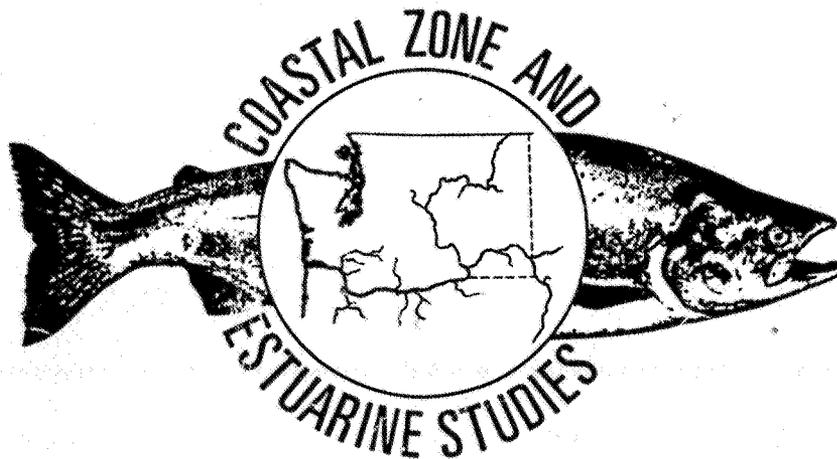


Fishes, Benthic Invertebrates, and Sediment Characteristics in Intertidal and Subtidal Habitats at Five Areas in the Columbia River Estuary

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

August 1990



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INTRODUCTION

Each year, the U.S. Army Corps of Engineers (COE) dredges and disposes of more than 2 million yd³ (1.5 million m³) 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

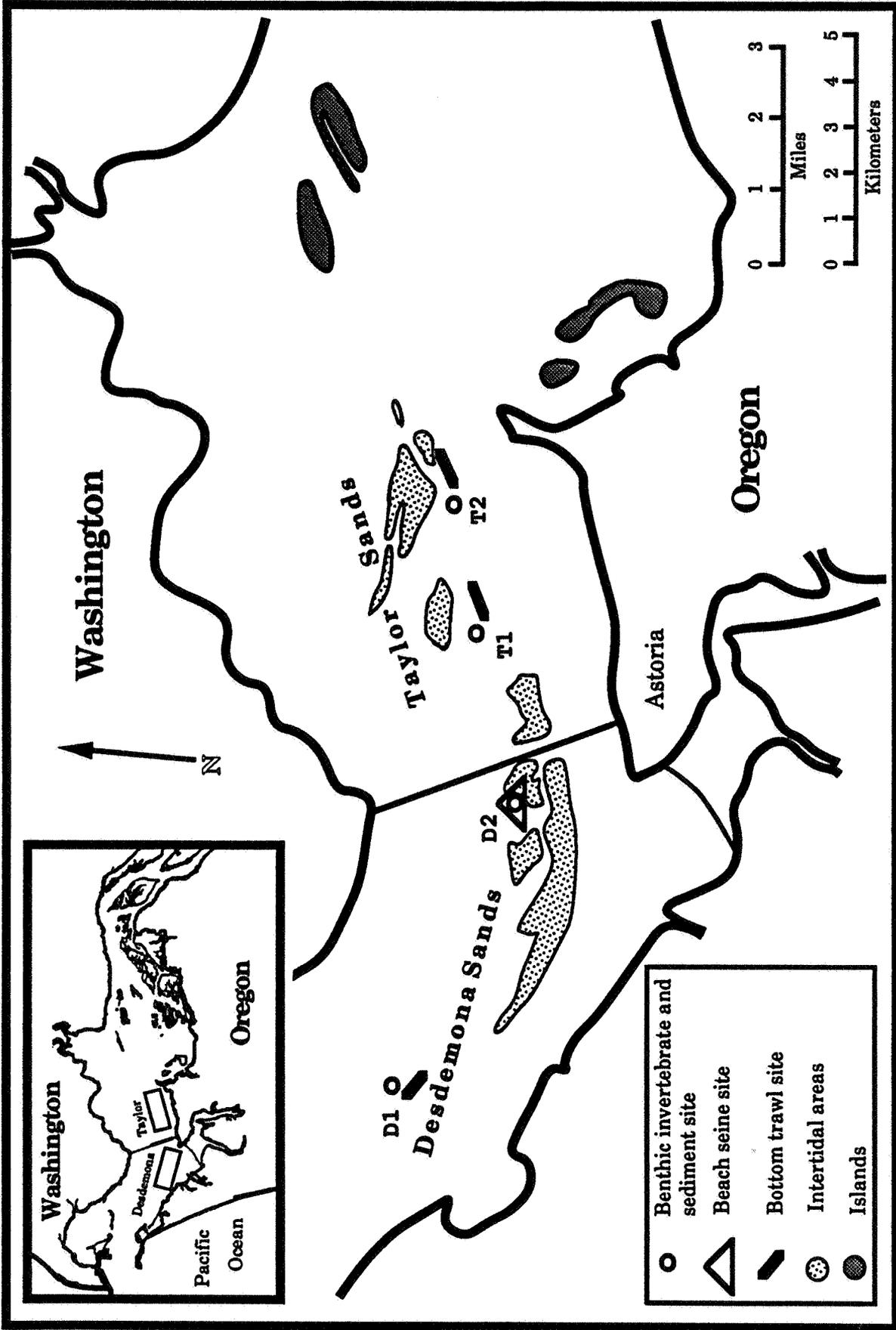


Figure 1.--Sampling locations for fishes, benthic invertebrates, and sediments at Desdemona Sands and Taylor Sands, Columbia River estuary, 1988-1989.

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).

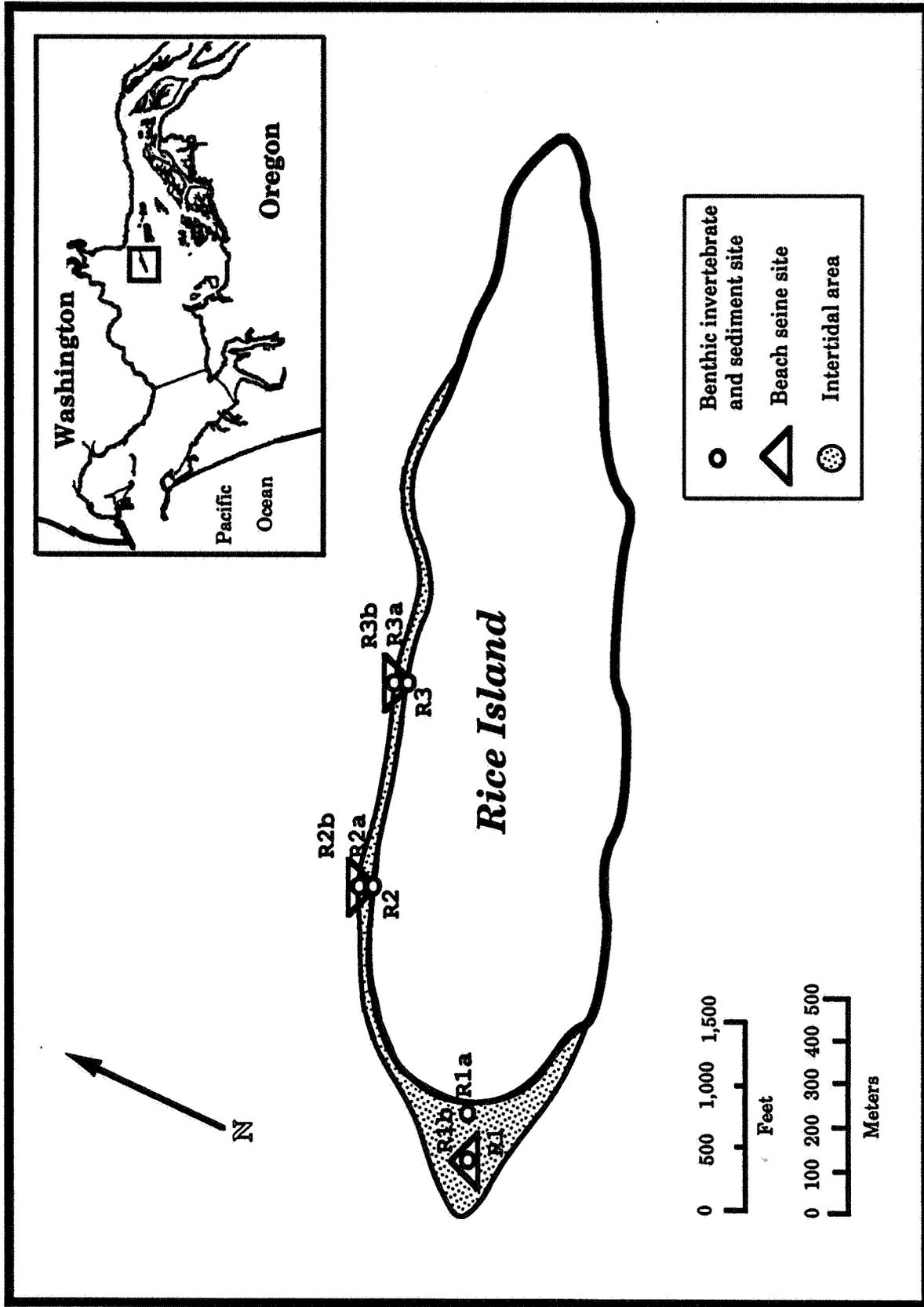


Figure 2.--Sampling locations for fishes, benthic invertebrates, and sediments at Rice Island, Columbia River estuary, 1988-1989.

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 yd³ (305,800 m³) 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

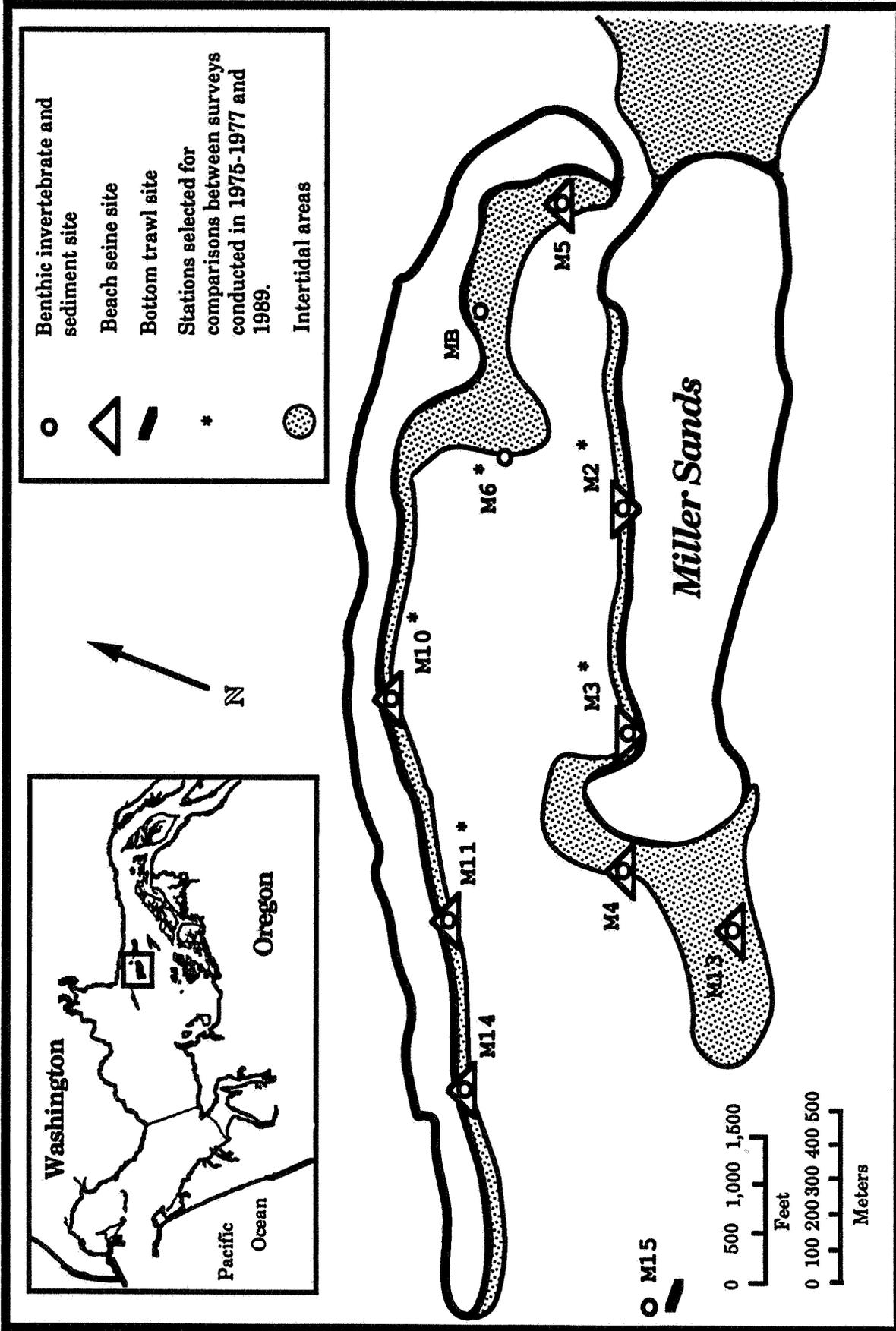


Figure 3.--Sampling locations for fishes, benthic invertebrates, and sediments at Miller Sands, Columbia River estuary, 1988-1989.

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

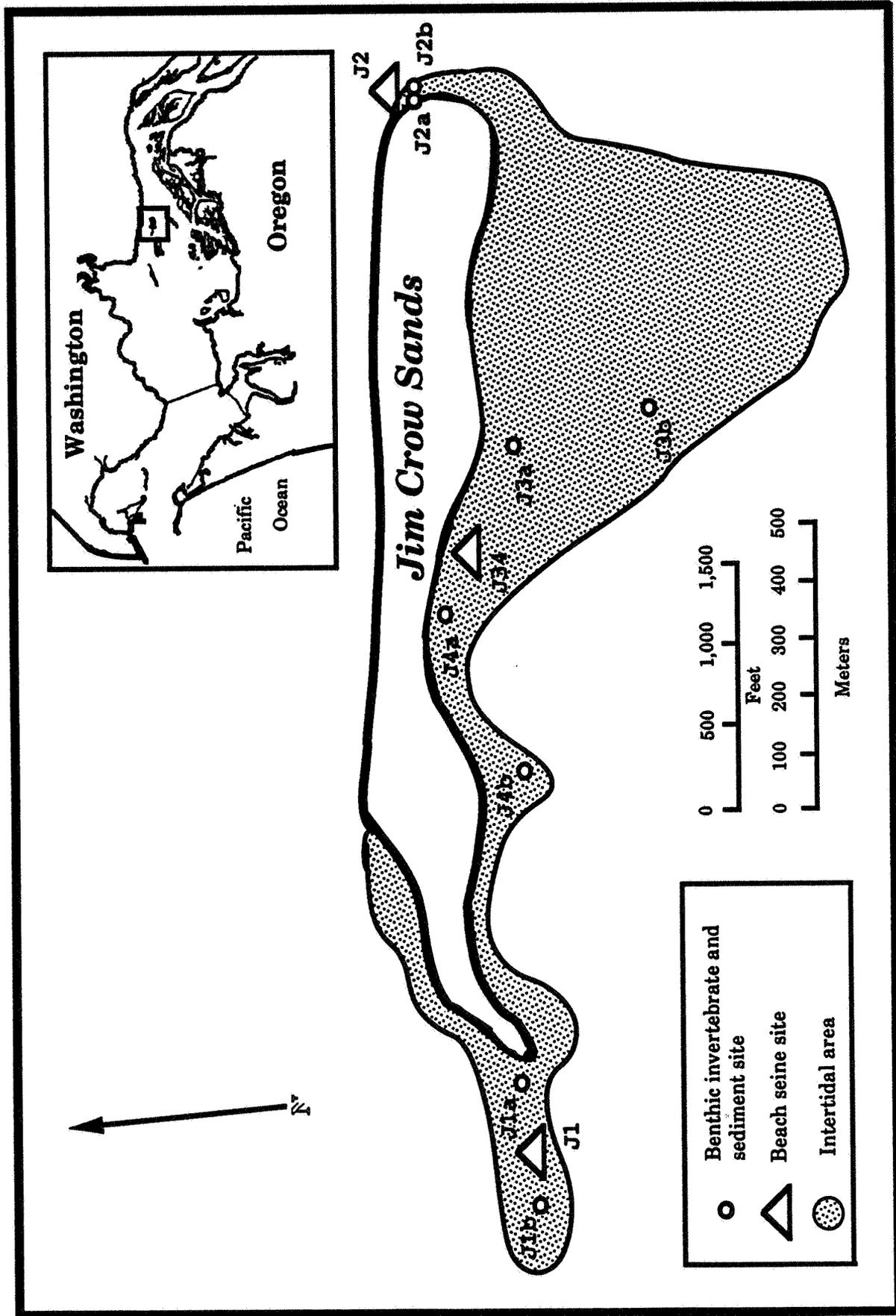


Figure 4.--Sampling locations for fishes, benthic invertebrates, and sediments at Jim Crow Sands, Columbia River estuary, 1988-1989.

that had an inside diameter of 3.85 cm, a penetrating depth of 15 cm, and collected a 174.6-cm³ 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 2100A¹ 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

