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GEOTHERMAL SERVICE OF CANADA

A Survey of Seabottom Temperatures and Salinities in
Barrow Strait

John Collier and Alan Judge

34 pp. including figures
Price \$ 10.00

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ABSTRACT

A survey of both summer and winter bottom water temperatures and salinities has been undertaken in the Barrow Strait region of the Canadian Arctic Islands. Data are available at 335 stations and contoured maps have been prepared showing the temperature and salinity distributions. In general, bottom water temperatures are negative above a water depth of 400m and in certain areas persist to below 600m. Bottom water salinities increase with depth to below 600m. The results suggest the presence of several major currents on the sea floor in the region flowing generally from west to east and from the Barrow Strait-Lancaster Sound area into the surrounding inlets.

RÉSUMÉ

Une enquête a été entreprise dans la région du détroit de Barrow dans les îles de l'Arctique canadienne, pour mesurer la température et la salinité de l'eau du fond de la mer en été et en hiver. Des données pour 335 endroits sont disponibles et des cartes en courbes de niveau ont été préparées qui montrent les distributions de la température et de la salinité. En général, les températures de l'eau du fond sont négatives au dessus d'un fond de 400 mètres et dans certains endroits elles persistent jusqu'en dessous de 600 mètres. La salinité de l'eau du fond s'accroît avec une augmentation de profondeur, jusqu'en dessous de 600 mètres. Les résultats suggèrent la présence de plusieurs courants majeurs sur le fond de la mer dans la région qui coule généralement de l'ouest à l'est et du détroit de Barrow et du détroit de Lancaster aux anses environnantes.

BARROW STRAIT BOTTOM TEMPERATURES

AND SALINITIES

John Collier and Alan Judge
Earth Physics Branch
Department of Energy, Mines and Resources

Introduction

A survey of the bottom temperatures and salinities in the Barrow Strait region was carried out to provide the necessary boundary conditions at the sea water-sediment interface for the prediction of the presence of sub-sea permafrost. Knowledge of the extent of sub-sea permafrost is required for sea floor engineering projects such as drilling for petroleum and pipeline construction.

The area surveyed includes Barrow Strait, Wellington Channel, Byam Channel, Austin Channel, and parts of Viscount Melville Sound, Lancaster Sound, Prince Regent Inlet, Admiralty Inlet, Peel Sound, and Queen's Channel. Also included in the region is a small part of Jones Sound, north of Devon Island. The region is shown in Fig. 1.

The majority of depth, temperature and salinity data are from oceanographic surveys summarized by the Marine Environmental Data Service of Environment Canada. A total of 322 stations are included in their listings for this region. An additional 13 stations were surveyed in early May, 1975, in Barrow Strait by the Earth Physics Branch.

A listing of the measurements used in this report is contained in Appendix 1. Stations with numbers less than 323 are from regular oceanographic surveys. At some locations no measurements were made close enough to the bottom to be useful. The criteria for bottom measurements are given in Appendix 2. A total of 244 stations were usable. Because

of duplication at some locations, these represent a total of 183 separate locations.

Several stations had either no usable temperature or no usable salinity readings taken. These are indicated by a value of 99.99 in the appropriate space in Appendix 1.

Distribution of Data

The majority of the locations surveyed are in Barrow Strait and the western end of Lancaster Sound. In particular, the area between Cornwallis and Somerset Islands is well-covered. There are also numerous locations in Prince Regent Inlet, and at the Southern end of Byam Channel. Additional locations are in Wellington Channel, north of Cornwallis Island (Queen's Channel), and in Bear Bay. Data are sporadic or missing for other areas.

Temperature data exist for 231 stations. Salinity data exist for only 185 stations. Temperatures were recorded at 160 locations in summer, and 15 locations in winter. Salinities are available for 150 locations for the summer and 2 for the winter. The number of observations in each depth zone, for summer and winter, is listed in Table 1.

Summary of Data

Station locations and bathymetry are plotted on Fig. 2. Temperature averages for each location, and contours, have been plotted on Fig. 3. Salinity data are plotted on Fig. 4. Summer and winter temperature and salinity data have been grouped together since there is little seasonal variation.

Means and standard deviations for each depth zone are listed in Table 1 together with the number of observations used. Most of the measurements are from depths greater than 100 m; shallower data are from a small number of separate locations. The seven stations with summer measurements in the 20 m to 40 m zone, for example, are all at one location near Resolute. Twenty of the measurements in the 40 m to 60 m zone are from two locations less than a kilometre apart north of Cornwallis Island. Eleven of the winter measurements in the 80 m to 100 m zone are from one location near the shore of Bear Bay, on the north side of Devon Island. The distribution of salinity data is similar, although there are fewer stations overall.

In general, there is little winter data. Other than the stations in Bear Bay, one location was surveyed near Arctic Bay, on the Borden Peninsula, and thirteen surveyed in Barrow Strait in May 1975. These latter are not accompanied by salinity data.

There is no significant difference between the summer and winter temperatures in any depth zone, except 80 m to 100 m. Some differences may be seen, to a lesser degree, in the 100 m to 200 m zone which are probably regional rather than seasonal in origin. Summer and winter temperatures in the 100 m to 200 m zone from one region are quite similar, e.g., Barrow Strait in Fig. 3. A rather low winter salinity in

the 100 m to 200 m zone was measured in Adams Sound (on the Bordon Peninsula). Otherwise summer and winter salinities as shown in Table 1 are also similar, within the accuracies of the survey.

Temperatures decrease from slightly negative at 20 m to 40 m to a minimum of -1.5°C in the 50 m to 200 m zone. At greater depths, temperatures increase to a maximum of 0.5°C at 500 m, and then decrease slowly below that. Salinities increase steady with depth to a maximum of about 34.5‰. The greatest range of temperatures and salinities within the survey area is found between 100 m and 300 m depths, where much mixing probably occurs.

Different temperature measurements can be grouped by region and depth, as indicated in Figure 5. Although most of the data fit a generalized curve quite well, data from various areas form distinct clusters, with little overlap. Figure 6 shows salinities vs depth. There is little scatter at depths greater than 200 m.

Discussion and interpretation of the data

1. Bathymetry

The Bathymetry is shown in Fig. 2. The survey area west of 92°W is generally less than 250 m in depth, except for isolated areas north east of Byam Martin Island, south and west of Little Cornwallis Island, and east of Prince of Wales Island. The southern part of Parry Channel west of 102°W is also deeper - maximum water depth greater than 500 m - but there are no deep oceanographic data for this region.

Lancaster Sound, east of 92°W , is considerably deeper with depths increasing steadily eastward to more than 650 m at 84°W . Admiralty and Prince Regent Inlets, entering Lancaster Sound from the south, are both greater than 500 m deep. Depths greater than 500 m are also found in Bear Bay.

The areas north of Cornwallis Island and Byam Island are relatively shallow (less than 150 m), as is an extensive area south of Bathurst Island. It is these areas which are most likely to be affected by seasonal changes. Unfortunately, only summer data are available, and few of them.

The most noteworthy feature of the bathymetry of the area is a sill across Barrow Strait separating the deep waters of the western portion of Viscount Melville Sound from those of Lancaster Sound. The sill rises near 102°W and drops off east of 93°W . Depths on the sill vary between 150 m and 200 m in the deepest part of the channel. The top of the sill is virtually flat, being at $170\text{ m} \pm 20\text{ m}$, except for a ridge extending from Bathurst Island to Lowther Island, and thence to Young and Russell Islands' at the west end of Barrow Strait. This ridge is generally less than 100 m deep at its peak.

2. Water Masses

Barrow Strait is an area of interaction of the waters of the Canada Basin and Baffin Bay, further complicated by mixing from channels in the Arctic Archipelago. Four different water masses are significant in this interaction: Arctic Water and Polar Atlantic Water of the Canada Basin, and Cold Arctic Water and the Intermediate Warm Layer of Baffin Bay (Collin, 1963). Temperature-salinity curves for the Arctic Ocean and Baffin Bay are shown in Fig. 7, superimposed on the temperature-salinity data used in this survey. Water masses and inferred currents are plotted in Fig. 8.

In the Canada Basin, Arctic Water (also called Cold Arctic Water), is found to a depth of 150 m. It has temperatures of -1.2° to -1.4°C and salinities of 32.2‰ to 33.5‰. Temperature varies little with depth, while salinity steadily increases. Between 150 m and 250 m, there is a uniform increase of temperature and salinity, below which lies Polar Atlantic Water. This mass is characterized by rapidly increasing temperature with depth to a sharp maximum of 0.43°C (salinity 34.9‰) at 500 m. Salinity remains constant, while temperature decreases towards the bottom of the layer at 1000 m. Underlying "Bottom Water" of the Canada Basin does not affect Barrow Strait directly.

