

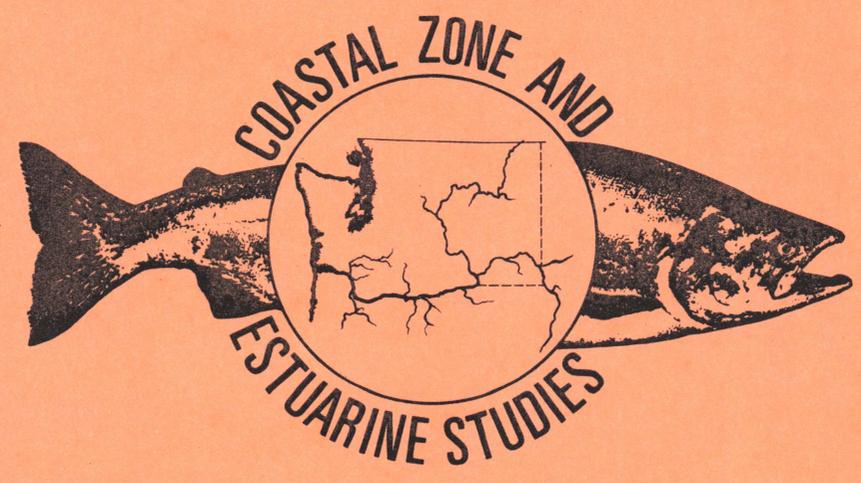
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**A Preliminary Survey
of Benthic Invertebrates
in the Vicinity of the Coos Bay,
Oregon, Navigation Channel**

by
David R. Miller,
Robert L. Emmett, and
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Final Report of Research

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INTRODUCTION

Potential biological impacts of deepening the Coos Bay, Oregon navigation channel from River Mile (RM) 0 to 15 were discussed at an interagency meeting in March 1989. Participants included the U.S. Army Corps of Engineers (COE) (Division of Ecological Services, Portland District), the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service (NMFS) (Environmental and Technical Services Division of the Northwest Region and Coastal Zone and Estuarine Studies [CZES] Division of the Northwest Fisheries Science Center). One result of this meeting was a general agreement that a preliminary biological survey was required to determine the need for a comprehensive biological assessment of the area impacted by the deepening of the navigation channel. Subsequently, a cooperative agreement was reached between the COE and CZES Division to collect sediment samples at selected intervals over the length of the project and to determine the distribution and abundance of benthic invertebrates. This report summarizes the results of this preliminary investigation.

METHODS

Benthic Invertebrates

Benthic invertebrates were collected at 20 stations in and adjacent to the navigation channel from about RM 2 to 15 (Fig. 1) on 22-23 May 1989. A 0.1-m² Gray-O'Hara box corer (Pequegnat et al. 1981) was used to collect one sample at each station. Each sample was sieved through a 0.5-mm mesh screen, and the residue containing the macroinvertebrates was preserved with a buffered 5% formaldehyde solution containing rose bengal (a protein stain). Benthic organisms were sorted from the preserved samples, identified to the lowest possible taxonomic level (usually species), and counted. All specimens were placed in vials containing 70% ethyl alcohol and stored at the NMFS Point Adams Biological Field Station, Hammond, Oregon.