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

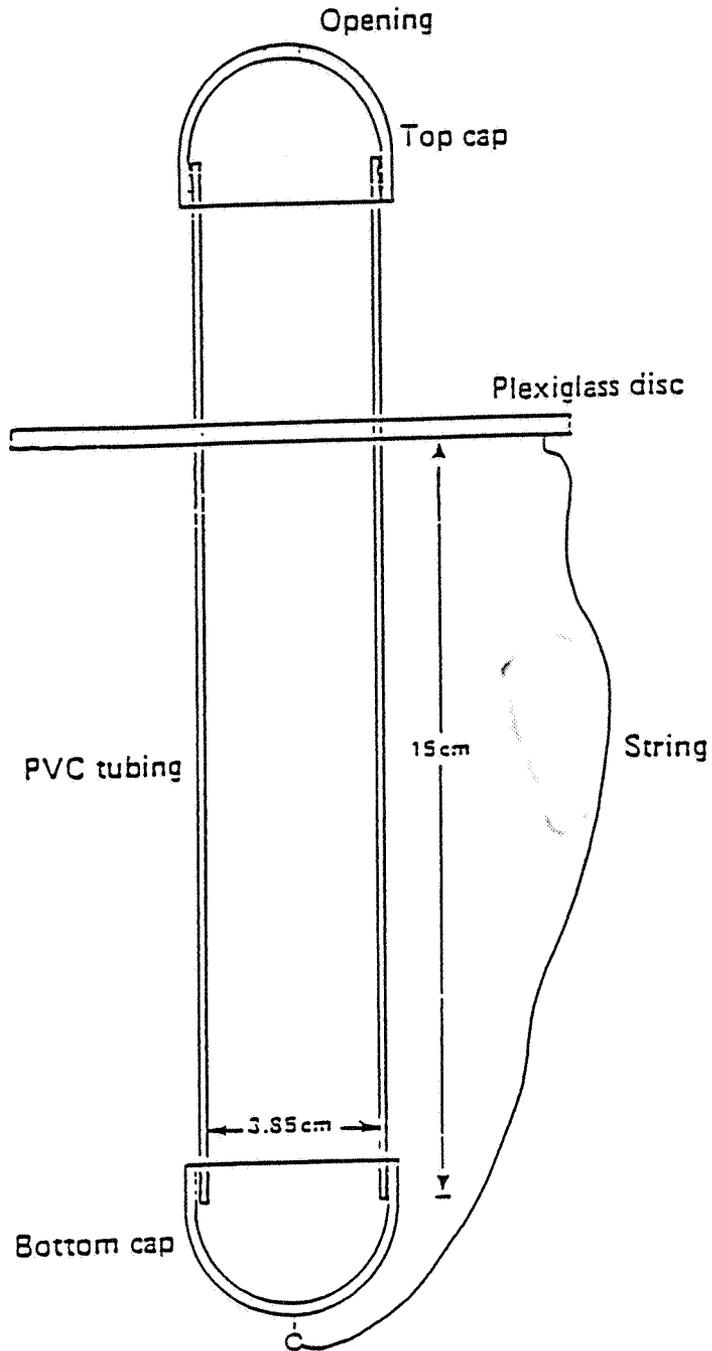


Figure 5.--PVC coring device used to collect benthic invertebrate and sediment samples in the Columbia River estuary, 1988-1989.

fishing width of the trawl (5 m), and the number of fish caught. Densities were expressed as number/hectare (ha) (10,000 m²). 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 m². 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 m².

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).

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

where $P_i = X_a/n$ (X_a is the number of individuals of a particular species in the sample, 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/m² 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 m². 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-m² Eckman dredge. During May 1975 through May 1976, two samples were combined so that each replicate equaled 0.1 m² of material. Six replicates were taken at each station. During July 1976 through July 1977, one sample was used for each replicate (0.05 m² 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/m² 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/m²), oligochaetes

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

| <u>Beach seine</u> | | | | |
|--------------------|-------------------|-----------------|------|------|
| 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 |

| <u>Trawl</u> | | | | |
|-----------------|-------------------|-----------------|------|------|
| 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/m²), oligochaetes in July 1989 (mean 4,791/m²), and C. salmonis in September 1989 (mean 8,142/m²) (Appendix Table 4).

Total benthic invertebrate densities were significantly different among the five areas, with the highest mean density at Miller Sands (25,568/m²) and the lowest at Taylor Sands (1,029/m²) (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.

| <u>Beach seine</u> | | | | |
|--------------------|----------------------|--------------------|------|------|
| 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 |

| <u>Trawl</u> | | | | |
|------------------|----------------------|--------------------|------|------|
| 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 (Figure 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/m²) were observed during May 1989 (Table 6). The lowest mean number of taxa (6) and lowest mean density (3,009 invertebrates/m²) 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.

| Species | <u>Beach seine</u> | | | |
|------------------------------|----------------------|----------------------|----------------------|----------------------|
| | 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.

| Species | <u>Trawl</u> | | | |
|--------------------------|----------------------|----------------------|----------------------|----------------------|
| | 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 |

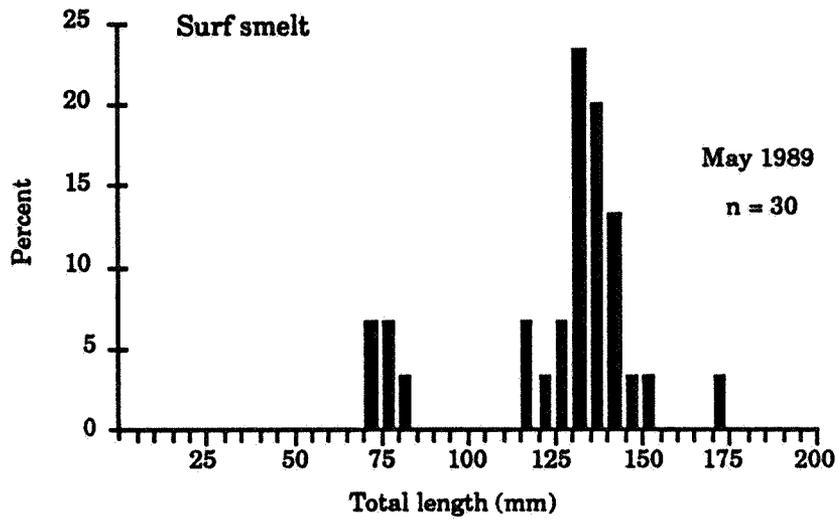
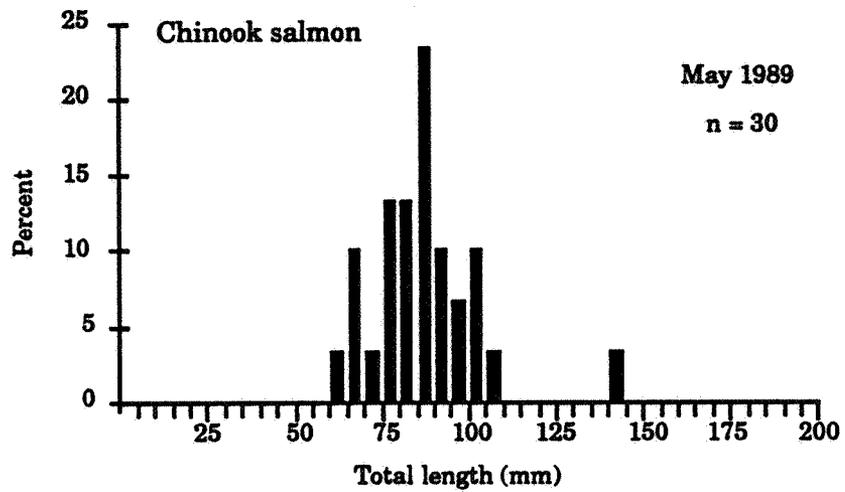


Figure 6.-- Length-frequency distributions of chinook salmon and surf smelt captured by beach seine at Desdemona Sands, Columbia River estuary, May 1989. Sample size (n) equals the number of fish measured, not the total number captured.

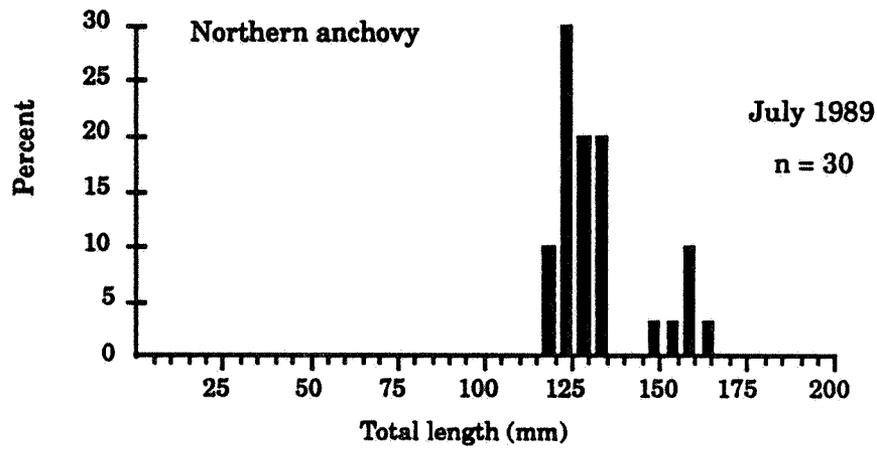
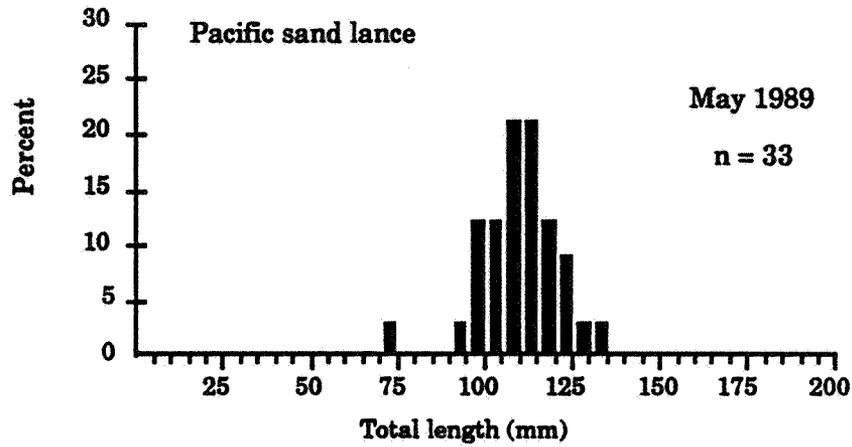


Figure 7.-- Length-frequency distributions of Pacific sand lance and northern anchovy captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

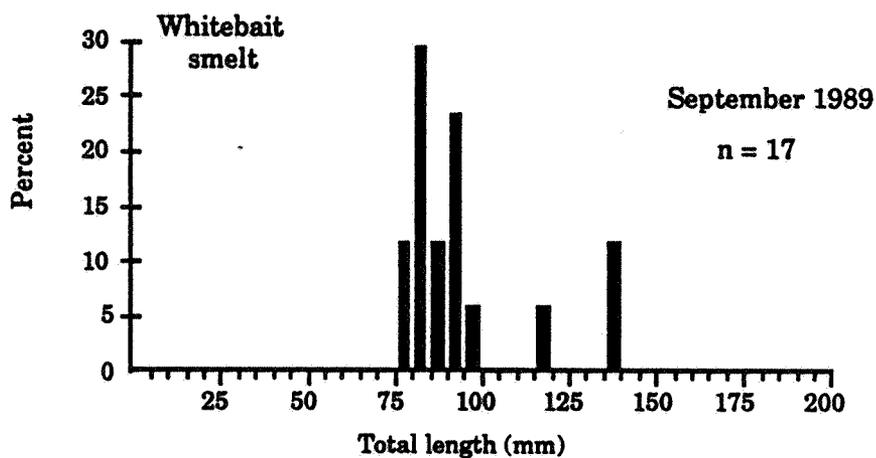
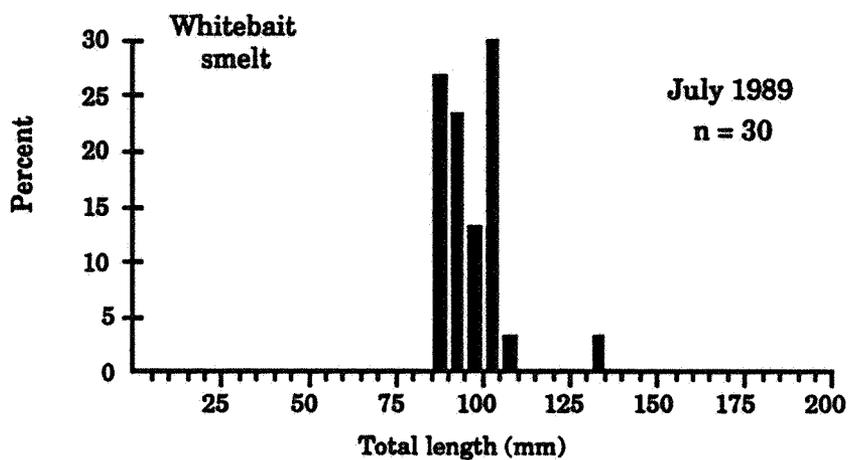


Figure 8.-- Length-frequency distributions of whitebait smelt captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

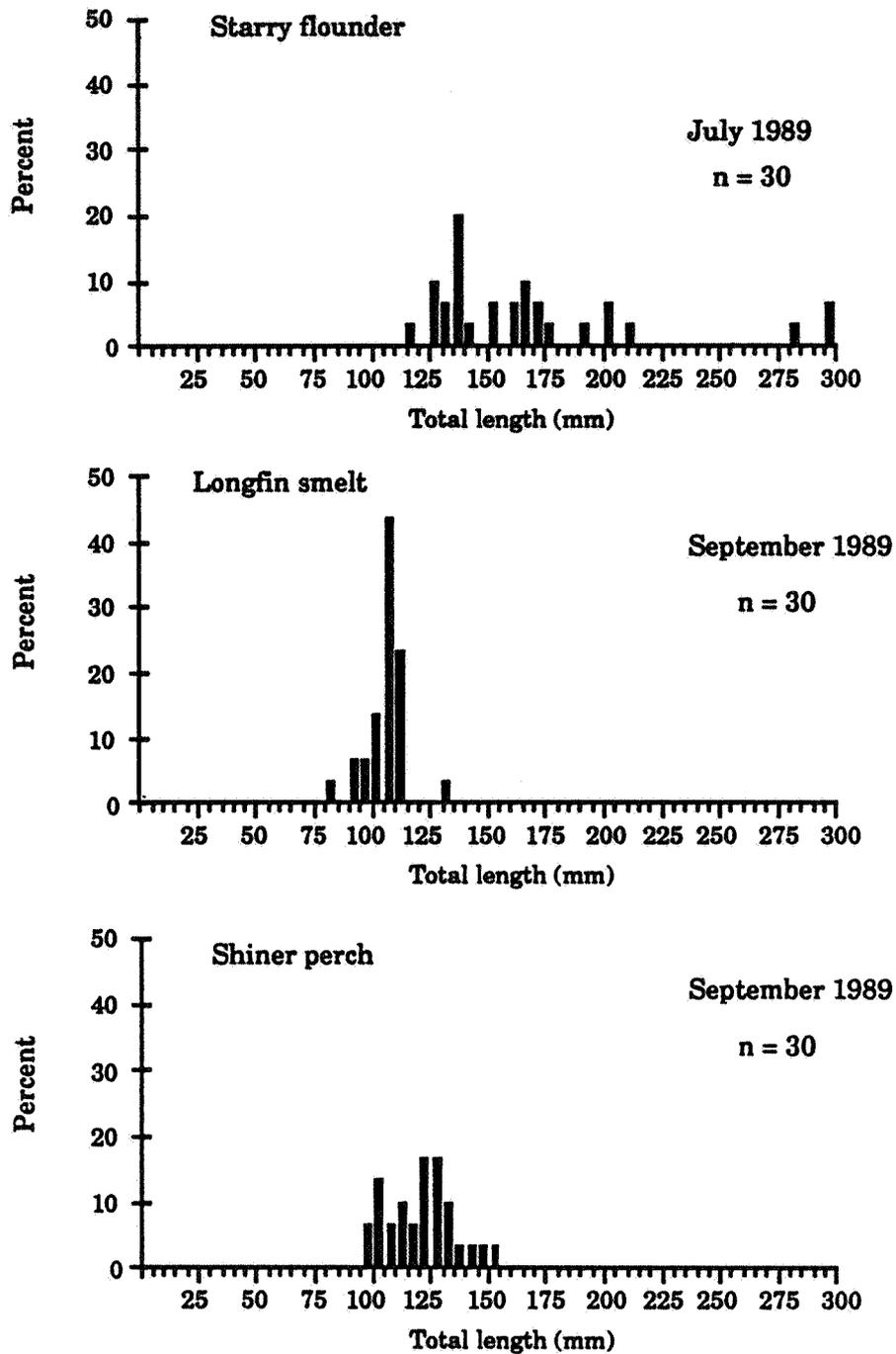


Figure 9.-- Length-frequency distributions of starry flounder, longfin smelt, and shiner perch captured by 8-m trawl at Desdemona Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m².

| 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 | | | | |
| <u>Eteone</u> sp. | 89 | 0 | 177 | 0 |
| <u>Glycinde picta</u> | 885 | 89 | 0 | 133 |
| <u>Glycera</u> sp. | 0 | 44 | 0 | 0 |
| <u>Neanthes limnicola</u> | 0 | 0 | 177 | 0 |
| <u>Pseudopolydora kemp</u> i | 0 | 0 | 0 | 1,195 |
| Unid. Spionidae | 0 | 0 | 0 | 265 |
| Amphipoda | | | | |
| <u>Eohaustorius estuarius</u> | 0 | 133 | 1,681 | 619 |
| misc. | 89 | 132 | 0 | 45 |
| Insecta | | | | |
| misc. | 0 | 442 | 0 | 0 |
| Bivalvia | | | | |
| <u>Macoma balthica</u> | 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 |

