CZES Coastal Zone and Estuarine Studies

IMPACT OF FLOW–LANE DISPOSAL AT DOBELBOWER BAR

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INTRODUCTION

Columbia River channel dredging was first authorized in 1877. Although averaging about 8 million cubic yards per year from 1913 to 1975, the amount of material dredged has declined to some extent in recent years. Current maintenance of the Columbia River navigation channel (600 feet wide by 40 feet deep from River Mile (RM) 3.0 to 105.5 requires moving approximately 4.5 million cubic yards of dredged material annually. Structural modifications are mostly responsible for the reduction in required dredging.

Various methods of dredging are used by the U.S. Army Corps of Engineers (CofE) to accomplish the channel maintenance. Hopper dredges are utilized at locations where the dredged material can be placed in deep areas of the river or taken out to sea. Pipeline dredges are used in locations where material can be pumped to a site on land or to an in-water site away from the channel. Clamshell dredging is sometimes required; with the dredged material being placed on a barge for subsequent removal to a location for disposal or commercial use. Another method occasionally employed is agitation dredging; the propeller wash from the employed vessel dislodges the material which is then carried away from the shoaled area by river flow. This action is also accomplished to a minor extent every time a deep draft vessel transits the channel.

Dredging by whatever means, involves the movement of a significant amount of dredged material even in the low volume years. In the past, dredged material was used for the construction of islands and for beach nourishment along eroded areas. During recent years, however, there has been a reduced need for this material along the Columbia River, and it has become increasingly difficult to find suitable disposal sites.

Difficulty in locating new disposal sites prompted a search for different means of disposing of the dredged material (Blahm et al. 1979). Personnel of

National Marine Fisheries Service (NMFS) suggested that placement of the dredged material in a self-scouring area in or near the channel might help resolve some of the disposal problems while causing less damage to the aquatic resource and retaining the sediment in the ecosystem for eventual ocean shoreline accretion. Sanborn (1975) indicated that benthic life forms were less in number in the channel area of the Columbia River, particularly the self-scouring areas and the areas where there is enough river traffic to keep the bottom sand active.

The concept of placing the material in water near the channel (flow-lane disposal) was developed with the idea that there would be less adverse impact on uplands and wetlands and on aquatic life forms and the associated fisheries (Durkin et al. 1979). To test this concept, the Dobelbower Dredge Study, was developed to examine the extent of the turbidity plume, distribution of the dredged material, and the impact on the aquatic life forms resulting from in-water pipeline disposal. This pilot study was conducted by personnel of the NMFS operating from the Prescott Facility which is located on the Columbia River (Figure 1) near Dobelbower Bar.

The study had the following objectives:

1. Monitor the extent and concentration of turbidity created by dredging and disposal.
2. Assess the impact of the dredging activity on water quality, zooplankton, and benthos.
3. Determine the retention time of the dredged material that was "windrowed" at the site.

STUDY PLAN AND METHODOLOGY

The procedure was to collect data before, during, and after the dredging operation and use this information to form the basis from which comparisons could be made to assess the overall impact. The dredging operation took place

