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BIOLOGICAL IMPACT OF A FLOWLANE DISPOSAL PROJECT NEAR PILLAR ROCK IN THE COLUMBIA RIVER ESTUARY

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INTRODUCTION

The National Marine Fisheries Service (NMFS) and other resource agencies were notified by the Portland District, U. S. Army Corps of Engineers (C. E.) during a March 1977 meeting that a threat to ship navigation existed at the Pillar Rock upper range. C. E. staff believed an immediate solution was to widen the 600-foot navigation channel to 900 feet through this stretch of the river and proposed the necessary dredging work be done during the summer of 1977. Removal of approximately 600,000 cubic yards of sediment was believed required to bring the channel to an acceptable 40-foot deep conformation. The Columbia River estuarine area involved was between river mile (RM) 27 and 29.

The effects of pipeline dredging as well as the in-river (flow-lane) sediment disposal on economically important finfish and benthic food organisms were unknown in this area. However, previous beach seining and purse seining by NMFS personnel (1967 to 1972) indicated many juvenile salmonids would be present during spring and summer. The C. E. and NMFS believed a biological study of this project would assist all agencies in evaluating future projects of a similar nature in this estuarine area (RM 22 to 35).

Previous evaluation of pipeline dredging at Dobelbower

Bar (RM 68) by NMFS staff[1/] provided a basis for determining channel maintenance and flow-lane disposal impacts above the estuary. By combining our results from Pillar Rock with those from the Dobelbower Bar study as well as other dredge assessment studies (Durkin et al. 1977 and Blahm et al. 1977), we plan to clarify and establish a continuity of knowledge for agencies to judge potential dredging impacts throughout the general area. The study of dredging effects at the Pillar Rock upper range was designed to include aspects that had not been examined in the earlier studies. The purpose was to provide a wider scope of knowledge for interested agencies and individuals.

Scheduled dredging near Pillar Rock was postponed several times because of altered priorities in the C. E. operating schedule caused by record low stream flows, conflict with commerical fishing seasons, etc. This caused our investigations to be delayed as well. Because dredging was scheduled to start in September, our initial baseline surveys of the dredge, disposal, and comparison site took place in August. However, dredging was subsequently rescheduled for mid-November; therefore, continuance of our study was rescheduled for early November.

The NMFS study design, methods, equipment, and techniques were formulated in anticipation of a summer sampling effort.

1/ Biological assessment of in water dredged material disposal at upper Dobelbower Bar, Columbia River, River kilometer 113, Blahm, T.H., McConnell, R.J. (in preparation).

The unanticipated and unavoidable delays in scheduling the dredging operation as well as other factors necessitated that the same effort and sampling approach be directed to the late fall and winter study despite the fact that the lower freshwater temperatures expected usually result in finfish seasonal change, reduced metabolic levels, and decreased movement. Consistent heavy rain through November and into December did not affect the scheduled operation but did cause a variety of changes in water temperature and clarity, finfish assemblages, and surface debris. The changes in sampling periods and water quality were not desirable for our conduct of the study but could not be avoided.

METHODS

Sampling Approach and Equipment

A total of six surveys were conducted over a 5-month period. Each of the surveys consisted of a set number of demersal trawl tows, purse seine sets, beach seine hauls, benthic grabs, epibenthic sled tows, and water quality measurements. Stomach contents were examined for subsamples of all finfish species. Sediment cores were gathered at each benthic station on every other survey. Each survey included sampling the dredge and/or disposal site and a nearby comparison site. Two complete surveys were scheduled before dredging began, two during the actual dredging operation, and two following the completion of dredging. The locations of the dredge area, disposal site, and comparison site are shown in Figure 1. The sampling sites within the study area are shown in Figure 2.

Demersal fish were collected with an 8 m shrimp trawl that was towed from a 12.2 m vessel (Figure 3). The trawl was made with 38 mm stretched mesh overall and a 12 mm stretched mesh cod-end liner. Approximately 90 m of cable were released for each 5-minute tow irregardless of location or direction. Tows were usually in an easterly direction during flood tides. Two tows were made at the 100 m wide

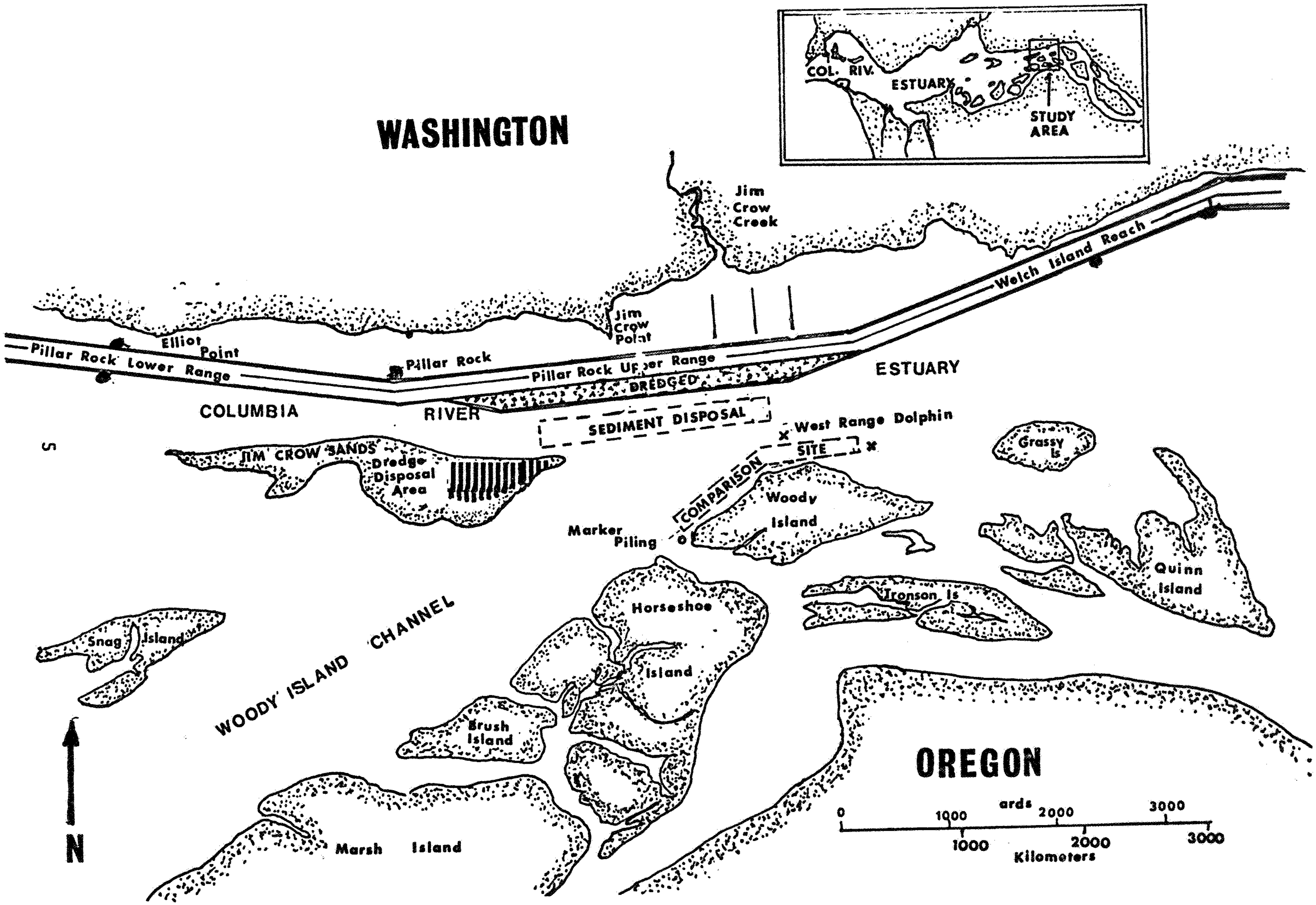


Figure 1. Location of the Pillar Rock,channel widening project and investigative area.

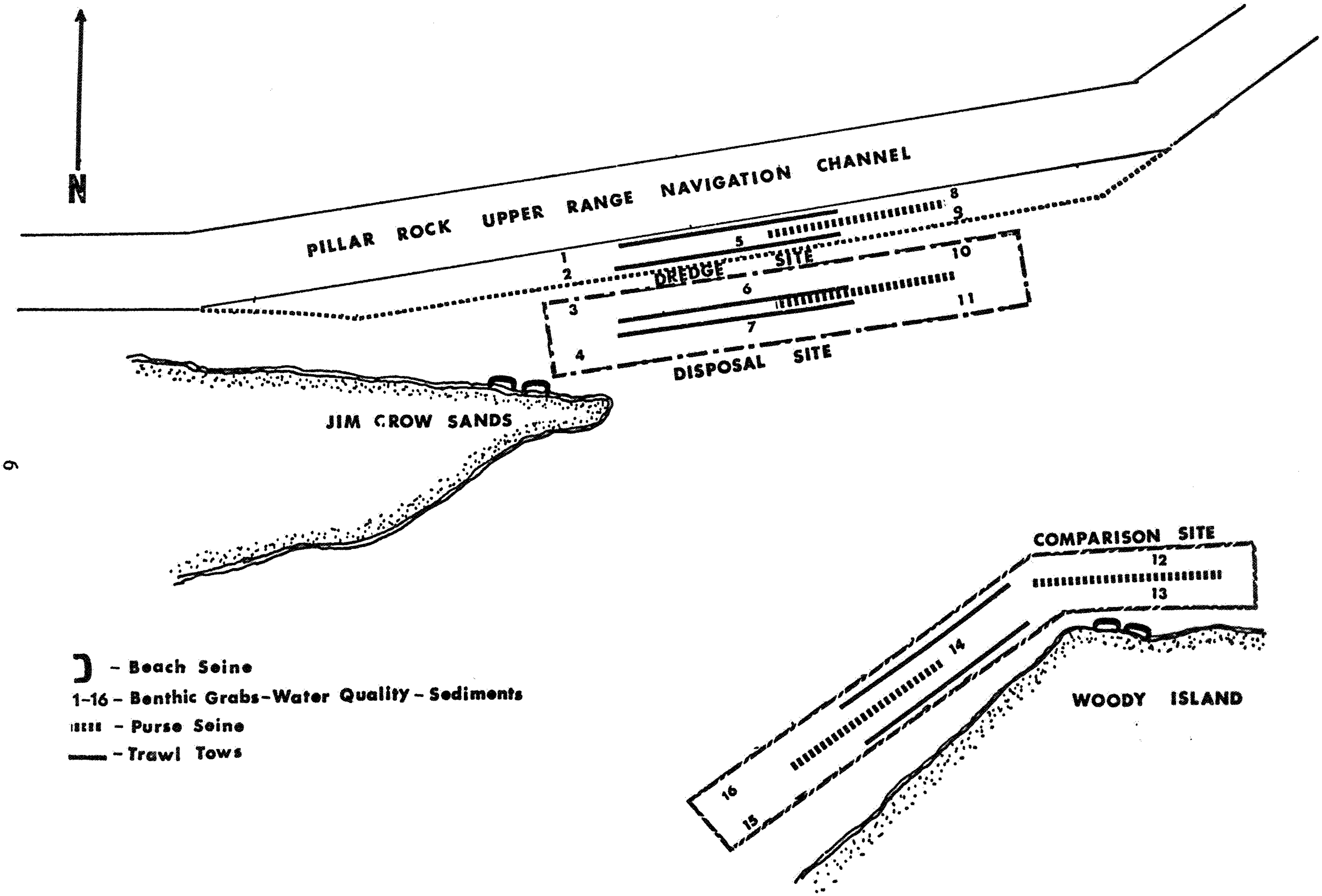


Figure 2. Schematic portrayal of sampling areas at the Pillar Rock study.

Figure 3. NMFS 12.2 m utility boat used specifically for trawl tows, benthic grabs, and sediment texture sampling.

dredge site and two tows at the 200 m wide disposal site. A tow began at RM28, approximately halfway between Pillar Rock and Jim Crow Point and usually was completed near Jim Crow Point or red buoy 18. When tidal conditions required tows be made in a westerly direction they began at red buoy 18. Distance sampled ranged from 300 to 500 m but was dependent on water velocities, volume, and tidal influence. The two tows at the comparison site sampled a similar distance and began either at the western Woody Island range marker or the piling marker at the west end of Woody Island (Figure 1).

A purse seining survey consisted of four sets with two made at the comparison site near Woody Island and two at the dredge/disposal area. The 150 m long net consisted of stretched mesh sizes ranging from 20 mm to 12 mm and sampled fish found between the surface and 7 m. A seine skiff was used to hold one end of the net open while a 9 X 3 m barge towed the other end for a period of 5 minutes before closure began. After the open end was transferred to the barge, retrieval of the purse line started. When the net was pursed and retrieved, fish were brought aboard the barge. Tows were made in the same area, from the same starting point, and during similar tidal conditions described for the trawl tows.

Beach seine sets were made at Woody Island just south of the west range marker and on the northern beach of Jim Crow Sands at approximately RM28. Hauls were made with a 100 m long variable mesh seine described by Sims and Johnsen (1974). The net was towed by an outboard powered dory, and a 180 degree sweep was made either east or west depending upon current and tide. When the set was completed, fish were worked up to the bag, removed, and processed on the purse seine barge.

All fish captured by purse seining, beach seining, or trawling were examined, identified to species, and counted. Subsamples of all species were individually measured to the nearest mm fork length and weighed to the nearest gram. Weight data were gathered on all fish. Identification was based upon Eddy (1957); Hubbs and Lagler (1958); Carl, Clemens, and Wilby (1959); Hart (1973); Scott and Crossman (1973); and Reimers and Bond (1967).

Up to 10 fish of each species captured were selected from each sample for determining the types of food utilized. After lengths and weights were recorded, stomachs were removed at the throat and junction of the pyloric caeca (if present), and stored in vials with 5% Formalin[2/] until later analysis.

In the laboratory, each stomach was emptied into a watch glass and individual organisms identified to the lowest possible taxon, counted, and weighed to the nearest 0.0001 gm with a Mettler type H6T digital balance. A small invertebrate reference collection was prepared and saved.

Species identifications were made using a variety of dichotomous keys. The principal references used for taxonomic information included: Jaques (1947), Banner (1948), Chu (1949),

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

Brodskii (1950), Pennak (1953), Schultz (1969), and Smith and Carlton (1975).

Benthic invertebrates were taken with a 0.05 m^2 Ponar gravity activated grab sampler (Figures 4 and 5) which has been discussed by Word (1977). In each survey a single grab was taken at each of the five dredge stations, six disposal stations, and five comparison stations. Stations were selected to represent the entire impacted area and were established by depth determination and fixes at visual cross reference points such as jetties, dolphins, points, and buoys. Some sample site deviation occurred during the six surveys but probably did not exceed 50 m. When currents made it necessary, the 12.2 m utility boat was anchored to take a grab, but samples were frequently taken without anchoring.

The first four sample stations were taken north to south at RM28; two stations were in the dredge area and two in the sediment disposal area. We used Jim Crow Point and buoy 18 as references for the center three stations. Station 5 was in the dredge area while 6 and 7 were in the disposal area. Four stations were located directly south of jetty 21 with stations 8 and 9 in the dredge area and 10 and 11 in the disposal area. Comparison stations 12 and 13 were located between the western range marker and Woody Island. Station 14 was located off a tide marker and tree approximately 600 m

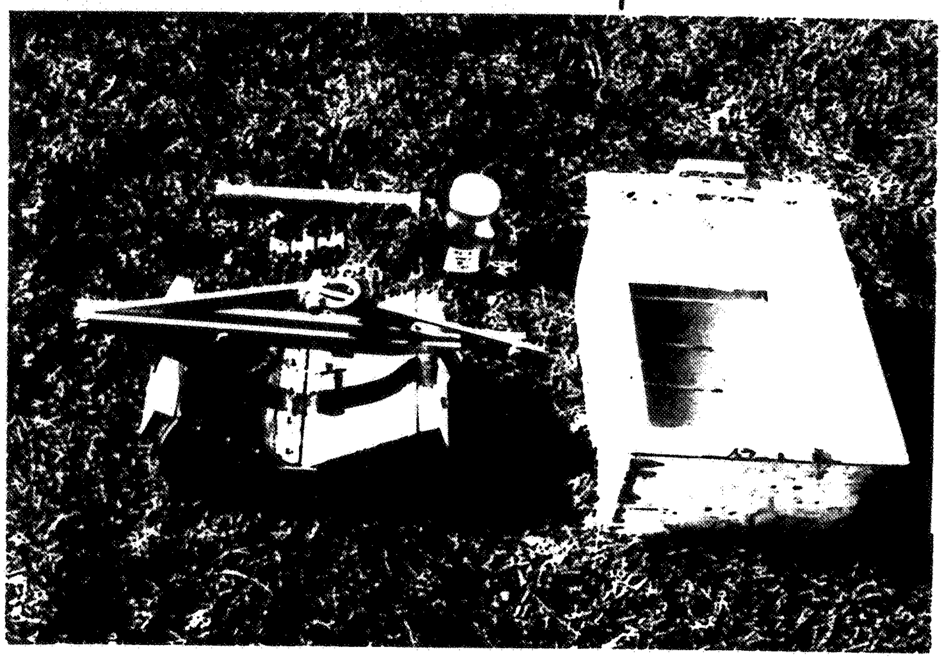


Figure 4. Ponar 0.05 m^2 gravity activated sampler, sediment core sampler, and screen sieve box for removing fine sand, silt, and clay from benthic organisms.

Figure 5. Shaking sediment from a sample grab in the Pillar Rock disposal area.

west of the west range marker dolphin. Stations 15 and 16 were south to north from the single marker piling at the northwest end of Woody Island. All sample grabs were made the same day during all six surveys.

A replicate sample was taken at each station on every second survey to obtain a sediment core. The specimen was placed in an individual plastic package, labeled, and delivered to the C. E. Portland office. Sediments were graded by sieves into metric categories and group classifications such as medium sand, clay, small gravel, etc. The categories were tabulated and presented to NMFS as percentages of the total sample. Organic content of sediment was determined by the percent of volatile solids according to procedures described by EPA (1974).

Epibenthic tows were made with a sled-mounted net having a 45 by 21 cm mouth and comprised of 1 mm mesh (Figure 6). A detachable cup also had 1 mm screen. Normally the net was released from the vessel while it was slowly underway. When 600 m of cable had been released, the vessel was placed in neutral and the sled and cable were retrieved by winch. Unfortunately the uneven bottom consisting of fine to medium sand complicated our efforts to make and retrieve tows at either the dredge, disposal, or comparison areas. Even after making height adjustments and modifying our towing procedure the net would usually fill with sand. Quantitative measurements

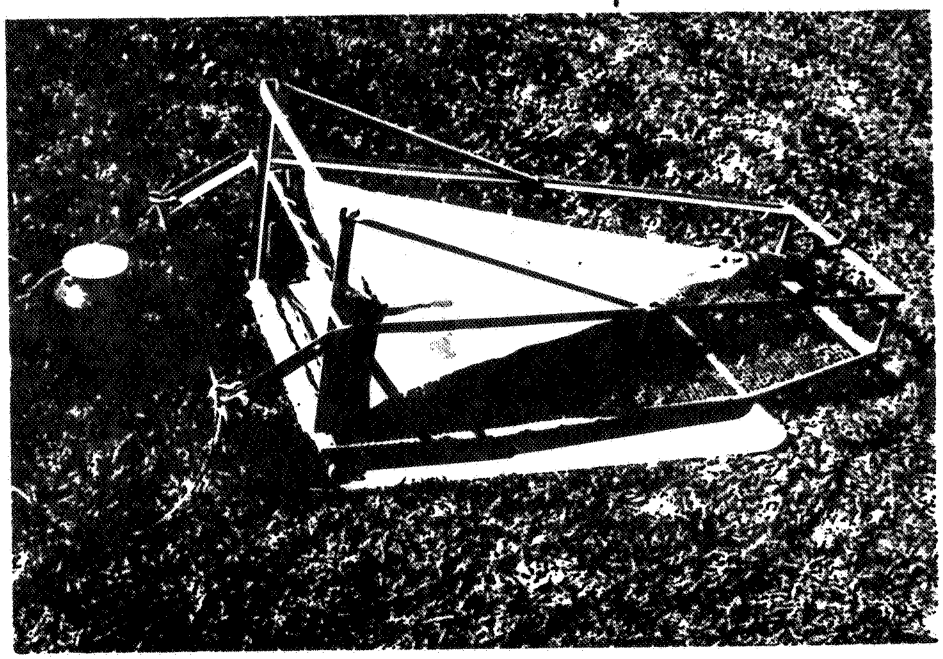


Figure 6. Sled with 1 mm net mounted for capturing epibenthic fauna.

on epibenthic fauna were unrealistic under these circumstances even though the information was desirable. A decision was made to make at least a single sled haul each survey in order to provide qualitative information on local species.

