Indexed

(MIAS)

MRS. P Edwards.

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH

CRUISE REPORT
FREDERICK RUSSELL

VES 2.1
cc VES 11.1

VESSEL R.R.S. FREDERICK RUSSELL CRUISE (11) 1/87

CRUISE PERIOD 3-24 February 1987

PERSONNEL

N J P Owens	IMER	
E M Somerville-Woodward	IMER	3-15 February
D Plummer	Dundee University/IMER	
[2 x SMBA personnel, not part of IMER programme]		6-7 February
J A Lindley	IMER (Principal Scientist)	
A W G John	IMER	
N R Collins	IMER	7-24 February
N C Halliday	IMER	
I E Bellan	IMER	
D V P Conway	IMER	16-24 February
E MacLeod	NCS	

ITINERARY

Tuesday 3 February	Load equipment and embark 3 scientists at Plymouth.
3-5 February	Leg 1. Plymouth - Great Yarmouth. Set up and calibrate equipment.
Friday 6 February	[Embark 2 SMBA personnel not part of IMER programme].
6-7 February	Leg 2. Great Yarmouth - Great Yarmouth. Recording of nutrients, POC, PON, chlorophyll and ^{15}N. [Servicing 2 SMBA moorings, not part of IMER programme]
Saturday 7 February	[2 SMBA personnel disembark] 5 IMER personnel travel from Plymouth to Great Yarmouth and embark.
8-15 February	Leg 3. Great Yarmouth - Plymouth. Continue nutrient, POC, PON, chlorophyll and ^{15}N studies throughout.
Sunday 8 February	Depart Great Yarmouth 1300. Station 1, 1335-1600 Grab sample, Lowestoft 30" and Macer sledge samples. UOR tow 1615-2050. Station 2, 2124-2208 Grab sample, Craib corer deployed (unsuccessfully).

Monday 9 February

Recording nutrients etc. off Rhine outfall.
1342-1900 UOR tow.
Station 3 2052-2321. Grab sample, Craib corer deployed (unsuccessfully) Lowestoft 30" and Macer sledge samples. Hand net deployed during sediment sampling.

Tuesday 10 February

0048 vessel stopped due to fuel leak.
0142 main engine restarted.
Station 4 0238-0400. Grab samples and cores taken.
0500-1010 UOR tow.
Station 5 1200-1250 Grab sample. Craib corer deployed (unsuccessfully).

Wednesday 11 February

Station 6, 0445-2337.
0503-0517 Water bottle drop, to obtain samples for in-situ incubations for primary production.
0606-0609 deploying drifting rig for in-situ incubations.
0630-0651 Lowestoft 30" samples
0905-1000 Sediment sampling (Grab + cores)
1006-1034 Vertical profile with UOR
1050-1120 Macer sledge
1143-1158 LHPR tow
1239-1252 Vertical profile with UOR
1255-1306 Water bottle drop
1655 Recover drifting rig
1901-1921 Lowestoft 30" tow
2240-2255 Macer sledge
2320-2336 LHPR tow

Hand netting between major operations throughout.

Thursday 12 February

2357 depart station deploy UOR
0449 recover UOR
Station 7, 0512-0600 Sediment samples (Grab and core)
0730-1026 UOR tow
Station 8 1036-1244, sediment samples (Grab and corer), Macer sledge and Lowestoft 30" samples.
Hand net deployed during sediment sampling.
1347-1653 UOR tow
Station 9 1709-1738 Sediment samples (Grab and corer). Hand net deployed during sediment samples.
1830-2130 UOR tow
Station 10 2138-2256 Grab sample (coarse gravel only)
Lowestoft 30" and Macer sledge

Friday 13 February

Recording nutrients etc. off Humber and Wash.
Station 1(a) 0815-1015 Hand net sampling.
1030-1430 UOR tow.

	Recording nutrients etc. off Thames Station 11 1816-1822 Grab sample only
Saturday 14 February	1959 Deploy UOR 0336 Recover UOR 0350 Cease nutrient recording etc. Station 12 0353-0612. Grab sample (coarse gravel only), water bottle drop, Macer sledge, Lowestoft 30" Hand net deployment Station 13 0900-0916 Grab sample (coarse gravel) Station 14 1253-1301 Grab sample (coarse gravel) Station 15 1554-1620 Grab and core samples Station 16 1728-1940 Grab sample, corer deployed (unsuccessfully) Lowestoft 30", Macer sledge
Sunday 15 February	Dock at Plymouth 0800-1130 Unloading autoanalysers and other equipment related to objectives (3a-d). 3 scientists disembark
Sunday 15- Monday 16 February	Adjustments to UOR data loggers etc. by IMER electronics staff
Monday 16 February	2 scientists embark Depart Plymouth 1700
Tuesday 17 February	0500-0800 passage northwards delayed by apparent problem with UOR. (resolved). 0810-1135 UOR tow 1140-1205 Handling UOR, towing wire kinked. 1337-1632 UOR tow 1747- |
Wednesday 18 February	5 x UOR tows with plankton net fitted 0618| 1025-2256 6 x UOR tows with plankton net fitted
Thursday 19 February	Stations 17 and 18 0040-1912 0048-0125 Macer sledge tow 0145-0220 LHPR tow 0303-0330 Water bottle drop 0611-0658 Lowestoft 30" sampler tow 0915-1005 Sediment sampling (Grab and corer) 1014-1052 LHPR tow 1126-1200 Water bottle drop and vertical profile with UOR 1200-1353 Passage to station 18 1353-1416 Grab sample station 18 1416-1610 Return to station 17 1833-1905 Lowestoft 30" sample tow Hand netting between major operations throughout