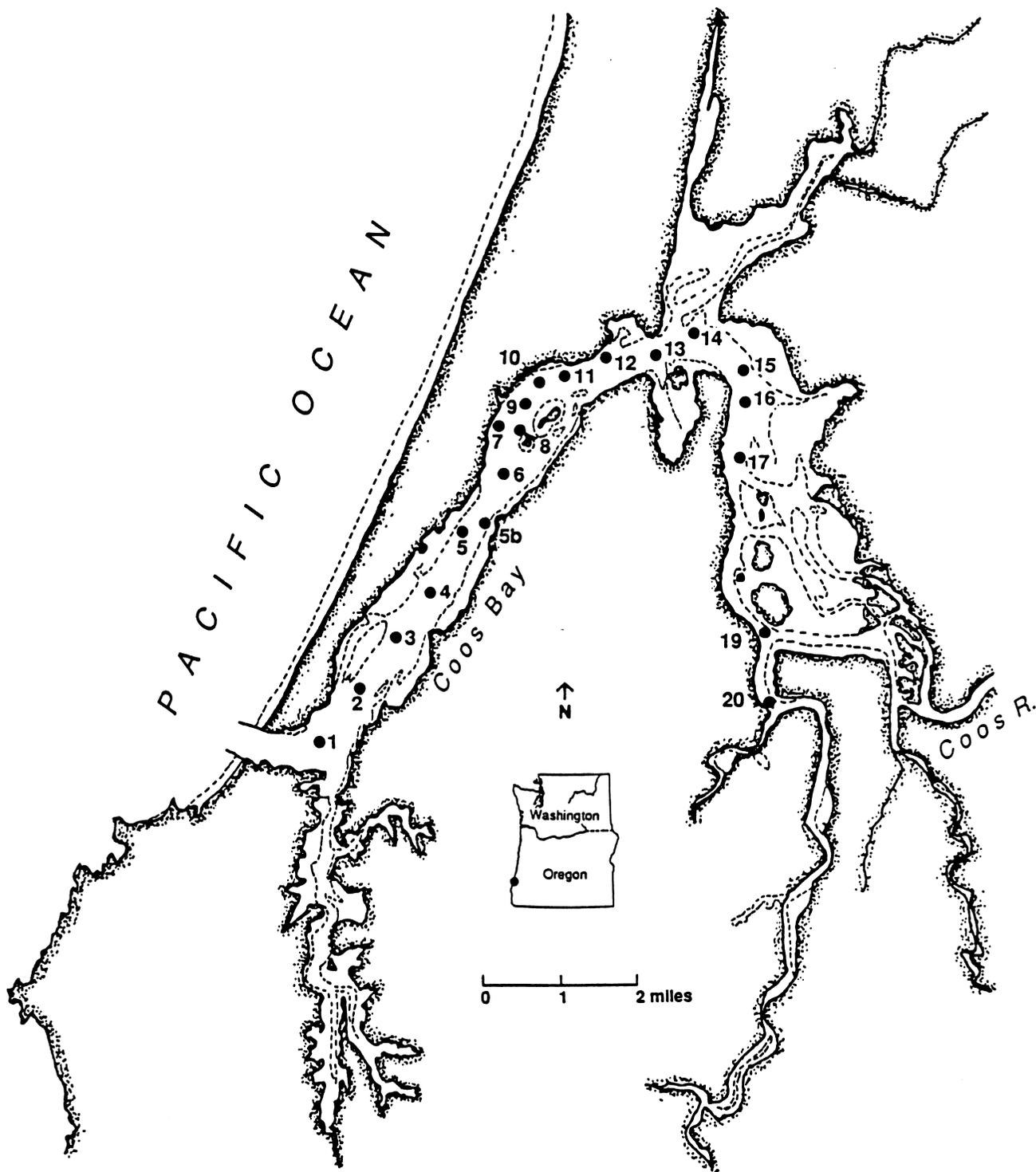


Figure 1.--Benthic invertebrate sampling stations along the Coos Bay, Oregon navigation channel, 22-23 May 1989.

Data Analysis

Four community structure indices were calculated for each station.

1) Shannon-Weaver Diversity Index (H') (Shannon and Weaver 1963):

$$H' = - \sum_{i=1}^s P_i \log_2 P_i$$

where $P_i = X_a/n$ (X_a is the number of individuals of a particular species in the sample, n is the total number of individuals in the sample), and s = number of species.

2) Simpson Diversity Value (SDV) (Simpson 1949):

$$SDV = 1 - \sum_{i=1}^s P_i^2$$

where $P_i = X_a/n$ (X_a is the number individuals of a particular species in the sample, n is the total number of individuals in the sample), and s = number species. Diversity values are sensitive to two components, the number of species in a sample (species richness) and the distribution of individuals among species (evenness) (Lloyd and Ghelardi 1964).

3) Species Richness (SR) was estimated using Margalef's formula (Margalef 1958):

$$SR = (s - 1) / \ln(n)$$

where s = number of species and n = total number of individuals in the sample.

4) Species Evenness (J') was calculated using Pielou's formula (Pielou 1966):

$$J' = H' / \log_2 s$$

where H' = Shannon-Weaver Diversity Index, and s = number of species.

Cluster analysis, using the Bray-Curtis dissimilarity index with a group-averaging fusion strategy (Clifford and Stephenson 1975), was used to identify station groupings

that had similar species and densities. A 0.5 dissimilarity value was considered a significant difference between groups. The number of each species/m² per station was used in this analysis. Species with densities <10/m² were excluded to reduce the effect of rare species.

RESULTS

A total of 121 invertebrate taxa with a mean density of 2,617/m² were identified from the Coos Bay navigation channel. Highest invertebrate densities were found in the lower estuary (RM 2 to 5) at Stations 1, 4, 5, and 5b. These four stations had a mean invertebrate density of 10,441/m² with an individual high density of 13,546/m² at Station 4. In contrast, the remaining 16 stations had a mean density of 661/m², with an individual high density of 1,521/m² at Station 12 (Table 1).

Community structure indices (H', SDV, SR, and J') are shown in Table 1. These values generally reflect the relatively low number of taxa at most stations (range 6 to 22); the exceptions were stations 5 and 5b with 50 and 53 species and SR values of 7.83 and 7.47, respectively. Dominant species were the polychaetes Polygordius sp. and Mediomastus californiensis at the four high density stations, and the polychaetes Heteropodarke heteromorpha and Glycera tenuis and the cumacean Eudorellopsis sp. at the lower density stations. Corophium sp. (an amphipod which is an important component of the diet of salmonids and several other species of marine and estuarine fishes), several species of clams, Dungeness and red rock crabs, oysters, bay mussels, ghost shrimp, kelp worms, or mud shrimp (all species of potential commercial, recreational, or ecological importance in the Coos Bay estuary [Roye 1979]) were either not found at the stations sampled or were found to be extremely restricted in distribution.

