CZES Coastal Zone and Estuarine Studies

An aquatic species evaluation at four self scouring sites in the Columbia River Estuary

by

Joseph T. Durkin, Travis C. Coley,
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AN AQUATIC SPECIES EVALUATION

AT FOUR

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LETTER REPORT

Results of this inventory indicated Jetty A had a low biological standing crop of benthic invertebrates and demersal finfish. There was a great species diversity of fish encountered in the essentially marine habitat, but few had either commercial or recreational value. There was little evidence to indicate feeding occurs in this habitat because the number of any species was low and those benthic invertebrates present were not being utilized. There was greater evidence of increased numbers of pelagic and demersal fish, shellfish, benthic invertebrates, and increased feeding activity at each successive scour site upstream. Tongue Point, the farthest upstream site, had a diminished number of demersal fish and shellfish during the freshwater period; however, there were increased densities of benthic invertebrates, particularly amphipods. These amphipods were important prey items for anadromous species found in the area.

With proper statistical evaluation of the Jetty A site during a summer and winter test period, it is conceivable that this particular area could function as a year-round sediment disposal site. Use of Tansy Point as a test disposal area should only be attempted at those times of the year when there are low numbers of fish, shellfish, benthic invertebrates, and feeding activity; this sampling effort did not clearly identify that time. Use of the Interstate Bridge and Tongue Point as sediment test areas appears clearly inadvisable because of the high standing crop of aquatic life. Comparative catch data in the upper estuary (Miller Sands and Skamokawa) suggests investigation of freshwater scour areas east of

Harrington Point (Bayview and Wauna) as possible sites for further intensive inventory sampling.

INTRODUCTION

A large spring discharge is a major characteristic of the Columbia River. The increased flow is particularly noticeable between May and early July when snow melt runoff from several mountain ranges may average 20,300 m^3/s. The movement of water in the estuary is magnified by twice daily flood and ebb tide ranges that may exceed 3 m. The water velocities generated by these combined forces within the estuary tend to scour certain areas of the river bottom, especially adjacent to jetties, penisulas, and bridge pilings.

Maintenance dredging is not required at these scour sites since the authorized navigation depth of 12 m is exceeded by 3 to 20 m (Figure 1). Between these hydraulic scour areas, however, there is usually an accumulation of sediments, resulting in shoals that must periodically be removed by dredging (Figure 1). Channel depths are maintained at 14.4 m (48') at the entrance and 12 m (40') through the remainder of the estuary.

The U.S. Army Corps of Engineers (CofE) removes 3,000,000 m^3 of sediments annually from the federally maintained Columbia River estuary channel, and most is placed in the ocean off the river mouth. The remaining amount (550,000 m^3) is redeposited within the estuary off Chinook, Washington. The CofE is concerned about any adverse impacts of its dredging activities but is charged with the responsibility of maintaining safe depths in the 180-m (600') wide navigation channel for ocean shipping. The principal means of sediment removal in the area from the river mouth to River Km 32 is with hopper dredges, which results in inwater disposal.

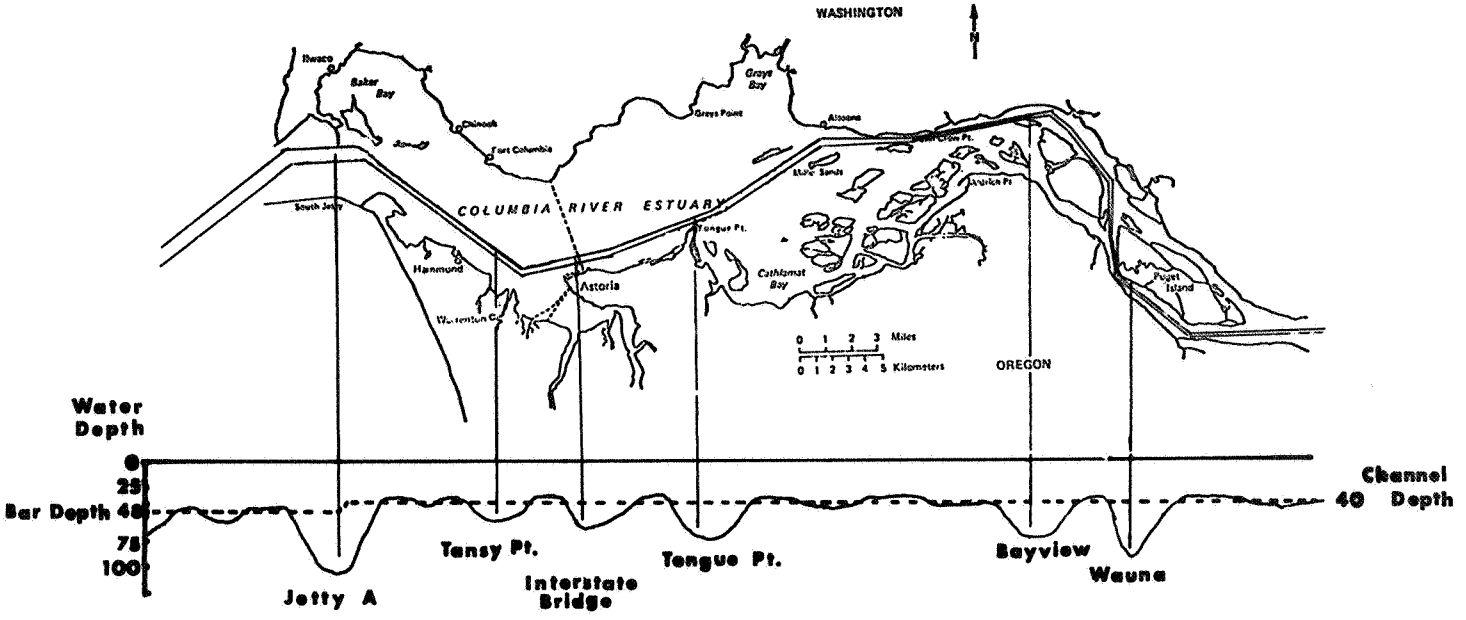


Figure 1.--The Columbia River estuary ship channel with depths showing the shoals and hydraulic scour areas. The Bayview and Wauna scour areas were not examined in this study.

The deposition of sediment can adversely impact many groups and species of aquatic life. Particle size change, smothering, and recirculation of toxic substances are several factors which can alter a natural biological system. Larval fish, epibenthic shellfish, and benthic invertebrates are those most directly affected. The National Marine Fisheries Service (NMFS) is vitally interested in minimizing adverse impacts to commercially and recreationally important fish and their food organisms.

An earlier NMFS study by Durkin (1975) indicated relatively few finfish and shellfish were found near the Columbia River's North Jetty, whereas comparable sampling at nearby ocean sites produced many times more fish. The results suggested water turbulence in the 19.5-m deep area off the North Jetty produced biological instability and a low standing crop of demersal fish. Projecting this concept to an estuarine habitat suggests less biological damage from sediment deposition at high flow, self scouring sites rather than at stable, less dynamic sites.

A study, funded by the CofE and conducted by NMFS research personnel, provided a biological inventory or survey of four hydrologically dynamic sites within the estuary--Jetty A, Tansy Point, Interstate Bridge, and Tongue Point (Figure 2). The objectives were to determine: if the scour sites had a low standing crop of aquatic life, if the populations were stable, and whether species tolerant of stress dominated the catch. Inventory sampling was scheduled at a 6-month interval to evaluate aquatic life at the conclusion (Oct-Nov 1978) and beginning (May 1979) of normal hopper dredging activity. It was emphasized from the beginning that any site found to have a low standing crop, would still require a complete

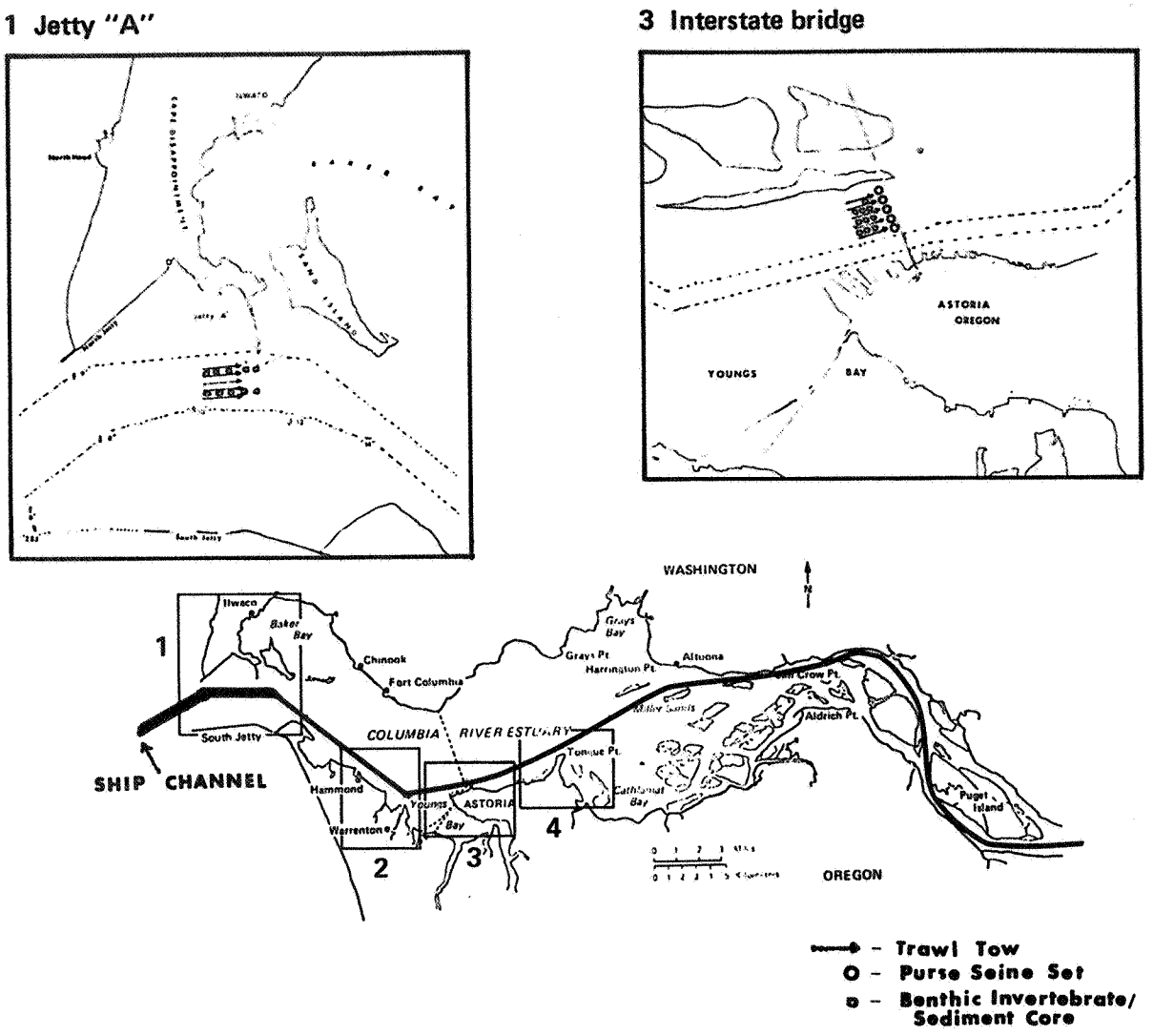


Figure 2.--The four test sites examined for aquatic life in the Columbia River estuary with a diagramatic indication of the sampling approach.

biological evaluation prior to, during, and following sediment deposition by CofE hopper dredges.

INVENTORY METHOD

The four test sites selected for inventory studies were within or adjacent to the navigation channel in the first 29 km (18 mile) of the estuary (Figure 2). The two survey periods were October-November 1978 and May 1979. Sampling consisted of 5 trawl sets, 5 purse seine sets, 10 benthic invertebrate grabs, and 10 sediment samples at three of the four sites during each survey period. The exception was Jetty A, where hazardous conditions precluded the five purse seine efforts. Temperature and salinity were recorded at the surface and bottom for each sampling effort. Overall, 30 pelagic finfish surveys were made with a 200-m purse seine, and 40 demersal finfish surveys were made with an 8-m shrimp trawl. Each sample effort was 5 min in duration. Purse seine and trawl sets were made in an upstream or easterly direction. Trawling was undertaken during flood tide conditions.

Finfish were anesthetized, identified to species, examined, measured in millimeters, and weighed in grams. Random samples of $\leq$ 50 individuals of each species were used for length/weight frequency measurements for each set, and a random subsample was extracted from these groups for stomach content analysis. Decapod crustaceans such as crab and shrimp were identified, counted, measured, weighed, and released.

Specimens retained for food utilization studies were injected with Formalin[1/] into the stomach immediately after capture. The stomach was

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

removed between the esophagus and pyloric sphincter, and its contents were placed in 70% alcohol and examined with a 10 X stereoscopic microscope. Food items were identified to the lowest possible taxon, air dried, and weighed to the nearest 0.0001 g.

