Benthic Invertebrates, Sediment Characteristics, and Demersal Fishes Off Cottonwood Island, Columbia River, Before and After Rock Groin Construction, 1987-1988

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COASTAL ZONE AND ESTUARINE STUDIES

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INTRODUCTION

In 1987, the National Marine Fisheries Service (NMFS) entered into a cooperative agreement with the U.S. Army Corps of Engineers (COE) to study benthic invertebrates, sediment characteristics, and demersal fishes near pile dikes and rock groins at Cottonwood Island (Dobelbower Bar) in the Columbia River. Pile dikes in the Columbia River are used to help maintain the navigational channel and reduce maintenance dredging costs.

From 1925 to 1969, fifteen wooden pile dikes were constructed along Cottonwood Island (COE 1987). Over the years these pile dikes deteriorated and by 1987 most of the dikes were in poor condition. In early 1987, the COE proposed to replace seven of the pile dikes with submerged rock groins by placing rock along and around the existing pile dikes (COE 1987). Because of the paucity of information about benthic invertebrates and demersal fishes, particularly white sturgeon (*Acipenser transmontanus*), near the pile dikes, the COE arranged for NMFS to conduct four environmental surveys in the vicinity of the pile dikes and rock groins. Two surveys were to be done prior to rock groin construction and two after construction to assess short-term changes in the benthos and demersal fish community.

METHODS

Four benthic surveys were conducted at six stations near the pile dikes and rock groins along Cottonwood Island; the sampling

stations ranged from River Mile (RM) 68.4 to 70.6 (Fig. 1; Appendix Table 1). The first two surveys, July and November 1987, were prior to the rock-groin construction and the last two, July and December 1988, were after the construction. Construction began in January 1988 and was completed in March 1988. Five benthic invertebrate samples and one sediment sample were collected at each station using a 0.1-m^2 Van Veen grab sampler (Word 1976). When practical, each benthic invertebrate sample was sieved through a 0.5-mm screen and the residue preserved in a buffered formaldehyde solution ($\geq$4%) containing rose bengal, an organic stain. If it appeared that most of the sample would not wash through the sieve, then the entire sample was preserved and sieved at a later time. Later the samples were washed with water and preserved in a 90% ethyl alcohol solution to prevent the destruction of calcareous invertebrate parts by formaldehyde. Each benthic invertebrate sample was sorted and the invertebrates were identified to the lowest practical taxonomic level and counted. Sediment samples were analyzed by the COE (North Pacific Division Materials Laboratory, Troutdale, Oregon) for sediment grain size and percent organic carbon (total volatile solids).

The benthic invertebrate data were analyzed by station. Information calculated for each station included the number of taxa; total number, frequency of occurrence, and mean number/m^2 and standard deviation (SD) for individuals in each taxon; mean number of invertebrates/sample and SD; and mean number of invertebrates/m^2

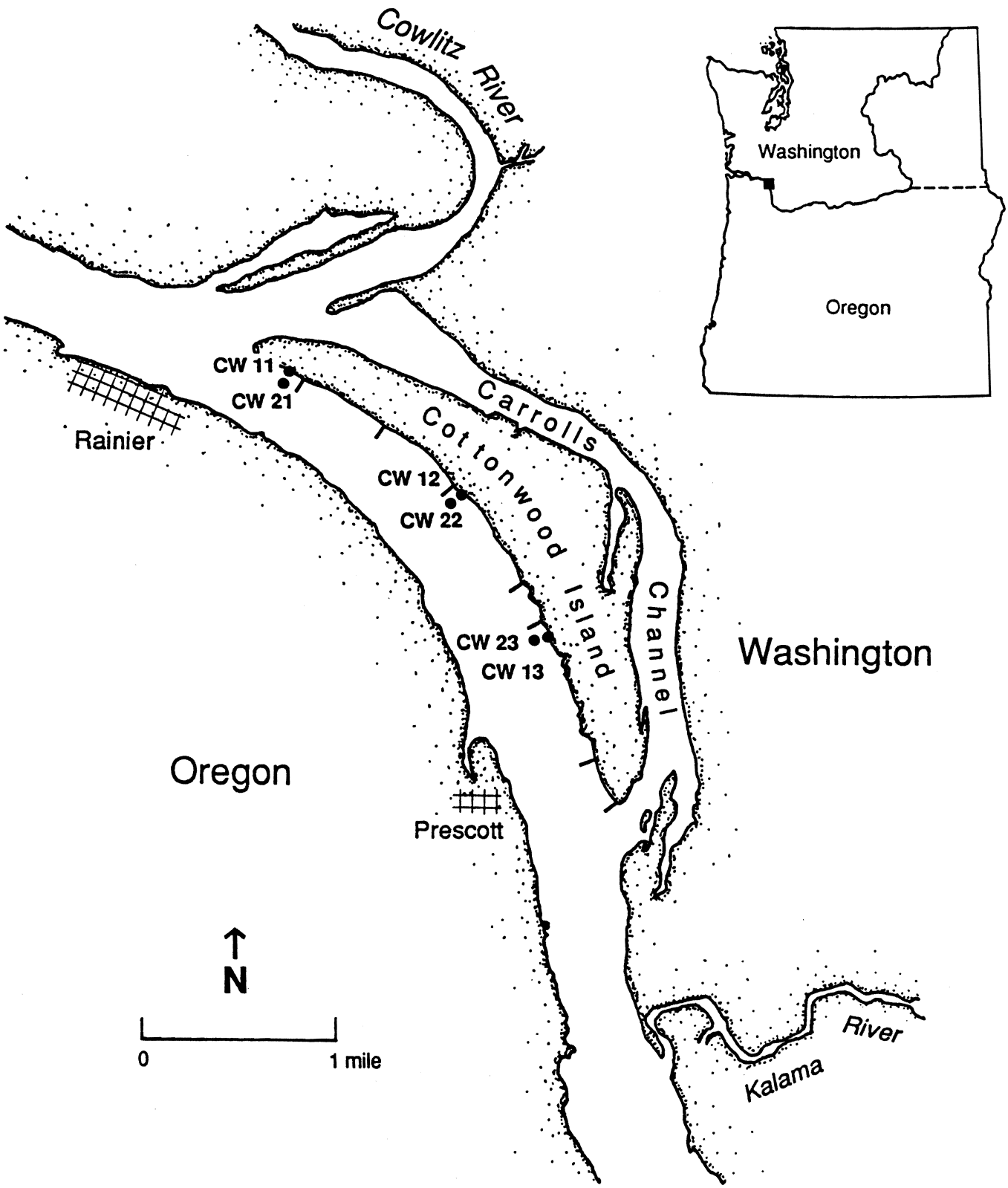

Figure 1.--Locations of the benthic and bottom-trawling stations off Cottonwood Island, Columbia River, 1987-1988. Benthic samples were collected at all six stations; however, trawling was done only at Stations CW21, CW22, and CW23. The seven pile dikes that were replaced with rock groins are indicated with heavy lines.

and SD. Also, two community structure indices were calculated for each station--Shannon-Wiener function (H′) (Krebs 1978) and Evenness (J′) (Pielou 1966):

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

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

where Pi = Xa/n (Xa is the number of individuals of a particular species in a sample and n is the total number of individuals in the sample), and s = number of species. The Shannon-Wiener function is a diversity index that incorporates two elements of diversity--number of species and species evenness (Krebs 1978). Evenness is a measure of the equitability of the proportional abundances of various species in the sample.

Total mean numbers (by station) for each survey were compared using a two-sample t-test (unpaired data, assuming unequal variance); the data were transformed to $\log_{10}$ prior to making the comparisons (Elliott 1977). Mean numbers of the amphipod Corophium salmonis, the bivalve Corbicula manilensis, Heleidae larvae, and Oligochaeta were compared by survey (by station for each taxon) using the t-test. The data were transformed to $\log_{10}$ prior to analysis. For Heleidae larvae, the data were transformed to $\log_{10}$ of (number + 1) prior to analysis; 1 was added to the number because of one zero count.