Water quality parameters were gathered at the surface and bottom at all 16 stations during the six surveys of the Pillar Rock study.

Water temperature, conductivity, and salinity were monitored <u>in-situ</u> with a Beckman Model RS5-3 salinometer and probe (Figure 7). Temperature was recorded to the nearest tenth of a degree Celsius (°C), salinity to the nearest tenth of a part per thousand, and conductivity to the closest hundredth of a millimho per centimeter.

The modified Winkler System (EPA 1974) was used for on-site calibration of YSI (Model 57) dissolved oxygen meter which in turn was used for <u>in-situ</u> measurements. Disolved oxygen was recorded as milligrams per liter (mg/l)

A three liter Van Dorn sampler was used to collect water samples for use in determination of turbidity and pH. A Leeds and Northrup Model 7404 meter was used to measure the hydrogen ion activity of the water and is expressed as the pH value, while an H.F. Instrument Model DRT100 nephelometric turbidimeter was used to measure turbidity. This parameter is expressed in formazin turbidity units (FTU). 3/

3/ FTU, NTU, and JTU are synonymous units.

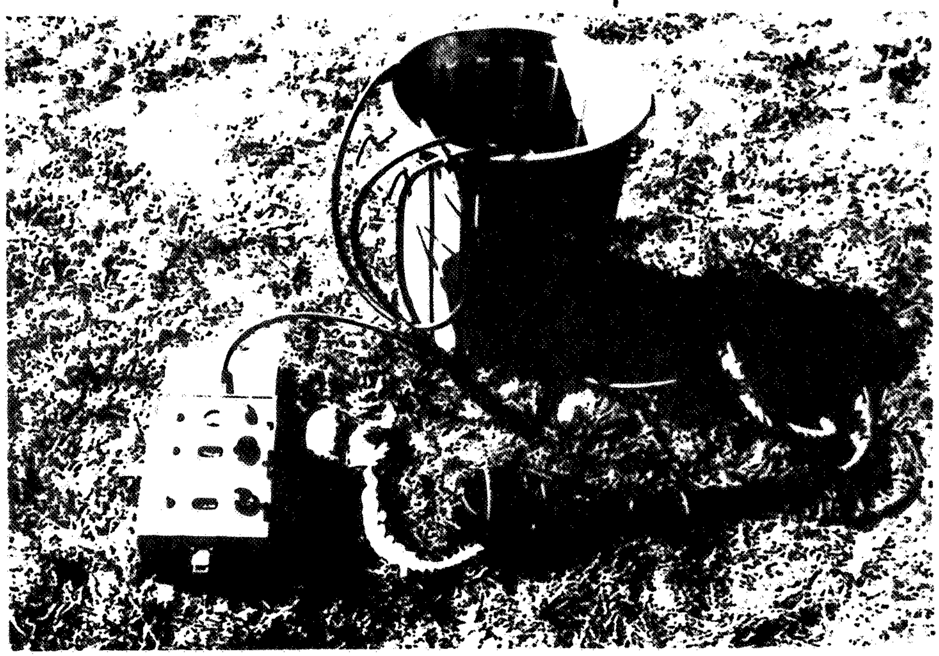


Figure 7. RS5-3 Beckman salinometer with cord and probe used to measure temperature, conductivity, and salinity.

Processing of Samples and Analysis of Data

Individual numbers were useful for determining species dominance, diversity, richness, and equitability. Length measurements provided an indication of year class or age. Overall weights of finfish were useful for comparative changes between time and area.

Benthic infauna, after being preserved and stained, were sorted into groups such as nematodes, polychaetes, bivalves, etc. An overall species list was prepared but samples were essentially dominated by several species. Weights of benthic fauna were determined to the nearest 0.0001 gram with a Mettler Type H6T digital balance. Species diversity and numerical and gram weight values were tabulated to determine change within areas and between sampling periods.

Food utilization was studied for those fish which had eaten and the proportion of empty stomachs determined. Food consumption by the dominant species of fish was analyzed.

All food items were listed and shifts in utilization in relation to time and area were studied.

Sediment data were grouped by area, averaged, and examined by time for changes in particle size proportions. Volatile solids were examined in a similar way. Complete sediment readings, curve charts, and tabular lists of volatile solids are available from the Corps' Portland District.

SAMPLING RESULTS - FINFISH

The combined seining and trawling effort during the study produced 8506 specimens from 15 species (two marine, eight anadromous, and eight freshwater - Table 1). The threespine stickleback, Gasterosteus aculeatus, was numerically the most abundant species captured in the area. Substantial numbers of starry flounder, Platichthys stellatus; chinook salmon, Oncorhynchus tshawytscha; and prickly sculpin, Cottus asper, were also taken.

Gram weights of finfish captured in the vicinity of Pillar Rock are presented in Table 2. The composition of the catch based on weight is somewhat different than the composition based on numbers of individuals. Rainbow (steelhead) trout, Salmo gairdneri, though numerically only 0.15% of the catch represented over one-fourth of the finfish total weight (26.52%). Chinook salmon and starry flounder had weight values which ranked similar to their numerical status. Threespine stickleback, though most abundant, represented less than 3% of the overall weight. Coho salmon, Oncorhynchus kisutch, and steelhead weights were significant but essentially represented adult fish. The total finfish weight of 137.976 kg is not large when considering the number of samples (88) taken during the 5-month study. For example the Chinook Channel Corps of Engineers study had

TABLE 1. FINFISH, CRUSTACEANS, AND AMPHIBIANS CAPTURED AT OR NEAR A PIPELINE DREDGE AND DISPOSAL SITE IN THE COLUMBIA RIVER ESTUARY FROM AUGUST 1977 TO JANUARY 1978.

Common Name	Genus Species	100 m Beach Seine (No.)	150 m Purse Seine (No.)	8 m Shrimp Trawl (No.)	Total (No.)	Total (%)
Pacific lamprey	*Entosphenus tridentatus*	0	0	2	2	0.02
White sturgeon	*Acipenser transmontanus*	0	0	3	3	0.03
American shad	*Alosa sapidissima*	21	87	82	190	2.23
Coho salmon	*Oncorhynchus kisutch*	2	2	0	4	0.05
Chinook salmon	*Oncorhynchus tshawytscha*	977	359	2	1338	15.73
Mountain whitefish	*Prosopium williamsoni*	1	0	0	1	0.01
Rainbow trout[1/]	*Salmo gairdneri*	6	7	0	13	0.15
Longfin smelt	*Spirinchus thaleichthys*	13	39	265	317	3.73
Eulachon	*Thaleichthys pacificus*	4	208	87	299	3.52
Peamouth	*Mylocheilus caurinus*	40	12	83	135	1.59
Largescale sucker	*Catostomus macrocheilus*	3	0	20	23	0.27
Threespine stickleback	*Gasterosteus aculeatus*	3948	46	11	4005	47.08
Bluegill	*Lepomis macrochirus*	1	0	0	1	0.01
White crappie	*Pomoxis annularis*	1	1	0	2	0.02
Coastrange sculpin	*Cottus aleuticus*	0	0	1	1	0.01
Prickly sculpin	*Cottus asper*	21	0	724	745	8.76
Pacific staghorn sculpin	*Leptocottus armatus*	4	0	55	59	0.69
Starry flounder	*Platichthys stellatus*	306	7	1051	1364	16.04
Pacific crayfish	*Pacifasticus leniusculus*	1	0	1	2	0.02
Juvenile bullfrog	*Rana catesbeiana*	0	2	0	2	0.02
TOTALS		5349	770	2387	8506	99.98

1/ Steelhead trout

TABLE 2. GRAM WEIGHT OF FINFISH, CRUSTACEANS, AND AMPHIBIANS CAPUTRED AT OR NEAR A PIPELINE DREDGE AND DISPOSAL SITE IN THE COLUMBIA RIVER ESTUARY BETWEEN AUGUST 1977 AND JANUARY 1978.

Species	100 m Beach Seine	150 m Purse Seine	8 m Shrimp Trawl	Total Weight	
	(g)	(g)	(g)	(g)	(%)
Pacific lamprey	0	0	6	6	0.00
White sturgeon	0	0	1577	1577	1.14
American shad	504	1517	792	2873	2.04
Coho salmon	2178	10072	0	12250	8.88
Chinook salmon	22595	7348	17	29960	21.71
Mountain whitefish	14	0	0	14	0.01
Rainbow trout	13268	23325	0	36593	26.52
Longfin smelt	119	356	2659	3134	2.27
Eulachon	170	8569	3518	12257	8.88
Peamouth	1941	1268	3601	6810	4.94
Largescale sucker	1961	0	788	2749	1.99
Threespine stickleback	4005	50	11	4066	2.95
Bluegill	1	0	0	1	0.00
White crappie	1	1	0	2	0.00
Coastrange sculpin	0	0	1	1	0.00
Prickly sculpin	49	0	7175	7224	5.24
Pacific staghorn sculpin	121	0	1479	1600	1.16
Starry flounder	2035	56	14724	16815	12.19
Pacific crayfish	83	0	13	96	0.07
Juvenile bullfrog	0	8	0	8	0.01
TOTALS	49045	52570	36361	137976	100.00

24 rather than 41 trawl tows and the total catch weight was 843.666 kg (Durkin et al. 1977). Obviously the finfish standing crop in the lower estuary during the Spring of 1976 was greater than found in the upper Columbia River estuary during the fall and winter of 1977.

The finfish habitats were sampled by specific gear in predetermined locations to determine if obvious impacts or change occurred from pipeline dredging.

Purse Seine Catch

Finfish inhabiting a pelagic habitat were captured with the purse seine. Essentially the same species of fish appeared at both sites (Table 3). More fish were taken at the dredge/disposal site than were captured at the comparison site (Table 3). The imbalance resulted from a large catch of downstream migrant juvenile chinook salmon in the second set on August 26.

The impact of pipeline dredging at the dredge/disposal site on pelagic species was apparently minor. The diversity during dredging (November 30) was similar to the pre-dredge diversity (November 10); however, the number of fish was less. A sampling series on December 8 resulted in a substantial increase in the catch. Finfish numbers at the dredge/disposal site diminished in January, however; the catches at the comparison site also fluctuated and consequently, no

TABLE 3. NUMBER OF FINFISH AND AMPHIBIANS CAPTURED WITH A PURSE SEINE AT TWO SITES IN THE UPPER COLUMBIA ESTUARY BETWEEN AUGUST 1977 AND JANUARY 1978.

SPECIES	Pre-dredge				During dredge				Post dredge				TOTALS
	Aug 26 1977	Aug 26	Nov 10	Nov 10	Nov 30	Nov 30	Dec 8	Dec 8	Jan 9 1978	Jan 9	Jan 13	Jan 13	
Comparison Site - Woody Island Channel													
American shad					1	5	5	9					20
Chinook salmon	14	17	4	4		1							40
Coho salmon													0
Steelhead trout			1		1			1					3
Longfin smelt					9	2			2	6			19
Eulachon				2					9	31	67	57	166
Peamouth chub				1	1	8					1	1	12
3-spine stickleback	1		1	21		4	1						28
White crappie													0
Starry flounder					2				3	1			6
Juvenile bullfrog						1							1
TOTALS	15	17	6	28	14	21	6	10	14	38	68	58	295
Dredge/Disposal Site - Pillar Rock Channel													
American shad	8				4	3	24	28					67
Chinook salmon	69	223	8	5		1	10	3					319
Coho salmon		2											2
Steelhead trout		4											4
Longfin smelt					3	8	1		4	4			20
Eulachon			1						22	15	4		42
Peamouth chub												EMPTY	0
3-spine stickleback		1	2	15									18
White crappie								1					1
Starry flounder						1							1
Juvenile bullfrog										1			1
TOTALS	77	230	11	20	7	13	35	32	26	20	4	0	475

clear cut correlations were apparent.

The gram weight changes essentially mirrored the numerical catches (Table 4). Adult steelhead represented a major portion of the weight at each sampling site. The total gram weight at the dredge site was more than twice that found at the comparison site. However, during dredging on November 30 and after dredging on January 13 the catches at the dredge/disposal site had lower gram weight, reflecting fewer adult fish.

Numbers of dominant fish species captured during the surveys and examined for food utilization are shown in Table 5. Principal species were chinook salmon, American shad, threespine stickleback, longfin smelt, peamouth, and eulachon. A total of 262 fish of these species was examined; 68% of them were empty. In fact, only chinook salmon, American shad, and threespine stickleback contained any food, and 39% of the chinook, 59% of the shad, and 57% of the stickleback examined were empty.

Eulachon and longfin smelt were in spawning condition, therefore few contained food, and as we found in other studies, few peamouth stomachs contained food. The numbers and weights of items consumed by the dominant species of fish that had food in their stomachs are shown in table 6 and 7. Feeding was not intensive but the trends and specific items consumed provide essential knowledge about food preferences.

TABLE 4. GRAM WEIGHT OF FINFISH AND AMPHIBIANS CAPTURED WITH A PURSE SEINE AT TWO SITES IN THE UPPER COLUMBIA RIVER ESTUARY BETWEEN AUGUST 1977 AND JANUARY 1978.

Comparison Site - Woody Island

	Pre-Dredge				During Dredge				Post Dredge				
SPECIES	Aug 26	Aug 26	Nov 10	Nov 10	Nov 30	Nov 30	Dec 8	Dec 8	Jan 9	Jan 9	Jan 13	Jan 13	TOTALS
American shad					5	22	26	56					109
Chinook salmon	324	394		170		26							914
Coho salmon													0
Steelhead trout					6363			179					6542
Longfin smelt					62	13			21	57			153
Eulachon				101					308	1227	2776	2394	6806
Peamouth				191	22	669					135	251	1268
Threespine stickleback	2		1	21		5	1						30
White crappie													0
Starry flounder					12				26	16			54
Bullfrog juvenile						5							5
TOTALS	326	394	1	483	6464	740	27	235	355	1300	2911	2645	15881

Dredge and Disposal Site - Pillar Rock Channel

SPECIES	Aug 26	Aug 26	Nov 10	Nov 10	Nov 30	Nov 30	Dec 8	Dec 8	Jan 9	Jan 9	Jan 13	Jan 13	TOTALS
American shad	877				23	20	214	274					1408
Chinook salmon	1950	6237	253	159		58	376	125					9158
Coho salmon		7348											7348
Steelhead trout		16783											16783
Longfin smelt					33	90	11		37	32			203
Eulachon			48						715	848	152	EMPTY	1763
Peamouth													0
Threespine stickleback		3	2	15									20
White crappie								1					1
Starry flounder						2							2
Bullfrog juvenile									3				3
TOTALS	2827	30371	303	174	56	170	601	400	755	880	152	0	36689

TABLE 5. DOMINANT SPECIES OF PURSE SEINE-CAUGHT FISH AND THE NUMBERS CAUGHT AND EXAMINED FOR FOOD UTILIZATION, PILLAR ROCK AREA

	DREDGE/DISPOSAL SITE				COMPARISON SITE			
Dominant Species	Total Caught	Number Examined	Number Empty	Percent Empty	Total Caught	Number Examined	Number Empty	Percent Empty
1977								
AUGUST								
PRE-SURVEY								
Chinook salmon	292	24	19	79	31	20	7	35
Shad	8	8	0	0	0	0	0	0
NOVEMBER								
PRE-SURVEY								
Chinook salmon	13	13	0	0	8	4	1	25
Stickleback	17	12	5	42	22	11	8	73
NOVEMBER								
DURING DISPOSAL								
Shad	7	7	4	57	6	6	6	100
Longfin smelt	11	11	11	100	11	11	10	91
Peamouth chub	0	0	0	0	9	9	8	89
DECEMBER								
DURING DISPOSAL								
Shad	52	20	11	55	14	14	10	71
Chinook salmon	13	13	2	15	0	0	0	0
1978								
JANUARY								
POST-DISPOSAL								
Eulachon	4	4	4	100	124	20	20	100
JANUARY								
POST-DISPOSAL								
Eulachon	53	26	26	100	24	19	19	100
Longfin smelt	10	4	4	100	6	6	2	33
TOTALS	480	142	86		255	120	91	
WEIGHTED AVE.				61				76

TABLE 6. NUMBERS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF PURSE SEINE-CAUGHT FISH, PILLAR ROCK AREA.

Food Species 1/	Dredge/Disposal Site			Comparison Site		
	Chinook	Shad	Stickleback	Chinook	Shad	Stickleback
1977						
AUGUST						
PRE-DISPOSAL						
C. salmonis	4	4		17		
Dig. cladocerans	44					
Chironomid larvae		2				
Dig. material	*	*	*	*		
Fish scales		5				
D. longispina				653		
E. hirundoides						
NOVEMBER						
PRE-DREDGING						
C. salmonis	56		17			5
Neuroptera				1		
Hemiptera	60			15		
Coleoptera	10			2		
Arachnid	13			17		
Diptera	52			13		
Hymenoptera	17			6		
Ephemeroptera				3		
Plecoptera	1					
C. fluminea	13		14			2
Dig. Corophium				*		
Dig. insects	*			*		
Chiro. larvae			1			
Copepods						201
NOVEMBER						
DURING DREDGING						
C. salmonis						
Dig. material	*	*				*
A. confervicolus	1					
Trichoptera		1				
Plecoptera		1				
N. mercedis						
DECEMBER						
DURING DREDGING						
Dig. cladocerans		*				
A. confervicolus	4	3			1	
Dig. copepods		*				
Ostracod		11				
C. occidentalis		3				
Unid. copepod		7				
C. salmonis	29	16			2	
Dig. material	*	*				
Chiro. larvae		1				
Bosmina sp.		3				
E. hirundoides		434			16	
N. mercedis					16	
Coleoptera	4					
Arachnid	1					
Sticks	1					
Dig. insects	*					
1978						
JANUARY 1.						
POST-DREDGING						
A. confervicolus						
N. mercedis						
C. salmonis						
JANUARY 2.						
POST-DREDGING						

1/ See food item species list for taxonomic classification.

* Indeterminate numbers of digested items.

TABLE 7. WEIGHTS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF PURSE SEINE-CAUGHT FISH, PILLAR ROCK AREA.