Friday 20 February	2055-0601	4 x UOR tows with plankton net fitted on station 19 (CS2)
	2200	
	2232-2258	Macer sledge tow
	2309-2357	LHPR tow
Saturday 21 February	0043-0125	Water bottle drop
	0609-0649	Lowestoft 30" tow
	0900-0938	Grab deployed - recovered damaged Cores taken with Craib corer
	1005-1025	Macer sledge tow
	1043-1123	LHPR tow
	1212-1231	Water bottle drop
	1231-1257	UOR vertical profile
	1520-1732	Calibration tows with Macer sledge and Lowestoft 30"
	1835-1912	Lowestoft 30" sample tow
	Hand netting between major operations throughout	
Sunday 22 February	0736-0022	Station 21
	0905-0929	Sediment samples (Corer only)
	1006-1036	Macer sledge tow
	1044-1150	LHPR tow
	1207-1247	Water bottle drop and vertical profile with UOR
	1421-1557	Calibration tows with Mace and Lowestoft 30"
	1832-1930	Lowestoft 30" tow
	2200-2236	Macer sledge tow
	2245-2352	LHPR tow
Monday 23 February	0007-0022	Water bottle drop
	Hand netting between major operating throughout	
	1249-1314	Station 23 Deployment of corer - much shell in sediment, no sample.
	2230-	Station 24 Corer failed to penetrate sediment, no sample. Bottle drop,
Tuesday 24 February	0036	Macer sledge and Lowestoft 30" sample.
	0800	Dock Plymouth disembark personnel and unload equipment.

OBJECTIVES

1. To study aspects of the overwintering of zooplankton.

   a. To determine the abundance, identity and viability of calanoid copepod eggs in sea bed sediment in relation to sediment type and hydrography.

   b. To describe the vertical distributions of the zooplankton, particularly to identify aggregations near the sea bed in

relation to hydrography and sediment type.

c. To measure dry weight, carbon and nitrogen content, lipid content (to be determined by IMB) and lipid classes in zooplankton species.

d. To study feeding rates and size selectivity in relation to food and rates of egg production an faecal pellet production of overwintering zooplankton at ambient temperatures in relation to food availability and the physical environment.

2. To describe the plankton and hydrography of the Irish Sea in mid-winter as a contribution to the Irish Sea Programme.

3. Aspects of nutrient cycling in the southern North Sea during the winter.

a. To assess spatial variability in the concentrations of nitrogenous nutrients.

b. To quantify rates of primary production and nitrogen assimilation in relation to the distribution of nutrients.

c. To measure the distribution of ^{15}N in soluble and particulate nitrogen in relation to riverine inputs.

d. To quantify rates of bacterial production in relation to particulate matter.

METHODS

1a. Two sub-samples of the top 5 cm from each station where grab samples were obtained were preserved in formalin for analysis for copepod eggs and 2 sub-samples were frozen for determination of organic content.

Where core samples as well as grab samples were obtained these were sectioned at 1cm intervals to enable analysis of the vertical distribution of eggs and organic content of sediment to be made.

The grab was useless after station 19 and all sediment samples had to be taken with the corer at stations 19, 21, 23 and 24.

At station 6, 3 undisturbed sediment samples and 3 samples which were spread out in a beaker and stirred at least daily were incubated for 3 days under filtered sea water and the supernatant water poured off and preserved for examination for the presence of nanplii. Differences between the two sets of results should indicate the extent to which burial in the sediment suppresses hatching.

1b. Two hauls (day and night, approx 12 hr. apart, midday and midnight) were taken with the LHPR at each of the "24 hr stations". Samples were taken with the Lowestoft 30" sampler at other stations and at intermediate times between the LHPR hauls (approx 0600 and 1800) at

24 hr stations. Macer sledge samples were taken immediately before or after LHPR hauls (at "24 hr" stations) or the Lowestoft 30" samples (at other stations).

1c. Fresh (live) zooplankton taken by a hand net was sorted and dried for dry-weight determination and analysis of carbon and nitrogen content (at IMER) and preserved in chloroform-ethanol mixture for lipid analysis at IMB.

1d. Live specimens from hand net hauls were placed in petri dishes of filtered seawater for studies of eggs and faecal pellet production. Restrictions on the time available for sorting and paucity of material in the hand net hauls prevented experimental determination of feeding rates and size selectivity in addition to the other objectives in 1c. and 1d.

Potential food was measured as chlorophyll, POC and PON from samples taken on passage in the North Sea (c.f. 3c) and from water bottle profiles at stations 3, 12, 16, 17, 19, 21 and 24. Particle size spectrum analysis using a Coulter TAII particle counter were carried out on all samples from 7-24 February. 35 water samples were preserved with Lugol's iodine for analysis of phytoplankton. Chlorophyll was also recorded by the UOR.

2. An UOR measuring physical parameters and chlorophyll and fitted with a plankton net was towed in the Irish Sea giving 15 plankton samples. A "24 hour" station (17) and an additional sediment station (18) were worked in the Irish Sea.