A 4.9-m (headrope length) semiballoon shrimp trawl was used to collect demersal fishes near the pile dikes and rock groins at Cottonwood Island; trawling was done slightly west or southwest of the river ends of the dikes and groins. Mesh size in the body of the trawl was 32 mm (stretched); a 10-mm mesh liner was inserted in the cod end. Also, 10-mm knotless mesh was inserted in the wings and throat of the trawl. Trawl efforts were normally 5 minutes in duration in an upstream direction. Trawling began when the trawl and the proper amount of cable were deployed, and the effort was considered complete after 5 minutes. The distance the net fished was estimated during each sampling effort using a radar range-finder. Using the distance fished during trawling and the estimated fishing width of the net (3.3 m), the area fished for each effort was calculated. The fish densities (by species) for each effort were calculated and expressed as number/hectare (ha) (10,000 m^2). The two community structure indices calculated for benthic invertebrates were also calculated for each trawling effort.

RESULTS

Benthic Invertebrates

Benthic invertebrate densities (total) off Cottonwood Island varied both spatially and temporally (Table 1; Appendix Table 2). Overall, the highest mean densities occurred during Survey 3 (21 July 1988), with densities ranging from 3,780 to 6,506

Table 1.--Summary of benthic invertebrate collections off Cottonwood Island, Columbia River, 1987-1988; five replicates were collected at each station. A mean depth (m) and standard deviation are shown for each station; depths at an individual station varied among surveys.

Station (Depth)	Survey 1 (7-9 Jul 87) Mean no./m^2	SD	Survey 2 (19 Nov 87) Mean no./m^2	SD	Survey 3 (21 Jul 88) Mean no./m^2	SD	Survey 4 (6-7 Dec 88) Mean no./m^2	SD
CW11 (3±1)	1,707	2,435	970	469	5,450	2,495	2,407	3,052
CW21 (12±2)	3,135	339	1,418	663	5,569	2,618	817	376
CW12 (4±2)	3,217	718	50	52	6,506	1,978	1,514	1,123
CW22 (12±3)	3,583	2,084	1,989	1,047	3,780	1,372	3,545	4,213
CW13 (4±1)	1,149	228	3,719	3,336	3,980	1,844	924	132
CW23 (11±2)	876	503	4,206	3,924	4,108	1,033	666	600

invertebrates/m^2. Within each year, invertebrates tended to be more abundant during July as compared to November and December; numbers were not significantly different for the first year (July vs November), but were significantly different ($P < 0.05$) for the second year (July vs December) (Table 2). Benthic invertebrate numbers were significantly higher in July 1988 (post-groin construction) than in July 1987 (pre-groin construction); however, there was no significant difference in invertebrate numbers between November 1987 (pre-groin construction) and December 1988 (post-groin construction). For the purposes of this study, the most important comparisons are for corresponding time periods of the two years, since even undisturbed benthic invertebrate populations fluctuate seasonally.

Diversity (H′) was higher in July 1988 (mean 1.69) than in July 1987 (mean 1.32), and Evenness (J′) values were similar for July 1987 and July 1988 (means 0.46 and 0.42, respectively). The primary reason for the higher diversity in July 1988 was the increase in the number of taxa, since the distribution among individual species abundances (Evenness) was similar in both years. In July 1988, the mean number of taxa collected at each station was 16, whereas in July 1987, the mean number of taxa at each station was 8. Both Diversity (H′) and Evenness (J′) were higher in December 1988 (means 1.78 and 0.52, respectively) than in November 1987 (means 1.00 and 0.38, respectively). There were two reasons for the higher diversity in December 1988--greater evenness among

Table 2.--Comparisons of benthic invertebrate numbers (by specific taxa and total) for the four surveys off Cottonwood Island, Columbia River; total includes all invertebrates, not just the dominant taxa listed below. T-test values are shown in the table; P values are shown in parentheses. The four surveys were on 7-9 July 1987, 19 November 1987, 21 July 1988, and 6-7 December 1988, respectively. Surveys 1 and 2 were prior to rock-groin construction, and Surveys 3 and 4 were after the construction.

Taxon	Survey comparisons			
	1 vs 2	3 vs 4	1 vs 3	2 vs 4
Corophium salmonis	0.52 (0.62)	3.72 (0.01)	-2.86 (0.03)	1.25 (0.24)
Corbicula manilensis	-1.03 (0.35)	-0.89 (0.41)	-3.69 (0.00)	-0.97 (0.36)
Heleidae larvae	3.78 (0.01)	7.42 (0.00)	-3.23 (0.02)	-1.16 (0.29)
Oligochaeta	1.08 (0.31)	1.27 (0.24)	-3.16 (0.01)	-2.33 (0.04)
Total	0.79 (0.46)	4.42 (0.00)	-3.38 (0.02)	-0.26 (0.81)

the species as evidenced by the higher J′ in 1988 and an increase in the number of taxa in 1988. In December 1988, the mean number of taxa collected at each station was 11, whereas in November 1987, the mean number of taxa at each station was 7.

The tube-dwelling amphipod Corophium salmonis was by far the dominant benthic invertebrate collected at the Cottonwood Island sites; mean densities ranged from 27 to 3,912/m^2, with densities frequently exceeding 1,600/m^2 (Table 3; Appendix Table 2). Other important taxa included the bivalve Corbicula manilensis, Heleidae larvae, and Oligochaeta. Corophium salmonis numbers were significantly higher in July 1988 as compared to December 1988 ($P < 0.05$), yet numbers in 1987 were not significantly different between July and November (Table 2). Numbers of C. salmonis were significantly higher in July 1988 (post-groin construction) than in July 1987 (pre-groin construction); whereas numbers during the November 1987 (pre-groin construction) and December 1988 (post-groin construction) surveys were not significantly different. Numbers of Corbicula manilensis, Heleidae larvae, and Oligochaeta were significantly higher in July 1988 than in July 1987 (Table 2). Comparing November 1987 and December 1988, numbers of Oligochaeta were significantly higher in 1988.

Sediment Characteristics

Sand was the predominant sediment type at the Cottonwood Island sampling stations; however, gravel was important at some stations (Table 4; Appendix Table 3). Organic content was less

Table 3.--Mean densities (number/m^2) of four dominant benthic invertebrate taxa found off Cottonwood Island, Columbia River. The four surveys were on 7-9 July 1987, 19 November 1987, 21 July 1988, and 6-7 December 1988, respectively.

Station	Taxon	Survey 1	Survey 2	Survey 3	Survey 4
CW11	*Corophium salmonis*	1,094	544	3,912	2,079
	Corbicula manilensis	27	120	71	92
	Heleidae larvae	479	231	903	61
	Oligochaeta	32	57	225	105
CW21	*Corophium salmonis*	1,774	1,042	3,387	132
	Corbicula manilensis	29	237	128	464
	Heleidae larvae	691	38	867	136
	Oligochaeta	132	8	67	36
CW12	*Corophium salmonis*	2,230	44	3,805	861
	Corbicula manilensis	34	2	61	97
	Heleidae larvae	735	0	985	105
	Oligochaeta	202	4	1,504	321
CW22	*Corophium salmonis*	2,690	1,638	2,113	27
	Corbicula manilensis	86	44	281	2,337
	Heleidae larvae	716	67	802	336
	Oligochaeta	38	237	472	682
CW13	*Corophium salmonis*	794	3,370	2,480	357
	Corbicula manilensis	15	164	80	31
	Heleidae larvae	279	160	777	223
	Oligochaeta	57	21	445	265
CW23	*Corophium salmonis*	500	3,547	2,369	242
	Corbicula manilensis	36	422	139	187
	Heleidae larvae	321	132	1,176	80
	Oligochaeta	17	34	275	52

Table 4.--Summary of percent sediment composition at six sampling stations off Cottonwood Island, Columbia River. The four surveys were on 7-9 July 1987, 19 November 1987, 21 July 1988, and 6-7 December 1988, respectively. A mean depth and standard deviation are shown for each station; depths at an individual station varied among surveys.

	Survey 1			Survey 2			Survey 3			Survey 4		
Station (Depth, m)	Gr.[a]	Sd.[b]	Fn.[c]	Gr.	Sd.	Fn.	Gr.	Sd.	Fn.	Gr.	Sd.	Fn.
CW11 (3±1)	32	68	0	33	66	1	28	71	1	29	70	1
CW21 (12±2)	53	47	0	57	41	2	44	56	0	31	67	2
CW12 (4±2)	17	82	1	6	94	0	9	91	0	10	89	1
CW22 (12±3)	3	96	1	13	86	1	11	88	1	10	90	<1
CW13 (4±1)	2	98	0	10	90	0	4	96	0	5	95	<1
CW23 (11±2)	33	67	0	59	41	0	47	53	0	69	31	0

[a] Gr. = gravel; grain size ≥2 mm to <64 mm.
[b] Sd. = sand; grain size 0.0625 to <2 mm.
[c] Fn. = fines; grain size <0.0625 mm.

than 1% at all stations during all four surveys. The proportions of gravel, sand, and fines at the three shallower stations (CW11, CW12, and CW13) generally did not change dramatically from survey to survey. At two of the deeper stations (CW21 and CW23), changes in proportions of gravel and sand between surveys were more pronounced than at the shallower stations.