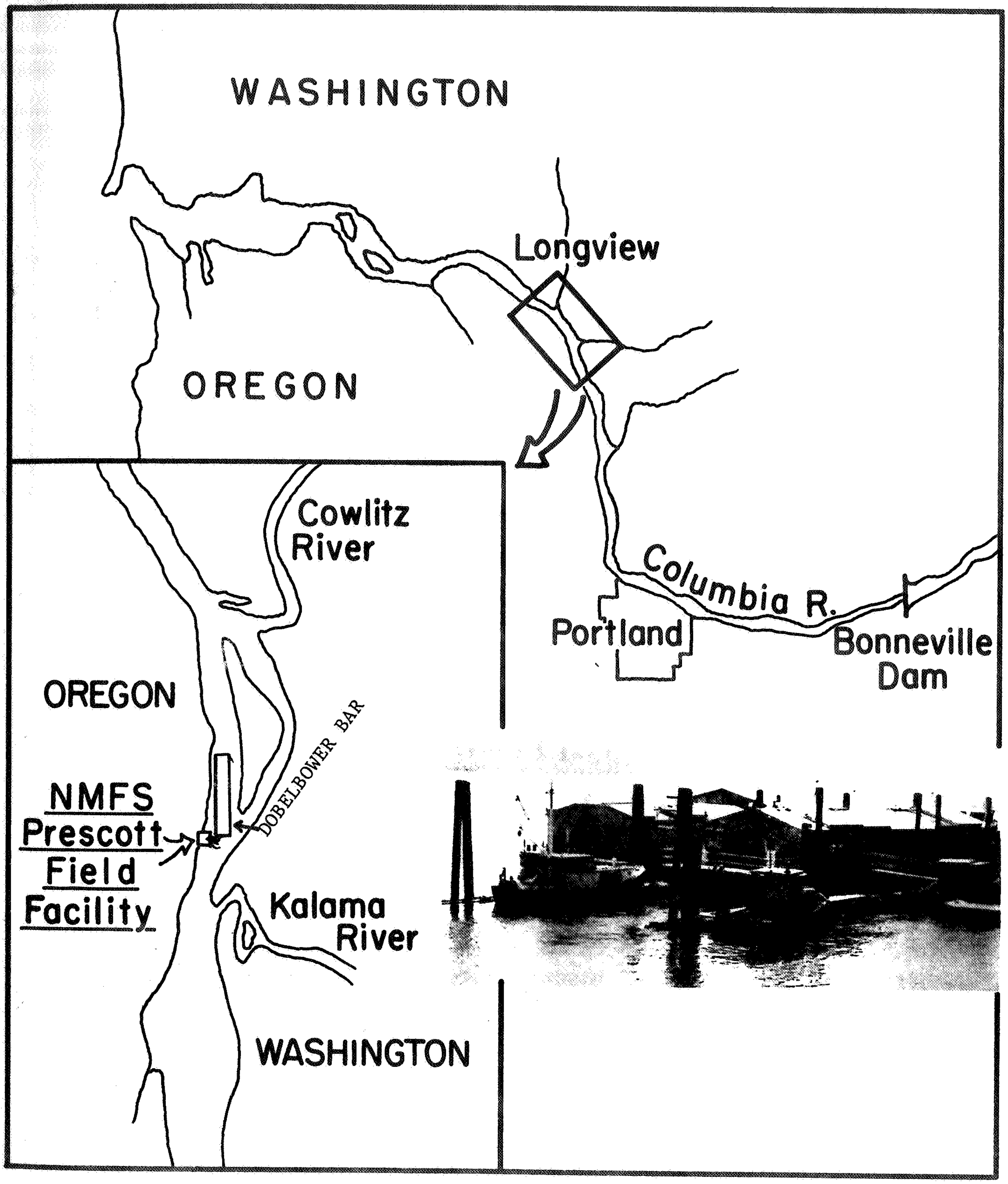

Figure 1...Lower Columbia River and locale (insert) of Prescott Field Facility.

10 to 18 October 1976.

SAMPLING LOCATIONS

Sampling sites in relation to control, dredge, and disposal areas are shown on Figure 2. During the dredging period, water samples and/or *in situ* measurements were taken both upstream and downstream (from 20 to 1900 feet) from the pipeline discharge point. The before and after dredging measurements were made at the stations indicated in Figure 2.

DATA COLLECTION AND ANALYSIS

All measurements, water samples, and analyses were completed using standard methods (American Public Health Assoication 1975). Both metric and English units are used in this report. Metric units are associated with various measurements; whereas, the English units are used for distances, etc. associated with navigation and dredging charts which commonly use the English notation.

Turbidity measurements (JTU) were made *in situ* with a flow-through Hach turbidimeter at the dredge and disposal areas.[1/] Emphasis was placed on comparing values found at varying distances downstream from the discharge pipe with control conditions found upstream from the dredge site. The river background turbidity values found during dredging were compared to those recorded at the dredge and disposal areas. Suspended sediment samples were collected from the water column when turbidity exceeded the background level.

Water quality measurements were generally taken weekly from September 1975 (before dredging) to December 1976 (after dredging). During dredging (10 to 18 October 1976) they were recorded daily and/or coincidentally with turbidity measurements. The parameters monitored were: 1) water temperature (°C); 2) conductivity (millimhos cm); 3) pH; and 4) dissolved oxygen (mg/liter). Results from the diferent periods were compared to determine possible changes associated with the dredging activity.