Food Species	Dredge/Disposal Site			Comparison Site		
	Chinook (g)	Shad (g)	Stickleback (g)	Chinook (g)	Shad (g)	Stickleback (g)
1977						
AUGUST						
PRE-DISPOSAL						
C. salmonis	.0199	.0110		.0607		
Dig. cladocerans	.0133					
Chironomid larvae		.0040				
Dig. material	.0274	.1600	.0040	.0399		
Fish scales		.0220				
D. longispina				.1637		
E. hirundoides						
NOVEMBER						
PRE-DREDGING						
C. salmonis	.1047		.0507			.0174
Neuroptera				.0007		
Hemiptera	.0701			.0134		
Coleoptera	.0791			.0008		
Arachnid	.0415			.0141		
Diptera	.0583			.0029		
Hymenoptera	.0209			.0020		
Ephemeroptera				.0003		
Plecoptera	.0008					
C. fluminea	.0270		.0161			.0094
Dig. Corophium				.0049		
Dig. insects	.1413			.0672		
Chiro. larvae			.0025			
Copepods						.0189
NOVEMBER						
DURING DREDGING						
C. salmonis						
Dig. material	.1291	.1062				.0064
A. confervicolus	.0214					
Trichoptera		.0006				
Plecoptera		.0009				
N. mercedis						
DECEMBER						
DURING DREDGING						
Dig. cladocerans		.0011				
A. confervicolus	.0504	.0374			.0116	
Dig. copepods		.0036				
Ostracod		.0001				
C. occidentalis		.0008				
Unid. copepod		.0005				
C. salmonis	.0851	.0199			.0047	
Dig. material	.0544	.0144				
Chiro. larvae		.0001				
Bosmina sp.		.0004				
E. hirundoides		.0249			.0009	
N. mercedis					.1136	
Coleoptera	.0188					
Arachnid	.0051					
Sticks	.0211					
Dig. insects	.0411					
1978						
JANUARY 1.						
POST DREDGING						
A. confervicolus						
N. mercedis						
C. salmonis						
JANUARY 2.						
POST DREDGING						

Beach Seine Catch

Paired seine hauls at Woody Island during each of the six surveys produced an overall catch of 2372 finfish. A similar number of sets at Jim Crow Sands resulted in 2977 fish (Table 8). Stickleback numerically dominated the total catch at both sites with chinook salmon and starry flounder next in importance. The other 13 species taken by beach seine occurred incidentally or rarely.

It was difficult to evaluate dredge/disposal impacts upon finfish using the beach seine catch data at Jim Crow Sands. At times seining had to be conducted between equipment rafts and barges moored at the island. The seining area was also limited because of containment berms prepared by bulldozers. For these reasons it was not possible to make a second seine haul on December 8th. The single set that was made indicated substantially more fish were at Woody Island. Differences at the two sites in the January survey were negligible.

Gram weights of finfish taken at both sites are presented in Table 9. Adult steelhead trout and coho salmon contributed a considerable portion of the finfish weight at the comparison site. This indicated a greater total gram weight at the Woody Island site though catches were numerically inferior to those taken at Jim Crow Sands.

TABLE 8. NUMBER AND SPECIES OF FINFISH AND CRUSTACEANS CAPTURED BEACH SEINING IN THE UPPER COLUMBIA RIVER ESTUARY AT A CHANNEL WIDENING PROJECT AND A NEARBY SITE.

Comparison Site - Woody Island

SPECIES	Pre-dredge Aug 29	Aug 29	Nov 8	Nov 8	During dredge Nov 28	Nov 28	Dec 8	Dec 6	Post dredge Jan 10	Jan 10	Jan 17	Jan 17	TOTALS
American shad	3					1							4
Chinook salmon	204	386	1	2			2			2			597
Coho salmon	1											1	2
Mountain whitefish													0
Steelhead trout	2	2	1							1			6
Longfin smelt							9	1					10
Eulachon													0
Peamouth	9				2		2	1		1			15
Threespine stickleback	488	679	198	88	13	2	79	39		1	1	3	1591
Largescale sucker					1		1			1			3
Bluegill						1							1
White crappie								1					1
Prickly sculpin		1			3		4	1					9
Pacific staghorn sculpin					1								1
Starry flounder		5	9	30	15	4	7	7	2	4	17	31	131
Pacific crayfish											1		1
TOTALS	707	1073	209	120	35	8	104	50	2	10	19	35	2372

Dredge/Disposal Area - Jim Crow Sands

	Aug 26	Aug 29	Nov 8	Nov 8	Nov 28	Nov 28	Dec 8	Dec 8	Jan 10	Jan 10	Jan 17	Jan 17	TOTALS
American shad		16					1	NO SET (EQUIPMENT OBSTRUCTION)					17
Chinook salmon	8	367	1		2	2							380
Coho salmon													0
Mountain whitefish		1											1
Steelhead trout													0
Longfin smelt										1		2	3
Eulachon									2	2			4
Peamouth		22	1		2								25
Threespine stickleback	8	2273	29	19	1	6	7		3	11			2357
Largescale sucker													0
Bluegill													0
White crappie													0
Prickly sculpin		1			1	7			2	1			12
Pacific staghorn sculpin					2	1							3
Starrv flounder	1	50	19	8	26	39	7		2	2	13	9	175
Pacific crayfish													0
TOTALS	17	2730	50	27	34	54	15	0	9	17	13	11	2977

TABLE 9. GRAM WEIGHT OF FINFISH AND CRUSTACEANS CAPTURED WITH A BEACH SEINE IN THE UPPER COLUMBIA RIVER ESTUARY AT CHANNEL WIDENING PROJECT BETWEEN AUGUST 1977 AND JANUARY 1978.

Comparison Site - Woody Island		Pre-dredge			During dredge				Post dredge				
SPECIES	Aug 29	Aug 29	Nov 8	Nov 8	Nov 28	Nov 28	Dec 6	Dec 6	Jan 10	Jan 10	Jan 17	Jan 17	TOTALS
American shad	129					8							137
Chinook salmon	4933	9148	17	17			24			28			14167
Coho salmon	2177											1	2178
Mountain whitefish													0
Steelhead trout	8346	1076	172							3674			13268
Longfin smelt							85	10					95
Eulachon													0
Peamouth	17				289		232	153		57			748
Threespine stickleback	488	679	218	91	13	2	92	39		1	1	5	1629
Largescale sucker					7		1089			865			1961
Bluegill						1							1
White crappie								1					1
Prickly sculpin		1			4		25	1					31
Pacific staghorn sculpin					43								43
Starry flounder		108	36	69	93	15	36	26	3	5	58	90	539
Pacific crayfish											83		83
TOTALS	16090	11012	443	177	449	26	1583	230	3	4630	142	96	34881

Dredge Disposal Area - Jim Crow Sands

SPECIES	Aug 26	Aug 29	Nov 8	Nov 8	Nov 28	Nov 28	Dec 8	Dec 8	Jan 10	Jan 10	Jan 17	Jan 17	TOTALS
American shad		359					8	NO SET EQUIPMENT OBSTRUC.					367
Chinook salmon	158	8089	37		21	123							8428
Coho salmon													0
Mountain whitefish		14											14
Steelhead trout													0
Longfin smelt										9		15	24
Eulachon									103	67			170
Peamouth		1187	4		2								1193
Threespine stickleback	10	2273	39	26	1	6	7		3	11			2376
Largescale sucker													0
Bluegill													0
White crappie													0
Prickly sculpin		1			2	10			4	1			18
Pacific staghorn sculpin					61	17							78
Starry flounder	1	608	75	43	442	226	44		6	5	32	14	1496
Pacific crayfish													0
TOTALS	169	12531	155	69	529	382	59	0	116	93	32	29	14164

Disposal of sediments on Jim Crow Sands probably caused a catch difference during the December 8th survey. Species diversity at the disposal island was considerably less than at Woody Island. An increase in finfish numbers, diversity, and weight occurred earlier at the flowlane disposal site during the prior dredging phase. In theory, beach seining at Jim Crow Sands may have measured increased numbers of finfish due to dislodged food; however, absence of organism shown in the stomach analysis data minimized this possibility. Possibly finfish numbers increased due to avoidance of dredge or disposal activities.

The numbers of dominant fish species captured during beach seine surveys and examined for food utilization are shown in Table 10. Of 338 fish examined 100 (26%) contained food. Principal species studied were chinook salmon, American shad, threespine stickleback, peamouth, starry flounder, and prickly sculpin. Numerically important species with a high incidence of empty stomachs include 138 (87%) of 158 starry flounder, 106 (74%) of 144 threespine stickleback, 17 (89%) of 19 peamouth, and 12 (75%) of 16 prickly sculpin and 10 (27%) of 37 chinook salmon, and all of 11 American shad examined had food organisms.

Tables 11 and 21 show the numbers and weights of items consumed by the dominant fish with food in their stomachs. Though feeding was not intensive, the tables show trends in food

TABLE 10. DOMINANT SPECIES OF BEACH SEINE-CAUGHT FISH AND THE NUMBERS CAUGHT AND EXAMINED FOR FOOD UTILIZATION, PILLAR ROCK AREA

	DREDGE/DISPOSAL SITE				COMPARISON SITE			
Dominant Species	Total Caught	Number Examined	Number Empty	Percent Empty	Total Caught	Number Examined	Number Empty	Percent Empty
1977								
AUGUST								
PRE-DISPOSAL								
Chinook salmon	375	17	8	47	590	20	2	10
Shad	16	10	0	0	3	1	0	0
Stickleback	2281	18	17	94	1167	20	4	20
Peamouth chub	22	10	8	80	9	9	9	100
Starry flounder	51	11	7	64	5	3	0	0
NOVEMBER								
PRE-DISPOSAL								
Starry flounder	27	18	16	89	39	20	17	85
Stickleback	48	20	9	45	286	20	17	85
NOVEMBER								
DURING DISPOSAL								
Starry flounder	64	20	17	85	19	14	13	93
Stickleback	7	7	7	100	15	14	14	100
Prickly sculpin	8	8	8	100	3	3	1	33
DECEMBER								
DURING DREDGING								
Starry flounder	7	7	6	86	14	14	13	93
Stickleback	7	7	6	86	118	20	18	90
Prickly sculpin	0	0	0	0	5	5	3	60
JANUARY (1)								
POST-DREDGING								
Starry flounder	22	19	19	100	48	20	20	100
Stickleback	0	0	0	0	4	4	4	100
1978								
JANUARY (2)								
POST-DREDGING								
Starry flounder	4	4	4	100	6	6	6	100
Stickleback	14	13	9	69	1	1	1	100
TOTALS	2953	189	141		2332	194	142	
WEIGHTED AVE.				75				73

TABLE 11. NUMBERS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF BEACH SEINE-CAUGHT FISH, PILLAR ROCK AREA

	Dredge/Disposal Site				Comparison Site			
Dominant Species	Chinook	Stickleback	Starry Flounder	Shad	Chinook	Stickleback	Starry Flounder	Shad
1977								
AUGUST								
PRE-DISPOSAL								
C. salmonis	5		22	39	24		11	2
D. longispina	687			784	3882	160		
E. hirundoides					9	257		
Chiro. pupae					1			
N. mercedis	104		9	64				
Fish scales				3				
Chiro. larvae				5				
Dig. material		*		*				*
NOVEMBER								
PRE-DISPOSAL								
C. salmonis	42	3			2		3	
Dig. insects					*			
N. mercedis			8				38	
C. fluminea		39						
Copepods						38		
NOVEMBER								
DURING DISPOSAL								
Dig. material	*							
C. salmonis	4		2				14	
N. mercedis			3					7
Dig. Corophium								
DECEMBER								
DURING DISPOSAL								
C. salmonis		2		2		6		
N. mercedis			2	21		1	1	
A. confervicolus					2			
1978								
JANUARY 1.								
POST DISPOSAL								
C. salmonis		20						
Ephemeroptera		1						
Trichopteran		1			1			
Dig. material		*						
JANUARY 2.								
POST DISPOSAL								

* Indeterminate number of ingested items.

TABLE 12. WEIGHTS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF BEACH SEINE-CAUGHT FISH, PILLAR ROCK AREA.

	Dredge/Disposal Site				Comparison Site			
Dominant Species	Chinook (g)	Stickleback (g)	Starry Flounder (g)	Shad (g)	Chinook (g)	Stickleback (g)	Starry Flounder (g)	Shad (g)
1977								
AUGUST								
PRE-DISPOSAL								
C. salmonis	.0181		.0360	.0763	.0880		.0227	.0080
D. longispina	.2139			.2444	1.4613	.0494		
E. hirundoides					.0010	.0373		
Chiro. pupae					.0020			
N. mercedis	.8861		.0900	.4601				
Fish scales				.0254				
Chiro. larvae				.0091				
Dig. material		.0041		.5584				.0200
NOVEMBER								
PRE-DISPOSAL								
C. salmonis	.1239	.0091			.0057		.0087	
Dig. insects					.0146			
N. mercedis			.0382				.0072	
C. fluminea		.0473						
Copepods						.0035		
NOVEMBER								
DURING DISPOSAL								
Dig. material	.0041		.0021				.0406	
C. salmonis	.0174		.0183					
N. mercedis								.0448
Dig. corophium								
DECEMBER								
DURING DISPOSAL								
C. salmonis		.0054		.0056		.0181		
N. mercedis			.0146	.1509		.0034	.0071	
A. confervicolus					.0254			
1978								
JANUARY 1.								
POST DISPOSAL								
C. salmonis		.0321						
Ephemeroptera		.0016						
Trichopteran		.0017			.0141			
Dig. material		.0010						
JANUARY 2.								
POST DISPOSAL								

preference and rate of consumption.

Trawl Catch

Dredging and in-water disposal would be expected to cause some effect in those finfish species associated with the bottom habitat. Change could result in either an assembly or dispersal of finfish. Trawl sampling of the dredge and disposal sites was separate to assess the two different impacts (Table 13). Numerically important species were similar at both test areas and the control site. In order of numerical importance were: starry flounder, prickly sculpin, and longfin smelt. Flounder and sculpin numbers diminished during the 5-month study while longfin smelt numbers increased. Other common species taken with the trawl include eulachon, peamouth, shad, and Pacific staghorn sculpin. Several other species were also taken but in very small numbers.

Generally our trawl catches before, during, and after dredging were highest at the Woody Island comparison site and lowest at the dredge site. Trawling effort was increased during ongoing dredging to more effectively assess any numerical finfish changes. Trawl tows in the area being actively dredged (November 23, 28, and December 5th) indicated there were a diminished quantity of fish in respect to earlier pre-dredge efforts. However the first two November 23 tows at the disposal site revealed no change in finfish numbers from predredging. A second pair of trawl tows on the 23rd was

TABLE 13. NUMBER AND SPECIES OF FINFISH AND CRUSTACEANS CAPTURED WITH A 8 m SHRIMP TRAWL IN THE UPPER COLUMBIA RIVER AT A DREDGE, DISPOSAL, AND NEARBY COMPARISON SITE.

Comparison Site - Woody Island

	Pre-dredge				During dredge					Post dredge				
SPECIES	Aug 18	Aug 18	Nov 7	Nov 7	Nov 23	Nov 23	Dec 5	Dec 5	Dec 5 (two min. tow-hung up on log)	Jan 4	Jan 4	Jan 11	Jan 11	TOTALS
Pacific lamprey														0
White sturgeon														0
American shad			23	7	1									31
Chinook salmon			1											1
Longfin smelt			19	22	10	3				3	38		1	96
Eulachon										13	2	15	5	35
Peamouth chub	3	7	2	2	5	5								24
Threespine stickleback					1									1
Largescale sucker	1	1			6	1								9
Coastrange sculpin														0
Prickly sculpin	103	208	30	11	47	46	4	2		16	6	5	26	504
Pacific staghorn sculpin	1	2		1	10	6							2	22
Starry flounder	30	72	43	3	225	60	10	27	20	14		9	86	599
Pacific crayfish											1			1
TOTALS	138	290	118	46	305	121	14	29	20	46	47	29	120	1323

Dredge Site - Pillar Rock Channel

SPECIES	Aug 18	Aug 18	Nov 7	Nov 7	Nov 27	Nov 23	Nov 28	Nov 28	Dec 5	Dec 5	Jan 4	Jan 4	Jan 11	Jan 11	TOTALS
Pacific lamprey												1		1	2
White sturgeon	2							1							3
American shad			1	14					1	1					17
Chinook salmon															0
Longfin smelt			13	12	2		1		3	1	27	23			82
Eulachon											4	12	8	10	34
Peamouth chub	1	2	9	9		1									22
Threespine stickleback								1			4	1			6
Largescale sucker			1												1
Coastrange sculpin															0
Prickly sculpin	11	9	15	20	6	6	1	5	1	1	4			1	80
Pacific staghorn sculpin			2	1		3									6
Starry flounder	3	9	15	32	6	17	2	10	3		3		2	1	103
Pacific crayfish															0
TOTALS	17	20	56	88	14	27	4	17	8	3	42	37	10	13	356

Disposal Site - Jim Crow Sands

SPECIES	Aug 19	Aug 19	Nov 7	Nov 7	Nov 23	Nov 23	Nov 23	Nov 23	Dec 5	Dec 5	Jan 4	Jan 4	Jan 11	Jan 11	TOTALS
Pacific lamprey															0
White sturgeon															0
American shad		2	7	21	2	1			1						34
Chinook salmon							1								1
Longfin smelt			3	3	1		2			1	33	43	1		87
Eulachon											5	5	3	5	18
Peamouth chub	1	16	2	13	4	1									37
Threespine stickleback											2	2			4
Largescale sucker				3	5	2									10
Coastrange sculpin					1										1
Prickly sculpin	10	39	3	19	28	22	9	1	2	2	3	1	1		140
Pacific staghorn sculpin	1	1	1	13		8		1			1	1			27
Starry flounder	8	29	14	85	87	106	6	1			5	4	3	1	349
Pacific crayfish															0
TOTALS	20	87	30	157	128	140	18	3	3	3	49	56	8	6	708

was made further upstream directly over the active disposal area and did result in less fish. Tows on December 5th in the same area, during the latter stage of dredging, also produced few fish. However, the supposedly unaffected comparison site had fewer numbers of fish as well. The first post-dredging tows resulted in little difference in catches between all sites, though catches during the second January survey were lower at the dredge and disposal sites.

Examination of the gram weight values for the trawl captured finfish reveals a general similarity to numerical proportions (Table 14). Dredge or disposal related impacts on the gram weight changes of trawl captured finfish were not great based on our comparison site catch. Some depression in weights was obvious but for a comparatively short time (less than a month).

Numbers of dominant fish species captured by month and examined for food utilization are shown in Table 15. Principal species were the peamouth, starry flounder, prickly sculpin, longfin smelt, and eulachon. A total of 740 fish of these species was examined. Analysis revealed that of the numerically important finfish 77% were empty. Over the entire period all 77 eulachon (100%), 215 (86%) of 250 starry flounder, 28 (82%) of 34 peamouth, 90 (76%) of 119 longfin smelt, and 123 (56%) of 220 prickly sculpin had nothing in their stomachs.

TABLE 14. GRAM WEIGHT OF FINFISH AND CRUSTACEANS TAKEN WITH AN 8 m SHRIMP TRAWL IN THE UPPER COLUMBIA RIVER ESTUARY BETWEEN AUGUST 1977 AND JANUARY 1978.

