sal	Mean % G	i Mean % Sau	id Mean %Sitt	Mean % Clay	Mean % TC	ı L
		12.67	11725.00	1.30	0.53	20.0	19.9	6.6	6.2	14.3	14.0	0.03	4.55 8 D	53.90 S D	41.40 S D	9.64 S D	
		S.D.	S.D.			S.D.	3.14	5.0.	3.0	3.D. 9.5	3-12- 9 7	5.0.	A 10	14.15	15.81	9.26	
		4.10	13923,24	0.76	0.42	(14) (17)	200		7.4	6.2	6.2					3.45	
91	-	6	2000	0.70	0.42	25.1	25.0			4.1	4.0	0.58	89.27	6.95	0	5.85	sand
87	_	14	4150	0.99	0.38	20.5	20.5	6.2	6.4	16.6	16.7	0.1	7.81	50.96	41.14	1.75	silty clay
		Mean No. Taxa	Mean D	Mean H	Mean J'	Mean S. Temp	Mean B. Temp	Mean S. DO	Mean B. DO	Mean S. Sal	Mean B. Sal	Mean % G	6 Mean % San	id Mean %Silt	Mean % Clay	Mean % TC	۰C
		8.67	4200.00	0.76	0.37	21.9	21.8	6.9	6.9	8.97	9.0	0,34	48.54	28,96	20.57 S.D	1.08 F D	
		S.D.	S.D.			5.D,	S.D.	S.D.	S.D.	S.D.	5.D.	5.D.	8.U. 57.60	5.0.	3.0.	a.u. 2.06	
		4.62	1325,71			2,75	2.15	1,0	0.7	0.09	0.79	0.54	37.00	31.14	29.09	2.140	



Figure 1. Sediment composition for Delaware Bay sites 1-41, September 1997.



Figure 2. Sediment composition for Delaware Bay sites 42-92, September 1997.



Figure 3. Percent total organic carbon (TOC) content of the sediment for Delaware Bay and adjacent waters sites 1-41, September 1997.



Figure 4. Percent total organic carbon (TOC) content of sediments for Delaware Bay and adjacent waters sites 42-92, September 1997.

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Figure 5. Sediment composition of the Delaware Bay and adjacent waters strata, September 1997.

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Figure 6. Mean % gravel of the Delaware Bay and adjacent waters strata, September 1997.

Stratum

Mean % gravel (± SD)



Figure 7. Mean % sand of the Delaware Bay and adjacent waters strata, September 1997.

Stratum



Figure 8. Mean % silt of the Delaware Bay and adjacent waters strata, September 1997.

Stratum



Stratum

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Taxon Name	Phylum	Class	No. of Individuals	% Total	C	ummulati %	ve	Station Occurren	ce	Station % Occurrence	Comments
		Mala	2007	10 277		10 277	<u></u>	20		247	
Ampeusca aballa		Olig	3587	19.377		37 258		50		617	sexually immature
Mediomastus (1 PH)		Poly	2090	10.419		47 677		22		27.2	anterior portions only, probably <i>M. ambiseta</i> , pygidium needed
Leucon oppericonus	Ar	Mala	1162	5.793		53.470		20		24.7	
Limnodrilus hoffmeisteri	A	Olig	1006	5.015		58.485		23		28.4	
Sabellaria vulgaris	A	Poly	969	4.831		63.315		8		9.9	
Streblospio benedicu	A	Poly	800	3.988		67.303		12		14.8	
Oligochaeta (LPIL)	A	Olig	389	1.939		69.242		19		23.5	marine and some estuarine specimens only identified to class.
Ganunarus tigrinus	Ar	Mala	348	1.735		70.977		10		12.3	
Cyathura polita	Ar	Mala	284	1.416		72.393		33		40.7	
Glycinde solitaria	A	Poly	244	1.216		73.609		11		13.6	
Tellina agilis	M	Biva	205	1.022		74.631		18		22.2	
Chiridotea tuftsi	Ar	Mala	191	0.952		75.583		14		17.3	
Polydora cornuta	A	Poly	175	0.872		76.456		6		7.4	· · · · · · · · · · · · · · · · · · ·
Chironomidae (LPIL)	Ar	Inse	168	0.837		77.293		13		16.0	immature and/or damaged specimen
Dipolydora socialis	A	Poly	161	0.803		78.096		8		9.9	
Acteocina canaliculata	М	Gast	161	0.803		78.898		13		16.0	
Rhepoxynius hudsoni	Ar	Mala	154	0.768		/9.000		14		17.3	
Gemma gemma	м	Biva	151	0.753		80.419		9		11.1	
Lysianopsis alba	Ar	Mala	144	0.718		81.13/		2		2.5	immeture and/or demograd specimen
Folypeanian (LFIL)	Ar	Inse	142	0.708		01.044		14		17.5	minature and/or damaged specimen
Arisidaa (I PU)		Poly	136	0.088		83 141		10		12.3	missing identification characters
Telling (1 PH)	M	Biva	122	0.603		83 744		16		19.8	due to small size, external and internal characters are not apparent.
Coronhium tubarculation		Mala	115	0.503		84 317		8		9.9	
Almuracuma provinaculi	Ar	Mala	102	0.508		84.826		6		7.4	
Corbicula manilensis	м	Biva	98	0.489		85.314		6		7.4	
Aricidea cathermae	A	Poly	98	0.489		85.803		5		6.2	
Heteromastus filiformis	Ā	Polv	97	0.484		86.286		13		16.0	
Corophium lacustre	Ar	Mala	97	0.484		86.770		3		3.7	
Ouistadrilus multisetosus	A	Olig	93	0.464		87.233		9		11.1	
Rhynchocoela (LPIL)	R	0	93	0,464		87.697		26		32.1	no identifible characters.
Cirratulidae (LPIL)	A	Poly	87	0.434		88.131		15		18.5	anterior fragment, posterior needed for specis ID.
Crepidula plana	М	Gast	85	0.424		88.554		5		6.2	
Marenzellaria viridis	A	Poly	77	0.384		88.938		10		12.3	· · · · · · · · · · · · · · ·
Polygordius (LPIL)	A	Poly	71	0.354		89.292		13		16.0	genus is lowest identification level
Paracaprella tenuis	Ar	Mala	70	0.349		89.641		3		3.7	
Protonaustorius sp.B	Ar	Mala	65	0.324		89.965		4		4.9	
Mutinia lateralis	LM	Biva	01	0.304		90.209		10		12.3	
Pisidium compressum	M	Biva	54	0.269		90.538		3		3.7	
Sphaerium (LPIL)	М	Biva	54	0.269		90.808		6		7.4	ч ж и и
Mitrella lunata	М	Gast	52	0.259		91.067		6		7.4	
raypedium natierate group	Ar	Inse	51	0.254		91.321		4		4.9	, ™e r JP

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Table 2. Abundance and distribution of taxa for the Delaware Bay and adjacent waters sites, September 1997.

