RRS CHALLENGER

CRUISE REPORT 62/A

23rd OCTOBER - 3rd NOVEMBER 1989

Jean Noarret maintenant

OBJECTIVES

1. To measure the concentrations and investigate the spatial distribution of the major nutrients: Nitrate, Nitrite, Ammonia, Silicate, Urea and Phosphate. Particular emphasis is being placed on these distributions in the sea area influenced by the major european estuaries flowing into the North Sea.

2. To establish the relationships, and contribution of, these nutrient species to the formation of phytoplankton blooms. Specific attention will be paid to the contributions made by ammonia, phosphate, and urea.

3. To carry out on-board mixing experiments using estuarine and offshore water samples.

4. To carry out deep gravity coring in order to study the historical record of Eutrophication using 15N, 13C and 14C compounds and other isotope dating techniques.

5. To investigate the distributions of chlorophyll and particulate organic carbon and nitrogen within the study area.

6. To study the primary production and assimilation rates of the phytoplankton using 32P, 14C and 15N tracers.

7. To investigate bacterial production using ^{3}H-thymidine and methane oxidising bacteria using $^{14}CH_4$.

8. To investigate the influence of benthic macrofauna on re-suspension of particulate matter of two contrasting sites of the North Sea.

PERSONNEL

N J P Owens	(Principal Scientist)
E M S Woodward	(1st Scientist)
A P Rees	
A Rowden	
D Plummer	(University of Southampton)
X Yu	(Peoples Republic of China/PML)
S J Bury	(SURRC/PML)
V Lees	(University of Warwick/PML)
E Wood	(UCNW/PML)
K Batten	(RVS Computing)
R Powell	(RVS Instrumentation)

ITINERARY (ALL TIMES GMT)

22nd OCT	0500	Vehicles departed Plymouth with equipment and majority of scientific complement
	PM	Unloaded equipment at Great Yarmouth and commenced set up.
23rd OCT	AM	Continued setting up laboratory and equipment
(GMT DAY 296)	PM	Remainder of scientific party arrived
	1700	Sailed Great Yarmouth
	1945	Deployed overside pump
		Hove to prior to setting up and calibration of nutrient analysers
24th OCT	0100	Commenced surface monitoring
(GMT DAY 297)	0932	CTD Station 2911
	0943	Completed Station, resumed monitoring
	1734	CTD Station 2912
	1750	Completed Station, resumed monitoring
25th OCT	0849	CTD Station 2913
(GMT DAY 298)	0902	Completed Station resumed monitoring
	1734	CTD Station 2914
	1746	Completed Station, resumed monitoring
		Continued overnight
26th OCT	0902	CTD Station 2915
(GMT DAY 299)	0917	Completed Station. Hove to due to compass fault
	1018	Resumed monitoring
	1631	CTD Station 2916
	1642	Completed Station, resumed monitoring
		Continued overnight
27th OCT	0300	Hove to at rig station
(GMT DAY 300)	0505	CDT Station 2917
	0616	In Situ incubation rig deployed
	0710	Box coring started - "Northern Station A"
	1204	CDT Station 2918
		Continued overnight
	1303	Box coring abandoned due to heavy swell

	1646	In situ incubation rig recovered
	1730	Resumed surface monitoring
28th OCT	0947	CTD Station 2919
(GMT DAY 301)	0954	Station completed
	1629	CTD Station 2920
	1641	Station completed, resumed surface monitoring
		Continued overnight
29th OCT	0400	Reduce speed for weather
(GMT DAY 302)	AM/PM	Speed further reduced due to weather, maintained surface monitoring, continued overnight
30th OCT	AM	Continued surface monitoring
(GMT DAY 303)	1200	Hove to, recalibrating nutrient analysers
	1700	Resumed monitoring, continued overnight
31st OCT	AM	Continued surface monitoring
(GMT DAY 304)	1020	Commenced Box and gravity coring
	1316	Completed coring
	1405	Resumed surface monitoring
	1640	Commenced gravity coring
	1715	Completed coring, resumed surface monitoring
	2100	Hove to, recalibrating nutrient analysers
	2217	Resumed monitoring, continued overnight
1st NOV	0956	CTD Station 2921
(GMT DAY 305)	1010	Completed Station, resumed monitoring
	1705	CTD Station 2922
	1715	Completed Station
2nd NOV	0013	CTD Station 2923
	0023	Completed Station
	0035	Commenced gravity coring
	0104	Completed gravity coring
	0120	Commenced Box coring
	0218	Completed coring, resumed surface monitoring
	0800	Completed surface monitoring
	1300	Overside pump recovered - passage to Plymouth
3rd NOV	1030	Scientists disembarked Plymouth by boat transfer
		Vessel continued to Cardiff
6th NOV	AM/PM	Equipment transferred by road to Plymouth

NARRATIVE: (times GMT)

Sunday 22nd October 1989

Vehicles and majority of scientific complement left Plymouth early AM. Arrived at Great Yarmouth PM and commenced loading and setting up equipment. Scientists victualled onboard.

Monday 23rd October 1989

Remainder of scientific party arrived. Continued setting up laboratory. Much of the surface monitoring equipment remained in place from North Sea project cruises. Sailed 1700 close to high water Great Yarmouth. Deployed overside pump when clear of traffic, commissioned non-toxic supply and surface monitoring equipment. Hove to for part of early evening commissioning nutrient analysers. Night watches set.

Tuesday 24th October 1989

Completed chemistry set up and commenced surface monitoring - midnight. Vessel moving easily in slight swell. Commenced Northward track towards River Tyne, zig-zagging 5-15 miles off coast. Completed 2 CTD Stations AM/PM. Slight swell. Commenced 3 watch system to cover 2000-0800 (ship's time) period.

Wednesday 25th October 1989

Arrived off Tyne mouth 0330. Hove to for one hour to recalibrate nutrient analysers. Recommenced track towards South. Continued monitoring throughout the day. Noted particularly high ammonia concentrations in the vicinity of River Tees. 2 CTD's completed during the day. Wind gusting 45 kts at times but sheltered position resulted in only slight seas.

Thursday 26th October 1989

Left coastal region early AM in SE direction. Completed 2 CTD's. Halted chemistry and surface sampling PM in order to prepare for following day's station work.

Friday 27th October 1989

CTD 0500 and water collection for in situ incubation rig. Productivity rig deployed at dawn (0615) in very slight sea conditions. Commenced box coring for micro-fauna work. Number of successful box cores obtained around station grid. CTD midday for light profile. Wind steadily increased during morning/afternoon. Gusting 40 kts (NW) by 1300. Heavy swell developed and coring abandoned. In situ incubation rig recovered at dusk in moderate sea conditions. Re-commenced surface monitoring. Sea state reduced ship's speed to 8 kts through the evening. Night watches commenced 2000. EW trapped thumb in constant temperature laboratory door.

Saturday 28th October 1989

Continued surface monitoring along Danish coast and towards German Bight. Weather forecast for severe weather. Late PM decision made to abandon planned incubation rig/coring station in German Bight. Adjusted sampling track to take account of new plans. Night watches commenced amid much confusion due to time zone change. Weather deteriorated overnight.

Sunday 29th October 1989

Continued monitoring along W track off German/Dutch coast. Weather deteriorated rapidly. Ships speed reduced to <5 kts in heavy seas. Wind speed gusting +50 kts. Sea conditions too rough for overside operations.

Continued monitoring overnight.

Monday 30 October 1989

Slight moderation in weather allowed ship's speed to increase during early AM watches, however, seas still too rough for overside work. Hove to 1200 to allow re-tuning of nutrient analyser prior to surface monitoring leg into Rhine area. Continued monitoring 1700 towards Belgian coast. Sea state moderated considerably during night.

Tuesday 31st October 1989

Weather further moderated overnight. Arrived off Scheldt estuary AM in calm conditions. Took two successful box cores from sandy bottom - very rich benthic fauna. Gravity coring unsuccessful. Resumed surface monitoring along coast and then turned towards Thames estuary.

Wednesday 1st November 1989

Arrived off N. Thames AM. Proceeded along a grid pattern, surface sampling in calm, pleasant conditions. Turned towards S. Thames and continued sampling throughout the day and evening.

Thursday 2nd November 1989

Arrived at S. Thames estuary 0015 - CTD. Commenced coring 15' N Margate. One successful gravity core. Failed box coring. This is a promising area for historical record coring purposes but a popular anchorage. Departed station 0245 and commenced sampling leg towards Dover straits. Arrived off Dover 0700. Completed sampling survey track. Commenced demobilisation of scientific equipment during passage down English Channel. Moderate sea conditions during afternoon due to strong SW winds. Weather moderated during afternoon.

Friday 3rd November 1989

Arrived off Plymouth 1000. Scientists disembarked by boat transfer in Plymouth Sound 1030. Equipment remained onboard. Returned to Plymouth 6th November.

Voyage Total Time 233 hours, Distance 1633 Nautical Miles.

PROCEDURES AND METHODS

Two types of approach were adopted to meet the objectives of the cruise.

(a) Continuous monitoring of surface variables
(b) Discrete sampling for state and rate measurements.

CONTINUOUS SAMPLING

Continuous sampling of surface variables was carried out throughout the cruise period apart from periods when stations were occupied for *in situ* incubations. Sampling underway was carried out on water collected from a sub-surface pump (~1.5 m) and piped into the laboratory. Analyses were performed for nutrients: NO_3, NO_2, SiO_3, PO_4, NH_4, using colorimetric techniques. Temperature salinity, fluorescence, incident radiation and transmission were measured continuously and logged on computer. Ship's position was continuously logged.

