Fishes, Benthic Invertebrates, and Sediment Characteristics in Intertidal and Subtidal Habitats at Five Areas in the Columbia River Estuary

by
Susan A. Hinton, George T. McCabe, Jr.,
and Robert L. Emmett

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George T. McCabe, Jr.
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INTRODUCTION

Each year, the U.S. Army Corps of Engineers (COE) dredges and disposes of more than 2 million yd^3 (1.5 million m^3) of sediment from the navigation channel between River Miles (RMs) 4.4 and 28.8 in the Columbia River estuary. The existing upland dredged-material disposal sites are almost filled to capacity, and options for the disposal of this volume of sediment are presently extremely limited. Accordingly, in 1988 the COE initiated a study to develop a Long-Term Management Strategy (LTMS) for dredging and disposal operations in the Columbia River estuary (U.S. Army Corps of Engineers 1989). The goal of the LTMS is to ensure that future dredging and disposal activities will be economical, minimize adverse environmental impacts, and take advantage of opportunities for beneficial uses of dredged material.

One of the major concerns associated with new dredged-material disposal sites, especially when creating islands, is the effect on aquatic biological communities. To address this concern, the National Marine Fisheries Service (NMFS) and the COE initiated a cooperative study to assess aquatic resources in intertidal and subtidal habitats at or adjacent to five present or potential disposal areas in the Columbia River estuary--Desdemona Sands, Taylor Sands, Rice Island, Miller Sands, and Jim Crow Sands. Specific objectives of the study were 1) to describe the bottom sediment characteristics and the benthic invertebrate and fish communities at each of the five areas and 2) at Miller Sands (where in 1975-1976 dredged material was used to create a marsh and lagoon), to compare the bottom sediment characteristics and benthic invertebrate and fish communities present in 1989 to what existed in

1975-1977 (McConnell et al. 1978). The scope of this study, as originally planned, also included collection of zooplankton samples at Miller Sands for comparisons to samples collected in 1975-1977 (McConnell et al. 1978). However, substantial physical changes at the zooplankton stations previously occupied precluded the collection of comparable samples. Accordingly, it was mutually agreed that this objective be dropped (Geoffrey Dorsey, U.S. Army Corps of Engineers, Portland District, personal communication).

METHODS

Study Areas

Benthic samples and fishes were collected at five study areas in the Columbia River estuary--Desdemona Sands, Taylor Sands, Rice Island, Miller Sands, and Jim Crow Sands--during September-October 1988 (Survey 1), May 1989 (Survey 2), July 1989 (Survey 3), and September 1989 (Survey 4). In the remainder of the report, the September-October 1988 survey will be referred to as the September 1988 survey.

Desdemona Sands

Located in the lower Columbia River estuary, Desdemona Sands consists of large natural intertidal areas that extend from RM 8.7 to 13.8 (Fig. 1). The intertidal areas are bordered by extensive shallow subtidal areas, many of which are less than 5 m deep (Mean Lower Low Water [MLLW]). These intertidal and shallow subtidal areas are located in the mixing zone of the estuary, with salinities ranging widely depending upon tide stage and river flow. In the subtidal areas during low river flows, minimum salinity is <0.5 ppt and maximum salinity is 25->30 ppt (Fox et al. 1984). Minimum and

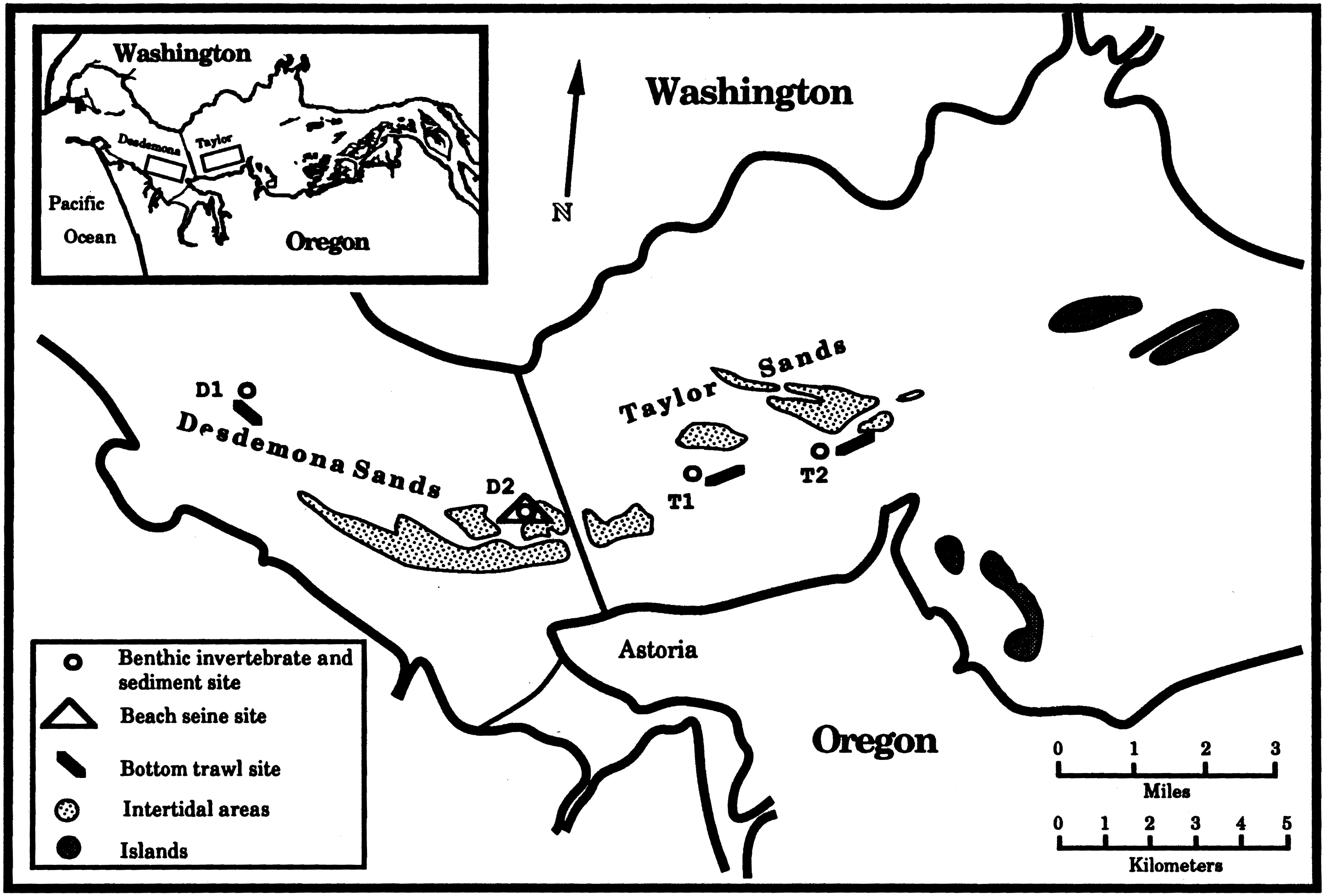

Figure 1.--Sampling locations for fishes, benthic invertebrates, and sediments at Desdemona Sands and Taylor Sands, Columbia River estuary, 1988-1989.

maximum salinities in the subtidal areas during high river flows are <0.5 ppt and 5-25 ppt, respectively. Sampling for the present study was done at one subtidal and one intertidal station (Fig. 1).

Taylor Sands

Similar to Desdemona Sands, Taylor Sands consists of large natural intertidal areas that are surrounded by shallow subtidal areas, many of which are less than 5 m deep (MLLW). Taylor Sands is located upstream from Desdemona Sands and extends from RM 15.5 to 18.7. Both the intertidal and surrounding subtidal areas are located in the mixing zone of the estuary. Tide stage and river flow affect salinities in the Taylor Sands area. In subtidal areas during low river flows, minimum and maximum salinities are <0.5 ppt and 10-25 ppt, respectively (Fox et al. 1984). During high river flows, both minimum and maximum salinities are <0.5 ppt. Benthic sampling and bottom trawling were conducted at two shallow subtidal sites (Fig. 1). Although benthic samples were collected in all four surveys at Taylor Sands, fish samples were only collected during the three surveys in 1989.

Rice Island

Rice Island, which is located between RMs 21.0 and 22.6, is a 250-acre man-made island that has been used for dredged-material disposal for at least the last 25 years (U.S. Army Corps of Engineers 1989). The intertidal and shallow subtidal areas adjacent to the island are freshwater environments throughout the year (Fox et al. 1984). In the present study, benthic samples were collected at six intertidal sites, and beach seining was conducted at three intertidal sites (Fig. 2).

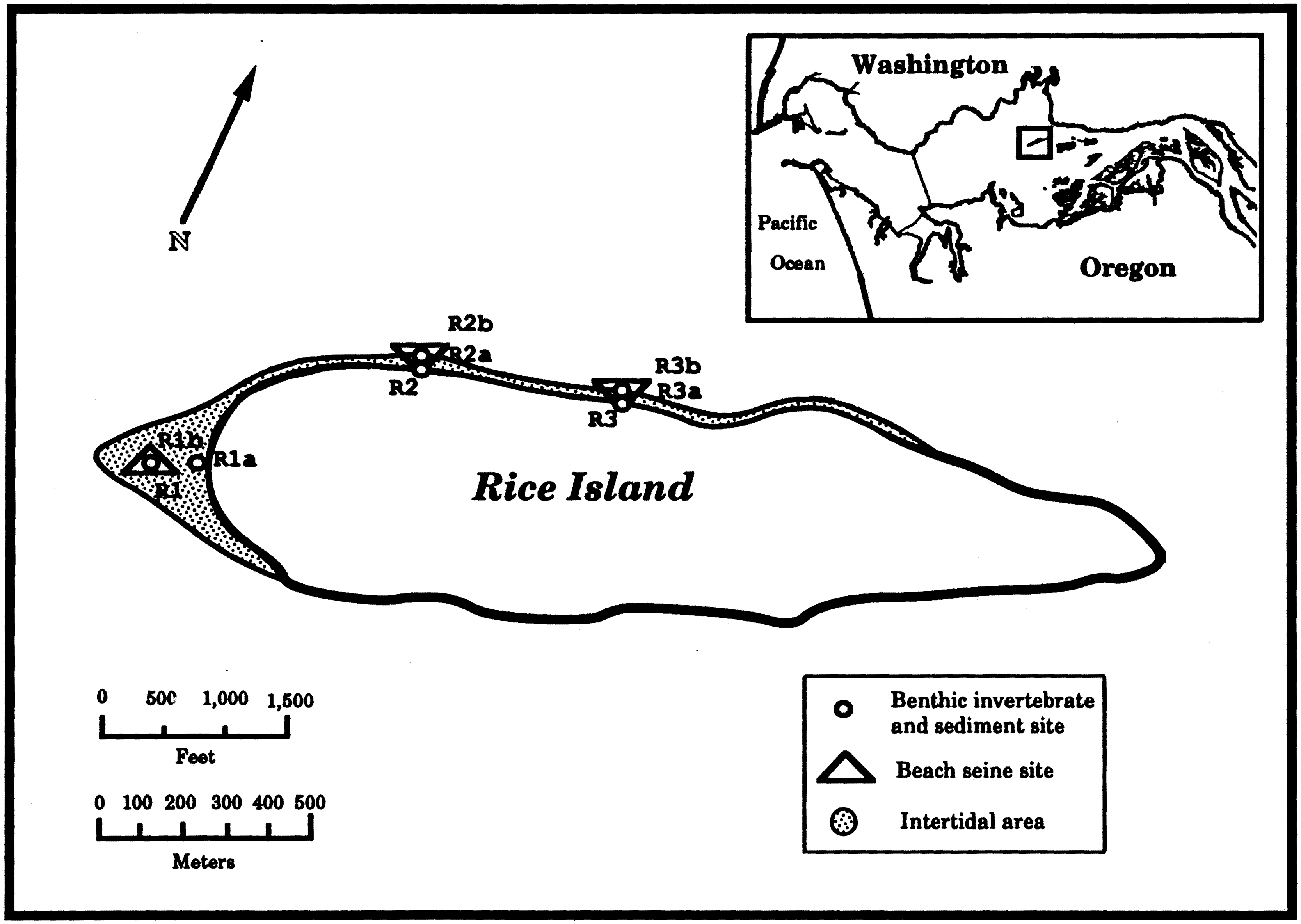

Figure 2.--Sampling locations for fishes, benthic invertebrates, and sediments at Rice Island, Columbia River estuary, 1988-1989.

Miller Sands

Located between RMs 21.4 and 25.2, Miller Sands is a 320-acre island and spit complex that was constructed with sediments dredged from the navigation channel. Island construction was initiated and completed in the 1930s. In 1975-1976, the COE created a marsh and lagoon at Miller Sands by constructing a 3-mile long spit adjacent to the channel using dredged material. The spit currently receives 400,000 yd^3 (305,800 m^3) of dredged-material annually. During the 1975-1977 period, the NMFS conducted biological studies in the marsh and lagoon areas to determine the effects of the habitat alterations. The intertidal and shallow subtidal areas along Miller Sands are freshwater environments, except during periods of low river flow (Fox et al. 1984). In shallow subtidal areas during low river flows, which typically occur in the late summer and early fall, salinities range from <0.5 to 5 ppt at maximum salinity intrusion. During low flows and minimum salinity intrusion, salinities are <0.5 ppt. In the present study, benthic samples were collected at ten intertidal sites and one shallow subtidal site, and beach seining was conducted at eight intertidal sites (Fig. 3). Bottom trawling was conducted at one shallow subtidal site.

Jim Crow Sands

Jim Crow Sands is a 50-acre man-made island (U.S. Army Corps of Engineers 1989) created with sediments dredged from the nearby navigation channel. Jim Crow Sands is located between RMs 26.7 and 27.8 in the upper estuary and was last used as a disposal site in 1988. The intertidal and shallow subtidal areas adjacent to the island are freshwater environments (Fox et al. 1984). In the present study, benthic samples were collected at eight intertidal

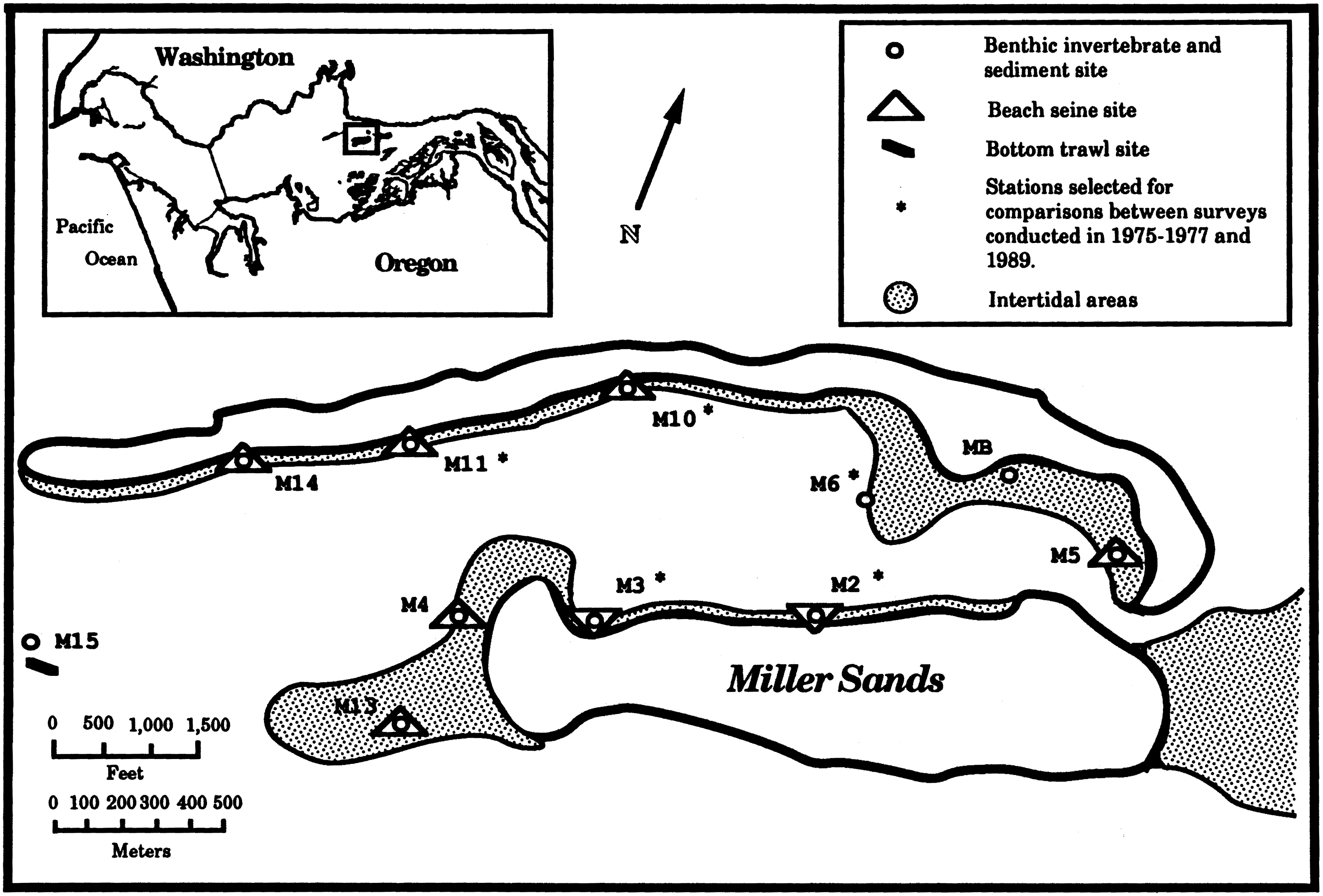

Figure 3.--Sampling locations for fishes, benthic invertebrates, and sediments at Miller Sands, Columbia River estuary, 1988-1989.

sites, and beach seining was conducted at three intertidal sites (Fig. 4).

1988-1989 Surveys

Sampling

Fishes--At Desdemona Sands, Taylor Sands, and Miller Sands, an 8-m semiballoon shrimp trawl was used to collect demersal fishes. Trawl mesh size was 38.1 mm, with a knotless 9.5-mm mesh liner inserted in the cod end of the net (all mesh sizes are stretched measures). Trawling was done for 5 minutes in an upstream direction during a flood tide. Distance trawled was determined using a radar range-finder. Beach seining was done at all areas except Taylor Sands, where no suitable beach was available. A 50-m variable mesh (19.0, 12.7, and 9.5 mm) beach seine was used. Knotless web was used in the beach seine bunt to reduce descaling of fish. Beach seining was done on a variety of tides. Typically, one end of the seine was anchored in the dry sand, and the net was extended in a downstream direction along the waterline. Then, using a 5-m boat, the free end of the net was pulled off the beach in a wide arc and completed a semicircle upon returning to the beach at the upstream end.

At the collection sites, fishes were identified, counted, and a subsample was measured (total length in mm) and weighed (nearest g). Juvenile salmonids were usually anesthetized using a benzocaine (ethyl-p-aminobenzoate) solution prior to being measured and weighed.

Benthic Invertebrates and Sediments--Twelve core samples were taken at each station with a polyvinyl chloride (PVC) coring device

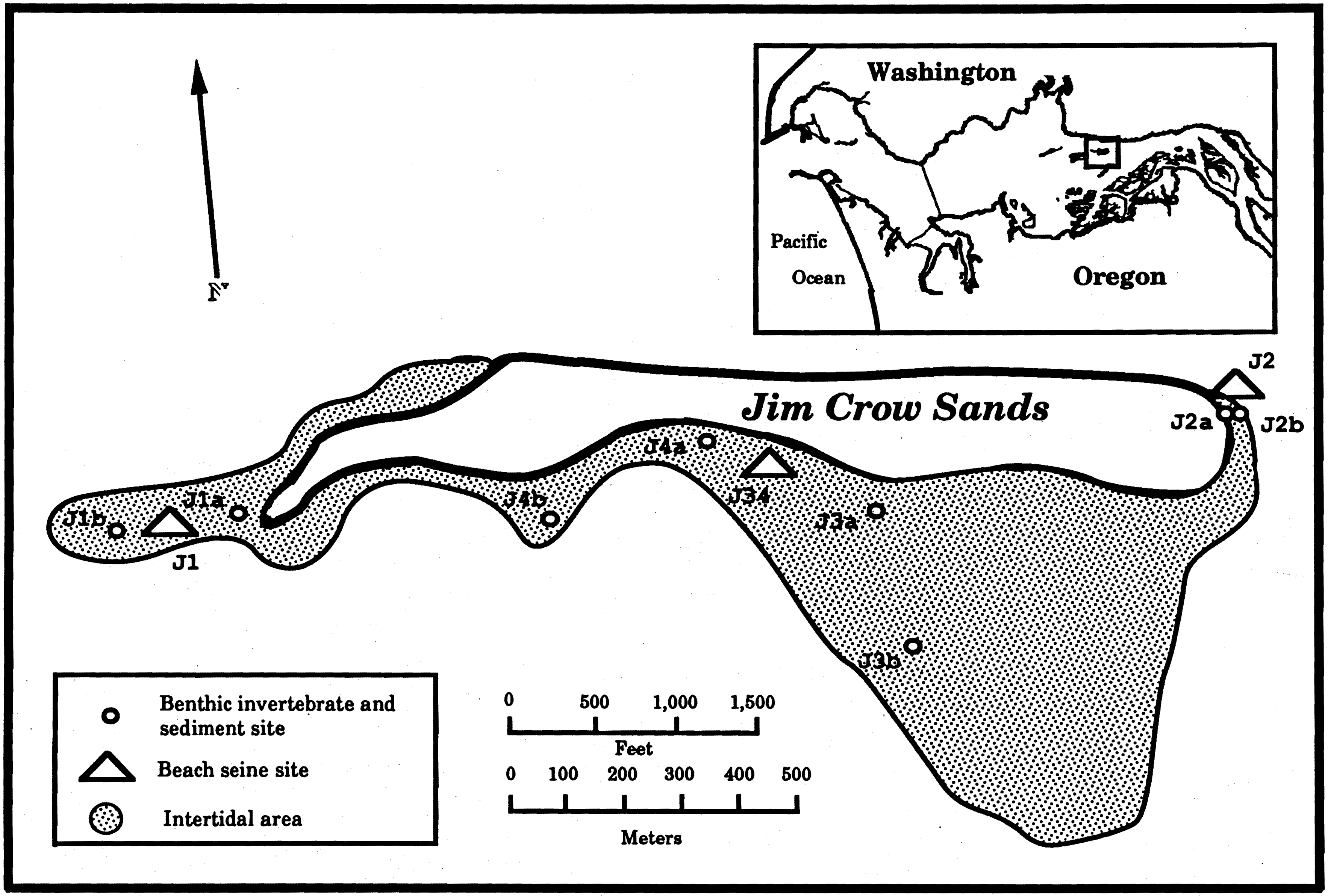

Figure 4.--Sampling locations for fishes, benthic invertebrates, and sediments at Jim Crow Sands, Columbia River estuary, 1988-1989.

that had an inside diameter of 3.85 cm, a penetrating depth of 15 cm, and collected a 174.6-cm^3 sample (Fig. 5). Samples were collected by hand at intertidal stations and by scuba divers at subtidal stations. Ten core samples were placed in labeled jars and preserved in a buffered 4% formaldehyde solution that contained rose bengal, a protein stain. In the laboratory, samples were washed through a 0.5-mm screen. Miller Sands samples were washed through both 0.6-mm and 0.5-mm screens to allow comparisons to data collected in 1975-1977. Benthic invertebrates were then sorted from the preserved samples, identified to the lowest practical taxonomic level (usually species), and counted. All specimens were placed in labeled vials containing 70% ethyl alcohol. Two of the 12 core samples were placed in labeled plastic bags and refrigerated at the NMFS laboratory prior to transfer to the COE for physical characterizations.

Water Quality--In conjunction with fish sampling, we measured temperature (°C), turbidity [Nephelometric Turbidity Units (NTU)], and pH. Turbidity and pH were measured in the laboratory using a Hach Turbidimeter Model 2100A[1] and a Horizon Digital Mini-pH-Meter. For the bottom trawling stations at Desdemona and Taylor Sands, salinity (ppt) was measured *in situ* using a Beckman Model RS5-3 salinometer.

Data Analyses

Fishes--The densities of demersal fishes at each trawl station were calculated using the distance fished, the estimated effective

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[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

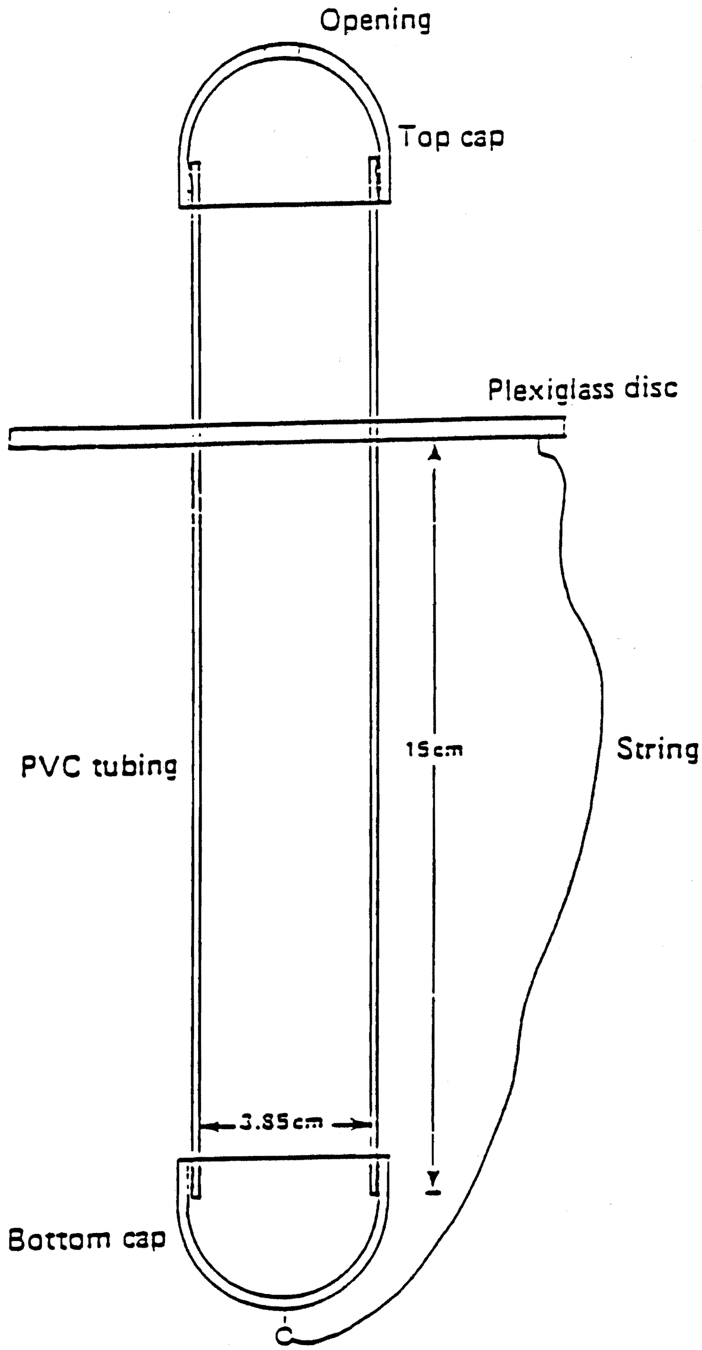


Figure 5.--PVC coring device used to collect benthic invertebrate and sediment samples in the Columbia River estuary, 1988-1989.

fishing width of the trawl (5 m), and the number of fish caught. Densities were expressed as number/hectare (ha) (10,000 m^2). Fish densities were also calculated for each beach seine effort. The effective sampling length of the seine was estimated to be 42 m, and because the waterline along the beach was not always straight, an average loss of 15° out of the possible 180° was calculated for each sampling effort. Total area sampled during a typical seining effort was about 2,540 m^2. Several exceptions occurred at Miller Sands (Stations M2, M3, M4, and M5), where smaller areas were sampled due to beach configurations. For these exceptions, the effective sampling length of the seine was estimated to be 30 m, and the total area sampled was about 1,296 m^2.

Data were processed using a FORTRAN computer program. Output from the program included water quality measurements, number of fishes captured (by species and total), number of fish/ha (by species and total), and two community structure indices (diversity and species evenness) for each sampling effort. The first community structure index was the Shannon-Weiner function (H'), which contains two components of diversity--number of species and evenness of individuals among species (Krebs 1978).

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

where Pi = Xa/n (Xa is the number of individuals of a particular species in the sample, and n is the total number of all individuals in the sample) and s = number of species. The second community structure index was Species Evenness (J'), which measures the proportional abundances among the various species in a sample

(Pielou 1966). J′ has a possible range of 0.00 to 1.00, with 1.00 indicating all species in the sample are numerically equal.

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

where H′ = Shannon-Weiner function and s = number of species. The Kruskal-Wallis test (Wilkinson 1989) was used to compare fish densities and community structure indices among areas.

Benthic Invertebrates--The ten benthic invertebrate samples from each station were treated as replicates, allowing calculation of a mean number/m^2 and a standard deviation (SD) by species and station. The two previously described community structure indices (H′ and J′) were also calculated. The Kruskal-Wallis test was used to compare benthic invertebrate densities and community structure indices among areas.

Sediments--Sediment analyses were done by the COE (North Pacific Division Materials Laboratory, Troutdale, Oregon). Sediment grain size was determined by sieving and weighing and total organic carbon (TOC) by burning for 1 hour at 600°C. Median grain size (phi), percent silt/clay (particles <0.0625 mm or 4 phi) and percent TOC were calculated for each sample. The Kruskal-Wallis test was used to compare median grain size, percent silt/clay, and percent TOC among areas.

Miller Sands Comparisons

Sampling

Methods employed to collect fish, benthic invertebrate, and sediment samples and to measure water quality at Miller Sands from

1975 to 1977 are described below. Further information regarding the collection of these samples can be found in McConnell et al. (1978).

Fishes--Samples were collected in 1975-1977 using a beach seine constructed of 12.7-mm nylon web (stretched measure). The seine was 76.2 m long and 3.7 m deep. One end of the seine was anchored in the dry sand, and the net was pulled off the beach at a 40-60° angle using a 5-m boat. Once the net was fully extended and towed back to the beach, a 120-135° arc was completed. Area sampled was about 4,555 m^2. Captured fishes were identified, counted, and a subsample was weighed and measured.

Benthic Invertebrates--Benthic invertebrates were collected in 1975-1977 using a 0.05-m^2 Eckman dredge. During May 1975 through May 1976, two samples were combined so that each replicate equaled 0.1 m^2 of material. Six replicates were taken at each station. During July 1976 through July 1977, one sample was used for each replicate (0.05 m^2 of material), and three replicates were taken at each station. All samples were washed through a 0.6-mm sieve; retained material was placed in jars and preserved with a 4% formaldehyde solution containing rose bengal. Benthic invertebrates were then sorted from the preserved samples, identified, and counted.

Sediments--From May 1976 to July 1977, sediment samples were collected at the same time as the benthic invertebrate samples. A coring device with an inside diameter of 3.8 cm was used to obtain the samples. Penetration of the Eckman dredge (used for collecting benthic invertebrates) into the substrate was measured to provide a guideline on which to base the depth of each sediment core.

Samples were placed in labeled plastic bags and sent to Northwest Testing Laboratory (Portland, Oregon) for analyses.

Water Quality--In 1975-1977, water quality measurements were made at beach seine sampling sites. Temperature, conductivity, and salinity were measured with a Beckman Model RS5-3 salinometer. Turbidity was determined with an H.F. Instrument Model DRT100 meter during the first three surveys and with a Hach "Surface Scatter" Turbidimeter during the remainder of the surveys. A Leeds and Northrup Model 7404 meter was used to measure pH.

Data Analyses

Fishes--Fish data from four stations (M2, M3, M10, and M11) for May, July, and September in 1975-1977 (no sampling was done in September 1977) and in 1989 were compared (Fig. 3). The four stations were the only beach seine sampling sites that were the same in all surveys. Since sampling methods varied between the 1975-1977 and 1989 surveys, all fish data were converted to number/ha for each sampling effort to allow comparisons between months and years.

Paired t-tests (Wilkinson 1989) were used to compare fish densities between years and between the same months in different years; similar comparisons were done for the community structure indices (H′ and J′). Fish densities were transformed to $\log_{10}$ prior to doing the t-tests. Community structure indices were transformed to $\log_{10}$ of (number + 1) prior to doing the t-tests; 1 was added to the number because of some 0 values (Sokal and Rohlf 1969).

Benthic Invertebrates--Benthic invertebrate data from five stations (M2, M3, M6, M10, and M11) for May, July, and September in 1975-1977 (no sampling was done in September 1977) and in 1989 were compared (Fig. 3). The five stations were the only benthic sampling sites that were the same in all surveys. Because various sampling methods were used during the surveys, all benthic invertebrate data were converted to mean number/m^2 to allow comparisons between months and years.

Paired t-tests were used to compare benthic invertebrate densities between years and between the same months in different years; similar comparisons were done for the community structure indices (H′ and J′). Benthic invertebrate densities were transformed to $\log_{10}$ prior to testing. Community structure indices were transformed to $\log_{10}$ of (number + 1) prior to testing; 1 was added to the number because of some 0 values (Sokal and Rohlf 1969).

Sediments--Sediment data from five stations (M2, M3, M6, M10, and M11) for May, July, and September in 1976-1977 (no sampling was done in September 1977) and in 1989 were compared (Fig. 3). For the 1976-1977 surveys, particle size was determined by standard sieve and pipette procedures. Total organic carbon (volatile solids) was determined using standard methods of the U.S. Environmental Protection Agency (1974). Standards for classifying grain sizes changed between 1975-1977 and 1989; therefore, all data were converted to median grain size, percent silt/clay, and percent TOC to allow comparisons.

Paired t-tests were used to compare median grain sizes between years and between the same months in different years; similar comparisons were done for percent silt/clay and percent TOC. Median grain sizes were transformed to $\log_{10}$ prior to doing the t-tests. Percent silt/clay and percent TOC were arcsine-transformed before testing (Sokal and Rohlf 1969).

RESULTS

1988-1989 Surveys

Areas Comparisons

Fishes--Overall, 27 fish species and Dungeness crab (Cancer magister) were captured during the four surveys (Appendix Table 1). The most species were captured in July 1989 (25) and the fewest species in May and September 1989 (16). The most abundant fishes, by survey, were starry flounder (Platichthys stellatus) during September 1988 (241 individuals), juvenile chinook salmon (Oncorhynchus tshawytscha) during May 1989 (1,524 individuals), starry flounder during July 1989 (2,004 individuals), and peamouth (Mylocheilus caurinus) during September 1989 (1,201 individuals) (Appendix Table 2).

Mean beach seine catches were highest at Miller Sands (1,037 fishes/ha) and lowest at Desdemona Sands (206 fishes/ha) (Table 1), but were not significantly different among the areas (Kruskal-Wallis, $P > 0.05$). The community structure indices H′ and J′ were also not significantly different among areas (Kruskal-Wallis, $P > 0.05$). For the trawling efforts, catches were highest at Desdemona Sands (2,064 fishes/ha) and lowest at Taylor Sands (443 fishes/ha) (Table 1). Because of the low number of trawling efforts, no statistical analyses were done.

Benthic Invertebrates--A total of 52 different invertebrate taxa were identified during the four benthic surveys (Appendix Table 3). The most taxa were collected in May 1989 (37) and the least in July 1989 (27). The most abundant invertebrates were the amphipod Corophium salmonis in September 1988 (mean 9,140/m^2), oligochaetes

Table 1.--Summaries of fish catches at five areas in the Columbia River estuary, 1988-1989. All values are means.

Beach seine

Area	Number of species	Number/ hectare	H′	J′
Desdemona Sands	4	206	1.38	0.76
Taylor Sands	-	-	-	-
Rice Island	3	381	0.92	0.56
Miller Sands	4	1,037	0.79	0.40
Jim Crow Sands	5	581	1.10	0.54

Trawl

Area	Number of species	Number/ hectare	H′	J′
Desdemona Sands	8	2,064	1.49	0.49
Taylor Sands	5	443	1.07	0.48
Rice Island	-	-	-	-
Miller Sands	6	873	1.46	0.57
Jim Crow Sands	-	-	-	-

in May 1989 (mean 8,069/m^2), oligochaetes in July 1989 (mean 4,791/m^2), and C. salmonis in September 1989 (mean 8,142/m^2) (Appendix Table 4).

Total benthic invertebrate densities were significantly different among the five areas, with the highest mean density at Miller Sands (25,568/m^2) and the lowest at Taylor Sands (1,029/m^2) (Kruskal-Wallis, $P < 0.05$) (Table 2). H′ and J′ were also significantly different among all areas (Kruskal-Wallis, $P < 0.05$). Highest H′ and J′ were at Taylor Sands and lowest H′ and J′ at Rice Island and Jim Crow Sands, respectively.

Sediments--Median grain size varied by area and station, ranging from 4.3 to 1.5 phi. Mean percent silt/clay also varied widely by area and station. Although sediments at most stations were low in silt/clay (<6%), one sample from Miller Sands was as high as 50.6% (Appendix Table 5). Mean percent TOCs at all five areas were <6%, with most <3%.

Median grain size indicated all five areas were composed of medium (≥2 phi) to fine grain sand (≥3 phi). Mean median grain size was significantly different among the five areas, with the largest at Rice Island (2.08 phi) and smallest at Desdemona Sands (2.85 phi)(Kruskal-Wallis, $P < 0.05$) (Table 3). Percent silt/clay was significantly different among the areas, with Miller Sands having the highest (10.63%) and Rice Island the lowest (0.32%) (Kruskal-Wallis, $P < 0.05$). Although mean TOC was low, it was significantly different among areas, with the highest at Desdemona Sands (1.08) and the lowest at Rice Island (0.58) (Kruskal-Wallis, $P < 0.05$).

Table 2.--Summary of benthic invertebrate collections at five areas in the Columbia River estuary, 1988-1989. All values are means.

