Department of Environment
Environmental Protection Service
Pacific Region

AN ENVIRONMENTAL ASSESSMENT OF THE POINT GREY OCEAN DISPOSAL AREA IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA

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by

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ABSTRACT

Two surveys were conducted at the designated Point Grey disposal area off Point Grey in the Strait of Georgia in 1975 and 1978. The purpose of the surveys was to assess the impact of ocean disposal activities upon the marine receiving environment with respect to water quality, sediment chemistry and benthic biological communities.

The data indicate that a significant increase in the proportion of the coarse sediment fraction occurred between 1975 and 1978, particularly in the northeast sector of the sample grid between the dumpsite and Vancouver. The Pisces IV submersible dives showed an accumulation of woodwastes on the bottom between the designated dumpsite and the North Arm of the Fraser River. The benthic infaunal data indicated a poorly defined but different biological province in the northeast sector. The differing province may have been due to dumping activity or to natural changes in substrate and currents in that area. The results of the study generally indicated that a significant proportion of dumping had occurred outside the confines of the designated dumpsite.

RESUME

Deux relevés on été effectuées, un en 1975, l'autre en 1978, dans la zone de déversement au large de Point Grey, dans le détroit de Georgia. Ces relevés avaient pour but de mesurer l'impact de l'utilisation de la mer, comme déversoir, sur l'environnment aquatique en ce qui a trait à la qualité de l'eau, la composition chimique des sédiments et la faune at la flore benthique.

Les données recueillies indiquent qu'entre 1975 and 1978, la fraction brute de sédiment avait subie une importante augmentation, en particulier dans le secteur nord-est de l'aire d'échantillonnage, entre la zone de déversement et Vancouver, Les plongées du sous-marin Pisces IV ont indiquées une accumulation de résidus du bois sur les fonds entre la zone de déversement et le bras nord du fleuve Fraser. Les données sur la faune benthique indiquent un milieu biologique pauvre mais différent dans le secteur nord-est. Cette différence est peut-être due aux déversements ou à des changements naturels dans les substrates et les courants dans ce secteur. Enfin, l'étude inclut, de façon générale, qu'une partie importante des déversements a été effectuée en dehors des limites de la zone réservée à cette fin.

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SUMMARY

1. Studies were undertaken to assess the effects of ocean disposal upon the marine environment at the Point Grey dumpsite. The parameters examined included water quality, physical and chemical characteristics of the sediments, benthic infauna, and visual appearance of the substrate.

2. The oceanographic data did not demonstate any lasting effect of ocean disposal upon the water quality parameters examined, which included temperature, salinity, dissolved oxygen, suspended solids and nutrients.

3. Sediment Data

   (i) Sediment Size

   The sediment in the northeast sector of the grid was coarser in both sampling periods. A significant increase in the proportion of the coarse sediment fraction occurred between 1975 and 1978. Chunks of concrete, rubble and woodwastes were noted in the samples from the northeast sector at the time of sampling.

   (ii) Organic Content

   The measured organic carbon content of the sediments in the disposal area were typical for the Strait of Georgia. There was no significant increase between the two sampling periods. Woodwastes may not have been included in the analysis due to problems of extraction. This needs to be born in mind when examining the data and formulating conclusions. Pisces submarine observations indicated that woodwastes were a significant portion of the dumped material visible on the sea floor.

   (iii) Trace Metals

   No significant trends in trace metal accumulation were apparent over space or time.

4. Benthic Infauna

The dominant infaunal forms in terms of numbers were the errantiate polychaete Lumbrinereis luti, Dentalium sp. and Sipunculids. Brittle starfish (Ophiuroidea) were more prevalent in the northeast sector. A cluster analysis was performed using the infaunal data. The stations in the western portion of the sample grid, where the substrate is most homogeneous, were found to be the most closely associated. The differences in infaunal community in the northeast sector may have been due to the natural change in substrate in that area as well as the presence of dumped material.

5. Pisces IV Dives

Dumped material in the form of broken concrete, rubble and wood-wastes was most prevalent in the northeast and eastern sectors. This material did, in some cases, provide cover for fish and crustaceans. Significantly more dumped material was apparent on the bottom in 1978 as compared with 1975. Woodwastes were noted in undispersed piles on the bottom in the NE sector in 1978. In the area between the North Arm jetty and the dumpsite a heavy deposition of woodwastes was apparent. The sediments consequently were black, and appeared to be in a state of anaerobic reduction. In the northeast and eastern sectors fewer bathypelagic and epifaunal forms were noted in 1978 as compared to 1975; however, this was a purely qualitative assessment. The Pisces IV submersible proved to be an effective and necessary tool for rounding out the available data so that accurate conclusions could be drawn.

6. The results of the study indicated that a significant proportion of material dumped had been deposited outside the boundaries of the designated dumpsite, in the area between the North Arm of the Fraser River and the dumpsite; and in an area northeast of the dumpsite enroute from Vancouver. A need for increased surveillance of actual dumping activity is thereby indicated.

1 INTRODUCTION

In 1975/76 and 1978 the Marine Programs Group of the Environmental Protection Service conducted surveys of physical, chemical and biological parameters in the marine environment at the major ocean disposal site serving Metropolitan Vancouver and the Lower Mainland of British Columbia. The location of this ocean disposal area is depicted in Figure 1. This site was established in 1969 by the Ministry of Transport in consultation with the resource agencies, taking into account marine navigation requirements, water depth and distance from the source of waste material.

The Ocean Dumping Control Act was passed in parliament on December 13, 1975, to control and record the types and volumes of material to be disposed of in the ocean and to designate appropriate sites. Further information on the Ocean Dumping Control Act and its application to the Point Grey site is contained in Hoos (1977A and B).

Environmental conditions at this dumpsite were first assessed in 1975/76 before ocean disposal activities were controlled. As such, the data collected in the initial survey provided a good baseline for subsequent surveys where the volumes and types of materials dumped in the intervening time were known. A list of sources, volumes and types of material disposed of at the site between the two surveys discussed in this report is presented in Appendix I.

1.1 Study Area

The Point Grey disposal area is located 4 miles (7.41 km) west of Point Grey in the Strait of Georgia, in a depth of 210-275 metres of water (Figure 1).

The designated dump site is delineated by a circular boundary with a 1 nautical mile (1.85 km) radius, centered at 49°15.45'N, 123°22.10'W in the Strait of Georgia. Water depths at this site vary from 210 to 275 metres, with an average of approximately 250 m. The study area extended 2 nautical miles (3.7 km) beyond the dump site

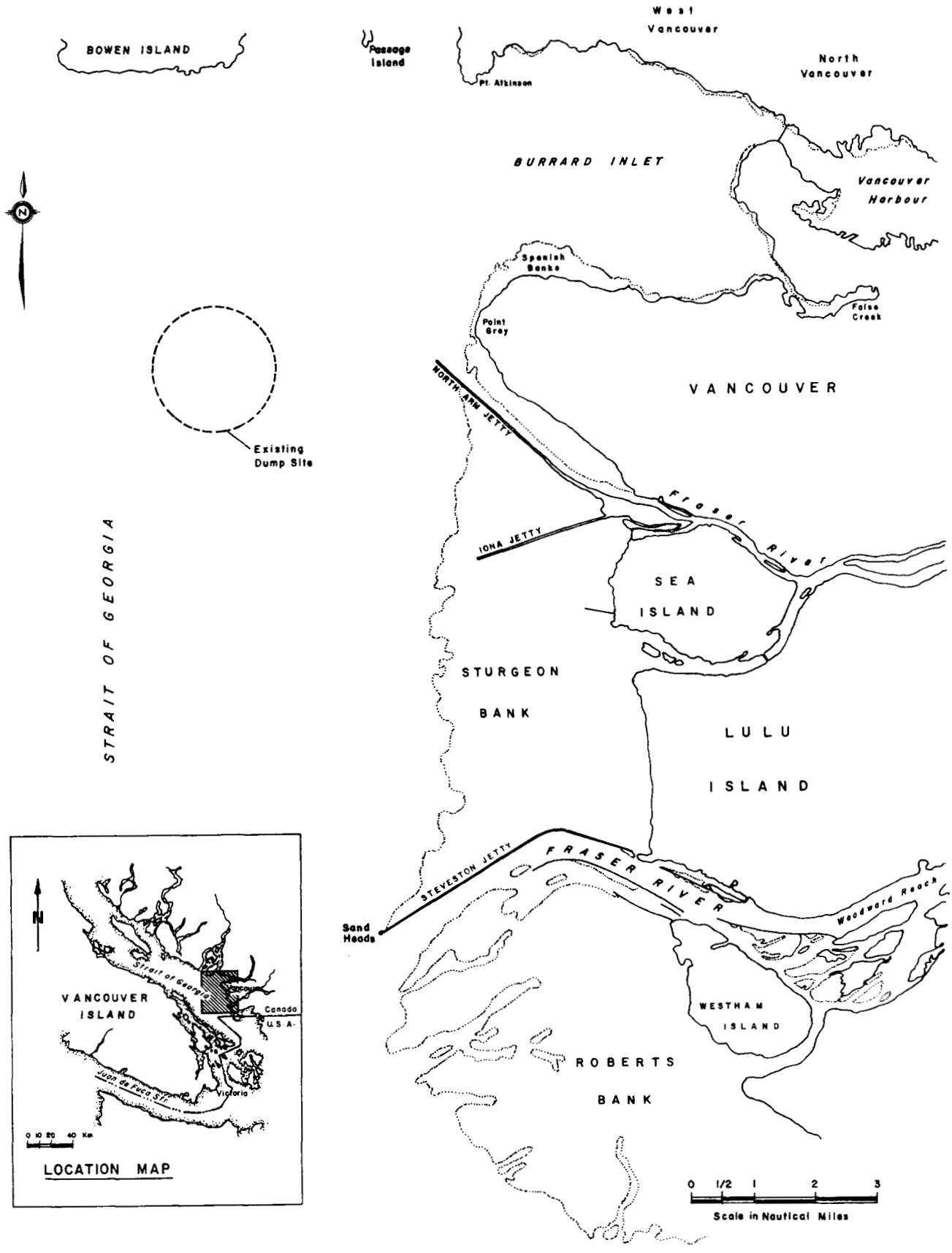

FIGURE 1 POINT GREY DUMP SITE

boundary, having a radius of 3 nautical miles (5.55 km) and encompassing approximately 28 square nautical miles (96 square kilometres).

"The physical oceanography of this region of the the Strait of Georgia is greatly influenced by the freshwater input from the Fraser River. Winds, tidal action, and currents impose secondary effects."

"The deep-water sediments of the lower strait, including the study area, are typically silts and clays (Pharo, 1972), becoming more coarse with increasing proximity to the foreslope of the Fraser delta and the mainland. Although the delta front at the main arm of the Fraser River is advancing at a rate of approximately 3.5 m/yr laterally, and 30.5 cm/yr vertically, there has been no evidence of delta advancement in the study area since 1968 (Luternaur, personal communication). It is, therefore, assumed that the rate of natural sediment accretion at the dump site is very low."

"The principal fish resources of the area are the 5 species of salmon, steelhead trout, eulachon and smelt, which migrate through the Strait into the Fraser River system, and herring. The demersal fish present include sole and grey cod. The 30 to 100 m contours along the western front of Point Grey and Sturgeon Banks provide a habitat for substantial populations of 6 species of shrimp, which are commercially harvested with small-meshed trawls." Hoos (1977B).

2 METHODS AND MATERIALS

The work at Point Grey was conducted in 1975, 1976 and 1978 according to the schedule laid out in Table 1. The sampling stations are outlined in Figures 2-4. Station positions on the water were established using radar on all vessels except the B.C. Trapper where a sextant and three arm protractor were used to establish the stations by means of horizontal triangulation.

2.1 Physical Oceanographic Sampling

The water column at each of the stations depicted in Figure 2 was sampled for temperature, salinity, dissolved oxygen, non-filterable residue (1975) and nutrients (1978). Sampling was conducted in 1975 using Nansen bottles and in 1978 using N.I.O. bottles, each equipped with paired, protected, reversing thermometers.

Temperatures in all cases were read and recorded as soon as possible after sample collection and re-calculated to temperature at depth using the equation outlined in Sverdrup et al. (1946).

Dissolved oxygen concentrations were measured using the azide modification of the Winkler method (E.P.S., 1979). Salinity values in 1975 were obtained using a refractometer while in 1978 salinity was measured using a Guildline salinometer ("Autosal" Model 8400). The percent saturation of dissolved oxygen in seawater was calculated according to the equation outlined in Gameson and Robertson (1955).

Subsamples of water were also obtained from the sample bottles for analysis for non-filterable residue (NFR) levels in 1975 and nutrient concentrations (nitrate, ammonia and total phosphate) in 1978. NFR values were determined by weighting the dried residue (dried at 103°C for one hour) remaining on 0.45 micron filters. Samples for nutrient analysis were stored in a frozen state until analyzed on an Autoanalyzer at the E.P.S. Chemistry Laboratory in West Vancouver.

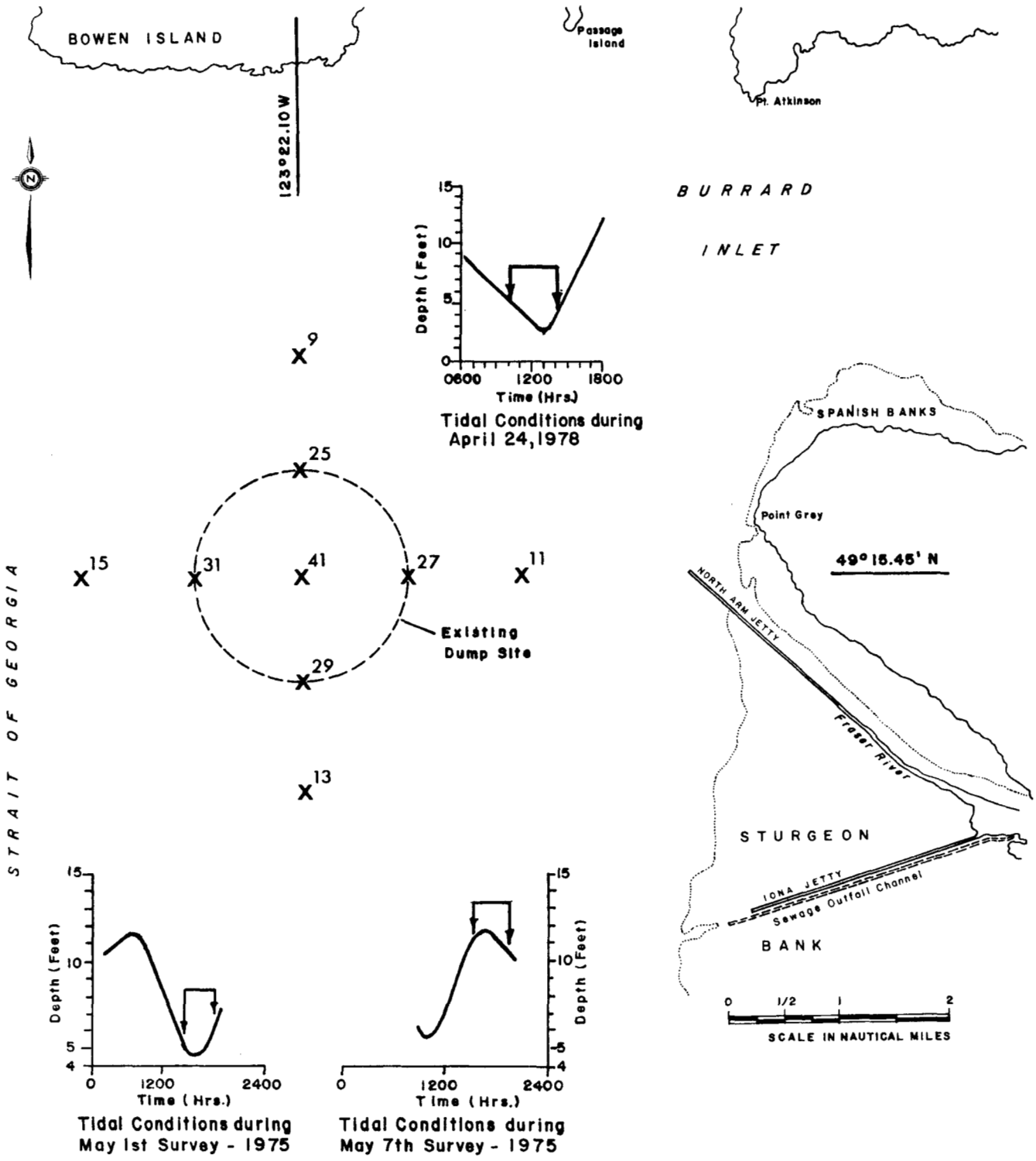

FIGURE 2 WATER COLUMN SAMPLING STATIONS - PREVAILING TIDAL CONDITIONS

TABLE 1 SCHEDULE OF ACTIVITIES

Survey	Parameter	Dates	Gear	Vessel
Survey I 1975/76	Water Quality	May 1 & May 7, 1975	Nansen Bottles	B.C. Trapper
	Benthic Sampling	May 22-June 9, 1975	Peterson Grab	B.C. Trapper
	Core Sampling	July 14, 1975	"Benthos" Gravity Core	CFAV Laymore
	Trawling	July 14, 1975	3 metre Beam Trawl	CFAV Laymore
	Pisces Dive	January 22-24, 1976	Pisces IV - 3 man submersible	Pandora II
Survey II 1978	Water Quality	April 24-25, 1978	N.I.O. Bottles	Vector
	Benthic Sampling	April 24-25, 1978	Peterson Grab	Vector
	Cores	April 26, 1978	"Benthos" Gravity Corer	Vector
	Pisces Dives	November 27-29, 1978	Pisces IV - 3 man submersible	Pandora II

2.2 Sediment Sampling

2.2.1 Grab Samples. Sediment samples were obtained at all of the stations depicted in Figure 3 in both 1975 and 1978 with the exception of Station 42 which was only sampled in 1975. Samples were obtained using a Peterson grab which sampled a sediment surface area of 0.17 m^2. Each sample was placed in a polypropylene tub, hand mixed to obtain homogeneity and subsamples removed for analysis of sediment size distribution, organic carbon content and trace metal analysis. The subsamples were placed in plastic "Whirlpak" bags and stored frozen until analysed.

Sediment size analysis was performed by wet sieving through three screens of size 0.5 mm, 0.25 mm and 0.0625 mm with the fraction passing through the final screen being obtained by calculation.

Organic carbon content was determined by thawing samples at room temperature, drying at 103°C, grinding with a mortar and pestle to pass through a 0.5 mm screen, digesting with a chromic acid-sulphuric acid mixture, and titrating with ferrous sulphate to yield a chromic acid oxidation value. Total volatile residue was determined by placing a dried and weighed sample of sediment in a muffle furnace at 550°C for 1 hour to burn off all organic carbon material. The sample was then re-weighed and the weight of organic carbon obtained by calculation.

Sediment samples to be analysed for trace metal concentrations were thawed and air dried under cover at room temperature, disaggregated with a ceramic mortar and pestle in 1975 and an agate mortar and pestle in 1978, and sieved through an 80-mesh nylon sieve (2.5 phi). Portions of the less than 80-mesh fractions were forwarded to the laboratory of Dr. W.K. Fletcher (Department of Geology, University of British Columbia). They were then digested in a 4:1 nitric-perchloric acid mixture, evaporated to dryness over an air bath, taken up in 1.5 ml HCl and analysed for cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb) and zinc (Zn) with a Perkin Elmer 303 atomic absorption spectrophotometer. Background corrections were utilized in the determination of cobalt, nickel and lead.

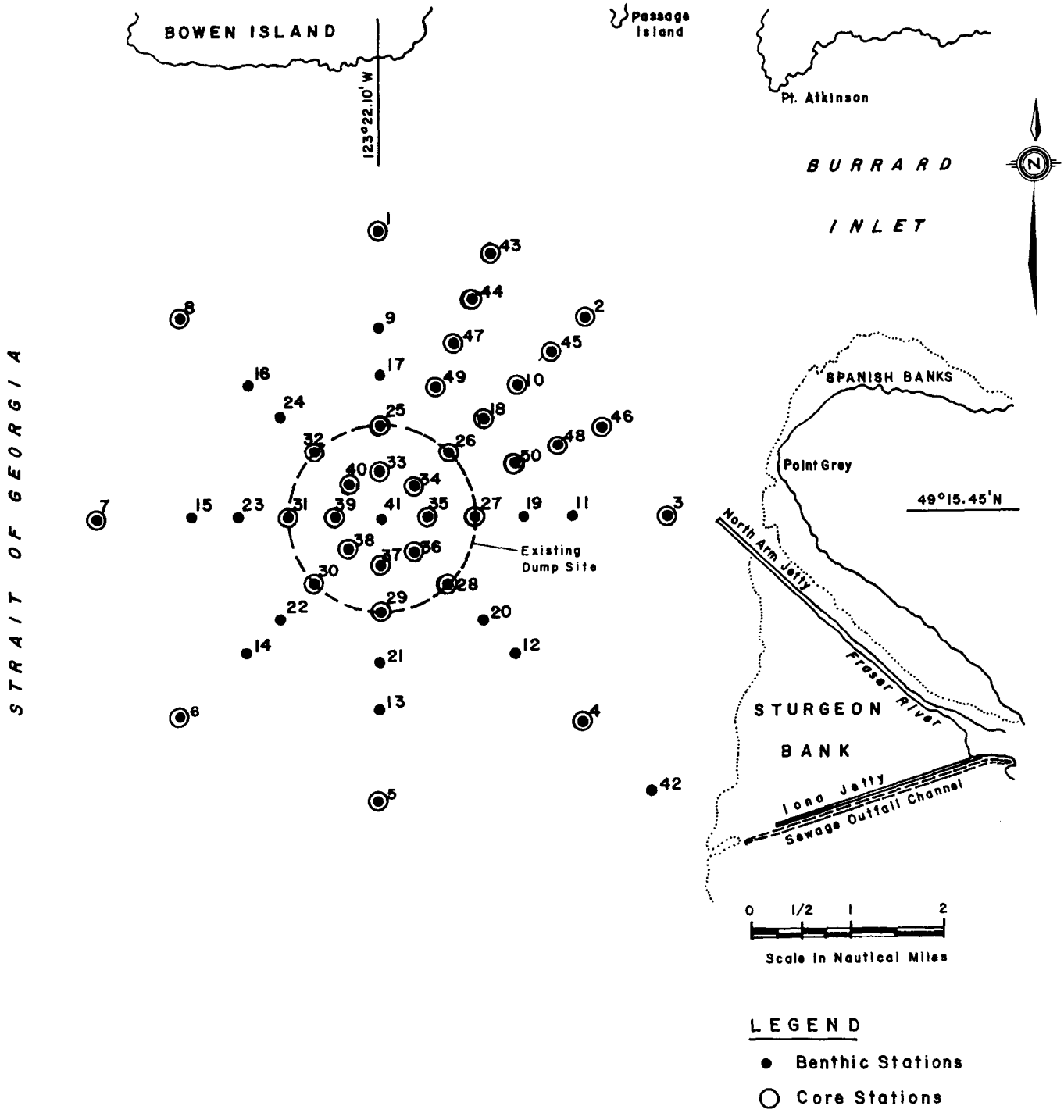

FIGURE 3 BENTHIC GRAB AND SEDIMENT CORE STATIONS

Six litres of the original sediment sample were also measured out and sieved through a 0.5 mm screen in order to extract the organisms in the sediment. The benthic fauna remaining were fixed in formalin and after three days preserved in 70% isopropyl alcohol. The fauna were later sorted, identified and enumerated.

Cluster analysis was performed on the data obtained from the sorting and identification of the benthic infauna. The NT-SYS computer system at the University of British Columbia computing centre was used to perform the cluster analysis using the SIMINT and TAXON programs. Euclidean distance was used as the measure of similarity while clustering was performed using the Weighted Pair-Group method using arithmetic averages (Sneath et al., 1973; Rohlf et al., 1978).

2.2.2 Core Sampling. Sediment cores were obtained in 1975 and 1978 using a "Benthos" gravity corer at the 35 stations shown in Figure 3. Upon retrieval the intact cores were extruded onto polyethylene liners, the length measured and 5 cm core sections cut out at selected depth intervals (0-5 cm; 50-55 cm; 75-80 cm). The samples were then placed in plastic "Whirlpak" bags and treated in the same manner as the sediments described previously under the benthic sampling section.

2.3 Pisces IV Submersible Dives

Pisces IV submersible dives were conducted in 1976 and again in 1978. The locations of the dive tracks (Figure 4) were established based on information gained from the sediment and trawl sampling programs.

Observations made during the course of the dives were recorded on 16 mm movie film (Ektachrome EF 7242; Tungsten Light Balanced-3200K; ASA 125) and 70mm still film (Kodak Aerocolor Negative Film #2445). Observations were also verbally tape recorded for future compilation. In 1976 the dives were recorded in their entirety on video tape as well.

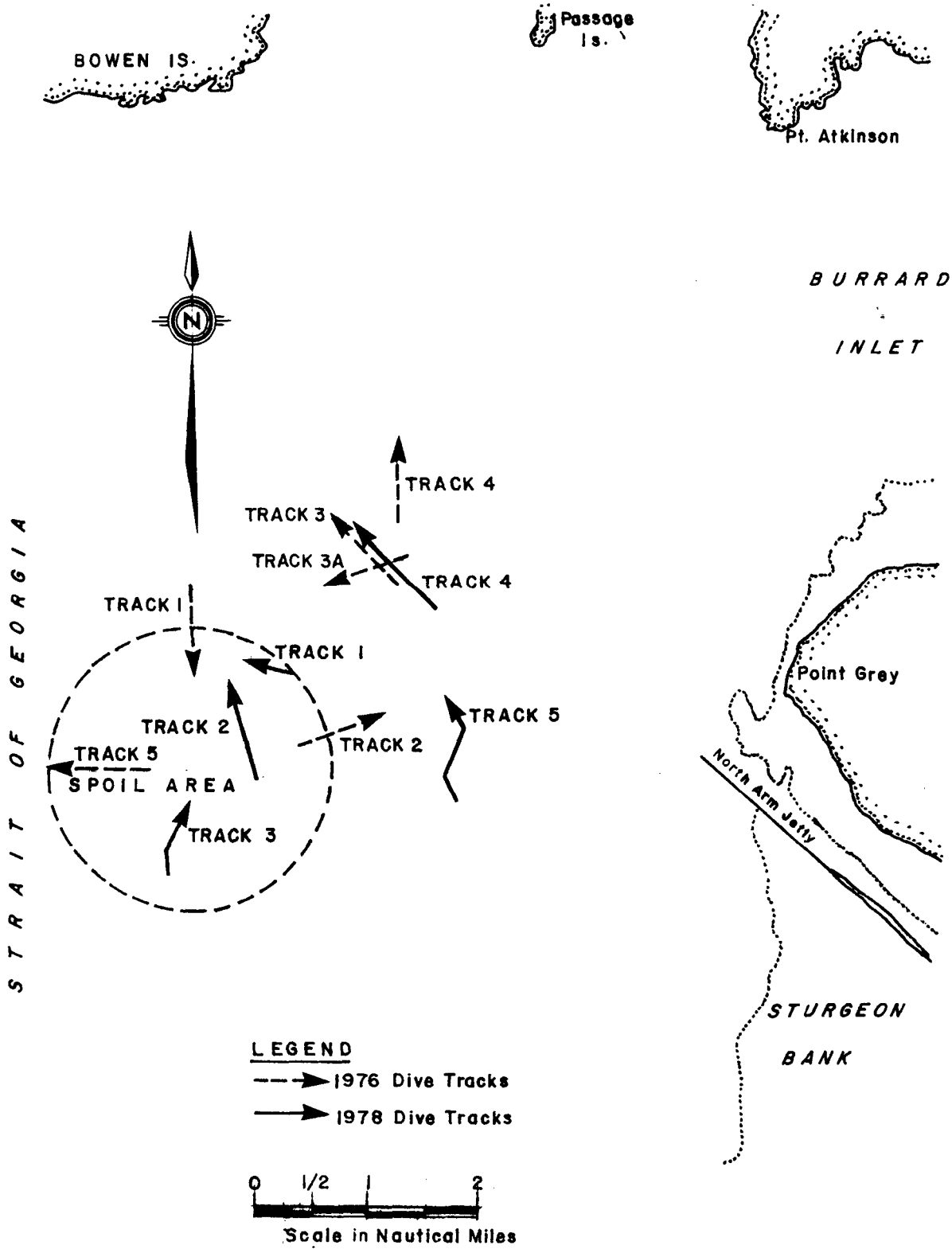

FIGURE 4 PISCES DIVE TRACKS AT POINT ATKINSON DUMPSITE (1976 and 1978)

3 RESULTS AND DISCUSSION

3.1 Physical Oceanography

All physical oceanographic data obtained are contained in Appendix II and presented graphically in Figures 5 and 6. The number of stations was reduced to 5 in 1978 from 9 in 1975 due to the lateral uniformity of the watercolumn characteristics observed in 1975.

The major factor affecting the surface water characteristics in this area is the presence and flow rate of the Fraser River (Waldichuk 1957; Hoos and Packman, 1974). The silt laden fresh water of the Fraser River fans out over the saline water of the Strait of Georgia in the form of a freshwater lens, accounting for the stratification observed in the water column profiles. The presence of the Fraser River also affects the levels of non-filterable residue in the water column. The effects of the Fraser River change seasonally with the changing flow rate of the river.

Examination of the water column profiles indicate that in 1978 the stratification was less defined than in the 1975 sampling period. This was probably due to the fact that the 1975 sampling was conducted in June during the Fraser River freshet while the 1978 sampling was conducted in April when the water column is normally less stratified. Waldichuk (1957) stated that, "The Fraser River discharge undergoes seasonal variation from a low in February and March to a peak in late June."