DISCRETE SAMPLING

Discrete samples were obtained from various depths using CTD rosette, and, whilst underway, from a manifold in the pump system. Samples were collected for particulate C and N analysis, chlorophyll, and dissolved organic nitrogen and phosphorus.

RATE MEASUREMENTS

Surface phytoplankton production was measured using the ^{14}C assimilation technique. Samples collected underway were incubated at constant light (~100 μ Em^{-2} $s\mu$) at surface seawater temperature. The use of this protocol enabled all incubations to be normalised for light, irrespective of their time of collection. Surface samples were collected at approximately 3 hourly intervals whilst underway. Depth related production was also measured on one occasion using an *in situ* incubation rig. All primary production measurements were made using size-fractionation techniques. Size fractionated nitrogen assimilation rates were measured concurrently with primary production measurement using ^{15}N techniques, phosphorus uptake was measured concurrently using ^{32}P methods. Bacterial production was measured using ^{3}H-thymidine incorporation methods. This cruise also provided the opportunity to measure methane oxidation rates which were examined at four stations.

EQUIPMENT PERFORMANCE AND OVERALL SUCCESS OF THE CRUISE

Overall, PML equipment worked satisfactorily. Urea measurements were unsuccessful due to faulty components in colorimeter. All RVS equipment worked satisfactorily. A total of 52 ^{15}N and ^{14}C size fractionation incubations were carried out. 45 bacterial production estimates and 27 phosphorus assimilation measurements. A significant amount of time was lost due to bad weather. Coring work was halted at one station and impossible at a second. All overside operations were suspended for a period of 40 hours over the 29th-31st October. Ship's speed was severely reduced on several occasions. This necessitated abandoning two *in situ* incubation experiments, however, the highest priority work covering the surface sampling track was successfully achieved.

Coring attempts for objective 4 were only partly successful but provided sufficient material for the pilot nature of the experiment.

Some initial doubts were felt about the closure of the GO-FLO bottles - these were successfully rectified, however, only limited use was made of the bottles. The computing logging and plotting were successful.

SHIP'S NON-TOXIC SUPPLY

This was found to be very heavily colonised by a variety of macro-faunal and floral species - notably *Mylilus edulis* and various filamentous algae (*Cladophora* (?)). Judging from the size of the organisms it is clear that the colonisation had been very long established (months) and must cast suspicion on any critical chemical measurements previously made by this system. Such a problem has been noted on many occasions on every ship on which our group has sailed, and is the reason why we routinely provide our own non-toxic supply. We consider that physical measurements ($T°C/s^{o}/oo$ etc) will be unaffected, however, we have not tested this. It is conceivable that surface fluorescence measurements and transmission data could be in error due to the breaking off

of large pieces of matter of algal origin. It is also possible that more critical experiments/measurements will be unaffected because of the high flow-rate to surface area ratio. Nevertheless, it is clearly erroneous to describe this system as "non-toxic". Two courses of action are available to RVS. (1) Accept that such a system will continue to be fouled and to point out the limitations to all subsequent users. (2) Adopt a rigorous cleaning of the system as a routine procedure between cruises. The latter option is highly desirable but in practice may be difficult to achieve. Various methods of cleaning could be suggested, and a consensus from a variety of users is probably desirable. It is accepted that the designation of responsibility for this action might prove difficult. I would suggest that notification of this problem to previous users of the Challenger is in order.

DISPOSAL OF WASTE CHEMICALS

The current provision for disposal of chemical wastes is not satisfactory. Whilst the principle of non-disposal at sea is highly honourable, the current arrangements are potentially hazardous to personnel and must be re-examined. The principle objection is that 2 x 50 gallon containers of a cocktail of chemicals is potentially lethal. Although all the individual chemicals disposed of are recorded (or should be) it would tax the abilities of an industrial chemist to work out the myriad of reactions that might be occurring within the tanks. It is quite possible that lethal volatile/explosive mixtures could be generated within the containers. A second objection to the present system is the difficulty of the mechanics of transfer of chemicals into the tanks.

The matter of waste disposal is clearly important and a rigorous procedure is to be encouraged and enforced. I suggest that the responsibility be devolved to the users, who should provide for the best safety/environmental considerations. These should be notified to the master.

PRELIMINARY RESULTS

HYDROGRAPHY (N.J.P. OWENS)

Conditions were typical for the time of year for the North Sea. It was hoped that some residual stratification might have remained, however, the water column was entirely well mixed. Slight evidence of resuspension of bottom sediments was found at a number of shallow sites, however, no evidence of chemical stratification was apparent. Good temperature and salinity ranges were encountered (figs. 3 and 4) which will provide the necessary data for examining the various inputs of nutrients.

Fluorescence measurements (fig. 5) indicated the presence of elevated phytoplankton biomass in the German Bight and off the large continental rivers. Slightly elevated fluorescence levels were apparent off the River Thames but not elsewhere off the UK coast.

CHEMICAL MEASUREMENTS (E.M.S. WOODWARD)

The major nutrients were detectable over the whole sampling area. No stratification of chemical species was observed. The chemical data require significant work up, however, two observations are notable. First, high concentrations of NH_4 were observed off the mouth of the River Tees. NH_4

concentrations are consistently elevated in this region but we have not previously encountered such levels. There was no evidence of elevated phytoplankton biomass associated with this input. Second, exceptionally high concentrations (>2 mmol NO_3-N l^{-1}) of nitrate were observed off the Scheldt Rhine estuary. These levels were approximately 10 times higher than previously recorded. In part, this was due to the low salinity encountered (~ 25‰). However, if data from previous cruises are extrapolated to a similar salinity, the concentrations observed on this cruise remain at least 3 times higher than those previously found. These concentrations were not accompanied by notably elevated phytoplankton biomass - rather the whole southern Bight region exhibited a generalised elevation of levels. We do not have a firm explanation for these data, but they possibly reflect the reduced phytoplankton activity compared with typical summer levels. However, the highest nitrate concentrations previously recorded (Feb, 1987) also coincided with low phytoplankton activity, thus we conclude that the Nitrate inputs in this region during this period must have been substantially greater than previously observed. These data require considerable further analysis.

PHYTOPLANKTON PRODUCTION (N.J.P. OWENS, A. REES, D. PLUMMER, S. BURY, E. WOOD)

All ^{15}N measurements require mass spectrometric analysis and ^{14}C counting is currently being completed; these will be carried out in 2 months. A full surface water survey for Oxygen concentration was carried out - the data require computer analysis. Data from 3 experiments to examine the time course assimilation of ^{15}N and ΔO_2 require examination.

This cruise saw the first simultaneous measurement of a complete suite of tracers including: $^{15}NO_3$, $^{15}NH_4$, ^{15}N-urea, $^{32}PO_4$ and ^{14}C. All incubations were subsequently size-fractionated into less than and greater than 5 μm fractions to examine the relative importance of nano and net plankton.

Preliminary PO_4 assimilation data are available. In general, the <5μm size fraction assimilated more PO_4 than the larger fraction. In 40% of cases the >5μm fraction apparently assimilated no phosphate. The equivalent figure for the smaller fraction was 14%. This apparent zero assimilation may be an artefact of the method and requires further investigation. The spatial distribution of PO_4 assimilation (fig. 7) was not related to the distribution of phytoplankton biomass (fluorescence) or phosphorus concentration. The significance of this observation is unknown but suggests that additional measurements (eg. alkaline phosphatase activity) may be necessary to understand phorphorus assimilation.

METHANE OXIDATION RATE/BACTERIAL PRODUCTION (V. LEES)

Methane oxidation rates were investigated at four sites. 3 incubations were successful, with methane oxidation being divided into both cell carbon and respiration fractions. Cell carbon estimates were reproducible, however, respiration measurements were highly variable suggesting that modification of the technique is necessary.

Preliminary calculations suggest methane oxidation rates between 4.7×10^{-6} and 18.8×10^{-6} μmoles cell carbon fixed l^{-1} d^{-1}. These rates compare with typical North Sea bacterial activities of $10\ 1 \times 10^{-3}$ μmoles $Cl^{-1}d^{-1}$.

BENTHIC MACROFAUNA STUDY (A. ROWDEN)

Station A:

Five 0.25m2 box cores (Hessler/Sandia USNEL or "SMBA Type") were recovered from a pre-determined grid (fig. 8) and each was treated in the following manner:-

Five replicate cores (10cm diameter) to the maximum depth obtainable were taken to assess species occurrence and abundance. These cores were pre-sieved on board through a 0.5mm mesh and fixed/preserved in 10% formalin. One sediment core (6.5cm diameter) was taken to a minimum depth of 20cm, this was frozen and returned to the laboratory for sectioning - allowing the determination of water content/organic content/grain size with depth. One sediment core (4cm diameter) was taken to a depth of 5cm and frozen for return to the laboratory. It is hoped that the latter cores will be analysed for mucus content once an appropriate method has been devised. One surface (5mm) sample was taken using a syringe with a 1.5cm diameter. This was frozen and will be used in the laboratory to measure pigments for evaluating the presence of diatoms and faeces, and surface organic content (an indirect measure of faeces). Sediment temperature was measured at a depth of 10cm. Observations were made on each box core, and notes taken on the RPD layer, sediment structure, dead faunal remains, surface topography, the presence and numbers of conspicuous animals. The remainder of the sediment in the box was sieved through a 2mm mesh to improve abundance estimates of the larger and relatively lower density macrofauna.

Bulk sediment was collected from "failed" cores, bagged and frozen for return to the laboratory.