Taxon Name	Phylum	Class	No. of Individuals	% Total	Commulative	Station	Station % Occurrence Comments		
Polypedilum illinoense group	Ar Ar	Inse	47	0.234	91,555	7	8.6		
Nucula proxima	м	Biva	46	0.229	91.785	6	7.4		
Odostomia (LPIL)	М	Gast	43	0.214	91,999	8	9.9		
Spionidae (LPIL)	A	Poly	43	0.214	92.213	11	13.6	1	
Unciola sertata	Ar	Mala	41	0.204	92.418	4	4.9		
Ascidiacea (LPIL)	С	Asci	41	0.204	92.622	5	6.2		
Pseudunciola obliquua	Ar	Mala	40	0.199	92.822	. 1	1.2		
Tanaissus psammophilus	Ar	Mala	40	0.199	93.021	5	6.2		
Capitellidae (LPIL)	A	Poly	38	0.189	93.210	12	14.8		
Laeonereis culveri	A	Poly	35	0.174	93.385	4	4.9		
Leitoscolopios robustus	A	Poly	35	0.174	93.559	6	7.4		
Astarte castanea	М	Biva	34	0.169	93.729	3	3.7		
Gammarus (LPIL)	Ar	Mala	32	0.160	93.888	12	14.8		
Ampharetidae (LPIL)	A	Poly	32	0.160	94.048	. 11	13.6		
Eusarsiella zostericola	Ar	Ostr	31	0.155	94.202	8	9.9		
Bivalvia (LPIL)	M	Biva	30	0.150	94.352	7	8.6		
Ancylidae (LPIL)	м	Gast	30	0.150	94.501	2	2.5		
Giyceru sp.D	A	Poly	29	0.145	94.646	12	14.8		
Protohaustorius wigieyi	Ar	Mala	28	0.140	94.786	5	6.2		
Cyathura burbancki	Ar	Mala	24	0.120	94.905	1	1.2		
Raithropanopeus harrisu	Ar	Mala	22	0.110	95.015	6	7.4		
Lonnodritus udekenuanus	A	Olig	22	0.110	95.125	2	2.5		
Scoletoma tenuis	A	Poly	22	0.110	95.234	2	2.5		
Hypereteone neteropoda	A	Poly	21	0.105	95.339	2	2.5		
Lyonsia nyauna	M	Biva	21	0.105	95.444	5	0.2		
Leptocnetrus piumutosus	Ar	Mala	21	0.105	95.548	1	1.2		
		Dalu	21	0.105	95.055	5	0.2		
Brockedius (1 PH)	A	Poly	20	0.100	95.755	1	1.2		
(i)(childing (EFIE))	Ar	Dele	20	0.100	95.652	5	0.2		
Cenosconopios (LIIL)	A	Poly	20	0.100	95.952	9	11.1		
Metrels succined	A	Poly	19	0.095	90.047	0	9.9		
	Ar	Nala D-1-	19	0.095	90.142	2	0.2		
Brania weiifleetensis	A	Poly	18	0.090	96.231	3	3.7		
Parasierope poliex	Ar	Ostr	17	0.085	90.310	3	0.2		
Polycirrus eximus	A	Poly	17	0.085	96.401	2	2.5		
Cerapus tubularis	Ar	Mala	16	0.080	96.481	- 4	4.9		
Crypioentiononus (LFIL)	Ar	Inse	10	0.080	90.300	8	9.9		
Erichthonius brasiliensis	Ar	Mala	15	0.075	90.033	4	4.9		
Autobase (1 DH)	A	Poly	15	0.075	96.710	0	1.4		
Autoryus (LFIL)	A	Poly	15	0.075	90.785	1	1.2		
Ousnopoda (LPIL)		Gast	15	0.075	90.839	ð 10	7.7 10.2		
sprocaderoprerus oculatus		Poly	14	0.070	90.929	10	12.3		
nacianis punciosirianis		Dalu	15	0.005	90.994	5	0.2		
Ampalicoa (1 RH)	A A-	Poly	13	0.003	97.039	2	2.3		
		Mala	13	0.000	97.124	5	86		N
rancinus aepressus		wiara	12	0.000	97,105	1	.0.0		
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Taxon Name	Phylum	Class	No. of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence Comments	5	
Streptosyllis arenae	A	Poly	12	0.060	97.243	1	1.2		
Nereis (LPIL)	A	Poly	12	0.060	97.303	5	6.2		
Phyllodocidae (LPIL)	A	Poly	12	0.060	97.363	8	9.9		1
Gillia altilis	M	Gast	11	0.055	97.418	3	3.7		
Ilvanassa trivittata	М	Gast	11	0.055	97.473	8	9.9		
Tubificoides heterochaetus	A	Olig	11	0.055	97.527	1	1.2		
Unciola (LPIL)	Ar	Mala	11	0.055	97.582	2	2.5		
Terebellidae (LPIL)	A	Poly	11	0.055	97.637	2	2.5		
Jassa falcata	Ar	Mala	10	0.050	97.687	4	4.9		
Asabellides oculata	A	Poly	10	0.050	97.737	7	8.6		
Nephtys picta	A	Poly	10	0.050	97.787	5	6.2		
Parahaustorius attenuatus	Ar	Mala	10	0.050	97.836	1 .	1.2		
Leptochetrus (LPIL)	Ar	Mala	10	0.050	97.886	1	1.2		
Phyllodoce arenae	A	Poly	9	0.045	97.931	5	6.2		
Spisula solidissima	М	Biva	9	0.045	97.976	2	2.5		
Crevidula maculosa	М	Gast	9	0.045	98.021	4	4.9		
Pisidium (LPIL)	М	Biva	9	0.045	98.066	3	3.7		
Goniadidae (LPIL)	A	Poly	9	0.045	98.111	4	4.9		
Sphaeriidae (LPIL)	M	Biva	9	0.045	98.156	6	7.4		
Parapionosyllis longicirrata	A	Poly	8	0.040	98.195	1	1.2		
Scoloplos rubra	A	Poly	8	0.040	98.235	1	1.2		
Deutella incerta	Ar	Mala	8	0.040	98.275	1	1.2		
Oxyurostylis smithi	Ar	Mala	8	0.040	98.315	6	7.4		
Ilyanassa obsoleta	М	Gast	8	0.040	98.355	3	3.7		
Acanthohaustorius intermedius	Ar	Mala	8	0.040	98.395	1	1.2		
Tharys acutus	A	Poly	8	0.040	98.435	5	6.2		
Echinoidea (LPIL)	E	Echi	8	0.040	98.475	2	2.5		
Neomysis americana	Ar	Mala	7	0.035	98.509	3	3.7		
Ampelisca vadorum	Ar	Mala	7	0.035	98.544	I	1.2		
Pagurus (LPIL)	Ar	Mala	7	0.035	98.579	5	6.2		
Ceratopogonidae (LPIL)	Ar	Inse	7	0.035	98.614	4	4.9		
Mactridae (LPIL)	M	Biva	7	0.035	98.649	3	3.7		
Corophium (LPIL)	Ar	Mala	6	0.030	98.679	3	3.7		
Tubutanus (LPIL)	R		6	0.030	98.709	3	3.7		
Naididae (LPIL)	A	Olig	6	0.030	98.739	1	1.2		
Glyceridae (LPIL)	A	Poly	6	0.030	98.769	3	3.7		
Nephtyidae (LPIL)	A	Poly	6	0.030	98.799	4	4.9		
Batea catharinensis	Ar	Mala	5	0.025	98.824	2	2.5		
Mediomastus ambiseta	A	Poly	5	0.025	98.848	1	1.2		
Spiophanes bombyx	A	Poly	5	0.025	98.873	4	4.9		
Urosalpinx cinera	M	Gast	5	0.025	98.898	3	3.7		
Monoculodes edwardsi	Ar	Mala	5	0.025	98.923	4	4.9		
Serpundae (LPIL)	A	Poly	5 ·	0.025	98.948	2	2.5		
Actiniaria (LPIL)	Cn V	Anth	5	0.025	90.973	5	1.2	h.	
Doriaella obscura	M	Gast	4	0.020	98.995	· ~ 1	1.2 ' 🐨		4
Nepntys bucera	A	Poly	4	0.020	99.015	2	5.1 , **	14	J.
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			No. of		Cummulative	Station	Station %			