Baffin Bay shows characteristics of both Arctic and Atlantic Waters. Surface water, with temperatures varying between -1.0°C and 5.0°C and salinity between 30.0‰ and 33.5‰, reflects the local effects of summer heating, winter chilling, and ice movement. A cold water mass, with temperatures down to -1.6°C and salinity of 33.8‰, is found between 50 m and 200 m. This layer is called Cold Arctic Water, and is both colder and more saline than the Arctic Water of the Canada Basin. It is considered to be indigenous to Baffin Bay (Collin, 1963).

The Intermediate Warm Layer is characterized by temperatures greater than -0.5°C , and a salinity between 34.2‰ and 34.5‰. It extends to 1000 M depth, and has a maximum temperature of 1.0°C at 500 m. Lower temperatures are observed at this depth, however, in Lancaster Sound.

At depths greater than 1000 m, temperature decreases to less than -0.5°C , and salinity is constant at 34.45‰. This "Deep Baffin Bay" water is thought to be of Arctic origin, entering through Smith Sound (Collin, 1963). Low temperatures and high salinities observed in Bear Bay at about 500 m suggest that Arctic Water also enters through Jones Sound.

The major influence on bottom temperatures in Barrow Strait comes from the Intermediate layer and the Arctic Water Mass, which meet just to the east of the Barrow sill. Bottom temperature conditions are strongly dependent upon the direction and intensity of currents in these layers, especially at depths greater than 100 m to the east of 96°W . Current flow through Barrow Strait is thought to be predominantly eastwards, based on studies of plankton distribution (Collin, 1963). Westward flow, at least in the eastern end of Lancaster Sound, has been noted (Lewis, 1963).

3. Temperature and salinity conditions

Bottom temperatures are influenced primarily by two factors, local seasonal changes and regional currents. The effects of seasonal changes are generally limited to near shore areas where surface water layers meet the sea bottom. Seasonal changes affecting temperature and salinity in these layers include spring and summer run-off from the land, melting ice, direct solar heating of the water, and, in shallow water (<50 m),

solar heating of the sea bottom. In confined channels such as Barrow Strait, surface run-off from nearby land masses can affect temperature distribution to at least 200 m (Lewis, 1963). Such effects may account for anomalies in the temperature data in such areas. Alternatively, anomalous measurements may be due to unusual transport of water masses, as probably happened in 1961 in Wellington Channel.

Since little winter data are available, the effects of seasonal changes are difficult to determine, if, indeed, they are significant at all. As suggested above, statistical differences between winter and summer conditions were small, and are likely due to regional rather than seasonal variations. It is assumed, therefore, that seasonal fluctuations are negligible in a survey of this detail, except in the very near-shore.

Temperatures in the shallower ranges (<60 m) are, in general, moderate, averaging about -0.5°C . Salinities are near 32.5‰. This range corresponds to the Cold Arctic Water of Baffin Bay, which extends into eastern Barrow Strait (Collin, 1963). Similar conditions are found in Queen's Channel, north of Cornwallis Island, but the data were obtained in 1961, when unusual conditions prevailed. An atypical temperature of -1.36°C measured on the west side of Byam Channel is more like that of the Arctic Water Mass, which enters through M'Clure Strait.

Similar conditions exist in the 60-80 m zone, with a temperature of -0.31°C just off Cornwallis Island, consistent with Lancaster Sound-Baffin Bay water, and one of -1.01°C just south of Bathurst Island, fitting (if allowance is made for a small amount of summer heating) the Arctic Water Mass. A measurement of -1.37°C in 63 m of water in Barrow

Strait, taken in early May, is also typical of the Arctic Water Mass, which may extend further east at this level in late winter. Both Collin (1963) and Lewis (1963) show a low temperature (below -1.5°C) zone to about 100 m, but whereas Collin shows it extending eastward to about 95°W , and then ending (based on data from 1956, 1957, 1960 and 1961), Lewis (based on 1954 data) shows a break in the zone from 113°W to 98°W , and then has it continuing eastward into Baffin Bay.

In Byam Channel, deeper water (200 m) is surprisingly warm and saline, and possibly indicates Polar Atlantic Water which has been forced up from lower depths by deep currents through Viscount Melville Sound. These measurements, as well as measurements in shallower water on the west side of the channel are typical of M'Clure Strait (based on Collin's temperature-salinity curves). The other side of Byam Channel is much warmer. No salinities are available to determine whether the water originates from greater depths. South of the channel entrance conditions are similar to those given by Collin for Viscount Melville Sound: slightly warmer than the usual Polar Atlantic Water, but of similar salinity. Further east, towards Bathurst Island, conditions are similar, except for the unusually high 1961 temperatures.

The intersection of Peel Sound and Viscount Melville Sound has conditions similar to those Collin describes in Lancaster Sound and Baffin Bay. Depths are from 200 m to 275 m, and bottom waters are warmer and less saline, typical of the Intermediate Warm Layer. It seems unlikely that this layer is present west of the sill. Furthermore, while the elevated temperatures may be explained by currents pushing deeper water to the surface, salinity is rather low. Further into Peel Channel, temperatures in the same depth range are lower, as are salinities. This

situation is most easily explained by water from shallower layers sinking into the channel. A current into Peel Sound, over the shallow region north of Prince of Wales Island, is suggested, resulting in rather low bottom temperatures and salinities.

Bottom temperatures through Barrow Strait are surprisingly uniform, despite depth variations from 63 m to 200 m, the average temperature being close to -1.35°C . Temperatures on the extreme north side of the channel are usually high (greater than -1.0°C). Measurements taken in 1961 are around -1.0°C , even in the centre of the channel. Again, 1961 measurements were generally abnormal throughout the area. All but three other measurements, which are colder, are within a tenth of a degree of -1.34°C . Salinities are quite variable, but not systematically, averaging slightly greater than 33‰. These temperature-salinity conditions are typical of the Arctic Water Mass. It is probable that a current funnelling through Barrow Strait tends to homogenize bottom conditions irrespective of depth. Low temperatures are found in deeper water around 92°W . Arctic water appears to be spilling over the sill and spreading out over the deeper bottom to the east where conditions are similar to those in Peel Sound.

Farther east into Lancaster Sound the water is warmer, and the Intermediate Warm Layer is in evidence, with a maximum temperature of 0.70°C at about 510 m. As depths increase eastward, bottom water temperatures increase, and then decrease to 0.2°C at 600 m. In general, water is warmer to the north. Salinities are comparable to those in Baffin Bay.

Bottom temperatures in Prince Regent Sound decrease towards the South, with no corresponding change in depth or salinity. An arm of

colder water extends along the north shore of Brodeur Peninsula. There is a noteworthy "cold zone" accompanied by low salinities around, but principally to the east of, Prince Leopold Island, which may be due to currents around the northeast corner of Somerset Island sinking into Prince Regent Sound.

Through Wellington Channel, between Cornwallis and Devon Islands, temperatures and salinities are quite low (-1.57°C , 33.25‰), probably representing the Arctic Water Mass, though conditions are more typical of shallower water. The southern end is relatively shallow allowing only cool shallow water to enter from Barrow Strait. This is particularly evident on the westward side. In 1961, much higher temperatures (-1.10°C) were recorded, indicating a change in this condition.

Water in Bear Bay is warmer than average at shallower depths, but distinctly colder at depths greater than 400 m. Salinities at depth are also somewhat low, as a result of a deep current of Cold Arctic water flowing into Baffin Bay through Jones Sound, north of Devon Island. It is suggested that this contributes to the cold and saline "Deep Baffin Bay" water.

Summary and Conclusions

Little winter data are available, but variations, especially at depth, are dependent on regional and nonseasonal differences. Conditions can vary significantly from year to year. In 1961, in particular, conditions were quite different from normal, as data from Barrow Strait, Wellington Channel, and near Bathurst Island indicate.

Fig. 8 shows the discrete water masses and inferred directions of current flow across the bottom. Flow is generally eastwards through Parry Channel, and southwards into Peel Sound and Prince Regent Inlet. Flow through Wellington Channel is inferred to be generally southwards. Occasionally, as in 1961, these flow directions may be reversed. Barrow Strait is an area of mixing of deep waters from the Canada Basin, and shallower waters from Baffin Bay.

Cold temperatures at 400 m to 600 m in Bear Bay suggest a strong current flowing through Jones Sound from the Arctic Basin, allowing Cold Arctic Water to enter the deeper reaches of Baffin Bay.

Different water masses can be distinguished by their effects on temperatures and salinities. It is possible to infer direction of current flow assuming (1) local effects of surface water runoff, and atmospheric and solar heating are small, and (2) water masses have a tendency to maintain their integrity. While both of these assumptions are valid throughout most of the study area, extrapolation of known conditions to areas lacking data would be aided by information on bottom currents.

Interpretation of flow dynamics and accurate prediction of bottom-water temperatures is hampered by (1) clumping of data locations, (2) paucity of winter data, (3) the relative deficit of salinity data,

and (4) large regions without data. Information about deep current flow would be very valuable.