Comparison Site - Woody Island Channel

SPECIES	Pre-dredge Aug 18	Aug 18	Nov 7	Nov 7	During dredge Nov 23	Nov 23	Dec 5	Dec 5	Dec 5		Post dredge Jan 4	Jan 4	Jan 11	Jan 11	TOTALS
Pacific lamprey															0
White sturgeon															0
American shad			221	65	10										296
Chinook salmon			16												16
Longfin smelt			186	208	84	28					22	373		9	910
Eulachon											529	67	636	207	1439
Peamouth	114	843	5	76	297	127									1462
Threespine stickleback					1										1
Largescale sucker	443	82			111	.10									646
Coastrange sculpin															0
Prickly sculpin	1455	1122	242	90	575	547	94	12			353	165	36	322	5013
Pacific staghorn sculpin	16	31		51	310	171								59	638
Starry flounder	515		642	50	3695	749	88	574	341		259		108	916	7937
Pacific crayfish												13			13
TOTALS	2543	2078	1312	540	5083	1632	182	586	341		1163	618	780	1513	18371

Dredge Site - Pillar Rock Channel

SPECIES	Aug 18	Aug 18	Nov 7	Nov 7	Nov 23	Nov 23	Dec 5	Dec 5	Dec 5		Jan 4	Jan 4	Jan 11	Jan 11	TOTALS
Pacific lamprey												4		2	6
White sturgeon	1171									406					1577
American shad			14	141			9	11							175
Chinook salmon															0
Longfin smelt			140	104	23		30	5	14		290	249			855
Eulachon											172	446	317	405	1340
Peamouth	82	182	245	84		21									614
Threespine stickleback										1	4	1			6
Largescale sucker			13												13
Coastrange sculpin															0
Prickly sculpin	19	59	129	302	28	125	2	6	2	142	68			50	932
Pacific staghorn sculpin			69	46		69									184
Starry flounder	46	158	236	688	107	143	56		27	76	57		12	5	1611
Pacific crayfish															0
TOTALS	1318	399	846	1365	158	358	97	22	43	625	591	700	329	462	7313

Disposal Site - Jim Crow Sands

SPECIES	Aug 19	Aug 19					Nov 23	Nov 23	Dec 5	Dec 5					TOTALS
Pacific Lamprey															0
White sturgeon															0
American shad		3	72	199	21	6			20						321
Chinook salmon							1								1
Longfin smelt			25	31	13		17			19	351	426	12		894
Eulachon											222	182	147	188	739
Peamouth	28	1382	5	86	17	7									1525
Threespine stickleback											2	2			4
Largescale sucker				44	58	27									129
Coastrange sculpin					1										1
Prickly sculpin	125	170	7	77	240	345	82	42	5	5	72	56	4		1230
Pacific staghorn sculpin	6	7	28	290		187		36			48	55			657
Starry flounder	141	443	202	1761	1077	1354	60	14			51	37	24	12	5176
Pacific crayfish															0
TOTALS	300	2005	339	2488	1427	1926	160	92	25	24	746	758	187	200	10677

TABLE 15. DOMINANT SPECIES OF TRAWL-CAUGHT FISH AND THE NUMBERS CAUGHT AND EXAMINED FOR FOOD UTILIZATION, PILLAR ROCK AREA

Dominant Species	DREDGE SITE Total Caught	Number Examined	Number Empty	Percent Empty	DISPOSAL SITE Total Caught	Number Examined	Number Empty	Percent Empty	COMPARISON SITE Total Caught	Number Examined	Number Empty	Percent Empty
1977												
AUGUST												
PRE-DREDGING												
Peamouth	3	3	3	100	17	11	8	73	10	10	9	90
Starry flounder	12	12	9	75	37	19	6	32	102	20	13	65
Prickly sculpin	20	20	4	20	49	19	4	21	311	20	2	10
NOVEMBER												
PRE-DREDGING												
Starry flounder	70	36	36	100	292	40	36	90	46	13	13	100
Peamouth	19	19	19	100	20	17	17	100	4	4	4	100
Longfin smelt	27	23	12	52	7	7	5	71	41	20	8	40
Prickly sculpin	47	31	25	81	72	33	18	54	41	20	16	80
NOVEMBER												
DURING DREDGING												
Starry flounder	12	12	12	100	7	7	7	100	285	20	15	75
Longfin smelt	1	1	1	100	2	2	2	100	13	13	9	69
Peamouth	0	0	0	0	0	0	0	0	10	10	8	80
Prickly sculpin	6	6	5	83	10	10	8	80	93	20	10	50
DECEMBER												
DURING DREDGING												
Starry flounder	3	3	2	67	0	0	0	0	37	20	18	90
JANUARY (1)												
POST-DREDGING												
Eulachon	16	14	14	100	10	10	10	100	15	12	12	100
Longfin smelt	50	20	20	100	76	20	20	100	41	13	13	100
Starry flounder	3	3	3	100	9	9	9	100	14	10	10	100
Prickly sculpin	4	4	2	50	4	4	2	50	22	16	14	88
JANUARY (2)												
POST-DREDGING												
Starry flounder	3	3	3	100	4	4	4	100	95	19	19	100
Prickly sculpin	1	1	1	100	1	1	1	100	31	15	11	73
Eulachon	18	18	18	100	8	8	8	100	20	15	15	100
TOTALS	315	229	189		625	221	165		1231	290	219	
WEIGHTED AVE.				83				75				76

The numbers and weights of items consumed by representatives of the dominant species of fish that had food in their stomachs are shown in tables 16 and 17. While feeding was not intensive, few differences between sites were noted, yet more food organisms were utilized at the comparison site than at either the dredge or disposal site.

Food Organisms

From the stomachs examined, 31 types of food organisms were identified along with indistinguishable digested material, fish bones, fish scales, gravel, sticks, and leaves (Table 18). Five of the 31 species identified were important in terms of numbers and weight and are presented graphically in Figure 8.

In numbers, C. salmonis and D. longispina contributed most to the diets of fish. By weight the food was dominated by several longfin smelt that had been consumed. The information is generally the same as results of a food utilization study conducted in the Columbia River estuary at Miller Sands (McConnell et al., in review), near Pillar Rock.

Length Characteristics

Based on the data, there were no obvious or significant differences in the size of fish between the three sites. Should size differences actually have existed, they could not be confirmed since the number of species available for measurements during the study fluctuated. Since we had gathered measurement

TABLE 16. NUMBERS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF TRAWL-CAUGHT FISH, PILLAR ROCK AREA.

Food Species	Dredge Site			Disposal Site			Comparison Site		
	Starry Flounder	Prickly Sculpin	Longfin Smelt	Starry Flounder	Prickly Sculpin	Longfin Smelt	Starry Flounder	Prickly Sculpin	Longfin Smelt
1977									
AUGUST									
PRE-DISPOSAL									
C. salmonis	28	120		25	127		55	324	
N. mercedis	8			154	15		2	4	
C. fluminea				1					
Dig. material								*	
Chiro. pupae					1				
Gravel					*				
NOVEMBER									
PRE-DISPOSAL									
C. salmonis		21	77	7	124	3		24	
Lamprey		1							
Longfin smelt		1			1				
N. mercedis			41		1	13			57
Dig. material									
S. entomon		1			1				
C. fluminea		2		2					
Dig. C. fluminea				*					
Dig. Corophium					*				
leaf								1	
NOVEMBER									
DURING DISPOSAL									
C. salmonis							62	60	29
C. fluminea							9		
Dig. material	*	*			*		*	*	
N. mercedis									10
Longfin smelt								1	
Oligochaetes dig.								*	
DECEMBER									
DURING DISPOSAL									
Dig. material	*								
Gravel						*		*	
C. salmonis		1					16		
Coleoptera larvae							1		
N. mercedis		1						4	
1978									
JANUARY 1									
POST DISPOSAL									
A. confervicolus									6
N. mercedis									28
C. salmonis					1				44
Snails								2	
Dig. material								*	
Isopods		13							
Barnacle		1							
P. leniusculus					1				
JANUARY 2									
POST-DISPOSAL									
A. confervicolus								4	
C. salmonis								7	
Oligochaete								2	
N. limnicola								1	
Dig. fish								1	

* Indeterminate number of food items.

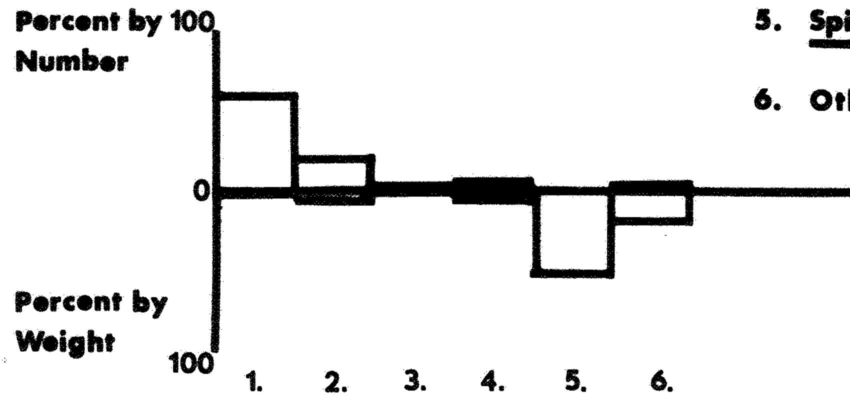
TABLE 17. WEIGHTS OF FOOD ITEMS CONSUMED BY DOMINANT SPECIES OF TRAWL-CAUGHT FISH, PILLAR ROCK AREA.

Food Species	Dredge Site			Disposal Site			Comparison Site		
	Starry Flounder	Prickly Sculpin	Longfin Smelt	Starry Flounder	Prickly Sculpin	Longfin Smelt	Starry Flounder	Prickly Sculpin	Longfin Smelt
	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
1977									
AUGUST									
PRE-DISPOSAL									
C. salmonis	.0521	.2857		.2790	.3629		.2079	1.0106	
N. mercedis	.0754			1.3395	.1225		.0160	.0344	
C. fluminea				.0287					
Dig. Material									
Chiro. pupae					.0150			.0216	
Gravel					.0130				
NOVEMBER									
PRE-DISPOSAL									
C. salmonis		.0067	.1530	.0114	.3076	.0210		.0840	
Lamprey		1.0282							
Longfin smelt		8.1826			7.6532				
N. mercedis			.2114		.0105	.1199			.5653
Dig. material									
S. entomon		.0460			.0480				
C. fluminea		.3184		.0183					
Dig. C. fluminea				.1115					
Dig. Corophium					.0106				
leaf								.0316	
NOVEMBER									
DURING DISPOSAL									
C. salmonis							.1880	.3940	.0697
C. fluminea							.0194		
Dig. material		.0231			.0547		.0163	.1095	
N. mercedis									.1205
Longfin smelt								3.2154	
Oligochaetes dig.								.0037	
DECEMBER									
DURING DISPOSAL									
Dig. material	.0555								
Gravel						.0044		.0714	
C. salmonis		.0026					.0464		
Coleoptera larvae							.0513		
N. mercedis		.0071						.0281	
1978									
JANUARY 1									
POST-DISPOSAL									
A. confervicolus									.0346
N. mercedis									.1672
C. salmonis					.0021				.1021
Snails								.3415	
Dig. material								.0757	
Isopods		1.2914							
Barnacle		.0532							
P. leniusculus					.3792				
JANUARY 2									
POST-DISPOSAL									
A. confervicolus								.0392	
C. salmonis								.0147	
Oligochaete								.0042	
N. limnicola								.0345	
Dig. fish								2.0421	

TABLE 18. SPECIES, NUMBERS, WEIGHTS, AND THE PERCENTAGE BY NUMBER AND WEIGHT OF ALL ITEMS CONSUMED BY FISH CAPTURED AT PILLAR ROCK, AUGUST 1977 THROUGH JANUARY 1978.

Species consumed	Number	% of diet based on No.	Weight (g)	% of diet based on weight
Annelida				
Polychaeta				
Neanthes limnicola	1		0.0345	
Oligochaeta	2		0.0042	
Digested oligochaetes	*		0.0337	
Mollusca				
Gastropoda	2		0.3415	
Amnicolidae	6		0.1129	
Bivalva				
Corbicula fluminea	108		1.0787	2
Digested *C. fluminea*	*		0.6103	1
Arthropoda				
Ostracoda	11		0.0001	
Cirripedia	1		0.0532	
Mysidacea				
Neomysis mercedis	599	6	4.8442	9
Cumacea				
Colurostylis occidentalis	3		0.0008	
Amphipoda				
Corophium salmonis	2100	21	6.3167	12
Digested *Corophium*	*		0.5314	1
Anisogammarus confervicolus	22		0.2320	
Decapoda				
Pacifasticus leniusculus	1		0.3792	
Isopoda				
Saduria entomon	2		0.0940	
Synidotea sp.	13		1.2914	2
Cladocera				
Daphnia longispina	6166	61	2.1327	4
Bosmina sp.	3		0.0004	
Unid. cladocerans	44		0.0133	
Dig. cladocerans	*		0.0072	
Copepoda				
Eurytemora hirundoides	716	7	0.0641	
Unid. copepods	10		0.0229	
Dig. copepods	*		0.0036	
Insecta				
Chironomid larvae	10		0.0177	
Chironomid pupae	2		0.0170	
Trichoptera larvae	2		0.0023	
Trichoptera	1		0.0141	
Neuroptera	1		0.0007	
Hemiptera	79	1	0.1002	
Coleoptera	17		0.1500	
Diptera	74	1	0.0738	
Hymenoptera	23		0.0229	
Ephemeroptera	4		0.0019	
Plecoptera	2		0.0017	
Digested insects	*		0.2642	
Other				
Fish bones	*		0.2120	
Digested fish	1		2.0421	4
Fish scales	8		0.0474	
Gravel	*		0.0605	
Arachnid	32		0.0669	
Sticks	*		0.0422	
Leaf	1		0.0316	
Entosphenus tridentatus	1		1.0282	2
Spirinchus thaleichthys	3		29.0512	54
Dig. material	*		2.2814	4
All other combined		2		5
TOTALS	10071	100	53.7330	100

* Indeterminate numbers due to digested state.



	Species	% No.	% Wt.
1.	*Daphnia longispina*	61	4
2.	*Corophium salmonis*	21	12
3.	*Eurytemora hirundoides*	7	1
4.	*Neomysis mercedis*	6	9
5.	*Spirinchus thaleichthys*	1	54
6.	Other	4	20

Figure 8. Proportional importance, by number and weight, of food organisms consumed by Pillar Rock finfish.

data it seemed best to utilize it in a grouped manner separated only by individual survey time periods. This then provided a means for determining the size of dominant finfish, their age groupings, as well as revealing growth.

Length frequency histograms are shown for American shad, Figure 9; juvenile fall Chinook salmon, Figure 10; longfin smelt, Figure 11; eulachon, Figure 12; threespine stickleback, Figure 13; prickly sculpin, Figure 14; Pacific staghorn sculpin, Figure 15; and starry flounder, Figure 16.

American shad were mainly juveniles ranging from 46 to 130 mm. Juvenile fall chinook were common during the August survey when their size ranged from 88 to 151 mm. Considerably fewer chinook were taken in November and thereafter, though some growth was evident. Longfin smelt appeared in all sampling surveys except August. The longfin smelt stock seemed to consist entirely of adult spawning fish which appear to peak in this area during January.

Eulachon ranged in length from 142 to 208 mm and though a few were captured in early Nobember, most appeared during Jnauary.

Threespine stickleback, the most abundant fish, occurred in all six surveys, but most appeared prior to dredging. A single age group seem to characterize these fish and growth was evident.

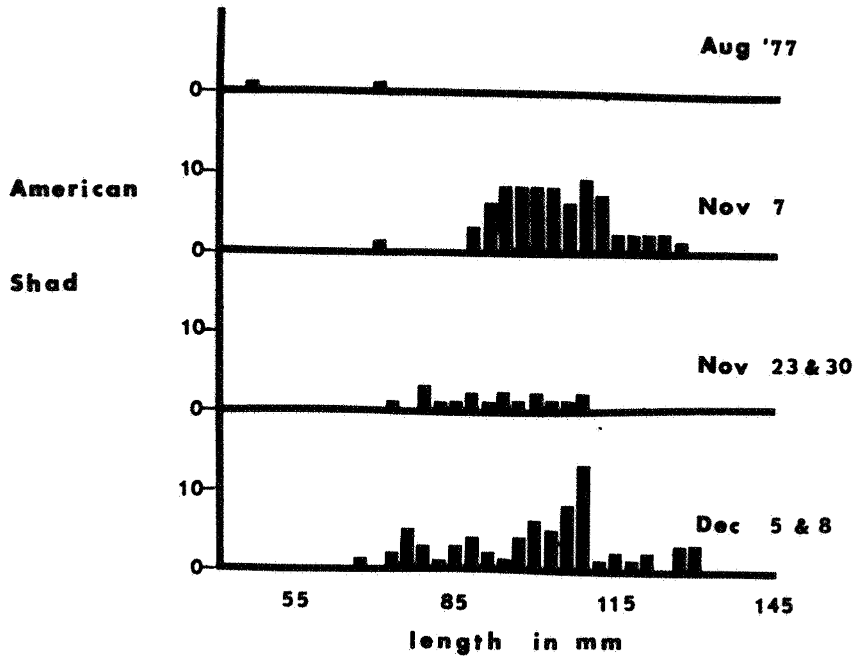


Figure 9. Length frequency histogram of American shad (Alosa sapidissima) captured during surveys at the Pillar Rock area.

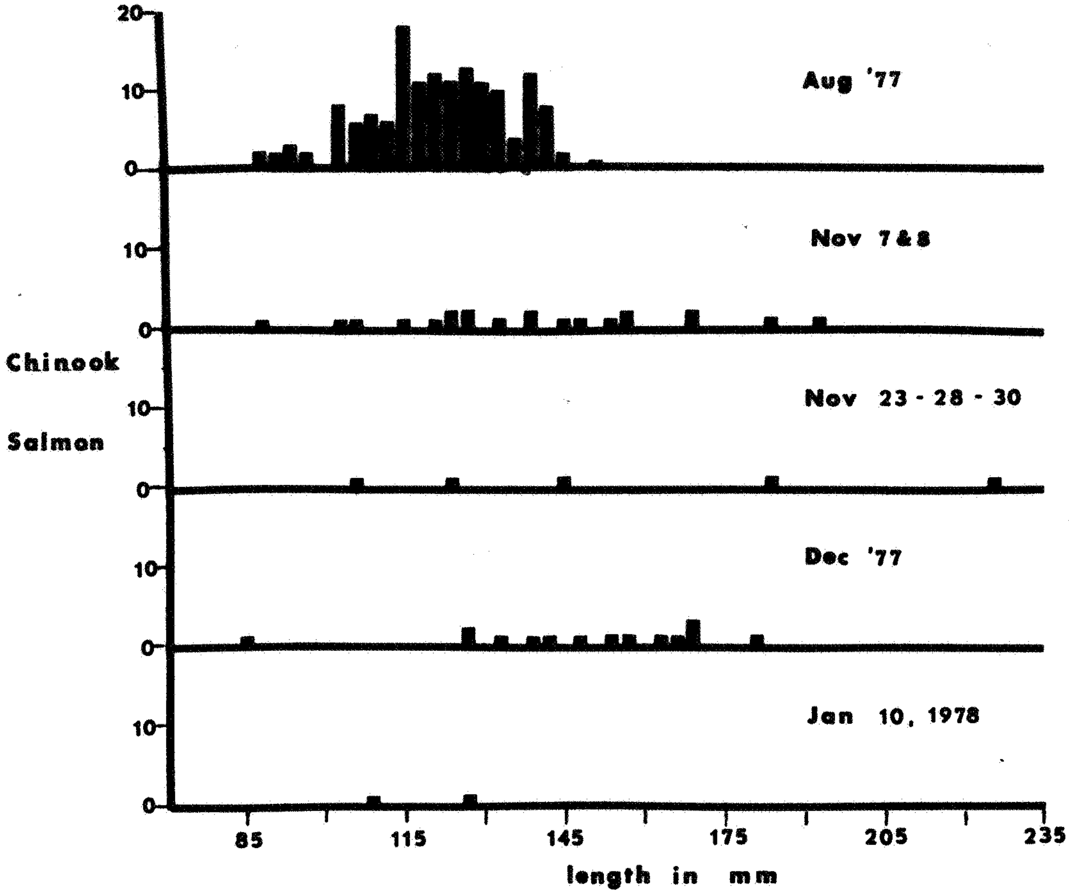


Figure 10. Length frequency histogram of chinook salmon (<u>Oncorhynchus tshawytscha</u>) captured during surveys at the Pillar Rock area.

