Challenger 108A/93
[LOIS RACS 1]
8-24 November 1993
Cruise Report

PML Cruise: LOIS RACS-1
RVS Cruise: CH 108a/93

HUMBER PLUME AND E. COAST CRUISE REPORT

VESSEL: RRS CHALLENGER

PERIOD: 8 NOVEMBER-24 NOVEMBER

PERSONNEL:

R. Howland (PML) Senior scientist
G. Ballard (POL)
C. Barrett (PML)
A. Cormack (RVS)
M. Finch (SUDO)
D. Flatt (POL)
A. Harrison (POL)
S. Hudson (UOP)
J. Hughes (BODC)
R. Lowry (BODC)
A. Pantiulin (Moscow State University)
D. Plummer (PML)
R. Powell (RVS)
T. Sands (UOP)
M. Williams UOP)
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OBJECTIVES:

a). To quantify hydrodynamical transports and the processes affecting transformations, interactions and fates of particles, biogeochemically important elements and representative contaminants from land sources to the coastal zone.

b). To provide the first integrated environmental data base for a UK coastal region covering seasonal cycles and interannual variability and incorporating measurements of the fluxes of materials and rates of biological productivity.

c). To generate new quantitative understanding of estuarine and coastal zone processes controlling the fluxes and reactivities of both natural and anthropogenic materials.

d). To provide integratable models of these processes as building blocks for comprehensive coastal zone system models which will realistically predict the affects of future environmental change.

ITINERARY:

Monday 8th Nov.: Scientific party, (with the exception of R. Lowry and J. Hughes (BODC) and C.Barrett and D. Plummer (PML) who will be joining in the Humber when the POL mooring team disembark) joined the ship in Barry. Loaded scientific equipment.

Tuesday 9th Nov.: Ship sailed from Barry at 1200 en route for the Humber/Wash area. The day was spent setting up equipment and checking that everything worked.

Wednesday 10th Nov.: On passage.

Thursday 11th Nov.: On passage. Commenced continuous underway monitoring of salinity, temperature, suspended particulate material, chlorophyll fluorescence and nutrients (phosphate, nitrate and nitrite) off Great Yarmouth.

Friday 12th Nov.: Arrived off the Holderness coast during the forenoon and commenced laying the PMP rigs (figure 1 shows the positions of the Holderness moorings). All the moorings for the Holderness coast experiment were laid during the afternoon without any problems. The weather was quiet and the sea state slight. On completion, we commenced monitoring on the Humber/Wash grid. (see figure 2).

Saturday 13th Nov.: Broke off from the Humber/Wash Grid in the late forenoon to transit to the Humber to lay the final mooring and exchange personnel (A. Harrison, G. Ballard and D. Flatt disembarked and R. Lowry, J. Hughes, D. Plummer and C. Barrett joined) via the pilot boat. These two operations were successfully completed by dusk and we then recommenced the Humber/Wash grid. By late evening the weather was deteriorating fast and we had to abandon the sampling grid at midnight. However, all continuously monitoring equipment was kept going.

Sunday 14th Nov.: Spent the whole day hove to in force 10/11 north easterly winds. When we abandoned the grid we were at the entrance to the Wash and throughout the storm the ship was kept head to sea at a speed necessary to maintain steerage. As a result of this we made very slow headway north east, ending up near the north east corner of the Humber/Wash grid area.

Monday 15th Nov.: Recommenced the Humber/Wash grid at station 12 at midday. The UOR was towed from station 13 and from station 12 to 14.

Tuesday 16th Nov.: Completed the Humber/Wash grid and commenced N.E. Coast track (see figure 3) at station C3 at 1300. During the run up the coast we followed the inshore zig-zag track.

Wednesday. 17th Nov.: Continued N.E. Coast track.

Thursday 18th Nov.: Continuing N.E. Coast track. The weather was deteriorating again with southerly winds, force 7-8 so, offshore CTD stations were not possible. We arrived off Berwick on Tweed at 0900. We were only able to carry out CTD's on inshore stations due to the heavy swell. The outer return leg was pushed out from 20 to 23 miles in order to better characterise the offshore gradients. Due to the weather the ships speed was reduced to 4-5 knots.

Friday 19th Nov.: Arrived back in the Humber/Wash grid area in the late afternoon and immediately commenced the second Humber/Wash grid at the northern end.

Saturday 20th Nov.: Carried out CTD's at Holderness mooring sites 2 and 3, plus deployments of the 'interfacial sampler', at Holderness station 3. This was the first deployment of the 'interfacial sampler' with the newly designed water sampling bottles and it worked very well. Only one of the ten bottles failed to fire, and one fired but did not seal properly. On completion (1200), we continued south on the Humber/Wash grid.

Sunday 21st Nov.: Arrived at station 13 in the Wash at 0800 to deploy the interfacial sampler. Then continued on the grid, back up towards the Humber. Arrived at the anchor station in the Humber mouth at 1600. Commenced the CTD's at 1630 and continued at half hourly intervals until 0700 Monday.

Monday 22nd Nov.: Transferred personel by pilot boat at 0930. C. Barrett and D. Plummer disembarked and A. Harrison and G. Ballard joined. Recovered the mooring in the Humber mouth (just upstream of Bull Sand Fort) late in the forenoon and then steamed to the Holderness area to recover Holderness moorings 3a and 3b. This operation commenced at 1500 and was completed at dusk. The ship then carried out an underway monitoring grid north as far as station C6 and out to 00° 30'E overnight.

Tuesday 23rd Nov.: The ship returned to Holderness at 0800 in preparation to recover the moorings at Holderness stations 1 and 2. There was a delay because of thick fog but the moorings were eventually recovered. As the forecast was for the fog to become thicker on Wednesday, with likely restrictions on the pilots, I decided to take the ship in on the night tide, eight hours ahead of schedule.

Wednesday 24th Nov.: Docked in Hull at 0230.

A full listing of sampling operations is given in Table 1.

Individual cruise reports.

Holderness coast moorings.
Alan Harrison

Aims: To deploy moorings at the four sites shown in figure 1. The individual mooring configurations are shown in figures 1(a) to 1(c) and the mooring positions and types are given in Table 2.

Mooring deployments: Each POL PMP frame is equiped with a 1MHz ADCP, an optical transmissometer, a pressure recorder (WLR), an EMP 2000 multi-parameter environmental monitoring probe and an Inter Ocean S4 EM current meter.
The instruments and PMP frames were prepared during passage from Barry to the Holderness area to be ready for immediate deployment on arrival. Deployments commenced at Site 3 at 0930 on 12 November and continued with Sites 2 and 1. The final deployment, in the Humber, was carried out on the following morning. All instruments were deployed without incident in good weather conditions, close to slack water.
At the end of CH 108/A and prior to the port call at Hull the moorings at each of the four sites were successfully recovered, starting with Site 4 at 1145 on 22 November. This was followed at 1600 by the two moorings at Site 3. The two remaining moorings on Sites 2 and 1 were recovered the following day at 0945 and 1345 respectively. Despite the very extreme weather during much of the deployment period all the moorings were in position, in good order with no damage to instruments or frames.

Optical ground truth measurements.
Samantha Hudson

There were problems with the initial idea of deploying the PRR (Profiling Reflectance Radiometer) on the hydro-wire, as the instrument was not heavy enough to keep it taut. I got round this problem by lowering it on its own cable. There are eleven light profiles, from various stations, but some were not vertical because when there was a strong current the instrument tended to get dragged under or along the length of Challenger. The PRR is capable of measuring depth, temperature, upwelling and downwelling radiance in 6 channels and downwelling PAR.

On the 15th November the UOR (Undulating Oceanographic Recorder) was deployed for the first time. We were unable to deploy it earlier because all the winch drums were being used for the Holderness moorings. Deployment was achieved (when the vessel was at a speed of 4 knots) by lifting the UOR above the height of the gunwhale, moving the A-frame outboard and paying out the cable as Challenger came up to full speed. The starboard pulley was used, with the UOR trolley secured in the corner. It was initially deployed for 1hr 21 min. Recovery was achieved by using the same procedure in reverse. The UOR planed at a relatively steady four metres depth when towing, which appeared to be deep enough to avoid wake problems. It was then re-deployed for another hour and a half on the same day, and then over the rest of the first leg of the cruise for about 22 hours. The towing depth varied with the vessel's speed through the water, but for the various tows was between 2 and 4 metres, with the parameters such as salinity matching up closely to those measured onboard Challenger. The light sensors on the UOR that differ from those carried by Challenger are a set of upwelling and downwelling irradiance sensors, blue wavelength transmissometer and near infra-red turbidity sensor.

The Malvern (laser) particle sizer was used to measure the size distribution of the suspended sediment in the surface CTD bottles. Additionally, some samples were taken from bottles fired near the bottom on CTD profiles.

Trace metal chemistry.
Mark Williams and Tonia Sands

Introduction:
The aims of the trace metal chemistry component were:.

a). To examine the spatial and temporal variation of particulate trace metals within the Humber-Wash grid and the Humber-Tweed grid.

b). To investigate mixing of particles and their associated trace metals within the Humber Plume.

This was achieved by the temporal and spatial collection of suspended particulate matter (SPM). Hourly sampling was achieved during the anchor station in the mouth of the Humber. Later analysis of trace metals (to include Cd, Co, Cu, Fe, Mn, Pb, Zn and $^{206/207}$Pb stable isotopic ratio) will be compared with complementary data obtained during CH99. Additionally samples of SPM were collected at selected sites for analysis by scanning electron microscopy, sizing and density determinations.

Sample collection:

a). SPM For trace metal analysis

Samples throughout the coastal boundary zone and within the Humber Plume were obtained using 10l Go-Flo sampling bottles, specially treated and cleaned for trace metal sampling. Samples were also obtained from two additional sites - close to the tip of Spurn Head and at the POL mooring sites normal to the Holderness coastline.

The bottles were mounted on the CTD rosette; depth permitting; their pressure releases were set to open the bottles at 10m during deployment. Samples were obtained from the surface waters.

After deployment water samples were filtered through acid washed pre weighed 147mm 0.45μm Nuclepore filters held within Teflon filter presses. All sample handling was confined to the clean containerised laboratory situated on the aft deck of Challenger. After filtration the SPM obtained was sparingly washed using Milli-Q water to remove seawater salts and stored at -18°C.

b). Settling velocity experiments

Five experiments were performed which covered the coastline along the Holderness Cliffs to south of the Humber Mouth. Further experiments were performed at the mouth of the Tees and the Tyne. No experiment was performed at the mouth of the Tweed due to low turbidity.

Samples were taken directly following a CTD deployment from the surface water using a modified bottom withdrawal tube, referred to as a settling velocity tube (SVT). The SVT yielded five 1l fractions (5 min, 20 min, 80 min, 280 min, and residual), from each fraction small sub samples were taken for sizing and SEM. The remaining fraction was filtered through Nuclepore filters (described previously). Density samples were also taken from one experiment.

c). SPM for scanning electron microscopy (SEM)

Small samples from the Go-flo bottles were filtered through a 12mm 0.45μm Sartorius filter to give a fine coating of SPM over the filter surface. Later analysis by SEM will examine the size and shape of the particle's. X-ray analysis will determine any spatial or temporal changes in particulate mineralogy.

d). Sizing

From each sample filtered a subsample was used to examine the size distribution using a Malvern (laser) particle sizer.

e). Density

Where SPM concentrations were suitable samples were filtered using 47mm 0.45μ m Sartorius filters to obtain the maximum SPM loading. It is intended that determination of the particulate density will be achieved using a flotation method based on solutions of differing densities.

Summary:

Overall the cruise has been a successful sampling opportunity for the collection of SPM samples (over 100 filtered samples plus associated sizing, SEM and density samples). Thanks to the P.S.O and officers and crew aboard "Challenger" additional strategic sampling was successful with samples taken at Spurn Head and nearshore to the Holderness coastline. These samples will form an integral part of the study of this area. The data from cruise CH99 will be combined with the results from this cruise and with further data to be acquired during the third leg of this cruise, CH108/C.

Continuous dissolved oxygen measurements.

Miles Finch and Richard Williams

Continuous underway measurements of sea surface dissolved oxygen was carried out using two pulsed dissolved oxygen electrodes similar to those used on the NERC North Sea Project. The electrodes were supplied with seawater from the non-toxic supply at a flow rate of ca. 6 litres per minute. Measurement were made every five minutes, beginning in the Great Yarmouth region and continued until the end of the cruise in the Humber Estuary. The data were logged to a personal computer and subsequently transferred to the shipboard mainframe computer. Approximately 3,500 measurements of sea surface dissolved oxygen were made during the cruise using this system. In order to calibrate the output from the pulsed oxygen electrodes, every six hours water samples were collected from the non-toxic seawater supply and fixed using the standard Winkler method. These samples were analysed on the cruise using an endpoint titration system designed specifically for the measurement of discrete dissolved oxygen samples. Twenty five calibration points were used to adjust the probe data to produce absolute dissolved oxygen concentrations. All dissolved oxygen data, once calibrated will be available from BODC.

Additionally, samples were taken from the non-toxic supply for the analysis of organic, inorganic and particulate phosphate. Periodically, samples were drawn from Niskin bottles on the CTD frame, to be used to determine contamination

from the non-toxic supply. Samples were collected on the Humber/Wash and Coastal grids.
During a 16 hour anchor station in the Humber mouth samples for phosphate analysis were taken hourly from Niskin bottles on the CTD frame.
All samples for phosphate analysis were filtered through ashed/weighed GF/F filters in all glass filtration equipment. Filtrate and filter were then stored frozen for later analysis back in Southampton.
Two primary production deck incubation experiments were performed using three different light intensities. Samples were abstracted at time zero and again after 24 hours.

Nutrients.
Robb Howland

This cruise marked the first time that the new Alpkem nutrient auto-analyser had been used in the field. Continuous underway monitoring of phosphate, nitrate and nitrite was carried out throughout the cruise, starting in the Great Yarmouth area as we approached the Humber/Wash grid for the first time, and finishing as we entered the lock at Hull on completion of the first leg. Problems with the analysis of silicate were unresolved although great efforts were made to find the problem.
In general the new analyser, which employs technology somewhere between conventional bubbled flow and flow-injection analysis, worked exceptionally well.
At the beginning of the cruise the PC connected to the analyser developed a fault but, as we had chart recorders as a back-up (and the data was being logged directly to the shipboard mainframe computer) this did not pose any problem.
Much of the initial editing of the data was carried out during the cruise and BODC now have it all on file.
It appears that there may be a significant time delay between the non-toxic intake and the nutrient analyser continuous filtration system. I will investigate this during the next LOIS cruise in Oct./Nov. 94.

