School of
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A Grab-Sample Study of the Benthic Invertebrates of the Columbia River Estuary

Supplemental Data Report
1 November 1975 through 29 February 1976

Submitted to:
Port of Astoria
Astoria, Oregon

by
Duane L. Higley and Robert L. Holton

Supplement to Reference 76-3 July 1978

OREGON STATE UNIVERSITY

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G. Ross Heath
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Michael Richardson, Michael Kravitz, Howard Jones, and William Colgate aided in specimen identification. Beverly Knapp provided editorial assistance and Rebecca Hanson typed the manuscript.

NOTICE

The conclusions presented in this report are tentative, and are subject to change based on a more complete study of the data.

ABSTRACT

The report provides benthic invertebrate densities and sediment texture data for 48 stations in the Columbia River estuary (Columbia River mile 0-28) sampled by grab sampler between 31 August 1975 and 22 January 1976.

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INTRODUCTION

This report provides data developed from a short-term study made of the benthic invertebrate fauna of the Columbia River estuary. Sampling was conducted between 31 August 1975 and 22 January 1976, and included an area of approximately 130 square miles between Columbia River mile (CRM) 0 and CRM 28. Samples were taken by grab sampler.

An earlier, taxonomically less complete version of the data was presented in a final report (Higley, Holton, and Komar, 1976) submitted to the Port of Astoria, Oregon, which supported the study. That report, while satisfying the contractural agreement stopped short of a complete analysis of the samples. The present supplement greatly improves the taxonomic detail of the study, provides more complete counts on some samples, and expands the sediment texture information provided for each sample. This additional work was performed with the view that these samples provide the most complete survey available of the benthic infauna of the Columbia River estuary and should be better utilized. The data should provide a useful basis for developing further studies and should aid in making management decisions affecting the estuary.

The survey was conducted as a result of a proposal by the Port of Astoria to fill a 32 hectare intertidal and subtidal region adjacent to and west of their Pier 3 in Youngs Bay. Earlier work (Higley and Holton, 1975) had shown that benthic habitats in Youngs Bay are quite productive of invertebrate organisms consumed by both transient and resident fish populations, prompting concern for habitat loss at the fill site. Benthic infauna and fish studies were therefore conducted at the fill site, and a survey of benthic infauna and habitats was made in the lower 28 miles of the Columbia River estuary to give perspective to the data developed for the fill site. It is the estuary-wide survey which is reported in greater detail here. The benthic infauna at the fill site and other areas of Youngs Bay are described in Higley and Holton (1975), Higley, Holton and Komar (1976), and Higley, Morgan and Holton (in press).

Because of the sampling technique used (grab-sampler), the survey is basically an infauna study. However, several epifaunal forms were captured and are included.

METHODS

The specifics of sample collection and analysis were presented in Higley, Holton and Komar (1976). Briefly, 51 stations were occupied, their location chosen according to bathymetric charts and shoreline features (Figure 1). Two grabs per station (except one each at stations 108-110) were taken with a 0.107 m^2 Smith-McIntyre sampler, washed on a 0.425 mm screen, and fixed in 5 percent buffered formalin. Later in the lab, samples were split (usually with a Folsam plankton splitter) as required by their size, and preserved in 40 percent isopropanol. Organisms in a portion or all of 92 samples from 48 stations were picked, sorted, and identified. Samples with high sand content were first flushed with excess water which washed light-bodied animals onto a sieve beneath. These animals were then sorted, and most of the residual sand fractions were examined for molluscs and other heavy animals which did not wash out.

Invertebrate identification in the final report (Higley, Holton and Komar, 1976) was restricted to order and higher taxomonic categories. In the present report, identification is to species where possible, although some groups (Nematoda, Nemertea, Oligochaeta, and Ostracoda) remain as reported before.

The use of "spp" varies among taxa. In the amphipod genus *Corophium*, which is extremely abundant as *C. salmonis* in some muddy-sand areas, *Corophium* spp. usually indicates animals not individually examined for species identification. For some *Corophium* and for other taxa, "spp" is used for animals which could not be identified to species because they were lost or damaged, were too young to identify, or did not fit available