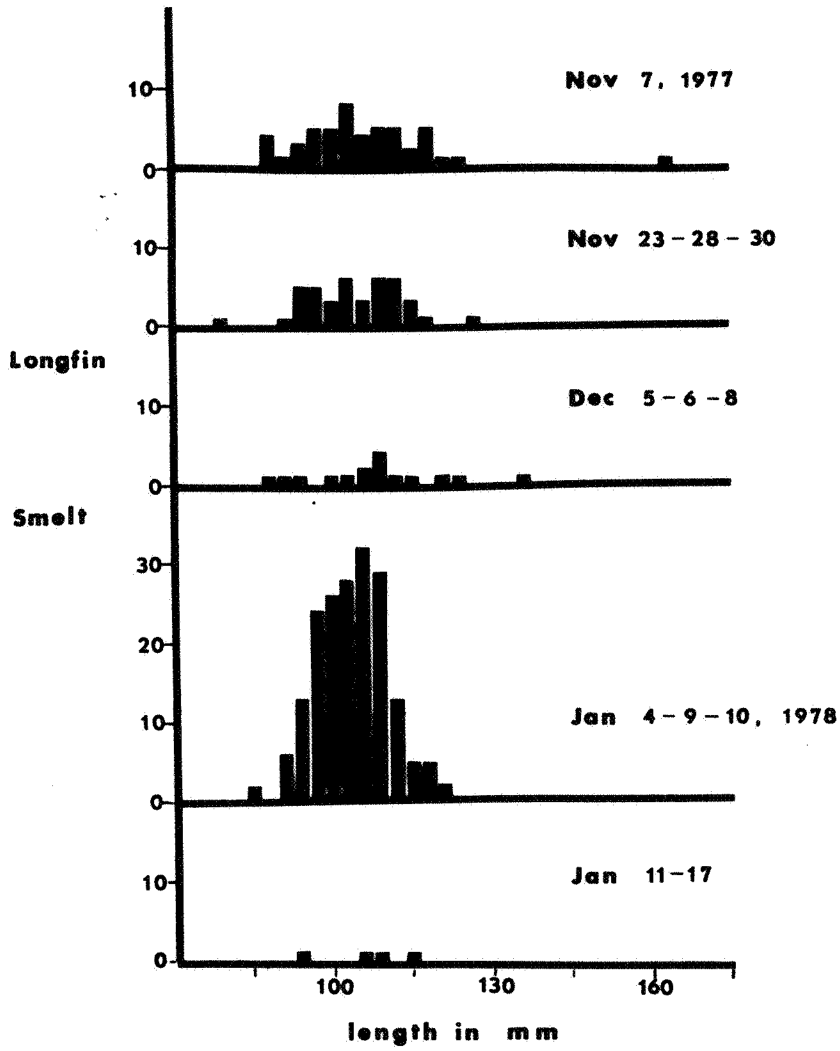


Figure 11. Length frequency histogram of longfin smelt (Spirinchus thaleichthys) captured during surveys at the Pillar Rock area.

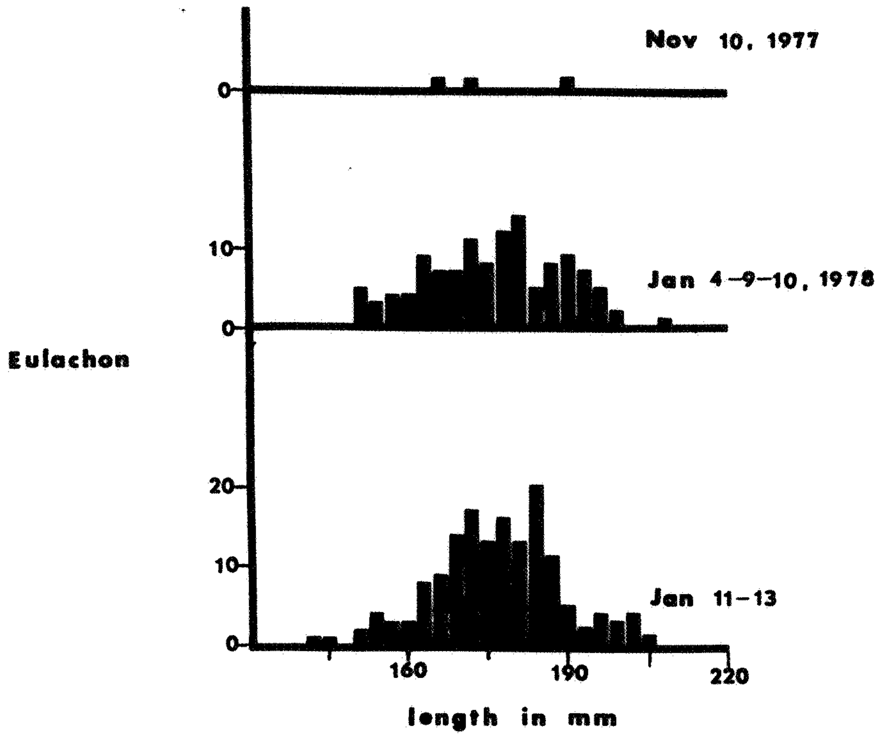


Figure 12. Length frequency histogram of eulachon (*Thaleichthys pacificus*) captured during surveys at the Pillar Rock area.

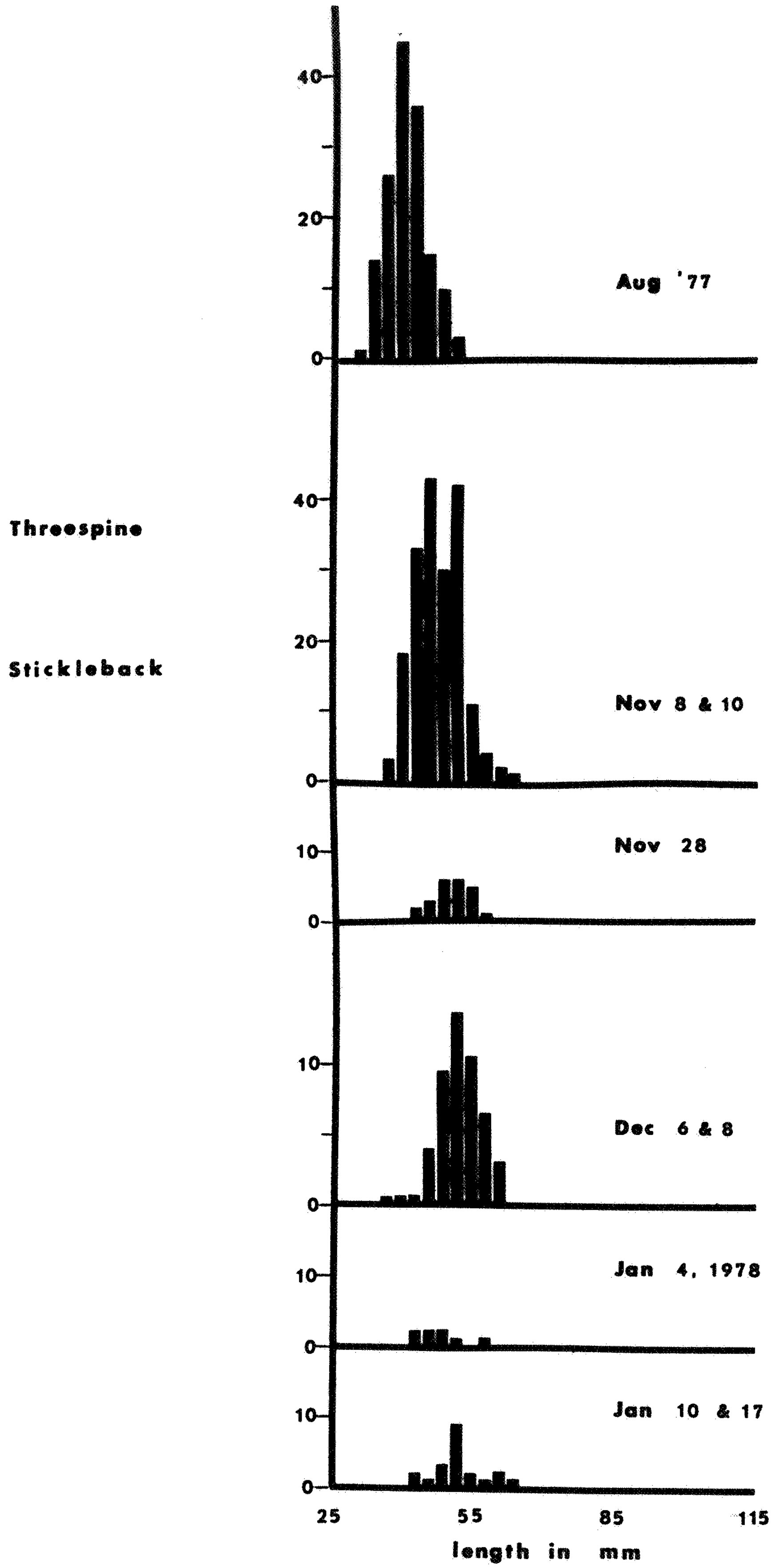


Figure 13. Length frequency histogram of threespine stickleback (<u>Gasterosteus aculeatus</u>) captured during surveys at the Pillar Rock area.

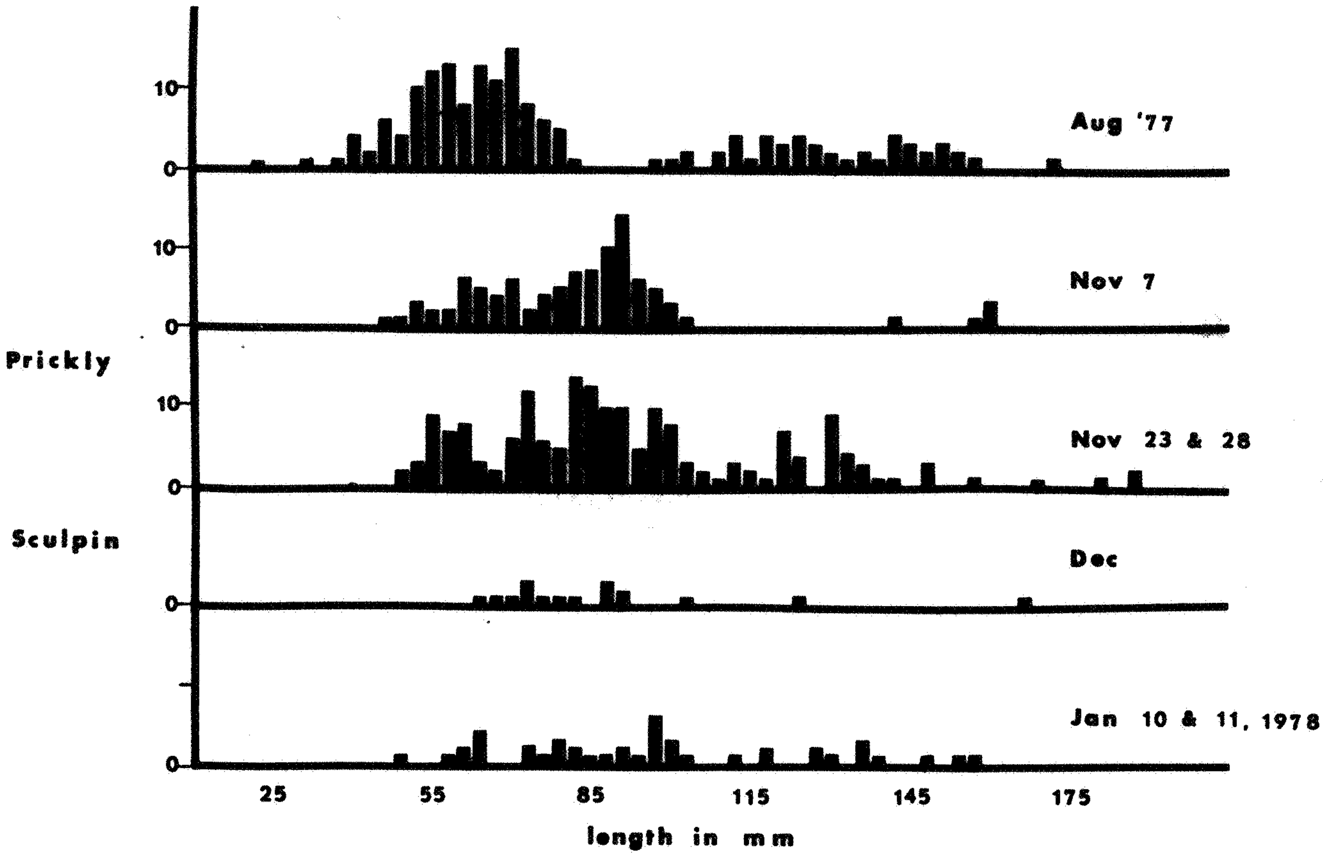


Figure 14. Length frequency histogram of prickly sculpin (Cottus asper) captured during surveys at the Pillar Rock area.

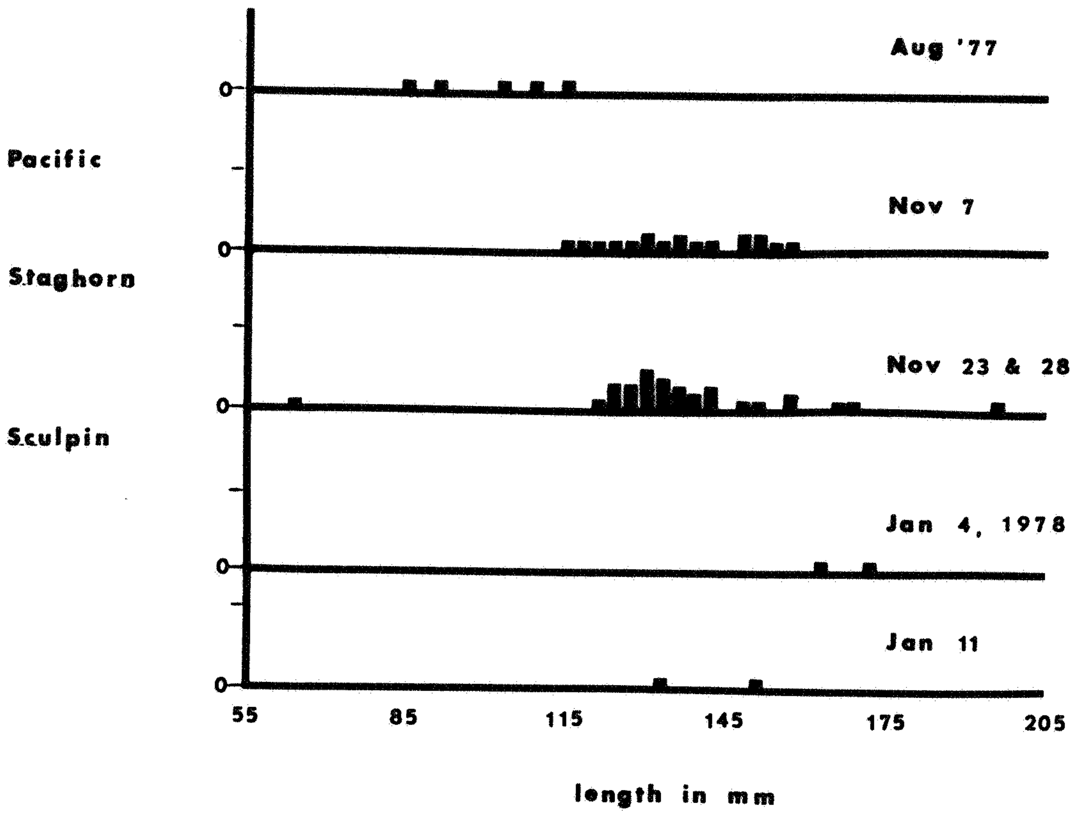


Figure 15. Length frequency histogram of Pacific staghorn sculpin (Leptocottus armatus) captured during surveys at Pillar Rock area.

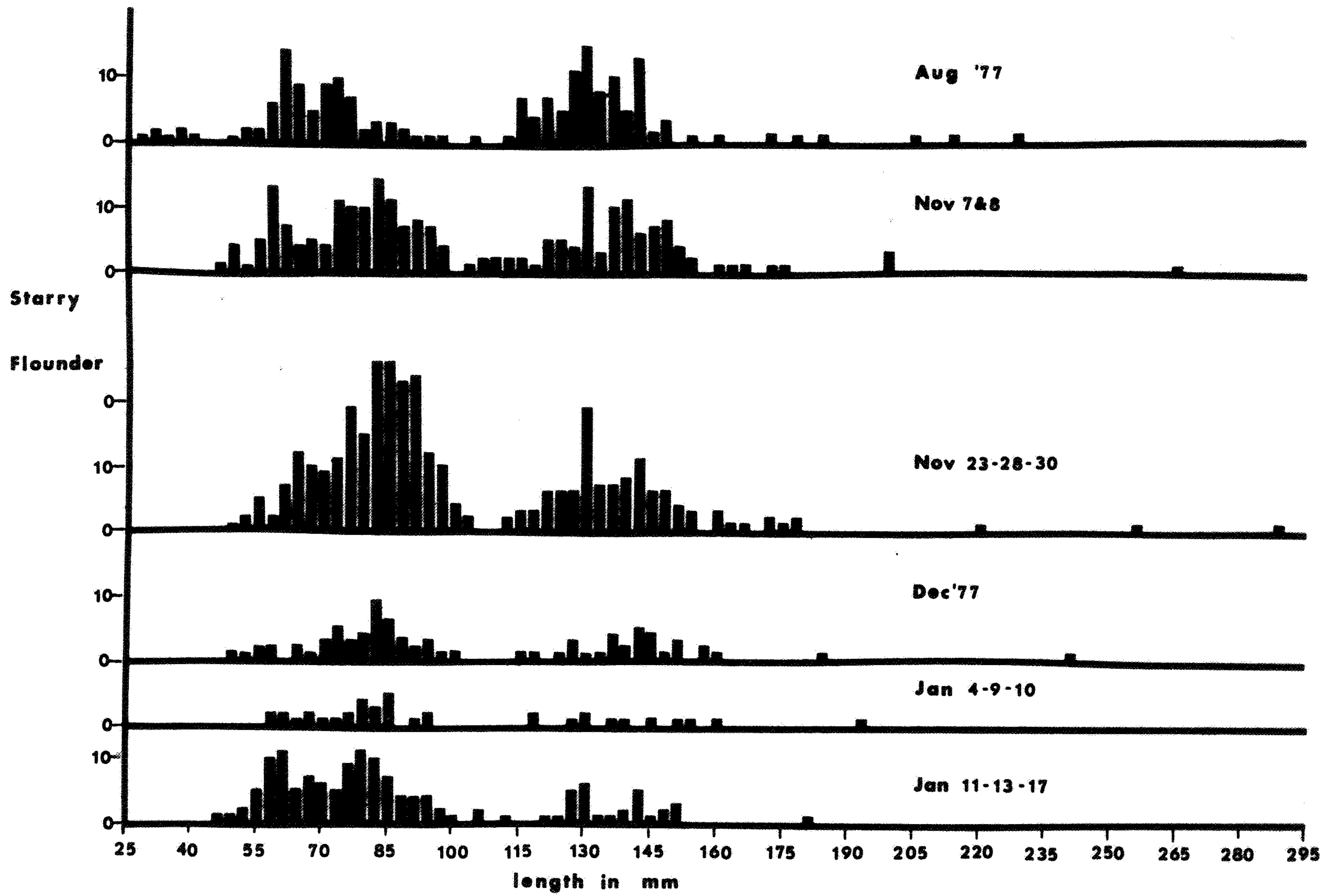


Figure 16. Length frequency histogram of starry flounder (<u>Platichthys stellatus</u>) captured during surveys at Pillar Rock area.

Prickly sculpin was one of the few species with more than one size or age group. Several size groups were apparent in August though each may have included two year classes. Pacific staghorn sculpin are a marine species previously unreported in this particular area. Most appeared in late November but some occurred in each survey. At least several age groups use the area and these tolerate both fresh water and the associated water temperatures. Starry flounder were common in each of the six surveys. Several size groups were distinct through the sampling period but only the younger group increased in size.

Marked Fish Recoveries

A total of eight fin-clipped salmonids were captured in the study, seven by purse seine and one with the beach seine. Information about the fish and their marks is listed below.

