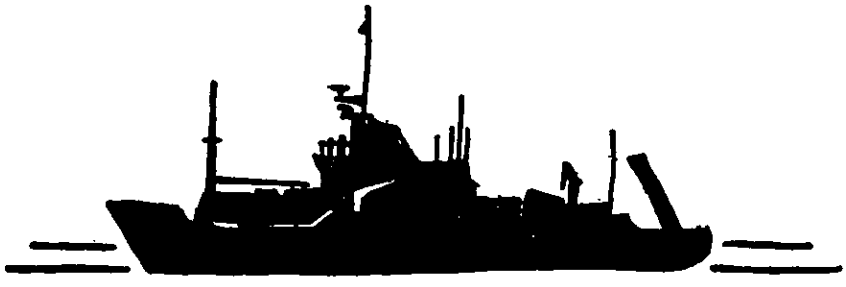
*Scottish Marine Biological Association*

*Dunstaffnage Marine Research Laboratory*



# CRUISE REPORT

R R S Frederick Russell

Cruise 13/87

19 - 27 March 1987

*S.M.B.A., P.O. Box No. 3, Oban, Argyll, Scotland.*

Cruise Report

RRS Frederick Russell 13/87

Duration: 19 - 27 March 1987

Location: Firth of Lorn, Firth of Clyde, North Channel, Scottish continental shelf 55°46' - 56°41'N and east of 8°45'W.

Scientific Staff:

| | | |
|---|---|---|
| Professor J.B.L.Matthews | SMBA Principal Scientist |
| Dr K.J. Jones | SMBA |
| Mr B.E. Grantham | SMBA |
| Dr P.B. Tett | University College of North Wales |
| Miss E Woods | University College of North Wales |
| Mr D. Setiapermana | University College of North Wales |
| Miss M. Macdonald | University College of North Wales |

Aims: 1. To obtain vertical CTD profiles in the Firth of Lorn, Firth of Clyde, North Channel and across the west Scottish continental shelf, in order to chart the distribution and record the characteristics of the main water masses.

2. To obtain measurements of chlorophyll, nutrient levels, and light attenuation and scattering in order to assess the standing stock of phytoplankton and the conditions for primary production.

3. a) To obtain estimates of primary production in the main water masses and relate these to physical and chemical conditions.

b) to compare physical, chemical and phytoplankton conditions at one or more sites with a time lapse of a few days in order to assess net population change for comparison with assessed phytoplankton production (carbon fixation) in the same period.

4. To obtain samples of zooplankton for analysis of community composition near the surface in the main areas, and to estimate zooplankton grazing pressure by gut-pigment analysis.

Narrative: In order to prepare the autoanalyser in advance, Mr Grantham joined the ship in Plymouth on 16 March, as did Mr Setiapermana. The rest of the scientific personnel embarked in Campbeltown just before noon on the 19th. The ship set sail at 16.20 hrs and we were on the first station 20 minutes later. Thereafter sampling continued without interuption throughout the Clyde Sea Area as far as Loch Fyne.(Tarbert), the Firth of Clyde north of Cumbrae and the east and west Kyles of Bute. All the regular stations in the Firth of Clyde and Clyde Sea area were visited, sailing first north up Kilbrannan Sound, into /

into Loch Fyne and the West Kyle, then into the Firth of Clyde north of Cumbrae, and the East Kyle. South of Garroch Head intensive sampling was carried out in a transect across Garroch Head dumping ground to measure nutrient levels particularly in the water near the bottom. Thereafter sampling was continued at all regular stations east and south of Arran. This part of the cruise occupied three and a half days in mixed and often wintry conditions, but no delays were incurred.

The fourth day continued with stations being occupied on the transect across the North Channel from Galloway near Portpatrick to Copeland, Northern Ireland, followed by the remaining stations in the Clyde Sea Area, northwards towards Kintyre with a return visit to the position of the first station just off Campbeltown. Stations were then occupied on the second transect of the North Channel, from Mull of Kintyre to Red Bay. The ship steamed through Rathlin Sound and one station was taken in Portrush Bay where the ship hove to for a couple of hours to allow for routine maintenance of the autoanalyser. By the start of the sixth day (p.m. 24 March) stations were being taken on the transect across to Loch Indaal, Islay. There then followed the transect westwards from the Rhinns of Islay along 55°46'N as far as 8°00W. By the start of the seventh day the cruise had started on the "Firth of Lorn" transect starting at 56°10'N 8°45'W moving eastwards towards the Ross of Mull. The weather worsened, reaching gale force 9 for a time, but the sampling programme was unaffected, except that zooplankton pumping was cancelled at one station and one other station was aborted.

Once back in the calm of the Firth of Lorn (the wind was from the north) the standard stations were occupied as planned. As the weather was still unsettled and the forecast poor, the stations in the Lynn of Lorn and Sound of Mull were then occupied during the night and early morning of the eighth day, in the hope that the weather would ameliorate and allow a transect from Ardnamurchan to Barra Head to be taken without a delay.

Our hopes were not realized. In a gale and with weather charts black with isobars, we occupied the last station at the mouth of the Sound of Mull and turned back, - making the point that the Barra Head transect had always been an optional, though desirable, extra !

Results: /

Results: Data tables are provided as an appendix to this report.

Aim 1) CTD profiles were taken at all but two of the 117 stations visited on the cruise. The exceptions were two of the six stations in close proximity to each other crossing the Garroch Head sludge dumping ground where it was considered important to obtain water samples in quick succession. All data were immediately logged. Salinity and temperature measurements were made at the bottom of each dip and salinity measurements at the surface for calibration purposes.

The network and transects of stations have enabled the distribution of salinity and temperature characteristics to be charted. Plots of selected sections are presented in the accompanying figures.

In addition large water samples were taken at two stations at the N.W. end of the Sound of Mull for subsequent analysis of Caesium isotopes.

Aim 2) Chlorophyll distribution

Vertical profiles of chlorophyll concentration were made at a total of 117 stations during the cruise. Concentrations in the near-surface waters were 0.4-2.0 mg chl $m^{-3}$ over much of the cruise area. Higher chlorophyll concentrations (c.4 mg chl $m^{-3}$) were observed in the near-bottom water in parts of the Firth of Clyde. These were associated with high levels of phaeopigment and may have arisen due to grazing and/or sinking of an earlier phytoplankton bloom. Size fractionation of chlorophyll standing stock was carried out on samples taken from near-surface waters in the Firth of Clyde, Firth of Lorn and Outer Shelf during the cruise. In the firths phytoplankton >5 μm constituted more than 60% of the total chlorophyll and those in the 1 - 5 μm range, 20-25%. Offshore about 60% of the chlorophyll was found in the 1 - 5 μm size fraction. The proportion of chlorophyll found in the 1 μm size fraction did not vary with location.

Results of analysis of variance of log-transformed chlorophyll concentrations from stations AB30, FLO and E4, which were revisited after 6 to 10 hours, are as follows :

| degrees of freedom | variance amongst repeated samples from similar depths at the same station ($\log_{10}$ mg chl $m^{-3}$ O)$^2$ | standard variation as a coefficient of variation |
|---|---|---|
| 14 | 0.0112 | 28% |

At /

At AB30, in the Firth of Clyde, and E4, in the Firth of Lorn, this variability was associated with salinity variation and thus perhaps with tidal changes in estuarine circulation. In the case of FLO, the variability was related to changes in thermocline depth, perhaps reflecting a short or medium term internal wave.

Nutrient measurements

Nutrients were measured at 111 stations using a 4-channel Autoanalyzer. Some problems were experienced with the ammonia analysis caused by precipitation of magnesium hydroxide in the mixing coils, requiring regular treatment with dilute acid to clear the system. The data lost because of this amounted to 10-15% of the total. Complete coverage was obtained of the other three nutrients, nitrate, phosphate and silicate.

Irradiance measurements

The irradiance/depth probe functioned satisfactorily during the cruise with only occasional loss of communications which were attributable to displacement of sensor connectors from the main body of the sea-unit. For most of the cruise output from the irradiance probe was logged on a BBC Master microcomputer using the newly developed suite of programmes. Minor problems with the logging and data processing software were rectified during the cruise.

Aim 3) a) $^{14}C$ assimilation experiments were carried out in a deck incubator to determine photosynthetic characteristics for near-surface phytoplankton populations in the Firths of Clyde and Lorn and Outer Shelf. Higher rates of chlorophyll-specific carbon assimilation at sub-saturating irradiances were observed in Clyde samples than in the other two areas. Estimates of column production for the three areas using these parameters and observed phytoplankton biomass and irradiance attenuation values were 25 mg C $m^{-2}$ $day^{-1}$ in the Firth of Lorn, 48 mg C $m^{-2}$ $day^{-1}$ in the Firth of Clyde and 84 mg C $m^{-2}$ $day^{-1}$ on the Outer Shelf region. Normalisation of these estimates for depth suggests production levels per $m^{-3}$ in the firths were similar during the cruise but less than those on the Outer Shelf by a factor of two.

Experiments /

Experiments were also carried out to determine relative photosynthetic activity of phytoplankton in different size-fractions in the firths and on the shelf. In the Firths of Clyde and Lorn 60% and 75% of the total carbon assimilation respectively was occurring within the >5 μm fraction. On the Outer Shelf, however, the >5 μm and 1 - 5 μm fractions each contributed about 40% of the total production.

b) Station AB17, at the southern entrance to Kilbrannan Sound, was visited on 19 and 24 March, with an interval of 4.3 days. Comparison of the two chlorophyll profiles gives a mean specific rate of change of $-0.35\ day^{-1}$. Assuming the same water mass was visited on each occasion, this decline might be explained by grazing, or grazing and sinking. If this rate is applicable throughout the Firth of Clyde it points to a phytoplankton time-scale (the interval in which concentrations change by $e$ or $1/e$) of about 3 days. Since our survey of the Clyde took about 5 days, and showed ln(chl) at given depths varying by 1 to 2, we should bear in mind that observed patterns of chlorophyll distribution may be partly explained by aliasing between sampling sequence and natural change.

Aim 4) The plankton pump functioned well throughout the cruise, enabling size-fractionated samples to be taken at 10 and 30 m depth at a total of 39 stations (one station was too shallow for a 30 m sample) throughout the sample area. The samples were divided into two equal portions, one being filtered, rinsed in distilled water and frozen for subsequent analysis of consumed plant pigments, the other being fixed in formalin and preserved for subsequent specific analysis. There were clear signs of differences in species composition and in biomass within the area sampled.

Acknowledgements: The ship served us well thorughout the cruise and the crew was helpful at all times. The scientists were much encouraged by the interest shown by the crew in the work being carried out. Our thanks are due to Captain Jonas, the officers and crew for their skill and assistance in making the cruise a success.