Area	Number of taxa	Number/m^2	SD	H′	J′
Desdemona Sands	7	6,422	5,400	1.81	0.65
Taylor Sands	5	1,029	672	1.99	0.89
Rice Island	3	2,485	3,497	1.08	0.60
Miller Sands	8	25,568	23,479	1.45	0.52
Jim Crow Sands	6	16,961	18,660	1.19	0.48

Table 3.--Sediment characteristics at five areas in the Columbia River estuary, 1988-1989. All values are means.

Area	Median grain size (phi)	Silt/clay (%)	Total organic carbon (%)
Desdemona Sands	2.85	2.78	1.08
Taylor Sands	2.26	0.53	0.70
Rice Island	2.08	0.32	0.58
Miller Sands	2.82	10.63	1.04
Jim Crow Sands	2.73	7.86	0.93

Desdemona Sands

Fishes--The most species captured by beach seining at Desdemona Sands were collected in July 1989 (6) and the fewest in September 1989 (2) (Table 4). Highest fish density was observed in May 1989 (418 fishes/ha) and lowest in September 1989 (62 fishes/ha). H′ was highest in July 1989 (1.83), reflecting the relatively high number of taxa and the relative evenness (J′ = 0.71) of their proportional abundances. J′ was highest in September 1989 (1.00) because the two species that were captured were equally represented.

Surf smelt (Hypomesus pretiosus) and juvenile chinook salmon were the most abundant fishes captured by beach seine in May 1989 (Table 5). Starry flounder was the primary fish captured during July 1989, and shiner perch (Cymatogaster aggregata) and starry flounder were the only species caught by beach seine in September 1989.

In trawling efforts at Desdemona Sands, the most species were captured in July 1989 (11) and the fewest in September 1988 (6) (Table 4). Fish density was highest in May 1989 (3,955 fishes/ha) and lowest in September 1988 (827 fishes/ha). H′ was highest in July 1989 (2.27), and J′ was highest in July and September 1989 (0.65). H′ was highest in July 1989 because of the relatively high number of species and the evenness of the proportional abundances of the various species in comparison to the other surveys. The low H′ in May 1989 was due primarily to the numerical dominance of Pacific sand lance (Ammodytes hexapterus).

Most abundant fishes for the trawl surveys were starry flounder in September 1988, Pacific sand lance in May 1989, whitebait smelt (Allosmerus elongatus) in July 1989, and longfin smelt (Spirinchus

Table 4.--Summary of fish catches at Desdemona Sands, Columbia River estuary, during four surveys in 1988-1989. One trawling effort and one beach seining effort (except in September 1988) were done during each survey.

Beach seine

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	-	-	-	-
2 (May 89)	5	418	1.32	0.57
3 (Jul 89)	6	139	1.83	0.71
4 (Sep 89)	2	62	1.00	1.00

Trawl

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	6	827	1.44	0.56
2 (May 89)	7	3,955	0.30	0.11
3 (Jul 89)	11	1,938	2.27	0.65
4 (Sep 89)	8	1,536	1.94	0.65

thaleichthys) in September 1989 (Table 5). Other abundant species captured during various surveys included northern anchovy (Engraulis mordax), shiner perch, English sole (Parophrys vetulus), and Dungeness crab.

Length-frequency histograms of numerically dominant fishes captured in beach seines indicated that most fishes were in one or two size classes (Fig. 6). The length-frequency histograms suggest that most of the chinook salmon were subyearlings (see Dawley et al. 1984 for length-age relationship). Trawl-caught Pacific sand lance and northern anchovy were in one or two size classes (Fig. 7). Most of the whitebait smelt captured in July and September 1989 were shorter than 125 mm (Fig. 8). Starry flounder captured in July 1989 were most likely at least 1 year old or older (Fig. 9; see National Marine Fisheries Service 1981 for length-age relationship). Most of the longfin smelt caught in September 1989 were probably at least yearlings (Fig. 9; see National Marine Fisheries Service 1981 for length-age relationship). Most of the shiner perch caught in September 1989 were probably 1 year old and older (Fig. 9; see Anderson and Bryan 1970 for length-age relationship).

Benthic Invertebrates--At Desdemona Sands, the highest mean number of benthic invertebrate taxa (10) and highest mean density (11,770 invertebrates/m^2) were observed during May 1989 (Table 6). The lowest mean number of taxa (6) and lowest mean density (3,009 invertebrates/m^2) were observed in September 1988. H′ was highest in July 1989 (2.21). Although the mean number of taxa in July 1989 was not the highest observed among the surveys, the abundances of species were more equally distributed than during other surveys (J′ = 0.82).

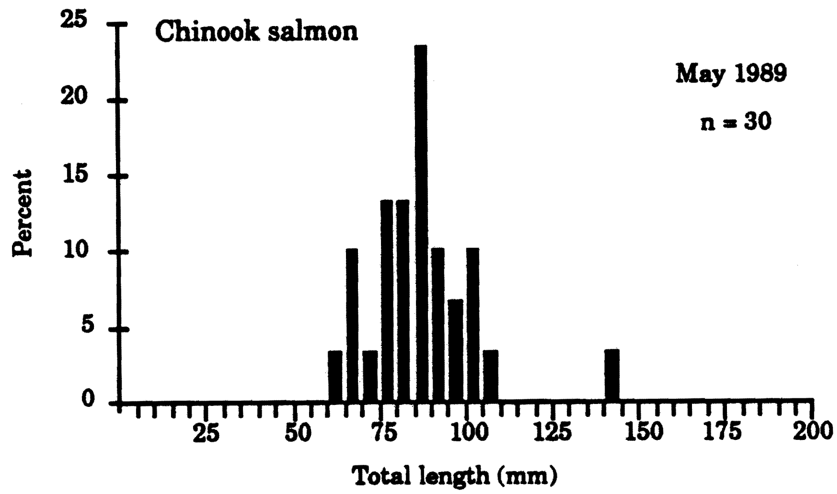
Table 5.--Composition and abundance of fishes captured at Desdemona Sands, Columbia River estuary, during four surveys in 1988-1989. All values are numbers/hectare.

Beach seine

Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Pacific herring	-	0	4	0
Coho salmon	-	16	0	0
Chinook salmon (subyearling)	-	177	12	0
Chinook salmon (yearling)	-	4	0	0
Surf smelt	-	217	20	0
Shiner perch	-	0	8	31
Pacific staghorn sculpin	-	4	12	0
Starry flounder	-	0	83	31
TOTAL	-	418	139	62

Table 5.--Continued.

	Trawl			
Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
River lamprey	0	5	0	0
American shad	0	0	0	4
Pacific herring	0	85	10	16
Northern anchovy	0	0	566	0
Whitebait smelt	0	0	781	392
Surf smelt	0	5	31	0
Longfin smelt	0	0	5	792
Pacific tomcod	16	0	62	20
Shiner perch	0	0	10	156
Snake prickleback	16	5	5	0
Saddleback gunnel	0	5	0	0
Pacific sand lance	0	3,798	0	0
Pacific staghorn sculpin	11	0	0	0
English sole	108	0	98	0
Starry flounder	568	52	262	88
Dungeness crab	108	0	108	68
TOTAL	827	3,955	1,938	1,536



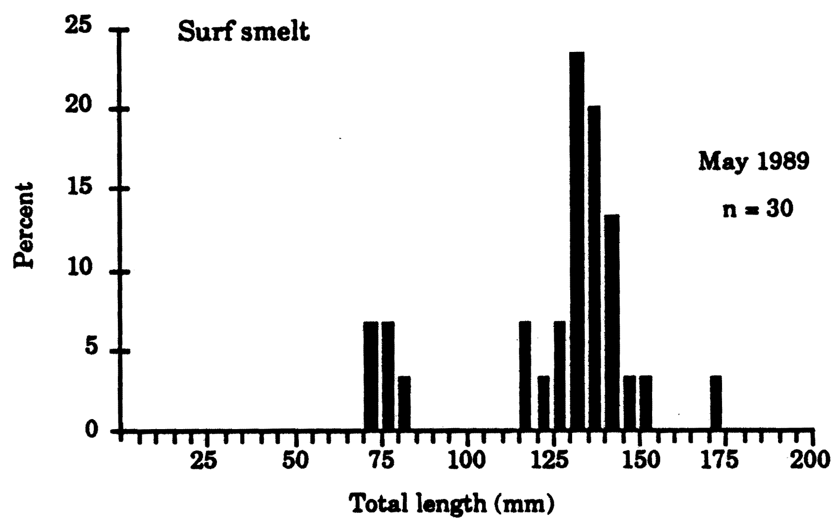


Figure 6.-- Length-frequency distributions of chinook salmon and surf smelt captured by beach seine at Desdemona Sands, Columbia River estuary, May 1989. Sample size (n) equals the number of fish measured, not the total number captured.

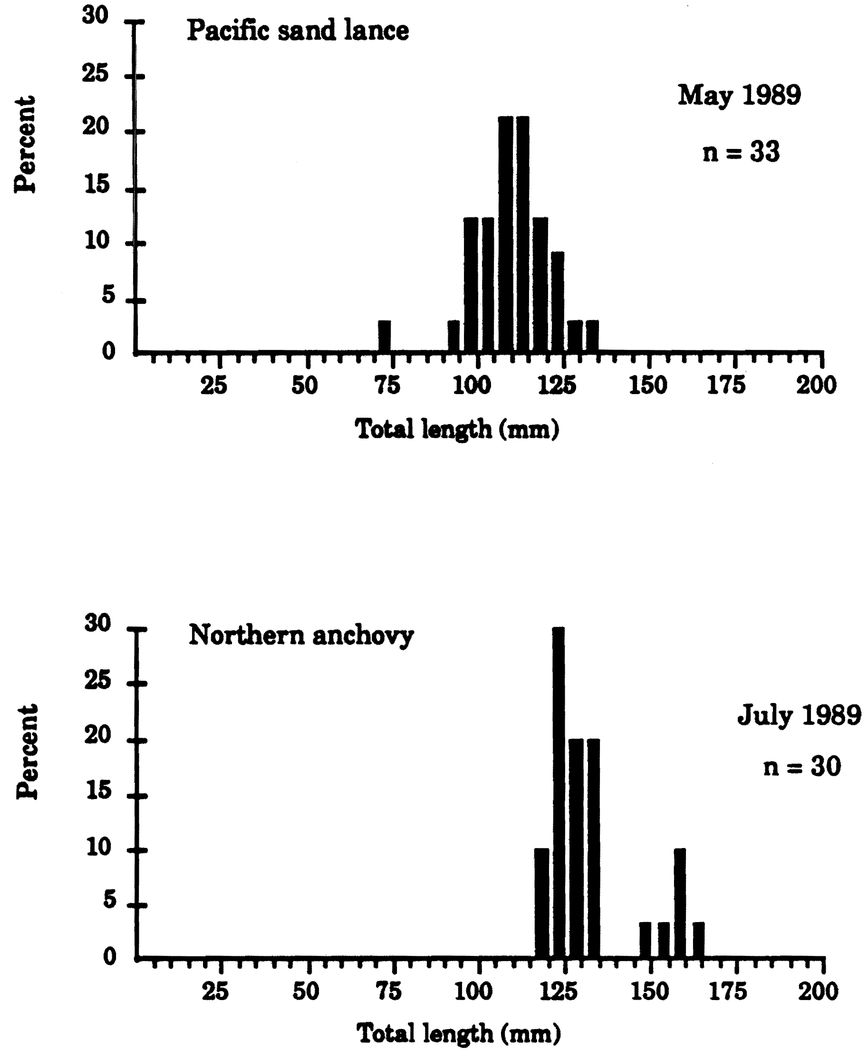
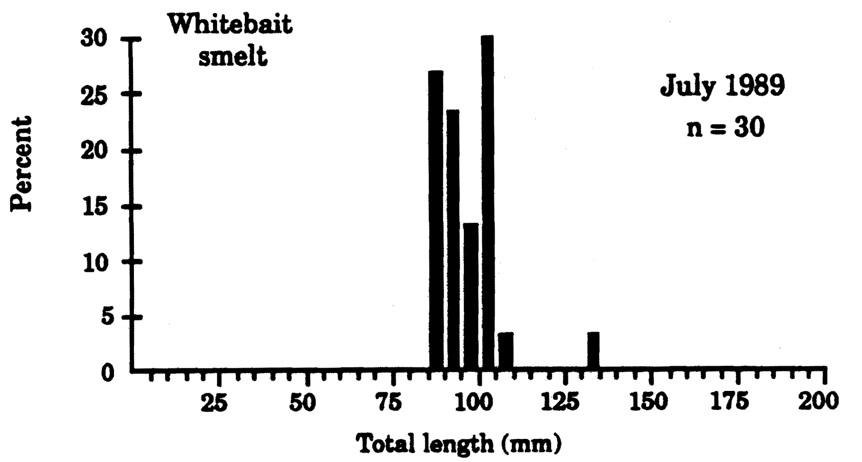


Figure 7.-- Length-frequency distributions of Pacific sand lance and northern anchovy captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.



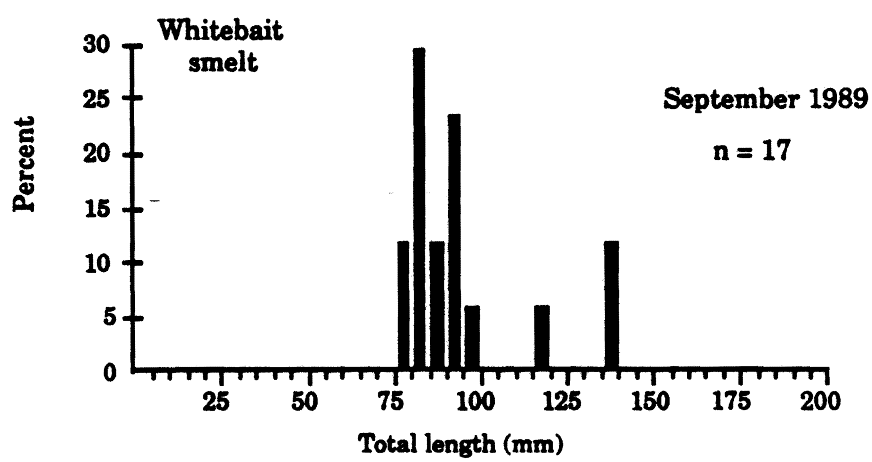


Figure 8.-- Length-frequency distributions of whitebait smelt captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

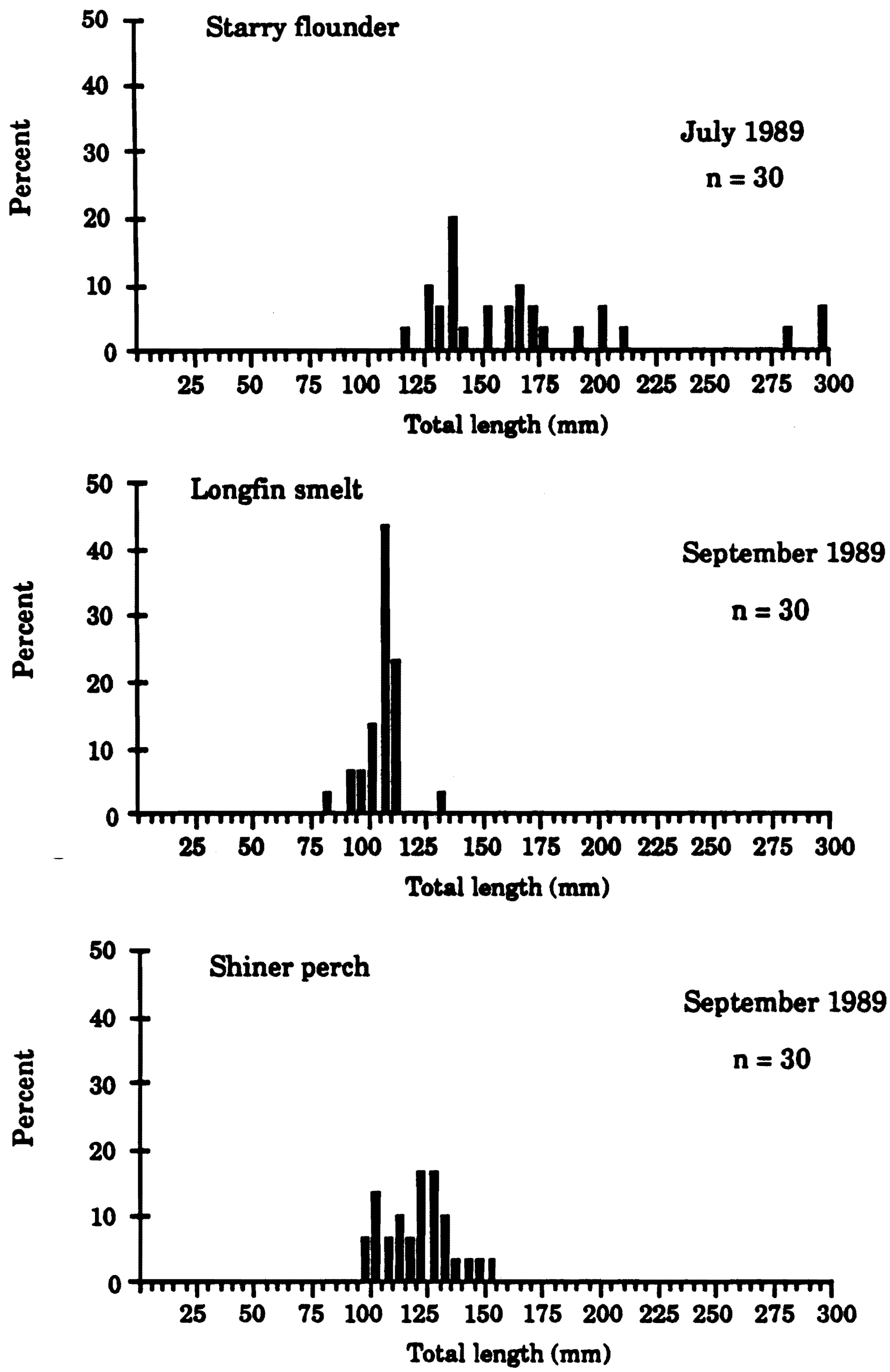


Figure 9.-- Length-frequency distributions of starry flounder, longfin smelt, and shiner perch captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

Table 6.--Summary of benthic invertebrate collections at Desdemona Sands, Columbia River estuary, from four surveys in 1988-1989. All values are means.

Survey (date)	Number of taxa	Number/m^2	SD	H′	J′
1 (Sep 88)	6	3,009	3,009	1.83	0.71
2 (May 89)	10	11,770	8,135	1.71	0.52
3 (Jul 89)	7	4,381	1,815	2.21	0.82
4 (Sep 89)	7	4,823	4,818	1.49	0.56

Most abundant benthic invertebrate taxa collected at Desdemona Sands included the bivalve Macoma balthica (September 1988 and 1989), Turbellaria (May 1989), and the amphipod Eohaustorius estuarius (July 1989) (Table 7). Oligochaetes were abundant in all surveys.

Sediments--Sediments at Desdemona Sands were composed primarily of very fine or fine sands, with mean median grain size ranging from 3.2 to 2.8 phi (Table 8). Mean percent silt/clay was <2% in three of the four surveys. Mean TOC was low, ranging from 1.7% in September 1988 to 0.8% in July 1989.

Taylor Sands

Fishes--Although there was no change between surveys in the mean number of species captured (5) at Taylor Sands, mean fish densities varied between surveys (Table 9). The highest mean density was observed in September 1989 (935 fishes/ha) and the lowest in May 1989 (165 fishes/ha). Community structure indices H′ and J′ did not vary widely among the three surveys.

Subyearling chinook salmon was the most abundant fish captured in May 1989 (Table 10). Although juvenile chinook salmon are not often captured in bottom trawls, the shallowness of the sites (about 5 m) allowed fishes which are typically found in intertidal and near surface waters to be captured. During July and September 1989, shiner perch was the most abundant species (Table 10). Starry flounder was also relatively abundant in all surveys.

Most of the chinook salmon captured in May 1989 were subyearlings (Fig. 10; see Dawley et al. 1984 for length-age relationship). Shiner perch length-frequency distributions for July

Table 7.--Composition and abundance of major benthic invertebrate taxa at Desdemona Sands, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/m^2.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Oligochaeta	354	3,717	1,018	1,106
Polychaeta				
Eteone sp.	89	0	177	0
Glycinde picta	885	89	0	133
Glycera sp.	0	44	0	0
Neanthes limnicola	0	0	177	0
Pseudopolydora kempi	0	0	0	1,195
Unid. Spionidae	0	0	0	265
Amphipoda				
Eohaustorius estuarius	0	133	1,681	619
misc.	89	132	0	45
Insecta				
misc.	0	442	0	0
Bivalvia				
Macoma balthica	1,504	1,903	487	1,239
misc.	0	0	221	0
Others				
Isopoda	89	177	0	0
Turbellaria	0	4,027	0	89
misc.	0	1,106	619	133
TOTAL	3,010	11,770	4,380	4,824

Table 8.--Sediment characteristics at Desdemona Sands, Columbia River estuary, during four surveys in 1988-1989. All values are means.

	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Median grain size (phi)	3.2	2.9	2.8	2.8
Percent silt/clay	10.2	1.3	1.8	1.0
Percent total organic carbon	1.7	0.9	0.8	1.2

Table 9.--Summary of fish catches at Taylor Sands, Columbia River estuary, during three surveys in 1989. Two trawling efforts were done during each survey, except during Survey 1. All values are means.

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	-	-	-	-
2 (May 89)	5	165	1.14	0.53
3 (Jul 89)	5	229	0.98	0.44
4 (Sep 89)	5	935	1.11	0.48

Table 10.--Composition and abundance of fishes captured in an 8-m trawl at Taylor Sands, Columbia River estuary, during three surveys in 1989. All values are mean numbers/hectare.

Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
White sturgeon	-	0	5	0
American shad	-	7	2	13
Pacific herring	-	0	0	27
Chinook salmon (subyearling)	-	115	2	0
Chinook salmon (yearling)	-	2	0	0
Unidentified Osmeridae	-	0	2	0
Longfin smelt	-	0	0	54
Peamouth	-	0	0	2
Threespine stickleback	-	7	0	0
Snake prickleback	-	0	2	0
Shiner perch	-	0	120	677
Prickly sculpin	-	5	0	0
Pacific staghorn sculpin	-	0	2	11
Starry flounder	-	27	86	142
TOTAL	-	163	221	926

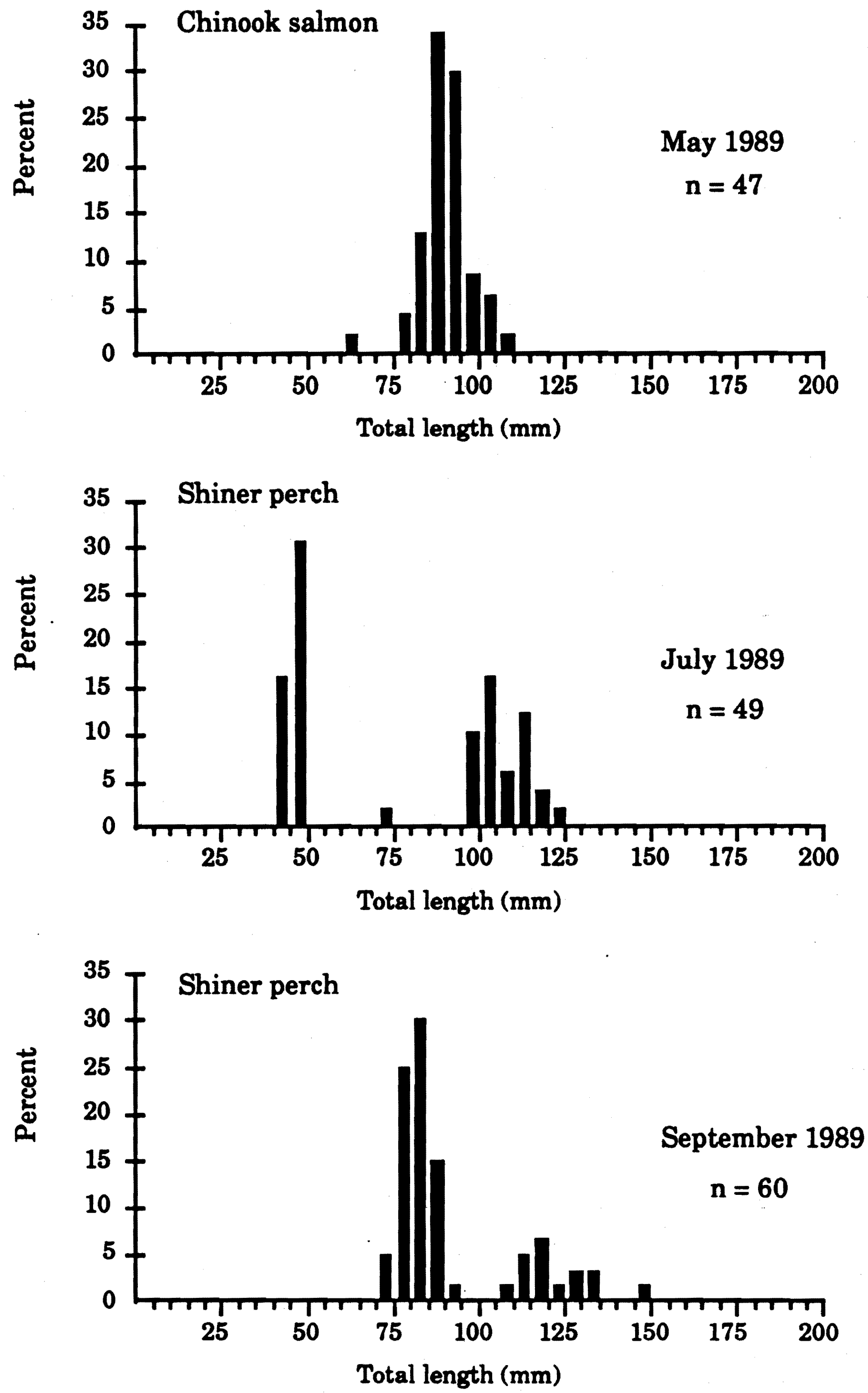
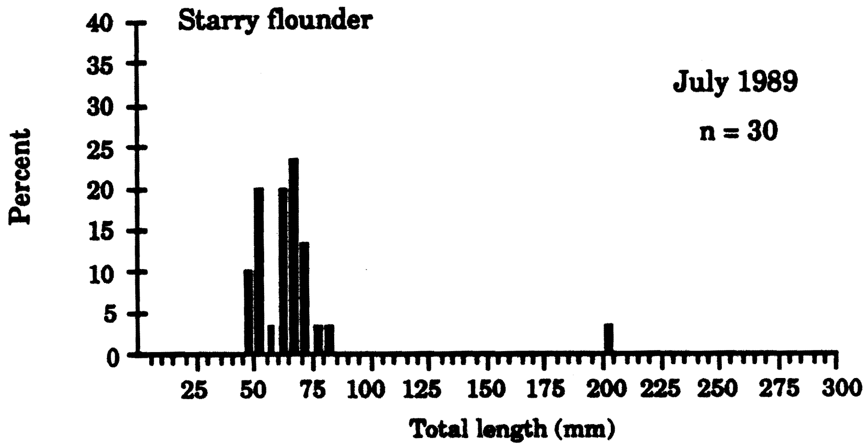


Figure 10.-- Length-frequency distributions of chinook salmon and shiner perch captured by 8-m trawl at Taylor Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

and September 1989 revealed that at least two age groups use this area (Fig. 10). The smaller size group of shiner perch was composed of subyearlings, and the larger group was probably composed of fish 1 year old and older (see Anderson and Bryan 1970 for length-age relationship). Starry flounder captured in July and September 1989 appeared to be primarily subyearlings (Fig. 11; see National Marine Fisheries Service 1981 for length-age relationship).

Benthic Invertebrates--At Taylor Sands, the highest mean number of benthic invertebrate taxa (7) and highest mean density (2,035 invertebrates/m^2) were documented in May 1989; the lowest mean number of taxa (4) and lowest mean density (354 invertebrates/m^2) were observed in September 1988 (Table 11). H' was highest in September 1989 (mean = 2.15), reflecting the relatively high number of taxa (6) and the relatively high species evenness (mean J' = 0.88). The very high J' for September 1988 (mean = 0.98) was the result of the nearly equal proportional abundances of the four species collected. Abundant benthic invertebrates at Taylor Sands were *E. estuarius* in September 1988, July 1989, and September 1989 and *C. salmonis* in May 1989 (Table 12). Other well-represented taxa included oligochaetes, the polychaete *Neanthes limnicola*, unidentified Spionidae, Copepoda, various larval aquatic insects, and the bivalve *Corbicula manilensis*.

Sediments--Sediments at Taylor Sands were composed primarily of fine sand (2.2 to 2.5 phi) (Table 13). Mean percent silt/clay ranged from a high of 1.7% in September 1988 to a low of 0.1% in May 1989. Mean TOC was <1% all surveys.



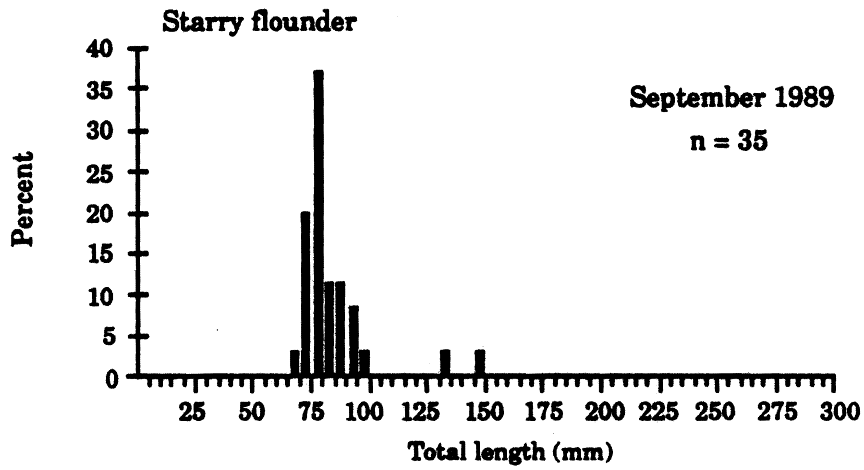


Figure 11.-- Length-frequency distributions of starry flounder captured by 8-m trawl at Taylor Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

Table 11.--Summary of benthic invertebrate collections at Taylor Sands, Columbia River estuary, from four surveys in 1988-1989. All values are means.

Survey (date)	Number of taxa	Number/m^2	SD	H′	J′
1 (Sep 88)	4	354	0	1.75	0.98
2 (May 89)	7	2,035	0	2.06	0.77
3 (Jul 89)	5	929	188	2.00	0.93
4 (Sep 89)	6	797	250	2.15	0.88

Table 12.--Composition and abundance of major benthic invertebrate taxa at Taylor Sands, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/m^2.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Oligochaeta	44	265	89	44
Polychaeta				
Neanthes limnicola	0	0	133	0
Unid. Spionidae	44	0	44	0
Amphipoda				
Eohaustorius estuarius	133	221	354	354
Corophium salmonis	44	1,062	89	44
misc.	44	0	0	44
Copepoda	0	177	133	177
Insecta	0	265	44	89
Bivalvia				
Corbicula manilensis	44	0	44	0
Others				
misc.	0	44	0	44
TOTAL	353	2,034	930	796

Table 13.--Sediment characteristics at Taylor Sands, Columbia River estuary, during four surveys in 1988-1989. All values are means.

	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Median grain size (phi)	2.5	2.3	2.2	2.2
Percent silt/clay	1.7	0.1	0.3	0.2
Percent total organic carbon	0.8	0.6	0.6	0.6

Rice Island

Fishes--At Rice Island, the mean number of species captured was low for all surveys, ranging from one to four species (Table 14). The highest mean density was observed in May 1989 (723 fishes/ha) and the lowest in September 1988 (12 fishes/ha). H′ was highest in May 1989 (mean = 1.22), reflecting the higher number of species captured (4) and relatively high species evenness (mean J′ = 0.70).

During September 1988, July 1989, and September 1989, starry flounder was the most abundant fish captured at Rice Island (Table 15). Present in all surveys, juvenile chinook salmon was the most abundant fish in May 1989. Other abundant fishes captured in May 1989 included surf smelt and Pacific staghorn sculpin (Leptocottus armatus) (Table 15). Peamouth were common in all surveys, except the September 1988 survey.

Chinook salmon length-frequency histograms revealed two possible subyearling size groups in May 1989, a smaller size group with a mean total length of about 55 mm and a larger size group with a mean total length of about 85 mm (Fig. 12; see Dawley et al. 1984 for length-age relationship). All chinook salmon captured in July 1989 were probably subyearlings.

Starry flounder length-frequency histograms indicated that predominantly subyearlings utilized Rice Island (Fig. 13; see National Marine Fisheries Service 1981 for length-age relationship). The longer lengths observed in September 1989 probably represent growth of this group.

Surf smelt, Pacific staghorn sculpin, and peamouth appeared to be members of one size group (Fig. 14).

Table 14.--Summary of fish catches at Rice Island, Columbia River estuary, during four surveys in 1988-1989. Three beach seining efforts were done during each survey. All values are means.

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	1	12	0.38	0.24
2 (May 89)	4	723	1.22	0.70
3 (Jul 89)	4	426	0.89	0.49
4 (Sep 89)	2	110	0.50	0.44

Table 15.--Composition and abundance of fishes captured by beach seine at Rice Island, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/hectare.

Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Chinook salmon (subyearling)	4	307	31	13
Surf smelt	0	176	7	0
Peamouth	0	20	41	3
Largescale sucker	0	0	3	3
Threespine stickleback	0	10	0	0
Prickly sculpin	1	0	0	0
Pacific staghorn sculpin	0	207	1	0
Starry flounder	7	1	343	92
TOTAL	12	721	426	111

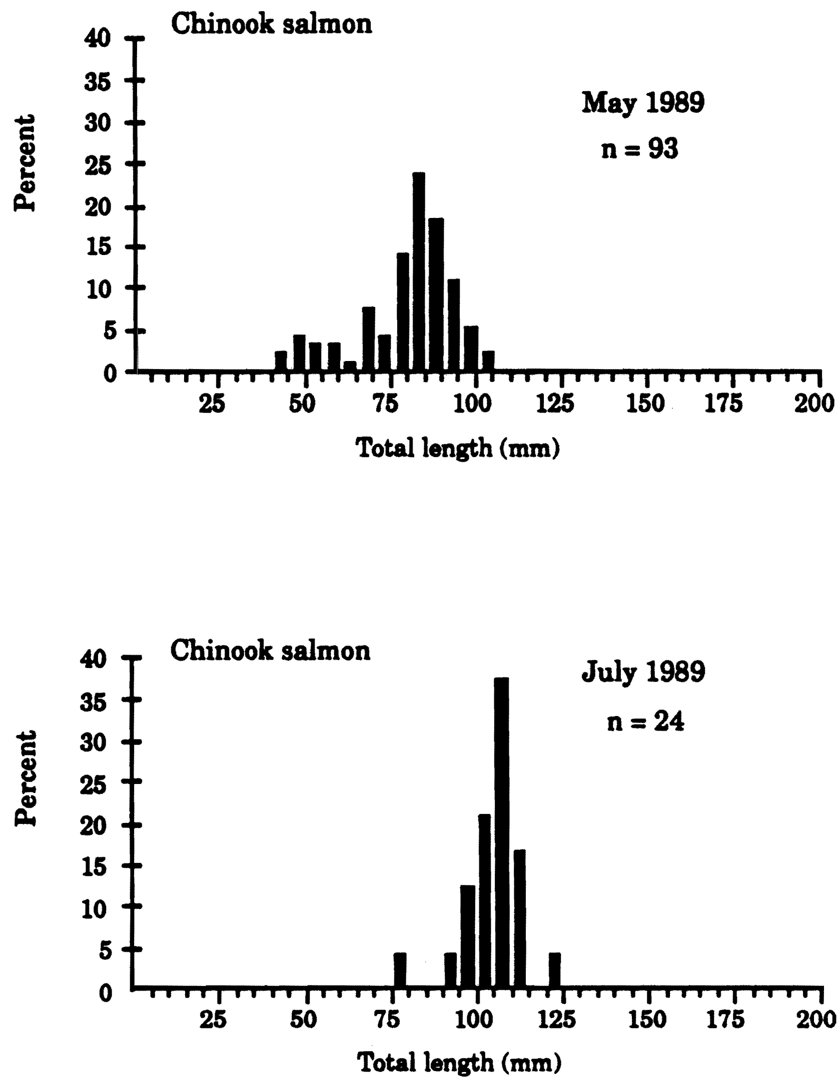


Figure 12.-- Length-frequency distributions of chinook salmon captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

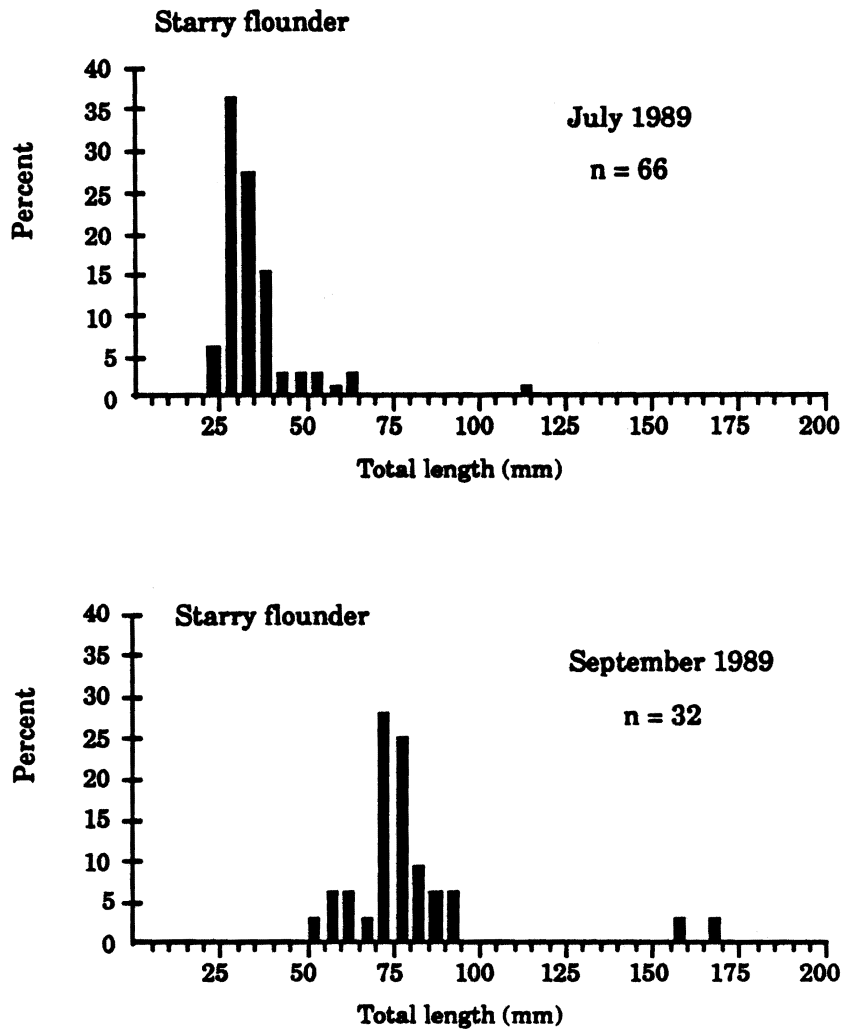


Figure 13.-- Length-frequency distributions of starry flounder captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

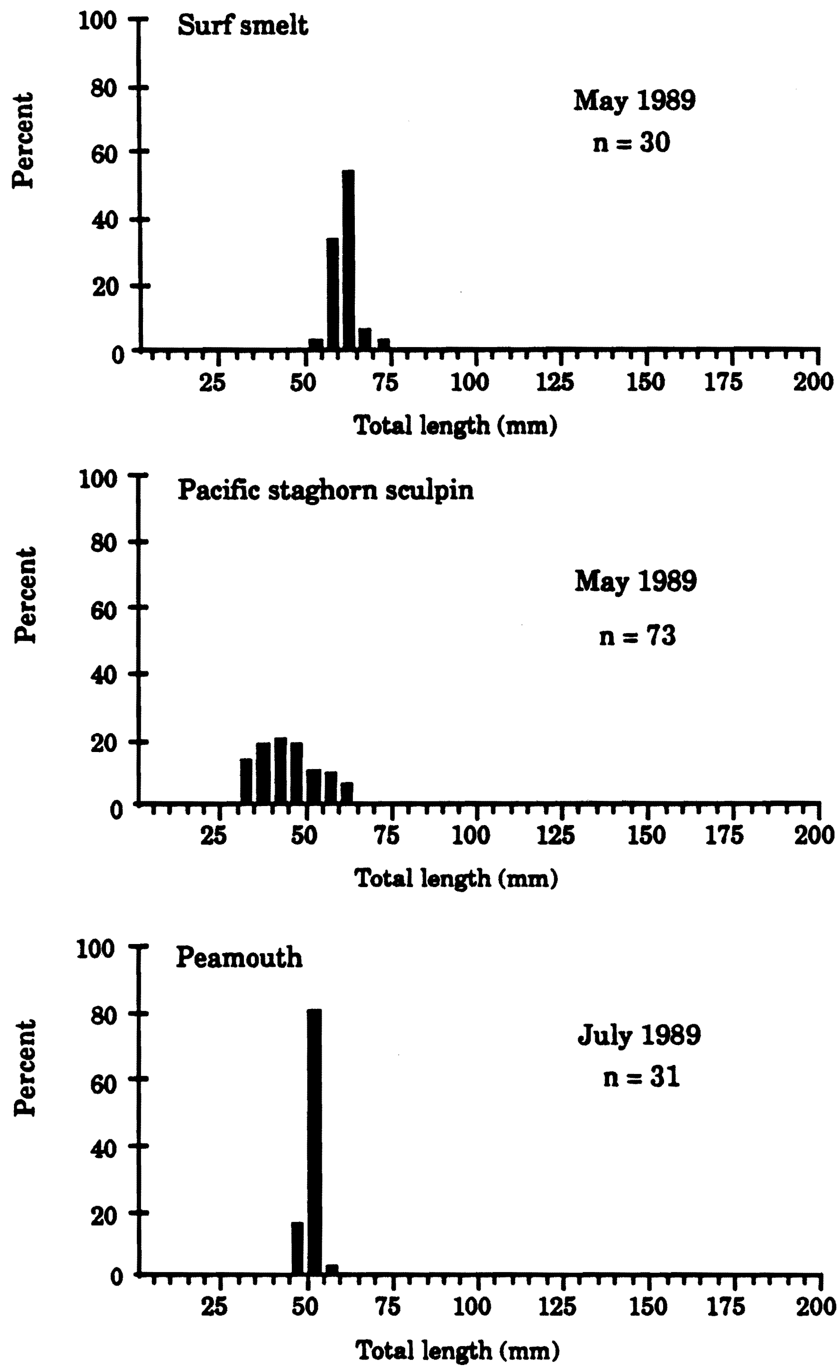


Figure 1´.--Length-frequency distributions of surf smelt, Pacific staghorn sculpin, and peamouth captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

Benthic Invertebrates--At Rice Island, the highest mean number of benthic invertebrate taxa was observed in May 1989 (5), and the lowest in September 1989 (2) (Table 16). Mean density was highest in September 1988 (5,162 invertebrates/m^2) and lowest in September 1989 (487 invertebrates/m^2). H′ was highest in May 1989 (mean = 1.50) due to the higher number of taxa collected and similar proportional abundances of the species (mean J′ = 0.69). H′ was lowest in September 1988 (mean = 0.66) when three taxa were collected and J′ was 0.40.

Corophium salmonis was the dominant invertebrate in September 1988 and May 1989 (Table 17). In July and September 1989, oligochaetes were the most abundant invertebrates. Other important invertebrates included N. limnicola, larval aquatic insects, and Corbicula manilensis.

Sediments--The sediment characteristics at Rice Island were very consistent throughout the study period (Table 18). The mean median grain size was fine sand, ranging from 2.1 phi (September 1988, July and September 1989) to 2.2 phi (May 1989). Mean percent silt/clay was consistently very low, ranging from 0.5% in September 1988 to 0.2% in September 1989. Mean TOC was also low, ranging from 0.7% in September 1989 to 0.5% in May 1989.

Miller Sands

Fishes--At Miller Sands, the mean density of fishes captured in beach seines was highest in September 1989 (1,635 fishes/ha) and lowest in September 1988 (416 fishes/ha) (Table 19). H′ was highest in May 1989 when both the number of species and J′ were highest. In

Table 16.--Summary of benthic invertebrate collections at Rice Island, Columbia River estuary, from four surveys in 1988-1989. All values are means.

Survey (date)	Number of taxa	Number/m^2	SD	H′	J′
1 (Sep 88)	3	5,162	4,882	0.66	0.40
2 (May 89)	5	3,171	3,664	1.50	0.69
3 (Jul 89)	3	1,121	1,612	1.28	0.60
4 (Sep 89)	2	487	450	0.87	0.71

Table 17.--Composition and abundance of major benthic invertebrate taxa at Rice Island, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/m^2.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Oligochaeta	1,327	560	442	192
Polychaeta				
Neanthes limnicola	59	15	15	0
Amphipoda				
Corophium salmonis	3,201	1,180	251	30
misc.	15	133	103	0
Insecta	74	118	15	118
Bivalvia				
Corbicula manilensis	354	678	236	147
Others				
misc.	133	487	59	0
TOTAL	5,163	3,171	1,121	487

Table 18.--Sediment characteristics at Rice Island, Columbia River estuary, during four surveys in 1988-1989. All values are means.

	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Median grain size (phi)	2.1	2.2	2.1	2.1
Percent silt/clay	0.5	0.4	0.3	0.2
Percent total organic carbon	0.6	0.5	0.6	0.7

Table 19.--Summary of fish catches at Miller Sands, Columbia River estuary, during four surveys in 1988-1989. Eight beach seining efforts and one trawling effort were done during each survey. All values for beach seines are means.

Beach seine

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	4	416	0.82	0.38
2 (May 89)	5	830	0.97	0.48
3 (Jul 89)	4	1,111	0.81	0.43
4 (Sep 89)	3	1,635	0.57	0.31

Trawl

Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	6	1,207	1.10	0.43
2 (May 89)	5	551	1.51	0.65
3 (Jul 89)	9	1,087	1.53	0.48
4 (Sep 89)	5	646	1.70	0.73

general, species evenness was relatively low in all surveys, indicating unequal proportional abundances of the various species.

The most abundant fishes, by survey, caught in beach seines at Miller Sands included peamouth in September 1988 and 1989, chinook salmon (subyearling) in May 1989, and starry flounder in July 1989 (Table 20). Generally, all three of the above species commonly occurred in each survey. Other relatively abundant species captured during at least one survey included shiner perch and Pacific staghorn sculpin.

The most species captured in trawling efforts at Miller Sands were collected in July 1989 (9) and the lowest in May and September 1989 (5) (Table 19). Fish density was highest in September 1988 (1,207 fishes/ha) and lowest in May 1989 (551 fishes/ha). H′ was highest in September 1989 (mean = 1.70), even though relatively few species were present. Species evenness for September 1989 (mean J′ = 0.73) was relatively high compared to that observed in the other surveys.

The most abundant fishes, by survey, captured by trawl at Miller Sands were shiner perch in September 1988, starry flounder in May and September 1989, and longfin smelt in July 1989 (Table 20). Other important species included peamouth and Pacific staghorn sculpin.

Chinook salmon captured in beach seines at Miller Sands were primarily subyearlings (Fig. 15; see Dawley et al. 1984 for length-age relationship). Beach-seine caught starry flounder consisted of at least two size groups during September 1988, but primarily one size group during July and September 1989 (Fig. 16). The smaller size groups of starry flounder were probably subyearlings (see

Table 20.--Composition and abundance of fishes captured at Miller Sands, Columbia River estuary, during four surveys in 1988-1989. All beach seine values are mean numbers/hectare, trawl values are numbers/hectare.

Beach seine

Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
American shad	2	0	0	3
Chum salmon	0	12	0	0
Coho salmon	0	2	0	0
Chinook salmon (subyearling)	37	495	83	79
Chinook salmon (yearling)	0	1	0	0
Common carp	1	1	2	1
Peamouth	150	38	38	703
Largescale sucker	1	1	7	1
Banded killifish	12	0	11	8
Threespine stickleback	4	3	7	1
Largemouth bass	0	0	1	0
Yellow perch	0	0	4	0
Shiner perch	5	0	0	155
Prickly sculpin	1	0	1	0
Pacific staghorn sculpin	0	68	0	0
Starry flounder	75	7	857	222
TOTAL	288	628	1,011	1,173

Table 20.--Continued.

Taxon	Trawl Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
American shad	66	9	0	4
Chinook salmon (yearling)	0	41	0	0
Unidentified Osmeridae	0	0	17	0
Longfin smelt	18	0	795	0
Peamouth	0	185	30	225
Largescale sucker	0	0	9	0
Pacific tomcod	6	0	0	0
Threespine stickleback	0	0	4	0
Shiner perch	961	0	43	0
Prickly sculpin	0	0	60	41
Pacific staghorn sculpin	36	14	99	70
Starry flounder	120	302	30	276
TOTAL	1,207	551	1,087	616

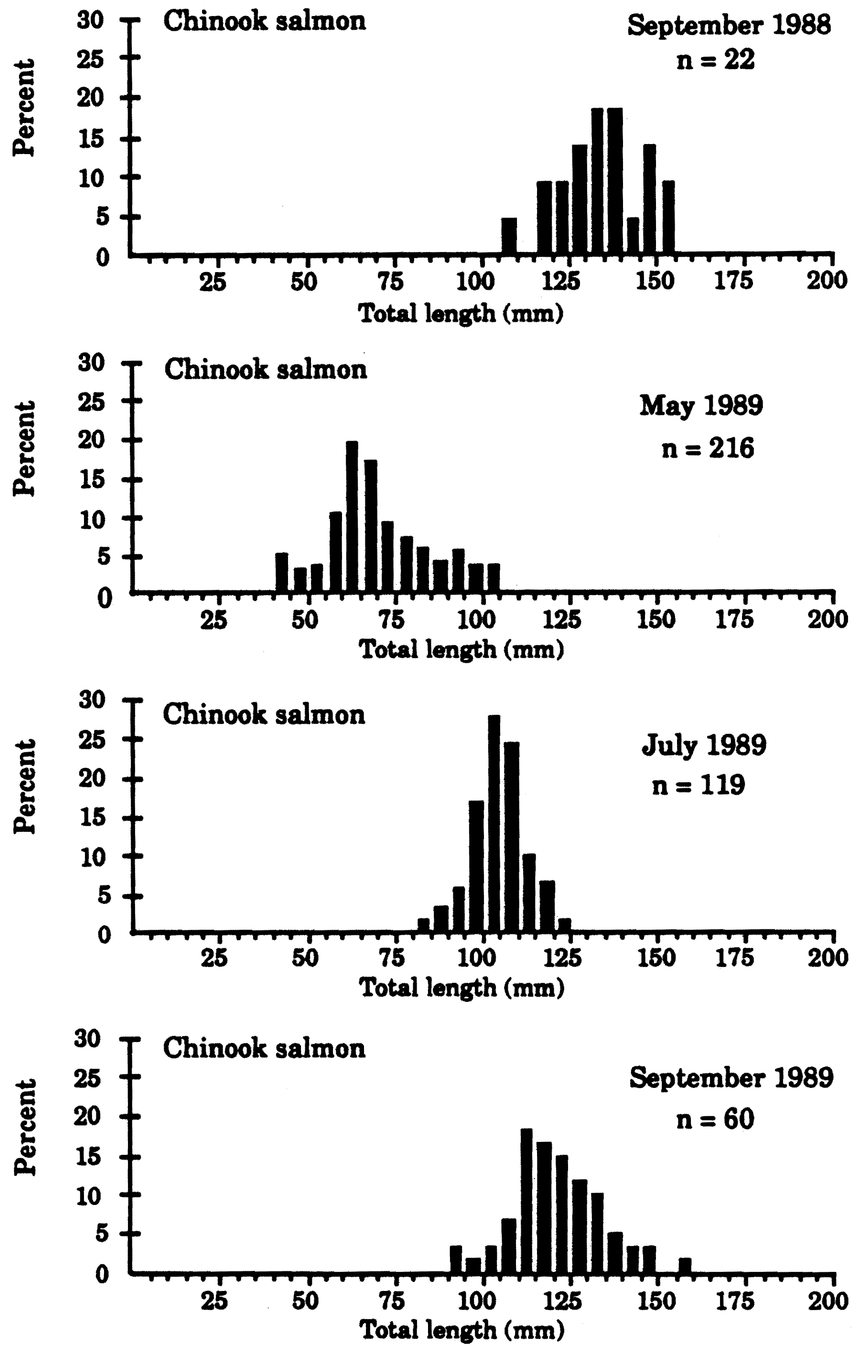


Figure 15.-- Length-frequency distributions of chinook salmon captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

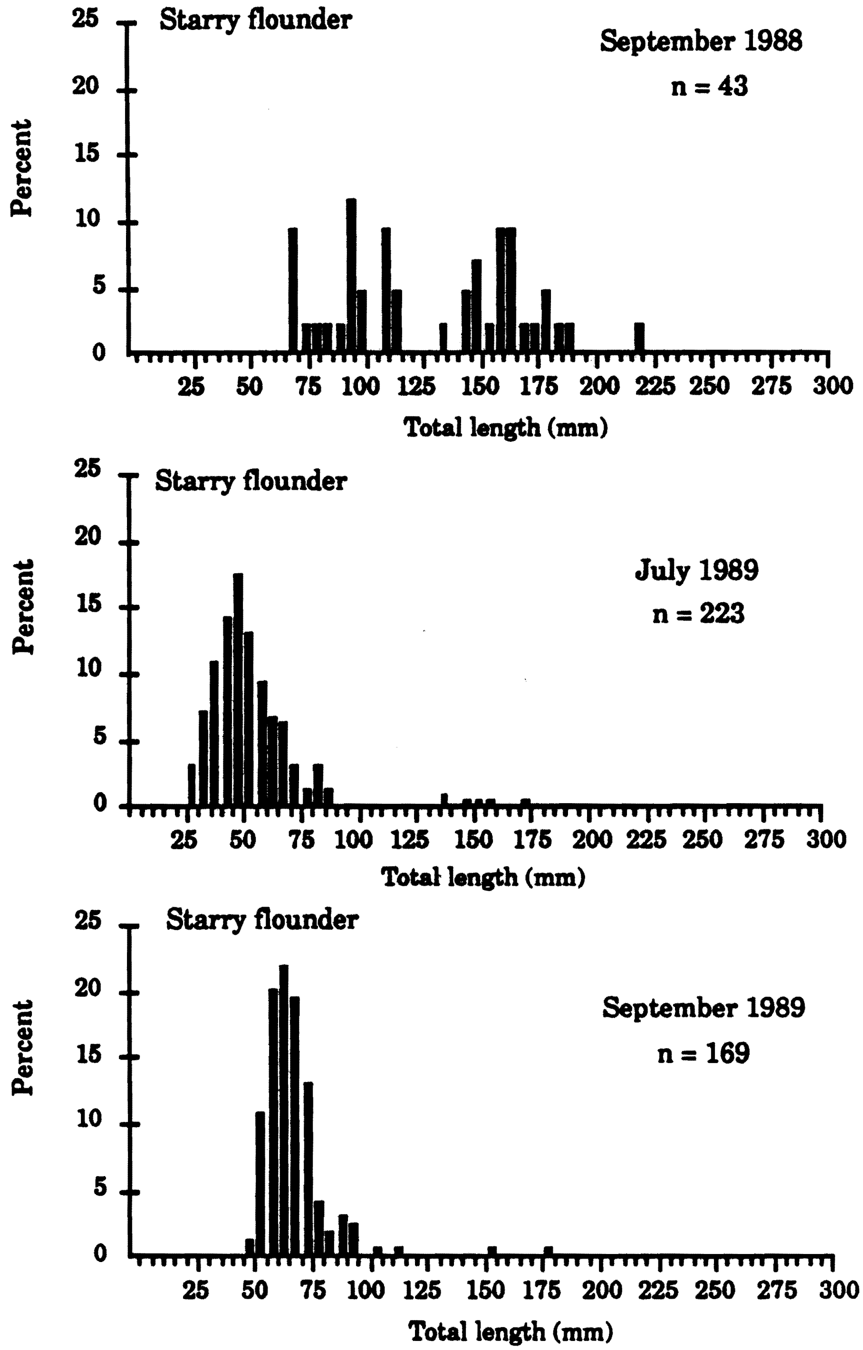
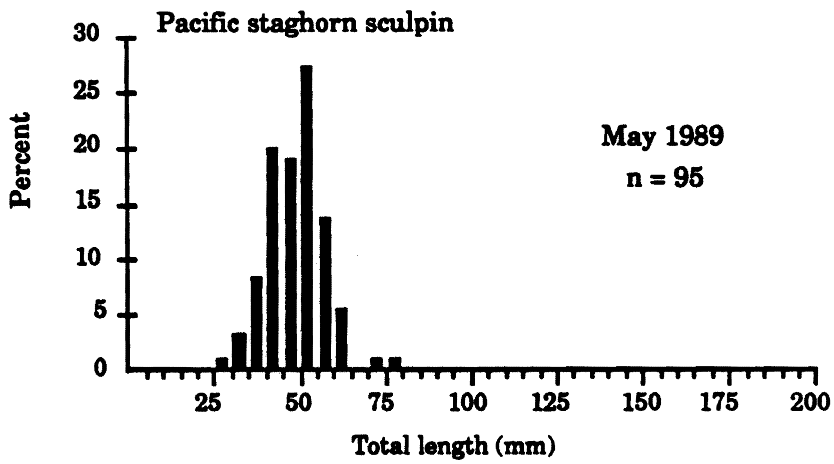


Figure 16.-- Length-frequency distributions of starry flounder captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

National Marine Fisheries Service 1981 for length-age relationship). Most beach-seine caught Pacific staghorn sculpins were in one size group (Fig. 17). Shiner perch captured in beach seines at Miller Sands were represented by at least two size groups (Fig. 17). The smaller size group of shiner perch was probably composed of subyearlings, and the larger size group was composed of fish at least 1 year old (see Anderson and Bryan 1970 for length-age relationship). Peamouth length-frequency distributions indicated the population was composed primarily of one size group during September 1988 and July and September 1989, but more than one during May 1989 (Fig. 18). Longfin smelt caught by trawling were primarily members of one size class (Fig. 19). Length-frequency distributions of trawl-caught peamouth and starry flounder indicated at least two size groups for each of these species (Fig. 19). The smaller size group of starry flounder was probably subyearlings.

Benthic Invertebrates--At Miller Sands, the highest mean number of benthic invertebrate taxa was observed in September 1988 and May 1989 (9) and the lowest in July and September 1989 (7) (Table 21). The highest mean density was found in September 1988 (36,880 invertebrates/m^2) and the lowest in July 1989 (18,109 invertebrates/m^2) (Table 21). In October 1988 (i.e., during the September-October 1988 survey), the subtidal Station M15 had the highest benthic invertebrate density found during the entire study (90,751 invertebrates/m^2), of which 71,087 invertebrates/m^2 were *C. salmonis* (Appendix Table 4). This station had consistently high densities during all four surveys. Among the intertidal stations, Station M3 in September 1988 had the highest density (71,058 invertebrates/m^2); oligochaetes were the most abundant invertebrates



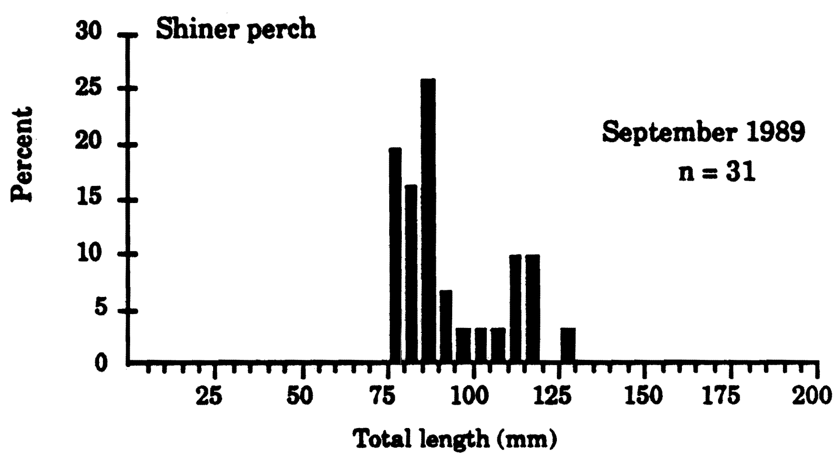


Figure 17.--Length-frequency distributions of Pacific staghorn sculpin and shiner perch captured by beach seine at Miller Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

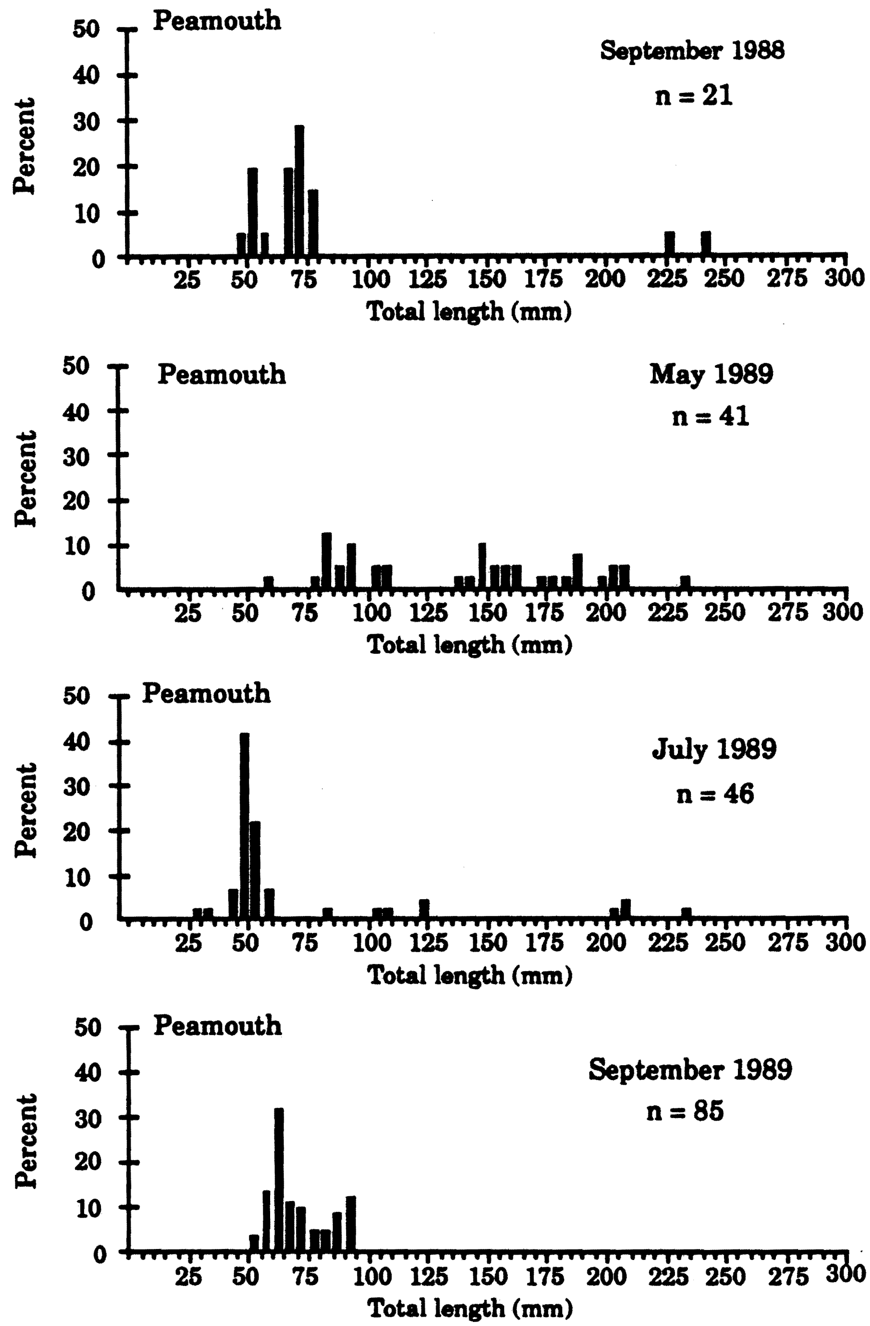


Figure 18.-- Length-frequency distributions of peamouth captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

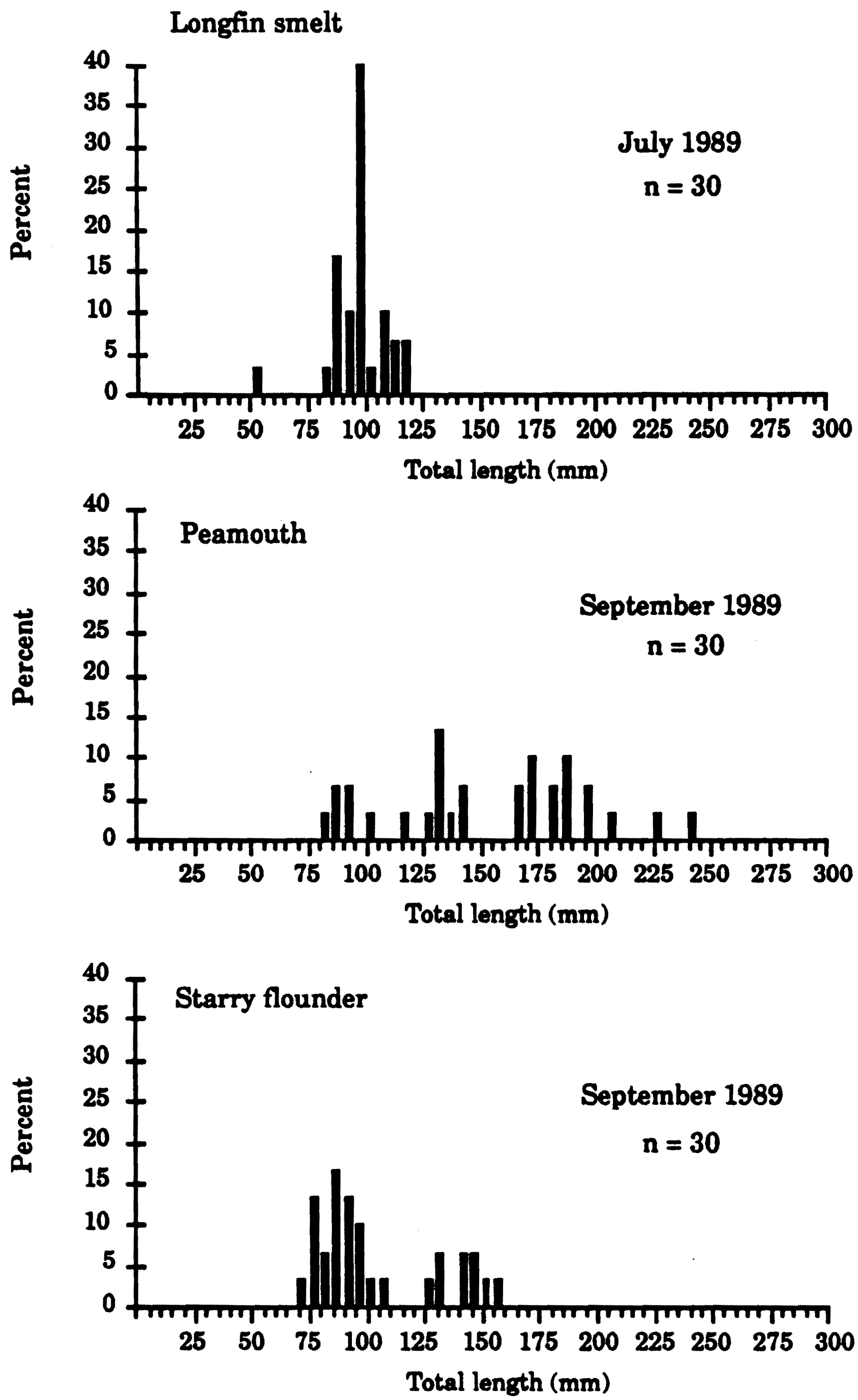


Figure 19.-- Length-frequency distributions of longfin smelt, peamouth, and starry flounder captured by 8-m trawl at Miller Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

Table 21.--Summary of benthic invertebrate collections at Miller Sands, Columbia River estuary, from four surveys in 1988-1989. All values are means.

Survey (date)	Number of taxa	Number/m^2	SD	H′	J′
1 (Sep 88)	9	36,880	31,572	1.56	0.51
2 (May 89)	9	22,714	15,988	1.73	0.59
3 (Jul 89)	7	18,109	21,450	1.33	0.48
4 (Sep 89)	7	26,275	22,163	1.25	0.50

($40,351/m^2$) at this station in September 1988 (Appendix Table 4). Several intertidal stations had high densities of C. salmonis during all four surveys (Appendix Table 4). The community structure indices, particularly J', did not fluctuate widely during the four surveys. H' was highest in May 1989 (mean = 1.73) when the highest number of taxa (9) were collected and J' was highest (mean = 0.59).

Corophium salmonis was the dominant benthic invertebrate in September 1988 and 1989 (Table 22). Oligochaetes were the dominant invertebrates in May and July 1989. Other important invertebrates included N. limnicola, Copepoda, Ostracoda, Chironomidae larvae, and Corbicula manilensis.

Sediments--Mean median grain size of sediments at Miller Sands ranged from very fine sand in September 1988 (3.1 phi) to fine sand in May, July, and September 1989 (2.8 phi) (Table 23). Mean percent silt/clay ranged from 14.3% in September 1988 to 8.1% in September 1989. Mean TOC did not vary widely and was consistently low ($\leq$1.4%).

Jim Crow Sands

Fishes--At Jim Crow Sands, the highest mean fish density was observed in July 1989 (860 fishes/ha) and the lowest in September 1988 (112 fishes/ha) (Table 24). H' was highest in July 1989 (mean = 1.77) when the highest mean number of taxa (6) was collected and species evenness was highest (mean J' = 0.68). H' was lowest in September 1989 (mean = 0.55) when the lowest number of taxa (3) was collected and species evenness was lowest (mean J' = 0.44).

Threespine stickleback (Gasterosteus aculeatus) dominated the fish catches at Jim Crow Sands during the September 1988 and 1989

Table 22.--Composition and abundance of major benthic invertebrate taxa at Miller Sands, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/m^2.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Oligochaeta	12,638	14,149	10,161	5,350
Polychaeta				
Manayunkia speciosa	1,849	0	0	0
Neanthes limnicola	994	177	402	386
Unid. Spionidae	0	0	563	0
Copepoda	89	79	1,738	145
Ostracoda	686	865	418	185
Amphipoda				
Corophium salmonis	17,371	3,235	3,661	17,184
misc.	875	98	105	547
Insecta				
Chironomidae larvae	259	1,180	668	1,754
Heleidae larvae	40	197	8	56
misc.	50	29	89	24
Bivalvia				
Corbicula manilensis	915	551	233	475
misc.	199	0	0	0
Others				
misc.	915	2,153	64	169
TOTAL	36,880	22,713	18,110	26,275

Table 23.--Sediment characteristics at Miller Sands, Columbia River estuary, during four surveys in 1988-1989. All values are means.

	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Median grain size (phi)	3.1	2.8	2.8	2.8
Percent silt/clay	14.3	9.9	10.8	8.1
Percent total organic carbon	1.3	1.0	1.0	1.4

Table 24.--Summary of fish catches at Jim Crow Sands, Columbia River estuary, during four surveys in 1988-1989. Three beach seine efforts were done during each survey. All values are means.

		Beach seine		
Survey (date)	Number of species	Number/ hectare	H′	J′
1 (Sep 88)	4	112	1.01	0.56
2 (May 89)	5	652	1.07	0.47
3 (Jul 89)	6	860	1.77	0.68
4 (Sep 89)	3	701	0.55	0.44

surveys (Table 25). In May 1989, juvenile chinook salmon was the dominant fish captured, and in July 1989, starry flounder was the dominant species. Although not always the dominant species, subyearling chinook salmon, threespine stickleback, and starry flounder were found in all four surveys. Peamouth were moderately abundant during July and September 1989.

Length-frequency histograms of chinook salmon captured at Jim Crow Sands showed two possible size groups were caught in May 1989, but probably only one major group in both July and September 1989 (Fig. 20). The chinook salmon appeared to be primarily subyearlings (see Dawley et al. 1984 for length-age relationship). Threespine stickleback length-frequency histograms indicated at least two size classes in July 1989 (Fig. 21). Distinct size classes of threespine sticklebacks were not identifiable in September 1989. Peamouth catches also showed at least two size groups in July 1989, but only one in September 1989 (Fig. 22). Pacific staghorn sculpins collected in May 1989 were members of one size class (Fig. 23). Starry flounder length-frequency distributions in July 1989 showed primarily one size group, which was probably composed of subyearlings (Fig. 23; see National Marine Fisheries Service 1981 for length-age relationship).

Benthic Invertebrates--The mean number of benthic invertebrate taxa at Jim Crow Sands was highest in September 1988 (7) and lowest in July and September 1989 (5) (Table 26). The highest mean density of benthic invertebrates was observed in September 1989 (24,635 invertebrates/m^2) and the lowest in July 1989 (6,449 invertebrates/m^2). H′ was highest in May 1989 (mean = 1.43). Although the highest number of taxa was not captured in May 1989,

Table 25.--Composition and abundance of fishes captured by beach seine at Jim Crow Sands, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/hectare.