The ranges of temperature, salinity and dissolved oxygen in 1975 and 1978 are presented in Tables 2 and 3. The thermocline during both sampling programs existed between 5 metres and 10 metres. At stations 25, 29 and 41 in 1975 a thin layer of cool water was present at a depth of approximately 50 metres between two warmer layers. According to Waldichuk (1957), this is probably attributable to localized sinking of surface water cooled during the winter months. This phenomenon is probably enhanced by the presence of the freshwater lens from the Fraser River.

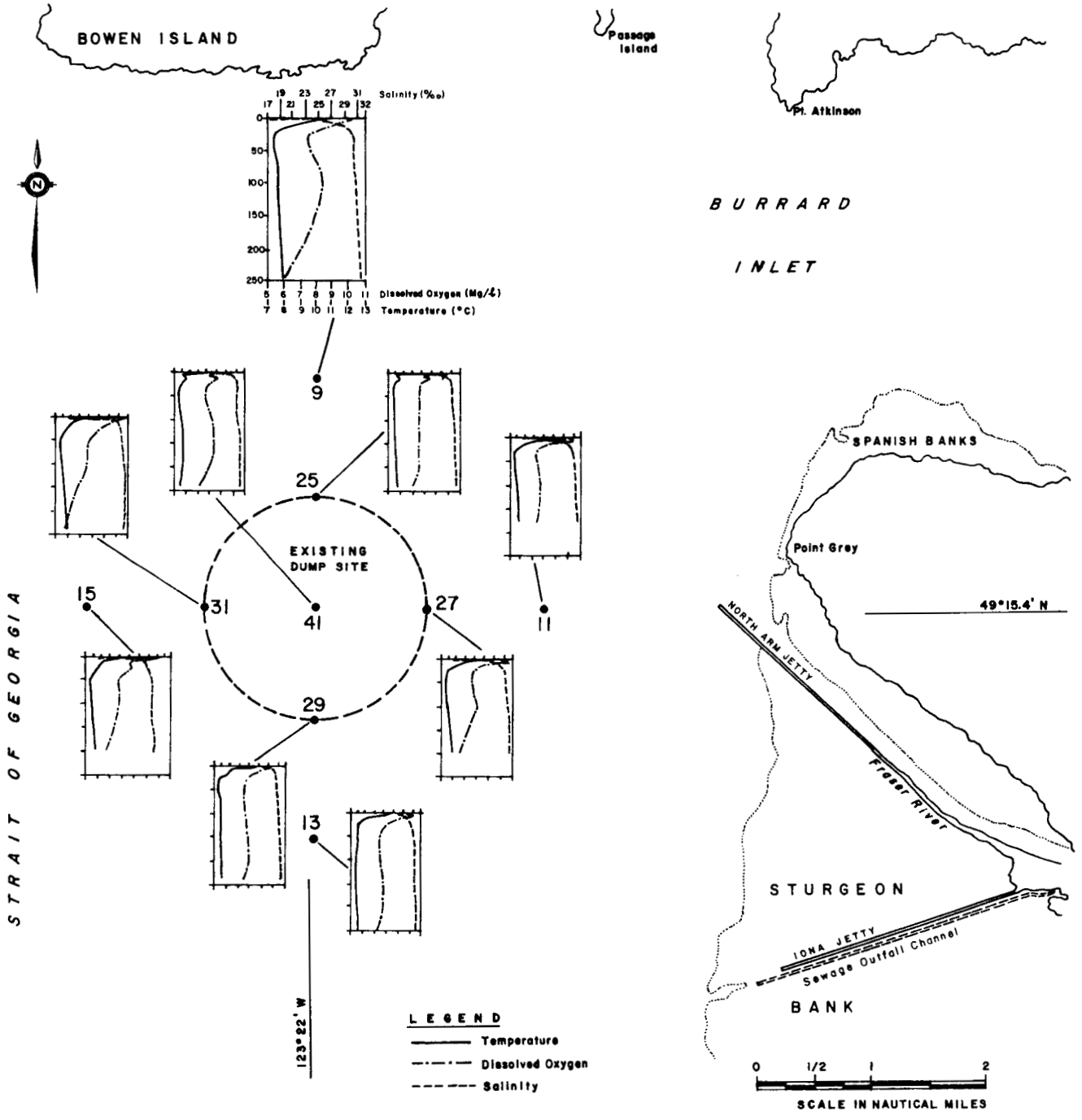

FIGURE 5 WATER COLUMN PROFILES - 1975

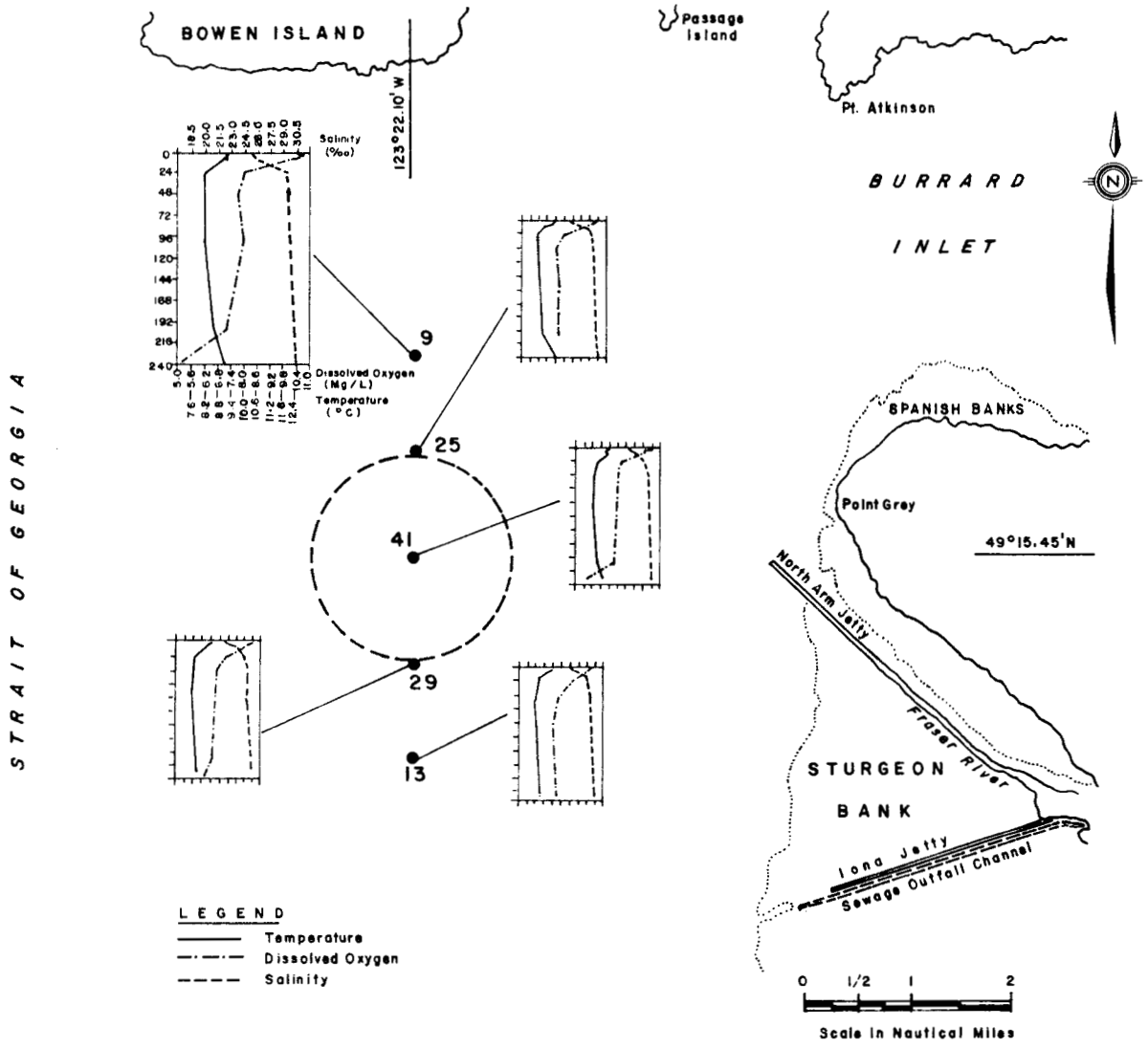

FIGURE 6 WATER COLUMN PROFILES - 1978

TABLE 2 RANGES OF OCEANOGRAPHIC DATA - 1975

	STATION	DEPTH(m)	MAX	MIN
Temperature	PG-27	0	12.53°C	
	PG-29	50		7.28°C
Salinity	PG-9	0		17.5°/oo
	PG-9	250	31.5°/oo	
Dissolved Oxygen	PG-13	0		9.5 mg/l
	PG-27	0	10.45 mg/l	
	PG-31	240		5.9 mg/l
	PG-29	240	7.55 mg/l	

TABLE 3 RANGES OF OCEANOGRAPHIC DATA - 1978

	STATION	DEPTH(m)	MAX	MIN
Temperature	PG-13	0	9.78°C	
	PG-9	50		8.15°C
	PG-25	25		8.15°C
Salinity	PG-9	0		25.02°/oo
	PG-25	240	30.59°/oo	
Dissolved Oxygen	PG-9	0		10.3 mg/l
	PG-41	0	10.6 mg/l	
	PG-25	240		4.7 mg/l
	PG-13	235	7.6 mg/l	

The minimum salinity value in 1975 was much lower than in 1978, probably due to the fact that the 1975 sampling was conducted in June at the time of the Fraser River freshet. Water column salinities recorded at Stations 9, 11, 15, 27 and 31 in 1975 revealed the presence of low salinity water (17.5-19.5%) which extended to a depth of approximately 2 metres. The halocline in 1978 generally existed between 5 and 10 metres. Salinities in the bottom water were fairly constant between 30.3% and 31.5%.

Dissolved oxygen concentrations in the bottom water were generally lower during the 1978 sampling program but this was not necessarily as a result of the presence of dumped organic material on the bottom.

Non-filterable residue (NFR) is a parameter that was analyzed for at all stations and depths in the 1975 program only. In some cases, i.e. at Stations PG-9, PG-11, PG-15 and PG-25, the NFR levels in the surface water were elevated relative to the rest of the water column while in other cases they were not. This was dependent upon which side of the tide line the sample was taken from and whether or not the fresh, turbid water of the Fraser River was present. Elevated NFR values were occasionally obtained in the bottom water due to tidal currents stirring up silt near the bottom. At Station PG-9 a value of 206 mg/l was obtained in the bottom water. This was felt to be an artifact caused by the bottle touching the bottom.

In the 1978 sampling program, samples were collected for analysis of nitrate, nitrite, ammonia and total phosphate concentrations. The results are presented in Appendix II. These results proved typical for the Strait of Georgia at this time of year. The values obtained for surface waters are consistent with those of Stockner and Cliff (1979), who state that at times of stable stratification and during phytoplankton blooms such as occur in late April and early May, nitrate values in the surface waters would become depleted. Under natural conditions nutrients would be replenished by the deep mixing of

bottom water during October and November. It is evident in Appendix II that at the time of sampling in April 1978, nutrient levels were generally higher in the bottom water.

3.2 Sediment Characteristics

3.2.1 Sediment Size. The results of the sediment size analysis are presented in Appendix III, Figures 7 and 8. Appendix III also presents the observations of sediment characteristics made during the course of the core and grab sampling programs, which are useful in comparison with the sediment size data. The sediment size data indicates that the major portion of the sediment in both the 1975 and 1979 sample programs was the less than 0.0625 mm fraction.

Both Figure 7 and Figure 8 indicate that the material in the northeast quadrant of the sampling grid is generally coarser in nature. This was confirmed, in part, by the fact that the material in this area was observed during dives aboard the Pisces IV submersible, to be sandy in nature. This is probably due to the relatively strong tidal currents at this location which would tend to scour the finer fraction. However, observations made at the time of sample collection indicated a collection of concrete chunks, hardpan, rubble and woodwastes in the northeast quadrant of the sample grid. Therefore, the increased particle size in that quadrat cannot be attributed entirely to natural conditions.

Comparison of the sediment size data between 1975 and 1978 shows a significant increase in the coarser fraction in the 1978 data. For example, in 1978 the average percentage of material less than 0.0625 mm (excluding PG-42) was 93.22%, while in 1978 the average was 82.9%. Examination of the tables shows that the net increase in the percentage of material represented by the coarser fraction occurred at those stations in the northeast quadrant of the study area.

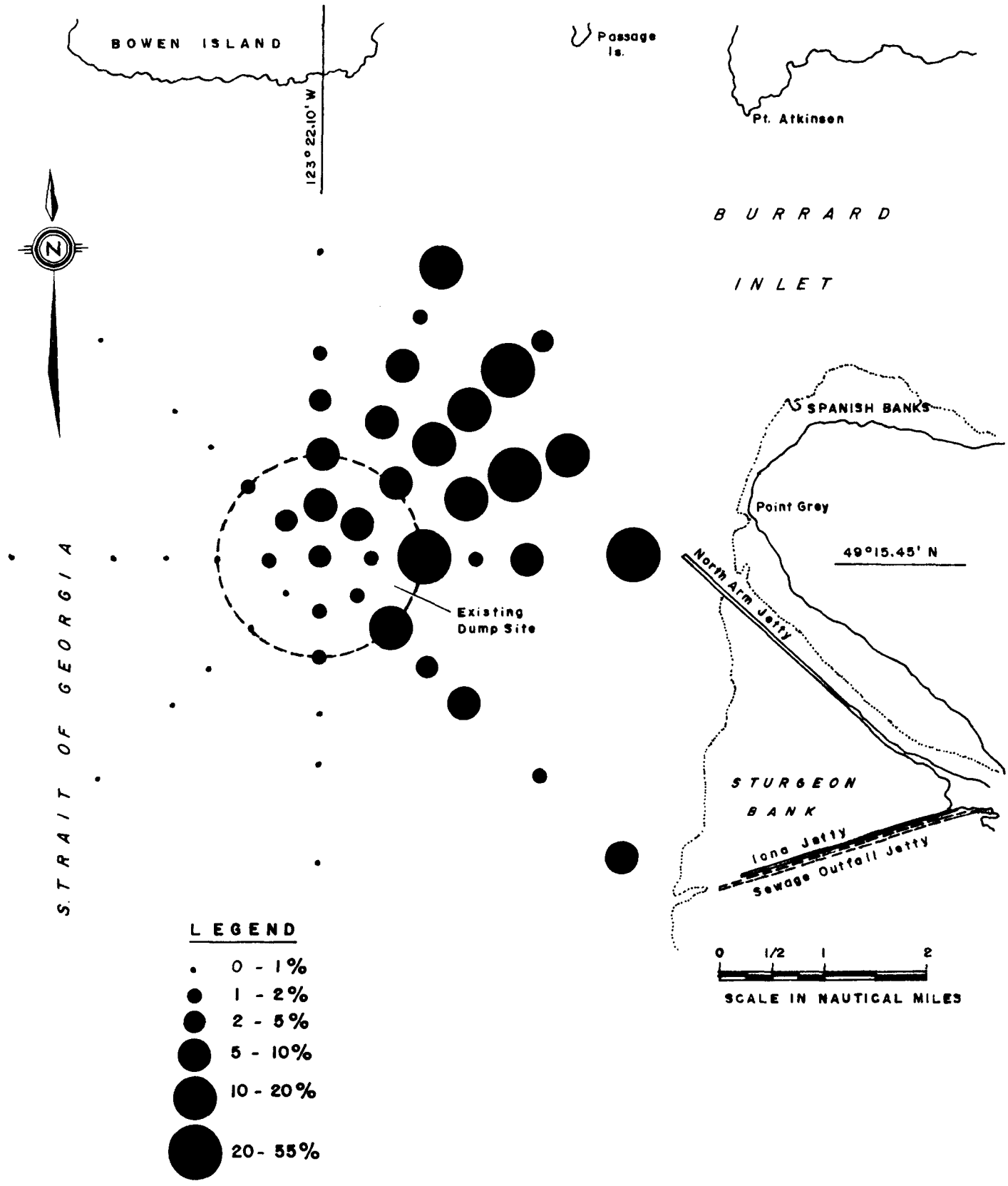

FIGURE 7 PERCENT OF SEDIMENT GREATER THAN 63 μ (SILTS AND CLAYS) - 1975

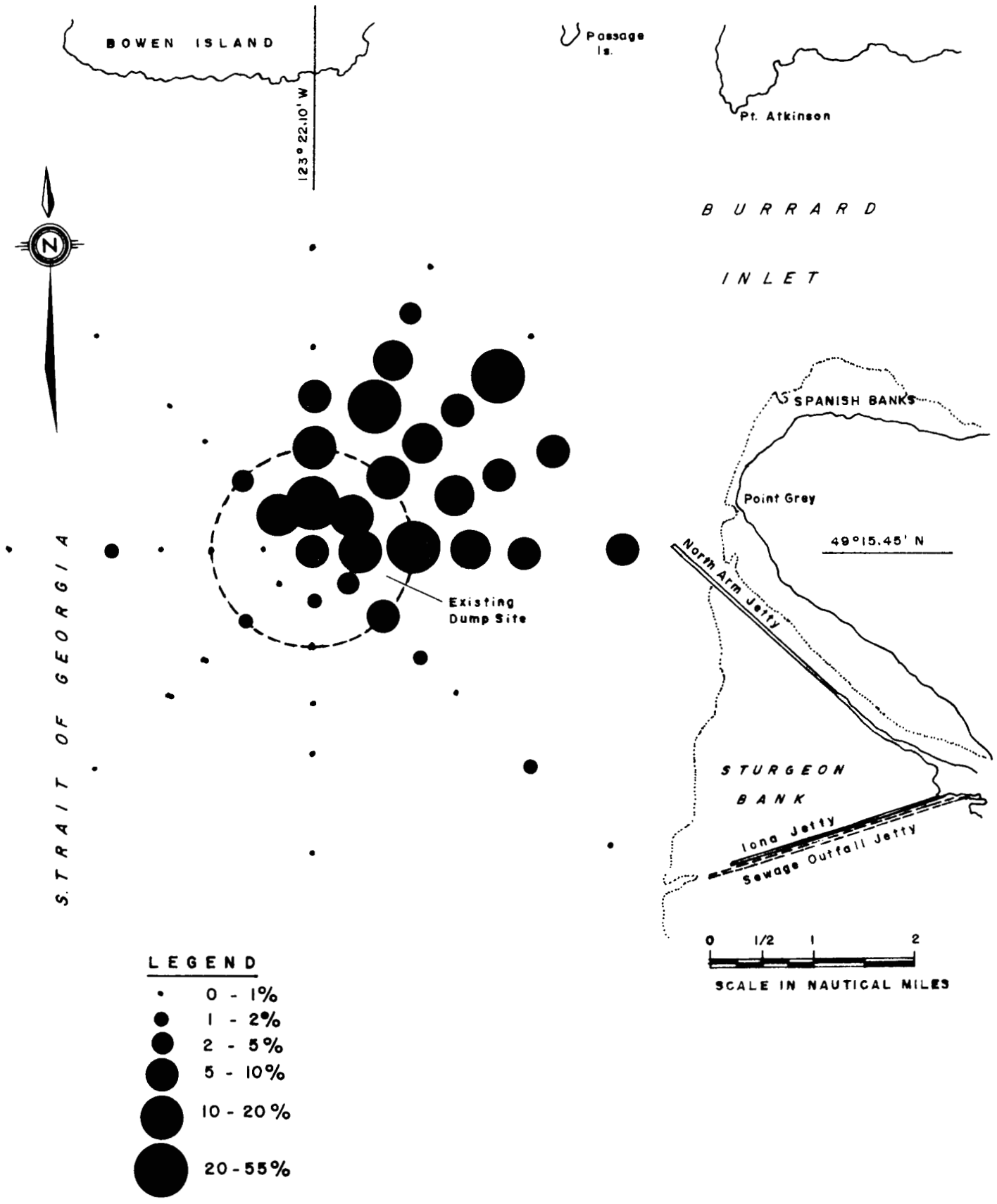

FIGURE 8 PERCENT OF SEDIMENT GREATER THAN 0.0625mm - 1978

3.2.2 Organic Content. The values obtained in the Total Organic Carbon analyses run on the 1975 and 1978 samples are presented in Appendix IV and Figures 9, 10 and 11. These data include Chromic Acid Oxidation Values (CAOV) for the 1975 and 1978 samples and Total Volatile Residue (TVR) for the 1978 samples.

Examination of the CAOV data did not reveal a significant difference between the values obtained during the two sampling periods. The mean value in 1978 was 1.6% which was higher than the 1975 mean of 1.39%. These values are typical of the low values found in the Strait of Georgia. Pharo (1972) reported an average organic carbon content in the Strait of Georgia sediments of 1.08%. He noted however that intermediate concentrations of organic carbon (1.0-1.5%) occur through most of the Strait northwest of Sandheads. Pharo (1972) also stated that the percentage of organic material is also dependent upon sedimentation rates from terrigenous sources, and the clay content of the sediment. A high rate of deposition of terrigenous material dilutes the organic content of the sediment while a low rate permits oxidation and consequent loss of organic material before it can be buried. It is possible that in the case of the Point Grey dumpsite the available organic carbon deposited through ocean dumping activities may be diluted to some extent by sedimentation from the Fraser River. Pharo (1972) found a high degree of correlation (0.788) between the percent clay content of sediments and the percent organic content. The correlation in our work was 0.428 in 1975 and 0.349 in 1979. In some cases however samples containing coarse material also had relatively high organic carbon values (e.g., PG-18) indicating that the organic carbon probably had been deposited by other than natural processes.

There was no apparent pattern in the distribution of total organic carbon as measured by the CAOV method in the sediments in relation to ocean disposal activities, in either 1975 or 1978. It is interesting to note, however, that the highest value in 1978 for total

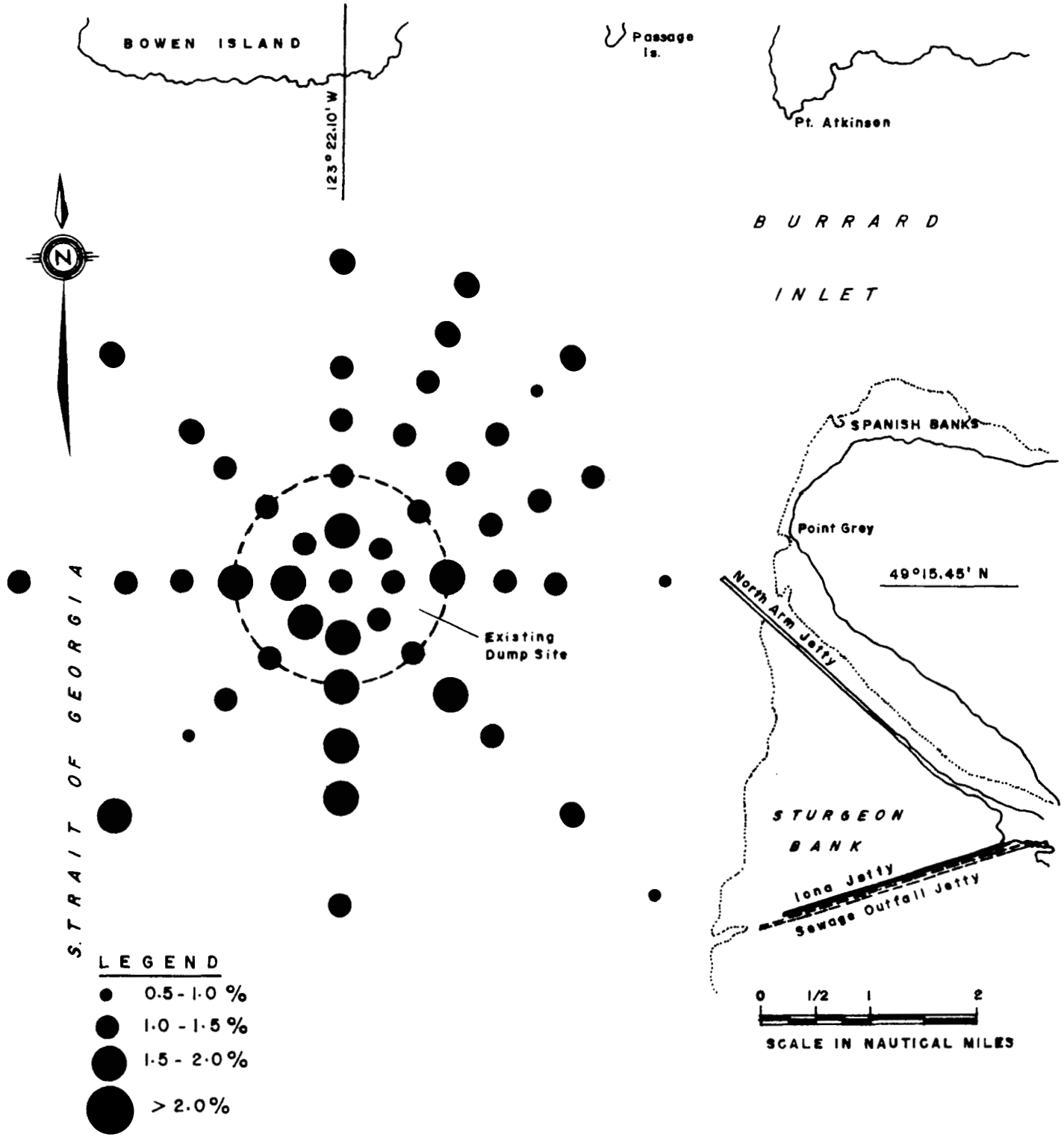

FIGURE 9 TOTAL ORGANIC CARBON (CAOV) - 1975

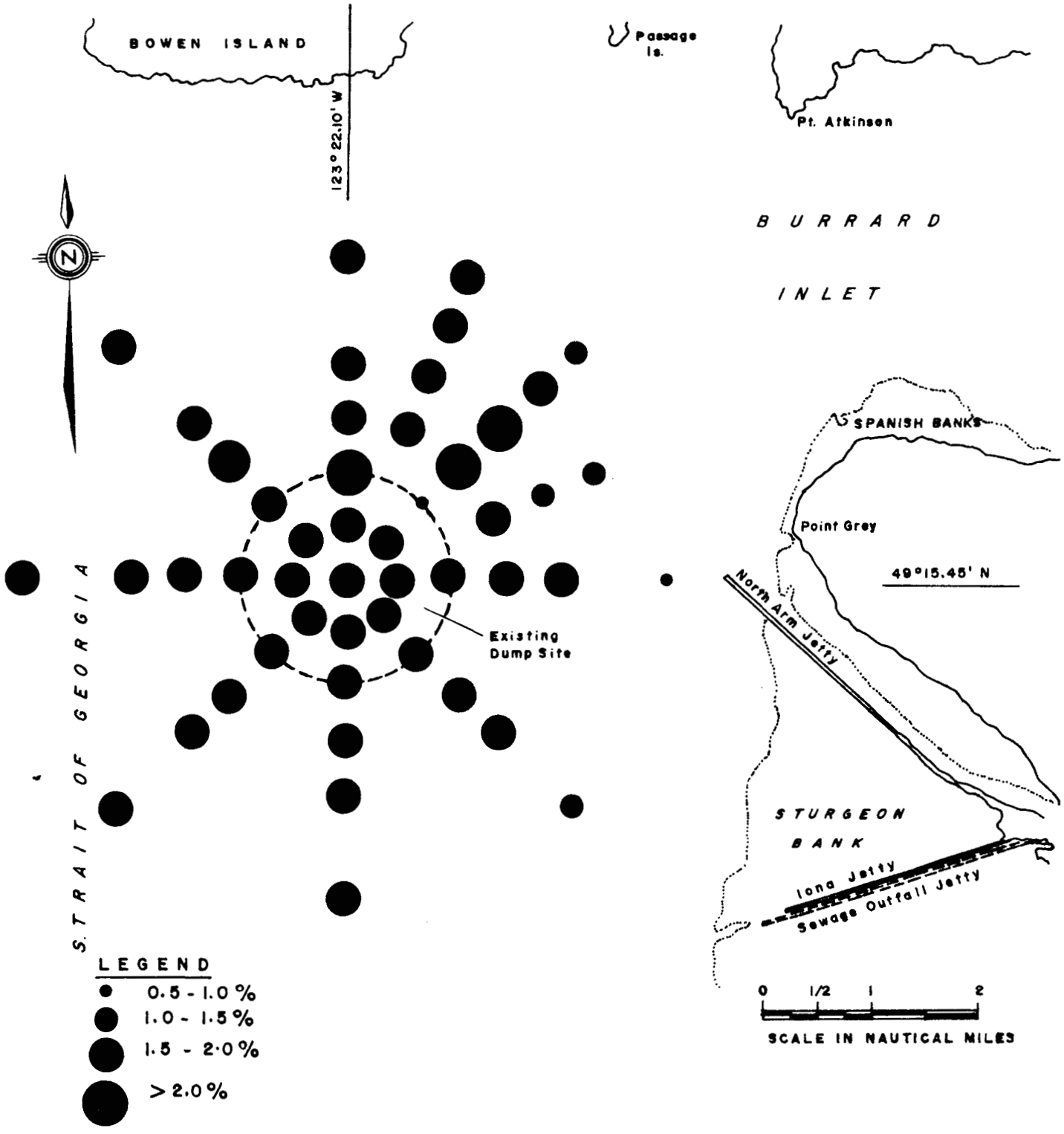

FIGURE 10 TOTAL ORGANIC CARBON (CAOV) - 1978

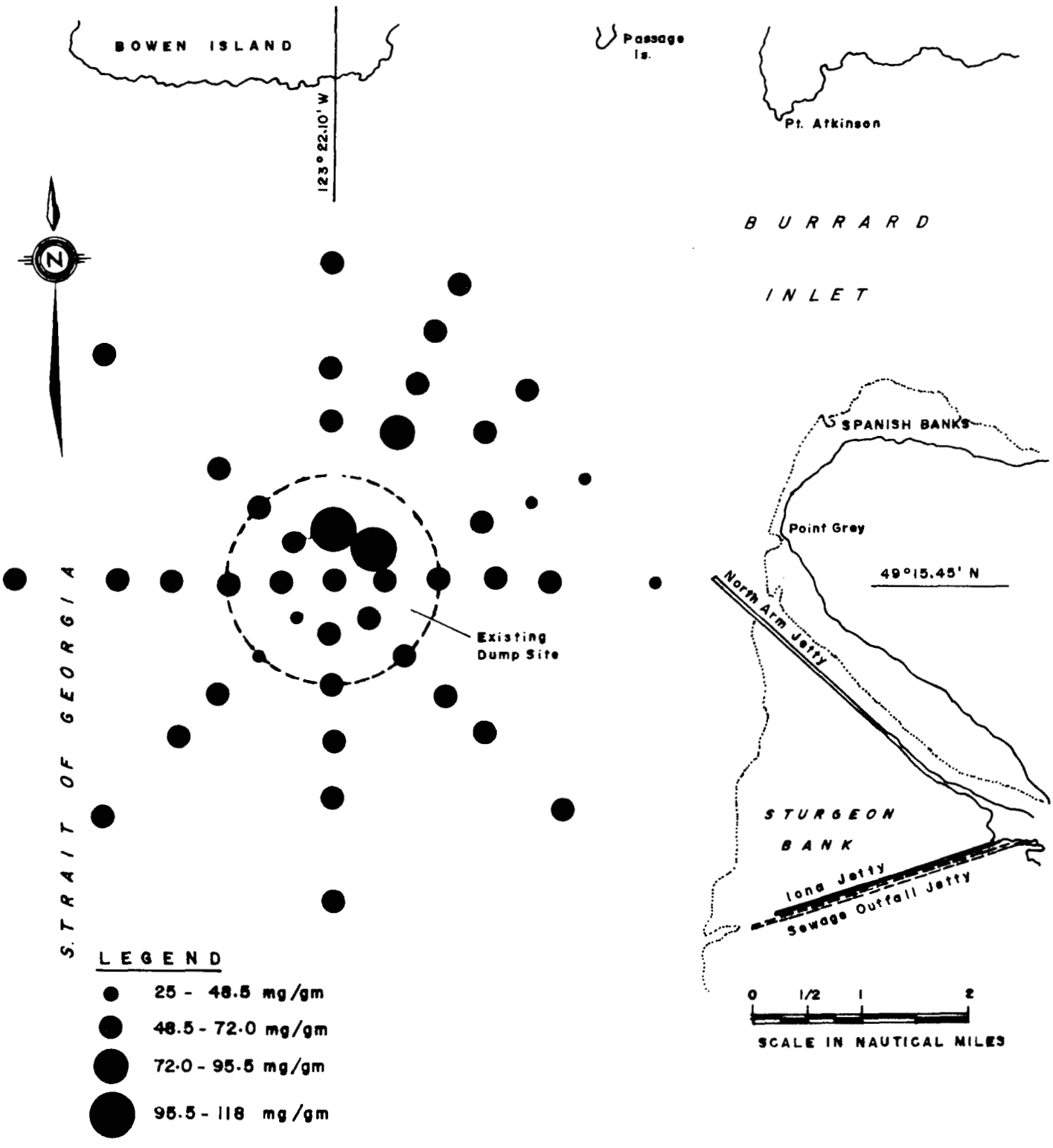

FIGURE 11 TOTAL ORGANIC CARBON (Total Volatile Residue) - 1978

organic carbon of 2.8% was found at Station PG-18 where the most intense disposal activities appeared to have taken place.