# F.RUSSELL CRUISE 13/87 STATION LIST

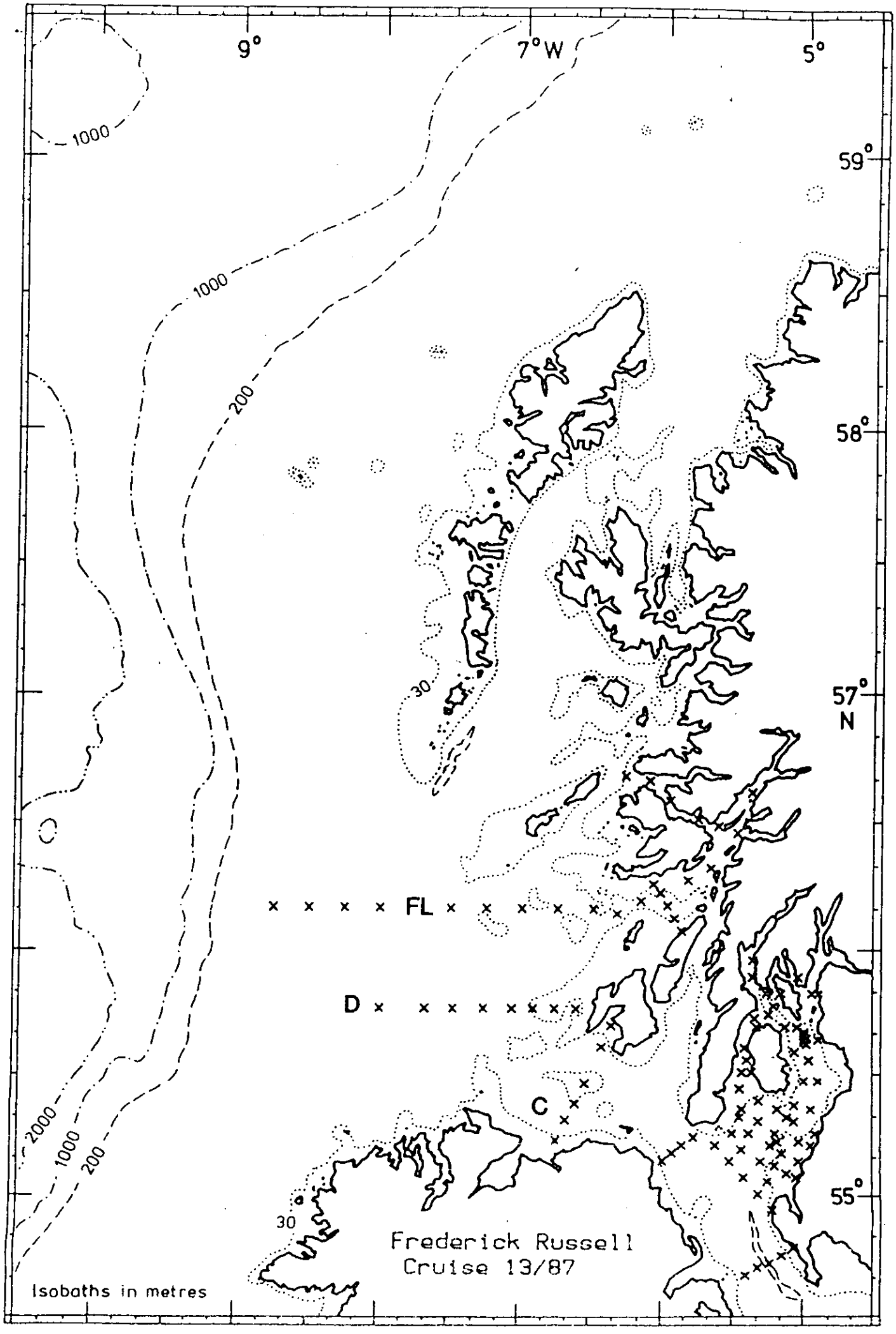
| Name | Lat N | Long W | Dp m | Time GMT | Date GMT | CTD Dip | L | Z | Sample depths Nut. + Phyt. | | | | | | Cs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AB17 | 55.270 | 5.280 | 68 | 1645 | 19/ 3 | 1 | 0 | 2 | 5 | 15 | 30 | 45 | 55 | | - |
| AB48 | 55.310 | 5.230 | 70 | 2135 | 19/ 3 | 2 | 0 | 0 | 5 | 20 | 35 | 60 | | | - |
| AB47 | 55.310 | 5.270 | 62 | 2235 | 19/ 3 | 3 | 0 | 0 | 5 | 20 | 35 | 50 | | | - |
| AB46 | 55.340 | 5.250 | 106 | 2330 | 19/ 3 | 4 | 0 | 0 | 5 | 15 | 30 | 90 | | | - |
| AB45 | 55.370 | 5.260 | 130 | 37 | 20/ 3 | 5 | 0 | 0 | 5 | 30 | 60 | 110 | | | - |
| AB44 | 55.420 | 5.210 | 110 | 146 | 20/ 3 | 6 | 0 | 2 | 5 | 30 | 50 | 80 | | | - |
| AB43 | 55.440 | 5.220 | 68 | 412 | 20/ 3 | 7 | 0 | 0 | 5 | 10 | 20 | 40 | 60 | | - |
| AB42 | 55.450 | 5.160 | 135 | 519 | 20/ 3 | 8 | 0 | 0 | 5 | 20 | 40 | 60 | 100 | 120 | - |
| AB38 | 55.470 | 5.140 | 156 | 608 | 20/ 3 | 9 | 0 | 2 | 5 | 20 | 40 | 70 | 100 | 135 | - |
| AB38A | 55.500 | 5.110 | 59 | 843 | 20/ 3 | 10 | 1 | 2 | 5 | 20 | 30 | 40 | 50 | | - |
| AB39 | 55.500 | 5.170 | 156 | 1050 | 20/ 3 | 11 | 0 | 0 | 5 | 30 | 50 | 90 | 145 | | - |
| AB40 | 55.540 | 5.230 | 144 | 1205 | 20/ 3 | 12 | 1 | 2 | 5 | 30 | 60 | 90 | 120 | | - |
| AB41 | 55.580 | 5.230 | 128 | 1518 | 20/ 3 | 13 | 0 | 0 | 5 | 20 | 40 | 70 | 100 | | - |
| AB37 | 55.420 | 5.090 | 168 | 1804 | 20/ 3 | 14 | 0 | 0 | 5 | 30 | 60 | 100 | 150 | | - |
| AB36 | 55.420 | 5.040 | 76 | 1919 | 20/ 3 | 15 | 0 | 0 | 5 | 20 | 40 | 55 | 70 | | - |
| AB34 | 55.500 | 4.550 | 67 | 2058 | 20/ 3 | 16 | 0 | 2 | 5 | 10 | 25 | 40 | 60 | | - |
| AB35 | 55.500 | 4.580 | 40 | 2230 | 20/ 3 | 17 | 0 | 0 | 5 | 10 | 20 | 30 | | | - |
| AB35A | 55.540 | 5.040 | 56 | 2340 | 20/ 3 | 18 | 0 | 2 | 5 | 15 | 30 | 45 | | | - |
| TOM1 | 55.408 | 5.010 | 80 | 247 | 21/ 3 | 19 | 0 | 0 | 7 | 17 | 62 | 72 | 82 | | - |
| Clyde dumping ground | | | | | | | | | | | | | | | |
| TOM2 | 55.403 | 5.010 | 78 | 318 | 21/ 3 | 20 | 0 | 0 | 3 | 13 | 53 | 63 | 73 | | - |
| TOM3 | 55.398 | 5.010 | 84 | 345 | 21/ 3 | 21 | 0 | 0 | 3 | 13 | 58 | 68 | 78 | | - |
| TOM4 | 55.393 | 5.000 | 99 | 410 | 21/ 3 | 22 | 0 | 0 | 5 | 20 | 75 | 85 | 95 | 105 | - |
| TOM5 | 55.389 | 5.010 | 118 | 452 | 21/ 3 | 23 | 0 | 0 | 5 | 20 | 105 | 115 | 125 | | - |
| TOM6 | 55.384 | 5.010 | 185 | 620 | 21/ 3 | 24 | 0 | 0 | 5 | 50 | 155 | 175 | 165 | | - |
| Last of Clyde dumping ground stations. | | | | | | | | | | | | | | | |
| AB33 | 55.390 | 4.550 | 74 | 728 | 21/ 3 | 25 | 1 | 0 | 5 | 15 | 30 | 45 | 60 | | - |
| AB32 | 55.380 | 5.000 | 112 | 839 | 21/ 3 | 26 | 1 | 0 | 5 | 20 | 50 | 80 | 105 | | - |
| AB31 | 55.360 | 5.050 | 80 | 940 | 21/ 3 | 27 | 1 | 0 | 11 | 12 | 35 | 55 | 70 | | - |
| AB30 | 55.340 | 4.590 | 99 | 1059 | 21/ 3 | 28 | 1 | 2 | 5 | 15 | 30 | 60 | 90 | | - |
| AB29 | 55.310 | 4.520 | 74 | 1350 | 21/ 3 | 29 | 1 | 0 | 5 | 30 | 45 | 60 | | | - |
| AB28 | 55.280 | 4.450 | 44 | 1501 | 21/ 3 | 30 | 1 | 2 | 5 | 20 | 35 | | | | - |
| AB27 | 55.280 | 4.500 | 60 | 1651 | 21/ 3 | 31 | 1 | 0 | 5 | 35 | 55 | | | | - |
| AB26 | 55.290 | 4.550 | 74 | 1802 | 21/ 3 | 32 | 0 | 0 | 5 | 30 | 40 | 65 | | | - |
| AB25 | 55.290 | 5.010 | 102 | 1858 | 21/ 3 | 33 | 0 | 0 | 5 | 30 | 60 | 90 | | | - |
| AB30 | 55.340 | 4.590 | 99 | 2050 | 21/ 3 | 34 | 0 | 2 | 5 | 15 | 30 | 60 | 90 | | - |
| AB24 | 55.230 | 5.050 | 68 | 2343 | 21/ 3 | 35 | 0 | 0 | 5 | 30 | 40 | 55 | | | - |
| AB23 | 55.220 | 4.580 | 52 | 42 | 22/ 3 | 36 | 0 | 0 | 5 | 20 | 40 | | | | - |
| AB23A | 55.220 | 4.510 | 42 | 146 | 22/ 3 | 37 | 0 | 0 | 5 | 30 | | | | | - |
| AB22 | 55.160 | 4.560 | 36 | 248 | 22/ 3 | 38 | 0 | 2 | 5 | 30 | | | | | - |
| AB21 | 55.190 | 5.050 | 52 | 727 | 22/ 3 | 39 | 1 | 0 | 5 | 10 | 20 | 30 | 42 | | - |
| AB20 | 55.200 | 5.080 | 56 | 815 | 22/ 3 | 40 | 1 | 2 | 5 | 15 | 30 | 45 | | | - |
| AB19 | 55.220 | 5.120 | 56 | 1005 | 22/ 3 | 41 | 1 | 0 | 5 | 20 | 30 | 45 | | | - |
| AB18 | 55.240 | 5.200 | 44 | 1125 | 22/ 3 | 42 | 1 | 0 | 5 | 20 | 35 | | | | - |
| AB14 | 55.190 | 5.200 | 46 | 1251 | 22/ 3 | 43 | 1 | 2 | 5 | 20 | 35 | | | | - |
| AB13 | 55.160 | 5.130 | 48 | 1444 | 22/ 3 | 44 | 1 | 0 | 5 | 20 | 40 | | | | - |
| AB12 | 55.140 | 5.120 | 48 | 1535 | 22/ 3 | 45 | 1 | 0 | 5 | 20 | 40 | | | | - |
| AB11 | 55.140 | 5.030 | 44 | 1636 | 22/ 3 | 46 | 1 | 0 | 5 | 15 | 25 | 40 | | | - |
| AB10 | 55.130 | 4.580 | 30 | 1729 | 22/ 3 | 47 | 1 | 0 | 5 | 15 | 23 | | | | - |
| AB9 | 55.090 | 5.030 | 44 | 1855 | 22/ 3 | 48 | 1 | 0 | 5 | 20 | 29 | | | | - |
| AB8 | 55.110 | 5.100 | 52 | 1947 | 22/ 3 | 49 | 0 | 2 | 5 | 15 | 25 | 42 | | | - |
| AB7 | 55.130 | 5.150 | 48 | 2110 | 22/ 3 | 50 | 0 | 0 | 5 | 15 | 30 | 40 | | | - |