Benthic invertebrates were captured with a 0.05 m^2 Ponar grab sampler, washed free of sediments, retained on a 0.595 mm sieve, and fixed in a 10% Formalin-Rose Bengal solution. Invertebrates were identified, sorted into various groups, and counted. Following independent verification, the taxonomic groups were air dried for 10 min, weighed, and represerved in an alcohol-glycerin solution.

Sediment samples were gathered with the 0.05 m^2 Ponar grab sampler during each benthic invertebrate survey. Sediment samples were refrigerated and transferred to a private analytical laboratory for determination of particle texture components and total volatile solids. Particle size categories followed the Wentworth scale described by Twenhofel and Tyler (1941), and were listed in percentage weight of the total sample.

INVENTORY RESULTS

Finfish and Decapod Crustacean Catches

A total of 46 finfish and shellfish species were captured during the surveys; 36 species in trawl catches and 21 species in purse seine catches (Table 1). The fall 1978 trawling survey produced 56.3 finfish and 78.5 shellfish per minute of sampling effort, whereas the May 1979 survey yielded only 7.5 finfish and 34.7 shellfish for each minute of effort. Purse seining in the fall 1978 survey produced 274.8 finfish per minute of effort, whereas the May 1979 survey yielded 66.4 finfish per minute. Overall there were 31,870 finfish and 4,957 shellfish from a wide variety

TABLE 1.--Finfish and decapod shellfish captured with purse seine and trawl nets during sampling at four hydraulic scour sites in the Columbia River estuary Oct./Nov. 1978-May 1979

COMMON FISH	SCIENTIFIC NAME	Number 1978 Trawl	Number 1978 Purse Seine	Number 1979 Trawl	Number 1979 Purse Seine	Total
Pacific lamprey	Entosphenus tridentatus	-	-	4	4	8
Spiny dogfish	Squalus acanthias	2	-	-	-	2
White sturgeon	Acipenser transmontanus	1	-	1	-	2
American shad	Alosa sapidissima	-	571	-	156	727
Pacific herring	Clupea harengus pallasi	2	17343	-	228	17573
Northern anchovy	Engraulis mordax	127	2183	29	16	2355
Chum salmon	Oncorhynchus keta	-	-	-	9	9
Coho salmon	Oncorhynchus kisutch	-	3	1	1473	1477
Sockeye salmon	Oncorhynchus nerka	-	-	-	9	9
Chinook salmon "0"	Oncorhynchus tshawytscha	-	95	-	1151	1246
Chinook salmon "1"	Oncorhynchus tshawytscha	-	6	-	450	456
Cutthroat trout	Salmo clarki	-	-	-	13	13
Rainbow (steelhead) trout	Salmo gairdneri	-	-	-	173	173
Whitebait smelt	Allosmerus elongatus	1	-	5	-	6
Surf smelt	Hypomesus pretiosus	-	190	-	898	1088
Longfin smelt	Spirinchus thaleichthys	3719	4	2	314	4039
Eulachon	Thaleichthys pacificus	-	1	-	3	4
Peamouth	Mylocheilus caurinus	-	-	-	32	32
Largescale sucker	Catostomus macrocheilus	-	-	5	2	7
Pacific tomcod	Microgadus proximus	497	-	275	2	774
Walleye pollock [1/]	Theragra chalcogramma	-	-	5	-	5
Threespine stickleback	Gasterosteus aculeatus	-	39	-	27	66
Bay pipefish	Syngnathus griseolineatus	1	-	-	-	1
Redtail surfperch	Amphistichus rhodoterus	5	-	-	-	5
Shiner perch	Cymatogaster aggregata	553	65	5	11	634
Spotfin surfperch [1/]	Hyperprosopon anale	4	-	-	-	4
Snake prickleback	Lumpenus sagitta	18	-	63	-	81
Saddleback gunnel	Pholis ornata	31	-	1	-	32
Pacific sand lance	Ammodytes hexapterus	-	-	1	-	1
Vermillion rockfish [1/]	Sebastes miniatus	-	-	1	-	1
Padded sculpin	Artedius fenestralis	-	-	1	-	1
Prickly sculpin	Cottus asper	29	-	26	-	55
Buffalo sculpin	Enophrys bison	1	-	-	-	1
Pacific staghorn sculpin	Leptocottus armatus	315	1	166	1	483
Warty poacher	Occella verrucosa	1	-	3	-	4
Pricklebreast poacher	Stellerina xyosterna	5	-	25	-	30
Showy snailfish	Liparis pulchellus	-	-	21	-	21
Pacific sanddab	Citharichthys sordidus	1	-	-	-	1
Speckled sanddab	Citharichthys stigmaeus	1	-	4	-	5
Butter sole	Isopsetta isolepis	6	-	1	-	7
English sole	Parophrys vetulus	20	-	20	-	40
Starry flounder	Platichthys stellatus	255	6	81	13	355
Sand sole	Psettichthys melanostictus	33	-	4	-	37
	Sub Total	5628	20507	750	4985	31870

COMMON DECAPOD CRUSTACEANS	SCIENTIFIC NAME	Trawl	Purse Seine	Trawl	Purse Seine	Total
Sand shrimp	Crangon franciscorum	1881	0	2218	19	4118
Crangon sp.	Crangon stylirostris	169	0	289	-	458
Crangon sp.	Crangon nigromaculata	7	0	-	-	7
Dungeness crab	Cancer magister	161	0	213	-	374
	Sub Total	2218	0	2720	19	4957
	TOTAL	7846	20507	3470	5004	36827

[1/] Previously unreported in the Columbia River estuary.

of species captured during the surveys. Several economically important species were common: coho and chinook salmon, starry flounder, American shad, and Pacific herring. The number and weight of finfish and shellfish species captured at each sampling site are shown in Tables 2 through 8.

Tongue Point

The October trawl series exhibited consistency of species composition, with brackish tolerant marine species and sand shrimp, C. franciscorum, dominating the catches (Table 2). The May trawl series produced few finfish, and most were freshwater species. October purse seine catches varied widely in numbers and species composition (Table 3). Pacific herring, chinook salmon, and threespine stickleback were the only species common to the five sets. The May purse seine sets were comparatively stable in species composition and numbers. The fish caught in October were anadromous or marine, whereas those captured in May were essentially anadromous with several freshwater and marine species.

Interstate Bridge

The trawl catches in the fall and spring (Table 4) were similar to those at Tongue Point. There were more fish and a greater number of species at the Interstate Bridge but less set to set consistency between trawl efforts.

Dungeness crab and sand shrimp, C. franciscorum, were captured during the fall and spring. Purse seining in October did not produce substantial numbers of fish (Table 5). Those captured were nearly all marine or anadromous species. In contrast, the May purse seine effort was rich in species, numbers caught, and had set to set catch consistency.

TABLE 2.-- Numbers and weights of finfish and decapod shellfish captured with an 8-m trawl at Tongue Point in the Columbia River estuary (weight in grams).

A. 11 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
White sturgeon	----	----	----	----	----	----	1	798	----	----	1	798
Pacific Herring	----	----	----	----	----	----	----	----	1	4	1	4
Northern anchovy	17	324	26	539	28	522	11	233	1	20	83	1638
Longfin smelt	33	160	344	3120	314	2519	400	3245	138	1162	1229	10206
Pacific tomcod	4	164	10	42	17	560	21	706	27	419	79	1891
Shiner perch	2	17	3	54	3	26	2	44	1	10	11	151
Snake prickleback	----	----	----	----	1	64	3	156	6	318	10	538
P. staghorn sculpin	22	1599	11	614	15	1182	25	1716	33	2155	106	7266
Prickly sculpin	----	----	----	----	----	----	1	99	----	----	1	99
Starry flounder	17	1866	2	429	8	383	21	1710	19	586	67	4974
TOTAL	95	4130	396	4798	386	5256	485	8707	226	4674	1588	27565
Sand shrimp	528	388	92	83	225	211	372	338	304	331	1521	1351
TOTAL	528	388	92	83	225	211	372	338	304	331	1521	1351

B. 14 May 1979

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Pacific lamprey	----	----	1	5	----	----	----	----	----	----	1	5
White sturgeon	----	----	----	----	----	----	----	----	1	533	1	533
Coho salmon	----	----	1	26	----	----	----	----	----	----	1	26
Largescale sucker	1	1353	----	----	----	----	----	----	3	2695	4	4048
Prickly sculpin	17	555	3	95	4	131	----	----	2	39	26	820
Starry flounder	----	----	----	----	----	----	1	10	----	----	1	10
TOTAL	18	1908	5	126	4	131	1	10	6	3267	34	5442

Table 3.--Numbers and weights of finfish captured with a 230-m purse seine off Tongue Point in the Columbia River estuary (weight in grams).

A. 12,19 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
American shad	230	8790	250	5962	22	1495	55	6917	----	----	557	23164
Pacific herring	17146	158920	10	64	24	142	10	92	2	14	17192	159232
Coho salmon	----	----	1	641	1	334	----	----	1	834	3	1809
Chinook salmon	64	1360	4	63	4	52	2	37	8	130	82	1642
Surf smelt	91	1034	24	182	3	26	----	----	5	60	123	1302
Eulachon	1	42	----	----	----	----	----	----	----	----	1	42
Threespine stickleback	6	7	1	1	8	9	17	17	3	3	35	37
Shiner perch	63	355	----	----	----	----	----	----	----	----	63	355
P. staghorn sculpin	1	43	----	----	----	----	----	----	----	----	1	43
Starry flounder	----	----	1	4	----	----	----	----	----	----	1	4
TOTAL	17602	170551	291	6917	62	2058	84	7063	19	1041	18058	187630

B. 17 May 1979 (303 m) Purse seine

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Pacific lamprey	----	----	----	----	----	----	3	9	----	----	3	9
American shad	1	20	----	----	3	51	3	81	7	573	14	725
Coho salmon	66	1466	71	1695	110	2654	164	4323	676	14369	1087	24507
Chum salmon	----	----	----	----	1	1	----	----	4	9	5	10
Sockeye salmon	----	----	1	14	2	40	----	----	1	18	4	72
Fall chinook salmon	57	392	37	283	86	674	114	976	302	2698	596	5023
Spring chinook salmon	16	348	18	463	55	1261	81	1825	148	3523	318	7420
Cutthroat trout	1	512	4	190	2	115	2	167	3	134	12	1118
Steelhead	2	105	8	423	52	3419	21	1721	27	2014	110	7682
Surf smelt	----	----	1	4	----	----	----	----	----	----	1	4
Peamouth	2	307	3	540	2	350	----	----	1	129	8	1326
Threespine stickleback	1	2	1	2	3	3	2	2	3	4	10	13
Starry flounder	1	31	----	----	----	----	1	8	2	62	4	101
TOTAL	147	3183	144	3614	316	8568	391	9112	1174	23533	2172	48010

TABLE 4.--Numbers and weights of finfish and decapod shellfish captured with an 8-m trawl at the Interstate Bridge in the Columbia River estuary (weight in grams).

A. 7 November 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Longfin smelt	787	6203	645	5604	130	1334	691	5660	170	1504	2423	20305
Pacific tomcod	50	2837	80	3798	51	3420	37	1832	12	399	230	12286
Shiner perch	126	2106	51	917	35	919	241	3299	44	680	497	7921
P. staghorn sculpin	65	3564	51	3234	31	2155	33	4757	11	659	191	14369
Prickly sculpin	7	344	13	703	8	807	----	----	----	----	28	1854
Northern anchovy	2	41	----	----	1	20	12	225	----	----	15	286
Saddleback gunnel	2	16	24	252	5	50	----	----	----	----	31	318
Snake prickleback	5	224	2	25	----	----	1	16	----	----	8	265
Speckled sanddab	----	----	1	1	----	----	----	----	----	----	1	1
English sole	5	95	5	120	----	----	----	----	1	17	11	232
Sand sole	----	----	2	89	----	----	----	----	2	112	4	201
Starry flounder	67	2572	77	5488	16	1976	7	3100	4	215	171	13351
TOTAL	1116	18002	951	20231	277	10681	1022	18889	244	3586	3610	71389
Sand shrimp	10	18	19	27	12	21	18	22	11	17	70	105
Dungeness crab	34	5019	22	3807	16	2304	3	562	3	343	78	12035
TOTAL	44	5039	41	3834	28	2325	21	584	14	360	148	12140

B. 15 May 1979

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Longfin smelt	----	----	----	----	----	----	1	10	----	----	1	10
Largescale sucker	----	----	----	----	----	----	1	1111	----	----	1	1111
P. staghorn sculpin	15	785	7	363	----	----	45	2168	32	1521	99	4837
Starry flounder	9	338	17	1146	3	88	30	990	14	643	73	3205
TOTAL	24	1123	24	1509	3	88	77	4279	46	2164	174	9163
Sand shrimp	1	1	1	1	----	----	13	13	2	2	17	17
Dungeness crab	----	----	2	28	----	----	1	15	1	8	4	51
TOTAL	1	1	3	29	----	----	14	28	3	10	21	68

TABLE 5.--Numbers and weights of finfish and decapod shellfish captured at the Interstate Bridge in the Columbia River estuary with a 230-m purse seine (weight in grams).