Taxon Name	Phylum	Class	Individuals	% Total	%	Occurrence	Occurrence	Comments	<u> </u>	
Kurtziella cerina	M	Gast	4	0.020	99.033	2	2.5			
Marginella apicina	М	Gast	4	0.020	99.053	2	2.5			*
Harmothoe extenuata	Α	Poly	4	0.020	99.073	2	2.5			,
Macoma balthica	М	Biva	4	0.020	99.093	3	3.7			
Nanocladius (LPIL)	Ar	Inse	4	0.020	99.113	1	1.2			
Dicrotendipes (LPIL)	Ar	Inse	4	0.020	99.133	3	3.7			
Tanytarsus (LPIL)	Ar	Inse	4	0.020	99.153	3	3.7			
Branchiostoma (LPIL)	С	Lept	4	0.020	99.172	2	2.5			
Lumbrineridae (LPIL)	A	Poly	4	0.020	99.192	2	2.5			
Nereididae (LPIL)	А	Poly	4	0.020	99.212	4	4.9			
Polynoidae (LPIL)	А	Poly	4	0.020	99.232	1	1.2			
Paguridae (LPIL)	Ar	Mala	4	0.020	99.252	2	2.5			
Xanthidae (LPIL)	Ar	Mala	4	0.020	99.272	1	1.2			
Mysidae (LPIL)	Ar	Mala	4	0.020	99.292	4	4.9			
Lenidonotus sublevis	A	Poly	3	0.015	99.307	2	2.5			
Pectinaria souldii	A	Poly	3	0.015	99.322	3	3.7			
Crangon sentemspinosa	Ar	Mala	3	0.015	99.337	3	3.7			
Cassidinidea ovalis	Ar	Mala	3	0.015	99.352	2	2.5			
Neverita dunlicata	м	Gast	3	0.015	99.367	3	3.7			
Encie directur	м	Biya	3	0.015	99.382	2	2.5			
Micromotonus rangui	Ar	Mala	3	0.015	99.397	2	2.5			
Microprotopias raneyi		Poly	3	0.015	99.412	2	2.5			
Hawathan impring to		Poly	3	0.015	99.427	1	1.2			
Harmoinoe Indricala		Poly	3	0.015	99.442	2	2.5			
Girronharun (LHL)		Poly	3	0.015	99.457	2	2.5			
Chinemonius (LPIL)		Ince	3	0.015	99 472	2	2.5			
Chironomus (Litic)		Poly	3	0.015	99.487	1	1.2			
Urbinidae (LPIL)		Mala	3	0.015	99.501	2	2.5			
raustoriude (Li iL)		Olig	2	0.010	99.511	1	1.2			
Autoarius pigueti		Mala	2	0.010	99.521	1	1.2			
Euceranius praeungas		Fchi	2	0.010	99.531	2	2.5			
Echinaracinius parma		Poly	2	0.010	99 541	1	1.2			
Dritonereis ionga		Mala	2	0.010	99 551	1	1.2			
Bainyporeia parkeri		Doly	2	0.010	99 561	2	2.5			
Signion arenicola	A	Poly	2	0.010	99 571	2	2.5			
Pinnixa chaetopterana	Ar	Mala	2	0.010	00 581	1	1.2			
Cyclaspis varians	Ar	Dela	2	0.010	00 501	1	12			
Hydroides dianthus	A	Poly	2	0.010	00 601	1	1.2			
Microphthaunus (LPIL)	A	Poly	2	0.010	99.001	1	1.2			
Bezzia Complex (LPIL)	Ar	Inse	2	0.010	99.011	2	2.5			
Monoculades (LPIL)	Ar	Mala	2	0.010	99.021	2	2.5			
Pinnixa (LPIL)	Ar	Mala	2	0.010	99.031	2	2.5			
Crepidula (LPIL)	M	Gast	2	0.010	99.041	4	2.5			
Maldanidae (LPIL)	A	Poly	2	0.010	99.651	2	2.5			
Paraonidae (LPIL)	A	Poly	2	0.010	99.001	2	2.5			
Syllidae (LPIL)	A	Poly	2	0.010	99.0/1	1	1.2			N.
Aoridae (LPII.)	Ar	Mala	2	0.010	99.001	2	2.5			
Melitidae (LPIL)	Ar	Mala	2	0.010	99.091	2	2.5	2 1		·k.
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Town Name	Dhulum		No. of	@ Tatal	Cummulative	Station	Station %			
Desenada Pestentia (LPII.)	rayaan	Mala	norviouais	70 LOLAI	70	Occurrence	Occurrence Co	omments		
Majidan (LPIII)	Ar	Molo	2	0.010	99.701	2	2.5			
Musidaesa (LPIL)	Ar	Mala	2	0.010	99.711	2	2.5			
Supertidee (LPIL)	F	Holo	2	0.010	99.721	1	1.2			
Lineidae (LPH)	R	11010	2	0.010	00 741	2	2.5			
Placobdella papillifera	Δ	Him	-	0.010	00 746	2	2.5			
	A	Poly	1	0.005	99.740	1	1.2			
Repueria bataroasta		Poly	1	0.005	99.751	1	1.2			
Diawana nelejoseta	A .	Poly	1	0.005	99.750	1	1.2			
Giytera ameritana	A	Poly	1	0.005	99.701	1	1.2			
Grubeosyus ciavaia	A	Poly	1	0.005	99.700	1	1.2			
Monuceiuna aorsobranchiaiis	A	Poly	1	0.005	99.771	l	1.2			
Nemaionereis nebes	A	Poly	1	0.005	99.776	1	1.2			
Parougia caeca	A	Poly	l	0.005	99.781	1	1.2			
Sigambra bassi	A	Poly	1	0.005	99.786	1	1.2			
Americhelidium americanum	Ar	Mala	1	0.005	99.791	1	1.2			
Pleusymtes glaber	Ar	Mala	1	0.005	99.796	1	1.2			
Pagurus pollicaris	Ar	Mala	1	0.005	99.801	1	1.2			
Anomia simplex	М	Biva	1	0.005	99.806	1	1.2			
Microphthalmus hartmanae	A	Poly	1	0.005	99.811	1	1.2			
Neopanope sayi	Ar	Mala	1	0.005	99.816	1	1.2			
Laevapex fuscus	М	Gast	1	0.005	99.821	1	1.2			
Dero digitata	А	Olig	1	0.005	99.826	1	1.2			
Libinia dubia	Ar	Mala	1	0.005	99.831	1	1.2			
Loimia medusa	А	Poly	1	0.005	99.835	1	1.2			
Nephtys incisa	А	Poly	1	0.005	99.840	1	1.2			
Eupleura caudata	М	Gast	1	0.005	99.845	1	1.2			
Cirrophorus ilvana	A	Poly	1	0.005	99.850	ī	1.2			
Cirrophorus lyra	A	Poly	1	0.005	99.855	1	1.2			
Aricidea wassi	A	Poly	t	0.005	99,860	1	1.2			
Aricidea suecica	A	Poly	ī	0.005	99.865	1	1.2			
Maselona papillicornis	A	Poly	1	0.005	99.870	i	1.2			
Rheotanytarsus (LPIL)	Ar	Inse	1	0.005	99.875	1	12			
Prionospio (LPIL)	A	Polv	1	0.005	99.880	i	1.2			
Polydora (LPIL)	A	Polv	1	0.005	99.885	ĩ	12			
Ovalipes (LPIL)	Ar	" Mala	1	0.005	99.890	1	1.2			
Cerapus (LPIL)	Ar	Mala	1	0.005	99.895	1	1.2			
Cyathura (LPIL)	Ar	Mala	1	0.005	99,900	1	1.2			
Eusarsiella (LPIL)	Δ.	Octr	1	0.005	00 005	1	1.2			
Oecetis (1 PH)	Ar Ar	Ince	1	0.005	00.010	1	1.2			
(urbonilla (LPIL)	M	Gast	1	0.005	99.910	1	1.2			
("hastanteridae (T PII)	Δ	Poly	1	0.005	00 020	1	1.4			
Agginglidge (I PH)	Δr	Mala	1	0.005	00 025	1	1.4			
Amphinoda (TPIL)	Ar	Mala	1	0.005	99.925	1	1.2			
Ischyroceridae (LPIII)	Ar	Mala	1	0.005	99.930	1	1.2			
Oedicerolidae (I PII)	Ar	Mala	1	0.005	99 940	1	1.2	· 👘		н.
Phoxocenhalidae (1 PII)	Ar	Mala	1	0.005	99 945	i	1.2	*		3
Pleustidae (LPIL)	Ar	Mala	î	0.005	99.950	ī	1.2	z 👾		J.