	Beach seine			
Species	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
American shad	10	0	0	3
Chum salmon	0	14	0	0
Coho salmon	0	1	0	0
Chinook salmon (subyearling)	9	560	171	52
Unidentified Cyprinidae	0	0	4	0
Common carp	0	0	1	0
Peamouth	13	0	80	76
Largescale sucker	0	1	1	0
Banded killifish	1	0	0	3
Threespine stickleback	55	16	175	530
Largemouth bass	0	0	1	0
Yellow perch	0	0	10	0
Unidentified Cottidae	0	0	1	0
Prickly sculpin	1	0	0	0
Pacific staghorn sculpin	1	41	3	0
Starry flounder	20	17	412	37
TOTAL	110	650	859	701

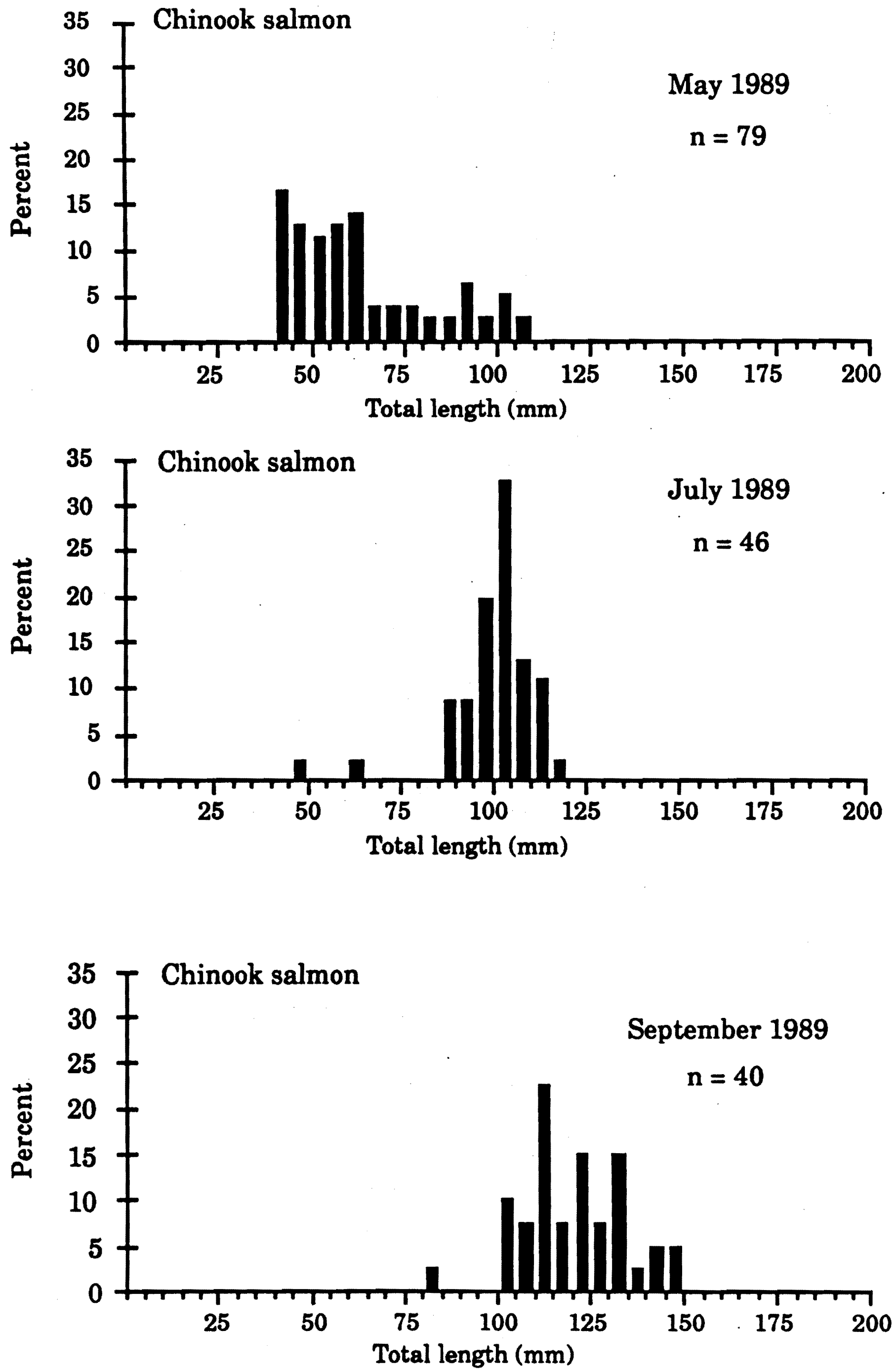
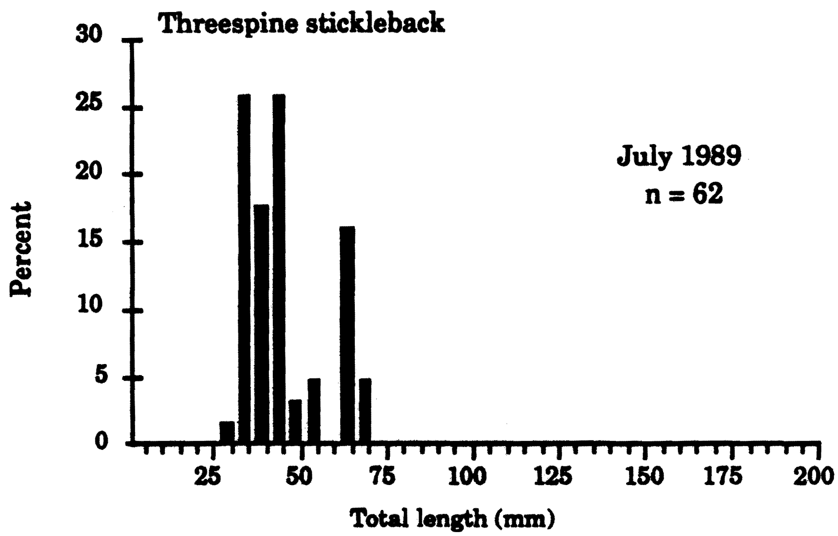


Figure 20.--Length-frequency distributions of chinook salmon captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.



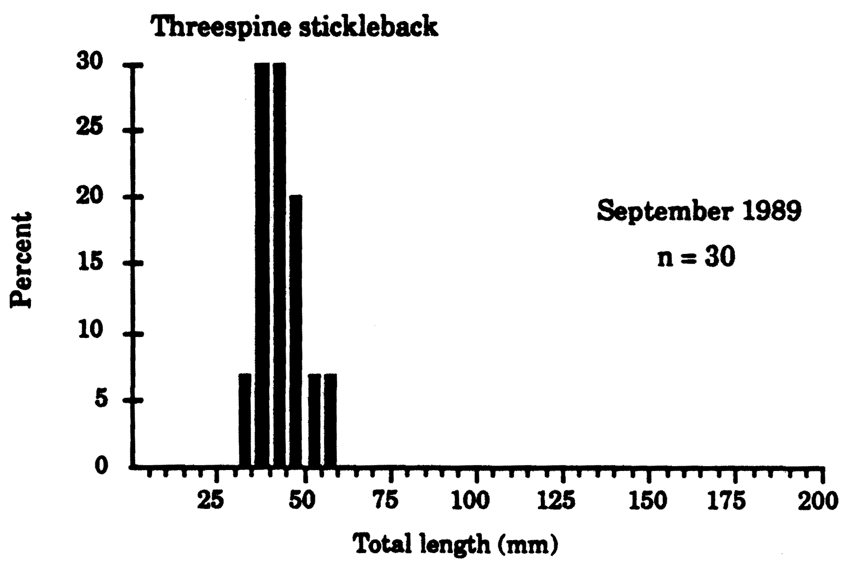


Figure 21.-- Length-frequency distributions of threespine stickleback captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

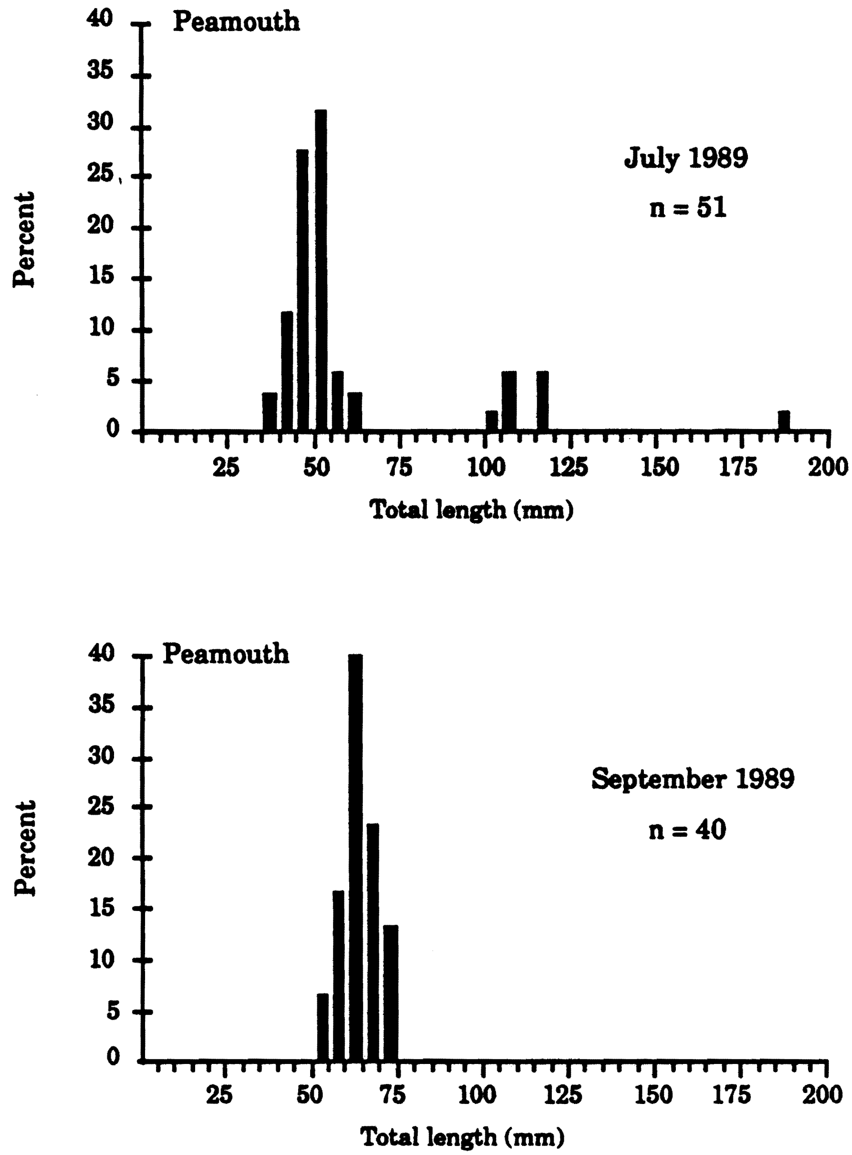


Figure 22.-- Length-frequency distributions of peamouth captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

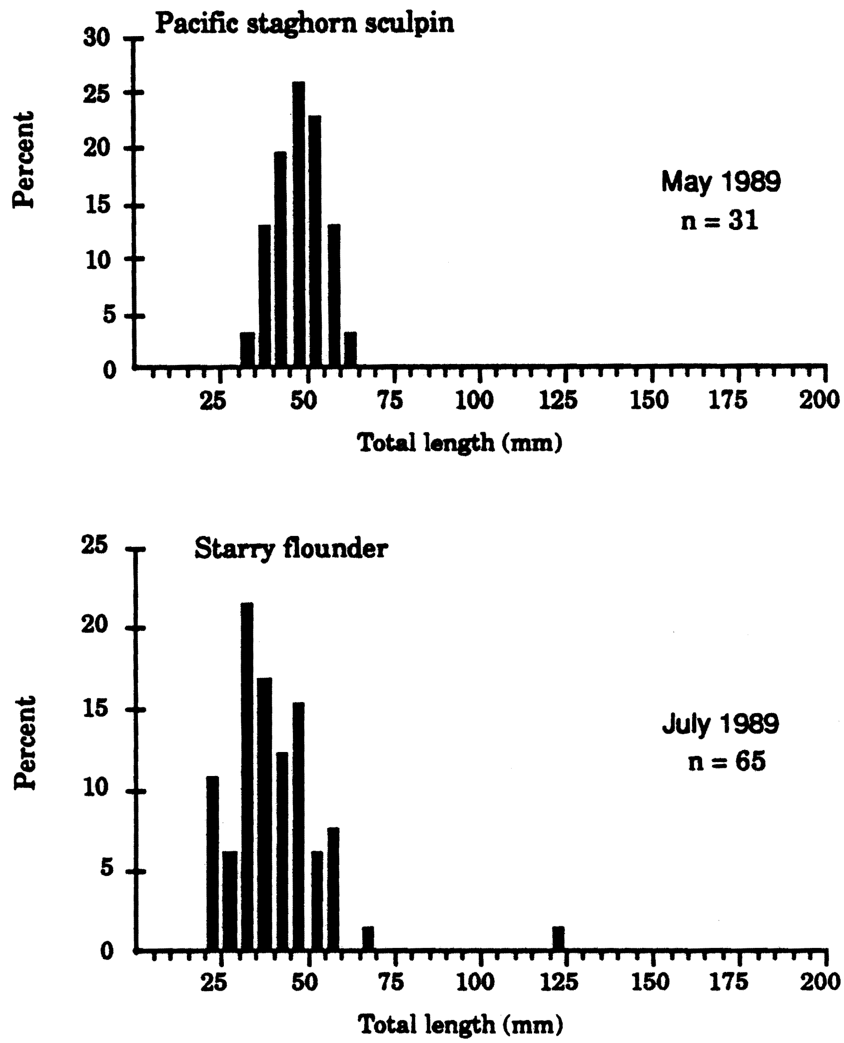


Figure 2 .-- Length-frequency distributions of Pacific staghorn sculpin and starry flounder captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

Table 26.--Summary of benthic invertebrate collections at Jim Crow Sands, Columbia River estuary, from four surveys in 1988-1989. All values are means.

Survey (date)	Number of taxa	Number/m^2	SD	H′	J′
1 (Sep 88)	7	20,133	15,884	1.24	0.47
2 (May 89)	6	16,626	19,178	1.43	0.63
3 (Jul 89)	5	6,449	4,721	1.23	0.50
4 (Sep 89)	5	24,635	26,354	0.87	0.31

species evenness (mean J′ = 0.63) was high enough to produce the highest diversity.

Although their mean densities varied between surveys, oligochaetes were the dominant benthic invertebrates in all four surveys at Jim Crow Sands (Table 27). Corophium salmonis was the second most abundant invertebrate in three of the four surveys. Other abundant taxa included N. limnicola, Ostracoda, Pontoporeia hoyi, Chironomidae larvae, and Corbicula manilensis.

Sediments--Mean median grain size at Jim Crow Sands was very consistent between surveys, ranging from 2.7 phi in May 1989 to 2.8 phi in September 1988 and July and September 1989 (Table 28). Mean percent silt/clay ranged from 9.6% in September 1988 to 5.9% in July 1989. Mean TOC was $\leq$1% in all surveys.

Miller Sands Comparisons

Fishes

The mean fish density (mean number/ha) in 1989 was significantly higher than densities in 1975, 1976, or 1977 (t-test, $P \leq 0.05$). Comparing densities of similar months for different years, the July 1989 density was significantly higher than the July 1977 density, and the September 1989 density was significantly higher than the September 1975 density. There were no significant differences between May 1989 and May in 1975, 1976, and 1977. Little change occurred in fish species composition (for the most common species) at the four similar stations between the surveys in 1975-1977 and the surveys in 1989 (Appendix Table 6). Mean number of fish species per survey ranged from three to six (Table 29). H′ and J′ were highest in May 1977 (means = 1.64 and 0.71, respectively) and lowest

Table 27.--Composition and abundance of major benthic invertebrate taxa at Jim Crow Sands, Columbia River estuary, during four surveys in 1988-1989. All values are mean numbers/m².

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Oligochaeta	8,993	9,900	2,788	14,115
Polychaeta				
Neanthes limnicola	177	44	144	597
Unid. Spionidae	44	0	0	0
Copepoda	33	0	11	0
Ostracoda	210	1,670	155	409
Amphipoda				
Corophium salmonis	7,854	1,615	1,416	5,852
Pontoporeia hoyi	354	1,007	0	55
misc.	100	221	177	11
Insecta				
Chironomidae larvae	288	442	199	1,515
Heleidae larvae	11	122	33	11
misc.	11	0	22	11
Bivalvia				
Corbicula manilensis	1,604	962	1,217	1,681
misc.	22	55	0	0
Others				
misc.	431	586	288	387
TOTAL	20,132	16,624	6,450	24,644

Table 28.--Sediment characteristics at Jim Crow Sands, Columbia River estuary, during four surveys in 1988-1989. All values are means.

	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Median grain size (phi)	2.8	2.7	2.8	2.8
Percent silt/clay	9.6	8.7	5.9	8.6
Percent total organic carbon	1.0	0.8	1.0	0.9

Table 29.--Summary of fish catches at Miller Sands, Columbia River estuary, during surveys in 1975-1977 and 1989. Selected for comparison were Stations M2, M3, M10, and M11 (see Fig. 3 for station locations). All values are means.

Date	Number of species	Number/ hectare	H′	J′
May 1975	6	247	1.29	0.53
Jul 1975	4	238	0.82	0.46
Sep 1975	3	53	1.10	0.68
May 1976	5	359	1.09	0.55
Jul 1976	4	381	0.91	0.50
Sep 1976	5	457	0.92	0.53
May 1977	5	190	1.64	0.71
Jul 1977	4	110	1.31	0.70
May 1989	5	562	1.02	0.47
Jul 1989	4	1,465	0.75	0.48
Sep 1989	3	749	0.70	0.34

in September 1989 (mean = 0.70 and 0.34, respectively). Comparing 1989 mean values of diversity and species evenness with the earlier years, only H′ for 1977 was significantly higher than 1989 (t-test, $P \leq 0.05$); none of the differences in J′ were statistically significant. Comparing mean values of diversity and species evenness of similar months for different years, only one significant difference was found: H′ in July 1977 was significantly higher than H′ in July 1989.

In 1989, densities of chinook salmon (primarily subyearlings), peamouth, shiner perch, and starry flounder were higher than densities in 1975-1977 (Table 30). Of the less dominant species, banded killifish (Fundulus diaphanus), largemouth bass (Micropterus salmoides), and yellow perch (Perca flavescens) were represented in 1989, but were not found at the selected sites in 1975-1977. The threespine stickleback, which was moderately abundant in 1975-1977, was poorly represented in 1989.

Benthic Invertebrates

At Miller Sands, the mean density of benthic invertebrates in 1989 was significantly higher than the density in 1976 (t-test, $P \leq 0.05$), but not significantly different than densities in 1975 and 1977 (Table 31). Comparisons of mean invertebrate densities in May, July, and September of 1989 to similar months in 1975, 1976, and 1977 revealed no significant differences. The composition of benthic invertebrate taxa at the five similar stations remained consistent between surveys conducted in 1975-1977 (Appendix Table 7) and 1989 (Appendix Table 8). The mean number of taxa varied from five to nine.

Table 30.--Species composition and abundance of fishes captured at Miller Sands, Columbia River estuary, during surveys in 1975-1977 and 1989. Selected for comparison were Stations M2, M3, M10, and M11 for May, July, and September of each year (see Fig. 3 for station locations). All values are mean numbers/hectare.

Species	1975	1976	1977*	1989
Pacific lamprey	<1	0	0	0
American shad	3	8	1	3
Chum salmon	1	0	1	9
Coho salmon	1	<1	1	1
Chinook salmon	74	99	55	265
Common carp	1	<1	3	1
Peamouth	14	44	10	77
Largescale sucker	1	5	0	5
Banded killifish	0	0	0	7
Threespine stickleback	11	97	13	3
Largemouth bass	0	0	0	1
Yellow perch	0	0	0	2
Shiner perch	0	0	0	152
Prickly sculpin	0	1	20	0
Pacific staghorn sculpin	0	0	2	19
Starry flounder	74	145	47	601
TOTAL	180	399	153	1,146

* Surveys were conducted only in May and July 1977.

Table 31.--Summary of benthic invertebrate collections at Miller Sands, Columbia River estuary, during surveys in 1975-1977 and 1989. Selected for comparison were Stations M2, M3, M6, M10, and M11 (see Fig. 3 for station locations). All values are means.

Date	Number of taxa	Number/m²	SD	H′	J′
May 1975	8	7,469	4,916	1.08	0.37
Jul 1975	7	6,242	6,676	0.79	0.29
Sep 1975	9	6,940	2,987	0.91	0.30
May 1976	6	2,765	3,668	1.42	0.55
Jul 1976	6	2,097	1,394	1.13	0.47
Sep 1976	6	3,472	621	1.42	0.56
May 1977	5	4,657	4,127	1.02	0.45
Jul 1977	5	2,693	794	1.51	0.61
May 1989	6	9,358	8,501	1.75	0.73
Jul 1989	6	13,345	11,464	0.90	0.34
Sep 1989	7	14,177	12,877	1.43	0.57

Mean values for community structure indices H′ and J′ at Miller Sands were highest in May 1989 (1.75 and 0.73, respectively) and lowest in July 1975 (0.79 and 0.29, respectively) (Table 31). Mean H′ in 1989 was not significantly different than mean H′ in 1975, 1976, and 1977. Mean J′ in 1989 was significantly higher than mean J′ in 1975, but not significantly different than mean J′ in 1976 and 1977. Comparing the individual months of May, July, and September of 1989 to similar months in 1975, 1976, and 1977, mean H′ in September 1989 was significantly higher than H′ in September 1975 (t-test, $P \leq 0.05$). Also, comparing mean J′ of similar months, May 1989 was significantly higher than May 1975 and 1977. No other significant differences occurred for the community structure indices. Overall, mean J′ tended to be relatively low in all 4 years at the sampling stations, indicating that the proportional abundances of the various benthic invertebrate taxa at Miller Sands were not equally distributed.

In 1989, all major benthic invertebrate taxa at Miller Sands increased in abundance compared to 1975, 1976, and 1977 (Table 32). Oligochaetes were by far the most abundant taxon and *C. salmonis* the second most abundant taxon for all years at the five stations used for comparison. Other common taxa included *N. limnicola*, Chironomidae, and *Corbicula manilensis*.

Sediments

Sediment characteristics at Miller Sands changed between the surveys in 1976-1977 and 1989 (Table 33 and Appendix Table 9). For all months in 1976-1977, median grain size was >3.3-3.6 phi (very fine sand) whereas for all months in 1989, median grain size was >2.5-2.8 phi (fine sand). Mean median grain size was significantly

Table 32.--Composition and abundance of major benthic invertebrate taxa at Miller Sands, Columbia River estuary, during surveys in 1975-1977 and 1989. Selected for comparison were Stations M2, M3, M6, M10, and M11 for May, July, and September of each year (see Fig. 3 for station locations). All values are mean numbers/m^2.

Taxon	1975	1976	1977*	1989
Oligochaeta				
misc.	5,626	1,568	2,021	6,527
Polychaeta				
Neanthes limnicola	17	16	8	324
Copepoda				
misc.	0	0	0	47
Amphipoda				
Corophium salmonis	801	1,020	950	3,426
misc.	0	1	1	65
Insecta				
Chironomidae	352	100	464	777
misc.	2	4	0	43
Bivalvia				
Corbicula manilensis	81	97	215	302
Others				
misc.	28	132	15	782
TOTAL	6,907	2,938	3,674	12,293

* Surveys were conducted only in May and July 1977.

Table 33.--Sediment characteristics at Miller Sands, Columbia River estuary, during surveys in 1975-1977 and 1989. Selected for comparison were Stations M2, M3, M6, M10, and M11 (see Fig. 3 for station locations). All values are means.

Date	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
Jul 76	3.4	13.0	2.5
Sep 76	3.4	14.7	2.8
May 77	3.3	14.1	2.4
Jul 77	3.6	22.8	2.7
May 89	2.6	7.3	0.8
Jul 89	2.8	11.0	0.9
Sep 89	2.5	4.4	0.8

larger in 1989 than 1976 and 1977 (t-test, $P \leq 0.05$). Comparing mean median grain size of May, July, and September 1989 to similar months in 1976 and 1977 revealed no significant differences.

Mean percent silt/clay varied between the surveys conducted in 1976-1977 and 1989, ranging from 22.8% in July 1977 to 4.4% in September 1989. Mean percent silt/clay was significantly higher in 1977 than 1989, but not significantly different between 1976 and 1989 (t-test, $P \leq 0.05$). There were no significant differences when comparing similar months between 1989 and 1976-1977.

Mean TOC was low for all years, ranging from 2.8% in September 1976 to 0.8% in May and September 1989. Mean TOC was significantly higher in 1976 and 1977 compared to 1989 (t-test, $P \leq 0.05$). When comparing similar months in 1989 to 1976-1977, mean TOC was significantly lower in 1989 compared to May 1977, July 1976 and 1977, and September 1976 (Table 33).

DISCUSSION

1988-1989 Surveys

All five areas that were surveyed in 1988-1989 are productive estuarine habitats. Miller Sands and Jim Crow Sands in particular appear to be important feeding and rearing areas for several species of fishes, including juvenile salmonids, starry flounder, and peamouth. Since the distribution and feeding of fishes are influenced directly by the availability of specific benthic invertebrate taxa (Bottom et al. 1984), it is not surprising that Miller Sands and Jim Crow Sands had the highest average benthic invertebrate densities of the five survey areas. Compared to earlier estuarine studies, Miller Sands and Jim Crow Sands had some of the highest benthic invertebrate densities in the estuary (McConnell et al. 1978; Holton et al. 1984; Emmett et al. 1986). Densities of the amphipod C. salmonis, an important prey for juvenile salmonids and starry flounder (McCabe et al. 1983, 1986), frequently exceeded 10,000/m^2 in our study.

Rice Island had the lowest densities of fishes and benthic invertebrates of the three man-made islands in this study. Intertidal stations at Rice Island appear to be subject to harsher physical conditions than intertidal stations at Miller Sands and Jim Crow Sands, a factor that could be limiting biological production. Winds appeared to blow sand from the higher unvegetated elevations of the island onto the intertidal flats. The moving sand and wave action create an environment which is unstable for colonization by most benthic invertebrates. Also, prevailing winds often produce rough waves throughout the intertidal area, thus forcing juvenile fishes into the slightly deeper and calmer subtidal region.

Rice Island, Miller Sands, and Jim Crow Sands have extensive shallow subtidal areas surrounding portions of the main islands. Limited sampling at the Miller Sands subtidal station (M15) indicated that benthic invertebrate densities in subtidal habitats can be very high, often exceeding densities observed at intertidal stations. This finding emphasizes that the standing crop of fishes and invertebrates in intertidal habitats is not necessarily representative of the standing crop in subtidal habitats. Further evidence of this was the observation of large flocks of gulls, terns, and cormorants feeding on fish in the shallow subtidal region north of Rice Island; yet few fish were captured in intertidal areas along the island. During minus tides, many benthic invertebrates were observed on the substrate surface in the subtidal area. Similar observations were made on the south side of Jim Crow Sands.

The limited biological sampling at Desdemona Sands and Taylor Sands did not generate enough data to fully describe these areas. Nonetheless, Desdemona Sands trawl catches were high, suggesting that the area supports a variety of marine fish species. Measured benthic invertebrate densities at Desdemona Sands were also high, and many of the species were marine. Previous benthic invertebrate surveys at Desdemona Sands have documented densities as high as 81,024 invertebrates/m^2 (Holton et al. 1984). The limited sampling at Taylor Sands suggests the area is also used as a feeding ground by juvenile fishes, although to a lesser extent than Desdemona Sands.

Numerous studies in North American estuaries have shown that species composition and densities of benthic invertebrates and fishes vary in time and space. Therefore, a long-term study is required to describe the natural fluctuations in population abundances within a given area (Meeter et al. 1979). Long-term studies are also essential in developing a better understanding of the life history characteristics and interactions of key species (Underwood 1989). Accordingly, a study of at least 3 to 5 years would be recommended prior to the initiation of any habitat modifications. The results of such a study would provide a solid foundation of data from which the environmental success or failure of the modification could be evaluated.

Miller Sands Comparisons

Fish and benthic invertebrate densities were higher in 1989 than 1975-1977 at the Miller Sands lagoon, suggesting that the creation of the marsh and lagoon was a beneficial use of dredged-material. Juvenile fishes, particularly chinook salmon, starry flounder, and peamouth, showed increased use of the marsh and lagoon as a feeding and rearing area. However, timing of our sampling in relation to when large numbers of hatchery-reared chinook salmon migrate into the estuary could account for some of the variation between years. Also, the success of starry flounder spawning and subsequent larval recruitment in the ocean could affect the number of individuals using Miller Sands. In the absence of a time-series of data on starry flounder population dynamics, it is not known whether this was the case. In addition, the presence of shiner perch at Miller Sands in 1989 is of particular importance. The presence of this estuarine species indicates that saline water is penetrating into or near the Miller Sands lagoon. Although Miller Sands and surrounding areas are now productive freshwater habitats, increased salinities resulting from reduced river flows or channel deepening could alter this status. Altering hydrologic conditions will clearly cause changes in species usage and shifts in biological communities.

Sediment composition at Miller Sands has also changed over the years, with median grain size increasing from very fine sand in 1976-1977 to fine sand in 1989. The reason for this increase is unclear; however, it may have been caused by strong winds blowing coarse sand from the unvegetated portions of the island into the intertidal areas. The decrease in percent silt/clay and TOC in 1989 may be due to better flushing of the lagoon. Extremely low river flows in 1976 and 1977 may have decreased circulation in the lagoon, allowing the accumulation of silt/clay and organic material.

Any future modifications of Miller Sands should give full consideration to the importance of the existing lagoon channel. From a biological perspective, maintaining a channel though the lagoon is probably critical for the present fauna. The channel aids in flushing and may prevent productive subtidal and intertidal habitats from filling with sediments. The channel also provides a refuge for fishes during low tide and maintains adequate water circulation. Good circulation is essential to maintaining dissolved oxygen and nutrient concentrations required to sustain benthic communities (Gilmore and Trent 1974).

For the same reasons that it is not possible to describe natural variations in the biological communities at potential dredged-material disposal sites with only 1 year of data, it is also not possible to unequivocally judge the success of the habitat modification at Miller Sands. Multiple years of sample collection and analyses will be required to determine if indeed the measured increases in abundances of fishes and invertebrates were the results of habitat changes ("improvement") or due to natural, interannual cycles in abundances and distributions of key species. Furthermore, it is not possible to predict that habitat modifications (similar to those done at Miller Sands) at other estuarine areas would be beneficial to biological communities because every area in the Columbia River estuary has unique hydrological and biological characteristics.

In conclusion, although comparisons between Miller Sands in 1975-77 and 1989 include a number of uncertainties, it appears that the creation of the lagoon and marsh resulted in increased standing crops of fishes and invertebrates. Hence, the available evidence from Miller Sands supports the concept of economical, yet beneficial use of dredged material and should only encourage further evaluation of this disposal alternative.

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

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APPENDIX

Data Tables

Appendix Table 1.--Fishes and crabs captured at five areas of the Columbia River estuary--Desdemona Sands, Taylor Sands, Rice Island, Miller Sands, and Jim Crow Sands--during four surveys. Survey 1 was in September-October 1988, Survey 2 in May 1989, Survey 3 in July 1989, and Survey 4 in September 1989.

Scientific name	Common name	Survey			
		1	2	3	4
Petromyzontidae					
Lampetra ayresi	River lamprey	x			
Acipenseridae					
Acipenser transmontanus	White sturgeon			x	
Clupeidae					
Alosa sapidissima	American shad	x	x	x	x
Clupea harengus pallasi	Pacific herring		x	x	x
Engraulidae					
Engraulis mordax	Northern anchovy			x	
Salmonidae					
Oncorhynchus keta	Chum salmon		x		
Oncorhynchus kisutch	Coho salmon		x		
Oncorhynchus tshawytscha	Chinook salmon	x	x	x	x
Osmeridae					
Unidentified Osmeridae					
Allosmerus elongatus	Whitebait smelt			x	x
Hypomesus pretiosus	Surf smelt		x	x	
Spirinchus thaleichthys	Longfin smelt	x		x	x
Cyprinidae					
Unidentified Cyprinidae				x	
Cyprinus carpio	Common carp	x	x	x	x
Mylocheilus caurinus	Peamouth	x	x	x	x
Catostomidae					
Catostomus macrocheilus	Largescale sucker	x	x	x	x

Appendix Table 1.-- Continued.

Scientific name	Common name	Survey 1	Survey 2	Survey 3	Survey 4
Gadidae					
Microgadus proximus	Pacific tomcod	x		x	x
Cyprinodontidae					
Fundulus diaphanus	Banded killifish	x		x	x
Gasterosteidae					
Gasterosteus aculeatus	Threespine stickleback	x	x	x	x
Centrarchidae					
Micropterus salmoides	Largemouth bass			x	
Percidae					
Perca flavescens	Yellow perch			x	
Embiotocidae					
Cymatogaster aggregata	Shiner perch	x		x	x
Stichaeidae					
Lumpenus sagitta	Snake prickleback	x	x	x	
Pholidae					
Pholis ornata	Saddleback gunnel		x		
Ammodytidae					
Ammodytes hexapterus	Pacific sand lance		x		
Cottidae					
Unidentified Cottidae				x	
Cottus asper	Prickly sculpin	x	x	x	x
Leptocottus armatus	Pacific staghorn sculpin	x	x	x	x
Pleuronectidae					
Parophrys vetulus	English sole	x		x	
Platichthys stellatus	Starry flounder	x	x	x	x
Misc.					
Canceridae					
Cancer magister	Dungeness crab	x		x	x
	Total number of species:	17	16	25	16

Appendix Table 2.--Fish and crab catch summaries at five sampling areas in the Columbia River estuary--Desdemona Sands (D), Taylor Sands (T), Rice Island (R), Miller Sands (M), and Jim Crow Sands (J). Four surveys were conducted during 1988-1989.

Station: D1

Gear: 8-m trawl
Date: 19 Oct 1988
Depth: 6.4 m
Distance traveled: 370 m
Tide stage: Late flood

	Surface	Bottom
Temperature (C):	13.9	12.5
Salinity (ppt):	12.3	28.4
Turbidity (NTU):	2.4	-
pH:	8.1	-

Species	No. captured	No. per Hectare
Starry flounder	105	568
English sole	20	108
Pacific staghorn sculpin	2	11
Snake prickleback	3	16
Pacific tomcod	3	16
Dungeness crab	20	108
TOTALS	153	827

H′ = 1.44   J′ = 0.56

Appendix Table 2.--Continued.

Station: R1

Gear: 50-m beach seine
Date: 22 Sep 1988
pH: 7.5

Temperature: 18.0 C
Turbidity: 2.6 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
NO FISH captured		

Station: R2

Gear: 50-m beach seine
Date: 23 Sep 1988
pH: 7.

Temperature: 18.0 C
Turbidity: 2.1 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	4
Starry flounder	5	20
Prickly sculpin	1	4
TOTALS	7	28

H′ = 1.15   J′ = 0.72

Appendix Table 2.--Continued.

Station: R3

Gear: 50-m beach seine
Date: 23 Sep 1988
pH: 7.8
Temperature: 17.0 C
Turbidity: 4.7 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	2	8
TOTALS	2	8

H' = 0.00 J' = 0.00

Station: M3

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 6.9
Temperature: 15.0 C
Turbidity: 4.4 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	35	270
American shad	1	8
Peamouth	165	1,273
Shiner perch	6	46
Largescale sucker	1	8
Common carp	1	8
Banded killifish	3	23
Prickly sculpin	1	8
Threespine stickleback	4	31
Starry flounder	33	255
TOTALS	250	1,930

H' = 1.61 J' = 0.48

Appendix Table 2.--Continued.

Station: M4

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 6.9

Temperature: 19.0 C
Turbidity: 2.0 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Starry flounder	29	224
Peamouth	1	8
TOTALS	30	232

H' = 0.21   J' = 0.21

Station: M10

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 7.0

Temperature: 18.0 C
Turbidity: 4.4 NTU
Tide stage: -

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	5	20
Peamouth	25	98
Starry flounder	21	83
Banded killifish	12	47
Threespine stickleback	1	4
TOTALS	64	252

H' = 1.89   J' = 0.81

Appendix Table 2.--Continued.

Station: M11

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 6.9

Temperature: 18.5C
Turbidity: 2.0 NTU
Tide stage: -

Species	No. captured	No. per hectare
Starry flounder	1	4
TOTALS	1	4

H′ = 0.00 J′ = 0.00

Station: M13

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 7.4

Temperature: 18.0 C
Turbidity: 2.8 NTU
Tide stage: Mid ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	7	28
Starry flounder	11	43
American shad	1	4
TOTALS	19	75

H′ = 1.21 J′ = 0.76

Appendix Table 2.--Continued.

Station: M14

Gear: 50-m beach seine
Date: 21 Sep 1988
pH: 7.2

Temperature: 19.0 C
Turbidity: 2.4 NTU
Tide stage: -

Species	No. captured	No. per hectare
Starry flounder	1	4
TOTALS	1	4

H' = 0.00   J' = 0.00

Station: M15

Gear: 8-m trawl
Date: 20 Oct 1988
Depth: 7.9 m
Distance traveled: 333 m
Tide stage: Late flood

	Surface	Bottom
Temperature (C):	16.1	15.3
Salinity (ppt):	0.3	6.6
Turbidity NTU :	3.6	
pH:	7.3	

Species	No. captured	No. per Hectare
Shiner perch	160	961
American shad	11	66
Longfin smelt	3	18
Starry flounder	20	120
Pacific tomcod	1	6
Pacific staghorn sculpin	6	36
TOTALS	201	1,207

H' = 1.10   J' = 0.43

Appendix Table 2.--Continued.

Station: J1

Gear: 50-m beach seine
Date: 21 Oct 1988
pH: -

Temperature: 15.0 C
Turbidity: 0.0 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	3	12
Starry flounder	3	12
American shad	6	24
Prickly sculpin	1	4
Pacific staghorn sculpin	1	4
Threespine stickleback	42	165
Banded killifish	1	4
TOTALS	57	225

H′ = 1.42   J′ = 0.51

Station: J2

Gear: 50-m beach seine
Date: 21 Oct 1988
pH: -

Temperature: 15.0 C
Turbidity: 0.0 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	3	12
Starry flounder	12	47
American shad	2	8
TOTALS	17	67

H′ = 1.16   J′ = 0.73

Appendix Table 2.--Continued.

Station: J34

Gear: 50-m beach seine
Date: 21 Oct 1988
pH: -

Temperature: 14.0 C
Turbidity: 0.0 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	4
Peamouth	10	39
TOTALS	11	43

H′ = 0.44   J′ = 0.44

Appendix Table 2.--Continued.

Station: D1

Gear: 8-m trawl		Surface	Bottom
Date: 4 May 1989	Temperature (C):	14.0	12.3
Depth: 7.0 m	Salinity (ppt):	10.7	22.0
Distance traveled: 426 m	Turbidity (NTU):	4.4	-
Tide stage: -	pH:	7.5	-

Species	No. captured	No. per Hectare
Pacific herring	18	85
Starry flounder	11	52
Pacific sand lance	809	3,798
Surf smelt	1	5
Snake prickleback	1	5
River lamprey	1	5
Saddleback gunnel	1	5
TOTALS	842	3,955

H' = 0.30   J' = 0.11

Appendix Table 2.--Continued.

Station: D2

Gear: 50-m beach seine
Date: 8 May 1989
pH: 7.1

Temperature: 13.8C
Turbidity: 9.8 NTU
Tide stage: Late ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	45	177
Chinook salmon (yearling)	1	4
Coho salmon	4	16
Surf smelt	55	217
Pacific staghorn sculpin	1	4
TOTALS	106	418

H′ = 1.32   J′ = 0.57

Appendix Table 2.--Continued.

Station: T1

Gear: 8-m trawl		Surface	Bottom
Date: 18 May 1989	Temperature (C):	13.7	13.6
Depth: 4.3 m	Salinity (ppt):	-	-
Distance traveled: 407 m	Turbidity NTU :	-	-
Tide stage: flood	pH:	-	-

Species	No. captured	No. per Hectare
Chinook salmon	17	84
American shad	1	5
Threespine stickleback	2	10
TOTALS	20	99

H′ = 0.75   J′ = 0.47

Appendix Table 2.--Continued.