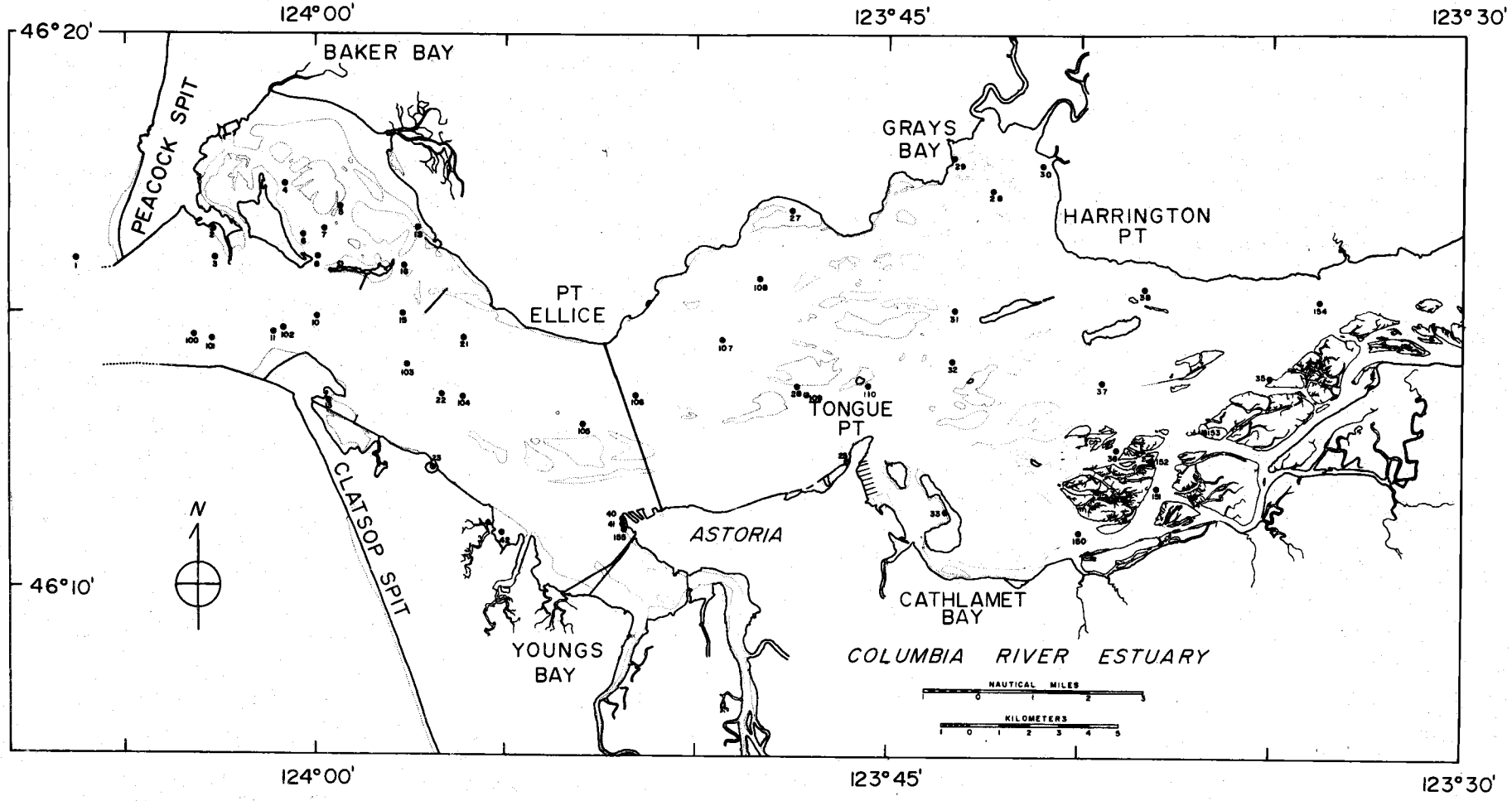

Figure 1. Benthos and sediment sample stations in the Columbia River estuary, 31 August 1975 to 22 January 1976.

keys. The amphipod *Anisogammarus* apparently exists primarily as *A. confervicolus* in the estuary. However, this species cannot be separated from *A. ramellus* in the juvenile stage, which dominated the catch, and therefore is usually called *Anisogammarus* spp. Among bivalves, juveniles less than 3 mm long are reported separately because counts of larger individuals may more accurately indicate successful substrate colonization.

A sediment subsample was removed from each grab sample and subjected to a combination wet-dry sieving process on screens of 1.0, 0.5, 0.25, 0.125, and 0.063 mm, corresponding to phi sizes of 0, 1, 2, 3, and 4, respectively.

RESULTS

Animal taxa identifed in the survey are listed in Table 1. Sediment texture data are presented in Table 2, which includes Inman mean, median, and standard deviation values for most samples. Inman values requiring extrapolation of size distribution data are not included.

Table 3 provides the revised faunal densities, as well as station depth and some details of sample analysis.

It is apparent from Table 3 that most marine invertebrate taxa do not penetrate deep into the estuary. The rich marine fauna described by Richardson, Carey, and Colgate (1977) for stations located offshore of the mouth of the Columbia River has greatly diminished near the river mouth and mostly gives way upstream of Baker Bay to brackish and freshwater forms as described in Higley and Holton (1975) for Youngs Bay. However, some marine-oriented polychaetes persist along the north channel up to Greys Bay (e.g. stations 28, 29, 107, 108). This channel tends to carry more saline waters than does the south channel (Neal, 1972).

As described in Higley, Holton and Komar (1976), a deficiency of this survey was the lack of intensive sampling in the shoaling areas. These extensive shallow areas, as well as vegetated islands, may harbor large populations of invertebrates important to estuarine fish production. Certainly future studies should aim at identifying the dominant invertebrate forms in these habitats, and investigate the relation of shoal movement to animal abundance.

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TABLES

TABLE 1

Checklist of benthic invertebrate taxa captured in the Columbia River estuary, 31 August 1975 to 22 January 1976. Classification is based on Barnes (1968). Table 3 of Higley and Holton (1976) presents an earlier version of this checklist.

Phylum Cnidaria
Class Anthozoa

Phylum Nemertea

Phylum Nematoda

Phylum Platyhelminthes
Class Turbellaria

Phylum Annelida
Class Polychaeta

Family Ampharetidae
Amphicteis floridus
Family Capitellidae
Barantolla americana
Capitella capitata
Capitella capitata oculata
Mediomastus acutus
Mediomastus californiensis
Superfamily Glyceroidea
Glyceroidea sp.
Family Glyceridae
Glycera convoluta
Family Goniadidae
Family Hesionidae
Hessionella mccallochae
Family Magelonidae
Magelona pitelkai
Magelona sacculata
Family Nephtyidae
Nephtys californiensis
Nephtys parva
Family Nereidae
Neanthes limnicola
Family Orbiniidae
Haploscoloplos spp.
Scoloplos armiger
Family Parionidae
Paraonella platybranchia
Family Phyllodocidae
Eteone dilatae
Family Spionidae
Scolelpsis cirratulus
Polydora spp.
Pygospio californica
Spio filicornis
Family Syllidae

Table 1 (continued)