Poor weather conditions suspended coring operations which meant that only a very small number of *Callianassa subterranea* were recovered alive and no cores were available for resin casting.

Station C:

Coring was not even attempted owing to severe weather conditions.

Station D (Scheldt Estuary):

Two 0.25m2 box cores were taken to assess species occurrence and abundance in order to evaluate the suitability of this site for future bioturbation studies. The entire core contents were pre-sieved on board one through 2mm, the other a 0.5mm mesh and fixed/preserved using 10% formalin. A qualitative analysis of the infauna is appended.

Assistance was provided for sedimentary investigations carried out by Dr Nick Owens.

Station E (Thames Estuary):

Box coring at this location was unsuccessful due to bottom conditions - coarse flint/shell gravel which permitted only shallow penetration and recovery. That material returned was sieved using a 2mm mesh, and on inspection was deemed to have a very impoverished fauna which was not preserved. Operations

were suspended as the corer was unlikely to succeed in recovering a suitably representative sample at this site.

Summary:

On completion of Cruise CH62A/89 only about a third of the objectives relating to the Benthic study were fulfilled. However failure was entirely due to unsuitable weather conditions occurring on those days allocated for coring at the designated study sites.

"On hands" experience of collecting and preparing samples for Carbon 14 analysis was successfully achieved.

STATION LIST (See also fig. 2)

NO.	DATE	TIME (2)	POSITION		ACTIVITY
2911	24/10	297. 0932	53°32'.4	00°59'.2E	C
2912		297. 1734	54°08'.9	00°04'.4E	C
2913	25/10	298. 0849	54°40'.3	01°06'.1W	C
2914		298. 1734	53°54'.4	00°00'.2W	C
2915	26/10	299. 0902	53°06'.1	02°57'.4E	C
2916		299. 1631	53°55'.4	02°20'.9E	C
2917	27/10	300. 0505	54°34'.9	04°50'.5E	C, IR
A		300. 0710	54°34'.5	04°50'.7E	BC
2918		300. 1204	54°33'.6	04°49'.5E	C
2919	28/10	301. 0947	54°50'.7	07°00'.1E	C
2920		301. 1629	53°59'.1	07°45'.9E	C
D.1	31/10	304. 1020	52°04'.0	04°01'.2E	BC.GC
D.2		304. 1640	51°53'.8	03°41'.8E	GC
2921	1/11	305. 0956	52°08'.7	01°47'.2E	C
2922		305. 1705	51°57'.7	01°46'.7E	C
2923	2/11	306. 0013	51°25'.4	01°25'.0E	C
E		306. 0035	51°25'.5	01°24'.8E	BC.GC

ACTIVITIES: C -CTD; IR - In Situ Rig; BC - Box Corer; GC - Gravity Corer

CORING STATION LIST

STATION A (MACROFAUNA - NORTHERN STATION) 27-10-89

TIME	POSITION AT DEPLOYMENT		COMMENT
0710	54°34'.50N	04°50'.70E	
0725	54°34'.59	04°50'.83	
0828	54°34'.50	04°48'.92	
0930	54°35'.58	04°48'.75	
1024	54°35'.62	04°49'.33	DECCA UNRELIABLE
1039	54°35'.63	04°48'.76	DECCA UNRELIABLE
1147	54°33'.80	04°49'.17	SAT. FIX
1303	54°34'.77	04°50.'00	SAT. FIX

STATION D.1 (SCHELDT) 31-10-89

1020	52°04'.00N	04°01'.20E	BOX CORE UNSUCCESSFUL/DISCARDED
1030	52°03'.81	04°01'.15	BOX CORE RETAINED (#1)
1048	52°04'.07	04°01'.56	BOX CORE UNSUCCESSFUL/DISCARDED
1126	52°04'.21	04°01'.54	BOX CORE RETAINED (#2)
1256	52°04'.47	04°01'.80	GRAVITY CORE UNSUCCESSFUL
1305	52°04'.48	04°01'.25	GRAVITY CORE UNSUCCESSFUL
1316	52°04'.66	04°01'.57	GRAVITY CORE UNSUCCESSFUL

STATION D.2 (SCHELDT) 31-10-89

1640	51°53'.84	03°41'.81	GRAVITY CORE UNSUCCESSFUL
1704	51°53'.85	03°41'.89	GRAVITY CORE UNSUCCESSFUL

STATION E (THAMES) 1-11-89

0035	51°25'.47N	01°24'.79E	GRAVITY CORE SUCCESSFUL
0045	51°25'.42	01°25'.00	GRAVITY CORE UNSUCCESSFUL
0052	51°25'.41	01°25'.00	GRAVITY CORE UNSUCCESSFUL
0104	51°25'.39	01°25'.13	GRAVITY CORE UNSUCCESSFUL

METEOROLOGY (X Yu) - (see Figure 9)

Weather conditions varied markedly over the cruise period.

Air temperatures varied between 10°C and 16°C. Wind strength was initially moderate, but shelter was obtained from the proximity to the coast and only slight seas were experienced. Barometric pressure remained largely steady during the first half of the cruise but began to fall rapidly during the 27th October. This was accompanied by strong to gale force winds from the NW. This was followed by a period of further pressure drop and strong to severe S - SW gale during 28-29th October. Wave heights reached 20 feet during this period. A period of rapid pressure rise at the end of the period was accompanied by moderate - strong SE winds and heavy seas.

ACKNOWLEDGEMENTS

The excellent service provided by the Master, G. Long, Officers and crew is gratefully acknowledged, as is the sterling service of Robin (dad!) Powell and Kay Batten from RVS. This cruise was funded by the Department of Environment and forms part of commission no:

This cruise forms part of PML Laboratory Project 2.

Prepared by:- N J P Owens
29.11.89

Authorised by:- B L Bayne

CIRCULATION

INTERNAL

CRUISE PERSONNEL (11 copies)
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FIGURE LEGENDS

Fig. 1. Cruise track - Challenger 62/A. Numbers refer to GMT date and time. Small crosses indicate intermediate ½ hourly positions.

Fig. 2. Station positions. Activities N = ^{15}N incubations; C = ^{14}C incubations; T = ^{3}H incubations; P = ^{32}P incubations; O = discrete O_2 measurements.

Fig. 3. Uncorrected surface temperature (°C) contours.

Fig. 4. Uncorrected surface salinity (°/∞) contours.

Fig. 5. Uncorrected surface chlorophyll fluorescence (mgm^{-3}) contours.

Fig. 6. Surface phosphate-P concentration ($\mu mol\ l^{-1}$ contours.

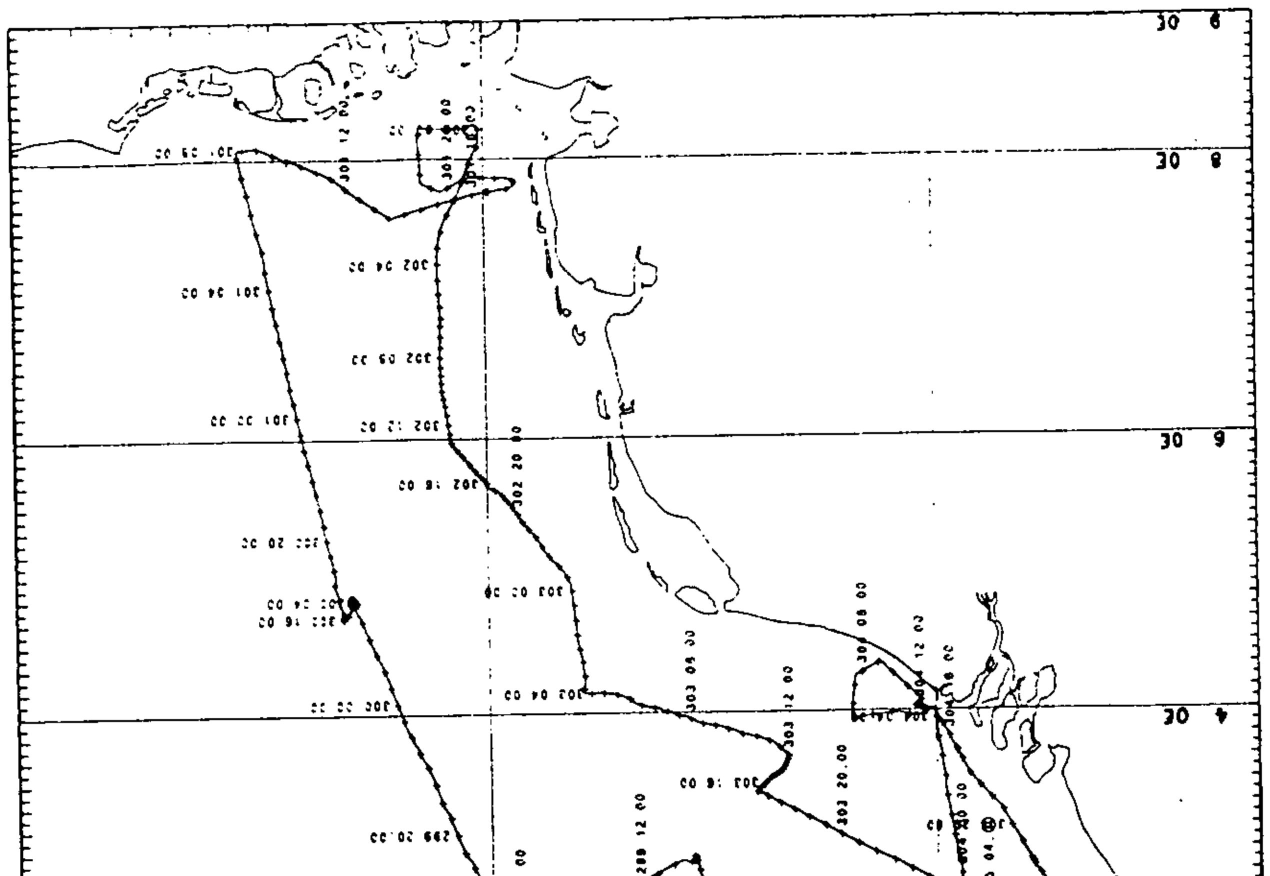
Fig. 7A. Phosphate assimilation (< 5 μm fraction).