3. For further details see Appendix I.

a. Nutrients were analysed by autoanalysers during Legs 2 and 3 in the North Sea up to Station 12.

b. Primary production was determined by <u>in situ</u> incubation at station 6.

c. Water samples taken from the pumped supply at approximately 3 hr intervals throughout Legs 2,3 and 4 were filtered and frozen.

d. Bacterial production was determined by shipboard incubation.

RESULTS

1a. Grab samples were successfully taken at stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 15, 16, 17 and 18. At stations 10, 12, 13 and 14, coarse gravel only was retained and no sample was preserved. The grab lost a flap at station 19 and was not suitable for taking samples without it.

Cores were obtained at stations 4, 6, 7, 8, 9, 15, 16, 17, 18, 19 and 21. At station 23 a very small quantity of material was brought up by the corer, most of which was large fragments of shell. At station 24 the corer failed to retain any sample and the core tube

cracked. It was assumed that the bottom was too hard for successful coring so no sediment was obtained from either of these stations. Sediment samples were incubated at station 6.

1b. Two LHPR tows were taken at each "24 hour" station (stations 6, 17, 19, 21). Details of the number and treatment of the samples are given in Table IIa.

Two Lowestoft 30" net hauls (coarse and fine mesh) were taken at each of stations 6, 17, and 19. One haul was taken at each of stations 1, 3, 6, 8, 10, 12, 16, 21 and 24.

Two Macer sledge tows were taken at stations 6, 17, 19 and 21 and one at station 1, 3, 6, 8, 10, 12, 16 and 24.

1c. Samples taken for dry weight, C and N analyses and for lipid analysis are listed in Table IIf and g. A comparison of dry weights of adult female Calanus from 7 stations is given in Table 3.

1d. Incubations in filtered sea water of 24 specimens from sites in the North Sea and English Channel provided data on egg and faecal pellet production. Calanus from 2 sites in the North Sea produced both eggs and faecal pellets, but neither were produced by specimens from station 12 in the Channel. No faecal pellets or eggs were produced by incubated Pseudocalanus or Acartia.

2. All planned operations to contribute to the Irish Sea were carried out but on 2 occasions the UOR was hauled earlier than planned due to the water depth being less than anticipated.

3. a-d see also Appendix 1. Nutrient concentrations were recorded over 1190 nm of cruise, the studies on production were conducted successfully and samples were filtered for ^{15}N analysis at approx 3 hr. intervals over 3000 nm of the cruise.

EQUIPMENT AND OPERATIONAL PROBLEMS

1. Day Grab. The locking pin was lost when the wire attaching it to the grab was severed. This was replaced by a nut and bolt. A flap was lost when the grab was deployed on station 19. As this exposed the superficial sediments during hauling the grab was not used at subsequent stations.

2. UOR deployment. The Rex Roth winch provided was unsuitable because it was too slow and lacked a spooling mechanism. The slow speed restricted deployment in fog and heavy traffic conditions where rapid hauling could have been necessary. Also where the plankton nets were fitted (in the Irish Sea) and the tows were short (approx 2 hrs) a substantial proportion of each tow was occupied by paying out or hauling. This probably meant that undulations to the full programmed depth were not achieved during these periods. The towing wire was kinked on the winch drive on one occasion. This could have been prevented by the presence of a spooling mechanism. Subsequently a member of the deck crew fed the wire onto the winch

during hauling.

3. Problems with UOR instrumentation and data logger. On the tow on 8 February no data were logged. It was found that the instrument package and data logger had to be connected prior to installation in the body. This problem was not overcome until modifications were made at Plymouth (15-16 Feb). On 9 February the chlorophyll data recorded by the instrument/logger packages used were found to drift due to excessive load on the batteries caused by an increased flash rate on the tow, making calibration impossible. The resulting drift of chlorophyll data caused the other data readings to be affected. The second instrument/logger pair were found to be free of this problem. Some data were lost on tows in the North Sea possibly due to reduced battery performance in the very low temperatures (<5°C).

   Some of the faults with the UOR were corrected during the call at Plymouth (15-16 February) but departure was delayed for about 6 hours to allow the work to be carried out. A further problem with the UOR caused about 3 hours delay.

   The drift in chlorophyll readings and its effects on other sensors on one sensor package meant that all subsequent data was collected using the second package. It was necessary to transfer the data from the solid state data logger to a disc file on the IBM computer between each tow. This resulted in a time lag of 30-45 minutes (c.f.5-10 minutes to change electronics and net) between each of the 15 deployments in the Irish Sea. Therefore a further 7 hours (approx) were lost.

   In order to make up for this loss of time, the time spent on stations 17, 19 and 21 was reduced from the planned 24 hrs, stations 20 (40° 30' N 9° 00' W) and 22 (49° 00'N, 8° 00'W) were omitted, sediment sampling only was carried out at station 23.

4. Macer sledge. On station 17 the net was filled with fine silt. The sample was discarded. On station 21 th sledge was damaged during towing but subsequently repaired by I E Bellan.

   On station 24 the sledge was severely damaged during the tow. As this was the last station, the programme was not impaired.

5. The main scientific clock failed causing a failure of the programme for printing out thermosalinograph data. This was overcome by re-programming to use the computer's internal clock but real time was no longer displayed.