- Class oligochacta
- Phylum Mollusca
  - Class Gastropoda
    - Subclass Prosobranchia
      - Family Amnicolidae
        - *Fluminicola virens*
      - Family Olividae
        - *Olivella biplicata*
      - Family Pleuroceridae
        - *Goniobasis(=Oxytrema) plicifera* var. *oregonensis*
  - Class Bivalvia
    - Family Cyrenidae
      - *Corbicula manilensis*
    - Family Myidae
      - *Cryptomya californica*
    - Family Solenidae
      - *Siliqua patula*
    - Family Sphaeriidae
      - *Pisidium* spp.
    - Family Tellenidae
      - *Macoma balthica*
- Phylum Arthropoda
  - Subphylum Mandibulata
    - Class Crustacea
      - Subclass Ostracoda
      - Subclass Cirrepedia
        - Family Balanidae
          - *Balanus amphitrite amphitrite*
      - Subclass Malacostraca
        - Superorder Peracarida
          - Order Mysidacea
            - Family Mysidae
              - *Archeomysis grebnitzkii*
              - *Neomysis mercedis*
          - Order Cumacea
            - Family Diastylidae
              - *Diastylopsis dawsoni*
          - Order Isopoda
            - Suborder Flabellifera
              - Family Sphaeromatidae
                - *Bathycopea daltonae*
                - *Gnorimosphaeroma oregonensis*
                - *Tecticeps convexus*
            - Suborder Valifera
              - Family Idoteidae
                - *Mesidotea(=Saduria) entomon*
            - Suborder Epicaridae
              - Family Bopyridae
                - *Argeia pugettensis*

Table 1 (concluded)

- Order Amphipoda
  - Suborder Gammaridae
    - Family Atylidae
      - *Atylus tridens*
    - Family Corphiidae
      - *Corophium brevis*
      - *Corophium salmonis*
      - *Corophium spinicorne*
    - Family Gammaridae
      - *Anisogammarus confervicolus*
    - Family Haustoriidae
      - *Eohaustorius estuarius*
      - *Eohaustorius sawyeri*
      - *Eohaustorius washingtonianus*
    - Family Lysianassidae
      - *Hippomedon denticulatus*
    - Family Oedicerotidae
      - *Monoculodes spinipes*
    - Family Phoxocephalidae
      - *Mandibulophoxus uncirostrata*
      - *Paraphoxus milleri*
- Superorder Eucarida
  - Order Decapoda
    - Suborder Natantia
      - Family Crangonidae
        - *Crangon franciscorum*
        - *Crangon stylirostris*
    - Suborder Reptantia
      - Family Callianassidae
        - *Callianassa californiensis*
      - Family Cancridae
        - *Cancer magister*
        - *Cancer oregonensis*
- Class Insecta
  - Order Odonata
    - Family Gomphidae
      - *Gomphus* spp.
  - Order Diptera
    - Family Chironomidae (=Tendipedidae)

TABLE 2

Sediment texture data for samples taken in the Columbia River estuary 31 August 1975 to 22 January 1976. Phi (ϕ) values represent sediment particle size groups as follows: > 1.000 mm (ϕ=0); 0.500 mm-1.000 mm (ϕ=1); 0.250 mm-0.500 mm (ϕ=2); 0.125 mm-0.250 mm (ϕ=3); 0.063 mm-0.125 mm (ϕ=4); < 0.063 mm (ϕ=5). Table 4 of Higley and Holton (1976) presents an earlier version of these data.

SAMPLE	1(A)	1(B)	2(A)	2(B)	3(A)	3(B)	4(A)	4(B)	5(A)
SIZE CLASS (%)									
≥ 1.000MM	0	0	.3	0	.2	0	0	.5	0
0.500MM-1.000MM	0	0	0	.2	.1	0	0	.5	0
0.250MM-0.500MM	24.9	15.7	47.9	43.7	78.5	58.9	1.0	.5	65.7
0.125MM-0.250MM	61.2	58.3	46.0	52.5	18.4	37.0	5.2	3.5	25.4
0.063MM-0.125MM	12.2	8.0	4.2	3.4	1.1	1.9	39.1	23.2	2.6
< 0.063MM	1.7	18.0	1.6	.2	1.7	2.2	54.7	71.8	6.3
INMAN VALUES									
MEDIAN	2.29	2.61	2.01	2.06	1.77	1.88			1.97
MEAN	2.39	3.17	2.15	2.07	1.83	2.21			2.26
STAND. DEV.	0.54	1.17	0.50	0.42	0.34	0.30			0.36

SAMPLE	5(B)	6(A)	6(B)	7(A)	7(B)	8(A)	8(B)	10(A)	10(B)
SIZE CLASS (%)									
≥ 1.000MM	0	.7	1.4	1.0	1.8	.6	.6	0	0
0.500MM-1.000MM	0	.7	.3	0	.7	0	.3	.9	.4
0.250MM-0.500MM	53.8	45.7	1.4	2.0	8.9	10.5	6.7	78.6	74.7
0.125MM-0.250MM	42.8	47.0	9.3	9.7	30.4	60.5	46.5	16.6	19.9
0.063MM-0.125MM	3.3	3.3	26.3	9.7	14.7	7.6	8.8	.9	.6
< 0.063MM	.1	2.6	61.3	77.6	43.5	20.8	37.1	3.0	4.4
INMAN VALUES									
MEDIAN	1.95	2.04				2.68		1.74	1.80
MEAN	2.20	2.11						1.81	1.91
STAND. DEV.	0.27	0.54						0.38	0.41

SAMPLE	11(A)	11(B)	13(A)	13(B)	15(A)	15(B)	16(A)	16(B)	18(A)
SIZE CLASS (%)									
≥ 1.000MM	0	0	0	0	0	0	0	0	3.0
0.500MM-1.000MM	0	2.2	0	0	0	0	0	0	0
0.250MM-0.500MM	77.2	75.3	66.8	69.0	26.8	55.7	54.4	42.9	.8
0.125MM-0.250MM	20.1	16.3	29.9	26.2	69.0	42.4	31.6	39.7	2.6
0.063MM-0.125MM	.3	.3	1.0	.8	4.9	1.9	5.4	5.9	14.2
< 0.063MM	2.4	5.9	2.3	4.0	.3	0	8.6	11.5	79.4
INMAN VALUES									
MEDIAN	1.95	1.73	1.97	1.97	2.16	1.94	1.90	2.16	
MEAN	2.05	1.84	2.15	2.16	2.23	2.18	2.34	2.56	
STAND. DEV.	0.16	0.47	0.25	0.26	0.36	0.26	0.42	0.62	

Table 2 (continued).