A. 23, 26 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
American shad	----	----	----	----	9	1268	----	----	----	----	9	1268
Pacific herring	4	91	13	568	2	117	----	----	1	6	20	782
Northern anchovy	----	----	----	----	----	----	----	----	2	49	2	49
Fall chinook	3	91	2	75	----	----	1	28	3	69	9	263
Surf smelt	9	76	7	72	8	99	----	----	----	----	24	247
Longfin smelt	----	----	2	13	----	----	----	----	2	20	4	33
Threespine stickleback	1	1	----	----	1	1	----	----	----	----	2	2
Starry flounder	----	----	----	----	----	----	----	----	1	302	1	302
TOTAL	17	259	24	728	20	1485	1	28	9	446	71	2946

B. 30 May 1979

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
American shad	8	1750	48	8564	22	3759	27	3942	10	743	115	18758
Pacific herring	116	4121	9	319	----	----	----	----	----	----	125	4440
Northern anchovy	16	224	----	----	----	----	----	----	----	----	16	224
Coho salmon	45	1007	22	560	97	2508	38	844	61	1354	263	6273
Sockeye salmon	----	----	----	----	1	9	2	8	----	----	3	17
Fall chinook salmon	27	204	108	865	42	313	21	172	15	105	213	1659
Spring chinook salmon	8	181	10	191	49	1152	15	348	9	191	91	2063
Steelhead	2	97	5	391	9	742	1	55	1	65	18	1350
Surf smelt	2	27	----	----	----	----	----	----	1	8	3	35
Longfin smelt	4	20	258	2576	2	12	1	5	1	10	266	2623
Eulachon	----	----	----	----	----	----	1	36	----	----	1	36
Peamouth	----	----	----	----	2	373	21	3885	----	----	23	4258
Largescale sucker	----	----	----	----	----	----	2	2791	----	----	2	2791
Pacific tomcod	----	----	3	111	----	----	----	----	----	----	3	111
Shiner perch	----	----	10	28	----	----	----	----	----	----	10	28
P. staghorn sculpin	----	----	1	125	----	----	----	----	----	----	1	125
Starry flounder	----	----	2	54	1	96	6	116	----	----	9	266
TOTAL	228	7631	476	13784	225	8964	135	12202	98	2476	1162	45057
Sand shrimp	1	3	16	56	----	----	----	----	----	----	17	59
TOTAL	1	3	16	56	----	----	----	----	----	----	17	59

TABLE 6.--Numbers and weights of finfish and decapod shellfish captured in two surveys off Tansy Point in the Columbia River estuary using an 8-m bottom trawl (weight in grams).

A. 10 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Pac. herring	----	----	----	----	----	----	----	----	1	8	1	8
Longfin smelt	3	18	10	80	1	6	22	173	30	250	66	527
Pacific tomcod	----	----	36	195	24	118	18	277	20	186	98	776
Shiner perch	1	24	----	----	2	16	28	571	5	98	36	709
P. staghorn sculpin	----	----	2	69	2	222	7	373	2	94	13	758
Buffalo sculpin	----	----	----	----	----	----	1	56	----	----	1	56
English sole	----	----	1	6	1	17	3	44	3	39	8	106
Sand sole	----	----	1	3	3	504	----	----	1	6	5	513
Starry flounder	1	31	3	93	4	727	5	415	3	51	16	1317
TOTAL	5	73	53	446	37	1610	84	1909	65	732	244	4770
Sand shrimp	1	1	70	58	51	54	67	41	48	41	237	195
Dungenness crab	1	201	15	4616	9	2663	20	4580	17	4493	62	16553
TOTAL	2	202	85	4674	60	2717	87	4621	65	4534	299	16748

B. 21 May 1979

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Pacific lamprey	1	4	----	----	1	5	----	----	----	----	2	9
Northern anchovy	----	----	4	83	----	----	----	----	25	710	29	793
Longfin smelt	----	----	----	----	----	----	----	----	1	4	1	4
Whitbait smelt	----	----	----	----	----	----	1	4	----	----	1	4
Pacific tomcod	57	2886	57	3157	37	1963	66	3750	41	1867	258	13623
Shiner perch	----	----	----	----	1	30	1	11	----	----	2	41
Snake prickleback	35	1346	22	880	3	64	1	1	2	113	63	2404
Saddleback gunnel	----	----	1	27	----	----	----	----	----	----	1	27
P. staghorn sculpin	18	1980	24	2431	5	311	8	869	12	830	67	6421
Showy snailfish	----	----	----	----	----	----	1	----	1	33	2	33
Speckled sanddab	----	----	----	----	----	----	1	1	----	----	1	1
Butter sole	----	----	----	----	----	----	1	1	----	----	1	1
English sole	5	238	5	111	1	24	6	205	2	52	19	630
Starry flounder	----	----	----	----	3	1565	4	1600	----	----	7	3165
Sand sole	----	----	----	----	----	----	----	----	4	157	4	157
TOTAL	116	6454	113	6689	51	3962	90	6442	88	3766	458	27313
Sand shrimp	47	95	355	1067	499	1318	606	1705	532	1739	2039	5924
Dungeness crab	69	14466	48	11341	29	7490	30	7664	24	4487	200	45448
TOTAL	116	14561	403	12408	528	8808	636	9369	556	6226	2239	51372

TABLE 7.--Numbers and weights of finfish and decapod shellfish captured with a 230-m purse seine at Tansy Point in the Columbia River estuary (weight in grams).

A. 6, 12, 26 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
American shad	----	----	----	----	5	922	----	----	----	----	5	922
Pacific herring	6	130	1	58*	123	9323	1	61	----	----	131	9572
Northern anchovy	287	5208	----	----	1892	42067	2	32	----	----	2181	47307
Spring chinook salmon	1	19	----	----	1	22	4	95	----	----	6	136
Fall chinook salmon	----	----	----	----	----	----	----	----	4	84	4	84
Surf smelt	25	222	2	20*	8	87	2	23	6	73	43	425
Threespine stickleback	----	----	----	----	1	2	1	1	----	----	2	3
Shiner perch	----	----	----	----	2	25	----	----	----	----	2	25
Starry flounder	----	----	----	----	3	59	1	43	----	----	4	102
TOTAL	319	5579	3	78	2035	52507	11	255	10	157	2378	58576

B. 16, 25, 31 May 1979

SPECIES	Tow 1*		Tow 2*		Tow 3*		Tow 4		Tow 5*		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Pacific lamprey	1	2	----	----	----	----	----	----	----	----	1	2
American shad	1	14	----	----	23	4612	3	291	----	----	27	4917
Pacific herring	4	105	2	33	3	59	8	187	86	2806	103	3190
Coho salmon	43	1055	19	399	31	795	17	393	13	365	123	3007
Chum salmon	1	3	----	----	2	7	----	----	1	3	4	13
Sockeye salmon	----	----	----	----	2	15	----	----	----	----	2	15
Spring chinook salmon	16	315	3	51	15	274	3	86	4	92	41	818
Fall chinook	15	130	2	17	293	2358	1	9	31	207	342	2721
Cutthroat trout	1	95	----	----	----	----	----	----	----	----	1	95
Steelhead	37	2570	1	98	3	325	1	97	3	287	45	3377
Surf smelt	7	51	108	227	39	122	2	9	738	3183	894	3592
Longfin smelt	----	----	1	16	14	108	33	259	----	----	48	383
Eulachon	1	22	1	23	----	----	----	----	----	----	2	45
Peamouth	----	----	----	----	1	47	----	----	----	----	1	47
Threespine stickleback	2	2	8	8	1	3	3	7	3	5	17	25
Shiner perch	----	----	1	38	----	----	----	----	----	----	1	38
TOTAL	129	4364	146	910	427	8725	71	1338	879	6948	1652	22285
Sand shrimp	----	----	----	----	----	----	2	5	----	----	2	5
TOTAL	----	----	----	----	----	----	2	5	----	----	2	5

* 303-m purse seine

TABLE 8.--Numbers and weights of finfish and decapod shellfish captured with an 8-m trawl off Jetty A in the Columbia River Estuary (weight in grams).

A. 27 October 1978

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Spiny dogfish	----	----	2	2996	----	----	----	----	----	----	2	2996
North. anchovy	2	6	6	11	12	13	5	7	4	20	29	57
Whitebait smelt	----	----	----	----	----	----	----	----	1	9	1	9
Longfin smelt	1	19	----	----	----	----	----	----	----	----	1	19
Pac. tomcod	33	1965	40	2828	1	9	15	291	1	149	90	5242
Bay pipefish	----	----	1	2	----	----	----	----	----	----	1	2
Redtail surfperch	1	277	1	67	----	----	----	----	----	----	2	344
Shiner perch	5	26	5	41	1	7	----	----	1	14	12	88
Spotfin perch	1	19	3	87	----	----	----	----	----	----	4	106
Pac. staghorn sculpin	----	----	----	----	4	213	1	33	----	----	5	246
Warty poacher	----	----	----	----	----	----	1	1	----	----	1	1
Pricklebreast poacher	----	----	4	22	1	12	----	----	----	----	5	34
Speckled sanddab	----	----	----	----	1	5	----	----	----	----	1	5
Pacific sanddab	----	----	----	----	----	----	1	350	----	----	1	350
Butter sole	1	382	----	----	3	198	1	55	----	----	5	635
English sole	----	----	1	66	----	----	----	----	----	----	1	66
Starry flounder	----	----	----	----	----	----	1	552	----	----	1	552
Sand sole	2	22	4	106	15	198	2	587	1	16	24	929
TOTAL	46	2716	67	6226	38	655	27	1876	8	208	186	11681
Sand shrimp	9	14	7	14	2	3	10	13	3	4	31	48
Crangon stylirostris	59	99	56	121	18	39	30	71	13	22	176	352
Cranyon nigromacula	----	----	4	8	----	----	3	5	----	----	7	13
Dungeness crab	5	617	7	1576	1	153	6	648	2	475	21	3469
TOTAL	73	730	74	1719	21	195	49	737	18	501	235	3882

B. 9-10 May 1979

SPECIES	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		TOTAL	
	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.	NO.	WT.
Whitebait smelt	----	----	2	18	----	----	2	19	----	----	4	37
Pacific tomcod	----	----	5	357	5	167	6	367	1	59	17	950
Walleye pollock	----	----	----	----	4	10	1	1	----	----	5	11
Shiner perch	----	----	1	8	1	9	1	6	----	----	3	23
Pac. sandlance	1	7	----	----	----	----	----	----	----	----	1	7
Vermillion rockfish	----	----	----	----	1	1	----	----	----	----	1	1
Padded sculpin	----	----	----	----	----	----	1	4	----	----	1	4
Warty poacher	----	----	----	----	2	1	1	1	----	----	3	2
Pricklebreast poacher	----	----	----	----	2	1	23	2	----	----	25	3
Showy snailfish	1	50	2	25	7	128	7	166	2	35	19	404
Speckled sanddab	----	----	----	----	1	1	----	---	2	2	3	3
English sole	----	----	----	----	----	----	----	----	1	1	1	1
Starry flounder	----	----	1	273	----	----	----	----	----	----	1	273
TOTAL	2	57	11	681	23	318	42	566	6	97	84	1719
Sand shrimp	1	2	17	22	68	95	61	76	15	21	162	216
Crangon stylirostris	25	49	10	17	18	39	140	228	96	167	289	500
Dungeness crab	1	1	2	943	1	578	2	1380	3	1342	9	4244
TOTAL	27	52	29	982	87	712	203	1684	114	1530	460	4960

Approximately 50% of the May total catch was marine and 50% anadromous, though several freshwater species were captured.

Tansy Point

October trawl catches were fairly consistent in species composition and quantity in the last four efforts (Table 6). Species were almost entirely marine in spring and fall surveys. The increased number of species in May did not produce an improvement of trawl catch consistency or result in an increased number of fish captured. The number of decapod crustaceans was consistently greater here than at other sites. Purse seine sampling catches were influenced by the presence or absence of schooling anchovy in October (Table 7). The inconsistency in species composition observed during October stabilized in May. Anadromous and marine fish occurred in all sets and a few freshwater species were captured.

Jetty A

Trawl catches consisted entirely of marine finfish and decapod crustaceans (Table 8). There was a variety of fish species encountered in both October and May, however, there was little consistency in species composition between tows and surveys. The low catch of finfish was consistent in October and particularly in May.

A summarization of the species and numbers captured by site and survey is shown in Table 9. Grouped weights are included to provide a further means of evaluating the catch results. Purse seine catches at Tongue Point had substantially greater numbers of finfish than the other areas, both in October and May. October trawl catches indicated most demersal finfish were at the Interstate Bridge, but many were also found at Tongue Point. The May trawl catches were generally low with the greatest number of fish

Table 9.--A summary of finfish and shellfish taken at four sampling sites in the Columbia River estuary.