RVS Computing.
Andrew Cormack

During the cruise the following instruments were logged continuously by the ship's computer system:

a). Navigation: GPS, transit satellite, gyro-compass (the EM Log was not working during the cruise).
b). Bathymetry: RD200A (bridge) and EA500 (scientific) echo sounders.
c). Non-toxic: Thermosalinograph, auto-analyser, fluorometer, transmissometer.

d). Light: Solar integrator, 2ΠPAR light meters.
e). Others: ADCP, winch monitor.

The RVS CTD was also logged during profiling stations. Additional datasets were loaded off-line from the UOR and Oxygen systems. Most instruments had associated Level A instrument interfaces to convert the instrument output to the standard Ship Message Protocol (SMP). Twelve of these Level As were in use during the cruise. The SMP messages were transmitted via RS232 serial links to a Level B data logger where they were recorded onto magnetic tape and buffered before being forwarded to the Sun Level C for processing and display. Just over 100Mbytes of raw data were collected during the cruise.

The Level C system was used to calibrate and edit many of the raw data files: this was routinely done for navigation, bathymetry, TSG and CTD data. The ADCP values, logged relative to the ship, were corrected to ground-reference using the bottom track values also logged by the instrument.

The analogue voltages produced by the auto-analyser were calibrated approximately during the cruise using data from sets of standard solutions which were inserted in place of the normal seawater input to the instrument.
A series of T-S plots were produced which showed changes in the water masses both during the cruise and in comparison with the same measurements made during Challenger 99 last year.

The data will be retained on the ship for reference during the two subsequent legs of the cruise. A tape copy of the files was also given to staff from BODC for permanent storage.

Interfacial sampler.
C. Barrett

The frame was fitted out with 10 syringe type water bottles, of 4l capacity, sited horizontally. An electronic control cylinder, mounted in the top of the frame, is programmed to release the piston of the bottles at a predetermined time after two conditions are met simultaneously and for the duration of the time period, (i) the frame is in the water and (ii) the frame is level (± 5°). The frame is lowered from an off-centre lifting point, this keeps the frame at an angle until it is landed on the bottom. The time delay from touch down on the bottom is to allow any disturbed sediment to disperse before the samples are taken. A compromise may have to be made between optimum time for sediment to clear and the duration of the stay of the frame on the bottom permissible from the aspect of the ship manoeuvrability. The piston is released and draws in a sample. At completion of the piston stroke, a mechanism is triggered to close the bottle inlet.

The bottles were mounted at the following heights in the frame from the bottom :

1	2125mm
2	1875mm
3	1625mm
4	1375mm
5	1125mm
6	925mm
7	725mm
8	525mm
9	325mm
10	125mm

NOTE: Distances are to the centre of each bottle.

20/11/93 Deployment 1

This was a test deployment at the second mooring site POL#2. The water depth was 20m, sea condition was slight. It was noted from this deployment that the frame was too light, causing the wire to go slack when lowering. Upon recovery, 8 out of the 10 bottles had closed.
Initial results from the particle sizing shows an increase in larger particulates from bottles 5 to 9 with 38.5% of the total weight of bottle 9 particulates being between 87.2 and 188 μm. All samples except bottle 10 had low concentrations indicated by a meter deflection of greater than 90%. Bottle 10 produced a range equally distributed over the size bands.

20/11/93 Deployment 2

A second deployment at Holderness site 3 was carried out but, the same problems were experienced. When the frame was lifted from the water, 7 out of the 10 bottles had closed. Bottles 4, 7 and 8 had drawn in the samples but failed to close. Bottles 1 and 2 again had a small leak from the piston end. Bottle 8 had failed to close because the triggering pin had become dislodged, bottle 4 because the piston had not correctly seated and bottle 7 because of poor alignment of the triggering mechanism.

21/11/93 Deployment 3

The third deployment was at station HW13 in the Wash. The water depth was 30m and the sea state was good. The frame was deployed at 180° to the previous attempts. When the frame was brought back to the surface 8 of the 10 bottles had closed.

Initial results form particle sizing show that samples from all the bottles had a concentration suitable for measurement with an increase in total weights from bottles 1 to 10. Relative particulate size was very similar in all bottle samples with the particles being smaller than 28µm.

Results

During this leg of the cruise we had two significant storm events, the first from a northeasterly direction (force 11 for 36 hours) and the second from the south east (force 8/9 for 24 hours). We were very fortunate to have deployed the POL PMP rigs on the Holderness coast just prior to the first storm. Mounted on each of these rigs was an EMP 2000, multiparameter environmental monitoring probe. Suspended particulate matter and temperature data from this deployment are shown in figures 8 and 9. The storm events on 14-15 Feb. and 18-19 Feb. are clearly shown in the turbidity data (fig. 8), as is the underlying tidal signal. Water temperature (fig. 9) shows a drop during the cruise of 1.5°C and, again, a strong tidal variation.
Figures 10a & b show light attenuation for the Humber/Wash area only and the whole of the RACS (C) survey area, respectively. It is interesting to note that particles from the Humber seem to be transported north of Spurn Head along the Holderness coast. This effect is mirrored on a satellite thermal image (figure 11) taken on the 19th November. This image shows the colder estuary water (denoted by the lighter shades) moving north of Spurn but, more generally south along the coast, as shown in the contour plots for salinity (figures12a & b).
The only nutrient data that has so far been validated for this leg of the cruise is nitrate. Contour plots of this data are shown in figures 7a &b. As expected, the plots show a strong covariance with those of salinity (figures 12a & b). As we have observed on previous winter cruises in this area the main source of nitrate is the Humber estuary and this is dispersed south and east from the Humber mouth along the coast of east anglia. Figure 7b shows shows a strong nitrate signal from the R. Tees and a lesser one from the R. Tyne. Again, the direction of dispersion is south east along the coast. CTD's carried out at intervals along the Humber/Wash and north east coast grid tracks showed the water to be well mixed vertically throughout the survey area.

General Points:

a) Prior to the cruise the clean container was examined and cleaned. This included the removal of scrap wood among other things. On every occasion when we have used the clean chemistry container it has been necessary to tidy and clean it to make it fit for trace metal work.

b) The Milli-Q system worked satisfactorily during the cruise. A perpetual minor leak occurred throughout the cruise on the outlet pipe from the water purifier. A major leak was seen on the inlet pipe to the purifier but after tightening the fitting it appeared to stop. The filters for the Milli-Q system did not arrive until the last minute. If enquiries into their whereabouts had not been made during a visit to RVS a week or so before the cruise to view the clean container, it is doubtful if they would have arrived at all! This specific point was raised by us at the pre-cruise planning meeting and we were assured that the spares would be purchased in good time. This piece of equipment is of fundamental importance to much of the scientific work of the cruise so, it is imperitive that we are warned well in advance if there is a problem so that we can take appropriate action.

Ship operations and facilities.

All the operational requirements of this cruise were fully met and the deck operations were run very smoothly and efficiently. No time was lost during the cruise due to equipment failures. The domestic arrangements were of the usual high standard and, the new more flexible arrangements for mealtimes were welcomed by the scientific party.

As always, it was a pleasure to work aboard Challenger. My thanks go to the Captain, officers and all the crew who must take the lions share of the credit for making this a very happy and successful cruise.

Report prepared by R.J.M. Howland
Senior scientist

Figure 10(b). Contour plot of light attenuation data from CH108a for the whole survey area.

Figure 11. Satellite thermal image taken on 19 November of the Humber/Wash region.

Figure 12(a). Contour plot of salinity data for the Humber/Wash area from CH 108a.

Figure 12(b). Contour plot of salinity data for the whole survey area from CH108a.

Table 1. Station log for CH 108A.

Table 2. Mooring positions and types.

Site No	Position		Mooring type	Depth
Site 1	53° 47.8'N	0° 00'E	POL PMP	10m
Site 2	53° 48.6'N	0° 2.8'E	POL PMP	14m
Site3	53° 50.6'N	0° 9.1'E	POL Pop-up	25m
Site 3	53° 506'N	0° 9.1'E	POL BM/CM/Trans	25m
Site 4	53° 33.9'N	0° 3.6'E	POL PMP	9m

Table 1

Identifier	Code	Start Time	End Time	Latitude	Longitude	Depth	Waypoint	Start Lat.	Start Long.	End Lat.	End Long.	COMMENT
PG1	GPUMP	10/11/1993 13:26		49.8604	-4.2779	79.9						Salinity
PG2	GPUMP	11/11/1993 07:40		50.4238	0.4261	44.2						Salinity
PG3	GPUMP	12/11/1993 10:33		53.8207	0.0779	18.4						Salinity
CTD1	CTD	12/11/1993 10:48	12/11/1993 11:10	53.8175	0.0741	18.9	HM3					Holderness mooring
CTD2	CTD	12/11/1993 13:55	12/11/1993 14:02	53.7918	0.0061	16.0	HM2					Holderness mooring
P931112A	PRRAD	12/11/1993 15:22	12/11/1993 15:28	53.8628	-0.0074	20.2	HW1					
CTD3	CTD	12/11/1993 15:25	12/11/1993 15:45	53.8611	-0.0059	20.2	HW1					
PG501	GPUMP	12/11/1993 15:40		53.8609	-0.0050		HW1					Phosphorus(Richard)
SV1	SETVEL	12/11/1993 15:55		53.8616	-0.0027	20.7	HW1					Low turbidity Holderness (CTD3)
PG502	GPUMP	12/11/1993 16:45		53.9246	0.1900	43.0						Phosphorus(Richard)
PG503	GPUMP	12/11/1993 18:04		54.0323	0.5180	51.8	HW2					Phosphorus(Richard)
CTD4	CTD	12/11/1993 18:12	12/11/1993 18:13	54.0324	0.5226	51.0	HW2					
CTD5	CTD	12/11/1993 19:49	12/11/1993 20:00	53.8960	0.6872	41.0	HW4					
PG504	GPUMP	12/11/1993 19:50		53.8946	0.6862	41.7	HW4					Phosphorus(Richard)
PG101	GPUMP	12/11/1993 20:20		53.8808	0.6472	40.8						Oxygen
PG505	GPUMP	12/11/1993 21:00		53.8220	0.5473	38.3						Phosphorus(Richard)
PG506	GPUMP	12/11/1993 22:50		53.7317	0.1610	16.7	HW3					Phosphorus(Richard)
CTD6	CTD	12/11/1993 22:58	12/11/1993 23:09	53.7250	0.1590	15.6	HW3					
SV2	SETVEL	12/11/1993 23:01		53.7252	0.1585	15.5	HW3					Low turbidity Holderness (CTD6)
PG507	GPUMP	13/11/1993 01:50		53.7653	0.8352	32.4	HW6					Phosphorus(Richard)
CTD7	CTD	13/11/1993 01:57	13/11/1993 02:12	53.7587	0.8404	31.8	HW6					
PG102	GPUMP	13/11/1993 02:15		53.7538	0.8424	33.0						Oxygen
PG508	GPUMP	13/11/1993 05:00		53.4891	0.3990	18.0	HW7					Phosphorus(Richard)
SV3	SETVEL	13/11/1993 05:02		53.4877	0.3990	18.1	HW7					(CTD8)
CTD8	CTD	13/11/1993 05:04	13/11/1993 05:14	53.4848	0.3986	17.7	HW7					
PG4	GPUMP	13/11/1993 05:29		53.4900	0.3938	18.0						Salinity
PG509	GPUMP	13/11/1993 06:15		53.5328	0.5681	23.0						Phosphorus(Richard)
PG103	GPUMP	13/11/1993 07:00		53.5903	0.7597	62.8						Oxygen
PG510	GPUMP	13/11/1993 07:50		53.6517	0.9688	25.3	HW8					Phosphorus(Richard)
P931113A	PRRAD	13/11/1993 07:54	13/11/1993 08:00	53.6540	0.9712	25.1	HW8					
CTD9	CTD	13/11/1993 07:57	13/11/1993 08:07	53.6554	0.9724	25.2	HW9					
PG511	GPUMP	13/11/1993 09:34		53.4888	0.9984	20.4	HW11					Phosphorus(Richard)
P931113B	PRRAD	13/11/1993 09:35	13/11/1993 09:41	53.4860	0.9990	20.4	HW11					
CTD10	CTD	13/11/1993 09:38	13/11/1993 09:45	53.4861	0.9979	20.4	HW10					
PG512	GPUMP	13/11/1993 11:00		53.4176	0.7599	18.4	HW10					Phosphorus(Richard)
CTD11	CTD	13/11/1993 11:02	13/11/1993 11:10	53.4191	0.7558	18.5	HW11					
PG513	GPUMP	13/11/1993 11:55		53.4634	0.6695	84.8						Phosphorus(Richard)
PG514	GPUMP	13/11/1993 12:35		53.5063	0.5700	19.8						Phosphorus(Richard)
PG515	GPUMP	13/11/1993 13:05		53.5309	0.5024	16.8						Phosphorus(Richard)
PG516	GPUMP	13/11/1993 13:35		53.5570	0.4279	18.8						Phosphorus(Richard)
PG104	GPUMP	13/11/1993 13:50		53.5567	0.3736	18.1						Oxygen