6. Others. A fuel leak on 9 February stopped the vessel for about 1 hour. There was a temporary problem with the cooling system for the constant temperature laboratory. Neither of these impeded the programme.

PREPARED BY:- J A LINDLEY

APPROVED BY:- R. Williams 30 June 1987

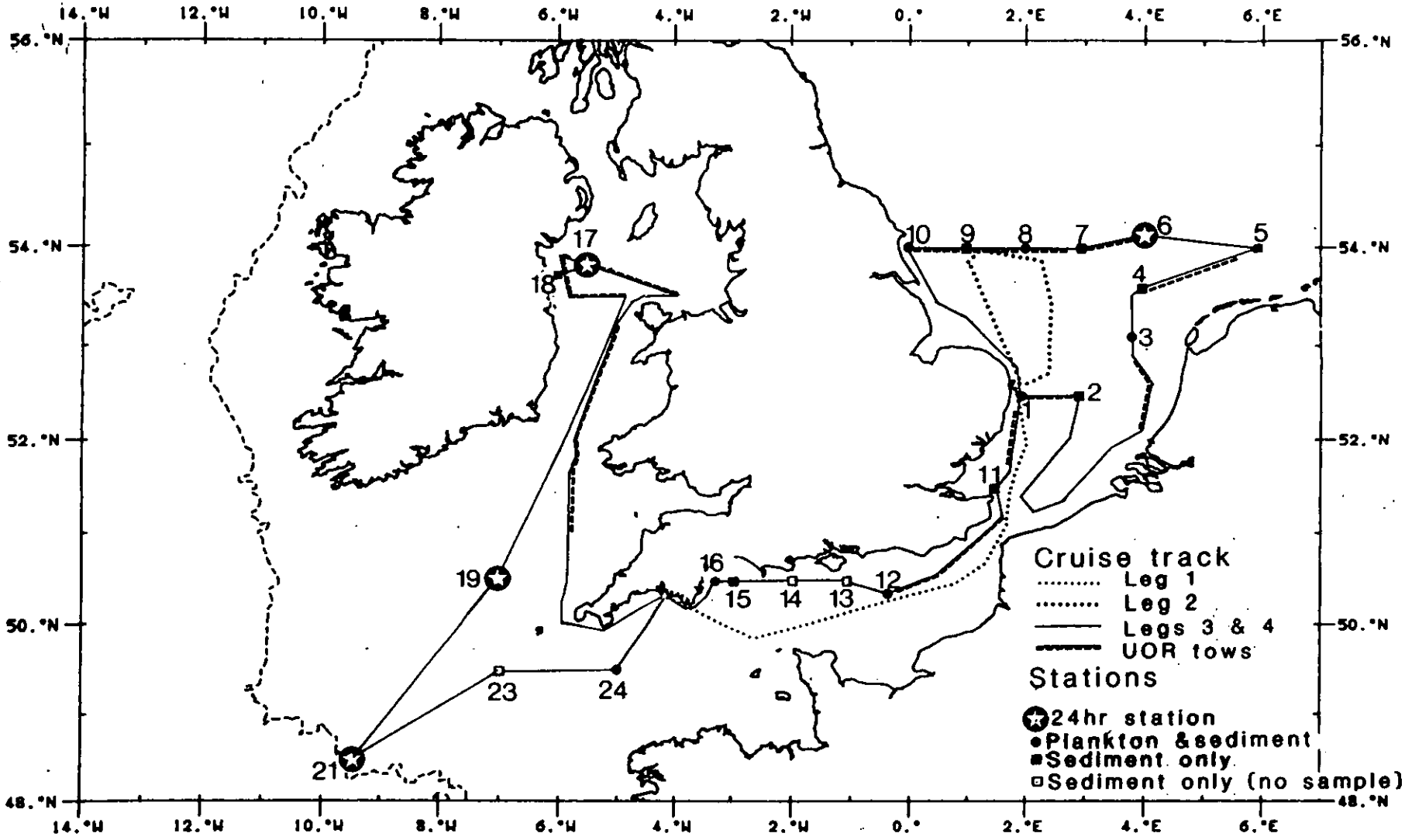
CIRCULATION LIST

Internal	B L Bayne	
	R Williams	
	J M Colebrook	
	S H Coombs	
	I R Joint	
	Cruise Personnel	
	Notice Board	
	File	
External	NERC Swindon	D Pugh
		S White
	IOS (Wormley)	M Angel + Library (x2)
	(Bidston)	Acting Director + Library (x1)
	(MIAS)	Mrs P Edwards
	RVS	L Skinner (x 2)
	MBA	Prof. Denton
	DAFS	Dr. A Hawkins
	MAFF	D Garrod, K Brander
	SMBA	J L Matthews
	Menai Bridge	I Rees, R Shields
	IMB	A I Mitchell

Table I Station positions and temperature, salinity and depth at time of sampling. (Temperature and salinity were uncorrected thermosalinograph data).

