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No. 883

TITLE

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in 1959 and 1961. Detailed record
of identifications and other data.

AUTHORSHIP

Delphine C. Maclellan and J.B. Sprague

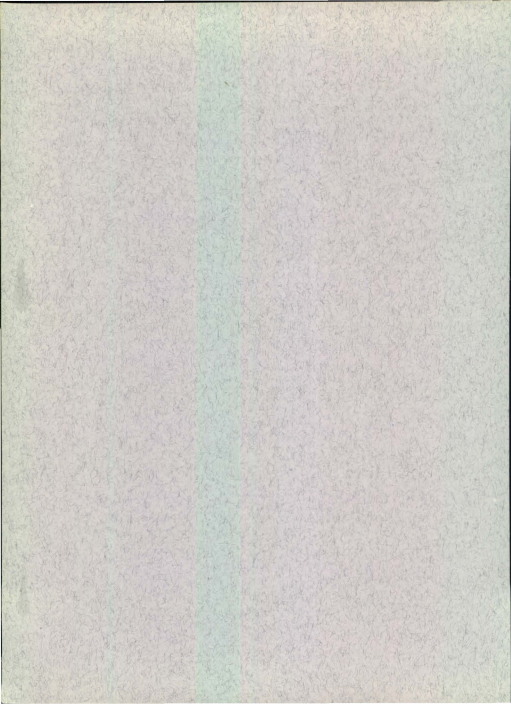
Establishment

Biological Station
St. Andrews, N.B.

Dated : December 1966

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INTRODUCTION

The purpose of this report is to give a detailed record of the data obtained in two surveys of bottom fauna in the harbour and estuary at Saint John, N.B. There has been no attempt to summarize or interpret results. Subsequent reports or papers will give general accounts of findings and conclusions, without repeating the voluminous background of data given here. This report then, makes available the raw data for inspection of those specialists who may at some time in the future be particularly interested in the precise details of these bottom fauna surveys.

The senior author carried out all the identification and weighing of animals, with one or two minor exceptions. This was, of course, by far the biggest portion of the work represented in this report. The junior author was responsible for planning the surveys and collecting the samples.

The original purpose of these two surveys was to see whether there were changes caused by pollution from an oil refinery. The Irving Oil Refinery in East Saint John releases most of its chemical wastes into Saint John Harbour through a pipeline terminating near the tip of Courtenay Bay breakwater (near station X, Figure 1). The refinery started up in stages from late March to mid-June 1960 by which time it was in full operation.

The 1959 survey was carried out about four months before any waste was produced by the refinery, and thus serves as a base-line for detecting changes. The 1961 survey, following full-scale operation of the refinery for sixteen months, was the follow-up.

Sampling stations in the lower part of the estuary were included, with a view to assessing effects of pulp and paper mill waste released at the Reversing Falls.

The results represent a reasonably comprehensive survey of bottom fauna in the waters near Saint John. The 1959 or 1961 surveys, or both, will serve as base-lines in future pollution surveys, whether related to the oil refinery or to some other source of pollution.

ACKNOWLEDGMENTS

Almost all the sampling was done from the M.V. Mallotus, and we wish to thank William G. Carson, skipper of the vessel at that time, and his assistant Floyd R. Johnson. We also thank Gordon F. Wentworth for assistance in obtaining the samples.

For verifying identification of several of the polychaetes, we wish to thank Dr. Marian H. Pettibone, of the Smithsonian Institution. For verifying identification of amphipods, we thank Dr. Don H. Steele of Memorial University, St. John's, Newfoundland.

SAMPLING AND COLLECTING METHODS

Stations

The general location of stations is shown in Figure 1. There were 11 stations in Saint John Harbour. Stations I to VI form a line from the inner harbour out the main channel to the open bay opposite Black Point. Stations VII and VIII were located to the west of this line in the outer harbour. Stations IX, X, and XI were to the east, in Courtenay Bay.