PG517	GPUMP	13/11/1993 14:02		53.5577	0.3270	15.8						Phosphorus(Richard)
PG518	GPUMP	13/11/1993 14:37		53.5456	0.1867	21.2						Phosphorus(Richard)
PG519	GPUMP	13/11/1993 15:20		53.5657	0.0612	13.7						Phosphorus(Richard)
CTD12	CTD	13/11/1993 16:45	13/11/1993 17:00	53.5493	0.1432	20.8	HW5					
PG520	GPUMP	13/11/1993 16:50		53.5490	0.1431	21.0	HW5					Phosphorus(Richard)
PG521	GPUMP	13/11/1993 19:00		53.3714	0.4629	21.4	HW7					Phosphorus(Richard)
CTD13	CTD	13/11/1993 19:19	13/11/1993 19:29	53.3437	0.4818	17.6	HW9					
PG522	GPUMP	13/11/1993 19:20		53.3424	0.4803	17.5	HW9					Phosphorus(Richard)
PG105	GPUMP	13/11/1993 20:20		53.4053	0.7086	22.6						Oxygen
PG523	GPUMP	13/11/1993 20:35		53.4203	0.7684	20.7	HW10					Phosphorus(Richard)
CTD14	CTD	13/11/1993 20:38	13/11/1993 20:49	53.4239	0.7740	20.4	HW10					
CTD15	CTD	13/11/1993 22:45	13/11/1993 23:00	53.2538	0.6475	20.8	HW12					
PG524	GPUMP	13/11/1993 22:45		53.2504	0.6456	20.1	HW12					Phosphorus(Richard)
PG5	GPUMP	14/11/1993 08:16		53.3783	0.6532							Salinity
PG249	GPUMP	14/11/1993 08:24		53.3812	0.6520							Particle size spectra:during storm
PG250	GPUMP	15/11/1993 08:17		53.5442	0.6441	25.6						Particle size spectra:after storm
PG106	GPUMP	15/11/1993 09:45		53.3271	0.6535	28.4						Oxygen
PG251	GPUMP	15/11/1993 10:19		53.2486	0.6510		HW12					Particle size spectra
PG525	GPUMP	15/11/1993 12:25		53.0001	0.3999	27.5	HW13					Phosphorus(Richard)
CTD16	CTD	15/11/1993 12:29	15/11/1993 12:41	53.0007	0.3980	29.9	HW13					
P931115A	PRRAD	15/11/1993 12:42	15/11/1993 12:45	53.0001	0.3973	29.5	HW13					
PG6	GPUMP	15/11/1993 12:50		53.0008	0.3977	29.5						Salinity
H1193151	UORT	15/11/1993 13:00	15/11/1993 14:19					53.0060	0.4073	53.1770	0.6144	
H1193152	UORT	15/11/1993 15:14	15/11/1993 16:48					53.2498	0.7033	53.0828	0.9980	
PG107	GPUMP	15/11/1993 16:00		53.1691	0.8532	19.5						Oxygen
CTD17	CTD	15/11/1993 17:29	15/11/1993 17:39	53.0000	1.0661	20.5	HW14					
PG526	GPUMP	15/11/1993 17:45		53.0059	1.0722	18.0	HW14					Phosphorus(Richard)
PG527	GPUMP	15/11/1993 20:00		53.2907	1.3477	24.1	HW15					Phosphorus(Richard)
CTD18	CTD	15/11/1993 20:02	15/11/1993 20:13	53.2904	1.3515	25.2	HW15					
PG108	GPUMP	15/11/1993 21:51		53.0256	1.4733	31.1						Oxygen
PG528	GPUMP	15/11/1993 22:35		52.8995	1.5204	21.1	HW16					Phosphorus(Richard)
CTD19	CTD	15/11/1993 22:37	15/11/1993 22:47	52.8974	1.5232	22.8	HW16					
PG529	GPUMP	15/11/1993 23:40		52.8003	1.6819	26.3						Phosphorus(Richard)
PG530	GPUMP	16/11/1993 00:22		52.7201	1.8101	35.9	HW17					Phosphorus(Richard)
CTD20	CTD	16/11/1993 00:27	16/11/1993 00:37	52.7200	1.8176	34.0	HW17					
PG531	GPUMP	16/11/1993 01:27		52.7446	2.0104	30.3						Phosphorus(Richard)
PG532	GPUMP	16/11/1993 02:15		52.7835	2.1981		HW18					Phosphorus(Richard)
CTD21	CTD	16/11/1993 02:19	16/11/1993 02:29	52.7882	2.1997	43.4	HW18					
PG533	GPUMP	16/11/1993 03:15		52.8861	2.0073	35.0						Phosphorus(Richard)
PG534	GPUMP	16/11/1993 04:15		53.0285	1.7452	27.4						Phosphorus(Richard)
CTD22	CTD	16/11/1993 05:34	16/11/1993 05:45	53.1961	1.4937	30.3						
CTD23	CTD	16/11/1993 05:59	16/11/1993 06:05	53.1895	1.4955	29.3						

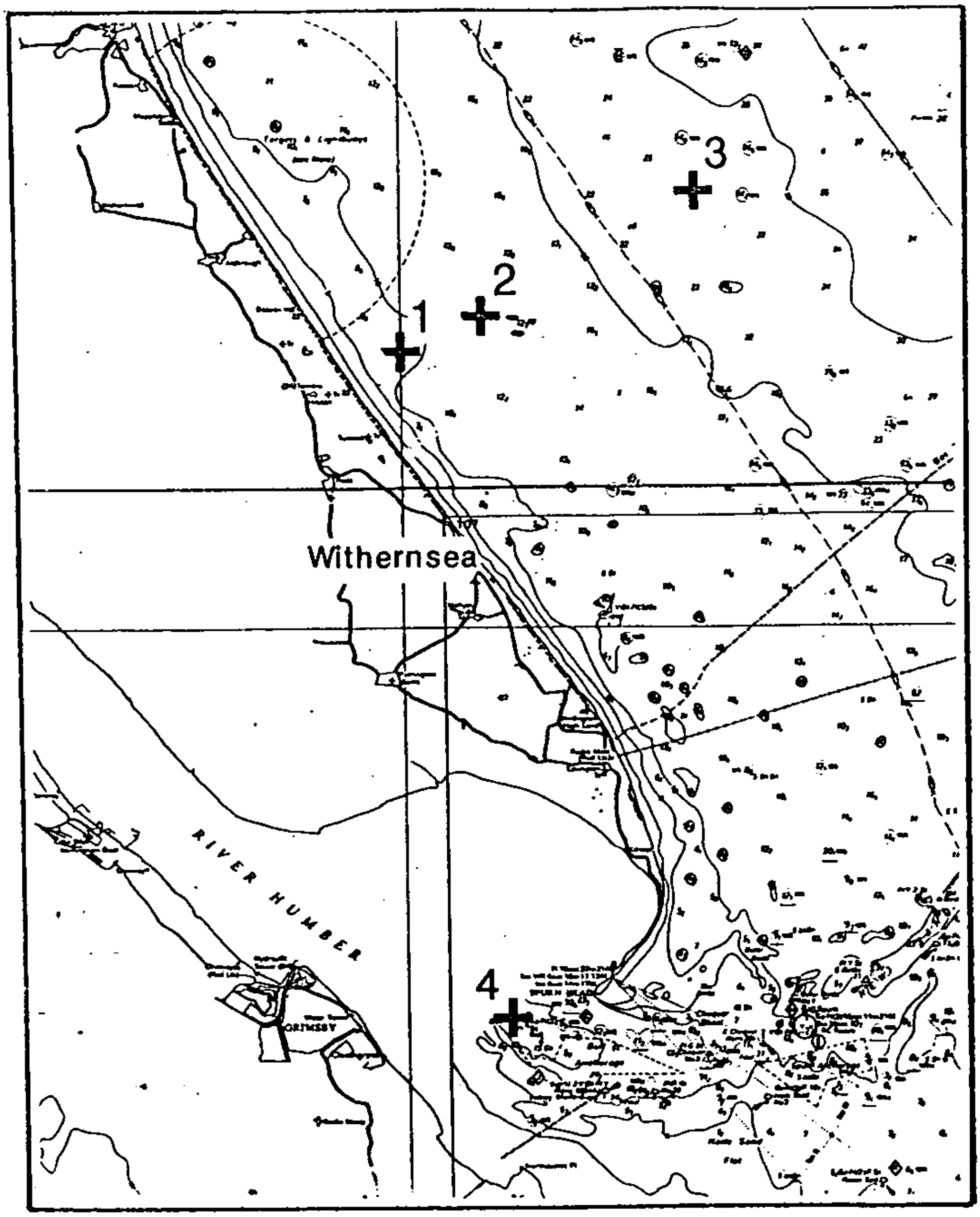
PG535	GPUMP	16/11/1993 06:15		53.2015	1.4758	28.2						Phosphorus(Richard)
PG536	GPUMP	16/11/1993 07:00		53.2877	1.3601	26.2						Phosphorus(Richard)
PG109	GPUMP	16/11/1993 07:00		53.2877	1.3601	26.2						Oxygen
H1193161	UORT	16/11/1993 08:13	16/11/1993 12:59					53.4251	1.2052	54.0364	0.3078	
PG7	GPUMP	16/11/1993 09:13		53.5418	1.0597	25.1						Salinity
PG537	GPUMP	16/11/1993 10:40		53.7668	0.8352	30.6	HW6					P:Chl:Grav:Al:lugol:formalin
PG538	GPUMP	16/11/1993 11:35		53.9156	0.6537	41.8	HW4					P:Chl:Al:Grav:lug:form
PG539	GPUMP	16/11/1993 12:15		54.0271	0.5228		HW2					P:Chl:Al:Grav:lug:form
CTD24	CTD	16/11/1993 13:04	16/11/1993 13:17	54.0377	0.3040	52.4	C3					Salinity/Oxygen/Temp useless
PG540	GPUMP	16/11/1993 13:05		54.0366	0.3038		C3					P
P931116A	PRRAD	16/11/1993 13:17	16/11/1993 13:23	54.0376	0.3038	52.3	C3					
CTD25	CTD	16/11/1993 14:43	16/11/1993 14:54	54.0463	-0.0516	22.2	C4					
PG110	GPUMP	16/11/1993 14:45		54.0472	-0.0514	22.4						Oxygen
PG546	GPUMP	16/11/1993 14:50		54.0460	-0.0519	22.0	C4					P
P931116B	PRRAD	16/11/1993 14:55	16/11/1993 14:57	54.0443	-0.0518	22.3	C4					
H1193162	UORT	16/11/1993 15:05	16/11/1993 16:18					54.0420	-0.0476	54.1221	0.2342	
PG547	GPUMP	16/11/1993 15:50		54.0971	0.1235	51.4						P
PG548	GPUMP	16/11/1993 16:20		54.1213	0.2360	57.9	C5					P
CTD26	CTD	16/11/1993 16:21	16/11/1993 16:30	54.1188	0.2392	58.0	C5					
PG549	GPUMP	16/11/1993 17:20		54.1480	0.0633	55.4						P
PG550	GPUMP	16/11/1993 18:30		54.1913	-0.2114	31.6	C6					P
CTD27	CTD	16/11/1993 18:37	16/11/1993 18:42	54.1898	-0.2163	29.2	C6					
PG551	GPUMP	16/11/1993 20:09		54.3814	0.0383		C7					P:Chl:Grav:Al:lug:form
PG111	GPUMP	16/11/1993 20:47		54.3868	-0.1403							Oxygen
PG552	GPUMP	16/11/1993 21:47		54.3953	-0.4413	35.5	C8					P
PG553	GPUMP	16/11/1993 22:17		54.4703	-0.3796		C9					P:Chl:Al:Grav:lug:form
CTD28	CTD	17/11/1993 01:13	17/11/1993 01:24	54.5659	-0.7469	33.9	C10					
PG554	GPUMP	17/11/1993 01:17		54.5659	-0.7464	33.8	C10					P
PG112	GPUMP	17/11/1993 02:50		54.7965	-0.6009							Oxygen
PG555	GPUMP	17/11/1993 02:50		54.7965	-0.6009		C11					P
CTD29	CTD	17/11/1993 02:56	17/11/1993 03:07	54.7990	-0.5955	63.6	C11					
CTD30	CTD	17/11/1993 05:09	17/11/1993 05:18	54.6387	-1.0272	29.6	C12					
PG556	GPUMP	17/11/1993 05:40		54.6861	-0.9833		C12					P
PG557	GPUMP	17/11/1993 06:50		54.8593	-0.8500		C13					P:Chl:Al:Grav:lug:form
CTD31	CTD	17/11/1993 06:57	17/11/1993 07:10	54.8726	-0.8377	69.0	C13					
PG558	GPUMP	17/11/1993 07:10		54.8688	-0.8408							P
PG559	GPUMP	17/11/1993 08:15		54.7418	-1.0398							P
SV4	SETVEL	17/11/1993 08:44		54.6910	-1.1195	27.1	C14					Tees (CTD32)
CTD32	CTD	17/11/1993 08:45	17/11/1993 08:55	54.6919	-1.1220	27.0	C14					
PG560	GPUMP	17/11/1993 08:45		54.6909	-1.1201	27.2	C14					P
P931117A	PRRAD	17/11/1993 09:01	17/11/1993 09:03	54.6920	-1.1238	26.3	C14					
PG113	GPUMP	17/11/1993 09:07		54.6934	-1.1212	27.2						Oxygen

H1193171	UORT	17/11/1993 09:07	17/11/1993 11:12					54.6934	-1.1212	55.0486	-0.9192	
PG8	GPUMP	17/11/1993 09:32		54.7597	-1.0878	43.3						Salinity
PG561	GPUMP	17/11/1993 09:55		54.8258	-1.0455							P
CTD33	CTD	17/11/1993 11:17	17/11/1993 11:29	55.0534	-0.9137	73.1	C15					
PG562	GPUMP	17/11/1993 11:20		55.0530	-0.9146		C15					P
P931117B	PRRAD	17/11/1993 11:30	17/11/1993 11:32	55.0539	-0.9110	73.1	C15					Current too strong for successful deployment
CTD34	CTD	17/11/1993 13:16	17/11/1993 13:28	54.9394	-1.2894	34.8	C16					
PG565	GPUMP	17/11/1993 13:20		54.9391	-1.2892	34.8	C16					P
P931117C	PRRAD	17/11/1993 13:29	17/11/1993 13:31	54.9406	-1.2913	34.6	C16					
H1193172	UORT	17/11/1993 13:38	17/11/1993 15:06					54.9421	-1.2898	55.1076	-0.9799	
PG114	GPUMP	17/11/1993 13:47		54.9586	-1.2615							Oxygen
PG566	GPUMP	17/11/1993 14:20		55.0157	-1.1298							P
PG567	GPUMP	17/11/1993 15:05		55.1067	-0.9819		C17					P
CTD35	CTD	17/11/1993 15:17	17/11/1993 15:32	55.1140	-0.9639	90.0	C17					
P931117D	PRRAD	17/11/1993 15:33	17/11/1993 15:38	55.1118	-0.9630	90.0	C17					
PG568	GPUMP	17/11/1993 16:30		55.0628	-1.1835							P
CTD36	CTD	17/11/1993 17:15	17/11/1993 17:23	55.0232	-1.3628	30.5	C18					
SV5	SETVEL	17/11/1993 17:18		55.0235	-1.3632	30.7	C18					Tyne (CTD36)
PG569	GPUMP	17/11/1993 17:20		55.0231	-1.3628	30.5	C18					P
PG570	GPUMP	17/11/1993 18:25		55.1178	-1.1823							P
PG571	GPUMP	17/11/1993 19:10		55.2053	-1.0326		C19					P
CTD37	CTD	17/11/1993 19:20	17/11/1993 19:30	55.2070	-1.0262	91.0	C19					
PG574	GPUMP	17/11/1993 20:15		55.2057	-1.2313							P
PG115	GPUMP	17/11/1993 21:00		55.2041	-1.4415							Oxygen
PG575	GPUMP	17/11/1993 21:05		55.2049	-1.4464		C20					P
CTD38	CTD	17/11/1993 21:08	17/11/1993 21:14	55.2053	-1.4482	42.7	C20					
PG576	GPUMP	17/11/1993 22:05		55.2683	-1.2641							P
PG577	GPUMP	17/11/1993 22:55		55.3444	-1.0585		C21					P:Chl:Al:Grav:Lug:Form
PG578	GPUMP	18/11/1993 00:30		55.4043	-1.4968	39.6	C22					P:Chl:Al:Grav:Lug:Form
PG579	GPUMP	18/11/1993 02:22		55.4929	-1.0741		C23					P:Chl:Al:Grav:Lug:Form
PG116	GPUMP	18/11/1993 03:37		55.5422	-1.3994							Oxygen
PG580	GPUMP	18/11/1993 04:15		55.5668	-1.5531	38.3	C24					P:Chl:Al:Grav:Lug:Form
PG581	GPUMP	18/11/1993 06:00		55.7462	-1.2430		C25					P:Chl:Al:Grav:Lug:Form
PG582	GPUMP	18/11/1993 07:10		55.7578	-1.5261							P
PG583	GPUMP	18/11/1993 08:50		55.7724	-1.9388		C26					P
CTD39	CTD	18/11/1993 08:51	18/11/1993 08:59	55.7740	-1.9363	36.3	C26					
PG584	GPUMP	18/11/1993 10:00		55.8542	-1.7443							P
PG9	GPUMP	18/11/1993 10:11		55.8707	-1.6994							Salinity
PG117	GPUMP	18/11/1993 10:32		55.9041	-1.6160	73.2						Oxygen
PG585	GPUMP	18/11/1993 10:45		55.9204	-1.5911		C27					P:Chl:Al:Grav:Lug:Form
PG586	GPUMP	18/11/1993 12:30		55.9151	-2.0816		C28					P
CTD40	CTD	18/11/1993 12:34	18/11/1993 12:46	55.9163	-2.0838	68.5	C28					