Station: T2

Gear: 8-m trawl		Surface	Bottom
Date: 18 May 1989	Temperature (C):	14.0	14.0
Depth: 5.5 m	Salinity (ppt):	-	-
Distance traveled: 407 m	Turbidity NTU :	-	-
Tide stage: Flood	pH:	-	-

Species	No. captured	No. per Hectare
Chinook salmon	30	147
Chinook salmon (>1 year)	1	5
Threespine stickleback	1	5
American shad	2	10
Starry flounder	11	54
Prickly sculpin	2	10
TOTALS	47	231

H′ = 1.53 J′ = 0.59

Appendix Table 2.--Continued.

Station: R1

Gear: 50-m beach seine
Date: 9 May 1989
pH: 6.6
Temperature: 13.5C
Turbidity: 6.6 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	71	280
Surf smelt	134	528
Pacific staghorn sculpin	115	453
Threespine stickleback	7	28
Starry flounder	1	4
TOTALS	328	1,293

H' = 1.68   J' = 0.72

Station: R2

Gear: 50-m beach seine
Date: 9 May 1989
pH: 6.6
Temperature: 13.5C
Turbidity: 7.4 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	80	315
Pacific staghorn sculpin	21	83
TOTALS	101	398

H' = 0.74   J' = 0.74

Appendix Table 2.--Continued.

Station: R3

Gear: 50-m beach seine
Date: 9 May 1989
pH: 6.6

Temperature: 14.3C
Turbidity: 11.0 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	83	327
Threespine stickleback	1	4
Peamouth	15	59
Pacific staghorn sculpin	22	87
TOTALS	121	477

H' = 1.25   J' = 0.63

Appendix Table 2.--Continued.

Station: M2

Gear: 50-m beach seine
Date: 5 May 1989
pH: 7.3

Temperature: 16.0 C
Turbidity: 15.0 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	80	617
Coho salmon	2	15
Pacific staghorn sculpin	7	54
Chum salmon	4	31
Starry flounder	1	8
Threespine stickleback	1	8
Peamouth	49	378
Largescale sucker	1	8
Common carp	1	8
TOTALS	146	1,127

H′ = 1.64   J′ = 0.52

Appendix Table 2.--Continued.

Station: M3

Gear: 50-m beach seine
Date: 2 May 1989
pH: 7.2
Temperature: 15.7 C
Turbidity: 9.5 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	142	1,096
Starry flounder	1	8
Pacific staghorn sculpin	4	31
Peamouth	1	8
Chum salmon	8	62
TOTALS	156	1,205

H' = 0.57   J' = 0.25

Station: M4

Gear: 50-m beach seine
Date: 2 May 1989
pH: 7.2
Temperature: 15.0 C
Turbidity: 8.0 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	367	2,832
Threespine stickleback	1	8
Starry flounder	3	23
Pacific staghorn sculpin	12	93
Chum salmon	3	23
TOTALS	386	2,979

H' = 0.36   J' = 0.15

Appendix Table 2.--Continued.

Station: M5

Gear: 50-m beach seine
Date: 5 May 1989
pH: 6.9

Temperature: 17.4C
Turbidity: 9.8 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	48	370
Peamouth	9	69
Pacific staghorn sculpin	6	46
Starry flounder	2	15
TOTALS	65	500

H′ = 1.19   J′ = 0.59

Station: M10

Gear: 50-m beach seine
Date: 2 May 1989
pH: 7.1

Temperature: 13.6C
Turbidity: 10.5 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	35	138
Pacific staghorn sculpin	5	20
TOTALS	40	158

H′ = 0.54   J′ = 0.54

Appendix Table 2.--Continued.

Station: M11

Gear: 50-m beach seine
Date: 2 May 1989
pH: 7.2

Temperature: 12.8C
Turbidity: 7.4 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	53	209
Pacific staghorn sculpin	30	118
Starry flounder	1	4
Threespine stickleback	1	4
Chum salmon	4	16
TOTALS	89	351

H′ = 1.32   J′ = 0.57

Appendix Table 2.--Continued.

Station: M13

Gear: 50-m beach seine
Date: 9 May 1989
pH: 6.7
Temperature: 14.3C
Turbidity: 8.0 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	24	94
Chinook salmon (yearling)	1	4
Coho salmon	1	4
Largescale sucker	1	4
Starry flounder	2	8
Pacific staghorn sculpin	1	4
Threespine stickleback	2	8
TOTALS	32	126

H′ = 1.44   J′ = 0.51

Appendix Table 2.--Continued.

Station: M14

Gear: 50-m beach seine
Date: 2 May 1989
pH: 7.2

Temperature: 12.8C
Turbidity: 7.4 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	10	39
Pacific staghorn sculpin	40	157
TOTALS	50	196

H' = 0.72 J' = 0.72

Station: M15

Gear: 8-m trawl
Date: 24 Apr 1989
Depth: 7.3 m
Distance traveled: 444 m
Tide stage: Early ebb

	Surface	Bottom
Temperature (C):	11.0	-
Salinity (ppt):	-	-
Turbidity NTU :	12.0	-
pH:	-	-

Species	No. captured	No. per Hectare
Chinook salmon	9	41
American shad	2	9
Peamouth	41	185
Pacific staghorn sculpin	3	14
Starry flounder	67	302
TOTALS	122	551

H' = 1.51 J' = 0.65

Appendix Table 2.--Continued.

Station: J1

Gear: 50-m beach seine
Date: 5 May 1989
pH: 6.8

Temperature: 13.9C
Turbidity: 11.0 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	19	75
Starry flounder	2	8
Coho salmon	1	4
Pacific staghorn sculpin	2	8
TOTALS	24	95

H′ = 1.06   J′ = 0.53

Station: J2

Gear: 50-m beach seine
Date: 1 May 1989
pH: 7.4

Temperature: 12.3C
Turbidity: 6.4 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	36	142
Starry flounder	6	24
Chum salmon	1	4
Threespine stickleback	5	20
Pacific staghorn sculpin	2	8
Largescale sucker	1	4
TOTALS	51	202

H′ = 1.45   J′ = 0.56

Appendix Table 2.--Continued.

Station: J34

Gear: 50-m beach seine
Date: 1 May 1989
pH: 7.6

Temperature: 12.8C
Turbidity: 8.5 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	372	1,465
Starry flounder	5	20
Pacific staghorn sculpin	27	106
Threespine stickleback	7	28
Chum salmon	10	39
TOTALS	421	1,658

$H' = 0.71$ $J' = 0.31$

Appendix Table 2.--Continued.

Station: D1

Gear: 8-m trawl		Surface	Bottom
Date: 13 Jul 1989	Temperature (C):	18.2	15.7
Depth: 5.2 m	Salinity (ppt):	6.2	18.4
Distance traveled: 389 m	Turbidity (NTU):	-	3.0
Tide stage: High slack	pH:	-	6.9

Species	No. captured	No. per Hectare
Whitebait smelt	152	781
Surf smelt	6	31
Starry flounder	51	262
Northern anchovy	110	566
English sole	19	98
Shiner perch	2	10
Pacific herring	2	10
Snake prickleback	1	5
Pacific tomcod	12	62
Longfin smelt	1	5
Dungeness crab	21	108
TOTALS	377	1,938

H' = 2.27   J' = 0.65

Appendix Table 2.--Continued.

Station: D2

Gear: 50-m beach seine
Date: 19 Jul 1989
pH: 7.1

Temperature: 19.5C
Turbidity: 4.5 NTU
Tide stage: Low slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	3	12
Pacific herring	1	4
Shiner perch	2	8
Starry flounder	21	83
Pacific staghorn sculpin	3	12
Surf smelt	5	20
TOTALS	35	139

H′ = 1.83   J′ = 0.71

Appendix Table 2.--Continued.

Station: T1

		Surface	Bottom
Gear: 8-m trawl			
Date: 14 Jul 1989	Temperature (C):	-	18.0
Depth: 3.4 m	Salinity (ppt):	-	-
Distance traveled: 426 m	Turbidity NTU :	-	3.6
Tide stage: Flood	pH:	-	7.1

Species	No. captured	No. per Hectare
Shiner perch	21	99
Snake prickleback	1	5
Unidentified juv. smelt	1	5
TOTALS	23	109

H′ = 0.51   J′ = 0.32

Appendix Table 2.--Continued.

Station: T2

			Surface	Bottom
Gear: 8-m trawl				
Date: 14 Jul 1989		Temperature (C):	-	18.0
Depth: 4.6 m		Salinity (ppt):	-	-
Distance traveled: 389 m		Turbidity NTU :	-	4.0
Tide stage: Flood		pH:	-	6.8

Species	No. captured	No. per Hectare
Shiner perch	28	144
Chinook salmon	1	5
Starry flounder	35	180
White sturgeon	2	10
American shad	1	5
Pacific staghorn sculpin	1	5
TOTALS	68	349

H′ = 1.44   J′ = 0.56

Appendix Table 2.--Continued.

Station: R1

Gear: 50-m beach seine
Date: 19 Jul 1989
pH: 7.6

Temperature: 21.0 C
Turbidity: 7.0 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	17	67
Starry flounder	6	24
Largescale sucker	1	4
TOTALS	24	95

H′ = 1.04   J′ = 0.66

Station: R2

Gear: 50-m beach seine
Date: 12 Jul 1989
pH: 6.9

Temperature: -
Turbidity: 2.9 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Surf smelt	5	20
Pacific staghorn sculpin	1	4
Peamouth	4	16
Starry flounder	48	189
TOTALS	58	229

H′ = 0.90   J′ = 0.45

Appendix Table 2.--Continued.

Station: R3

Gear: 50-m beach seine
Date: 12 Jul 1989
pH: 6.9

Temperature: -
Turbidity: 2.9 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	7	28
Starry flounder	207	815
Largescale sucker	1	4
Peamouth	27	106
TOTALS	242	953

H′ = 0.73   J′ = 0.36

Appendix Table 2.--Continued.

Station: M2

Gear: 50-m beach seine
Date: 25 Jul 1989
pH: 6.4

Temperature: 19.0 C
Turbidity: 6.8 NTU
Tide stage: Mid ebb

Species	No. captured	No. per hectare
Starry flounder	363	2,801
Chinook salmon (subyear.)	8	62
Peamouth	5	39
Largescale sucker	1	8
Threespine stickleback	3	23
Largemouth bass	1	8
Banded killifish	7	54
Yellow perch	1	8
TOTALS	389	3,003

H′ = 0.51 J′ = 0.17

Appendix Table 2.--Continued.

Station: M3

Gear: 50-m beach seine
Date: 24 Jul 1989
pH: 7.1

Temperature: 21.0 C
Turbidity: 7.7 NTU
Tide stage: Mid ebb

Species	No. captured	No. per hectare
Starry flounder	161	1,242
Banded killifish	3	23
Peamouth	43	332
Largescale sucker	6	46
TOTALS	213	1,643

H′ = 1.00   J′ = 0.50

Station: M4

Gear: 50-m beach seine
Date: 24 Jul 1989
pH: 6.6

Temperature: 19.7C
Turbidity: 4.3 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Starry flounder	67	517
Prickly sculpin	1	8
Peamouth	1	8
TOTALS	69	533

H′ = 0.22   J′ = 0.14

Appendix Table 2.--Continued.

Station: M5

Gear: 50-m beach seine
Date: 25 Jul 1989
pH: 6.5
Temperature: 18.0 C
Turbidity: 8.8 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	28	216
Starry flounder	13	100
Peamouth	9	69
Threespine stickleback	7	54
Common carp	2	15
Banded killifish	7	54
TOTALS	66	508

H′ = 2.22   J′ = 0.86

Station: M10

Gear: 50-m beach seine
Date: 25 Jul 1989
pH: 6.4
Temperature: 19.0 C
Turbidity: 5.5 NTU
Tide stage: Early flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	35	138
Starry flounder	34	134
TOTALS	69	272

H′ = 1.00   J′ = 1.00

Appendix Table 2.--Continued.

Station: M11

Gear: 50-m beach seine
Date: 24 Jul 1989
pH: 6.5

Temperature: 20.9C
Turbidity: 6.0 NTU
Tide stage: Mid ebb

Species	No. captured	No. per hectare
Starry flounder	414	1,630
Chinook salmon (subyear.)	33	130
Yellow perch	5	20
Common carp	1	4
TOTALS	453	1,784

H′ = 0.49   J′ = 0.24

Station: M13

Gear: 50-m beach seine
Date: 24 Jul 1989
pH: 6.6

Temperature: 23.9C
Turbidity: 4.0 NTU
Tide stage: Early flood

Species	No. captured	No. per hectare
Starry flounder	156	614
Chinook salmon (subyear.)	3	12
Peamouth	1	4
TOTALS	160	630

H′ = 0.19   J′ = 0.12

Appendix Table 2.--Continued.

Station: M14

Gear: 50-m beach seine
Date: 24 Jul 1989
pH: 6.7

Temperature: 21.7C
Turbidity: 5.0 NTU
Tide stage: Late ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	20	79
Starry flounder	107	421
Threespine stickleback	1	4
Largescale sucker	3	12
TOTALS	131	516

H′ = 0.83   J′ = 0.42

Appendix Table 2.--Continued.

Station: M15

		Surface	Bottom
Gear: 8-m trawl			
Date: 14 Jul 1989	Temperature (C):	-	18.0
Depth: 7.3 m	Salinity (ppt):	-	-
Distance traveled: 463 m	Turbidity NTU :	-	3.0
Tide stage: Late flood	pH:	-	7.5

Species	No. captured	No. per Hectare
Threespine stickleback	1	4
Pacific staghorn sculpin	23	99
Shiner perch	10	43
Largescale sucker	2	9
Peamouth	7	30
Longfin smelt	184	795
Starry flounder	7	30
Prickly sculpin	14	60
Unidentified juv. smelt	4	17
TOTALS	252	1,087

H' = 1.53 J' = 0.48

Appendix Table 2.--Continued.

Station: J1

Gear: 50-m beach seine
Date: 11 Jul 1989
pH: 6.4

Temperature: 21.0 C
Turbidity: 8.6 NTU
Tide stage: Late ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	114	449
Yellow perch	3	12
Unidentified cyprinid	3	12
Largescale sucker	1	4
Pacific staghorn sculpin	2	8
Threespine stickleback	101	398
Peamouth	39	154
Starry flounder	269	1,059
TOTALS	532	2,096

H' = 1.84   J' = 0.61

Appendix Table 2.--Continued.

Station: J2

Gear: 50-m beach seine
Date: 11 Jul 1989
pH: 7.0

Temperature: 19.0 C
Turbidity: 2.0 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	9	35
Threespine stickleback	24	94
Largemouth bass	1	4
Starry flounder	5	20
TOTALS	39	153

H′ = 1.43   J′ = 0.72

Station: J34

Gear: 50-m beach seine
Date: 11 Jul 1989
pH: 7.5

Temperature: 18.6C
Turbidity: 7.0 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	7	28
Starry flounder	40	157
Unidentified sculpin	1	4
Threespine stickleback	8	31
Common carp	1	4
Peamouth	22	[illegible]7
Yellow perch	5	20
TOTALS	84	331

H′ = 2.03   J′ = 0.72

Appendix Table 2.--Continued.

Station: D1

Gear: 8-m trawl		Surface	Bottom
Date: 19 Sep 1989	Temperature (C):	-	11.0
Depth: 7.3 m	Salinity (ppt):	-	27.6
Distance traveled: 500 m	Turbidity NTU :	-	3.7
Tide stage: Late flood	pH:	-	7.0

Species	No. captured	No. per Hectare
Whitebait smelt	98	392
Longfin smelt	198	792
Starry flounder	22	88
Dungeness crab	17	68
Pacific herring	4	16
American shad	1	4
Shiner perch	39	156
Pacific tomcod	5	20
TOTALS	384	1,536

H' = 1.94 J' = 0.65

Appendix Table 2.--Continued.

Station: D2

Gear: 50-m beach seine
Date: 26 Sep 1989
pH: 7.5

Temperature: 17.0 C
Turbidity: 2.2 NTU
Tide stage: Early flood

Species	No. captured	No. per hectare
Starry flounder	8	31
Shiner perch	8	31
TOTALS	16	62

H′ = 1.00 J′ = 1.00

Appendix Table 2.--Continued.

Station: T1

Gear: 8-m trawl		Surface	Bottom
Date: 19 Sep 1989	Temperature (C):	-	19.0
Depth: 3.7 m	Salinity (ppt):	-	-
Distance traveled: 407 m	Turbidity NTU :	-	15.0
Tide stage: Flood	pH:	-	6.9

Species	No. captured	No. per Hectare
Shiner perch	174	855
Starry flounder	5	25
Longfin smelt	24	118
Pacific staghorn sculpin	4	20
Peamouth	1	5
TOTALS	208	1,023

H′ = 0.85   J′ = 0.37

Appendix Table 2.--Continued.

Station: T2
Gear: 8-m trawl
Date: 19 Sep 1989
Depth: 4.6 m
Distance traveled: 482 m
Tide stage: Flood

	Surface	Bottom
Temperature (C):	-	19.0
Salinity (ppt):	-	-
Turbidity NTU :	-	4.0
pH:	-	7.0

Species	No. captured	No. per Hectare
Shiner perch	127	527
Starry flounder	58	241
Pacific herring	12	50
American shad	6	25
Pacific staghorn sculpin	1	4
TOTALS	204	847

H′ = 1.37 J′ = 0.59

Appendix Table 2.--Continued.

Station: R1

Gear: 50-m beach seine
Date: 13 Sep 1989
pH: 7.0

Temperature: 21.0 C
Turbidity: 2.5 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
NO FISH captured		

Station: R2

Gear: 50-m beach seine
Date: 13 Sep 1989
pH: 7.6

Temperature: 23.0 C
Turbidity: 1.6 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Peamouth	1	4
Starry flounder	2	8
TOTALS	3	12

H' = 0.92   J' = 0.92

Appendix Table 2.--Continued.

Station: R3

Gear: 50-m beach seine
Date: 13 Sep 1989
pH: 7.1

Temperature: 20.0 C
Turbidity: 2.6 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	10	39
Starry flounder	68	268
Peamouth	1	4
Largescale sucker	2	8
TOTALS	81	319

H′ = 0.79   J′ = 0.40

Station: M2

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.2

Temperature: 19.0 C
Turbidity: 2.7 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	12	93
Starry flounder	94	725
Peamouth	3	23
American shad	2	15
TOTALS	111	856

H′ = 0.80   J′ = 0.40

Appendix Table 2.--Continued.

Station: M3

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.2

Temperature: 20.0 C
Turbidity: 1.4 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	91	702
Shiner perch	237	1,829
Starry flounder	57	440
Peamouth	18	139
American shad	2	15
TOTALS	405	3,125

H' = 1.57   J' = 0.68

Station: M4

Gear: 50-m beach seine
Date: 13 Sep 1989
pH: 7.0

Temperature: 20.0 C
Turbidity: 2.6 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Starry flounder	4	31
Peamouth	35	270
TOTALS	39	301

H' = 0.48   J' = 0.48

Appendix Table 2.--Continued.

Station: M5

Gear: 50-m beach seine
Date: 11 Sep 1989
pH: 7.3

Temperature: 20.0 C
Turbidity: 4.3 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Peamouth	1,018	7,855
Banded killifish	11	85
Threespine stickleback	1	8
Shiner perch	1	8
Largescale sucker	2	15
TOTALS	1,033	7,971

H′ = 0.13   J′ = 0.05

Station: M10

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.4

Temperature: 21.0 C
Turbidity: 1.5 NTU
Tide stage: High slack

Species	No. captured	No. per hectare
Starry flounder	41	161
Peamouth	2	8
Banded killifish	1	4
TOTALS	44	173

H′ = 0.42   J′ = 0.27

Appendix Table 2.--Continued.

Station: M11

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.4
Temperature: 21.0 C
Turbidity: 1.5 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Starry flounder	15	59
TOTALS	15	59

H' = 0.00   J' = 0.00

Station: M13

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.4
Temperature: 19.0 C
Turbidity: 2.6 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	18	71
Starry flounder	46	181
Peamouth	2	8
Common carp	2	8
TOTALS	68	268

H' = 1.19   J' = 0.59

Appendix Table 2.--Continued.

Station: M14

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.1

Temperature: 20.0 C
Turbidity: 2.0 NTU
Tide stage: Early ebb

Species	No. captured	No. per hectare
Starry flounder	83	327
TOTALS	83	327

H' = 0.00 J' = 0.00

Station: M15

Gear: 8-m trawl
Date: 18 Sep 1989
Depth: 7.6 m
Distance traveled: 486 m
Tide stage: Flood

	Surface	Bottom
Temperature (C):	-	19.0
Salinity (ppt):	-	-
Turbidity NTU :	-	4.9
pH:	-	7.6

Species	No. captured	No. per Hectare
Peamouth	62	255
Starry flounder	67	276
Pacific staghorn sculpin	17	70
Prickly sculpin	10	41
American shad	1	4
TOTALS	157	646

H' = 1.70 J' = 0.73

Appendix Table 2.--Continued.

Station: J1

Gear: 50-m beach seine
Date: 12 Sep 1989
pH: 7.5

Temperature: 18.0 C
Turbidity: 3.5 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	29	114
Starry flounder	13	51
TOTALS	42	165

H' = 0.89   J' = 0.89

Station: J2

Gear: 50-m beach seine
Date: 11 Sep 1989
pH: 7.6

Temperature: 20.0 C
Turbidity: 2.3 NTU
Tide stage: Mid flood

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	11	43
Threespine stickleback	404	1,591
Starry flounder	14	55
American shad	2	8
TOTALS	431	1,697

H' = 0.42   J' = 0.21

Appendix Table 2.--Continued.

Station: J34

Gear: 50-m beach seine
Date: 11 Sep 1989
pH: 7.5

Temperature: 20.0 C
Turbidity: 1.8 NTU
Tide stage: Late flood

Species	No. captured	No. per hectare
Peamouth	58	228
Banded killifish	2	8
Starry flounder	1	4
TOTALS	61	240

H′ = 0.33   J′ = 0.21

Appendix Table 3.--Invertebrate taxa found at five areas in the Columbia River estuary--Desdemona Sands, Taylor Sands, Rice Island, Miller Sands, and Jim Crow Sands. Four surveys were conducted in 1988-1989.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Turbellaria	x	x	x	x
Nemertea	x	x	x	x
Nematomorpha	x		x	x
Oligochaeta	x	x	x	x
Hirudinea	x			
Polychaeta	x		x	
Eteone sp.	x		x	
Glycinde picta	x	x		x
Glycera sp.		x		
Manayunkia speciosa	x			
Neanthes limnicola	x	x	x	x
Pseudopolydora kempi				x
Unidentified Spionidae				x
Cladocera				
Daphnia spp.	x	x	x	x
Copepoda				x
Calanoida	x	x	x	x
Cyclopoida	x	x	x	x
Harpacticoida	x	x	x	x
Scottolana canadensis	x	x	x	
Ostracoda	x	x	x	x
Mysidacea				
Neomysis mercedis	x			
Isopoda				
Porcellio scaber	x			
Gnorimosphaeroma oregonensis	x			
Saduria entomon		x		

Appendix Table 3.--Continued.

Taxon	Survey 1 (Sep 88)	Survey 2 (May 89)	Survey 3 (Jul 89)	Survey 4 (Sep 89)
Amphipoda				
Eogammarus oclairi		x		
Eogammarus confervicolus				x
Eohaustorius estuarius	x	x	x	x
Corophium spp.	x	x	x	x
Corophium salmonis	x	x	x	x
Corphium spinicorne		x		x
Hyalella azteca	x		x	
Pontoporeia hoyi	x	x		x
Ramellogammarus oregonensis	x		x	x
Decapoda				
Callianassa californiensis				x
Hydracarina	x	x		x
Insecta		x		
Odonata		x		x
Hemiptera	x		x	
Coleoptera	x		x	x
Coleoptera larvae			x	
Diptera adult		x		
Diptera pupae		x		
Chironomidae larvae	x	x	x	x
Chironomidae pupae	x	x	x	x
Heleidae larvae	x	x	x	x
Tabanidae		x		x
Gastropoda (unid.)	x			
Fluminicola sp.	x			x
Bivalvia				
Corbicula manilensis	x	x	x	x
Pisidium sp.	x	x		
Macoma balthica	x	x	x	x
Arachnida		x		
Misc.				
Invertebrate eggs	x	x	x	x
Total number of taxa	37	33	27	33

Appendix Table 4.--Benthic invertebrates at five areas in the Columbia River estuary--Desdemona Sands (D), Taylor Sands (T), Rice Island (R), Miller Sands (M), and Jim Crow Sands (J). Four surveys were conducted in 1988-1989.

Station: D1 Date: 21 Oct 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Eteone sp.	1	10.0	88.5	279.8
Glycinde picta	10	50.0	884.9	1,103.7
Oligochaeta	4	30.0	354.0	618.7
Macoma balthica	17	80.0	1,504.3	1,026.0
Ramellogammarus oregonensis	1	10.0	88.5	279.8
Porcellio scaber	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 3.4 Standard deviation/sample: 1.4

Mean number/m²: 3,008.7 Standard deviation/m²: 1,265.3

H' = 1.83 J' = 0.71

Appendix Table 4.--Continued.

Station: T1 Date: 21 Oct 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Polychaeta	1	10.0	88.5	279.8
Corbicula manilensis	1	10.0	88.5	279.8
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium salmonis	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 0.4 Standard deviation/sample: 0.8

Mean number/m^2: 354.0 Standard deviation/m^2: 746.2

H′ = 2.00 J′ = 1.00

Appendix Table 4.--Continued.

Station: T2 Date: 21 Oct 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1	10.0	88.5	279.8
Eohaustorius estuarius	2	20.0	177.0	373.1
Ramellogammarus oregonensis	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 0.4 Standard deviation/sample: 0.5

Mean number/m²: 354.0 Standard deviation/m²: 457.0

H′ = 1.50 J′ = 0.95

Appendix Table 4.--Continued.

Station: R1A   Date: 16 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Oligochaeta	36	100.0	3,185.6	4,005.5
Corbicula manilensis	1	10.0	88.5	279.8

Number of taxa: 2

Mean number/sample: 3.7   Standard deviation/sample: 4.5

Mean number/m^2: 3,274.1   Standard deviation/m^2: 4,002.2

H′ = 0.18   J′ = 0.18

Appendix Table 4.--Continued.

Station: R1B Date: 16 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	8	50.0	707.9	1,087.8
Corbicula manilensis	10	60.0	884.9	1,103.7
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 2.0 Standard deviation/sample: 1.4

Mean number/m^2: 1,769.8 Standard deviation/m^2: 1,251.4

H' = 1.46 J' = 0.73

Appendix Table 4.--Continued.

Station: R2A   Date: 16 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	31	90.0	2,743.2	1,691.9

Number of taxa: 1

Mean number/sample: 3.1   Standard deviation/sample: 1.9

Mean number/m^2: 2,743.2   Standard deviation/m^2: 1,691.9

H′ = 0.00   J′ = 0.00

Appendix Table 4.--Continued.

Station: R2B Date: 16 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	4	40.0	354.0	457.0
Oligochaeta	13	50.0	1,150.4	1,671.2
Corbicula manilensis	8	50.0	707.9	813.2
Corophium salmonis	96	100.0	8,495.0	3,394.0

Number of taxa: 4

Mean number/sample: 12.1 Standard deviation/sample: 5.1

Mean number/m²: 10,707.3 Standard deviation/m²: 4,482.1

H′ = 1.03 J′ = 0.52

Appendix Table 4.--Continued.

Station: R3A   Date: 16 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	1	10.0	88.5	279.8
Coleoptera	5	40.0	442.5	625.7

Number of taxa: 2

Mean number/sample: 0.6   Standard deviation/sample: 0.8

Mean number/m^2: 530.9   Standard deviation/m^2: 746.2

H′ = 0.65   J′ = 0.65

Appendix Table 4.--Continued.

Station: R3B   Date: 16 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	9	50.0	796.4	973.8
Corbicula manilensis	5	40.0	442.5	625.7
Corophium salmonis	120	90.0	10,618.8	7,947.7
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 13.5   Standard deviation/sample: 9.7

Mean number/m^2: 11,946.2   Standard deviation/m^2: 8,602.2

H′ = 0.64   J′ = 0.32

Appendix Table 4.--Continued.

Station: M2 Date: 15 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	2	20.0	177.0	373.1
<u>Neanthes limnicola</u>	1	10.0	88.5	279.8
Oligochaeta	48	100.0	4,247.5	3,358.0
<u>Corbicula manilensis</u>	5	40.0	442.5	625.7
Ostracoda	15	60.0	1,327.4	1,518.4
<u>Corophium salmonis</u>	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 7.2 Standard deviation/sample: 4.5

Mean number/m^2: 6,371.3 Standard deviation/m^2: 3,953.0

H' = 1.44 J' = 0.56

Appendix Table 4.--Continued.

Station: M3 Date: 14 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	7	40.0	619.4	937.4
Nematomorpha	13	60.0	1,150.4	1,183.5
Turbellaria	4	20.0	354.0	854.9
Manayunkia speciosa	182	90.0	16,105.2	16,003.4
Oligochaeta	456	100.0	40,351.4	15,058.9
Hirudinea	2	10.0	177.0	559.7
Gastropoda	6	40.0	530.9	854.9
Fluminicola sp.	12	50.0	1,061.9	1,305.9
Corbicula manilensis	10	60.0	884.9	1,103.7
Pisidium sp.	19	70.0	1,681.3	2,104.4
Ostracoda	30	80.0	2,654.7	2,284.8
Hyalella azteca	28	40.0	2,477.7	4,250.0
Corophium salmonis	3	20.0	265.5	597.3
Cyclopoida	1	10.0	88.5	279.8
Chironomidae larvae	16	60.0	1,415.8	1,515.6
Heleidae larvae	3	30.0	265.5	427.4
Hemiptera	2	20.0	177.0	373.1
Invertebrate eggs	8	20.0	707.9	1,492.4
Hydracarina	1	10.0	88.5	279.8

Number of taxa: 19

Mean number/sample: 80.3 Standard deviation/sample: 23.2

Mean number/m^2: 71,057.5 Standard deviation/m^2: 20,550.7

H′ = 2.15 J′ = 0.50

Appendix Table 4.--Continued.

Station: M4 Date: 14 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	15	90.0	1,327.4	752.0
Oligochaeta	21	90.0	1,858.3	1,932.0
Corbicula manilensis	8	70.0	707.9	559.7
Eohaustorius estuarius	7	50.0	619.4	728.5
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	184	100.0	16,282.2	7,580.1
Harpacticoida	1	10.0	88.5	279.8

Number of taxa: 7

Mean number/sample: 23.7 Standard deviation/sample: 10.0

Mean number/m²: 20,972.1 Standard deviation/m²: 8,888.7

H′ = 1.23 J′ = 0.44

Appendix Table 4.--Continued.

Station: M6 Date: 15 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	1	10.0	88.5	279.8
Manayunkia speciosa	1	10.0	88.5	279.8
Neanthes limnicola	25	70.0	2,212.3	1,967.7
Oligochaeta	289	100.0	25,573.6	15,666.3
Corbicula manilensis	10	70.0	884.9	722.5
Ostracoda	6	50.0	530.9	618.7
Corophium salmonis	209	100.0	18,494.4	6,359.9
Pontoporeia hoyi	2	20.0	177.0	373.1
Daphnia spp.	1	10.0	88.5	279.8
Scottolana canadensis	2	10.0	177.0	559.7
Chironomidae larvae	2	20.0	177.0	373.1

Number of taxa: 11

Mean number/sample: 54.8 Standard deviation/sample: 24.9

Mean number/m²: 48,492.5 Standard deviation/m²: 2,2013.3

H′ = 1.54 J′ = 0.44

Appendix Table 4.--Continued.

Station: M10 Date: 15 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Manayunkia speciosa	1	10.0	88.5	279.8
Neanthes limnicola	5	40.0	442.5	625.7
Oligochaeta	134	100.0	11,857.7	5,676.9
Corbicula manilensis	17	30.0	1,504.3	3,869.6
Ostracoda	14	70.0	1,238.9	1,332.3
Corophium salmonis	165	90.0	14,600.8	8,692.8
Cyclopoida	1	10.0	88.5	279.8
Harpacticoida	1	10.0	88.5	279.8
Chironomidae larvae	4	40.0	354.0	457.0
Chironomidae pupae	2	20.0	177.0	373.1

Number of taxa: 10

Mean number/sample: 34.4 Standard deviation/sample: 11.6

Mean number/m²: 30,440.6 Standard deviation/m²: 10,279.1

H′ = 1.72 J′ = 0.52

Appendix Table 4.--Continued.

Station: M11 Date: 14 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	25	60.0	2,212.3	3,918.7
Turbellaria	1	10.0	88.5	279.8
<u>Neanthes</u> <u>limnicola</u>	41	100.0	3,628.1	1,742.6
Oligochaeta	143	100.0	12,654.1	7,427.7
<u>Corbicula</u> <u>manilensis</u>	9	60.0	796.4	1,059.4
<u>Pisidium</u> sp.	1	10.0	88.5	279.8
Ostracoda	4	30.0	354.0	618.7
<u>Corophium</u> <u>salmonis</u>	441	100.0	39,024.1	8,200.4
Harpacticoida	1	10.0	88.5	279.8
Chironomidae larvae	3	30.0	265.5	427.4
Chironomidae pupae	1	10.0	88.5	279.8

Number of taxa: 11

Mean number/sample: 67.0 Standard deviation/sample: 11.0

Mean number/m²: 59,288.3 Standard deviation/m²: 9,738.4

H′ = 1.51 J′ = 0.44

Appendix Table 4.--Continued.

Station: M13 Date: 14 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Corbicula manilensis	5	30.0	442.5	860.0
Eohaustorius estuarius	49	90.0	4,336.0	2,749.7
Corophium salmonis	19	70.0	1,681.3	1,691.9
Daphnia spp.	2	20.0	177.0	373.1

Number of taxa: 4

Mean number/sample: 7.5 Standard deviation/sample: 2.6

Mean number/m²: 6,636.8 Standard deviation/m²: 2,331.9

H′ = 1.30 J′ = 0.65

Appendix Table 4.--Continued.

Station: M14 Date: 14 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	5	30.0	442.5	860.0
Manayunkia speciosa	2	10.0	177.0	559.7
Oligochaeta	10	60.0	884.9	1,103.7
Corbicula manilensis	16	90.0	1,415.8	854.9
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium salmonis	2	20.0	177.0	373.1
Cyclopoida	1	10.0	88.5	279.8

Number of taxa: 7

Mean number/sample: 3.7 Standard deviation/sample: 2.2

Mean number/m^2: 3,274.1 Standard deviation/m^2: 1,913.9

H′ = 2.16 J′ = 0.77

Appendix Table 4.--Continued.

Station: M15 Date: 21 Oct 88 Sample size: 9

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	1	11.1	98.3	295.0
<u>Neanthes limnicola</u>	13	66.7	1,278.2	1,474.8
Oligochaeta	170	100.0	16,714.8	5,976.3
<u>Corbicula manilensis</u>	12	88.9	1,179.9	989.3
<u>Corophium salmonis</u>	723	100.0	71,087.0	5,869.8
<u>Gnorimosphaeroma oregonensis</u>	1	11.1	98.3	295.0
Cyclopoida	1	11.1	98.3	295.0
Chironomidae larvae	1	11.1	98.3	295.0
Heleidae larvae	1	11.1	98.3	295.0

Number of taxa: 9

Mean number/sample: 102.6 Standard deviation/sample: 11.6

Mean number/m^2: 90,751.4 Standard deviation/m^2: 10,254.1

$H' = 0.95$ $J' = 0.30$

Appendix Table 4.--Continued.

Station: J1A Date: 26 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	11	20.0	973.4	2,145.4
Turbellaria	1	10.0	88.5	279.8
Oligochaeta	10	40.0	884.9	1,251.4
Corbicula manilensis	8	70.0	707.9	559.7
Corophium salmonis	41	90.0	3,628.1	2,518.5

Number of taxa: 5

Mean number/sample: 7.1 Standard deviation/sample: 5.2

Mean number/m²: 6,282.8 Standard deviation/m²: 4,578.2

H′ = 1.71 J′ = 0.74

Appendix Table 4.--Continued.

Station: J1B   Date: 26 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	2	20.0	177.0	373.1
<u>Neanthes</u> <u>limnicola</u>	2	20.0	177.0	373.1
Oligochaeta	26	80.0	2,300.7	1,965.5
<u>Fluminicola</u> sp.	1	10.0	88.5	279.8
<u>Corbicula</u> <u>manilensis</u>	27	100.0	2,389.2	1,183.5
<u>Corophium</u> <u>salmonis</u>	180	100.0	15,928.2	2,735.4
Heleidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	10	60.0	884.9	834.3

Number of taxa: 8

Mean number/sample: 24.9   Standard deviation/sample: 5.0

Mean number/m^2: 22,034.0   Standard deviation/m^2: 4,403.8

H′ = 1.39   J′ = 0.46

Appendix Table 4.--Continued.

Station: J2A   Date: 26 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Corbicula</u> <u>manilensis</u>	4	30.0	354.0	618.7
Ostracoda	1	10.0	88.5	279.8

Number of taxa: 2

Mean number/sample: 0.5   Standard deviation/sample: 1.0

Mean number/m²: 442.5   Standard deviation/m²: 860.0

H′ = 0.72   J′ = 0.72

Appendix Table 4.--Continued.

Station: J2B Date: 26 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$

Number of taxa: 0

Mean number/sample: 0.0 Standard deviation/sample: 0.0

Mean number/m^2: 0.0 Standard deviation/m^2: 0.0

H' = 0.00 J' = 0.00

Appendix Table 4.--Continued.