Demersal Fishes

Densities of demersal fishes off Cottonwood Island were relatively low; total densities ranged from 10 to 176 fishes/ha (Table 5; Appendix Table 4). Fishes collected during the surveys included white sturgeon, peamouth (*Mylocheilus caurinus*), northern squawfish (*Ptychocheilus oregonensis*), largescale sucker (*Catostomus macrocheilus*), sand roller (*Percopsis transmontana*), prickly sculpin (*Cottus asper*), unidentified Cottidae, and starry flounder (*Platichthys stellatus*). The mean fish density for July 1988 (mean 130 fish/ha) was somewhat higher than the density for July 1987 (mean 100 fish/ha), and densities for November 1987 (mean 28 fish/ha) and December 1988 (mean 29 fish/ha) were similar. Apparently, juvenile white sturgeon were not utilizing the area to any great degree during the times that we sampled, since only two juvenile sturgeon were collected during the four surveys.

DISCUSSION

Overall, the installation of rock groins along Cottonwood Island did not appear to adversely affect the benthic invertebrate

Table 5.--Catch summaries for fishes collected with a 4.9-m bottom trawl off Cottonwood Island, Columbia River, 1987-1988. There was one trawling effort at each station during each survey.

Station (depth, m)	Total no. captured	No./ha, total	Taxa captured (no./ha)
		Survey 1 (7-9 Jul 1987)	
CW21 (17)	5	48	Prickly sculpin (10), Cottidae (38)
CW22 (17)	7	76	Cottidae (76)
CW23 (15)	14	176	White sturgeon (13), prickly sculpin (50), Cottidae (113)
		Survey 2 (19 Nov 1987)	
CW21 (18)	3	33	Northern squawfish (11), peamouth (11), starry flounder (11)
CW22 (17)	2	20	White sturgeon (10), peamouth (10)
CW23 (16)	3	30	Peamouth (20), starry flounder (10)
		Survey 3 (21 Jul 1988)	
CW21 (16)	9	99	Sand roller (55), prickly sculpin (11), Cottidae (33)
CW22 (17)	17	163	Sand roller (19), largescale sucker (19), prickly sculpin (10), Cottidae (115)
CW23 (15)	14	128	Prickly sculpin (46), Cottidae (82)
		Survey 4 (6-7 Dec 1988)	
CW21 (16)	3	27	Peamouth (18), Cottidae (9)
CW22 (16)	1	10	Prickly sculpin (10)
CW23 (14)	5	51	Prickly sculpin (41), peamouth (10)

community, at least in the short-term. Because of natural fluctuations in benthic invertebrate populations, variables other than the groin construction, and the short-term sampling, one should be cautious in attributing any specific observations to groin construction. Ideally, the benthos off Cottonwood Island should have been sampled for several years prior to and several years after the construction of the rock groins to accurately assess the effects of construction.

The area along Cottonwood Island (RM 68 to 71) is an important habitat for C. salmonis, as evidenced by the relatively high densities. Corophium salmonis is a common benthic invertebrate in the lower Columbia River (McCabe et al. 1989), yet its densities are often much lower than the densities reported off Cottonwood Island. Mean densities of C. salmonis at subtidal sampling stations between RMs 75 and 79 did not exceed 360/m^2 during two surveys, April and September 1988 (McCabe et al. 1989). Corophium salmonis is particularly important in the lower Columbia River and its estuary as food for a variety of fishes, including juvenile Pacific salmon (Oncorhynchus spp.) and juvenile white sturgeon (McCabe et al. 1983; Kirn et al. 1986; Muir et al. 1988).

Results from the November 1987 and December 1988 trawling surveys near Cottonwood Island were consistent with trawling by NMFS in the same general area in November 1989 (unpublished data). Fish densities in 1989 were relatively low, averaging 34 fish/ha (range 11 to 69 fish/ha); during the 1987-1988 fall surveys,

densities were also low, averaging 28 fish/ha (range 20 to 33 fish/ha) and 29 fish/ha (range 10 to 51 fish/ha), respectively. A 7.9-m semiballoon trawl was used in 1989 instead of the 4.9-m semiballoon trawl used in 1987 and 1988. Seven juvenile white sturgeon were collected in three trawling efforts in 1989, compared to the two captured during the four surveys in 1987 and 1988. Four of the sturgeon collected in 1989 were young-of-the-year; one young-of-the-year sturgeon was collected in November 1987. It should be noted that all NMFS trawling was done during the day. Fish numbers during darkness could be considerably different than during the day.

It appears from NMFS sampling that the installation of rock groins along Cottonwood Island did not adversely affect the benthic invertebrate and demersal fish communities. This sampling addressed only short-term effects of rock-groin construction on the benthic invertebrate and demersal fish communities. Additional sampling over a period of several years would be needed to determine long-term changes. Also, this study should be viewed as a site-specific study. Construction of rock groins at other locations in the Columbia River should be considered and studied on a site-specific basis.

This report does not constitute NMFS' 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.--Locations of benthic and bottom trawling stations off Cottonwood Island, Columbia River, 1987-1988.

	Benthic stations	
Station	Latitude	Longitude
CW11	46° 05' 28''N.	122° 54' 59''W.
CW21	46° 05' 26''N.	122° 55' 00''W.
CW12	46° 04' 51''N.	122° 53' 45''W.
CW22	46° 04' 50''N.	122° 53' 48''W.
CW13	46° 04' 06''N.	122° 53' 04''W.
CW23	46° 04' 05''N.	122° 53' 06''W.

	Trawl stations	
Station	Latitude	Longitude
CW21	46° 05' 26''N.	122° 55' 00''W.
CW22	46° 04' 50''N.	122° 53' 48''W.
CW23	46° 04' 05''N.	122° 53' 06''W.

Appendix Table 2.--Summaries of benthic invertebrate collections off Cottonwood Island, Columbia River, 1987-1988. Two community structure indices -- H' and J' -- were calculated for each station; see Methods for descriptions of indices.

Station: CW11 Date: 7 Jul 87 Sample size: 5
Depth: 3.4 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	15	60.0	31.5	38.6
Corbicula manilensis	13	80.0	27.3	19.0
Ostracoda	1	20.0	2.1	4.7
Corophium salmonis	521	100.0	1,094.1	1,850.0
Cladocera	2	20.0	4.2	9.4
Bosmina sp.	5	20.0	10.5	23.5
Daphnia sp.	2	20.0	4.2	9.4
Calanoida	16	60.0	33.6	52.7
Cyclopoida	6	40.0	12.6	18.8
Harpacticoida	1	20.0	2.1	4.7
Chironomidae pupae	3	20.0	6.3	14.0
Heleidae larvae	228	100.0	478.8	413.5

Number of taxa: 12

Mean number/sample: 162.6 Standard deviation (SD): 231.9

Mean number/m²: 1,707.3 SD/m²: 2,434.6

H' = 1.43 J' = 0.40

Appendix Table 2.--Continued.

Station: CW21 Date: 7 Jul 87 Sample size: 5
Depth: 8.5 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	63	100.0	132.3	86.5
Corbicula manilensis	14	100.0	29.4	8.8
Ostracoda	2	40.0	4.2	5.8
Corophium salmonis	845	80.0	1,774.5	1,025.4
Isopoda	236	20.0	495.6	1,108.2
Chironomidae pupae	4	60.0	8.4	8.8
Heleidae larvae	329	100.0	690.9	131.0

Number of taxa: 7

Mean number/sample: 298.6 Standard deviation (SD): 32.3

Mean number/m²: 3,135.3 SD/m²: 339.2

H' = 1.66 J' = 0.59

Appendix Table 2.--Continued.

Station: CW12 Date: 9 Jul 87 Sample size: 5
Depth: 5.8 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Neanthes limnicola	1	20.0	2.1	4.7
Oligochaeta	96	100.0	201.6	96.6
Corbicula manilensis	16	100.0	33.6	15.6
Ostracoda	1	20.0	2.1	4.7
Eogammarus confervicolus	1	20.0	2.1	4.7
Corophium salmonis	1,062	100.0	2,230.2	391.9
Chironomidae larvae	2	20.0	4.2	9.4
Chironomidae pupae	3	40.0	6.3	9.4
Heleidae larvae	350	100.0	735.0	258.4

Number of taxa: 9

Mean number/sample: 306.4 Standard deviation (SD): 68.4

Mean number/m²: 3,217.2 SD/m²: 718.0

H' = 1.22 J' = 0.39

Appendix Table 2.--Continued.