SAMPLE	19(B)	21(A)	21(B)	22(A)	22(B)	23(A)	23(B)	25(A)	25(B)
SIZE CLASS (%)									
≥ 1.000MM	2.5	2.4	0	0	0	1.8	1.3	2.9	2.0
0.500MM-1.000MM	.6	6.1	.3	.3	.2	.9	1.3	.5	.5
0.250MM-0.500MM	.6	72.8	73.0	37.0	56.3	1.8	1.3	2.1	2.0
0.125MM-0.250MM	1.2	6.2	20.7	58.6	40.5	3.2	3.6	54.5	48.6
0.063MM-0.125MM	12.3	1.3	1.7	3.8	2.5	20.8	19.6	26.7	26.0
< 0.063MM	82.8	11.2	4.3	.3	.5	71.5	72.9	13.3	21.0
INMAN VALUES									
MEDIAN		1.61	1.82	2.11	1.92			2.86	2.99
MEAN		1.74	1.96	2.11	1.90			3.00	
STAND. DEV.		0.67	0.44	0.41	0.38			0.68	

SAMPLE	26(A)	26(B)	27(A)	27(B)	28(A)	28(B)	29(A)	29(B)	30(A)
SIZE CLASS (%)									
> 1.000MM	.2	0	.3	.2	.5	.8	54.2	.3	0
0.500MM-1.000MM	.2	.3	.5	4.8	2.2	2.5	14.6	.6	0
0.250MM-0.500MM	40.6	49.0	50.2	56.7	48.4	53.4	16.4	8.8	1.1
0.125MM-0.250MM	48.8	45.2	36.9	28.8	39.5	37.5	7.3	10.2	32.2
0.063MM-0.125MM	8.0	5.5	11.1	5.7	4.5	3.9	2.2	8.5	55.3
< 0.063MM	2.2	0	1.0	3.8	4.9	1.9	5.3	71.6	11.4
INMAN VALUES									
MEDIAN	2.09	2.01	1.99	1.81	1.99	1.96	-0.08		3.25
MEAN	2.21	2.08	2.21	1.93	2.21	2.00	0.60		3.27
STAND. DEV.	0.52	0.53	0.63	0.61	0.54	0.58	1.30		0.59

SAMPLE	30(B)	31(A)	31(B)	32(A)	32(B)	33(A)	33(B)	34(A)	34(B)
SIZE CLASS (%)									
≥ 1.000MM	.4	0	.3	5.0	2.2	.7	0	1.2	.9
0.500MM-1.000MM	0	.3	.8	10.2	3.2	.7	0	.8	.9
0.250MM-0.500MM	.6	6.7	6.7	70.3	78.5	15.8	28.4	3.3	13.8
0.125MM-0.250MM	36.0	83.4	77.4	6.9	14.1	62.4	53.3	24.7	55.4
0.063MM-0.125MM	51.6	7.5	8.1	.4	0	16.5	15.5	47.3	22.4
< 0.063MM	11.4	2.1	6.7	7.2	2.0	3.9	2.8	22.7	6.6
INMAN VALUES									
MEDIAN	3.22	2.53	2.58	1.49	1.62	2.48	2.33	3.24	2.62
MEAN	3.27	2.43	2.52	1.45	1.62	2.55	2.52		2.70
STAND. DEV.	0.60	0.30	0.40	0.43	0.38	0.59	0.56		0.69

Table 2 (concluded).

SAMPLE	35(A)	35(B)	36(A)	36(B)	37(A)	37(B)	38(A)	38(B)	40(A)
SIZE CLASS (%)									
> 1.000MM	.3	0	.3	.2	.9	.4	9.0	4.4	.2
0.500MM-1.000MM	.3	.3	.1	.2	.3	.4	10.5	11.7	.1
0.250MM-0.500MM	23.4	20.3	1.0	7.8	1.7	1.7	56.2	57.2	63.9
0.125MM-0.250MM	56.7	57.9	67.6	55.7	51.0	57.1	23.8	19.5	28.4
0.063MM-0.125MM	16.2	15.8	24.7	26.2	29.4	31.2	.5	.5	1.3
≤ 0.063MM	3.1	5.7	6.3	9.9	16.7	9.2	0	6.7	6.1
INMAN VALUES									
MEDIAN	2.39	2.39	2.94	2.75	2.98	2.96	1.55	1.63	1.88
MEAN	2.47	2.56	2.87	2.92	3.26	2.97	1.47	1.72	2.07
STAND. DEV.	0.63	0.66	0.42	0.71	0.81	0.53	0.70	0.72	0.51

SAMPLE	40(B)	41(A)	41(B)	42(A)	42(B)	100(A)	100(B)	101(A)	101(B)
SIZE CLASS (%)									
> 1.000MM	0	5.7	.8	.2	0	0	0	0	0
0.500MM-1.000MM	16.5	2.0	.9	1	0	0	0	0	0
0.250MM-0.500MM	52.2	4.9	3.4	42.5	23.3	18.2	14.3	40.8	15.4
0.125MM-0.250MM	26.1	19.9	30.3	45.5	61.3	71.4	78.1	47.7	72.2
0.063MM-0.125MM	2.1	23.0	44.8	3.4	4.6	7.0	5.9	8.2	10.4
≤ 0.063MM	3.1	44.4	19.8	8.3	10.8	3.4	1.7	3.3	2.0
INMAN VALUES									
MEDIAN	1.63		3.17	2.13	2.42	2.42	2.43	2.06	2.47
MEAN	1.72			2.28	2.39	2.42	2.43	2.35	2.43
STAND. DEV.	0.73			0.58	0.51	0.46	0.40	0.41	0.43