There was also no defined pattern of organic carbon content as measured by the TVR method other than the fact that the two exceptionally high values obtained were located in the northeast sector of the sample grid.

3.2.3 Trace Metals. The results of the trace metal analyses are presented in Appendix V. Table 4 presents the mean trace metal values in 1975 and 1978 from both the Peterson grab and gravity core sampling programs. The mean trace metal values presented in Table 4 are slightly higher than those reported by Grieve and Fletcher (1975) for the foreslope of the Fraser River delta and by Packman (1977) for the sediment in the vicinity of Nanaimo, B.C. The values however do not appear to be high enough to be a cause for concern at this time. Cadmium was below detection limits in both sample series.

Comparison of the trace metal values over the sampling grid in space and time did not reveal any gross trends in terms of metal accumulation. Figures 12 to 16 demonstrate the distribution of the individual trace metals over the sample grid during the two sampling periods. From examination of these figures some conclusions may be drawn. Statistical analyses of the data are only presented for elements where changes in concentrations over time were felt to be significant.

The initial discussion in this section will deal with the surface core samples as they are most representative in terms of the accumulation of trace metals from dumping activities. The copper distributions presented in Figure 12 indicated slightly elevated values in the northeast sector of the sample grid. The values obtained in 1978 appeared to be elevated in relation to those recorded in 1975. The nickel distributions depicted in Figure 13 did not demonstrate a defined pattern spatially; however, the mean of the values in 1975 was shown to be significantly higher ($p = 0.001$, t 3.385, $n = 34$) than the mean of

the 1978 values at the 0.001% level using the T-test for comparing paired observations. The values for lead were generally higher in the northeast sector than in the other areas of the sample grid. There was a significant increase in lead concentrations in the 1978 sample over 1975 ($p = 0.001$, $t \quad 3.385$, $n = 34$) when comparing paired observations. Mercury concentrations were determined to be significantly higher in 1978 as compared to 1975 ($p = 0.001$, $t \quad 3.385$, $n = 31$). There did not, however, appear to be a pattern in the spatial distribution of mercury concentrations in the sample grid.

A comparison of the mean trace metal values for the different depths in the sediment cores, across the sample grid, is presented in Table 5. The data in this table show that the copper, lead, zinc and to a lesser extent mercury values tended to be higher on the surface and decrease with increasing depth in the sediment core in both sampling programs. In the case of some of the elements such as copper, iron, nickel, lead and zinc the concentrations at the bottom of the core were lower in 1978 than in 1975. As the sediments at these depths may be assumed to have remained unaffected by dumping activity, the real metal concentrations should have remained unchanged between the two sampling periods. The difference is likely an artifact of actual or sampling variability.

3.3 Benthos

The results of the 1975 benthic sampling and analyses have been discussed in Hoos (1977 b) and as such will not be discussed in this report. The results of the 1978 benthic work are presented in Appendix VI. From these data, calculations were made expressing the number of individuals in each taxonomic group at each station as a percentage of the total number of individuals at that station in order to determine what the dominant taxonomic groups were over the sample

TABLE 4 MEAN TRACE METAL VALUES (ug/gm)

1975 Grabs

	Co	Cu	Fe(%)	Mn	Ni	Pb	Zn	Cd	Hg
Mean	15.1	45.06	3.52	363.57	49.29	18.04	106.47	L2.0	0.31
Std. Dev.	1.92	5.45	0.20	45.11	3.41	5.09	5.09	L2.0	0.14
Std. Error	0.27	0.77	0.03	6.38	0.48	0.72	0.72	L2.0	0.02
Max. Val.	19.1	69.3	4.2	493.8	54.6	38.8	122.9	L2.0	1.2
Min. Val.	11.5	37.1	3.0	240.4	39.2	9.5	87.5	L2.0	0.19

1975 Cores Surface Values

	Co	Cu	Fe(%)	Mn	Ni	Pb	Zn	Cd	Hg
Mean	13.49	45.89	3.39	330.35	48.64	18.25	102.32	L2.0	0.202
Std. Dev.	1.43	5.07	0.31	22.56	3.29	3.72	5.6	L2.0	0.052
Std. Error	0.24	0.87	0.05	3.81	0.56	0.63	0.95	L2.0	0.0089
Max. Val.	16.1	59.5	3.8	377.1	53.9	27.7	113.1	L2.0	0.360
Min. Val.	10.4	38.3	2.8	290.0	41.3	11.2	87.5	L2.0	0.113

1978 Grabs

	Co	Cu	Fe(%)	Mn	Ni	Pb	Zn	Cd	Hg
Mean	13.39	40.39	2.76	338.53	39.00	18.85	104.15	L2.0	0.346
Std. Dev.	0.89	4.84	0.25	24.82	2.29	6.29	29.54	L2.0	0.101
Std. Error	0.13	0.69	0.04	3.55	0.33	0.90	4.22	L2.0	0.015
Max. Val.	14.989	53.088	3.198	397.339	44.081	49.283	283.705	L2.0	0.906
Min. Val.	10.688	29.442	1.923	268.601	29.466	12.107	76.517	L2.0	0.186

1978 Cores Surface Values

	Co	Cu	Fe(%)	Mn	Ni	Pb	Zn	Cd	Hg
Mean	13.43	40.27	2.7	335.54	38.42	18.89	101.33	L2.0	0.548
Std. Dev.	0.80	4.57	0.3	29.82	2.89	6.31	13.79	L2.0	0.212
Std. Error	0.13	0.77	0.05	5.04	0.49	1.07	2.33	L2.0	0.036
Max. Val.	15.219	47.065	3.131	393.337	43.18	42.945	139.854	L2.0	1.23
Min. Val.	10.705	26.049	2.063	283.056	27.893	8.16	67.477	L2.0	0.182

L = less than

TABLE 5 MEAN TRACE METAL VALUES AT DEPTH IN CORE SAMPLES (ug/gm)

	Mean Values							
	Co	Cu	Fe(%)	Mn	Ni	Pb	Zn	Hg
1975 Cores								
0-5 cm	13.49	45.89	3.39	330.35	48.64	18.25	102.32	0.202
50-55 cm	13.63	43.23	3.47	319.0	48.23	12.92	95.57	0.197
Bottom	13.84	41.88	3.48	326.4	49.17	10.87	90.56	0.158
1978 Cores								
0-5 cm	13.43	40.27	2.7	335.54	38.42	18.89	101.23	0.548
50-55 cm	14.36	37.28	2.81	337.09	39.97	10.08	88.65	0.52
75-80 cm	14.64	35.76	2.81	340.01	40.62	8.52	84.63	0.50

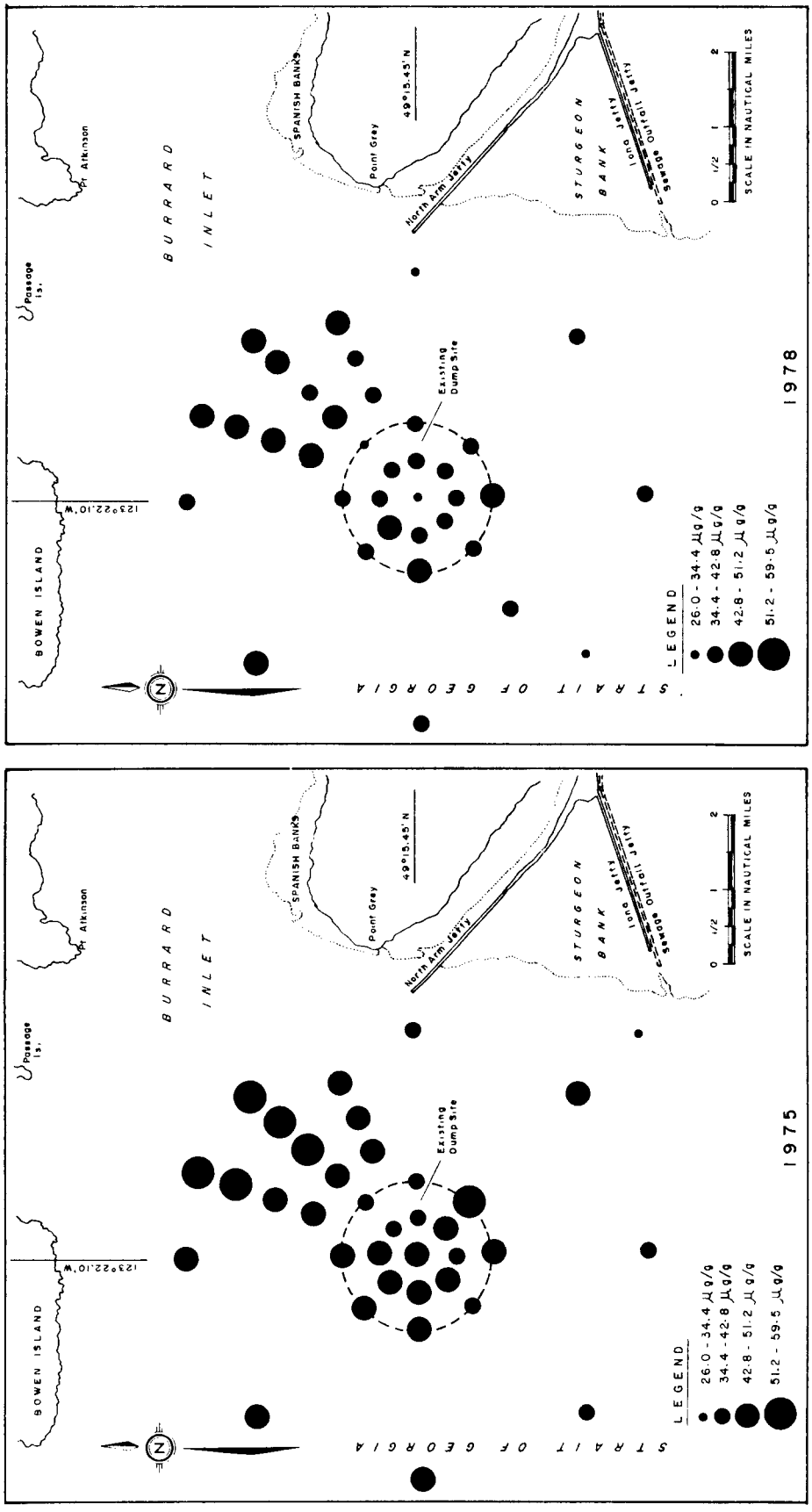

FIGURE 12 COPPER VALUES CORES - 1975 and 1978

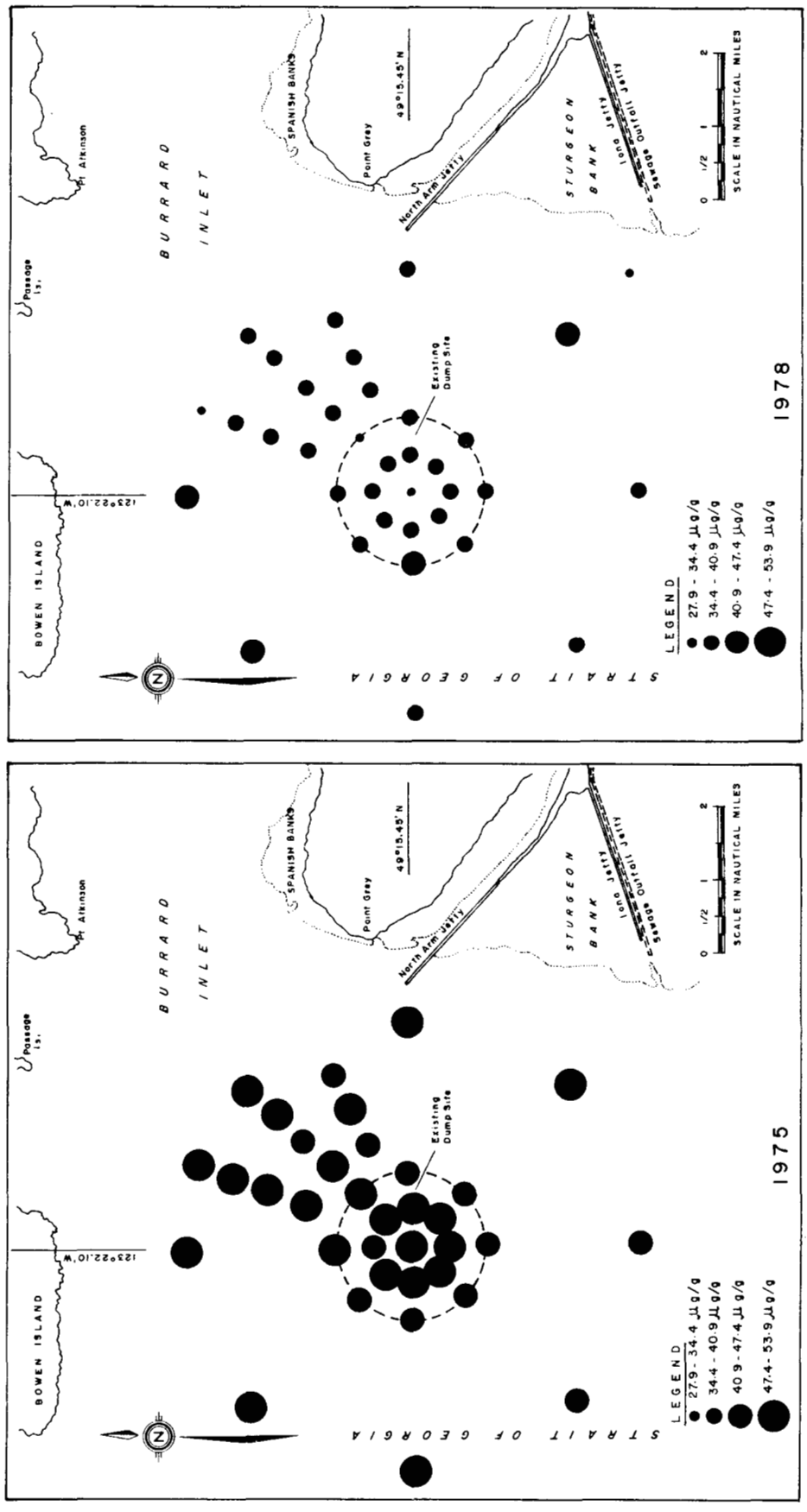

FIGURE 13 NICKEL VALUES CORES-1975 and 1978

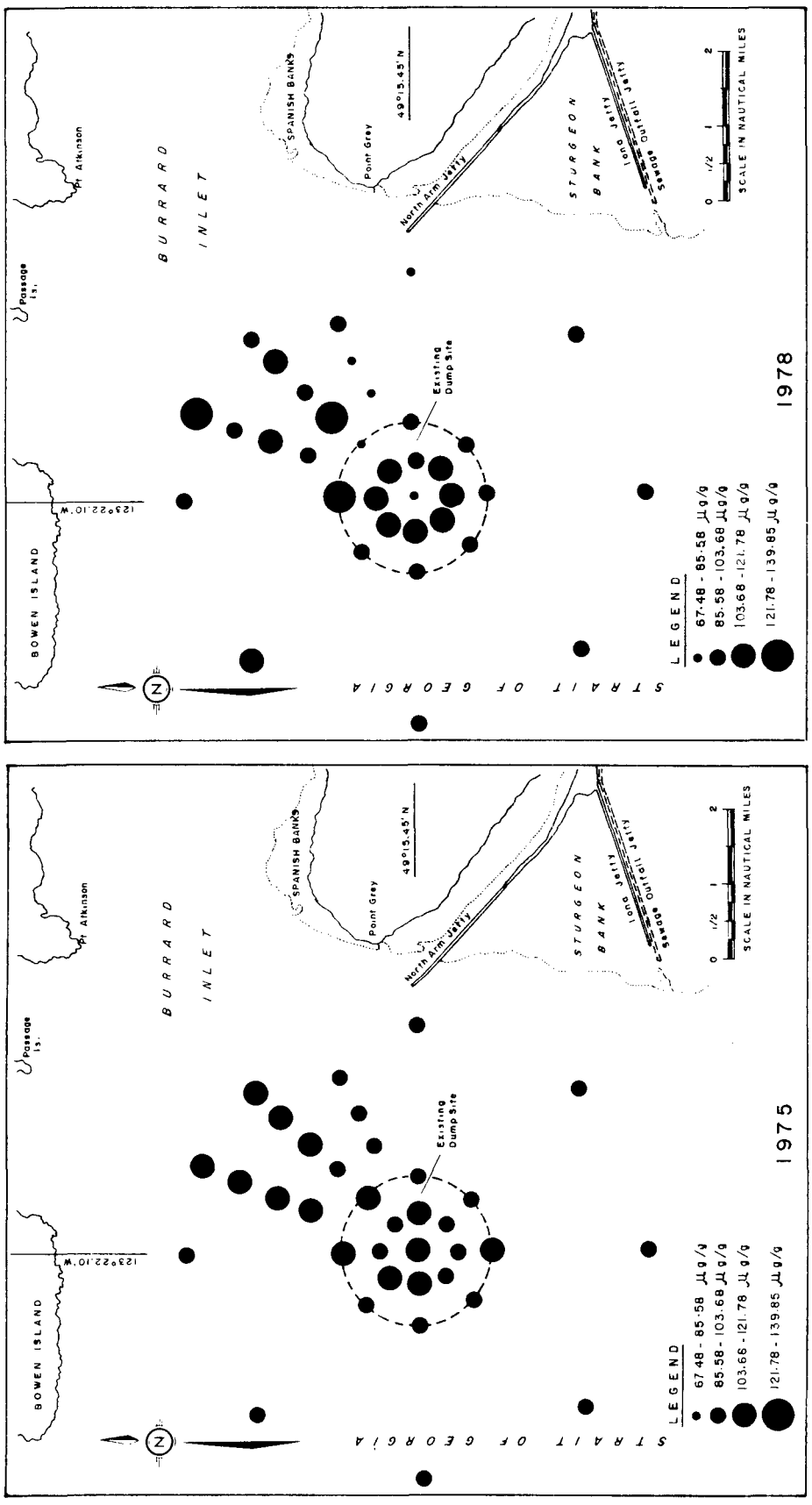

FIGURE 14 ZINC VALUES CORES - 1975 and 1978

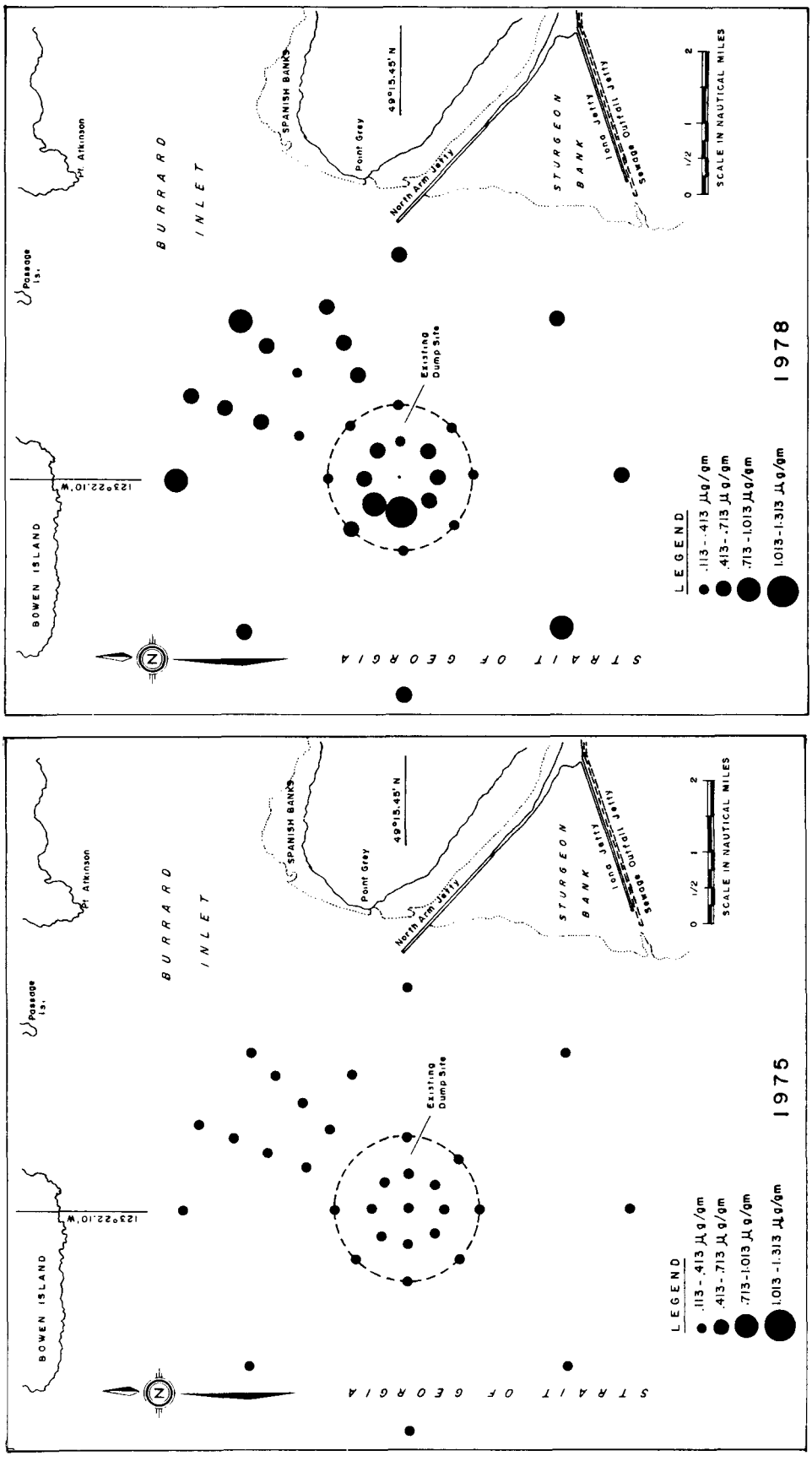

FIGURE 15 MERCURY VALUES CORES - 1975 and 1978

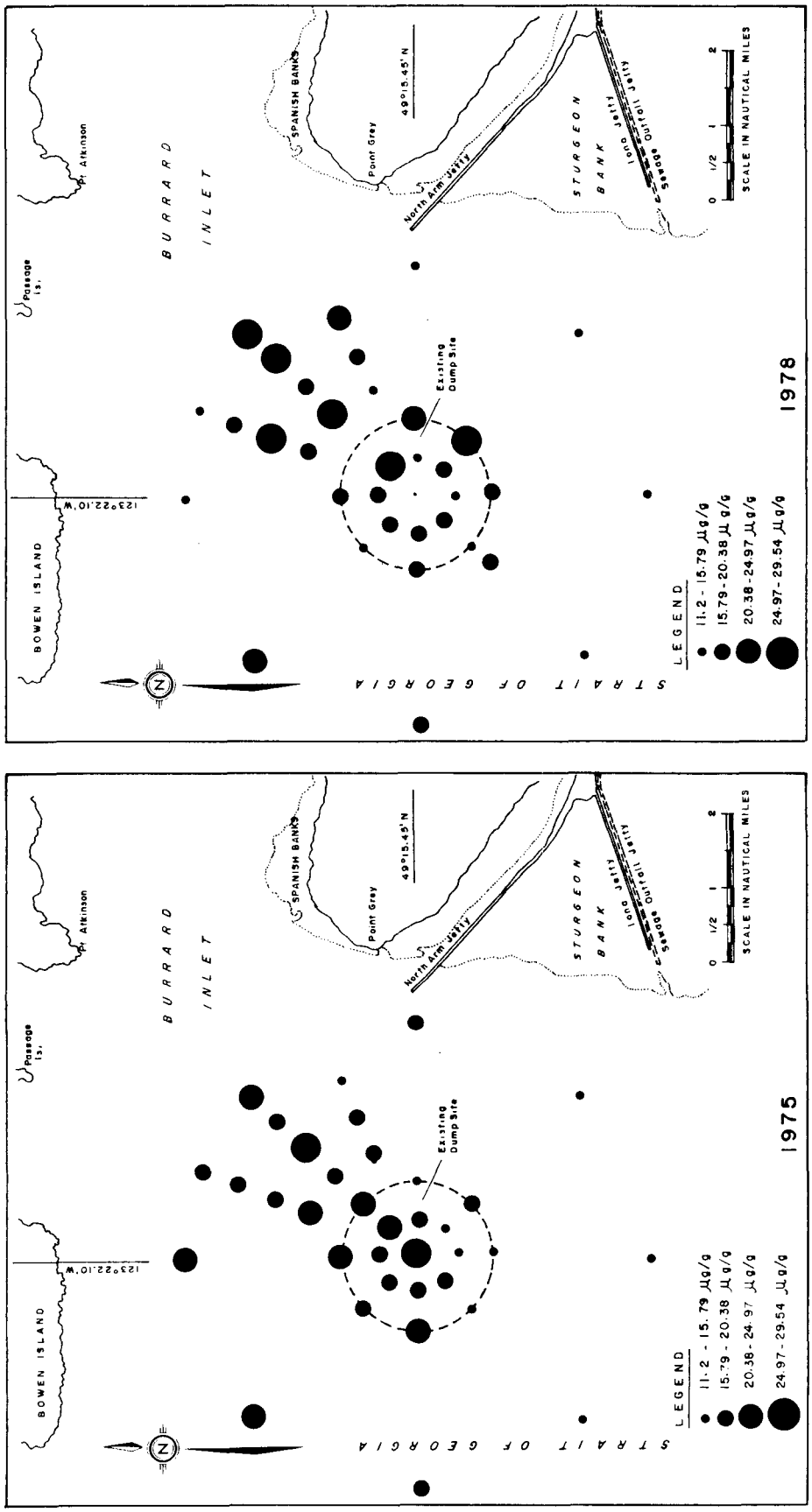

FIGURE 16 LEAD VALUES CORES - 1975 and 1978

grid. The dominant groups were determined to be the errantiate polychaete Lumbrinereis luti, a mollusc of the Class Scaphopoda, Dentalium sp.; and the Phylum Sipuncula. The distributions of these groups are presented in Figures 17, 18 and 19. Other taxonomic groups which were felt to be important to the benthic community, at least in terms of biomass if not numbers of individuals, included the heart urchin, Brisaster latifrons; brittle stars, (Ophiuroidea); and sea cucumbers Molpadia intermedia and Chirodota sp. The distributions of these groups are presented in Figures 20 to 23.