Acknowledgements

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TABLE 1 Statistical Summary Barrow Strait and Adjoining Waters Bottom Oceanographic Data

Depth Zone m	Number of Observations	<u>Summer Temperatures</u>		
		Arithmetic °C	Range °C	Standard Deviation °C
0 - 10	0			
10 - 20	0			
20 - 40	7	-0.4	0.7	0.3
40 - 60	26	-0.6	1.1	0.2
60 - 80	2	-1.0		
80 - 100	3	-1.2		
100 - 200	49	-1.2	1.1	0.3
200 - 1000	105	-0.6	2.4	0.6

Winter Temperatures

0 - 10				
10 - 20				
20 - 40				
40 - 60				
60 - 80	1	-1.4		
80 - 100	13	-1.6	0.8	0.2
100 - 200	11	-1.4	0.2	0.1
200 - 1000				

TABLE 1 CONTINUED

Summer Salinities

Depth Zone m	Number of Observations	Arithmetic Mean ‰	Range ‰	Standard Deviation ‰
0 - 10				
10 - 20				
20 - 40	4	32.4	0.9	0.4
40 - 60	5	32.7	0.9	0.4
60 - 80	1	32.7		
80 - 100	2	32.9		
100 - 200	43	33.1	1.6	0.3
200 - 1000	103	33.9	2.2	0.5

Winter Salinities

0 - 10				
10 - 20				
20 - 40				
40 - 60				
60 - 80				
80 - 100	11	33.0	1.0	0.4
100 - 200	1	32.8		
200 - 1000				