Station: J3A Date: 26 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	345	100.0	30,529.1	13,563.7
Corbicula manilensis	26	80.0	2,300.7	2,509.8
Pisidium sp.	2	10.0	177.0	559.7
Ostracoda	9	60.0	796.4	880.0
Corophium spp.	2	10.0	177.0	559.7
Corophium salmonis	25	90.0	2,212.3	1,629.0
Pontoporeia hoyi	8	40.0	707.9	1,165.0
Chironomidae larvae	4	40.0	354.0	457.0
Invertebrate eggs	2	20.0	177.0	373.1

Number of taxa: 10

Mean number/sample: 42.4 Standard deviation/sample: 15.9

Mean number/m²: 37,519.8 Standard deviation/m²: 14,098.0

H′ = 1.15 J′ = 0.35

Appendix Table 4.--Continued.

Station: J3B   Date: 26 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes</u> <u>limnicola</u>	8	50.0	707.9	913.9
Oligochaeta	72	100.0	6,371.3	5,355.1
Gastropoda	1	10.0	88.5	279.8
<u>Corbicula</u> <u>manilensis</u>	43	90.0	3,805.1	3,066.8
Ostracoda	3	20.0	265.5	597.3
<u>Corophium</u> spp.	3	10.0	265.5	839.5
<u>Corophium</u> <u>salmonis</u>	190	100.0	16,813.1	7,152.6
<u>Pontoporeia</u> <u>hoyi</u>	18	100.0	1,592.8	813.2
Chironomidae larvae	2	20.0	177.0	373.1
Chironomidae pupae	1	10.0	88.5	279.8
Invertebrate eggs	2	20.0	177.0	373.1

Number of taxa: 11

Mean number/sample: 34.3   Standard deviation/sample: 16.1

Mean number/m²: 30,352.1   Standard deviation/m²: 14,207.8

H′ = 1.93   J′ = 0.56

Appendix Table 4.--Continued.

Station: J4A   Date: 26 Sep 88   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Polychaeta	4	10.0	354.0	1,119.3
Neanthes limnicola	5	40.0	442.5	625.7
Oligochaeta	298	100.0	26,370.0	16,095.6
Corbicula manilensis	6	50.0	530.9	618.7
Ostracoda	6	50.0	530.9	618.7
Neomysis mercedis	1	10.0	88.5	279.8
Corophium spp.	2	20.0	177.0	373.1
Corophium salmonis	87	100.0	7,698.6	3,415.8
Pontoporeia hoyi	6	50.0	530.9	618.7
Calanoida	1	10.0	88.5	279.8
Chironomidae larvae	19	90.0	1,681.3	1,212.6

Number of taxa: 11

Mean number/sample: 43.5   Standard deviation/sample: 19.9

Mean number/m^2: 38,493.2   Standard deviation/m^2: 17,580.9

$H' = 1.50$ $J' = 0.43$

Appendix Table 4.--Continued.

Station: J4B Date: 26 Sep 88 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	1	10.0	88.5	279.8
Turbellaria	6	50.0	530.9	618.7
Oligochaeta	62	100.0	5,486.4	2,729.0
Gastropoda	1	10.0	88.5	279.8
Corbicula manilensis	31	90.0	2,743.2	1,691.9
Corophium spp.	2	20.0	177.0	373.1
Corophium salmonis	187	100.0	16,547.6	2,737.0
Calanoida	2	20.0	177.0	373.1
Chironomidae larvae	1	10.0	88.5	279.8

Number of taxa: 9

Mean number/sample: 29.3 Standard deviation/sample: 5.1

Mean number/m^2: 25,927.6 Standard deviation/m^2: 4,532.3

H′ = 1.53 J′ = 0.48

Appendix Table 4.--Continued.

Station: D1 Date: 3 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	1	10.0	88.5	279.8
Turbellaria	91	100.0	8,052.6	6,757.9
Glycinde picta	2	10.0	177.0	559.7
Glycera sp.	1	10.0	88.5	279.8
Oligochaeta	27	40.0	2,389.2	5,227.7
Macoma balthica	41	100.0	3,628.1	1,976.5
Saduria entomon	4	20.0	354.0	746.2
Calanoida	4	20.0	354.0	854.9
Harpacticoida	6	30.0	530.9	1,119.3
Scottolana canadensis	12	20.0	1,061.9	2,564.7
Heleidae larvae	9	30.0	796.4	1,691.9

Number of taxa: 11

Mean number/sample: 19.8 Standard deviation/sample: 11.3

Mean number/m²: 17,521.0 Standard deviation/m²: 1,0001.1

H′ = 2.35 J′ = 0.68

Appendix Table 4.--Continued.

Station: D2 Date: 8 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	57	90.0	5,043.9	3,516.2
Macoma balthica	2	10.0	177.0	559.7
Eogammarus oclairi	1	10.0	88.5	279.8
Eohaustorius estuarius	3	30.0	265.5	427.4
Corophium salmonis	2	20.0	177.0	373.1
Calanoida	1	10.0	88.5	279.8
Harpacticoida	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 8

Mean number/sample: 6.8 Standard deviation/sample: 4.2

Mean number/m²: 6,017.3 Standard deviation/m²: 3,749.7

H' = 1.07 J' = 0.36

Appendix Table 4.--Continued.

Station: T1 Date: 3 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	1	10.0	88.5	279.8
Oligochaeta	4	30.0	354.0	618.7
Eohaustorius estuarius	4	40.0	354.0	457.0
Corophium salmonis	12	60.0	1,061.9	1,237.5
Heleidae larvae	1	10.0	88.5	279.8
Odonata	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 2.3 Standard deviation/sample: 1.6

Mean number/m^2: 2,035.3 Standard deviation/m^2: 1,448.0

$H' = 1.96$ $J' = 0.76$

Appendix Table 4.--Continued.

Station: T2 Date: 3 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	2	20.0	177.0	373.1
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium salmonis	12	90.0	1,061.9	559.7
Calanoida	3	30.0	265.5	427.4
Harpacticoida	1	10.0	88.5	279.8
Chironomidae larvae	1	10.0	88.5	279.8
Heleidae larvae	3	10.0	265.5	839.5

Number of taxa: 7

Mean number/sample: 2.3 Standard deviation/sample: 1.6

Mean number/m^2: 2,035.3 Standard deviation/m^2: 1,386.7

H′ = 2.15 J′ = 0.77

Appendix Table 4.--Continued.

Station: R1A Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	11	60.0	973.4	1,138.6
Oligochaeta	1	10.0	88.5	279.8
<u>Corbicula</u> <u>manilensis</u>	2	20.0	177.0	373.1
Heleidae larvae	2	10.0	177.0	559.7
Arachnida	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 1.7 Standard deviation/sample: 1.6

Mean number/m^2: 1,504.3 Standard deviation/m^2: 1,448.0

H′ = 1.61 J′ = 0.69

Appendix Table 4.--Continued.

Station: R1B Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	10	60.0	884.9	932.8
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	20	80.0	1,769.8	1,615.6
Corbicula manilensis	2	10.0	177.0	559.7
Eohaustorius estuarius	6	50.0	530.9	618.7
Corophium salmonis	75	100.0	6,636.8	1,922.9
Corophium spinicorne	2	20.0	177.0	373.1
Heleidae larvae	3	30.0	265.5	427.4

Number of taxa: 8

Mean number/sample: 11.9 Standard deviation/sample: 4.4

Mean number/m²: 10,530.3 Standard deviation/m²: 3,923.2

H' = 1.76 J' = 0.59

Appendix Table 4.--Continued.

Station: R2A Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Nemertea	8	50.0	707.9	913.9
Oligochaeta	2	10.0	177.0	559.7
Corbicula manilensis	1	10.0	88.5	279.8
Corophium salmonis	3	30.0	265.5	427.4

Number of taxa: 4

Mean number/sample: 1.4 Standard deviation/sample: 1.9

Mean number/m^2: 1,238.9 Standard deviation/m^2: 1,679.0

H' = 1.61 J' = 0.81

Appendix Table 4.--Continued.

Station: R2B   Date: 11 May 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	1	10.0	88.5	279.8
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	17	70.0	1,504.3	1,506.9
Tabanidae	1	10.0	88.5	279.8
Unidentified insect	2	10.0	177.0	559.7

Number of taxa: 5

Mean number/sample: 2.2   Standard deviation/sample: 2.1

Mean number/m^2: 1,946.8   Standard deviation/m^2: 1,856.2

H′ = 1.21   J′ = 0.52

Appendix Table 4.--Continued.

Station: R3A   Date: 11 May 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	2	10.0	177.0	559.7
Oligochaeta	6	50.0	530.9	618.7
Corbicula manilensis	2	20.0	177.0	373.1
Pontoporeia hoyi	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 1.1   Standard deviation/sample: 0.9

Mean number/m^2: 973.4   Standard deviation/m^2: 774.8

H′ = 1.69   J′ = 0.84

Appendix Table 4.--Continued.

Station: R3B　　Date: 11 May 89　　Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	8	60.0	707.9	813.2
Corbicula manilensis	22	80.0	1,946.8	1,604.8
Corophium salmonis	2	20.0	177.0	373.1

Number of taxa: 3

Mean number/sample: 3.2　　Standard deviation/sample: 2.2

Mean number/m^2: 2,831.7　　Standard deviation/m^2: 1,947.7

H′ = 1.12　　J′ = 0.71

Appendix Table 4.--Continued.

Station: M3 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	29	60.0	2,566.2	3,425.9
Nematomorpha	26	60.0	2,300.7	2,544.2
Turbellaria	4	30.0	354.0	618.7
Neanthes limnicola	8	40.0	707.9	1,370.9
Oligochaeta	158	100.0	13,981.4	6,056.5
Corbicula manilensis	8	70.0	707.9	559.7
Ostracoda	13	60.0	1,150.4	1,107.6
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	13	60.0	1,150.4	1,107.6
Diptera adult	1	10.0	88.5	279.8
Chironomidae larvae	55	100.0	4,867.0	3,156.3
Chironomidae pupae	1	10.0	88.5	279.8
Heleidae larvae	4	40.0	354.0	457.0
Invertebrate eggs	6	20.0	530.9	1,396.0
Hydracarina	1	10.0	88.5	279.8

Number of taxa: 15

Mean number/sample: 32.8 Standard deviation/sample: 12.9

Mean number/m²: 29,024.7 Standard deviation/m²: 11,376.7

H' = 2.53 J' = 0.65

Appendix Table 4.--Continued.

Station: M2 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	35	40.0	3,097.2	4,516.9
Nematomorpha	18	90.0	1,592.8	813.2
Turbellaria	1	10.0	88.5	279.8
Neanthes limnicola	7	10.0	619.4	1,958.8
Oligochaeta	129	100.0	11,415.2	7,290.5
Ostracoda	12	70.0	1,061.9	913.9
Corophium spp.	5	10.0	442.5	1,399.1
Corophium salmonis	48	100.0	4,247.5	2,277.2
Harpacticoida	2	10.0	177.0	559.7
Chironomidae larvae	25	90.0	2,212.3	1,574.7
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 11

Mean number/sample: 28.3 Standard deviation/sample: 11.6

Mean number/m^2: 25,042.7 Standard deviation/m^2: 10,252.4

H' = 2.42 J' = 0.70

Appendix Table 4.--Continued.

Station: M4 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	2	10.0	177.0	559.7
Neanthes limnicola	2	20.0	177.0	373.1
Oligochaeta	394	100.0	34,865.1	8,479.5
Corbicula manilensis	5	30.0	442.5	752.0
Ostracoda	46	100.0	4,070.5	2,052.1
Corophium salmonis	7	40.0	619.4	1,107.6
Pontoporeia hoyi	1	10.0	88.5	279.8
Calanoida	2	10.0	177.0	559.7
Cyclopoida	1	10.0	88.5	279.8
Chironomidae larvae	13	80.0	1,150.4	1,026.0
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 11

Mean number/sample: 47.4 Standard deviation/sample: 11.3

Mean number/m²: 41,944.3 Standard deviation/m²: 10,021.9

H' = 1.01 J' = 0.29

Appendix Table 4.--Continued.

Station: M5 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	14	30.0	1,238.9	2,367.1
Nematomorpha	1	10.0	88.5	279.8
Oligochaeta	386	100.0	34,157.1	35,050.7
Corbicula manilensis	6	40.0	530.9	854.9
Ostracoda	4	10.0	354.0	1,119.3
Diptera pupae	1	10.0	88.5	279.8
Chironomidae larvae	14	70.0	1,238.9	1,332.3
Heleidae larvae	3	20.0	265.5	597.3
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 9

Mean number/sample: 43.0 Standard deviation/sample: 42.2

Mean number/m²: 38,050.7 Standard deviation/m²: 37,336.3

H′ = 0.72 J′ = 0.23

Appendix Table 4.--Continued.

Station: M10 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	25	70.0	2,212.3	2,646.5
Oligochaeta	29	90.0	2,566.2	1,639.7
Corbicula manilensis	2	10.0	177.0	559.7
Ostracoda	1	10.0	88.5	279.8
Corophium salmonis	1	10.0	88.5	279.8
Chironomidae larvae	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	3	30.0	265.5	427.4

Number of taxa: 8

Mean number/sample: 6.3 Standard deviation/sample: 3.7

Mean number/m²: 5,574.9 Standard deviation/m²: 3,259.3

H′ = 1.79 J′ = 0.60

Appendix Table 4.--Continued.

Station: M11 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	5	40.0	442.5	625.7
Corbicula manilensis	4	30.0	354.0	618.7
Corophium salmonis	7	50.0	619.4	728.5
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 1.7 Standard deviation/sample: 1.5

Mean number/m^2: 1,504.3 Standard deviation/m^2: 1,322.4

H′ = 1.78 J′ = 0.89

Appendix Table 4.--Continued.

Station: M13 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	2	20.0	177.0	373.1
Corbicula manilensis	13	90.0	1,150.4	597.3
Corophium salmonis	30	100.0	2,654.7	1,251.4
Heleidae larvae	7	40.0	619.4	937.4

Number of taxa: 4

Mean number/sample: 5.2 Standard deviation/sample: 1.9

Mean number/m^2: 4,601.5 Standard deviation/m^2: 1,709.8

$H' = 1.53$ $J' = 0.76$

Appendix Table 4.--Continued.

Station: M14 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	16	40.0	1,415.8	2,439.5
Turbellaria	8	40.0	707.9	1,004.6
Oligochaeta	100	100.0	8,849.0	4,171.5
Corbicula manilensis	15	80.0	1,327.4	1,123.2
Ostracoda	2	20.0	177.0	373.1
Corophium salmonis	57	100.0	5,043.9	1,772.3
Cyclopoida	3	20.0	265.5	597.3
Chironomidae larvae	6	40.0	530.9	746.2
Heleidae larvae	2	20.0	177.0	373.1

Number of taxa: 9

Mean number/sample: 20.9 Standard deviation/sample: 8.3

Mean number/m^2: 18,494.4 Standard deviation/m^2: 7,314.3

H′ = 2.12 J′ = 0.67

Appendix Table 4.--Continued.

Station: M15 Date: 3 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nematomorpha	1	10.0	88.5	279.8
Turbellaria	10	20.0	884.9	2,246.4
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	236	100.0	20,883.6	7,917.0
Corbicula manilensis	3	30.0	265.5	427.4
Ostracoda	10	50.0	884.9	1,179.9
Corophium salmonis	166	100.0	14,689.3	2,439.5
Corophium spinicorne	3	20.0	265.5	597.3
Chironomidae larvae	6	40.0	530.9	746.2
Invertebrate eggs	18	50.0	1,592.8	2,352.3

Number of taxa: 10

Mean number/sample: 45.4 Standard deviation/sample: 11.8

Mean number/m^2: 40,174.5 Standard deviation/m^2: 10,405.3

H′ = 1.67 J′ = 0.50

Appendix Table 4.--Continued.

Station: J2A Date: 10 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	1	10.0	88.5	279.8
Daphnia spp.	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 0.3 Standard deviation/sample: 0.5

Mean number/m^2: 265.5 Standard deviation/m^2: 427.4

H′ = 1.58 J′ = 1.00

Appendix Table 4.--Continued.

Station: J2B　　Date: 10 May 89　　Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Corbicula manilensis	7	50.0	619.4	839.5

Number of taxa: 1

Mean number/sample: 0.7　　Standard deviation/sample: 0.9

Mean number/m²: 619.4　　Standard deviation/m²: 839.5

H′ = 0.00　　J′ = 0.00

Appendix Table 4.--Continued.

Station: J1A   Date: 10 May 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	18	80.0	1,592.8	1,991.8
Corbicula manilensis	46	100.0	4,070.5	1,626.3

Number of taxa: 2

Mean number/sample: 6.4   Standard deviation/sample: 2.6

Mean number/m^2: 5663.4   Standard deviation/m^2: 2330.0

H' = 0.86   J' = 0.86

Appendix Table 4.--Continued.

Station: J1B Date: 10 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	7	40.0	619.4	937.4
Corbicula manilensis	9	70.0	796.4	652.9
Pontoporeia hoyi	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 1.7 Standard deviation/sample: 1.4

Mean number/m^2: 1,504.3 Standard deviation/m^2: 1,254.9

H' = 1.25 J' = 0.79

Appendix Table 4.--Continued.

Station: J3A   Date: 10 May 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	11	40.0	973.4	1,471.9
Oligochaeta	423	100.0	37,431.3	10,926.1
Corbicula manilensis	6	40.0	530.9	854.9
Ostracoda	98	100.0	8,672.0	8,748.1
Corophium salmonis	22	90.0	1,946.8	1,549.6
Pontoporeia hoyi	7	50.0	619.4	839.5
Chironomidae larvae	14	70.0	1,238.9	1,332.3
Heleidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	23	50.0	2,035.3	2,737.0

Number of taxa: 9

Mean number/sample: 60.5   Standard deviation/sample: 17.3

Mean number/m²: 53,536.5   Standard deviation/m²: 15,317.0

H′ = 1.53   J′ = 0.48

Appendix Table 4.--Continued.

Station: J3B Date: 10 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	2	20.0	177.0	373.1
Turbellaria	1	10.0	88.5	279.8
Neanthes limnicola	2	20.0	177.0	373.1
Oligochaeta	90	100.0	7,964.1	2,703.4
Corbicula manilensis	5	30.0	442.5	752.0
Ostracoda	17	70.0	1,504.3	1,254.9
Corophium spp.	18	90.0	1,592.8	1,492.4
Corophium salmonis	38	100.0	3,362.6	1,370.9
Pontoporeia hoyi	34	100.0	3,008.7	1,626.3
Chironomidae larvae	7	40.0	619.4	839.5
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 11

Mean number/sample: 21.5 Standard deviation/sample: 4.1

Mean number/m^2: 19,025.3 Standard deviation/m^2: 3,666.4

H′ = 2.46 J′ = 0.71

Appendix Table 4.--Continued.

Station: J4A Date: 10 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Nematomorpha	1	10.0	88.5	279.8
Neanthes limnicola	2	20.0	177.0	373.1
Oligochaeta	258	100.0	22,830.4	7,137.9
Pisidium sp.	5	30.0	442.5	860.0
Ostracoda	23	90.0	2,035.3	2,248.3
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	34	80.0	3,008.7	4,398.9
Pontoporeia hoyi	49	100.0	4,336.0	1,639.7
Daphnia spp.	2	20.0	177.0	373.1
Chironomidae larvae	19	90.0	1,681.3	1,059.4

Number of taxa: 10

Mean number/sample: 39.4 Standard deviation/sample: 12.9

Mean number/m^2: 34,865.1 Standard deviation/m^2: 11,379.8

H′ = 1.73 J′ = 0.52

Appendix Table 4.--Continued.

Station: J4B　　Date: 10 May 89　　Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	10	40.0	884.9	1,179.9
Turbellaria	1	10.0	88.5	279.8
Oligochaeta	98	100.0	8,672.0	3,383.8
Corbicula manilensis	13	80.0	1,150.4	839.5
Ostracoda	13	70.0	1,150.4	937.4
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	52	100.0	4,601.5	2,077.4
Daphnia spp.	1	10.0	88.5	279.8
Heleidae larvae	9	70.0	796.4	652.9

Number of taxa: 9

Mean number/sample: 19.8　　Standard deviation/sample: 3.5

Mean number/m^2: 17,521.0　　Standard deviation/m^2: 3,059.7

$H' = 2.06$　　$J' = 0.65$

Appendix Table 4.--Continued.

Station: D1 Date: 28 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	1	10.0	88.5	279.8
Eteone sp.	4	40.0	354.0	457.0
Oligochaeta	5	40.0	442.5	625.7
Corbicula manilensis	5	20.0	442.5	955.8
Macoma balthica	11	60.0	973.4	973.8
Eohaustorius estuarius	3	30.0	265.5	427.4
Scottolana canadensis	4	20.0	354.0	746.2
Invertebrate eggs	2	10.0	177.0	559.7

Number of taxa: 8

Mean number/sample: 3.5 Standard deviation/sample: 1.4

Mean number/m^2: 3,097.2 Standard deviation/m^2: 1,268.7

$H' = 2.73$ $J' = 0.91$

Appendix Table 4.--Continued.

Station: D2 Date: 19 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	5	40.0	442.5	625.7
Neanthes limnicola	4	30.0	354.0	618.7
Oligochaeta	18	60.0	1,592.8	1,759.9
Eohaustorius estuarius	35	90.0	3,097.2	2,217.2
Scottolana canadensis	2	20.0	177.0	373.1

Number of taxa: 5

Mean number/sample: 6.4 Standard deviation/sample: 3.9

Mean number/m^2: 5,663.4 Standard deviation/m^2: 3,470.1

H′ = 1.68 J′ = 0.73

Appendix Table 4.--Continued.

Station: T1 Date: 28 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Polychaeta	3	20.0	265.5	597.3
Oligochaeta	2	20.0	177.0	373.1
Eohaustorius estuarius	5	40.0	442.5	625.7
Corophium salmonis	2	10.0	177.0	559.7

Number of taxa: 4

Mean number/sample: 1.2 Standard deviation/sample: 1.4

Mean number/m^2: 1,061.9 Standard deviation/m^2: 1,237.5

H′ = 1.89 J′ = 0.94

Appendix Table 4.--Continued.

Station: T2 Date: 28 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	1	10.0	88.5	279.8
Corbicula manilensis	1	10.0	88.5	279.8
Eohaustorius estuarius	3	20.0	265.5	597.3
Scottolana canadensis	3	20.0	265.5	597.3
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 0.9 Standard deviation/sample: 1.3

Mean number/m^2: 796.4 Standard deviation/m^2: 1138.6

H′ = 2.11 J′ = 0.91

Appendix Table 4.--Continued.

Station: R1A   Date: 12 Jul 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	1	10.0	88.5	279.8
<u>Corbicula manilensis</u>	2	20.0	177.0	373.1
<u>Corophium salmonis</u>	2	20.0	177.0	373.1

Number of taxa: 3

Mean number/sample: 0.5   Standard deviation/sample: 0.8

Mean number/m^2: 442.5   Standard deviation/m^2: 752.0

H′ = 1.52   J′ = 0.96

Appendix Table 4.--Continued.

Station: R1B   Date: 12 Jul 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	23	60.0	2,035.3	2,830.8
Corbicula manilensis	4	20.0	354.0	854.9
Ostracoda	1	10.0	88.5	279.8
Eohaustorius estuarius	3	20.0	265.5	597.3
Corophium spp.	4	30.0	354.0	618.7
Corophium salmonis	13	70.0	1,150.4	1,107.6

Number of taxa: 7

Mean number/sample: 4.9   Standard deviation/sample: 3.0

Mean number/m²: 4,336.0   Standard deviation/m²: 2,653.1

H′ = 2.09   J′ = 0.74

Appendix Table 4.--Continued.

Station: R2A Date: 12 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2

Number of taxa: 0

Mean number/sample: 0.0 Standard deviation/sample: 0.0

Mean number/m^2: 0.0 Standard deviation/m^2: 0.0

H′ = 0.00 J′ = 0.00

Appendix Table 4.--Continued.

Station: R2B   Date: 12 Jul 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Corbicula manilensis	6	50.0	530.9	618.7

Number of taxa: 1

Mean number/sample: 0.6   Standard deviation/sample: 0.7

Mean number/m²: 530.9   Standard deviation/m²: 618.7

H′ = 0.00   J′ = 0.00

Appendix Table 4.--Continued.

Station: R3A Date: 12 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	1	10.0	88.5	279.8
Daphnia spp.	1	10.0	88.5	279.8
Chironomidae pupae	1	10.0	88.5	279.8

Number of taxa: 4

Mean number/sample: 0.4 Standard deviation/sample: 0.7

Mean number/m^2: 354.0 Standard deviation/m^2: 618.7

H' = 2.00 J' = 1.00

Appendix Table 4.--Continued.

Station: R3B Date: 12 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	5	20.0	442.5	955.8
Corbicula manilensis	3	30.0	265.5	427.4
Corophium salmonis	2	10.0	177.0	559.7
Calanoida	1	10.0	88.5	279.8
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 1.2 Standard deviation/sample: 1.6

Mean number/m^2: 1,061.9 Standard deviation/m^2: 1,432.9

H′ = 2.05 J′ = 0.88

Appendix Table 4.--Continued.

Station: M2 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	13	50.0	1,150.4	1,563.6

Number of taxa: 1

Mean number/sample: 1.3 Standard deviation/sample: 1.8

Mean number/m^2: 1,150.4 Standard deviation/m^2: 1,563.6

H′ = 0.00 J′ = 0.00

Appendix Table 4.--Continued.

Station: M3 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	7	60.0	619.4	597.3
Oligochaeta	180	100.0	15,928.2	6,130.8
Ostracoda	1	10.0	88.5	279.8
Corophium salmonis	9	70.0	796.4	774.8
Chironomidae larvae	20	70.0	1,769.8	1,504.0

Number of taxa: 5

Mean number/sample: 21.7 Standard deviation/sample: 7.7

Mean number/m²: 19,202.3 Standard deviation/m²: 6,804.1

H′ = 0.93 J′ = 0.40

Appendix Table 4.--Continued.

Station: M4 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
<u>Neanthes limnicola</u>	19	90.0	1,681.3	1,138.6
Oligochaeta	75	100.0	6,636.8	5,961.7
<u>Corbicula manilensis</u>	5	40.0	442.5	625.7
Ostracoda	3	20.0	265.5	597.3
<u>Corophium salmonis</u>	46	100.0	4,070.5	2,474.9
<u>Scottolana canadensis</u>	28	90.0	2,477.7	2,664.5
Chironomidae larvae	1	10.0	88.5	279.8

Number of taxa: 7

Mean number/sample: 17.7 Standard deviation/sample: 7.1

Mean number/m^2: 15,662.7 Standard deviation/m^2: 6,285.6

H′ = 2.08 J′ = 0.74

Appendix Table 4.--Continued.

Station: M5 Date: 19 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	4	40.0	354.0	457.0
Oligochaeta	195	100.0	17,255.5	6,288.4
Corbicula manilensis	2	20.0	177.0	373.1
Ostracoda	8	60.0	707.9	698.0
Corophium salmonis	10	60.0	884.9	932.8
Chironomidae larvae	11	70.0	973.4	880.0

Number of taxa: 6

Mean number/sample: 23.0 Standard deviation/sample: 7.7

Mean number/m^2: 20,352.7 Standard deviation/m^2: 6,829.0

H′ = 0.94 J′ = 0.36

Appendix Table 4.--Continued.

Station: M6 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Neanthes limnicola	7	50.0	619.4	728.5
Oligochaeta	312	100.0	27,608.9	5,624.5
Corbicula manilensis	2	20.0	177.0	373.1
Ostracoda	31	80.0	2,743.2	2,962.9
Eohaustorius estuarius	6	40.0	530.9	746.2
Corophium salmonis	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Scottolana canadensis	1	10.0	88.5	279.8
Chironomidae larvae	15	80.0	1,327.4	1,123.2
Chironomidae pupae	5	30.0	442.5	752.0

Number of taxa: 10

Mean number/sample: 38.1 Standard deviation/sample: 8.9

Mean number/m^2: 33,714.7 Standard deviation/m^2: 7,908.7

H′ = 1.10 J′ = 0.33

Appendix Table 4.--Continued.

Station: MB   Date: 19 Jul 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	1	10.0	88.5	279.8
Oligochaeta	113	100.0	9,999.4	4,811.7
<u>Daphnia</u> spp.	2	20.0	177.0	373.1
Chironomidae larvae	26	90.0	2,300.7	1,332.3
Chironomidae pupae	1	10.0	88.5	279.8
Hemiptera	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 14.4   Standard deviation/sample: 4.4

Mean number/m²: 12,742.6   Standard deviation/m²: 3,850.4

H′ = 0.96   J′ = 0.37

Appendix Table 4.--Continued.

Station: M10 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	94	100.0	8,318.1	5,489.9
Corbicula manilensis	9	60.0	796.4	774.8
Ostracoda	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Chironomidae pupae	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 10.6 Standard deviation/sample: 5.9

Mean number/m²: 9,379.9 Standard deviation/m²: 5,263.3

H′ = 0.65 J′ = 0.28

Appendix Table 4.--Continued.

Station: M11 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	4	40.0	354.0	457.0
Oligochaeta	39	100.0	3,451.1	1,791.8
Corbicula manilensis	3	30.0	265.5	427.4
Ostracoda	3	30.0	265.5	427.4
Corophium salmonis	32	100.0	2,831.7	1,305.9
Scottolana canadensis	3	20.0	265.5	597.3
Chironomidae larvae	2	20.0	177.0	373.1

Number of taxa: 7

Mean number/sample: 8.6 Standard deviation/sample: 3.4

Mean number/m^2: 7,610.1 Standard deviation/m^2: 2,984.9

H′ = 1.89 J′ = 0.67

Appendix Table 4.--Continued.

Station: M13 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	2	20.0	177.0	373.1
Corbicula manilensis	2	20.0	177.0	373.1
Eohaustorius estuarius	3	30.0	265.5	427.4
Corophium salmonis	18	90.0	1,592.8	913.9
Daphnia spp.	1	10.0	88.5	279.8
Scottolana canadensis	3	30.0	265.5	427.4
Chironomidae larvae	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 8

Mean number/sample: 3.1 Standard deviation/sample: 1.3

Mean number/m²: 2743.2 Standard deviation/m²: 1138.6

H′ = 2.10 J′ = 0.70

Appendix Table 4.--Continued.

Station: M14 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	6	50.0	530.9	618.7
Daphnia spp.	1	10.0	88.5	279.8
Coleoptera	1	10.0	88.5	279.8
Coleoptera larvae	2	10.0	177.0	559.7

Number of taxa: 5

Mean number/sample: 1.1 Standard deviation/sample: 1.1

Mean number/m²: 973.4 Standard deviation/m²: 973.8

H′ = 1.87 J′ = 0.80

Appendix Table 4.--Continued.

Station: M15 Date: 28 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Polychaeta	70	30.0	6,194.3	16,934.3
Neanthes limnicola	9	60.0	796.4	880.0
Oligochaeta	239	100.0	21,149.1	12,377.7
Ostracoda	5	40.0	442.5	625.7
Corophium spp.	4	30.0	354.0	618.7
Corophium salmonis	339	100.0	29,998.1	13,762.3
Daphnia spp.	3	20.0	265.5	597.3
Calanoida	3	20.0	265.5	597.3
Cyclopoida	1	10.0	88.5	279.8
Harpacticoida	5	30.0	442.5	752.0
Scottolana canadensis	170	80.0	15,043.3	13,715.2
Chironomidae larvae	7	60.0	619.4	597.3

Number of taxa: 12

Mean number/sample: 85.5 Standard deviation/sample: 39.8

Mean number/m^2: 75,659.0 Standard deviation/m^2: 35,199.4

H′ = 2.12 J′ = 0.59

Appendix Table 4.--Continued.

Station: J1A Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	8	40.0	707.9	1,370.9
<u>Corbicula</u> <u>manilensis</u>	57	90.0	5,043.9	2,921.5
Chironomidae pupae	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 6.6 Standard deviation/sample: 4.4

Mean number/m²: 5,840.3 Standard deviation/m²: 3,917.6

H′ = 0.64 J′ = 0.41

Appendix Table 4.--Continued.

Station: J1B Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	3	30.0	265.5	427.4
Corbicula manilensis	30	90.0	2,654.7	1,668.6
Corophium salmonis	2	20.0	177.0	373.1

Number of taxa: 3

Mean number/sample: 3.5 Standard deviation/sample: 2.2

Mean number/m^2: 3,097.2 Standard deviation/m^2: 1,922.9

H′ = 0.73 J′ = 0.46

Appendix Table 4.--Continued.

Station: J2A Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2

Number of taxa: 0

Mean number/sample: 0.0 Standard deviation/sample: 0.0

Mean number/m^2: 0.0 Standard deviation/m^2: 0.0

H' = 0.00 J' = 0.00

Appendix Table 4.--Continued.

Station: J2B Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	8	40.0	707.9	1,165.0
Cyclopoida	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 1.0 Standard deviation/sample: 1.3

Mean number/m^2: 884.9 Standard deviation/m^2: 1,179.9

H′ = 0.92 J′ = 0.58

Appendix Table 4.--Continued.

Station: J3A   Date: 11 Jul 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes</u> <u>limnicola</u>	4	20.0	354.0	854.9
Oligochaeta	81	100.0	7,167.7	3,451.2
<u>Corbicula</u> <u>manilensis</u>	3	20.0	265.5	597.3
Ostracoda	1	10.0	88.5	279.8
<u>Corophium</u> <u>salmonis</u>	19	60.0	1,681.3	2,020.0
Chironomidae larvae	6	50.0	530.9	618.7
Chironomidae pupae	1	10.0	88.5	279.8
Invertebrate eggs	18	40.0	1,592.8	3,059.7

Number of taxa: 8

Mean number/sample: 13.3   Standard deviation/sample: 7.0

Mean number/m^2: 11,769.2   Standard deviation/m^2: 6,159.8

$H' = 1.81$ $J' = 0.60$

Appendix Table 4.--Continued.

Station: J3B Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	2	20.0	177.0	373.1
Oligochaeta	21	100.0	1,858.3	1,411.5
Ostracoda	8	50.0	707.9	813.2
Hyalella azteca	8	60.0	707.9	698.0
Corophium salmonis	49	90.0	4,336.0	3,134.2
Ramellogammarus oregonensis	2	20.0	177.0	373.1
Chironomidae larvae	4	40.0	354.0	457.0
Invertebrate eggs	7	10.0	619.4	1,958.8

Number of taxa: 8

Mean number/sample: 10.1 Standard deviation/sample: 4.2

Mean number/m^2: 8,937.5 Standard deviation/m^2: 3,718.2

H′ = 2.23 J′ = 0.74

Appendix Table 4.--Continued.

Station: J4A Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	6	40.0	530.9	746.2
Oligochaeta	81	100.0	7,167.7	5,184.2
Corbicula manilensis	2	20.0	177.0	373.1
Ostracoda	3	30.0	265.5	427.4
Hyalella azteca	3	30.0	265.5	427.4
Corophium spp.	3	20.0	265.5	597.3
Corophium salmonis	28	90.0	2,477.7	1,370.9
Daphnia spp.	1	10.0	88.5	279.8
Chironomidae larvae	8	50.0	707.9	813.2

Number of taxa: 9

Mean number/sample: 13.5 Standard deviation/sample: 7.6

Mean number/m^2: 11,946.2 Standard deviation/m^2: 6,755.3

H' = 1.86 J' = 0.59

Appendix Table 4.--Continued.

Station: J4B Date: 11 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	57	100.0	5,043.9	3,466.3
Corbicula manilensis	10	50.0	884.9	1,251.4
Ostracoda	2	20.0	177.0	373.1
Corophium salmonis	30	90.0	2,654.7	2,167.6
Heleidae larvae	3	20.0	265.5	597.3

Number of taxa: 6

Mean number/sample: 10.3 Standard deviation/sample: 6.4

Mean number/m^2: 9,114.5 Standard deviation/m^2: 5,628.4

H′ = 1.64 J′ = 0.63

Appendix Table 4.--Continued.

Station: D1 Date: 18 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Turbellaria	1	10.0	88.5	279.8
Unidentified Spionidae	6	40.0	530.9	746.2
Glycinde picta	3	30.0	265.5	427.4
Pseudopolydora kempi	27	90.0	2,389.2	1,820.7
Oligochaeta	24	70.0	2,123.8	2,009.2
Macoma balthica	28	80.0	2,477.7	1,549.6
Eogammarus confervicolus	1	10.0	88.5	279.8
Callianassa californiensis	1	10.0	88.5	279.8
Cyclopoida	1	10.0	88.5	279.8
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 10

Mean number/sample: 9.3 Standard deviation/sample: 4.7

Mean number/m^2: 8,229.6 Standard deviation/m^2: 4,151.6

H′ = 2.31 J′ = 0.70

Appendix Table 4.--Continued.

Station: D2 Date: 26 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Turbellaria	1	10.0	88.5	279.8
Oligochaeta	1	10.0	88.5	279.8
<u>Eohaustorius</u> <u>estuarius</u>	14	70.0	1,238.9	1,827.8

Number of taxa: 3

Mean number/sample: 1.6 Standard deviation/sample: 2.0

Mean number/m^2: 1,415.8 Standard deviation/m^2: 1,779.6

H′ = 0.67 J′ = 0.42

Appendix Table 4.--Continued.

Station: T1 Date: 18 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Eohaustorius estuarius	2	20.0	177.0	373.1
Corophium salmonis	1	10.0	88.5	279.8
Calanoida	2	20.0	177.0	373.1
Chironomidae larvae	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 0.7 Standard deviation/sample: 0.9

Mean number/m²: 619.4 Standard deviation/m²: 839.5

H′ = 2.24 J′ = 0.96

Appendix Table 4.--Continued.

Station: T2 Date: 18 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1	10.0	88.5	279.8
Eohaustorius estuarius	6	40.0	530.9	746.2
Ramellogammarus oregonensis	1	10.0	88.5	279.8
Cladocera	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Cyclopoida	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 1.1 Standard deviation/sample: 1.1

Mean number/m²: 973.4 Standard deviation/m²: 973.8

H′ = 2.05 J′ = 0.79

Appendix Table 4.--Continued.

Station: R1A   Date: 13 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	4	10.0	354.0	1,119.3
Corbicula manilensis	1	10.0	88.5	279.8

Number of taxa: 2

Mean number/sample: 0.5   Standard deviation/sample: 1.3

Mean number/m²: 442.5   Standard deviation/m²: 1,123.2

H′ = 0.72   J′ = 0.72

Appendix Table 4.--Continued.