CTD41	CTD	18/11/1993 13:45	18/11/1993 13:56	56.0008	-2.2811	60.0	C29					
PG587	GPUMP	18/11/1993 13:45		56.0010	-2.2810		C29					P
PG588	GPUMP	18/11/1993 14:59		56.0036	-2.0698							P
PG10	GPUMP	18/11/1993 15:20		56.0008	-1.9886							Salinity
PG589	GPUMP	18/11/1993 16:00		56.0004	-1.8331							P
PG590	GPUMP	18/11/1993 17:20		56.0003	-1.5180		C30					P:Chl:Al:Grav:Lug:Form
PG118	GPUMP	18/11/1993 17:40		55.9757	-1.4667							Oxygen
PG591	GPUMP	18/11/1993 18:40		55.8974	-1.3242	70.4						P
PG592	GPUMP	18/11/1993 21:54		55.7029	-0.9790		C31					P:Chl:Al:Grav:Lug:Form
CTD42	CTD	19/11/1993 05:35	19/11/1993 05:47	54.9758	-0.7004	65.5						
PG593	GPUMP	19/11/1993 06:55		54.8843	-0.6509	66.7	C32					P:Chl:Al:Grav:Lug:Form
CTD43	CTD	19/11/1993 09:00	19/11/1993 09:12	54.7514	-0.2067	67.7	C33					
PG594	GPUMP	19/11/1993 09:00		54.7508	-0.2096		C33					P
PG11	GPUMP	19/11/1993 10:30		54.6359	-0.0322							Salinity
H1193191	UORT	19/11/1993 10:47	19/11/1993 16:30					54.6170	-0.0038	53.9444	0.2420	
PG595	GPUMP	19/11/1993 11:50		54.5072	0.1446		C34					P:Chl:Al:Grav:Lug:Form
PG596	GPUMP	19/11/1993 15:45		54.0025	0.4260	53.4	C35					P:Chl:Al:Grav:Lug:Form
PG597	GPUMP	19/11/1993 17:30		53.8650	0.0075	18.6	HW1					Al:Grav
CTD44	CTD	19/11/1993 18:35	19/11/1993 18:47	53.7193	0.1391	19.8	HW3					
CTD45	CTD	20/11/1993 01:15	20/11/1993 01:24	53.5491	0.1355	16.9	HW5					
CTD46	CTD	20/11/1993 02:43	20/11/1993 02:51	53.4963	0.4004	14.3	HW7					
CTD47	CTD	20/11/1993 05:15	20/11/1993 05:23	53.6525	0.9646	24.9	HW8					
H1193201	UORT	20/11/1993 05:29	20/11/1993 08:36					53.6566	0.9620	53.8473	0.2170	
PG119	GPUMP	20/11/1993 08:00		53.8159	0.3383	37.6						Oxygen
CTD48	CTD	20/11/1993 09:33	20/11/1993 09:41	53.7994	0.0413	18.8	HM2					Holderness mooring
P931120A	PRRAD	20/11/1993 09:42	20/11/1993 09:44	53.7975	0.0425	18.9	HM2					
IFS1	IFSAMP	20/11/1993 10:10		53.8039	0.0668	19.6	HM2					Particle sizing:CHN:nutrients:gravimetry
CTD49	CTD	20/11/1993 10:40	20/11/1993 10:50	53.8382	0.1398	28.7	HM3					Holderness mooring
P931120B	PRRAD	20/11/1993 10:51	20/11/1993 10:53	53.8389	0.1408	28.7	HM3					
IFS2	IFSAMP	20/11/1993 11:05		53.8397	0.1406	28.4	HM3					Test only: no samples taken
PG12	GPUMP	20/11/1993 12:25		53.7856	0.4002	37.4						Salinity
H1193202	UORT	20/11/1993 12:57	20/11/1993 16:33					53.7544	0.5129	53.4688	1.1417	
PG598	GPUMP	20/11/1993 14:45		53.6642	0.9038	26.3	HW8					Al:Grav
PG599	GPUMP	20/11/1993 16:15		53.5008	1.1041	18.0	HW15					Al:Grav
PG120	GPUMP	20/11/1993 19:08		53.2770	1.3340	21.8						Oxygen
PG13	GPUMP	21/11/1993 03:26		53.2883	0.6736	24.7						Salinity
CTD50	CTD	21/11/1993 05:36	21/11/1993 05:46	53.2210	0.6361	24.8						
CTD51	CTD	21/11/1993 08:11	21/11/1993 08:20	52.9983	0.4028	25.0	HW13					
PG14	GPUMP	21/11/1993 08:21		52.9985	0.4041	24.0						Salinity
IFS3	IFSAMP	21/11/1993 08:22		52.9986	0.4044	24.0	HW13					Particle sizing:nutrients:CHN:salinity:gravimetry
PG600	GPUMP	21/11/1993 10:40		53.2402	0.6434	23.5	HW12					Al:Grav
PG601	GPUMP	21/11/1993 12:00		53.4089	0.7614	20.5	HW10					Al:Grav

CTD52	CTD	21/11/1993 13:15	21/11/1993 13:24	53.3389	0.4809	17.5	HW9					
PG602	GPUMP	21/11/1993 14:20		53.4792	0.4041	15.1	HW7					Al:Grav
CTD53	CTD	21/11/1993 16:32	21/11/1993 16:37	53.5494	0.1185	16.0	HAS					
CTD54	CTD	21/11/1993 17:00	21/11/1993 17:04	53.5495	0.1177	15.9	HAS					
CTD55	CTD	21/11/1993 17:30	21/11/1993 17:36	53.5492	0.1170	15.7	HAS					
CTD56	CTD	21/11/1993 18:00	21/11/1993 18:06	53.5496	0.1167	15.8	HAS					
CTD57	CTD	21/11/1993 18:30	21/11/1993 18:36	53.5498	0.1163	16.1	HAS					
CTD58	CTD	21/11/1993 19:00	21/11/1993 19:04	53.5498	0.1162	16.5	HAS					
CTD59	CTD	21/11/1993 19:32	21/11/1993 19:37	53.5501	0.1162	16.8	HAS					
CTD60	CTD	21/11/1993 20:02	21/11/1993 20:08	53.5505	0.1161	17.2	HAS					
CTD61	CTD	21/11/1993 20:32	21/11/1993 20:38	53.5502	0.1160	17.5	HAS					
CTD62	CTD	21/11/1993 21:01	21/11/1993 21:07	53.5504	0.1160	17.8	HAS					
SV6	SETVEL	21/11/1993 21:01		53.5503	0.1161	17.8	HAS					Humber maximum flood (CTD62)
CTD63	CTD	21/11/1993 21:31	21/11/1993 21:36	53.5503	0.1159	18.0	HAS					
CTD64	CTD	21/11/1993 22:03	21/11/1993 22:10	53.5506	0.1160	18.4	HAS					
CTD65	CTD	21/11/1993 22:31	21/11/1993 22:37	53.5502	0.1163	18.5	HAS					
CTD66	CTD	21/11/1993 23:00	21/11/1993 23:06	53.5504	0.1166	18.6	HAS					
PG603	GPUMP	21/11/1993 23:19		53.5501	0.1166	18.6	HAS					137Cs
CTD67	CTD	21/11/1993 23:30	21/11/1993 23:35	53.5501	0.1158	18.5	HAS					
CTD68	CTD	22/11/1993 00:03	22/11/1993 00:13	53.5497	0.1180	18.3	HAS					
CTD69	CTD	22/11/1993 00:33	22/11/1993 00:40	53.5499	0.1184	18.2	HAS					
CTD70	CTD	22/11/1993 01:03	22/11/1993 01:11	53.5502	0.1187	17.8	HAS					
CTD71	CTD	22/11/1993 01:31	22/11/1993 01:37	53.5495	0.1186	17.5	HAS					
CTD72	CTD	22/11/1993 02:01	22/11/1993 02:08	53.5502	0.1187	17.0	HAS					
CTD73	CTD	22/11/1993 02:31	22/11/1993 02:38	53.5499	0.1189	16.9	HAS					
PG604	GPUMP	22/11/1993 03:00		53.5500	0.1190	16.4	HAS					137Cs
CTD74	CTD	22/11/1993 03:01	22/11/1993 03:08	53.5499	0.1193	16.4	HAS					
SV7	SETVEL	22/11/1993 03:30		53.5503	0.1188	16.0	HAS					Humber maximum ebb (CTD75)
CTD75	CTD	22/11/1993 03:33	22/11/1993 03:40	53.5501	0.1189	15.9	HAS					
CTD76	CTD	22/11/1993 04:01	22/11/1993 04:07	53.5502	0.1190	15.8	HAS					
CTD77	CTD	22/11/1993 04:30	22/11/1993 04:37	53.5501	0.1191	15.5	HAS					
CTD78	CTD	22/11/1993 05:00	22/11/1993 05:06	53.5499	0.1189	15.5	HAS					
CTD79	CTD	22/11/1993 05:30	22/11/1993 05:36	53.5497	0.1187	15.4	HAS					
PG605	GPUMP	22/11/1993 05:57		53.5497	0.1184	15.3	HAS					137Cs
CTD80	CTD	22/11/1993 06:01	22/11/1993 06:06	53.5496	0.1186	15.4	HAS					
CTD81	CTD	22/11/1993 06:30	22/11/1993 06:35	53.5498	0.1187	15.5	HAS					
CTD82	CTD	22/11/1993 06:59	22/11/1993 07:05	53.5497	0.1185	15.5	HAS					
CTD83	CTD	22/11/1993 10:03	22/11/1993 10:08	53.5698	0.1017	22.4	BFM					Surface water collection - no profile
PG252	GPUMP	22/11/1993 11:29		53.5658	0.0591	13.1						Particle size spectra
PG15	GPUMP	22/11/1993 16:14		53.8467	0.1526	29.5						Salinity
PG16	GPUMP	23/11/1993 08:01		53.8280	0.0739	20.7						Salinity
CTD84	CTD	23/11/1993 14:00	23/11/1993 14:06	53.7976	0.0066	15.9	HM1					Holderness mooring

Figure 1. Holderness coast and Humber mouth mooring positions.



Positions				
	Lat.	Long.	Decca (5B)	
	(N)	(E)	Red	Purple
1	53° 47.8′	0° 00′	H15.0	F54.6
2	53° 48.6′	0° 2.8′	H17.2	F52.8
3	53° 50.6′	0° 9.1′	H22.0	E79.0
4	53° 33.9′	0° 3.6′	H12.3	E76.8