FIGURE 1
SURVEY REGION

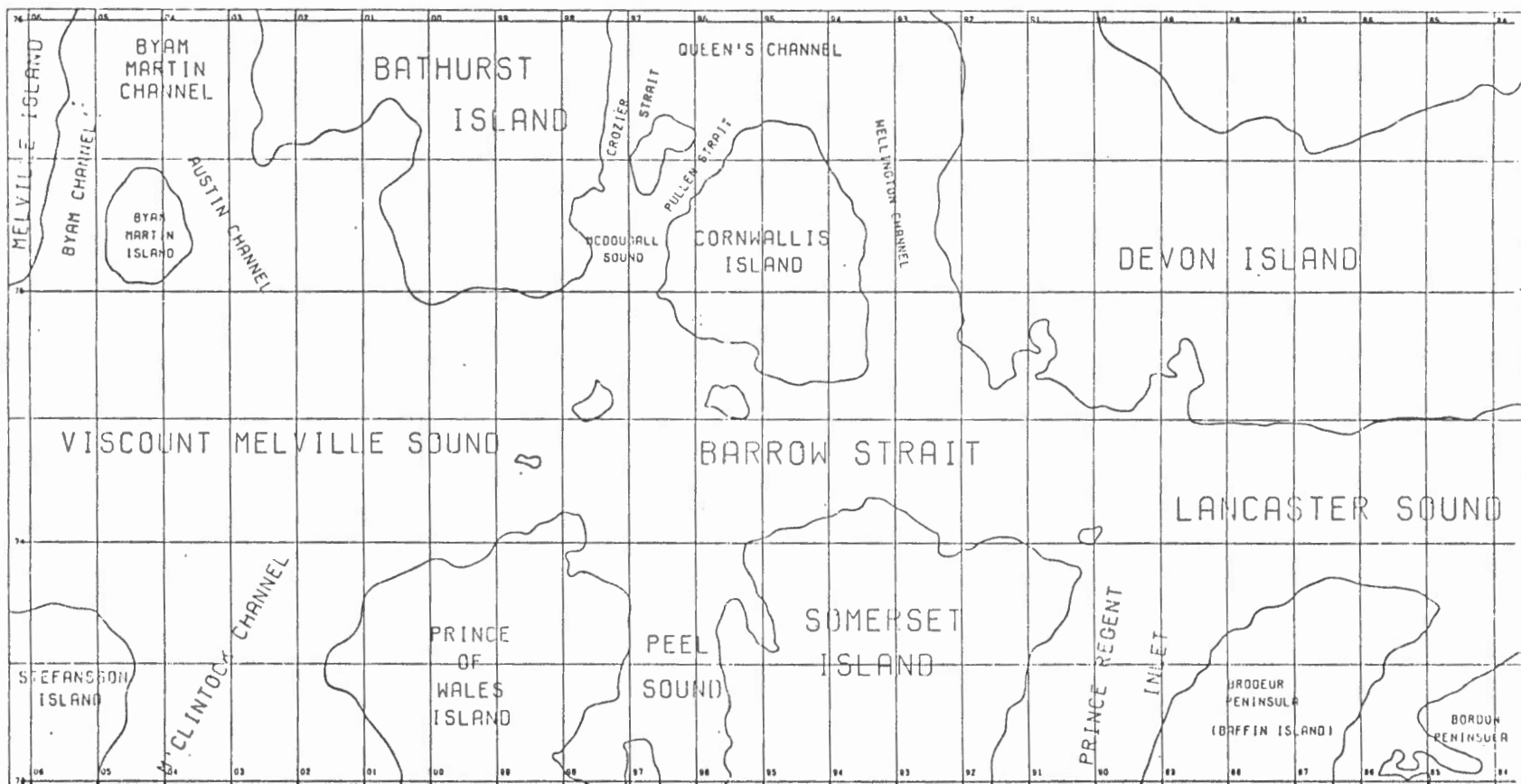


FIGURE 2

BATHYMETRY

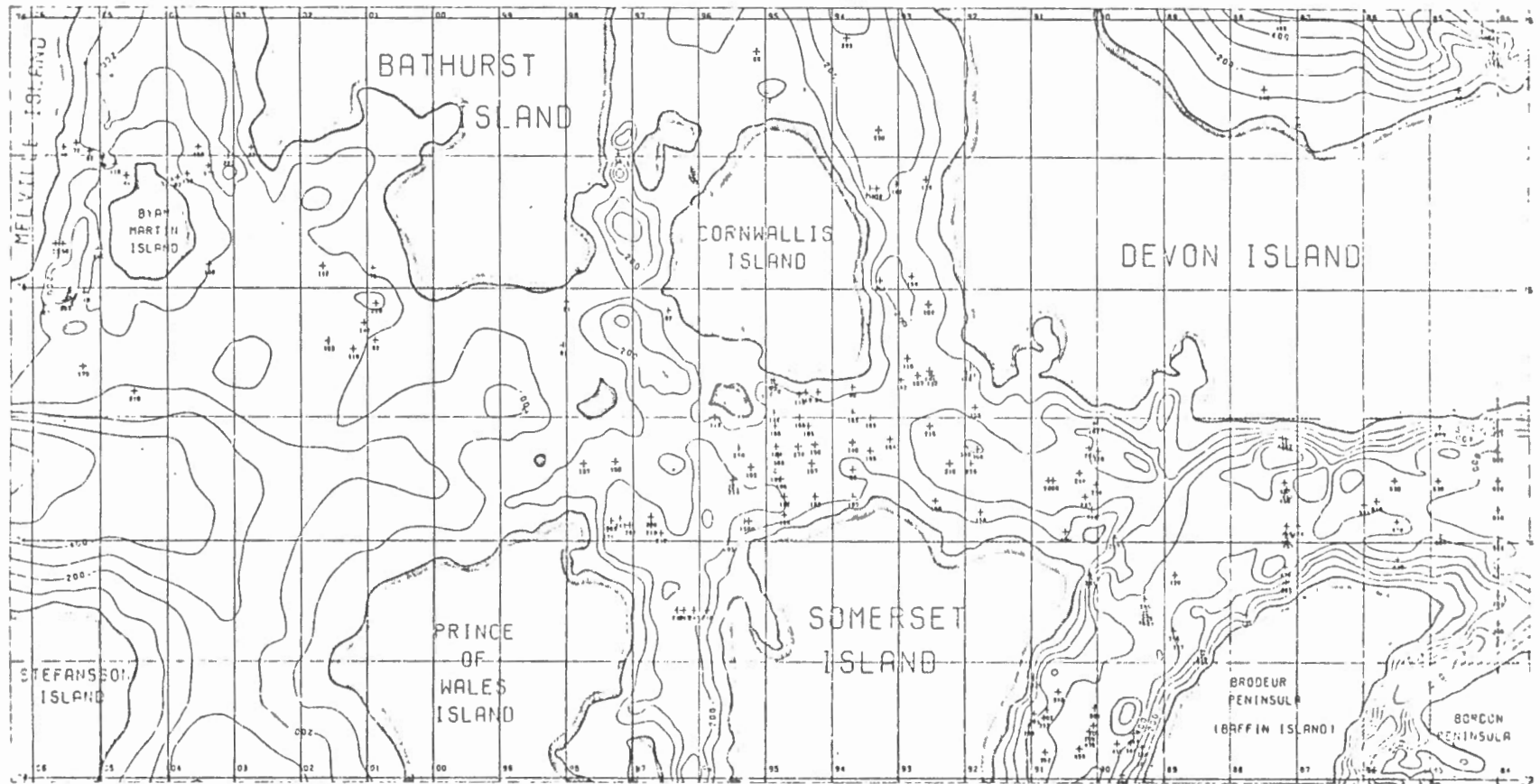


FIGURE 3

TEMPERATURE

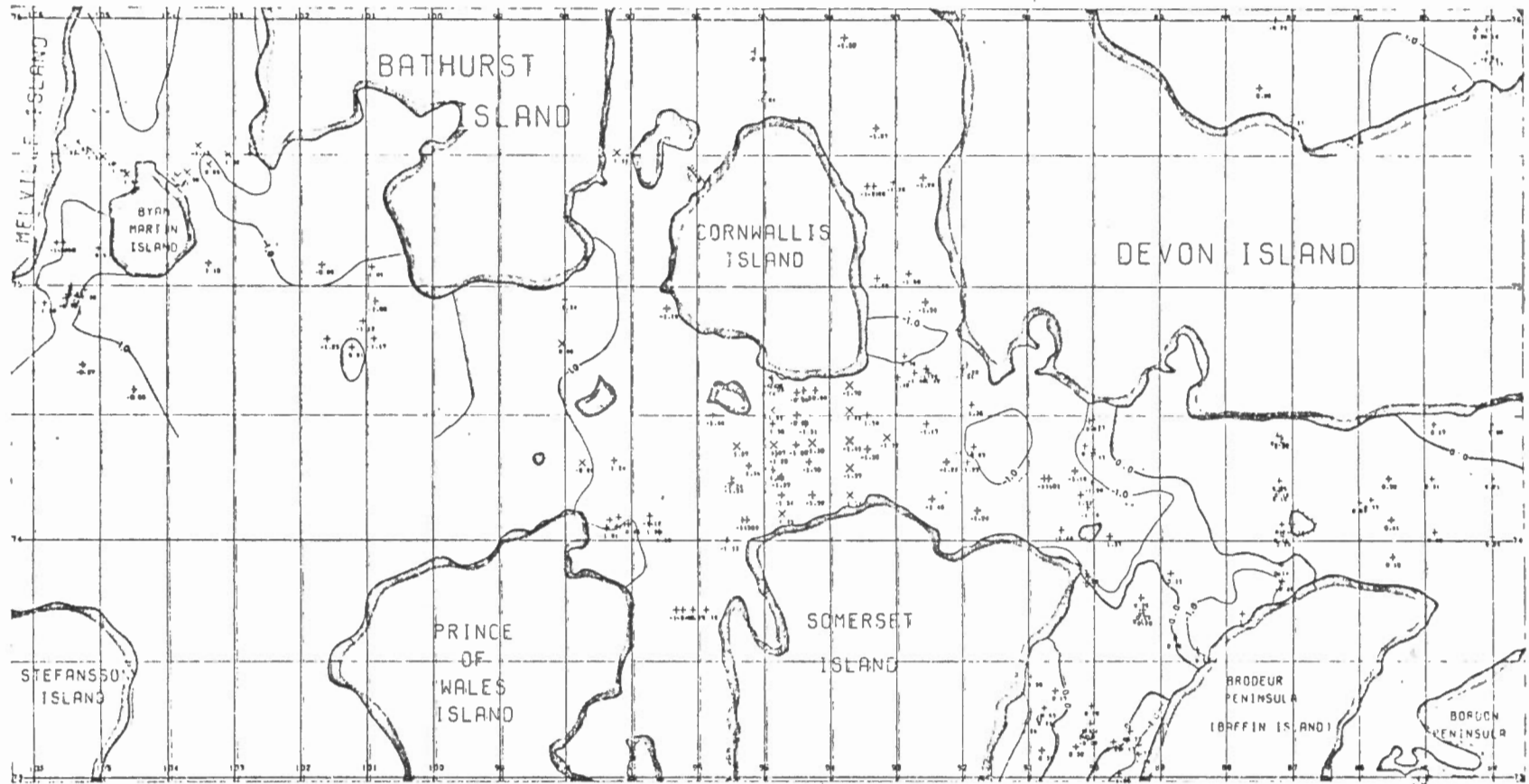


FIGURE 4

SALINITIES