The following general conclusions may be drawn from examination of the distribution of these dominant taxonomic groups. Dentalium sp., Brisaster latifrons, Chirodota sp. and Molpadia intermedia did not appear to have a defined distributional pattern. It was felt that sample replication would reveal a uniform distribution of these groups. Lumbrinereis luti and Ophiuroidea both appeared to be more predominant in the northeast sector of the sample grid. These animals are generally associated with coarser sediment types. As the sediments in the northeast sector were generally coarser as determined from the sediment size analyses, and the Pisces IV observations, these faunal distributions were not unexpected. Also during the dives large numbers of Ophiuroids were noted in this area. The number of individuals of the Phylum Sipuncula appeared to decrease in the northeast sector. This group, upon closer examination, could be divided into two sub-groups which were tentatively identified as Phascolosoma sp. and Sipuncula B. Phascolosoma sp. occurred in relatively high numbers in the western portion of the grid while Sipuncula B exhibited a lower number of individuals per station and occurred mainly in the northeast sector.

A cluster analysis was performed with the benthic data in an attempt to associate the stations numerically according to their faunal composition. The results of this analysis are presented as a phenogram in Figure 24. In the phenogram some weakly delineated provinces are apparent. One group of stations of relatively close association is

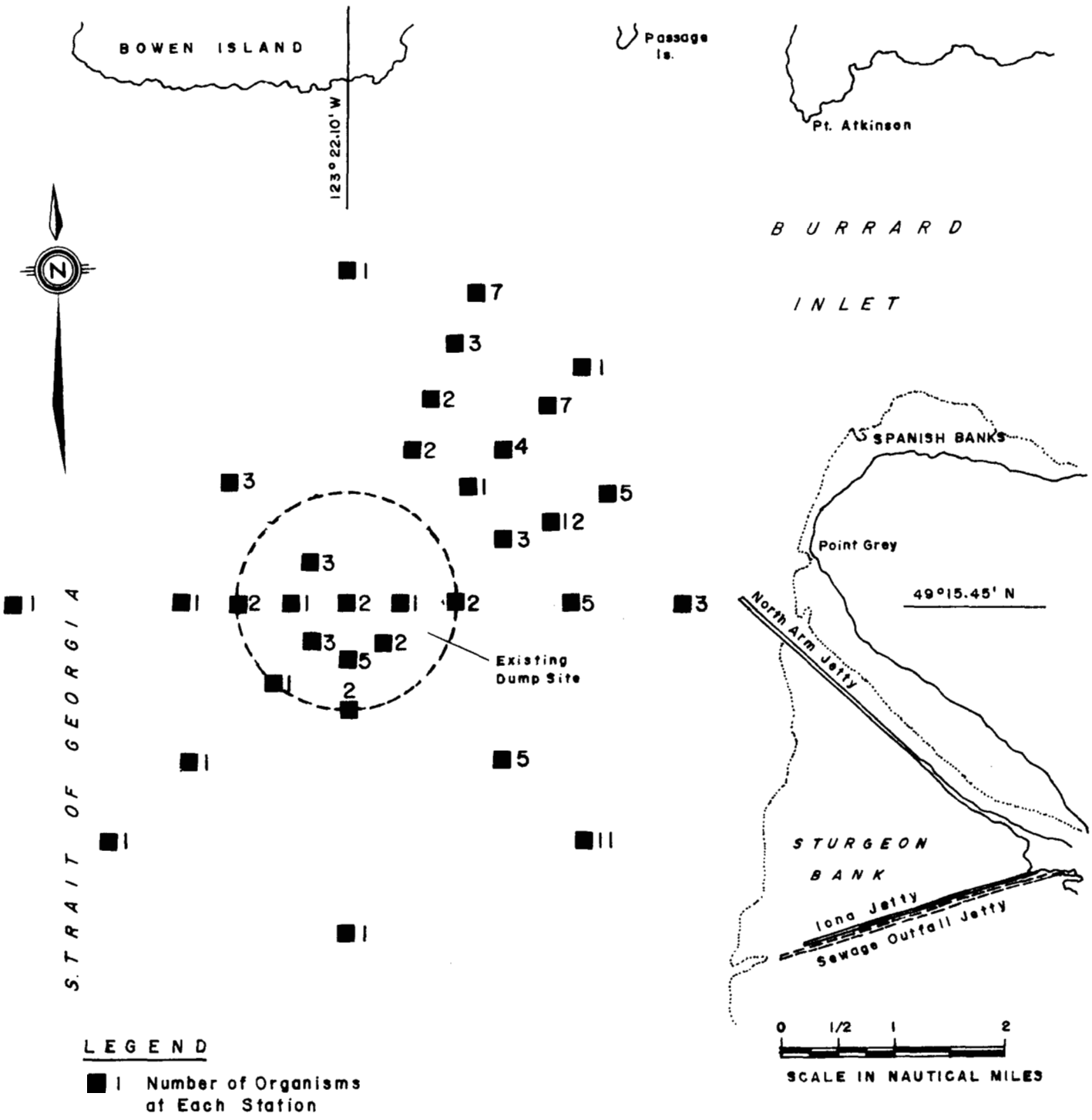

FIGURE 17 DISTRIBUTION OF THE ERRANTIATE POLYCHAETE Lumbrinereis luti

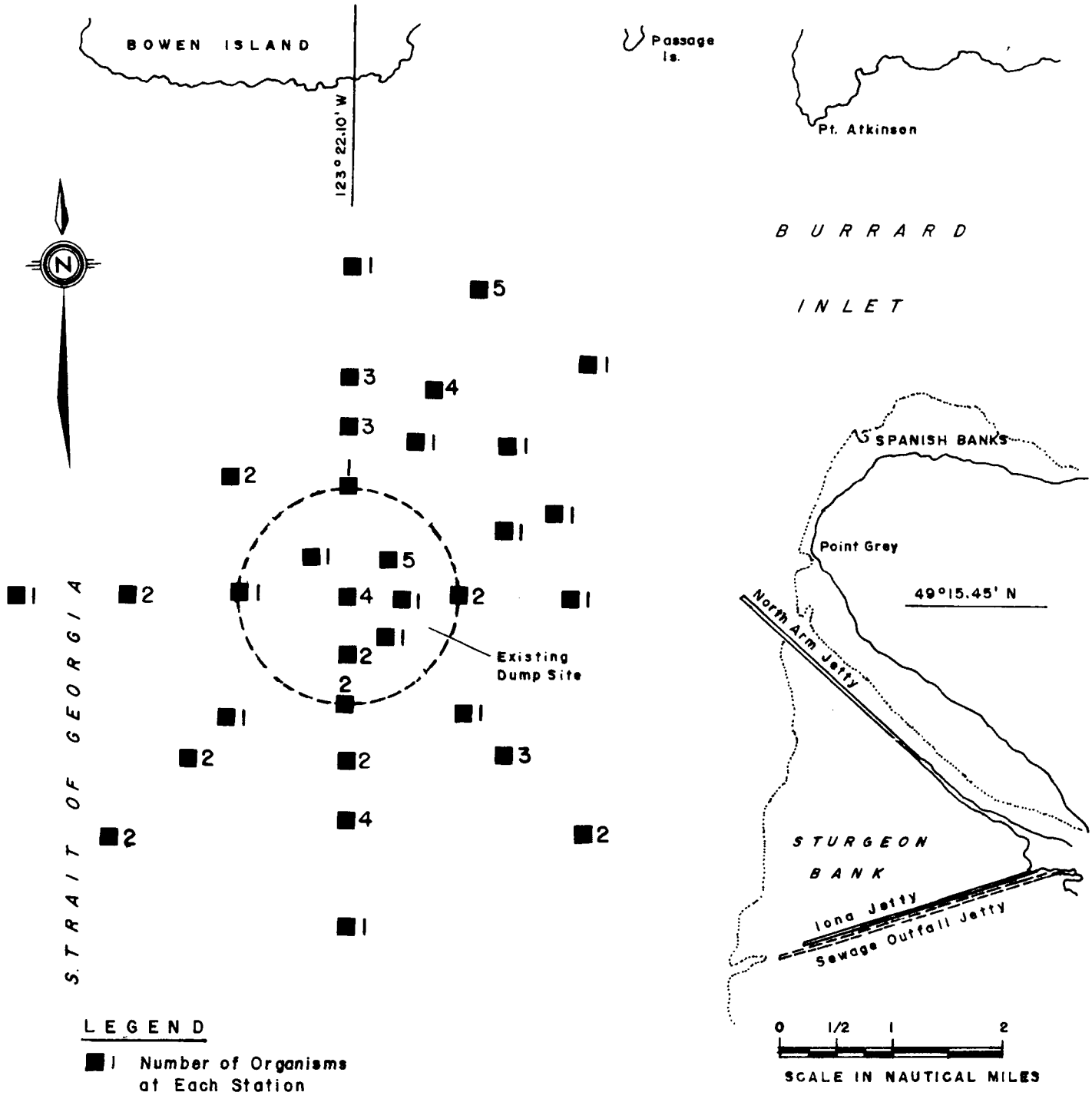

FIGURE 18 DISTRIBUTION OF *Dentalium* sp.

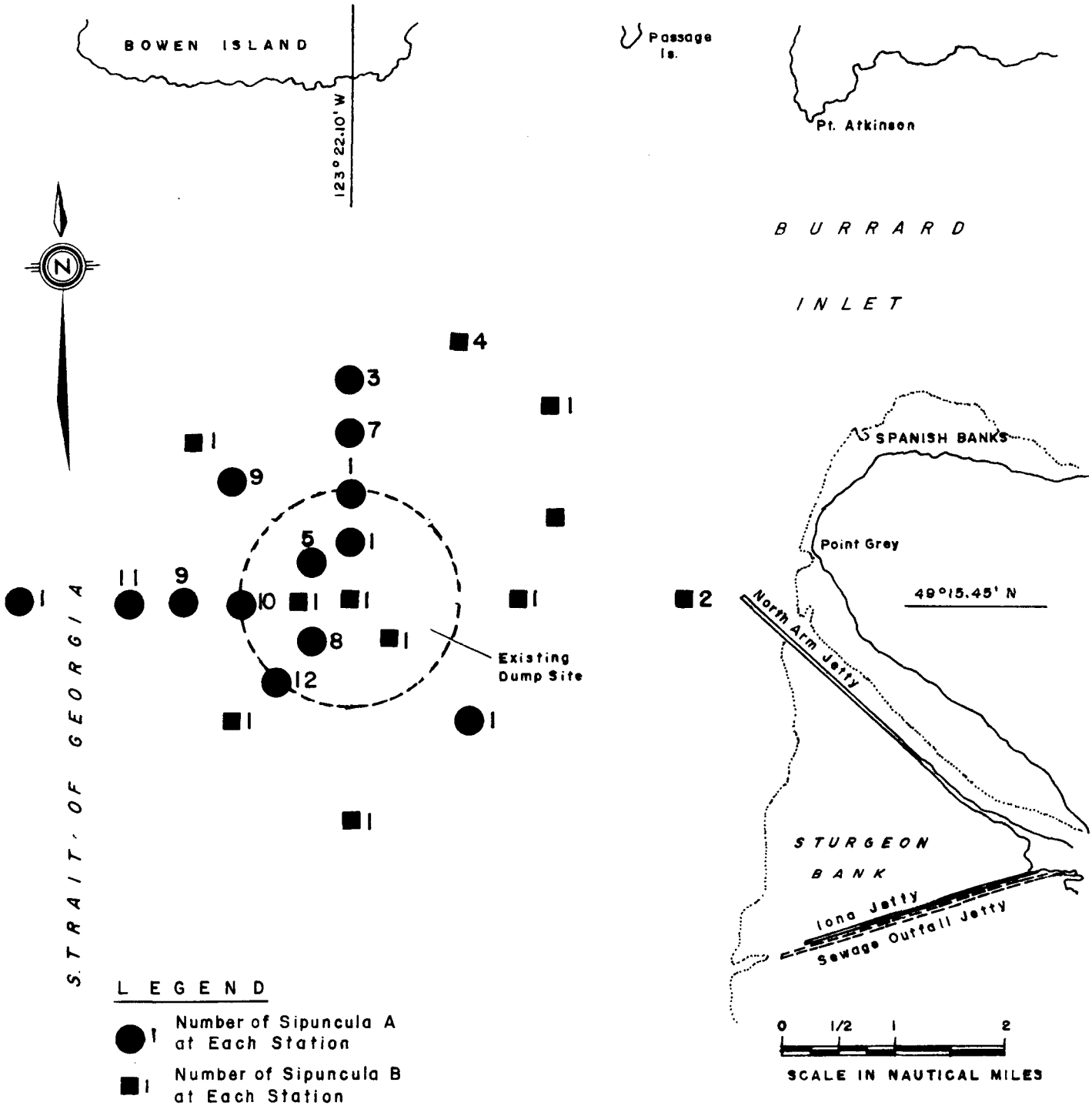

FIGURE 19 DISTRIBUTION OF THE TWO GROUPS OF Sipuncula

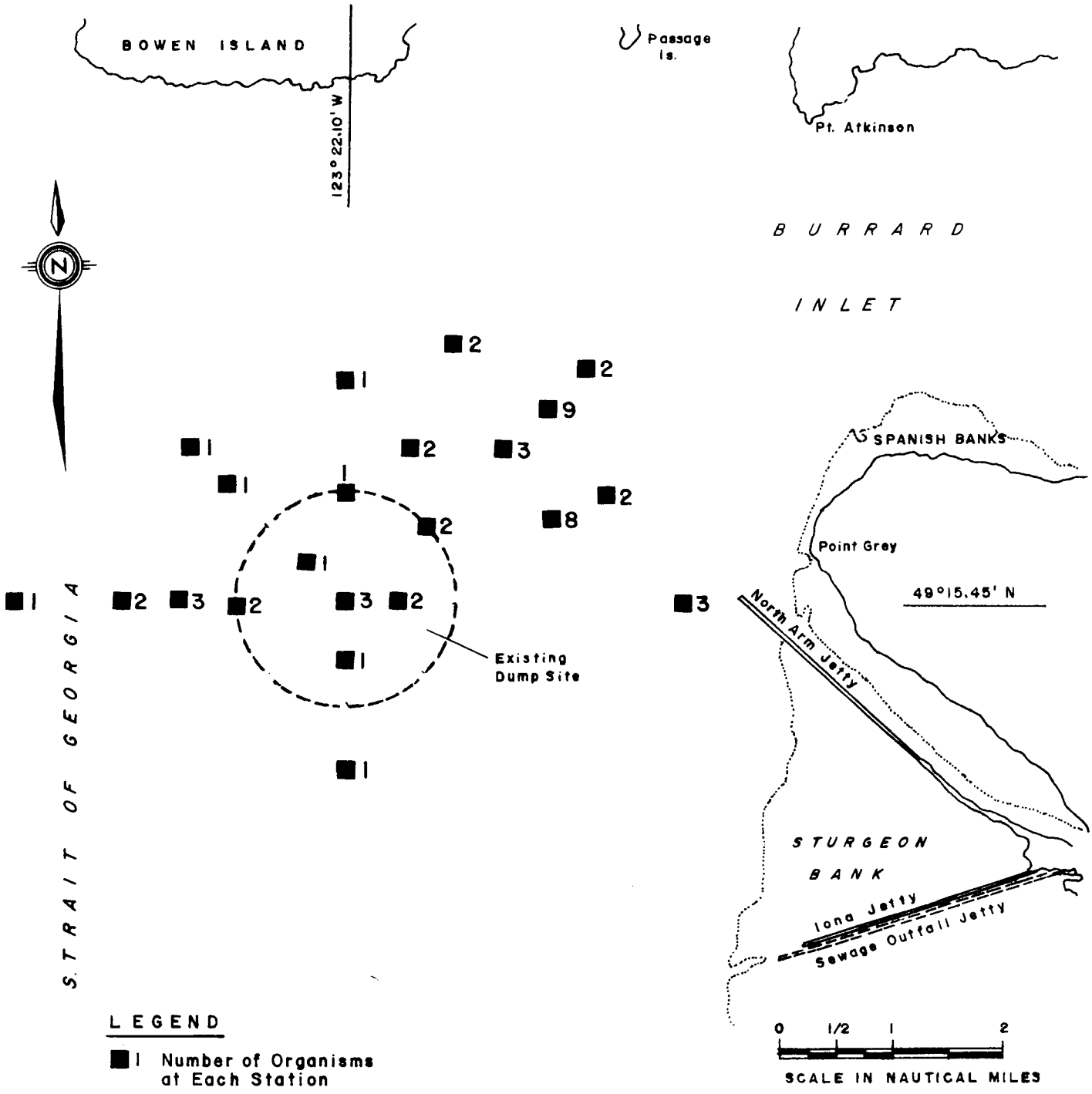

FIGURE 20 DISTRIBUTION OF Ophiuroidea

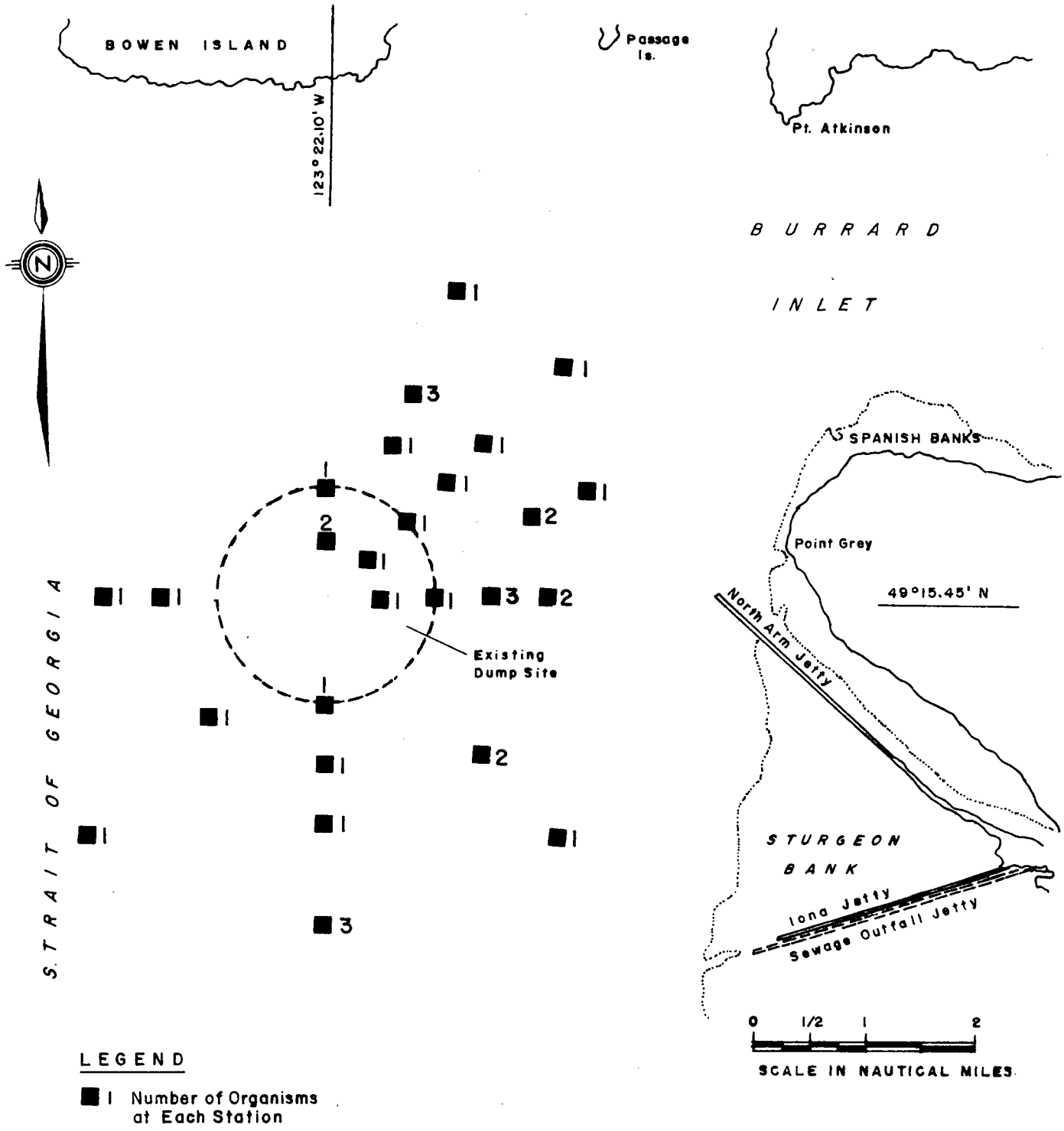

FIGURE 21 DISTRIBUTION OF Molpadia intermedia

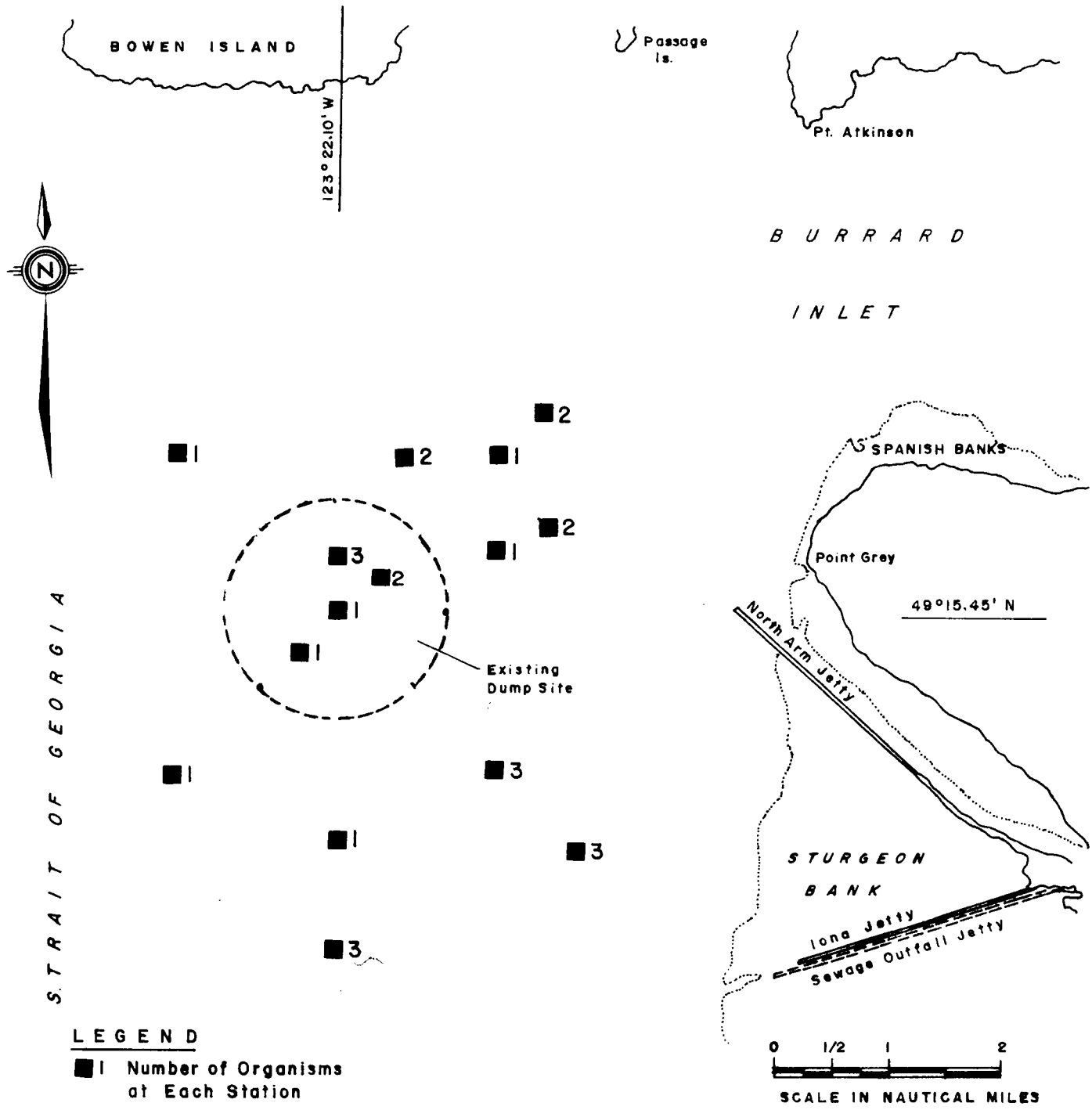

FIGURE 22 DISTRIBUTION OF Chirodota sp.

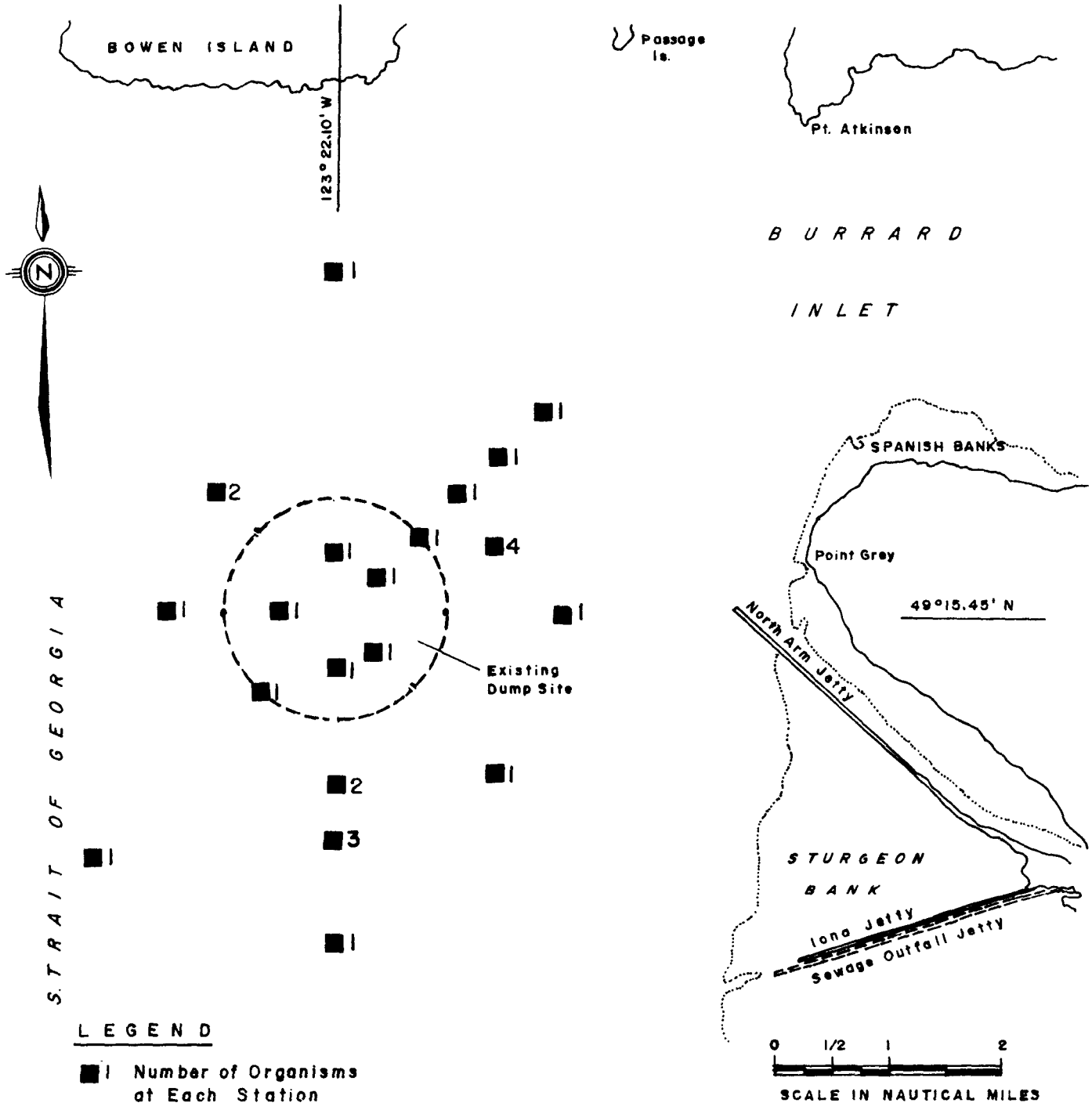

FIGURE 23 DISTRIBUTION OF THE SEA URCHIN
Brisaster latifrons

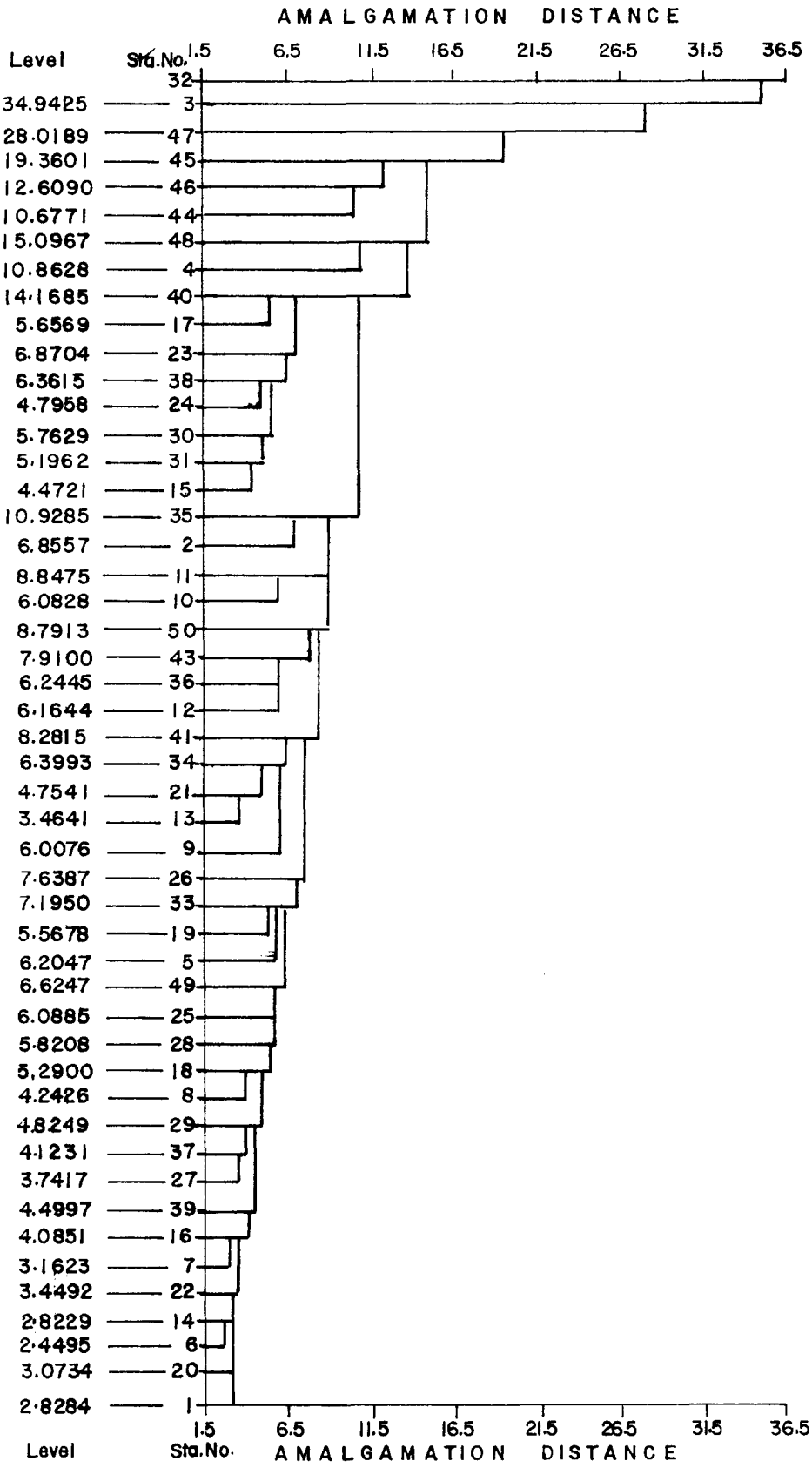

FIGURE 24 CLUSTER ANALYSIS PHENOGRAM

apparent between PG-1 and PG-26 at the right hand side of the phenogram while another group occurs between PG-15 and PG-40. The stations in these groups have been plotted in Figure 25. Figure 25 indicates that those groups of stations with the highest degree of association occur in the western portion of the study area where the bottom substrate is most uniform as determined from the sediment data and Pisces IV observations. PG-32 exhibited the least association with any of the other stations. The only animals collected in this sample were 28 bivalves of the Genus Macoma. Had the samples been replicated this anomaly would probably have been removed. The conclusions of this analysis therefore correspond with the other analyses in that the northeast sector of the study area is somewhat different as compared with the remainder. It is likely that this is at least partly a result of ocean disposal activity.