Cluster analysis indicated that the stations could be divided into five groups based on similarity of species and their densities. The groups were composed of 1) Stations 2,

Table 1.--Benthic invertebrates at 20 sampling stations in and adjacent to the Coos Bay, Oregon, navigation channel, 22-23 May 1989.

Station	Number of taxa	Density of invertebrates (number/m ²)	H ^a	SDV ^b	SR ^c	J ^d
1	16	11,764	2.11	0.61	2.13	0.53
2	12	657	2.46	0.73	2.65	0.69
3	10	479	2.45	0.75	2.35	0.74
4	22	13,546	2.02	0.64	2.93	0.45
5	50	5,450	4.54	0.93	7.83	0.80
5b	53	11,004	3.57	0.80	7.47	0.62
6	12	375	2.56	0.74	3.07	0.72
7	7	427	1.77	0.62	1.62	0.63
8	7	1,105	1.59	0.55	1.29	0.57
9	11	667	2.27	0.70	2.40	0.65
10	6	500	1.57	0.59	1.29	0.61
11	16	552	3.03	0.78	3.78	0.76
12	14	1,521	2.06	0.57	2.61	0.54
13	8	469	2.18	0.70	1.84	0.73
14	17	563	3.71	0.90	4.01	0.91
15	20	1,000	3.04	0.77	4.16	0.70
16	17	563	3.45	0.88	4.01	0.84
17	15	490	3.16	0.84	3.64	0.81
19	10	386	2.79	0.82	2.49	0.84
20	11	823	2.25	0.66	2.29	0.65
Means	17	2,617				

^a Shannon-Weaver Diversity Index

^b Simpson Diversity Value

^c Species Richness

^d Species Evenness

3, 6, 7, 8, 9, 10, 11, and 13 (mean density 581/m², 10 taxa); 2) Stations 1, 4, and 12 (mean density 8,944/m², 17 taxa); 3) Stations 14, 15, and 16 (mean density 709/m², 18 taxa); 4) Stations 5 and 5b (mean density 8,227/m², 52 taxa); and 5) Stations 17, 19, and 20 (mean density 566/m², 12 taxa).

DISCUSSION

The Coos Bay estuary is characterized by complex physical, chemical, and biological interactions. These interactions are strongly influenced by the Bay's unique estuarine physiography which includes numerous sloughs, broad tide flats, extensive seagrass (eelgrass and ditchgrass) meadows, and intricate twisting and turning side channels. Large-scale seasonal changes in temperature, tidal circulation, estuarine flushing, freshwater inflow (ranging from 100 cubic feet per second [cfs] in the summer to 100,000 cfs in the winter from about 30 tributaries [COE 1975]) all influence freshwater and saltwater mixing (Arneson 1975) and contribute to this complexity. Major estuarine alterations (e.g., channel deepening, extensive filling and diking, accelerated erosion and sediment deposition, construction of jetties and breakwaters) have, over the years, already significantly impacted these interactions. Future modifications to the estuary should be carefully evaluated to ensure that Coos Bay will continue as a biologically productive, multiple-use estuary.

This preliminary survey of the Coos Bay navigation channel indicated the presence of a diverse and, in some areas, dense benthic infauna. However, based on this limited sampling, benthic invertebrate densities appear to be generally lower than those of the Umpqua River estuary where invertebrate densities ranged from <200 to >50,000/m² (Bottom et al. 1985, Miller et al. 1989) and the Columbia River estuary where densities ranged from <1,000 to >60,000/m² (Durkin and Emmett 1980). Nonetheless, a channel deepening project of this magnitude has the potential to markedly alter ecological relationships by changing the complex pattern of freshwater inflow, tidal circulation,

estuarine flushing, and freshwater and saltwater mixing. More direct biological impacts are also likely as side-channel sloughing increases the channel width. At a minimum, additional survey work will be required to evaluate benthic species composition and density at stations adjacent to the existing channel and to obtain critical data on natural seasonal variation in infaunal community structure. Based on this need, it is recommended that a more comprehensive areal survey over a minimum of four seasons be conducted before dredging and that follow-up surveys be conducted after dredging. It is only through this type of comprehensive assessment that the impacts of channel deepening on the aquatic resources can be determined.

This report does not constitute NMFS's formal comment under the Fish and Wildlife Coordination Act or the National Environmental Policy Act.

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APPENDIX

Appendix Table 1.--Benthic invertebrates at 20 sampling stations in and adjacent to the navigation channel in Coos Bay, Oregon, 22-23 May 1989.