F.RUSSELL CRUISE 13/87 STATION LIST

| Name | Lat N | Long W | Dp m | Time GMT | Date GMT | CTD Dip | L | Z | Sample depths Nut. + Phyt. | | | | | Cs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AB6 | 55.160 | 5.240 | 48 | 2206 | 22/ 3 | 51 | 0 | 0 | 5 | 20 | 40 | | | - |
| AB5 | 55.120 | 5.270 | 73 | 2254 | 22/ 3 | 52 | 0 | 2 | 5 | 25 | 45 | 65 | | - |
| AB4 | 55.090 | 5.190 | 60 | 26 | 23/ 3 | 53 | 0 | 0 | 5 | 20 | 50 | | | - |
| AB3 | 55.080 | 5.130 | 60 | 206 | 23/ 3 | 54 | 0 | 0 | 5 | 20 | 50 | | | - |
| AB2 | 55.060 | 5.080 | 36 | 249 | 23/ 3 | 55 | 0 | 0 | 5 | 30 | | | | - |
| AB1 | 55.050 | 5.040 | 20 | 326 | 23/ 3 | 56 | 0 | 1 | 5 | 15 | | | | - |
| AB3A | 55.040 | 5.160 | 75 | 500 | 23/ 3 | 57 | 0 | 2 | 5 | 20 | 40 | 64 | | - |
| Y1 | 54.570 | 5.140 | 54 | 725 | 23/ 3 | 58 | 0 | 2 | 5 | 15 | 30 | 47 | | - |
| 6Z | 54.480 | 5.050 | 21 | 923 | 23/ 3 | 59 | 1 | 0 | 5 | 15 | | | | - |
| 5Z | 54.460 | 5.100 | 132 | 1015 | 23/ 3 | 60 | 1 | 0 | 5 | 50 | 120 | | | - |
| 4Z | 54.440 | 5.150 | 253 | 1113 | 23/ 3 | 61 | 1 | 2 | 5 | 85 | 165 | 245 | | - |
| 3Z | 54.430 | 5.200 | 130 | 1316 | 23/ 3 | 62 | 1 | 0 | 5 | 20 | 60 | 120 | | - |
| 2Z | 54.410 | 5.250 | 92 | 1407 | 23/ 3 | 63 | 1 | 0 | 5 | 20 | 80 | | | - |
| 2Y | 55.010 | 5.200 | 112 | 1656 | 23/ 3 | 64 | 1 | 0 | 5 | 30 | 60 | 90 | 101 | - |
| 3Y | 55.050 | 5.260 | 96 | 1804 | 23/ 3 | 65 | 0 | 2 | 5 | 20 | 70 | | | - |
| 4Y | 55.090 | 5.320 | 107 | 1936 | 23/ 3 | 66 | 0 | 0 | 5 | 20 | 40 | 60 | 93 | - |
| AB5A | 55.160 | 5.310 | 60 | 2045 | 23/ 3 | 67 | 0 | 0 | 5 | 25 | 40 | 60 | | - |
| AB15 | 55.200 | 5.280 | 50 | 2154 | 23/ 3 | 68 | 0 | 2 | 5 | 20 | 40 | | | - |
| AB16 | 55.220 | 5.270 | 34 | 2306 | 23/ 3 | 69 | 0 | 0 | 5 | 28 | | | | - |
| AB17 | 55.270 | 5.280 | 62 | 2355 | 23/ 3 | 70 | 0 | 2 | 5 | 20 | 50 | | | - |
| 5Y | 55.130 | 5.380 | 82 | 248 | 24/ 3 | 71 | 0 | 0 | 5 | 20 | 40 | 70 | | - |
| A2 | 55.150 | 5.470 | 120 | 400 | 24/ 3 | 72 | 0 | 2 | 5 | 25 | 60 | 107 | | - |
| A3 | 55.130 | 5.520 | 128 | 1748 | 24/ 3 | 73 | 0 | 0 | 5 | 30 | 70 | 110 | | - |
| A4 | 55.110 | 5.560 | 137 | 638 | 24/ 3 | 74 | 1 | 2 | 5 | 70 | 126 | | | - |
| A5 | 55.090 | 6.000 | 70 | 843 | 24/ 3 | 75 | 1 | 0 | 5 | 30 | 55 | | | - |
| C1 | 55.140 | 6.450 | 22 | 1115 | 24/ 3 | 76 | 1 | 0 | 5 | 15 | | | | - |
| C2 | 55.190 | 6.410 | 72 | 1528 | 24/ 3 | 77 | 1 | 0 | 5 | 20 | 60 | | | - |
| C3 | 55.230 | 6.370 | 80 | 1630 | 24/ 3 | 78 | 1 | 2 | 5 | 25 | 50 | 67 | | - |
| C4 | 55.280 | 6.330 | 94 | 1810 | 24/ 3 | 79 | 0 | 0 | 5 | 25 | 50 | 73 | | - |
| C5 | 55.280 | 6.330 | 100 | 19 | 24/ 3 | 80 | 0 | 2 | 5 | 45 | 80 | | | - |
| C6 | 55.370 | 6.260 | 66 | 2043 | 24/ 3 | 81 | 0 | 0 | 5 | 50 | | | | - |
| C7 | 55.420 | 6.220 | 21 | 2135 | 24/ 3 | 82 | 0 | 0 | 5 | 15 | | | | - |
| D7 | 55.460 | 6.370 | 60 | 2310 | 24/ 3 | 83 | 0 | 2 | 5 | 50 | | | | - |
| D6 | 55.460 | 6.460 | 40 | 58 | 25/ 3 | 84 | 0 | 0 | 5 | 30 | | | | - |
| D5 | 55.460 | 6.550 | 44 | 157 | 25/ 3 | 85 | 0 | 0 | 5 | 35 | | | | - |
| D4 | 55.460 | 7.040 | 45 | 251 | 25/ 3 | 86 | 0 | 2 | 5 | 35 | | | | - |
| D3 | 55.460 | 7.160 | 60 | 450 | 25/ 8 | 87 | 0 | 0 | 5 | 15 | 30 | 40 | 48 | - |
| D2 | 55.460 | 7.290 | 52 | 640 | 25/ 3 | 88 | 0 | 0 | 5 | 20 | 36 | | | - |
| D1 | 55.460 | 7.410 | 80 | 800 | 25/ 3 | 89 | 1 | 0 | 5 | 30 | 60 | | | - |
| D0 | 55.460 | 8.000 | 101 | 1005 | 25/ 3 | 90 | 1 | 2 | 5 | 45 | 90 | | | - |
| FL0 | 56.100 | 8.450 | 124 | 1504 | 25/ 3 | 91 | 1 | 2 | 5 | 20 | 40 | 70 | 110 | - |
| FL1 | 56.100 | 8.300 | 118 | 1752 | 25/ 3 | 92 | 0 | 0 | 5 | 30 | 75 | 103 | | - |
| FL0 | 56.100 | 8.450 | 122 | 1945 | 25/ 4 | 93 | 0 | 0 | 5 | 30 | 60 | 80 | 108 | - |
| FL2 | 56.100 | 8.150 | 110 | 2155 | 25/ 3 | 94 | 0 | 0 | 5 | 40 | 55 | 100 | | - |
| FL3 | 56.100 | 8.000 | 110 | 2352 | 25/ 3 | 95 | 0 | 0 | 5 | 30 | 90 | | | - |
| FL5 | 56.100 | 7.300 | 112 | 220 | 26/ 3 | 96 | 0 | 0 | 5 | 50 | 90 | | | - |
| FL6 | 56.100 | 7.150 | 72 | 346 | 26/ 3 | 97 | 0 | 0 | 5 | 20 | 50 | | | - |
| FL7 | 56.100 | 7.000 | 64 | 508 | 26/ 3 | 98 | 0 | 0 | 5 | 15 | 25 | 35 | 48 | - |
| FL8 | 56.100 | 6.450 | 61 | 635 | 26/ 3 | 99 | 0 | 0 | 5 | 25 | 48 | | | - |
| FL9 | 56.100 | 6.300 | 55 | 804 | 26/ 3 | 100 | 1 | 2 | 5 | 25 | 45 | | | - |
| FL10 | 56.090 | 6.200 | 70 | 1000 | 26/ 3 | 101 | 1 | 2 | 5 | 30 | 60 | | | - |
| FL11 | 56.120 | 6.100 | 73 | 1214 | 26/ 3 | 102 | 1 | 0 | 5 | 20 | 60 | | | - |
| FL12 | 56.140 | 6.020 | 75 | 1325 | 26/ 3 | 103 | 1 | 2 | 5 | 20 | 40 | 60 | | - |
| E4 | 56.140 | 6.020 | 75 | 1325 | 26/ 3 | 103 | 1 | 2 | 5 | 20 | 40 | 60 | | - |

F.RUSSELL CRUISE 13/87 STATION LIST

| Name | Lat N | Long W | Dp m | Time GMT | Date GMT | CTD Dip | L | Z | Sample depths Nut. + Phyt. | | | | | | Cs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E3 | 56.110 | 5.590 | 96 | 1517 | 23/ 3 | 104 | 1 | 0 | 5 | 20 | 70 | | | | - |
| E2 | 56.080 | 5.560 | 80 | 1627 | 26/ 3 | 105 | 1 | 2 | 5 | 25 | 50 | 66 | | | - |
| E1 | 56.050 | 5.530 | 103 | 1804 | 26/ 3 | 106 | 0 | 0 | 5 | 30 | 70 | 84 | | | - |
| E4 | 56.140 | 6.020 | 78 | 1940 | 26/ 3 | 107 | 0 | 0 | 5 | 25 | 50 | 64 | | | - |
| E5 | 56.160 | 6.050 | 70 | 2025 | 26/ 3 | 108 | 0 | 0 | 5 | 20 | 40 | 60 | | | - |
| FL13 | 56.170 | 5.504 | 130 | 2143 | 26/ 3 | 109 | 0 | 2 | 5 | 35 | 70 | | | | - |
| FL14 | 56.200 | 5.410 | 216 | 2308 | 26/ 3 | 110 | 0 | 0 | 5 | 20 | 80 | 140 | 200 | | - |
| FL15 | 56.280 | 5.300 | 45 | 53 | 27/ 3 | 111 | 0 | 2 | 2 | 5 | 10 | 20 | 30 | | - |
| LM1 | 56.296 | 5.380 | 206 | 257 | 27/ 3 | 112 | 0 | 2 | 5 | 80 | 160 | | | | - |
| LM2 | 56.374 | 5.240 | 90 | 528 | 27/ 3 | 113 | 0 | 0 | 5 | 10 | 15 | 25 | 50 | 77 | - |
| SM1 | 56.312 | 5.465 | 120 | 748 | 27/ 3 | 114 | 1 | 2 | 2 | 5 | 10 | 50 | 112 | | - |
| SM2 | 56.354 | 5.585 | 125 | 952 | 27/ 3 | 115 | 1 | 0 | 2 | 5 | 10 | 30 | 70 | 115 | - |
| G1 | 56.400 | 6.070 | 76 | 1108 | 27/ 3 | 116 | 1 | 0 | 5 | 20 | 35 | 50 | 65 | | 0 |
| G2 | 56.410 | 6.170 | 36 | 1258 | 27/ 3 | 117 | 1 | 0 | 5 | 25 | | | | | 0 |