Station: R1B   Date: 13 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	4	40.0	354.0	457.0
Corbicula manilensis	5	50.0	442.5	466.4
Corophium salmonis	1	10.0	88.5	279.8
Coleoptera	5	20.0	442.5	1,123.2

Number of taxa: 4

Mean number/sample: 1.5   Standard deviation/sample: 1.4

Mean number/m²: 1,327.4   Standard deviation/m²: 1,268.7

H′ = 1.83   J′ = 0.91

Appendix Table 4.--Continued.

Station: R2A Date: 13 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1	10.0	88.5	279.8
Odonata	3	30.0	265.5	427.4

Number of taxa: 2

Mean number/sample: 0.4 Standard deviation/sample: 0.7

Mean number/m²: 354.0 Standard deviation/m²: 618.7

H′ = 0.81 J′ = 0.81

Appendix Table 4.--Continued.

Station: R2B   Date: 13 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	4	30.0	354.0	618.7
Corbicula manilensis	2	20.0	177.0	373.1

Number of taxa: 2

Mean number/sample: 0.6   Standard deviation/sample: 1.1

Mean number/m²: 530.9   Standard deviation/m²: 951.2

H′ = 0.92   J′ = 0.92

Appendix Table 4.--Continued.

Station: R3A   Date: 13 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²

Number of taxa: 0

Mean number/sample: 0.0   Standard deviation/sample: 0.0

Mean number/m²: 0.0   Standard deviation/m²: 0.0

H′ = 0.00   J′ = 0.00

Appendix Table 4.--Continued.

Station: R3B Date: 13 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Corbicula</u> <u>manilensis</u>	2	20.0	177.0	373.1
<u>Corophium</u> <u>salmonis</u>	1	10.0	88.5	279.8

Number of taxa: 2

Mean number/sample: 0.3 Standard deviation/sample: 0.5

Mean number/m^2: 265.5 Standard deviation/m^2: 427.4

H′ = 0.92 J′ = 0.92

Appendix Table 4.--Continued.

Station: M2 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	38	90.0	3,362.6	3,279.3
Ostracoda	1	10.0	88.5	279.8
<u>Corophium</u> <u>salmonis</u>	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Harpacticoida	4	40.0	354.0	457.0
Chironomidae larvae	19	80.0	1,681.3	1,411.5
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 7

Mean number/sample: 6.5 Standard deviation/sample: 4.9

Mean number/m²: 5,751.8 Standard deviation/m²: 4,299.8

H′ = 1.59 J′ = 0.57

Appendix Table 4.--Continued.

Station: M3 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	3	30.0	265.5	427.4
Corbicula manilensis	3	30.0	265.5	427.4
Corophium salmonis	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 0.7 Standard deviation/sample: 0.7

Mean number/m^2: 619.4 Standard deviation/m^2: 597.3

$H' = 1.45$ $J' = 0.91$

Appendix Table 4.--Continued.

Station: M4 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	1	10.0	88.5	279.8
Neanthes limnicola	4	40.0	354.0	457.0
Oligochaeta	5	40.0	442.5	625.7
Corbicula manilensis	10	70.0	884.9	722.5
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium salmonis	394	100.0	34,865.1	11,501.4
Harpacticoida	2	10.0	177.0	559.7
Chironomidae larvae	1	10.0	88.5	279.8

Number of taxa: 8

Mean number/sample: 41.8 Standard deviation/sample: 13.1

Mean number/m^2: 36,988.8 Standard deviation/m^2: 11,603.9

$H' = 0.45$ $J' = 0.15$

Appendix Table 4.--Continued.

Station: M5 Date: 11 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	14	30.0	1,238.9	2,330.0
Ostracoda	2	10.0	177.0	559.7
<u>Corophium salmonis</u>	1	10.0	88.5	279.8
Chironomidae larvae	3	30.0	265.5	427.4

Number of taxa: 4

Mean number/sample: 2.0 Standard deviation/sample: 3.2

Mean number/m^2: 1,769.8 Standard deviation/m^2: 2,859.8

H′ = 1.32 J′ = 0.66

Appendix Table 4.--Continued.

Station: M6 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	12	70.0	1,061.9	913.9
Oligochaeta	178	100.0	15,751.2	7,632.7
Corbicula manilensis	10	60.0	884.9	834.3
Ostracoda	8	50.0	707.9	813.2
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	206	100.0	18,228.9	4,398.9
Chironomidae larvae	9	40.0	796.4	1,411.5

Number of taxa: 8

Mean number/sample: 42.5 Standard deviation/sample: 8.4

Mean number/m²: 37,608.3 Standard deviation/m²: 7,441.7

H' = 1.57 J' = 0.52

Appendix Table 4.--Continued.

Station: MB　　Date: 15 Sep 89　　Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	1	10.0	88.5	279.8
Oligochaeta	120	100.0	10,618.8	4,001.1
Corbicula manilensis	5	40.0	442.5	625.7
Ostracoda	4	20.0	354.0	746.2
Corophium salmonis	2	20.0	177.0	373.1
Harpacticoida	2	10.0	177.0	559.7
Chironomidae larvae	182	100.0	16,105.2	4,861.1
Chironomidae pupae	1	10.0	88.5	279.8
Heleidae larvae	2	20.0	177.0	373.1
Invertebrate eggs	3	20.0	265.5	597.3

Number of taxa: 10

Mean number/sample: 32.2　　Standard deviation/sample: 7.7

Mean number/m^2: 28,493.8　　Standard deviation/m^2: 6,775.3

H′ = 1.42　　J′ = 0.43

Appendix Table 4.--Continued.

Station: M10 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	5	30.0	442.5	752.0
Oligochaeta	41	90.0	3,628.1	2,552.8
Corbicula manilensis	11	70.0	973.4	774.8
Ostracoda	4	30.0	354.0	618.7
Corophium salmonis	125	100.0	11,061.3	5,753.7
Copepoda	2	10.0	177.0	559.7
Calanoida	6	40.0	530.9	854.9
Chironomidae larvae	3	20.0	265.5	597.3
Chironomidae pupae	1	10.0	88.5	279.8
Tabanidae	1	10.0	88.5	279.8
Invertebrate eggs	2	20.0	177.0	373.1

Number of taxa: 11

Mean number/sample: 20.1 Standard deviation/sample: 6.0

Mean number/m²: 17,786.5 Standard deviation/m²: 5,349.4

H′ = 1.82 J′ = 0.53

Appendix Table 4.--Continued.

Station: M11 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	1	10.0	88.5	279.8
Turbellaria	2	10.0	177.0	559.7
Neanthes limnicola	5	50.0	442.5	466.4
Oligochaeta	95	100.0	8,406.6	6,690.6
Corbicula manilensis	7	40.0	619.4	839.5
Ostracoda	3	30.0	265.5	427.4
Corophium spp.	5	30.0	442.5	752.0
Corophium salmonis	212	100.0	18,759.9	6,990.1
Chironomidae larvae	1	10.0	88.5	279.8
Heleidae larvae	5	40.0	442.5	625.7
Invertebrate eggs	2	20.0	177.0	373.1
Hydracarina	1	10.0	88.5	279.8

Number of taxa: 12

Mean number/sample: 33.9 Standard deviation/sample: 7.7

Mean number/m²: 29,998.1 Standard deviation/m²: 6,783.6

H′ = 1.54 J′ = 0.43

Appendix Table 4.--Continued.

Station: M13 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Corbicula manilensis	4	30.0	354.0	618.7
Eohaustorius estuarius	52	100.0	4,601.5	2,884.0
Corophium salmonis	23	100.0	2,035.3	1,563.6

Number of taxa: 3

Mean number/sample: 7.9 Standard deviation/sample: 3.6

Mean number/m²: 6,990.7 Standard deviation/m²: 3,161.8

H′ = 1.13 J′ = 0.72

Appendix Table 4.--Continued.

Station: M14 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	8	60.0	707.9	698.0
Neanthes limnicola	6	40.0	530.9	746.2
Oligochaeta	5	40.0	442.5	625.7
Corbicula manilensis	9	60.0	796.4	774.8
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium salmonis	717	100.0	63,447.3	16,449.8
Corophium spinicorne	1	10.0	88.5	279.8
Harpacticoida	1	10.0	88.5	279.8

Number of taxa: 8

Mean number/sample: 74.8 Standard deviation/sample: 17.8

Mean number/m²: 66,190.5 Standard deviation/m²: 15,718.2

H' = 0.35 J' = 0.12

Appendix Table 4.--Continued.

Station: M15 Date: 18 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	15	80.0	1,327.4	1,123.2
Oligochaeta	166	100.0	14,689.3	7,287.5
Ostracoda	1	10.0	88.5	279.8
Corophium spp.	4	20.0	354.0	854.9
Corophium salmonis	454	100.0	40,174.5	23,723.1
Corophium spinicorne	2	20.0	177.0	373.1

Number of taxa: 6

Mean number/sample: 64.2 Standard deviation/sample: 27.3

Mean number/m²: 56,810.6 Standard deviation/m²: 24,114.5

H′ = 1.07 J′ = 0.41

Appendix Table 4.--Continued.

Station: J1A Date: 12 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	49	90.0	4,336.0	2,062.7

Number of taxa: 2

Mean number/sample: 5.0 Standard deviation/sample: 2.5

Mean number/m^2: 4,424.5 Standard deviation/m^2: 2,207.3

H′ = 0.14 J′ = 0.14

Appendix Table 4.--Continued.

Station: J1B Date: 12 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Corbicula manilensis	29	90.0	2,566.2	1,742.6
Corophium salmonis	2	20.0	177.0	373.1
Chironomidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	2	20.0	177.0	373.1

Number of taxa: 4

Mean number/sample: 3.4 Standard deviation/sample: 2.1

Mean number/m^2: 3,008.7 Standard deviation/m^2: 1,827.8

$H' = 0.83$ $J' = 0.41$

Appendix Table 4.--Continued.

Station: J2A Date: 13 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²

Number of taxa: 0

Mean number/sample: 0.0 Standard deviation/sample: 0.0

Mean number/m²: 0.0 Standard deviation/m²: 0.0

H′ = 0.00 J′ = 0.00

Appendix Table 4.--Continued.

Station: J2B   Date: 13 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2

Number of taxa: 0

Mean number/sample: 0.0   Standard deviation/sample: 0.0

Mean number/m^2: 0.0   Standard deviation/m^2: 0.0

H′ = 0.00   J′ = 0.00

Appendix Table 4.--Continued.

Station: J3A   Date: 14 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Turbellaria	6	30.0	530.9	854.9
Neanthes limnicola	3	30.0	265.5	427.4
Oligochaeta	521	100.0	46,103.3	13,622.5
Corbicula manilensis	11	70.0	973.4	880.0
Ostracoda	19	70.0	1,681.3	1,282.3
Corophium salmonis	37	100.0	3,274.1	2,361.6
Pontoporeia hoyi	1	10.0	88.5	279.8
Chironomidae larvae	32	90.0	2,831.7	1,709.8

Number of taxa: 8

Mean number/sample: 63.0   Standard deviation/sample: 18.0

Mean number/m^2: 55,748.7   Standard deviation/m^2: 15,922.7

H′ = 1.05   J′ = 0.35

Appendix Table 4.--Continued.

Station: J3B | Date: 14 Sep 89 | Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Neanthes limnicola	7	50.0	619.4	728.5
Oligochaeta	142	90.0	12,565.6	6,990.1
Fluminicola sp.	1	10.0	88.5	279.8
Corbicula manilensis	31	80.0	2,743.2	2,339.4
Ostracoda	12	70.0	1,061.9	1,004.6
Corophium salmonis	170	100.0	15,043.3	3,979.3
Pontoporeia hoyi	4	30.0	354.0	618.7
Chironomidae larvae	21	70.0	1,858.3	1,839.7
Invertebrate eggs	9	40.0	796.4	1,212.6

Number of taxa: 9

Mean number/sample: 39.7 Standard deviation/sample: 11.1

Mean number/m^2: 35,130.5 Standard deviation/m^2: 9,792.3

$H' = 2.03$ $J' = 0.64$

Appendix Table 4.--Continued.

Station: J4A Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	44	90.0	3,893.6	2,773.3
Oligochaeta	518	100.0	45,837.8	17,736.3
Corbicula manilensis	11	60.0	973.4	1,059.4
Ostracoda	3	30.0	265.5	427.4
Corophium salmonis	73	100.0	6,459.8	2,639.9
Chironomidae larvae	79	100.0	6,990.7	2,685.7
Chironomidae pupae	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 9

Mean number/sample: 73.1 Standard deviation/sample: 20.6

Mean number/m^2: 64,686.2 Standard deviation/m^2: 18,252.0

H′ = 1.44 J′ = 0.45

Appendix Table 4.--Continued.

Station: J4B   Date: 14 Sep 89   Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	6	40.0	530.9	854.9
Oligochaeta	94	100.0	8,318.1	4,237.7
Corbicula manilensis	20	90.0	1,769.8	1,021.8
Ostracoda	3	30.0	265.5	427.4
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	247	100.0	21,857.0	3,123.0
Chironomidae larvae	4	30.0	354.0	618.7
Invertebrate eggs	10	50.0	884.9	1,103.7

Number of taxa: 8

Mean number/sample: 38.5   Standard deviation/sample: 5.6

Mean number/m²: 34,068.7   Standard deviation/m²: 4,975.2

H′ = 1.50   J′ = 0.50

Appendix Table 5.--Sediment characteristics at five areas in the Columbia River estuary--Desdemona Sands (D), Taylor Sands (T), Rice Island (R), Miller Sands (M), and Jim Crow Sands (J). Four surveys were conducted in 1988-1989.

SURVEY 1

Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
21 Oct 88	D1	A	3.0	7.1	1.9
21 Oct 88	D1	B	3.3	13.2	1.5
21 Oct 88	T1	A	2.3	0.5	0.6
21 Oct 88	T1	B	3.1	5.6	1.3
21 Oct 88	T2	A	2.3	0.1	0.6
21 Oct 88	T2	B	2.3	0.2	0.5
16 Sep 88	R1A	A	1.9	0.6	0.8
16 Sep 88	R1A	B	1.9	0.3	0.4
16 Sep 88	R1B	A	2.2	1.4	0.5
16 Sep 88	R1B	B	2.2	0.3	0.4
16 Sep 88	R2A	A	2.1	0.7	0.6
16 Sep 88	R2A	B	2.1	0.7	0.5
16 Sep 88	R2B	A	2.2	1.0	0.6
16 Sep 88	R2B	B	2.0	0.0	0.5
16 Sep 88	R3A	A	2.1	0.5	0.6
16 Sep 88	R3A	B	2.2	0.1	0.4
16 Sep 88	R3B	A	2.1	0.6	0.6
16 Sep 88	R3B	B	2.1	0.0	0.4
15 Sep 88	M2	A	3.6	38.4	2.2
15 Sep 88	M2	B	3.9	50.6	1.7
14 Sep 88	M3	A	1.8	3.1	1.3
14 Sep 88	M3	B	1.7	3.8	0.9
14 Sep 88	M4	A	2.8	1.2	0.5
14 Sep 88	M4	B	2.8	0.8	0.7
15 Sep 88	M6	A	3.7	22.5	1.8
15 Sep 88	M6	B	3.8	27.6	1.4
15 Sep 88	M10	A	2.8	7.6	1.5
15 Sep 88	M10	B	2.9	10.8	1.0
14 Sep 88	M11	A	2.7	3.9	1.0
14 Sep 88	M11	B	2.7	3.7	0.9
14 Sep 88	M13	A	2.8	0.1	0.6
14 Sep 88	M13	B	2.8	0.2	0.9
14 Sep 88	M14	A	2.6	0.6	0.6
14 Sep 88	M14	B	2.5	0.5	0.5
21 Oct 88	M15	A	4.2	39.5	3.2
21 Oct 88	M15	B	4.3	41.2	2.5
26 Sep 88	J1A	A	2.1	0.3	0.5
26 Sep 88	J1A	B	2.1	0.0	0.5
26 Sep 88	J1B	B	2.3	0.5	1.0
26 Sep 88	J1B	A	2.4	3.5	0.6
26 Sep 88	J2A	B	1.9	0.1	0.4
26 Sep 88	J2A	A	1.9	0.2	0.8

Appendix Table 5.--Continued.

Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
SURVEY 1					
26 Sep 88	J2B	A	1.9	0.6	0.7
26 Sep 88	J2B	B	1.6	0.1	0.6
16 Sep 88	J3A	A	3.8	28.3	2.0
16 Sep 88	J3A	B	3.9	31.2	1.4
26 Sep 88	J3B	A	3.5	7.5	1.0
26 Sep 88	J3B	B	3.7	14.2	0.8
26 Sep 88	J4A	A	3.9	33.6	2.2
26 Sep 88	J4A	B	3.9	27.5	1.4
26 Sep 88	J4B	A	2.4	2.5	0.9
26 Sep 88	J4B	B	2.4	2.2	1.1
SURVEY 2					
3 May 89	D1	A	3.2	2.3	1.2
8 May 89	D2	A	2.5	0.2	0.6
3 May 89	T1	A	2.4	0.1	0.4
3 May 89	T2	A	2.1	0.1	0.7
11 May 89	R1A	A	2.2	0.2	0.5
11 May 89	R1B	A	2.0	0.2	0.5
11 May 89	R2A	A	2.1	0.1	0.6
11 May 89	R2B	A	2.4	1.0	0.5
11 May 89	R3A	A	2.3	0.3	0.5
11 May 89	R3B	A	2.1	0.4	0.4
11 May 89	M2	A	2.9	1.6	0.9
11 May 89	M3	A	2.5	10.8	0.8
11 May 89	M4	A	3.3	27.4	1.4
12 May 89	M5	A	2.4	2.3	0.7
12 May 89	M10	A	2.3	1.1	0.4
12 May 89	M11	A	2.2	0.4	0.5
11 May 89	M13	A	2.9	0.3	0.6
12 May 89	M14	A	2.2	1.2	0.6
3 May 89	M15	A	4.3	44.4	2.7
10 May 89	J1A	A	2.1	0.5	0.5
10 May 89	J1B	A	2.1	0.3	0.6
10 May 89	J2A	A	1.7	0.1	0.5
10 May 89	J2B	A	1.8	0.1	0.5
10 May 89	J3A	A	3.6	13.6	1.0
10 May 89	J3B	A	3.7	15.4	1.0
10 May 89	J4A	A	3.8	27.6	1.7
10 May 89	J4B	A	2.4	6.1	0.6

Appendix Table 5.--Continued.

SURVEY 3					
Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
28 Jul 89	D1	A	3.2	5.3	1.0
28 Jul 89	D1	B	2.8	0.8	1.0
19 Jul 89	D2	A	2.6	0.4	0.6
19 Jul 89	D2	B	2.6	0.3	0.5
28 Jul 89	T1	A	2.2	0.1	0.6
28 Jul 89	T1	B	2.2	0.1	0.5
28 Jul 89	T2	A	2.1	0.1	1.6
28 Jul 89	T2	B	2.1	0.0	0.6
12 Jul 89	R1A	A	2.2	0.2	0.5
12 Jul 89	R1A	B	2.3	0.1	1.5
12 Jul 89	R1B	A	2.3	0.2	0.5
12 Jul 89	R1B	B	2.3	0.1	0.4
12 Jul 89	R2A	A	2.4	0.3	0.5
12 Jul 89	R2A	B	2.3	0.2	0.5
12 Jul 89	R2B	A	2.3	0.7	0.5
12 Jul 89	R2B	B	2.3	0.4	0.5
12 Jul 89	R3A	A	1.6	0.1	0.3
12 Jul 89	R3A	B	1.6	0.1	0.4
12 Jul 89	R3B	A	1.8	0.2	0.5
12 Jul 89	R3B	B	1.7	0.1	0.6
18 Jul 89	M2	A	3.0	13.1	1.1
18 Jul 89	M2	B	3.2	18.7	1.6
18 Jul 89	M3	A	2.5	11.5	0.7
18 Jul 89	M3	B	2.5	8.0	0.7
18 Jul 89	M4	A	2.6	2.6	0.9
18 Jul 89	M4	B	2.6	4.1	0.9
19 Jul 89	M5	A	2.4	6.3	0.6
19 Jul 89	M5	B	2.4	6.4	0.9
18 Jul 89	M6	A	3.9	38.4	1.3
19 Jul 89	MB	B	3.8	35.4	0.4
18 Jul 89	M10	A	2.2	0.4	0.5
18 Jul 89	M10	B	2.2	0.5	0.4
18 Jul 89	M11	A	2.3	2.4	0.7
18 Jul 89	M11	B	2.3	2.5	0.8
18 Jul 89	M13	A	2.8	0.2	0.4
18 Jul 89	M13	B	2.8	0.3	0.4
18 Jul 89	M14	A	1.5	0.2	0.3
18 Jul 89	M14	B	1.5	0.1	0.4
28 Jul 89	M15	A	4.2	30.0	3.0
28 Jul 89	M15	B	4.1	30.9	2.3

Appendix Table 5.--Continued.

Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
		SURVEY 3			
11 Jul 89	J1A	A	2.1	0.6	0.4
11 Jul 89	J1A	B	2.1	0.6	0.5
11 Jul 89	J1B	A	2.6	0.3	0.4
11 Jul 89	J1B	B	2.7	0.6	0.4
11 Jul 89	J2A	A	1.9	0.2	0.3
11 Jul 89	J2A	B	1.9	0.1	0.4
11 Jul 89	J2B	A	2.2	0.1	0.5
11 Jul 89	J2B	B	1.5	0.1	0.4
11 Jul 89	J3A	A	3.7	21.2	1.1
11 Jul 89	J3A	B	3.6	15.6	5.3
11 Jul 89	J3B	A	3.7	11.4	0.9
11 Jul 89	J3B	B	3.6	8.2	0.9
11 Jul 89	J4A	A	3.6	17.1	1.6
11 Jul 89	J4A	B	3.5	12.0	1.6
11 Jul 89	J4B	A	2.6	3.7	1.0
11 Jul 89	J4B	B	2.5	2.5	0.2
		SURVEY 4			
18 Sep 89	D1	A	3.2	1.7	1.9
18 Sep 89	D1	B	3.2	1.6	1.6
26 Sep 89	D2	A	2.3	0.2	0.5
26 Sep 89	D2	B	2.3	0.2	0.6
18 Sep 89	T1	A	2.3	0.1	0.5
18 Sep 89	T1	B	2.0	0.2	0.7
18 Sep 89	T2	A	2.1	0.1	0.6
18 Sep 89	T2	B	2.1	0.1	0.6
13 Sep 89	R1A	A	2.2	0.1	0.7
13 Sep 89	R1A	B	2.3	0.2	0.7
13 Sep 89	R1B	A	1.7	0.1	0.5
13 Sep 89	R1B	B	2.1	0.1	1.0
13 Sep 89	R2A	A	2.2	0.2	0.7
13 Sep 89	R2B	A	2.3	0.2	0.6
13 Sep 89	R2B	B	2.2	0.2	0.7
13 Sep 89	R3A	A	1.4	0.1	0.4
13 Sep 89	R3A	B	1.5	0.1	1.3
13 Sep 89	R3B	A	2.1	0.3	0.5
13 Sep 89	R3B	B	2.1	0.2	0.6

Appendix Table 5.--Continued.

		SURVEY 4			
Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
14 Sep 89	M2	A	3.0	10.2	1.4
14 Sep 89	M2	B	2.9	7.9	1.5
14 Sep 89	M3	A	1.8	0.1	0.5
14 Sep 89	M3	B	1.8	0.2	0.5
14 Sep 89	M4	A	2.3	1.0	0.7
14 Sep 89	M4	B	2.5	1.8	0.6
11 Sep 89	M5	A	2.0	0.2	0.6
11 Sep 89	M5	B	1.9	0.2	0.7
15 Sep 89	M6	A	3.6	18.5	0.5
15 Sep 89	M6	B	3.4	13.0	1.2
15 Sep 89	MB	A	4.0	39.5	1.7
15 Sep 89	MB	B	4.1	40.9	1.9
15 Sep 89	M10	A	2.4	1.2	0.5
15 Sep 89	M10	B	2.3	1.2	0.8
15 Sep 89	M11	A	2.2	1.8	0.7
15 Sep 89	M11	B	2.3	1.5	0.8
14 Sep 89	M13	A	2.8	0.3	0.5
14 Sep 89	M13	B	2.9	0.1	0.8
15 Sep 89	M14	A	2.4	1.7	0.7
15 Sep 89	M14	B	2.4	3.0	0.5
18 Sep 89	M15	A	3.8	15.4	2.4
18 Sep 89	M15	B	3.8	16.0	2.2
12 Sep 89	J1A	A	2.0	0.6	0.6
12 Sep 89	J1A	B	2.0	0.5	0.5
12 Sep 89	J1B	A	2.3	0.2	0.5
12 Sep 89	J1B	B	2.3	0.3	0.5
11 Sep 89	J2A	A	2.2	0.1	0.5
11 Sep 89	J2A	B	2.1	0.1	0.3
11 Sep 89	J2B	A	2.1	0.1	1.2
11 Sep 89	J2B	B	1.9	0.1	0.5
14 Sep 89	J3A	A	3.7	23.6	1.5
14 Sep 89	J3A	B	4.0	38.3	1.6
14 Sep 89	J3B	A	3.5	8.1	1.0
14 Sep 89	J3B	B	3.4	6.4	0.9
14 Sep 89	J4A	A	3.8	27.8	1.5
14 Sep 89	J4A	B	3.6	21.6	1.3
14 Sep 89	J4B	A	2.5	3.6	0.5
14 Sep 89	J4B	B	2.6	4.9	1.1

Appendix Table 6.--Fish catch summaries for eight surveys at Miller Sands, Columbia River estuary, 1975-1977. The four beach seine stations (M2, M3, M10, and M11) were selected for comparison with the same stations from three surveys in 1989.

Station: M2

Gear: 76.2-m beach seine
Date: May 1975 Temperature: 11.6 C
Salinity: 0.4 ppt Turbidity: 25.0 NTU
pH: 8.2

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	108	237
Chum salmon	3	7
Threespine stickleback	43	94
American shad	9	20
Starry flounder	2	4
Peamouth	27	59
TOTALS	192	421

H′ = 1.72 J′ = 0.66

Appendix Table 6.--Continued.

Station: M3

Gear: 76.2-m beach seine
Date: May 1975
Salinity: 0.4 ppt
pH: 8.4
Temperature: 12.8 C
Turbidity: 23.0 NTU

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	87	191
Coho salmon	3	7
Chum salmon	2	4
Threespine stickleback	5	11
Starry flounder	16	35
Largescale sucker	1	2
Pacific lamprey	1	2
TOTALS	115	252

H′ = 1.26 J′ = 0.45

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: May 1975 — Temperature: 13.7 C
Salinity: 0.3 ppt — Turbidity: 23.0 NTU
pH: 8.3

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	49	108
Threespine stickleback	1	2
American shad	4	9
Starry flounder	15	33
TOTALS	69	152

H′ = 1.16 J′ = 0.58

Station: M11

Gear: 76.2-m beach seine
Date: May 1975 — Temperature: 14.6 C
Salinity: 0.3 — Turbidity: 18.0 NTU
pH: 8.0

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	59	130
Chum salmon	2	4
Threespine stickleback	4	9
American shad	1	2
Starry flounder	6	13
TOTALS	72	158

H′ = 1.00 J′ = 0.43

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: Jul 1975 — Temperature: 17.2 C
Salinity: 0.3 ppt — Turbidity: 14.0 NTU
pH: 8.6

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	2
Starry flounder	10	22
TOTALS	11	24

H' = 0.44   J' = 0.44

Station: M3

Gear: 76.2-m beach seine
Date: Jul 1975 — Temperature: 15.2 C
Salinity: 0.3 — Turbidity: 22.0 NTU
pH: -

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	37	81
Threespine stickleback	1	2
Starry flounder	168	369
Peamouth	7	15
TOTALS	213	467

H' = 0.91   J' = 0.45

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: Jul 1975 Temperature: 14.6 C
Salinity: 0.3 ppt Turbidity: 22.0 NTU
pH: 7.9

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	9	20
Threespine stickleback	2	4
Starry flounder	58	127
TOTALS	69	151

H′ = 0.74 J′ = 0.47

Station: M11

Gear: 76.2-m beach seine
Date: Jul 1975 Temperature: 14.6 C
Salinity: 0.3 Turbidity: 18.0 NTU
pH: 8.0

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	34	75
Threespine stickleback	4	9
Starry flounder	98	215
Peamouth	2	4
Common carp	1	2
Unidentified sculpin	1	2
TOTALS	140	307

H′ = 1.19 J′ = 0.46

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: Sep 1975 Temperature: 16.2 C
Salinity: 0.1 ppt Turbidity: 13.0 NTU
pH: 6.7

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	2	4
Peamouth	28	61
TOTALS	30	65

H′ = 0.35 J′ = 0.35

Station: M3

Gear: 76.2-m beach seine
Date: Sep 1975 Temperature: 18.7 C
Salinity: 0.1 Turbidity: 7.4 NTU
pH: 7.3

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	16	35
American shad	3	7
Starry flounder	15	33
Peamouth	6	13
Largescale sucker	1	2
Common carp	1	2
TOTALS	42	92

H′ = 1.99 J′ = 0.77

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: Sep 1975 | Temperature: 18.3 C
Salinity: 0.1 ppt | Turbidity: 11.0 NTU
pH: 7.4

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	2	4
Starry flounder	10	22
Peamouth	3	7
TOTALS	15	33

H′ = 1.24   J′ = 0.78

Station: M11

Gear: 76.2-m beach seine
Date: Sep 1975 | Temperature: 19.2 C
Salinity: 0.1 | Turbidity: 5.3 NTU
pH: 6.8

Species	No. captured	No. per hectare
Starry flounder	6	13
Peamouth	2	4
TOTALS	8	17

H′ = 0.81   J′ = 0.81

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: May 1976 Temperature: 12.3 C
Salinity: 0.2 ppt Turbidity: 16.0 NTU
pH: 6.8

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	47	103
Threespine stickleback	7	15
American shad	14	31
Peamouth	54	119
Common carp	1	2
Rainbow trout (steelhead)	2	4
TOTALS	125	274

H′ = 1.79 J′ = 0.69

Station: M3

Gear: 76.2-m beach seine
Date: May 1976 Temperature: 12.6 C
Salinity: 0.1 Turbidity: 10.5 NTU
pH: 7.2

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	6	13
American shad	2	4
Starry flounder	2	4
TOTALS	10	21

H′ = 1.37 J′ = 0.86

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: May 1976 — Temperature: 12.9 C
Salinity: 0.1 ppt — Turbidity: 10.0 NTU
pH: 7.3

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	89	195
American shad	7	15
Starry flounder	10	22
TOTALS	106	232

H' = 0.79 J' = 0.50

Station: M11

Gear: 76.2-m beach seine
Date: May 1976 — Temperature: 15.0 C
Salinity: 0.1 — Turbidity: 9.0 NTU
pH: 7.4

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	388	852
Coho salmon	1	2
Threespine stickleback	5	11
American shad	12	26
Starry flounder	2	4
Peamouth	1	2
Largescale sucker	1	2
TOTALS	410	899

H' = 0.40 J' = 0.14

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: Jul 1976 — Temperature: 20.9 C
Salinity: 0.1 ppt — Turbidity: 4.8 NTU
pH: 8.0

Species	No. captured	No. per hectare
Starry flounder	26	57
Peamouth	30	66
Threespine stickleback	1	2
Largescale sucker	5	11
TOTALS	62	136

H′ = 1.42   J′ = 0.71

Station: M3

Gear: 76.2-m beach seine
Date: Jul 1976 — Temperature: 21.7 C
Salinity: 0.1 — Turbidity: 7.7 NTU
pH: 7.8

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	2
Starry flounder	369	810
Peamouth	2	4
Threespine stickleback	156	342
Largescale sucker	2	4
Prickly sculpin	4	9
TOTALS	534	1,171

H′ = 1.02   J′ = 0.39

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: Jul 1976 Temperature: 20.3 C
Salinity: 0.1 ppt Turbidity: 4.3 NTU
pH: 8.1

Species	No. captured	No. per hectare
Starry flounder	28	61
Threespine stickleback	5	11
TOTALS	33	72

H' = 0.61 J' = 0.61

Station: M11

Gear: 76.2-m beach seine
Date: Jul 1976 Temperature: 20.5 C
Salinity: 0.1 Turbidity: 4.2 NTU
pH: 8.1

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	2
Starry flounder	60	132
Peamouth	5	11
Threespine stickleback	1	2
TOTALS	67	147

H' = 0.60 J' = 0.30

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: Sep 1976 Temperature: 18.1 C
Salinity: 0.1 ppt Turbidity: 5.0 NTU
pH: 7.8

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	1	2
Starry flounder	14	31
Peamouth	98	215
Threespine stickleback	2	4
American shad	6	13
TOTALS	121	265

H′ = 0.98 J′ = 0.42

Station: M3

Gear: 76.2-m beach seine
Date: Sep 1976 Temperature: 18.2 C
Salinity: 0.1 Turbidity: 3.5 NTU
pH: 7.7

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	3	7
Starry flounder	43	94
Peamouth	36	79
Threespine stickleback	352	773
Largescale sucker	10	22
Prickly sculpin	2	4
TOTALS	446	979

H′ = 1.09 J′ = 0.42

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: Sep 1976 Temperature: 18.2 C
Salinity: 0.1 ppt Turbidity: 3.5 NTU
pH: 7.7

Species	No. captured	No. per hectare
Starry flounder	6	13
Peamouth	6	13
TOTALS	12	26

H' = 1.00 J' = 1.00

Station: M11

Gear: 76.2-m beach seine
Date: Sep 1976 Temperature: 18.2 C
Salinity: 0.1 Turbidity: 3.0 NTU
pH: 7.9

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	3	7
Starry flounder	232	509
Peamouth	10	22
Largescale sucker	8	18
American shad	2	4
TOTALS	255	560

H' = 0.59 J' = 0.26

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: May 1977 | Temperature: 12.9 C
Salinity: 0.1 ppt | Turbidity: 8.0 NTU
pH: 8.5

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	70	154
Chum salmon	1	2
Peamouth	7	15
Threespine stickleback	24	53
Prickly sculpin	1	2
TOTALS	103	226

H′ = 1.26   J′ = 0.54

Station: M3

Gear: 76.2-m beach seine
Date: May 1977 | Temperature: 12.7 C
Salinity: 0.1 | Turbidity: -
pH: 8.3

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	39	86
Coho salmon	2	4
Starry flounder	22	48
Peamouth	26	57
Threespine stickleback	1	2
Prickly sculpin	6	13
Common carp	9	20
TOTALS	105	230

H′ = 2.21   J′ = 0.79

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: May 1977 Temperature: 13.0 C
Salinity: 0.1 ppt Turbidity: 5.2 NTU
pH: 8.7

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	37	81
Starry flounder	5	11
Prickly sculpin	45	99
TOTALS	87	191

H' = 1.25 J' = 0.79

Station: M11

Gear: 76.2-m beach seine
Date: May 1977 Temperature: 12.9 C
Salinity: 0.1 Turbidity: 4.0 NTU
pH: 8.5

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	24	53
Coho salmon	2	4
Starry flounder	4	9
Threespine stickleback	3	7
Prickly sculpin	19	42
Common carp	1	2
TOTALS	53	117

H' = 1.85 J' = 0.72

Appendix Table 6.--Continued.

Station: M2

Gear: 76.2-m beach seine
Date: Jul 1977 — Temperature: 18.0 C
Salinity: 0.2 ppt — Turbidity: 4.1 NTU
pH: 7.6

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	4	9
Starry flounder	3	7
Threespine stickleback	1	2
TOTALS	8	18

H' = 1.41   J' = 0.89

Station: M3

Gear: 76.2-m beach seine
Date: Jul 1977 — Temperature: 18.0 C
Salinity: 0.1 — Turbidity: 4.4 NTU
pH: 7.9

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	12	26
Starry flounder	41	90
Peamouth	1	2
Threespine stickleback	12	26
Pacific staghorn sculpin	2	4
TOTALS	68	148

H' = 1.56   J' = 0.67

Appendix Table 6.--Continued.

Station: M10

Gear: 76.2-m beach seine
Date: Jul 1977 Temperature: 18.3 C
Salinity: 0.2 ppt Turbidity: 4.3 NTU
pH: 7.8

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	6	13
Starry flounder	22	48
Threespine stickleback	6	13
TOTALS	34	74

H′ = 1.29 J′ = 0.81

Station: M11

Gear: 76.2-m beach seine
Date: Jul 1977 Temperature: 18.3 C
Salinity: 0.2 ppt Turbidity: 3.8 NTU
pH: 8.0

Species	No. captured	No. per hectare
Chinook salmon (subyear.)	9	20
Starry flounder	72	158
Threespine stickleback	1	2
Pacific staghorn sculpin	5	11
American shad	1	2
TOTALS	88	193

H′ = 0.96 J′ = 0.41

Appendix Table 7.--Benthic invertebrate taxa at Miller Sands, Columbia River estuary, during eight surveys in 1975-1977. Five stations (M2, M3, M6, M10, and M11) were selected for comparison with similar stations from three surveys in 1989.

Station: M2 Date: May 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	6	33.3	9.6	16.1
Oligochaeta	5,852	100.0	9,380.9	2,212.1
Corbicula manilensis	88	100.0	141.1	57.9
Neomysis mercedis	4	16.7	6.4	15.7
Corophium salmonis	18	50.0	28.9	45.1
Insecta	2	33.3	3.2	5.0
Chironomidae	1,054	100.0	1,689.6	596.1

Number of taxa: 7

Mean number/sample: 1,170.7 Standard deviation/sample: 279.2

Mean number/m^2: 11,259.7 Standard deviation/m^2: 2,685.5

H' = 0.75 J' = 0.27

Appendix Table 7.--Continued.