Station: CW22 Date: 9 Jul 87 Sample size: 5
Depth: 9.8 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematoda	1	20.0	2.1	4.7
Oligochaeta	18	40.0	37.8	59.7
Corbicula manilensis	41	100.0	86.1	51.1
Ostracoda	6	60.0	12.6	17.2
Corophium salmonis	1,281	100.0	2,690.1	1,590.4
Cladocera	5	40.0	10.5	18.2
Bosmina sp.	1	20.0	2.1	4.7
Daphnia sp.	5	60.0	10.5	10.5
Calanoida	3	40.0	6.3	9.4
Chironomidae larvae	1	20.0	2.1	4.7
Chironomidae pupae	3	40.0	6.3	9.4
Heleidae larvae	341	100.0	716.1	488.0

Number of taxa: 12

Mean number/sample: 341.2 Standard deviation (SD): 198.4

Mean number/m²: 3,582.6 SD/m²: 2,083.6

H' = 1.10 J' = 0.31

Appendix Table 2.--Continued.

Station: CW13 Date: 9 Jul 87 Sample size: 5
Depth: 4.0 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	27	100.0	56.7	52.3
Corbicula manilensis	7	60.0	14.7	15.9
Corophium salmonis	378	100.0	793.8	181.0
Chironomidae pupae	2	40.0	4.2	5.8
Heleidae larvae	133	100.0	279.3	113.2

Number of taxa: 5

Mean number/sample: 109.4 Standard deviation (SD): 21.8

Mean number/m²: 1,148.7 SD/m²: 228.4

H' = 1.19 J' = 0.51

Appendix Table 2.--Continued.

Station: CW23 Date: 9 Jul 87 Sample size: 5
Depth: 10.4 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	8	40.0	16.8	27.4
Corbicula manilensis	17	100.0	35.7	17.6
Corophium salmonis	238	100.0	499.8	332.8
Chironomidae larvae	1	20.0	2.1	4.7
Heleidae larvae	153	80.0	321.3	283.5

Number of taxa: 5

Mean number/sample: 83.4 Standard deviation (SD): 47.9

Mean number/m²: 875.7 SD/m²: 503.0

H' = 1.31 J' = 0.56

Appendix Table 2.--Continued.

Station: CW11 Date: 19 Nov 87 Sample size: 5
Depth: 2.4 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Hydra sp.	1	20.0	2.1	4.7
Oligochaeta	27	80.0	56.7	48.5
Corbicula manilensis	57	100.0	119.7	99.0
Corophium salmonis	259	100.0	543.9	284.3
Cladocera	6	20.0	12.6	28.2
Bosmina sp.	1	20.0	2.1	4.7
Calanoida	1	20.0	2.1	4.7
Heleidae larvae	110	80.0	231.0	440.8

Number of taxa: 8

Mean number/sample: 92.4 Standard deviation (SD): 44.7

Mean number/m²: 970.2 SD/m²: 469.4

H' = 1.71 J' = 0.57

Appendix Table 2.--Continued.

Station: CW21 Date: 19 Nov 87 Sample size: 5
Depth: 12.8 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Hydra sp.	1	20.0	2.1	4.7
Oligochaeta	4	60.0	8.4	8.8
Corbicula manilensis	113	100.0	237.3	163.6
Eogammarus confervicolus	2	20.0	4.2	9.4
Corophium salmonis	496	100.0	1,041.6	492.3
Corophium spinicorne	38	60.0	79.8	107.2
Heleidae larvae	18	60.0	37.8	67.5
Ephemeroptera	3	20.0	6.3	14.1

Number of taxa: 8

Mean number/sample: 135.0 Standard deviation (SD): 63.1

Mean number/m²: 1,417.5 SD/m²: 663.0

H' = 1.25 J' = 0.42

Appendix Table 2.-- Continued.

Station: CW12 Date: 19 Nov 87 Sample size: 5
Depth: 1.5 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	2	40.0	4.2	5.8
Corbicula manilensis	1	20.0	2.1	4.7
Corophium salmonis	21	100.0	44.1	53.2

Number of taxa: 3

Mean number/sample: 4.8 Standard deviation (SD): 5.0

Mean number/m²: 50.4 SD/m²: 52.2

H' = 0.66 J' = 0.42

Appendix Table 2.--Continued.

Station: CW22 Date: 19 Nov 87 Sample size: 5
Depth: 7.9 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	113	100.0	237.3	164.0
Corbicula manilensis	21	100.0	44.1	20.2
Eogammarus confervicolus	1	20.0	2.1	4.7
Corophium salmonis	780	100.0	1,638.0	1,247.8
Heleidae larvae	32	100.0	67.2	58.7

Number of taxa: 5

Mean number/sample: 189.4 Standard deviation (SD): 99.7

Mean number/m²: 1,988.7 SD/m²: 1,047.2

H' = 0.89 J' = 0.38

Appendix Table 2.--Continued.

Station: CW13 Date: 19 Nov 87 Sample size: 5
Depth: 2.7 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	10	80.0	21.0	19.6
Corbicula manilensis	78	100.0	163.8	118.0
Corophium salmonis	1,605	100.0	3,370.5	3,115.3
Calanoida	1	20.0	2.1	4.7
Chironomidae larvae	1	20.0	2.1	4.7
Heleidae larvae	76	100.0	159.6	170.8

Number of taxa: 6

Mean number/sample: 354.2 Standard deviation (SD): 317.7

Mean number/m²: 3,719.1 SD/m²: 3,336.2

H' = 0.58 J' = 0.22

Appendix Table 2.--Continued.

Station: CW23 Date: 19 Nov 87 Sample size: 5
Depth: 9.1 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Oligochaeta	16	80.0	33.6	29.1
Corbicula manilensis	201	100.0	422.1	164.9
Corophium salmonis	1,689	100.0	3,546.9	3,925.0
Corophium spinicorne	15	40.0	31.5	64.7
Isopoda	1	20.0	2.1	4.7
Bosmina sp.	2	40.0	4.2	5.8
Calanoida	2	40.0	4.2	5.8
Cyclopoida	1	20.0	2.1	4.7
Chironomidae larvae	12	40.0	25.2	37.6
Heleidae larvae	63	80.0	132.3	162.9
Homoptera	1	20.0	2.1	4.7

Number of taxa: 11

Mean number/sample: 400.6 Standard deviation (SD): 373.7

Mean number/m²: 4,206.3 SD/m²: 3,924.0

H' = 0.89 J' = 0.26

Appendix Table 2.--Continued.

Station: CW11 Date: 21 Jul 88 Sample size: 5
Depth: 4.9 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	2	20.0	4.2	9.4
Nematomorpha	13	100.0	27.3	12.0
Turbellaria	6	40.0	12.6	22.8
Neanthes limnicola	5	40.0	10.5	18.2
Oligochaeta	107	100.0	224.7	118.2
Corbicula manilensis	34	100.0	71.4	38.9
Ostracoda	40	100.0	84.0	59.9
Neomysis mercedis	1	20.0	2.1	4.7
Corophium salmonis	1,863	100.0	3,912.3	1,830.6
Corophium spinicorne	7	60.0	14.7	21.8
Daphnia sp.	8	80.0	16.8	20.5
Cyclopoida	11	80.0	23.1	17.2
Diptera adults	1	20.0	2.1	4.7
Chironomidae larvae	10	60.0	21.0	22.3
Chironomidae pupae	50	100.0	105.0	53.5
Heleidae larvae	430	100.0	903.0	504.7
Odonata	2	40.0	4.2	5.8
Ephemeroptera	1	20.0	2.1	4.7
Hydracarina	4	40.0	8.4	11.5

Number of taxa: 19

Mean number/sample: 519.0 Standard deviation (SD): 237.6

Mean number/m²: 5,449.5 SD/m²: 2,495.2

H' = 1.48 J' = 0.35

Appendix Table 2.--Continued.