9°
7°W
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1000
1000
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30
2000
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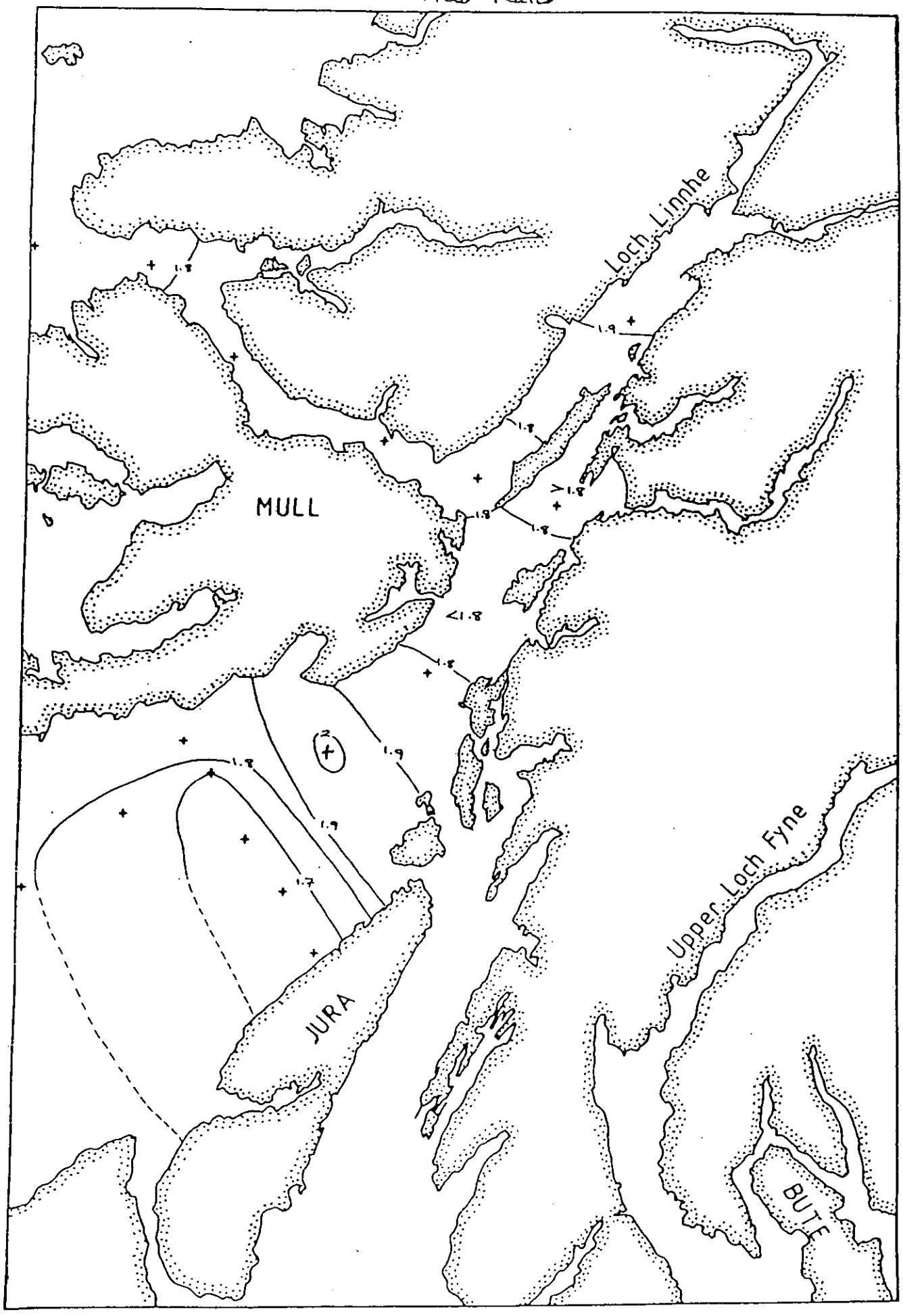
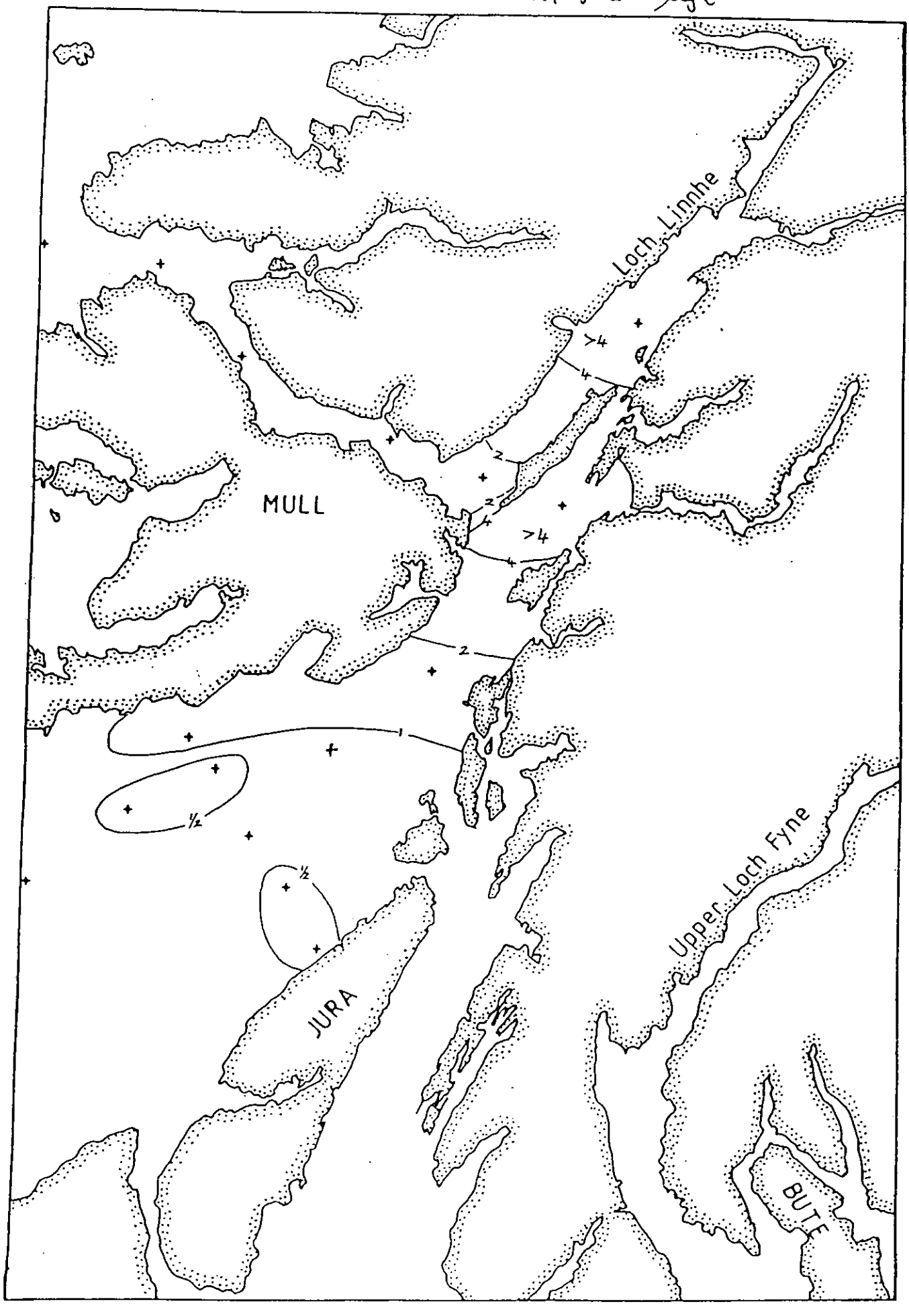
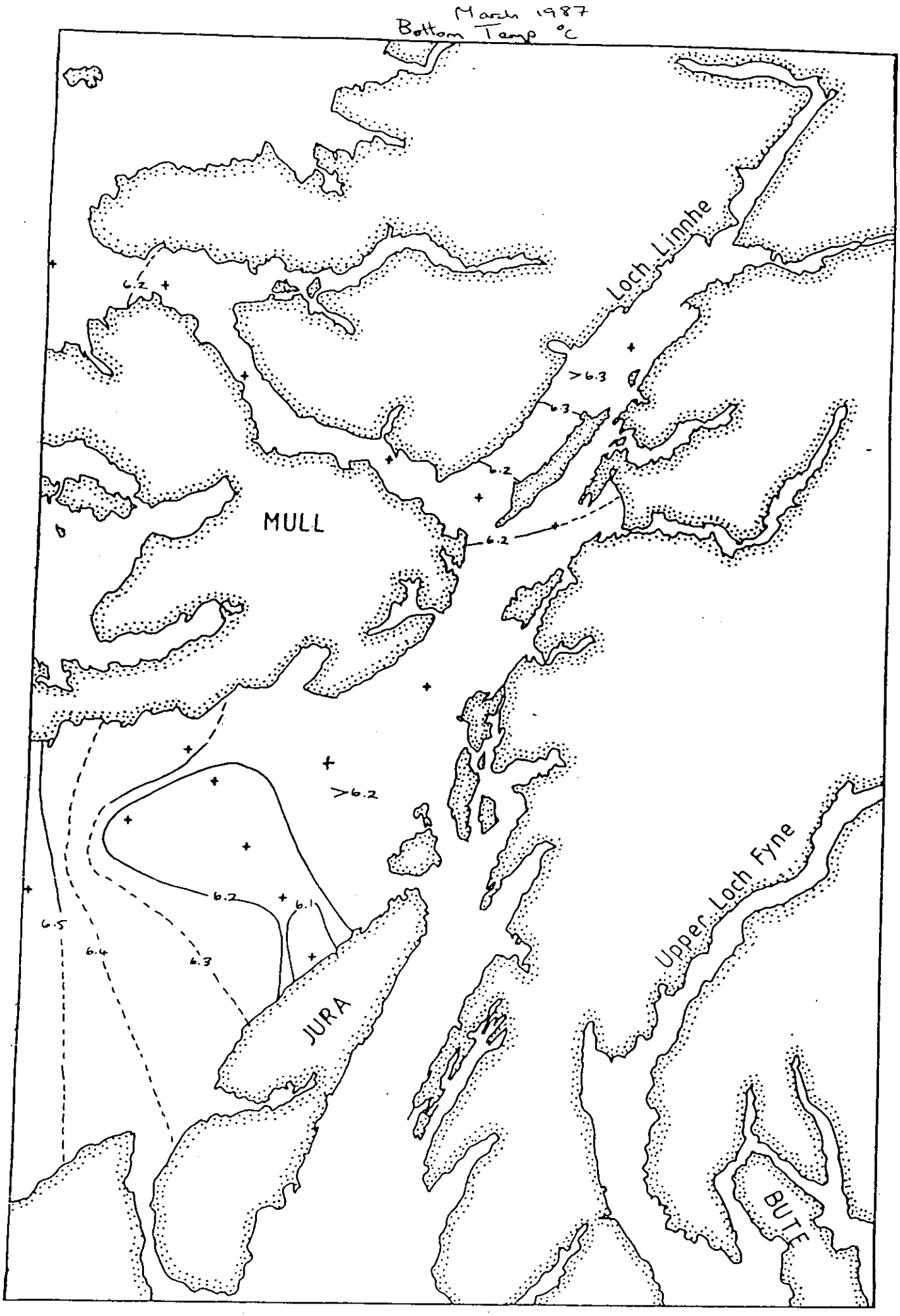
30
FL
D
C
Frederick Russell
Cruise 13/87
Isobaths in metres

March 1987

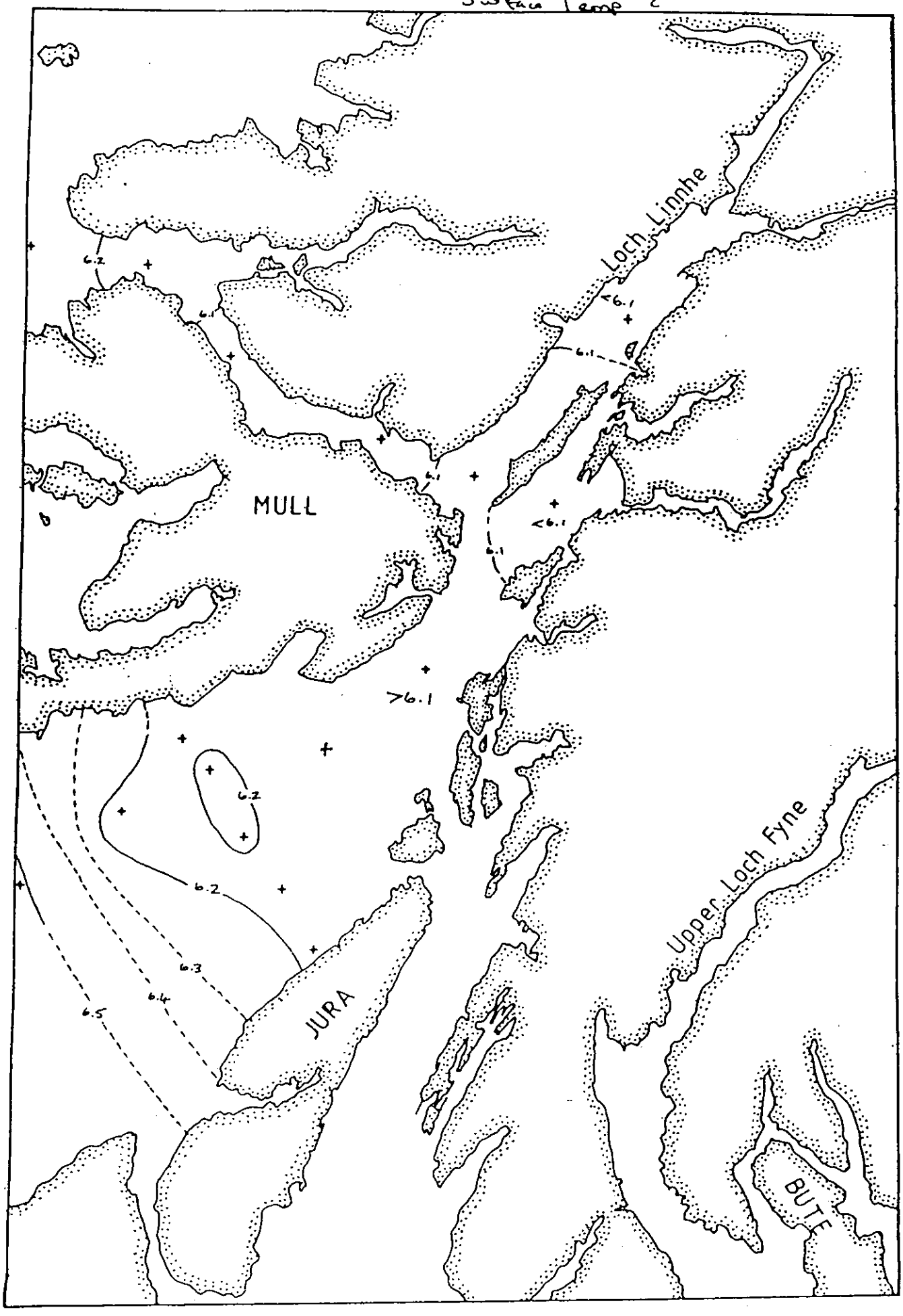
Acid Ratio




March 1987
Chlorophyll a mg l⁻¹
Loch Linnhe
MULL
JURA
Upper Loch Fyne
BUTE
>4
4
2
2
4
>4
4
2
1
½
½