There were four stations in the estuary of the Saint John River, above the Reversing Falls. These stations were numbered according to miles of river channel, starting far upstream where the river enters New Brunswick. Station 280.3 was upstream of Grand Bay, near Brandy Point. The station called "Kennebecasis Mouth" is described by its name, although this part of the river is a large bay. Station 284.8 is at the upper end of the gorge of the Saint John River, at the edge of Grand Bay. Station 287.7 was in the deep water just above the Reversing Falls.

Reference points which may be used to locate these stations exactly are given in Table XI.

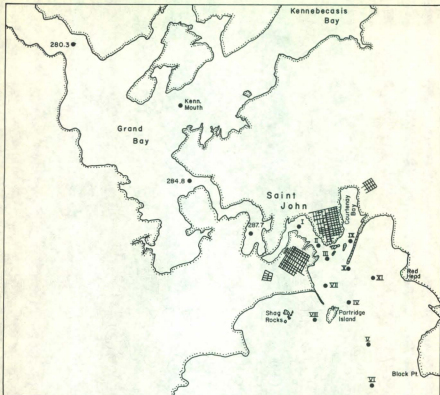


Fig. 1. General locations of stations used in biological surveys of the Saint John river estuary and Saint John harbour, in 1959 and 1961

The 1959 survey was carried out from October 30 to December 4, but most samples were collected from November 30 to December 4. The 1961 survey was collected in about the same season, October 24 to October 26. Exact dates of each station are given in Tables XII and XIII.

The vessel was not anchored for sampling, but was held on station by cruising against the current at whatever speed was necessary, with constant checking of reference points and checking to keep the wire of the sampler vertical.

A van Veen sampler was used, with a nominal sampling area of 0.1 sq. metres. This grab sampler was manufactured by Laboratoire Océanographique, Charlottenlund, Denmark. It is described and evaluated by Holmes (1964) and Lie and Pamatmat (1965). The sampler was operated on the usual hydrographic wire and davit, using a small gasoline-powered winch.

Three samples were collected at each station. Very good samples were obtained in muddy or soft bottoms. The sampler was usually nearly full, the layers of sediment were apparently little disturbed, and could be inspected if the sampler were opened carefully. In sandy bottom less material was obtained, the sampler usually being one-fifth to one-half full. However, it is assumed that this merely represented a shallower bite, with 0.1 sq. m. of surface material collected and representing an adequate sample.

Two stations, I and 287.7, seemed to have a bottom composed mostly of rocks, gravel, or woody detritus, and the adequacy of samples is uncertain. These materials were obtained in the sampler, but seldom occupied a very large proportion of the sampler's volume. Judgement was exercised in these cases, and the sample was accepted if it seemed to be a reasonable approximation of what might cover 0.1 sq. m. of bottom. Obviously poor samples which contained only a few pieces of material were discarded and another attempt made.

Samples were also discarded if something was jammed between the jaws of the sampler so that they did not close. This happened at various stations from time to time.

Each sample was emptied into a galvanized wash-tub and the inside of the sampler was thoroughly washed into the tub.

The sample was then rinsed through a series of three screens, the finest having 7.9 openings per cm. (20.1 per inch) and apparent size of openings of 0.87 mm. A hose delivering sea water at very low velocity was used to rinse the fine sediments to waste through the three screens. The material remaining on the screen was inspected carefully and all organisms were collected. Often the entire contents of the screens were rinsed into a sample bottle and final separation of the organisms was done in the laboratory. This procedure was followed in the 1961 survey and all empty mollusc shells were also preserved.

Samples were preserved in 70% alcohol and were changed to fresh 70% alcohol a few days later.

Bottom Materials

During the rinsing and screening process the percentage composition by volume of the various materials in the bottom sample was estimated and recorded. The sizes used to classify "rocks" and "gravel" are given in footnotes to Tables XII and XIII. Smaller particles were classified as "granules", "sand", "silt", or "clay" according to the common application of these terms. No measurements of particle size were made. These constituents were classified by appearance, feel, and ease of rinsing through the three sizes of screens. The estimates of percentage composition by volume were also aided by noting the separation of components as they were rinsed through the screens.