Station: CW21 Date: 21 Jul 88 Sample size: 5
Depth: 13.4 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Turbellaria	3	40.0	6.3	9.4
Oligochaeta	32	80.0	67.2	50.7
Corbicula manilensis	61	100.0	128.1	98.9
Ostracoda	4	60.0	8.4	8.8
Corophium spp.	65	40.0	136.5	195.0
Corophium salmonis	1,613	100.0	3,387.3	1,401.4
Corophium spinicorne	371	80.0	779.1	1,649.0
Ramellogammarus oregonensis	18	40.0	37.8	78.8
Daphnia sp.	29	60.0	60.9	71.4
Cyclopoida	6	40.0	12.6	17.2
Diptera adults	3	40.0	6.3	9.4
Chironomidae larvae	6	40.0	12.6	17.2
Chironomidae pupae	28	100.0	58.8	44.3
Heleidae larvae	413	100.0	867.3	291.7

Number of taxa: 14

Mean number/sample: 530.4 Standard deviation (SD): 249.3

Mean number/m²: 5,569.2 SD/m²: 2,617.9

H' = 1.85 J' = 0.49

Appendix Table 2.--Continued.

Station: CW12 Date: 21 Jul 88 Sample size: 5
Depth: 3.7 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	1	20.0	2.1	4.7
Nematomorpha	5	60.0	10.5	12.9
Turbellaria	2	20.0	4.2	9.4
Neanthes limnicola	4	20.0	8.4	18.8
Oligochaeta	716	100.0	1,503.6	1,044.3
Corbicula manilensis	29	100.0	60.9	31.8
Ostracoda	1	20.0	2.1	4.7
Neomysis mercedis	1	20.0	2.1	4.7
Corophium salmonis	1,812	100.0	3,805.2	1,221.1
Corophium spinicorne	3	20.0	6.3	14.1
Daphnia sp.	9	60.0	18.9	26.1
Cyclopoida	11	100.0	23.1	11.5
Diptera adults	4	40.0	8.4	13.7
Chironomidae larvae	8	80.0	16.8	15.9
Chironomidae pupae	22	100.0	46.2	19.1
Heleidae larvae	469	100.0	984.9	201.9
Hydracarina	1	20.0	2.1	4.7

Number of taxa: 17

Mean number/sample: 619.6 Standard deviation (SD): 188.4

Mean number/m²: 6,505.8 SD/m²: 1,978.2

H' = 1.61 J' = 0.39

Appendix Table 2.--Continued.

Station: CW22 Date: 21 Jul 88 Sample size: 5
Depth: 14.0 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	3	40.0	6.3	9.4
Turbellaria	7	60.0	14.7	14.1
Oligochaeta	225	100.0	472.5	283.2
Corbicula manilensis	134	100.0	281.4	151.3
Ostracoda	1	20.0	2.1	4.7
Corophium spp.	5	20.0	10.5	23.5
Corophium salmonis	1,006	100.0	2,112.6	890.7
Corophium spinicorne	2	40.0	4.2	5.8
Daphnia sp.	5	40.0	10.5	14.8
Cyclopoida	8	60.0	16.8	21.8
Diptera adults	1	20.0	2.1	4.7
Chironomidae larvae	8	100.0	16.8	5.8
Chironomidae pupae	11	60.0	23.1	28.2
Heleidae larvae	382	100.0	802.2	323.3
Arachnida	2	40.0	4.2	5.8

Number of taxa: 15

Mean number/sample: 360.0 Standard deviation (SD): 130.7

Mean number/m²: 3,780.0 SD/m²: 1,372.0

H' = 1.84 J' = 0.47

Appendix Table 2.--Continued.

Station: CW13 Date: 21 Jul 88 Sample size: 5
Depth: 4.0 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	4	40.0	8.4	13.7
Neanthes limnicola	1	20.0	2.1	4.7
Oligochaeta	212	100.0	445.2	479.2
Corbicula manilensis	38	100.0	79.8	26.4
Corophium salmonis	1,181	100.0	2,480.1	1,115.0
Corophium spinicorne	7	80.0	14.7	15.9
Daphnia sp.	4	60.0	8.4	8.8
Cyclopoida	3	60.0	6.3	5.8
Diptera adults	2	40.0	4.2	5.8
Chironomidae larvae	64	60.0	134.4	209.7
Chironomidae pupae	7	60.0	14.7	21.8
Heleidae larvae	370	80.0	777.0	505.9
Odonata	1	20.0	2.1	4.7
Ephemeroptera	1	20.0	2.1	4.7

Number of taxa: 14

Mean number/sample: 379.0 Standard deviation (SD): 175.6

Mean number/m²: 3,979.5 SD/m²: 1,843.7

H' = 1.66 J' = 0.44

Appendix Table 2.--Continued.

Station: CW23 Date: 21 Jul 88 Sample size: 5
Depth: 12.8 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nematomorpha	14	100.0	29.4	26.1
Oligochaeta	131	100.0	275.1	221.2
Corbicula manilensis	66	80.0	138.6	98.9
Amphipoda (Gammaridae)	1	20.0	2.1	4.7
Corophium spp.	11	60.0	23.1	23.9
Corophium salmonis	1,128	100.0	2,368.8	726.6
Corophium spinicorne	10	80.0	21.0	24.6
Ramellogammarus sp.	1	20.0	2.1	4.7
Daphnia sp.	9	80.0	18.9	11.5
Cyclopoida	5	60.0	10.5	12.9
Tipulidae larva	1	20.0	2.1	4.7
Chironomidae larvae	6	80.0	12.6	11.5
Chironomidae pupae	9	100.0	18.9	8.8
Heleidae larvae	560	100.0	1,176.0	193.2
Homoptera	2	40.0	4.2	5.8
Collembola	1	20.0	2.1	4.7
Arachnida	1	20.0	2.1	4.7

Number of taxa: 17

Mean number/sample: 391.2 Standard deviation (SD): 98.4

Mean number/m²: 4,107.6 SD/m²: 1,032.6

H' = 1.69 J' = 0.41

Appendix Table 2.--Continued.

Station: CW11 Date: 6 Dec 88 Sample size: 5
Depth: 1.8 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	4	60.0	8.4	8.8
Hydra sp.	3	40.0	6.3	9.4
Turbellaria	6	40.0	12.6	18.8
Oligochaeta	50	100.0	105.0	77.9
Corbicula manilensis	44	100.0	92.4	120.0
Ostracoda	2	40.0	4.2	5.8
Corophium spp.	8	60.0	16.8	21.8
Corophium salmonis	990	100.0	2,079.0	2,849.6
Corophium spinicorne	3	20.0	6.3	14.1
Ramellogammarus oregonensis	3	20.0	6.3	14.1
Cyclopoida	1	20.0	2.1	4.7
Diptera larvae	1	20.0	2.1	4.7
Chironomidae larvae	2	20.0	4.2	9.4
Heleidae larvae	29	80.0	60.9	75.9

Number of taxa: 14

Mean number/sample: 229.2 Standard deviation (SD): 290.7

Mean number/m²: 2,406.6 SD/m²: 3,052.0

H' = 0.93 J' = 0.24

Appendix Table 2.--Continued.

Station: CW21 Date: 6 Dec 88 Sample size: 5
Depth: 13.4 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	15	100.0	31.5	47.0
Nematomorpha	2	40.0	4.2	5.8
Turbellaria	2	20.0	4.2	9.4
Oligochaeta	17	100.0	35.7	17.6
Corbicula manilensis	221	100.0	464.1	339.4
Corophium spp.	2	40.0	4.2	5.8
Corophium salmonis	63	100.0	132.3	85.8
Corophium spinicorne	2	40.0	4.2	5.8
Heleidae larvae	65	100.0	136.5	85.6

Number of taxa: 9

Mean number/sample: 77.8 Standard deviation (SD): 35.9

Mean number/m²: 816.9 SD/m²: 376.5

H' = 1.85 J' = 0.59

Appendix Table 2.--Continued.

Station: CW12 Date: 7 Dec 88 Sample size: 5
Depth: 4.3 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	33	100.0	69.3	59.7
Nematomorpha	3	60.0	6.3	5.8
Hydra sp.	1	20.0	2.1	4.7
Turbellaria	19	100.0	39.9	42.9
Oligochaeta	153	100.0	321.3	158.8
Corbicula manilensis	46	100.0	96.6	59.1
Corophium spp.	1	20.0	2.1	4.7
Corophium salmonis	410	100.0	861.0	1,004.7
Corophium spinicorne	2	20.0	4.2	9.4
Chironomidae larvae	3	40.0	6.3	9.4
Heleidae larvae	50	100.0	105.0	107.8

Number of taxa: 11

Mean number/sample: 144.2 Standard deviation (SD): 106.9

Mean number/m²: 1,514.1 SD/m²: 1,122.6

H' = 1.92 J' = 0.55

Appendix Table 2.--Continued.