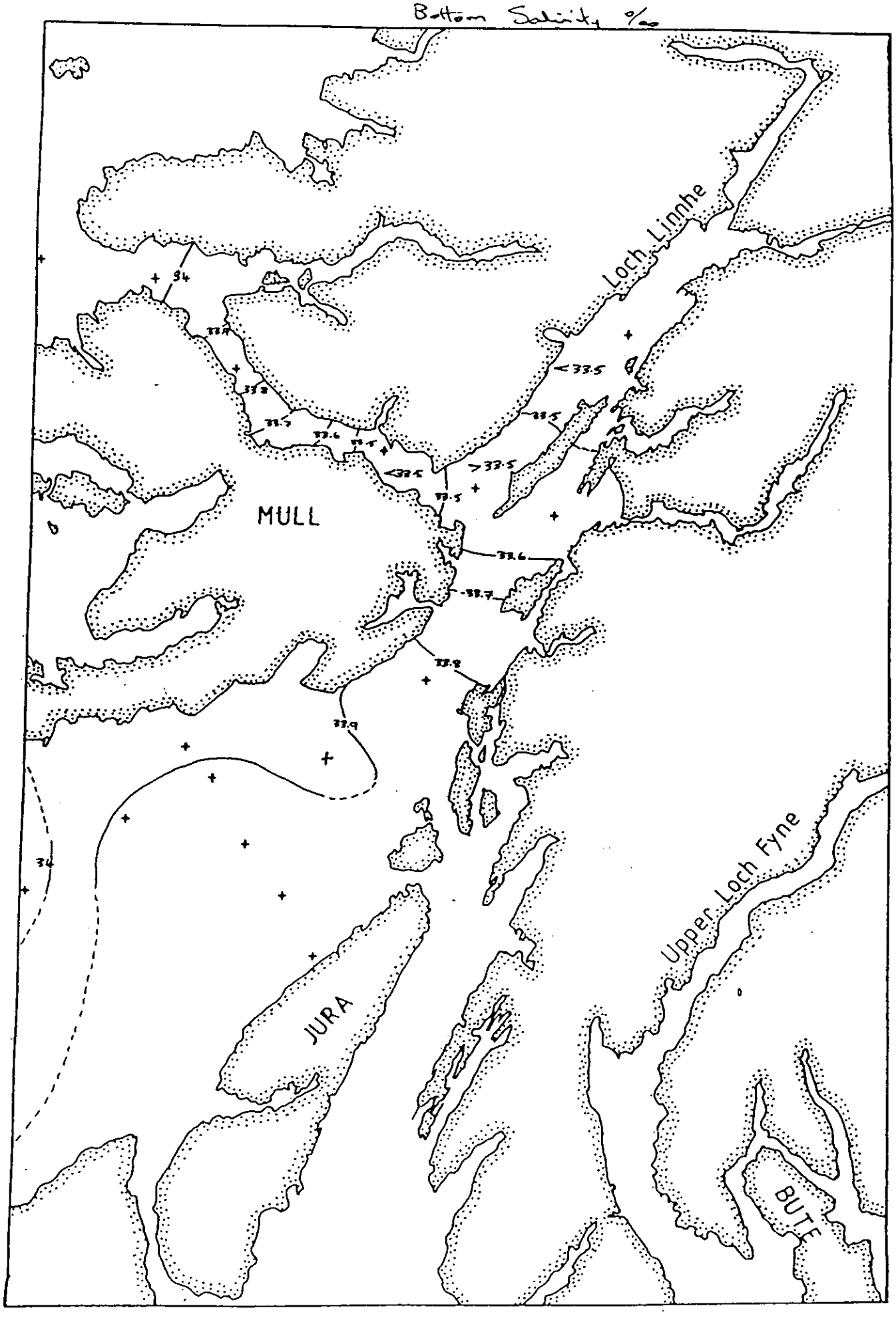

March 1987
Bottom Temp °C
Loch Linnhe
MULL
JURA
Upper Loch Fyne
BUTE
6.2
>6.3
6.3
6.2
6.2
>6.2
6.2
6.1
6.5
6.4
6.3