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Taxon Name	Phylun	n Class	No, of Individuals	% Total	Cummulative %	Station Occurrence	Station % Occurrence	Comments	
Bodotriidae (LPIL)	Ar	Mala	1	0.005	99.955	1	1.2		
Decenada Natantia (LPIL)	Ar	Mala	1	0.005	99.960	1	1.2		د.
Callianarsidae (LPII)	Ar	Mala	1 ¹	0.005	99.965	1	1.2		,
Anthuridae (LPIL)	Ar	Mala		0.005	99.970	1	1.2		
Ostracoda (LPIL)	Ar	Ostr	1	0.005	99.975	1	1.2		
Holothuroidea (LPII)	E	Holo	1	0.005	99.980	1	1.2		
Arcidae (LPII)	м	Biva	I	0.005	99.985	1	1.2		
Cardiidae (LPII)	м	Biva	1	0.005	99.990	1	1.2		
Columbellidae (LPIL)	M	Gast	1	0.005	99.995	1	1.2		
Hydrobiidae (LPIL)	M	Gast	1	0.005	100.000	1	1.2		

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Taxa Key

A = Annelida Hiru = Hirudinea Olig = Oligochaeta Poly = Polychaeta Ar = Arthropoda Inse = Insecta Mala = Malacostraca Ostr = Ostracoda C = Chordata Asci = Ascidiacea Lept = Leptocardia Cn = Cnidaria Anth = Anthozoa E = Echinodermata Echi = Echinoidea Holo = Holothuroidea M = Mollusca Biva = Bivalvia Gast = Gastropoda R = Rhynchocoela

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Figure 10. Mean % total organic carbon (TOC) of the Delaware Bay and adjacent waters strata, September 1997.

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BENTHIC COMMUNITY CHARACTERIZATION

Faunal Composition, Abundance, And Community Structure

Table 2 provides a complete phylogenetic listing for all sites as well as data on taxa abundance and site occurrence. Four Microsoft [™]Excel 5.0 (Macintosh version) spreadsheets are being provided separately to NOAA which include: raw data on taxa abundance and density by replicate, a complete taxonomic listing with station abundance and occurrence and QA/QC comments, a major taxa table with overall taxa abundance, and an assemblage parameter table including data on mean number of taxa, mean density, taxa diversity and taxa evenness by station.

A total of 20,060 organisms, representing 239 taxa, were identified from the 81 sites (Table 3). Polychaetes were the most numerous taxa present representing 34.7% of the total assemblage, followed in abundance by malacostracans (31.4%) and gastropods (9.6%). Malacostracans represented 36.1% of the total number of individuals followed by polychaetes (28.0%), oligochaetes (25.5%), and bivalves (4.6%) (Table 3).

The dominant taxa collected from the samples was the amphipod, *Ampelisca abdita* which accounted for 19.38% of all individuals, but occurred at only 24.7% of the sites (Table 2). The next most abundant taxon was the oligochaete Family <u>Tubificidae</u> at 17.88% of allindividuals $U_{\text{more sens file to b D.0. theorem most dispertant$ identified (Table 2). This taxa was also the most widespread occurring at 61.7% of the sites (Table2). The polychaete genus*Mediomastus*accounted for 10.42% of all individuals and wasidentified at 27.2% of the sites (Table 2). All other taxa accounted for less than 6.0% of the totalnumber of individuals. The isopod,*Cyathura polita*, Rhynchocoela (LPIL), the oligochaete*Limnodrilus hoffmeisteri*, the cumacean*Leucon americanus*and the class Oligochaeta (LPIL)were the next most widespread occurring at 40.7%, 32.1%, 28.4%, 24.7% and 23.5%respectively (Table 3). The distribution of dominant taxa representing >10% of the totalassemblage at each site is given in Table 4.

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ТАХА	Total No. Taxa	% Total	Total No. Individuals	% Total
Annelida				
Polychaeta	83	34.7	5607	28.0
Oligochaeta	9	3.8	5117	25.5
Hirudinea	1	0.4	1	< 0.1
L				
Arthropoda				
Malacostraca	75	31.4	7246	36.1
Insecta	14	5.9	470	2.3
Ostracoda	4	1.7	50	0.2
-				
Mollusca				
Bivalvia	20	8.4	919	4.6
Gastropoda	23	9.6	486	2.4
Other Taxa	<u> </u>	4.2	164	0.8
TOTAL	239		20060	

Table 3. Summary of abundance of major taxonomic groups for the Delaware Bay and adjacent waters sites, September, 1997.

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Table 4. Percentage abundance of dominant taxa (>10%) for the Delaware Bay and adjacent waters sites, September 1997.

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	19	10	19	20	20	20	,	T	Strata	7	2	2	3	2	3	4	4	* *
					20			-	Site No).).	-							
RHYNCHOCOELA		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Rhynchocoela (LPIL)																		•
ANNELIDA																		
Capitellidae (LPIL)																		
Heteromastus filiformis Mediomastus (LPIL)																		
Cirratulidae (LPIL) Glycera, sp.D																		
Glycinde solitaria																		
Aricidea catherinae																		
Aricidea cerrutii Aricidea (LPIL)																		
Spionidae (LPIL) Pobulora comuta																		
Streblospio benedicti																		4 .≱
Marenzellaria viridis																		• •
Parapionosyllis longicirrata Brania wellfleetensis																		
Polygordius (LPIL) Sebellaria milaaris																		
Oligochaeta																		
Tubificidae (LPIL)	45.7	14.0	36.9	77.3	80.7	15.0	59.4	89.0	31.9	16.1		16.4	38.7			17.0	12.9	44.1
Limuodrilus hoffmeisteri Quistadrilus multisetosus	23.6		25.2 12.1	11.5		19.5	21.5		34.6	33.7		43.6	49.3		10.2			40.9
MOLLUSCA Bivalvia																		
Bivalvia (LPIL)																		
Tellina (LPIL)																		
Gemma gemma Astarte castanea																		
Pisidium compressum Corhicula manilensis		518	12.4															
Gastropoda		51.0																
Crepidula plana																		
ARTHROPODA Malacostraca																		
Cyathura polita Chiridotea tuftsi		18.9				13.5					25.2				62.7		50.0	
Corophium tuberculatum															02.7	147	20.0	
Corophium (LPIL)																14.5		•
Ampelisca abdita Ampelisca vadorum																		
Gammarus tigrinus Leptocheirus plumulosus																51.2		
Leptocheirus (LPIL)																		
Rhepoxynius hudsoni																•		
Protohaustorius sp.B																		
Parahaustorius attenuatus Lysianopsis alba																		
Leucon americanus										20.1	25.8							
Tanaissus psammophilus										20.1	23.0							5 7
Ceratopogonidae (LPIL)																		; —
Chironomidae (LPIL) Polypedilum halterale group						27.1					17.2	14.9		19.3 33.3			13.6	
Polypedilum (LPIL)						15.8			23.4					26.3			12.9	