Station: CW22 Date: 7 Dec 88 Sample size: 5
Depth: 15.2 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	25	100.0	52.5	47.5
Nematomorpha	1	20.0	2.1	4.7
Hydra sp.	3	60.0	6.3	5.8
Turbellaria	45	100.0	94.5	45.8
Oligochaeta	325	100.0	682.5	580.8
Corbicula manilensis	1,113	100.0	2,337.3	4,358.2
Corophium salmonis	13	60.0	27.3	44.3
Corophium spinicorne	1	20.0	2.1	4.7
Chironomidae larvae	1	20.0	2.1	4.7
Heleidae larvae	160	100.0	336.0	435.7
Ephemeroptera	1	20.0	2.1	4.7

Number of taxa: 11

Mean number/sample: 337.6 Standard deviation (SD): 401.2

Mean number/m²: 3,544.8 SD/m²: 4,213.2

H' = 1.50 J' = 0.43

Appendix Table 2.--Continued.

Station: CW13 Date: 7 Dec 88 Sample size: 5
Depth: 4.3 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	10	80.0	21.0	19.6
Nematomorpha	1	20.0	2.1	4.7
Turbellaria	10	80.0	21.0	19.6
Oligochaeta	126	100.0	264.6	92.3
Corbicula manilensis	15	100.0	31.5	19.6
Corophium salmonis	170	100.0	357.0	109.6
Cyclopoida	1	20.0	2.1	4.7
Heleidae larvae	106	100.0	222.6	110.2
Lamprey	1	20.0	2.1	4.7

Number of taxa: 9

Mean number/sample: 88.0 Standard deviation (SD): 12.6

Mean number/m²: 924.0 SD/m²: 131.8

H' = 2.02 J' = 0.64

Appendix Table 2.--Continued.

Station: CW23 Date: 7 Dec 88 Sample size: 5
Depth: 13.1 m

Taxon	Total number	Frequency of occurrence (%)	Mean number /m²	Standard deviation /m²
Nemertea	15	60.0	31.5	44.6
Hydra sp.	2	20.0	4.2	9.4
Turbellaria	10	20.0	21.0	47.0
Oligochaeta	25	80.0	52.5	94.2
Corbicula manilensis	89	100.0	186.9	164.6
Corophium spp.	1	20.0	2.1	4.7
Corophium salmonis	115	100.0	241.5	232.4
Corophium spinicorne	16	60.0	33.6	45.4
Ramellogammarus oregonensis	2	20.0	4.2	9.4
Chironomidae larvae	1	20.0	2.1	4.7
Heleidae larvae	38	80.0	79.8	114.2
Ephemeroptera	1	20.0	2.1	4.7

Number of taxa: 12

Mean number/sample: 63.4 Standard deviation (SD): 57.1

Mean number/m²: 665.7 SD/m²: 599.8

H' = 2.45 J' = 0.68

Appendix Table 3.--Summaries of sediment characteristics off Cottonwood Island, Columbia River, 1987-1988.

System : Columbia River
Project: Cottonwood Island
Station: CW11

Date : 7 Jul 1987
Depth : 3.4 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	99.0	1.0	
8 mm	5/16 in	-3	97.0	2.0	3.0 % Medium gravel
4 mm	No. 5	-2	87.0	10.0	
2 mm	10	-1	68.0	19.0	29.0 % Fine gravel
1 mm	18	0	50.0	18.0	
0.5 mm	35	1	33.0	17.0	35.0 % Coarse sand
0.25 mm	60	2	16.0	17.0	17.0 % Medium sand
0.125 mm	120	3	4.0	12.0	
0.0625 mm	230	4	0.0	4.0	16.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 32.0 %
Sand = 68.0 %
Fines = 0.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW11

Date : 19 Nov 1987
Depth : 2.4 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	98.0	2.0	2.0 % Medium gravel
4 mm	No. 5	-2	85.0	13.0	
2 mm	10	-1	67.0	18.0	31.0 % Fine gravel
1 mm	18	0	51.0	16.0	
0.5 mm	35	1	36.0	15.0	31.0 % Coarse sand
0.25 mm	60	2	16.0	20.0	20.0 % Medium sand
0.125 mm	120	3	4.0	12.0	
0.0625 mm	230	4	1.0	3.0	15.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 33.0 %
Sand = 66.0 %
Fines = 1.0 %

0.3 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW11

Date : 21 Jul 1988
Depth : 4.9 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	96.0	4.0	
8 mm	5/16 in	-3	93.0	3.0	7.0 % Medium gravel
4 mm	No. 5	-2	84.0	9.0	
2 mm	10	-1	72.0	12.0	21.0 % Fine gravel
1 mm	18	0	56.0	16.0	
0.5 mm	35	1	38.0	18.0	34.0 % Coarse sand
0.25 mm	60	2	24.0	14.0	14.0 % Medium sand
0.125 mm	120	3	10.0	14.0	
0.0625 mm	230	4	1.0	9.0	23.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 28.0 %
Sand = 71.0 %
Fines = 1.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW11

Date : 6 Dec 1988
Depth : 1.8m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	99.0	1.0	
8 mm	5/16 in	-3	96.7	2.3	3.3 % Medium gravel
4 mm	No. 5	-2	84.8	11.9	
2 mm	10	-1	70.9	13.9	25.8 % Fine gravel
1 mm	18	0	61.4	9.5	
0.5 mm	35	1	51.3	10.1	19.6 % Coarse sand
0.25 mm	60	2	34.0	17.3	17.3 % Medium sand
0.125 mm	120	3	8.7	25.3	
0.0625 mm	230	4	1.3	7.4	32.7 % Fine sand
<.0625 mm	<230			1.3	1.3 % Silt/clay

Gravel = 29.1 %
Sand = 69.6 %
Fines = 1.3 %

0.6 % Organics

Appendix Table 3.--Continued.

System : Columbia River
Project: Cottonwood Island
Station: CW21

Date : 7 Jul 1987
Depth : 8.5 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	98.0	2.0	
8 mm	5/16 in	-3	93.0	5.0	7.0 % Medium gravel
4 mm	No. 5	-2	72.0	21.0	
2 mm	10	-1	47.0	25.0	46.0 % Fine gravel
1 mm	18	0	28.0	19.0	
0.5 mm	35	1	16.0	12.0	31.0 % Coarse sand
0.25 mm	60	2	8.0	8.0	8.0 % Medium sand
0.125 mm	120	3	1.0	7.0	
0.0625 mm	230	4	0.0	1.0	8.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 53.0 %
Sand = 47.0 %
Fines = 0.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW21

Date : 19 Nov 1987
Depth : 12.8 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	82.0	18.0	18.0 % Coarse gravel
16 mm	5/8 in	-4	71.0	11.0	
8 mm	5/16 in	-3	61.0	10.0	21.0 % Medium gravel
4 mm	No. 5	-2	52.0	9.0	
2 mm	10	-1	43.0	9.0	18.0 % Fine gravel
1 mm	18	0	33.0	10.0	
0.5 mm	35	1	26.0	7.0	17.0 % Coarse sand
0.25 mm	60	2	16.0	10.0	10.0 % Medium sand
0.125 mm	120	3	4.0	12.0	
0.0625 mm	230	4	2.0	2.0	14.0 % Fine sand
<.0625 mm	<230			2.0	2.0 % Silt/clay

Gravel = 57.0 %
Sand = 41.0 %
Fines = 2.0 %

0.4 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW21

Date : 21 Jul 1988
Depth : 13.4 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	92.0	8.0	8.0 % Coarse gravel
16 mm	5/8 in	-4	86.0	6.0	
8 mm	5/16 in	-3	74.0	12.0	18.0 % Medium gravel
4 mm	No. 5	-2	64.0	10.0	
2 mm	10	-1	56.0	8.0	18.0 % Fine gravel
1 mm	18	0	43.0	13.0	
0.5 mm	35	1	31.0	12.0	25.0 % Coarse sand
0.25 mm	60	2	16.0	15.0	15.0 % Medium sand
0.125 mm	120	3	1.0	15.0	
0.0625 mm	230	4	0.0	1.0	16.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 44.0 %
Sand = 56.0 %
Fines = 0.0 %

0.3 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW21

Date : 6 Dec 1988
Depth : 13.4 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	99.6	0.4	
8 mm	5/16 in	-3	99.1	0.5	0.9 % Medium gravel
4 mm	No. 5	-2	90.6	8.5	
2 mm	10	-1	69.3	21.3	29.8 % Fine gravel
1 mm	18	0	54.9	14.4	
0.5 mm	35	1	41.1	13.8	28.2 % Coarse sand
0.25 mm	60	2	14.2	26.9	26.9 % Medium sand
0.125 mm	120	3	6.5	7.7	
0.0625 mm	230	4	2.2	4.3	12.0 % Fine sand
<.0625 mm	<230			2.2	2.2 % Silt/clay

Gravel = 30.7 %
Sand = 67.1 %
Fines = 2.2 %

0.3 % Organics

Appendix Table 3.--Continued.