March 1987
Surface Temp °C



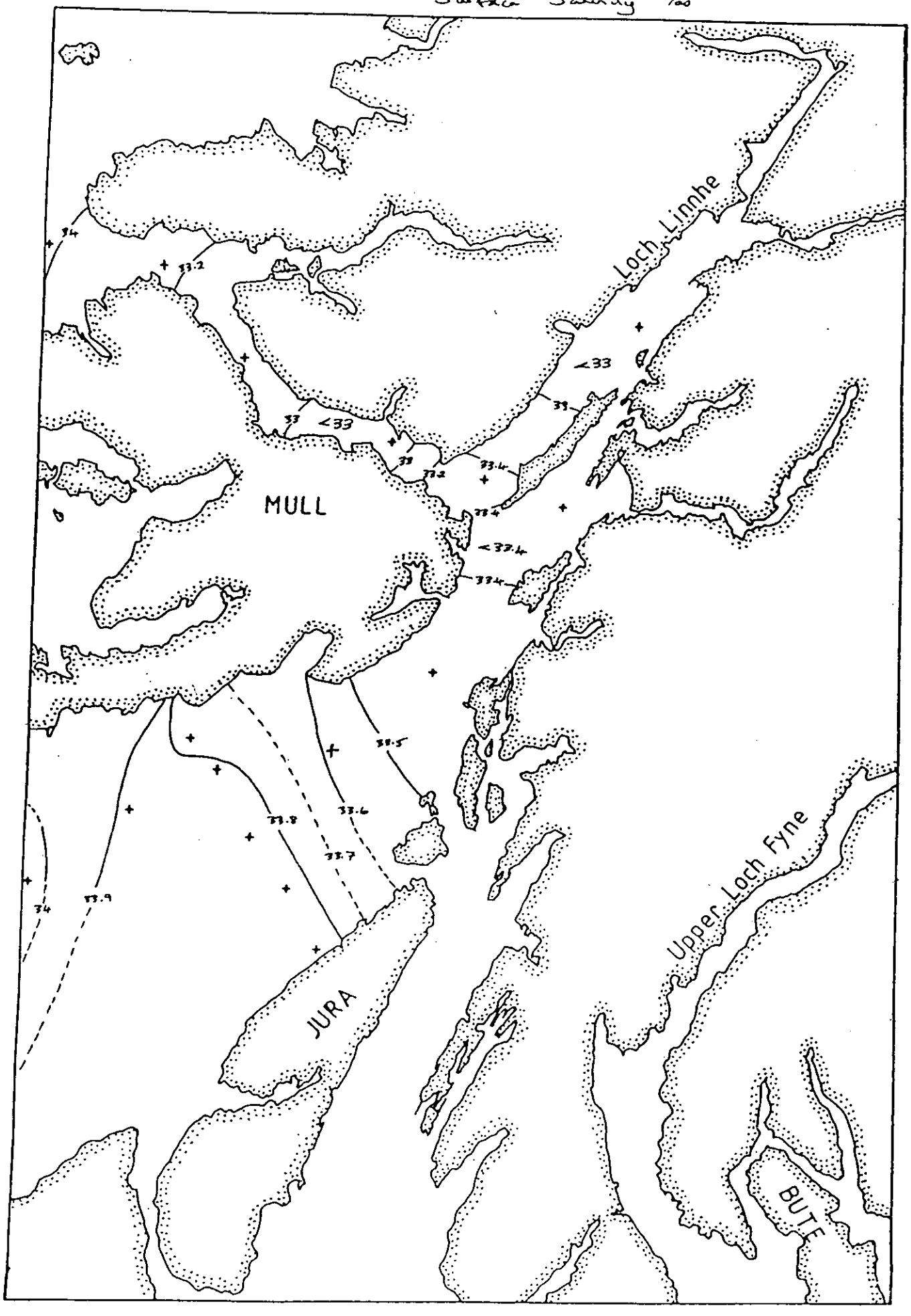
March 1987

Bottom Salinity ‰



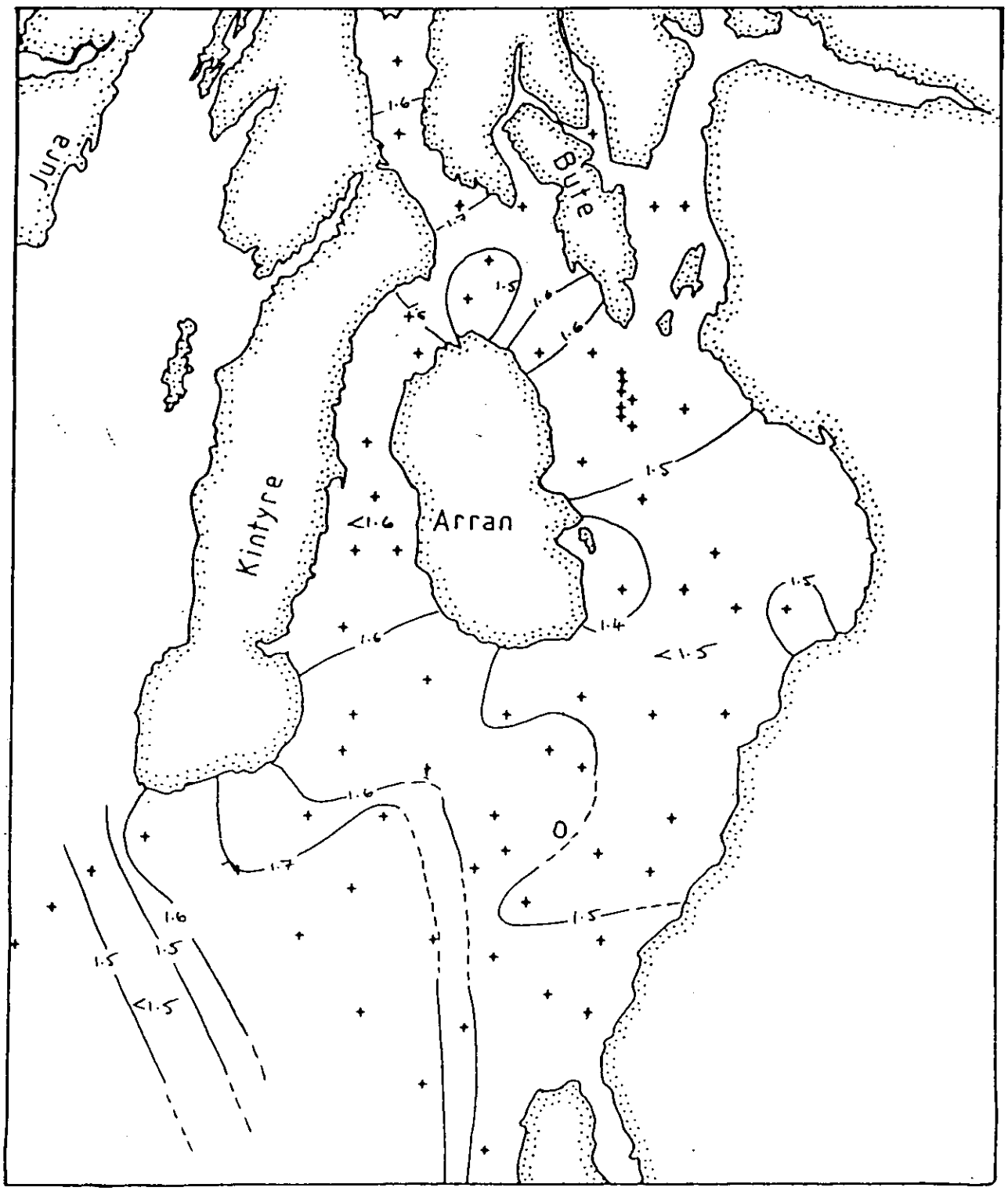
March 1987

Surface Salinity ‰

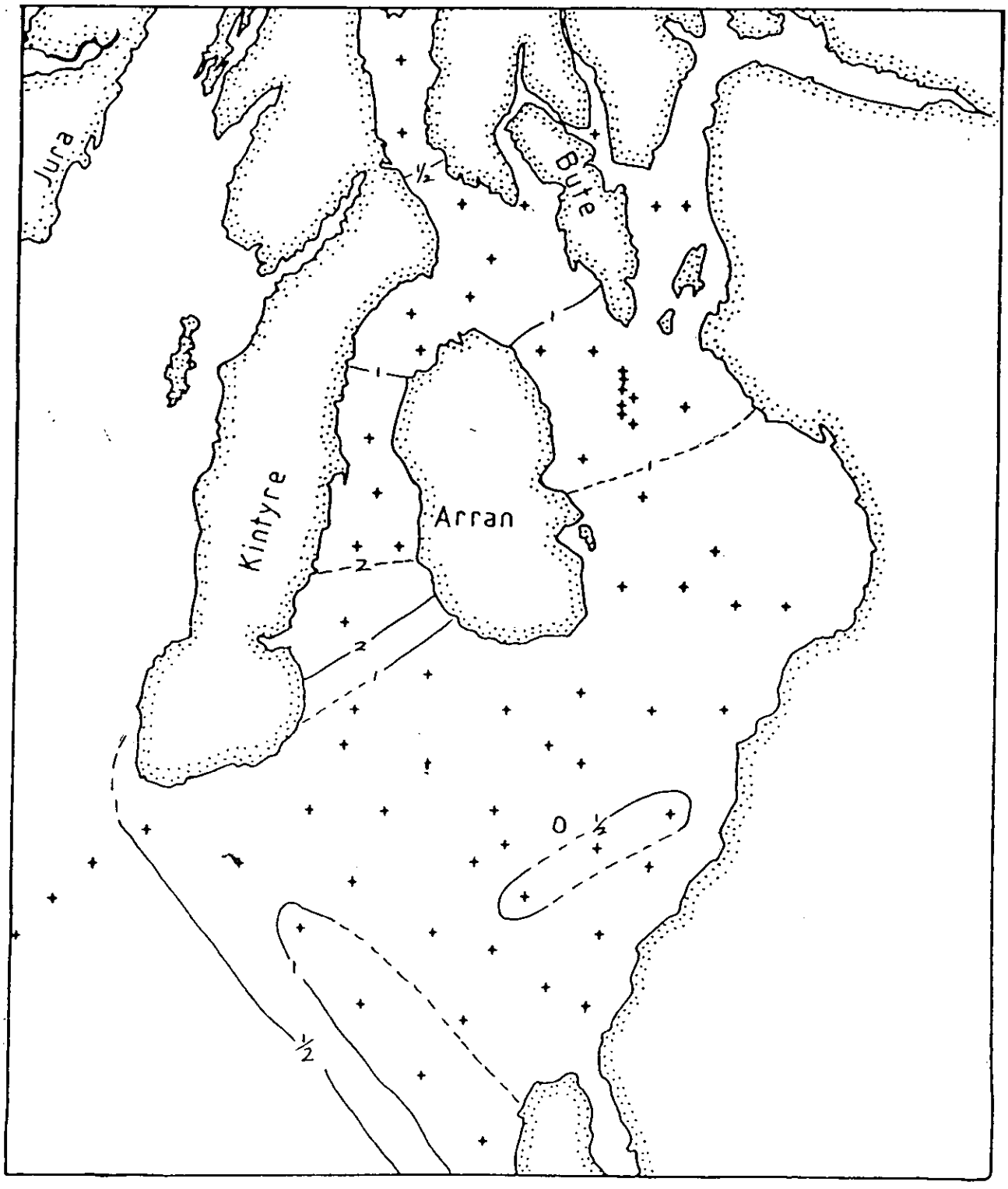


March 1987

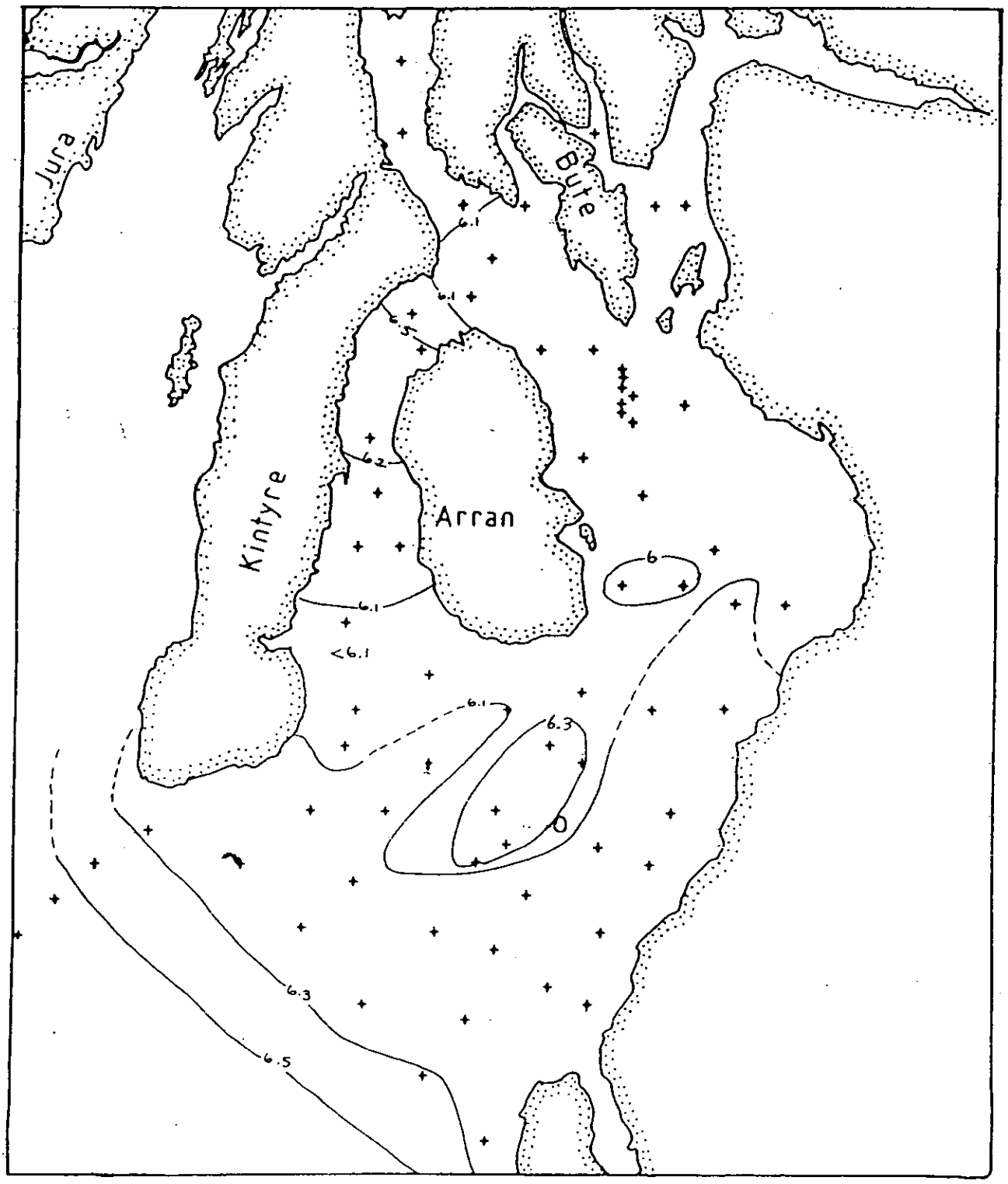
Acid Ratio



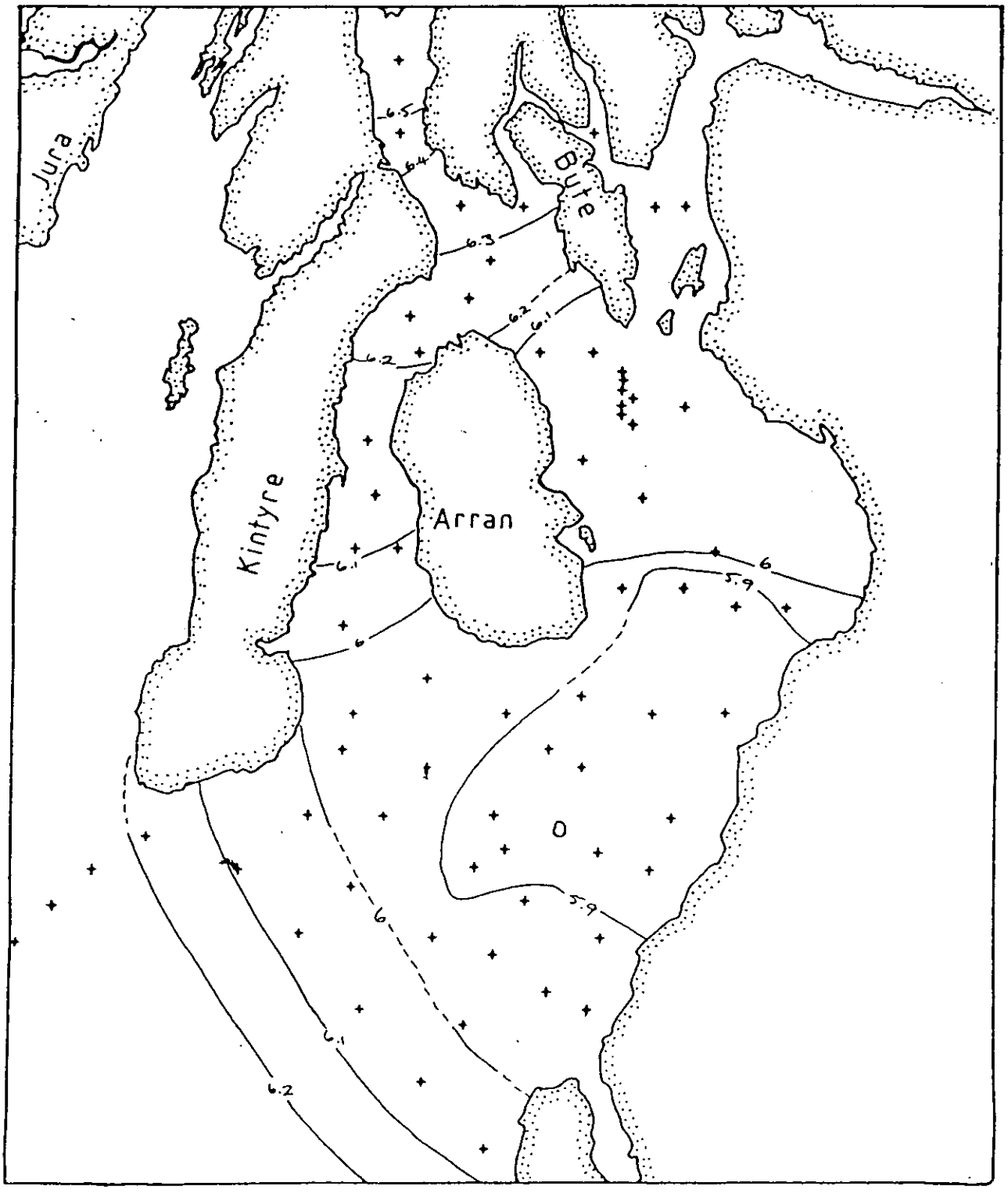
March 1987
Surface Chlorophyll a. $\mu g l^{-1}$