SAMPLE	102(A)	102(B)	103(A)	103(B)	104(A)	104(B)	105(A)	105(B)	106(A)
SIZE CLASS (%)									
> 1.000MM	0	0	.3	.3	.1	0	4.5	.9	.1
0.500MM-1.000MM	0	0	.1	.4	0	0	10.6	5.6	1.0
0.250MM-0.500MM	54.9	31.3	4.1	3.8	40.0	17.7	71.2	80.2	44.6
0.125MM-0.250MM	41.7	62.8	78.6	77.0	54.5	76.8	11.7	10.0	42.9
0.063MM-0.125MM	1.6	2.6	12.9	14.0	3.8	3.6	.3	.2	2.7
≤ 0.063MM	1.8	3.3	4.0	4.5	1.6	1.9	1.7	3.1	8.6
INMAN VALUES									
MEDIAN	1.94	2.24	2.51	2.60	2.13	2.37	1.62	1.46	2.08
MEAN	2.22	2.26	2.66	2.74	2.20	2.37	1.49	1.58	2.27
STAND. DEV.	0.30	0.46	0.37	0.35	0.47	0.39	0.45	0.32	0.57

SAMPLE	106(B)	107(A)	107(B)	108(A)	109(A)	110(A)
SIZE CLASS (%)						
> 1.000MM	1.0	0	0	.5	6.0	.3
0.500MM-1.000MM	4.9	.1	0	4.6	14.0	1.1
0.250MM-0.500MM	39.0	6.2	16.6	85.0	59.9	40.2
0.125MM-0.250MM	47.1	83.9	70.1	8.9	15.7	47.3
0.063MM-0.125MM	2.9	7.9	8.7	1.0	.8	6.7
≤ 0.063MM	5.0	1.9	4.6	0	3.6	4.5
INMAN VALUES						
MEDIAN	2.08	2.54	2.47	1.57	1.55	2.04
MEAN	2.11	2.43	2.42	1.59	1.51	2.14
STAND. DEV.	0.62	0.32	0.42	0.26	0.67	0.54

Table 3

Densities (number/m^2) of benthic taxa and sampling information for samples taken in Columbia River estuary, 31 August 1975 to 22 January 1976. Water depth is ship's fathometer reading, uncorrected for transducer depth (about 1 m) or tidal stage. Sample depth was measured at deepest point (center of sampler jaws). The fraction of each sample counted is shown. Also indicated is treatment of sand and rubble residue if animals were concentrated by the flushing technique: X = not flushed; T = all residue examined for organisms; 0 = none of residue examined; C = residue fraction > 0.991 mm examined; F = residue fraction 0.425-0.991 mm examined. Table 4 of Higley and Holton (1976) presents an earlier version of these data.

Table 3. Densities of benthic taxa.

SAMPLE	1A	1B	2A	2B	3A	3B	4A	4B
WATER DEPTH (M)	10.7	11.0	5.5	6.1	12.2	11.3	3.7	4.0
SAMPLE DEPTH (CM)	10	7	9	10	12	11	19	19
FRACTION COUNTED	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.25
ER CHECK	X	X	X	X	X	X	X	X
TAXON								
NEMERTEA								
NEMERTEA SPP.	9	37	19	28	94	65	37	37
POLYCHAETA								
AMPHICTEIS FLORIDUS							37	
CAPITELLA CAPITATA					9		9	37
CAPITELLA SPP.				9				
ETEONE SPP.			9	9			56	
GLYCERA CONVOLUTA						9		
GLYCEROIDEA SPP.							19	
GONIADIDAE SPP.							9	
HAPLOSCOLOPLOS SPP.		28						
HESIONELLA MCCALLOCHAE					19	9		
MAGELONA PITELKAI		9						
MAGELONA SACCULATA	19							
MEDIOMASTUS CALIFORNIENSIS							28	411
NEPHTYS PARVA		28	56	28	9	19		
ORBINIIDAE SPP.	9				9			
POLYDORA SPP.							9	
SCOLELPSIS CIRRATULUS				19				
SCOLOPLOS ARMIGER	9							
SPIO FILICORNIS	9	9	280	9	75	150	9	
SYLLIDAE SPP.		19	9	28	19	9		
POLYCHAETA SPP.							9	
OLIGOCHAETA								
OLIGOCHAETA SPP.	131				9		37925	17308
GASTROPODA								
OLIVELLA BIPLICATA	196	47						
BIVALVIA								
MACOMA BALTHICA				9	9		2159	860
MACOMA BALTHICA JUVENILE							47	
SILIQUA PATULA		9						
MYSIDACEA								
ARCHEOMYSIS GREBNITZKII		9		19	19			
CUMACEA								
DIASTYLOPSIS DAWSONI	28							
ISOPODA								
BATHYCOPEA DALTONAE	9	9						
TECTICEPS CONVEXUS	19							
AMPHIPODA								
ANISOGAMMARUS SPP.							9	
COROPHIUM SALMONIS					9			
COROPHIUM SPINICORNE	9							
EOHAUSTORIUS SAWYERI	9	9	94	65		9		
EOHAUSTORIUS WASHINGTONIANUS			140	168	9	9		
HIPPOMEDON DENTICULATUS	215	65						
MANOIBULOPHOXUS UNCIRCSTRATA	234	374			9			
MONOCULODES SPINIPES	47				9	9		
MONOCULODES SPP.	19	9	9	9				
PARAPHOXUS MILLERI			56		65	234		
DECAPODA								
CANCER MAGISTER				9				
CRANGON STYLIROSTRIS	9			9				
TOTAL	980	661	672	418	372	522	40382	18653

Table 3. Densities of benthic taxa (continued)