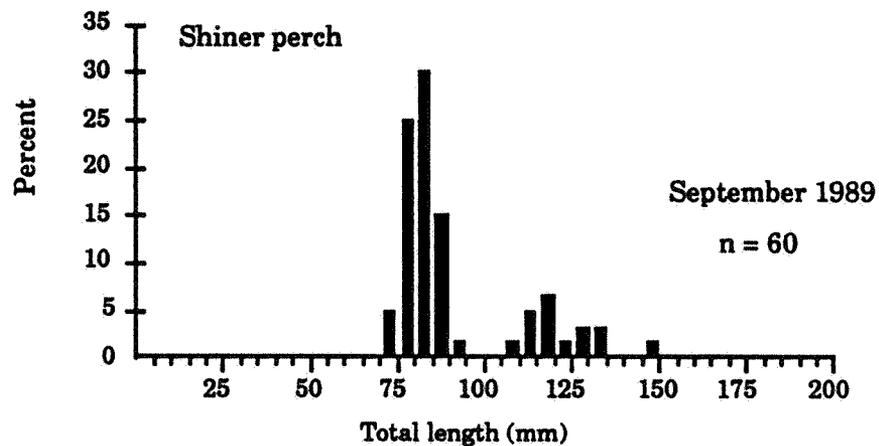
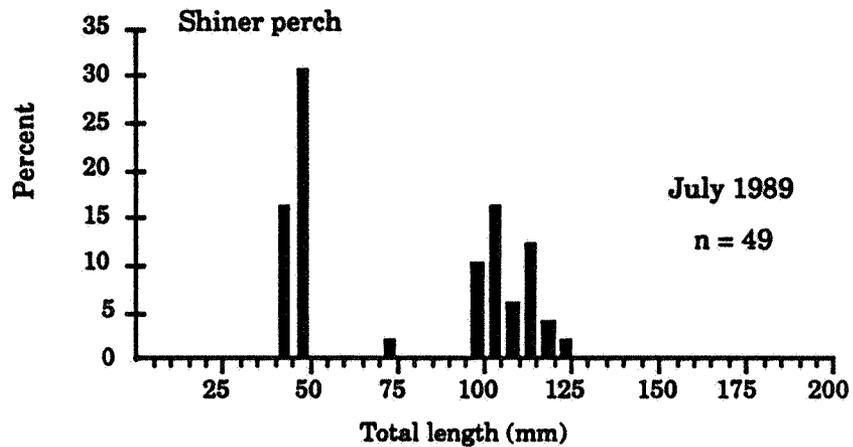
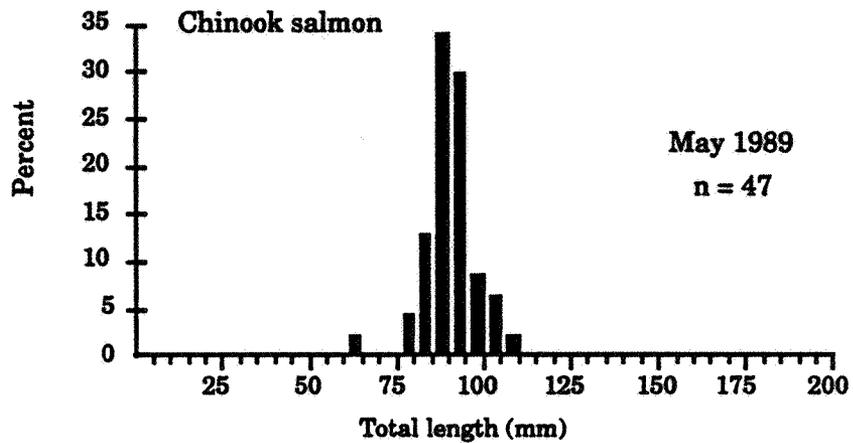


Figure 10.-- Length-frequency distributions of chinook salmon and shiner perch captured by 8-m trawl at Taylor Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m²) were documented in May 1989; the lowest mean number of taxa (4) and lowest mean density (354 invertebrates/m²) 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.

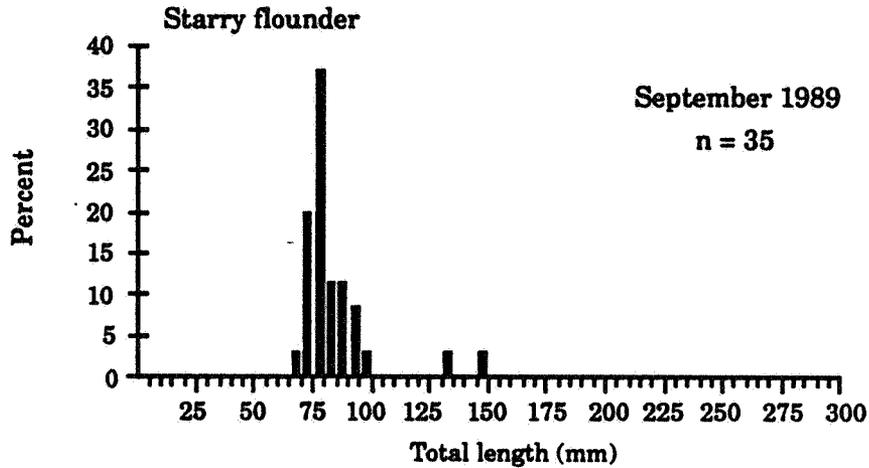
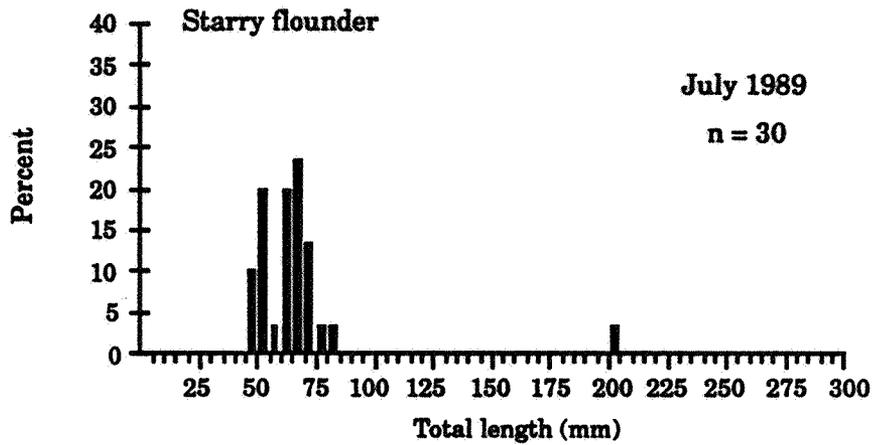


Figure 11.-- Length-frequency distributions of starry flounder captured by 8-m trawl at Taylor Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m².

| Taxon | Survey 1 (Sep 88) | Survey 2 (May 89) | Survey 3 (Jul 89) | Survey 4 (Sep 89) |
|-------------------------------|----------------------|----------------------|----------------------|----------------------|
| Oligochaeta | 44 | 265 | 89 | 44 |
| Polychaeta | | | | |
| <u>Neanthes limnicola</u> | 0 | 0 | 133 | 0 |
| Unid. Spionidae | 44 | 0 | 44 | 0 |
| Amphipoda | | | | |
| <u>Eohaustorius estuarius</u> | 133 | 221 | 354 | 354 |
| <u>Corophium salmonis</u> | 44 | 1,062 | 89 | 44 |
| misc. | 44 | 0 | 0 | 44 |
| Copepoda | 0 | 177 | 133 | 177 |
| Insecta | 0 | 265 | 44 | 89 |
| Bivalvia | | | | |
| <u>Corbicula manilensis</u> | 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 |

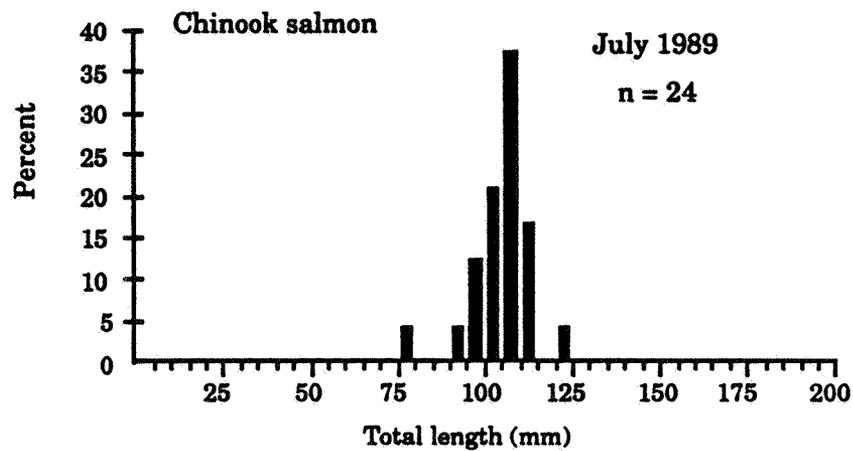
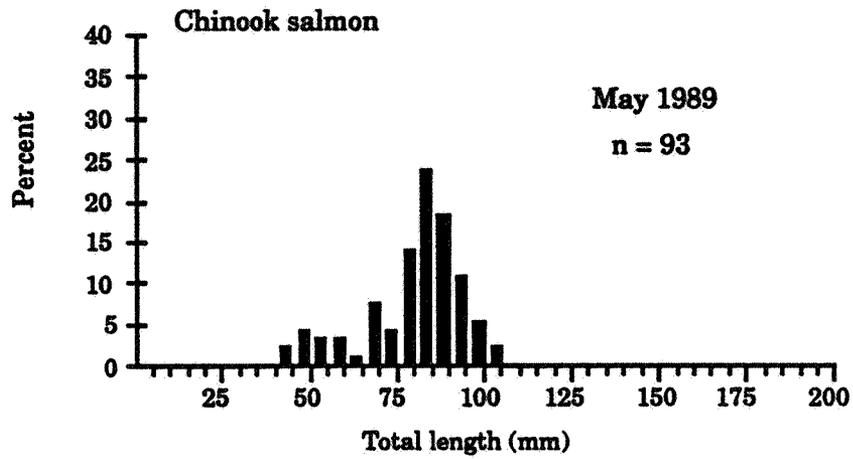


Figure 12.-- Length-frequency distributions of chinook salmon captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

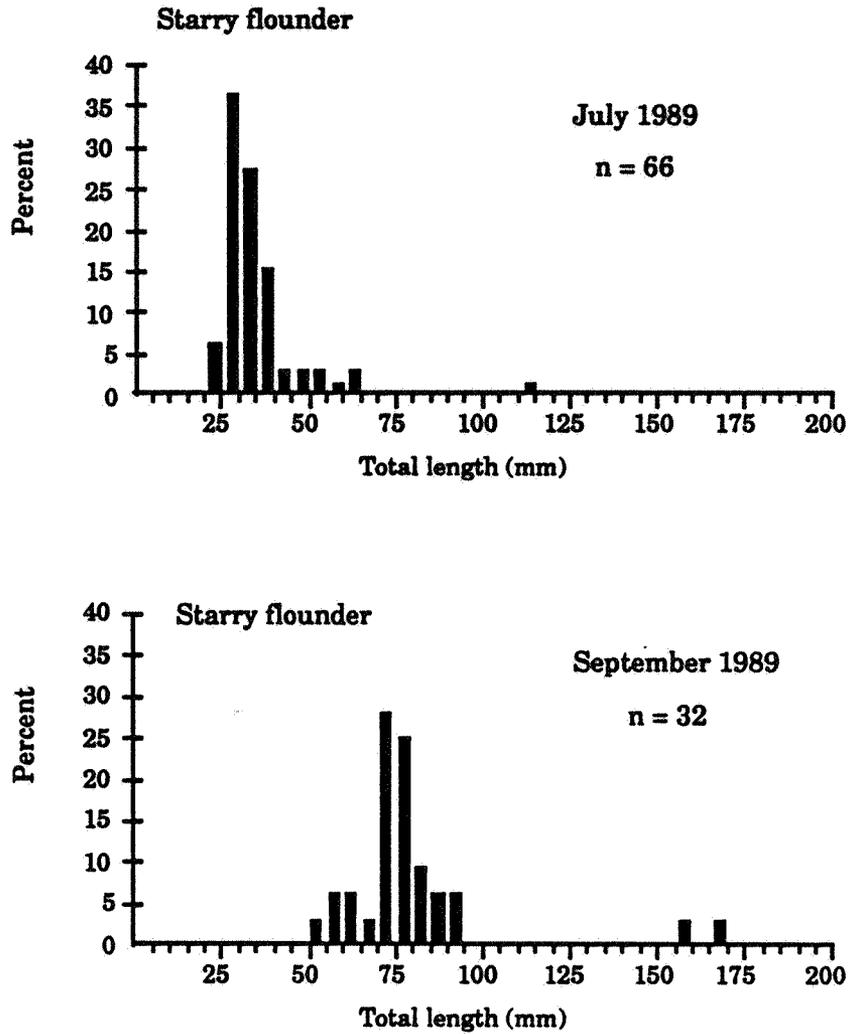


Figure 13.-- Length-frequency distributions of starry flounder captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

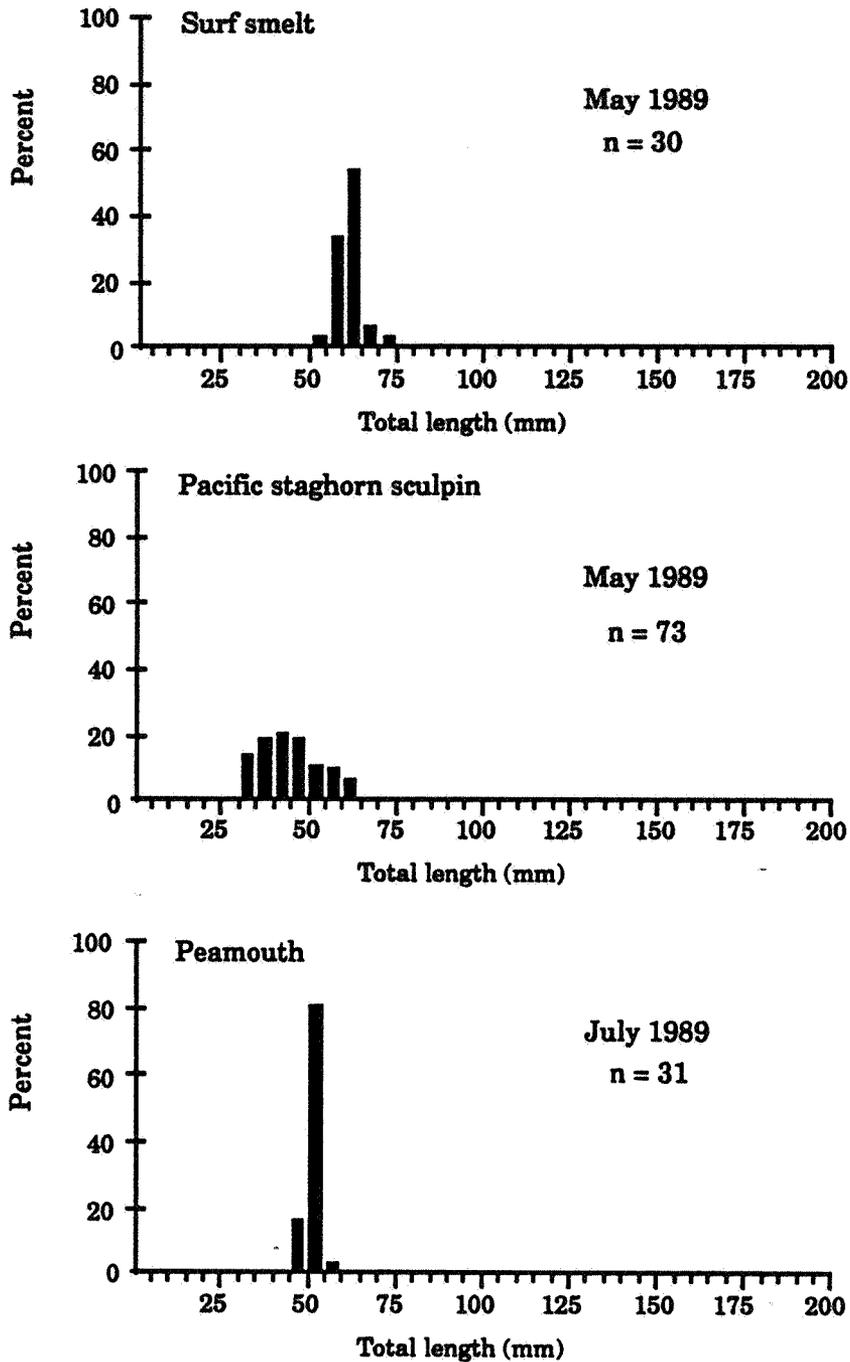


Figure 14.-- Length-frequency distributions of surf smelt, Pacific staghorn sculpin, and peamouth captured by beach seine at Rice Island, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m²) and lowest in September 1989 (487 invertebrates/m²). 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/m².

| Taxon | Survey 1 (Sep 88) | Survey 2 (May 89) | Survey 3 (Jul 89) | Survey 4 (Sep 89) |
|-----------------------------|----------------------|----------------------|----------------------|----------------------|
| Oligochaeta | 1,327 | 560 | 442 | 192 |
| Polychaeta | | | | |
| <u>Neanthes limnicola</u> | 59 | 15 | 15 | 0 |
| Amphipoda | | | | |
| <u>Corophium salmonis</u> | 3,201 | 1,180 | 251 | 30 |
| misc. | 15 | 133 | 103 | 0 |
| Insecta | 74 | 118 | 15 | 118 |
| Bivalvia | | | | |
| <u>Corbicula manilensis</u> | 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.

| <u>Beach seine</u> | | | | |
|--------------------|----------------------|--------------------|------|------|
| 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 |

| <u>Trawl</u> | | | | |
|------------------|----------------------|--------------------|------|------|
| 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.

| Species | <u>Beach seine</u> | | | |
|------------------------------|----------------------|----------------------|----------------------|----------------------|
| | 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 | <u>Trawl</u> | | | |
|---------------------------|----------------------|----------------------|----------------------|----------------------|
| | 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 |