IDENTIFICATION METHODS

This phase of the work was carried out by the senior author. A few individuals of the amphipod family Caprellidae and the isopod Cyathura polita in some estuarial samples were identified by the junior author.

Taxonomy

Identifications were made with the aid of a Zeiss binocular microscope (magnification 10X) or the low-power objective of an Olympus compound microscope. Taxonomic publications consulted are given in the list of References. Difficulties were encountered in identification to species of certain polychaetes, since many were in juvenile stages or were fragmented.

The identification of the following polychaetes was verified by Dr. M. Pettibone, of the Smithsonian Institution:

<u>Family</u>	<u>Species</u>
Paraonidae	<u>Paraonis gracilis</u> (Tauber)
Cossuridae	<u>Cossura</u> sp. (2 anterior ends - specimens not complete)
Orbiniidae	<u>Scoloplos acutus</u> (Verrill)
Paraonidae	<u>Aricidea suecica</u> Eliason
Spionidae	<u>Polydora</u> sp. (specimens not complete)
Terebellidae	<u>Terebellides stroemi</u> Sars

Amphipods identified by Dr. D. Steele, Memorial University, Newfoundland were:

Gammaridae	<u>Gammarus oceanicus</u>
Ampeliscidae	Species 1
"	Species 2
Lysianassidae	<u>Hippomedon</u> sp.
Photidae	<u>Leptocheirus</u> sp.
Corophiidae	<u>Unciola</u> sp.
Phoxocephalidae	species

A reference collection, made up of suitably labelled representatives of the various kinds of animals found in this study, is available for observation and is presently stored with the Pollution Investigation, Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

Numbers and Weights

The animals were counted individually and numbers recorded for each kind in each sample. In the case of fragmented specimens, the number of heads was taken to be the total number of animals. To weigh animals, they were lifted from the alcohol, deposited for a second on a paper towel to blot the excess liquid, placed on a previously weighed watch glass and immediately weighed while wet. A Mettler balance of capacity 80 grams was used for weighing the smallest animals, and allowed weighing to the nearest 0.1 mg. A larger balance was used for larger animals, especially bivalves. The balance was adjusted between each weighing.

Usually the weight was determined for all individuals of a given species. When very small weights were involved, two or more kinds of animals were weighed together. The total weight was credited to the kind of animal which made up the most weight in the mixed group. Animals which were present but have no weight listed in Tables V to VIII were of negligible weight taken separately, although their weight is included in that given for a nearby taxonomic group.

Empty shells were excluded from tabulations.

The percentage of dry organic matter as compared with the rough alcohol weight was determined by using the following conversion factors:

polychaetes	14%
prosobranchs	6.6%
lamellibranchs	5.4%
crustaceans	4.06%

These were taken from Jensen, in Petersen (1911) and Molander (1928a) as given in Thorson (1957), Table 2, p. 495. Final figures for weights are given in mgms. per 0.1 sq. metre.

RESULTS

The tabulations of kinds, numbers, and weights of animals are given in Tables I to IX. Although three samples were taken at each location, some of them subsequently dried up during storage and could not be analyzed. This explains six missing samples at four stations in the 1961 survey.

The final screen used for rinsing samples was 7.9 meshes/cm. (20.1 /inch). In tests of efficiency of such a screen, Reish (1959) found that it retained 95% or more of the biomass, 93% of the species, and 60% of the individuals which were actually contained in a series of samples. Most of the 40% of individuals which passed through the screen were small nematodes or polychaetes of the Genus Cossura. Reish was working on the coast of California, but it seems likely that our sampling and sorting can be considered effective for all but the very small invertebrates. The hole size of 0.87 mm. which was used in our screen apparently retains species much better than a screen with holes of 1.5 mm. diameter (12 mesh to the inch) commonly used in marine benthic surveys.