	Jetty A	Tansy Point	Interstate Bridge	Tongue Point	TOTAL
October					
TRAWL CATCH					
Finfish species	18	9	12	10	24
Decapod species	4	2	2	1	4
Finfish numbers	186	244	3610	1588	5628
Decapod numbers	228	321	148	1521	2218
Finfish weight(g)	11681	4770	71388	27560	115399
Decapod weight(g)	3882	16748	12140	1350	34120
May					
TRAWL CATCH					
Finfish species	13	15	4	6	25
Decapod species	3	2	2	0	3
Finfish numbers	84	458	174	34	750
Decapod numbers	460	2239	21	0	2720
Finfish weight(g)	1710	27313	9163	5442	43628
Decapod weight(g)	4960	51372	68	0	56400
October					
PURSE SEINE					
Finfish species	--	9	8	10	13
Decapod species	--	0	0	0	0
Finfish numbers	--	2378	71	18058	20507
Decapod numbers	--	0	0	0	0
Finfish weight(g)	--	58576	2946	187630	249152
Decapod weight(g)	--	0	0	0	0
May					
PURSE SEINE					
Finfish species	--	16	17	13	21
Decapod species	--	1	1	0	1
Finfish numbers	--	1652	1162	2172	4986
Decapod numbers	--	2	17	0	19
Finfish weight(g)	--	22285	45057	48010	115352
Decapod weight(g)	--	5	59	0	64

occurring at Tansy Point. Trawl caught Dungeness crab and Crangon shrimp were abundant at Tansy Point.

Lengths and Diet of Selected Finfish

Eight species made up 85% of the finfish captured--Pacific herring, American shad, chinook salmon, coho salmon, longfin smelt, Pacific tomcod, Pacific staghorn sculpin, and starry flounder. Samples of these fish were examined to determine if their lengths and diets were comparable between sample sites (Figures 3 through 10). Proportional values of food organisms consumed by fish are shown with Index of Relative Importance (IRI) charts (Pinkas et al. 1971). The number of each food item, their weight, and frequency of occurrence are described numerically by using the formula in Figure 3.

The length and food consumption of Pacific herring are shown in Figure 3. The chart reveals several age groups of the pelagic species occurred at the sites. A comparison of sizes indicates most large individuals were found downstream where higher salinity occurs. Reduced salinity was responsible for the absence of herring at Tongue Point in May. Copepods appear to be a primary dietary item of herring. The identifiable food organisms or those with an undigested appearance were more prevalent in stomachs of herring at the upstream (Tongue Point, Interstate Bridge) sites.

American shad were found principally at Tongue Point in October, and there were two distinct size groups (Figure 4). Calanoid copepods were utilized by shad at Tongue Point and vegetative material at the other sites. In May, two size groups of shad occurred with most found at the Interstate Bridge. Calanoid copepods were numerically important but the

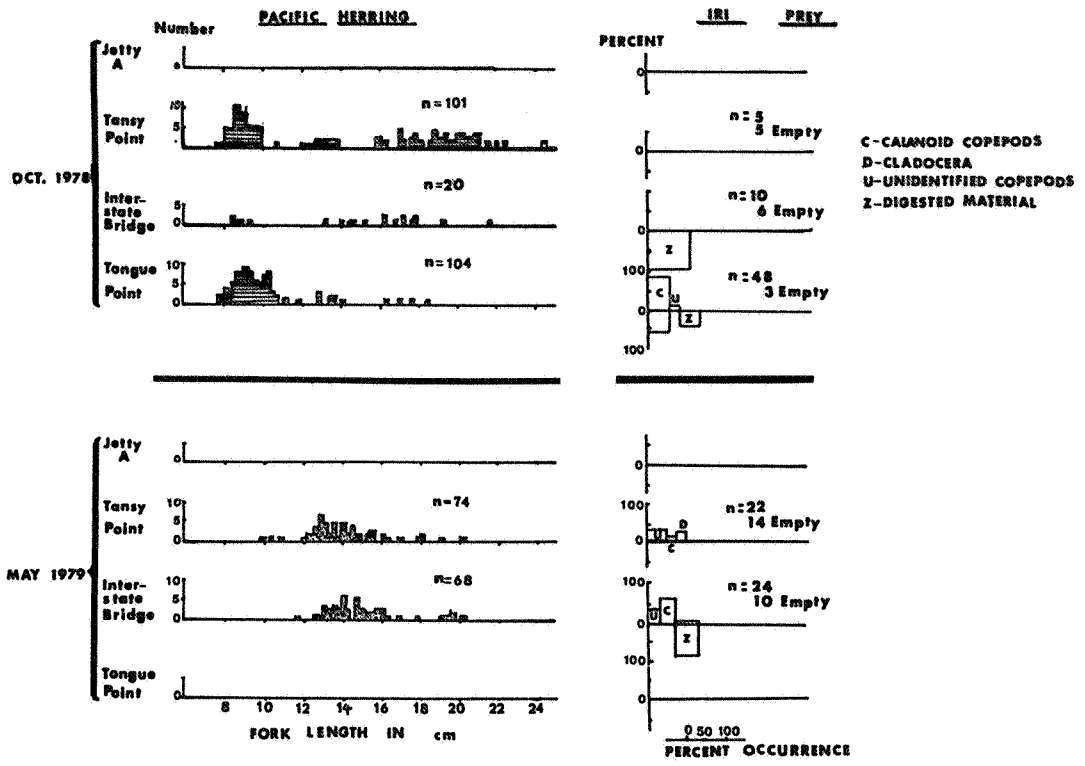


Figure 3.--Length frequency and food habits of Pacific herring captured at four estuarine hydraulic scour sites during two surveys. The IRI diagram for this and the following figures shows percent numbers of different food items above the horizontal line, the percent weight below the horizontal line. Width of each box represents the frequency of occurrence of a particular item in the stomachs (see diagram below).

Index of Relative Importance (IRI)

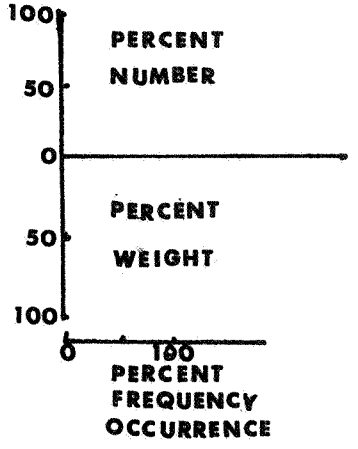
numerical value

(N + W)F = IRI.

N = Percent numbers

W = Percent weight

F = Percent frequency occurrence



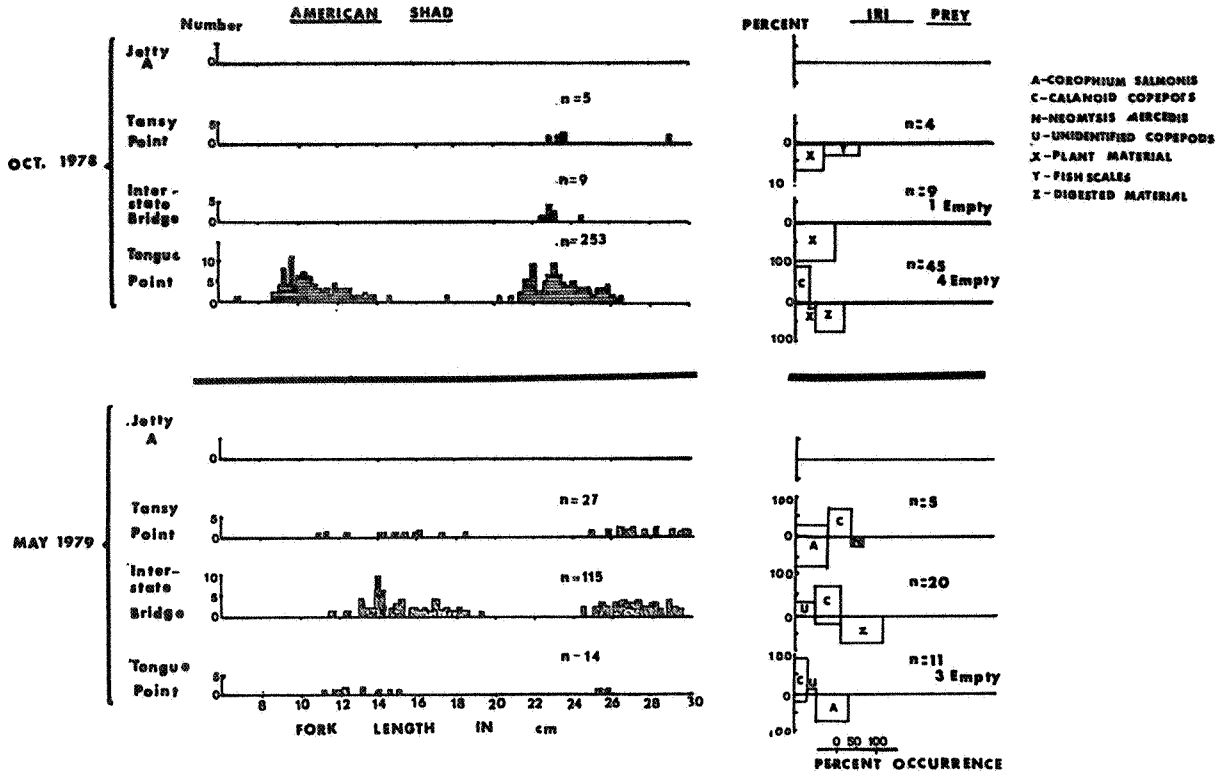


Figure 4.--Lengths of American shad and their food consumption at several estuarine sites.

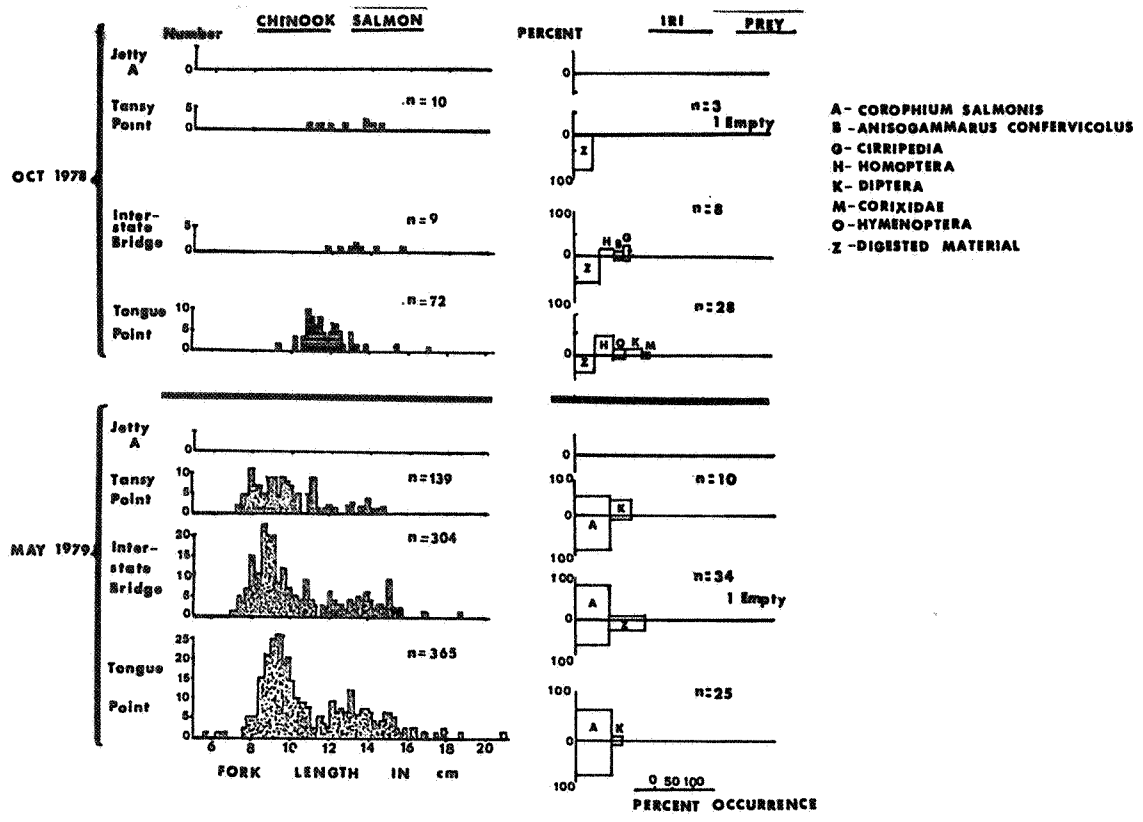


Figure 5.--Chinook salmon lengths and food consumption in 1978 and 1979 at several estuarine sites.