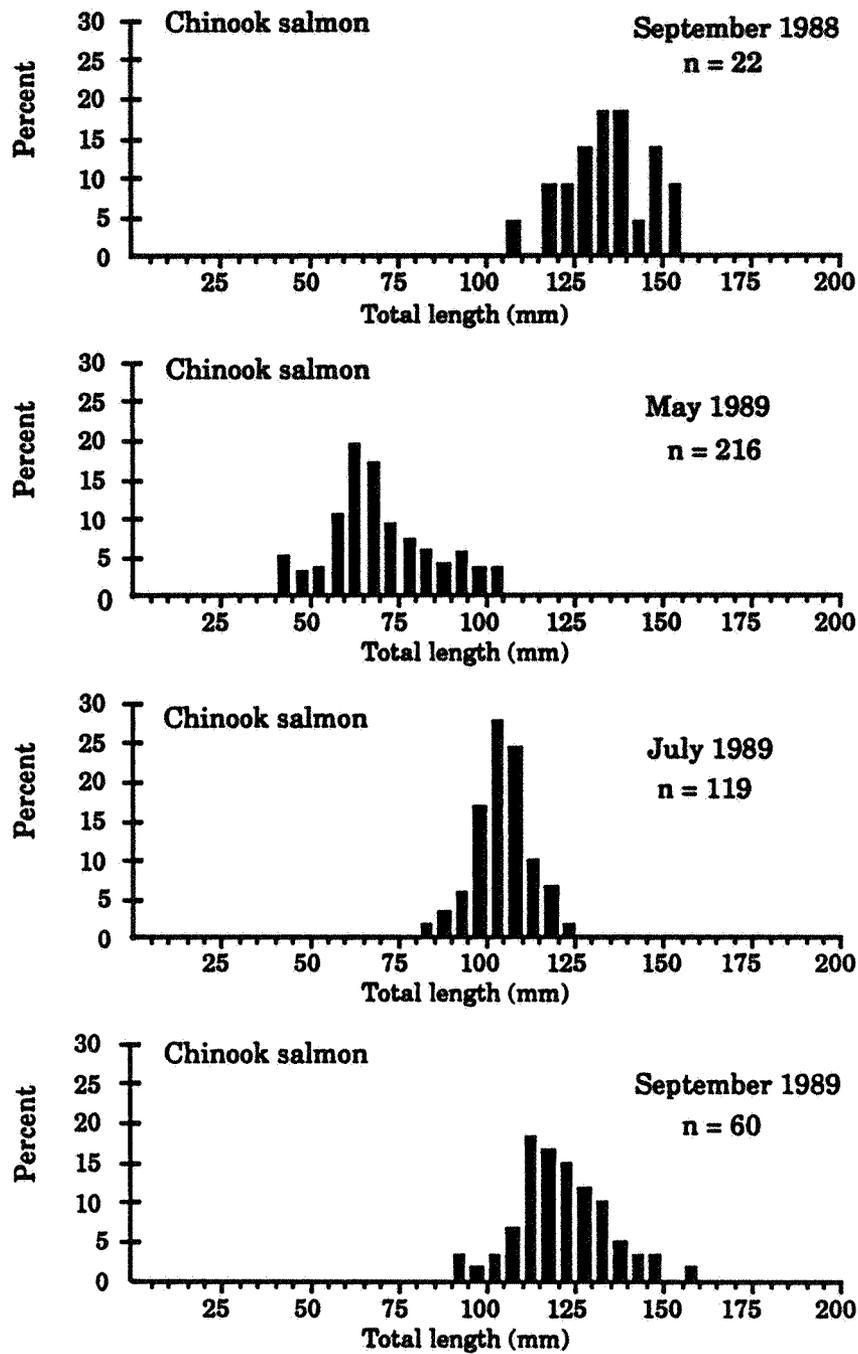


Figure 15.-- Length-frequency distributions of chinook salmon captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

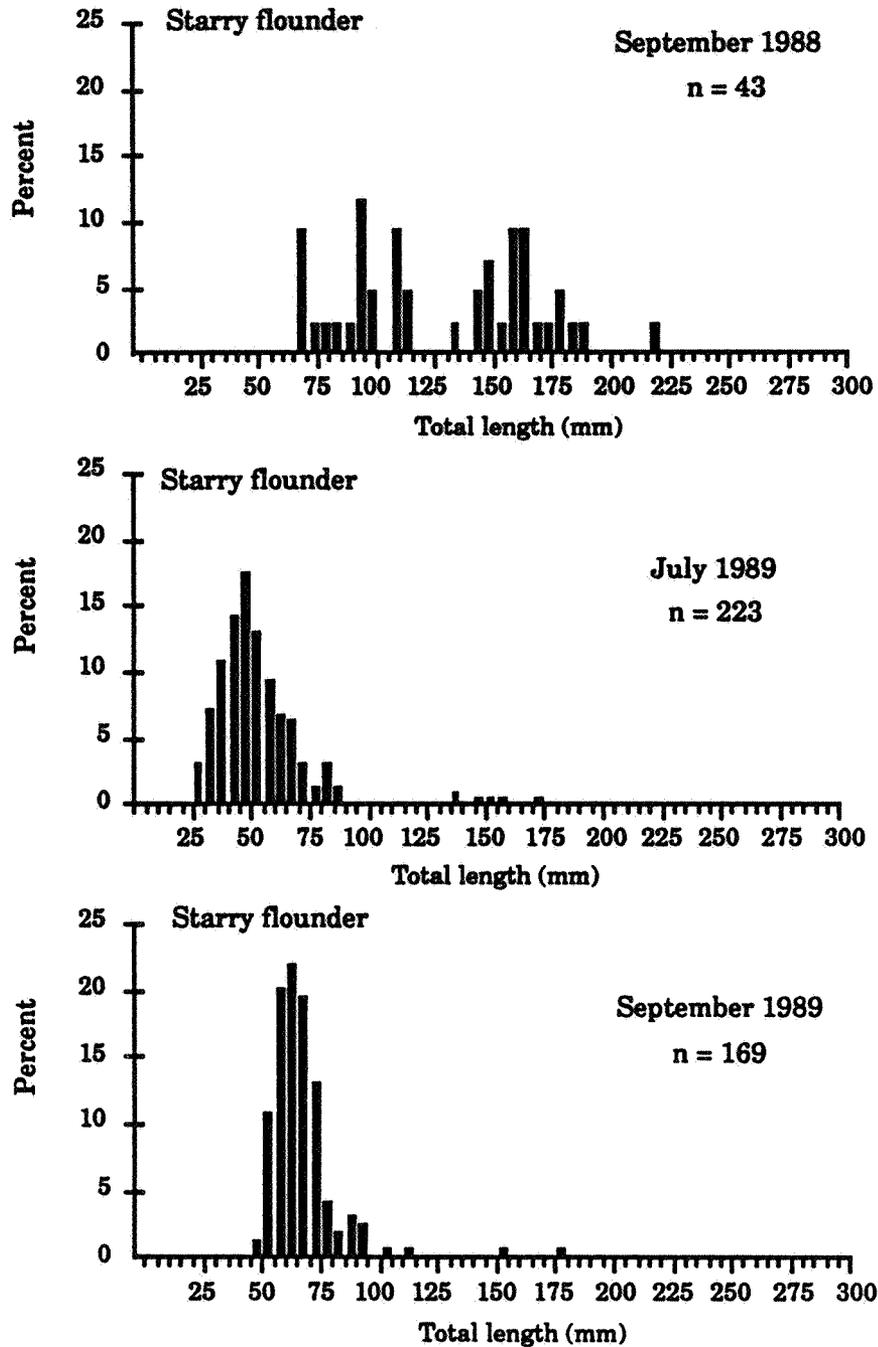


Figure 16.-- Length-frequency distributions of starry flounder captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m²) and the lowest in July 1989 (18,109 invertebrates/m²) (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/m²), of which 71,087 invertebrates/m² 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/m²); oligochaetes were the most abundant invertebrates

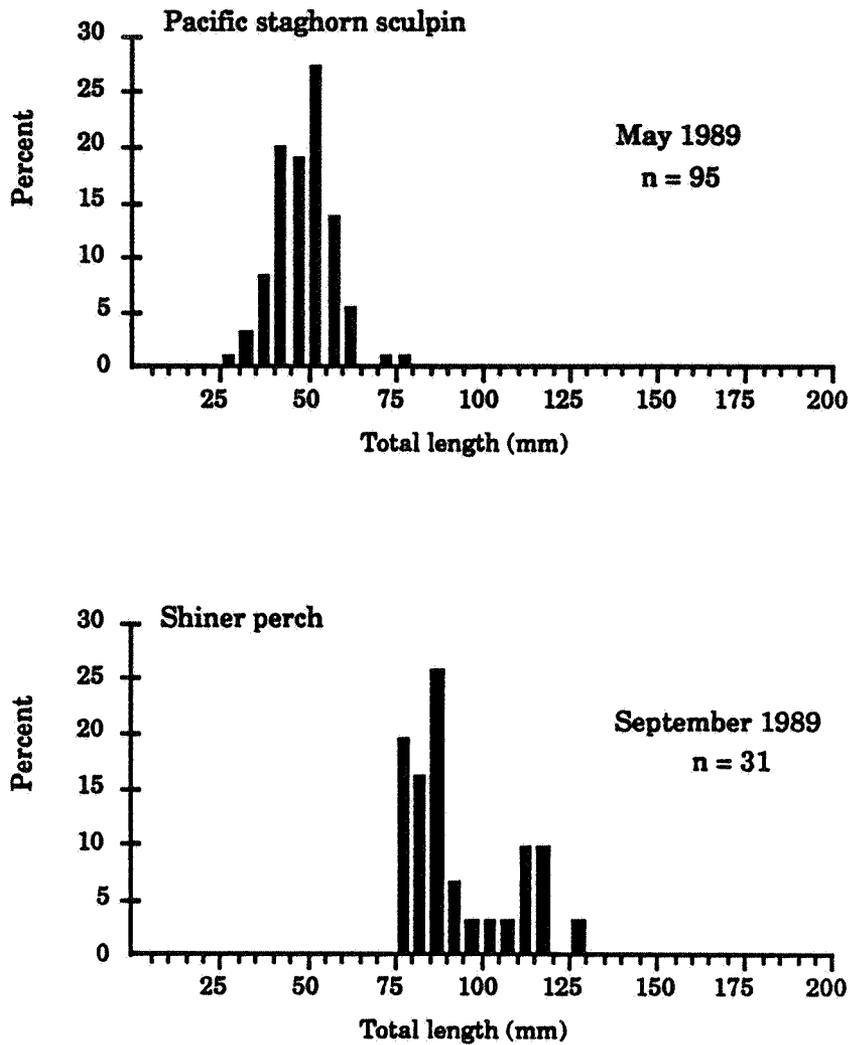


Figure 17.-- Length-frequency distributions of Pacific staghorn sculpin and shiner perch captured by beach seine at Miller Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

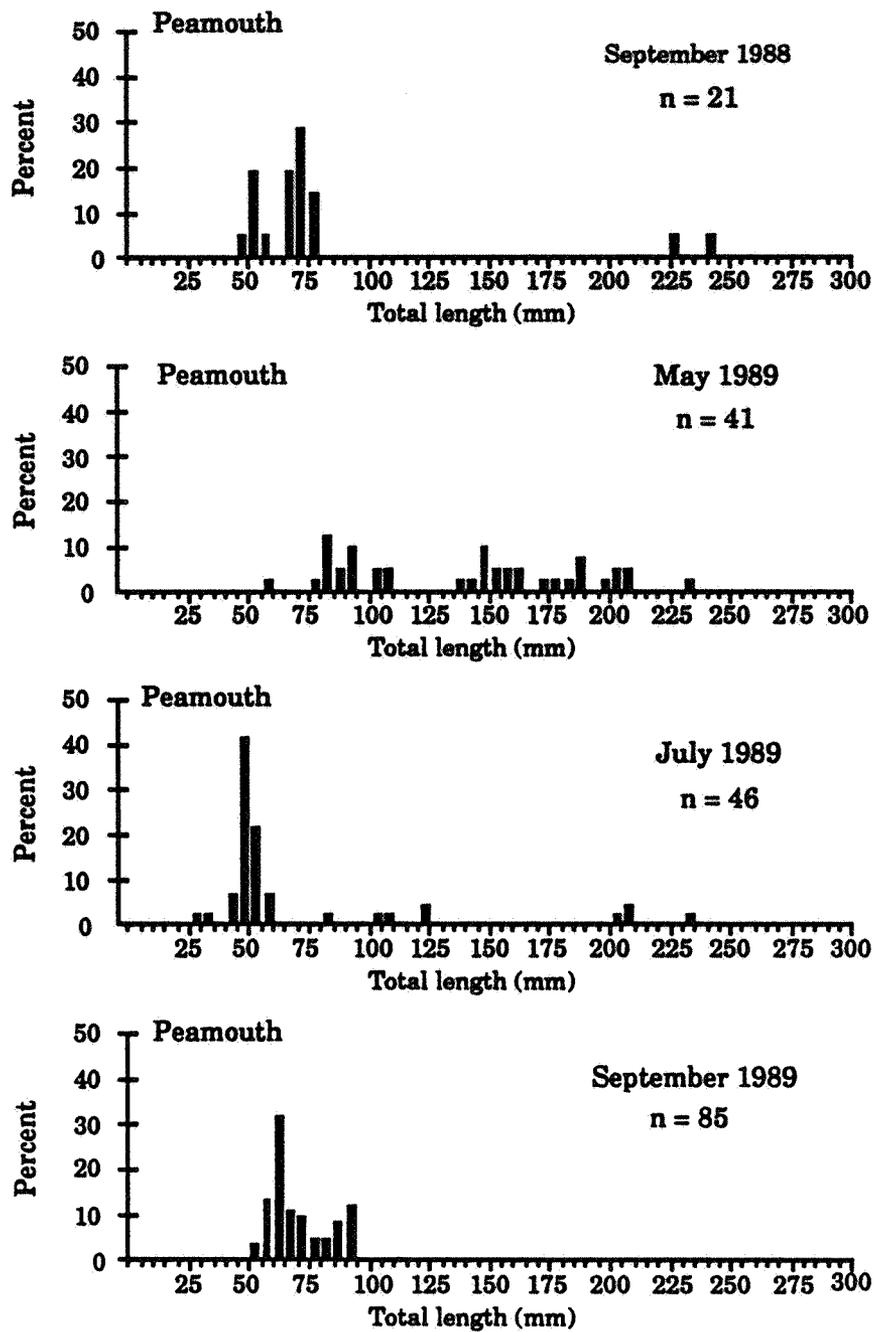


Figure 18.-- Length-frequency distributions of peamouth captured by beach seine at Miller Sands, Columbia River estuary, 1988-1989. Sample size (n) equals the number of fish measured, not the total number captured.

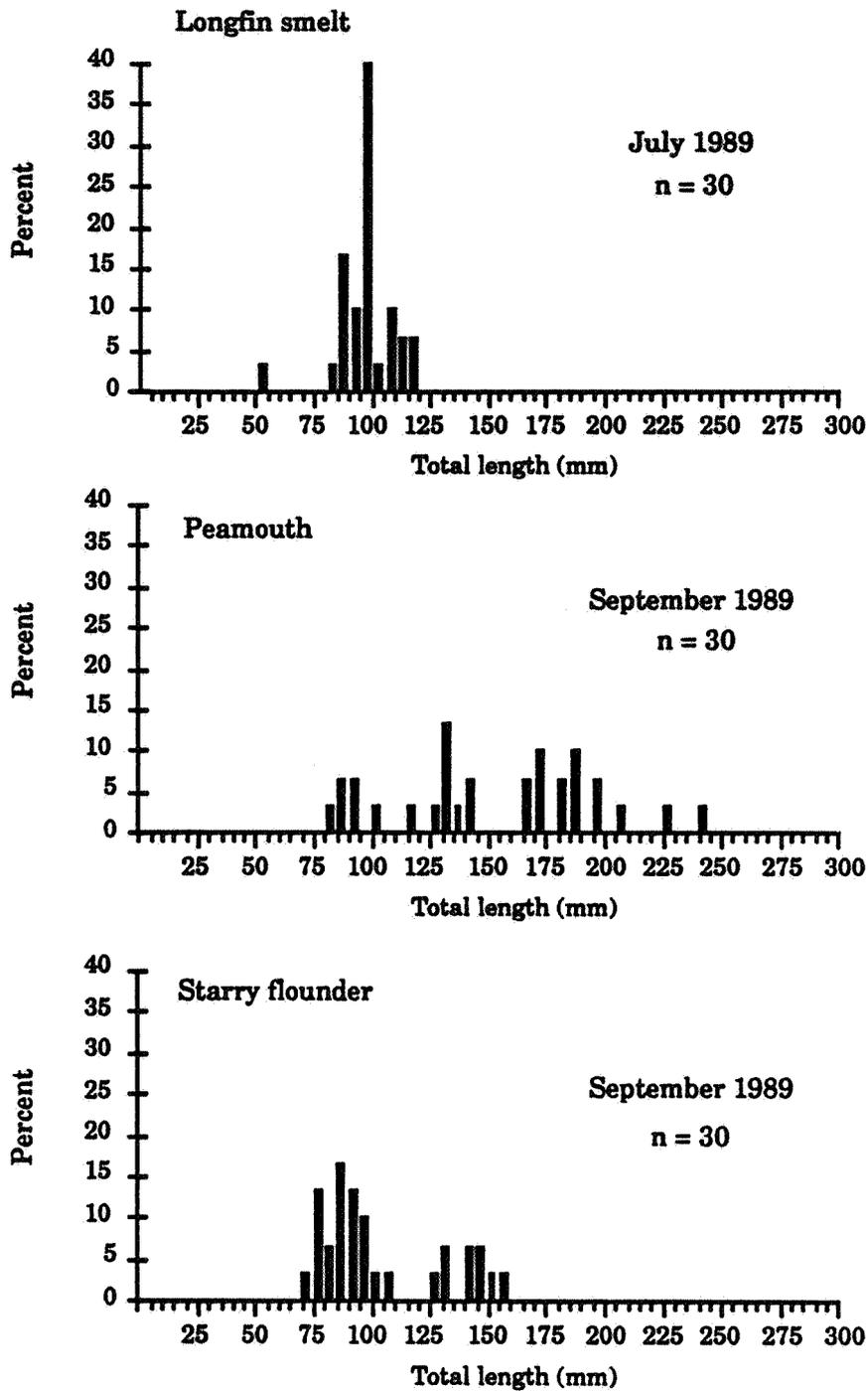


Figure 19.-- Length-frequency distributions of longfin smelt, peamouth, and starry flounder captured by 8-m trawl at Miller Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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/m²) 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/m².