Table 4. continued

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	5	5	5	6	6	6	7	7	Strata 7	8	8	8	9	9	9	9	9 2 0
	19	20	21	22	23	24	25	26	Site No 27	28	29	30	31	32	33	34	
RHYNCHOCOELA Rhynchocoela (LPIL) Lineidae (LPIL)									16.7								
ANNELIDA Polychaeta Capitellidae (LPIL)																	
Heleromastus (LPIL) Cirtatulidae (LPIL) Glycera sp.D Glycinde solitaria Laeonereis culveri																	
Aricidea catherinae Aricidea cerrutii Aricidea (LPIL) Spionidae (LPIL) Polydora cornuta Steplosnia benedicti						33.3			50.0								4
Dipolydora socialis Marenzellaria viridis Parapionosyllis longicirrata							20.0				63.9		25.0	64.1	72.0		
Brania wellfleetensis Polygordius (LPIL) Sabellaria vulgaris																	
Oligochaeta Oligochaeta (LPIL) Tubificidae (LPIL) Limuodrilus hoffmeisteri	50.0	59.1 37 9	18.8	61.1 22.2	75.9	66.7	40.0	96.2		59.1		36.0				18.1	
Quistadrilus multisetosus MOLLUSCA Bivalvia	45.1	51.5		22.2	27.1												
Bivelvia (LPIL) Tellina agilis Tellina (LPIL)																	
Astarie castanea Pisidium compressum Corbicula manilensis																	
Gastropoda Acteocina canaliculata Crepidula plana																	
AKLHROPODA Malacostraca Cyathura polita Chiridotea tuttsi			813				20.0		16.7	19.7	13.9		66.7		12.0		
Corophium tuberculatum Corophium lacustre Corophium (LPIL) Ampelisca abdita Ampelisca sodorum							2010		16.7					16.2			
Gammarus tigrinus Leptocheirus plumalosus Leptocheirus (LPIL) Psaudmeiola ablianna												21.0 10.0					
Rhepoxynius hudsoni Haustoriidae (LPIL) Protohaustorius sp.B Parahaustorius attanuatus																	
Lysianopsis alba Leucon americanus Almyracuma proximoculi															3	20.8	÷
Tanaissus psommophilus Insecta Ceratopogonidae (LPIL) Chirpnomidae (LPIL)							20.0										2
Polypedilum halterale group Polypedilum (LPIL)																	

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	10	10	10 10	11	11	11 II	12	Strata 12	12	12	13	13	13	13 13	Î
· - ·	35	36	37 38	39	40	41 42	43	Site No 44	. 45	46	47	48	49	50 51	52
RHYNCHOCOELA Rhynchocoela (LPIL) Lineidae (LPIL)	15.3								10.7				i, ei ei		
ANNELIDA Polychaeta															
Capitellidae (LPIL) Heteromastus filiformis Mediomastus (LPIL)		15.5		66.0		27.0			14.3			20.9		59.1	
Cirratulidae (LPIL) Glycera sp.D	÷.,											14.0			
Glycinde solitaria Laeonereis culveri Aricidea calherinae						14.9									
Aricidea cerrutii Aricidea (LPIL)															
Spionidae (LPIL) Polydora cornuta Strablancia burgaficti			19.1				17.5							4	4
Dipolydora socialis Marenzellaria viridis	50.0	17.2	22.2											Ţ	2
Parapionosyllis longicirrata Brania wellfleetensis Palvaardius (UPIU)															20.6
Sabellaria vulgaris Oligochaeta							44.2	55.7							20.0
Oligochaeta (LPIL) Tubificidae (LPIL)		22.4	30.4 27.	3	25.6										i. Ist
Quistadrilus multisetosus MOLLUSCA															
Bivalvia Bivalvia (LPIL)															40 11
Tellina agilis Tellina (LPIL) Gauma camma									10.7	15.5		20.9 16.3	15.8	69 1	11.8
Astarte castanea Pisidium compressum			34.	1		*									
Corbicula manilensis Gastropoda						14.2			25.0						
Crepidula plana ARTHROPODA						14.2			25.0						
Malacostraca Cyathura polita Chiefdotae uttri	25.0	10.3		18.0											
Corophium tuberculatum Corophium lacustre	23.0	15.0								42.9					
Corophium (LPIL) Ampelisca abdita						12.1 72.5								27.2	
Gammarus tigrinus Leptocheirus plumulosus															
Leptocheirus (LPIL) Pseudunciola obliquua											62.0			18.8	118
Haustoriidae (LPIL) Protohaustorius sp.B											13.0		56.1	10.0	11.0
Parahaustorius allenuolus Lysianopsis alba	167				517										
Almyracuma proximoculi Tanaissus psammophilus	10.7				/ +در										ž
Insecta Ceratopogonidae (LPIL)		-						-							-
Polypedilum halterale group Polypedilum (LPIL)															

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• -	13	13	13	13	14	14	14 14	Strata 14	15	15 15	16	16	17	17	17 I	7
	53	54	55	56	57	58	59 6(Site No 61	62	63 64	1 65	66	67	68	69 -	70
RHYNCHOCOELA Rhynchocoeia (LPIL)								11.1								
Lineidae (LPIL)								11.1								
Polychaeta																
Capitellidae (LPIL) Heteromastus filiformis																
Mediomastus (LPIL) Curratulidae (LPIL)		21.3	63.4	20.1	20.2	20.9				10.7						
Glycera sp.D										19.7						
Laconereis cuiveri																
Aricidea catherinae Aricidea cerrutii													19.4			
Aricidea (LPIL) Spionidae (LPIL)													15.6			
Polydora cornuta															4.	ž
Strebiospio benedich Dipolydora socialis																
Marenzellaria viridis Parapionosyllis longicirrata									157							
Brania wellfleetensis Polygordius (1 PH)									23.5					· .		
Sabellaria vulgaris															31.1	
Oligochaeta Oligochaeta (LPIL)												30.3				
Tubificidae (LPIL) Linuodrilus hoffmeisteri					14.1										11.1	
Quistadrilus multisetosus																
Bivalvia																
Bivalvia (LPIL) Tellina agilis							40.4	11.1						37.8	15.6 51	3.3
<i>Tellina</i> (LPIL) Genma semina	18.2	16.3						40.7		26.2	30.8				29	80
Astarte castanea											50.0		• .		20	1.9
Corbicula manilensis																
Gastropoda Acteocina canaliculata							•									
Crepidula plana ARITHROPODA				18.5												
Malacostraca																
Chiridotea tuftsi											61.5					
Corophium tuberculatum Corophium lacustre																
Corophium (LPIL) Ampelisca abdita						70.2	84	9								
Ampelisca vadorum						10.2	14.9	,								
Leptocheirus plumulosus																
Leptocheirus (LPIL) Pseudunciola obliguua				•												
Rhepoxynius hudsoni Haustoriidae (LPIL)								11.1		14	2			25.6		
Protohaustorius sp.B		25.0														
Lysianopsis alba										71.	4	18.3				
Leucon americanus Almyracuma proximoculi				23.8	50.1										-	ž
Tanaissus psammophilus Insecta																_
Ceratopogonidae (LPIL)																
Polypedilum halterale group																
Polypedilum (LPIL)																