Station 1

Taxa	Total number	Mean number /m ²
Nemertinea	35	364.7
<u>Paraonella platybranchia</u>	1	10.4
<u>Polydora socialis</u>	1	10.4
Euclymeninae sp. juvenile	1	10.4
<u>Ophelia</u> sp. 1 juvenile	17	177.1
<u>Hesionura coineaui difficilis</u>	84	875.3
<u>Pisione</u> sp. indeterminate	8	83.4
<u>Heteropodarke heteromorpha</u>	110	1,146.2
<u>Glycera tenuis</u>	3	406.4
<u>Polygordius</u> sp. indeterminate	682	7,106.4
<u>Saccocirrus exoticus</u>	106	1,104.5
Mytilidae sp. juvenile	9	93.8
<u>Tellina nukuloides</u>	26	270.9
<u>Eogammarus confervicolus</u>	1	10.4
<u>Eohaustorius sawyeri</u>	1	10.4
<u>Dendraster excentricus</u>	8	83.4

Number of taxa = 16

Number of invertebrates/sample: 1,129.0

Number of invertebrates/m²: 11,764.2

H' = 2.11 SDV = 0.61 SR = 2.13 J' = 0.53

Appendix Table 1.--Continued.

Station 2

Taxa	Total number	Mean number /m ²
<u>Nemertinea</u>	1	10.4
<u>Ophelia sp. 1</u>	3	31.3
<u>Heteropodarke heteromorpha</u>	21	218.8
<u>Glycera tenuis</u>	24	250.1
<u>Polygordius sp. indeterminate</u>	1	10.4
<u>Mytilidae sp. juvenile</u>	2	20.8
<u>Tellina nuculoides</u>	4	41.7
<u>Archaeomysis grebnitzkii</u>	1	10.4
<u>Lamprops carinata</u>	1	10.4
<u>Eudorellopsis sp. indeterminate</u>	1	10.4
<u>Crangonidae - larvae</u>	1	10.4
<u>Dendraster excentricus</u>	3	31.3

Number of taxa = 12

Number of invertebrates/sample: 63.0

Number of invertebrates/m²: 656.5

H' = 2.46 SDV = 0.73 SR = 2.65 J' = 0.69

Appendix Table 1.--Continued.

Station 3

Taxa	Total number	Mean number /m ²
<u>Nemertinea</u>	1	10.4
<u>Paraonella platybranchia</u>	1	10.4
<u>Ophelia</u> sp. 1 juvenile	1	10.4
<u>Heteropodarke heteromorpha</u>	13	135.5
<u>Glycera tenuis</u>	18	187.6
<u>Tellina nukuloides</u>	5	52.1
<u>Archaeomysis grebnitzkii</u>	3	31.3
<u>Eohaustorius</u> sp. juvenile	1	10.4
Crangonidae - larvae	1	10.4
<u>Cancer magister</u> - megalopa	2	20.8

Number of taxa = 10

Number of invertebrates/sample: 46.0

Number of invertebrates/m²: 479.3

H' = 2.45 SDV = 0.75 SR = 2.35 J' = 0.74

Appendix Table 1.--Continued.

Station 4

Taxa	Total number	Mean number /m ²
Nemertinea	78	812.8
<u>Heteromastus filiformis</u>	1	10.4
<u>Mediomastus californiensis</u>	5	52.1
<u>Ophelia</u> sp. 1	9	93.8
<u>Hesionura coineaui difficilis</u>	290	3,021.8
<u>Heteropodarke heteromorpha</u>	130	1,354.6
<u>Syllidae</u> sp. (epitoke)	1	10.4
<u>Exogone</u> sp. (epitoke)	1	10.4
<u>Glycera tenuis</u>	20	208.4
<u>Microphthalmus</u> sp. 1	1	10.4
<u>Polygordius</u> sp. indeterminate	711	7,408.6
<u>Oligochaeta</u>	2	20.8
<u>Ocenebra</u> sp. indeterminate	1	10.4
<u>Epitonium indianorum</u>	2	20.8
<u>Bivalvia</u> sp. indeterminate	2	20.8
<u>Mytilidae</u> sp. juvenile	32	333.4
<u>Macoma</u> sp. indeterminate	2	20.8
<u>Tellina nuculoides</u>	5	52.1
<u>Archaeomysis grebnitzkii</u>	1	10.4
<u>Lamprops</u> nr. <u>quadriplicata</u>	2	20.8
<u>Cumella vulgaris</u>	1	10.4
<u>Dendraster excentricus</u>	3	31.3

Number of taxa = 22

Number of invertebrates/sample: 1,300.0

Number of invertebrates/m²: 13,546.0

H' = 2.02 SDV = 0.64 SR = 2.93 J' = 0.45

Appendix Table 1.--Continued.