| 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 | | | | |
| <u>Manayunkia speciosa</u> | 1,849 | 0 | 0 | 0 |
| <u>Neanthes limnicola</u> | 994 | 177 | 402 | 386 |
| Unid. Spionidae | 0 | 0 | 563 | 0 |
| Copepoda | 89 | 79 | 1,738 | 145 |
| Ostracoda | 686 | 865 | 418 | 185 |
| Amphipoda | | | | |
| <u>Corophium salmonis</u> | 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 | | | | |
| <u>Corbicula manilensis</u> | 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.

| Survey (date) | <u>Beach seine</u> | | | |
|------------------|----------------------|--------------------|------|------|
| | 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 |

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.

| Species | <u>Beach seine</u> | | | |
|------------------------------|----------------------|----------------------|----------------------|----------------------|
| | 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 |

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/m²) and the lowest in July 1989 (6,449 invertebrates/m²). H' was highest in May 1989 (mean = 1.43). Although the highest number of taxa was not captured in May 1989,

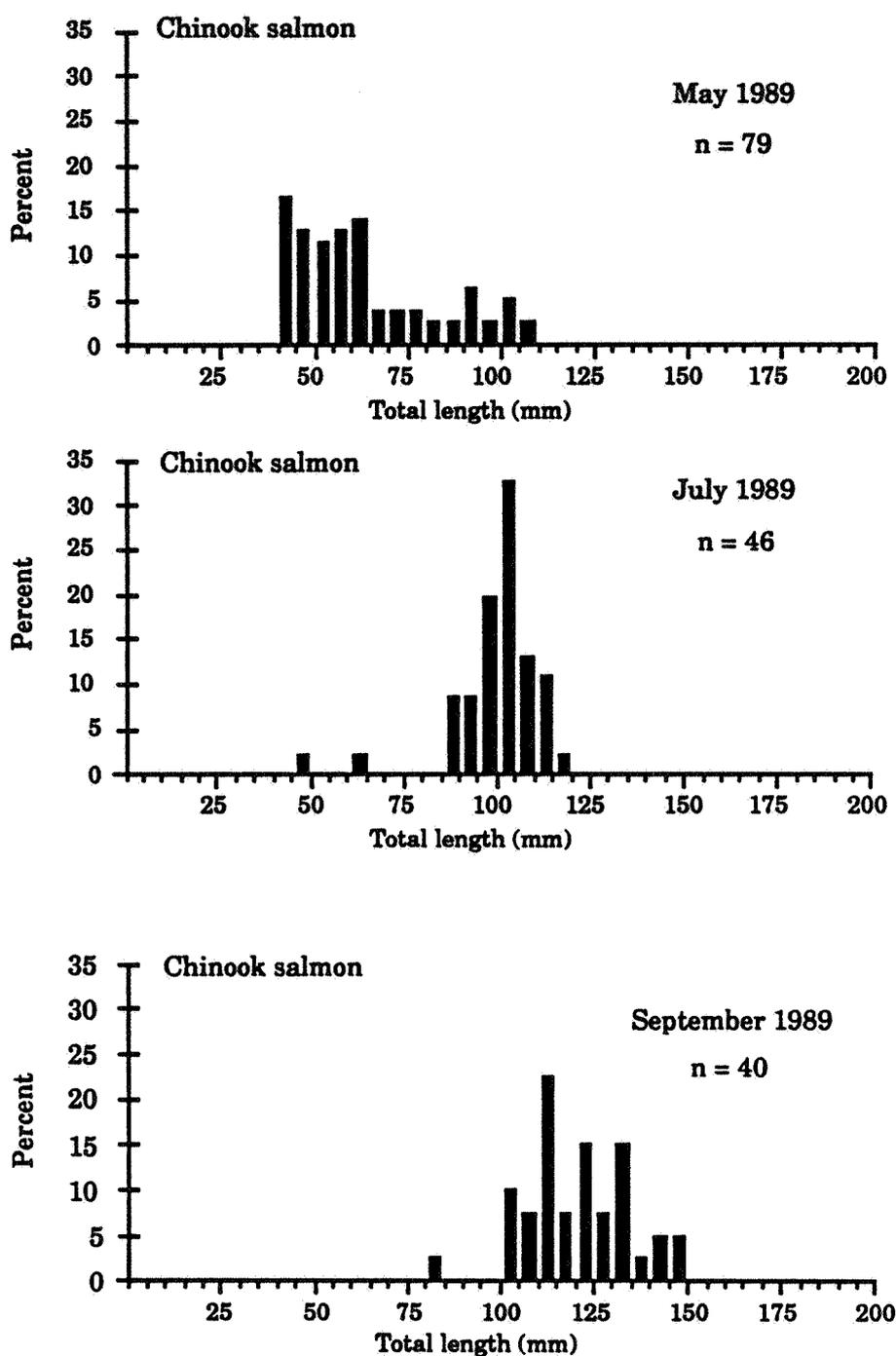


Figure 20.-- Length-frequency distributions of chinook salmon captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

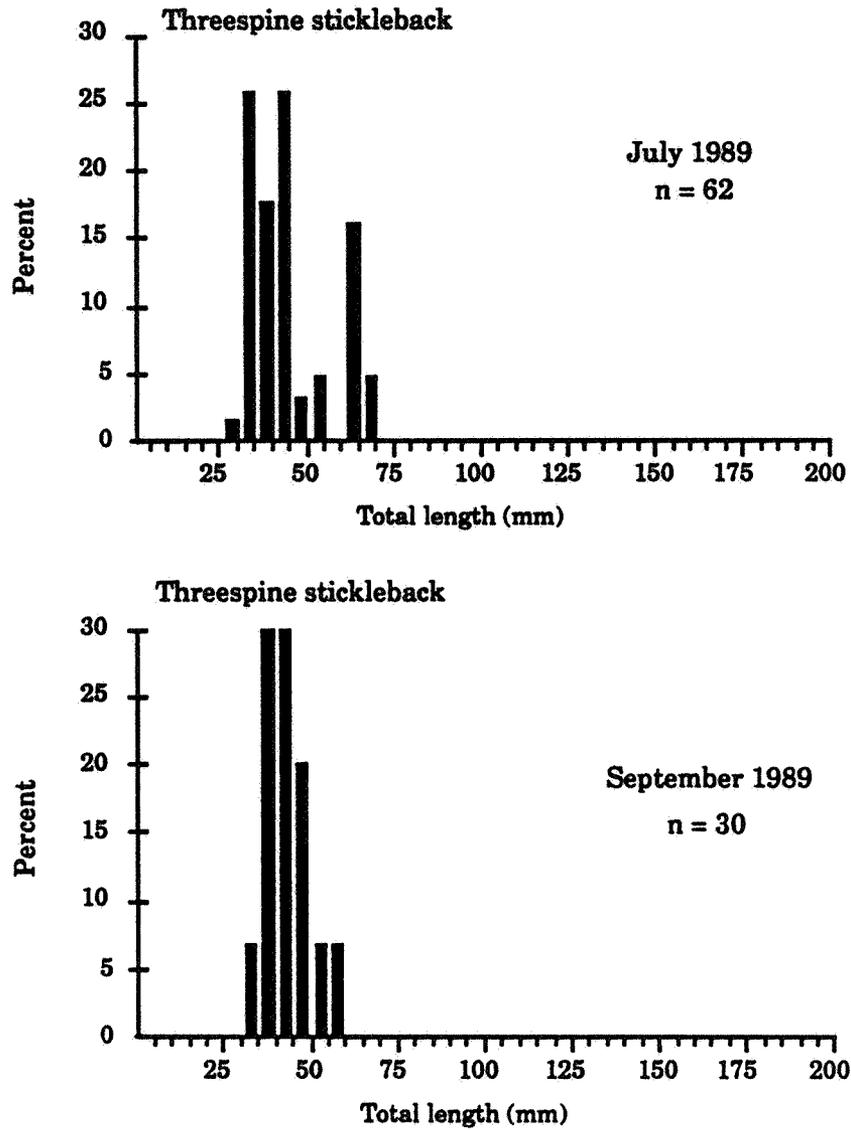


Figure 21.-- Length-frequency distributions of threespine stickleback captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

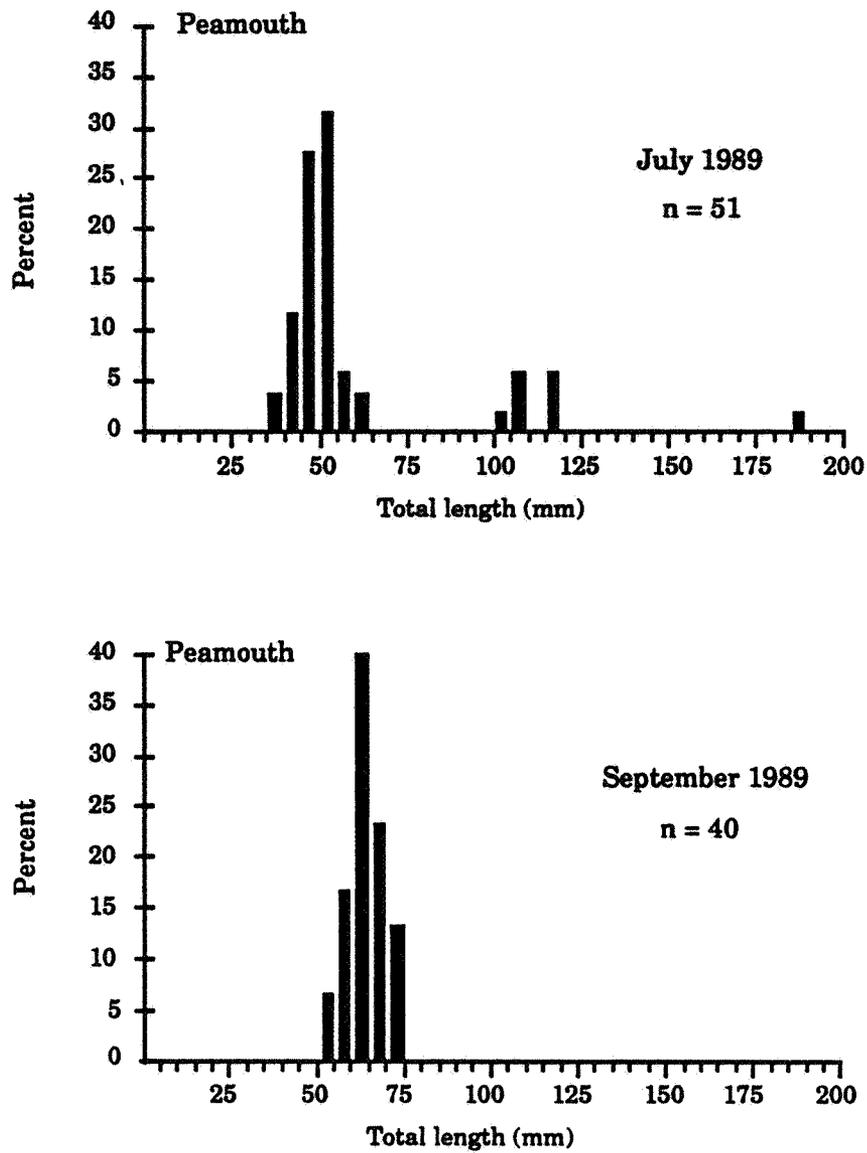


Figure 22.-- Length-frequency distributions of peamouth captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

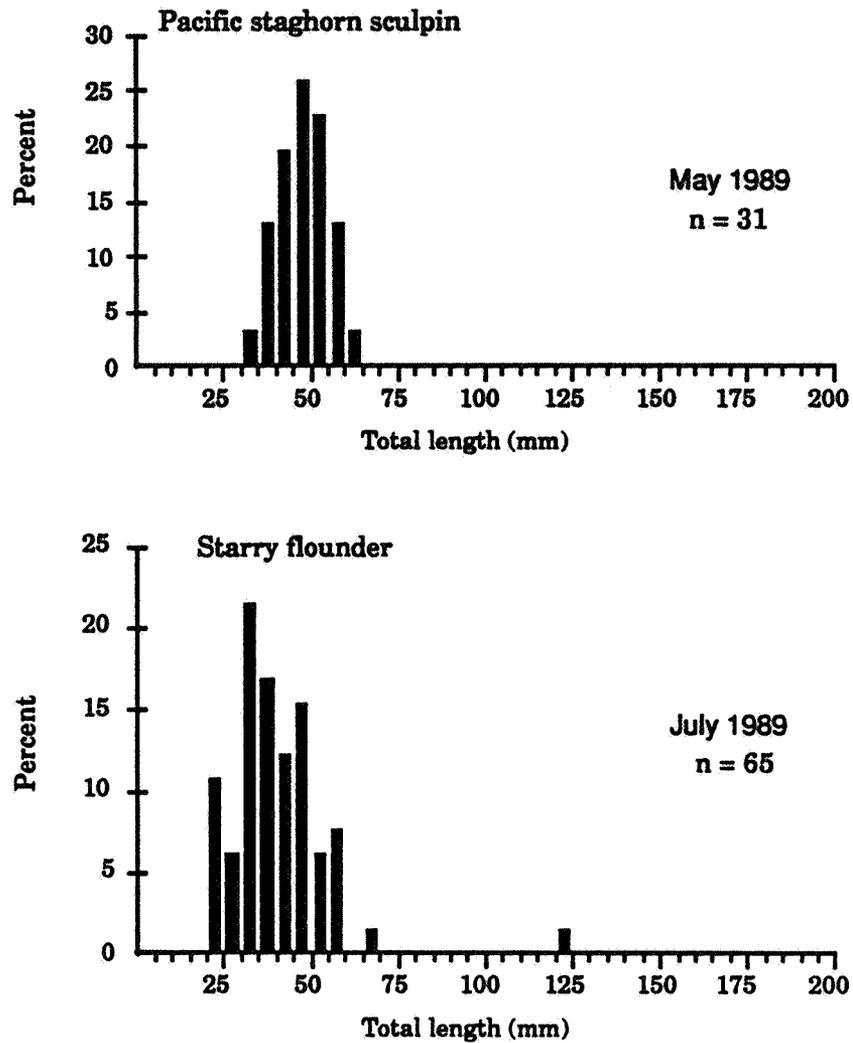


Figure 23.-- Length-frequency distributions of Pacific staghorn sculpin and starry flounder captured by beach seine at Jim Crow Sands, Columbia River estuary, 1989. Sample size (n) equals the number of fish measured, not the total number captured.

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 | | | | |
| <u>Neanthes limnicola</u> | 177 | 44 | 144 | 597 |
| Unid. Spionidae | 44 | 0 | 0 | 0 |
| Copepoda | 33 | 0 | 11 | 0 |
| Ostracoda | 210 | 1,670 | 155 | 409 |
| Amphipoda | | | | |
| <u>Corophium salmonis</u> | 7,854 | 1,615 | 1,416 | 5,852 |
| <u>Pontoporeia hoyi</u> | 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 | | | | |
| <u>Corbicula manilensis</u> | 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/m ² | 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 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/m² 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/m² (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 increase 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 dredge 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 | | | | | |
| <u>Lampetra ayresi</u> | River lamprey | x | | | |
| Acipenseridae | | | | | |
| <u>Acipenser transmontanus</u> | White sturgeon | | | x | |
| Clupeidae | | | | | |
| <u>Alosa sapidissima</u> | American shad | x | x | x | x |
| <u>Clupea harengus pallasii</u> | Pacific herring | | x | x | x |
| Engraulidae | | | | | |
| <u>Engraulis mordax</u> | Northern anchovy | | | x | |
| Salmonidae | | | | | |
| <u>Oncorhynchus keta</u> | Chum salmon | | x | | |
| <u>Oncorhynchus kisutch</u> | Coho salmon | | x | | |
| <u>Oncorhynchus tshawytscha</u> | Chinook salmon | x | x | x | x |
| Osmeridae | | | | | |
| Unidentified Osmeridae | | | | | |
| <u>Allosmerus elongatus</u> | Whitebait smelt | | | x | x |
| <u>Hypomesus pretiosus</u> | Surf smelt | | x | x | |
| <u>Spirinchus thaleichthys</u> | Longfin smelt | x | | x | x |
| Cyprinidae | | | | | |
| Unidentified Cyprinidae | | | | | |
| <u>Cyprinus carpio</u> | Common carp | x | x | x | x |
| <u>Mylocheilus caurinus</u> | Peamouth | x | x | x | x |
| Catostomidae | | | | | |
| <u>Catostomus macrocheilus</u> | Largescale sucker | x | x | x | x |

Appendix Table 1.-- Continued.

| Scientific name | Common name | Survey | | | |
|-------------------------------|--------------------------|--------|----|----|----|
| | | 1 | 2 | 3 | 4 |
| Gadidae | | | | | |
| <u>Microgadus proximus</u> | Pacific tomcod | x | | x | x |
| Cyprinodontidae | | | | | |
| <u>Fundulus diaphanus</u> | Banded killifish | x | | x | x |
| Gasterosteidae | | | | | |
| <u>Gasterosteus aculeatus</u> | Threespine stickleback | x | x | x | x |
| Centrarchidae | | | | | |
| <u>Micropterus salmoides</u> | Largemouth bass | | | x | |
| Percidae | | | | | |
| <u>Perca flavescens</u> | Yellow perch | | | x | |
| Embiotocidae | | | | | |
| <u>Cymatogaster aggregata</u> | Shiner perch | x | | x | x |
| Stichaeidae | | | | | |
| <u>Lumpenus sagitta</u> | Snake prickleback | x | x | x | |
| Pholidae | | | | | |
| <u>Pholis ornata</u> | Saddleback gunnel | | x | | |
| Ammodytidae | | | | | |
| <u>Ammodytes hexapterus</u> | Pacific sand lance | | x | | |
| Cottidae | | | | | |
| Unidentified Cottidae | | | | x | |
| <u>Cottus asper</u> | Prickly sculpin | x | x | x | x |
| <u>Leptocottus armatus</u> | Pacific staghorn sculpin | x | x | x | x |
| Pleuronectidae | | | | | |
| <u>Parophrys vetulus</u> | English sole | x | | x | |
| <u>Platichthys stellatus</u> | Starry flounder | x | x | x | x |
| Misc. | | | | | |
| Canceridae | | | | | |
| <u>Cancer magister</u> | 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 | | <u>Surface</u> | <u>Bottom</u> |
| Date: 19 Oct 1988 | Temperature (C): | 13.9 | 12.5 |
| Depth: 6.4 m | Salinity (ppt): | 12.3 | 28.4 |
| Distance traveled: 370 m | Turbidity (NTU): | 2.4 | - |
| Tide stage: Late flood | 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

| | <u>Surface</u> | <u>Bottom</u> |
|------------------|----------------|---------------|
| 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 | | <u>Surface</u> | <u>Bottom</u> |
| 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 | | <u>Surface</u> | <u>Bottom</u> |
| 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 | | <u>Surface</u> | <u>Bottom</u> |
| 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

| | <u>Surface</u> | <u>Bottom</u> |
|------------------|----------------|---------------|
| 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 | | <u>Surface</u> | <u>Bottom</u> |
| 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

| | | | |
|--------------------------|------------------|----------------|---------------|
| Gear: 8-m trawl | | <u>Surface</u> | <u>Bottom</u> |
| 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

Gear: 8-m trawl

Date: 14 Jul 1989

Depth: 4.6 m

Distance traveled: 389 m

Tide stage: Flood

| | <u>Surface</u> | <u>Bottom</u> |
|------------------|----------------|---------------|
| Temperature (C): | - | 18.0 |
| Salinity (ppt): | - | - |
| Turbidity NTU : | - | 4.0 |
| 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

| | | | |
|--------------------------|------------------|----------------|---------------|
| Gear: 8-m trawl | | <u>Surface</u> | <u>Bottom</u> |
| 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 | 87 |
| Yellow perch | 5 | 20 |
| TOTALS | 84 | 331 |

 $H' = 2.03$ $J' = 0.72$

Appendix Table 2.--Continued.