Date	Site	Gear	Species	Fork Length	Mark
8/26/77	Disposal	Purse Seine	Steelhead	612 mm	Deformed dorsal and right pectoral
11/08/77	Comparison	Beach Seine	Steelhead	269 mm	Adipose, Left pectoral, Right ventral, dorsal, Right anterior 3 brand
	--Released from Ringold Hatchery 4/15/77--				
11/10/77	Dredge	Purse Seine	Chinook	134 mm	Adipose
	--Released from Kalama Falls Hatchery 9/28/77--				
11/10/77	Comparison	Purse Seine	Chinook	194 mm	Adipose, Right maxillary, Right anterior 3 brand
11/30/77	Comparison	Purse Seine	Chinook	145 mm	Adipose
12/08/77	Disposal	Purse Seine	Chinook	141 mm	Adipose
12/08/77	Comparison	Purse Seine	Steelhead	281 mm	Adipose

SAMPLING RESULTS - INVERTEBRATES

Benthic Infauna

A total of 5669 benthic invertebrates weighing 48.96 grams (net weight) were collected. Tables are presented that compare the benthic invertebrate populations at the dredge, disposal, and comparison sites based on either number/m^2 or weight/m^2. The Asiatic clam, Corbicula fluminea, was tabulated separately while the remaining species were combined.

The following groups made up 93% of all invertebrates and 99% of their weight.

Group	Actual Total No.	Percent By Number	Gram Wet Wt.	Percent By Weight
Oligochaeta	145	3	0.098	tr
Bivalvia	1206	21	43.545	89
Amphipoda	3579	63	4.873	10
Diptera	326	6	0.094	tr
TOTAL	5256	93	48.610	99

The complete benthic invertebrate species list is shown in Table 19. Twenty types were encountered during the study, of which 14 were identified to genus and 11 further identified to species.

Average numbers and weights of benthic invertebrates per m^2 (except C. fluminea) declined steadily after the pre-dredge

TABLE 19. LIST OF BENTHIC INVERTEBRATE SPECIES COLLECTED DURING PILLAR ROCK STUDY.

Nematoda
- Unidentified nematodes

Annelida
- Oligochaeta
  - Unidentified oligochaetes
- Polychaeta
  - *Neanthes limnicola*

Mollusca
- Gastropoda
  - Amnicolidae
  - *Pleurocera* sp.
- Bivalva
  - *Corbicula fluminea*

Arthropoda
- Mysidacea
  - *Neomysis mercedis*
- Amphipoda
  - *Corophium salmonis*
  - *Anisogammarus confervicolus*
  - *Eohaustorius* sp.
- Cladocera
  - *Daphnia longispina*
  - *Bosmina longirostris*
  - *Leptodora kindtii*
- Copepoda
  - *Diaptomus* sp.
  - *Eurytemora hirundoides*
  - *Epischura nevadensis*
  - *Cyclops vernalis*

Insecta
- Diptera
  - Tendipedidae
- Coleoptera
  - Scarabidae

Other
- Arachnid

surveys (Table 20 and 21). A 95% decline in both numbers and weights occurred during the study at the dredge sites. Numbers of invertebrates declined by 85% and weights by 80% at the comparison sites.

Amphipod distribution, especially C. salmonis, at the comparison site is probably patchy as indicated by the variations in numbers captured. For example in August, 988 amphipods were collected at Station 16 yet only 43 at Station 12. In contrast invertebrate distribution at the dredge and disposal sites was comparatively even.

Changes in numbers and weights of C. fluminea (Tables 22 and 23) were analyzed separately from other invertebrates because the weight of their shells obscured other organisms' weight. A 75% reduction in numbers of C. fluminea and a 92% weight reduction occurred at the dredge site. Numbers and weights of clams at the comparison site dropped by 82% and 52%, respectively.

Benthic Epifauna

Collection of epibenthic samples was attempted during the surveys but sand clogged the equipment on most tows. Each successful sample was preserved, sorted, and counted for a determination of species diversity. Table 24 lists the 16 categories collected. Organism counts are available but do not provide an accurate picture of the proportion in which

TABLE 20. NUMBERS PER m^2 OF BENTHIC INVERTEBRATES (except *Corbicula fluminea*) AT THE PILLAR ROCK STUDY AREA. COMPARISON BY STATION, AREA, AND TIME.

Station	Pre-dredge 1/	During dredge 2/	Post-dredge 3/	TOTAL	AVERAGE
Dredge					
1	72.0	6.0	2.5	80.5	26.8
2	11.5	16.0	1.5	29.0	9.7
5	24.0	3.0	1.5	28.5	9.5
8	47.0	11.0	2.5	60.5	20.2
9	113.0	6.0	6.0	125.0	41.7
T	267.5	42.0	14.0	323.5	107.9
Ave.	53.5	8.4	2.8	64.7	21.6
Disposal					
3	14.0	8.5	2.5	25.0	8.3
4	17.0	8.0	0.5	25.5	8.5
6	58.0	10.5	9.0	77.5	25.8
7	27.0	27.5	7.0	61.5	20.5
10	24.0	7.0	3.5	34.5	11.5
11	21.0	18.0	2.0	41.0	13.7
T	161.0	79.5	24.5	265.0	88.3
Ave.	26.8	13.3	4.1	44.2	14.7
Comparison site					
12	38.5	10.5	9.5	58.5	19.5
13	120.0	10.5	6.0	136.5	45.5
14	173.5	26.5	86.5	286.5	95.5
15	111.0	49.0	10.5	170.5	56.8
16	514.5	485.5	6.0	1006.0	335.3
T	957.5	582.0	118.5	1658.0	552.6
Ave.	191.5	116.4	23.7	331.6	110.5

1/ Average of August 30 and November 9, 1977
2/ Average of November 29 and December 7, 1977
3/ Average of January 6 and January 12, 1978

TABLE 21. WEIGHTS PER m^2 OF BENTHIC INVERTEBRATES (except *Corbicula fluminea*) AT THE PILLAR ROCK STUDY AREA. COMPARISON BY STATION, AREA, AND TIME.

Station	Pre-dredge 1/	During dredge 2/	Post-dredge 3/	TOTAL	AVERAGE
	(g)	(g)	(g)	(g)	(g)
Dredge					
1	0.0144	0.0039	0.0002	0.0185	0.0062
2	0.0016	0.0351	0.0013	0.0380	0.0127
5	0.0061	0.0109	0.0012	0.0182	0.0061
8	0.0119	0.0019	0.0029	0.0167	0.0056
9	0.1066	0.0040	0.0020	0.1126	0.0375
T	0.1406	0.0558	0.0076	0.2040	0.0681
Ave.	0.0281	0.0112	0.0015	0.0408	0.0136
Disposal					
3	0.0089	0.0013	0.0030	0.0132	0.0044
4	0.0067	0.0036	0.0008	0.0111	0.0037
6	0.0375	0.0076	0.0028	0.0479	0.0160
7	0.0135	0.0110	0.0086	0.0331	0.0110
10	0.0185	0.0062	0.0018	0.0265	0.0088
11	0.0143	0.0100	0.0032	0.0275	0.0092
T	0.0994	0.0397	0.0202	0.1593	0.0531
Ave.	0.0166	0.0066	0.0034	0.0265	0.0088
Comparison site					
12	0.0428	0.0102	0.0203	0.0733	0.0244
13	0.1754	0.0115	0.0784	0.2653	0.0884
14	0.2189	0.0257	0.1123	0.3569	0.1190
15	0.1339	0.0288	0.0096	0.1723	0.0574
16	0.8890	0.5895	0.0042	1.4827	0.4942
T	1.4600	0.6657	0.2248	2.3505	0.7834
Ave.	0.2920	0.1331	0.0450	0.4701	0.1567

1/ Average of August 30 and November 9, 1977
2/ Average of November 29 and December 7, 1977
3/ Average of January 6 and January 12, 1978

TABLE 22. NUMBERS PER m^2 OF *Corbicula fluminea* AT THE PILLAR ROCK STUDY AREA. COMPARISON BY STATION, AREA, AND TIME.

Station	Pre-dredge 1/	During dredge 2/	Post-dredge 3/	TOTAL	AVERAGE
Dredge					
1	16.0	0.5	1.0	17.5	5.8
2	11.0	4.0	7.0	22.0	7.3
5	28.0	2.5	2.0	32.5	10.8
8	14.5	2.5	1.5	18.5	6.2
9	7.5	1.0	9.0	17.5	5.8
T	77.0	10.5	19.5	108.0	35.9
Ave.	15.4	2.1	3.9	21.6	7.2
Disposal					
3	7.5	2.5	7.5	17.5	5.8
4	13.5	2.5	4.0	20.0	6.7
6	10.0	25.5	3.0	38.5	12.8
7	21.0	9.5	1.5	32.0	10.7
10	8.5	4.0	2.5	15.0	5.0
11	8.5	11.5	0.5	20.5	6.8
T	69.0	55.5	19.0	143.5	47.8
Ave.	11.5	9.2	3.2	23.9	7.9
Comparison site					
12	11.0	7.0	0.0	18.0	6.0
13	12.0	3.0	9.5	24.5	8.2
14	65.0	7.0	14.5	86.5	28.8
15	20.0	68.0	2.0	90.0	30.0
16	44.5	102.0	1.5	148.0	49.3
T	152.5	187.0	27.5	367.0	122.3
Ave.	30.5	37.4	5.5	73.4	24.5

1/ Average of August 30 and November 9, 1977
2/ Average of November 29 and December 7, 1977
3/ Average of January 6 and January 12, 1978

TABLE 23. WEIGHT PER m^2 OF *Corbicula fluminea* AT THE PILLAR ROCK STUDY AREA. COMPARISON BY STATION, AREA, AND TIME.

Station	Pre-dredge 1/	During dredge 2/	Post-dredge 3/	TOTAL	AVERAGE
	(g)	(g)	(g)	(g)	(g)
Dredge					
1	0.2140	tr	0.0006	0.2146	0.0715
2	0.0104	0.0038	0.0105	0.0247	0.0082
5	0.0483	0.0028	0.0036	0.0547	0.0182
8	0.1112	0.4909	0.0071	0.6092	0.2031
9	0.0844	0.0003	0.0179	0.1026	0.0342
T	0.4683	0.4978	0.0397	1.0058	0.3352
Ave.	0.0937	0.0996	0.0079	0.2012	0.0670
Disposal					
3	0.2608	0.0854	0.4140	0.7602	0.2534
4	2.4360	0.0032	0.2179	2.6571	0.8857
6	0.0619	0.4434	0.0019	0.5072	0.1691
7	0.0912	0.0120	0.0003	0.1035	0.0345
10	0.0093	0.0051	0.0070	0.0214	0.0071
11	0.0159	4.1930	0.0006	4.2095	1.4032
T	2.8751	4.7421	0.6417	8.2589	2.7530
Ave.	0.4792	0.7903	0.1069	1.3765	0.4588
Comparison site					
12	0.3219	0.1325	0.0000	0.4544	0.1515
13	1.3099	0.7471	0.0093	2.0663	0.6888
14	1.1523	0.0112	2.9694	4.1329	1.3776
15	2.0733	0.5909	0.0006	2.6648	0.8883
16	1.3539	1.8377	0.0001	3.1917	1.0639
T	6.2113	3.3194	2.9794	12.5101	4.1701
Ave.	1.2423	0.6639	0.5959	2.5020	0.8340

1/ Average of August 30 and November 9, 1977
2/ Average of November 29 and December 7, 1977
3/ Average of January 6 and January 12, 1978

TABLE 24. LIST OF EPIBENTHIC SPECIES COLLECTED DURING THE PILLAR ROCK STUDY

SPECIES	Presence Aug 30	Nov 9	Nov 29	Dec 7	Jan 9	Jan 13
Nematoda						
Unidentified nematodes			x	x		
Annelida						
Oligochaeta						
Unidentified oligochaetes	x			x		
Polychaeta	x					
Neanthes limnicola						
Mollusca						
Gastropoda						
Amnicolidae		x	x			
Bivalva						
Corbicula fluminea	x	x	x	x		x
Arthropoda						
Mysidacea						
Neomysis mercedis	x	x	x	x	x	x
Amphipoda						
Corophium salmonis	x	x	x	x	x	x
Isopoda						
Saduria entomon		x				
Cladocera	x	x	x	x		
Daphnia longispina						
Bosmina longirostris						
Leptodora kindtii						
Copepoda	x	x				
Insecta			x	x		
Diptera	x	x	x	x		
Tendipedidae						
Plecoptera						x
Ephemeroptera						
Fish						
Platichthys stellatus	x	x				
Cottus asper	x	x				
Miscellaneous						
Eggs				x		

the animals occurred in the epibenthos because of the clogging problem.

Gross estimates indicate the most abundant epifauna are (1) amphipods, C. salmonis; (2) mysids, N. mercedis; and (3) bivalves, C. fluminea. The clams, C. fluminea, are surface dwellers or shallow burrowers and were captured by trawl and epibenthic equipment as well as the grab sampler.

Because of the problems encountered during epibenthic sampling, numerical changes occurring relative to dredging activities cannot be evaluated.

SAMPLING RESULTS - PHYSICAL STUDIES

Sediment Texture

Bottom grabs were taken for sediment texture analysis at each of the 16 benthic and water quality stations during every second survey. Pre-dredging samples were taken August 30, dredging samples November 29, and post-dredging samples January 6. The North Pacific Division Materials Laboratory at Troutdale, Oregon sieved the individual samples for particle size determination.

Tests reveal the bottom was essentially fine and medium sand with minor proportions of fine gravel, coarse sand, and clay. Bottom texture data were grouped by area, averaged, and compared by survey to determine changes. This tended to smooth the data and was useful for graphic presentations.

Sediments at the dredge site were composed primarily of material ranging from 0.125 to 0.5 mm throughout the entire study (Figure 17). During dredging a slightly higher proportion of medium sand, coarse sand, and fine gravel was noted. However, post-dredge sediment samples had a lower proportion of coarse material and a higher proportion of medium to fine sand.

Sediments at the disposal site (Figure 18) also had high proportions of medium to fine sand throughout the study.

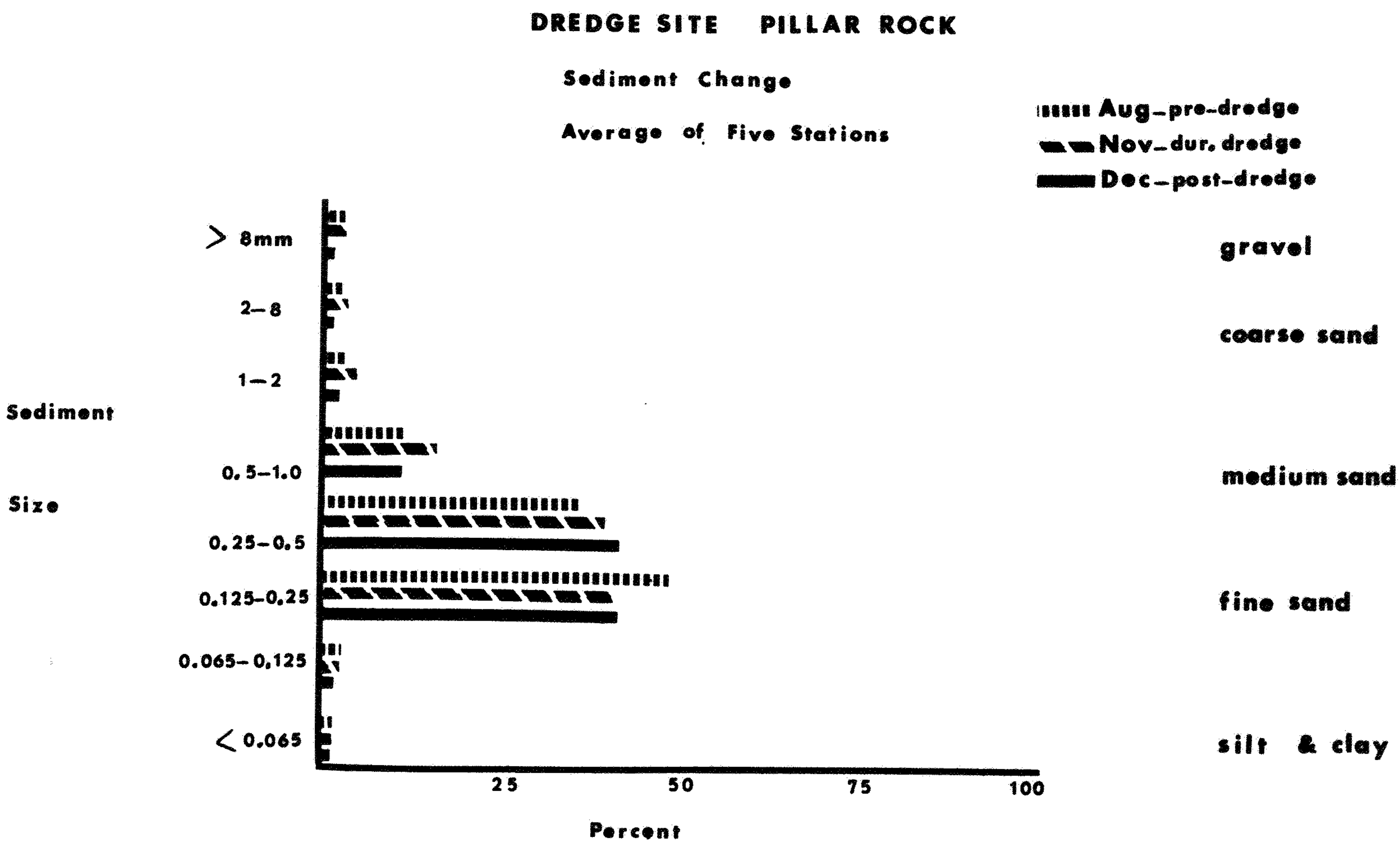


Figure 17. Particle size comparison of bottom sediments taken during three surveys at the Pillar Rock study dredge site.

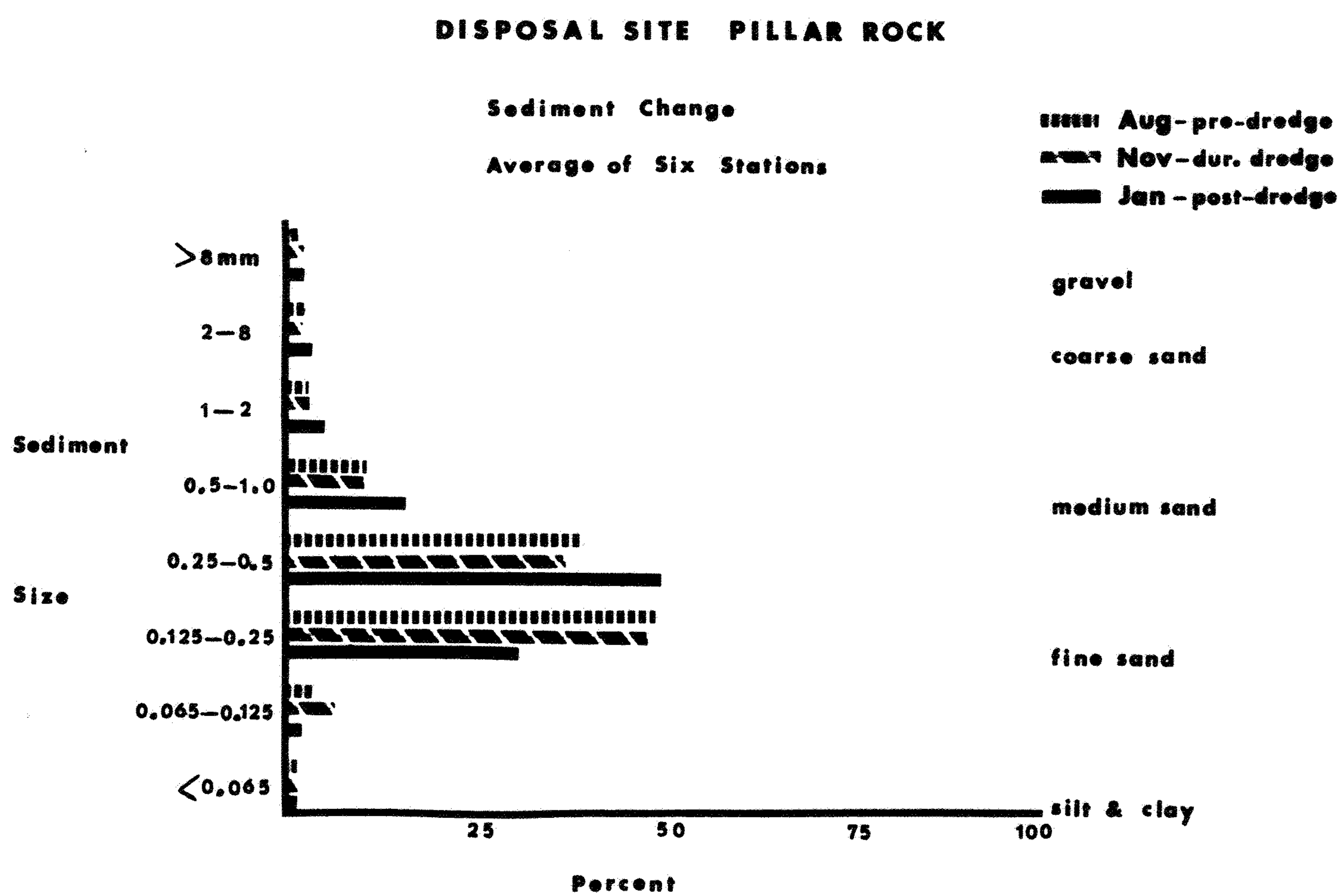


Figure 18. Particle size comparison of bottom sediments taken during three surveys at the Pillar Rock study disposal site.