Station 5

Taxa	Total number	Mean number /m ²
Anthozoa	2	20.8
Nemertinea	20	208.4
<u>Protodorvillea gracilis</u>	4	41.7
<u>Scoloplos armiger</u>	1	10.4
<u>Spiophanes bombyx</u>	29	302.2
Cirratulidae sp. indeterminate	2	20.8
<u>Caulleriella hamata</u>	4	41.7
<u>Tharyx multifilis</u>	1	10.4
<u>Mediomastus californiensis</u>	98	1,021.2
<u>Praxillella</u> sp. indeterminate	1	10.4
<u>Ophelia</u> sp. 1	2	20.8
<u>Phyllodoce williamsi</u>	3	31.3
<u>Eumida sanguinea</u>	4	41.7
<u>Hesionura coineai difficilis</u>	3	31.3
<u>Lepidonotus squamatus</u>	4	41.7
<u>Paleanotus bellis</u>	17	177.1
<u>Heteropodarke heteromorpha</u>	28	291.8
<u>Micropodarke dubia</u>	16	166.7
Syllidae sp. indeterminate	1	10.4
<u>Autolytus</u> sp. indeterminate	7	72.9
<u>Pionosyllis uraga</u>	20	208.4
<u>Syllis heterochaeta</u>	1	10.4
<u>Sphaerosyllis brandhorsti</u>	8	83.3
<u>Glycera capitata</u>	1	10.4
<u>Glycera tenuis</u>	2	20.8
<u>Microphthalmus</u> sp. 1	1	10.4
<u>Owenia fusiformis</u>	2	20.8
<u>Polycirrus</u> sp. complex	9	93.9
<u>Chone dunneri</u>	24	250.1
<u>Polygordius</u> sp. indeterminate	16	166.7
<u>Saccocirrus exoticus</u>	1	10.4
Oligochaeta	4	41.7
Nudibranchia sp. indeterminate	4	41.7
<u>Ocenebra</u> sp. indeterminate	1	10.4
Mytilidae sp. juvenile	65	677.3
<u>Clinocardium</u> sp. juvenile	1	10.4
<u>Protothaca staminea</u>	11	114.6
<u>Macoma nasuta</u>	3	31.3
<u>Macoma</u> sp. indeterminate	14	145.9
<u>Tellina nuculoides</u>	3	31.3
Cirripedia	10	104.2
<u>Melita desdichada</u>	4	41.7
<u>Corophium brevis</u>	11	114.6

Appendix Table 1.--Continued.

Station 5

Taxa	Total number	Mean number /m ²
<u>Corophium</u> nr. <u>panamense</u>	2	20.8
<u>Photis</u> nr. <u>brevipes</u> Juv.	32	333.4
<u>Leptochelia</u> <u>dubia</u>	7	72.9
<u>Cancer</u> <u>magister</u>	3	31.3
<u>Dendraster</u> <u>excentricus</u>	11	114.6
Asteroidea	1	10.4
Pycnogonida	4	41.7

Number of taxa = 50

Number of invertebrates/sample: 523.0

Number of invertebrate/m²: 5,449.7

H' = 4.54 SDV = 0.93 SR = 7.83 J' = 0.80

Appendix Table 1.--Continued.

Station 5b

Taxa	Total number	Mean number /m ²
Porifera	1	10.4
Nemertinea	8	83.4
<u>Leitoscoloplos pugettensis</u>	7	72.9
<u>Scoloplos armiger</u>	4	41.7
<u>Polydora</u> sp. indeterminate	1	10.4
<u>Mediomastus californiensis</u>	439	4,574.4
<u>Eteone californica</u>	1	10.4
<u>Eumida sanguinea</u>	2	20.8
Polynoidae sp. indeterminate	1	10.4
<u>Harmothoe imbricata</u>	1	10.4
<u>Lepidonotus squamatus</u>	23	239.7
<u>Paleanotus bellis</u>	20	208.4
<u>Gyptis brevipalpa</u>	1	10.4
<u>Autolytus</u> sp. indeterminate	7	72.9
<u>Pionosyllis uraga</u>	8	83.4
<u>Syllis elongata</u>	1	10.4
<u>Syllis</u> sp. indeterminate	1	10.4
<u>Sphaerosyllis brandhorsti</u>	3	31.3
<u>Sphaerosyllis hystrix</u>	11	114.6
Nereidae sp. indeterminate	1	10.4
<u>Nereis</u> sp. juvenile	17	177.1
<u>Glycinde picta</u>	9	93.8
<u>Lumbrineris</u> sp. indeterminate	2	20.8
<u>Microphthalmus</u> sp. 1	5	52.1
<u>Sabellaria cementarium</u>	1	10.4
<u>Polycirrus</u> sp. complex	19	198.0
<u>Chone dunneri</u>	6	62.5
<u>Polygordius</u> sp. indeterminate	29	302.2
Oligochaeta	35	364.7
Nudibranchia	6	62.5
<u>Littorina</u> sp. indeterminate	11	114.6
Bivalvia sp. indeterminate	11	114.6
Mytilidae sp. juvenile	116	1,208.7
<u>Hiatella arctica</u>	1	10.4
Teredinidae sp. indeterminate	1	10.4
<u>Protothaca staminea</u>	18	187.6
<u>Macoma</u> sp. juvenile	57	593.9
<u>Oxyurostylis pacifica</u>	1	10.4
<u>Cumella vulgaris</u>	1	10.4
<u>Eudorellopsis</u> sp. indeterminate	1	10.4
<u>Eohaustorius</u> sp. juvenile	1	10.4
<u>Pontogeneia rostrata</u>	11	114.6
<u>Pontogeneia</u> sp. juvenile	1	10.4

Appendix Table 1.--Continued.