1/ Reference to trade names does not imply endorsement by NMFS, NOAA

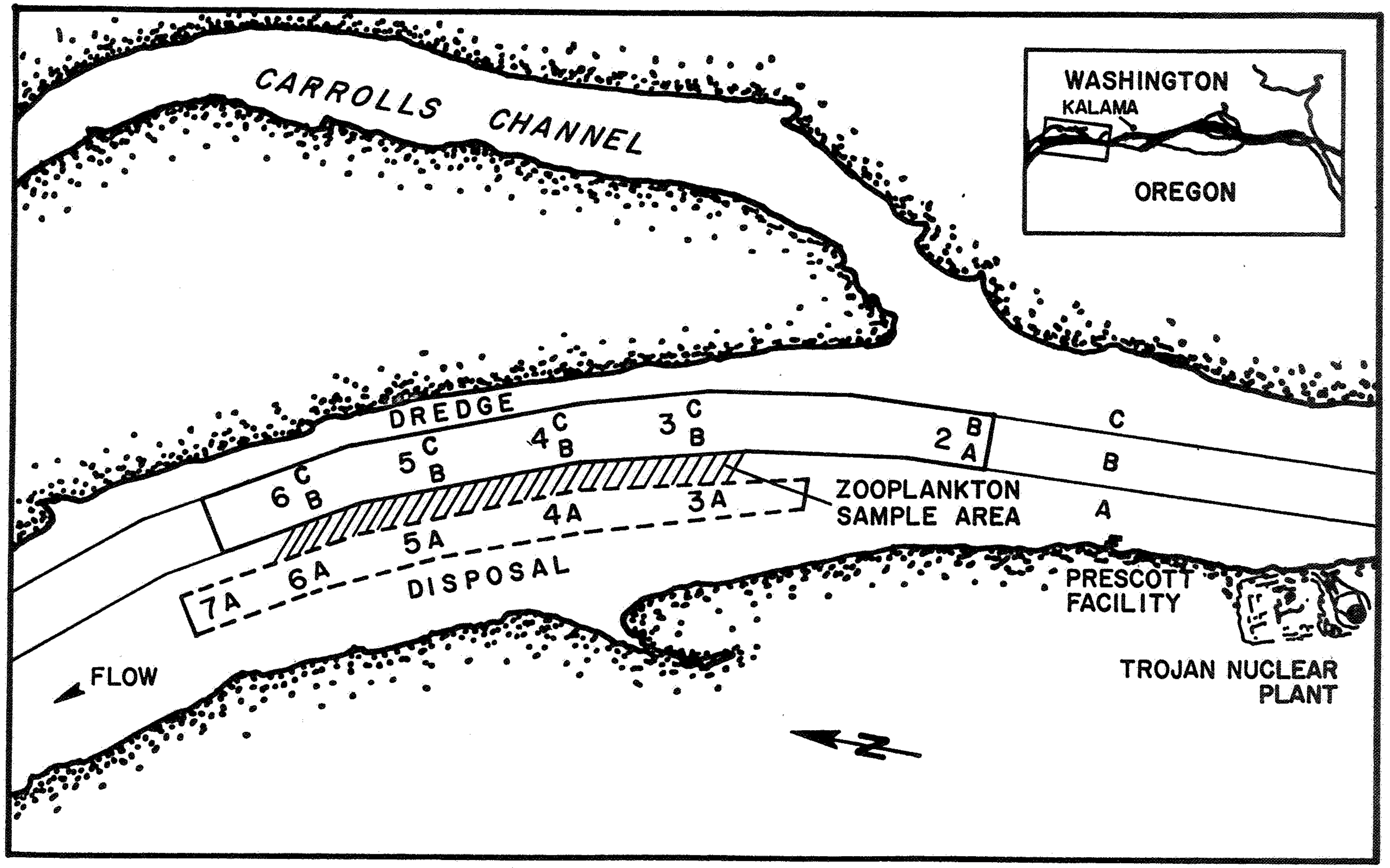

Figure 2...Location map for the Dobelbower Bar Dredge Study. Shown are the sampling sites in relation to the control, dredge, and disposal area.

Zooplankton tows were completed at least monthly and sometime weekly between September 1975 and May 1977. Only September, October, November, and December counts from 1975 and 1976 were used for comparison, because the data from the other months complicated the analyses due to seasonal variations. However, the additional weekly information is available upon request from NMFS, Prescott Facility. On each occasion a 5-minute tow with a 12.5 cm Clark-Bumpus sampler was made in the dredge area, Figure 2. The three most dominant genera (*Cyclops, Bosmina, and Daphnia*) were used for comparison.

IMPACT OF FLOW-LANE DISPOSAL

TURBIDITY AND SUSPENDED MATERIAL

During 1976 the highest recorded naturally occurring turbidity at RM 72.0 was 72.0 JTU in January. Average natural turbidity during 1977 was somewhat less than in 1976 (Figure 3) due to low flows and subnormal runoff during the spring and summer of 1977.

During the dredging period 10 to 18 October, increases in turbidity (primarily on the bottom) near the pipeline discharge (Table 1) were noted. The dredged material from the ship channel was clean sand; while being discharged in the disposal area, it sank rapidly to the bottom. Table 1 provides JTU values recorded during dredging. Shown are the readings at both surface and bottom for various distances downstream from and in line with the discharge. The highest level recorded was 30 JTU near the bottom on 14 October within 25 feet of the discharge pipe. The river background remained within a turbidity range of 3.2 to 4.3 JTU's. Surface turbidity downstream from the discharge ranged from 3.2 to 8.0 JTU. The major turbidity increases were noted near the bottom; however, at 1825 feet downstream from the discharge, the turbidity decreased to near background level.

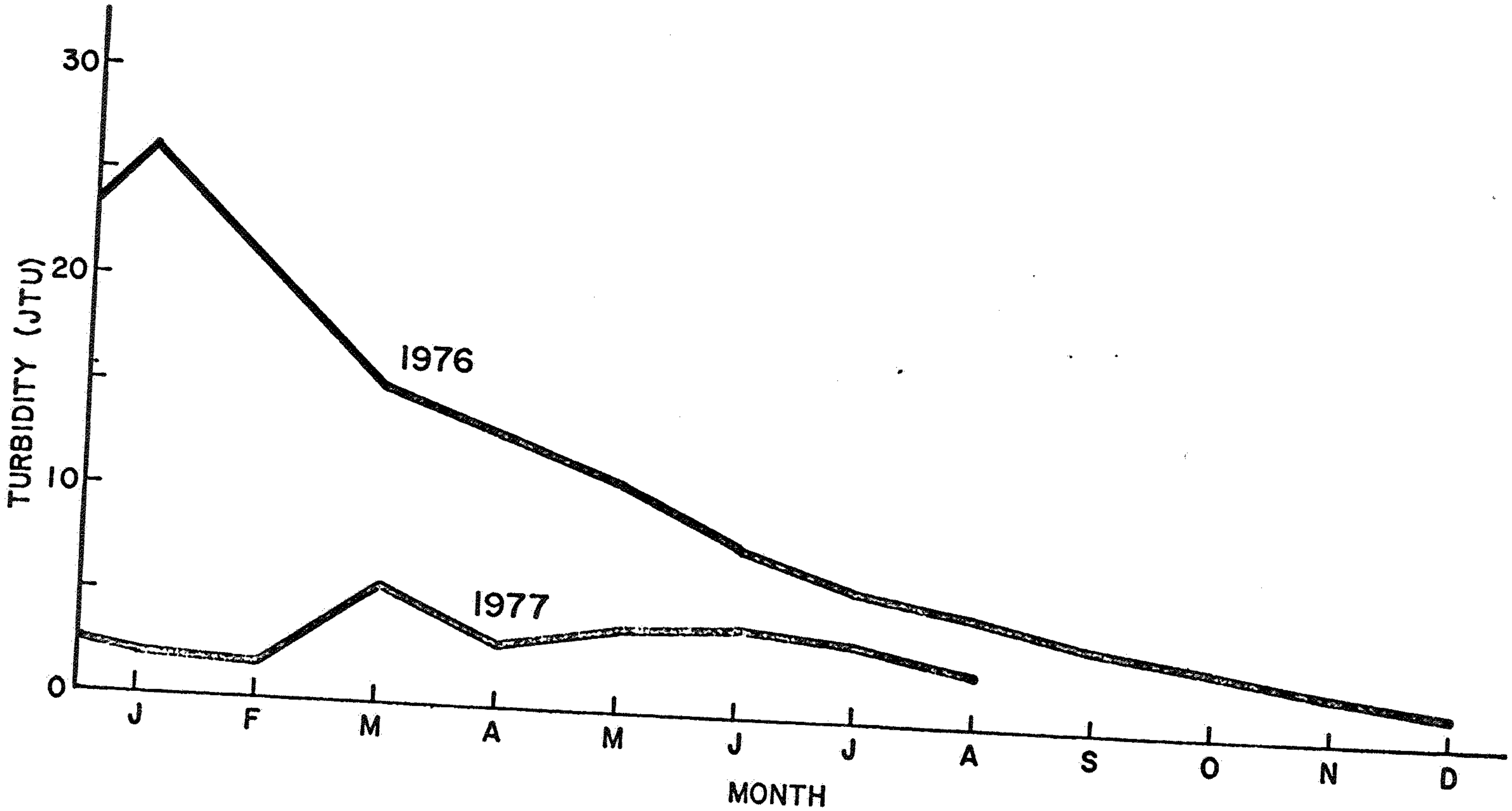

Figure 3...Average turbidity (JTU) for September, October, November, and December of 1976 and 1977 at Columbia River Mile 72.0.