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Site No.RHYNCHOCOCIA (JPL)RHYNCHOCOCIA (JPL)77778486888990919287RHYNCHOCOCIA (JPL)13.429.814.013.429.814.014.0PolychaetaCapitellidae (JPL)13.429.814.014.0Otycena sp.DG(X)cinde solitaria13.614.014.0Articidae cerratiaArticidae cerratia13.616.316.3Articidae cerratia13.611.916.316.3OligochaetaDispondura socialis11.913.429.814.0OligochaetaOligochaeta11.916.316.3OligochaetaOligochaeta11.913.412.813.514.6OligochaetaOligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta11.913.413.514.0Oligochaeta13.412.813.514.0Oligochaeta13.413.514.0Oligochaeta13.413.514.0Oligochaeta13.413.514.0Oligochaeta13.413.514.0Oligocha		18	18	18	21	Strata 21	22	22	22	NA	NA NA
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ANNELUA ANNELUA ANNELUA ANIELUA Capitellidae (LPL) Gerera s.D Govera S.D	RHYNCHOCOELA Rhynchocoela (LPIL)										
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Objective de (CPL) 12.8 77.5 51.4 64.7 77.9 87.9 Imodellus hoffneisseri Quistadrilus multisetosus 12.8 77.5 51.4 64.7 77.9 87.9 MOLLUSCA Bivalvia (LPL) 12.8 77.5 51.4 64.7 77.9 87.9 MOLLUSCA Bivalvia (LPL) 12.8 77.5 51.4 64.7 77.9 87.9 MOLLUSCA Bivalvia (LPL) Tellina agitis 44.4 12.8	Oligochaeta				10.0						
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MOLLUSCA Bivalvia Bivalvia (LPIL) Tellina agilis Tellina agilis Astarte castanea Pisidium compressum Coroptium luatata Corophium luberculatam Corophium luberculatam	Quistadrilus multisetosus							18.9			
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ARTHROPODA Malacostraca Christota tuftsi Corophium tuberculatum Corophium lacustre Corophium lacustre	Acteocina canaliculata Crepidula plana										
Cyathura polita Chiridota tuftsi Corophium tuberculatum Corophium (LPIL) Ampelisca abdita Ampelisca abdita Ampelisca vadorum Gammarus tigrinus Leptocheirus glumulosus Leptocheirus (LPIL) Pseudanciola obliguua Rhepoxynias hudsoni Haustoridae (LPIL) Protohaustorius ap.B Parahaustorius altenuatus Lysianopsis alba Leucon americanus Leucon americanus Systamopsis alba Leucon americanus Caratopogonidae (LPIL) Chironomidae (LPIL) Polypedilum halferale group	ARTHROPODA Malacostraca										
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Corophium (LPIL) Ampelisca abdita Ampelisca abdita Ampelisca vadorum Gammarus tigrinus Leptocheirus (LPIL) Pseudanciola obliquua Rhepotynius hudsoni Haustoriidae (LPIL) Protohaustorius ap.B Parahaustorius attenuatus Lysianopsis abda Leucon americanus Amyracuma proximoculi Tanaissus psammophilas Insecta Insecta Ceratopogonidae (LPIL) Chironomidae (LPIL) Chironomidae (LPIL) Chironomidae (LPIL)	Corophium tuberculatum Corophium lacustre										
Ampelisca vadorum Gammarus tigrinus Leptocheirus glamulosus Leptocheirus (LPIL) Pseudunciola obliquaa Rheposynus hudsoni Haustoriidae (LPIL) Protohaastorius attenuatus Lysionopsis alba Leucon americanus Ainyracuma proximoculi Tanaissus psammophilus Leucon dae (LPIL) Ceratopogonidae (LPIL) Chironomidae (LPIL) Polypedilum halierale group	Corophium (LPIL) Ampelisca abdita										79.5
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Pseudunciola obliguua Rhepoxynias hudsoni Haustoriidae (LPIL) Protohnastorius sp.B Parahaustorius attenuatuss Lysionopsis alba Leucon americanus Almyracuma proximoculi Tanaissus psammophilas Insecta Ceratopogonidae (LPIL) Chironomidae (LPIL) Chironomidae (LPIL) Polypedilum halierale group	Leptocheirus plumulosus Leptocheirus (LPIL)										
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Parahaustorius altenuatus Lysianoptis alba Leucon americanus Almyracuma proximoculi Tanaissus psammophilus Insecta Ceratopogonidae (LPIL) Chironomidae (LPIL) Polypedilum halierale group	Haustoriidae (LPIL) Bratohoustorius, sp.B										
Lystability tuba 36.0 Almyracuma proximoculi 31.1 Transisus psammophilus 21.1 Insecta Ceratopogonidae (LPIL) Chironomidae (LPIL) Chironomidae group	Parahaustorius attenuatus										
Taniylacuma proximoculi 21.1 Tinsecta Ceratopogonidas (LPIL) Chironomidae (LPIL) Polypedilum halierale group	Lysianopsis alba Leucon americanus				36.0						
Ceratopogonidae (LPIL) Chironomidae (LPIL) Polypedilum halierale group	Aimyracuma proximoculi Tanaissus psammophilus	21.1									
Chronomidae (LPIL) Polypedilum halferale group	Insecta Ceratopogonidae (L.PIL)										
	Chironomidae (LPIL) Polypedilum halferale group										

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Station mean density and mean number of taxa data are given in Table 1 and Figures 11 and 12. Mean densities ranged from 1412.5 organisms·m⁻² at Stratum 9 to 26985.0 organisms·m⁻² at Stratum 14 (Table 1; Figure 11). The mean number of taxa per replicate ranged from 3.67 at Stratum 6 to 26.25 at Stratum 12 (Table 1; Figure 12).

ANOVA analyses were performed on natural log transformed density and taxa abundance data for the Delaware Bay and adjacent waters strata. ANOVA and post-hoc test results for these two parameters are given in Tables 5 and 6.

Density and taxa abundance data were compared to various physical parameters using nonparametric correlation analyses. There was a significant positive correlation between strata mean density data and mean taxa per strata (Table 7). Also, TOC and density showed a significant positive correlation (Table 7). There were additional significant correlations between various physical parameters: % gravel + sand was inversely correlated with TOC; and % silt + clay was positively correlated with TOC (Table 7).

Taxa diversity and evenness are given in Table 1 and Figure 13. Taxa diversity (H') ranged from 0.77 at Stratum 5 to 2.46 at Stratum 18. Taxa evenness (J') values ranged from 0.14 at Stratum 1 to 0.78 at Strata 10 and 18 (Table 1; Figure 13).

Cluster Analysis

Normal (stations) and inverse (species) cluster analyses were performed on the Delaware Bay and adjacent waters data set and displayed as dendrograms (Figures 14 and 15). Selection of the species included in the analyses was based on a minimum representation of 0.3% of total individuals which encompassed 39 taxa. These taxa accounted for 90.3% of the macroinfaunal assemblage collected.

Numerical clustering of the 81 sites can be interpreted at a five-group level at a 10% level of similarity (Figure 14). One group contained only Site 64 with a macroinfaunal assemblage *contained only Site 64* with a macroinfaunal assemblage *contained 20* dominated by the amphipod, *Parahaustorius attenuatus* (Table 5). A second group contained 20

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Figure 13. Taxa diversity (H') and taxa eveness (J') of the Delaware Bay and adjacent waters strata, September 1997.



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Stratum

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Table 7. Spearman Rho correlation coefficients for the Delaware Bay and adjacent waters sites, September 1997.