Station 5b

Taxa	Total number	Mean number /m ²
<u>Corophium brevis</u>	56	583.5
<u>Photis brevipes</u>	51	531.4
Caprellidae sp. indeterminate	2	20.8
<u>Leptochelia dubia</u>	31	323.0
<u>Heptacarpus pictus</u>	2	20.8
<u>Cancer magister</u> - megalopa	1	10.4
<u>Cancer magister</u>	5	52.1
Ophiuroidea	1	10.4
Asteroidea (<u>Pisaster</u> sp. juvenile)	1	10.4
Pycnogonida	5	52.1

Number of taxa = 53

Number of invertebrates/sample: 1,056.0

Number of invertebrates/m²: 11,003.5

H' = 3.57 SDV = 0.80 SR = 7.47 J' = 0.62

Appendix Table 1.--Continued.

Station 6

Taxa	Total number	Mean number /m ²
<u>Nemertinea</u>	1	10.4
<u>Spiophanes bombyx</u>	2	20.8
<u>Heteromastus filiformis</u>	1	10.4
<u>Heteropodarke heteromorpha</u>	15	156.3
<u>Glycera tenuis</u>	10	104.2
<u>Polygordius</u> sp. indeterminate	1	10.4
<u>Oligochaeta</u>	1	10.4
<u>Mytilidae</u> sp. juvenile	1	10.4
<u>Tellina nukuloides</u>	1	10.4
<u>Archaeomysis grebnitzkii</u>	1	10.4
<u>Hemilamprops</u> sp. indeterminate	1	10.4
<u>Dendraster excentricus</u>	1	10.4

Number of taxa = 12

Number of invertebrates/sample: 36.0

Number of invertebrates/m²: 375.1

H' = 2.56 SDV = 0.74 SR = 3.07 J' = 0.72

Appendix Table 1.--Continued.

Station 7

Taxa	Total number	Mean number /m ²
<u>Spiophanes bombyx</u>	1	10.4
<u>Heteropodarke heteromorpha</u>	15	156.3
<u>Glycera tenuis</u>	20	208.4
<u>Polygordius sp. indeterminate</u>	1	10.4
<u>Archaeomysis grebnitzkii</u>	2	20.8
<u>Lamprops quadriplicata</u>	1	10.4
<u>Eogammarus sp. juvenile</u>	1	10.4

Number of taxa = 7

Number of invertebrates/smples: 41.0

Number of invertebrates/m²: 427.2

H' = 1.77 SDV = 0.62 SR = 1.62 J' = 0.63

Appendix Table 1.--Continued.

Station 8

Taxa	Total number	Mean number /m ²
Nemertinea	1	10.4
<u>Paraonella platybranchia</u>	1	10.4
<u>Ophelia</u> sp. 1	10	104.2
<u>Heteropodarke heteromorpha</u>	66	687.7
<u>Glycera tenuis</u>	23	239.7
<u>Macoma</u> sp. indeterminate	1	10.4
<u>Lamprops carinata</u>	4	41.7

Number of taxa = 7

Number of invertebrates/sample: 106.0

Number of invertebrates/m²: 1,104.5

H' = 1.59 SDV = 0.55 SR = 1.29 J' = 0.57

Appendix Table 1.--Continued.

Station 9

Taxa	Total number	Mean number /m ²
<u>Nemertinea</u>	1	10.4
<u>Ophelia</u> sp. 1	1	10.4
<u>Heteropodarke heteromorpha</u>	26	270.9
<u>Glycera tenuis</u>	23	239.7
<u>Nephtys</u> sp. juvenile	2	20.8
<u>Oligochaeta</u>	2	20.8
<u>Macoma</u> sp. indeterminate	2	20.8
<u>Tellina carpenteri</u>	1	10.4
<u>Lamprops quadriplicata</u>	3	31.3
<u>Photis</u> nr. <u>brevipes</u> juvenile	1	10.4
<u>Dendraster excentricus</u>	2	20.8

Number of taxa = 11

Number of invertebrates/sample: 64.0

Number of invertebrates/m²: 666.9

H' = 2.27 SDV = 0.70 SR = 2.40 J' = 0.65

Appendix Table 1.--Continued.

Station 10

Taxa	Total number	Mean number /m ²
Nemertinea	1	10.4
<u>Spiophanes bombyx</u>	2	20.8
<u>Heteropodarke heteromorpha</u>	24	250.1
<u>Glycera tenuis</u>	19	198.0
Oligochaeta	1	10.4
<u>Cancer magister</u> - megalopa	1	10.4

Number of taxa = 6

Number of invertebrates/sample: 48.0

Number of invertebrates/m²: 500.2

H' = 1.57 SDV = 0.59 SR = 1.29 J' = 0.61

Appendix Table 1.--Continued.