B. Phosphate assimilation (< 5 μm fraction) $\mu mol\ P\ l^{-1}\ d^{-1}$.

Fig. 8. Station positions for macrofauna-bioturbation study - Northern Site.

Fig. 9. Four hourly meteorological observations.

Fig.1



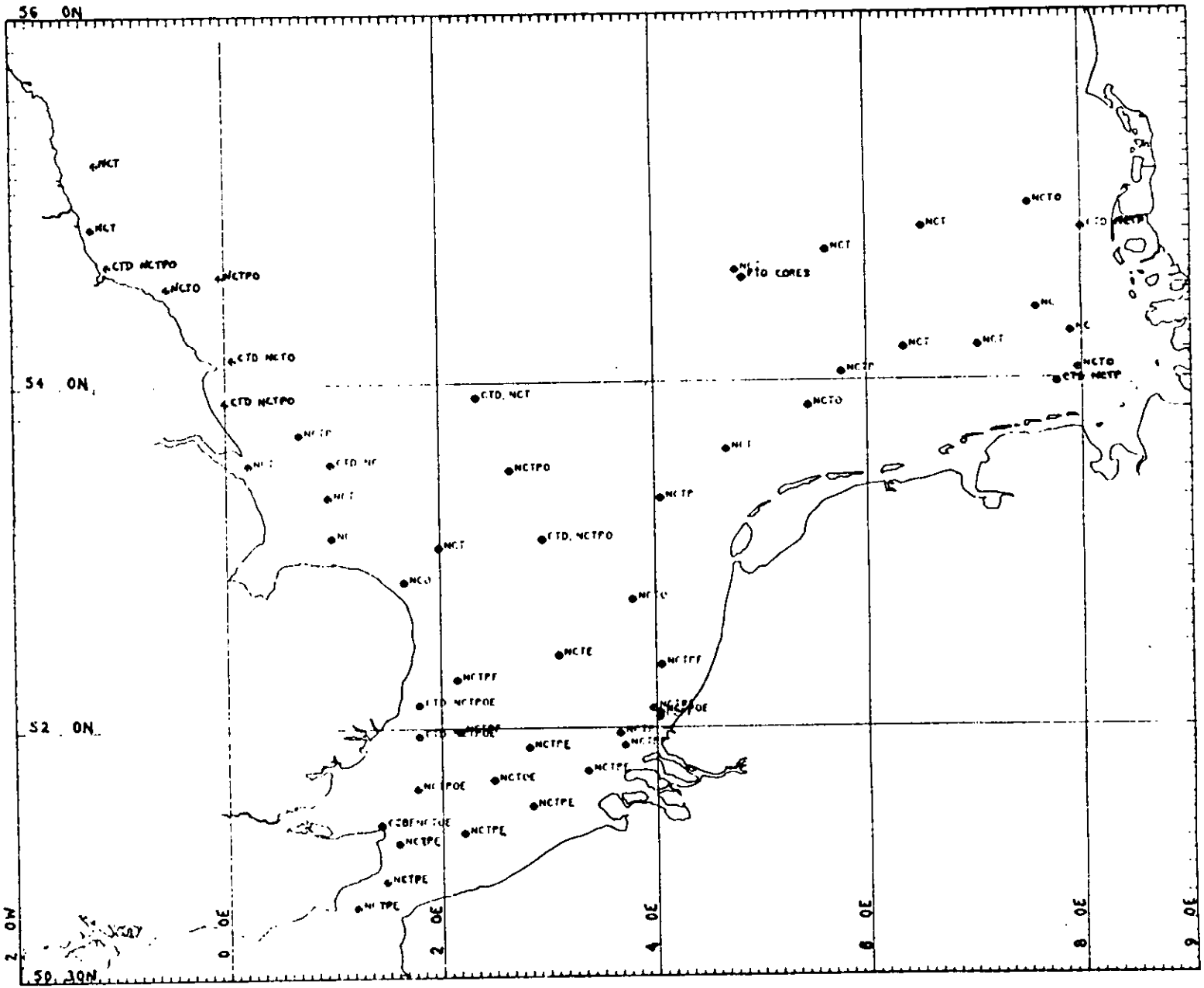
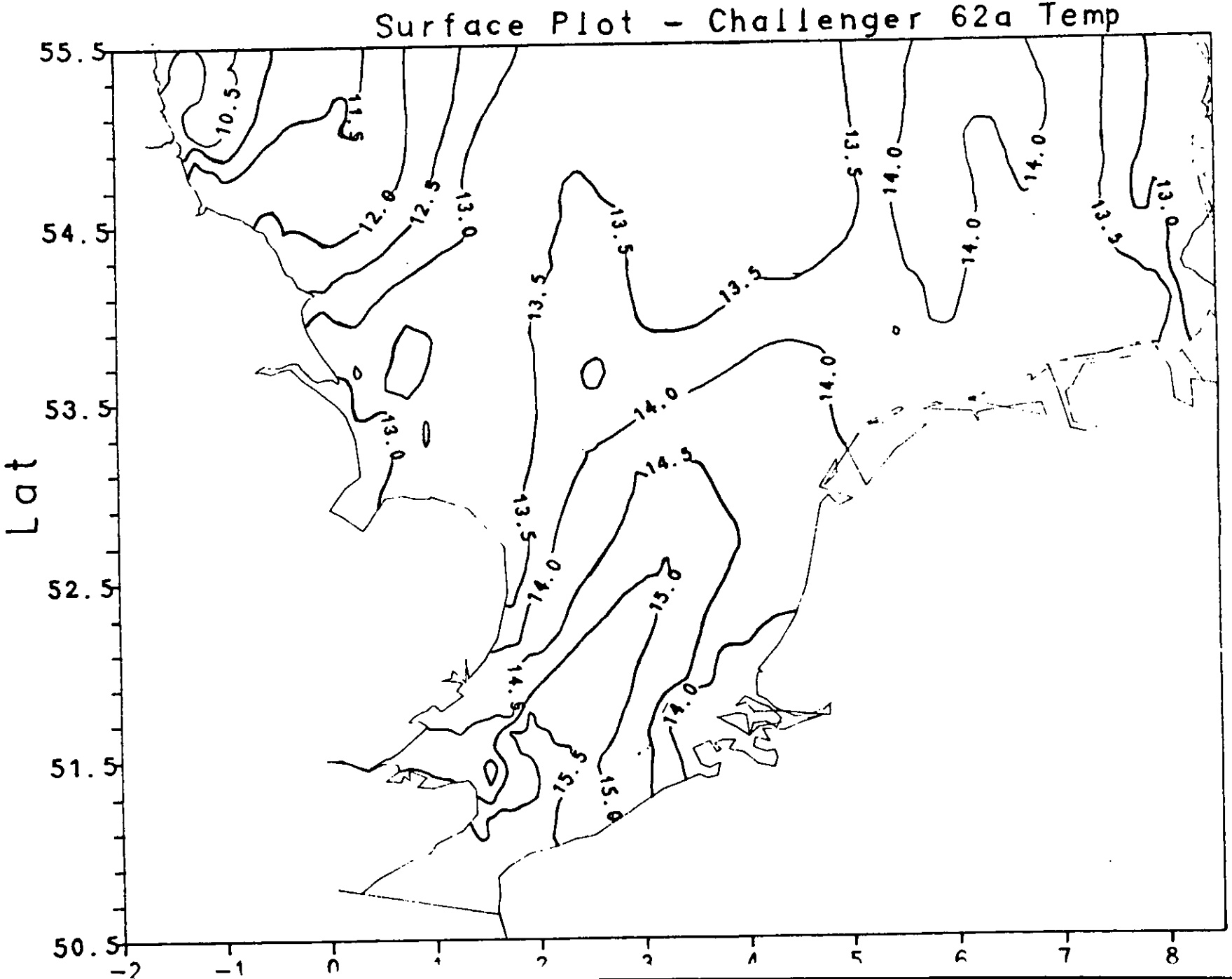

56 0N
54 0N
52 0N
50 30N
2 0W
0 30E
2 0E
4 0E
6 0E
8 0E
9 0E
NCT
NCTO
NCTPO
CTD NCTPO
CTD NCTO
CTD, NCT
CTD, NCTPO
bio CORES
NCTPE
NCTPF
NCTPOE

Fig.2


Surface Plot - Challenger 62a Temp
Lat
55.5
54.5
53.5
52.5
51.5
50.5
-2
-1
0
1
2
3
4
5
6
7
8
10.5
11.5
12.0
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13.5
14.0
14.5
15.0
15.5