STATION	Position	Temp °C	Salinity °/₀₀	Depth
1	52° 30'N 2° 00'E	No data	No data	28 m
2	52° 30'N 3° 00'E	No data	No data	36 m
3	53° 10'N 3° 50'E	4.3	34.5 - 34.0	23 m
4	53° 35'N 4° 00'E	3.8	34.4	34 m
5	54° 00'N 6° 00'E	2.8	33.7	31 m
6	54° 10'N 4° 00'E	4.6	34.4	45 m
7	54° 10'N 3° 00'E	4.7	34.6	40 m
8	54° 00'N 2° 00'E	4.6	34.7	76 m
9	54° 00'N 1° 00'E	5.5	34.7	45 m
10	54° 00'N 0° 00'E	4.6	34.2	20 m
1a	52° 31'N 1° 54'E	3.7	33.9	
11	51° 30'N 1° 30'E	4.4	34.6	17.5 m
12	50° 20'N 0° 20'W	7.2	35.2	45 m
13	50° 30'N 1° 00'W	5.6	34.7	34 m
14	50° 30'N 2° 00'W	6.2	34.8	37 m
15	50° 30'N 3° 00'W	6.7	35.1	40 m
16	50° 30'N 3° 20'W	7.2	35.1	.28 m
17	53° 50'N 5° 30'W	7.3 - 7.7	34.1 - 34.2	94 m
18	53° 45'N 6° 00'W	6.2	33.8	33 m
19	50° 30'N 7° 00'W	8.8 - 8.9	35.3	104 m
21	48° 30'N 9° 30'W	11.0 - 11.2	35.6	C200 m
23	49° 30'N 7° 00'W	9.4	35.4	120 m
24	49° 30'N 5° 00'W	9.0 - 9.1	35.5	96 m

Stations 20 and 22 were omitted.



Cruise track & Station positions

Table II. Samples taken during the cruise

(a) Longhurst Hardy Plankton Recorder

Station	Time	Number of samples		Max depth
		Coarse mesh	Fine mesh	
6	1145	6	5	42
6	2319	8	9	43
17	0145	26	26	92
17	1014	26	25	95
19	2309	18	18	103
19	1044	17	17	101
21	1045	19	0*	198
21	2245	26	25	172

Treatment of samples

All coarse mesh samples from stations 6, 17 and 21 were preserved in formalin. At station 19 each sample was split and ½ preserved in formalin and ½ filtered on GFC filters. All fine mesh samples from stations 6 and 21 and the 0145 haul at station 17 were filtered onto GFC filters, the others were split and ½ preserved and ½ filtered.

Table II (b). Lowestoft 30" Samples and Macer Sledge

Station	Number of Samples		
	Lowestoft 30" (coarse)	Lowestoft 30" (fine)	Macer sledge
1	1	1	1
3	1	1	1
6	2	2	2
8	1	1	1
10	1	1	1
12	1	1	1
16	1	1	1
17	2	2	2
19	2	2	0
21	1	1	1
24	1	1	1

All preserved in formalin

Table II (c). Plankton sampling with the UOR

5 samples between	52° 00'N	5° 45'W	and	53° 15'N	5° 00'W
6 samples between	53° 30'N	4° 00'W	and	53° 55'N	6° 00'W
2 samples between	53° 55'N	6° 00'W	and	53° 30'N	5° 50'W
2 samples between	53° 30'N	5° 50'W	and	53° 30'N	4° 50'W

All preserved in formalin

Table II (d). Samples taken for chlorophyll, C:N and ^{15}N analyses.

Legs 1 & 2	49	samples taken on passage	
Leg 3	31	samples taken on passage	
	samples taken from water bottles at 1, 5, 10, 20, 30 & 40 m		Stn 6
	samples taken from water bottles at 1, 20 & 40 m		Stn 12
	samples taken from water bottles at 1 & 20 m		Stn 16
Leg 4	(Chlorophyll & C:N)		
	samples taken from 2 x water bottles at 1, 5, 10, 20, 30, 40, 50, 60 & 80 m		Stn 17
	Samples taken from 2 x water bottles at 1, 5, 10, 20, 30 40, 50, 60 & 80 m		Stn 19
	Samples taken from 2 x water bottles at 1, 25, 50, 100, & 150 m		Stn 21
	Samples taken from 1 x water bottle at 1, 40 & 80m		Stn 24

(^{15}N) 42 samples taken on passage.

Sub-samples of all samples taken on Leg 3 and water bottle samples during Leg 4 were analysed for particle-size-frequency using the Coulter TAII particle counter with population accessory.

100 ml sub-samples were preserved in Lugol's iodine for cell counts from 35 selected samples.

Table II (e). Sediment samples

Station	Grab Sub-samples taken	Corer
1	2 preserved 2 frozen	Not deployed, coarse gravel in sediment
2	" " " "	" " " " " "
3	" " " "	No sample
4	" " " "	Core taken
5	" " " "	No sample
6	" " " "[1]	Core taken
7	" " " "	Core taken
8	" " " "	" "
9	" " " "	" "
10	No sample, coarse gravel	only
11	2 preserved 2 frozen	Not deployed
12	No sample, coarse gravel	only
13	" " " "	"
14	" " " "	"
15	2 preserved 2 frozen	Core taken
16	" " " "	No sample (abundant Turitella shells)
17	" " " "	[core taken]
18	" " " "	Not deployed
19	No sample, grab U/S	Core taken
21	" " " "	Core taken
23	" " " "	No sample, shell abundant
24	" " " "	No sample, Hard bottom

[1] In addition 6 samples were taken for experimental incubation.