Table 1...Turbidity (JTU) recorded at surface and river bottom during the Dobelbower Bar dredging operation. The "readings" are taken at various distances downstream and in line with the discharge point; also shown are the river background levels of turbidity.

Date		Distance downstream from discharge (feet)					
		25	75	125	525	1825	River background 1/
		JTU 2/					
10 October	S 3/	3.8	3.7	3.9	3.9	3.9	3.7
	B	4.3	5.5	5.0	5.0	5.0	3.7
11 October	S	4.0	3.8	---	4.0	4.2	3.8
	B	9.0	6.0	---	5.5	4.5	4.3
12 October	S	3.2	---	3.6	3.6	3.6	3.5
	B	6.5	---	4.6	4.2	4.6	4.0
13 October	S	3.6	---	4.2	3.7	4.5	3.2
	B	4.0	---	6.0	4.4	4.6	4.0
14 October	S	3.6	3.4	4.0	---	3.7	3.2
	B	30.0	10.0	7.5	---	4.0	3.5
18 October	S	5.0	---	8.0	4.0	4.5	3.4
	B	10.0	---	11.0	8.8	4.6	3.4
Average	S	3.8	3.8	4.8	3.9	4.0	3.5
	B	10.4	5.8	6.6	5.5	4.5	3.8

1/ 0.5 mile upstream of dredging operation
2/ Jackson turbidity units
3/ Surface (S) and bottom (B)

Suspended sediment samples indicated a general relationship between JTU and mg/liter of nonfilterable residue. For example 25 feet from the discharge on 14 October, the surface to bottom turbidity ranged from 3.6 to 30.0 JTU (Table 1). Following is a tabulation of nonfilterable residue values associated with bottom turbidity readings on that day:

Bottom Turbidity (JTU)	Nonfilterable Residue (mg/liters)
2.8	9.20
4.0	8.50
4.3	22.96
5.5	65.50
6.5	81.00
9.0	79.24
30.0	67.60

The trend was for nonfilterable residue to increase with increasing turbidity.

The congruity of both turbidity and suspended sediment was somewhat adversly affected by the sporadic discharge from the dredge. However, considering the highest levels of turbidity (30 JTU) and suspended material (81.0 mg/liters) recorded during the study there would seem to be little, if any, effect on the biota in the dredge or disposal areas--physical displacement of benthos excluded. Harmful and lethal effects can occur in both fish and shellfish over a range of from 200 to 200,000 units (JTU) of turbidity (Ward 1938; Van Oosten 1945; Kemp 1949; and Wallen 1951).

Turbidity conditions found during the dredging operation did not exceed those which occur naturally during the spring "runoff".

WATER QUALITY

Water temperature, conductivity, pH, and dissolved oxygen did not vary between stations, except for normal seasonal changes. Nor did water quality differ between river background and the dredge or disposal areas during these operations. Monthly averages of the four water quality parameters measured during September, October, November, and December 1975 and 1976 are presented in Figure 4. The 1976 data encompassed the dredging period 10 to 18 October 1976. Comparing 1975 and 1976 data for October, it is evident that the dredging activity did not appreciably change the monthly average water quality. A comparison of water quality between the disposal area (while dredging was in progress) and control sites upstream is shown in Figure 5. The data for the disposal area were taken from 20 to 75 feet downstream from and in line with the discharge pipe. Although many water quality measurements were taken, both in and out of the discharge area, the compilations in Figures 4 and 5 represent the maximum differences in both year to year and control to disposal site comparisons.

Overall there was little, if any, effect on water quality caused by dredging or disposal at Dobelbower Bar.

ZOOPLANKTON

Twelve types of zooplankton were captured during the study period (Table 2). The three numerically dominant genera (*Bosmina*, *Cyclops*, and *Daphnia*) were used to assess the impact of the dredging activity. The total number per m^3 of all organisms captured during September, October, November, and December 1975 and 1976 are shown in Figure 6--catches for the 2 years are comparable. A slight decrease in total number is evident in October 1976; however, natural variances of this magnitude were also found in zooplankton catches during a study near Dobelbower Bar in 1968-69 (Craddock et al. 1976).

Zooplankton tows were made on 11 and 24 October 1975 and on 6 October (before dredging), 14 October (during dredging), and 24 October (after dredging) 1976. A compilation of the resulting data is shown in Table 3. The total zooplankton counts increased during October (for both years) and the total yearly counts remained close. The numbers of zooplankton captured during dredging on 14 October 1976 were slightly lower than the counts of 11 October 1975; however, the total