Fig.3

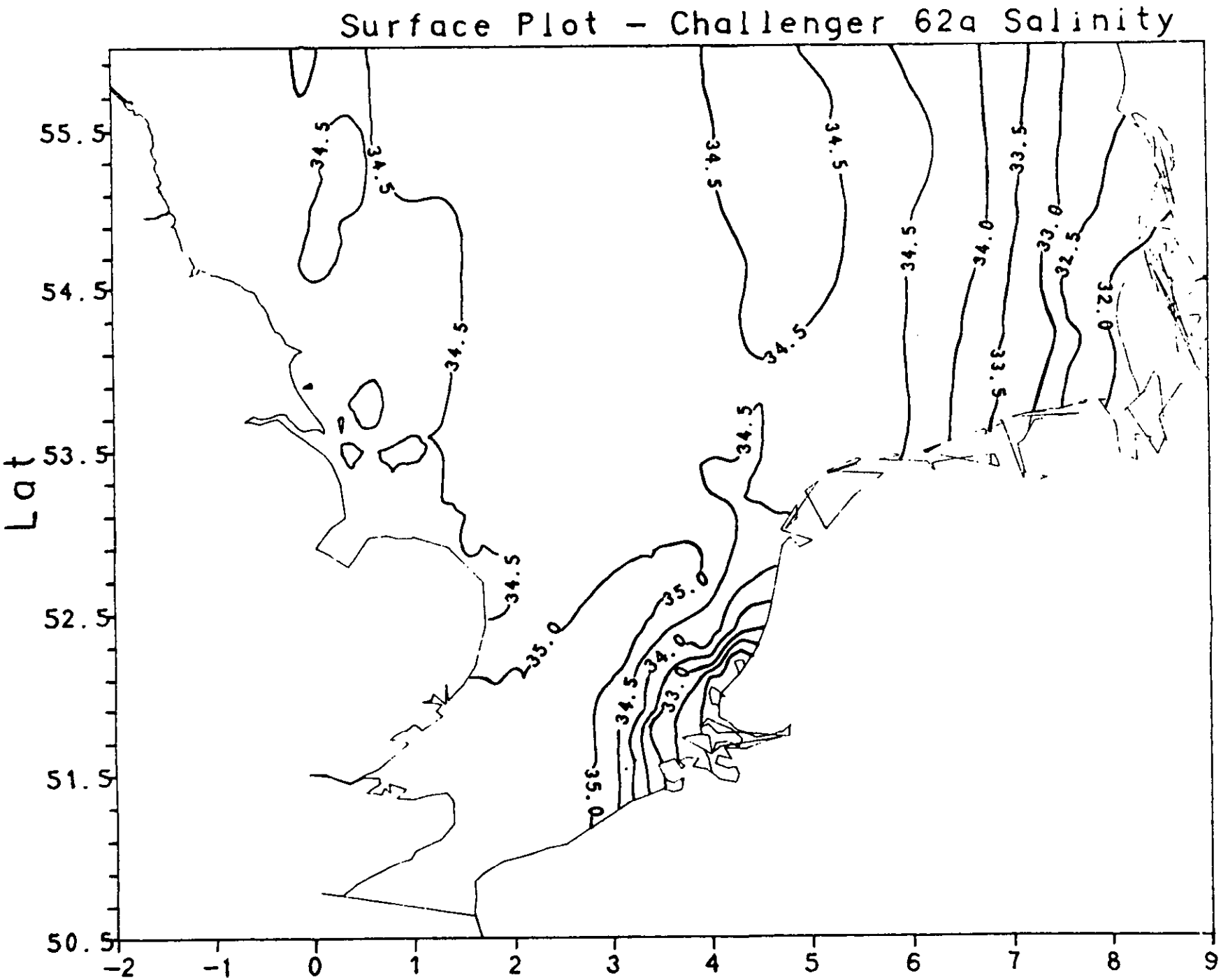
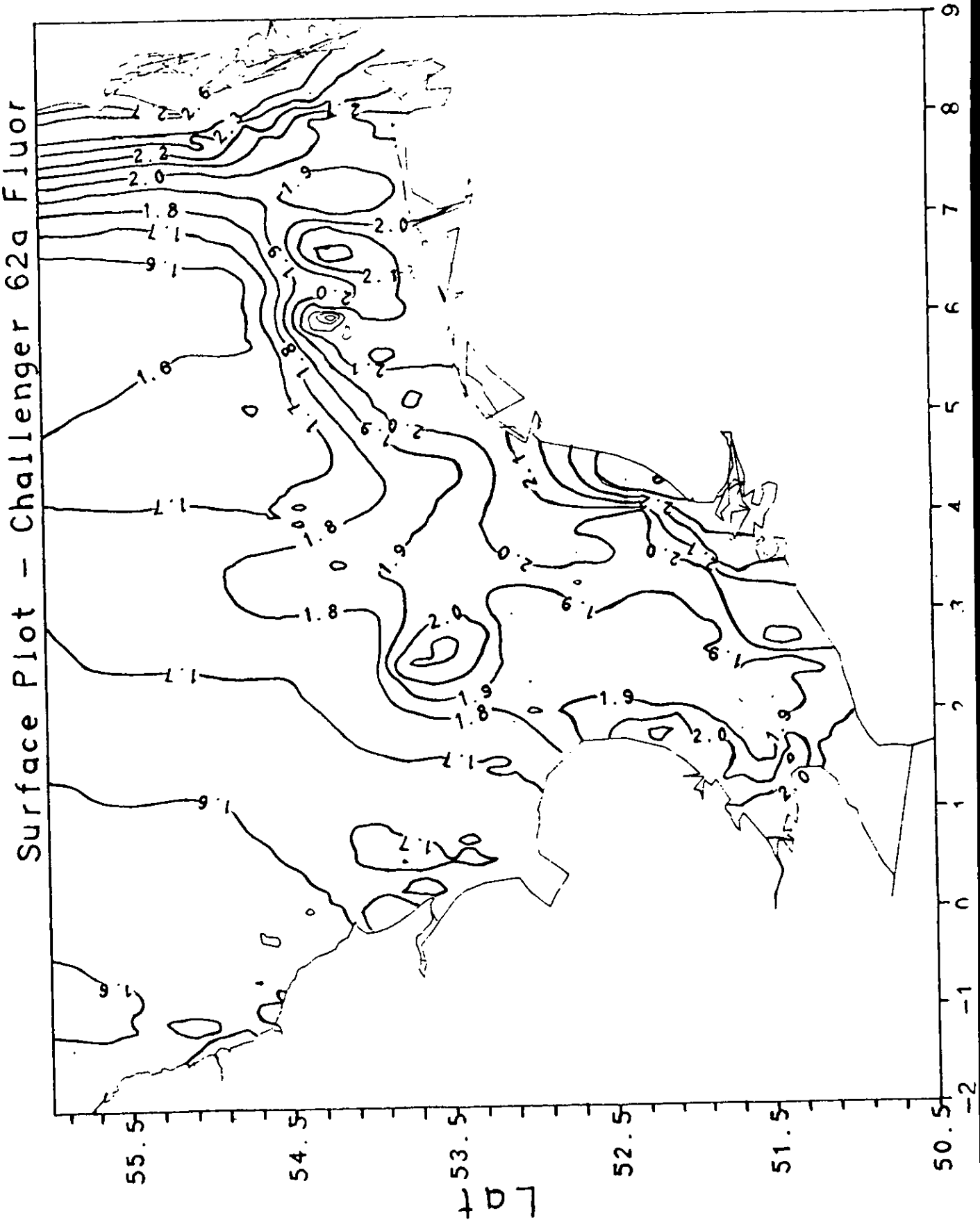

Surface Plot - Challenger 62a Salinity
Lat
55.5
54.5
53.5
52.5
51.5
50.5
-2
-1
0
1
2
3
4
5
6
7
8
9
34.5
35.0
34.0
33.5
33.0
32.5
32.0

Fig.4

Fig.5


Surface Plot - Challenger 62a Fluor
Lat
55.5
54.5
53.5
52.5
51.5
50.5
9
8
7
6
5
4
3
2
1
0
-1
-2