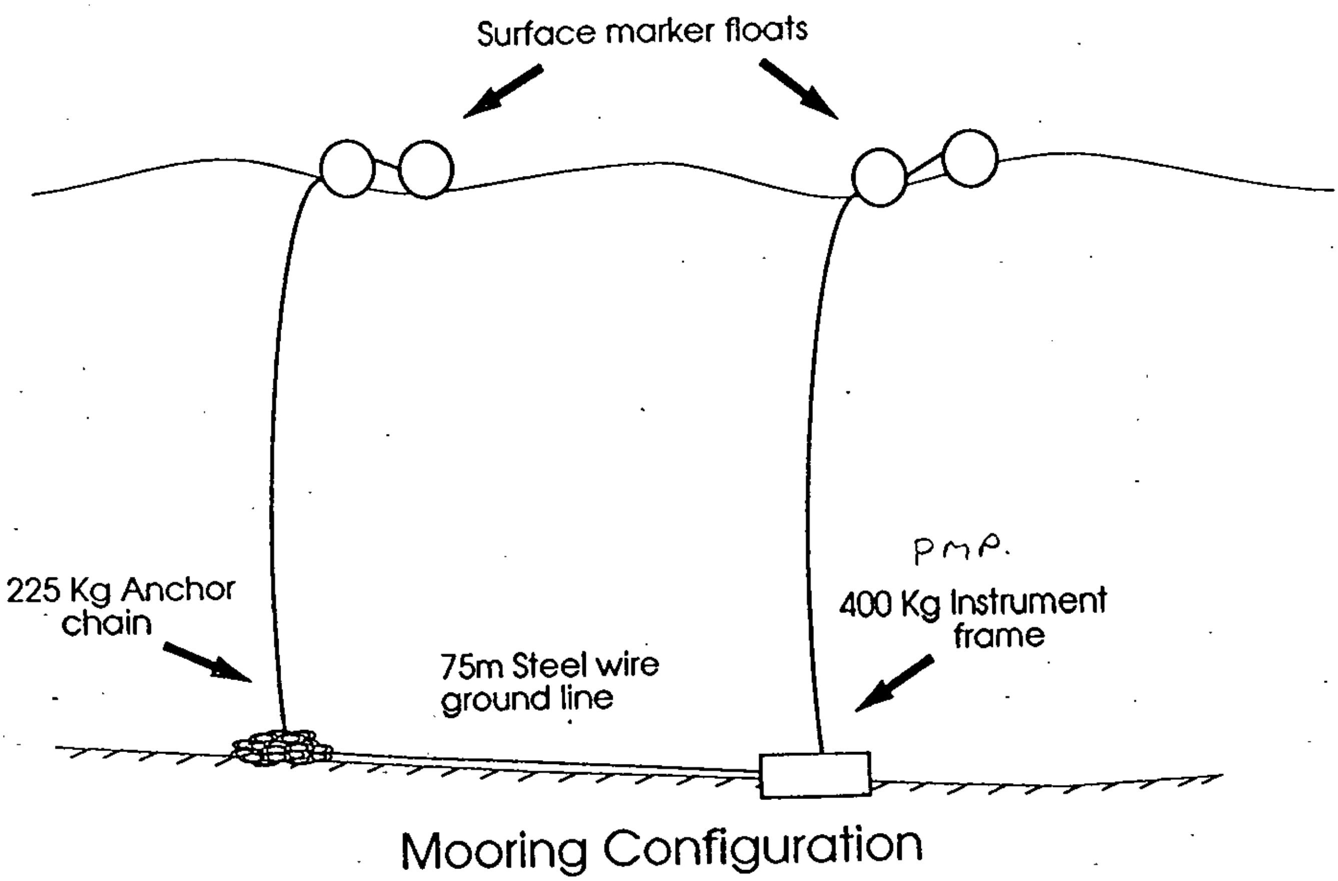
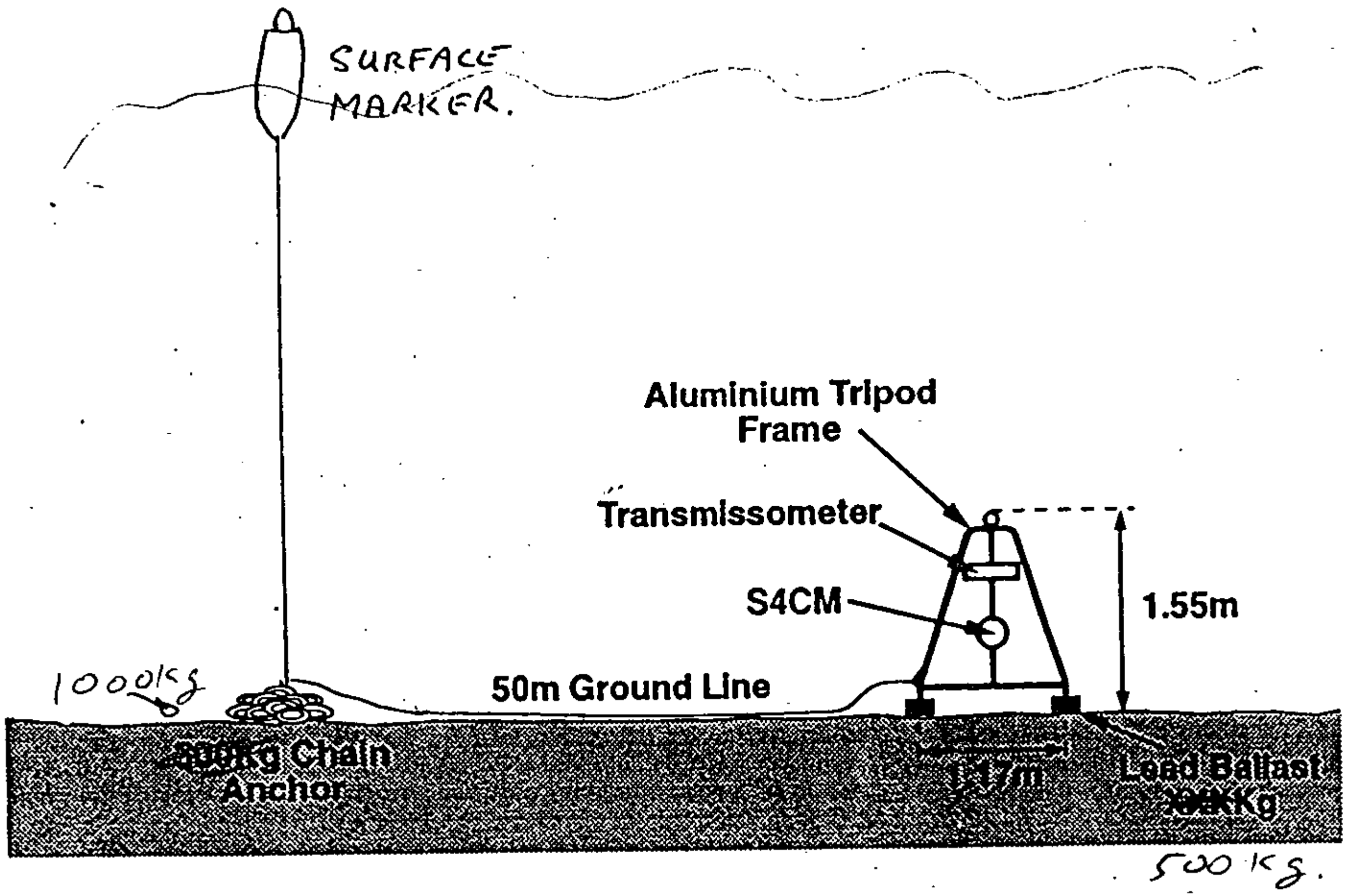


Figure 1(a). Mooring configuration, Sites 1 and 2.



Bottom Mounted CM/Transmissometer Mooring

Figure 1(b). Mooring configuration, Site 3.

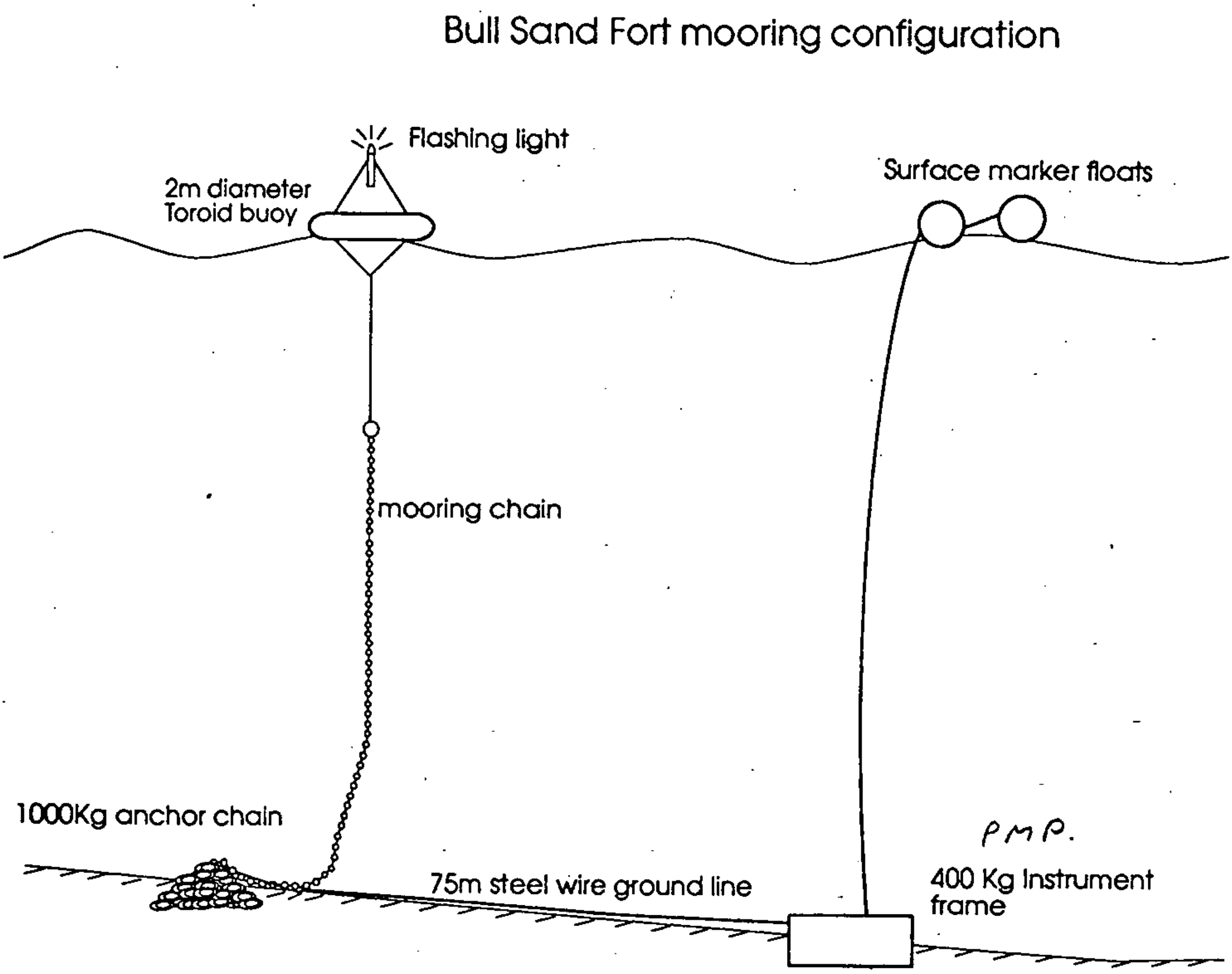


Figure 1(c). Mooring configuration, Site 4.

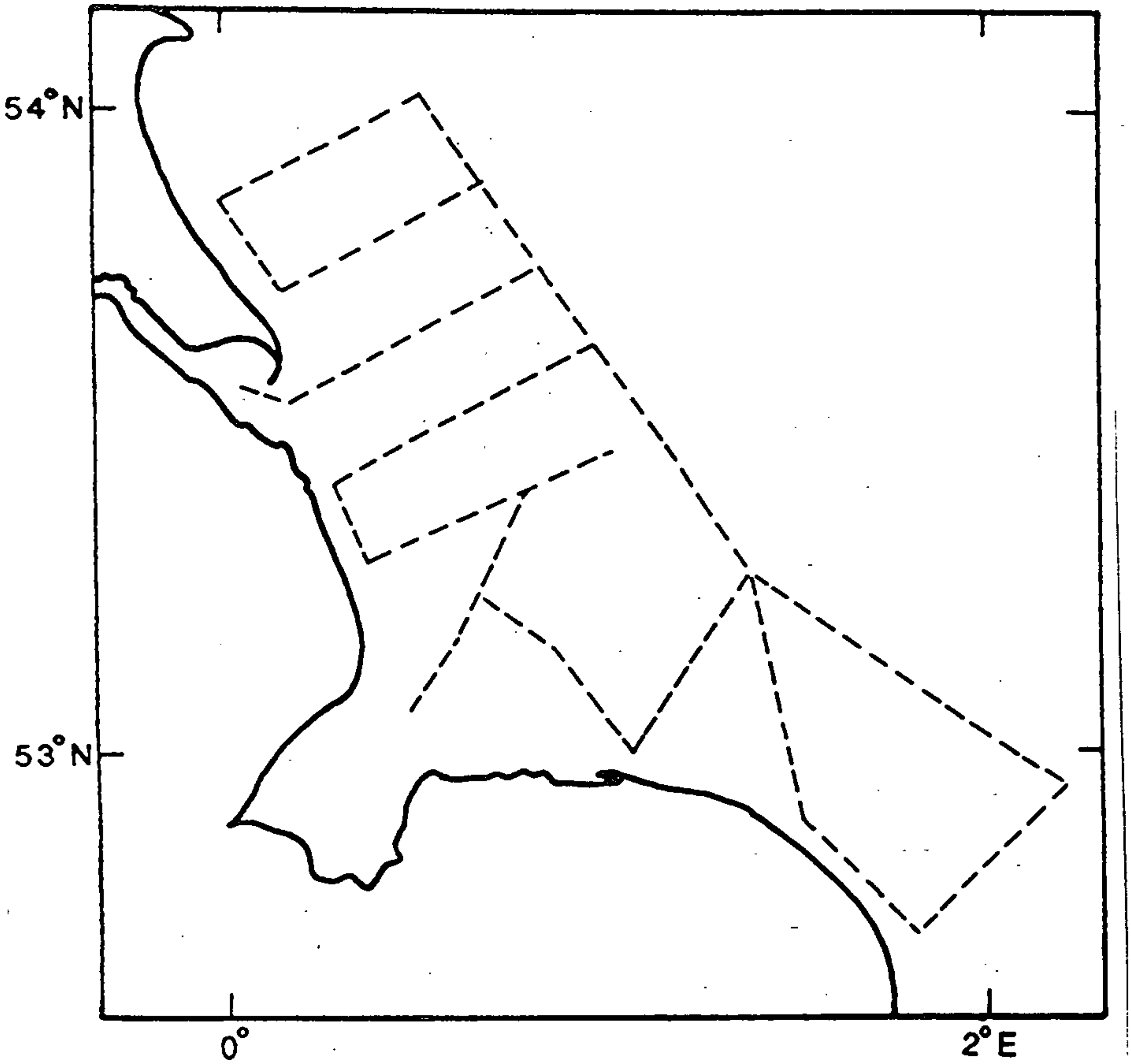
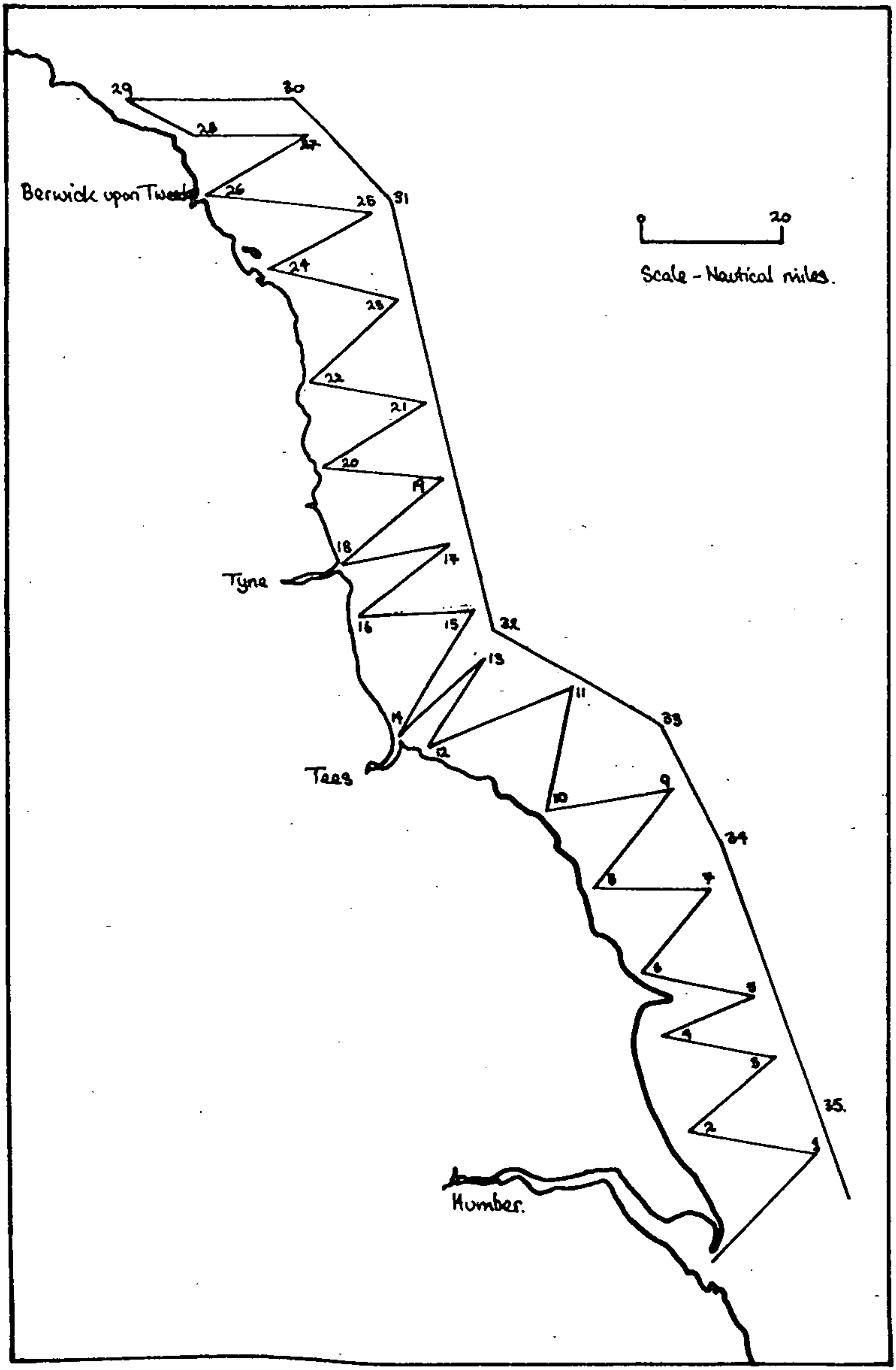


Figure 2. Humber/Wash grid track.