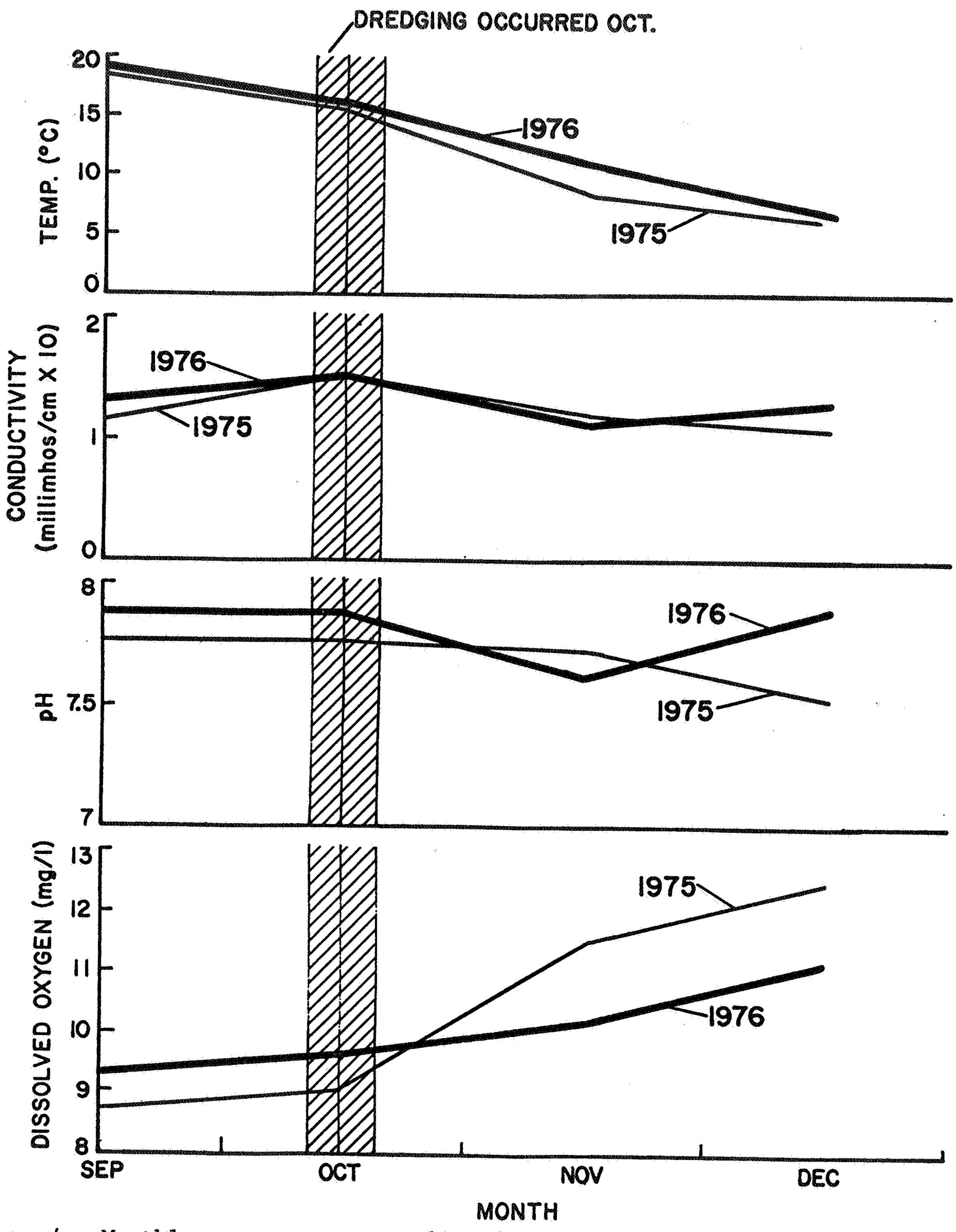

Figure 4...Monthly average water quality for September, October, November, and December of 1975 and 1976. Samples taken near Columbia River Mile 72.0. Dredging occurred 10 to 18 October 1976.