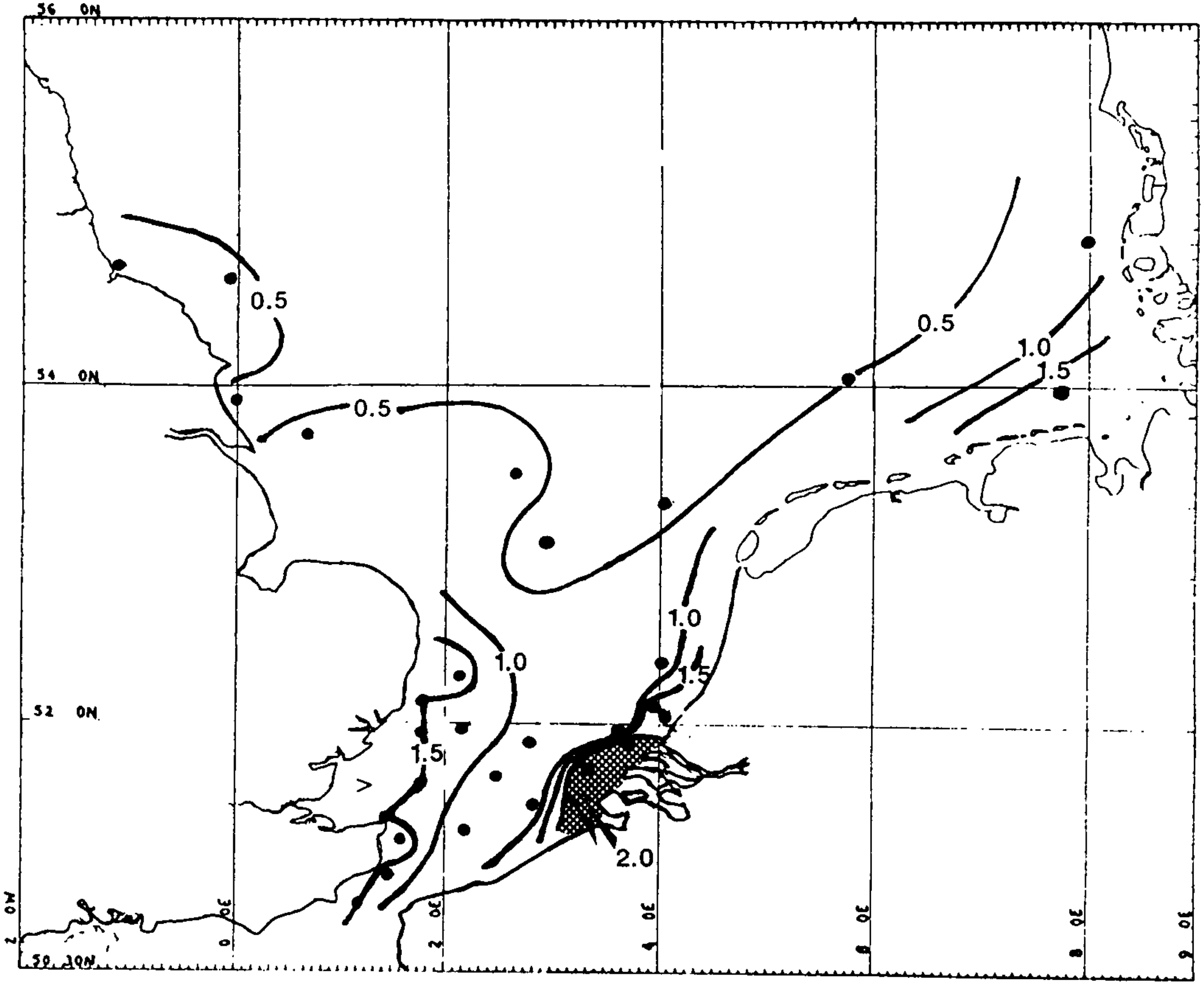
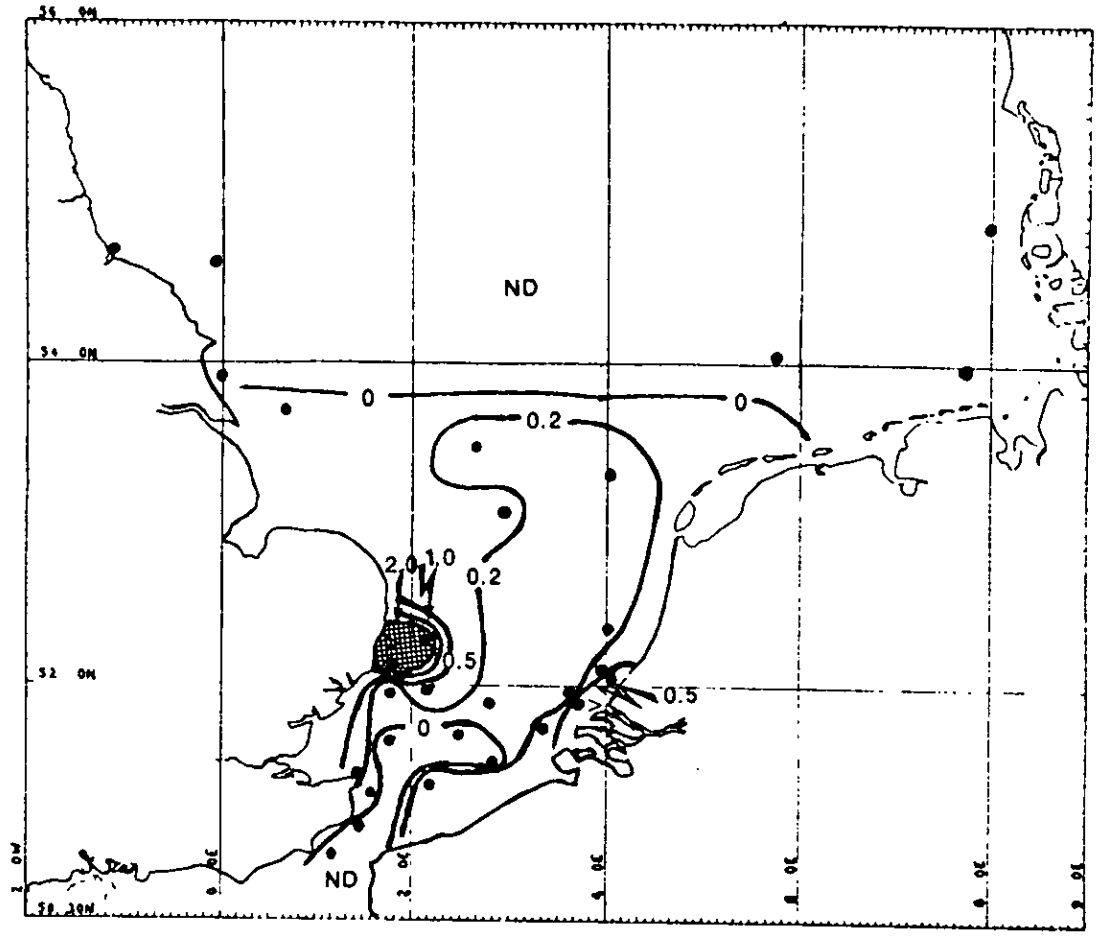
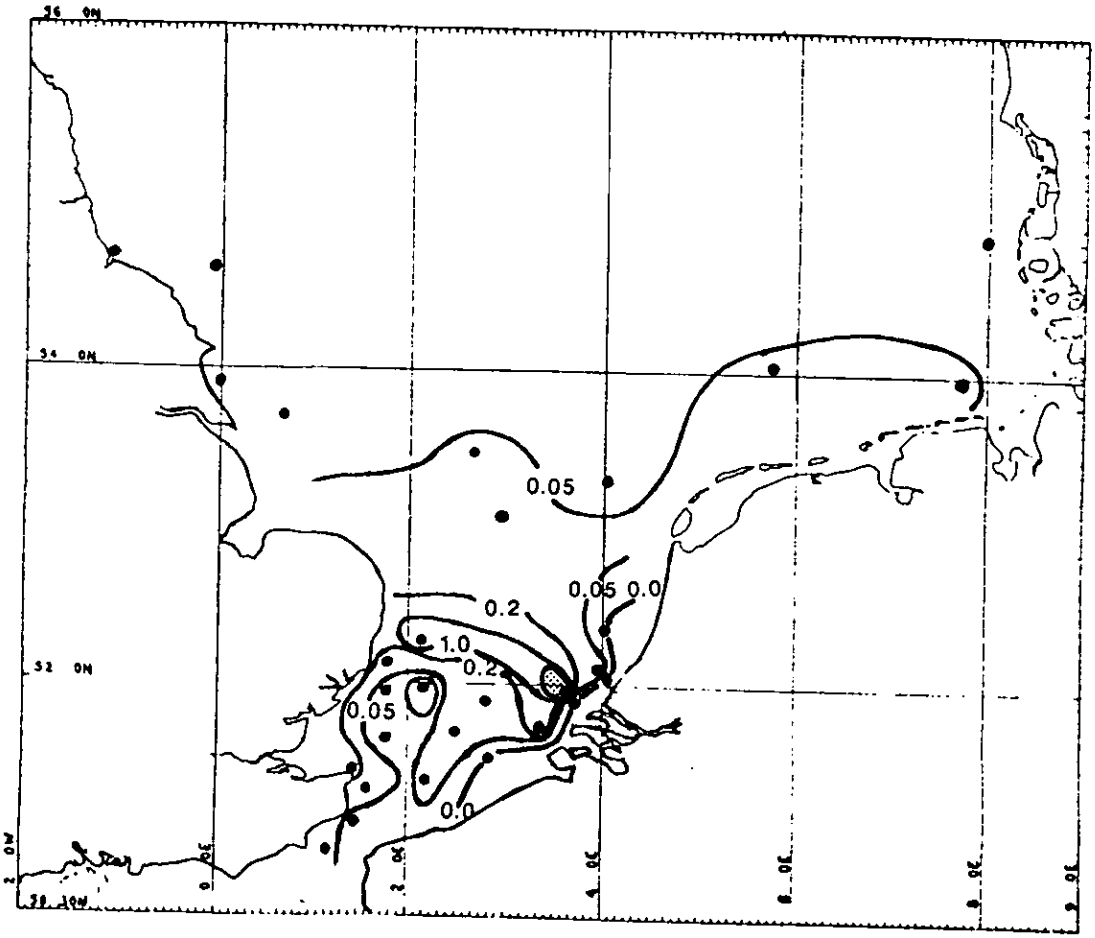


Fig.6

Fig.7





Box CORE STATIONS – OCT/NOV 1989

NORTH SEA

NORTHERN SITE (A)