There was little change between the pre-dredge and during-dredge results. Based on the post-dredge survey, sediments at this site differed from two previous surveys by having a higher proportion of medium and coarse sand. The site with the greatest change toward coarse material was located at the west or downstream end of the disposal site.

Comparison site sediments were also proportionately high in medium and fine sand (Figure 19). Changes in this area were greater than at the dredge and disposal sites; though logically they should have been less. Samples taken during dredging and following dredging indicate a higher proportion of fine sand accumulated and remained at the comparison site. Examination by specific stations indicates changes occurred at all but the northwest site (Station 6). Accumulated sediments may have come from the disposal site. They may also have settled out of turbid floodwaters.

Volatile Solids

A portion of each sediment sample was analysed by the North Pacific Division Materials Laboratory for organic content. Data were grouped by area, averaged, and compared by time and location with results graphically shown in Figure 20. Bottom sediments can be considered clean sand at all areas and during all three surveys. Only 3 of 48 samples contained over 1% volatile solids and those

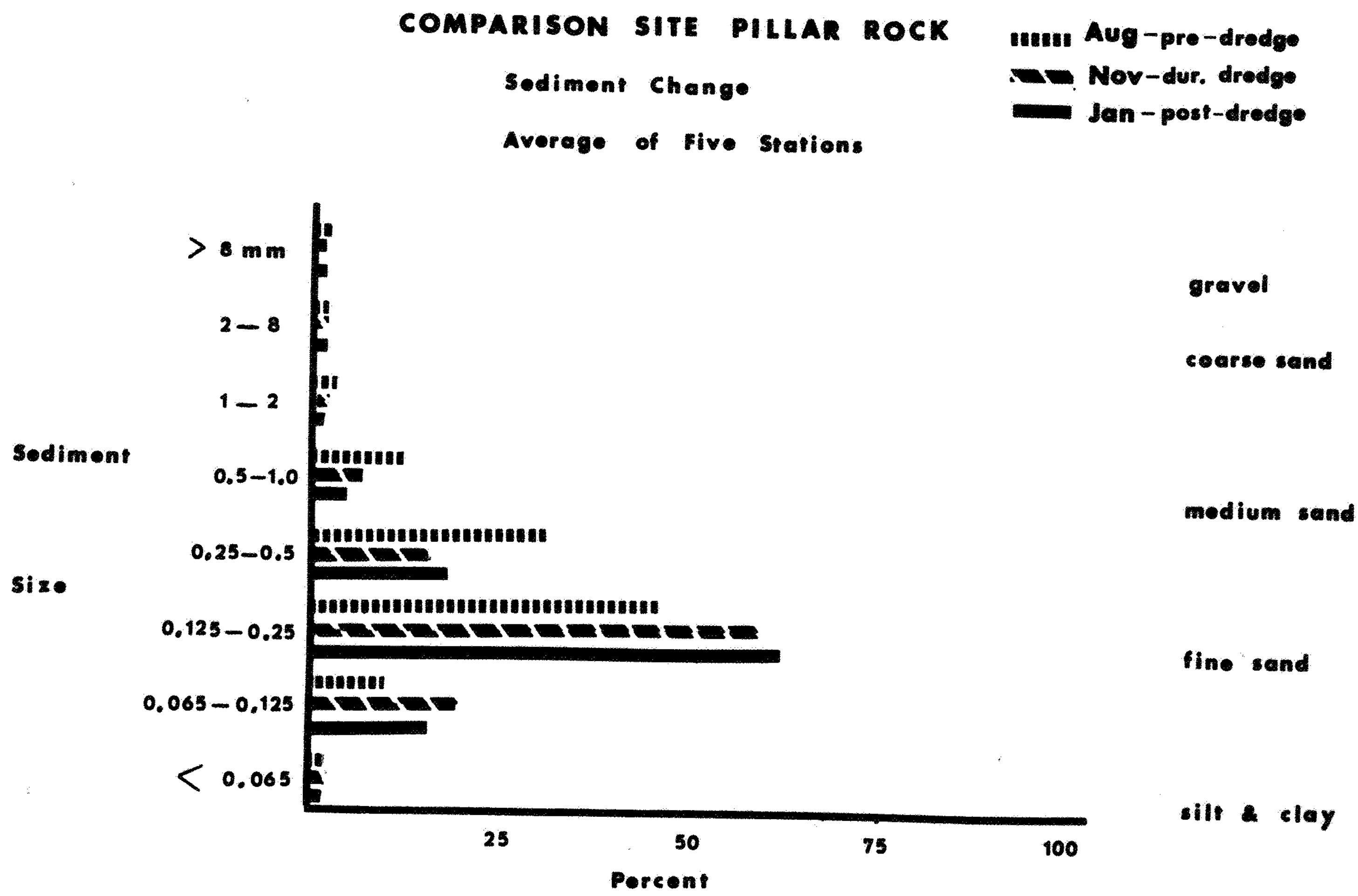


Figure 19. Particle size comparison of bottom sediments taken during three surveys at the Pillar Rock study comparison site.

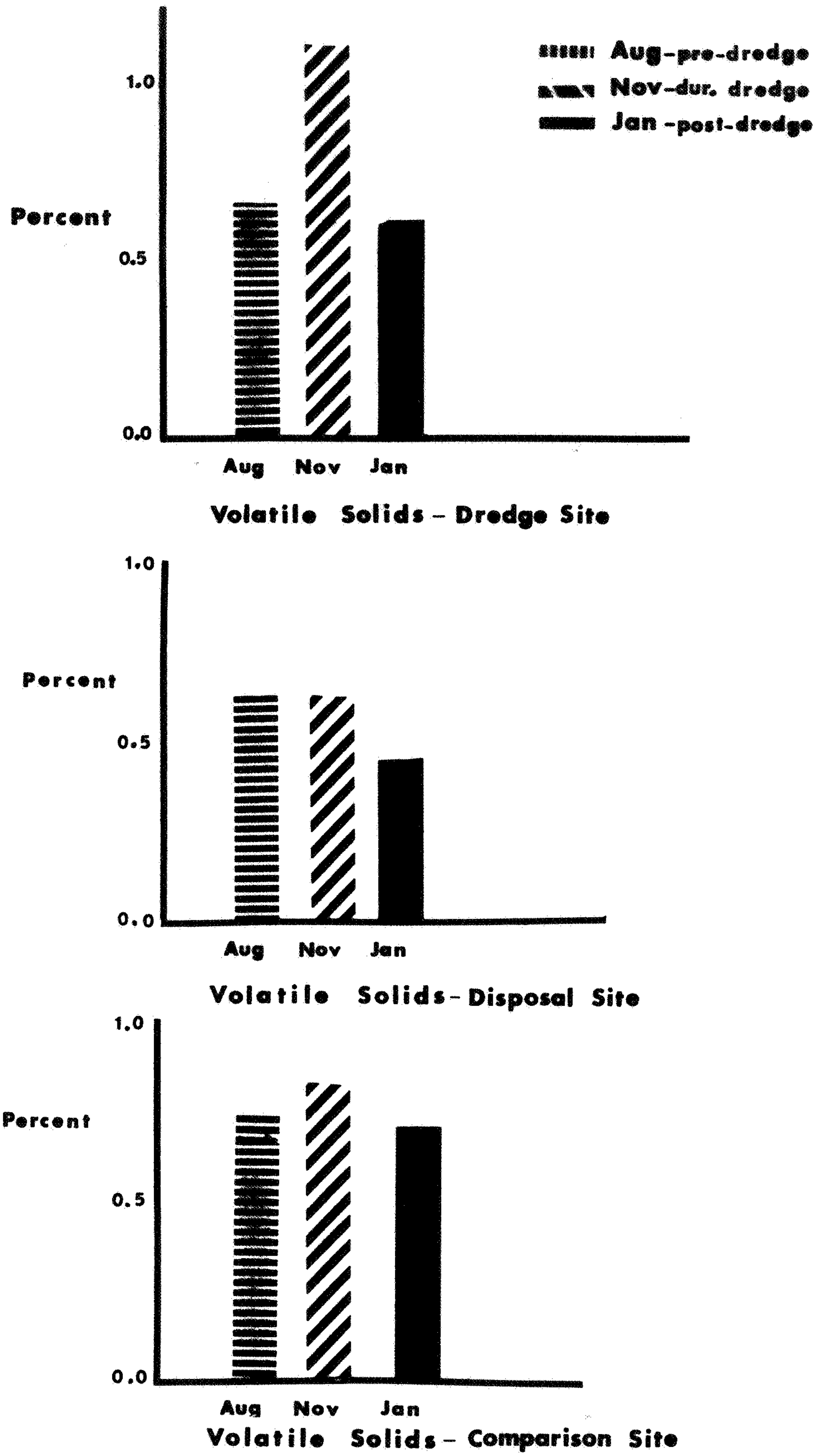


Figure 20. Average percent volatile solid content of sediments taken during three surveys at the Pillar Rock dredge, disposal, and comparison sites.

were found in samples taken during dredging. The highest percent organic matter was 2.5 % at the dredge site south of Jim Crow Point (Station 5). Lowest content recorded was 0.36% in a January sample south of red buoy 18 at the disposal area. Volatile content averaged highest during dredging and lowest after dredging, while pre-dredge levels were in between. The overall indicated change of volatile solids was not great.

Depth Changes

Depth readings taken from our research vessels have limited value in determining overall depth changes due to tidal effects and large differences in the volume of water in the Columbia River. The data gathered did not reveal any obvious deepening or shallowing of sample sites in relation to dredging. The C. E. Navigation Division provided depth charts of the flow-lane disposal site prior to dredging, during dredging, and following dredging (Fig. 21). Chart readings indicate the disposal area was somewhat shallower during active disposal. In January, a month after dredging ceased, depths at the eastern or upstream end of the disposal site appeared similar to depths prior to dredging. The notable overall change at the disposal site after dredging was a pronounced shallowing of approximately 5 feet at the western or downstream section.

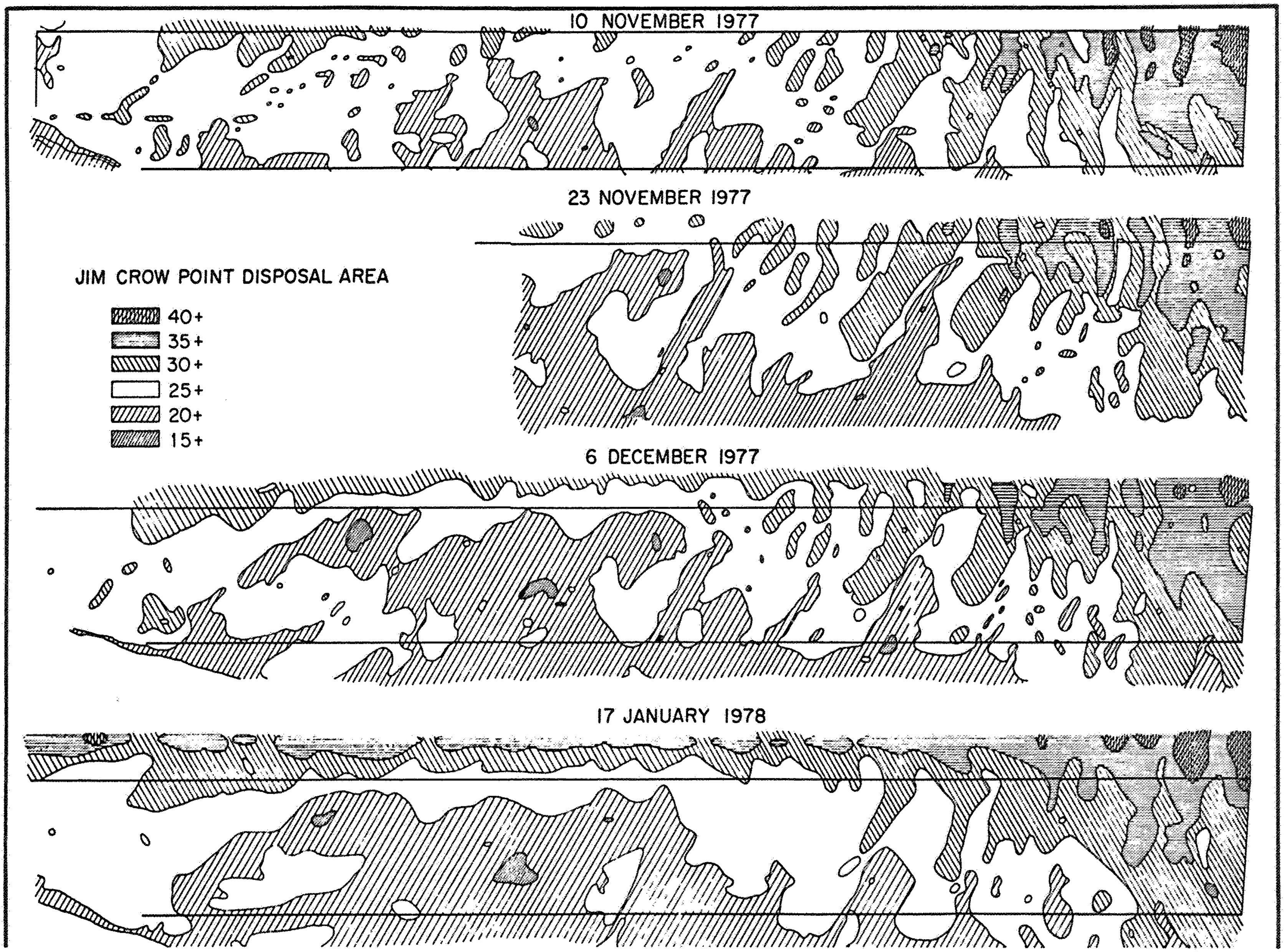


Figure 21. Indicated depths of the Pillar Rock flowlane disposal site before (10 Nov.), during (23 Nov. and 6 Dec.), and after (17 Jan.) 325,000 cubic yards of sediment deposition. Based on readings from U.S. Army Corps of Engineers Portland District).

Based on these charts flow-lane disposal resulted in sediment movement downstream as predicted.

Water Quality

For comparative purposes the 16 water quality stations monitored during the six surveys at Pillar Rock are grouped into three areas: dredge (Stations 1, 2, 5, 8, 9); disposal (Stations 3, 4, 6, 7, 10, 11); and the comparison area at Woody Island Channel (Stations 12, 13, 14, 15, and 16). Water quality values collected at each station (top and bottom) are averaged for each site and survey period and presented in Table 25. A comparison was also made with water quality parameters collected on the day prior to the Pillar Rock Survey at the National Marine Fisheries Service Facility at Prescott, Oregon. This facility is approximately 44 river miles upstream from the Pillar Rock study area.

Water quality data collected during the six surveys, for each site are presented in Tables 26 through 31.

Flow conditions during the actual dredging operation, in November and December 1977, were above normal. The Willamette River discharge was 152 and 181%, respectively greater than the 15 years average; while the discharge at the mouth of the Columbia in November was 184,000 cfs (103% above average). In December, the average flow was 400,200 cfs

TABLE 25. AVERAGE WATER QUALITY VALUES, BY SITE (DREDGE, DISPOSAL, AND COMPARISON) AND SAMPLING PERIOD, COLLECTED AT PILLAR ROCK, COLUMBIA RIVER MILE 28. VALUES FOR PRESCOTT WERE TAKEN 44 MILES UPSTREAM.

	Pre-Dredge		During		Post-Dredge	
	8-30	11-9	11-29	12-7	1-6	1-12
			Temperature (°C)			
Dredge	19.75	9.96	7.91	7.25	2.56	4.61
Disposal	19.75	9.92	7.88	7.32	2.49	4.82
Comparison	19.84	9.71	7.91	7.38	2.54	4.76
Prescott	19.75	11.00	8.40	8.07	2.67	4.90
			Conductivity (millimhos/cm)			
Dredge	.13	.24	.22	.45	.13	.12
Disposal	.15	.20	.18	.32	.13	.12
Comparison	.15	.23	.16	.26	.12	.14
Prescott	.14	.28	.28	.10	.15	.15
			Salinity (0/00)			
Dredge	.07	.20	.16	.24	.12	.09
Disposal	.08	.19	.14	.25	.10	.10
Comparison	.07	.22	.10	.21	.12	.11
Prescott	.05	.17	.18	.06	.10	.10
			Turbidity (FTU)			
Dredge	3.02	4.02	29.85	25.90	14.60	20.90
Disposal	2.88	3.90	30.67	26.33	15.00	18.92
Comparison	2.90	3.57	35.00	25.70	13.40	11.40
Prescott	2.83	3.17	53.00	21.50	12.30	17.00
			pH			
Dredge	7.43	7.80	7.50	7.06	7.58	7.45
Disposal	7.71	7.85	7.52	7.09	7.64	7.53
Comparison	7.62	7.73	8.01	7.28	7.48	7.55
Prescott	7.79	7.87	7.10	7.35	7.60	7.57
			O_2 (mg/l)			
Dredge	7.19	10.26	11.22	11.47	12.86	12.01
Disposal	7.18	10.28	11.26	11.57	12.98	11.94
Comparison	7.41	10.28	11.16	11.59	13.11	11.56
Prescott	8.18	10.00	11.54	11.18	12.71	12.44

TABLE 26. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED PRIOR TO THE DREDGING AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). AUGUST 30, 1977

Station	Temperature (°C)		Conductivity (millimhos/cm)		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
DREDGE SITE												
	A [1/]	B [2/]	A	B	A	B	A	B	A	B	A	B
1	19.8	19.8	.14	.14	.08	.08	7.1	6.1	7.3	7.4	2.9	4.6
2	19.7	19.7	.14	.14	.08	.08	7.4	7.5	7.6	6.8	2.4	4.6
5	19.7	19.7	.09	.07	.04	.07	7.7	7.8	7.2	6.9	2.0	3.3
8	19.9	19.7	.14	.14	.08	.08	7.7	7.6	7.4	6.9	2.0	3.8
9	19.8	19.7	.15	.14	.08	.07	7.7	7.7	7.5	6.9	1.8	2.8
Average	19.8	19.7	.13	.13	.07	.08	7.3	7.3	7.4	7.0	1.9	3.8
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	19.7	19.7	.18	.18	.09	.09	7.8	7.4	7.3	6.9	3.0	4.4
4	19.7	19.7	.17	.16	.08	.07	7.7	7.8	7.4	6.8	2.8	4.0
6	19.8	19.7	.17	.17	.08	.08	7.9	8.0	7.5	6.9	2.0	3.6
7	19.9	19.7	.13	.14	.09	.08	7.7	7.7	7.3	7.2	1.8	3.0
10	19.8	19.7	.14	.13	.07	.07	7.7	7.6	7.3	6.9	1.8	3.4
11	19.9	19.7	.13	.14	.06	.08	7.7	7.5	7.4	7.2	2.0	2.8
Average	19.8	19.7	.15	.15	.08	.08	7.8	7.7	7.4	6.9	2.2	3.5
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	19.8	19.8	.16	.13	.09	.06	7.8	7.7	7.4	7.3	1.8	4.4
13	19.9	19.7	.15	.15	.08	.08	7.7	7.6	7.4	7.3	1.8	4.4
14	19.9	19.9	.18	.13	.09	.07	7.6	7.6	7.5	7.4	2.0	4.0
15	19.8	19.8	.16	.15	.09	.06	7.6	7.8	7.6	7.3	2.2	3.0
16	19.8	19.8	.14	.13	.06	.04	7.6	7.6	7.6	7.3	3.0	4.0
Average	19.8	19.8	.16	.14	.08	.06	7.7	7.7	7.5	7.3	2.2	3.9