Station: D1

| | | | |
|--------------------------|------------------|----------------|---------------|
| Gear: 8-m trawl | | <u>Surface</u> | <u>Bottom</u> |
| 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 | | <u>Surface</u> | <u>Bottom</u> |
| 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

| | <u>Surface</u> | <u>Bottom</u> |
|------------------|----------------|---------------|
| 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

Temperature (C):

Salinity (ppt):

Turbidity NTU :

pH:

SurfaceBottom

-

-

-

-

19.0

-

4.9

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 |

 $H' = 0.33$ $J' = 0.21$

3-1

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 | |
| <u>Eteone</u> sp. | x | | x | |
| <u>Glycinde picta</u> | x | x | | x |
| <u>Glycera</u> sp. | | x | | |
| <u>Manayunkia speciosa</u> | x | | | |
| <u>Neanthes limnicola</u> | x | x | x | x |
| <u>Pseudopolydora kemp</u> | | | | x |
| Unidentified Spionidae | | | | x |
| Cladocera | | | | |
| <u>Daphnia</u> spp. | x | x | x | x |
| Copepoda | | | | x |
| Calanoida | x | x | x | x |
| Cyclopoida | x | x | x | x |
| Harpacticoida | x | x | x | x |
| <u>Scottolana canadensis</u> | x | x | x | |
| Ostracoda | x | x | x | x |
| Mysidacea | | | | |
| <u>Neomysis mercedis</u> | x | | | |
| Isopoda | | | | |
| <u>Porcellio scaber</u> | x | | | |
| <u>Gnorimosphaeroma oregonensis</u> | x | | | |
| <u>Saduria entomon</u> | | x | | |

| Taxon | Survey 1 (Sep 88) | Survey 2 (May 89) | Survey 3 (Jul 89) | Survey 4 (Sep 89) |
|------------------------------------|----------------------|----------------------|----------------------|----------------------|
| <u>Amphipoda</u> | | | | |
| <u>Eogammarus oclairi</u> | | x | | |
| <u>Eogammarus confervicolus</u> | | | | x |
| <u>Eohaustorius estuarius</u> | x | x | x | x |
| <u>Corophium</u> spp. | x | x | x | x |
| <u>Corophium salmonis</u> | x | x | x | x |
| <u>Corphium spinicorne</u> | | x | | x |
| <u>Hyaella azteca</u> | x | | x | |
| <u>Pontoporeia hoyi</u> | x | x | | x |
| <u>Ramellogammarus oregonensis</u> | x | | x | x |
| <u>Decapoda</u> | | | | |
| <u>Callinassa californiensis</u> | | | | x |
| <u>Hydracarina</u> | x | x | | x |
| <u>Insecta</u> | | | | |
| 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 |
| <u>Gastropoda (unid.)</u> | | | | |
| <u>Fluminicola</u> sp. | x | | | x |
| <u>Bivalvia</u> | | | | |
| <u>Corbicula manilensis</u> | x | x | x | x |
| <u>Pisidium</u> sp. | x | x | | |
| <u>Macoma balthica</u> | x | x | x | x |
| <u>Arachnida</u> | | | | |
| | | x | | |
| <u>Misc.</u> | | | | |
| 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 /m ² | Standard deviation /m ² |
|------------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Eteone</u> sp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Glycinde picta</u> | 10 | 50.0 | 884.9 | 1,103.7 |
| <u>Oligochaeta</u> | 4 | 30.0 | 354.0 | 618.7 |
| <u>Macoma balthica</u> | 17 | 80.0 | 1,504.3 | 1,026.0 |
| <u>Ramellogammarus oregonensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Porcellio scaber</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 6

Mean number/sample: 3.4

Standard deviation/sample: 1.4

Mean number/m²: 3,008.7Standard 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 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 4

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

Mean number/m²: 354.0 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|------------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Oligochaeta</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Ramellogammarus oregonensis</u> | 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 |
| <u>Corbicula manilensis</u> | 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 |
| <u>Corbicula manilensis</u> | 10 | 60.0 | 884.9 | 1,103.7 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 4 | 40.0 | 354.0 | 457.0 |
| <u>Oligochaeta</u> | 13 | 50.0 | 1,150.4 | 1,671.2 |
| <u>Corbicula manilensis</u> | 8 | 50.0 | 707.9 | 813.2 |
| <u>Corophium salmonis</u> | 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: 10,707.3Standard 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/m²: 530.9 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 9 | 50.0 | 796.4 | 973.8 |
| <u>Corbicula manilensis</u> | 5 | 40.0 | 442.5 | 625.7 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Manayunkia speciosa</u> | 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 |
| <u>Fluminicola sp.</u> | 12 | 50.0 | 1,061.9 | 1,305.9 |
| <u>Corbicula manilensis</u> | 10 | 60.0 | 884.9 | 1,103.7 |
| <u>Pisidium sp.</u> | 19 | 70.0 | 1,681.3 | 2,104.4 |
| Ostracoda | 30 | 80.0 | 2,654.7 | 2,284.8 |
| <u>Hyaella azteca</u> | 28 | 40.0 | 2,477.7 | 4,250.0 |
| <u>Corophium salmonis</u> | 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/m²: 71,057.5

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 15 | 90.0 | 1,327.4 | 752.0 |
| Oligochaeta | 21 | 90.0 | 1,858.3 | 1,932.0 |
| <u>Corbicula manilensis</u> | 8 | 70.0 | 707.9 | 559.7 |
| <u>Eohaustorius estuarius</u> | 7 | 50.0 | 619.4 | 728.5 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 1 | 10.0 | 88.5 | 279.8 |
| <u>Manayunkia speciosa</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Neanthes limnicola</u> | 25 | 70.0 | 2,212.3 | 1,967.7 |
| Oligochaeta | 289 | 100.0 | 25,573.6 | 15,666.3 |
| <u>Corbicula manilensis</u> | 10 | 70.0 | 884.9 | 722.5 |
| Ostracoda | 6 | 50.0 | 530.9 | 618.7 |
| <u>Corophium salmonis</u> | 209 | 100.0 | 18,494.4 | 6,359.9 |
| <u>Pontoporeia hoyi</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Daphnia</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Scottolana canadensis</u> | 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: 48,492.5Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Manayunkia speciosa</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Neanthes limnicola</u> | 5 | 40.0 | 442.5 | 625.7 |
| Oligochaeta | 134 | 100.0 | 11,857.7 | 5,676.9 |
| <u>Corbicula manilensis</u> | 17 | 30.0 | 1,504.3 | 3,869.6 |
| Ostracoda | 14 | 70.0 | 1,238.9 | 1,332.3 |
| <u>Corophium salmonis</u> | 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: 30,440.6Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 25 | 60.0 | 2,212.3 | 3,918.7 |
| Turbellaria | 1 | 10.0 | 88.5 | 279.8 |
| <u>Neanthes limnicola</u> | 41 | 100.0 | 3,628.1 | 1,742.6 |
| Oligochaeta | 143 | 100.0 | 12,654.1 | 7,427.7 |
| <u>Corbicula 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 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Corbicula manilensis</u> | 5 | 30.0 | 442.5 | 860.0 |
| <u>Eohaustorius estuarius</u> | 49 | 90.0 | 4,336.0 | 2,749.7 |
| <u>Corophium salmonis</u> | 19 | 70.0 | 1,681.3 | 1,691.9 |
| <u>Daphnia spp.</u> | 2 | 20.0 | 177.0 | 373.1 |

| | |
|------------------------------|-----------|
| Number of taxa: | 4 |
| Mean number/sample: | 7.5 |
| Mean number/m ² : | 6,636.8 |
| 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 5 | 30.0 | 442.5 | 860.0 |
| <u>Manayunkia speciosa</u> | 2 | 10.0 | 177.0 | 559.7 |
| Oligochaeta | 10 | 60.0 | 884.9 | 1,103.7 |
| <u>Corbicula manilensis</u> | 16 | 90.0 | 1,415.8 | 854.9 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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/m²: 3,274.1 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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/m²: 90,751.4 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Corbicula manilensis</u> | 8 | 70.0 | 707.9 | 559.7 |
| <u>Corophium salmonis</u> | 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/m ² : | 6,282.8 | Standard deviation/m ² : | 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 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 manilensis</u> | 27 | 100.0 | 2,389.2 | 1,183.5 |
| <u>Corophium 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/m²: 22,034.0

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Corbicula 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: 442.5Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 345 | 100.0 | 30,529.1 | 13,563.7 |
| <u>Corbicula manilensis</u> | 26 | 80.0 | 2,300.7 | 2,509.8 |
| <u>Pisidium</u> sp. | 2 | 10.0 | 177.0 | 559.7 |
| Ostracoda | 9 | 60.0 | 796.4 | 880.0 |
| <u>Corophium</u> spp. | 2 | 10.0 | 177.0 | 559.7 |
| <u>Corophium salmonis</u> | 25 | 90.0 | 2,212.3 | 1,629.0 |
| <u>Pontoporeia hoyi</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes 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 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 salmonis</u> | 190 | 100.0 | 16,813.1 | 7,152.6 |
| <u>Pontoporeia 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Polychaeta | 4 | 10.0 | 354.0 | 1,119.3 |
| <u>Neanthes limnicola</u> | 5 | 40.0 | 442.5 | 625.7 |
| Oligochaeta | 298 | 100.0 | 26,370.0 | 16,095.6 |
| <u>Corbicula manilensis</u> | 6 | 50.0 | 530.9 | 618.7 |
| Ostracoda | 6 | 50.0 | 530.9 | 618.7 |
| <u>Neomysis mercedis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium</u> spp. | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 87 | 100.0 | 7,698.6 | 3,415.8 |
| <u>Pontoporeia hovi</u> | 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/m²: 38,493.2Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 31 | 90.0 | 2,743.2 | 1,691.9 |
| <u>Corophium</u> spp. | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 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/m²: 25,927.6

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 1 | 10.0 | 88.5 | 279.8 |
| Turbellaria | 91 | 100.0 | 8,052.6 | 6,757.9 |
| <u>Glycinde picta</u> | 2 | 10.0 | 177.0 | 559.7 |
| <u>Glycera</u> sp. | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 27 | 40.0 | 2,389.2 | 5,227.7 |
| <u>Macoma balthica</u> | 41 | 100.0 | 3,628.1 | 1,976.5 |
| <u>Saduria entomon</u> | 4 | 20.0 | 354.0 | 746.2 |
| Calanoida | 4 | 20.0 | 354.0 | 854.9 |
| Harpacticoida | 6 | 30.0 | 530.9 | 1,119.3 |
| <u>Scottolana canadensis</u> | 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: 17,521.0Standard 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 57 | 90.0 | 5,043.9 | 3,516.2 |
| <u>Macoma balthica</u> | 2 | 10.0 | 177.0 | 559.7 |
| <u>Eogammarus oclairi</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 4 | 30.0 | 354.0 | 618.7 |
| <u>Eohaustorius estuarius</u> | 4 | 40.0 | 354.0 | 457.0 |
| <u>Corophium salmonis</u> | 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/m²: 2,035.3 Standard deviation/m²: 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 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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/m²: 2,035.3 Standard deviation/m²: 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 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/m²: 1,504.3 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 10 | 60.0 | 884.9 | 932.8 |
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 20 | 80.0 | 1,769.8 | 1,615.6 |
| <u>Corbicula manilensis</u> | 2 | 10.0 | 177.0 | 559.7 |
| <u>Eohaustorius estuarius</u> | 6 | 50.0 | 530.9 | 618.7 |
| <u>Corophium salmonis</u> | 75 | 100.0 | 6,636.8 | 1,922.9 |
| <u>Corophium spinicorne</u> | 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 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 3 | 30.0 | 265.5 | 427.4 |

Number of taxa: 4

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

Mean number/m²: 1,238.9 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corbicula manilensis</u> | 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/m²: 1,946.8 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 2 | 10.0 | 177.0 | 559.7 |
| Oligochaeta | 6 | 50.0 | 530.9 | 618.7 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Pontoporeia hoyi</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 4

Mean number/sample: 1.1

Standard deviation/sample: 0.9

Mean number/m²: 973.4Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 22 | 80.0 | 1,946.8 | 1,604.8 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Neanthes limnicola</u> | 8 | 40.0 | 707.9 | 1,370.9 |
| Oligochaeta | 158 | 100.0 | 13,981.4 | 6,056.5 |
| <u>Corbicula manilensis</u> | 8 | 70.0 | 707.9 | 559.7 |
| Ostracoda | 13 | 60.0 | 1,150.4 | 1,107.6 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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: 29,024.7Standard 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 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corophium</u> spp. | 5 | 10.0 | 442.5 | 1,399.1 |
| <u>Corophium salmonis</u> | 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/m²: 25,042.7 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 2 | 10.0 | 177.0 | 559.7 |
| <u>Neanthes limnicola</u> | 2 | 20.0 | 177.0 | 373.1 |
| Oligochaeta | 394 | 100.0 | 34,865.1 | 8,479.5 |
| <u>Corbicula manilensis</u> | 5 | 30.0 | 442.5 | 752.0 |
| Ostracoda | 46 | 100.0 | 4,070.5 | 2,052.1 |
| <u>Corophium salmonis</u> | 7 | 40.0 | 619.4 | 1,107.6 |
| <u>Pontoporeia hoyi</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Corbicula manilensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 25 | 70.0 | 2,212.3 | 2,646.5 |
| Oligochaeta | 29 | 90.0 | 2,566.2 | 1,639.7 |
| <u>Corbicula manilensis</u> | 2 | 10.0 | 177.0 | 559.7 |
| Ostracoda | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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: 5,574.9Standard 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 |
| <u>Corbicula manilensis</u> | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corophium salmonis</u> | 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/m²: 1,504.3 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corbicula manilensis</u> | 13 | 90.0 | 1,150.4 | 597.3 |
| <u>Corophium salmonis</u> | 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 |
| <u>Corbicula manilensis</u> | 15 | 80.0 | 1,327.4 | 1,123.2 |
| Ostracoda | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 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/m²: 18,494.4 Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 236 | 100.0 | 20,883.6 | 7,917.0 |
| <u>Corbicula manilensis</u> | 3 | 30.0 | 265.5 | 427.4 |
| Ostracoda | 10 | 50.0 | 884.9 | 1,179.9 |
| <u>Corophium salmonis</u> | 166 | 100.0 | 14,689.3 | 2,439.5 |
| <u>Corophium spinicorne</u> | 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/m²: 40,174.5Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Daphnia</u> spp. | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 3

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

Mean number/m²: 265.5 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Corbicula manilensis</u> | 7 | 50.0 | 619.4 | 839.5 |

Number of taxa: 1

Mean number/sample: 0.7

Standard deviation/sample: 0.9

Mean number/m²: 619.4Standard 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 |
| <u>Corbicula manilensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Oligochaeta</u> | 7 | 40.0 | 619.4 | 937.4 |
| <u>Corbicula manilensis</u> | 9 | 70.0 | 796.4 | 652.9 |
| <u>Pontoporeia hoyi</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 3