Table II (f). Samples sorted and dried for dry weight and C:N analyses

Station	Number of specimens				
	Calanus	Pseudocalanus	Acartia	Temora	Others
3	1♂, 12♀, 11CV, 1CIV	34VI♀ 5IV-(V)	36VI♀	15VI♂, 10VI♀	
6				25 copepodites	
7		4VI♀		13VI♂, 8VI♀	
8	25♀				
9	16♀				9 Hyperiids
12	25♀				
17	24♀, 1CV	42VI♀	33VI♀		
19	5♂, 27♀	36VI♀			5 Euphausiids
					2 Hyperiids
21	5♂, 39♀, 11CV				13 Metridia VI♀
					Candacia VI ♀
					1 C. tenuicornis ♂
					3 C. tenuicornis ♀

Table II (g). Samples preserved in chloroform/methanol with BHT for lipid analysis at IMB. Bulked samples to provide >10 mg wet weight.

Station	Species
6	Sagitta sp. Calanus VI♀ Hyperiids (Parathemisto) Mysids (Schistomysis sp.) Thysanoessa raschi (Euphausiids)
8	Hyperiids (Parathemisto)
8 + 9	Calanus VI♀
1(a)	Pseudocalanus VI♀ Acartia VI♀
12	Calanus VI♀
17	Meganyctiphanes (euphausiids) Sagitta sp. Pseudocalanus sp. VI♀ Calanus sp. VI♀
19	Nyctiphanes (euphausiids) Hyperiids (mostly Parathemisto) Calanus VI♀
21	Calanus VI♀ Mysids (Gasterosaccus sp.) Chaetognatha (mostly Sagitta)

Appendix 1.

CRUISE REPORT

RRS FREDERICK RUSSELL

FEBRUARY 4 - FEBRUARY 15 1987

(LEG 1 - FERTILIZER - N)

N J P OWENS

INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH

OBJECTIVES:

1. To measure the concentrations and distribution of major nutrients in the southern North Sea during winter, with particular emphasis on the sea areas bordering the major estuaries.

2. To measure the rates of primary production and nitrogen assimilation of phytoplankton and their horizontal distributions in relation to nitrogen inputs.

3. To measure the variations in the natural abundance of ^{15}N in particulate and dissolved nitrogen and to relate these to the natural inputs and internal recycling of nitrogen.

4. To measure the rates of bacterial production in the North Sea and its relation to estuarine plumes and particulate matter.

VESSEL: RRS FREDERICK RUSSELL

RVS REF: FR 11/87

IMER FILE: VES 11.1

PERSONNEL: N J P OWENS
E M S WOODWARD
D H PLUMMER (PDRA IMER/DUNDEE UNIVERSITY)

ITINERARY [TIMES GMT]

3 FEB		Loaded equipment and commenced commissioning.
4 FEB	1045	Sailed Plymouth on passage to Gt. Yarmouth. Continued commissioning equipment.
5 FEB		Continued commissioning. Arrived Gt. Yarmouth P.M. embarked 2 SMBA scientists.
	2100	Departed Gt. Yarmouth.
	2330	Commenced surface monitoring and sampling.
6 FEB		Continuous monitoring and sampling along Part 1 of sampling track (see cruise track).
7 FEB		Continued monitoring and sampling along track.
	0700	Completed Part 1 of sampling track.
	0900	Arrived Gt. Yarmouth, disembarked SMBA scientists. IMER scientists embarked P.M.
8 FEB	1100	Departed Gt. Yarmouth
	1530	Commenced continuous monitoring along Part 2 of sampling track.
10 FEB	2200	Suspended continuous monitoring.

11 FEB	0400	Arrived Station 6
	0500	30 l water bottle cast for ^{14}C and ^{15}N incubations.
	0600	Deployed in-situ incubation rig.
	1700	Recovered in-situ incubation rig.
12 FEB	0000	Recommenced continuous monitoring.
14 FEB	0330	Completed continuous monitoring.
15 FEB	0830	Berthed Plymouth, unloaded equipment, personnel disembarked.

PROCEDURES AND METHODS

Sampling was carried out using an overside pump that provided water for continuous analyses and for discrete samples. 30 l GO bottles were used for collection of samples for in-situ measurement of primary production and nitrogen assimilation. 7.1 l NIO bottles were used for vertical profiles.

CONTINUOUS SURFACE MONITORING

Continuous monitoring underway, the following variables were carried out over the entire sampling track: NO_3, PO_4, NO_2, SiO_4, NH_4, urea, T°, S°/$_{oo}$. Chemical variables were measured by colorimetric analysis and T° and S°/$_{oo}$ by a modified 9400 CTD system supplied by the ship's non-toxic water supply. The depth of sampling was approximately 1.5 m. Underway monitoring of T°, S°/$_{oo}$ and chlorophyll fluorescence was also achieved by UOR tows.

Discrete samples were obtained from the pump system at approximately 3 hourly intervals for the determination of S°/$_{oo}$. Particulate carbon and nitrogen, chlorophyll, ^{15}N natural abundance (dissolved and particulate), particulate concentration (gravimetric determination) and volume (coulter counter) and bacterial abundance. A vertical profile of the above variables was also obtained at Station 6.

RATE MEASUREMENTS

Discrete samples were also collected at approximately 3 hourly intervals for the determination of photosynthetic production, nitrogen assimilation and bacterial production.