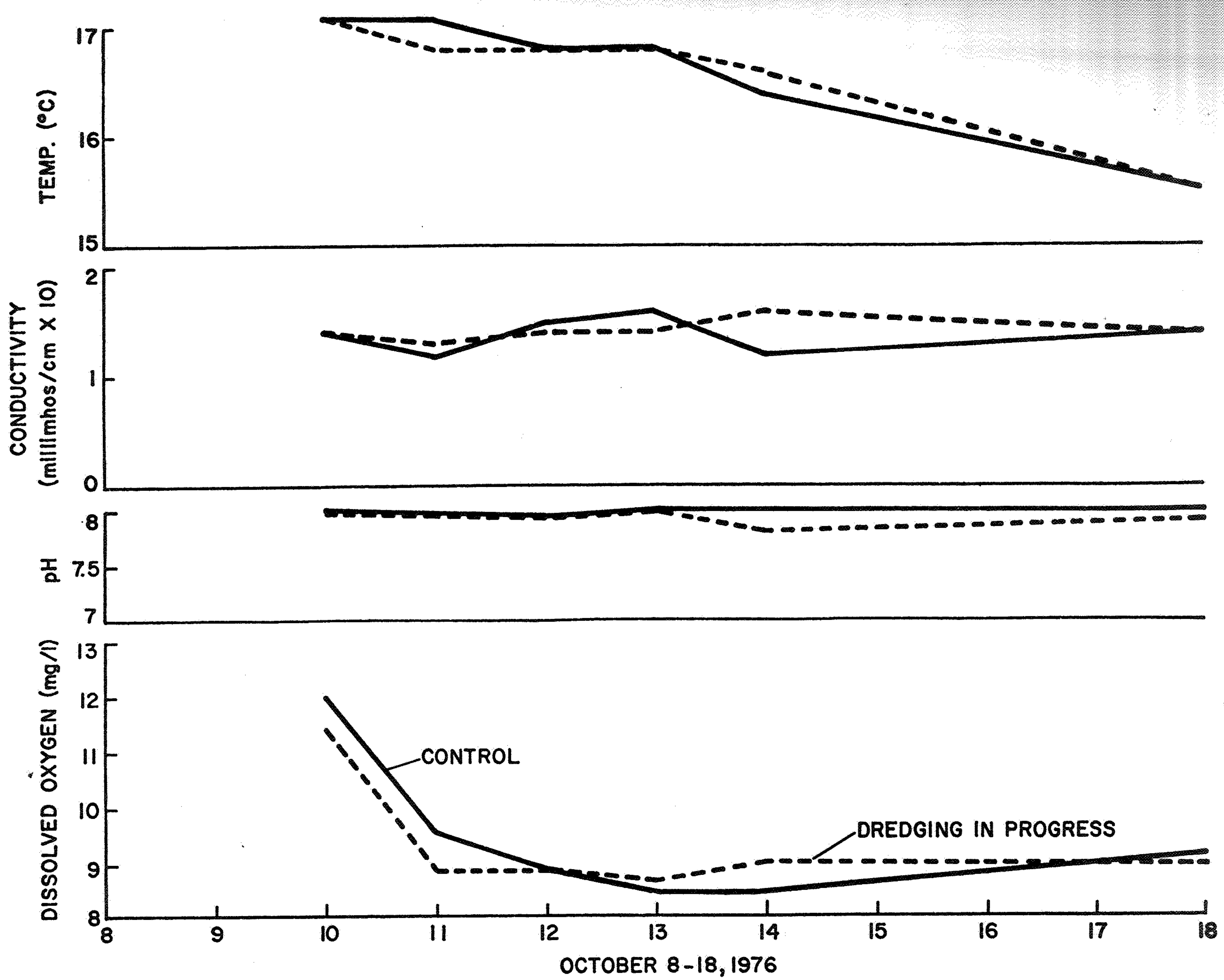

Figure 5...Water quality at Dobelbower Bar during the dredging operation (October 1976). Data from the control site are compared to that recorded in the discharge area during dredging.

Table 2...Numerical ranking, by numbers captured, of twelve types of zooplankton taken during the Dobelbower Bar study, September 1975 to May 1977.

Cladocera	
Eurycerus	12
Leptodora	10
Chydorus	9
Sida	8
Alona	7
Ceriodaphnia	6
Daphnia	3
Bosmina	1
Copepoda	
Immature	5
Mature	
Bryocamptus	11
Calanoida	4
Cyclops	2

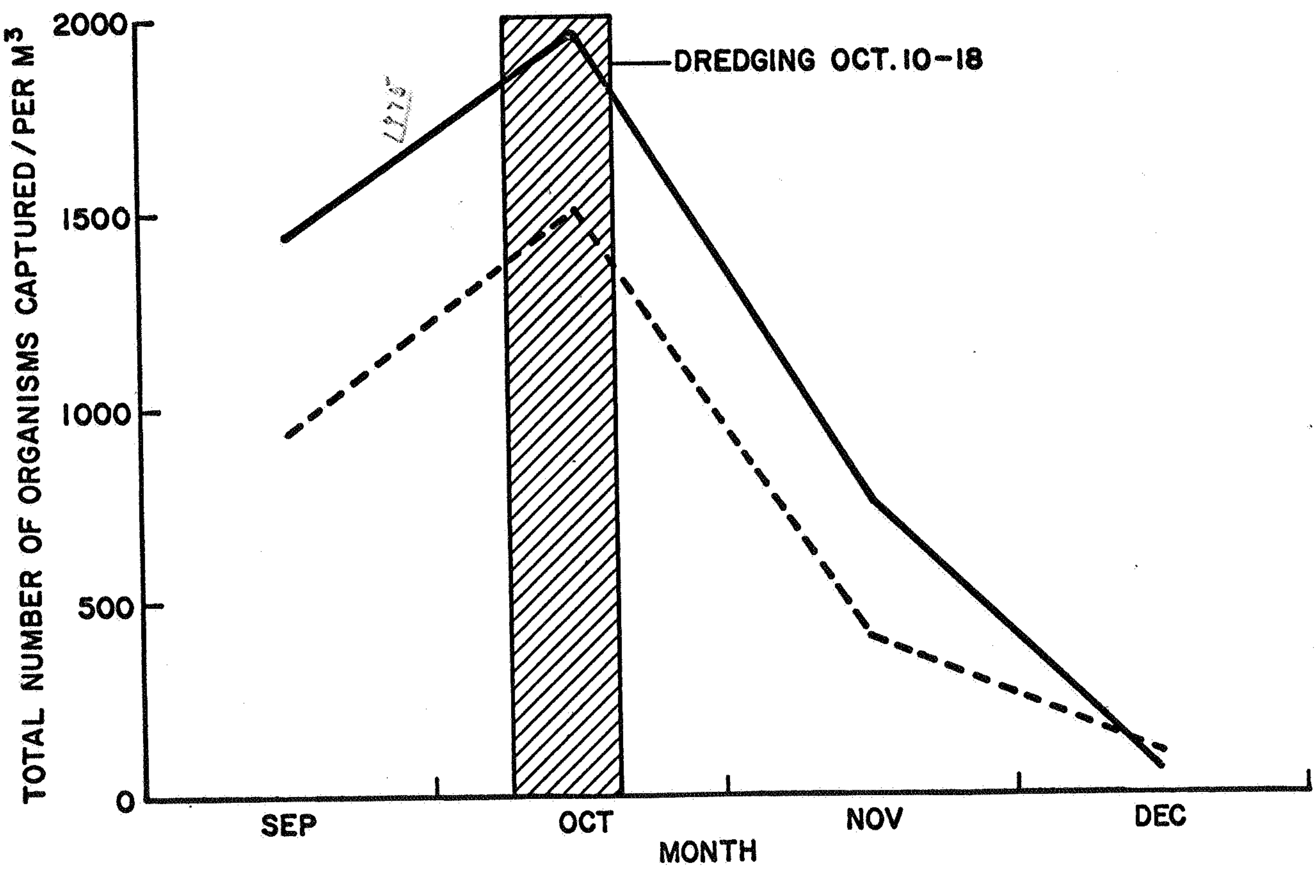

Figure 6...Average monthly zooplankton (all organisms combined) counts for 1975 (one year prior to Dobelbower Bar Study) and 1976. The dredging occurred on 10 through 18 October 1976.