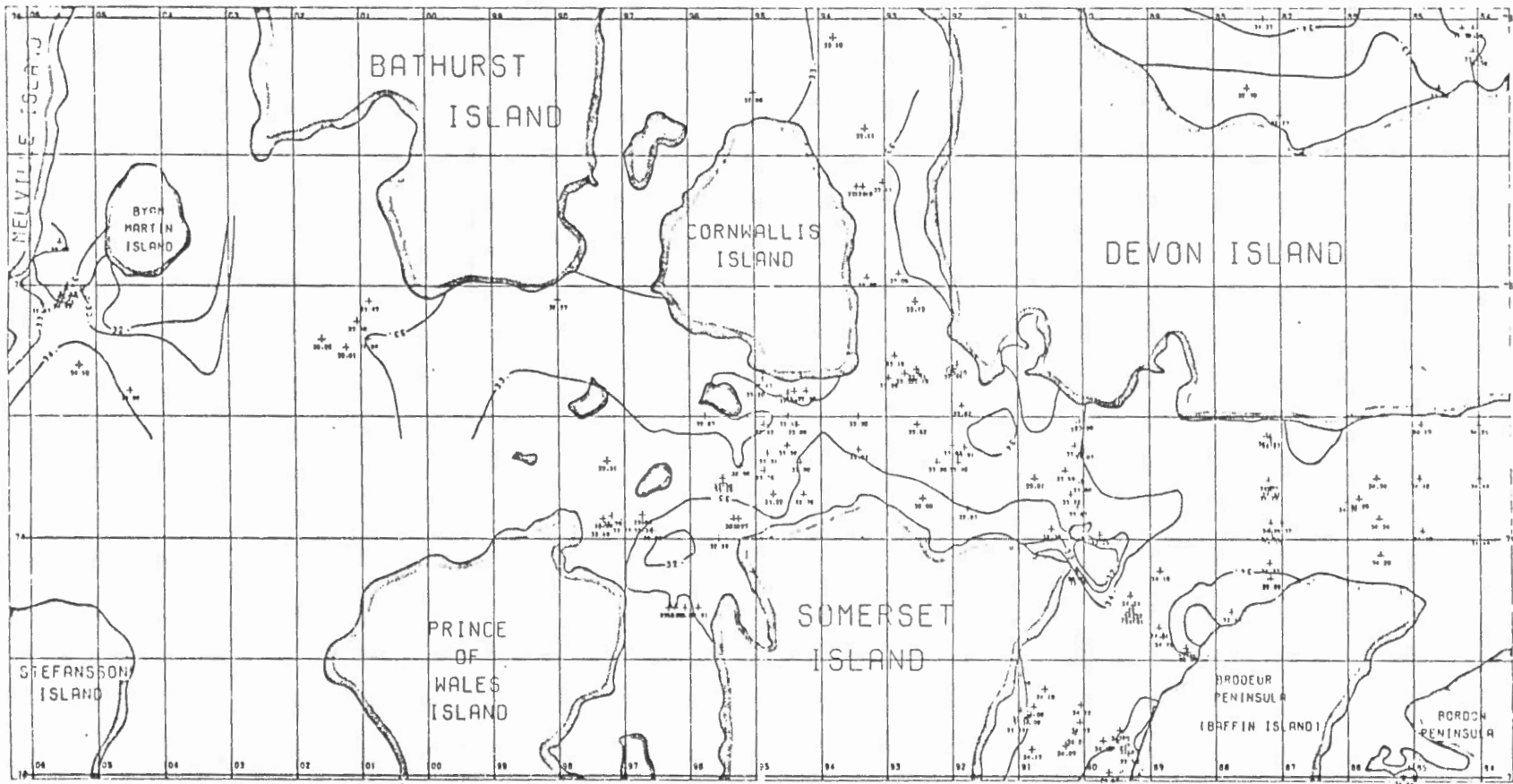


FIGURE 5

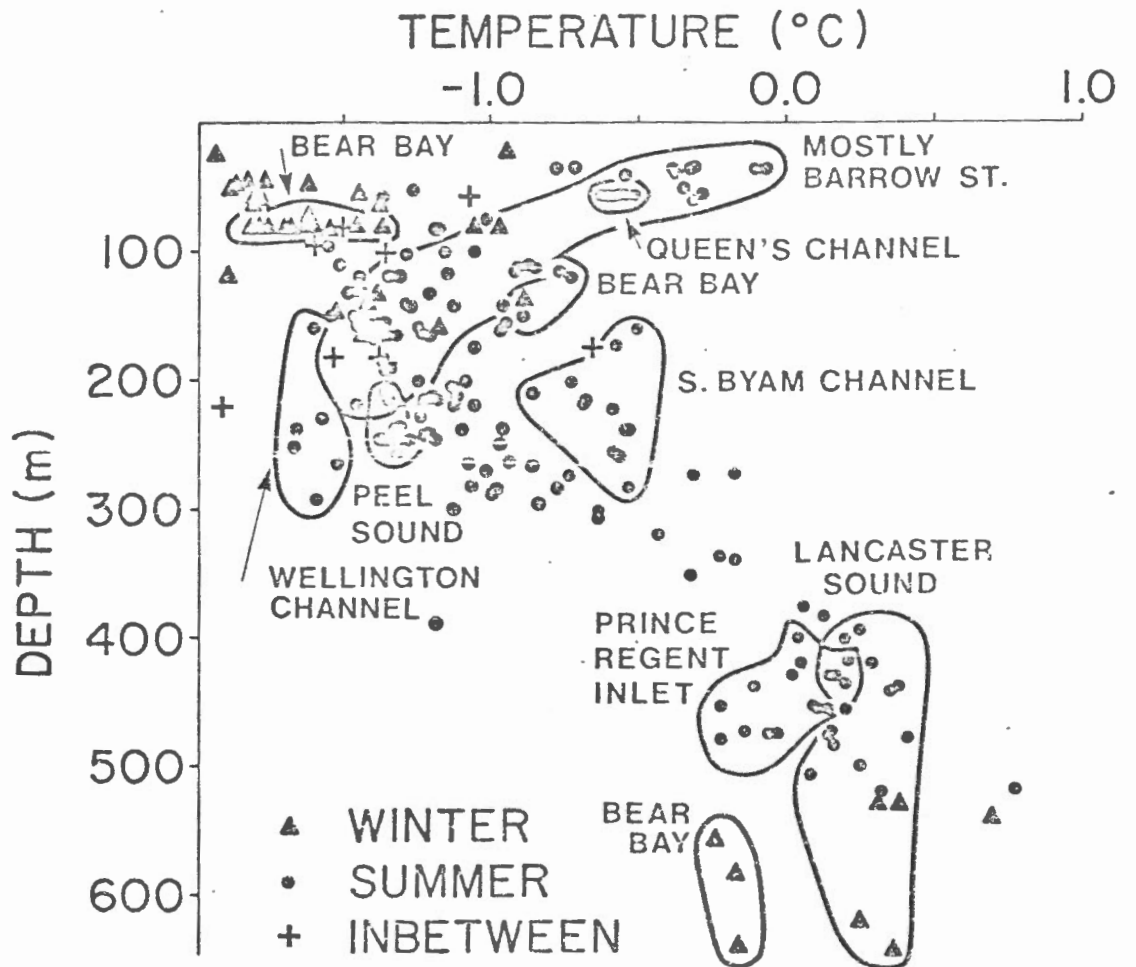


FIGURE 6

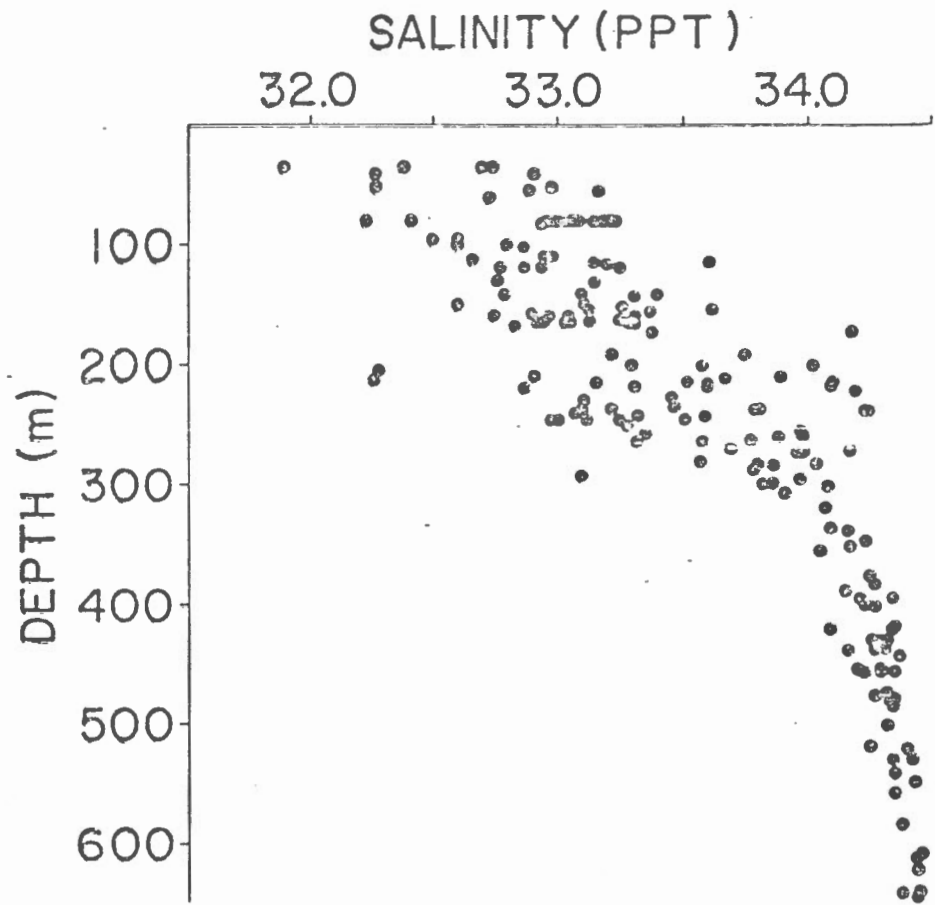


FIGURE 7

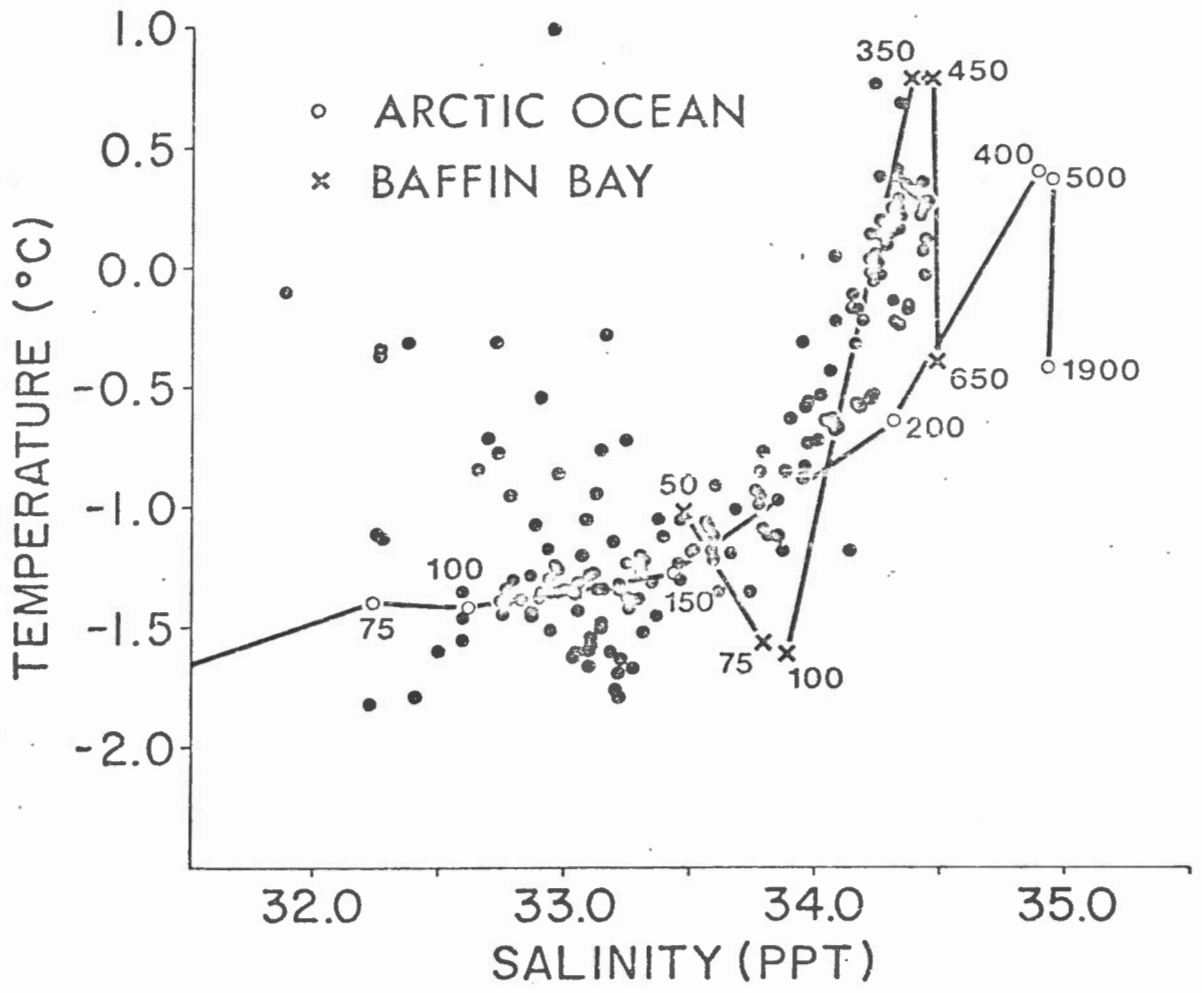
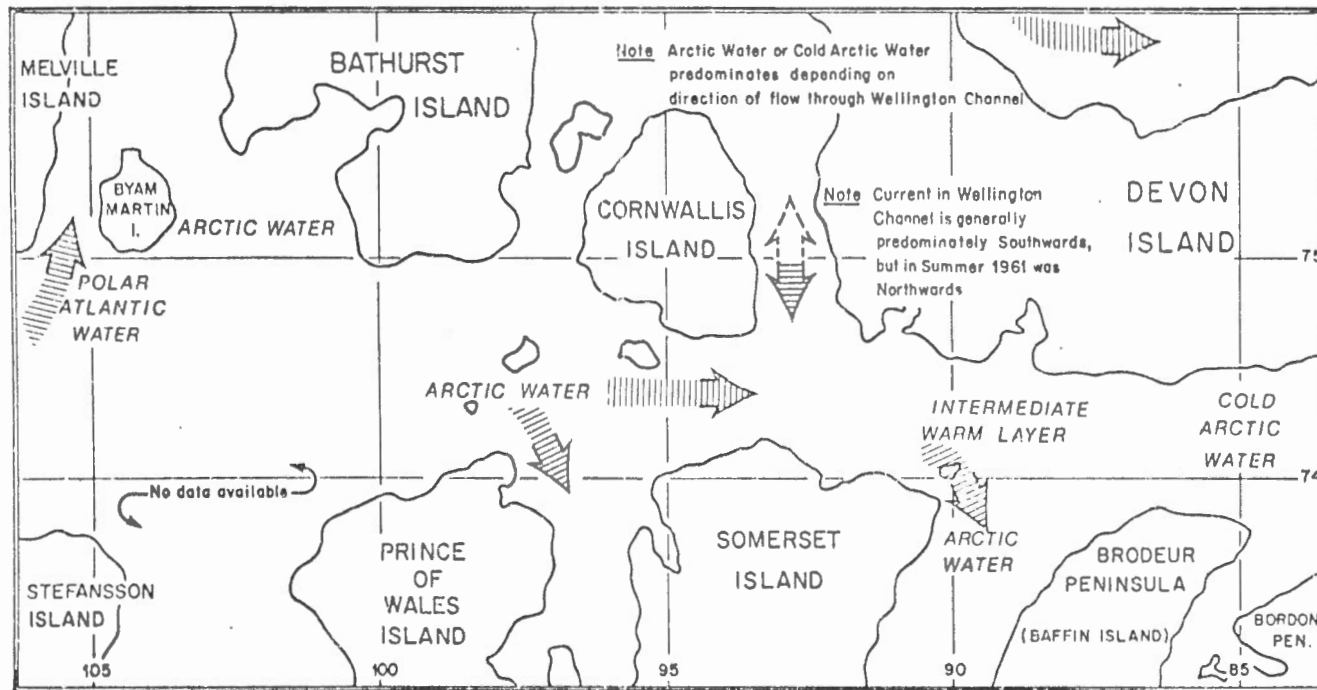