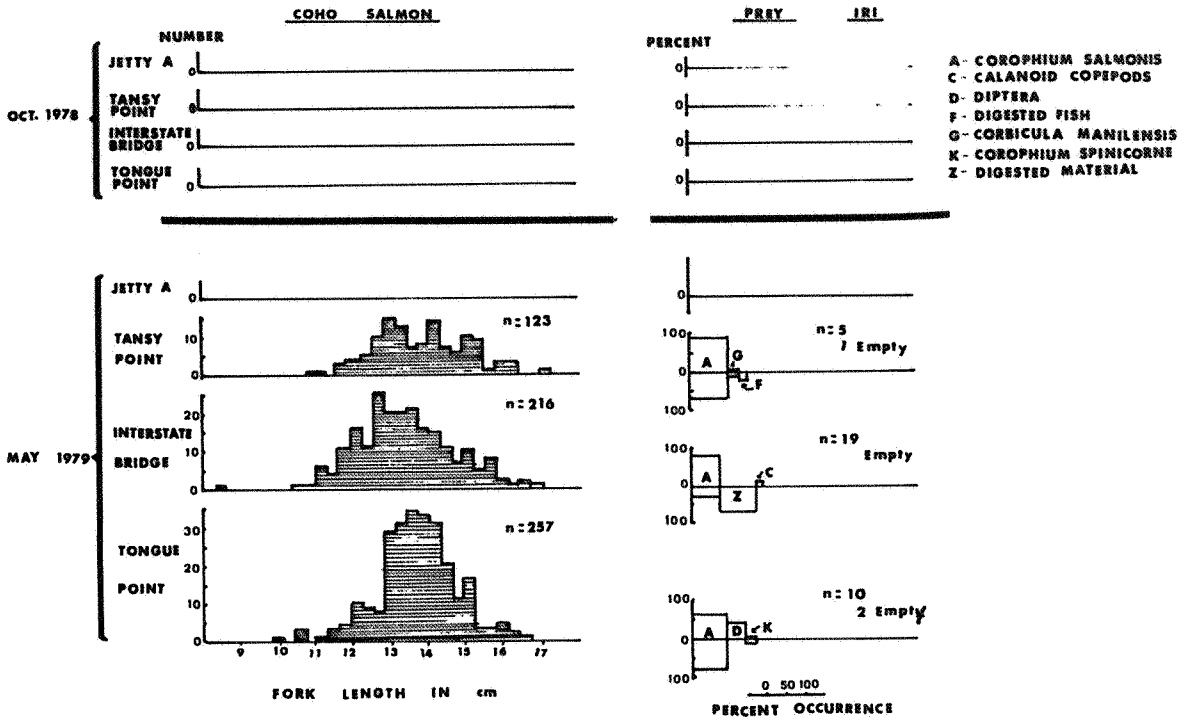


Figure 6.--Coho salmon lengths and food consumption during May 1979 at three estuarine sites.

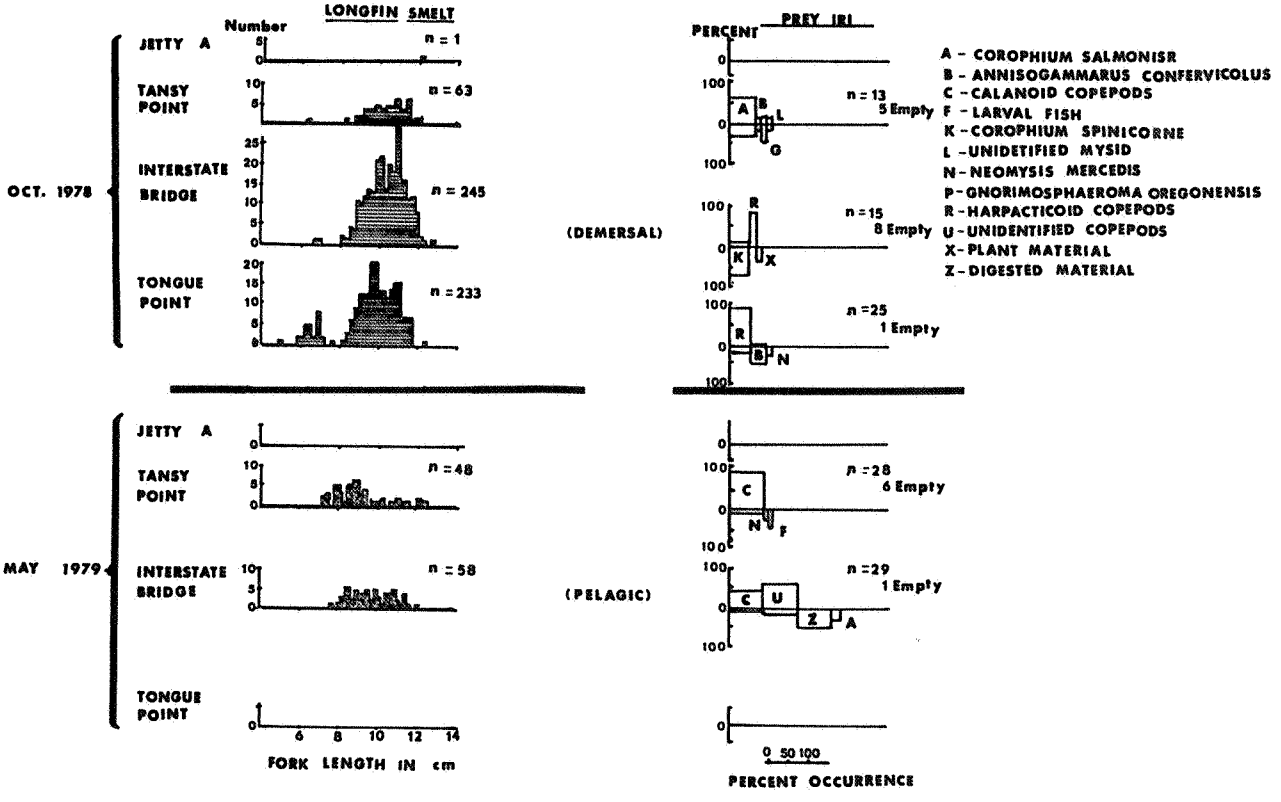


Figure 7.--Longfin smelt length frequency and food consumption at several estuarine sites in 1978 and 1979.

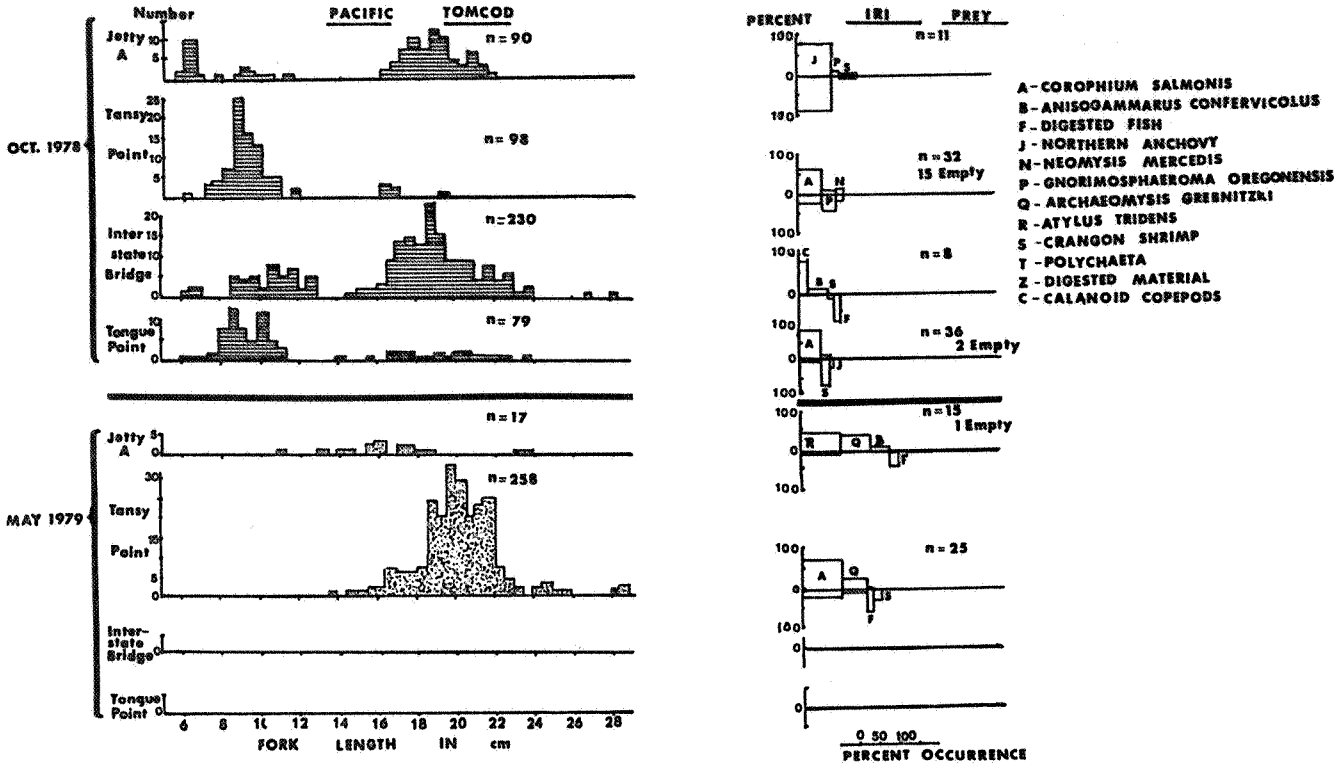


Figure 8.--The lengths of Pacific tomcod captured at several estuarine sites and the selection of prey items consumed.

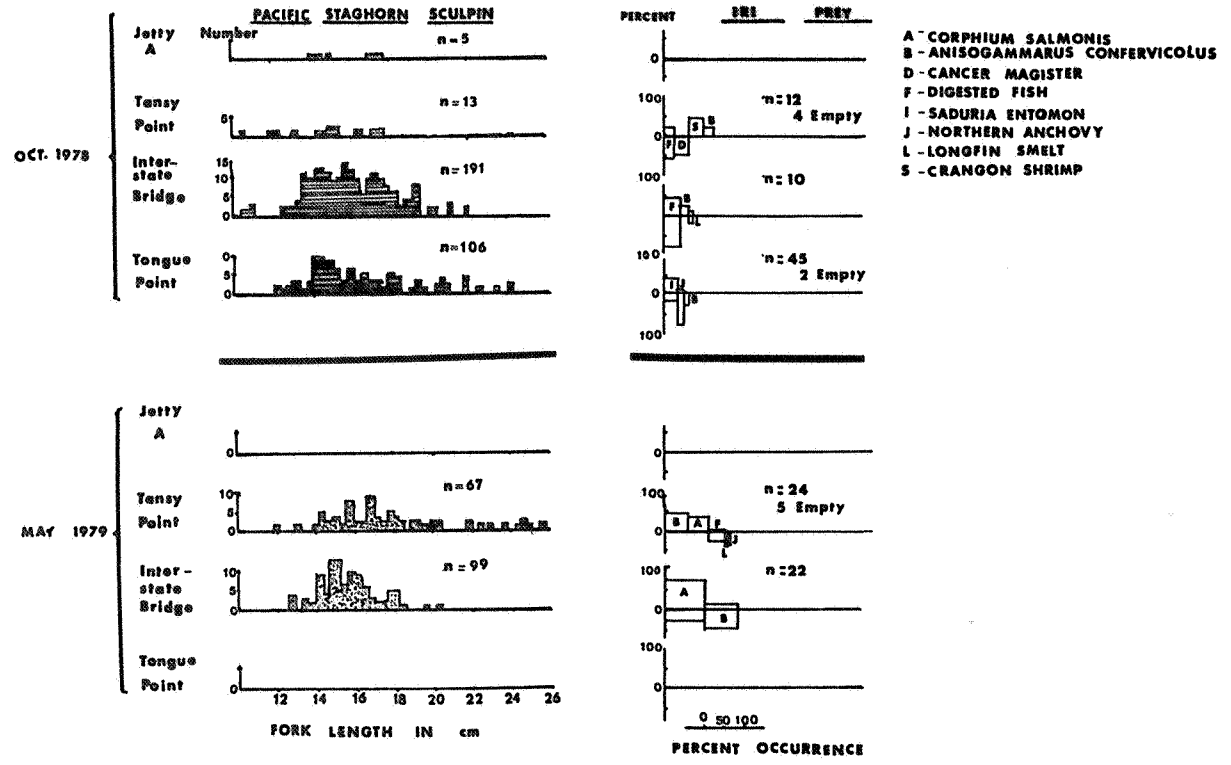


Figure 9.--Lengths of Pacific staghorn sculpin captured at several estuarine sites and the food items consumed.