System : Columbia River
Project: Cottonwood Island
Station: CW12

Date : 9 Jul 1987
Depth : 5.8 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	99.0	1.0	1.0 % Medium gravel
4 mm	No. 5	-2	96.0	3.0	
2 mm	10	-1	83.0	13.0	16.0 % Fine gravel
1 mm	18	0	63.0	20.0	
0.5 mm	35	1	44.0	19.0	39.0 % Coarse sand
0.25 mm	60	2	22.0	22.0	22.0 % Medium sand
0.125 mm	120	3	10.0	12.0	
0.0625 mm	230	4	1.0	9.0	21.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 17.0 %
Sand = 82.0 %
Fines = 1.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW12

Date : 19 Nov 1987
Depth : 1.5 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	100.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	99.0	1.0	
2 mm	10	-1	94.0	5.0	6.0 % Fine gravel
1 mm	18	0	77.0	17.0	
0.5 mm	35	1	43.0	34.0	51.0 % Coarse sand
0.25 mm	60	2	11.0	32.0	32.0 % Medium sand
0.125 mm	120	3	2.0	9.0	
0.0625 mm	230	4	0.0	2.0	11.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 6.0 %
Sand = 94.0 %
Fines = 0.0 %

0.3 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW12

Date : 21 Jul 1988
Depth : 3.7 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	100.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	97.0	3.0	
2 mm	10	-1	91.0	6.0	9.0 % Fine gravel
1 mm	18	0	78.0	13.0	
0.5 mm	35	1	55.0	23.0	36.0 % Coarse sand
0.25 mm	60	2	1.0	54.0	54.0 % Medium sand
0.125 mm	120	3	0.0	1.0	
0.0625 mm	230	4	0.0	0.0	1.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 9.0 %
Sand = 91.0 %
Fines = 0.0 %

0.3 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW12

Date : 7 Dec 1988
Depth : 4.3 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	98.0	2.0	2.0 % Coarse gravel
16 mm	5/8 in	-4	98.0	0.0	
8 mm	5/16 in	-3	98.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	96.4	1.6	
2 mm	10	-1	90.1	6.3	7.9 % Fine gravel
1 mm	18	0	83.1	7.0	
0.5 mm	35	1	66.6	16.5	23.5 % Coarse sand
0.25 mm	60	2	50.3	16.3	16.3 % Medium sand
0.125 mm	120	3	6.6	43.7	
0.0625 mm	230	4	1.1	5.5	49.2 % Fine sand
<.0625 mm	<230			1.1	1.1 % Silt/clay

Gravel = 9.9 %
Sand = 89.0 %
Fines = 1.1 %

0.4 % Organics

Appendix Table 3.--Continued.

System : Columbia River
Project: Cottonwood Island
Station: CW22

Date : 9 Jul 1987
Depth : 9.8 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	99.0	1.0	
8 mm	5/16 in	-3	99.0	0.0	1.0 % Medium gravel
4 mm	No. 5	-2	98.0	1.0	
2 mm	10	-1	97.0	1.0	2.0 % Fine gravel
1 mm	18	0	91.0	6.0	
0.5 mm	35	1	78.0	13.0	19.0 % Coarse sand
0.25 mm	60	2	61.0	17.0	17.0 % Medium sand
0.125 mm	120	3	15.0	46.0	
0.0625 mm	230	4	1.0	14.0	60.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 3.0 %
Sand = 96.0 %
Fines = 1.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW22

Date : 19 Nov 1987
Depth : 7.9 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	100.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	97.0	3.0	
2 mm	10	-1	87.0	10.0	13.0 % Fine gravel
1 mm	18	0	72.0	15.0	
0.5 mm	35	1	45.0	27.0	42.0 % Coarse sand
0.25 mm	60	2	15.0	30.0	30.0 % Medium sand
0.125 mm	120	3	5.0	10.0	
0.0625 mm	230	4	1.0	4.0	14.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 13.0 %
Sand = 86.0 %
Fines = 1.0 %

0.4 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW22

Date : 21 Jul 1988
Depth : 14.0 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	99.0	1.0	1.0 % Medium gravel
4 mm	No. 5	-2	97.0	2.0	
2 mm	10	-1	89.0	8.0	10.0 % Fine gravel
1 mm	18	0	72.0	17.0	
0.5 mm	35	1	42.0	30.0	47.0 % Coarse sand
0.25 mm	60	2	16.0	26.0	26.0 % Medium sand
0.125 mm	120	3	3.0	13.0	
0.0625 mm	230	4	1.0	2.0	15.0 % Fine sand
<.0625 mm	<230			1.0	1.0 % Silt/clay

Gravel = 11.0 %
Sand = 88.0 %
Fines = 1.0 %

0.4 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW22

Date : 7 Dec 1988
Depth : 15.2 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	99.8	0.2	0.2 % Medium gravel
4 mm	No. 5	-2	98.6	1.2	
2 mm	10	-1	90.3	8.3	9.5 % Fine gravel
1 mm	18	0	70.9	19.4	
0.5 mm	35	1	46.1	24.8	44.2 % Coarse sand
0.25 mm	60	2	20.1	26.0	26.0 % Medium sand
0.125 mm	120	3	1.0	19.1	
0.0625 mm	230	4	0.2	0.8	19.9 % Fine sand
<.0625 mm	<230			0.2	0.2 % Silt/clay

Gravel = 9.7 %
Sand = 90.1 %
Fines = 0.2 %

0.3 % Organics

Appendix Table 3.--Continued.

System : Columbia River
Project: Cottonwood Island
Station: CW13

Date : 9 Jul 1987
Depth : 4.0 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	100.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	99.0	1.0	
2 mm	10	-1	98.0	1.0	2.0 % Fine gravel
1 mm	18	0	95.0	3.0	
0.5 mm	35	1	84.0	11.0	14.0 % Coarse sand
0.25 mm	60	2	37.0	47.0	47.0 % Medium sand
0.125 mm	120	3	2.0	35.0	
0.0625 mm	230	4	0.0	2.0	37.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 2.0 %
Sand = 98.0 %
Fines = 0.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW13

Date : 19 Nov 1987
Depth : 2.7 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	99.0	1.0	
8 mm	5/16 in	-3	98.0	1.0	2.0 % Medium gravel
4 mm	No. 5	-2	96.0	2.0	
2 mm	10	-1	90.0	6.0	8.0 % Fine gravel
1 mm	18	0	82.0	8.0	
0.5 mm	35	1	69.0	13.0	21.0 % Coarse sand
0.25 mm	60	2	30.0	39.0	39.0 % Medium sand
0.125 mm	120	3	2.0	28.0	
0.0625 mm	230	4	0.0	2.0	30.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 10.0 %
Sand = 90.0 %
Fines = 0.0 %

0.5 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW13

Date : 21 Jul 1988
Depth : 4.0 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	100.0	0.0	0.0 % Medium gravel
4 mm	No. 5	-2	99.0	1.0	
2 mm	10	-1	96.0	3.0	4.0 % Fine gravel
1 mm	18	0	89.0	7.0	
0.5 mm	35	1	65.0	24.0	31.0 % Coarse sand
0.25 mm	60	2	12.0	53.0	53.0 % Medium sand
0.125 mm	120	3	2.0	10.0	
0.0625 mm	230	4	0.0	2.0	12.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 4.0 %
Sand = 96.0 %
Fines = 0.0 %

0.6 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW13

Date : 7 Dec 1988
Depth : 4.3 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	100.0	0.0	
8 mm	5/16 in	-3	99.6	0.4	0.4 % Medium gravel
4 mm	No. 5	-2	98.4	1.2	
2 mm	10	-1	95.7	2.7	3.9 % Fine gravel
1 mm	18	0	91.8	3.9	
0.5 mm	35	1	81.7	10.1	14.0 % Coarse sand
0.25 mm	60	2	39.0	42.7	42.7 % Medium sand
0.125 mm	120	3	2.7	36.3	
0.0625 mm	230	4	0.4	2.3	38.6 % Fine sand
<.0625 mm	<230			0.4	0.4 % Silt/clay

Gravel = 4.3 %
Sand = 95.3 %
Fines = 0.4 %

0.5 % Organics

Appendix Table 3.--Continued.