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Variable	By Variable	Correlation	Probability	sign
Density	No. Taxa	0.5411	<.0001	*
TOC	No. Taxa	-0.2109	0.0588	ns
TOC	Density	0.2765	0.0125	*
% gravel+sand	No. Taxa	0.1598	0.1542	ns
% gravel+sand	Density	-0.1240	0.2702	ns
% gravel+sand	ТОС	-0.6559	<.0001	*
% silt+clay	No. Taxa	-0.1189	0.2905	ns
% silt+clay	Density	0.1920	0.0860	ns
% silt+clay	TOC	0.6540	<.0001	*

* = significant correlation; ns = not significant

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take differences among strata

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Table 6. Continued

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	· 14	1	19	22	2	11	4	12	20	16	23	18	13	17	8	5	3	21	10	15	9	6	7
14		ns	*	ns	ns	ns	ns	ns	*	*	*	*	*										
1			ns	*	*	*																	
19				ns	ns	*	*																
22					ns	ns	*	*															
2						ns	ns	ns	*														
11							ns	ns	*	*													
4								ns	ns	ns	*												
12									ns	ns	ns	*											
20										ns	ns	ns	*										
16											ns	ns	ns	ns									
23												ns	ns	ns	*								
18													ns	ns.	ns	ns	ns						
13														ns	ns	ns	ns						
17															ns	ns	ns	ns	ns	ns	ns	ns	ns
8																ns	ns	ns	ns	ns	ns	ns	ns
5																	ns	ns	ns	ns	ns	ns	ns
3																		ns	ns	ns	ns	ns	ns
21 10																			ns	ns	ns	ns	ns
10																				ns	ns	ns	ns
12																					115	ns	ns
9																						112	ne
0 7																							115
1																							

*= a significant difference between strata

Table 6. ANOVA and post-hoc comparison results for taxa differences among sites for the Delaware Bay and adjacent waters samples, September 1997.

Shapiro-Wilk W test for normality

W=0.97 Prob < W=0.17

ANOVA Table

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model Error Total	22 58 80	14.64 13.55 28.19	0.67 0.23 0.35	2.85	0.0008

* *

density differences between strata

	-12	18	17	14	11	15	19	13	16	22	2	10	8	20	1	21	4	23	3	9	5	7	6
12		ns	*	*	*	*	*	*	*	*	*	*	*	*									
18			ns	ns	ns	ns	*	ns	*	*	*	*	*	*	*								
17				ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*	*							
14					ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*	*						
11						ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*	*
15							ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
19								ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*
13									ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	*	*
16										ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
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Table 5. ANOVA and post-hoc comparison results for density differences among sitesfor the Delaware Bay and adjacent waters samples, September 1997.

Shapiro-Wilk W test for normality

W=0.98 Prob < W=0.55

ANOVA Table

1

Source	DF	Sum of Squares	Mean Square	FRatio	Prob > F
Model	22	47.7	2.17	1.37	047:
Error	58	91.51	1.58		
Total	80	139.21	1.74		

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Mean No. taxa (± SD)

Figure 12. Mean number of macroinvertebrate taxa of the Delaware Bay and adjacent waters strata, September 1997.

Stratum





Mean Density (± SD)



Figure 15. Inverse (taxa) classification analysis for the Delaware Bay and adjacent waters sites, September 1997. Large, bolded numbers (1, 2, 3, 4, 5, 6) denote taxa groupings.

arph



Figure 14. Normal (station) classification analysis for the Delaware Bay and adjacent waters sites, September 1997. Large, bolded numbers (1, 2, 3, 4, 5) denote site groupings.

sites, three of which accounted for 100% of the sites within Stratum 18. The remaining sites in this group were from adjacent strata. Stratum 12 was represented by two of the four sites (45 and 46), while 80% of the sites within Stratum 13 were clustered in this group (Figure 14). Stratum 14 was represented by sites 59 and 61 which accounted for only 40% of its total. Sites within Strata 15 and 17 were also in this group and account for 66.6% and 75.0% of these strata respectively. Group 3 was the smallest, containing only 5 sites which represented Strata 7, 8 and 9. These sites accounted for only 33.3%, 33.3% and 50.0% of their respective strata. Group 4 contained 14 sites, representing Strata 10, 11, 12, 13, 14, 16, 17 and 22. No Strata were represented as a whole in this group, with the highest percentage being 75.0% of the total sites of Stratum 14. Group 5 was the largest group containing 41 of the 81 sites sampled. Strata 1, 2, 3, 4, 5, 6, 19, 20 and 21 were represented by 100% of the sites within these strata. The sites within these strata were dominated by the oligochaete family Tubificidae and also contained most of the insect taxa identified in the samples. Strata 7, 8, 9 and 10 were represented by 66.6%, 66.6%, 50.0% and 75.0% of their total sites in Group 5.

Clustering of the 39 taxa at the 81 sites was interpreted at a six-group level at a 15% level of similarity (Figure 15). The three largest groups (2, 4 and 6) consisted of taxa which can be separated by salinity gradients and sediment textures. Group 2 contained 10 taxa which are predominantly found in freshwater. Three of these were the only oligochaetes represented in the analysis. This group also contained the only 2 insect taxa. The presence of these taxa is indicative of freshwater and silty sediments; this is supported by the presence of *Gammarus tigrinus*, an amphipod restricted to fresh and low salinity waters. Group 4 contained 9 taxa which could be classified as marine. The bivalve species *Tellina agilis* and *Gemma gemma* are typically found in higher salinity, sandy environments. The polychaete family Cirratulidae and the polychaete genus *Aricidea* are predominantly marine as is the archiannelid genus *Polygordius*. Group 6 contained 12 taxa which are typically found in estuaries. These taxa are able to tolerate a wide range of

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salinities and prefer silty sediments. This group had a more diverse taxonomic assemblage with seven orders represented. Estuaries typically have a higher taxonomic diversity than freshwater or marine systems and are subject to varying salinities and sediment types. The remaining Groups in the analysis had 2, 1 and 3 taxa respectively. The two species in Group 1 were the polychaete *Dipolydora socialis* and the amphipod *Corophium lacustre*, both of which are esturine. Group 3 contained only *Protohaustorius* sp. B, a strictly marine amphipod that prefers sandy sediments. Group 5 contained three species which are typically marine. *Sabellairia vulgaris* is a tube-dwelling polychaete found in sandy sediments. The caprellid *Paracaprella tenuis* is usually found associated with hydroids which are typically restricted to marine systems.

sites, three of which accounted for 100% of the sites within Stratum 18. The remaining sites in this group were from adjacent strata. Stratum 12 was represented by two of the four sites (45 and 46), while 80% of the sites within Stratum 13 were clustered in this group (Figure 14). Stratum 14 was represented by sites 59 and 61 which accounted for only 40% of its total. Sites within Strata 15 and 17 were also in this group and account for 66.6% and 75.0% of these strata respectively. Group 3 was the smallest, containing only 5 sites which represented Strata 7, 8 and 9. These sites accounted for only 33.3%, 33.3% and 50.0% of their respective strata. Group 4 contained 14 sites, representing Strata 10, 11, 12, 13, 14, 16, 17 and 22. No Strata were represented as a whole in this group, with the highest percentage being 75.0% of the total sites of Stratum 14. Group 5 was the largest group containing 41 of the 81 sites sampled. Strata 1, 2, 3, 4, 5, 6, 19, 20 and 21 were represented by 100% of the sites within these strata. The sites within these strata were dominated by the oligochaete family Tubificidae and also contained most of the insect taxa identified in the samples. Strata 7, 8, 9 and 10 were represented by 66.6%, 66.6%, 50.0% and 75.0% of their total sites in Group 5.