Mean number/sample: 1.7

Standard deviation/sample: 1.4

Mean number/m²: 1,504.3Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 11 | 40.0 | 973.4 | 1,471.9 |
| Oligochaeta | 423 | 100.0 | 37,431.3 | 10,926.1 |
| <u>Corbicula manilensis</u> | 6 | 40.0 | 530.9 | 854.9 |
| Ostracoda | 98 | 100.0 | 8,672.0 | 8,748.1 |
| <u>Corophium salmonis</u> | 22 | 90.0 | 1,946.8 | 1,549.6 |
| <u>Pontoporeia hoyi</u> | 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: 53,536.5Standard 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 |
| <u>Neanthes limnicola</u> | 2 | 20.0 | 177.0 | 373.1 |
| Oligochaeta | 90 | 100.0 | 7,964.1 | 2,703.4 |
| <u>Corbicula manilensis</u> | 5 | 30.0 | 442.5 | 752.0 |
| Ostracoda | 17 | 70.0 | 1,504.3 | 1,254.9 |
| <u>Corophium</u> spp. | 18 | 90.0 | 1,592.8 | 1,492.4 |
| <u>Corophium salmonis</u> | 38 | 100.0 | 3,362.6 | 1,370.9 |
| <u>Pontoporeia hoyi</u> | 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/m²: 19,025.3Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 2 | 20.0 | 177.0 | 373.1 |
| Oligochaeta | 258 | 100.0 | 22,830.4 | 7,137.9 |
| <u>Pisidium</u> sp. | 5 | 30.0 | 442.5 | 860.0 |
| Ostracoda | 23 | 90.0 | 2,035.3 | 2,248.3 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 34 | 80.0 | 3,008.7 | 4,398.9 |
| <u>Pontoporeia hovi</u> | 49 | 100.0 | 4,336.0 | 1,639.7 |
| <u>Daphnia</u> 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/m²: 34,865.1Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Corbicula manilensis</u> | 13 | 80.0 | 1,150.4 | 839.5 |
| Ostracoda | 13 | 70.0 | 1,150.4 | 937.4 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 52 | 100.0 | 4,601.5 | 2,077.4 |
| <u>Daphnia</u> 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/m²: 17,521.0Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eteone sp.</u> | 4 | 40.0 | 354.0 | 457.0 |
| Oligochaeta | 5 | 40.0 | 442.5 | 625.7 |
| <u>Corbicula manilensis</u> | 5 | 20.0 | 442.5 | 955.8 |
| <u>Macoma balthica</u> | 11 | 60.0 | 973.4 | 973.8 |
| <u>Eohaustorius estuarius</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Scottolana canadensis</u> | 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/m²: 3,097.2Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 5 | 40.0 | 442.5 | 625.7 |
| <u>Neanthes limnicola</u> | 4 | 30.0 | 354.0 | 618.7 |
| Oligochaeta | 18 | 60.0 | 1,592.8 | 1,759.9 |
| <u>Eohaustorius estuarius</u> | 35 | 90.0 | 3,097.2 | 2,217.2 |
| <u>Scottolana canadensis</u> | 2 | 20.0 | 177.0 | 373.1 |

Number of taxa: 5

Mean number/sample: 6.4

Standard deviation/sample: 3.9

Mean number/m²: 5,663.4Standard deviation/m²: 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 |
| <u>Eohaustorius estuarius</u> | 5 | 40.0 | 442.5 | 625.7 |
| <u>Corophium salmonis</u> | 2 | 10.0 | 177.0 | 559.7 |

Number of taxa: 4

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

Mean number/m²: 1,061.9 Standard deviation/m²: 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 |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 3 | 20.0 | 265.5 | 597.3 |
| <u>Scottolana canadensis</u> | 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/m²: 796.4Standard deviation/m²: 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/m²: 442.5 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 23 | 60.0 | 2,035.3 | 2,830.8 |
| <u>Corbicula manilensis</u> | 4 | 20.0 | 354.0 | 854.9 |
| Ostracoda | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 3 | 20.0 | 265.5 | 597.3 |
| <u>Corophium</u> spp. | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corophium salmonis</u> | 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: 4,336.0Standard 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/m²: 0.0 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Corbicula manilensis</u> | 6 | 50.0 | 530.9 | 618.7 |

Number of taxa: 1

Mean number/sample: 0.6

Standard deviation/sample: 0.7

Mean number/m²: 530.9Standard 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 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Daphnia</u> 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/m²: 354.0Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 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/m²: 1,061.9Standard deviation/m²: 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 |
| Mean number/m ² : | 1,150.4 |
| H' = 0.00 | J' = 0.00 |

| | |
|-------------------------------------|---------|
| Standard deviation/sample: | 1.8 |
| Standard deviation/m ² : | 1,563.6 |

Appendix Table 4.--Continued.

Station: M3 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> | 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 |
| <u>Corophium salmonis</u> | 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/m²: 15,662.7

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 4 | 40.0 | 354.0 | 457.0 |
| Oligochaeta | 195 | 100.0 | 17,255.5 | 6,288.4 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| Ostracoda | 8 | 60.0 | 707.9 | 698.0 |
| <u>Corophium salmonis</u> | 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/m²: 20,352.7Standard deviation/m²: 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 |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 7 | 50.0 | 619.4 | 728.5 |
| Oligochaeta | 312 | 100.0 | 27,608.9 | 5,624.5 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| Ostracoda | 31 | 80.0 | 2,743.2 | 2,962.9 |
| <u>Eohaustorius estuarius</u> | 6 | 40.0 | 530.9 | 746.2 |
| <u>Corophium salmonis</u> | 1 | 10.0 | 88.5 | 279.8 |
| Calanoida | 1 | 10.0 | 88.5 | 279.8 |
| <u>Scottolana canadensis</u> | 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/m²: 33,714.7Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 94 | 100.0 | 8,318.1 | 5,489.9 |
| <u>Corbicula manilensis</u> | 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 |
|------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 4 | 40.0 | 354.0 | 457.0 |
| Oligochaeta | 39 | 100.0 | 3,451.1 | 1,791.8 |
| <u>Corbicula manilensis</u> | 3 | 30.0 | 265.5 | 427.4 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 32 | 100.0 | 2,831.7 | 1,305.9 |
| <u>Scottolana 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 4.--Continued.

Station: M13 Date: 18 Jul 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 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Eohaustorius estuarius</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 18 | 90.0 | 1,592.8 | 913.9 |
| <u>Daphnia</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Scottolana canadensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corbicula manilensis</u> | 6 | 50.0 | 530.9 | 618.7 |
| <u>Daphnia</u> 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: 973.4Standard 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 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corophium</u> spp. | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corophium salmonis</u> | 339 | 100.0 | 29,998.1 | 13,762.3 |
| <u>Daphnia</u> 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 |
| <u>Scottolana canadensis</u> | 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/m²: 75,659.0 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 8 | 40.0 | 707.9 | 1,370.9 |
| <u>Corbicula 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/m ² : | 5,840.3 |
| Standard deviation/m ² : | 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 |
| <u>Corbicula manilensis</u> | 30 | 90.0 | 2,654.7 | 1,668.6 |
| <u>Corophium salmonis</u> | 2 | 20.0 | 177.0 | 373.1 |

Number of taxa: 3

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

Mean number/m²: 3,097.2 Standard deviation/m²: 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/m²: 0.0Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 4 | 20.0 | 354.0 | 854.9 |
| Oligochaeta | 81 | 100.0 | 7,167.7 | 3,451.2 |
| <u>Corbicula manilensis</u> | 3 | 20.0 | 265.5 | 597.3 |
| Ostracoda | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium 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/m²: 11,769.2Standard deviation/m²: 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 |
|------------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 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 |
| <u>Hyaella azteca</u> | 8 | 60.0 | 707.9 | 698.0 |
| <u>Corophium salmonis</u> | 49 | 90.0 | 4,336.0 | 3,134.2 |
| <u>Ramellogammarus oregonensis</u> | 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/m²: 8,937.5Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 6 | 40.0 | 530.9 | 746.2 |
| Oligochaeta | 81 | 100.0 | 7,167.7 | 5,184.2 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Hyaella azteca</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium</u> spp. | 3 | 20.0 | 265.5 | 597.3 |
| <u>Corophium salmonis</u> | 28 | 90.0 | 2,477.7 | 1,370.9 |
| <u>Daphnia</u> 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/m²: 11,946.2Standard deviation/m²: 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 57 | 100.0 | 5,043.9 | 3,466.3 |
| <u>Corbicula manilensis</u> | 10 | 50.0 | 884.9 | 1,251.4 |
| Ostracoda | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 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/m²: 9,114.5Standard deviation/m²: 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 |
| <u>Glycinde picta</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Pseudopolydora kemp</u> | 27 | 90.0 | 2,389.2 | 1,820.7 |
| Oligochaeta | 24 | 70.0 | 2,123.8 | 2,009.2 |
| <u>Macoma balthica</u> | 28 | 80.0 | 2,477.7 | 1,549.6 |
| <u>Eogammarus confervicolus</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Callianassa californiensis</u> | 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/m²: 8,229.6Standard deviation/m²: 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 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 /m ² | Standard deviation /m ² |
|-------------------------------|-----------------|-----------------------------------|-----------------------------------|--|
| <u>Eohaustorius estuarius</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|------------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 1 | 10.0 | 88.5 | 279.8 |
| <u>Eohaustorius estuarius</u> | 6 | 40.0 | 530.9 | 746.2 |
| <u>Ramellogammarus oregonensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 4 | 10.0 | 354.0 | 1,119.3 |
| <u>Corbicula manilensis</u> | 1 | 10.0 | 88.5 | 279.8 |

| | |
|-----------------|---|
| Number of taxa: | 2 |
|-----------------|---|

| | | | |
|------------------------------|-------|-------------------------------------|---------|
| Mean number/sample: | 0.5 | Standard deviation/sample: | 1.3 |
| Mean number/m ² : | 442.5 | Standard deviation/m ² : | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 4 | 40.0 | 354.0 | 457.0 |
| <u>Corbicula manilensis</u> | 5 | 50.0 | 442.5 | 466.4 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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/m ² : | 354.0 |
| Standard deviation/m ² : | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |

| | |
|-------------------------------------|-----------|
| Number of taxa: | 2 |
| Mean number/sample: | 0.6 |
| Standard deviation/sample: | 1.1 |
| Mean number/m ² : | 530.9 |
| Standard deviation/m ² : | 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 /m ² | Standard deviation /m ² |
|-------|-----------------|-----------------------------------|-----------------------------------|--|
|-------|-----------------|-----------------------------------|-----------------------------------|--|

Number of taxa: 0

Mean number/sample: 0.0

Standard deviation/sample: 0.0

Mean number/m²: 0.0Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|-----------------|-----------------------------------|-----------------------------------|--|
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 1 | 10.0 | 88.5 | 279.8 |

| | |
|------------------------------|-----------|
| Number of taxa: | 2 |
| Mean number/sample: | 0.3 |
| Mean number/m ² : | 265.5 |
| H' = 0.92 | J' = 0.92 |

| | |
|-------------------------------------|-------|
| Standard deviation/sample: | 0.5 |
| Standard deviation/m ² : | 427.4 |

Appendix Table 4.--Continued.

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

| Taxon | Total number | Frequency of occurrence (%) | Mean number /m ² | Standard deviation /m ² |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 38 | 90.0 | 3,362.6 | 3,279.3 |
| Ostracoda | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium 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 |
| <u>Corbicula manilensis</u> | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 3

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

Mean number/m²: 619.4 Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 4 | 40.0 | 354.0 | 457.0 |
| Oligochaeta | 5 | 40.0 | 442.5 | 625.7 |
| <u>Corbicula manilensis</u> | 10 | 70.0 | 884.9 | 722.5 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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/m²: 36,988.8

Standard deviation/m²: 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/m²: 1,769.8 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 12 | 70.0 | 1,061.9 | 913.9 |
| Oligochaeta | 178 | 100.0 | 15,751.2 | 7,632.7 |
| <u>Corbicula manilensis</u> | 10 | 60.0 | 884.9 | 834.3 |
| Ostracoda | 8 | 50.0 | 707.9 | 813.2 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 10.0 | 88.5 | 279.8 |
| Oligochaeta | 120 | 100.0 | 10,618.8 | 4,001.1 |
| <u>Corbicula manilensis</u> | 5 | 40.0 | 442.5 | 625.7 |
| Ostracoda | 4 | 20.0 | 354.0 | 746.2 |
| <u>Corophium salmonis</u> | 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/m²: 28,493.8

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 5 | 30.0 | 442.5 | 752.0 |
| Oligochaeta | 41 | 90.0 | 3,628.1 | 2,552.8 |
| <u>Corbicula manilensis</u> | 11 | 70.0 | 973.4 | 774.8 |
| Ostracoda | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corophium salmonis</u> | 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: 17,786.5Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 1 | 10.0 | 88.5 | 279.8 |
| Turbellaria | 2 | 10.0 | 177.0 | 559.7 |
| <u>Neanthes limnicola</u> | 5 | 50.0 | 442.5 | 466.4 |
| Oligochaeta | 95 | 100.0 | 8,406.6 | 6,690.6 |
| <u>Corbicula manilensis</u> | 7 | 40.0 | 619.4 | 839.5 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium</u> spp. | 5 | 30.0 | 442.5 | 752.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-------------------------------|-----------------|-----------------------------------|-----------------------------------|--|
| <u>Corbicula manilensis</u> | 4 | 30.0 | 354.0 | 618.7 |
| <u>Eohaustorius estuarius</u> | 52 | 100.0 | 4,601.5 | 2,884.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Turbellaria | 8 | 60.0 | 707.9 | 698.0 |
| <u>Neanthes limnicola</u> | 6 | 40.0 | 530.9 | 746.2 |
| Oligochaeta | 5 | 40.0 | 442.5 | 625.7 |
| <u>Corbicula manilensis</u> | 9 | 60.0 | 796.4 | 774.8 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 717 | 100.0 | 63,447.3 | 16,449.8 |
| <u>Corophium spinicorne</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 15 | 80.0 | 1,327.4 | 1,123.2 |
| <u>Oligochaeta</u> | 166 | 100.0 | 14,689.3 | 7,287.5 |
| <u>Ostracoda</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium spp.</u> | 4 | 20.0 | 354.0 | 854.9 |
| <u>Corophium salmonis</u> | 454 | 100.0 | 40,174.5 | 23,723.1 |
| <u>Corophium spinicorne</u> | 2 | 20.0 | 177.0 | 373.1 |

Number of taxa: 6

Mean number/sample: 64.2

Standard deviation/sample: 27.3

Mean number/m²: 56,810.6Standard 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corbicula manilensis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Corbicula manilensis</u> | 29 | 90.0 | 2,566.2 | 1,742.6 |
| <u>Corophium salmonis</u> | 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 /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: 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/m²: 0.0Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 3 | 30.0 | 265.5 | 427.4 |
| Oligochaeta | 521 | 100.0 | 46,103.3 | 13,622.5 |
| <u>Corbicula manilensis</u> | 11 | 70.0 | 973.4 | 880.0 |
| Ostracoda | 19 | 70.0 | 1,681.3 | 1,282.3 |
| <u>Corophium salmonis</u> | 37 | 100.0 | 3,274.1 | 2,361.6 |
| <u>Pontoporeia hoyi</u> | 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/m²: 55,748.7Standard deviation/m²: 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 7 | 50.0 | 619.4 | 728.5 |
| Oligochaeta | 142 | 90.0 | 12,565.6 | 6,990.1 |
| <u>Fluminicola sp.</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corbicula manilensis</u> | 31 | 80.0 | 2,743.2 | 2,339.4 |
| Ostracoda | 12 | 70.0 | 1,061.9 | 1,004.6 |
| <u>Corophium salmonis</u> | 170 | 100.0 | 15,043.3 | 3,979.3 |
| <u>Pontoporeia hoyi</u> | 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/m²: 35,130.5

Standard deviation/m²: 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 44 | 90.0 | 3,893.6 | 2,773.3 |
| Oligochaeta | 518 | 100.0 | 45,837.8 | 17,736.3 |
| <u>Corbicula manilensis</u> | 11 | 60.0 | 973.4 | 1,059.4 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 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/m²: 64,686.2Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Turbellaria | 6 | 40.0 | 530.9 | 854.9 |
| Oligochaeta | 94 | 100.0 | 8,318.1 | 4,237.7 |
| <u>Corbicula manilensis</u> | 20 | 90.0 | 1,769.8 | 1,021.8 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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: 34,068.7Standard 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.

| <u>SURVEY 1</u> | | | | | | |
|-----------------|---------|-----------|-------------------------|-------------------|------------------------------|--|
| Date | Station | Replicate | Median grain size (phi) | Percent silt/clay | Percent total organic carbon | |
| 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 | |
| <u>SURVEY 2</u> | | | | | | |
| 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.

| <u>SURVEY 3</u> | | | | | | |
|-----------------|---------|-----------|-------------------------|-------------------|------------------------------|--|
| 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.

| <u>SURVEY 3</u> | | | | | | |
|-----------------|---------|-----------|-------------------------|-------------------|------------------------------|--|
| Date | Station | Replicate | Median grain size (phi) | Percent silt/clay | Percent total organic carbon | |
| 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 | |
| <u>SURVEY 4</u> | | | | | | |
| 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.

| <u>SURVEY 4</u> | | | | | |
|-----------------|---------|-----------|-------------------------|-------------------|------------------------------|
| 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

Salinity: 0.4 ppt

pH: 8.2

Temperature: 11.6 C

Turbidity: 25.0 NTU

| 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

Salinity: 0.3 ppt

pH: 8.3

Temperature: 13.7 C

Turbidity: 23.0 NTU

| 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

Salinity: 0.3

pH: 8.0

Temperature: 14.6 C

Turbidity: 18.0 NTU

| 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

Salinity: 0.3 ppt

pH: 8.6

Temperature: 17.2 C

Turbidity: 14.0 NTU

| 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

Salinity: 0.3

pH: -

Temperature: 15.2 C

Turbidity: 22.0 NTU

| 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

Salinity: 0.3 ppt

pH: 7.9

Temperature: 14.6 C

Turbidity: 22.0 NTU

| 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

Salinity: 0.3

pH: 8.0

Temperature: 14.6 C

Turbidity: 18.0 NTU

| 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

Salinity: 0.1 ppt

pH: 6.7

Temperature: 16.2 C

Turbidity: 13.0 NTU

| 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

Salinity: 0.1

pH: 7.3

Temperature: 18.7 C

Turbidity: 7.4 NTU

| 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

Salinity: 0.1 ppt

pH: 7.4

Temperature: 18.3 C

Turbidity: 11.0 NTU

| 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

Salinity: 0.1

pH: 6.8

Temperature: 19.2 C

Turbidity: 5.3 NTU

| 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

Salinity: 0.2 ppt

pH: 6.8

Temperature: 12.3 C

Turbidity: 16.0 NTU

| 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

Salinity: 0.1

pH: 7.2

Temperature: 12.6 C

Turbidity: 10.5 NTU

| 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

Salinity: 0.1 ppt

pH: 7.3

Temperature: 12.9 C

Turbidity: 10.0 NTU

| 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

Salinity: 0.1

pH: 7.4

Temperature: 15.0 C

Turbidity: 9.0 NTU

| 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

Salinity: 0.1 ppt

pH: 8.0

Temperature: 20.9 C

Turbidity: 4.8 NTU

| 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

Salinity: 0.1

pH: 7.8

Temperature: 21.7 C

Turbidity: 7.7 NTU

| 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

Salinity: 0.1 ppt

pH: 8.1

Temperature: 20.3 C

Turbidity: 4.3 NTU

| 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

Salinity: 0.1

pH: 8.1

Temperature: 20.5 C

Turbidity: 4.2 NTU

| 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
 Salinity: 0.1 ppt
 pH: 7.8