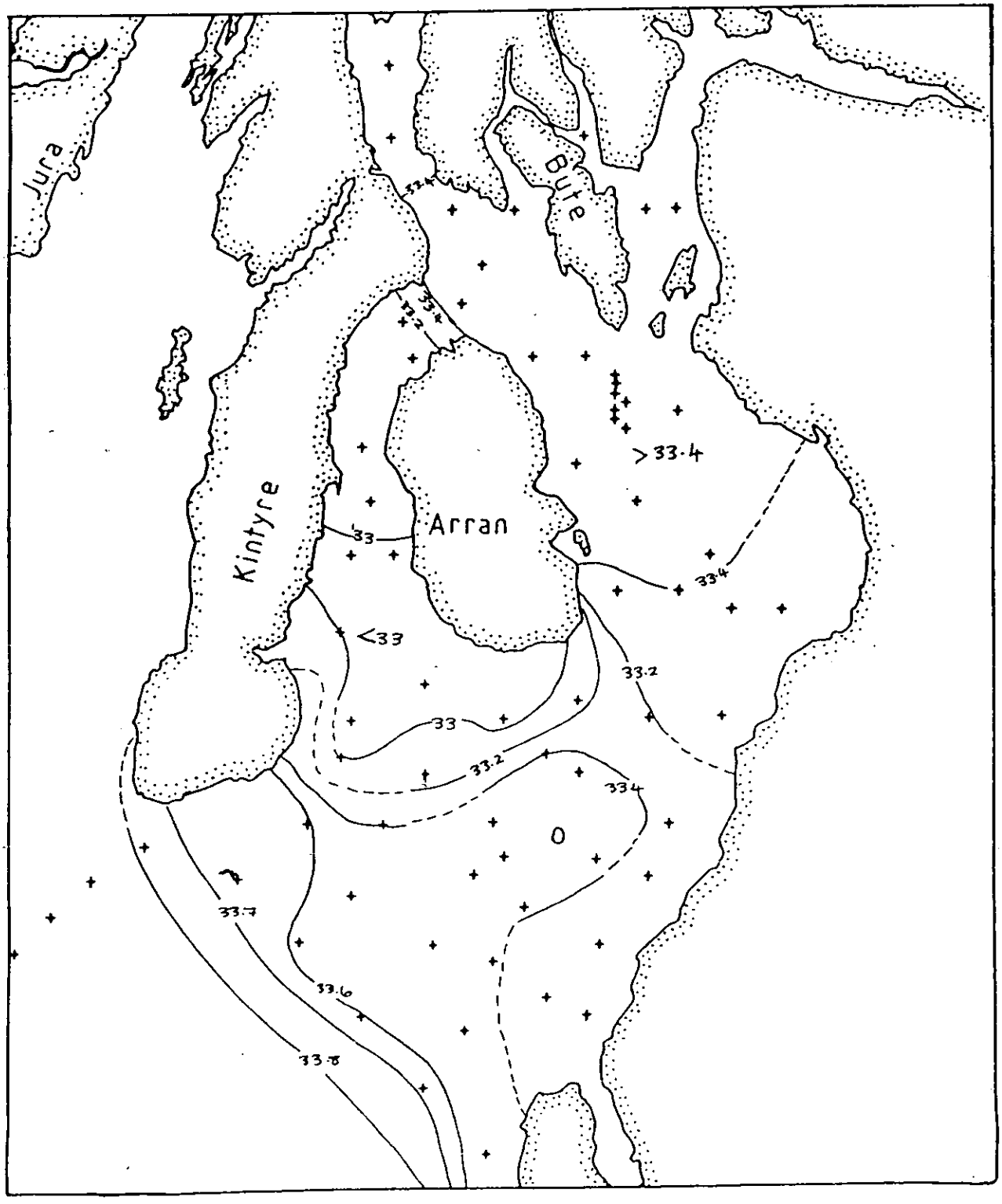
March 1987
Bottom Temp °C



March 1987
Surface Temp. °C

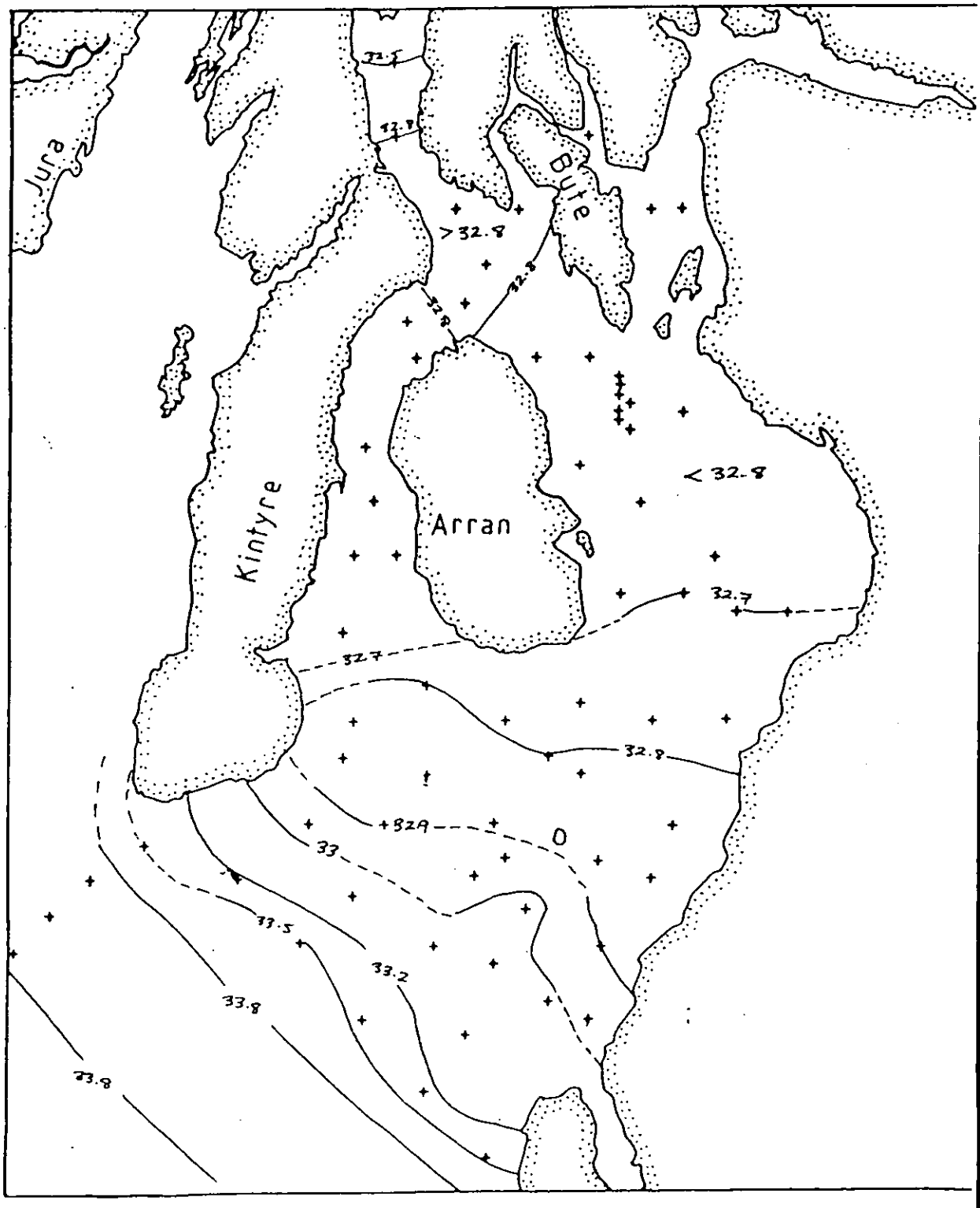


March 1987
Bottom Salinity. ‰



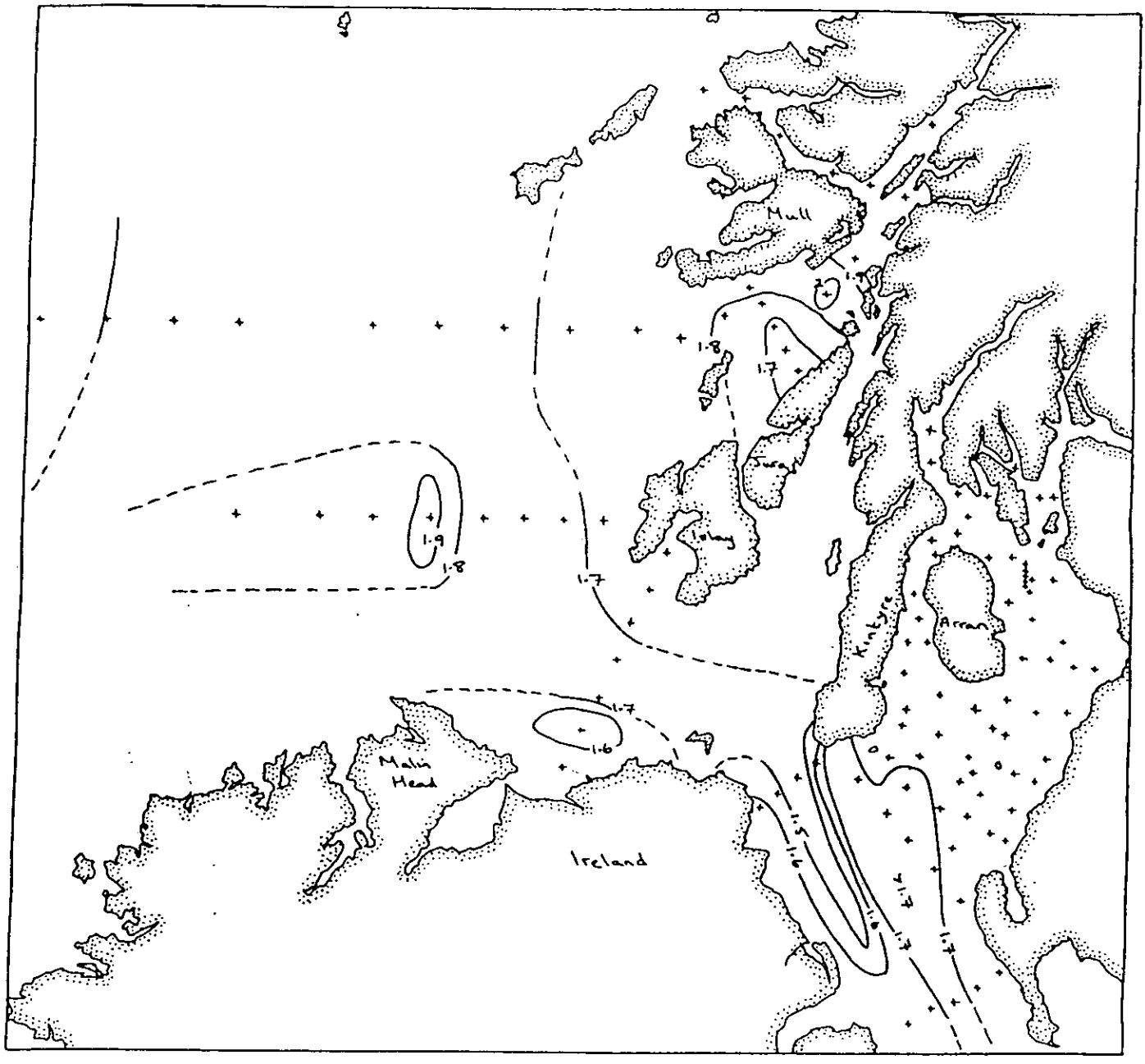
March 1987

Surface salinity ‰



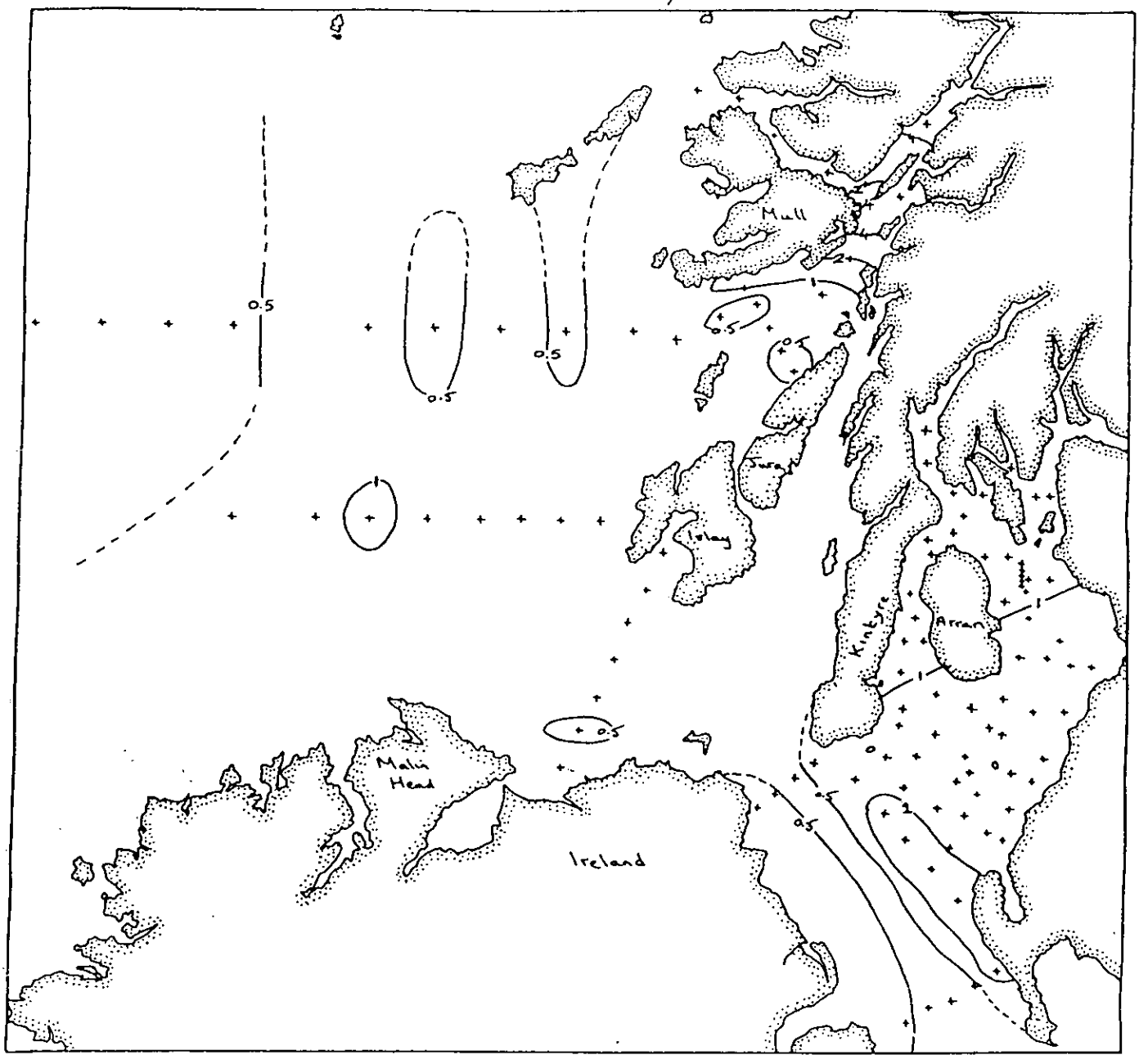
March 1987

Acid Ratio.