Clustering of the 39 taxa at the 81 sites was interpreted at a six-group level at a 15% level of similarity (Figure 15). The three largest groups (2, 4 and 6) consisted of taxa which can be separated by salinity gradients and sediment textures. Group 2 contained 10 taxa which are predominantly found in freshwater. Three of these were the only oligochaetes represented in the analysis. This group also contained the only 2 insect taxa. The presence of these taxa is indicative of freshwater and silty sediments; this is supported by the presence of *Gammarus tigrinus*, an amphipod restricted to fresh and low salinity waters. Group 4 contained 9 taxa which could be classified as marine. The bivalve species *Tellina agilis* and *Gemma gemma* are typically found in higher salinity, sandy environments. The polychaete family Cirratulidae and the polychaete genus *Aricidea* are predominantly marine as is the archiannelid genus *Polygordius*. Group 6 contained 12 taxa which are typically found in estuaries. These taxa are able to tolerate a wide range of

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APPENDIX

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BARRY A. VITTOR & ASSOCIATES, INC.

ENVIRONMENTAL RESEARCH & CONSULTING

Fax (334) 633-6738

8060 Cottage Hill Road

Mobile, Alabama 36695

Phone (334) 633-8100

QUALITY CONTROL REWORKS

Client/Project NOAA Work Assignment Title Delaware Bay 1997

Work Assignment Number FE-97-18-DB

Task Number 5

Sorting Results:

Sample #	% Accuracy		
14	100%		
18	100%		
38	100%		
31	100%		
59	100%		
61	100%		
29	100%		
47	100%		
62	100%		
5	100%		
27. and a feature way a	100%	an an an Braing an	
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Taxonomy Results:			
Sample #	Taxa	% Accuracy	
38	Crust./Moll.	100%	
61	Crust./Moll.	100%	
42	Crust/Moll.	98%	
2	Crust./Moll.	99%	
25	Crust./Moll.	100%	
43-2	Crust./Moll.	97%	
14 11 11 11 11 11 11 11 11 11 11 11 11 1	Crust./Moll.	100%	
59	Crust/Moll.	97.3%	
67-3	Poly/Misc.	98.3%	
60	Poly/Misc.	98.7%	
33	Poly./Misc.	100%	
30	Poly/Misc.	100%	
44	Poly./Misc.	98.2%	
29	Poly./Misc.	98.2%	
65	Poly./Misc.	100%	* *

Description of outstanding issues or deficiencies which may affect data quality: None 10/6/57

Signature of QA Officer or Reviewer

Date



BARRY A. VITTOR & ASSOCIATES, INC.

ENVIRONMENTAL RESEARCH & CONSULTING

8060 Cottage Hill Road

Mobile, Alebama 36695

Task Number S

Phone (334) 633-6100

Fax (334) 633-6738

QUALITY ASSURANCE STATEMENT

Client/Project NOAA

Work Assignment Title Delaware Bay 1997

Work Assignment Number FE-97-18-DB

Description of Data Set or Deliverable: 81 Benthic macroinvertebrate samples collected in July and August of 1997; Young Dredge grabs.

Description of audit and review activities: Judged accuracy rates were well above standard levels for sorting and taxonomy. Laboratory QC reports were completed. Copies

of QC results follow (see attachment.) All taxonomic data were entered into computer and printed. This list was checked for accuracy against original taxonomic data sheets.

Description of outstanding issues or deficiencies which may affect data quality: None

Signature of QA Officer or Reviewer

Signature of Project Manager

10/6/78

Date

Date

Linda Sierke Barry A. Vittor & Associates 8060 Cottage Hill Rd. Mobile, AL 36695 334-633-6100

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• Comments:

Hi lan,

The following are my QA/QC procedures for the benthic lab. If you have any questions, please call.

Sincerely,

Linda Sierke

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1.4 Quality Assurance and Quality Control

1.4.1 The following quality control (QC) procedures are conducted at Vittor & Associates to ensure data quality.

1.4.2 Sorting

1.4.2.1 – 1.4.2.11 At a minimum, 10 percent of all samples sorted per project will be resorted. This is accomplished by re-sorts conducted on a regular basis on batches of 10 samples; no one sorter will rework their own sample. All findings in the resort are noted (e.g., -1 crustacean, 1 echinoderm fragment). The minimum acceptable sorting efficiency is 95%. If the number of animals left behind after the first sort is equal to 5 percent or more of the number of organisms found in the entire sample, a QC failure will be noted in the log book, and another sample (in addition to the mandatory 10 percent) worked by the sorter during that period is QC'd. If this is also a failure, then all samples previously sorted by that person since the last QC period are resorted. Sorting efficiency (%) will be calculated using the following formula:

organisms originally sorted X 100 # organisms originally sorted + additional # found in resort

A QC period will be designated on a regular basis on batches of 10 samples. All individuals found in a QC resort will be identified, counted and added to the taxonomic data sheet. At the conclusion of the sorting phase of each project, a Quality Control Results form is completed. This tally forms the basis for a section summarizing the QC results of the sorting effort within the Laboratory QC Report (see 4.3).

1.4.3 Species Identification and Enumeration

1.4.3.1 - 1.4.3.11 Quality control at the identification and enumeration levels of sample processing relies upon: 1) preparation of voucher material for each species identified; 2) preparation of Consistency Card Files for each species identified; 3) in-house verifications of identifications during sample processing; 4) in-house examination of sample data sheets for questionable identification and enumeration data; 5) in-house support for scientific research and publications; 6) close communication with recognized outside experts, including verification of identifications; 7) constant update of our taxonomic libraries; 8) ten percent of the samples worked by a given

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 taxonomist will be re-identified; These samples will be randomly selected. After reidentification, any discrepancies will be recorded, corrections made and vials returned to samples. Accuracy shall be computed in the following manner:

total # of organisms originally sorted X 100 # organisms originally sorted + additional # found in resort

The minimum acceptable taxonomic efficiency will be 95%. If QC failures are found, all samples worked by that taxonomist since the last QC check are re-identified. All QC checks and rechecks will be noted (name, date, initials) on the log and in the log book. All corrections to data sheets will be initialed and dated appropriately.

1.4.4 Taxonomic Reference Collection

1.4.4.1 – 1.4.4.5 During sample analysis, a project-specific voucher collection will be prepared. This voucher collection is composed of representative individuals of each species encountered in the project's samples. The individuals are placed in covered vials, with the appropriate preservative (70% ethanol) and labeled. The label, written in India ink, will contain the species name, project location, station and replicate, collection date, taxonomist's name or initials, identification date, and the number of specimens present in the vial. The individual vials will then be placed inside museum jars with preservative, catalogued, and accessioned into the client's voucher collection. It is from this voucher collection that some specimens may be sent to outside taxonomic experts for verification of identifications. The Laboratory Manager is responsible for overseeing proper curating of voucher collection and recording any specimen loans to outside individuals. This collection and any documentation associated with it will be provided to the CCMA Project Manager upon completion of each project. A reference collection log will be maintained with all pertinent information recorded and will be forwarded to CCMA upon request.

1.5 Data Management

The Identification and Enumeration phase of laboratory analysis will generate the raw data which will be entered by each taxonomist on the data sheet in ink. Other pertinent data are also listed such as header information and comments. In the laboratory, only the taxon name, count data, and appropriate comments are listed for each replicate. The taxon number is added during data coding. If questions or problems arise during the data sheet QC, they are brought to the attention of the appropriate taxonomist for clarification and/or correction. Taxonomic data sheets are then sent to the Data Clerk for data entry, and Data Summary Report preparation. Completed data sheets will be kept in bound notebooks. The Laboratory Manager will complete a written Laboratory QC Report. This report is a summary of QC results from all phases of laboratory involvement. It also includes: 1) results of verifications of identifications by outside scientists; 2) QC problems, if any, and how these were handled; and 3) judged accuracy rates for all phases. The Laboratory QC Report and completed data sheets will be available to CCMA Project Manager.

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