3.4 Pisces IV Submersible Dives

Generally speaking the information gained through the dives aboard the Pisces IV confirmed the inferences derived from the other assessment methods, that is, the northeast and eastern sectors of the study area represented a different benthic province.

The 1976 dives were recorded by means of 70 mm still photographs, 16 mm movie shots and each track was recorded in its entirety on video tape. This procedure was repeated in 1978 except that video tape was not used. Dive reports containing photographs of the 1978 dives are presented in Appendix VII. A brief description of the 1976 dives is contained in Hoos (1977).

It was concluded from both series of dives that the northeastern and eastern sectors of the study area were the most affected by dumping activity. On the tracks run in 1976 in the northeast sector the most noticable portion of the material which had been disposed of consisted of construction rubble in the form of broken pieces of concrete, steel reinforcing rods and hardpan clay. Some woodwastes in the form of sunken logs and wood and bark debris were in evidence. Most of the

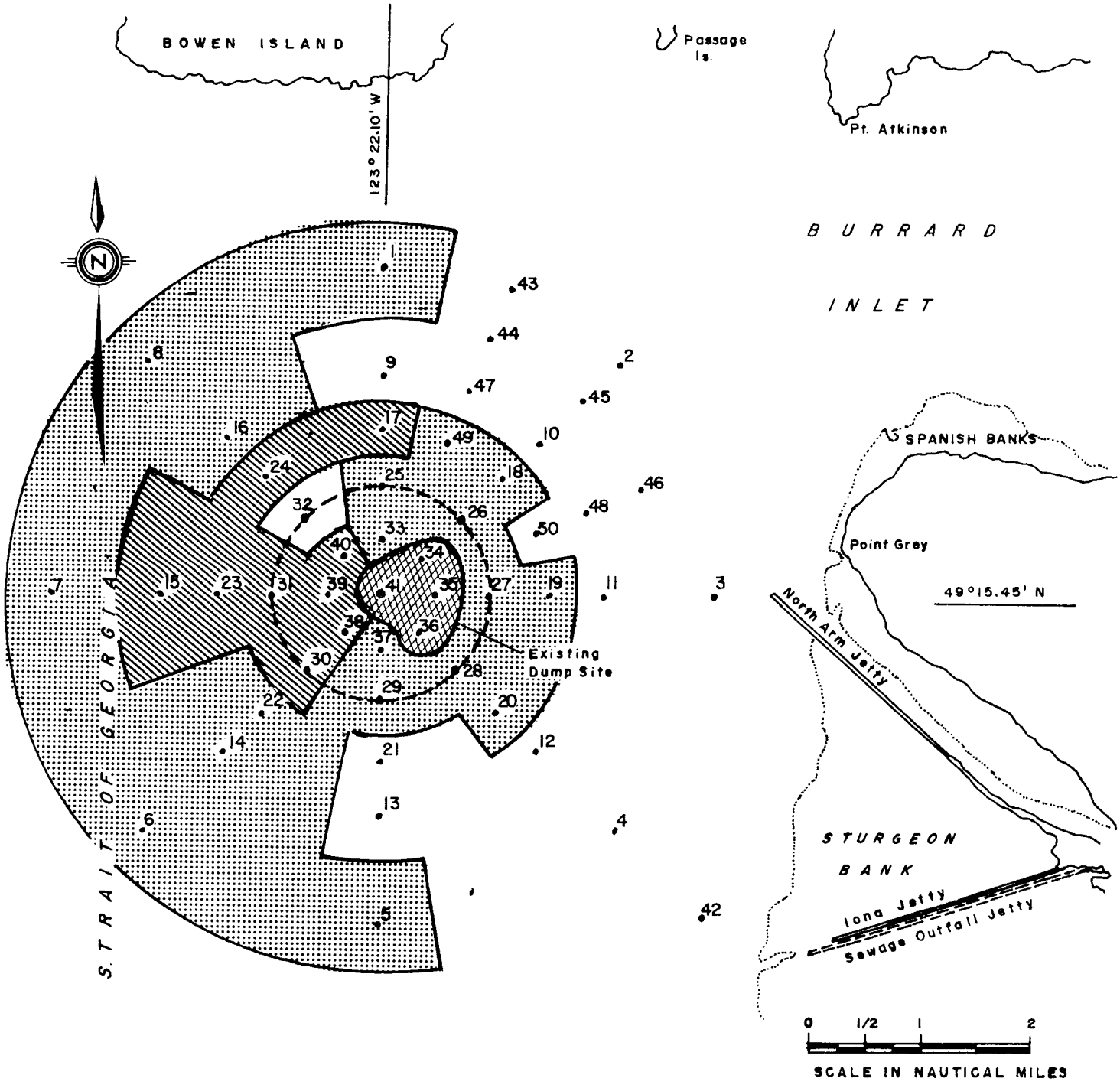

FIGURE 25 BIOLOGICAL "PROVINCES" DERIVED FROM CLUSTER ANALYSIS

smaller bits of woody debris were well mixed into the sediments. The area surveyed in the course of Track 3 had the highest degree of contamination with woodwastes, some patches being covered in wood and bark debris. The sediments in the eastern and northeastern sectors were probably naturally coarser due to the stronger tidal flows as the bathymetry shallowed; however, it appeared that this had been augmented by the dumping of construction rubble. The western portion of the designated dumpsite was noted to be virtually devoid of dumped material. The sediments in this area consisted of fine silt typical of deeper areas of the Strait of Georgia.

Benthic fauna in the northeast sector of the study area also differed from the other sectors. Brittle stars (Ophiuroidae) were very abundant and the dominant epibenthic form in both series of dives. In 1976 there did not appear to have been an extensive effect of the dumped material upon the benthic epifauna. Gastropods (Neptunea sp.), prawns (Pandalus platyceros), shrimp (Pandalus sp.) and rockfish (Sebastolobus alascanus) were often observed utilizing logs and pieces of concrete as protective cover.

During the course of the 1978 dives, as described in Appendix VII, the northeast and eastern sectors were also noted to have different characteristics from the rest of the study area in terms of coarser natural sediments and increased quantities of construction materials and woodwastes. In 1978, however, piles of woodwastes, obviously derived from log pond dredging activities, were noted during the course of Tracks 1, 2 and portions of 4. It appeared as though the quantities of woodwastes in the vicinity of these tracks had increased considerably over what was observed in 1976. In the area directly between the North Arm Jetty and the dumpsite on Track 5 the bottom was blanketed with woodwastes. The sediments appeared to be of a reducing nature and a white bacterial slime on the decaying wood was noted in some spots. As this area was not surveyed in 1976, it is not known if the quantities of woodwastes has increased markedly since that time.

The benthic epifauna, as described in Appendix VII for the 1978 dives appeared to be sparser than in 1976 in the northeast sector. In the latter third of Track 5 (1978) the benthic epifauna was extremely reduced in numbers with sidestripe shrimp (Pandalopsis dispar) being the most abundant form. As well, the number of infaunal burrows decreased markedly. These impressions are purely qualitative based on observations made during the dives and on comparison of the films from the two series of dives.

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APPENDIX I

DUMPSITE SUMMARY

APPENDIX I DUMPSITE SUMMARY

DUMPSITE		PERMIT NUMBER	TOTAL QUANTITY COVERED BY PERMIT (m^3)	ACTUAL QUANTITY DUMPED (m^3) 1976	1977	MATERIAL
Point Grey 49 15'N; 123 22'W	Fort Langley	4443-0011	(1,150,000)	127,575	-	Clean Sand
	Crown Zellerbach	4443-0013	7,600	7,600	-	Woodwastes
	CMHC False Creek	4443-0016	42,000	39,925	-	Chemically contaminated sand; construction debris
	MacMillan Bloedel	4443-0029	38,000	17,813	-	Woodwastes
	Eburne Sawmills	4443-0030	7,600	5,351	-	Woodwastes
	Rayonier	4443-0035	17,000	-	6,116	Woodwastes
	Weldwood	4443-0040	7,600	-	4,587	Woodwastes
	Terminal Sawmills	4443-0044	3,800	458	994	Woodwastes
	Mainland Sawmills	4443-0045	3,800	917	-	Woodwastes
	Fisherman's Cove	4443-0048	8,000	5,574	-	Clean Sand
	Rivtow	4443-0119	3,800	3,800	-	Clean Sand
	Ocean Construction	4443-0141	22,935	830 (tons)	8,410	Concrete culverts
	Bay Forest Products	4443-0169	12,996	6,400	2,446	Woodwastes
	Hercules Dredging	4443-0172	1,529	1,529	-	Clean Sand
	Marathon Realty	4443-0178	22,935	3,058	18,000	Clean sand; some construction debris
	Crown Zellerbach	4443-0180	7,600	-	7,600	Woodwastes
	MacMillan Bloedel	4443-0196	19,113	-	3,058	Woodwastes
	Eburne Sawmills	4443-0208	15,290	-	15,290	Woodwastes
	Dillingham Corp.	4443-0238	114,000	-	6,116	Clean Sand
	Rayonier Canada	4443-0282	17,201	-	3,058	Woodwastes
	Fraser River Pile Driving	4443-0296	76,000	-	55,579	25,000 Clean sand, remainder containing woodwastes
	Rivcon	4443-0322	340,000	-	340,000	Clean sand and fill
	Pioneer Grain	4443-0323	304,000	-	229,350	Sand, gravel, some construction debris
	Coal Harbour	4443-0324	6,120	-	6,120	Organic silt and sand
	Terminal Sawmills	4443-0325	3,800	-	3,800	Woodwastes
	Mainland Sawmills	4443-0326	3,800	-	3,800	Woodwastes
	Goldwood Industries	4443-0347	1,147	-	1,147	Clean Sand
	Crown Zellerbach	4443-0356	22,935	-	6,000	Woodwastes
	Byrne Construction	4443-0367	76,000	-	15,290	Organic Silt

NOTE: For the purposes of this table "woodwastes" are considered to be dredged material comprised of sand, silt, etc. up to 50% wood and bark debris.

APPENDIX II

PHYSICAL OCEANOGRAPHIC RESULTS
1975 & 1978

APPENDIX II OCEANOGRAPHIC DATA - 1975

Station	Time	Depth (m)	Temp. (°C)	Salinity (o/oo)	D.O. (mg/l)	% Sat. °2	NFR (mg/l)
9	1525	0		17.5	10.40		11
	May 7	2	11.02	23.5	10.10	109	36
		5	9.76	25.0	9.70	103	5
		10	8.8	28.0	9.30	98	5
		25	7.3	30.0	7.40	76	7
		50	7.29	30.0	7.70	79	3
		100	7.62	30.5	8.30	87	8
		200	7.74	31.0	7.10	74	7
		250	7.87	31.5	6.00	63	206
11	1948	0	11.98	19.0	10.30	110	18
	May 7	2	10.99	23.5	10.10	109	10
		5	11.51	24.5	10.20	112	4
		10	8.35	28.5	8.85	93	4
		25	7.34	30.0	7.20	74	4
		100	7.56	31.0	7.60	79	6
		180	7.7	31.5	7.25	76	4
13	1445	0	10.55	26.0	9.50	103	4
	May 1	2	10.27	26.5	9.50	103	9
		5	10.07	28.0	9.80	106	5
		10	8.66	28.5	9.10	96	10
		25	7.46	29.5	8.10	84	5
		50	7.42	30.0	7.40	77	3
		100	7.38	30.5	7.60	79	7
		200	7.64	31.0	7.80	82	8
		240	7.72	31.0	7.25	76	6
15	1715	0	12.52	19.0	10.30	112	13
	May 7	2	9.98	24.0	10.00	106	5
		5	9.79	25.5	9.90	105	7
		10	8.76	29.0	8.50	90	13
		25	7.79	29.5	8.80	92	4
		50	7.33	30.5	7.70	80	6
		100	7.41	30.5	7.75	80	6
		200	7.83	31.0	6.75	71	5

APPENDIX II OCEANOGRAPHIC DATA - 1975

Station	Time	Depth (m)	Temp. (°C)	Salinity (o/oo)	D.O. (mg/l)	% Sat. °2	NFR (mg/l)
25	1840	0	10.39	26.0	9.60	104	15
	May 1	2	8.20	28.0	8.60	89	7
		5	7.68	28.5	8.00	82	15
		10	7.89	29.5	8.60	90	8
		25	7.38	30.0	7.50	77	5
		50	7.31	30.0	7.50	77	7
		100	7.37	30.5	7.50	78	5
		200	7.55	31.0	7.50	78	16
		240	7.77	31.0	6.85	72	22
27	1908	0	12.53	19.5	10.45	114	8
	May 7	2	10.33	24.0	9.90	105	7
		5	9.47	25.5	10.60	112	6
		10	8.65	28.5	9.10	96	5
		25	7.54	30.0	7.60	79	4
		50	7.30	30.0	7.60	78	3
		100	7.59	31.0	8.10	85	3
		200	7.86	31.5	6.50	69	3
29	1550	0	10.36	27.0	9.55	104	5
	May 1	2	9.99	26.5	9.55	103	3
		5	8.68	28.0	9.40	99	3
		10	8.59	29.5	9.05	96	6
		25	7.5	30.0	7.80	81	3
		50	7.28	30.0	7.50	77	8
		100	7.45	30.5	7.65	79	6
		200	7.58	31.0	8.00	84	3
		240	7.65	31.0	7.55	79	9
31	1810	0	12.29	19.0	10.00	108	7
	May 7	2	10.35	23.5	10.10	107	4
		5	9.4	25.5	9.30	98	6
		10	8.48	29.5	9.50	100	8
		25	7.87	30.0	8.40	88	4
		50	7.29	30.5	7.70	80	3
		100	7.47	31.0	7.55	79	8
		200	7.84	31.5	6.10	64	5
		240	7.98	31.0	5.90	62	3

APPENDIX II OCEANOGRAPHIC DATA - 1975

Station	Time	Depth (m)	Temp. (°C)	Salinity (o/oo)	D.O. (mg/l)	% Sat. °2	NFR (mg/l)
41	1655 May 1	0	10.39	26.0	9.70	105	7
		2	9.88	26.5	9.65	103	5
		5	7.67	28.5	8.00	82	4
		10	7.89	29.5	8.65	90	4
		25	7.42	30.0	7.70	80	7
		50	7.29	30.0	7.50	77	6
		100	7.48	30.5	8.30	86	4
		200	7.64	31.0	7.95	83	8
		240	7.56	31.0	7.25	76	10

APPENDIX II OCEANOGRAPHIC DATA - 1978

Station	Depth (m)	Temperature (°C)	Salinity (o/oo)	Dissolved Oxygen (mg/l)	% Saturation
PG-9	0	9.37	25.02	10.30	108.05
	2	9.24	25.20	10.90	114.11
	5	9.17	25.57	10.50	110.01
	10	9.08	26.01	10.30	108.01
	25	8.22	29.08	8.00	83.87
	50	8.15	29.62	7.75	81.41
	100	8.20	29.87	8.00	84.28
	200	8.55	30.32	7.20	76.72
	240	9.01	30.57	5.00	53.95
PG-13	0	9.78	25.11	10.55	111.80
	2	9.78	25.11	10.35	109.68
	5	9.37	25.62	10.10	106.35
	10	8.83	28.51	9.70	102.80
	25	8.43	28.95	8.90	93.69
	60	8.21	29.71	7.90	83.15
	110	8.21	29.89	7.40	77.99
	210	8.45	30.33	7.60	80.79
	235	8.50	30.35	7.60	80.89
PG-25	0	9.37	25.29	10.50	110.33
	2	9.31	25.28	10.60	111.22
	5	9.09	26.14	9.80	102.87
	10	8.57	28.34	9.35	98.37
	25	8.15	29.20	7.90	82.74
	50	8.16	29.59	7.50	78.77
	100	8.20	29.88	7.55	79.54
	200	8.47	30.29	7.50	79.74
	240	9.35	30.59	4.70	51.12

APPENDIX II OCEANOGRAPHIC DATA - 1978

Station	Depth (m)	Temperature (°C)	Salinity (o/oo)	Dissolved Oxygen (mg/l)	% Saturation
PG-29	0	9.58	25.57	10.55	111.61
	2	9.47	25.71	10.35	109.31
	5	9.26	26.15	9.90	104.34
	10	9.06	28.19	9.80	104.20
	25	8.40	28.95	8.60	90.48
	50	8.33	29.67	7.95	83.91
	100	8.24	29.71	7.90	83.21
	200	8.46	30.23	7.65	81.28
	230	8.53	30.33	7.30	77.75
PG-41	0	9.55	25.45	10.60	111.97
	2	9.47	25.44	9.95	104.90
	5	9.11	26.53	9.80	103.18
	10	9.30	28.01	9.70	103.58
	25	8.58	29.00	8.30	87.73
	50	8.31	29.66	7.95	83.84
	100	8.20	29.81	7.90	83.19
	200	8.45	30.26	7.70	81.81
	230	8.81	30.44	5.75	61.70

APPENDIX II NUTRIENT DATA - 1978

Station	Depth (m)	Nitrate (mg/l)	Nitrite (mg/l)	Ammonia (mg/l)	Total Phospate (mg/l)
PG-9	0	0.174	0.005	0.0135	0.0476
	2	0.183	0.005	0.0106	0.0474
	5	0.199	0.005	00122	0.0478
	10	0.229	0.005	0.0122	0.0531
	25	0.405	0.005	0.0050	0.0765
	50	0.305	0.005	0.0050	0.0655
	100	0.345	0.005	0.0050	0.0722
	200	0.360	0.005	0.0050	0.0758
	240	0.415	0.005	0.0050	0.0930
PG-25	0	0.181	0.005	0.0145	0.0482
	2	0.185	0.005	0.0106	0.0482
	5	0.227	0.005	0.0155	0.0530
	10	0.303	0005	0.0085	0.0710
	25	0.390	0.005	0.0050	0.0712
	50	0.370	0.005	0.0050	0.0738
	100	0.345	0.005	0.0050	0.0698
	200	0.290	0.005	0.0135	0.0683
	240	0.405	0.005	0.0050	0.0943
PG-41	0	0.188	0.005	0.0115	0.0490
	2	0.192	0.005	0.0115	0.0474
	5	0.221	0.005	0.0115	0.0545
	10	0.275	0.005	0.0076	0.0613
	25	0.355	0.005	0.0050	0.0721
	50	0.350	0.005	0.0050	0.0697
	100	0.355	0.005	0.0050	0.0682
	200	0.325	0.005	0.0115	0.0690
	230	0.395	0.005	0.0115	

APPENDIX II NUTRIENT DATA - 1978

Station	Depth m	Nitrate (mg/l)	Nitrite (mg/l)	Ammonia (mg/l)	Total Phospate (mg/l)
PG-29	0	0.197	0.0050	0.0115	0.0462
	2	0.206	0.0050	0.0106	0.0510
	5	0.231	0.0050	0.0106	0.0537
	10	0.281	0.0054	0.0106	0.0625
	25	0.340	0.0050	0.0085	0.0731
	50	0.350	0.0050	0.0050	0.0697
	100	0.350	0.0050	0.0050	0.0695
	200	0.345	0.0050	0.0120	0.0692
	230	0.345	0.0050	0.0100	0.0759
PG-13	0	0.171	0.0050	0.0060	0.0462
	2	0.173	0.0050	0.0050	0.0437
	5	0.202	0.0050	0.0076	0.0502
	10	0.310	0.0050	0.0106	0.0652
	25	0.350	0.0050	0.0090	0.0737
	50	0.325	0.0050	0.0060	0.0648
	100	0.390	0.0050	0.0050	0.0697
	200	0.370	0.0050	0.0100	0.0717
	225	0.325	0.0050	0.0100	0.0656

APPENDIX III

SEDIMENT SIZE DATA & PHYSICAL DESCRIPTIONS OF SEDIMENTS AT TIME OF SAMPLING

APPENDIX III SEDIMENT SIZE DATA - 1975

Station	Sediment Size (% Retained on Mesh) 0.5 mm	0.25 mm	0.0625 mm	% Passing Through
PG-1	0.1	0.2	1.5	99.2
2	1.1	0.9	1.7	96.3
3	5.2	26.0	20.0	48.8
4	0.1	0.2	0.8	98.9
5	0.0	0.0	0.3	99.7
6	0.1	0.3	0.4	99.2
7	0.1	0.1	0.2	99.6
8	0.0	0.1	0.1	99.8
9	0.2	0.2	1.0	98.6
10	8.5	3.7	5.6	82.2
11	2.8	3.7	3.3	90.2
12	3.0	1.2	1.8	94.0
13	0.3	0.1	0.3	99.3
14	0.0	0.1	0.2	99.7
15	0.1	0.1	0.4	99.4
16	0.0	0.1	0.3	99.6
17	1.4	1.3	1.2	96.1
18	7.7	2.5	3.6	86.2
19	0.3	0.4	0.6	98.7
20	1.0	0.6	2.0	96.4
21	0.3	0.2	0.4	99.1
22	0.0	0.1	0.1	99.8
23	0.2	0.3	0.3	99.2
24	0.1	0.1	0.7	99.1
25	2.0	1.8	1.8	94.4
26	3.8	1.1	2.3	92.8
27	17.8	5.5	7.9	68.8
28	12.8	1.0	1.1	85.2
29	0.6	0.4	0.6	98.4
30	0.3	0.3	0.2	99.2
31	0.2	0.3	0.4	99.1
32	0.4	0.4	0.6	98.6
33	3.5	2.0	2.4	92.1
34	3.7	2.6	2.8	90.9
35	0.8	0.4	0.5	98.3
36	0.4	0.6	0.8	98.2

APPENDIX III SEDIMENT SIZE DATA - 1975

Station	Sediment Size (% Retained on Mesh) 0.5 mm	0.25 mm	0.0625 mm	% Passing Through
PG-37	0.4	0.6	1.0	98.0
38	0.2	0.2	0.5	99.1
39	0.5	0.5	0.5	98.5
40	0.7	1.3	1.6	96.4
41	2.7	1.1	1.2	95.0
42	0.1	0.0	7.8	92.1
43	1.2	3.6	1.3	93.9
44	0.2	0.3	0.7	98.8
45	21.5	2.5	19.8	56.2
46	5.7	2.9	5.6	85.8
47	2.7	2.2	3.7	91.4
48	13.6	2.9	4.1	79.4
49	3.0	1.2	1.8	94.0
50	4.9	5.0	3.7	86.4

APPENDIX III SAMPLE DESCRIPTIONS - 1975

Station Number	Depth (m)	Total Volume (l)	Qualitative Physical Description of Benthic Sample
PG-1	220	25	Fine silt & clay. No odour. Free of debris.
PG-2	140	15	Fine silt & clay. No odour. Several large pieces of wood (2.5 x 13 cm). Pieces of wood bark. Unidentifiable small rusty objects. Clumps of "hardpan clay".
PG-3	100	11	Sandy. No odour. Many pieces of black wood-like material. Some oil droplets.
PG-4	150	15	Fine silt & clay. No odour. A few wood chips.
PG-5	180	20	Silt & clay. No odour. Free of debris.
PG-6	280	24	Fine silt & clay. No odour. Free of debris.
PG-7	230	24	Silt & clay. No odour. Free of debris.
PG-8	183	28	Silt & clay. No odour. Free of debris.
PG-9	250	19	Silt & clay. No odour. Free of debris.
PG-10	150	12	Silt & clay. Slight odour of decomposition. Unscreened sample contained many rocks & one rusty metal concretion attached to which were 3 teeth of unidentified origin. Screened sample (6 liter) contained 10 angular stones (2.5 x 15 cm). Several rust covered lumps (2.5 x 1 cm). Several pieces of wood debris (2.5 to 5 cm). Many broken pieces of shell. One 5 cm diameter jar cap. One small piece of porcelain tile and one coat button.
PG-11	140	12	Silt & clay. No odour. Scattered patches of black material consisting of a variety of wood debris; i.e.: chips, bark & slivers.
PG-12	175	19	Silt & clay. No odour. Free of debris.

APPENDIX III SAMPLE DESCRIPTIONS - 1975

Station Number	Depth (m)	Total Volume (l)	Qualitative Physical Description of Benthic Sample
PG-13	230	22	Silt & clay. No odour. Free of debris.
PG-14	260	26	Silt & clay. No odour. Free of debris.
PG-15	180	21	Silt & clay. No odour. Free of debris.
PG-16	240	17	Silt & clay & some sand. No odour. Free of debris.
PG-17	250	22	Silt & clay. No odour. Moderate amount of debris consisting of small rocks and sticks.
PG-18	183	15	Silt & clay. No odour. Several large rocks interspersed with many small angular stones.
PG-19	197	19	Silt & clay. No odour. Considerable amount of gravel like material with broken shell pieces. One fragment of pottery.
PG-20	180	19	Silt & clay. No odour. Many broken shell pieces.
PG-21	240	22	Silt & clay. No odour. Few pebbles.
PG-22	240	27	Silt & clay. No odour. Free of debris.
PG-23	220	24	Very fine silt & clay. No odour. Free of debris.
PG-24	240	18	Fine silt & clay. No odour. Free of debris.
PG-25	240	22	Fine silt & clay. No odour. Some debris consisting of pieces of bark, small stones, coarse sand and broken pieces of shell.
PG-26	230	21	Silt & clay. No odour. Many sticks, stones and broken shell pieces.
PG-27	210	3	Clay. No odour. Heterogeneous mixture of clay, woodchips, stones, bark and rusty metallic material.
PG-28	200	18	Silt & clay. No odour. Small pieces of stone, bark and glass.
PG-29	220	16	Silt & clay. No odour. Free of debris.

APPENDIX III SAMPLE DESCRIPTIONS - 1975

Station Number	Depth (m)	Total Volume (l)	Qualitative Physical Description of Benthic Sample
PG-30	240	19	Silt & clay. No odour. Some small debris.
PG-31	250	15	Silt & clay. No odour. Free of debris.
PG-32	240	19	Silt & clay. No odour. Free of debris.
PG-33	238	97	Fine silt. No odour. Small quantity of bark.
PG-34	238	13	Silt & clay. No odour. Free of debris.
PG-35	234	14	Silt & clay. No odour. Free of debris.
PG-36	240	14	Silt & clay. No odour. Free of debris.
PG-37	240	20	Silt & clay. No odour. Small rocks. Several lighter coloured clumps of mud-sand-gravel in the otherwise fine silt.
PG-38	240	15	Silt & clay. Slight odour of H_2S. Free of debris.
PG-39	247	18	Silt & clay. No odour. Free of debris.
PG-40	240	19	Silt & clay. No odour. Several pieces of sand-stone & rock chips (2.5 to 5 cm). Some gravel material.
PG-41	240	15	Silt & clay. No odour. Free of debris.
PG-42	50	14	Silt & sand. No odour. Free of debris.
PG-43	172	15	Silt & clay. No odour. Free of debris.
PG-44	150	21	Silt & clay. No odour. Free of debris except for 1 x bottle cap.
PG-45	137	11	Silt & clay. No odour. Some small pieces of wood debris and approximately 50 x angular stones (2.5 cm). 2 x pieces of ferrous concretion (5 cm). 1 x piece of thin sheet metal (2.5 x 8 cm). 1 x piece of cardboard (2.5 cm sq). 1 x iron spike (15 cm).

APPENDIX III SAMPLE DESCRIPTIONS - 1975

Station Number	Depth (m)	Total Volume (l)	Qualitative Physical Description of Benthic Sample
PG-46	97	16	Silt & clay. No odour. Large quantity of black wood chips.
PG-47	179	16	Silt & clay. No odour. Many broken shell pieces including several empty Mytilus sp shells.
PG-48	137	19	Silt & clay. No odour. Considerable amount of black wood chips.
PG-49	200	20	Silt & clay. No odour. Some stones. 1 x wood stick (30 x 4 x 2 cm). 1 x piece of teredo affected wood (5 x 5 cm).
PG-50	183	18	Silt & clay. No odour. Free of debris.