System : Columbia River
Project: Cottonwood Island
Station: CW23

Date : 9 Jul 1987
Depth : 10.4 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	97.0	3.0	3.0 % Coarse gravel
16 mm	5/8 in	-4	89.0	8.0	
8 mm	5/16 in	-3	79.0	10.0	18.0 % Medium gravel
4 mm	No. 5	-2	72.0	7.0	
2 mm	10	-1	67.0	5.0	12.0 % Fine gravel
1 mm	18	0	62.0	5.0	
0.5 mm	35	1	53.0	9.0	14.0 % Coarse sand
0.25 mm	60	2	20.0	33.0	33.0 % Medium sand
0.125 mm	120	3	3.0	17.0	
0.0625 mm	230	4	0.0	3.0	20.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 33.0 %
Sand = 67.0 %
Fines = 0.0 %

? % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW23

Date : 19 Nov 1987
Depth : 9.1 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	73.0	27.0	
8 mm	5/16 in	-3	60.0	13.0	40.0 % Medium gravel
4 mm	No. 5	-2	50.0	10.0	
2 mm	10	-1	41.0	9.0	19.0 % Fine gravel
1 mm	18	0	35.0	6.0	
0.5 mm	35	1	31.0	4.0	10.0 % Coarse sand
0.25 mm	60	2	14.0	17.0	17.0 % Medium sand
0.125 mm	120	3	1.0	13.0	
0.0625 mm	230	4	0.0	1.0	14.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 59.0 %
Sand = 41.0 %
Fines = 0.0 %

0.5 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW23

Date : 21 Jul 1988
Depth : 12.8 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	89.0	11.0	11.0 % Coarse gravel
16 mm	5/8 in	-4	73.0	16.0	
8 mm	5/16 in	-3	64.0	9.0	25.0 % Medium gravel
4 mm	No. 5	-2	59.0	5.0	
2 mm	10	-1	53.0	6.0	11.0 % Fine gravel
1 mm	18	0	48.0	5.0	
0.5 mm	35	1	38.0	10.0	15.0 % Coarse sand
0.25 mm	60	2	9.0	29.0	29.0 % Medium sand
0.125 mm	120	3	1.0	8.0	
0.0625 mm	230	4	0.0	1.0	9.0 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 47.0 %
Sand = 53.0 %
Fines = 0.0 %

0.5 % Organics

System : Columbia River
Project: Cottonwood Island
Station: CW23

Date : 7 Dec 1988
Depth : 13.1 m
Method: 0.1-m2 Van Veen

Size mm	U.S.Sieve Pan #	Phi	Percent finer	Percent retained	Percent by size classification
64 mm	2-1/2 in	-6	100.0	0.0	0.0 % Rubble
32 mm	1-1/4 in	-5	100.0	0.0	0.0 % Coarse gravel
16 mm	5/8 in	-4	70.8	29.2	
8 mm	5/16 in	-3	43.3	27.5	56.7 % Medium gravel
4 mm	No. 5	-2	33.7	9.6	
2 mm	10	-1	31.1	2.6	12.2 % Fine gravel
1 mm	18	0	28.4	2.7	
0.5 mm	35	1	18.0	10.4	13.1 % Coarse sand
0.25 mm	60	2	6.7	11.3	11.3 % Medium sand
0.125 mm	120	3	0.4	6.3	
0.0625 mm	230	4	0.0	0.4	6.7 % Fine sand
<.0625 mm	<230			0.0	0.0 % Silt/clay

Gravel = 68.9 %
Sand = 31.1 %
Fines = 0.0 %

0.6 % Organics

Appendix Table 4.--Summaries of fish catches off Cottonwood Island, Columbia River, 1987-1988. Two community structure indices -- H' and J' -- were calculated for each trawling effort (see Methods for descriptions of indices).

STATION: CW21
Gear: 4.9-m Trawl
Date: 9 Jul 1987
Time: 1312 h
Depth: 17.4 m
Distance traveled: 315 m

Species	No. captured	No./ha
Prickly sculpin	1	10
Unidentified Cottidae	4	38
TOTAL	5	48

H' = 0.72 J' = 0.72

STATION: CW22
Gear: 4.9-m Trawl
Date: 9 Jul 1987
Time: 1244 h
Depth: 17.4 m
Distance traveled: 278 m

Species	No. captured	No./ha
Unidentified Cottidae	7	76
TOTAL	7	76

H' = 0.00 J' = 1.00

Appendix Table 4.--Continued.

STATION: CW23
Gear: 4.9-m Trawl
Date: 9 Jul 1987
Time: 1215 h
Depth: 14.9 m
Distance traveled: 241 m

Species	No. captured	No./ha
White sturgeon	1	13
Prickly sculpin	4	50
Unidentified Cottidae	9	113
TOTAL	14	176

H' = 1.20 J' = 0.76

STATION: CW21
Gear: 4.9-m Trawl
Date: 19 Nov 1987
Time: 0815 h
Depth: 18.0 m
Distance traveled: 278 m

Species	No. captured	No./ha
Northern squawfish	1	11
Starry flounder	1	11
Peamouth	1	11
TOTAL	3	33

H' = 1.58 J' = 1.00

Appendix Table 4.--Continued.

STATION: CW22
Gear: 4.9-m Trawl
Date: 19 Nov 1987
Time: 0901 h
Depth: 16.8 m
Distance traveled: 296 m

Species	No. captured	No./ha
White sturgeon	1	10
Peamouth	1	10
TOTAL	2	20

H' = 1.00 J' = 1.00

STATION: CW23
Gear: 4.9-m Trawl
Date: 19 Nov 1987
Time: 0931 h
Depth: 15.5 m
Distance traveled: 296 m

Species	No. captured	No./ha
Peamouth	2	20
Starry flounder	1	10
TOTAL	3	30

H' = 0.92 J' = 0.92

Appendix Table 4.--Continued.

STATION: CW21
Gear: 4.9-m Trawl
Date: 21 Jul 1988
Time: 1611 h
Depth: 16.2 m
Distance traveled: 278 m

Species	No. captured	No./ha
Sand roller	5	55
Prickly sculpin	1	11
Unidentified Cottidae	3	33
TOTAL	9	99

H' = 1.35 J' = 0.85

STATION: CW22
Gear: 4.9-m Trawl
Date: 21 Jul 1988
Time: 1544 h
Depth: 17.4 m
Distance traveled: 315 m

Species	No. captured	No./ha
Sand roller	2	19
Largescale sucker	2	19
Prickly sculpin	1	10
Unidentified Cottidae	12	115
TOTAL	17	163

H' = 1.32 J' = 0.66

Appendix Table 4.--Continued.

STATION: CW23
Gear: 4.9-m Trawl
Date: 21 Jul 1988
Time: 1453 h
Depth: 14.9 m
Distance traveled: 333 m

Species	No. captured	No./ha
Prickly sculpin	5	46
Unidentified Cottidae	9	82
TOTAL	14	128

H' = 0.94 J' = 0.94

STATION: CW21
Gear: 4.9-m Trawl
Date: 7 Dec 1988
Time: 1227 h
Depth: 15.5 m
Distance traveled: 333 m

Species	No. captured	No./ha
Peamouth	2	18
Unidentified Cottidae	1	9
TOTAL	3	27

H' = 0.92 J' = 0.92

Appendix Table 4.--Continued.

STATION: CW22
Gear: 4.9-m Trawl
Date: 7 Dec 1988
Time: 1159 h
Depth: 16.2 m
Distance traveled: 296 m

Species	No. captured	No./ha
Prickly sculpin	1	10
TOTAL	1	10

H' = 0.00 J' = 1.00

STATION: CW23
Gear: 4.9-m Trawl
Date: 7 Dec 1988
Time: 1130 h
Depth: 14.0 m
Distance traveled: 296 m

Species	No. captured	No./ha
Prickly sculpin	4	41
Peamouth	1	10
TOTAL	5	51

H' = 0.72 J' = 0.72