 Temperature: 18.1 C
 Turbidity: 5.0 NTU

| 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
 Salinity: 0.1
 pH: 7.7

 Temperature: 18.2 C
 Turbidity: 3.5 NTU

| 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

Salinity: 0.1 ppt

pH: 7.7

Temperature: 18.2 C

Turbidity: 3.5 NTU

| 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

Salinity: 0.1

pH: 7.9

Temperature: 18.2 C

Turbidity: 3.0 NTU

| 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

Salinity: 0.1 ppt

pH: 8.5

Temperature: 12.9 C

Turbidity: 8.0 NTU

| 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

Salinity: 0.1

pH: 8.3

Temperature: 12.7 C

Turbidity: -

| 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

Salinity: 0.1 ppt

pH: 8.7

Temperature: 13.0 C

Turbidity: 5.2 NTU

| 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

Salinity: 0.1

pH: 8.5

Temperature: 12.9 C

Turbidity: 4.0 NTU

| 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

Salinity: 0.2 ppt

pH: 7.6

Temperature: 18.0 C

Turbidity: 4.1 NTU

| 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

Salinity: 0.1

pH: 7.9

Temperature: 18.0 C

Turbidity: 4.4 NTU

| 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

Salinity: 0.2 ppt

pH: 7.8

Temperature: 18.3 C

Turbidity: 4.3 NTU

| 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

Salinity: 0.2 ppt

pH: 8.0

Temperature: 18.3 C

Turbidity: 3.8 NTU

| 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 6 | 33.3 | 9.6 | 16.1 |
| Oligochaeta | 5,852 | 100.0 | 9,380.9 | 2,212.1 |
| <u>Corbicula manilensis</u> | 88 | 100.0 | 141.1 | 57.9 |
| <u>Neomysis mercedis</u> | 4 | 16.7 | 6.4 | 15.7 |
| <u>Corophium salmonis</u> | 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/m²: 11,259.7Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 3 | 40.0 | 5.8 | 8.6 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 112 | 120.0 | 215.4 | 65.1 |
| <u>Neomysis mercedis</u> | 1 | 20.0 | 1.9 | 4.3 |
| <u>Eogammarus confervicolus</u> | 1 | 20.0 | 1.9 | 4.3 |
| <u>Corophium salmonis</u> | 343 | 120.0 | 659.8 | 156.7 |
| Chironomidae | 97 | 120.0 | 186.6 | 45.8 |
| <u>Lampetra</u> 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 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 60 | 100.0 | 96.2 | 47.1 |
| <u>Neomysis mercedis</u> | 4 | 16.7 | 6.4 | 15.7 |
| <u>Corophium salmonis</u> | 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/m²: 14,039.3

Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 62 | 100.0 | 99.4 | 52.6 |
| <u>Eogammarus confervicolus</u> | 1 | 16.7 | 1.6 | 3.9 |
| <u>Corophium salmonis</u> | 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/m²: 2,928.7 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 652 | 100.0 | 1,045.2 | 384.3 |
| Gastropoda | 6 | 83.3 | 9.6 | 6.1 |
| <u>Corbicula manilensis</u> | 159 | 100.0 | 254.9 | 86.6 |
| Ostracoda | 1 | 16.7 | 1.6 | 3.9 |
| <u>Corophium salmonis</u> | 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 |
| <u>Neanthes limnicola</u> | 4 | 16.7 | 6.4 | 15.7 |
| Oligochaeta | 10,592 | 100.0 | 16,979.3 | 6,403.5 |
| <u>Corbicula manilensis</u> | 28 | 66.7 | 44.9 | 56.6 |
| <u>Neomysis mercedis</u> | 2 | 16.7 | 3.2 | 7.9 |
| <u>Corophium salmonis</u> | 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/m²: 17,777.6

Standard deviation/m²: 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 16.7 | 1.6 | 3.9 |
| Oligochaeta | 717 | 100.0 | 1,149.4 | 344.7 |
| Gastropoda | 14 | 100.0 | 22.4 | 11.6 |
| <u>Corbicula manilensis</u> | 19 | 66.7 | 30.5 | 34.1 |
| <u>Neomysis mercedis</u> | 3 | 33.3 | 4.8 | 8.0 |
| <u>Corophium salmonis</u> | 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/m²: 2,156.1Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 10 | 50.0 | 16.0 | 23.3 |
| <u>Corophium salmonis</u> | 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/m²: 6,187.7

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 1,565 | 100.0 | 2,508.7 | 1,191.4 |
| Gastropoda | 37 | 100.0 | 59.3 | 42.3 |
| <u>Corbicula manilensis</u> | 31 | 83.3 | 49.7 | 39.1 |
| <u>Neomysis mercedis</u> | 1 | 16.7 | 1.6 | 3.9 |
| <u>Corophium 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/m²: 3,300.6 Standard deviation/m²: 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 limnicola</u> | 8 | 50.0 | 12.8 | 18.9 |
| Oligochaeta | 222 | 100.0 | 355.9 | 114.6 |
| <u>Corbicula manilensis</u> | 23 | 100.0 | 36.9 | 25.4 |
| <u>Neomysis mercedis</u> | 1 | 16.7 | 1.6 | 3.9 |
| <u>Corophium 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/m²: 1,787.4

Standard deviation/m²: 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 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 32 | 83.3 | 51.3 | 39.7 |
| <u>Neomysis mercedis</u> | 4 | 16.7 | 6.4 | 15.7 |
| <u>Corophium salmonis</u> | 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/m²: 8,656.3 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 2 | 16.7 | 3.2 | 7.9 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 21 | 100.0 | 33.7 | 19.0 |
| <u>Neomysis mercedis</u> | 2 | 33.3 | 3.2 | 5.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 4 | 33.3 | 6.4 | 9.9 |
| <u>Neanthes limnicola</u> | 29 | 83.3 | 46.5 | 36.7 |
| Oligochaeta | 5,616 | 100.0 | 9,002.6 | 2,087.0 |
| <u>Corbicula manilensis</u> | 61 | 100.0 | 97.8 | 48.1 |
| <u>Corophium salmonis</u> | 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/m²: 10,791.6 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 2,045 | 100.0 | 3,278.2 | 912.8 |
| Gastropoda | 8 | 100.0 | 12.8 | 5.0 |
| <u>Corbicula manilensis</u> | 10 | 66.7 | 16.0 | 14.5 |
| <u>Corophium salmonis</u> | 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/m ² : 4,078.1 | Standard deviation/m ² : 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Turbellaria | 1 | 16.7 | 1.6 | 3.9 |
| <u>Neanthes limnicola</u> | 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 |
| <u>Corbicula manilensis</u> | 25 | 100.0 | 40.1 | 25.4 |
| <u>Neomysis mercedis</u> | 5 | 50.0 | 8.0 | 11.2 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 103 | 100.0 | 165.1 | 253.3 |
| <u>Corbicula manilensis</u> | 3 | 33.3 | 4.8 | 8.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 |
| <u>Corbicula manilensis</u> | 81 | 100.0 | 129.8 | 57.3 |
| <u>Neomysis mercedis</u> | 113 | 33.3 | 181.1 | 439.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 93 | 100.0 | 149.1 | 129.0 |
| Gastropoda | 2 | 33.3 | 3.2 | 5.0 |
| <u>Corbicula manilensis</u> | 37 | 100.0 | 59.3 | 11.2 |
| <u>Neomysis mercedis</u> | 2 | 33.3 | 3.2 | 5.0 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 639 | 100.0 | 1,024.3 | 223.2 |
| Gastropoda | 11 | 66.7 | 17.6 | 15.4 |
| <u>Corbicula manilensis</u> | 45 | 100.0 | 72.1 | 37.4 |
| <u>Neomysis mercedis</u> | 5 | 50.0 | 8.0 | 9.5 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 5 | 66.7 | 32.1 | 29.4 |
| Oligochaeta | 126 | 100.0 | 808.0 | 587.0 |
| <u>Corbicula manilensis</u> | 2 | 66.7 | 12.8 | 11.1 |
| <u>Corophium 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 9 | 66.7 | 57.7 | 57.7 |
| Oligochaeta | 227 | 100.0 | 1,455.7 | 168.1 |
| <u>Corbicula manilensis</u> | 9 | 100.0 | 57.7 | 19.2 |
| <u>Corophium salmonis</u> | 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 2 | 66.7 | 12.8 | 11.1 |
| Oligochaeta | 102 | 100.0 | 654.1 | 374.5 |
| Gastropoda | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corbicula manilensis</u> | 10 | 100.0 | 64.1 | 44.4 |
| <u>Neomysis mercedis</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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/m²: 2,603.6

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <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/m²: 4,065.7 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 158 | 100.0 | 1,013.2 | 622.3 |
| Gastropoda | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 289 | 100.0 | 1,853.3 | 240.5 |
| <u>Corbicula manilensis</u> | 16 | 100.0 | 102.6 | 67.6 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|---------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 1 | 33.3 | 6.4 | 11.1 |
| Oligochaeta | 505 | 100.0 | 3,238.4 | 709.0 |
| <u>Corbicula manilensis</u> | 60 | 100.0 | 384.8 | 57.7 |
| Ostracoda | 14 | 100.0 | 89.8 | 90.9 |
| <u>Neomysis mercedis</u> | 7 | 33.3 | 44.9 | 77.8 |
| <u>Eogammarus confervicolus</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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 |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 5 | 66.7 | 32.1 | 29.4 |
| Oligochaeta | 140 | 100.0 | 897.8 | 1,055.2 |
| <u>Corbicula manilensis</u> | 13 | 100.0 | 83.4 | 77.8 |
| <u>Neomysis mercedis</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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/m²: 3,142.2

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 245 | 100.0 | 1,571.1 | 751.6 |
| <u>Corbicula manilensis</u> | 35 | 100.0 | 224.4 | 61.8 |
| <u>Neomysis mercedis</u> | 7 | 100.0 | 44.9 | 22.2 |
| <u>Eogammarus confervicolus</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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/m ² : | 2,661.3 | Standard deviation/m ² : | 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 manilensis</u> | 30 | 100.0 | 192.4 | 120.1 |
| <u>Corophium 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 24 | 100.0 | 153.9 | 57.7 |
| <u>Corbicula manilensis</u> | 3 | 33.3 | 19.2 | 33.3 |
| <u>Corophium salmonis</u> | 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 1,470 | 100.0 | 9,426.7 | 5,667.9 |
| Gastropoda | 2 | 33.3 | 12.8 | 22.2 |
| <u>Corbicula manilensis</u> | 111 | 100.0 | 711.8 | 83.9 |
| <u>Corophium salmonis</u> | 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/m²: 10,330.9 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 98 | 100.0 | 628.4 | 214.5 |
| Gastropoda | 2 | 66.7 | 12.8 | 11.1 |
| <u>Corbicula manilensis</u> | 42 | 100.0 | 269.3 | 69.4 |
| <u>Corophium salmonis</u> | 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 |
| <u>Corbicula manilensis</u> | 21 | 100.0 | 134.7 | 33.3 |
| <u>Eocammarus confervicolus</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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/m²: 7,618.3 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| 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 /m ² | Standard deviation /m ² |
|---------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 2 | 66.7 | 12.8 | 11.1 |
| Oligochaeta | 9 | 100.0 | 57.7 | 19.2 |
| <u>Corbicula manilensis</u> | 7 | 100.0 | 44.9 | 11.1 |
| <u>Eogammarus confervicolus</u> | 1 | 33.3 | 6.4 | 11.1 |
| <u>Corophium salmonis</u> | 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/m²: 2,109.8 Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 90 | 100.0 | 577.1 | 468.1 |
| <u>Corophium salmonis</u> | 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/m²: 3,052.5 Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 4 | 100.0 | 25.7 | 11.1 |
| Oligochaeta | 24 | 100.0 | 153.9 | 50.9 |
| <u>Corbicula manilensis</u> | 6 | 66.7 | 38.5 | 38.5 |
| <u>Corophium salmonis</u> | 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 limnicola</u> | 5 | 100.0 | 32.1 | 11.1 |
| Oligochaeta | 68 | 100.0 | 436.1 | 58.8 |
| <u>Corbicula manilensis</u> | 11 | 100.0 | 70.5 | 48.4 |
| <u>Corophium 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/m²: 3,488.5

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 2 | 33.3 | 12.8 | 22.2 |
| Oligochaeta | 91 | 100.0 | 583.6 | 165.9 |
| Gastropoda | 5 | 100.0 | 32.1 | 22.2 |
| <u>Corbicula manilensis</u> | 8 | 66.7 | 51.3 | 48.4 |
| <u>Neomysis mercedis</u> | 6 | 100.0 | 38.5 | 19.2 |
| <u>Corophium salmonis</u> | 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/m²: 3,199.9Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 12 | 40.0 | 1,061.9 | 1,432.9 |
| Nematomorpha | 16 | 90.0 | 1,415.8 | 746.2 |
| <u>Neanthes 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 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: 15,751.2Standard 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 limnicola</u> | 6 | 30.0 | 530.9 | 1,119.3 |
| Oligochaeta | 107 | 100.0 | 9,468.4 | 5,534.9 |
| <u>Corbicula manilensis</u> | 4 | 30.0 | 354.0 | 618.7 |
| <u>Corophium 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/m²: 17,521.0

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nemertea | 14 | 70.0 | 1,238.9 | 1,038.7 |
| Oligochaeta | 19 | 70.0 | 1,681.3 | 1,585.7 |
| <u>Corbicula manilensis</u> | 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/m²: 3,362.6Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <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 /m ² | Standard deviation /m ² |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 7 | 50.0 | 619.4 | 728.5 |
| Oligochaeta | 291 | 100.0 | 25,750.6 | 6,614.8 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| Ostracoda | 15 | 40.0 | 1,327.4 | 2,054.2 |
| <u>Eohaustorius estuarius</u> | 6 | 40.0 | 530.9 | 746.2 |
| <u>Corophium salmonis</u> | 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: 30,263.6Standard 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 |
| <u>Corbicula manilensis</u> | 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/m²: 8,495.0Standard deviation/m²: 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 |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 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 |
| <u>Corophium salmonis</u> | 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 8.--Continued.

Station: M11

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> | 4 | 40.0 | 354.0 | 457.0 |
| Oligochaeta | 39 | 100.0 | 3,451.1 | 1,791.8 |
| <u>Corbicula manilensis</u> | 3 | 30.0 | 265.5 | 427.4 |
| Ostracoda | 3 | 30.0 | 265.5 | 427.4 |
| <u>Corophium salmonis</u> | 32 | 100.0 | 2,831.7 | 1,305.9 |
| <u>Scottolana 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: 7,610.1Standard 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 /m ² | Standard deviation /m ² |
|---------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Oligochaeta | 34 | 90.0 | 3,008.7 | 3,154.9 |
| <u>Corophium salmonis</u> | 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/m²: 4,424.5 Standard deviation/m²: 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 |
| <u>Corbicula manilensis</u> | 2 | 20.0 | 177.0 | 373.1 |
| <u>Corophium salmonis</u> | 1 | 10.0 | 88.5 | 279.8 |

Number of taxa: 3

Mean number/sample: 0.4

Standard deviation/sample: 0.5

Mean number/m²: 354.0Standard deviation/m²: 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 |
|-------------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 12 | 70.0 | 1,061.9 | 913.9 |
| Oligochaeta | 149 | 100.0 | 13,185.0 | 6,468.5 |
| <u>Corbicula manilensis</u> | 8 | 50.0 | 707.9 | 813.2 |
| Ostracoda | 4 | 30.0 | 354.0 | 618.7 |
| <u>Eohaustorius estuarius</u> | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium</u> spp. | 1 | 10.0 | 88.5 | 279.8 |
| <u>Corophium salmonis</u> | 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/m²: 32,652.8

Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| <u>Neanthes limnicola</u> | 5 | 30.0 | 442.5 | 752.0 |
| Oligochaeta | 25 | 90.0 | 2,212.3 | 1,629.0 |
| <u>Corbicula manilensis</u> | 11 | 70.0 | 973.4 | 774.8 |
| Ostracoda | 3 | 20.0 | 265.5 | 597.3 |
| <u>Corophium 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/m²: 13,362.0Standard deviation/m²: 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 /m ² | Standard deviation /m ² |
|-----------------------------|--------------|-----------------------------|-----------------------------|------------------------------------|
| Nematomorpha | 1 | 10.0 | 88.5 | 279.8 |
| Turbellaria | 1 | 10.0 | 88.5 | 279.8 |
| <u>Neanthes limnicola</u> | 5 | 50.0 | 442.5 | 466.4 |
| Oligochaeta | 29 | 90.0 | 2,566.2 | 2,020.0 |
| <u>Corbicula manilensis</u> | 5 | 30.0 | 442.5 | 752.0 |
| <u>Corophium</u> spp. | 3 | 20.0 | 265.5 | 597.3 |
| <u>Corophium salmonis</u> | 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 |