SAMPLE	5A	5B	6A	6B	7A	7B	8A	8B
WATER DEPTH (M)	.9	.9	2.4	2.7	3.4	3.4	10.1	11.3
SAMPLE DEPTH (CM)	8	7	7	19	15	14	18	19
FRACTION COUNTED	1.00	0.50	1.00	0.25	0.25	0.25	0.50	0.25
ER CHECK	X	X	X	X	X	X	X	X
TAXON								
NEMERTEA								
NEMERTEA SPP.	28					860	94	
NEMATODA								
NEMATODA SPP.			1131	91477		486	19	1234
POLYCHAETA								
AMPHICTEIS FLORIDUS		19	9	37	37			37
BARANTOLLA AMERICANA				37		37		
CAPITELLA CAPITATA			9				224	187
CAPITELLA CAPITATA OCULATA				37				
ETEONE SPP.	140	112	47		150	75	916	636
GONIADIDAE SPP.						37		
HAPLOSCOLOPLOS SPP.	37							
MEDIOMASTUS CALIFORNIENSIS					1383	2243		
NEANTHES LIMNICOLA	84	131		37				
NEPHTYS PARVA							19	
POLYDORA SPP.		19		37		1084	19	
SCOLELPSIS CIRRATULUS					299	75	56	37
SPIO FILICORNIS							56	224
OLIGOCHAETA								
OLIGOCHAETA SPP.	94	19	59542	127103	710	449	94	262
BIVALVIA								
CORBICULA MANILENSIS JUVENILE						486		
CRYPTOMYA CALIFORNICA					187	748		
MACOMA BALTHICA	271	187	393	1645	75	187	150	75
MACOMA BALTHICA JUVENILE	19	19	168					
BIVALVIA JUV	9		112	37		37		
CIRREPEDIA								
BALANUS AMPHITRITE AMPHITRITE					299	37		
MYSIDACEA								
NEOMYSIS MERCEDIS	9							
AMPHIPODA								
ANISOGAMMARUS SPP.				112		224	37	
COROPHIUM BREVIS					37			
COROPHIUM SALMONIS					37	37	19	
EOHAUSTORIUS ESTUARIUS	794	1309						
EOHAUSTORIUS SPP.		75						
MONOCULODES SPP.		19						
PARAPHOXUS MILLERI	28	75						
DECAPODA								
CALLIANASSA CALIFORNIENSIS					75	84		
CALLIANASSA SPP.						37		
TOTAL	1513	1684	61411	220559	3289	7223	1703	2692

Table 3. Densities of benthic taxa (continued)

SAMPLE	10A	10B	11A	11B	13A	13B	15A	15B
WATER DEPTH (M)	18.3	20.1	5.5	5.5	1.5	0	4.6	4.9
SAMPLE DEPTH (CM)	9	13	11	16	8	6	8	14
FRACTION COUNTED	1.00	1.00	1.00	0.50	1.00	1.00	1.00	1.00
ER CHECK	T	O	O	T	X	X	X	T
TAXON								
NEMERTEA								
NEMERTEA SPP.	327	37	47	131	75	19	19	150
NEMATODA								
NEMATODA SPP.	28	37	37	19	19	37		9
POLYCHAETA								
AMPHICTEIS FLORIDUS					280	19		
CAPITELLA SPP.	252	75						
ETEONE DILATAE					56			75
ETEONE SPP.	9	9			19		206	47
HAPLOSCOLOPLOS SPP.	19	112					206	37
NEANTHES LIMNICOLA					290	56	65	9
NEPHTYS CALIFORNIENSIS	19		9	19				
PARAONELLA PLATYBRANCHIA								19
SCOLELPSIS CIRRATULUS					9			
SPIO FILICORNIS	75	19				9		75
SYLLIDAE SPP.		9						
OLIGOCHAETA								
OLIGOCHAETA SPP.	9		19	19	243	84	168	159
BIVALVIA								
MACOMA BALTHICA					140	224	65	243
MACOMA BALTHICA JUVENILE					374			
BIVALVIA JUV					28	47	112	28
MYSIDACEA								
ARCHEOMYSIS GREBNITZKII	47	9	84	19			19	
MYSIDAE SPP.			37					
ISOPODA								
GNORIMOSPHAEROMA OREGONENSIS					19			
AMPHIPODA								
ANISOGAMMARUS SPP.					9		215	84
COROPHIUM SALMONIS	9				47	19	47	9
COROPHIUM SPP.						9		
EOHAUSTORIUS ESTUARIUS				19	953	1467	9	9
EOHAUSTORIUS WASHINGTONIANUS	9	28	9	56				
EOHAUSTORIUS SPP.			9					
MONOCULODES SPINIPES			9					
MONOCULODES SPP.	19							
PARAPHOXUS MILLERI	9	19		75			28	56
DECAPODA								
CANCER MAGISTER		9						
CANCER OREGONENSIS		9						
CRANGON STYLIROSTRIS		9						
TOTAL	831	381	260	357	2561	1990	1159	1009

Table 3. Densities of benthic taxa (continued)

SAMPLE	16A	16B	18A	18B	21A	21B	22A	22B
WATER DEPTH (M)	2.7	2.7	2.1	2.4	11.0	11.0	4.6	4.6
SAMPLE DEPTH (CM)	8	7	19	19	17	9	12	11
FRACTION COUNTED	0.50	0.50	0.25	0.25	1.00	1.00	1.00	1.00
ER CHECK	X	X	X	T	0	0	X	X
TAXON								
NEMERTEA								
NEMERTEA SPP.	37				131	65	37	19
NEMATODA								
NEMATODA SPP.		879	561	82916	178	570		
POLYCHAETA								
AMPHICTEIS FLORIDUS		19	75	37				
CAPITELLA CAPITATA	19							
CAPITELLA SPP.					1196	963		
ETEONE SPP.	206	262				28	19	19
HAPLOSCOLOPLOS SPP.					47		523	682
NEANTHES LIMNICOLA	75	19	37	75				9
NEPHTYS PARVA						9		
POLYDORA SPP.		19						
PYGOSPIO CALIFORNICA								47
SCOLELPSIS CIRRATULUS	19							
SPIO FILICORNIS					65	4355	47	47
OLIGOCHAETA								
OLIGOCHAETA SPP.	3140	6935	21159	62094		37		
BIVALVIA								
MACOMA BALTHICA	206	430	2505	3645	28	9	290	112
MACOMA BALTHICA JUVENILE		3327	75					
BIVALVIA JUV	75		112	636		56		
MYSIDACEA								
ARCHEOMYSIS GREBNITZKII						9	9	
ISOPODA								
GNORIMOSPHAEROMA OREGONENSIS	19							
AMPHIPODA								
ANISOGAMMARUS SPP.		94			9	19		
COROPHIUM SALMONIS	19							
EOHAUSTORIUS ESTUARIUS	56	19					9	122
PARAPHOXUS MILLERI					56	65	112	140
OECAPODA								
CRANGON FRANCISCORUM				9				
TOTAL	3871	12003	24524	149412	1710	6185	1046	1197