Figure 3. North east coastal grid.



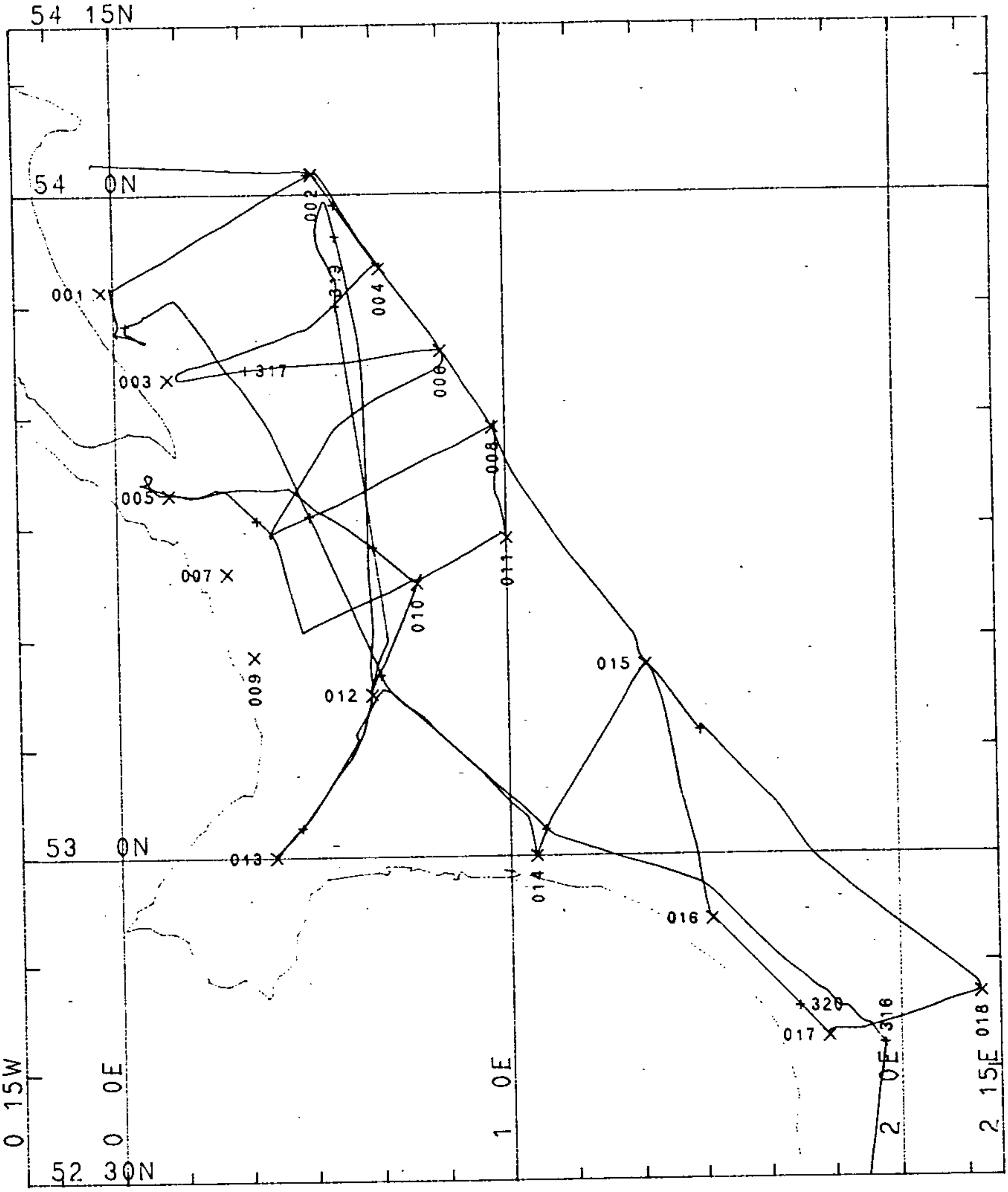


Figure 4. Track of first Humber/Wash grid, 12-16 November 1993.

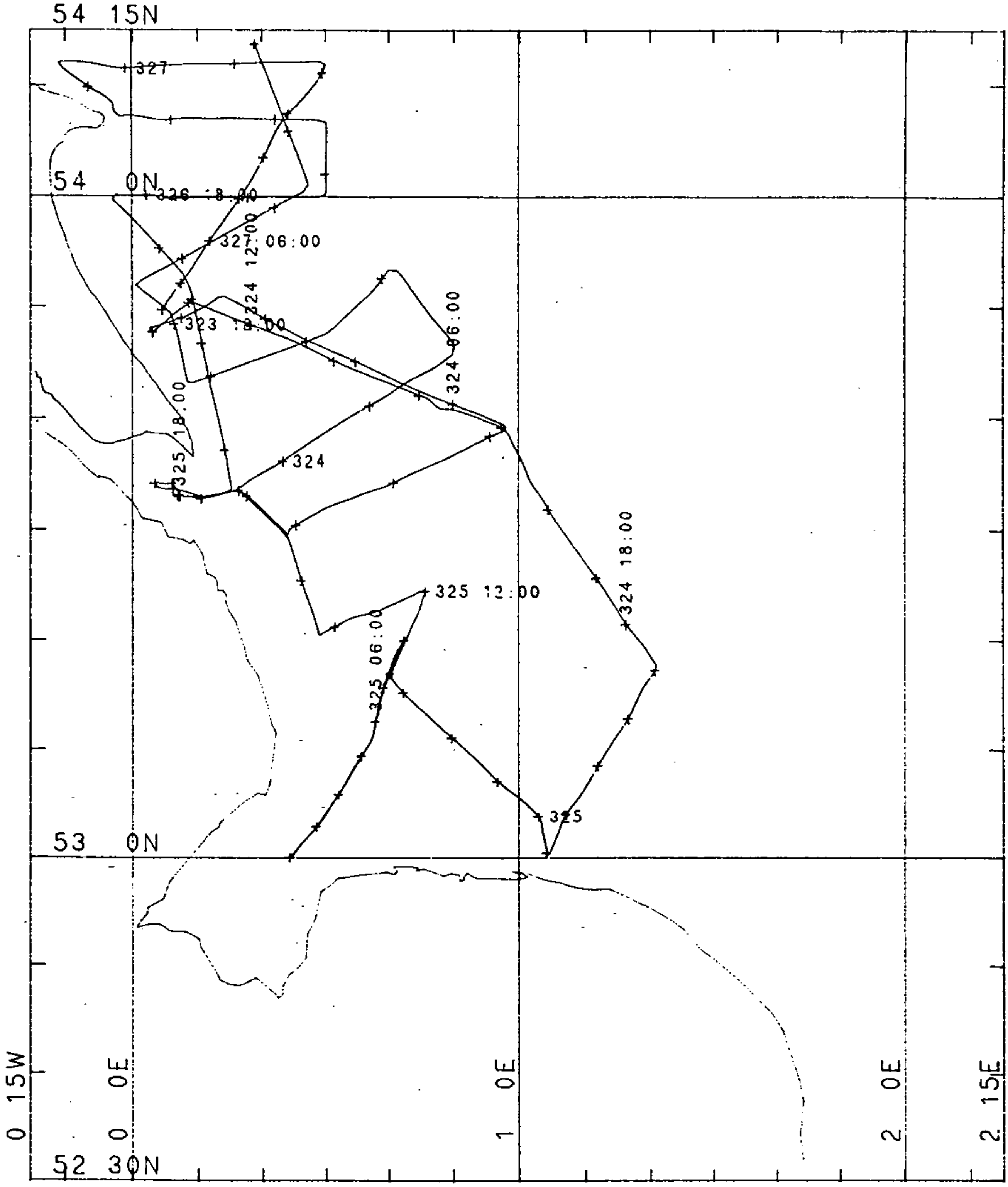


Figure 5. Track of second Humber/Wash grid, 19-22 November 1993.

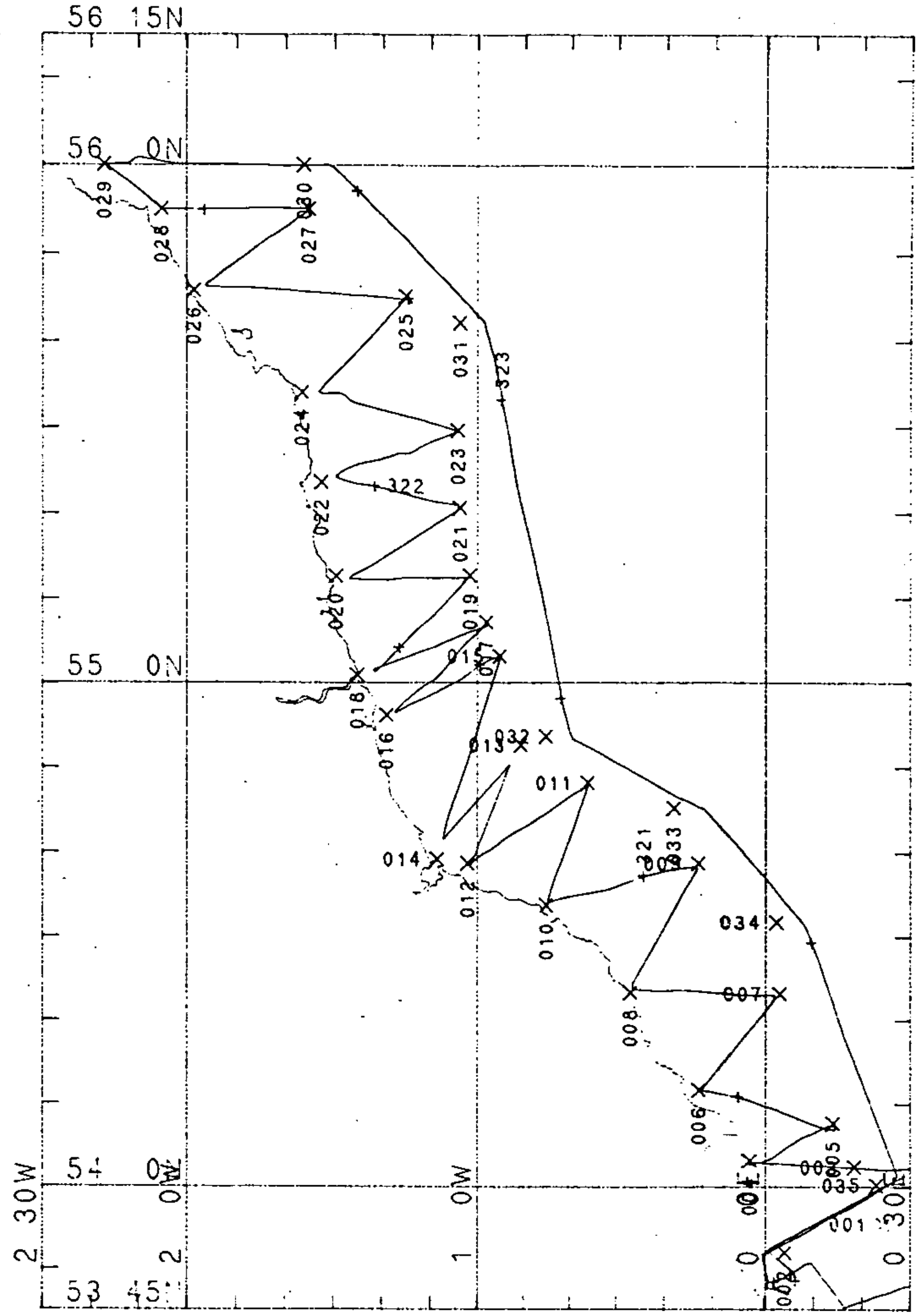


Figure 6. Track of N.E. coastal grid, 16-19 November 1993.