APPENDIX III SEDIMENT SIZE DATA - 1978

Station	Sediment Size (% retained on each screen) 0.5 mm	0.25 mm	0.0625 mm	< 0.0625
PG-1	4	2	2	92
2				
3	8	36	9	47
4	2	1	1	96
5	1	1	2	96
6	1	1	4	94
7	1	1	4	94
8	1	1	2	96
9	1	1	4	94
10	8	6	10	76
11	6	5	4	85
12	1	1	3	95
13	1	1	1	97
14	1	1	2	96
15	2	1	2	95
16	1	1	1	97
17	8	3	4	85
18	15	18	12	55
19	13	9	7	71
20	2	2	3	93
21	1	1	2	96
22	1	1	3	95
23	1	1	2	96
24	1	1	2	96
25	12	9	7	72
26	16	37	22	25
27	23	9	8	60
28	9	4	5	82
29	1	1	2	96
30	2	1	2	95
31	1	1	2	96
32	3	1	3	93
33	20	9	6	65

APPENDIX III SEDIMENT SIZE DATA - 1978

Station	Sediment Size (% retained on each screen) 0.5 mm	0.25 mm	0.0625 mm	< 0.0625
PG-34	14	8	10	68
35	14	13	8	65
36	3	4	3	90
37	2	1	3	94
38	1	2	4	93
39	1	1	1	97
40	10	3	2	85
41	6	4	4	86
43	1	1	2	92
44	3	1	4	92
45	27	7	8	58
46	5	9	10	76
47	5	3	7	85
48	7	18	9	66
49	32	10	11	47
50	11	12	13	64

APPENDIX III SAMPLE DESCRIPTIONS - GRABS - 1978

Station Number	Depth (m)	Total Volume (l)	Sediment Characteristics
PG-1	250	18	- fine grey clay - no gravel noted
PG-2	120	16	- fine silt and clay - some coarse particles - bits of ceramic - gravel and wood debris - brittle stars and tube worms present
PG-3	83	10	- sandy, considerable amount of wood debris - some broken shell fragments
PG-4	155	21	- mainly clay with a few small stones (1-2 cm) - very little retained on screen
PG-5	235	22	- fine grey clay with no debris
PG-6	299	21	- fine grey mud - no dumped material apparent
PG-7	241	21	- clean grey clay
PG-8	163	25	- clean grey clay, very little retained on screen after sieving - natural organic material only
PG-9	256	19	- fine grey clay with overlying brown sediment
PG-10	155	19	- clean grey clay with a sandy layer on top - some wood debris
PG-11	160	16	- mainly clay - wood debris (small pieces), piece of plastic, stone
PG-12	202	24	- clay, 9 stones (1-3 cm) - small amount of wood debris - little material retained on screen

APPENDIX III SAMPLE DESCRIPTIONS - GRABS - 1978

Station Number	Depth (m)	Total Volume (l)	Sediment Characteristics
PG-13	241	22	- fine grey clay - very little debris
PG-14	273	21	- fine grey clay
PG-15	224	20	- fine grey clay, very little retained on screen - natural organic material only
PG-16	178	25	- clay, very little retained on screen - natural organic material only
PG-17	249	22	- fine grey clay with a few wood chips
PG-18	190	21	- coarse sand, lots of reducing sediment (strong H_2S odour) - lots of woodchips, shells and debris - 1 piece of concrete
PG-19	199	15	- lots of wood debris (3 large pieces 10-15 cm) - 4-5 rocks (2 cm)
PG-20	215	22	- clay - small amount of wood debris
PG-21	245	21	- fine grey clay - very little debris
PG-22	250	24	- fine grey mud - no dumped material
PG-23	224	20	- clean grey clay, very little retained on screen - natural organic material only
PG-24	243	26	- clean grey clay, very little retained on screen - natural organic material only
PG-25	244	16	- fine grey clay with dredge spoil - wood debris, pieces of brick, rock, etc.

APPENDIX III SAMPLE DESCRIPTIONS - GRABS - 1978

Station Number	Depth (m)	Total Volume (l)	Sediment Characteristics
PG-26	235	12	- coarse sand, hard to sieve - wood chips
PG-27	215	18	- clay - moderate amount of wood debris, large wood pieces - small rocks
PG-28	226	26	- clay with a small amount of wood debris and shells plus natural organic material
PG-29	249	23	- fine grey clay - very little retained on sieve
PG-30	250	21	- fine mud - black sediment underlying surface
PG-31	234	25	- fine grey clay - very little material retained on sieve
PG-32	247	27	- fine grey clay with a few stones (2-4 cm)
PG-33	245	17	- fine grey clay, sand and lots of rock
PG-34	251	24	- woody material, shells, rock and rubble
PG-35	254	19	- clay, a few rock (2 cm) - small amount of woodchips
PG-36	234	23	- clay - large piece (22 cm) of concrete - small amount of wood debris
PG-37	251	25	- fine grey clay - lots of small shell fragments
PG-38	250	25	- fine grey clay - no dumped debris
PG-39	245	20	- clay, no rocks - very few wood chips

APPENDIX III SAMPLE DESCRIPTIONS - GRABS - 1978

Station Number	Depth (m)	Total Volume (l)	Sediment Characteristics
PG-40	247	24	- clay and 20 angular stones (1-6 cm) - otherwise little retained on screen
PG-41	248	20	- fine grey clay - some sand, rocks and wood debris
PG-43	161	19	- fine grey clay
PG-44	155	20	- fine grey clay - rocks, gravel, piece of sulphur, shells
PG-45	133	9	- coarse material - wood, shells, gravel
PG-46	110	16	- fine grey clay with rubble - lots of wood debris
PG-47	215	19	- fine grey clay - some wood debris and gravel
PG-48	134	10	- coarse material and fine silt - some wood debris and gravel
PG-49	242	13	- several large rocks (12.5x12.5x15 cm) - gravel, rocks and shells - wood debris
PG-50	197	19	- about 40% coarse material with the remainder being fine clay - gravel and some wood

APPENDIX III SAMPLE DESCRIPTIONS - CORES - 1978

Station Number	Depth (m)	Core Length (")	Description
PG-1	240	30	- fine consolidated clay
PG-2	128	63	- consolidated grey clay with small stones and sand on surface
PG-3	70	48	- sandy sediment especially the surface 8"
PG-4	145	50	- grey clay
PG-5	230	62	- grey clay
PG-6	305	65	- consolidated grey clay
PG-7	234	50	- consolidated grey clay
PG-8	182	76	- consolidated grey clay
PG-10	153	63	- some wood chips in top 3" - fine consolidated material - more black, reduced sediments than other cores
PG-18	201	67	- grey consolidated clay - some sand in top 2-3"
PG-25	250	59	- clay consolidated with a stone in the sediment surface - the stone appeared as if it had been dumped
PG-26	240	55	- the surface 3" of the core consisted of sand and wood debris as well as a piece of glass - the remainder was clay
PG-27	219	62	- fine grey clay, slightly coarser near surface
PG-28	227	67	- consolidated grey clay
PG-29	246	74	- consolidated grey clay
PG-30		57	- consolidated grey clay

APPENDIX III SAMPLE DESCRIPTIONS - CORES - 1978

Station Number	Depth (m)	Core Length (")	Description
PG-49	250	63	- consolidated grey clay
PG-50	185	52	- top 12" slightly coarser material - remainder consolidated grey clay

APPENDIX IV

SEDIMENT ORGANIC CARBON CONTENT

APPENDIX IV SEDIMENT ORGANIC CARBON CONTENT - 1975 & 1978

Station	Organic Carbon % (1975)	Organic Carbon % (1978)	Total Volatile Residue % (1978)	Station	Organic Carbon (% 1975)	Organic Carbon % (1978)	Total Volatile Residue (%) (1978)
PG-1	1.34	1.7	5.0	PG-26	1.37	0.76	3.3
PG-2	1.42	1.3		PG-27	1.58	1.5	5.8
PG-3	0.82	0.84	2.5	PG-28	1.47	1.6	5.7
PG-4	1.30	1.4	5.1	PG-29	1.52	1.9	5.8
PG-5	1.46	1.7	5.8	PG-30	1.47	1.6	
PG-6	1.54	1.8	6.3	PG-31	1.50	1.6	5.7
PG-7	1.42	1.6	5.6	PG-32	1.41	1.7	5.1
PG-8	1.37	1.7	5.7	PG-33	1.59	1.5	11.2
PG-9	1.47	1.6	5.6	PG-34	1.47	1.6	11.8
PG-10	1.30	2.0	5.0	PG-35	1.40	1.5	5.6
PG-11	1.35	1.9	5.2	PG-36	1.49	1.6	5.6
PG-12	1.41	1.7	5.8	PG-37	1.52	1.8	5.9
PG-13	1.56	1.8	5.9	PG-38	1.51	1.6	
PG-14	0.48	1.6	5.5	PG-39	1.57	1.9	5.5
PG-15	1.39	1.5	5.3	PG-40	1.46	1.9	5.6
PG-16	1.45	1.5		PG-41	1.47	1.9	5.7
PG-17	1.37	1.8	5.8	PG-42	0.86		
PG-18	1.24	2.8		PG-43	1.33	1.7	5.4
PG-19	1.43	1.7	4.9	PG-44	1.41	1.5	5.2
PG-20	1.61	1.8	5.9	PG-45	0.93	1.5	5.0
PG-21	1.51	1.7	6.0	PG-46	1.30	1.4	4.7
PG-22	1.49	1.8	6.3	PG-47	1.28	1.8	6.0
PG-23	1.38	1.6	5.5	PG-48	1.39	1.2	4.8
PG-24	1.46	2.1	5.7	PG-49	1.41	1.5	8.6
PG-25	1.41	2.0	4.7	PG-50	1.30	1.7	5.5

APPENDIX V

TRACE METAL CONCENTRATIONS

APPENDIX V TRACE METAL DATA - 1975 - GRAB SAMPLES

Station	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
1	14.8	48.5	3.7	360.6	50.7	17.9	107.3	L2.0	0.38
2	13.0	51.7	3.4	319.2	47.7	28.8	122.9	L2.0	0.29
3	11.5	37.1	3.0	285.4	43.3	13.8	89.1	L2.0	0.19
4	13.8	43.8	3.6	360.6	48.6	23.7	95.2	L2.0	0.26
5	12.5	38.5	3.5	330.5	44.6	17.7	96.9	L2.0	0.24
6	12.6	40.3	3.5	334.3	45.5	19.1	103.0	L2.0	0.27
7	13.6	43.5	3.7	356.8	51.6	20.8	109.0	L2.0	0.25
8	13.6	48.1	3.8	375.6	49.2	20.2	103.8	L2.0	0.30
9	12.5	44.9	3.9	394.4	45.6	18.1	106.4	L2.0	0.30
10	13.5	55.2	3.2	326.8	47.5	22.9	99.5	L2.0	0.38
11	12.3	45.3	3.6	368.1	45.7	16.5	106.4	L2.0	0.24
12	11.6	41.7	3.6	345.5	47.3	16.7	100.4	L2.0	0.27
13	15.8	39.9	3.4	240.4	48.4	13.7	103.8	L2.0	0.30
14	15.7	39.2	3.5	326.8	47.2	20.4	98.6	L2.0	0.36
15	15.3	44.2	3.6	345.5	49.6	19.9	105.6	L2.0	0.29
16	16.3	47.0	3.6	390.6	47.7	21.0	102.1	L2.0	0.30
17	15.8	45.6	3.8	338.0	47.6	25.0	114.2	L2.0	0.26
18	14.7	47.8	3.5	319.2	47.7	17.8	112.5	L2.0	0.24
19	16.9	44.2	3.7	315.5	48.7	21.1	112.5	L2.0	0.24
20	16.9	41.7	3.6	345.5	50.1	17.7	106.4	L2.0	0.26
21	14.2	39.9	3.7	349.3	44.6	10.9	99.5	L2.0	0.27
22	15.2	41.4	3.5	395.1	50.2	12.7	101.5	L2.0	
23	19.1	46.4	3.6	418.8	51.9	13.4	109.3	L2.0	0.29
24	16.3	48.6	3.5	438.5	51.8	17.0	110.2	L2.0	0.20
25	15.6	43.6	3.6	375.3	50.4	13.1	108.5	L2.0	0.48
26	14.8	43.6	3.5	363.5	49.6	18.2	105.0	L2.0	0.23
27	19.0	69.3	4.2	410.9	56.0	14.3	112.8	L2.0	0.26

L = less than

APPENDIX V TRACE METAL DATA - 1975 - GRAB SAMPLES

Station	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
28	16.7	42.1	3.5	379.3	51.2	13.7	105.0	L2.0	0.26
29	16.4	40.4	3.4	371.4	40.3	11.6	100.6	L2.0	0.41
30	15.4	41.1	3.4	399.0	49.1	17.9	108.5	L2.0	0.33
31	15.6	44.6	3.5	493.8	53.1	16.4	115.5	L2.0	0.27
32	15.7	47.1	3.7	462.2	51.0	20.2	112.8	L2.0	0.27
33	16.9	43.9	3.5	454.3	46.5	13.9	122.5	L2.0	0.33
34	15.9	42.9	3.6	355.6	47.9	17.7	105.0	L2.0	0.32
35	17.0	43.6	3.5	339.8	47.4	15.6	106.7	L2.0	0.42
36	16.6	43.6	3.5	359.5	49.3	13.3	107.6	L2.0	0.29
37	15.3	41.4	3.5	379.3	50.9	12.1	106.7	L2.0	0.26
38	16.7	41.1	3.4	375.3	53.6	16.5	101.5	L2.0	0.18
39	17.1	43.6	3.6	410.9	52.0	17.8	105.0	L2.0	0.24
40	17.5	43.6	3.6	410.9	51.4	16.9	105.0	L2.0	0.42
41	18.3	43.2	3.5	363.5	52.5	21.8	103.2	L2.0	0.27
42	16.0	38.6	3.0	335.8	50.7	9.5	87.5	L2.0	1.2
43	17.3	50.4	3.4	350.4	53.0	20.6	120.7	L2.0	0.30
44	15.4	49.7	3.3	338.9	53.5	14.5	107.2	L2.0	0.22
45	13.2	58.2	3.1	277.3	39.2	38.8	126.1	L2.0	0.38
46	13.8	50.4	3.3	338.9	52.7	19.9	105.4	L2.0	0.24
47	13.5	43.7	3.4	362.0	51.1	12.0	100.9	L2.0	0.26
48	13.7	48.3	3.4	354.3	54.6	26.9	108.1	L2.0	0.36
49	11.7	43.3	3.4	365.8	52.8	19.7	104.5	L2.0	0.27
50	12.4	47.2	3.5	369.7	51.9	22.3	115.3	L2.0	0.28

L = less than

APPENDIX V TRACE METAL DATA - 1975 - CORE SAMPLES

Station	Core Depth cm.	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
1	0	14.0	46.7	3.5	373.8	53.1	20.9	99.7	L2.0	0.178
	50	14.0	44.0	3.5	352.8	48.2	14.3	87.5	L2.0	0.145
	86	14.9	42.2	3.6	363.3	54.1	11.0	85.7	L2.0	0.143
2	0	13.3	53.5	3.2	331.9	48.9	23.1	104.3	L2.0	0.206
	50	13.3	46.7	3.4	335.4	47.6	16.1	95.0	L2.0	0.208
	79	14.7	45.6	3.5	356.3	52.4	15.2	88.5	L2.0	0.145
3	0	12.3	39.5	3.1	290.0	49.5	16.0	87.5	L2.0	0.148
	50	13.6	45.2	3.5	331.9	54.4	13.3	98.7	L2.0	0.311
	58	13.8	45.9	3.6	342.4	52.3	9.7	95.9	L2.0	0.148
4	0	12.5	43.7	3.6	335.4	47.7	11.2	97.8	L2.0	0.360
	50	13.1	43.3	3.6	314.4	50.5	12.6	99.7	L2.0	1.08
	69	12.0	44.4	3.7	338.9	49.2	15.0	102.4	L2.0	0.146
5	0	10.8	42.5	3.5	314.4	44.6	13.6	98.7	L2.0	0.149
	50	11.4	44.0	3.3	296.9	43.9	12.1	99.7	L2.0	L0.101
	81	10.9	40.3	3.5	290.0	40.1	9.8	95.0	L2.0	0.146
6	0	13.1	38.3	2.9	345.6	44.9	15.7	91.1	L2.0	0.148
	50	14.0	40.5	3.0	311.7	48.3	17.3	98.7	L2.0	0.145
	76	12.1	37.9	2.8	318.5	43.8	13.2	91.1	L2.0	0.200
7	0	13.9	44.6	2.9	328.6	48.7	17.5	104.4	L2.0	0.198
	50	13.9	42.0	3.0	338.8	50.5	14.3	98.7	L2.0	0.209
									L2.0	0.225
8	0	13.5	49.1	2.8	318.5	49.3	21.4	103.4	L2.0	0.232
	50	15.7	44.2	3.0	352.4	54.7	12.0	90.2	L2.0	0.212
	96	13.4	39.8	2.7	298.1	47.8	9.6	85.4	L2.0	L0.098
10	0	12.7	59.5	2.8	311.7	46.8	27.7	106.3	L2.0	0.148
	50	13.8	45.3	2.8	325.3	46.5	13.1	94.9	L2.0	0.208
	70	15.2	39.4	3.0	335.4	52.8	8.4	87.3	L2.0	0.146

L = less than

APPENDIX V TRACE METAL DATA - 1975 - CORE SAMPLES

Station	Core Depth cm.	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
18	0	14.3	43.1	2.9	315.1	51.5	17.7	95.8	L2.0	0.208
	50	15.0	40.5	3.1	311.7	48.7	11.0	92.1	L2.0	0.200
	75	15.7	39.0	3.0	321.9	50.2	11.9	87.3	L2.0	0.175
25	0	14.2	45.3	3.1	372.7	50.4	21.0	107.2	L2.0	0.261
	50	14.9	42.4	3.1	321.9	50.0	14.7	98.7	L2.0	0.208
	89	14.3	42.0	3.0	321.9	52.3	11.9	90.2	L2.0	0.202
26	0	13.1	42.7	3.0	301.5	50.0	22.2	109.1	L2.0	0.269
	50	14.4	41.2	3.5	290.6	49.5	11.7	93.9	L2.0	0.223
	77	14.1	39.0	3.1	311.4	49.7	10.2	86.4	L2.0	0.200
27	0	13.3	40.1	3.5	345.9	47.3	13.1	95.8	L2.0	0.225
	50	13.7	42.0	3.7	318.3	49.9	12.2	98.6	L2.0	0.198
	79	13.7	38.2	3.6	307.9	48.3	7.9	86.4	L2.0	0.206
28	0	14.1	55.5	3.6	325.2	46.9	16.9	98.6	L2.0	0.229
	50	13.0	41.2	3.4	297.5	45.0	10.6	91.1	L2.0	0.202
	57	13.4	38.6	3.6	307.9	41.4	9.1	91.1	L2.0	0.195
29	0	13.1	43.1	3.7	328.6	43.7	14.2	105.2	L2.0	0.202
	50	12.5	40.8	3.5	297.5	39.1	12.3	93.9	L2.0	0.173
	76	13.7	39.3	3.7	318.3	41.4	9.7	90.1	L2.0	0.141
30	0	13.9	42.0	3.6	342.5	46.1	11.8	98.6	L2.0	0.173
	50	13.1	37.8	3.6	283.7	43.3	14.3	88.3	L2.0	0.108
	79	14.7	39.3	3.7	304.4	42.9	13.7	84.5	L2.0	0.115
31	0	15.1	45.0	3.7	345.9	43.4	20.5	99.5	L2.0	0.160
	55	14.6	43.1	4.0	366.7	42.6	17.9	98.6	L2.0	0.173
32	0	14.3	50.6	3.8	377.1	42.9	19.3	101.4	L2.0	0.210
	50	14.4	43.5	3.8	356.3	41.7	16.3	87.3	L2.0	0.178
	58	13.7	40.5	3.8	352.9	44.4	12.7	84.5	L2.0	0.146

L = less than

APPENDIX V TRACE METAL DATA - 1975 - CORE SAMPLES

Station	Core Depth cm.	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
33	0	12.4	43.5	3.8	332.1	41.3	19.2	98.6	L2.0	0.202
	50	13.1	43.5	3.8	321.7	42.0	14.4	93.9	L2.0	0.145
	69	16.4	40.3	3.5	289.5	49.7	13.5	92.2	L2.0	0.143
34	0	15.1	42.2	3.4	317.1	49.8	22.8	101.4	L2.0	0.178
	50	15.4	40.7	3.5	303.3	51.6	14.1	94.0	L2.0	0.148
	77	15.5	39.2	3.6	296.4	49.9	12.9	88.5	L2.0	0.199
35	0	16.1	42.6	3.6	351.5	53.5	19.7	105.1	L2.0	0.261
	50	14.5	42.6	3.3	303.3	51.8	13.4	92.2	L2.0	0.206
	81	14.3	40.3	3.5	324.0	48.3	9.9	87.6	L2.0	0.178
36	0	14.5	43.3	3.6	324.0	49.7	13.5	101.4	L2.0	0.282
	50	15.4	40.7	3.6	320.5	50.9	11.6	92.2	L2.0	0.266
	86	16.4	42.4	3.5	306.7	49.9	13.6	92.2	L2.0	0.146
37	0	14.6	42.2	3.6	320.5	48.4	15.5	97.7	L2.0	0.266
	50	14.7	42.6	3.4	317.1	50.9	11.4	94.9	L2.0	0.210
	76	15.1	38.4	3.6	286.1	48.3	11.4	84.8	L2.0	0.116
38	0	14.5	43.3	3.6	324.0	50.3	17.1	98.6	L2.0	0.269
	50	14.1	42.2	3.6	320.5	48.4	10.0	99.5	L2.0	0.202
	76	13.7	42.6	3.5	324.0	49.0	10.4	88.5	L2.0	0.171
39	0	14.8	44.8	3.6	361.9	53.9	16.8	104.1	L2.0	0.176
	50	14.8	44.1	3.6	306.7	51.4	12.8	95.9	L2.0	0.149
	85	14.1	50.3	3.8	369.4	55.5	13.5	104.1	L2.0	L0.098
40	0	12.1	48.9	3.7	372.9	51.8	17.6	113.1	L2.0	0.210
	50	12.3	48.9	3.8	333.9	50.6	14.0	104.1	L2.0	0.145
	77	11.4	46.2	3.7	348.1	47.9	9.1	93.2	L2.0	0.115
41	0	14.6	46.0	3.5	330.9	52.4	25.4	106.9	L2.0	0.113
	50	14.6	42.9	3.5	320.5	47.9	16.7	92.2	L2.0	L0.095
	75	13.7	39.6	3.3	296.4	47.1	11.3	84.8	L2.0	L0.097

L = less than

APPENDIX V TRACE METAL DATA - 1975 - CORE SAMPLES

Station	Core Depth cm.	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
43	0	11.4	56.5	3.7	337.4	52.9	17.7	111.3	L2.0	0.146
	50	11.2	49.9	3.7	326.7	43.7	11.4	103.2	L2.0	0.118
	76	10.6	46.8	3.8	355.2	44.3	6.5	99.5	L2.0	0.210
44	0	10.9	53.0	3.4	291.2	49.6	18.8	105.9	L2.0	0.208
	50	10.3	45.5	3.8	291.2	45.0	7.9	95.0	L2.0	0.173
	85	12.2	47.5	3.8	337.4	53.2	4.3	92.3	L2.0	0.139
45	0	11.7	53.4	3.7	294.8	48.2	16.1	108.6	L2.0	0.206
	50	10.2	49.6	3.8	305.4	50.8	7.4	105.0	L2.0	0.173
	74	14.9	44.1	3.4	365.8	56.5	10.0	93.2	L2.0	0.209
46	0	10.4	43.7	3.2	326.7	46.2	14.7	103.2	L2.0	
	50	13.0	43.7	3.4	333.9	53.8	11.9	95.9	L2.0	0.195
	62	14.3	45.8	3.7	348.1	61.9	9.5	91.4	L2.0	0.229
47	0	12.2	47.5	3.4	316.1	52.0	20.1	113.1	L2.0	0.141
	50	12.3	42.0	3.4	323.2	52.2	11.5	92.3	L2.0	0.200
	74	12.0	44.8	3.8	355.2	54.7	10.7	94.1	L2.0	0.200
48	0	14.8	43.1	3.0	321.9	53.1	18.8	101.5	L2.0	0.173
	50	11.8	39.6	3.7	326.7	47.1	10.0	97.7	L2.0	L0.098
	75	12.8	43.1	3.7	348.1	55.2	7.4	92.3	L2.0	0.148
49	0	16.0	43.8	3.4	317.4	48.5	20.9	104.9	L2.0	0.146
	50	15.2	43.5	3.3	289.1	48.3	15.1	91.7	L2.0	0.141
	76	14.8	41.7	3.4	299.7	46.3	12.4	89.9	L2.0	0.149
50	0	14.6	43.5	3.3	317.4	45.1	20.1	101.4	L2.0	
	50	15.8	43.5	3.4	317.4	47.3	12.4	99.6	L2.0	0.151
	76	14.1	37.6	3.4	331.5	41.9	8.7	88.2	L2.0	0.180

L = less than

APPENDIX V TRACE METAL DATA - 1978 - GRAB SAMPLES

Station	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-1	14.217	43.066	2.612	340.529	38.389	14.601	97.452	L2.0	0.272
PG-2	13.861	51.994	2.649	329.031	39.306	25.517	105.571	L2.0	0.365
PG-3	12.777	38.294	2.637	321.286	37.356	14.099	87.923	L2.0	0.249
PG-4	14.658	44.807	2.581	348.837	40.982	18.983	116.348	L2.0	0.280
PG-5	12.756	37.385	2.490	330.413	38.581	13.398	96.119	L2.0	0.292
PG-6	13.485	37.486	2.783	356.838	38.895	13.018	96.826	L2.0	0.304
PG-7	13.590	40.620	2.670	343.331	38.196	13.878	101.653	L2.0	0.304
PG-8	13.527	45.674	2.692	347.682	40.592	18.334	103.904	L2.0	0.368
PG-9	12.341	41.094	2.461	355.542	36.782	16.614	95.829	L2.0	0.310
PG-10	14.364	45.483	2.629	338.876	39.451	20.672	99.335	L2.0	0.342
PG-11	14.343	45.399	2.611	327.026	39.281	49.283	99.293	L2.0	0.272
PG-12	14.008	39.760	2.504	324.276	38.461	15.525	91.461	L2.0	0.482
PG-13	12.154	36.522	2.577	312.379	34.644	12.797	87.277	L2.0	0.304
PG-14	12.528	39.882	2.771	349.607	38.846	13.618	95.621	L2.0	0.379
PG-15	13.381	41.465	2.632	364.129	38.919	15.606	97.702	L2.0	0.361
PG-16	14.364	44.997	2.601	372.803	40.567	16.412	99.923	L2.0	0.342
PG-17	13.193	44.490	2.571	389.073	38.461	18.658	100.513	L2.0	0.358
PG-18	10.688	35.802	1.923	268.601	29.466	18.800	79.786	L2.0	
PG-19	14.008	48.370	2.463	338.369	38.846	25.351	110.192	L2.0	0.295
PG-20	12.403	39.372	2.417	317.068	37.907	15.485	91.053	L2.0	0.310
PG-21	12.985	38.051	2.530	331.167	38.846	14.581	93.926	L2.0	0.358
PG-22	13.134	33.369	2.721	301.552	37.924	15.932	89.209	L2.0	0.272
PG-23	14.015	38.003	2.721	354.767	38.462	13.729	94.137	L2.0	0.310
PG-24	14.192	41.753	3.007	347.642	40.020	16.721	101.223	L2.0	0.368
PG-25	13.592	45.072	3.055	383.148	40.542	30.221	132.098	L2.0	0.394

L = less than

APPENDIX V TRACE METAL DATA - 1975 - GRAB SAMPLES

Station	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-26	11.701	29.442	2.625	308.647	37.857	12.107	76.517	L2.0	0.186
PG-27	11.979	36.091	2.721	361.863	38.171	17.109	129.927	L2.0	0.304
PG-28	12.977	35.575	2.959	329.933	38.732	13.732	94.018	L2.0	0.329
PG-29	13.082	34.550	3.007	333.481	39.160	15.453	92.037	L2.0	0.275
PG-30	14.298	38.584	3.198	354.767	41.865	15.932	98.989	L2.0	0.304
PG-31	14.758	40.721	3.007	365.410	41.590	15.932	105.453	L2.0	0.289
PG-32	14.139	46.038	3.103	397.339	42.025	21.646	123.951	L2.0	0.372
PG-33	13.627	53.088	3.055	368.958	40.929	22.593	283.705	L2.0	0.390
PG-34	13.680	34.897	2.864	344.124	37.164	21.504	93.541	L2.0	0.332
PG-35	12.906	38.584	2.768	333.481	38.193	21.220	95.013	L2.0	0.354
PG-36	13.064	36.590	3.007	322.838	38.935	18.276	94.814	L2.0	2.298
PG-37	14.121	36.849	3.007	33.481	38.260	14.159	94.787	L2.0	0.272
PG-38	13.768	37.425	3.007	337.029	40.519	16.458	97.980	L2.0	0.382
PG-39	14.989	39.942	3.055	361.863	41.020	16.179	97.618	L2.0	0.361
PG-40	13.381	38041	3.103	351.291	38.530	21.808	111.599	L2.0	0.368
PG-41	13.286	37.332	3.198	344.124	39.544	20.701	98.787	L2.0	0.347
PG-43	14.086	46.038	3.007	347.672	43.382	22.119	158.677	L2.0	0.386
PG-44	14.027	39.389	2.984	328.294	39.734	19.188	96.311	L2.0	0.332
PG-45	12.190	43.139	2.558	293.736	36.331	33.111	112.090	L2.0	0.275
PG-46	14.444	45.496	2.700	324.838	44.081	22.430	95.704	L2.0	0.295
PG-47	13.142	41.204	2.842	324.838	40.959	20.179	103.158	L2.0	0.323
PG-48	13.016	41.358	2.700	324.838	41.323	18.581	95.987	L2.0	0.365
PG-50	12.602	39.826	2.842	304.104	35.954	25.073	102.619	L2.0	0.906
PG-50	12.172	30.802	2.558	297.192	36.842	16.280	81.652	L2.0	0.552