Bottom materials and other physical data obtained at the time of sampling are given in Tables XII and XIII. Table X lists the kinds and numbers of empty mollusc shells found in the 1961 samples. These shells are one kind of detritus, but the kinds represented at various places may prove to be of interest.

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Table III. Numbers of animals collected in the 1959 survey of the Saint John River estuary. Arranged as in Table I.

	280.3			KENN. MOUTH			284.8			287.7			
	A	B	C	A	B	C	A	B	C	A	B	C	
1													8
2				1		6							2
3	4			1			98	800	4	454	470	60	1891
4				1					1				3
5				1		13							13
6													0
7						1	2		2				5
8	21	12	32				7	14	3			12	101
9	66	81	10		1	3			1				162
10													0
11													0
12													0
13													0
14	20					1							21
15					1								1
16											2		2
17													0
18													0
19						1							1
20													0
21		2				1					1		4
22						1							1
23				1									1
24					1	1							2
25						3							3
26											1		1
27					2								2
28													0
29													0
30													0
31					1	1							2
32			1		12								13
33													0
34													0
35	40	16			10		5	7				2	80
36	19	52	16					2					89
37													4
38													0
39													0
40			1				1	5		4	6		17
41													0
42													0
43													0
44										1	4	4	9
45													0
46													0
47					3	1							4
48	1	1	2										4
49													0
50													0
51													0
52													0
53					1					4	20	2	27
54													0
55											2		2
56												1	1
57													0
58													0
59										2		1	3
60													0
61	9	52	236	21		33	94	75		2		2	522
62		15	21				67	80				1	184
63													0
64													0
65													0
	180	231	319	24	35	67	274	828	166	465	507	89	3185

Table IV. Numbers of animals collected in the 1961 survey of the Saint John River estuary arranged as in Table I.

	280.3			Kenn ^x Mouth	284.8			287.7			
	A	B	C	C	A	B	C	A	B	C	
1				2	1		1				4
2				1							1
3	2										2
4				71							71
5	4	2	4					2			12
6				3							3
7						16	29				45
8	19	25	17		8					7	76
9											0
10	6	2	4	1	1		1				15
11											0
12											0
13											0
14											0
15											0
16											0
17											0
18											0
19											0
20											0
21	1			19		11	37			65	132
22				71							71
23											0
24				2							2
25											0
26											0
27			1	2							3
28											0
29											0
30											0
31											0
32				1							1
33											1
34	1			1							1
35		4	5		1					2	12
36	66	15	55	2	76		2				214
37	2		1		1					1	7
38											0
39											0
40					7	3	4	45		98	157
41											0
42											0
43											0
44											0
45											0
46											0
47											0
48	4		1								5
49											12
50					9	1	2				0
51								4		3	7
52											0
53								1			0
54								3			1
55	1				3		1	3			8
56											0
57											0
58											0
59								3			3
60								2	13	2	549
61	88	102	156	15	69	11	91				105
62	26	19	13	1	25	8	13				0
63											0
64											0
65										3	3
	220	169	257	192	201	50	183	58	13	181	1524

^x Kenn. mouth samples A and B dried up

Table VIII. Weights of animals collected in the 1961 survey of the Saint John River estuary.