Table 3...Number per m^3 of *Cyclops*, *Bosmina*, and *Daphnia* captured during October 1975 and 1976. The 1975 data were collected one year prior to the Dobelbower Bar Study. The 1976 samples were taken before (6 October), during (14 October), and after (21 October) the dredging operation. Also shown is the total per m^3 of all organisms combined.

Date	*Cyclops*	*Bosmina*	*Daphnia*	Total *Cyclops* *Bosmina* *Daphnia*	Total All Zooplankton Types	Average
	Number per m^3					
1975						
11 October	572	883	244	1699	1785	
24 October	499	1062	567	2128	2185	1985
1976						
6 October	279	262	252	793	947	
14 October	109	1143	194	1446	1520	
21 October	109	1762	160	2031	2127	1531

number of *Cyclops, Bosmina,* and *Daphnia* (as well as the total of all organisms) during sampling on 24 October 1976 was comparable to the 1975 level. The evidence, based on the average monthly (September, October, November, and December) counts for 1975 and 1976 (Figure 6) and the specific October 1975 and 1976 counts (Table 3) indicated that the dredging operation did not alter zooplankton abundance or diversity.

Zooplankton are an important food source for juvenile salmonids and non-salmonids in the Columbia River (Craddock et al. 1976). Durkin et al. 1979 reported that stomach analyses indicated *Daphnia* was an important source of food for fish near Pillar Rock (RM 28).

BENTHOS

Eighteen benthic forms, including some fish eggs, were captured at Dobelbower Bar (Table 4). Abundance of benthic organisms in the control, dredge, and disposal areas before (21 August 1976), during (10-18 October 1976), and after (24 January 1977) dredging are presented in Tables 5A, 5B, and 5C.

Station counts (2A and 2B and the B-C positions from stations 3, 4, 5, and 6) are combined for the dredge area in Table 5B. Disposal area counts include stations 3A, 4A, 6A, and 7A; whereas, the control area counts are for stations 1A, 1B, and 1C upstream (Figure 2 and Table 5). The five numerically dominant groups of organisms used for comparison and analysis were insect larvae, Bivalvia, Oligochaeta, Polychaeta, and Amphipoda.

It is apparent that both increases and decreases occurred between sampling periods (before, during, and after dredging) as well as between locations (control, dredged, and disposal sites). The changes in abundance do not seem to indicate an adverse affect of dredging and/or disposal. Considering the counts from five combined stations in the dredge area (Table 5B), the total count per square meter of the dominant forms each showed an increase from the before to the during dredging with one minor exception (Amphipoda).

Table 4...List of benthic forms of benthic fauna found during the Dobelbower Bar Flow-Lane Diposal Study; organisms are listed in decending order of abundance.

Type of fauna	Quantity (average number organisms per m^2 of sampled area)
INSECTA	
Diptera	
Chironomidae	252.44
Unidentified	13.58
Trichoptera	0.30
Ephemeroptera	0.21
Hempitera	0.04
	266.57
BIVALVIA	
Corbicula	113.15
OLIGOCHAETA	69.82
POLYCHAETA	28.63
CRUSTACEA	
Amphipoda	
Corophium	12.35
Anisogammarus	0.43
Gammarus	0.34
	13.12
GASTROPODA	2.27
HYDROZOA	
Hydra	2.65
NEMATODA	1.05
ARACHNIDA	0.13
Acarina	
Hydrachna	0.04
Other	0.09
	0.13
FISH EGGS	
Eulachon	0.94
Unidentified	0.21
	1.15

Table 5A, B, and C...Number per m^2 of the five dominant benthic organisms captured during the Dobelbower Bar Dredging Study. Shown are the numbers captured before (August 1976), during (October 1976) and after dredging (January 1977) in the control, dredged, and disposal areas. Stations shown are referenced in Figure 2 (where two stations are shown together their totals were combined). Also shown are the before, during, and after totals for each area (control, dredged, and disposal).

Table 5A
Control (Area 1)

	Insecta Aquatic Larva	Bivalvia	Oligochaeta	Polychaeta	Amphipoda	Total
	per m^2					
1-A						
Before	363.3	63.3	223.0	46.7	13.3	709.6
During	856.3	718.0	390.0	370.0	16.7	2351.0
After	553.4	53.3	296.7	63.3	0.0	966.7
1-B						
Before	26.7	16.7	3.3	0.0	3.3	50.0
During	160.0	106.7	0.0	0.0	10.0	276.7
After	30.0	36.7	0.0	0.0	0.0	66.7
1-C						
Before	6.6	10.0	0.0	0.0	6.7	23.3
During	13.4	3.3	0.0	0.0	3.3	20.0
After	13.3	3.3	0.0	0.0	0.0	16.6
Total by species						
Before	396.6	90.0	226.3	46.7	23.3	
During	1029.7	828.0	390.0	370.0	30.0	
After	596.7	93.3	296.7	63.3	0.0	
Average for total all stations (per m^2)						
Before	260.97					
During	882.57					
After	350.00					

Table 5B
Dredged (Area 2)