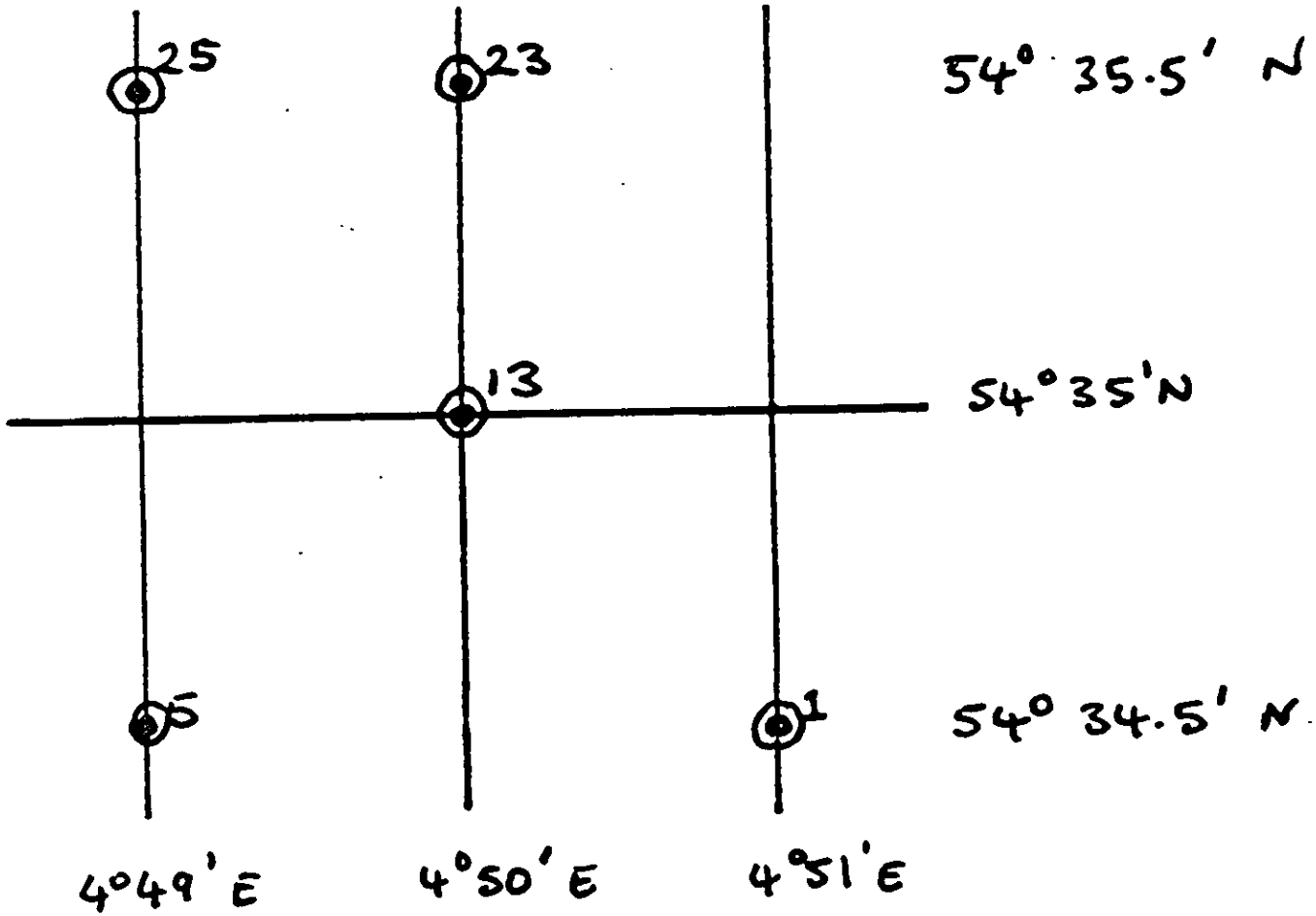
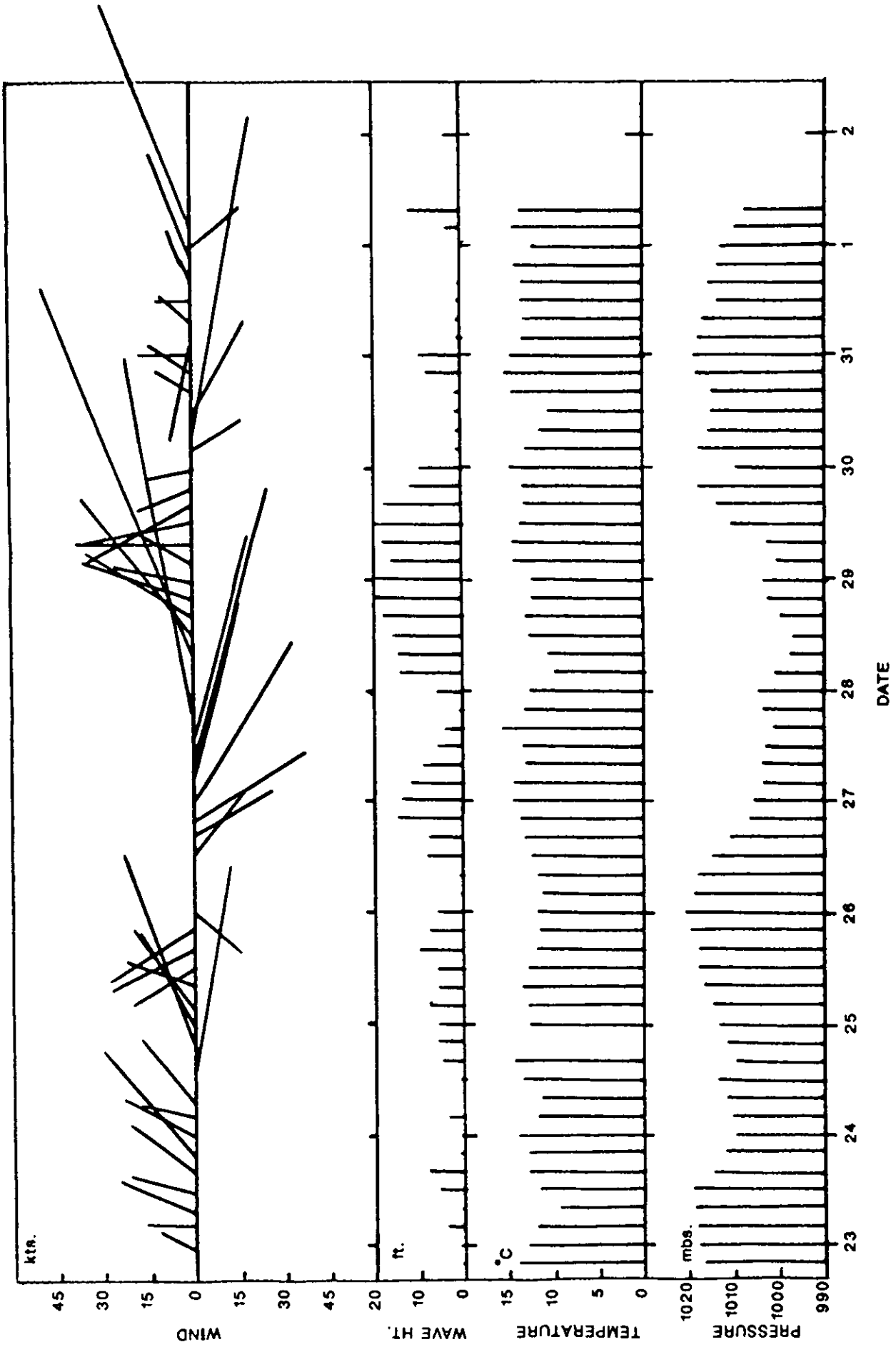


Fig.8

Fig.9


WIND
kts.
45
30
15
0
15
30
45
WAVE HT.
ft.
20
10
0
TEMPERATURE
°C
15
10
5
0
PRESSURE
mbs.
1020
1010
1000
990
DATE
23
24
25
26
27
28
29
30
31
1
2

NORTH SEA OCTOBER 1989 CH62A STATION D (off the Rhine)

BENTHIC MACROFAUNA (2MM SIEVE) : NUMBERS PER 0.25M2

Species	No.	Size(mm) (where appropriate)
CNIDARIA		
Sagartina troglodytes var. decorata	3	
Sargartiogeton undatus	2	
Calliactis parasitica ?	1	
NEMERTEA		
Tubulanus polymorphus	3	
Nemertean indet.	3+	
ANNELIDA		
Eumida punctifera	1	
Nereis longissima	2	
Nephtys hombergi	6	
Spio martinensis	18	
Spiophanes bombyx	1	
Chaetozone setosa	2	
Owenia fusiformis	11	
Amphictene koreni	2	
Ampharete fulcata	20	
CRUSTACEA		
Urothoe poseidonis	1	
Ampelisca brevicornis	18	
Processa canaliculata	1	
MOLLUSCA		
Natica alderi	2	
Tellimya ferruginosa	4	6,4,4,4
Spisula elliptica	2	11,9
Ensis ensis	1	
Phaxas pellucidus	1	
Tellina fabula	8	17,15,6,6,5,4,4,3
Abra alba	3	21,9,8
PHORONIDA		
Phoronidae indet.	6	
ECHINODERMATA		
Asterias rubens	2	70,65
Ophiura albida	12	11,9,8,8,5,4,3,2,2,2,2,2
Echinocardium cordatum	7	42,40,26,21,20,20,19
PISCES		
Callionymus lyra	1	

NORTH SEA OCTOBER 1989 CH62A STATION D (off the Rhine)