L = less than

APPENDIX V TRACE METAL DATA - 1978 - CORE SAMPLES

Station	Core Depth (cm)	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-1	0	13.286	38.915	2.984	345.572	41.369	16.059	98.671	L2.0	0.740
	20	16.086	37.372	3.126	362.851	46.246	8.969	86.783	L2.0	0.775
	30	13.448	30.838	2.842	300.648	37.913	7.461	77.519	L2.0	0.725
	0	13.502	40.399	3.079	311.015	42.077	15.317	97.570	L2.0	0.733
	20	15.354	38.934	3.173	359.395	45.592	9.015	88.396	L2.0	0.685
	30	14.426	30.481	2.984	321.382	41.734	7.583	80.843	L2.0	0.674
PG-2	0	12.998	43.842	2.842	300.648	40.663	24.975	100.597	L2.0	0.903
	20	15.738	37.597	2.984	328.294	42.605	9.572	86.509	L2.0	0.839
	30	15.793	36.625	3.173	342.116	44.800	7.491	85.961	L2.0	0.779
PG-3	0	13.539	34.004	2.652	300.648	40.686	13.494	83.430	L2.0	0.685
	20	14.735	32.512	2.842	311.015	39.960	9.649	82.501	L2.0	0.636
	30	15.720	35.050	3.079	321.382	43.019	9.154	85.102	L2.0	0.633
PG-4	0	14.953	36.550	2.984	317.927	43.180	15.679	95.623	L2.0	0.698
	20	14.808	36.457	3.079	335.205	44.127	9.927	93.127	L2.0	0.761
	30	14.891	35.729	3.160	341.523	41.436	9.506	87.031	L2.0	0.712
PG-5	0	12.850	35.356	3.113	334.408	38.954	13.049	92.950	L2.0	0.596
	20	13.425	36.103	3.160	305.948	42.005	10.788	94.469	L2.0	0.712
	30	12.742	33.122	2.925	298.833	37.081	9.190	90.212	L2.0	0.712
PG-6	0	12.598	33.086	2.830	320.178	35.667	15.221	92.751	L2.0	0.740
	20	13.119	33.141	3.019	313.063	38.149	13.522	91.400	L2.0	0.661
	30	13.119	35.431	3.113	320.178	37.170	11.423	94.149	L2.0	0.746
PG-7	0	12.957	35.953	2.925	330.850	38.462	16.343	97.653	L2.0	0.698
	20	14.746	35.450	2.972	337.966	41.868	8.124	81.537	L2.0	0.648
	30	13.588	29.199	2.830	302.390	37.170	7.511	77.428	L2.0	0.596
PG-8	0	15.219	44.909	2.972	345.081	41.322	20.596	109.185	L2.0	0.712
	20	15.328	33.691	2.925	345.081	41.459	8.904	84.310	L2.0	0.688
	30	15.438	32.173	3.066	330.850	42.667	8.229	81.921	L2.0	0.624
PG-10	0	13.443	39.777	2.830	309.505	38.931	18.508	99.768	L2.0	0.307
	20	15.128	38.764	3.160	337.966	42.735	8.109	94.269	L2.0	0.192
	30	16.921	37.286	3.160	345.081	44.969	8.724	87.970	L2.0	0.331

L = less than

APPENDIX V TRACE METAL DATA - 1978 - CORE SAMPLES

Station	Core Depth (cm)	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-18	0	13.696	46.447	2.830	309.505	37.993	42.945	124.513	L2.0	0.182
	20	14.619	35.673	3.113	309.505	40.258	10.124	92.353	L2.0	0.179
	30	14.637	33.141	3.019	320.178	41.118	8.394	82.612	L2.0	0.303
PG-25	0	13.497	38.992	3.113	373.541	37.325	20.159	139.854	L2.0	0.366
	20	14.039	36.834	3.066	320.178	39.942	9.852	92.035	L2.0	0.340
	30	13.981	34.645	2.804	349.225	39.104	10.658	83.550	L2.0	0.327
PG-26	0	10.705	26.049	2.336	283.056	34.159	8.160	67.477	L2.0	0.321
	20	12.379	35.810	2.991	294.084	35.973	10.106	83.963	L2.0	0.327
	30	13.398	33.768	2.710	312.464	35.604	6.728	80.595	L2.0	0.308
PG-27	0	13.398	41.971	2.944	294.084	38.464	23.892	103.016	L2.0	0.373
	20	13.486	35.753	3.037	294.084	36.908	9.436	83.211	L2.0	0.341
	30	13.539	36.737	3.131	305.112	38.861	9.317	82.199	L2.0	0.380
PG-28	0	13.363	41.422	2.944	312.464	39.236	25.948	102.009	L2.0	0.394
	20	13.416	36.927	2.664	290.408	37.498	10.002	85.701	L2.0	0.303
	30	13.469	37.269	2.804	305.112	37.586	9.347	80.669	L2.0	0.381
PG-29	0	13.187	43.732	3.037	319.816	37.871	18.685	98.853	L2.0	0.380
	20	13.504	37.498	2.991	316.140	37.717	10.032	88.673	L2.0	0.374
	30	13.451	36.150	2.710	294.084	36.887	8.961	79.518	L2.0	0.380
PG-30	0	12.888	40.504	2.944	323.492	38.442	14.583	96.598	L2.0	0.373
	20	14.780	39.071	2.944	330.844	40.345	9.883	82.949	L2.0	0.380
	30	15.725	39.573	3.037	367.605	44.054	9.065	80.669	L2.0	0.458
PG-31										
	0	14.442	42.839	3.131	393.337	41.864	17.215	102.452	L2.0	0.321
	20	14.780	37.842	2.991	341.872	41.237	10.614	84.114	L2.0	0.550
	30	14.744	35.904	3.037	356.577	41.841	6.713	77.156	L2.0	0.491
PG-32										
	0	14.265	39.071	3.037	378.633	39.745	12.126	85.701	L2.0	0.530
	20	14.176	42.839	2.991	452.154	39.302	18.501	98.496	L2.0	0.803
	30	15.301	36.890	3.039	377.280	41.657	8.524	92.912	L2.0	0.540

L = less than

APPENDIX V TRACE METAL DATA - 1978 - CORE SAMPLES

Station	Core Depth (cm)	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-33	0	12.762	37.941	2.533	364.896	35.272	19.796	120.792	L2.0	0.540
	20	13.292	34.044	2.421	325.047	34.890	10.396	89.710	L2.0	0.561
	30	15.301	33.854	2.599	352.274	39.352	7.448	87.727	L2.0	0.572
PG-34	0	13.312	41.680	2.386	328.981	34.819	27.428	110.148	L2.0	0.419
	20	14.007	35.019	2.545	331.219	39.011	9.797	89.949	L2.0	0.461
	30	14.191	32.698	2.416	321.911	37.821	9.604	82.166	L2.0	0.587
PG-35	0	13.210	35.115	2.271	352.678	35.727	15.674	90.388	L2.0	0.359
	20	13.864	37.356	2.485	326.094	37.193	10.550	91.187	L2.0	0.424
	30	15.198	36.425	2.502	342.219	39.645	8.601	89.074	L2.0	0.424
PG-36	0	13.782	39.374	2.635	367.360	39.011	18.252	104.108	L2.0	0.484
	20	13.761	37.902	2.592	329.113	39.352	9.604	95.052	L2.0	0.466
	30	14.212	36.328	2.638	340.620	37.724	9.430	88.241	L2.0	0.330
PG-37	0	13.966	39.256	2.570	348.373	38.476	14.303	104.108	L2.0	0.613
	20	14.437	38.528	2.618	348.910	38.088	11.597	92.068	L2.0	0.458
	30	14.109	35.249	2.555	337.564	39.401	8.370	86.465	L2.0	0.441
PG-38	0	13.802	39.888	2.525	371.067	40.428	16.675	106.206	L2.0	0.685
	20	14.581	36.057	2.555	346.228	36.422	10.086	91.027	L2.0	0.806
	30	14.499	35.287	2.559	363.395	38.719	7.717	86.071	L2.0	0.685
PG-39	0	13.823	41.680	2.646	379.082	39.011	18.707	109.978	L2.0	1.23
	20	15.652	37.707	2.484	365.580	39.059	10.009	88.836	L2.0	0.685
	30	14.914	38.200	2.753	392.806	41.845	7.560	81.611	L2.0	0.673
PG-40	0	13.475	44.076	2.725	392.389	40.125	18.958	108.075	L2.0	0.839
	20	14.193	40.442	2.621	344.500	40.224	10.262	90.813	L2.0	0.725
	30	14.873	39.910	2.808	387.262	43.907	7.985	87.126	L2.0	0.552
PG-43	0	12.373	43.656	2.393	371.105	27.893	15.308	128.591	L2.0	0.578
	20	15.616	37.917	2.638	381.067	42.697	6.045	85.263	L2.0	0.428
	30	13.885	35.431	2.668	355.367	41.445	7.459	85.566	L2.0	0.397

L = less than

APPENDIX V TRACE METAL DATA - 1978 - CORE SAMPLES

Station	Core Depth (cm)	Co ug/g	Cu ug/g	Fe %	Mn ug/g	Ni ug/g	Pb ug/g	Zn ug/g	Cd ug/g	Hg ug/g
PG-44	0	14.317	46.573	2.500	340.556	40.548	18.251	102.094	L2.0	0.549
	20	14.811	34.915	2.564	351.907	42.949	8.574	82.848	L2.0	0.420
	30	13.803	34.321	2.578	346.742	41.470	7.479	84.430	L2.0	0.494
PG-45	0	13.066	46.211	2.408	329.865	39.728	25.618	103.871	L2.0	0.549
	20	15.038	39.869	2.626	364.077	40.971	10.507	87.775	L2.0	0.412
	30	15.699	37.433	2.578	3666.638	44.059	7.459	81.686	L2.0	0.420
PG-46	0	12.862	47.065	2.387	316.232	39.927	22.516	93.767	L2.0	0.569
	20	15.306	42.010	2.739	362.731	44.059	8.533	84.317	L2.0	0.426
	30	15.182	42.404	2.679	367.449	46.144	9.590	87.393	L2.0	0.466
PG-47	0	13.742	46.232	2.475	330.255	38.076	29.536	109.435	L2.0	0.518
	20	13.475	38.585	2.569	340.818	39.432	9.488	85.339	L2.0	0.528
	30	15.451	38.748	2.563	354.302	42.321	9.265	82.547	L2.0	0.321
PG-48	0	12.617	35.233	2.063	285.984	34.592	15.908	78.671	L2.0	0.494
	20	14.831	39.869	2.513	344.763	39.382	10.568	89.348	L2.0	0.539
	30	15.187	38.026	2.618	358.160	43.614	7.586	84.411	L2.0	0.343
PG-49	0	13.945	43.377	2.520	335.475	35.911	19.841	100.339	L2.0	0.342
	20	14.407	38.797	2.781	334.563	38.119	9.438	89.666	L2.0	0.380
	30	16.033	36.616	2.749	334.824	39.460	7.979	85.795	L2.0	0.286
PG-50	0	14.050	38.229	2.093	325.761	38.836	11.357	83.938	L2.0	0.438
	20	14.512	37.058	2.586	339.652	39.244	11.059	93.548	L2.0	0.455
	30	14.681	35.716	2.584	337.692	39.364	7.822	88.264	L2.0	0.402

L = less than

APPENDIX VI

ANALYSIS OF MARINE BENTHIC SAMPLES FROM THE POINT GREY DUMPSITE IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA

Analysis of Marine Benthic Samples from the Point Grey Dumpsite in the Strait of Georgia, British Columbia

by
Penny A. Christie

submitted to the Environmental Protection Service, Pacific Region in completion of Contract # 08SB.KE 114-8-1970.
October 1978

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
NEMERTEA	unidentified			3	1			1					2				1										
NEMATODA	unidentified				1																						
ANNELIDA Cl: Polychaeta	Polynoidae (unid.)			1	1				2		1													1	1		
	Phyllodocidae Eteone sp.										1																
	Hesionidae Gyptis brevipalpa				1	2					1									1				2		1	
	Pilargidae Sigambra tentaculata																						1				
	Syllidae Syllis sp. Exogone lourei Syllis heterochaeta									1								1									1
	Nephtyidae Nephtys incisa			2	1				2		3	4	1						2					2			1
	Sphaerodoridae Sphaerodoropsis sp.						1	1			1		1		1												3

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																			
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
NEMERTEA	unidentified		2							3					1									
NEMATODA	unidentified		1															1				1		
ANNELIDA Cl: Polychaeta	Polynoidae (unid.)									1								1		2		1	1	2
	Phyllodocidae Eteone sp.																							
	Hesionidae Gyptis brevipalpa			1						1			1	1	2				1			1		
	Pilargidae Sigambra tentaculata								1									1						1
	Syllidae Syllis sp.												1	1										
	Exogone lourei		1		1								2											
	Syllis heterochaeta				1																			
	Nephtyidae Nephtys incisa	1			1	1					1	1				2	1	1	2	1	2			2
	Sphaerodoridae Sphaerodoropsis sp.	1				1						2												

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Glyceridae																										
	Glycera capitata		2	8															1								
	Glycera tesselata			1			1										1			1							
	Goniadidae																										
	Goniada annulata																										
	Goniada brunnea																	1							1		
	Onuphidae																										
	Onuphis iridescens		1		1												1										1
	Lumbrineridae																										
	Ninoe gemmea																							1			
	Lumbrineris luti	1	1	3	11	1	1	1			4	5	5		1				1					1	3		1
	Lumbrineridae (unid.)			1	1					3										2							
	Orbinidae (unid.)			1																							
	Paraonidae																										
	Aricidea quadrilobata								1										1								
	Aricidea neosuecica			1					1		1					1		1									
	Tauberia gracilis		3		2	1		1			5	5		1				1		1							
	Spionidae																										
	Polydora giardi		1	1																							
	Polydora hamata																										
	Laonice cirrata		1	1																							

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																					
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
	Glyceridae																							
	Glycera capitata		1											1				1	1					
	Glycera tesselata							1	1											1			1	
	Goniadidae																							
	Goniada annulata			1																				
	Goniada brunnea																							
	Onuphidae																							
	Onuphis iridescens														1					1				
	Lumbrineridae																							
	Ninoe gemmea																			2				
	Lumbrineris luti	2		2	1	2				1	5	2	3	1	3	2	7	3	7	5	2	12	2	3
	Lumbrineridae (unid.)																		1					
	Orbinidae (unid.)																							
	Paraonidae																							
	Aricidea quadrilobata																							
	Aricidea neosuecica			2	2					1						1								
	Tauberia gracilis					1				2								4		1				
	Spionidae																							
	Polydora giardi																							
	Polydora hamata																		1					
	Laonice cirrata																							

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Glyceridae																										
	Prionospio steenstrupi		1			3		1																			
	Spiophanes berkleyorum												1	1	1					2	1					1	3
	Spionidae (unid.)					1																					
	Cirratulidae																										
	Tharyx multifilis																										
	Tharyx sp.											1	1														
	Cossuridae																										
	Cossura sp.										1																
	Ophellidae																										
	Travisia gigas											2						1			1	1				4	
	Disomidae																										
	Disoma franciscosum		1													1											
	Sternaspidae																										
	Sternaspis scutata	2		1		1												1			1				1	1	1
	Capitellidae																										
	Mediomastus sp.			2							1																
	Decamastus gracilis		1	22																							
	Heteromastus filiformis			1																							
	Notomastus sp.			1																							
	Maldanidae																										
	Rhodine bitorquata																										
	Asychis sp.																										

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																				
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
	Prionospio steenstrupi			1							1			1					3	2		2		
	Spiophanes berkeleyorum				2			2	2	2					1	1								
	Spionidae (unid.)																							
	Cirratulidae																							
	Tharyx multifilis																		2					
	Tharyx sp.																1	1	1	3			1	
	Cossuridae																							
	Cossura sp.																	1						
	Ophellidae																							
	Travisia gigas		1	1				1												1			1	
	Disomidae																							
	Disoma franciscosum													1					3	3				
	Sternaspidae																							
	Sternaspis scutata														1					2		1		1
	Capitellidae																							
	Mediomastus sp.									1		1							3					
	Decamstus gracilis																							
	Heteromastus filiformis										1								1					
	Notomastus sp.																							
	Maldanidae																							
	Rhodine bitorquata																	1						
	Asychis sp.																		2	1				

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Clymenura columbiana		3		1								1														
	Maldane glebifex			2	5	1					1		2							2							
	Maldanidae (unid.)	1	4	1	2				1		2		1		1			1			1			1			1
	Oweniidae																										
	Myriochele oculata			4		1					1						1							3			2
	Pectinariidae																										
	Pectinaria sp.										1													1			1
	Ampharetidae																										
	Scionella japonica																										1
	Amphicteis mucronata																										
	Amphicteis scaphobranchiata												1														
	Ampharetidae (unid.)			1																							
	Terebellidae (unid.)			3																							
	Tricobranchidae																										
	Terebellides stroemi			1		2						1							2	3							

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																				
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
	Clymenura columbiana																	3	4	4				
	Maldane glebifex		2																	2	15			3
	Maldanidae (unid.)	2			1			1		5	1					2	1		2	3	1	1		1
	Oweniidae																							
	Myriochele oculata		1															7	10	8		2		
	Pectinariidae																							
	Pectinaria sp.		1			1		1	1												1	1	1	
	Amparetidae																							
	Scionella japonica																				1			
	Amphicteis mucronata																			1				
	Amphicteis scaphobranchiata							1																
	Ampharetidae (unid.)		1										1											1
	Terebellidae (unid.)																							
	Tricobranchidae																							
	Terebellides stroemi	1						1	2		1							1	3	2	2	1		

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - 50 STATIONS SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
MOLLUSCA																											
Cl: Amphineura	Chaetoderma				1	2			1	1	1	1	1			2				1		1		1	1	1	
Cl: Gastropoda	Gastropod A																										
	Gastropod B																										
Cl: Bivalvia	Solemya sp.																		1								
	Nucula tenuis									2				1								1			1		
	Nuculana minuta			1																							
	Yoldia beringiana					1		1		1			1	1				2		1		1		1			
	Delectopecten sp.			1																							
	Parvilucina sp.			2																							
	Axinopsida serricata		1	4												1			1							
	Thyasira gouldii			2							1										1				1		
	Clinocardium sp.		1																								
	Psephidia lordi		1	4							1																
	Macoma sp.		1		1																						
	Cardiomya sp.																				1						
Cl: Scaphopoda	Dentalium sp.	1	1		2	1	2	1		3	1	1	3	4	2	2		3			1	2	1		2	1	
CRUSTACEA	Cumacea										1																
	Amphipoda			3	1	1					1		2					1	1								

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																					
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
MOLLUSCA																								
Cl: Amphineura	Chaetoderma									2						2	1		1		1	2	1	1
Cl: Gastropoda	Gastropod A	1																						
	Gastropod B															1								
Cl: Bivalvia	Solemya sp.																							
	Nucula tenuis								1		1			2		3								
	Nuculana minuta																							
	Yoldia beringiana					1			1					1	2				1				3	
	Delectopecten																							
	Parvilucina																							
	Axinopsida serricata																1			4				
	Thyasira gouldii											1	1											
	Clinocardium sp.																							
	Psephidia lordi																1	2	1	6				
	Macoma sp.						28															2		
	Cardiomya sp.																							
Cl: Scaphopoda	Dentalium sp.	2		2		1			5	1	1	2			1	4	5				4	1	1	1
CRUSTACEA	Cumacea																	1		1				
	Amphipoda		1			1			1		1					1	4	1	1	1		1		

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Decapoda *Spirontocaris* sp.				1																						
SIPUNCULA	unidentified			2				1		3				1		11	1	7		1	1		1	9	9	1	
ECHIURA	unidentified *Nellobia eusoma*																									1	
ECHINODERMATA Cl: Ophuroidea	unidentified		2	3				1		1	3					2	1					1		3	1	1	2
Cl: Echinoidea	*Brisaster latifrons*	1				1	1				1	1	1	3					1			2		1	2	1	1
Cl: Holothuroidea	*Chirodota* sp.				3	3					1		3	1	1		1										
	Molpadia intermedia		1		1	3	1					2	2	1		1			1	3		1	1	1		1	1

APPENDIX VI POINT GREY DUMPSITE BENTHIC GRAB STATIONS - SAMPLED APRIL 1978

Phylum, Class	Family, Genus, Species	Number of Invertebrates in Grab Sample - Station by Station																						
		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
	Decapoda *Spirontocaris* sp.																								
SIPUNCULA	unidentified				12	10		1			1		8	1	5				4	1			8		
ECHIURA	unidentified	1																							
	Nellobia eusoma																								
ECHINODERMATA Cl: Ophuroidea	unidentified					2				2		1			1	3			2	9	2		8	2	
Cl: Echinoidea	*Brisaster latifrons*				1			1	1		1	1		1						1					4
Cl: Holothuroidea	*Chirodota* sp.							3	2				1			1				2			2	2	1
	Molpadia intermedia	1		1				2	1	1								1			1	3	2	1	

APPENDIX VII

PISCES DIVE REPORTS

DIVE REPORT - POINT GREY

Pisces Dive #714
Point Grey
Track 1
November 27, 1978
Film exposed - 16 mm - film #1; 0' 20" on film #2
70 mm - film #1 frames 1-29

Observers - Packman
Holman

Water Column

On descent the water column was fairly clear with good visibility down to a depth of approximately 60 meters. Between 70 meters and 80 meters a zooplankton layer was encountered. The predominant zooplankters in this layer were pelagic amphipods and euphausids. At approximately 80 m this layer cleared somewhat while the concentration of detrital material increased. From 80 m to the bottom at 240 m the concentration of detrital material continued to increase while the concentration of zooplankton remained minimal. At 120 m a number of chaetognaths were encountered. As well a few pelagic fish resembling smelt were observed during the descent. Near the bottom the visibility dropped markedly due to the presence of detrital material, which may have been stirred up from the bottom by the relatively strong bottom currents in the Point Grey area. Pelagic Shrimp (*Pasiphea pacifica*) were observed near the bottom. The characteristics of the water column were similar on ascent.

Table 1 below depicts the readings obtained from the CTD probes on the exterior of the boat. Although the values obtained by the CTD had not at that time been compared with values obtained by more traditional methods, they were stable and of the same order of magnitude as would be expected. Therefore, it has been assumed that these values are reasonably accurate, especially in light of the fact that the instrument had just been serviced by the manufacturer.

TABLE 1 CTD READINGS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen mg/l)
140 m	8.4	32.65	7.88
186 m	8.58	32.92	7.73
227 m	8.7	33.25	7.0
239 m (bottom)	8.65	33.25	6.13
240 m (bottom)	8.6	33.23	6.3
167 m	8.4	32.72	7.1
157 m	8.4	32.69	7.26

Bottom Characteristics

The bottom characteristics were fairly constant throughout the dive with the dominant charcteristic being a layer of woodwaste intermingled with and lying on top of the normally soft Point Grey sediments. Clumps or piles of bark and wood debris were observed regularly as though they had remained intact through the water column after being dumped off the barge. Also apparent in some locations were patches containing various combinations of broken granite, gravel and hardpan clay. In some areas the bottom felt quite solid under the Pisces and little sediment was stirred up by the boat. This was felt to be due to

the packing down of wood debris over the normally fine Strait of Georgia sediments. Numerous logs were observed on the bottom as well as other anthropogenic items, such as pieces of steel cable, a piece of sheet metal and a plastic container. The number of holes in the bottom, from benthic infaunal burrowing, was felt to have been reduced from what would be termed "normal" in the Strait of Georgia. In general it was felt that the bottom was significantly disturbed from the natural situation.

Bottom Fauna

A list of the fauna observed as well as an indication of abundance is presented in Table 2. The dominant impression of the dive was that the bottom dwelling animals were not very abundant. A concerted attempt was made to count every animal in the field of view with the exception of the Nemerteans, which were too abundant. Therefore, although some animals may haver been missed in the counting process, the numbers in the "abundance" column are fairly accurate and give an indication of the low level of abundance.

Woodwastes appeared to have covered the bottom and this might be correlated with the small number of holes in the bottom from benthic infauna. It should be pointed out, however, that the abundant orange nemerteans were associated with woodwastes approximately 70% of the time. The anemones observed were associated with logs etc., exclusively, while the shrimp and rock fish (Sebastolobus alascanus) were often found near logs and clumps of debris. The gastropod Neptunea sp. was found almost exclusively on sunken logs.

TABLE 2 FAUNAL LIST

Taxon	Abundance
Nemertea	One of the most numerous faunal forms, often located on a piece of wood protruding from the bottom
Actinaria	
Unidentified	2 - throughout dive
Unidentified: (orange with white spots on column)	3 - throughout dive
Pachycerianthus sp.	3 - throughout dive
Gastropoda	
Unidentified	1 - throughout dive
Nudibranch (unidentified)	1 - throughout dive
Neptunea sp.	13 - throughout dive; mainly on logs
Echinoidea	
Unidentified	2
Ateroidea	
Ctenodiscus sp.	4
Mediaster sp.	3
Crustacea	
Pasiphea pacifica	present in water column just above bottom
Pandalopsis dispar (side stripe shrimp)	29 - throughout dive
Pandalus platyceros	3 - throughout dive
Unidientifed pink shrimp	19 - throughout dive
Munida quadrispina	2 - throughout dive
Spider crab (unidentified)	1 - throughout dive

continued...

TABLE 2 FAUNAL LIST
(continued)

Taxon	Abundance
Pisces	
Squalus acanthias (juvenile dogfish)	4 - throughout dive
Hydrolagus colliei (ratfish)	3 - throughout dive
Microgradus proximus (tomcodi)	1 - throughout dive
Zoarcidae	3 - throughout dive
Sebastolobus alascanus (short spine thornyhead)	9 - throughout dive
Pleuronectidae	2 - throughout dive

Conclusions

Evidence of dumped material was apparent throughout the dive. The most surprising observation made in the course of the dive was that wood and bark debris had travelled through the water column and landed on the bottom in remarkably large clumps and aggregations. It had previously been assumed that this type of material would disperse before it hit the bottom. The general impression derived from the dive was that the benthic epifauna and infauna had been reduced somewhat by the presence of dumped wood debris, however, this was only a qualitative impression.

DIVE REPORT - POINT GREY

Pisces Dive #715
Point Grey
Track 2
November 28, 1978
Film exposed - 16 mm - rolls 3 and 4
70 mm - film #1 frame 31-60

Observers - Packman
Brothers

Water Column

On descent the water column was fairly clear with good visibility down to a depth of approximately 80 meters. Between 90 meters and 130 meters a zooplankton layer was encountered. Zooplankton observed in this layer included ctenophores, pelagic amphipods, euphausids, some decapod larvae and the occasional smelt-like fish. Slightly below the defined zooplankton layer, at about 150 meters, some Chaetognaths and Siphonophores were observed. Below the zooplankton layer the concentration of detrital material became thicker to the point where visibility was reduced to approximately 8 feet near the bottom. The depth at the bottom was 240 meters. On ascent surface light was first observed at approximately the 100 meter depth.

Table 1 presents the observations of depth, temperature, conductivity and dissolved oxygen obtained with the CTD probes outside the Pisces.

TABLE 1 CTD READINGS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen mg/l)
0 m	6.6	26.62	11.1
84 m	8.6	32.5	8.1
133 m	8.5	32.6	8.2
200 m	8.5	33.0	7.9
240 m (bottom)	8.55	33.17	6.4
246 m (bottom)	8.5	33.18	6.43
244 m (bottom)	8.5	33.2	6.6
221 m	8.5	33.1	6.4
194 m	8.5	33.1	6.4
115 m	8.9	33.1	6.6
100 m	8.5	32.5	6.8
65 m	9.2	33.0	6.2
29 m	9.4	32.8	5.1
18 m	9.3	31.9	5.8

Bottom Characteristics

The bottom characteristics were observed to be a light mud with a fair bit of wood waste and construction material mixed in. Patches of gravel, logs and clumps of wood debris were observed at intervals throught the dive. The clumps or piles of wood debris increased in frequency towards the end of the track. This was not surprising as the end of Track 2 was in close proximity to the end of Track 1 where these were observed. On occasion the bottom felt very firm under the skids of the Pisces, indicating that the normally soft sediments may have been strengthened with dumped material. Two unusual items observed during the dive were a piece of chain with a rope attached and a piece of scrap metal.

It generally appeared as though there were few holes in the bottom from infaunal burrowing. The presence of infaunal burrowers may have been reduced by dumping activities.

Bottom Fauna

The bottom fauna was generally sparse, having a fairly uniform composition throughout the dive. A list of the fauna noted is presented in Table 2. The dominant feature noted in the dive was the apparent lack of infaunal burrowing organisms. This was assumed to be associated with the changed bottom sediments stemming from ocean dumping activities. Organisms such as Neptunea sp., the unidentified orange anenome with white spots on the trunk, pink shrimp and Sebastolobus alascanus (short spine thornyhead) were often observed in assocation with logs or wood debris which appeared to have been there for a period of time.

It should be noted that, although there existed a fair proportion of wood waste in the sediments, there was no corresponding reduction in dissolved oxygen concentration as measured by the CTD unit on the exterior of the Pisces.

Conclusions

The bottom characteristics noted in Track 2 were very similar to those noted in Track 1, which was not surprising as they were located very close to each other. Dumped material was quite evident throughout the dive. Towards the end of the dive wood wastes were noted in piles as though they had remained intact throughout the water column after being dumped from the barge. The benthic infauna appeared to be relatively sparse. Shrimp were often found in association with sunken logs but not exclusively. Dumped material appeared to be having a qualitative impact upon the bottom characteristics.