Table 3. Densities of benthic taxa (continued)

SAMPLE	23A	23B	25A	26A	25B	26B	27A	27B
WATER DEPTH (M)	1.2	1.2	2.1	1.2	2.1	1.2	2.0	1.8
SAMPLE DEPTH (CM)	10	9	13	13	13	11	9	1[illegible]
FRACTION COUNTED	0.25	0.25	0.25	1.00	0.25	1.00	1.00	.50
ER CHECK	X	X	X	X	X	X	T	0
TAXON								
NEMERTEA								
NEMERTEA SPP.				19				19
NEMATODA								
NEMATODA SPP.	860	1346	37	664	262	720	19	523
POLYCHAETA								
AMPHICTEIS FLORIDUS	1009	5533						
ETEONE SPP.	112							
NEANTHES LIMNICOLA	2168	2056	935	103	710	103	224	935
OLIGOCHAETA								
OLIGOCHAETA SPP.	10019	15888	8935	271	10280	224	673	542
BIVALVIA								
MACOMA BALTHICA	636	224						
MYSIDACEA								
NEOMYSIS MERCEDIS							9	
MYSIDAE SPP.			37			47		
AMPHIPODA								
ANISOGAMMARUS SPP.	112				19			
CORCPHIUM SALMONIS	2056			16280	16075	7234	449	
CORCPHIUM SPINICORNE							19	
CORCPHIUM SPP.	4636	8486	9009	3579		6383	2365	5664
EOHAUSTORIUS ESTUARIUS					1972	3000	869	1009
EOHAUSTORIUS SPP.						37	19	
MONOCULODES SPINIPES							9	
AMPHIPODA SPP.					37			
TOTAL	21608	33533	18953	20916	29355	17748	4655	8692

Table 3. Densities of benthic taxa (continued)

SAMPLE	28A	28B	29A	29B	30A	30B	31A	31B
WATER DEPTH (M)	1.4	1.4	.9	.9	.9	.9	1.5	1.2
SAMPLE DEPTH (CM)	14	13	6	13	13	13	14	13
FRACTION COUNTED	0.50	0.50	0.50	0.50	0.50	0.50	1.00	1.00
ER CHECK	O	O	C	C	X	X	X	T
TAXON								
NEMERTEA								
NEMERTEA SPP.		56	19	37				
NEMATODA								
NEMATODA SPP.	19		131	430	5028	6449	336	336
POLYCHAETA								
CAPITELLA SPP.			19					
HAPLOSCOLOPLOS SPP.	19							
NEANTHES LIMNICOLA		19	19	19	131	75	9	
SPIO FILICORNIS		19						
OLIGOCHAETA								
OLIGOCHAETA SPP.	467	355	4103	4243	7495	3514	2761	1897
GASTROPODA								
FLUMINICOLA VIRENS	19	37	94	94			9	84
GONIOBASIS PLICIFERA OREGONENSIS		56	271	94			9	
GASTROPODA SPP.		112						
BIVALVIA								
CORBICULA MANILENSIS JUVENILE	37	56	9					
BIVALVIA JUV	19	112		654				
OSTRACODA								
OSTRACODA SPP.				112				
MYSIDACEA								
NEOMYSIS MERCEDIS						19		
MYSIDAE SPP.							9	
ISOPODA								
GNORIMOSPHAEROMA OREGONENSIS		19						
AMPHIPODA								
COROPHIUM SALMONIS	75			1495		206		1299
COROPHIUM SPP.	9701	7383	5533	1065	262		7000	5542
EOHAUSTORIUS ESTUARIUS		19						9
EOHAUSTORIUS SPP.	19							
INSECTA								
CHIRONOMIDAE SPP.	19	37		75	19	94		
TOTAL	10394	8280	10198	8318	12935	10357	10073	9167

Table 3. Densities of benthic taxa (continued)

SAMPLE	42A	42B	100A	100B	101A	101B	102A	102B
WATER DEPTH (M)	.6	.6	8.2	8.5	7.6	6.7	6.1	6.1
SAMPLE DEPTH (CM)	0	15	5	7	8	7	9	7
FRACTION COUNTED	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00
ER CHECK	X	X	X	X	X	X	X	X
TAXON								
NEMERTEA								
NEMERTEA SPP.	37			19	28	19	9	
NEMATODA								
NEMATODA SPP.	8299	2467						
PLATYHELMINTHES								
TURBELLARIA SPP.								9
POLYCHAETA								
AMPHICTEIS FLORIDUS	19							
CAPITELLA SPP.					19			
ETEONE SPP.			9		9	9		
HAPLOSCOLOPLOS SPP.			9					9
MAGELONA SACCULATA						9		
NEANTHES LIMNICOLA	1888	2449						
NEPHTYS CALIFORNIENSIS							28	9
NEPHTYS PARVA			9	9	28	9		
SCOLELPSIS CIRRATULUS					28			
SPIO FILICORNIS			47	159	243	140		9
SYLLIDAE SPP.			75	159	94	215	19	
OLIGOCHAETA								
OLIGOCHAETA SPP.	4860	5570						
BIVALVIA								
MACOMA BALTHICA	19					28		
MYSIDACEA								
MYSIDAE SPP.								19
ISOPODA								
ARGEIA PUGETTENSIS						19		19
GNORIMOSPHAEROMA OREGONENSIS								19
ISOPODA SPP.							9	
AMPHIPODA								
ATYLUS TRIDENS							75	28
ATYLUS SPP.								9
COROPHIUM SALMONIS		1869			9			
COROPHIUM SPINICORNE			19	9				
COROPHIUM SPP.	28037	24860						
EOHAUSTORIUS ESTUARIUS		56						
EOHAUSTORIUS WASHINGTONIANUS			19		131	19	178	215
MONOCULODES SPINIPES			9	9	9			
MONOCULODES SPP.							9	
PARAPHOXUS MILLERI			9					9
DECAPODA								
CRANGON STYLIROSTRIS						9	9	9
TOTAL	43159	37271	205	364	598	476	336	363