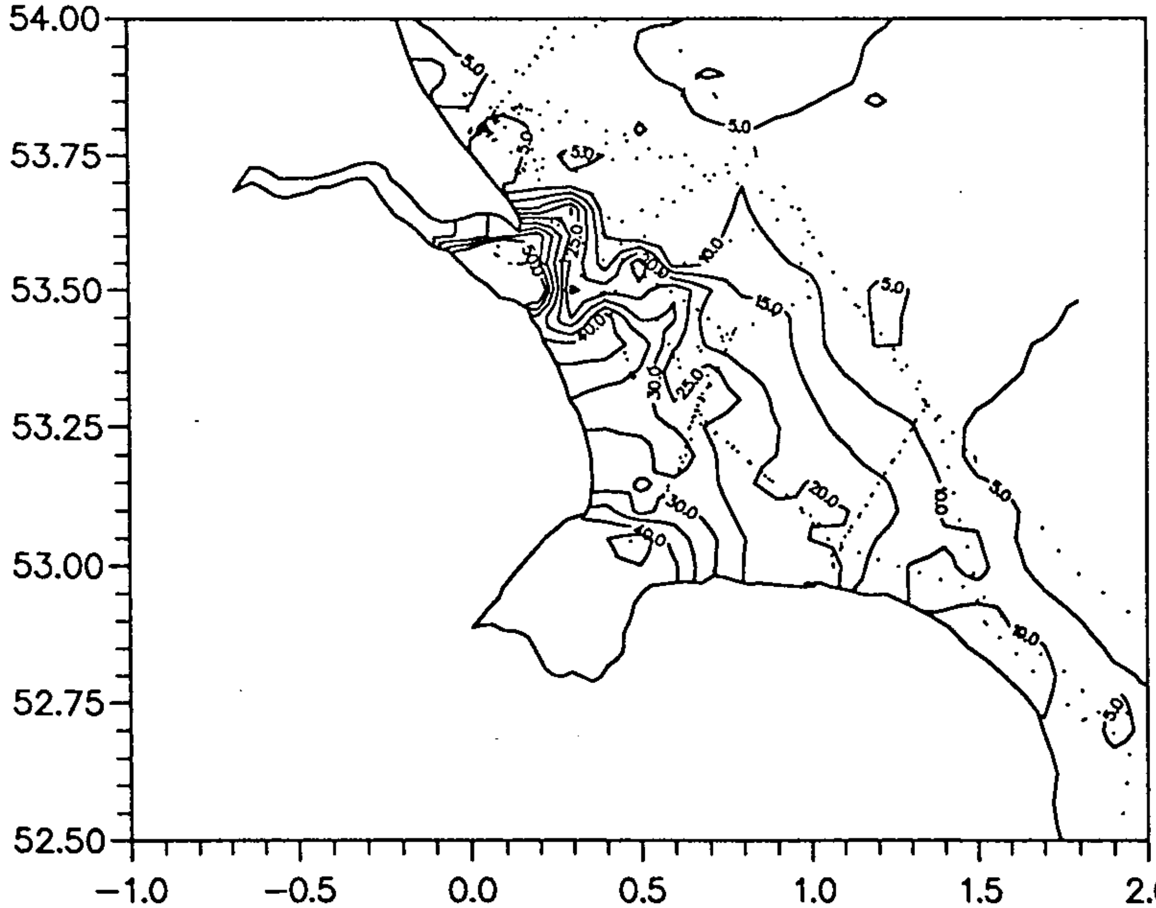


Figure 7(a). Contour plot of nitrate data from CH108a for the Humber/Wash area.

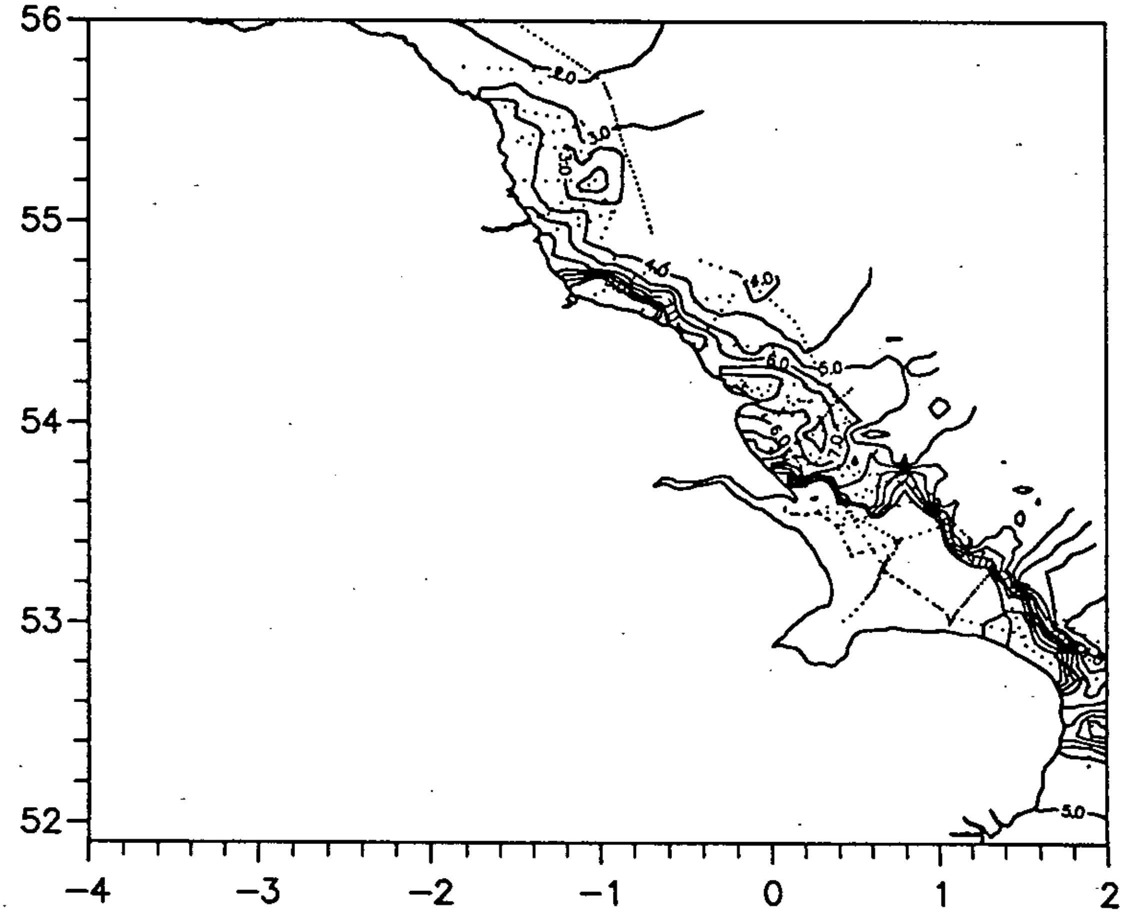
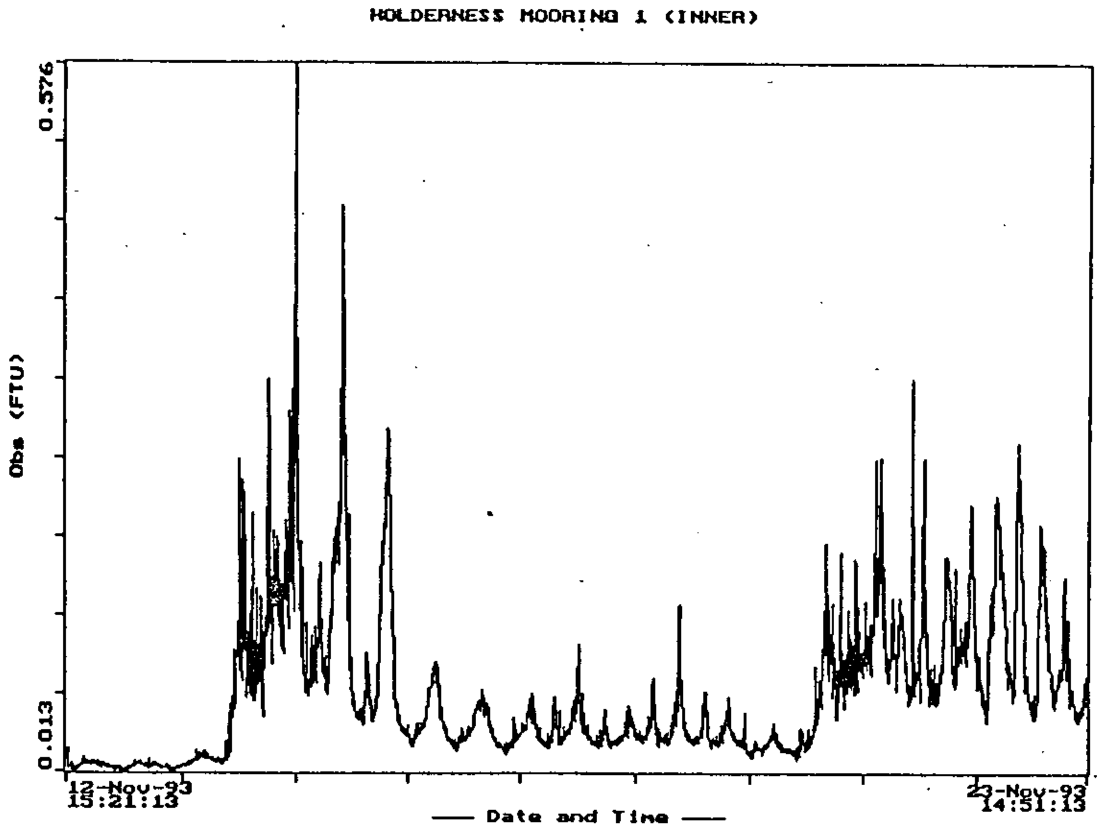


Figure7(b). Contour plot of nitrate data for CH108a for the whole survey area.



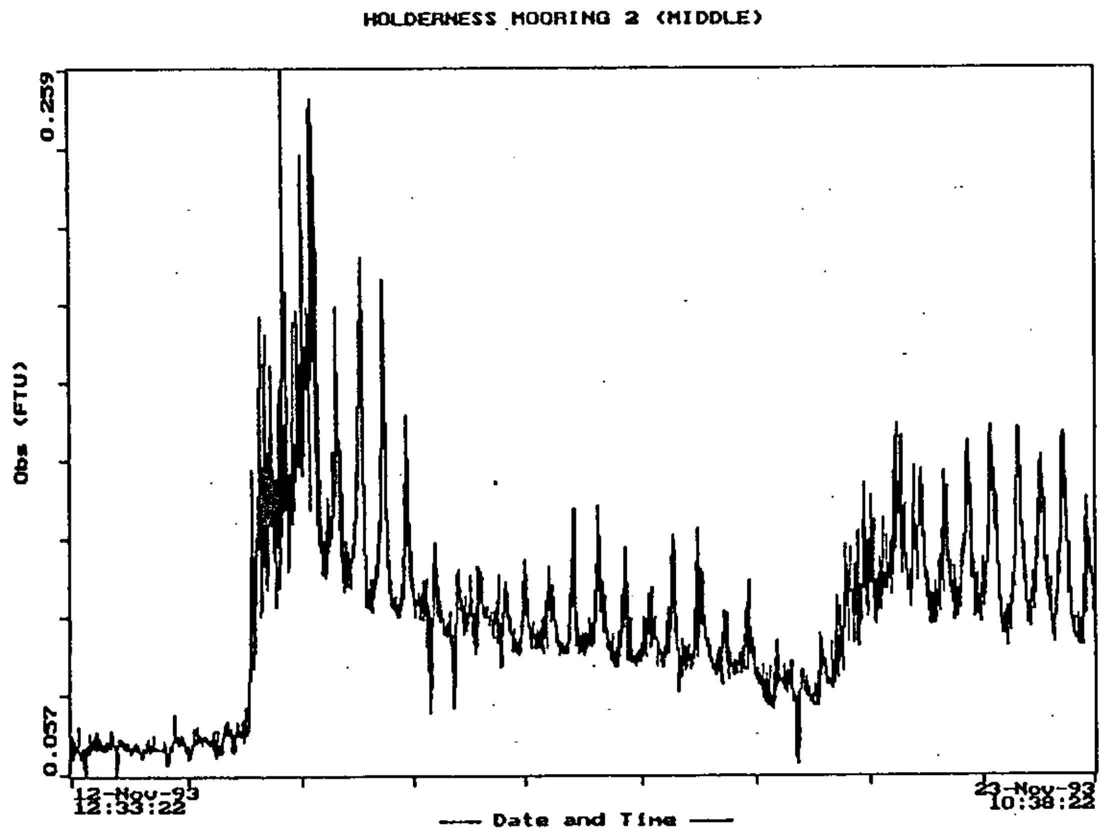


Figure 8. Suspended particulate matter data versus time from EMP 2000 instruments deployed at Holderness mooring sites 1 and 2.

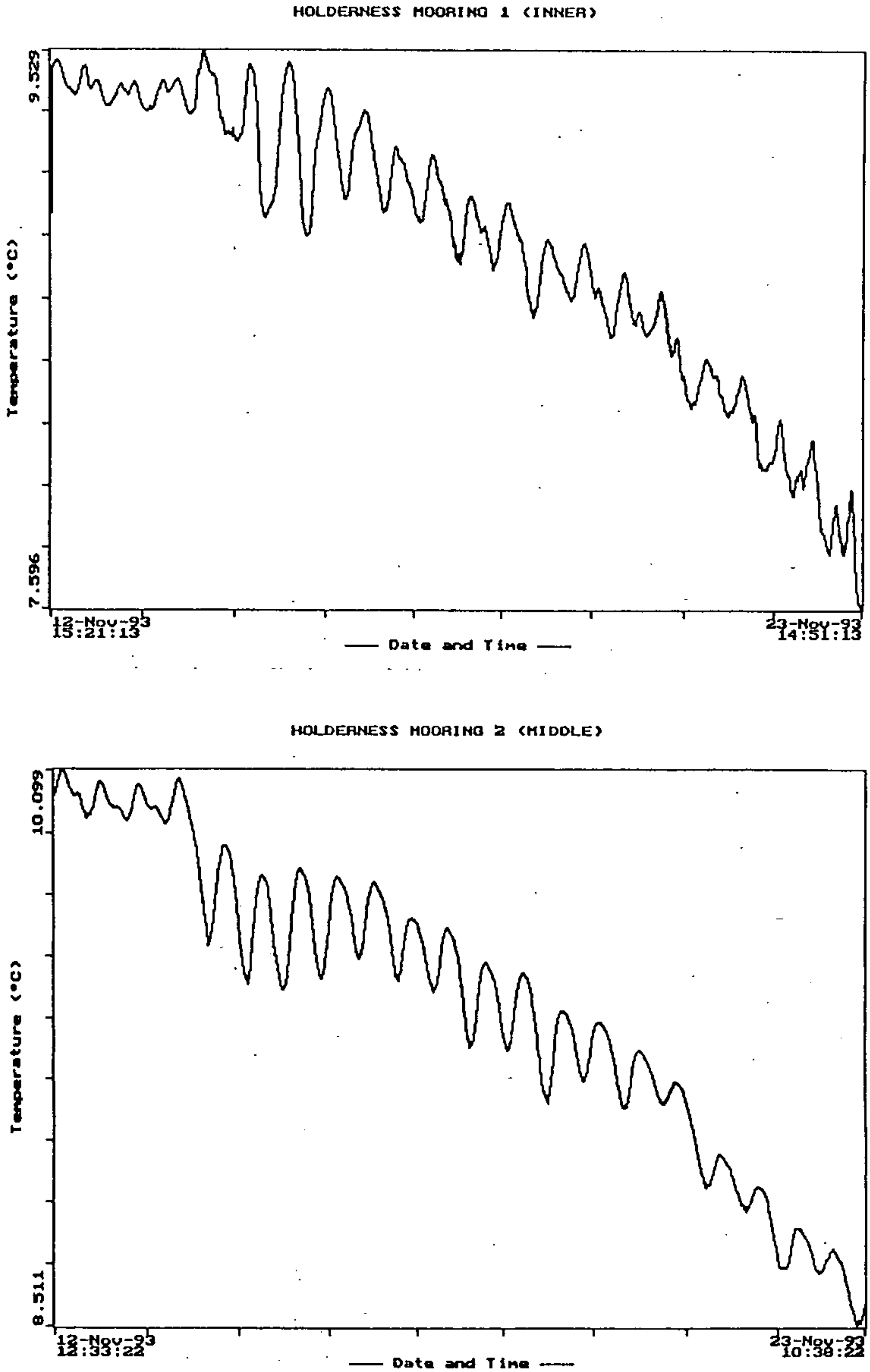


Figure 9. Temperature data versus time from EMP 2000 instruments deployed at Holderness mooring sites 1 and 2.