	280.3			Kenn. Mouth	284.8			287.7			
	A	B	C	C	A	B	C	A	B	C	
1				88.3	2.9		1.9				93.1
2				1509.3							1509.3
3											0
4				82.0							82.0
5	0.5	0.5	0.5				0.2				1.7
6				0.5							0.5
7						90.9	50.0				140.9
8	103.8	100.8	67.3		33.3					18.9	324.1
9											0
10	0.9	1.4	0.1	0.1	0.1		0.2				2.8
11											0
12											0
13											0
14											0
15											0
16											0
17											0
18											0
19											0
20	0.5										0.5
21				15.4		1.2	10.3			36.4	63.3
22				28.4							28.4
23											0
24				5.3							5.3
25											0
26											0
27			0.1	1.8							1.9
28											0
29											0
30											0
31											0
32				0.2							0.2
33											0
34											0
35		2.2	5.5		2.9					1.0	11.6
36	6.2	0.9	4.4		19.0		0.3				30.8
37	0.9		0.1	0.4	0.3						1.7
38											0
39											0
40					1.3		0.7	48.2		13.7	63.9
41											0
42											0
43											0
44											0
45											0
46											0
47											0
48	3.5		0.2		2.1	1.1					3.7
49											3.2
50											0
51								0.2		0.1	0.3
52											0
53											0
54								0.1			0.1
55	1.7				27.4		7.3	12.0			48.4
56											0
57											0
58											0
59											0
60								2.9			2.9
61	1871.8	1810.7	1839.0	229.9	974.2	424.5	1776.7	0.3	1.8	1.3	8930.2
62	466.2	624.0	646.4	0.4	210.8	150.5	226.7				2325.0
63											0
64										7.1	7.1
65											0
	2456.0	2540.5	2563.6	1962.0	1274.3	668.2	2074.3	63.7	1.8	78.5	13682.9

Table IX. List of kinds of animals found in 1959 and 1961 surveys of Saint John Harbour and the Saint John River estuary.

1	VERMETERA			Unident. species
2	PRIAPULOIDEA	Priapulidae	Priapulidae	Priapulus caudatus
3*	ANNELIDA	Oligochaeta	+ Nemathelminthes	Unident. species**
4**		Polychaeta	Miscellaneous or unidentified	Unidentified species**
5			Phyllodoceidae	Phyllodoce areolae
6			Phyllodoceidae	Etecta longa
7			Nereidae	Nereis diversicolor
8			Nereidae	Nereis succinea
9			Nephtyidae	Nephtys buccera
10			Nephtyidae	Nephtys sp.
11			Lumbrineriidae	Lumbrineris sp.
12			Lumbrineriidae	Lumbrineris sp.
13			Hesionidae	Microphthalma scselkowiei
14			Parsonidae	Parsonia gracilis
15			Parsonidae	Aricidae succinea
16			Orbinidae	Scoloplos acutus
17			Sternaspidae	Sternaspis sp.
18			Flabelligeridae	Pherusa sp.
19			Scalibregmidae	Scalibregma inflatum
20			Maldanidae	Clymenella torquata
21			Maldanidae	Maldanopsis sp.
22			Opheliidae	Ophelia sp.
23			Opheliidae	Amotrypane aulogaster
24			Trochochaetidae	Trochochaeta sp.
25			Capitellidae	species
26			Goniadidae	Goniada maculata
27			Polynoidae	Harmothoe imbricata
28			Polynoidae	Antinoella sarsi
29			Sigalionidae	Sthenelais limicola
30			Terebellidae	Pista maculata
31			Terebellidae	Terebellides stroemi
32			Cirratulidae	Cosura sp.
33			Cirratulidae	Cirratulus sp.
34			Spionidae	Prionospio malmgreni
35			Spionidae	Scolecipides viridis
36			Spionidae	Streblospio benedicti
37			Spionidae	Polydora sp.
38			Glyceridae	Glycera dibranchiata
39	ARTHIROPODA	Decapoda	Crago	species
40		Amphipoda	Gammaridae	Gammarus oceanicus
41			Aspeliiscidae	Species 1
42			Aspeliiscidae	Species 2
43			Photidae	Leptocheirus sp.
44			Corophiidae	Unciola sp.
45			Phoxocephalidae	species
46			Lysianassidae	Hippomedon sp.
47			Caprellidae	species
48		Isopoda	Anthuridae	Cyathura polita (?)
49			Idoteidae	Edotea triloba
50			Idoteidae	Chiridotea sp.
51			Janiridae	Jaera marina
52		Cumacea	Diastrylidae	Diastrylis bispinosus
53			Leuconidae	Eudorella hispida
54		Mysidacea	Mysidae	Michtheisymis stenolepis
55		Cirripedia	Balanidae	Balanus sp.
56	BRACHIOPODA		Terebratulidae	Terebratulina sp.
57	MOLUSCA	Gastropoda		Unidentified spp.
58			Bullidae	species
59		Pelecypoda		Unidentified spp.
60			Mytilidae	Mytilus edulis
61			Myacidae	Mya arenaria
62			Tellinidae	Macoma balthica
63			Waculidae	Wacula proxima
64			Astartidae	Astarte sp.
65	HEMICHORDATA	Ascidiacea		Unidentified spp.