	Insecta Aquatic Larva	Bivalvia	Oligochaeta	Polychaeta	Amphipoda	Total
	per m^2					
2-A & 2-B						
Before	126.7	35.0	3.4	0.0	1.7	166.8
During	230.0	215.0	66.7	53.4	6.7	571.8
After	66.7	46.7	16.7	16.7	6.7	153.5
3-B & 2-C						
Before	96.7	46.7	3.4	0.0	0.0	146.8
During	93.4	214.0	0.0	1.7	23.4	332.5
After	46.7	60.0	0.0	3.4	1.7	111.8
4-B & 4-C						
Before	103.3	50.0	23.3	0.0	98.4	275.0
During	306.7	76.7	0.0	11.7	21.7	416.8
After	211.7	21.7	0.0	5.0	1.7	240.1
5-B & 5-C						
Before	25.0	8.3	1.7	0.0	1.7	36.7
During	78.4	50.0	3.4	0.0	15.0	146.8
After	96.7	23.3	0.0	0.0	3.3	123.3
6-B & 6-C						
Before	53.3	50.0	1.7	20.0	5.0	130.0
During	120.0	60.0	0.0	0.0	5.0	185.0
After	33.4	40.0	0.0	1.7	5.0	80.1
Total by species						
Before	405.0	190.0	33.5	20.0	106.8	
During	828.5	615.7	70.1	66.8	71.8	
After	455.2	191.7	16.7	26.8	18.4	
Average for total all stations (per m^2)						
Before	151.06					
During	330.76					
After	141.6					

Table 5C
Disposal (Area 3)

Station	Insecta Aquatic Larva	Bivalvia	Oligochaeta	Polychaeta	Amphipoda	Total
	per m^2					
3-A						
Before	363.5	63.3	126.7	63.3	0.0	616.8
During	833.4	253.3	260.0	0.0	120.0	1466.7
After	270.0	223.3	40.0	276.6	3.3	813.2
4-A						
Before	186.6	210.0	60.0	10.0	16.7	483.3
During	30.0	90.0	30.0	0.0	20.0	170.0
After	133.4	13.3	3.3	3.3	6.7	140.0
5-A						
Before	116.7	140.0	76.7	0.0	0.0	333.4
During	246.7	200.0	120.0	40.0	6.7	613.4
After	560.0	303.0	56.7	20.0	6.7	946.4
6-A						
Before	116.7	140.0	76.7	0.0	0.0	333.4
During	380.0	83.3	140.0	0.0	16.7	620.0
After	420.0	90.0	290.0	40.0	10.0	850.0
7-A						
Before	206.7	46.7	26.7	40.0	16.6	336.7
During	1816.6	350.0	60.0	0.0	26.7	2253.3
After	1076.6	266.7	100.0	0.0	13.3	1456.6
Total by species						
Before	990.2	600.0	366.8	113.3	33.3	
During	3306.7	976.6	610.0	40.0	190.1	
After	2440.0	896.3	490.0	339.9	40.0	
Average total all stations						
Before	420.72					
During	1024.68					
After	841.24					

The control area data (Table 5A) show seasonal as well as station variations. Station 1A, which is most remote from the ship channel, showed much higher productivity than 1B and 1C which are in and near the channel. During freshet periods, increased scouring would be expected on the Washington side of the river; however, during the period of dredging bottom currents were comparable on both sides of the ship channel near stations 1A and 1C.

In general most samples showed an increasing trend from August 1976 (before dredging) to October 1976 (during dredging):

Time	Number of organisms/m^2
Before (August 76)	1260
During (October 76)	3141
After (January 77)	1988

The increases are probably due to seasonal variation; polychaetes, oligochaetes, and chironomides are reported to be numerous during the fall and winter months in some area (Brinkhurst 1966). When all samples (5 dominant forms) from the control, dredged, and disposal areas are combined and compared, the seasonal influence is evident (Table 5).

The river bottom at Dobelbower Bar consists of fine, clean sand both adjacent to, and in the ship channel; therefore, it is not a prime production area for benthic organisms. The diversity and abundance is low compared to more productive areas of the lower river. For example, the number of oligochaetes and bivalves near RM 24 (center of river) was reported at 16,000 and 916 per m^2 respectively (Higley et al. 1976) while at Dobelbower Bar they were 69.8 and 113.2 m^2.

The relatively low diversity and abundance of benthic organisms at RM 72 (near Dobelbower) were also indicated by comparison with results of a study done in relation to the Trojan Nuclear Power Plant on the Columbia River near Prescott, Oregon (Beak 1975).

Benthic organisms are an important source of food for juvenile salmonids and other fishes inhabiting the river. The three or four predominate organisms found in fish stomachs are: Insecta, Amphipoda, Bivalvia, and Oligochaeta (Durkin et al. 1979)(McConnell et al. 1978).

FATE OF DREDGED MATERIAL

The dredged material was deposited in the river between the 20 and 30-foot depth contours (Figure 2). However, in one instance the pipeline outflow remained at one position too long, and the material was piled to within a few feet of the water surface.

NMFS did periodic depth surveys to determine the decrease in the "windrowed" material. The aforementioned "hump" and "windrow" had virtually disappeared (resuspended and moved downstream) by the winter of 1977-78. Monitoring by the CofE using more sophisticated "sounding" and positioning gear resulted in the same conclusion.

During a November 1977 flow-lane disposal operation at Pillar Rock (RM 28) the "humping" or "piling" of dredged material was reduced significantly because of improved planning and control (Durkin et al. 1979).

RESULTS AND CONCLUSIONS

1. Turbidity in the Columbia River during the dredging effort did not exceed 30 JTU's; whereas, natural turbidity in 1976 exceeded 70 JTU's.
2. Turbidity levels during dredging and/or disposal apparently had little if any effect on finfish or shellfish.
3. Nonfilterable residue increased with increasing turbidity.
4. There were no long-term effects on those water quality parameters measured near the dredge and disposal operations.

5. The dredging operation did not noticeably alter zooplankton abundance or diversity.
6. The majority of benthic variations between sampling times (before, during, and after dredging) and sampling area (control, dredged, and disposal) can be attributed to seasonal variation and station location rather than a primary effect of the dredging operation.
7. The entire Dobelbower Bar area is relatively low in benthic production when compared with the estuary and slough areas of the river.
8. The material deposited in the flow-lane was dissipated within approximately 1 year.

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