Station 11

Taxa	Total number	Mean number /m ²
Nemertinea	1	10.4
<u>Spiophanes bombyx</u>	3	31.3
<u>Magelona longicornis</u>	2	20.8
<u>Heteromastus filiformis</u>	2	20.8
<u>Ophelia</u> sp. 1	7	72.9
<u>Eteone</u> sp. juvenile	1	10.4
<u>Heteropodarke heteromorpha</u>	2	20.8
<u>Glycera tenuis</u>	23	239.7
<u>Oligochaeta</u>	2	20.8
<u>Macoma</u> sp. indeterminate	1	10.4
<u>Tellina nuculoides</u>	3	31.3
<u>Archaeomysis grebnitzkii</u>	2	20.8
<u>Hemilamprops</u> sp. indeterminate	1	10.4
<u>Cancer magister</u>	1	10.4
<u>Dendraster excentricus</u>	1	0.4
<u>Ammodytes hexapterus</u>	1	10.4

Number of taxa = 16

Number of invertebrates/sample: 53.0

Number of invertebrates/m²: 552.3

H' = 3.03 SDV = 0.78 SR = 3.78 J' = 0.76

Appendix Table 1.--Continued.

Station 12

Taxa	Total number	Mean number /m ²
Nemertinea	12	125.0
Nematoda	2	20.8
<u>Spiophanes bombyx</u>	2	20.8
<u>Heteromastus filiformis</u>	2	20.8
<u>Mediomastus californiensis</u>	3	31.3
<u>Ophelia</u> sp. 1	1	10.4
<u>Heteropodarke heteromorpha</u>	93	969.1
Syllidae sp. indeterminate	1	10.4
<u>Sphaerosyllis brandhorsti</u>	1	10.4
<u>Glycera tenuis</u>	13	135.5
<u>Microphthalmus</u> sp. 1	2	20.8
Mytilidae sp. juvenile	2	20.8
<u>Macoma</u> sp. indeterminate	2	20.8
<u>Lamprops</u> nr. <u>quadriplicata</u>	10	104.2

Number of taxa = 14

Number of invertebrates/sample: 146.0

Number of invertebrates/m²: 1,521.3

H' = 2.06 SDV = 0.57 SR = 2.61 J' = 0.54

Appendix Table 1.--Continued.

Station 13

Taxa	Total number	Mean number /m ²
<u>Nemertinea</u>	5	52.1
<u>Naineris uncinata</u>	1	10.4
<u>Magelona sacculata</u>	1	10.4
<u>Caulleriella hamata</u>	1	10.4
<u>Ophelia sp. 1</u>	7	72.9
<u>Heteropodarke heteromorpha</u>	22	229.2
<u>Grandifoxus grandis</u>	1	10.4
<u>Dendroaster excentricus</u>	7	72.9

Number of taxa = 8

Number of invertebrates/sample: 45.0

Number of invertebrates/m²: 468.9

H' = 2.18 SDV = 0.70 SR = 1.84 J' = 0.73

Appendix Table 1.--Continued.

Station 14

Taxa	Total number	Mean number /m ²
Nemertinea	5	52.1
<u>Leitoscoloplos pugettensis</u>	1	10.4
<u>Spiophanes bombyx</u>	4	41.7
<u>Mediomastus californiensis</u>	5	52.1
<u>Heteropodarke heteromorpha</u>	11	114.6
<u>Autolytus sp. indeterminate</u>	2	20.8
<u>Glycera tenuis</u>	2	20.8
<u>Nephtys caecoides</u>	1	10.4
<u>Owenia fusiformis</u>	2	20.8
<u>Macoma sp. juvenile</u>	1	10.4
Cirripedia	3	31.3
<u>Oxyurostylis pacifica</u>	1	10.4
<u>Lamprops nr. quadriplicata</u>	1	10.4
<u>Eogammarus confervicolus</u>	6	62.5
<u>Aoroides sp. indeterminate</u>	3	31.3
Caprellidae sp. indeterminate	2	20.8
<u>Cancer magister</u>	4	41.7

Number of taxa = 17

Number of invertebrates/sample: 54.0

Number of invertebrates/m²: 562.7

H' = 3.71 SDV = 0.90 SR = 4.01 J' = 0.91

Appendix Table 1.--Continued.