FIGURE 8

WATER MASSES AND BOTTOM CURRENTS



BARROW STRAIT BOTTOM TEMPERATURES AND SALINITIES

	LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY
3	N73 40.0	W 84 0.0	2 10 1962	356.00	329.00	-.64	34.05
4	N73 47.0	W 84 0.0	2 10 1962	261.00	225.00	-1.18	33.88
5	N73 54.0	W 84 0.0	2 10 1962	640.00	620.00	-.03	34.45
7	N73 56.0	W 85 30.0	28 9 1958	430.00	391.00	.15	34.29
9	N73 2.0	W 85 5.0	22 9 1954	95.00	90.00	-1.55	32.60
10	N73 2.0	W 85 5.0	28 10 1934	95.00	90.00	-1.60	32.50
21	N73 0.0	W 85 10.0	18 11 1954	100.00	100.00	-1.35	32.60
12	N73 0.0	W 85 10.0	18 12 1954	100.00	100.00	-1.30	32.80
14	N73 40.0	W 87 46.0	20 8 1957	235.00	200.00	-1.30	33.47
16	N73 54.0	W 87 11.0	15 9 1960	476.00	376.00	.14	34.27
17	N73 50.0	W 87 10.0	15 9 1960	239.00	216.00	-.95	33.79
19	N73 50.2	W 87 10.0	9 9 1960	300.00	250.00	-1.12	33.86
19	N73 50.0	W 87 10.0	13 9 1961	296.00	275.00	-.83	33.97
22	N73 52.0	W 88 51.0	20 8 1957	439.00	363.00	-.11	34.16
23	N73 33.0	W 89 27.0	20 8 1957	259.00	250.00	-1.31	33.35
24	N73 35.9	W 88 49.0	31 8 1960	377.00	349.00	.06	34.25
25	N73 32.0	W 89 25.7	31 8 1960	256.00	225.00	-.58	33.97
26	N73 38.0	W 89 52.0	13 9 1961	395.00	380.00	99.99	34.21
28	N73 12.0	W 89 28.0	23 9 1956	454.00	362.00	-.22	34.20
29	N73 45.0	W 89 19.0	24 9 1956	395.00	394.00	.25	34.34
31	N73 42.0	W 89 19.0	20 8 1957	457.00	400.00	.14	34.23
34	N73 41.5	W 89 15.0	31 8 1960	437.00	399.00	.20	34.31
35	N73 9.5	W 89 30.5	2 9 1960	384.00	360.00	.13	34.27
36	N73 8.5	W 89 20.0	2 9 1960	220.00	190.00	-1.45	32.87
37	N73 6.0	W 89 20.0	12 9 1961	201.00	173.00	-1.08	33.58
39	N73 9.3	W 89 47.0	12 9 1961	421.00	391.00	.05	34.09
40	N73 43.0	W 89 16.0	13 9 1961	474.00	446.00	.15	34.32
41	N73 1.0	W 89 39.0	6 8 1962	282.00	250.00	-1.06	33.57
42	N74 2.0	W 84 52.0	20 9 1957	521.00	439.00	.32	34.40
43	N74 15.0	W 84 54.0	20 9 1957	530.00	500.00	.31	34.42
44	N74 29.0	W 84 52.0	20 9 1957	273.00	250.00	-.17	34.17
45	N74 28.0	W 84 0.0	24 9 1960	389.00	340.00	-1.18	34.15
46	N74 28.0	W 84 0.0	14 9 1961	477.00	400.00	-.03	34.27
47	N74 15.0	W 84 0.0	14 9 1961	644.00	573.00	.36	34.44
48	N74 1.0	W 84 0.0	14 9 1961	622.00	580.00	.25	34.44
49	N74 .5	W 84 0.0	3 10 1962	549.00	501.00	.22	34.43
50	N74 8.0	W 84 0.0	3 10 1962	640.00	600.00	.12	34.45
51	N74 15.0	W 84 0.0	3 10 1962	612.00	560.00	.07	34.44
52	N74 22.0	W 84 0.0	3 10 1962	603.00	560.00	.28	34.45
53	N74 29.0	W 84 0.0	3 10 1962	349.00	300.00	-.02	34.23
54	N74 10.0	W 85 49.4	24 8 1963	519.00	500.00	.77	34.25

	LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY
56	N74 15.0	W 85 33.0	28 9 1956	530.00	447.00	.38	34.34
57	N74 5.0	W 85 31.0	28 9 1956	479.00	445.00	.41	34.34
58	N74 9.2	W 86 0.0	3 9 1967	541.00	500.00	.69	34.35
51	N74 1.0	W 87 9.0	19 9 1957	457.00	400.00	.20	34.35
63	N74 25.0	W 87 10.0	19 9 1957	402.00	355.00	.20	34.27
64	N74 25.3	W 87 13.5	15 9 1960	421.00	400.00	.29	34.34
65	N74 14.5	W 87 12.0	15 9 1960	443.00	400.00	.35	34.37
66	N74 24.5	W 87 10.0	9 9 1961	454.00	400.00	.09	34.29
67	N74 12.0	W 87 12.0	9 9 1961	455.00	400.00	.10	34.29
68	N74 2.0	W 87 11.0	9 9 1961	485.00	450.00	.16	34.34
69	N74 4.0	W 87 10.0	13 9 1961	419.00	396.00	.21	34.35
70	N74 13.0	W 87 10.0	13 9 1961	430.00	400.00	.16	34.32
71	N74 24.5	W 87 10.0	13 9 1961	430.00	350.00	.02	34.26
74	N74 4.0	W 87 0.0	6 8 1962	474.00	400.00	-.14	34.32
75	N74 1.0	W 89 46.0	20 8 1957	247.00	200.00	-1.37	33.25
77	N75 58.0	W 84 14.0	30 9 1962	558.00	495.00	-.24	34.35
78	N75 53.0	W 84 4.0	30 9 1962	120.00	100.00	-.72	33.25
79	N75 58.0	W 84 4.0	25 9 1963	641.00	600.00	-.16	34.38
80	N75 52.0	W 84 0.0	25 9 1963	584.00	569.00	-.17	34.38
81	N75 45.0	W 84 35.0	13 11 1961	80.00	80.00	1.00	32.96
82	N75 45.0	W 84 35.0	27 11 1961	80.00	78.00	99.99	33.00
83	N75 45.0	W 84 35.0	24 12 1961	80.00	78.00	-1.05	33.09
84	N75 45.0	W 84 35.0	9 1 1962	80.00	78.00	-1.36	33.05
85	N75 45.0	W 84 35.0	21 1 1962	80.00	78.00	-1.62	33.04
86	N75 45.0	W 84 35.0	3 2 1962	80.00	78.00	-1.60	33.19
87	N75 45.0	W 84 35.0	15 2 1962	80.00	78.00	-1.79	32.41
88	N75 45.0	W 84 35.0	5 3 1962	80.00	78.00	-1.82	32.27
89	N75 45.0	W 84 35.0	19 3 1962	80.00	78.00	-1.76	33.21
90	N75 45.0	W 84 35.0	2 4 1962	80.00	78.00	-1.79	33.22
91	N75 45.0	W 84 35.0	16 4 1962	80.00	78.00	-1.79	33.22
92	N75 45.0	W 84 35.0	1 5 1962	80.00	78.00	-1.69	33.22
93	N75 45.0	W 84 35.0	26 5 1962	80.00	78.00	-1.63	33.23
94	N75 45.0	W 84 35.0	12 6 1962	80.00	78.00	-1.50	33.15
95	N75 45.0	W 84 35.0	29 6 1962	80.00	78.00	-1.43	33.06
96	N75 39.0	W 87 0.0	15 8 1962	40.00	30.00	-.37	32.27
98	N75 45.0	W 87 30.0	25 9 1963	142.00	123.00	-.95	32.79
100	N75 0.0	W 87 15.0	25 9 1963	480.00	442.00	-.22	34.33
101	N73 7.0	W 90 48.0	4 9 1963	352.00	328.00	-.32	34.17
102	N73 16.0	W 90 49.0	23 9 1955	337.00	290.00	-.22	34.09
103	N73 14.0	W 90 4.0	23 9 1956	401.00	384.00	.04	34.23
104	N73 51.0	W 90 6.0	20 8 1957	274.00	250.00	-.31	33.96
105	N73 8.0	W 90 17.0	21 8 1957	439.00	400.00	.38	34.27
106	N73 52.0	W 90 8.0	31 8 1960	284.00	250.00	-.53	34.03
107	N73 26.0	W 90 58.0	2 9 1960	260.00	249.00	-.56	33.98
108	N73 22.5	W 90 36.0	2 9 1960	340.00	340.00	-.17	34.16
109	N73 18.5	W 90 3.0	2 9 1960	501.00	475.00	.25	34.32
110	N73 12.5	W 90 8.0	12 9 1961	508.00	500.00	.08	99.99

	LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY
112	N73 17.0	W 90 58.0	12 9 1961	285.00	250.00	-.97	33.86
113	N73 52.0	W 90 7.0	13 9 1961	241.00	197.00	-1.20	33.07
114	N73 11.0	W 90 0.0	6 8 1962	476.00	400.00	-.06	34.24
115	N73 18.0	W 90 46.0	6 8 1962	302.00	300.00	-.63	34.08
117	N73 14.0	W 91 3.0	21 8 1957	289.00	250.00	-.99	33.78
118	N73 43.0	W 95 53.0	30 8 1957	210.00	200.00	-1.35	32.91
119	N73 43.0	W 96 5.0	30 8 1957	247.00	200.00	-1.27	33.12
120	N73 43.0	W 96 20.0	30 8 1957	247.00	200.00	-1.34	33.01
121	N73 43.0	W 96 14.0	31 8 1957	247.00	200.00	-1.35	32.98
122	N74 15.0	W 90 41.0	17 8 1967	246.00	200.00	-1.31	33.99
123	N74 15.0	W 90 45.0	3 9 1967	246.00	205.00	-1.18	35.51
125	N74 29.0	W 90 0.0	18 9 1957	274.00	250.00	-.73	33.98
126	N74 22.0	W 90 0.0	18 9 1957	320.00	300.00	-.43	34.07
127	N74 14.0	W 90 2.0	18 9 1957	238.00	200.00	-1.09	33.80
128	N74 8.0	W 90 6.0	18 9 1957	212.00	200.00	-1.19	33.67
129	N74 28.6	W 90 4.0	29 9 1970	264.00	250.00	-.93	33.77
130	N74 22.8	W 90 8.0	29 9 1970	284.00	271.00	-.77	33.80
131	N74 16.8	W 90 17.0	29 9 1970	244.00	230.00	-1.18	33.59
132	N74 11.0	W 90 12.0	29 9 1970	237.00	230.00	-1.32	33.22
133	N74 2.5	W 90 30.0	29 9 1970	130.00	120.00	-1.44	32.76
135	N74 41.0	W 91 59.0	28 8 1957	110.00	100.00	-1.51	32.95
138	N74 22.5	W 91 49.0	30 8 1960	308.00	299.00	-.63	33.91
141	N74 42.0	W 91 55.0	7 9 1961	141.00	125.00	-1.28	33.10
142	N74 32.5	W 91 51.0	7 9 1961	155.00	140.00	-1.35	33.62
143	N74 7.3	W 91 46.5	8 9 1961	159.00	140.00	-1.24	32.97
144	N74 19.0	W 91 55.0	8 9 1961	228.00	200.00	-1.23	33.46
146	N74 56.5	W 92 33.0	9 9 1967	164.00	150.00	-1.34	33.13
151	N74 44.0	W 92 52.0	18 8 1954	115.00	95.00	-.76	33.15
153	N74 10.0	W 92 27.0	28 8 1957	150.00	150.00	-1.46	32.60
154	N74 19.0	W 92 14.0	28 8 1957	216.00	200.00	-1.22	33.60
156	N74 40.0	W 92 30.0	28 8 1957	132.00	120.00	-1.48	33.15
157	N74 39.0	W 92 58.0	28 8 1957	152.00	150.00	-1.42	33.26
161	N74 41.0	W 92 32.0	7 9 1961	144.00	125.00	-1.26	33.31
164	N74 23.0	W 92 0.0	7 8 1962	300.00	250.00	-1.12	33.82

	LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY
166	N74 40.0	W 92 43.0	7 8 1962	157.00	150.00	-1.45	33.37
167	N74 28.0	W 92 32.0	29 9 1970	215.00	201.00	-1.17	33.52
174	N74 30.0	W 93 26.0	28 8 1957	165.00	150.00	-1.38	33.30
175	N74 22.0	W 93 26.0	28 8 1957	165.00	150.00	-1.35	33.03
180	N74 39.0	W 94 53.0	15 8 1954	35.00	25.00	-.71	32.70
181	N74 39.0	W 94 53.0	15 8 1954	35.00	25.00	-.77	32.74
182	N74 39.0	W 94 53.0	16 8 1954	35.00	25.00	-.31	32.38
183	N74 39.0	W 94 53.0	16 8 1954	35.00	25.00	-.38	99.99
184	N74 39.0	W 94 53.0	16 8 1954	35.00	25.00	-.10	31.89
185	N74 39.0	W 94 53.0	16 8 1954	35.00	25.00	-.32	99.99
186	N74 39.0	W 94 53.0	16 8 1954	35.00	25.00	-.06	99.99
188	N74 21.0	W 94 49.0	10 8 1954	165.00	145.00	-1.20	33.31
190	N74 11.0	W 94 44.0	27 9 1956	192.00	180.00	-1.34	33.22
191	N74 17.0	W 94 52.0	27 9 1956	192.00	178.00	-1.35	33.75
192	N74 28.0	W 94 52.0	27 9 1956	165.00	150.00	-1.35	32.92
194	N74 11.0	W 94 16.0	29 8 1957	159.00	150.00	-1.39	32.75
195	N74 19.0	W 94 19.0	29 8 1957	157.00	150.00	-1.38	32.90
196	N74 28.0	W 94 22.0	29 8 1957	165.00	150.00	-1.31	33.06
197	N74 36.0	W 94 24.0	29 8 1957	119.00	100.00	-1.34	32.77
198	N74 38.0	W 94 52.0	30 8 1957	100.00	100.00	-1.05	99.99
199	N74 36.0	W 94 13.0	28 6 1962	55.00	50.00	-1.07	32.89
200	N74 36.0	W 94 13.0	6 7 1962	52.00	50.00	-1.26	32.98
202	N74 36.0	W 94 13.0	25 7 1962	60.00	50.00	-.31	32.73
203	N74 36.0	W 94 13.0	7 8 1962	55.00	50.00	-.28	33.17
204	N74 36.0	W 94 13.0	14 8 1962	41.00	40.00	-.54	32.91
210	N74 35.5	W 94 30.0	7 9 1961	110.00	99.00	-.86	32.93
211	N74 30.0	W 94 30.0	7 9 1961	155.00	140.00	-.94	33.13
212	N74 23.0	W 94 31.0	7 9 1961	174.00	174.00	-1.05	33.38
215	N74 15.0	W 95 30.0	23 8 1954	201.00	175.00	-1.24	33.30
217	N74 30.0	W 95 46.0	29 8 1954	119.00	100.00	-1.44	32.87
218	N74 13.0	W 95 14.0	30 8 1954	165.00	150.00	-1.35	32.95
219	N74 5.0	W 95 16.0	30 8 1954	168.00	150.00	-1.39	32.77
220	N74 5.0	W 95 20.0	13 9 1957	168.00	150.00	-1.38	32.83

LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY	
221	N74 37.0	W 95 0.0	7 8 1962	117.00	100.00	-1.14	33.20
224	N74 0.0	W 95 34.0	7 8 1962	205.00	200.00	-1.13	32.28
225	N74 13.9	W 95 29.7	23 9 1970	215.00	201.00	-1.34	33.16
226	N74 6.0	W 96 44.0	22 8 1954	220.00	200.00	-1.12	33.60
228	N74 4.0	W 96 44.0	13 9 1957	219.00	200.00	-1.22	33.31
229	N74 2.0	W 96 35.0	8 9 1956	212.00	185.00	-1.11	32.26
230	N74 55.0	W 95 29.0	8 8 1962	82.00	75.00	-1.18	99.99
233	N74 19.3	W 97 15.0	8 9 1967	160.00	175.00	-1.24	33.31
234	N74 5.0	W 97 20.0	20 8 1954	265.00	225.00	-1.07	33.58
235	N74 3.0	W 97 23.0	22 8 1954	271.00	250.00	-1.01	33.69
236	N74 4.0	W 97 3.0	8 8 1962	267.00	250.00	-.85	33.79
237	N74 5.7	W 97 12.0	8 8 1962	243.00	209.00	-1.22	33.32
240	N74 57.0	W 98 0.0	8 8 1962	51.00	50.00	-.34	32.27
242	N75 3.0	W 92 48.0	15 9 1957	159.00	150.00	-1.60	33.05
245	N75 25.0	W 92 35.0	30 8 1961	132.00	123.00	-1.20	99.99
248	N75 2.0	W 93 17.0	15 9 1957	265.00	250.00	-1.52	33.32
249	N75 23.0	W 93 20.0	15 9 1957	238.00	200.00	-1.66	33.10
250	N75 24.0	W 93 2.0	15 9 1957	150.00	150.00	-1.54	33.11
251	N75 36.0	W 93 18.0	15 9 1957	230.00	200.00	-1.57	33.11
252	N75 56.0	W 93 47.0	17 9 1957	293.00	250.00	-1.59	33.10
253	N75 24.0	W 93 2.0	30 8 1961	161.00	148.00	-.96	99.99
254	N75 23.0	W 93 26.0	30 8 1961	250.00	200.00	-.96	99.99
257	N75 23.0	W 93 26.0	27 8 1962	252.00	250.00	-1.67	33.28
259	N75 44.0	W 95 0.0	15 9 1957	112.00	100.00	-.84	32.66
262	N75 53.0	W 95 8.0	28 8 1961	55.00	50.00	-.62	99.99
263	N75 53.0	W 95 8.0	28 8 1961	55.00	50.00	-.53	99.99
264	N75 53.0	W 95 8.0	28 8 1961	55.00	50.00	-.55	99.99
265	N75 53.0	W 95 8.0	28 8 1961	55.00	50.00	-.52	99.99
266	N75 53.0	W 95 8.0	29 8 1961	55.00	50.00	-.51	99.99
267	N75 53.0	W 95 8.0	29 8 1961	55.00	50.00	-.56	99.99
268	N75 53.0	W 95 8.0	29 8 1961	55.00	50.00	-.57	99.99
269	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.53	99.99
271	N75 53.0	W 95 8.3	29 8 1961	55.00	47.00	-.61	99.99
272	N75 53.0	W 95 8.3	29 8 1961	55.00	48.00	-.62	99.99
273	N75 53.0	W 95 8.3	29 8 1961	55.00	49.00	-.62	99.99
274	N75 53.0	W 95 8.3	29 8 1961	55.00	49.00	-.53	99.99

LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY	
277	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.56	99.99
278	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.56	99.99
280	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.56	99.99
281	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.60	99.99
282	N75 53.0	W 95 8.3	29 8 1961	55.00	49.00	-.57	99.99
283	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.58	99.99
284	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.56	99.99
285	N75 53.0	W 95 8.3	29 8 1961	55.00	50.00	-.55	99.99
286	N74 56.5	W100 52.0	5 9 1964	219.00	197.00	-1.05	33.47
287	N74 43.0	W100 53.0	24 8 1954	82.00	75.00	-1.17	32.94
288	N74 52.0	W101 3.0	26 8 1964	142.00	139.00	-1.12	33.40
290	N74 46.0	W101 13.0	5 9 1961	115.00	99.00	-.91	33.61
291	N74 47.9	W101 35.2	27 9 1970	163.00	150.00	-1.23	33.25
298	N74 36.0	W104 30.0	7 9 1967	210.00	175.00	-.85	33.89
299	N74 59.5	W105 26.5	4 9 1964	239.00	225.00	-.53	34.24
300	N74 59.0	W105 29.0	4 9 1964	239.00	225.00	-.54	34.23
302	N74 58.0	W105 29.0	4 9 1964	219.00	175.00	-.68	34.09
303	N74 57.2	W105 39.5	4 9 1964	215.00	180.00	-.67	34.10
304	N74 57.0	W105 31.0	4 9 1964	201.00	175.00	-.72	34.02
305	N74 59.0	W105 14.0	25 8 1954	119.00	100.00	-1.30	32.94
306	N74 56.0	W105 50.0	1 9 1962	102.00	100.00	-1.28	32.87
307	N74 41.8	W105 15.5	27 9 1970	173.00	160.00	-.57	34.18
309	N75 4.5	W100 55.0	3 9 1961	75.00	75.00	-1.01	99.99
310	N75 5.0	W101 40.0	3 9 1961	112.00	100.00	-.90	99.99
314	N75 5.3	W103 22.5	3 9 1961	100.00	100.00	-1.15	99.99
313	N75 0.0	W105 26.0	3 9 1961	223.00	200.00	-.58	34.19
319	N75 10.0	W105 33.0	25 8 1964	150.00	150.00	-.88	33.96
321	N75 10.0	W105 39.5	3 9 1961	55.00	50.00	-1.36	99.99
322	N75 8.8	W105 1.9	3 9 1961	160.00	150.00	-.50	99.99
323	N74 38.8	W 94 55.0	4 5 1975	80.00	80.00	-1.68	99.99
324	N74 31.2	W 94 53.0	3 5 1975	146.00	146.00	-1.52	99.99
325	N74 23.0	W 94 51.0	3 5 1975	183.00	183.00	-1.37	99.99
326	N74 15.3	W 94 47.0	3 5 1975	186.00	186.00	-1.37	99.99
327	N74 6.5	W 94 44.0	3 5 1975	186.00	186.00	-1.35	99.99
329	N74 37.2	W 93 42.0	4 5 1975	80.00	80.00	-1.70	99.99
329	N74 31.2	W 93 42.0	3 5 1975	163.00	163.00	-1.43	99.99
330	N74 24.0	W 93 42.0	3 5 1975	140.00	140.00	-1.41	99.99

	LATITUDE	LONGITUDE	DATE	DEPTH (METERS)	READING DEPTH	TEMPERATURE	SALINITY
331	N74 17.5	W 93 42.0	3 5 1975	63.00	63.00	-1.37	99.99
332	N74 11.0	W 93 42.0	3 5 1975	180.00	180.00	-1.54	99.99
333	N74 22.7	W 95 25.0	4 5 1975	168.00	168.00	-1.37	99.99
334	N74 23.5	W 94 16.0	4 5 1975	156.00	156.00	-1.35	99.99
335	N74 24.8	W 93 8.0	4 5 1975	164.00	164.00	-1.38	99.99

*****LULUILU //// END OF LIST ////
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Appendix 2

<u>Depth</u>	<u>Maximum distance from measurement to bottom</u>
0 - 5 m	1 m
5 - 15 m	2 m
15 - 30 m	5 m
30 - 100 m	10 m
100 - 200 m	20 m
200 - 400 m	50 m
400 - 1000 m	100 m
1000 - and up	200 m