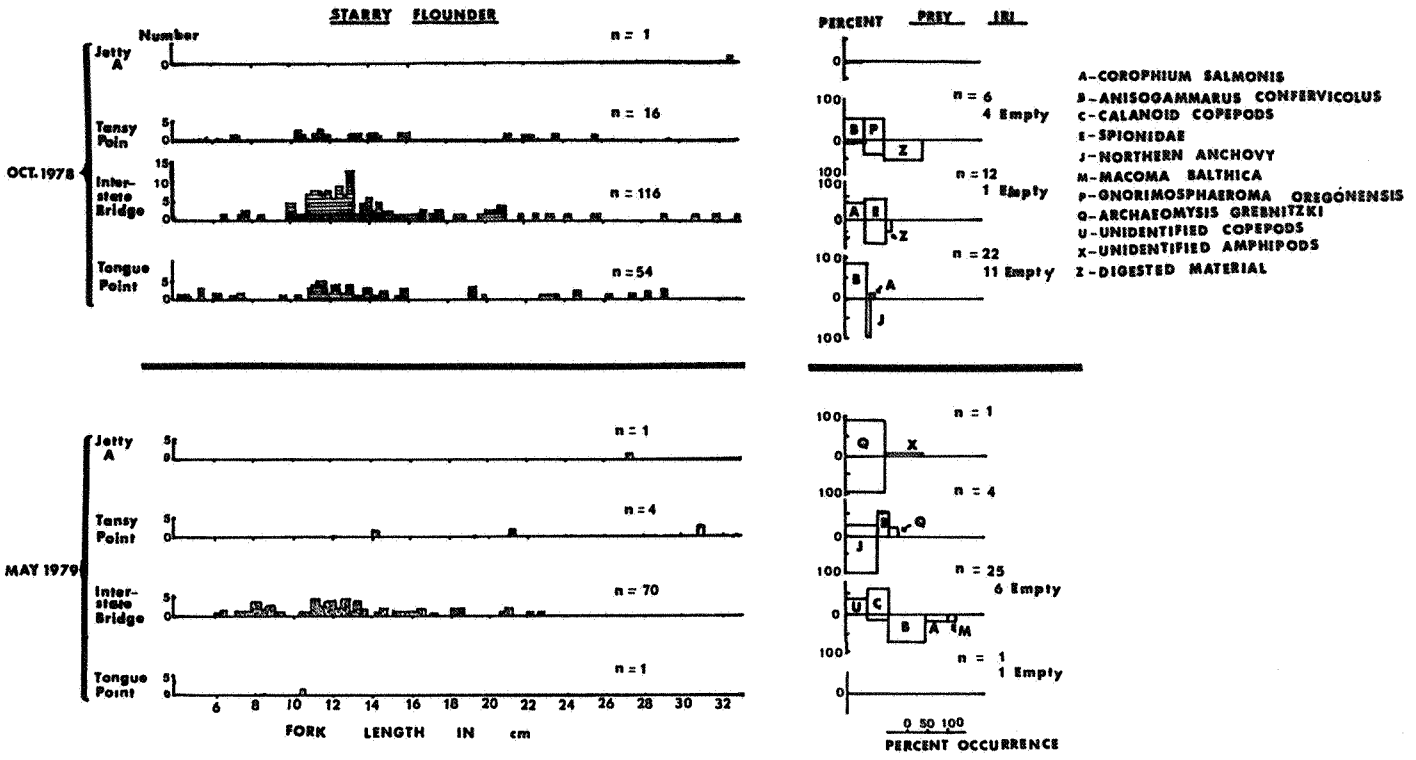


Figure 10.--Starry flounder length frequency at several estuarine sites and food items consumed.

amphipod, Corophium salmonis accounted for the weight of food consumed at Tongue Point and Tansy Point.

An important number of subyearling fall chinook salmon, apparently rearing in the estuary, were encountered in October 1978 at Tongue Point (Figure 5). Most identifiable food items eaten by these salmon were insects. In May 1979, the size range and abundance of juvenile chinook salmon were comparable at all sites. A majority of the food consumed by these young salmon was the amphipod, C. salmonis. Diptera was the only other identifiable food item.

Juvenile coho salmon were not taken in the October purse seine sampling, but they were found at three sites in May. The lengths of coho salmon and their size range were comparable between sample areas (Figure 6). C. salmonis was the major identifiable food item at all sites, although some bivalves, insects, copepods, and fish were also consumed.

Longfin smelt, a common estuarine finfish, are inhabitants of mixed and marine zones of the estuary and spawn in early winter. Smelt lengths indicated adults were present at three upstream sites, but a juvenile group also occurred at Tongue Point (Figure 7). Longfin smelt diet varied between sites, though amphipods and harpacticoid copepods were the important food items. The incidence of smelt actively feeding was substantially higher at Tongue Point than other sites. Fewer smelt were captured in May 1979, and they occurred below Tongue Point. The identifiable food consumed by smelt was chiefly calanoid copepods. Most smelt examined in May had food in their stomachs.

Pacific tomcod, a marine species, can exist in moderately brackish water. Several distinct size groups of tomcod were caught (Figure 8). They were found at all sites in October with the highest incidence at the

Interstate Bridge. Food consumption varied considerably between sites. Northern anchovy were preferred prey at Jetty A, and amphipods, isopods, and mysids at Tansy Point. At the Interstate Bridge calanoid copepods, amphipods, shrimp, and fish were major prey items while sand shrimp and amphipods were eaten at Tongue Point. The May survey indicated tomcod were found only west of the Interstate Bridge. Primary dietary items were marine mysids and amphipods, although C. salmonis was important at Tansy Point. Tomcod feeding intensity was high at both sites.

Pacific staghorn sculpin are a demersal marine species that we occasionally find in fresh water. Lengths of staghorn sculpin revealed no clearly distinguishable size groups; however, larger individuals were captured in October at the upstream sites (Figure 9). Various food items consumed were fish and epibenthic invertebrates such as Crangon shrimp, crabs, isopods, and amphipods. In May, staghorn sculpin were found downstream from Tongue Point and larger individuals occurred at Tansy Point. Dietary consumption in the spring was primarily amphipods.

Starry flounder are a marine flatfish found throughout the year in the estuary. Juvenile flounder are numerous and some move a considerable distance into the river. Lengths of flounder revealed a wide range of sizes which were comparable between sites (Figure 10). October food preferences consisted of amphipods at all sites but included isopods at Tansy Point, polychaetes at the Interstate Bridge, and anchovy at Tongue Point. In May, flounder were common only at the Interstate Bridge, and calanoid copepods, amphipods, bivalves, mysids, and anchovy were the principal food consumed.

The characteristics of the eight species indicate lengths of the

pelagic fish and demersal fish were generally comparable between sites. Normal migratory timing of anadromous pelagic species was the primary factor affecting their availability at inventory sites, whereas the level of salinity influenced the presence or absence of the marine bottom fish. Food consumption in the October survey varied considerably, depending on species of fish and location captured. Fish collected in May had less variation in diet between sites and made substantial use of amphipods and copepods. The incidence of fish with empty stomachs was lower at the Tongue Point and Interstate Bridge sites, and organisms were in a less digested state. This suggests a higher availability of prey items at those sites.

Prey organisms found in the stomachs of the fish are listed by taxonomic order in Table 10. A majority of the food items were arthropods.

Decapod Shellfish

Trawl sampling captured substantial numbers of crustaceans together with demersal fish. Crabs have economic value and shrimp are important fish prey.

The four decapod crustaceans captured during this study were marine species. Dungeness crab and sand shrimp, C. franciscorum, were the only species that migrated substantial distances into the estuary. Sand shrimp were found at all sites during October and appeared to be the same general size (Figure 11). In May the shrimp did not appear at Tongue Point, and only juveniles were captured at the Interstate Bridge. Gravid females made up the bulk of the large shrimp captured at Tansy Point. Crangon stylirostris, a smaller species intolerant of fresh water, were found only

Table 10.--The species and groups of food organisms found in the stomachs of the finfish examined during the estuarine inventory study.

- Phylum Platyhelminthes
  - Class Turbellaria
- Phylum Nemertea
- Phylum Nematoda
- Phylum Nematomorpha
- Phylum Annelida
  - Class Polychaeta
    - Family Nephtyidae
      - Nephtys spp.
    - Family Nereidae
      - Neanthes limnicola
    - Family Orbiniidae
      - Haploscoloplos spp.
    - Family Spionidae
      - Polydora spp.
    - Family Ampharetidae
      - Hobsonia florida
  - Class Oligochaeta
- Phylum Mollusca
  - Class Bivalvia
    - Family Corbiculidae
      - Corbicula manilensis
    - Family Tellinidae
      - Macoma balthica
    - Family Mytilidae
      - Mytilus edulis
- Phylum Arthropoda
  - Subphylum Chelicerata
    - Class Arachnida
      - Order Acarina
        - Suborder Trombidiformes
          - Hydracarina
      - Order Araneae
  - Subphylum Mandibulata
    - Class Crustacea
      - Subclass Branchiopoda
        - Order Cladocera
          - Family Daphnidae
            - Daphnia longispina
          - Family Bosminidae
            - Bosmina longirostris
      - Subclass Ostracoda
      - Subclass Copepoda
        - Order Calanoida
          - Diaptomus spp.
          - Eurytemora hirundoides
          - Calanus finmarchicus
          - Pseudocalanus minutis
        - Order Cyclopoida
          - Cyclops vernalis
        - Order Harpacticoida
          - Canuella canadensis
          - Bryocamptus spp.
      - Subclass Cirripedia
      - Subclass Malacostraca
        - Order Mysidacea
          - Family Mysidae
            - Archaeomysis grebnitzkii
            - Neomysis mercedis
            - Neomysis kadikensis
            - Acanthomysis davisi
        - Order Cumacea
          - Family Diasiylidae
            - Diastylopsis dawsoni
          - Family Leuconidae
            - Hemileucon comes
        - Order Isopoda
          - Suborder Flabellifera
            - Family Sphaeromatidae
              - Gnorimosphaeroma oregonensis
          - Suborder Valifera
            - Family Idoteidae
              - Mesidotea (=Saduria) entomon
              - Idotea spp.
        - Order Amphipoda
          - Suborder Gammaridea
            - Family Corophiidae
              - Corophium salmonis
              - Corophium spinicorne
            - Family Gammaridae
              - Anisogammarus confervicolus
              - Anisogammarus pugettensis
            - Family Haustoriidae
              - Eohaustorius estuarius
            - Family Oedicerotidae
              - Monoculodes spp.
            - Family Phoxocephalidae
              - Paraphoxus milleri
            - Family Lysianassidae
              - Hippomedon denticulatus
            - Family Dexaminidae
              - Atilus tridens
        - Superorder Eucarida
          - Order Decapoda
            - Suborder Natantia
              - Family Crangonidae
                - Crangon franciscorum
                - Crangon stylirostris
            - Suborder Reptantia
              - Cancer magister
  - Class Insecta
    - Subclass Pterygota
      - Order Ephemeroptera
        - Hexagina spp.
      - Order Odonata
      - Order Orthoptera
      - Order Isoptera
      - Order Hemiptera
        - Family Corixidae
      - Order Homoptera
        - Family Aphididae
      - Order Coleoptera
      - Order Diptera
        - Family Chironomidae
        - Family Heleidae
      - Order Trichoptera
      - Order Hymemoptera
- Phylum Chaetognatha
  - Sagitta spp.
- Phylum Chordata
  - Stellerina xyosterna
  - Hypomesus pretiosus
  - Spirinchus thaleichthys
  - Engraulis mordax
  - Clupea harengus pallasi
  - Gasterosteus aculeatus
- Phytoplankton

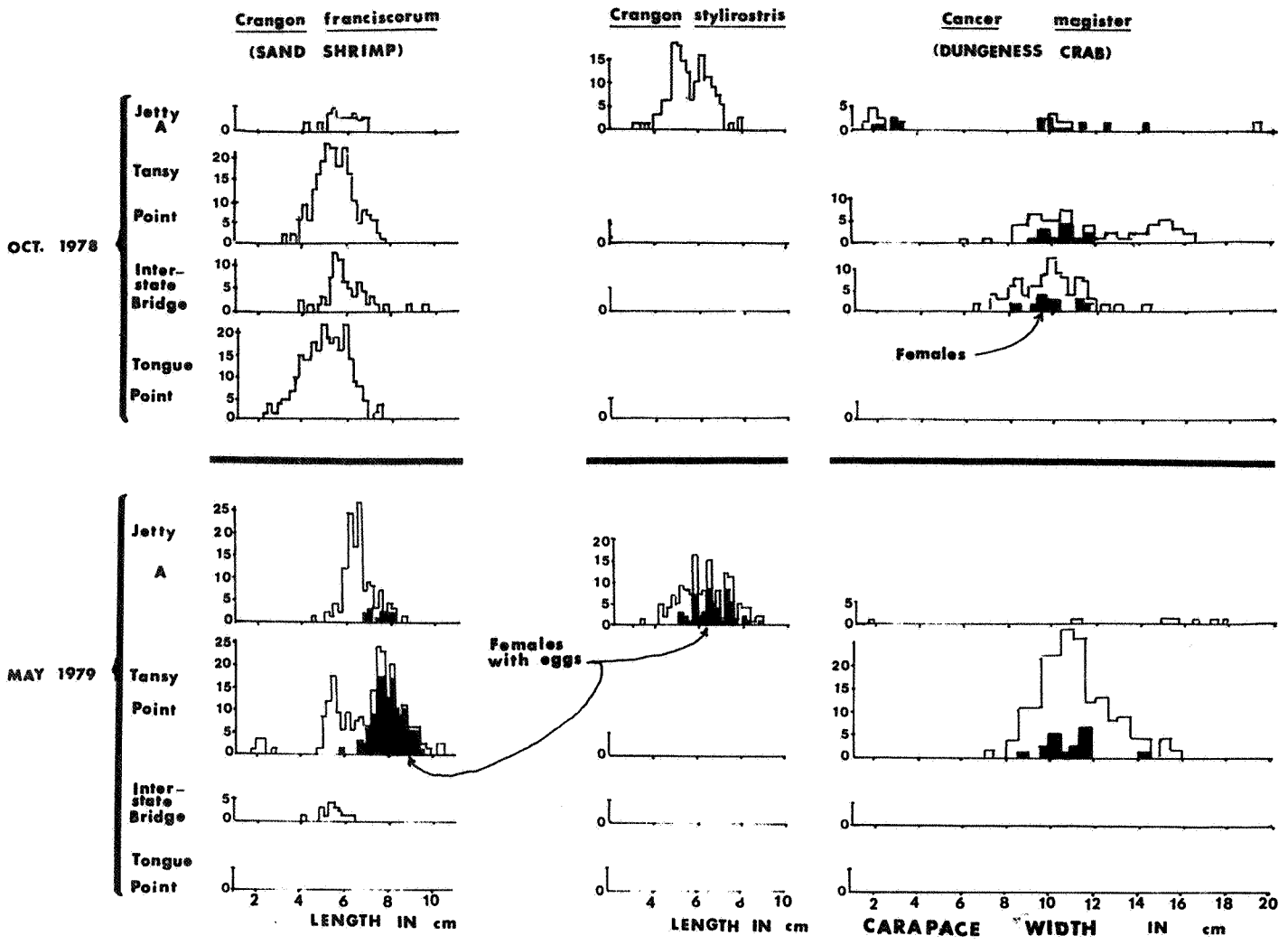


Figure 11.--Lengths and locations captured of several decapod shellfish during estuarine inventories.