Station: M3 Date: May 75 Sample size: 5

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	3	40.0	5.8	8.6
Neanthes limnicola	2	40.0	3.8	5.3
Oligochaeta	2,261	120.0	4,349.3	1,219.9
Gastropoda	6	60.0	11.5	15.8
Corbicula manilensis	112	120.0	215.4	65.1
Neomysis mercedis	1	20.0	1.9	4.3
Eogammarus confervicolus	1	20.0	1.9	4.3
Corophium salmonis	343	120.0	659.8	156.7
Chironomidae	97	120.0	186.6	45.8
Lampetra spp.	1	20.0	1.9	4.3
Unidentified osmerid	6	20.0	11.5	25.8

Number of taxa: 11

Mean number/sample: 566.6 Standard deviation/sample: 327.7

Mean number/m²: 5,449.6 Standard deviation/m²: 3,151.6

H′ = 1.05 J′ = 0.30

Appendix Table 7.--Continued.

Station: M6 Date: May 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Turbellaria	4	16.7	6.4	15.7
Neanthes limnicola	58	100.0	93.0	18.9
Oligochaeta	7,826	100.0	12,545.3	2,864.8
Gastropoda	8	33.3	12.8	19.9
Corbicula manilensis	60	100.0	96.2	47.1
Neomysis mercedis	4	16.7	6.4	15.7
Corophium salmonis	18	66.7	28.9	29.2
Insecta	8	16.7	12.8	31.4
Chironomidae	772	100.0	1,237.5	319.5

Number of taxa: 9

Mean number/sample: 1,459.7 Standard deviation/sample: 317.3

Mean number/m^2: 14,039.3 Standard deviation/m^2: 3,051.8

H′ = 0.60 J′ = 0.19

Appendix Table 7.--Continued.

Station: M10 Date: May 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	1,095	100.0	1,755.3	303.3
Gastropoda	25	100.0	40.1	11.2
Corbicula manilensis	62	100.0	99.4	52.6
Eogammarus confervicolus	1	16.7	1.6	3.9
Corophium salmonis	466	100.0	747.0	219.0
Chironomidae	178	100.0	285.3	68.2

Number of taxa: 6

Mean number/sample: 304.5 Standard deviation/sample: 34.9

Mean number/m^2: 2,928.7 Standard deviation/m^2: 335.7

H' = 1.53 J' = 0.59

Appendix Table 7.--Continued.

Station: M11 Date: May 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	652	100.0	1,045.2	384.3
Gastropoda	6	83.3	9.6	6.1
Corbicula manilensis	159	100.0	254.9	86.6
Ostracoda	1	16.7	1.6	3.9
Corophium salmonis	1,360	100.0	2,180.1	2,613.7
Chironomidae	110	100.0	176.3	42.0
Unidentified osmerid	1	16.7	1.6	3.9

Number of taxa: 7

Mean number/sample: 381.5 Standard deviation/sample: 292.6

Mean number/m²: 3,669.3 Standard deviation/m²: 2,814.0

H′ = 1.47 J′ = 0.52

Appendix Table 7.--Continued.

Station: M2 Date: Jul 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	4	16.7	6.4	15.7
Neanthes limnicola	4	16.7	6.4	15.7
Oligochaeta	10,592	100.0	16,979.3	6,403.5
Corbicula manilensis	28	66.7	44.9	56.6
Neomysis mercedis	2	16.7	3.2	7.9
Corophium salmonis	354	100.0	567.5	393.4
Chironomidae	106	100.0	169.9	94.6

Number of taxa: 7

Mean number/sample: 1,848.3 Standard deviation/sample: 678.8

Mean number/m^2: 17,777.6 Standard deviation/m^2: 6,528.8

H′ = 0.32 J′ = 0.11

Appendix Table 7.--Continued.

Station: M3 Date: Jul 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	1	16.7	1.6	3.9
Oligochaeta	717	100.0	1,149.4	344.7
Gastropoda	14	100.0	22.4	11.6
Corbicula manilensis	19	66.7	30.5	34.1
Neomysis mercedis	3	33.3	4.8	8.0
Corophium salmonis	581	100.0	931.4	154.1
Chironomidae	10	83.3	16.0	16.8

Number of taxa: 7

Mean number/sample: 224.2 Standard deviation/sample: 44.4

Mean number/m^2: 2,156.1 Standard deviation/m^2: 427.4

H′ = 1.24 J′ = 0.44

Appendix Table 7.--Continued.

Station: M6 Date: Jul 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Nemertea	4	33.3	6.4	9.9
Neanthes limnicola	6	50.0	9.6	14.9
Oligochaeta	3,697	100.0	5,926.4	4,188.5
Gastropoda	2	33.3	3.2	5.0
Corbicula manilensis	10	50.0	16.0	23.3
Corophium salmonis	10	50.0	16.0	21.6
Chironomidae	131	100.0	210.0	264.9

Number of taxa: 7

Mean number/sample: 643.3 Standard deviation/sample: 438.7

Mean number/m^2: 6,187.7 Standard deviation/m^2: 4,219.9

H′ = 0.30 J′ = 0.11

Appendix Table 7.--Continued.

Station: M10 Date: Jul 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1,565	100.0	2,508.7	1,191.4
Gastropoda	37	100.0	59.3	42.3
<u>Corbicula</u> <u>manilensis</u>	31	83.3	49.7	39.1
<u>Neomysis</u> <u>mercedis</u>	1	16.7	1.6	3.9
<u>Corophium</u> <u>salmonis</u>	400	100.0	641.2	156.8
Chironomidae	25	100.0	40.1	47.7

Number of taxa: 6

Mean number/sample: 343.2 Standard deviation/sample: 135.0

Mean number/m^2: 3,300.6 Standard deviation/m^2: 1,298.4

$H' = 1.04$ $J' = 0.40$

Appendix Table 7.--Continued.

Station: M11 Date: Jul 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Nemertea	1	16.7	1.6	3.9
<u>Neanthes</u> <u>limnicola</u>	8	50.0	12.8	18.9
Oligochaeta	222	100.0	355.9	114.6
<u>Corbicula</u> <u>manilensis</u>	23	100.0	36.9	25.4
<u>Neomysis</u> <u>mercedis</u>	1	16.7	1.6	3.9
<u>Corophium</u> <u>salmonis</u>	840	100.0	1,346.5	440.3
Chironomidae	20	100.0	32.1	18.9

Number of taxa: 7

Mean number/sample: 185.8 Standard deviation/sample: 55.7

Mean number/m^2: 1,787.4 Standard deviation/m^2: 535.9

H′ = 1.06 J′ = 0.38

Appendix Table 7.--Continued.

Station: M2 Date: Sep 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Nemertea	5	33.3	8.0	12.8
Neanthes limnicola	8	50.0	12.8	15.7
Oligochaeta	4,603	100.0	7,378.7	1,027.8
Gastropoda	2	16.7	3.2	7.9
Corbicula manilensis	32	83.3	51.3	39.7
Neomysis mercedis	4	16.7	6.4	15.7
Corophium salmonis	215	100.0	344.7	78.5
Cladocera	8	50.0	12.8	15.7
Chironomidae	521	100.0	835.2	107.5
Odonata	1	16.7	1.6	3.9
Ephemeroptera	1	16.7	1.6	3.9

Number of taxa: 11

Mean number/sample: 900.0 Standard deviation/sample: 115.1

Mean number/m^2: 8,656.3 Standard deviation/m^2: 1,107.0

H′ = 0.80 J′ = 0.23

Appendix Table 7.--Continued.

Station: M3 Date: Sep 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	2	16.7	3.2	7.9
Neanthes limnicola	24	100.0	38.5	29.8
Oligochaeta	3,649	100.0	5,849.4	2,349.9
Gastropoda*	18	83.3	28.9	20.2
Corbicula manilensis	21	100.0	33.7	19.0
Neomysis mercedis	2	33.3	3.2	5.0
Corophium salmonis	794	100.0	1,272.8	331.3
Cladocera	19	83.3	30.5	18.7
Chironomidae	41	100.0	65.7	23.9

Number of taxa: 9

Mean number/sample: 761.7 Standard deviation/sample: 282.2

Mean number/m²: 7,325.8 Standard deviation/m²: 2,714.4

H′ = 0.91 J′ = 0.29

Appendix Table 7.--Continued.

Station: M6 Date: Sep 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	4	33.3	6.4	9.9
Neanthes limnicola	29	83.3	46.5	36.7
Oligochaeta	5,616	100.0	9,002.6	2,087.0
Corbicula manilensis	61	100.0	97.8	48.1
Corophium salmonis	939	100.0	1505.2	394.5
Cladocera	13	83.3	20.8	19.6
Chironomidae	70	100.0	112.2	81.1

Number of taxa: 7

Mean number/sample: 1,122.0 Standard deviation/sample: 237.9

Mean number/m^2: 10,791.6 Standard deviation/m^2: 2,287.7

H′ = 0.80 J′ = 0.29

Appendix Table 7.--Continued.

Station: M10 Date: Sep 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	2,045	100.0	3,278.2	912.8
Gastropoda	8	100.0	12.8	5.0
Corbicula manilensis	10	66.7	16.0	14.5
Corophium salmonis	459	100.0	735.8	51.9
Cladocera	8	83.3	12.8	9.9
Chironomidae	14	83.3	22.4	19.9

Number of taxa: 6

Mean number/sample: 424.0 Standard deviation/sample: 92.9

Mean number/m²: 4,078.1 Standard deviation/m²: 893.5

H′ = 0.82 J′ = 0.32

Appendix Table 7.--Continued.

Station: M11 Date: Sep 75 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	1	16.7	1.6	3.9
Neanthes limnicola	18	83.3	28.9	24.3
Oligochaeta	1,639	100.0	2,627.4	1,022.0
Gastropoda	8	66.7	12.8	13.1
Corbicula manilensis	25	100.0	40.1	25.4
Neomysis mercedis	5	50.0	8.0	11.2
Corophium salmonis	624	100.0	1,000.3	474.1
Cladocera	3	50.0	4.8	5.3
Chironomidae	71	100.0	113.8	143.0
Odonata	6	66.7	9.6	8.6

Number of taxa: 10

Mean number/sample: 400.0 Standard deviation/sample: 100.2

Mean number/m²: 3,847.3 Standard deviation/m²: 964.1

H' = 1.24 J' = 0.37

Appendix Table 7.--Continued.

Station: M2 Date: May 76 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	103	100.0	165.1	253.3
Corbicula manilensis	3	33.3	4.8	8.0
Corophium salmonis	55	100.0	88.2	26.8
Chironomidae	1	16.7	1.6	3.9

Number of taxa: 4

Mean number/sample: 27.0 Standard deviation/sample: 27.8

Mean number/m^2: 259.7 Standard deviation/m^2: 267.7

H′ = 1.10 J′ = 0.55

Appendix Table 7.--Continued.

Station: M3 Date: May 76 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	248	100.0	397.6	208.7
Gastropoda	28	100.0	44.9	17.9
<u>Corbicula manilensis</u>	41	100.0	65.7	17.6
<u>Neomysis mercedis</u>	3	50.0	4.8	5.3
<u>Corophium salmonis</u>	578	100.0	926.5	289.4
Chironomidae	17	100.0	27.3	24.6

Number of taxa: 6

Mean number/sample: 152.5 Standard deviation/sample: 47.4

Mean number/m^2: 1,466.8 Standard deviation/m^2: 455.8

$H' = 1.42$ $J' = 0.55$

Appendix Table 7.--Continued.

Station: M6 Date: May 76 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	2	33.3	3.2	5.0
Oligochaeta	3,608	83.3	5,783.7	4,291.1
Gastropoda	909	33.3	1,457.2	3,564.6
Corbicula manilensis	81	100.0	129.8	57.3
Neomysis mercedis	113	33.3	181.1	439.0
Corophium salmonis	926	100.0	1,484.4	357.1
Chironomidae	70	100.0	112.2	78.3
Plecoptera	4	50.0	6.4	7.9

Number of taxa: 8

Mean number/sample: 952.2 Standard deviation/sample: 336.8

Mean number/m²: 9,158.1 Standard deviation/m²: 3,239.4

H′ = 1.55 J′ = 0.52

Appendix Table 7.--Continued.

Station: M10 Date: May 76 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	93	100.0	149.1	129.0
Gastropoda	2	33.3	3.2	5.0
Corbicula manilensis	37	100.0	59.3	11.2
Neomysis mercedis	2	33.3	3.2	5.0
Corophium salmonis	207	100.0	331.8	124.9
Chironomidae	12	100.0	19.2	12.2

Number of taxa: 6

Mean number/sample: 58.8 Standard deviation/sample: 24.7

Mean number/m²: 565.9 Standard deviation/m²: 237.4

H' = 1.55 J' = 0.60

Appendix Table 7.--Continued.

Station: M11 Date: May 76 Sample size: 6

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	639	100.0	1,024.3	223.2
Gastropoda	11	66.7	17.6	15.4
Corbicula manilensis	45	100.0	72.1	37.4
Neomysis mercedis	5	50.0	8.0	9.5
Corophium salmonis	720	100.0	1,154.2	244.8
Chironomidae	60	100.0	96.2	43.9
Plecoptera	1	16.7	1.6	3.9

Number of taxa: 7

Mean number/sample: 246.8 Standard deviation/sample: 35.4

Mean number/m²: 2,374.1 Standard deviation/m²: 340.3

H' = 1.46 J' = 0.52

Appendix Table 7.--Continued.

Station: M2 Date: Jul 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes</u> <u>limnicola</u>	5	66.7	32.1	29.4
Oligochaeta	126	100.0	808.0	587.0
<u>Corbicula</u> <u>manilensis</u>	2	66.7	12.8	11.1
<u>Corophium</u> <u>salmonis</u>	152	100.0	974.7	259.8
Chironomidae	1	33.3	6.4	11.1

Number of taxa: 5

Mean number/sample: 95.3 Standard deviation/sample: 43.0

Mean number/m²: 1,834.0 Standard deviation/m²: 828.0

H′ = 1.19 J′ = 0.51

Appendix Table 7.--Continued.

Station: M3 Date: Jul 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	9	66.7	57.7	57.7
Oligochaeta	227	100.0	1,455.7	168.1
Corbicula manilensis	9	100.0	57.7	19.2
Corophium salmonis	1	33.3	6.4	11.1
Chironomidae	25	100.0	160.3	29.4

Number of taxa: 5

Mean number/sample: 90.3 Standard deviation/sample: 10.8

Mean number/m^2: 1,737.8 Standard deviation/m^2: 207.5

H' = 0.89 J' = 0.38

Appendix Table 7.--Continued.

Station: M6 Date: Jul 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	2	66.7	12.8	11.1
Oligochaeta	102	100.0	654.1	374.5
Gastropoda	1	33.3	6.4	11.1
Corbicula manilensis	10	100.0	64.1	44.4
Neomysis mercedis	1	33.3	6.4	11.1
Corophium salmonis	285	100.0	1,827.6	309.6
Insecta	4	66.7	25.7	22.2
Chironomidae	1	33.3	6.4	11.1

Number of taxa: 8

Mean number/sample: 135.3 Standard deviation/sample: 30.9

Mean number/m^2: 2,603.6 Standard deviation/m^2: 594.9

H′ = 1.16 J′ = 0.39

Appendix Table 7.--Continued.

Station: M10 Date: Jul 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes limnicola</u>	16	100.0	102.6	77.8
Oligochaeta	408	100.0	2,616.4	208.1
Gastropoda	2	33.3	12.8	22.2
<u>Neomysis mercedis</u>	3	66.7	19.2	19.2
<u>Corophium salmonis</u>	154	100.0	987.6	48.4
Chironomidae	51	100.0	327.0	50.9

Number of taxa: 6

Mean number/sample: 211.3 Standard deviation/sample: 19.3

Mean number/m^2: 4,065.7 Standard deviation/m^2: 372.2

H′ = 1.39 J′ = 0.54

Appendix Table 7.--Continued.

Station: M11 Date: Jul 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	158	100.0	1,013.2	622.3
Gastropoda	1	33.3	6.4	11.1
Corophium salmonis	251	100.0	1,609.6	689.4
Insecta	2	33.3	12.8	22.2

Number of taxa: 4

Mean number/sample: 137.3 Standard deviation/sample: 64.2

Mean number/m²: 2,642.0 Standard deviation/m²: 1,235.8

H′ = 1.02 J′ = 0.51

Appendix Table 7.--Continued.

Station: M2 Date: Sep 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	289	100.0	1,853.3	240.5
Corbicula manilensis	16	100.0	102.6	67.6
Corophium salmonis	226	100.0	1,449.3	197.4
Insecta	1	33.3	6.4	11.1
Chironomidae	10	66.7	64.1	58.8

Number of taxa: 5

Mean number/sample: 180.7 Standard deviation/sample: 21.0

Mean number/m^2: 3,475.7 Standard deviation/m^2: 403.7

H' = 1.28 J' = 0.55

Appendix Table 7.--Continued.

Station: M3 Date: Sep 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	1	33.3	6.4	11.1
Oligochaeta	505	100.0	3,238.4	709.0
Corbicula manilensis	60	100.0	384.8	57.7
Ostracoda	14	100.0	89.8	90.9
Neomysis mercedis	7	33.3	44.9	77.8
Eogammarus confervicolus	1	33.3	6.4	11.1
Corophium salmonis	57	100.0	365.5	83.9
Cladocera	3	33.3	19.2	33.3
Chironomidae	22	100.0	141.1	58.8

Number of taxa: 9

Mean number/sample: 223.3 Standard deviation/sample: 25.6

Mean number/m²: 4,296.5 Standard deviation/m²: 492.1

H′ = 1.33 J′ = 0.42

Appendix Table 7.--Continued.

Station: M6 Date: Sep 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Neanthes limnicola	5	66.7	32.1	29.4
Oligochaeta	140	100.0	897.8	1,055.2
Corbicula manilensis	13	100.0	83.4	77.8
Neomysis mercedis	1	33.3	6.4	11.1
Corophium salmonis	308	100.0	1,975.1	952.3
Cladocera	1	33.3	6.4	11.1
Insecta	1	33.3	6.4	11.1
Chironomidae	21	100.0	134.7	50.9

Number of taxa: 8

Mean number/sample: 163.3 Standard deviation/sample: 100.5

Mean number/m^2: 3,142.2 Standard deviation/m^2: 1,933.1

H' = 1.39 J' = 0.46

Appendix Table 7.--Continued.

Station: M10   Date: Sep 76   Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	245	100.0	1,571.1	751.6
Corbicula manilensis	35	100.0	224.4	61.8
Neomysis mercedis	7	100.0	44.9	22.2
Eogammarus confervicolus	1	33.3	6.4	11.1
Corophium salmonis	95	100.0	609.2	194.6
Chironomidae	32	100.0	205.2	125.2

Number of taxa: 6

Mean number/sample: 138.3   Standard deviation/sample: 31.3

Mean number/m²: 2,661.3   Standard deviation/m²: 603.0

H' = 1.64   J' = 0.64

Appendix Table 7.--Continued.

Station: M11 Date: Sep 76 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	294	100.0	1,885.3	810.7
<u>Corbicula</u> <u>manilensis</u>	30	100.0	192.4	120.1
<u>Corophium</u> <u>salmonis</u>	235	100.0	1,507.0	763.8
Chironomidae	31	100.0	198.8	98.7

Number of taxa: 4

Mean number/sample: 196.7 Standard deviation/sample: 25.9

Mean number/m^2: 3,783.5 Standard deviation/m^2: 498.8

H′ = 1.47 J′ = 0.74

Appendix Table 7.--Continued.

Station: M2 Date: May 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	24	100.0	153.9	57.7
Corbicula manilensis	3	33.3	19.2	33.3
Corophium salmonis	7	100.0	44.9	29.4
Chironomidae	76	100.0	487.4	218.8

Number of taxa: 4

Mean number/sample: 36.7 Standard deviation/sample: 9.0

Mean number/m²: 705.4 Standard deviation/m²: 172.4

H′ = 1.24 J′ = 0.62

Appendix Table 7.--Continued.

Station: M3 Date: May 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	1,470	100.0	9,426.7	5,667.9
Gastropoda	2	33.3	12.8	22.2
Corbicula manilensis	111	100.0	711.8	83.9
Corophium salmonis	9	100.0	57.7	19.2
Chironomidae	19	100.0	121.8	11.1

Number of taxa: 5

Mean number/sample: 537.0 Standard deviation/sample: 297.2

Mean number/m^2: 10,330.9 Standard deviation/m^2: 5,717.6

$H' = 0.52$ $J' = 0.22$

Appendix Table 7.--Continued.

Station: M6 Date: May 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	98	100.0	628.4	214.5
Gastropoda	2	66.7	12.8	11.1
Corbicula manilensis	42	100.0	269.3	69.4
Corophium salmonis	298	100.0	1,911.0	661.5
Chironomidae	5	100.0	32.1	22.2

Number of taxa: 5

Mean number/sample: 148.3 Standard deviation/sample: 39.5

Mean number/m^2: 2,853.7 Standard deviation/m^2: 759.9

H′ = 1.30 J′ = 0.56

Appendix Table 7.--Continued.

Station: M10 Date: May 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Oligochaeta	1,115	100.0	7,150.2	1,010.4
Gastropoda	3	100.0	19.2	0.0
Corbicula manilensis	21	100.0	134.7	33.3
Eogammarus confervicolus	1	33.3	6.4	11.1
Corophium salmonis	21	100.0	134.7	77.0
Chironomidae	27	100.0	173.1	96.2

Number of taxa: 6

Mean number/sample: 396.0 Standard deviation/sample: 60.7

Mean number/m^2: 7,618.3 Standard deviation/m^2: 1,166.9

H′ = 0.45 J′ = 0.17

Appendix Table 7.--Continued.

Station: M11 Date: May 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	89	100.0	570.7	311.0
Gastropoda	5	66.7	32.1	29.4
<u>Corbicula manilensis</u>	36	100.0	230.9	173.1
<u>Corophium salmonis</u>	144	100.0	923.4	88.2
Chironomidae	3	33.3	19.2	33.3

Number of taxa: 5

Mean number/sample: 92.3 Standard deviation/sample: 24.0

Mean number/m²: 1,776.3 Standard deviation/m²: 462.3

H′ = 1.57 J′ = 0.68

Appendix Table 7.--Continued.

Station: M2 Date: Jul 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	2	66.7	12.8	11.1
Oligochaeta	9	100.0	57.7	19.2
Corbicula manilensis	7	100.0	44.9	11.1
Eogammarus confervicolus	1	33.3	6.4	11.1
Corophium salmonis	161	100.0	1,032.4	909.8
Chironomidae	149	100.0	955.5	790.7

Number of taxa: 6

Mean number/sample: 109.7 Standard deviation/sample: 88.6

Mean number/m^2: 2,109.8 Standard deviation/m^2: 1,705.2

$H' = 1.35$ $J' = 0.52$

Appendix Table 7.--Continued.

Station: M3 Date: Jul 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	163	100.0	1,045.3	212.8
Gastropoda	1	33.3	6.4	11.1
Corbicula manilensis	90	100.0	577.1	468.1
Corophium salmonis	31	66.7	198.8	327.8
Chironomidae	191	100.0	1,224.8	1,038.9

Number of taxa: 5

Mean number/sample: 158.7 Standard deviation/sample: 95.7

Mean number/m^2: 3,052.5 Standard deviation/m^2: 1,841.4

H' = 1.79 J' = 0.77

Appendix Table 7.--Continued.

Station: M6 Date: Jul 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	4	100.0	25.7	11.1
Oligochaeta	24	100.0	153.9	50.9
Corbicula manilensis	6	66.7	38.5	38.5
Corophium salmonis	115	100.0	737.5	982.2
Chironomidae	103	100.0	660.5	422.1

Number of taxa: 5

Mean number/sample: 84.0 Standard deviation/sample: 39.7

Mean number/m²: 1,616.0 Standard deviation/m²: 763.5

H′ = 1.59 J′ = 0.68

Appendix Table 7.--Continued.

Station: M10 Date: Jul 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
<u>Neanthes</u> <u>limnicola</u>	5	100.0	32.1	11.1
Oligochaeta	68	100.0	436.1	58.8
<u>Corbicula</u> <u>manilensis</u>	11	100.0	70.5	48.4
<u>Corophium</u> <u>salmonis</u>	403	100.0	2,584.3	727.6
Chironomidae	57	100.0	365.5	221.9

Number of taxa: 5

Mean number/sample: 181.3 Standard deviation/sample: 46.8

Mean number/m^2: 3,488.5 Standard deviation/m^2: 899.5

H' = 1.21 J' = 0.52

Appendix Table 7.--Continued.

Station: M11 Date: Jul 77 Sample size: 3

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	2	33.3	12.8	22.2
Oligochaeta	91	100.0	583.6	165.9
Gastropoda	5	100.0	32.1	22.2
Corbicula manilensis	8	66.7	51.3	48.4
Neomysis mercedis	6	100.0	38.5	19.2
Corophium salmonis	293	100.0	1,878.9	224.6
Chironomidae	94	100.0	602.8	232.7

Number of taxa: 7

Mean number/sample: 166.3 Standard deviation/sample: 12.3

Mean number/m^2: 3,199.9 Standard deviation/m^2: 237.4

$H' = 1.62$ $J' = 0.58$

Appendix Table 8.--Benthic invertebrate taxa at five Miller Sands stations, Columbia River estuary, during three surveys in 1989. The five stations (M2, M3, M6, M10, and M11) were selected for comparison with similar stations from eight surveys conducted in 1975-1977. The samples were washed through a 0.6-mm sieve, which was comparable to the sieve used in the 1975-1977 surveys.

Station: M2 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	12	40.0	1,061.9	1,432.9
Nematomorpha	16	90.0	1,415.8	746.2
<u>Neanthes</u> <u>limnicola</u>	6	10.0	530.9	1,679.0
Oligochaeta	83	100.0	7,344.7	5,092.8
Ostracoda	2	20.0	177.0	373.1
<u>Corophium</u> <u>salmonis</u>	41	100.0	3,628.1	1,932.0
Chironomidae larvae	17	80.0	1,504.3	1,107.6
Heleidae larvae	1	10.0	88.5	279.8

Number of taxa: 8

Mean number/sample: 17.8 Standard deviation/sample: 6.6

Mean number/m²: 15,751.2 Standard deviation/m²: 5,837.1

H' = 2.18 J' = 0.73

Appendix Table 8.--Continued.

Station: M3 Date: 11 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number $/m^2$	Standard deviation $/m^2$
Nemertea	6	20.0	530.9	1,396.0
Nematomorpha	19	60.0	1,681.3	2,020.0
Turbellaria	2	10.0	177.0	559.7
<u>Neanthes</u> <u>limnicola</u>	6	30.0	530.9	1,119.3
Oligochaeta	107	100.0	9,468.4	5,534.9
<u>Corbicula</u> <u>manilensis</u>	4	30.0	354.0	618.7
<u>Corophium</u> <u>salmonis</u>	12	60.0	1,061.9	1,087.8
Diptera adult	1	10.0	88.5	279.8
Chironomidae larvae	33	100.0	2,920.2	1,722.5
Chironomidae pupae	1	10.0	88.5	279.8
Heleidae larvae	2	20.0	177.0	373.1
Invertebrate eggs	5	10.0	442.5	1,399.1

Number of taxa: 12

Mean number/sample: 19.8 Standard deviation/sample: 7.8

Mean number/m^2: 17,521.0 Standard deviation/m^2: 6,877.2

H′ = 2.24 J′ = 0.63

Appendix Table 8.--Continued.

Station: M10 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	14	70.0	1,238.9	1,038.7
Oligochaeta	19	70.0	1,681.3	1,585.7
Corbicula manilensis	2	10.0	177.0	559.7
Ostracoda	1	10.0	88.5	279.8
Heleidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 6

Mean number/sample: 3.8 Standard deviation/sample: 2.1

Mean number/m^2: 3,362.6 Standard deviation/m^2: 1,856.2

$H' = 1.67$ $J' = 0.65$

Appendix Table 8.--Continued.

Station: M11 Date: 12 May 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Corbicula manilensis</u>	3	20.0	265.5	597.3
<u>Corophium salmonis</u>	6	50.0	530.9	618.7

Number of taxa: 2

Mean number/sample: 0.9 Standard deviation/sample: 0.9

Mean number/m^2: 796.4 Standard deviation/m^2: 774.8

H′ = 0.92 J′ = 0.92

Appendix Table 8.--Continued.

Station: M6 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	7	50.0	619.4	728.5
Oligochaeta	291	100.0	25,750.6	6,614.8
Corbicula manilensis	2	20.0	177.0	373.1
Ostracoda	15	40.0	1,327.4	2,054.2
Eohaustorius estuarius	6	40.0	530.9	746.2
Corophium salmonis	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Chironomidae larvae	14	80.0	1,238.9	1,038.7
Chironomidae pupae	5	30.0	442.5	752.0

Number of taxa: 9

Mean number/sample: 34.2 Standard deviation/sample: 9.2

Mean number/m²: 30,263.6 Standard deviation/m²: 8,118.8

H' = 0.98 J' = 0.31

Appendix Table 8.--Continued.

Station: M10 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	84	100.0	7,433.2	5,146.3
Corbicula manilensis	9	60.0	796.4	774.8
Ostracoda	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Chironomidae pupae	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 9.6 Standard deviation/sample: 5.6

Mean number/m^2: 8,495.0 Standard deviation/m^2: 4,921.6

H′ = 0.69 J′ = 0.30

Appendix Table 8.--Continued.

Station: M2 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	13	50.0	1,150.4	1,563.6

Number of taxa: 1

Mean number/sample: 1.3 Standard deviation/sample: 1.8

Mean number/m^2: 1150.4 Standard deviation/m^2: 1563.6

H′ = 0.00 J′ = 0.00

Appendix Table 8.--Continued.

Station: M3 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	7	60.0	619.4	597.3
Oligochaeta	180	100.0	15,928.2	6,130.8
Ostracoda	1	10.0	88.5	279.8
Corophium salmonis	9	70.0	796.4	774.8
Chironomidae larvae	20	70.0	1,769.8	1,504.0

Number of taxa: 5

Mean number/sample: 21.7 Standard deviation/sample: 7.7

Mean number/m^2: 19,202.3 Standard deviation/m^2: 6,804.1

H′ = 0.93 J′ = 0.40

Appendix Table 8.--Continued.

Station: M11 Date: 18 Jul 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes</u> <u>limnicola</u>	4	40.0	354.0	457.0
Oligochaeta	39	100.0	3,451.1	1,791.8
<u>Corbicula</u> <u>manilensis</u>	3	30.0	265.5	427.4
Ostracoda	3	30.0	265.5	427.4
<u>Corophium</u> <u>salmonis</u>	32	100.0	2,831.7	1,305.9
<u>Scottolana</u> <u>canadensis</u>	3	20.0	265.5	597.3
Chironomidae larvae	2	20.0	177.0	373.1

Number of taxa: 7

Mean number/sample: 8.6 Standard deviation/sample: 3.4

Mean number/m²: 7,610.1 Standard deviation/m²: 2,984.9

H′ = 1.89 J′ = 0.67

Appendix Table 8.--Continued.

Station: M2 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	34	90.0	3,008.7	3,154.9
Corophium salmonis	1	10.0	88.5	279.8
Calanoida	1	10.0	88.5	279.8
Chironomidae larvae	13	70.0	1,150.4	1,107.6
Invertebrate eggs	1	10.0	88.5	279.8

Number of taxa: 5

Mean number/sample: 5.0 Standard deviation/sample: 4.3

Mean number/m^2: 4,424.5 Standard deviation/m^2: 3,845.9

$H' = 1.22$ $J' = 0.53$

Appendix Table 8.--Continued.

Station: M3 Date: 14 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Oligochaeta	1	10.0	88.5	279.8
Corbicula manilensis	2	20.0	177.0	373.1
Corophium salmonis	1	10.0	88.5	279.8

Number of taxa: 3

Mean number/sample: 0.4 Standard deviation/sample: 0.5

Mean number/m^2: 354.0 Standard deviation/m^2: 457.0

H' = 1.50 J' = 0.95

Appendix Table 8.--Continued.

Station: M6 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m^2	Standard deviation /m^2
Neanthes limnicola	12	70.0	1,061.9	913.9
Oligochaeta	149	100.0	13,185.0	6,468.5
Corbicula manilensis	8	50.0	707.9	813.2
Ostracoda	4	30.0	354.0	618.7
Eohaustorius estuarius	1	10.0	88.5	279.8
Corophium spp.	1	10.0	88.5	279.8
Corophium salmonis	185	100.0	16,370.7	3,369.6
Chironomidae larvae	9	40.0	796.4	1,411.5

Number of taxa: 8

Mean number/sample: 36.9 Standard deviation/sample: 7.0

Mean number/m^2: 32,652.8 Standard deviation/m^2: 6,207.6

H' = 1.56 J' = 0.52

Appendix Table 8.--Continued.

Station: M10 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
<u>Neanthes</u> <u>limnicola</u>	5	30.0	442.5	752.0
Oligochaeta	25	90.0	2,212.3	1,629.0
<u>Corbicula</u> <u>manilensis</u>	11	70.0	973.4	774.8
Ostracoda	3	20.0	265.5	597.3
<u>Corophium</u> <u>salmonis</u>	99	100.0	8,760.5	4,201.6
Calanoida	2	20.0	177.0	373.1
Chironomidae larvae	2	20.0	177.0	373.1
Chironomidae pupae	1	10.0	88.5	279.8
Tabanidae	1	10.0	88.5	279.8
Invertebrate eggs	2	20.0	177.0	373.1

Number of taxa: 10

Mean number/sample: 15.1 Standard deviation/sample: 5.5

Mean number/m^2: 13,362.0 Standard deviation/m^2: 4,854.9

H′ = 1.72 J′ = 0.52

Appendix Table 8.--Continued.

Station: M11 Date: 15 Sep 89 Sample size: 10

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	1	10.0	88.5	279.8
Turbellaria	1	10.0	88.5	279.8
Neanthes limnicola	5	50.0	442.5	466.4
Oligochaeta	29	90.0	2,566.2	2,020.0
Corbicula manilensis	5	30.0	442.5	752.0
Corophium spp.	3	20.0	265.5	597.3
Corophium salmonis	179	100.0	15,839.7	6,179.5
Chironomidae larvae	1	10.0	88.5	279.8
Invertebrate eggs	2	20.0	177.0	373.1
Hydracarina	1	10.0	88.5	279.8

Number of taxa: 10

Mean number/sample: 22.7 Standard deviation/sample: 6.8

Mean number/m²: 20,087.2 Standard deviation/m²: 6,016.9

H′ = 1.17 J′ = 0.35

Appendix Table 9.--Sediment characteristics at Miller Sands, Columbia River estuary, during four surveys in 1976-1977. The five stations (M2, M3, M6, M10, and M11) were selected for comparison with the similar stations from three surveys in 1989.

Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organics carbon
Jul 76	M2	A	2.8	2.4	1.1
Jul 76	M2	B	2.7	0.6	8.4
Jul 76	M2	C	2.9	7.2	1.5
Jul 76	M3	A	4.0	42.2	3.3
Jul 76	M3	B	3.9	38.6	3.2
Jul 76	M3	C	4.0	41.5	3.6
Jul 76	M6	A	3.3	14.5	2.0
Jul 76	M6	B	3.0	5.1	1.5
Jul 76	M6	C	2.9	3.1	1.3
Jul 76	M10	A	3.9	16.7	1.8
Jul 76	M10	B	4.0	22.2	2.5
Jul 76	M10	C	3.9	19.7	2.5
Jul 76	M11	A	3.6	4.5	2.1
Jul 76	M11	B	3.7	14.9	1.0
Jul 76	M11	C	3.7	10.8	1.8
Sep 76	M2	A	2.9	2.7	1.7
Sep 76	M2	B	2.8	1.6	1.5
Sep 76	M2	C	2.7	0.8	1.5
Sep 76	M3	A	3.3	15.5	2.5
Sep 76	M3	B	3.1	12.5	2.5
Sep 76	M3	C	3.0	7.2	1.9
Sep 76	M6	A	3.9	26.7	3.8
Sep 76	M6	B	3.8	21.3	4.2
Sep 76	M6	C	3.8	20.0	3.6
Sep 76	M10	A	3.9	25.8	3.8
Sep 76	M10	B	3.7	13.6	2.8
Sep 76	M10	C	3.8	17.5	3.0
Sep 76	M11	A	3.5	12.6	2.6
Sep 76	M11	B	3.5	9.9	2.8
Sep 76	M11	C	3.6	14.2	3.1
May 77	M2	A	2.7	2.1	1.4
May 77	M2	B	2.7	1.2	1.2
May 77	M2	C	2.8	1.9	1.2
May 77	M3	A	3.5	23.5	2.7
May 77	M3	B	3.5	21.3	2.9
May 77	M3	C	3.4	21.1	2.7

Appendix Table 9.--Continued.

Date	Station	Replicate	Median grain size (phi)	Percent silt/clay	Percent total organic carbon
May 77	M6	A	3.1	5.7	1.8
May 77	M6	B	3.2	8.6	2.6
May 77	M6	C	3.2	8.7	2.2
May 77	M10	A	3.9	23.8	2.8
May 77	M10	B	3.9	23.9	3.2
May 77	M10	C	3.9	27.4	3.5
May 77	M11	A	3.6	10.7	2.1
May 77	M11	B	3.7	14.8	2.4
May 77	M11	C	3.6	10.3	2.4
Jul 77	M2	A	3.0	10.9	2.2
Jul 77	M2	B	2.8	5.0	1.5
Jul 77	M2	C	3.2	19.4	2.9
Jul 77	M3	A	3.4	25.1	3.0
Jul 77	M3	B	3.5	25.7	2.6
Jul 77	M3	C	3.5	23.0	2.4
Jul 77	M6	A	3.8	19.1	3.0
Jul 77	M6	B	4.8	21.3	3.6
Jul 77	M6	C	3.8	22.3	3.1
Jul 77	M10	A	4.0	28.6	2.9
Jul 77	M10	B	4.0	31.0	3.2
Jul 77	M10	C	3.9	18.9	2.5
Jul 77	M11	A	3.8	21.0	2.8
Jul 77	M11	B	3.8	20.9	2.9
Jul 77	M11	C	4.4	62.8	3.0