Station 15

Taxa	Total number	Mean number /m ²
<u>Anthozoa polyps</u>	41	427.2
<u>Nemertinea</u>	3	31.3
<u>Leitoscoloplos pugettensis</u>	1	10.4
<u>Scoloplos armiger</u>	3	31.3
<u>Spiophanes bombyx</u>	1	10.4
<u>Mediomastus californiensis</u>	17	177.1
<u>Ophelia sp. 1</u>	1	10.4
<u>Heteropodarke heteromorpha</u>	2	20.8
<u>Autolytus sp. indeterminate</u>	1	10.4
<u>Glycera tenuis</u>	4	41.7
<u>Glycinde picta</u>	2	20.8
<u>Nephtys caecoides</u>	1	10.4
<u>Oligochaeta</u>	5	52.1
<u>Clinocardium sp. juvenile</u>	1	10.4
<u>Macoma sp. indeterminate</u>	5	52.1
<u>Lamprops nr. quadriplicata</u>	1	10.4
<u>Gammaridae</u>	1	10.4
<u>Eogammarus confervicolus</u>	2	20.8
<u>Photis macinerneyi</u>	1	10.4
<u>Dendraster excentricus</u>	3	31.3

Number of taxa = 20

Number of invertebrates/sample: 96.0

Number of invertebrates/m²: 1,000.3

H' = 3.04 SDV = 0.77 SR = 4.16 J' = 0.70

Appendix Table 1.--Continued.

Station 16

Taxa	Total number	Mean number /m ²
Nemertinea	1	10.4
<u>Naineris uncinata</u>	10	104.2
<u>Scoloplos armiger</u>	1	10.4
<u>Paraonella platybranchia</u>	1	10.4
<u>Spio butleri</u>	2	20.8
<u>Spiophanes bombyx</u>	1	10.4
<u>Mediomastus californiensis</u>	5	52.1
<u>Ophelia</u> sp. 1 juvenile	1	10.4
<u>Heteropodarke heteromorpha</u>	12	125.0
<u>Glycera tenuis</u>	2	20.8
<u>Glycinde armigera</u>	1	10.4
<u>Glycinde picta</u>	3	31.3
<u>Nephtys</u> sp. juvenile	1	10.4
<u>Oligochaeta</u>	4	41.7
<u>Macoma</u> sp. indeterminate	7	72.9
<u>Lamprops quadriplicata</u>	1	10.4
<u>Dendraster excentricus</u>	1	10.4

Number of taxa = 17

Number of invertebrates/sample: 54.0

Number of invertebrates/m²: 562.7

H' = 3.45 SDV = 0.88 SR = 4.01 J' = 0.84

Appendix Table 1.--Continued.

Station 17

Taxa	Total number	Mean number /m ²
<u>Paraprionospio pinnata</u>	2	20.8
<u>Magelona sacculata</u>	1	10.4
<u>Barantolla americana</u>	1	10.4
<u>Glycinde picta</u>	2	20.8
<u>Polygordius sp indeterminate</u>	1	10.4
<u>Saccocirrus exoticus</u>	2	20.8
<u>Oligochaeta</u>	12	125.0
<u>Bivalvia sp. indeterminate</u>	1	10.4
<u>Macoma nasuta</u>	1	10.4
<u>Macoma sp. indeterminate</u>	9	93.8
<u>Archaeomysis grebnitzkii</u>	1	10.4
<u>Lamprops nr. quadriplicata</u>	10	104.2
<u>Eogammarus confervicolus</u>	1	10.4
<u>Aoroides sp. indeterminate</u>	2	20.8
<u>Grandifoxus grandis</u>	1	10.4

Number of taxa = 15

Number of invertebrates/sample: 47.0

Number of invertebrates/m²: 489.7

H' = 3.16 SDV = 0.84 SR = 3.64 J' = 0.81

Appendix Table 1.--Continued.

Station 19

Taxa	Total number	Mean number /m ²
<u>Paraprionospio pinnata</u>	3	31.3
<u>Glycinde picta</u>	2	20.8
<u>Oligochaeta</u>	5	52.1
<u>Macoma nasuta</u>	1	10.4
<u>Macoma sp. indeterminate</u>	3	31.3
<u>Oxyurostylis pacifica</u>	1	10.4
<u>Lamprops nr. quadriplicata</u>	10	104.2
<u>Eudorellopsis sp. indeterminate</u>	1	10.4
<u>Gammaridae</u>	1	10.4
<u>Eogammarus confervicolus</u>	10	104.2

Number of taxa = 10

Number of invertebrates/sample: 37.0

Number of invertebrates/m²: 385.5

H' = 2.79 SDV = 0.82 SR = 2.49 J' = 0.84

Appendix Table 1.--Continued.

Station 20

Taxa	Total number	Mean number /m ²
<u>Pygospio elegans</u>	1	10.4
<u>Paraprionospio pinnata</u>	4	41.7
<u>Barantolla americana</u>	1	10.4
<u>Heteropodarke heteromorpha</u>	1	10.4
<u>Glycinde picta</u>	1	10.4
Oligochaeta	13	135.5
Bivalvia sp. indeterminate	3	31.3
<u>Macoma nasuta</u>	3	31.3
<u>Macoma</u> sp. indeterminate	7	72.9
<u>Eudorellopsis</u> sp. indeterminate	43	448.1
<u>Corophium</u> sp. juvenile	2	20.8

Number of taxa = 11

Number of invertebrates/sample: 79.0

Number of invertebrates/m²: 823.2

H' = 2.25 SDV = 0.66 SR = 2.29 J' = 0.65