TABLE 2 FAUNAL LIST

Taxon		Relative abundance on a scale 1-10	
Nemertea		10	
Actinaria	- *Pachycerianthus* sp.	5	
	- unidentified - orange with white spots on trunk	7	
	- unidentifed	2	
Gastropoda	- *Neptunea* sp.	5	abundant on logs
	- unidentified	1	
Asteroidea	- *Mediaster* sp.	4	
	- *Ctenodiscus* sp.	4	
Crustacea	- *Pasiphea pacifica*	3	
	- *Pandaolpsis dispar*	7	
	- unidentified pink shrimp	5	
	- *Munida quadrispina*	1	
	- *Crangon* sp.	1	
Pisces	- *Hydrolagus colliei*	3	
	- *Squalus acanthias* (juvenile)	1	
	- Herring type	1	
	- Zoarcidae	1	
	- *Sebastolobus alascanus*	5	
	- Pleuronectidae	2	

DIVE REPORT - POINT GREY

Pisces Dive #716
Point Grey
Track 3
November 28, 1978
Film exposed - 16 mm - roll #5
70 mm - film #2 frame 1-34

Observers - Packman
Brothers

Water Column

From the surface to a depth of approximately 85 meters the water column was fairly clear with not much plankton and not much detritus. At 85 meters a zooplankton layer began, being composed mainly of pelagic amphipods, chaetognaths and euphausids. This zooplankton layer extended to approximately 130 meters. At 100 meters six dogfish (Squalus acanthias) were observed swimming around the boat, while at 120 meters a fish, which appeared to be a smelt, was observed. At 140 meters and 200 meters some small smelt-like fish, a few decapod larvae, some juvenile squid and siphonophores were observed.

As the bottom was approached the amount of detritus in the water column increased such that at the bottom (250 meters) the visibility was in the order of 6 feet. A current at a rate of approximately 0.5 knots was present on the bottom.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen mg/l)
25 m	9.1	32.16	9.9(may be suspect)
90 m	8.9	32.8	7.8
123 m	8.6	32.8	8.1
140 m	8.7	32.9	7.9
175 m	8.6	33.0	7.8
250 m (bottom)	8.4	33.0	7.0
248 m (bottom)	6.85	33.16	6.85

Bottom Characteristics

The bottom throughout Track 3 was a soft mud bottom typical of the Strait of Georgia. The occasional bit of woodwaste and hardpan clay was observed but not in nearly the same quantities as observed on Tracks 1 and 2. Logs were also noted intermittently, some of which were covered with sediment. Throughout the dive the number of infaunal holes in the sediment was approximately 5 per square meter. One of the prime reasons for diving at this location was to attempt to observe a number of concrete pipes whcich had been dumped two years previously. One of these pipes was located and inspected. It was protruding from the mud at approximately a 20 degree angle and buried in the mud for approximately 2/3 of its length. It was covered with a light dusting of silt and detritus.

Bottom Fauna

The bottom fauna observed on Track 3 was felt to be typical of a soft mud bottom in the Strait of Georgia. The taxa noted on this track are listed in Table 2. The fauna was evenly distributed throughout the dive with the number of holes from benthic infauna being of the

order of 5 per square meter. The predominant epifaunal forms were nemerteans, burrowing anemones (Pachycerianthus sp.) unidentified orange anemones with white spots on the column, Mediaster sp., sidestripe shrimp (Pandalopsis dispar), unidentified pink shrimp and the short-spine thornyhead rockfish (Sebastolobus alascanus).

Very little fauna was noted associated with the concrete pipe. The total life associated with the pipe was an unidentified orange anemone with white spots on the trunk, two Neptunea sp., one Neptunea sp. egg mass, one Munida quadrispina, two unidentified pink shrimp, one Sebastolobus alasacanus and a grey cod (Gadus macrocephalus).

Conclusions

The bottom throughout the dive was relatively unaffected by dumped material, indicating that that portion of the dumpsite is not used very frequently. The concrete pipes had not been extensively colonized since their deposition two years ago. Generally speaking, there did not appear to ba a high degree of biological productivity in the form of epifauna in this area.

TABLE 2 FAUNAL LIST

Taxon		Abundance
Nemertea		- fairly common throughout dive
Actinaria	- unidentified - orange with trunk with white spots	- fairly common throughout dive - mainly on logs, some of soft sediment
	- *Pachycerianthus* sp.	- fairly common throughout dive
Gastropoda	- *Neptunea* sp.	- present on most logs and occasionally on soft substrate
	Nudibranchia	- 2 noted during dive
Asteroidea	- *Mediaster* sp.	- fairly common throughout dive
Crustacea	- *Pasiphea pacifica*	- occasionally noted
	Pandaolpsis dispar	- most common animal
	Pandalus platyceros	- 1 noted
	unidentified pink shrimp	- second most common faunal form
	Crangon sp.	- fairly common throughout dive
	Pagurus sp.	- 2 noted
	Tanner Crab	- 1 noted
Pisces	- *Hydrolagus colliei*	- 1 noted
	Squalus acanthias	- 1 noted
	Gadus macrocephalus	- 2 noted
	Zoarcidae	- 3 noted
	Sebastolobus alascanus	- 3 noted
	Anoplopoma fimbria	- 1 noted
	Pleuronectidae	- 2 noted

DIVE REPORT - POINT GREY

Pisces Dive #718
Point Grey
Track 4
November 29, 1978
Film exposed - 16 mm - roll #9
70 mm - film #3 frame 0

Observers - Packman
Holman

Water Column

On descent through the water column the visibility was good to a depth of about 80 meters. Up to that depth very little zooplankton or detritus was apparent other than a few copepods noted at 50 meters. A fish approximately 10 inches in length, which was presumed to be a smelt, was noted at approximately 60 meters.

At 90 meters a zooplankton layer was encountered which contained pelagic amphipods, euphausids, the occasional decapod larva, as well as a few smelts. At 130 meters the zooplankton layer was noted to have thinned out considerably while the concentration of detritus increased and continued to increase until the bottom was reached. Pelagic shrimp (Pasiphea pacifica) were observed from 150 meteres down to the bottom at 160 meters.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen mg/l)
Surface	7.5	28.7	11.6
10 m	8.2	30.47	11.38
40 m	9.6	33.1	7.2
57 m	9.6	33.2	6.8
90 m	8.5	33.5	8.4
150 m	8.5	32.9	8.0
160 m (bottom)	8.46	32.9	7.7
158 m (bottom)	8.46	32.9	7.7

Bottom Characteristics

The substrate at Track 4 was generally a sandy material with a considerable quantity of woodwaste mixed in. The woodwastes occasionally occurred in piles as though dumped from a barge, remaining intact through the water column. Other material observed on the bottom included an occasional log, pieces of cable, a tire and pieces of concrete. Very few infaunal holes were observed in the substrate.

Bottom Fauna

Brittle stars (Ophiuroidea) were the dominant member of the benthic community at this location with 30-50 individuals being present in a square meter. The community was basically epifaunal due to the compact nature of the sandy substrate. An outline of the fauna noted is presented in Table 2. The presence of woodwastes did not appear to be exerting a terribly significant impact on the benthic community as it appears as if the community was already epifaunal in nature. Faunal forms other than brittle stars were quite limited in number.

Neptunea sp. were noted in abundance on certain logs (16 on one log) and occasionally on the sandy substrate.

TABLE 2 FAUNAL LIST

Taxon		Abundance
Actinaria	- *Metridium senile*	- noted occasionally
	Pachycerianthus sp.	- noted occasionally
	Unidentified - (orange with white spots)	- noted occasionally
Gastropoda	- *Neptunea* sp.	- 16 observed on one log; Seen occaionally out on sand but mainly on logs
Crustacea	- *Pandaolpsis dispar*	- Second most abundant form found after Ophiuroidea
	Unidentified pink shrimp	- Most abundant form found after Ophiuroidea
	Unidentified Decorator Crab	- 1 noted
	Unidentified Hermit Crab	- 1 noted
Ophiuroidea		- 30-50 individuals per square meter
Pisces	- *Hydrolagus colliei*	- 3 noted
	Gadus macrocephalus	- 1 noted
	Theragra chalcogramma	- 1 noted
	Ophion elongatus	- 1 noted
	Sebastolobus alascanus	- 1 noted
	Pleuronectidae	- 2 noted

Conclusions

The substrate at Track 4 was sandy in nature resulting in the fact that the community was basically epifaunal. Brittle stars (Ophiuroidea) were the dominant faunal form, with approximately 30-50 individuals being present in a square meter. Some woodwastes were noted indicating that dumping is occurring before the barges reach the designated dumpsite. The dissolved oxygen concentration, as measured by the CTD unit, was not depressed as a result of the presence of woodwastes. There appeared to be an impact on the bottom community at this site however, it was not as dramatic as at other dive sites around the dumpsite.

DIVE REPORT - POINT GREY

Pisces Dive #717
Point Grey
Track 5
November 29, 1978
Film exposed - 16 mm - rolls #6, 7 and 8
70 mm - film #2 frames 35-70

Observers - Packman
Holman

Water Column

The water column on descent was clear of detritus and zooplankton to a depth of approximately 80 meters. A zooplankton layer was present extending from 80 m - 110 m. The dominant zooplankters in this layer were pelagic amphipods and euphausids. At 110 m the defined zooplankton layer cleared leaving the water fairly clear as little detritus was present. At 122 meters a siphonophore, decapod larvae and chaetognaths were noted. A siphonphore was also noted at 170 meters. At 160 meters the concentration of detritus increased and kept increasing until the bottom was reached, where the visibility was poor.

The water column characteristics as determined by the CTD are presented in Table 1. These data indicate that the dissolved oxygen near the bottom was not depleted.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen mg/l)
0 m	7.3	28.5	11.5
30 m	9.5	32.4	8.6
65 m	9.35	33.1	7.2
168 m	8.48	32.8	8.1
190 m	8.5	32.9	7.1
195 m (bottom)	8.46	32.99	6.8
194 m (bottom)	8.46	32.95	6.9
190 m (bottom)	8.45	32.9	7.6
189 m (bottom)	8.46	32.9	7.9
187 m (bottom)	8.46	32.93	7.32
182 m	8.0	32.9	6.6

Bottom Characteristics

At the beginning of the dive, the bottom consisted of a fairly clean soft sediment with a small amount of woodwaste and some hardpan mixed in. Occasional logs were also encountered. There were approximately 5-10 holes per square meter and some worm casting on the sediment. These conditions extended along the first leg of the dive.

At approximately the first bend in Track 5 the wood debris began to occur in small concentrations and steel bands from bundle booming were encountered. In one instance a considerable pile of steel bands was observed, indicating that the woody material in the nearby sediments had probably originated from log pond dredging. At a point 1.8 cables north of the dive site, the sediment became lighter in consistency and darker in colour, indicating a reducing type of sediment. The number of holes in the sediment was significantly reduced here and the bottom was noted as being quite degraded.

During the final stages of Track 5, the proportion of woody debris increased again. In this area a lot of shell debris was mixed in with dredged material with not much of a silt cover. INfaunal burrows here were virtually non-exitent. Logs were also common in this area.

Bottom fauna

Table 2 presents a list of the fauna observed during Track 5. At the beginning of the dive a fairly "normal" soft bottom community was observed. The dominant animals in this community include side-stripe shrimp (Pandalopsis dispar) , unidentified pink shrimp and small shrimp which were either juvenile pinks or a small shrimp species. The large gastropod, Neptunea sp., was noted in abundance on sunken logs, presumably feeding on the white bacterial slime on these logs.

During the last 1/3 of the dive the number of infaunal holes decreased rapidly to the point where there were virtually none. This was observed to be concurrent with the increasing concentration of wood-wastes in the sediments and their more reducing nature. Mixed in with these degraded sediments were a fair number of broken bivalve shells which may have been killed in situ but were more likely deposited with the dredged material. In general, faunal colonization in the area of these degraded sediments was decreased markedly.

Conclusions

During the last 1/3 of Track 5, in the area on a line between the North Arm of the Fraser River and the dumpsite, the sediments were observed to be quite degraded, having a high concentration of woodwaste in them and having the appearance of reducing sediments.

The dissolved oxygen in the bottom water adjacent to these sediments was not depressed, however, according to the reading of the CTD unit. Biological activity was much reduced where the sediments were degraded, with infaunal burrows being almost non-existent.

TABLE 2 FAUNAL LIST

Taxon		Abundance
Nemertea		- fairly common
Actinaria	- *Pachycerianthus* sp.	- fairly common
	- Unidentified orange anemone with white spots on trunk	- fairly common,
Gastropoda	- *Neptunea* sp.	- on logs and in open - eggs on some logs
	- *Fusitriton* sp.	- 1 noted
Holothuroidea		
	- *Chirodota* sp.	- The present of CHirodota sp. was noted but abundance not obtained due to its infaunal nature
Asteroidea	- *Ctenodiscus* sp.	- fairly common
	- *Mediaster* sp.	- 1 noted
Echinoidea		- 1 noted
Crustacea	- *Pandaolpsis platyceros*	- 10 noted
	- *Pandalopsis dispar*	- common
	- Unidentified pink shrimp	- common
	- Unidentified juvenile shrimp (or smaller species)	- 1-2 individuals per square meter except in extremely degraded area
	- Unidentified *Crangon* sp.	- present but no indication od abundance
	- *Munida quadrispina*	- fairly common
	- *Pagurus* sp.	- fairly common
	- Tanner crab	- 8 noted

continued...

TABLE 2 FAUNAL LIST
(continued)

Taxon		Abundance
Pisces	- *Squalus acanthias* (juvenile)	- 9 noted
	- *Squalus acanthias* (adult)	- 1 noted
	- *Hydrolagus colliei*	- 4 noted
	- *Microgadus proximus*	- 3 noted
	- Stichaeidae	- 1 noted
	- *Sebastes* sp.	- 1 noted
	- *Sebastolobus alascanus*	- 14 noted
	Pleuronectidae	- 12 noted

APPENDIX VIII

PLATES

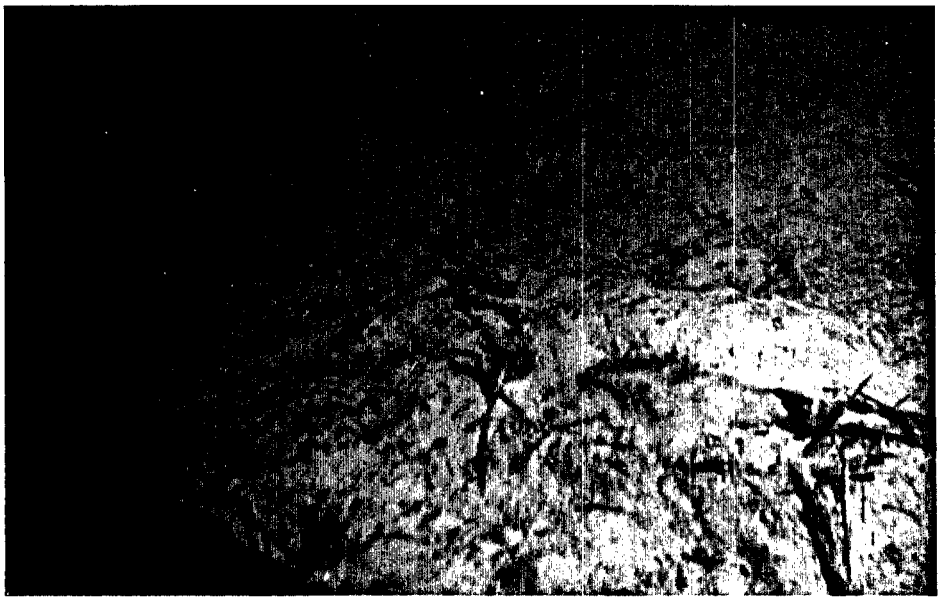

PLATE 1

Typical substrate throughout Track #1. Note layer of woodwaste mixed with sediments and paucity of infaunal burrows.

PLATE 2

Typical pile of wood debris which has remained intact through the water column as observed during Track #1.

PLATE 3

Log observed on bottom during Track #1. Note prawn and large gastropod associated with Log.

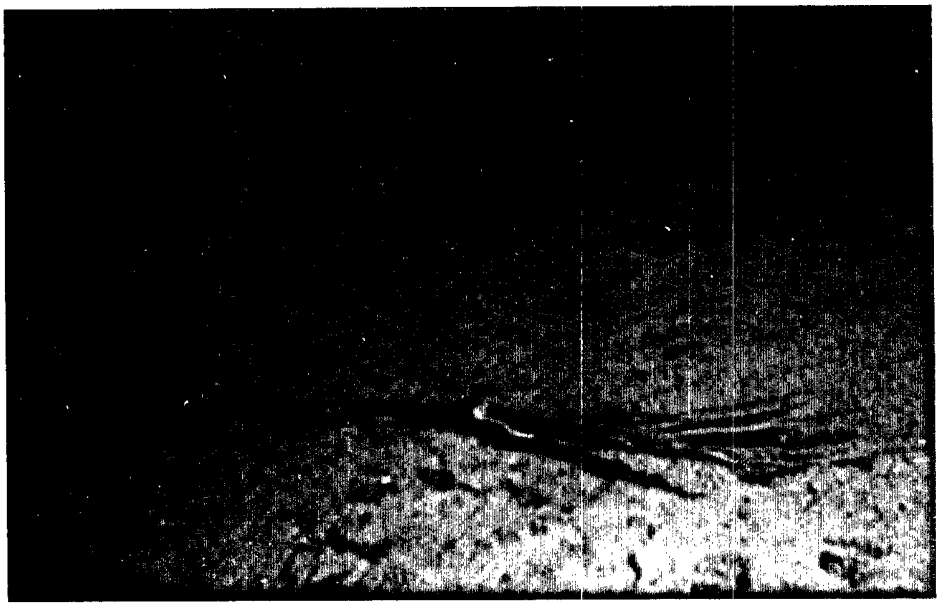

PLATE 4

The orange nemertean, centre was the most abundant animal observed on Track #1 and was usually associated with woodwastes.

PLATE 5

Substrate, Track #2, showing gravel etc. mixed with natural sediments, and lack of infaunal burrows.

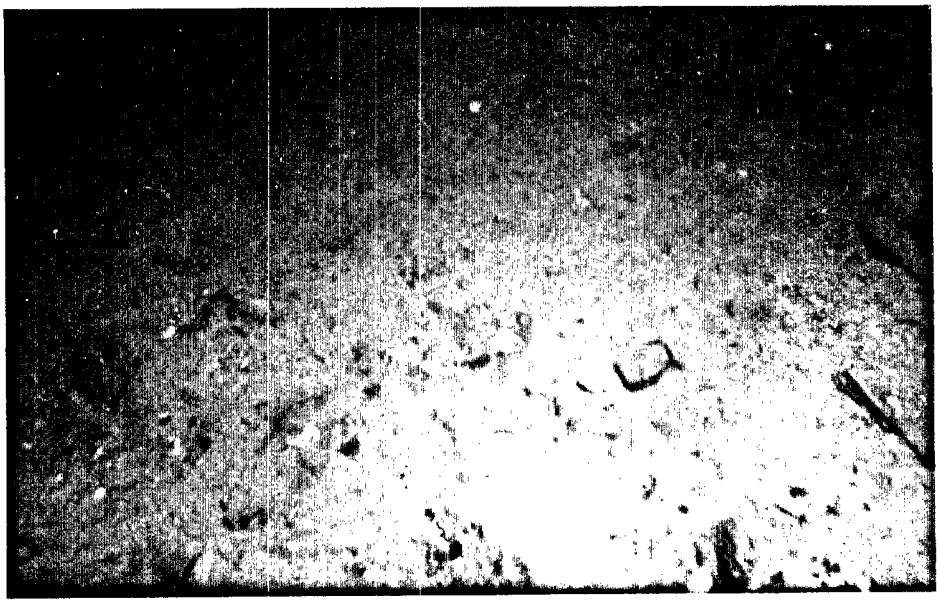

PLATE 6

Clump of wood debris typical of the latter portion of Track #2.

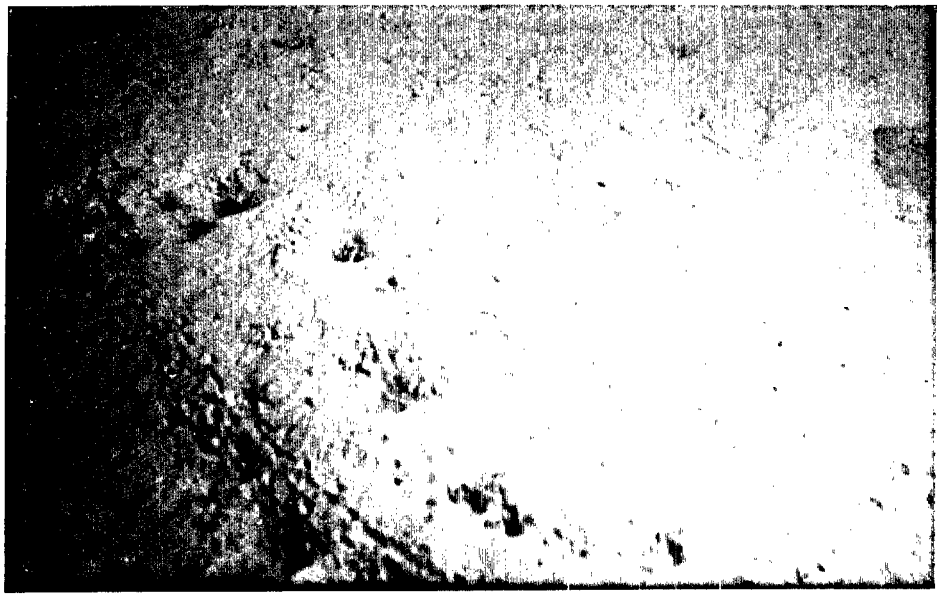

PLATE 7

Undisturbed sediment typical of the Strait of Georgia near the Fraser River, Track #3.

PLATE 8

Concrete pipe, Track #3. The pipe was dumped on January 12, 1977 and as of November 28, 1978 no colonization was apparent.

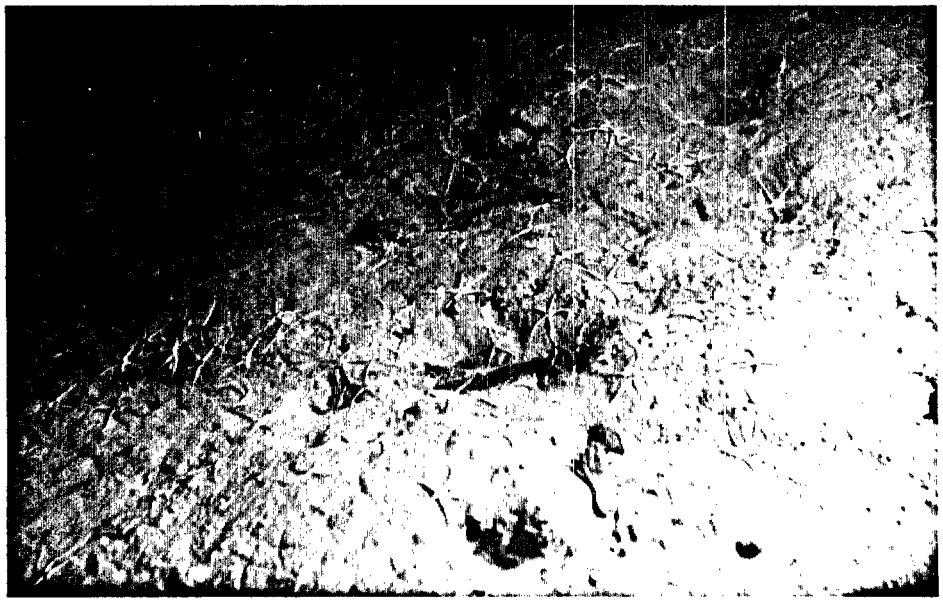

PLATE 9

High density of brittle starfish (Ophiuroidea) and compact substrate, typical of the terrain covered in Track #4.

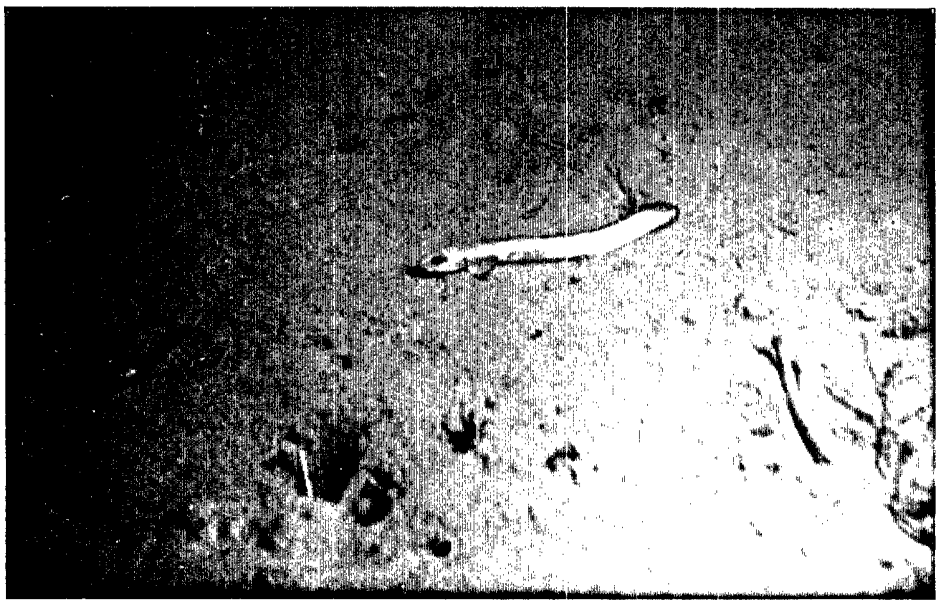

PLATE 10

Relatively undisturbed bottom Track #5, south of a line between the end of the North Arm Jetty and the dumpsite. Animals include a pink shrimp (Pandalus sp.) and a black belly eelpout (Lycodopsis pacifica).

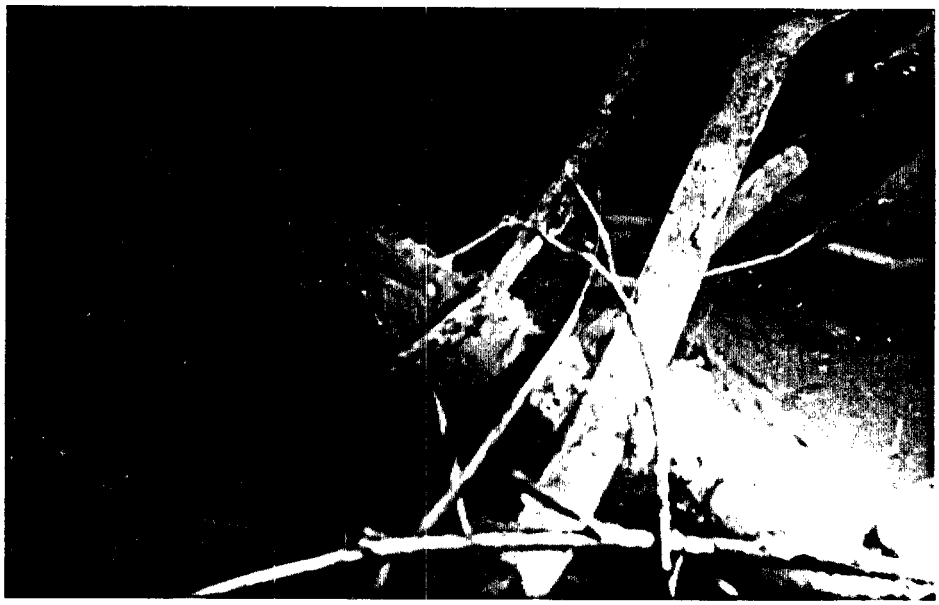

PLATE 11

Steel bands, used in bundling of logs, Track #5.

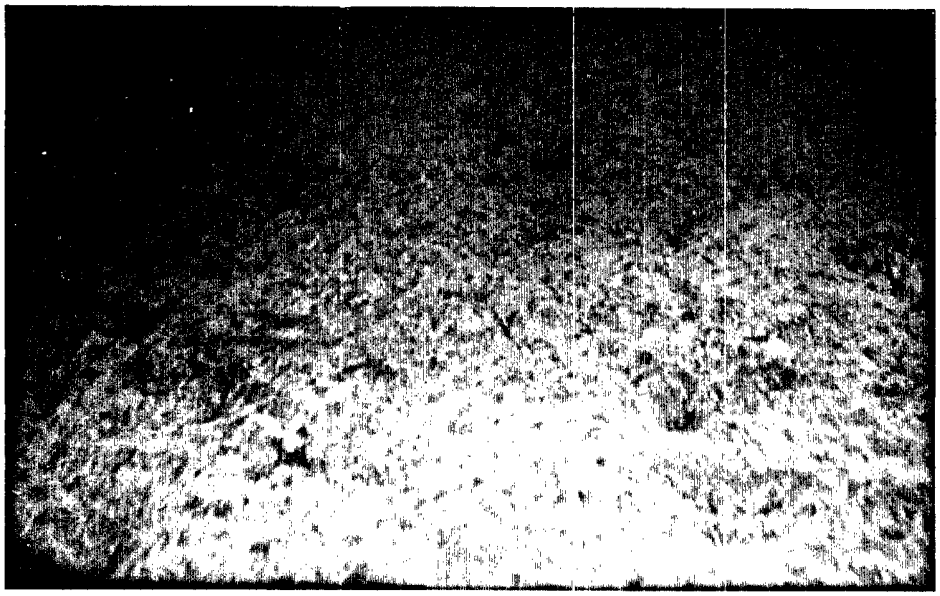

PLATE 12

Dark reducing sediments with a high woodwaste composition, prevalent between the end of the North Arm Jetty and the Point Grey dumpsite. Note the reduced number of infaunal burrows.