3* It proved difficult to separate with certainty, the Annelida from Nemathelminthes. Both were represented by small individuals. It is believed that most of the individuals were Annelida, Oligochaeta.

4** As well as a few unidentified polychaetes, and many unidentifiable fragments, the following five single specimens have been included in this grouping for the sake of abbreviating the tables. Each is given with the year and station at which it occurred, and the weight of the individual:

Aphroditidae,	Aphrodita sp.,	1961,	VIII-B,	2.9 mg.
Nereidae,	Nereis sp.,	1959,	28 ^a -9-C,	99.1 "
Arenicolidae,	Arenicola marina,	1959,	I-B,	0.5 "
Maldanidae,	Maldane sarsi,	1959,	Keen. mouth-C,	0.6 "
Terebellidae,	Amphitrite cirrata,	1959,	Keen. mouth-B,	12.0 "

Table X. Numbers of empty shells collected in samples during the 1961 surveys of Saint John harbour and estuary. Kinds of shellfish are listed down the left hand side following the code of Table IX.

	I			II			III			IV		V			VI			VII			
	A	B	C	A	B	C	A	B	C	A	B	A	B	C	A	B	C	A	B	C	
55																					
56																					
57		1		20		4	2	1		1	2			1					2	9	6
58														43		4			2	2	
59													1	3	1						
60	7	21	5	3040	1		2	4	10											25	2
61				110		4							1	1	3				1	4	6
62												2									
63																					
64																					
	7	22	5	3170	J	8	4	5	10	1	2	2	2	48	4	4	0	5	40	14	

	VIII		IX			X			XI	280.3			K.M.	284.8			287.7			TOTAL	
	B	C	A	B	C	A	B	C	C	A	B	C	C	A	B	C	A	B	C		
55										1	1			10		25					37
56																					0
57			11	4		1			159		3	1				1				1	230
58	3																				54
59																					5
60									17					1		4					3139
61			11		1					12	50	22	11	34	267	100					638
62			4								2			2	12	18					40
63																					0
64																					0
	3	0	26	4	1	1	0	0	176	13	56	23	11	47	279	148	0	0	1		4143

Table XI. Reference points used to locate sampling stations in Saint John harbour and estuary.

Locations and reference points in the estuary refer to Canadian Hydrographic Service chart number 4344, Edition of 1953. Locations in the harbour refer to chart 4319, Edition of 1945.

Stations above the reversing falls are designated by numbers which give miles of river channel, starting from the mouth of the St. Francis River, in northwestern New Brunswick, at the point where the Saint John River enters the province. Stations in the harbour are designated by Roman numerals arbitrarily assigned.

280.3 Opposite Brandy Point, in direct line with deepest part of cove on the other bank. Mid-river, in line between Sand Point lighthouse and westerly tip of Kennebecasis Island. Chart depth 70 feet.

Kennebecasis Mouth. In line between upstream tip of upper Brothers Island and southerly tip of Kennebecasis Island. Half way between these two points, in deep hole. Chart depth 123 feet.

284.8 Seven hundred metres out from Swift Point lighthouse in a line between that lighthouse and Brandy Point. About level with Green Head. Chart depth between 66 and 86 feet.

287.7 Above falls, directly west of Prospect Point and Goat Island, in deep hole. Chart depth 152 feet.

I. In line between S W corner of Long Wharf and can buoy 61J, about 200 metres off buoy, in deepest hole. Chart depth 153 feet, nearby.

II. In line between upstream corner of wharf of Atlantic Sugar Refinery and CPR elevator. Mid-channel. Chart depth 55 feet.