at Jetty A. C. stylirostris also had gravid females present in May. Various sizes of Dungeness crab were found at the three marine sites in October. In May, the crab distribution appeared concentrated at Tansy Point. The female crabs captured were less than 14 cm in carapace width and none were gravid. There was an apparent association of some marine demersal fish and decapod shellfish that should be considered when studying standing crop or distribution.

Finfish Diversity

October and May data comparisons were made between this study, previous research, and ongoing studies with the Columbia River Estuary Data Development Program (CREDDP). The purpose was to determine how the inventory study catches and community structure indices ranked with other assessment studies. This included trawl and purse seine sampling results in ocean and freshwater habitats. Five measures were used for comparing the catch values: average catch per minute of sampling effort, average number of species per effort, and three diversity index measures. The Shannon Weaver diversity index values increase (0.0 to 6.0) as number and equitability of species abundance increase (Shannon and Weaver 1963). The Pielou equitability or eveness index ranges from 0.0 to 1.0 from low to perfect equitability of the fish catch (Pielou 1966). Species richness index increases as the species and their equitability increase (Margalef 1951).

The significance of these tables is that the CREDDP sampling data at similar sites generally confirmed the scour inventory results. Ocean catches indicated a generally richer and more diverse finfish population than found at most estuarine sampling sites. The freshwater sites in the

estuary were comparatively poor in species number and community structure. Numerical values of the inventory study were usually highest at Tongue Point and Interstate Bridge.

The trawl inventory catch for October 1978 was compared with 1980 CREDDP studies in the same area, upstream freshwater areas, and 1975 ocean investigations (Table 11). Ocean sampling provided the highest catches and species, whereas the freshwater areas yielded the lowest. The 1978 scour investigation sampling was generally supported by the 1980 CREDDP sampling though there were some inconsistencies.

Purse seine catches in October indicated comparatively higher values occurred at Tongue Point than at other sites (Table 12). The freshwater sites and Tansy Point had low index values.

The 8-m trawl catches taken in May were compared (Table 13). Ocean sampling though productive of fish, had low equitability indicating several species dominated the catch. Results per unit of effort were poor at several estuarine sites and surveys. The 1980 CREDDP data reflected a greater number of fish and species at Tongue Point and Interstate Bridge than were found in the scour study.

May purse seine catches included only estuarine sites (Table 14). The number of fish caught at Tongue Point in 1979 was not corroborated by the 1980 survey, though diversity indices were similar. The highest diversity readings were found in 1980 at Tansy Point.

Tables 11-14 indicate the mixed zone of the estuary had more fish and species than the freshwater part of the system, but less than the adjacent ocean area. The four scour sites had a variety of rankings depending on season and gear. Though not consistent, the highest values were usually

Table 11.--Numerical value of 8-m trawl catches, 5 min in duration in the Columbia River estuary and nearby ocean water during October-November.

AREA	Number of finfish (ave. catch per min.)	Number of species per tow (average)	Shannon Weaver diversity ($H' = -\Sigma pi \log_2 pi$)	Equitability ($J = \frac{H'}{\log_2 S}$)	Species richness ($SR = \frac{S-1}{\ln N}$)
SCOUR INVESTIGATION (1978)					
Jetty A	7.4	8	2.0120	0.6926	1.9982
Tansy Point	9.8	6	1.7976	0.7152	1.4390
Interstate Bridge	63.5	7	1.6474	0.5366	1.1866
Tongue Point	144.4	9	1.3882	0.4958	1.1052
CREDDP STUDY 1980 1/					
River Mile 2	7.5	6	2.0956	0.8107	1.3846
Tansy Point	20.6	5	1.6375	0.7052	0.8630
Interstate Bridge	32.0	12	2.3238	0.6482	2.1764
Tongue Point	11.4	8	2.5893	0.8631	1.7313
CREDDP STUDY 1980 2/					
Freshwater					
Miller Sands RM 24	0.4	2	0.9998	0.9998	1.4427
Skamokawa RM 38	0.8	2	0.9998	0.9998	0.7213
OCEAN - 1975 3/					
North Head	263.3	17	3.2700	0.5925	2.6671
Buoy 1 Area B	151.0	18	3.0947	0.7285	2.6009
Buoy 2 Area F	841.4	16	2.9374	0.7186	2.4526
South of Area F	72.4	15	2.5663	0.6568	2.1427
Area 6	45.1	5	1.8215	0.7844	0.8414

1/ Columbia River Estuary Data Development Program mixed saline sites
2/ Columbia River Estuary Data Development Program freshwater sites
3/ Durkin etal. 1977

Table 12.--Numerical values of 200-m purse seine catches, 5 min in duration in the Columbia River estuary during October.

AREA	Number of finfish (ave. catch per min.)	Number of species per set (average)	Shannon Weaver diversity ($H' = -\sum p_i \log_2 p_i$)	Equitability ($J = \frac{H'}{\log_2 s}$)	Species richness ($SR = \frac{S-1}{\ln N}$)
SCOUR INVESTIGATION (1978)					
Tansy Point	95.1	4	1.0000	0.6450	0.9040
Interstate Bridge	2.8	4	1.4092	0.6742	0.9648
Tongue Point	722.3	6	1.4822	0.5958	1.0606
CREDDP STUDY 1980 1/					
Tansy Point	6.8	2	0.4304	0.4304	0.2836
Interstate Bridge	13.8	6	1.9876	0.7689	1.1808
Tongue Point	188.2	10	1.5863	0.4775	1.3144
CREDDP STUDY 1980 2/					
Miller Sands	2.0	2	0.4689	.4689	1.0000
Skamokawa	26.6	1	0.0000	0.0000	0.0000

1/ Columbia River Estuary Data Development Program mixed saline sites

2/ Columbia River Estuary Data Development Program freshwater sites

Table 13.--Numerical values of 8-m trawl catches, 5 min in duration in the Columbia River estuary and nearby ocean sites during May.

AREA	Number of finfish ave. catch per minute	Number of species per tow (average)	Shannon Weaver diversity ($H' = -\Sigma \text{per } \log_2 pi$)	Equitability ($J = \frac{H'}{\log_2 S}$)	Species richness ($SR \frac{S-1}{\log N}$)
SCOUR INVESTIGATION (1979)					
Jetty A	3.4	5	1.8474	0.8834	1.7294
Tansy Point	18.3	7	1.7200	0.6234	1.3956
Interstate Bridge	7.0	2	0.7714	0.6570	0.3164
Tongue Point	1.4	2	0.6280	0.4192	0.5398
CREDDP STUDY 1980 1/					
River Mile 2	2.4	3	0.9090	0.7580	1.6240
Tansy Point	11.6	9	2.4270	0.7660	1.9700
Interstate Bridge	47.6	11	2.1000	0.6070	1.8270
Tongue Point	26.6	6	1.0670	0.4130	1.0220
CREDDP STUDY 1980 2/					
Miller Sands RM 24	3.2	3	0.6690	0.4220	0.7210
Skamokawa RM 38	1.2	3	1.5850	1.0000	1.1160
OCEAN 1975 3/					
North Head	33.7	9	2.5956	0.7014	1.4934
Buoy 1 Area B	495.0	13	1.0320	0.2641	2.1282
Buoy 2 Area F	692.4	12	1.0673	0.2803	1.4701
South of F	212.3	14	0.7276	0.1744	2.2190

1/ Columbia River Estuary Data Development Program mixed saline sites

2/ Columbia River Estuary Data Development Program freshwater sites

3/ Durkin and Lipovsky 1977

Table 14.--Numerical Values of 200-m purse seine catches, 5 min in duration in the Columbia River estuary during May.

AREA	Number of finfish (ave. catch per min.)	Number of species per tow (average)	Shannon Weaver diversity ($H'=-\sum pi \log_2 pi$)	Equitability ($J=\frac{H'}{\log_2 S}$)	Species richness ($SR=\frac{S-1}{\ln N}$)
SCOUR INVESTIGATION (1979)					
Tansy Point	66.1	10	1.7680	0.5458	1.7590
Interstate Bridge	46.5	9	2.1448	0.6654	1.3188
Tongue Point	86.9	10	1.8968	0.5340	1.5084
CREDDP STUDY 1980 1/					
Tansy Point	83.4	12	2.3420	0.6530	1.8230
Interstate Bridge	95.2	11	1.3060	0.3780	1.6220
Tongue Point	14.8	6	1.9810	0.7660	1.1620
CREDDP STUDY 1980 2/ (Fresh Water)					
Miller Sands RM 24	29.4	7	1.8630	0.6640	1.2020
Skamokawa RM 38	46.2	9	2.1860	0.6900	1.4700

1/ CREDDP mixed saline sites

2/ CREDDP freshwater sites

associated with Tongue Point and the Interstate Bridge.

Sediment and Water Characteristics

Substrate particle size was classified by nine categories ranging from medium gravel >8mm down to clay <0.002mm. The average value of samples taken at each site was plotted by size category (Figure 12). Several sediment characteristics were indicated: (1) medium grain sand, 0.25-0.5mm, was the single dominant particle size category at all sites; (2) the dominance of medium grain sand did not change at any site between October and May; and (3) a slightly greater proportion of both large and fine grain sediments was found at the three sites upstream from Jetty A. There is however, little evidence that fine or coarse sediment accumulated or exhibited seasonal change at the scour sites.

Total volatile solids (TVS) from sediment samples were analyzed. The range and mean of TVS for each group of samples are shown by site and survey in Figure 12. Sediment was essentially clean sand at all sites with levels ranging from 1 to 2%. Only 2 of the 80 samples exceeded the 6% level.