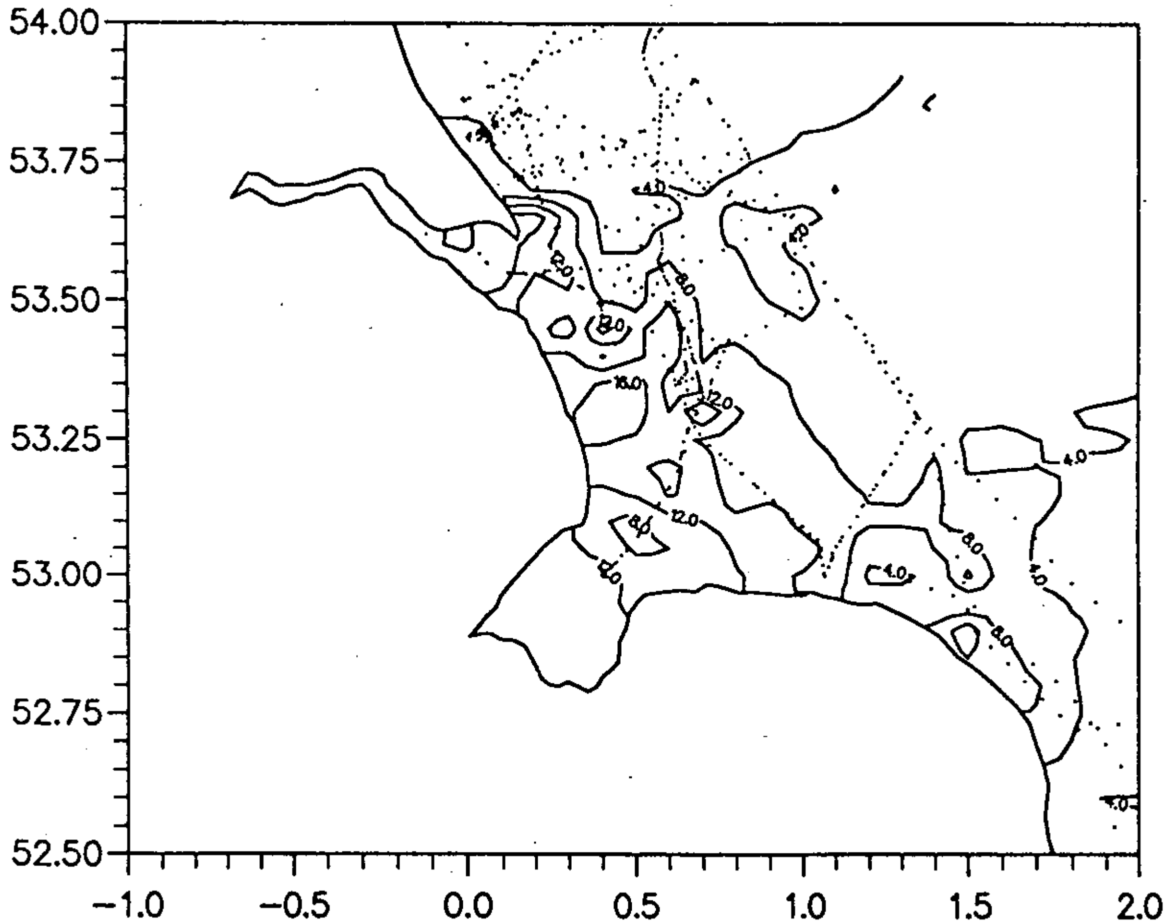


Figure 10(a). Contour plot of light attenuation data from CH108a for the Humber/Wash grid area.

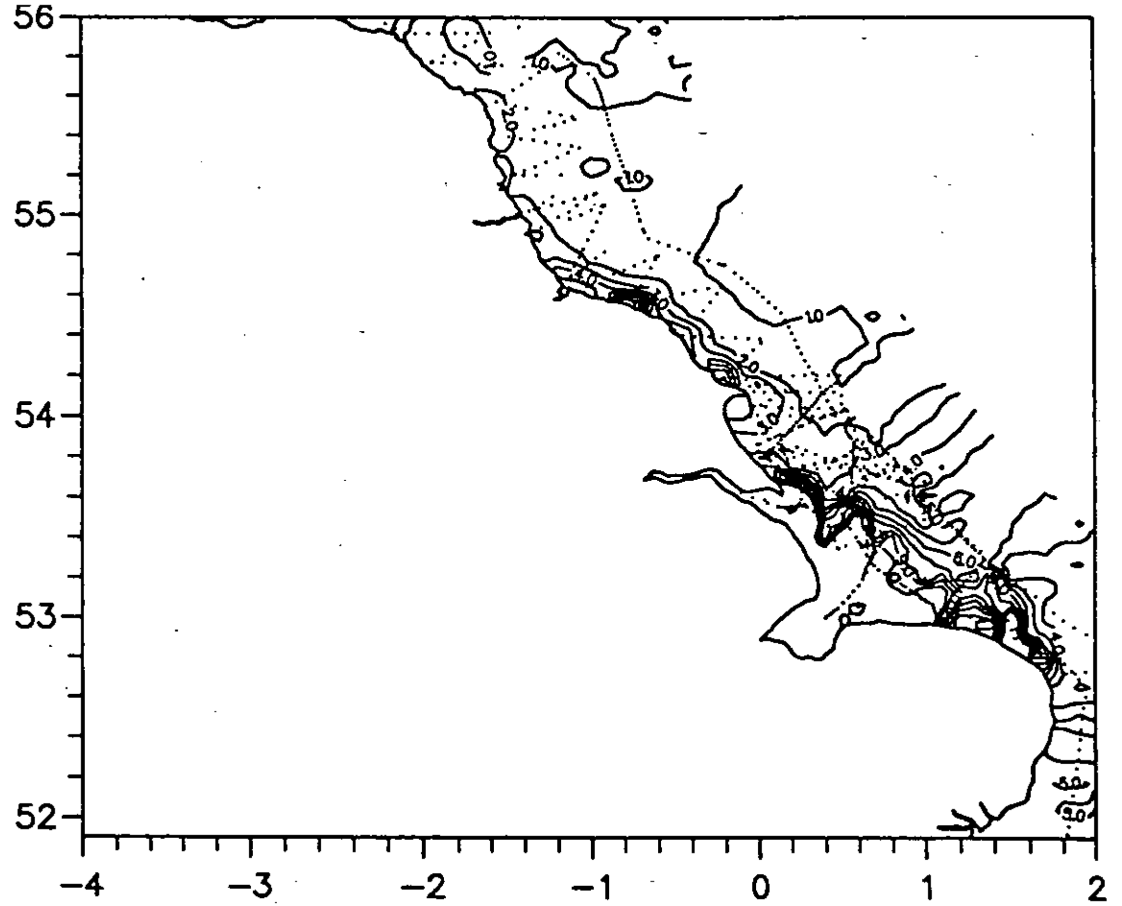


Figure 10(b). Contour plot of light attenuation data from CH108a for the whole survey area.

Figure 11. Satellite thermal image taken on 19 November of the Humber/Wash region.

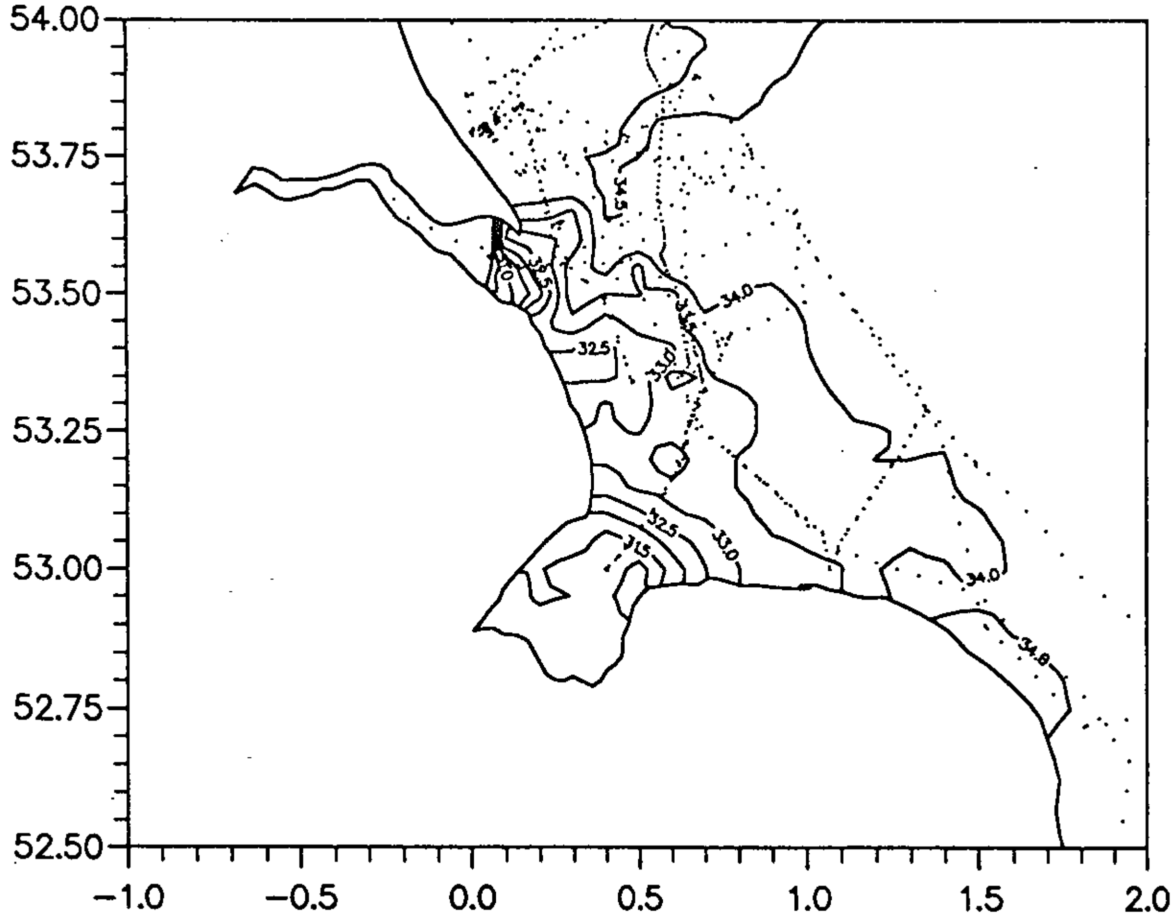


Figure 12(a). Contour plot of salinity data for the Humber/Wash area from CH 108a.

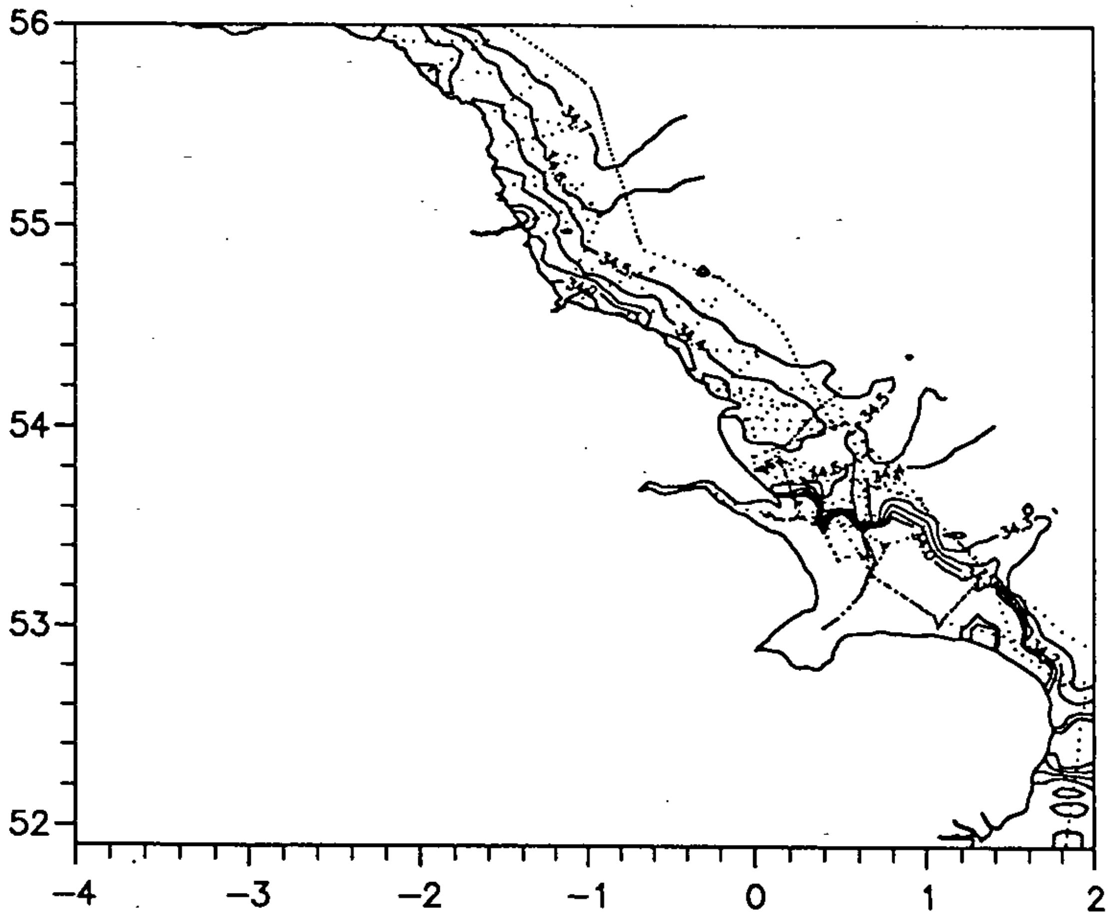


Figure 12(b). Contour plot of salinity data for the whole survey area from CH108a.