Primary production was determined using the incorporation of ^{14}C. Samples were fractionated following incubation into >5µm, <5 >0.8 µm and <0.8 >0.2 µm fractions. Incubations were carried out in an illuminated incubator at surface sea-water temperatures to normalise for the time of day samples were collected. Nitrogen assimilation rates were determined on the same surface samples by the incorporation of $^{15}NO_3$ and $^{15}NH_4$. The same incubation conditions were employed as above and the samples fractionated into >5 and <5 µm fractions.

Bacterial production was examined by the incorporation of ^{3}H thymidine. The contribution of free-living bacteria and those associated with

particulate matter was determined by incubating a whole water sample and a pre-filtered sample to remove particulate matter.

Rates of primary production and nitrogen assimilation under in-situ conditions were examined at Station 6 by incubating samples at six depths using an in-situ production rig. The incubation was carried out between dawn and dusk.

EQUIPMENT PERFORMANCE AND OVERALL SUCCESS OF THE LEG

All the major objectives of the leg were met. Despite poor weather on two occasions no time was lost. We encountered no difficulties with the performance of the vessel. All nutrient analyses were accomplished at near 100% success rate. No difficulties were experienced in the collection or incubation of rate measurement samples. The incubation rig was deployed and recovered perfectly.

A malfunction occurred, part way through the cruise, to the ship's scientific master clock which necessitated using a non real-time clock for logging temperature and salinity data. This caused minor inconvenience but no data were lost.

Problems occurred with the UOR which resulted in a loss of some data. Nevertheless much useful information was obtained. The deployment and recovery arrangements for the UOR were less than ideal. The overall performance of the UOR will be covered by a separate report.

PRELIMINARY RESULTS

The participation in this cruise was opportunistic and will provide much useful information on the winter conditions of nutrients and phytoplankton production and nitrogen assimilation in the North Sea.

HYDROGRAPHY

A total track length of approximately 1100 NM was sampled during the leg. The cruise track (Fig. 1) indicates that this provided an excellent coverage of the southern North Sea.

The predominant features of the hydrography are shown in Fig. 2 and 3. A large part of the study area was characterised by relatively cold (<5°C low salinity (<35°/$_{oo}$) water. The temperature of the continental coastal water was approximately 0.5°C less than the ICES 50 year averages. The salinity distributions were as expected for February and show the influence of saline, relatively warm English Channel water entering through the Dover Straits. The temperature v salinity plot for all of the data (Fig. 4) clearly shows the English Channel water (Salinity > 35°/$_{oo}$; Temperature <7°/$_{oo}$). The remaining data show significant deviations from conservative behaviour. A preliminary analysis of the salinity and temperature data reveal that at least four water masses can be identified. When complete, these data together with detailed nutrient concentrations will form the basis for the development of existing hydrodynamic dispersion models.

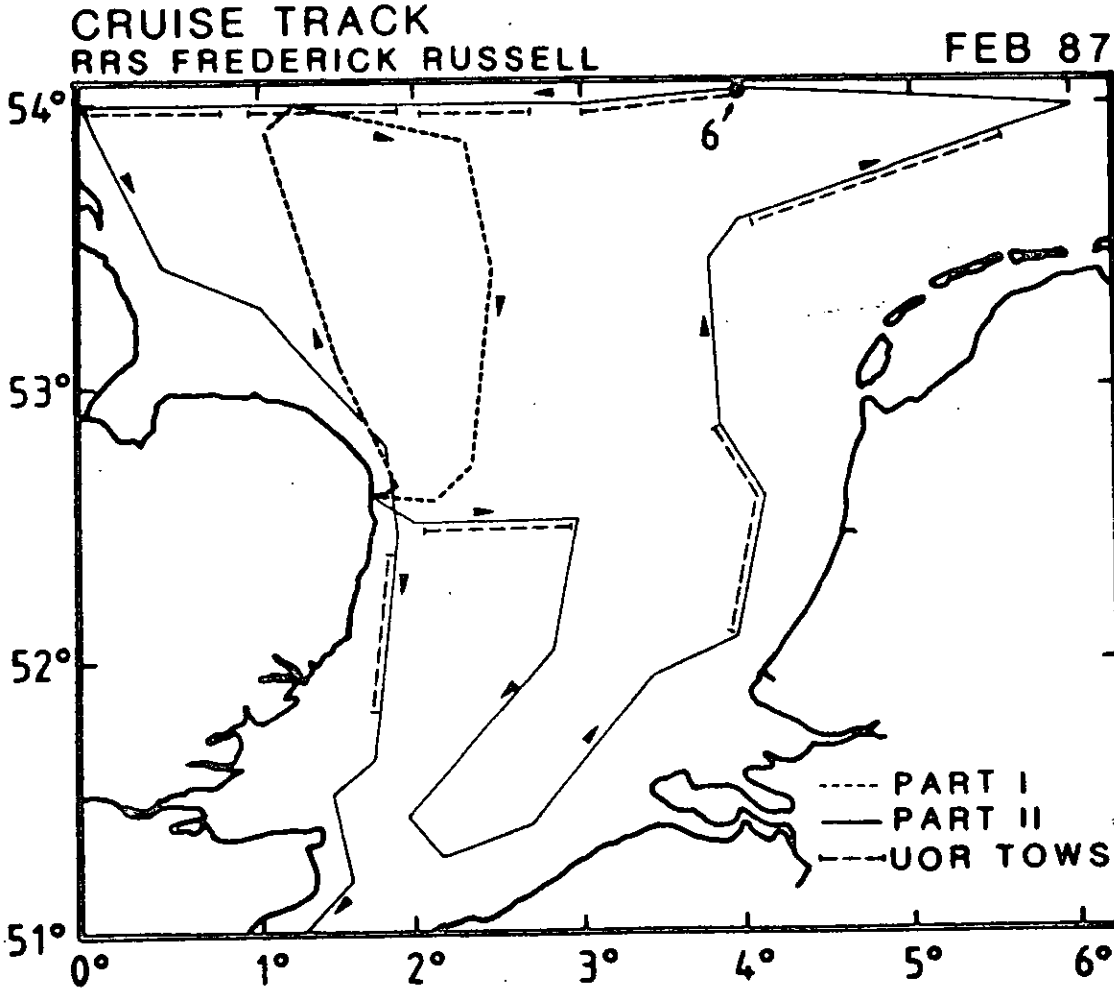
Nutrient data are not yet available but when fully worked up the data