Salinity and temperature readings were collected with a Beckman RS5-3 salinometer along with sediment and benthic infauna samples. The results also appear in Figure 12; readings represent measurements taken at the surface (S) and bottom (B). Salinity levels ranged from marine to fresh water from Jetty A to Tongue Point. Salinity can change dramatically with the season, within the water column, and during tide stage. The salinity measurements taken during the benthic studies were generally comparable in the October and May surveys. Water temperatures were also similar from surface to bottom through both surveys. The average depths recorded at

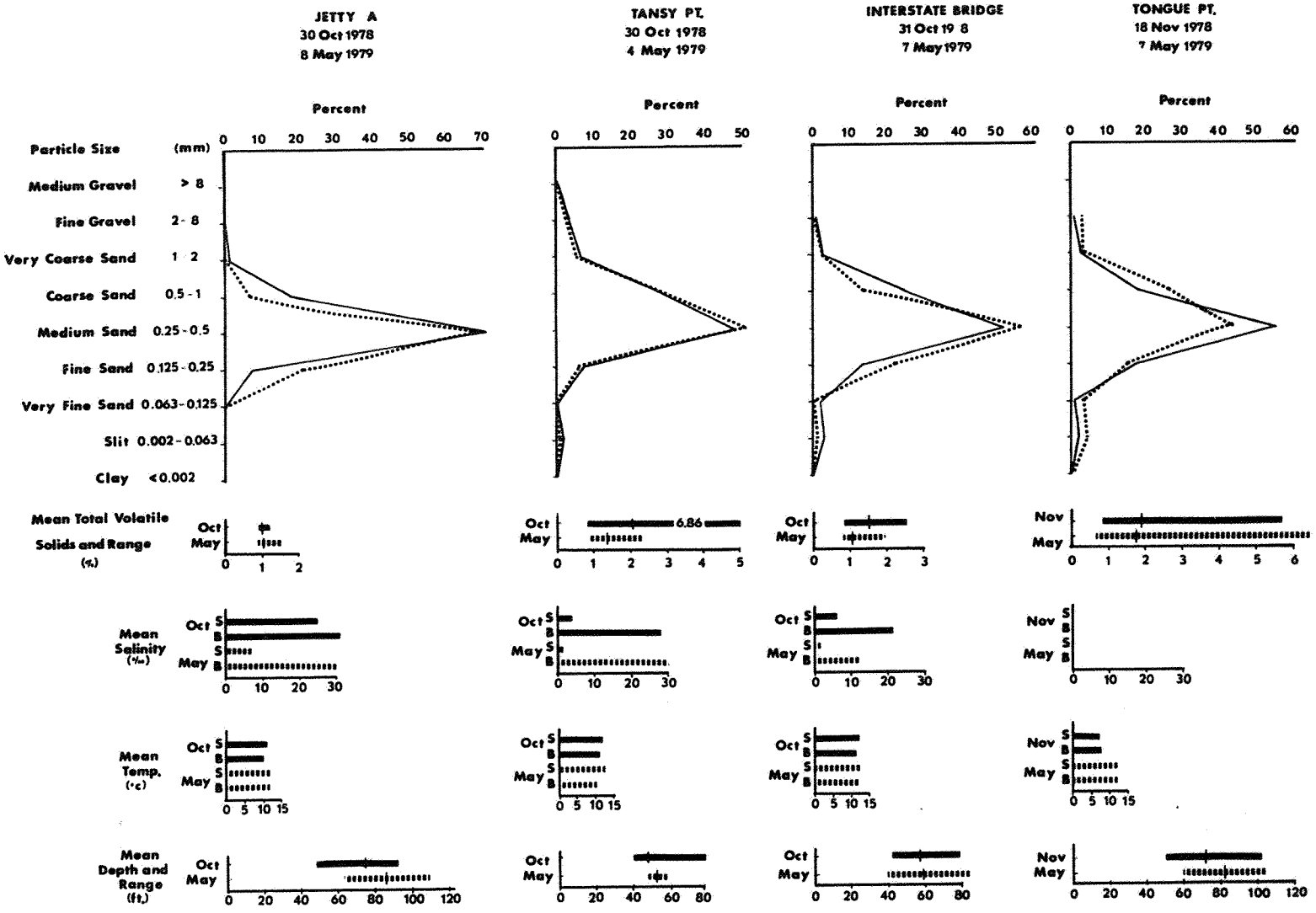


Figure 12.--Sediment particle size and physical conditions recorded during benthic surveys at four estuarine scour sites (unbroken lines indicate the 1978 surveys and dotted lines indicate the May 1979 surveys).

sample sites were greater during the May survey and may have reflected the increased volume of water during the freshet runoff.

Benthic Invertebrate Studies

Invertebrate groups and species captured in October and May are listed in Table 15. Forty-three groups or species were captured during the survey, with most found at Tansy Point and the Interstate Bridge. Some epibenthic invertebrates species were captured while taking infauna samples and others while trawling. Epifauna included bivalves Corbicula manilensis and Mytilus edulis, several species of mysids, Crangon shrimp, Dungeness crab, copepods, cladocerans, and trichopterans.

Several arthropods were collected for the first time in this estuary including the barnacle Balanus crenatus, mysids Acanthomysis macropsis and Neomysis kadiakensis, cumacean Hemileucon comes, and isopod Idotea fewkesi.

Benthic invertebrates were grouped to aid in comparing their abundance (Table 16). Densities of organisms per m^2 by site were low in October. Copepod epifauna was included in the samples and increased the invertebrate densities, particularly at the Interstate Bridge. The May data revealed greater infauna densities at all sites. Nearly all taxonomic groups increased, particularly the amphipods, nematodes, and copepods. Densities of organisms per m^2 were substantially greater than those reported in previous estuarine sampling studies near similar navigation channel areas by Sanborn (1975a, 1975b); Higley and Holton (1975, 1978); and Durkin and Emmett (1980). The invertebrate densities found in May at the scour sites, however, were considerably less than those found in nearby Youngs Bay and Cathlamet Bay by these same investigators. The more important aspect of the survey is that amphipods, copepods, and mysids taken at the sites were organisms utilized by fish.

Table 15.--Benthic invertebrate and epifauna collected October-November 1978, and May 1979 at four scour sites in the Columbia River estuary.

	Jetty A	Tansy Point	Interstate Bridge	Tongue Point
Phylum Ctenophora	1, 2[a/]			
Phylum Platyhelminthes				
Class Turbellaria		2	1, 2	1, 2
Phylum Nemertea	1, 2	1, 2	1, 2	1, 2
Phylum Acanthocephala				2
Phylum Nematoda	1, 2	1, 2	1, 2	1, 2
Phylum Annelida				
Class Polychaeta				
Family Nephtyidae				
Nephtys californiensis	1, 2			
Family Nereidae				
Neanthes limnicola		2		1
Family Orbiniidae				
Haploscoloplos spp.		1, 2	2	
Family Phyllococidae				
Eteone dilatea		2		
Family Spionidae				
Polydora spp.		1		
Spio filicornis	2	1		
Family Capitellidae				
Capitella capitata			1	
Class Oligochaeta	2	1	1, 2	
Phylum Mollusca				
Class Gastropoda	2			1
Class Bivalvia				
Family Corbiculidae				
Corbicula manilensis		1	2	1, 2
Family Tellinidae				
Macoma balthica		1, 2	1, 2	
Family Mytilidae				
Mytilus edulis	1, 2	2		
Phylum Arthropoda				
Subphylum Mandibulata				
Class Crustacea				
Subclass Branchiopoda				
Order Cladocera	1	2	2	1, 2
Subclass Copepoda	1, 2	1, 2	1, 2	1, 2
Subclass Cirripedia				
Family Balanidae				
Balanus crenatus	2			

[a/] 1 *Collected in October-November 1978*

2 *Collected in May 1979*

	Jetty A	Tansy Point	Interstate Bridge	Tongue Point
Subclass Malacostraca				
Superorder Peracarida				
Order Mysidacea				
Family Mysidae				
Archaeomysis grebnitzkii	1, 2	1, 2	1, 2	
Neomysis mercedis	1	2	1, 2	1, 2
Acanthomysis macropsis	Trawl[b/]			
Neomysis kadiakensis	Trawl			
Order Cumacea				
Family Diasiylidae				
Diastylopsis dawsoni	1, 2			
Family Leuconidae				
Hemileucon comes		2	2	
Order Isopoda				
Suborder Flabellifera				
Family Sphaeromatidae				
Gnorimosphaeroma oregonensis	1	1		
Suborder Valifera				
Family Idoteidae				
Mesidotea (=*Saduria*) *entomon*	2		2	1, 2
Idotea fewkesi			Trawl	Trawl
Order Amphipoda				
Suborder Gammaridea				
Family Corophiidae				
Corophium salmonis		1, 2	2	1, 2
Corophium spinicorne		1	2	
Family Gammaridae				
Anisogammarus confervicolus [c/]	1	1, 2	1, 2	1, 2
Family Haustoriidae				
Eohaustorius estuarius		2	1, 2	1, 2
Family Oedicerotidae				
Monoculodes spinipes	1, 2			
Family Phoxocephalidae				
Paraphoxus milleri		1, 2	1	
Superorder Eucarida				
Order Decapoda				
Suborder Natantia				
Family Crangonidae				
Crangon franciscorum	Trawl	Trawl	Trawl	
Crangon stylirostris	Trawl			
Suborder Reptantia				
Cancer magister	Trawl	Trawl	Trawl	
Class Insecta				
Order Diptera				
Family Chironomidae			2	2
Family Heleidae			2	2
Order Trichoptera		1		
Order Hymenoptera	1			
Phylum Chaetognatha	1, 2	2	2	

b/ *Species captured with 8 m shrimp trawl*

c/ Now classified as *Eogammarus confervicolus*, this change should also be reflected in IRI charts.

TABLE 16.--Abundance of various groups of benthic invertebrates in numbers per meter square as indicated by 10 ponar 0.05 m^2 grab samples at each of four sites during two survey periods.

	October 1978				May 1979			
GROUPS	Jetty A	Tansy Point	Interstate Bridge	Tongue Point	Jetty A	Tansy Point	Interstate Bridge	Tongue Point
Turbellaria			168	12		202	446	200
Nemertea	2	34	14	8	4	156	58	8
Nematoda	38	216	100	32	4486	704	756	1138
Acanthocephala								1
Polychaeta	6	40	14	6	56	60	8	
Oligochaeta			10		10		34	
Mollusca								
Gastropoda				2	4			
Bivalvia	2	10	8	76	2	34	12	18
Arthropoda								
Cirripedia					4			
Mysidacea	10	24	4		492	36	6	4
Cumacea	2				4	4	18	
Amphipoda	10	156	62	148	28	816	784	1830
Decapoda					10	36	22	24
Isopoda	2	6		2	2		6	2
Cladocera	4			20		2	76	40
Copepoda	36	36	2080	2	62	106	2810	3414
Insecta								
Diptera	2	4					8	28
Hymenoptera	4							
Trichoptera		2						
Other								
Ctenophora	4				30			
Chaetognatha	14				6	2	2	
Fish larvae	2					20	122	8
TOTAL	138	528	2460	308	5200	2178	5168	6716

DISCUSSION

The inventory sampling produced many finfish, shellfish, and aquatic invertebrates at several sites. Depending on site or survey, the standing crop of fish ranged from stable to relatively unstable. The average catch of finfish per minute of sampling effort was highest at the upstream scour sites. Most finfish captured during the October sampling were marine bottom or marine schooling surface fish. The May sampling indicated most marine finfish species were approximately 10 km downstream with a lower standing crop than the previous survey. Juvenile anadromous finfish dominated the pelagic sampling effort during May. There were several freshwater fish species that moved into the upper estuarine sites that were seasonally used and vacated by marine fish.

Sampling was conducted during a limited temporal period and this qualified the determination of population stability. A continuing association of many demersal and pelagic finfish species together with shellfish and aquatic invertebrates indicated at least partial stability.

Species were subjected to several stresses. The most obvious stress was the presence, absence, or level of salinity. An additional stress was water velocity at the scour sites. The geographic configuration of the river mouth suggests water velocities were highest at the Jetty A site. Varying water velocities which switch 180° twice daily with tides were a stress not encountered by fish in marine or freshwater habitats. The annual freshet resulting from spring snow melt in the mountains was a third stress. The increased volume of fresh water reduced the mixed salinity zone and reduced the habitat for marine species. As the freshet diminished in the summer and salinity increased, pelagic and demersal marine fish once

again occurred further upstream. The catch results indicated more fish occurred in the mixed salinity habitats than either the total freshwater area east of Harrington Point or the marine area from Jetty A to the mouth. Numerical abundance in stress areas is evidence of the species adaptability to their estuarine habitat. Diminished numbers indicated a lesser ability to contend with environmental stress.

Another explanation for the accumulation of fish is the availability and use of prey organisms. The low incidence of empty stomachs for most species suggested upper scour areas had high numbers of food organisms. The extensive use by pelagic fish of the benthic amphipod C. salmonis indicated some of these benthic invertebrates migrate into the water column.

Benthic invertebrate densities increased sharply between the October 1978 and May 1979 survey. Since the sediment texture did not change it was presumed the improved standing crop was a seasonal phenomenon.

CONCLUSIONS

Data supporting the premise that high velocity estuarine scour sites have essentially low standing crops of fish and invertebrates were found only at Jetty A. Substantial quantities of fish and invertebrates were found at the mixed saline inventory sites. The demersal and pelagic fish communities appeared consistent, suggesting seasonal population stability. Extensive utilization of estuarine food organisms indicated an interdependence of immature marine and anadromous finfish on these habitats. The supposition that low densities of benthic invertebrates occur in the estuarine navigation channels was supported during the October survey but rejected by the May results. Since there was little change in

substrate particle size between surveys, the increased density was very likely a seasonal occurrence. Sediment deposition, particularly at the Tongue Point and Interstate Bridge sites, could potentially smother enormous numbers of important benthic food organisms.

Inventory results indicated the Jetty A site should be evaluated as a permanent deposition site. A valid test would include summer and winter analysis of the impacts on aquatic life. Use of the Tansy Point site for sediment deposition may be possible, but the inventory results indicated it had high biological value for some species. A winter inventory evaluation of the site would be an appropriate approach for either rejecting the site for future consideration of sediment testing or for determining if a seasonal testing approach may be warranted. Tongue Point and the Interstate Bridge are a portion of the estuarine feeding habitat used by pelagic and demersal finfish, and future sediment tests at these sites are not recommended. The upper estuarine sites at Bayview and Wauna should be examined since freshwater finfish populations appear low in the navigation channel (Miller Sands and Skamokawa).

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