Table 3. Densities of benthic taxa (continued)

SAMPLE	103A	103B	104A	104B	105A	105B	106A	106B
WATER DEPTH (M)	7.0	7.0	4.6	4.0	4.9	4.9	4.6	7.6
SAMPLE DEPTH (CM)	5	7	14	10	11	14	15	17
FRACTION COUNTED	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ER CHECK	X	X	X	X	C	O	T	O
TAXON								
NEMERTEA								
NEMERTEA SPP.	56	84	28	56	47	84	84	19
NEMATODA								
NEMATODA SPP.			28		280		9	9
POLYCHAETA								
ETEONE SPP.	37	75	37	28				
HAPLOSCOLOPLOS SPP.	19	28	243	47	9	65	280	
NEANTHES LIMNICOLA							28	
POLYDORA SPP.		9						
SCOLELPSIS CIRRATULUS	9			9				
SPIO FILICORNIS	65			9				
OLIGOCHAETA								
OLIGOCHAETA SPP.	196	262	9		150			19
BIVALVIA								
MACOMA BALTHICA	19	9	19	19	9	9		28
MACOMA BALTHICA JUVENILE	65	94						
BIVALVIA JUV				84				9
MYSIDACEA								
ARCHEOMYSIS GREBNITZKII	37	75						
NEOMYSIS MERCEDIS							9	9
MYSIDAE SPP.		28					9	9
AMPHIPODA								
ANISOGAMMARUS CONFERVICOLUS					9			9
ANISOGAMMARUS SPP.				56			9	178
COROPHIUM BREVIS								9
COROPHIUM SALMONIS					9			19
COROPHIUM SPINICORNE		9						
EOHAUSTORIUS ESTUARIUS	9	19	37	37		19	28	
EOHAUSTORIUS SAWYERI						9		
EOHAUSTORIUS WASHINGTONIANUS	19	9	19			9		
PARAPHOXUS MILLERI	37	150	84	150	122	75	206	
AMPHIPODA SPP.	9							
INSECTA								
CHIRONOMIDAE SPP.						9		
UNIDENTIFIED								
UNIDENTIFIED SPP.						9		
TOTAL	577	851	504	495	635	288	662	317

Table 3. Densities of benthic taxa (continued)

SAMPLE	107A	107B	108A	109A	110A	151A	151B	152A
WATER DEPTH (M)	3.7	3.7	5.5	2.4	1.2	5.2	5.2	1.5
SAMPLE DEPTH (CM)	12	12	11	14	12	15	12	12
FRACTION COUNTED	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ER CHECK	X	X	O	C	T	T	F	X
TAXON								
NEMERTEA								
NEMERTEA SPP.	112	140	37	9				
NEMATODA								
NEMATODA SPP.			206	19	65			9
POLYCHAETA								
ETEONE SPP.	9	28	9					
HAPLOSCOLOPLOS SPP.	75	131						
NEANTHES LIMNICOLA	140	19	47		150			9
OLIGOCHAETA								
OLIGOCHAETA SPP.	65	19	9		112			215
GASTROPODA								
GASTROPODA SPP.						9		
BIVALVIA								
CORBICULA MANILENSIS								19
CORBICULA MANILENSIS JUVENILE					19		19	
MACOMA BALTHICA	56	56						
MACOMA BALTHICA JUVENILE	47	37						
BIVALVIA JUV					19			
ISOPODA								
MESIDOTEA ENTOMON		9		19				
AMPHIPODA								
ANISOGAMMARUS CONFERVICOLUS	19			19				9
ANISOGAMMARUS SPP.		9						
COROPHIUM SALMONIS		28	9		39206		19	206
COROPHIUM SPP.					34215	19		
EOHAUSTORIUS ESTUARIUS	710	720	869	271	140			
PARAPHOXUS MILLERI	65	75						
INSECTA								
CHIRONOMIDAE SPP.					47	103	84	
TOTAL	1298	1271	1186	337	73973	131	122	467

Table 3. Densities of benthic taxa (concluded)

SAMPLE	152B	154A	154B	155A
WATER DEPTH (M)	1.5	2.0	2.0	1.5
SAMPLE DEPTH (CM)	13	17	16	11
FRACTION COUNTED	1.00	1.00	1.00	1.00
ER CHECK	X	C	C	O
TAXON				
NEMERTEA				
NEMERTEA SPP.				28
NEMATODA				
NEMATODA SPP.				94
POLYCHAETA				
NEANTHES LIMNICOLA		9		748
OLIGOCHAETA				
OLIGOCHAETA SPP.	215			570
BIVALVIA				
CORBICULA MANILENSIS	9		9	
CORBICULA MANILENSIS JUVENILE		47	19	
BIVALVIA JUV		47		
AMPHIPODA				
ANISOGAMMARUS CONFERVICOLUS				9
COROPHIUM SALMONIS		28		935
COROPHIUM SPP.	131		37	4907
EOHAUSTORIUS ESTUARIUS				1000
INSECTA				
CHIRONOMIDAE SPP.		168	37	
TOTAL	355	299	102	8291