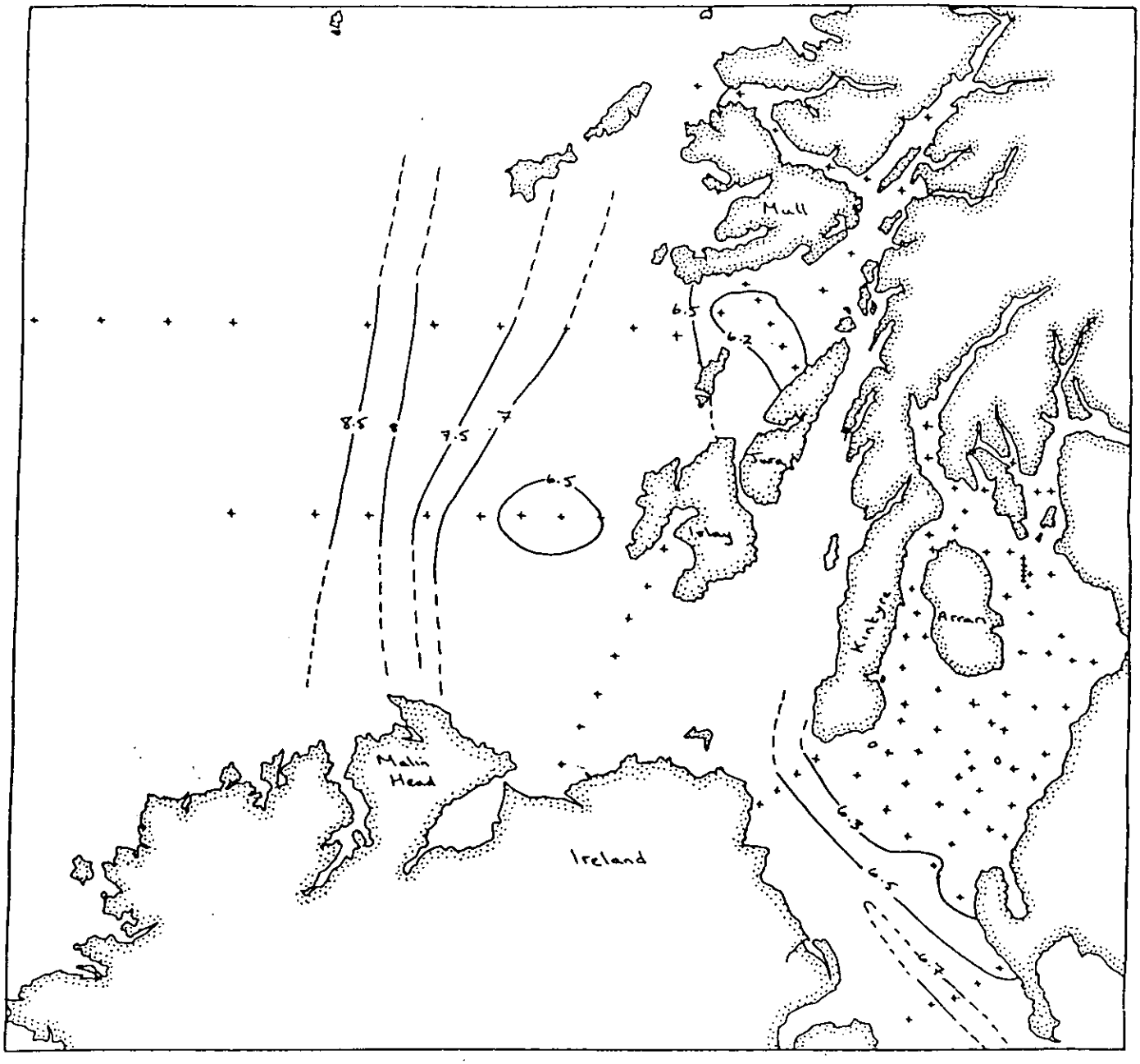


March 1987

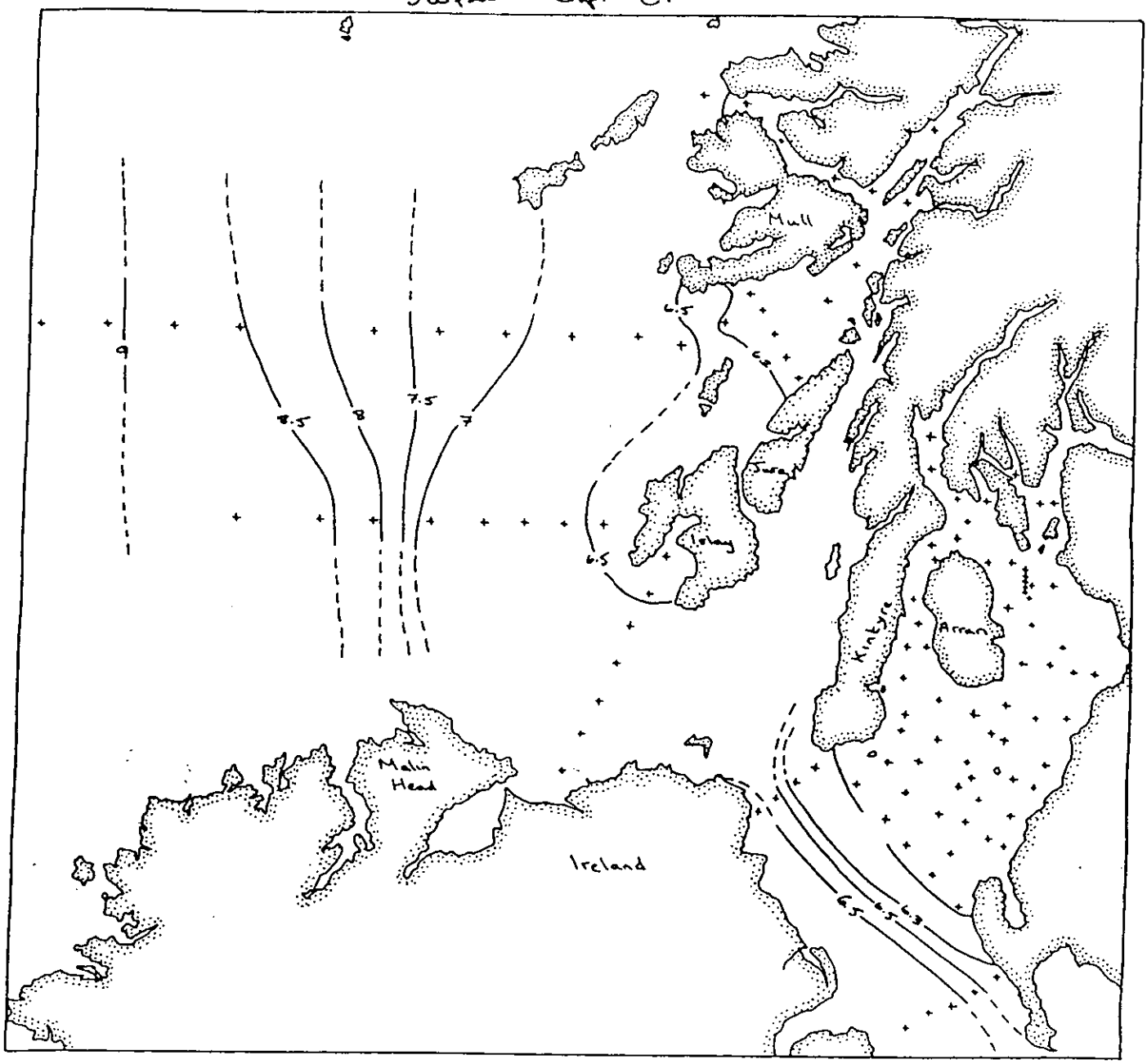
Chl a ($\mu g\ l^{-1}$)



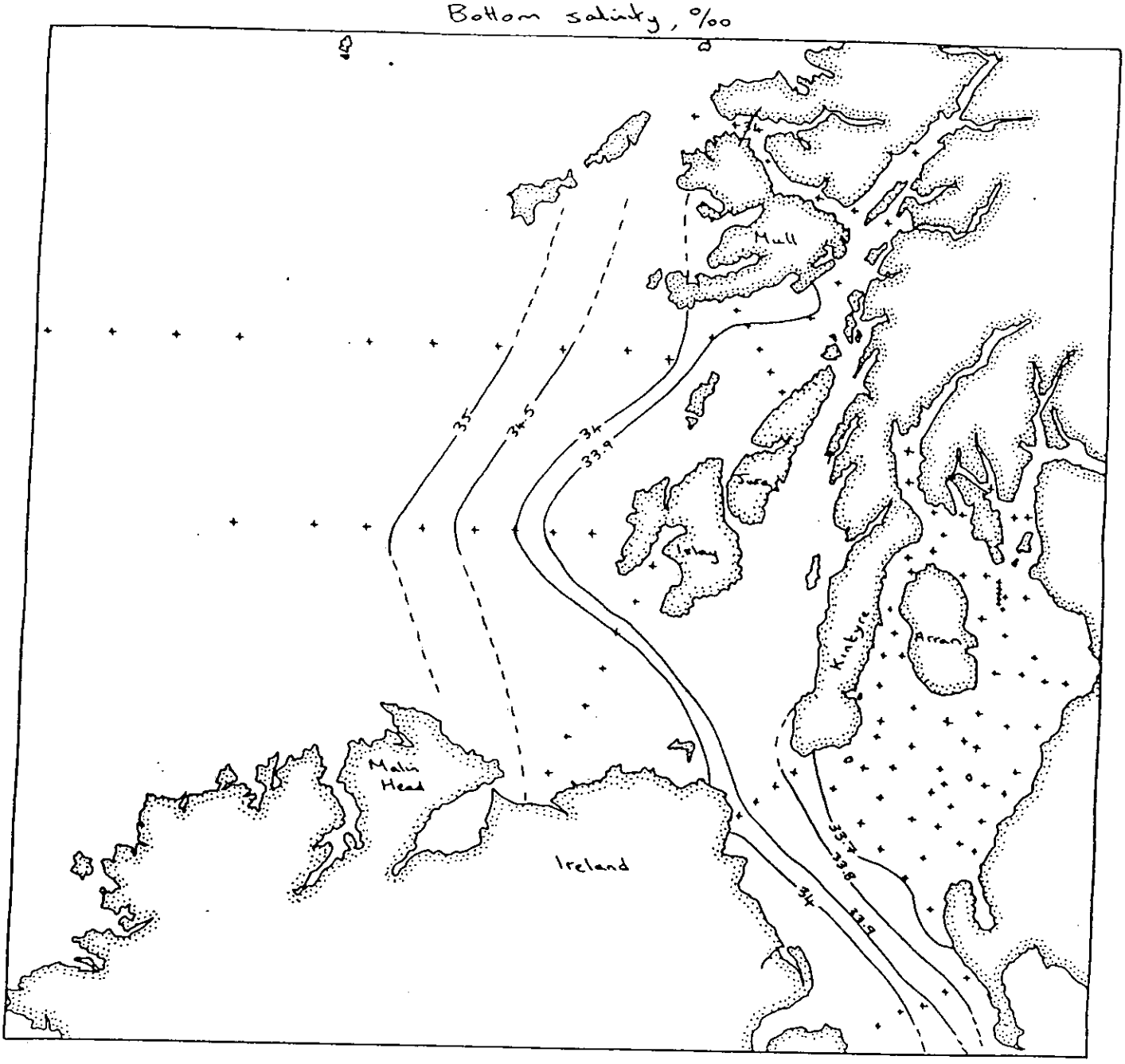
March 1987
Bottom Temp °C.



March 1987
Surface Temp. °C.



March 1987
Bottom salinity, ‰



March 1987

Surface salinity ‰