III. In 1959, 40 metres to west of buoy 60J, in channel. Chart depth between 37 and 50 feet.

In 1961, 30 metres to east of same buoy, out of the channel. Chart depth, between the 10-foot and 20-foot contours.

- IV. In line between buoy 54J and edge of wharves number 10 and 11. Also in line between mast at Red Head and northerly edge of Partridge Island. Chart depth, 30 feet, on contour.
- V. In direct line extended from channel to main harbour. Beyond buoy 43J by 1250 metres. This station found by compass bearings on landmarks. Chart depth 31 feet.
- VI. Generally, west of Black Point, out from harbour channel. Found by compass bearings on landmarks.

On chart, found by producing line from Atlantic Sugar Refinery chimney through buoy 43J, station is 300 metres past the line which would join buoy 41J with Black Point. Chart depth 49 feet.

- VII. Near Negro Point. In line between the inside angle at base of Negro Point breakwater and buoy 54J. Also in line between Partridge Island Mast and end of No. 14 wharf. Chart depth 23 feet.
- VIII. In line between southerly tip of Partridge Island and middle of Shag Rocks. In line produced from tip of Courtenay Bay breakwater through buoy 54J. Chart depth 24 feet.
- IX. On immediate shore side of buoy 67J, just off dredged channel.
- X. Due south of tip of Courtenay Bay breakwater, by 150 metres. In line produced from St. John Baptist Church past buoy 66J. In line produced from corner of no. 13 wharf past buoy 60J. Chart depth 18 feet. Should be 75 metres west of nominal position of diffuser outfall of oil refinery.
- XI. In line between Red Head mast and Martello Tower. In line produced from outer angle of wharves no. 9 and 10, past tip of Courtenay Bay breakwater. Chart depth 15 feet.

Table XIII. Physical characteristics of bottom materials obtained in bottom samples of 1961 survey.

Date of sampling	Oct. 24	Oct. 25	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26	Oct. 26
Time, hour, AOT	13	14	15	13	9	8	17	10	14	12	11	17	16	14	12
Chart depth at low tide, metres	47	17	13	9	9	15	7	7	6.7	6	5	21	37	46	46
Recorded depth, m.	43 49 45	26 20	16 16 16	12 12	11 11 11	16 16 16	12 12 12	10 10	14 14 14	8 8 8	6 21 21 21	25	50 40 24	37 37 37	
Station no.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	280.3	K.W.	284.8	287.7
Sample no.	A B C	A B C	A B C	A B	A B C	A B C	A B C	D C	A B C	A B C	C	A B C	C	A B C	A B C
Constituents, %:															
a Bubble															90
f Bubble															
a Gravel	5 5														5 50
f Gravel	5			10 10											30
Crassles		20 20 10		10 20						5					5
Sand		20 30 10		60 50 br		10				70 10 10	15 60 60	95			5
Silt		50 40	70 70 60	20 30	85 60 90 br	90 95 95 br	95 95 95 gr	90 90 br	30 60 60 br	50 30 30 br	10	95 95 95 bl	95	95 90 85 bl	90
Clay			10 10 10		10 40 10			10 10	10 10	30 5 5					5 5 50
Detritus	90 95 95 Wl Wl Wl	10 40 30	20 20 30							20 20 Vg Vg					5 5 Sk
Other		Sk Sk	Sk Leaves						Some oil in mud		fine sand				5 5 Sk

The bottom particles and sediments were classified according to the following standards:

coarse Bubble - rock material 6" to 12" in diameter

fine Bubble - " " 3" to 6" " "

coarse Gravel - " " 1" to 3" " "

fine Gravel - " " 1/8" to 1" " "

Crassles

Sand

Silt

Clay

Detritus

Other

- bl = black, br = brown, gr = gray

- Wl = wood, Sk = bark, Vg = general vegetable materials

- Sk = shell fragments, Wl = woody, Sk = bark, Vg = general vegetable materials

- Sk = shell fragments, Wl = woody, Sk = bark, Vg = general vegetable materials