1/ Surface
2/ Bottom

TABLE 27. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED PRIOR TO THE DREDGING AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). NOVEMBER 9, 1977

Station	Temperature (°C)		Conductivity (millimhos/cm		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
DREDGE SITE												
	A [1]	B [2]	A	B	A	B	A	B	A	B	A	B
1	10.3	10.0	.30	.24	.22	.18	7.6	7.8	10.1	10.0	2.7	4.7
2	9.8	9.9	.30	.21	.02	.22	7.9	7.9	10.3	10.2	2.6	4.8
5	9.9	10.0	.23	.22	.19	.20	7.9	7.7	10.3	10.3	3.8	5.0
8	9.9	10.0	.22	.24	.18	.19	7.8	7.9	10.4	10.3	3.4	4.8
9	9.9	9.9	.21	.21	.18	.18	7.8	7.8	10.4	10.3	3.4	5.0
Average	9.9	9.9	.25	.22	.16	.19	7.8	7.8	10.3	10.2	3.2	4.9
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	9.9	9.9	.24	.30	.22	.24	7.7	7.9	10.3	10.2	3.2	4.8
4	9.9	10.0	.24	.30	.26	.20	7.9	7.9	10.3	10.2	3.9	5.0
6	9.9	10.0	.22	.23	.19	.19	7.9	7.9	10.3	10.3	3.4	3.0
7	9.0	10.0	.21	.25	.17	.17	7.6	7.8	10.3	10.2	3.8	3.8
10	9.8	9.9	.22	.23	.16	.16	7.8	7.9	10.3	10.2	3.8	4.6
11	9.9	9.9	.22	.23	.16	.16	7.9	7.9	10.4	10.4	3.3	4.2
Average	9.9	9.9	.23	.26	.19	.19	7.8	7.8	10.3	10.3	3.6	4.2
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	9.7	9.7	.21	.21	.16	.16	7.7	7.7	10.3	10.4	3.4	4.2
13	9.7	9.7	.24	.23	.16	.17	7.7	7.8	10.2	10.3	3.4	4.0
14	9.7	9.7	.20	.26	.12	.22	7.7	7.7	10.2	10.2	3.2	4.7
15	9.7	9.7	.22	.22	.16	.18	7.7	7.8	10.2	10.2	2.6	3.2
16	9.8	9.7	.24	.26	.18	.20	7.7	7.8	10.4	10.4	3.0	4.0
Average	9.7	9.7	.22	.24	.16	.19	7.7	7.8	10.3	10.3	3.1	4.0

1/ Surface
2/ Bottom

TABLE 28. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED DURING THE ACTUAL DREDGE AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). NOVEMBER 29, 1977

Station	Temperature (°C)		Conductivity (millimhos/cm)		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
	A 1/	B 2/	A	B	A	B	A	B	A	B	A	B
DREDGE SITE												
1	7.9	7.9	.27	.27	.19	.19	7.2	7.1	11.2	11.1	27.0	30.0
2	7.9	7.9	.29	.30	.22	.24	7.2	7.1	11.3	11.3	27.0	30.0
5	7.9	7.9	.20	.20	.14	.15	7.4	7.4	11.1	11.3	26.0	26.0
8	7.9	7.9	.18	.16	.13	.12	7.8	7.8	11.2	11.3	29.0	34.0
9	7.9	8.0	.16	.14	.11	.10	8.0	8.1	11.2	11.2	38.0	34.0
Average	7.9	7.9	.22	.21	.16	.16	7.5	7.5	11.2	11.2	29.5	30.2
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	7.9	7.9	.23	.23	.18	.15	7.2	7.2	11.8	11.2	28.0	31.0
4	7.9	7.9	.20	.10	.12	.16	7.3	7.3	11.2	11.2	27.0	30.0
6	7.8	7.8	.18	.18	.12	.14	7.4	7.3	11.2	11.2	28.0	30.0
7	7.9	7.9	.18	.18	.12	.14	7.4	7.7	11.2	11.2	28.0	30.0
10	7.9	7.9	.17	.16	.12	.11	7.8	7.8	11.3	11.2	32.0	36.0
11	7.9	7.9	.14	.14	.07	.07	7.8	7.8	11.3	11.2	32.0	38.0
Average	7.9	7.9	.18	.17	.12	.13	7.5	7.5	11.3	11.2	29.2	32.2
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	8.1	8.0	.17	.15	.10	.10	7.8	8.1	11.2	11.2	32.0	36.0
13	7.9	8.0	.16	.16	.10	.10	8.1	8.1	11.2	11.2	34.0	38.0
14	7.9	7.9	.16	.16	.10	.10	8.2	8.1	11.2	11.2	34.0	38.0
15	7.7	7.8	.16	.15	.09	.08	7.9	8.1	11.1	11.1	32.0	38.0
16	7.9	7.8	.15	.16	.09	.11	7.9	8.1	11.0	11.1	32.0	38.0
Average	7.9	7.9	.16	.16	.09	.09	7.9	8.1	11.1	11.2	32.4	37.6

1/ Surface
2/ Bottom

TABLE 29. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED DURING THE ACTUAL DREDGING AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). DECEMBER 7, 1977

Station	Temperature (°C)		Conductivity (millimhos/cm)		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
DREDGE SITE												
	A 1/	B 2/	A	B	A	B	A	B	A	B	A	B
1	7.2	7.2	.34	.37	.28	.30	6.9	7.1	11.4	11.6	22.0	25.0
2	7.2	7.2	.40	.37	.32	.29	6.9	6.9	11.4	11.5	24.0	26.0
5	7.2	7.3	.32	.32	.24	.24	6.4	6.4	11.4	11.6	24.0	34.0
8	7.3	7.3	.25	.25	.23	.23	7.4	7.2	11.5	11.5	24.0	28.0
9	7.3	7.3	.32	.24	.25	.20	7.7	7.7	11.3	11.5	24.0	28.0
Average	7.2	7.3	.32	.31	.26	.25	7.1	7.1	11.4	11.5	23.6	28.2
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	7.2	7.3	.35	.35	.30	.29	6.9	6.9	11.6	11.5	24.0	26.0
4	7.2	7.3	.34	.34	.30	.29	7.1	7.1	11.4	11.5	24.0	26.0
6	7.2	7.7	.33	.33	.24	.26	6.6	6.6	11.5	11.8	24.0	30.0
7	7.3	7.3	.29	.24	.22	.21	6.9	6.9	11.6	11.6	25.0	29.0
10	7.3	7.3	.32	.30	.25	.20	7.6	7.5	11.7	11.6	24.0	27.0
11	7.4	7.3	.30	.30	.22	.22	7.6	7.6	11.5	11.5	28.0	29.0
Average	7.3	7.4	.32	.31	.26	.24	7.1	7.1	11.6	11.6	24.8	27.8
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	7.5	7.4	.28	.28	.23	.23	7.2	7.1	11.6	11.5	22.0	25.0
13	7.4	7.4	.26	.26	.22	.22	7.3	7.3	11.7	11.6	24.0	26.0
14	7.3	7.3	.26	.26	.22	.20	7.4	7.3	11.6	11.6	24.0	26.0
15	7.4	7.4	.26	.26	.21	.21	7.4	7.3	11.6	11.5	28.0	30.0
16	7.3	7.4	.26	.26	.19	.21	7.3	7.3	11.6	11.6	24.0	28.0
Average	7.4	7.4	.26	.26	.21	.21	7.3	7.3	11.6	11.5	24.4	27.0

1/ Surface
2/ Bottom

TABLE 30. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED AFTER THE ACTUAL DREDGING AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). JANUARY 6, 1978

Station	Temperature (°C)		Conductivity (millimhos/cm)		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
	A 1/	B 2/	A	B	A	B	A	B	A	B	A	B
DREDGE SITE												
1	2.6	2.5	.18	.14	.17	.13	7.1	7.2	12.8	12.9	13.0	15.0
2	2.5	2.5	.11	.14	.11	.12	7.6	7.6	12.8	12.8	13.0	15.0
5	2.5	2.5	.12	.12	.11	.11	7.7	7.8	12.8	12.9	15.0	15.0
8	2.5	2.8	.12	.13	.10	.11	7.7	7.7	12.9	12.9	14.0	18.0
9	2.5	2.5	.12	.12	.11	.11	7.7	7.7	12.9	12.9	13.0	15.0
Average	2.5	2.5	.13	.13	.12	.12	7.6	7.6	12.8	12.9	13.6	15.6
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	2.5	2.5	.13	.13	.11	.11	7.7	7.7	12.7	12.8	18.0	18.0
4	2.4	2.5	.13	.13	.11	.11	7.7	7.7	13.1	13.1	18.0	15.0
6	2.5	2.5	.14	.13	.12	.11	7.7	7.7	13.0	12.9	14.0	15.0
7	2.5	2.5	.15	.12	.12	.11	7.7	7.7	13.2	13.2	14.0	15.0
10	2.5	2.5	.10	.12	.06	.09	7.7	7.7	13.0	13.1	13.0	13.0
11	2.6	2.5	.12	.14	.10	.11	7.2	7.7	12.8	12.9	12.0	14.0
Average	2.5	2.5	.13	.13	.10	.11	7.6	7.7	12.9	13.0	14.8	15.0
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	2.5	2.5	.16	.14	.14	.12	7.8	7.7	13.2	13.1	13.0	14.0
13	2.5	2.5	.12	.14	.11	.12	7.7	7.7	13.2	13.1	13.0	14.0
14	2.6	2.5	.12	.13	.11	.11	7.2	7.3	13.2	13.1	13.0	14.0
15	2.6	2.5	.12	.12	.11	.11	7.4	7.4	13.0	13.1	13.0	13.0
16	2.6	2.5	.13	.13	.12	.11	7.5	7.5	13.1	13.1	13.0	13.8
Average	2.5	2.5	.13	.13	.12	.11	7.5	7.5	13.1	13.1	13.0	13.8

1/ Surface
2/ Bottom

TABLE 31. SURFACE AND BOTTOM WATER QUALITY VALUES, BY STATION, WHICH OCCURRED AFTER THE ACTUAL DREDGING AND DISPOSAL OPERATION AT PILLAR ROCK (CRM 28). JANUARY 12, 1978

Station	Temperature (°C)		Conductivity (millimhos/cm)		Salinity (0/00)		pH		O_2 (mg/l)		Turbidity (FTU)	
DREDGE SITE												
	A 1/	B 2/	A	B	A	B	A	B	A	B	A	B
1	4.7	4.7	.15	.10	.10	09	7.2	7.2	12.2	12.1	20.0	27.0
2	4.6	4.7	.13	.10	.10	.08	7.3	7.3	12.2	12.0	20.0	28.0
5	4.6	4.6	.11	.11	.09	.09	7.5	7.4	12.0	11.8	19.0	19.0
8	4.6	4.5	.11	.12	.09	.10	7.9	7.8	12.0	11.9	19.0	19.0
9	4.6	4.5	.12	.12	.10	.10	7.5	7.5	12.1	11.8	19.0	19.0
Average	4.6	4.6	.12	.11	.09	.09	7.5	7.4	12.1	11.9	19.4	22.4
DISPOSAL SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
3	4.7	4.6	.15	.12	.12	.10	7.4	7.4	12.2	12.2	19.0	19.0
4	4.6	4.6	.10	.11	.08	.09	7.3	7.2	12.2	12.1	19.0	19.0
6	4.6	4.5	.10	.10	.08	.08	7.4	7.4	11.9	11.7	19.0	18.0
7	4.6	4.5	.11	.10	.09	.08	7.5	7.5	12.0	11.8	19.0	19.0
10	4.7	4.6	.12	.13	.10	.11	7.5	7.4	12.0	11.8	19.0	19.0
11	4.8	4.6	.13	.13	.11	.11	8.0	8.4	11.7	11.7	20.0	18.0
Average	4.7	4.6	.12	.12	.09	.09	7.5	7.6	12.0	11.9	19.2	18.7
COMPARISON SITE												
	A	B	A	B	A	B	A	B	A	B	A	B
12	4.8	4.8	.14	.14	.10	.11	7.7	7.6	11.5	11.6	17.0	16.0
13	4.8	4.8	.14	.14	.11	.11	7.7	7.7	11.5	11.7	15.0	14.0
14	4.8	4.7	.14	.13	.11	.11	7.6	7.6	11.7	11.6	11.0	11.0
15	4.8	4.7	.14	.13	.11	.11	7.5	7.5	11.6	11.6	9.0	8.0
16	4.7	4.5	.12	.14	.06	.12	7.4	7.3	11.3	11.5	7.0	6.0
Average	4.8	4.7	.14	.14	.10	.11	7.6	7.5	11.5	11.6	11.8	11.0

1/ Surface
2/ Bottom

or 179% above average (USGS 1977).

These conditions are reflected in the water quality surveys conducted on November 29 and December 7, 1977, during the dredge and dredge disposal operation at Pillar Rock. Tables 28 and 29 are the water quality values for the three sites (dredge, disposal, and comparison) during dredging.

With the exception of turbidity, there are no significant differences between water quality values collected at the surface and near the bottom during the Pillar Rock study (Tables 26 through 31).

The highest water temperature (19.9°C) was recorded at the Woody Island comparison site during the August 30 survey. Minimum water temperature (2.4°C) occurred during the January 6, 1978 survey. On each survey there was less than a 1°C difference between top and bottom temperatures at all stations. Water temperatures recorded at Prescott were generally higher (Table 25) than those recorded 1 day later at Pillar Rock.

Conductivity did not vary significantly through the six surveys or between sites. Readings were similar to those values monitored at Prescott 44 miles upriver. An exception occurred during the December 7 survey when the conductivity at Pillar Rock averaged 0.30 millimhos/cm compared to 0.10 millimhos/cm at Prescott.

Salinity at Pillar Rock did not exceed 0.32 parts per thousa d (0/00). Salinities ranged from an average of 0.073 0/00 i August 1977 to an average of 0.23 0/00 during the December 7, 1977, survey. Essentially this is a freshwater area and there was little difference between salinities recorded at the surface or near the bottom during any of the six surveys.

Turbidity values during the study ranged from an average low of 2.03 FTUs recorded at Prescott on November 28 (Table 25) (this was the highest value recorded at this station since January 1976). Increased turbidities were directly related to high flow conditions in the lower Columbia River during November and December. These higher turbidity values probably overshadowed any subtle changes which could have been the result of the dredging operation.

Turbidity is the only water quality parameter, during the Pillar Rock study, to display a substantial difference between bottom and surface values. Turbidities were higher at the bottom at all stations during the six surveys with the exception of the disposal and comparison sites on January 12 (Table 31).

Students T-test were performed to determine if differences between the surface and bottom turbidities were significant. There was a significant difference (p=0.05, df=17).

Pillar Rock area pH values ranged from a low of 6.4 to a high of 8.2. The low value occurred at Station 5 during the December 7 survey (Table 29). The highest value was recorded on the surface at Station 14 during the November 29 survey (Table 28). The highest average pH value, 7.79, was recorded during the November 9 survey while the lowest average value, 7.14 was recorded on December 12 (Table 25).

Dissolved oxygen levels were compared during each of the six surveys. No significant difference occurred between sites (dredge, disposal, and control) for a given sampling period. A difference between dissolved oxygen levels at the surface (average value 7.42 mg/l) and at the bottom (average value 7.09 mg/l) did occur during the August survey.

Lowest O_2 values were recorded during the August 10 survey when a 6.8 mg/l value occurred at Station 4 (Table 26). Highest values were recorded in early January (Table 30) when a high of 13.2 mg/l was recorded at comparison Station 14.

SUMMARY

A hydrobiological study was conducted to assess impacts of a channel widening project near Jim Crow Point and Pillar Rock in the Columbia River estuary between August 1977 and January 1978.

Pre-dredge and post-dredge finfish catches and benthic invertebrate counts served as a base for determining changes that occurred during dredging. A nearby comparison site served as an additional means for assessing biological change. Catch results revealed diminished numbers of finfish occurred in the immediate vicinity of ongoing dredge or disposal work. However, finfish catches at the nearby comparison site also declined during the same period. A determination of catch effort change based upon the gram weight of finfish was complicated by the presence or absence of adult salmonids. Generally the catch weight results followed the numerical results.

A total of 8506 finfish (18 species) were caught with all types of gear. Purse seining accounted for 770 individuals in 24 sets with chinook salmon and eluachon dominating the catch. Beach seining produced a total of 5349 finfish in 23 sets, but the major species was three-spine stickleback. Trawling produced 2387 finfish in 41 tows. Common demersal species were starry flounder, prickly sculpin, and longfin smelt.

Adult fish in a pre-spawning state included coho salmon, chinook salmon, steelhead trout, eulachon, and longfin smelt. Only some of latter two species may spawn in the immediate study area. Other species were represented by subyearlings, yearlings, or intermediate age groups. The prickly sculpin and starry flounder were the only common species with several size groups.

Stomach content analysis was made on 1626 fish or 19% of all fish captured. Of these, 1206 or 74% were empty. Finfish taken in the purse seine (chinook, shad, stickleback) consumed the pelagic cladoceran Daphnia longispina, copepod, Eurytemara hirundoides and benthic amphipod Corophium salmonis. The principal beach seine caught fish (stickleback, chinook, shad, and starry flounder) consumed D. longispina, C. salmonis, the epidenthic mysid Neomysis mercedis, and benthic bivalve, Corbicula fluminea. Stomachs from trawl caught fish such as starry flounder, prickly sculpin, and longfin smelt contained C. salmonis and N. mercedis.

Few differences in feeding were attributed to dredging activities, although food consumption was less during and following dredging.

Analysis of 48 sediment samples texture indicated little change in particle size at the dredge and disposal sites.

There was, however, an increase in fine sand at the comparison site.

A total of 5669 benthic invertebrates weighing 48.96 grams was collected in 96 sample grabs. Based on this, the average invertebrate density in this area was 1,181 individuals per m^2 and these weighed 10.2 grams. Dominant invertebrate species were the amphipod C. salmonis and bivalve C. fluminia in terms of numbers and weight, respectively. In terms of dredge/disposal effect the benthic invertebrate, numbers declined by 50% after pre-dredge surveys. They also declined at the comparison site and this made it difficult to specifically associate the change to dredging activities.

Volatile solids analysis revealed low organic content indicating the sediments in the area were clean. There was essentially no change indicated during the study period.

Depth soundings indicated the sediments piped to the flow lane disposal site apparently moved in the desired downstream westerly direction. All water quality parameters measured during the study were within safe biological limits and did not exceed EPA standards. Dissolved oxygen content ranged from an average of 7.2 mg/l in August to 13.1 mg/l in January. Water temperatures ranged from 19.8°C in August to 2.5°C in January. Turbidity readings were significantly higher near the bottom than the surface throughout the study. Excessive runoff during November and December tended to overshadow any change in water quality which could be associated with this particular dredging operation.

A delay in initiating the dredging resulted in most of our sampling occurring at a time when finfish numbers were low in this particular area. The normal variation in low catch numbers tends to limit the reliability of assessing change. Ideally this study should either have been conducted earlier when larger numbers of fish were present, or sampling effort should have been intensified. The test results though qualified indicate minor short-term change in the secondary and tertiary trophic levels at the dredge/disposal site.

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