BENTHIC MACROFAUNA (0.5MM SIEVE) : NUMBERS PER 0.25M2

Species	No.	Size(mm) (where appropriate)
CNIDARIA		
Sargartiogeton undatus	3	
NEMERTEA		
Tubulanus polymorphus	1	
Nemertean indet.	8+	
ANNELIDA		
Eteone flava	3	
Anaitides subulifera	2	
Nereis longissima	2	
Nephtys hombergi	10	
Nephtys juv. indet.	1	
Scoloplos armiger	2	
Spio martinensis	26	
Spiophanes bombyx	19	
Magelona filiformis	1	
Chaetozone setosa	17	
Owenia fusiformis	13	
Amphictene koreni	1	
Ampharete fulcata	7	
Tubificoides sp.	14	
CRUSTACEA		
Copepoda indet.	1	
Mysidacea indet.	1	
Lysianassidae indet.	5	
Ampelisca brevicornis	2	
Pariambus typicus	5	
Amphipoda indet.	2	
Processa canaliculata	1	
Crangon crangon	1	
Pontophilus tripinosus	1	
Callianassa subterranea juv.	1	
MOLLUSCA		
Mysella bidentata	38	majority > 4mm
Tellimya ferruginosa	7	5,4,3,3,2,2,2
Spisula elliptica	1	7
Tellina fabula	5	18,18,7,5,4
Abra alba	2	18,5
PHORONIDA		
Phoronidae indet.	4	
ECHINODERMATA		
Asterias rubens	1	55
Ophiura albida	30	(10)2,(9)6,(8)8,(7)5,(6)1,(3)2,(2)4,(1)2
Echinocardium cordatum	9	43,25,22,22,21,21,20,18,17

ROSCOP (2nd edition)

OCEANOGRAPHY

GENERAL CRUISE INVENTORY

A00

DATA CENTRE: _____

REFERENCE No : _____

A - GENERAL INFORMATION ON WORK PERFORMED

A01 Expedition/Project NORTH SEA BLOOMS
Cruise No. or name CHALLENGER 62A/89

A91 Declared national prog. ? YES ☐ NO ☐ PART ☑
Exchange restricted ? ☐ ☐ ☑

A02 Ship or platform RRS CHALLENGER
Platform type RESEARCH SHIP

A92 Co-operative programme ? YES ☑ NO ☐ Name N. SEA BLOOMS
Co-ordinated internationally? ☐ ☒ By whom? _____

A03 Country UK

A04 Organization NERC

A05 Chief scientist(s) N.J.P. OWENS

A06 NAMES AND ADDRESSES OF ORGANIZATIONS AND PERSONS

Whom to query

a N.J.P. OWENS
b E.M.S. WOODWARD
c
d
e

Final disposition of data

A N.J.P OWENS & BODC
B EMS WOODWARD & BODC
C
D
E

A07 Date : from: 23/10/89 (DAY MONTH YEAR)
to: 03/11/89

A08 General ocean areas SOUTHERN NORTH SEA

A09 Type(s) of marine zone(s) COASTAL ZONE, CONTINENTAL SHELF

A10 Geographic area Latitude ° ' " N/S Longitude ° ' " E/W

If all data were collected at a fixed station, fill in the co-ordinates

Discipline and type of measurements	Index 10 x 10	Qc	L	G	G	Index 1° x 1°	Discipline and type of measurements	Index 10 x 10	Qc	L	G	G	Index 1° x 1°
M,HS,HP,HC,P,D,B,	1	5	0	0									
M,HS,HP,HC,P,D,B,	7	5	0	0									
G,	1	5	0	0									

M - METEOROLOGY

	Number	i	l	Format		Number	i	l	Format
M01 Upper air observations					M04 Ice observations				
M02 Incident radiation	1600 nMi	a	A	7	M05 Occasional standard measurements	40	a	A	3
M03 Air-sea interface studies					M06 Systematic standard measurements				
					M90 Other measurements				

Remarks

B - BIOLOGY

		Number	i	I	Format			Number	i	I	Format
B01	Primary productivity	56	a	A	9	B20	Commercial benthic molluscs				
B02	Phytoplankton pigments	56 1400 Mi	a	A	9 7	B21	Commercial benthic crustacean				
B03	Seston	56	a	A	9	B22	Attached plants and algae				
B04	Particulate organic carbon	56	a	A	9	B23	Intertidal organisms				
B05	Particulate organic nitrogen	56	a	A	9	B24	Borers and foulers				
B06	Dissolved organic matter					B25	Birds				
B07	Bacterial and pelagic micro-organisms	30	a	A	9	B26	Mammals and reptiles				
B08	Phytoplankton					B27	Deep scattering layers				
B09	Zooplankton					B28	Acoustical reflections on marine organisms				
B10	Neuston					B29	Biologic sounds				
B11	Nekton					B30	Bioluminescence				
B12	Invertebrate nekton					B31	Vitamin concentrations				
B13	Pelagic eggs and larvae					B32	Aminoacid concentration				
B14	Pelagic fish					B33	Hydrocarbon concentrations				
B15	Amphibians					B34	Lipid concentrations				
B16	Benthic bacteria and micro-organisms					B35	ATP-ADP-AMP concentrations				
B17	Phytobenthos					B36	DNA-RNA concentrations				
B18	Zoobenthos					B37	Taggings				
B19	Commercial demersal fish					B80	Other measurements				

Remarks

	BS TYPES OF STUDIES					B60	Physiology				
B51	Identification					B61	Behaviour				
B52	Spatial and temporal distribution	✓	a	A	7/9	B62	Pathology, parasitology				
B53	Monitoring and surveillance					B63	Toxicology				
B54	Biomass determination	✓	a	A	7/9	B64	Gear research				
B55	Description of communities					B65	Exploratory fishing				
B56	Food chains energy transfers	✓	a	A	7/9	B66	Commercial fishing				
B57	Population and environments					B67	Aquaculture				
B58	Population structures					B90	Other measurements				
B59	Taxonomy, systematics, classification										

Remarks

G - GEOLOGY GEOPHYSICS

	GL MEASUREMENTS MADE AT A SPECIFIC LOCATION	Number	i	I	Format			Number	i	I	Format
G01	Dredge					G09	Sea floor temperature ($\leqslant$ 1 m from bottom)				
G02	Grab					G10	Acoustical properties of the sea floor				
G03	Core-rock (no. of cores)					G11	Engineering properties of the sea floor				
G04	Core-soft bottom (no. of cores)	11	a	A	9	G12	Magnetic properties of the sea floor				
G05	Sampling by divers					G13	Gravimetric properties of the sea floor				
G06	Sampling by submersible					G14	Radioactivity measurements				
G07	Drilling					G70	Other measurements				
G08	Bottom photography										
	GU MEASUREMENTS UNDERWAY						**GE TYPES OF STUDIES**				
G21	Motion picture of sea floor (no. of nautical miles)					G31	Physical analysis of sediments				
G22	Bathymetry-wide beam (no. of nautical miles)					G32	Chemical analysis of sediments				
G23	Bathymetry-narrow beam (no. of nautical miles)					G33	Paleothermy				
G24	Side scan sonar (no. of nautical miles)					G34	Paleomagnetism and rock magnetism				
G25	Seismic reflection (no. of nautical miles)					G35	Paleontology				
G26	Seismic refraction (no. of nautical miles)					G36	Geothermy				
G27	Gravimetry					G37	Geochronology				
G28	Magnetism					G38	Mineral & fossil resources				
G80	Other measurements					G39	Littoral zone studies				
						G90	Other				

Remarks

D - DYNAMICS

D01	Current meters (no. of stat.)					D07	Drift cards (no. released)				
D02	Current meters (average duration of measurement)					D08	Bottom drifters (no. released)				
D03	Currents measured from ship drift					D09	Tidal observations (duration)				
D04	GEK					D10	Sea and swell (no. of observations)	40	a	A	3
D05	Drifters (number)					D90	Other				
D06	Swallow floats (number)										

H - HYDROGRAPHY

	HS SURFACE	Number	i	l	Format		NEAR SEA FLOOR (⩽ 10 m)	Number	i	l	Format
H01	Continuous temperature recording	1400 nMi	a	A	7	H05	Continuous temperature recording				
H02	Continuous salinity recording	1400 nMi	a	A	7	H06	Continuous salinity recording				
H03	Discrete temperature measurements	13	a	A	7	H07	Discrete temperature measurements	13	a	A	7
H04	Discrete salinity measurements	13	a	A	7	H08	Discrete salinity measurements	13	a	A	7
	HP PHYSICAL						HC CHEMICAL				
H09	Classical oceanographic stations					H21	Oxygen	1400 nMi	a	A	7
H10	Vertical profiles (STD/CTD)	13	a	A	7	H22	Phosphates	1400 nMi	b	B	7
H11	sub-surface measurements underway	1400 nMi	a	A	7	H23	Total - P				
H12	Mechanical bathythermograph (no. of drops)					H24	Nitrates	1400 nMi	b	B	7
H13	Bathythermograph-expendable (no. of drops)					H25	Nitrites	1400 nMi	b	B	7
H14	Sound velocity stations					H26	Silicates	1400 nMi	b	B	7
H15	Acoustic stations					H27	Alkalinity				
H16	Transparency	1400 nMi	a	A	7	H28	pH				
H17	Optics	13	a	A	7	H29	Chlorinity				
H18	Diffusion (Dynamic)					H30	Trace elements				
H80	Other measurements					H31	Radioactivity				
						H32	Isotopes				
						H33	Dissolved gases				
						H90	Other measurements DISSOLVED AMMONIUM	1400 nMi	b	B	7

Remarks

P - POLLUTION

P01	Suspended solids	56	a	A	9	P07	Waste water : BOD				
P02	Heavy metals					P08	Waste water : Nitrates				
P03	Petroleum residues					P09	Waste water : Microbiology				
P04	Chlorinated hydrocarbons					P10	Waste water : Other				
P05	Other dissolved substances ORGANIC ?	56	b	B	9	P11	Discoloured water				
P06	Thermal pollution					P12	Bottom deposits				
P90	Other measurements					P13	Contaminated organisms				

Remarks


FILE
END
cull micro imaging ltd
0151 638 6000