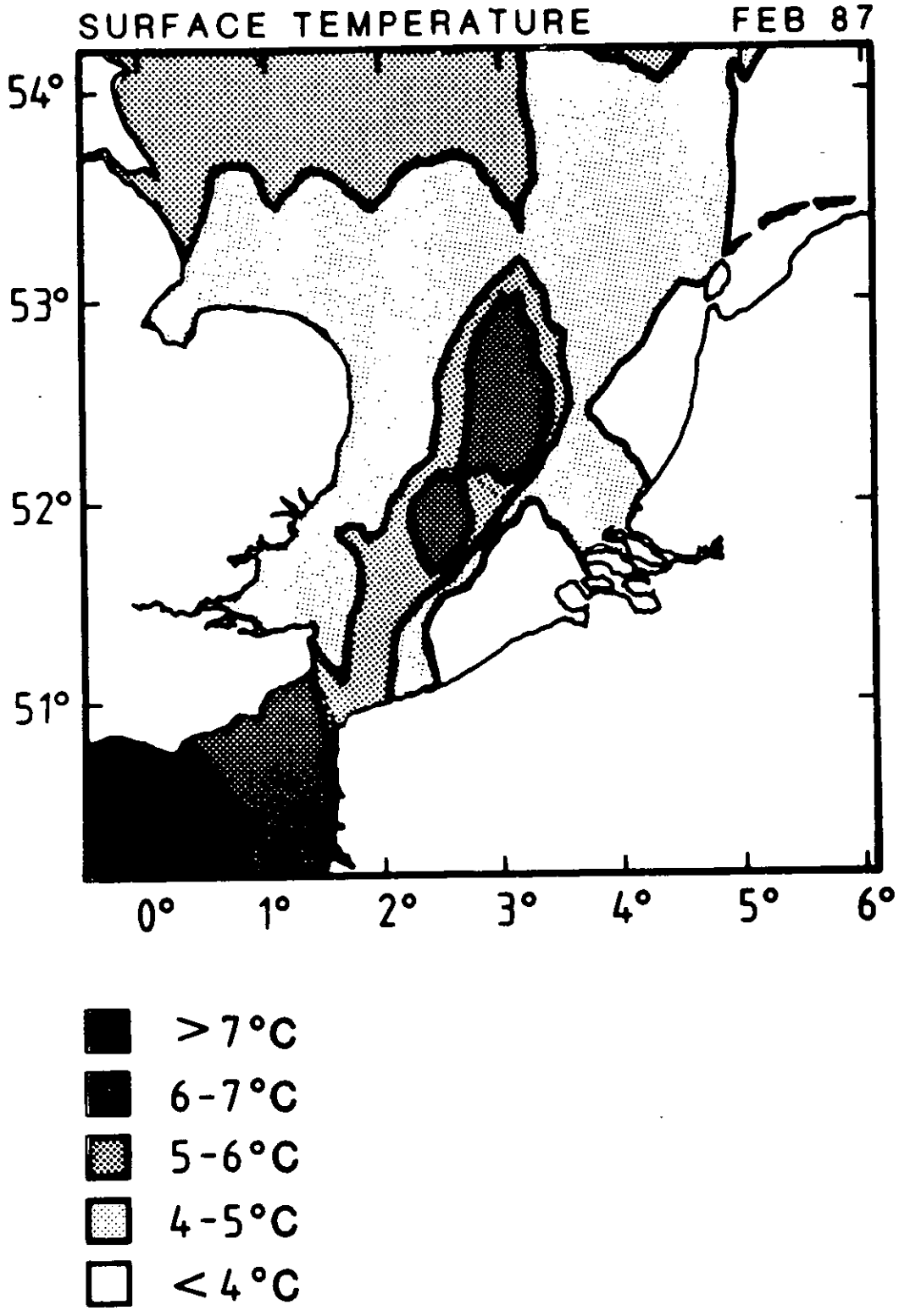
will provide essential information on the nutrient status of the water masses that comprise the Southern Bight and, importantly, the maximum concentrations likely to be observed. Both features are a prerequisite for subsequent modelling exercises.

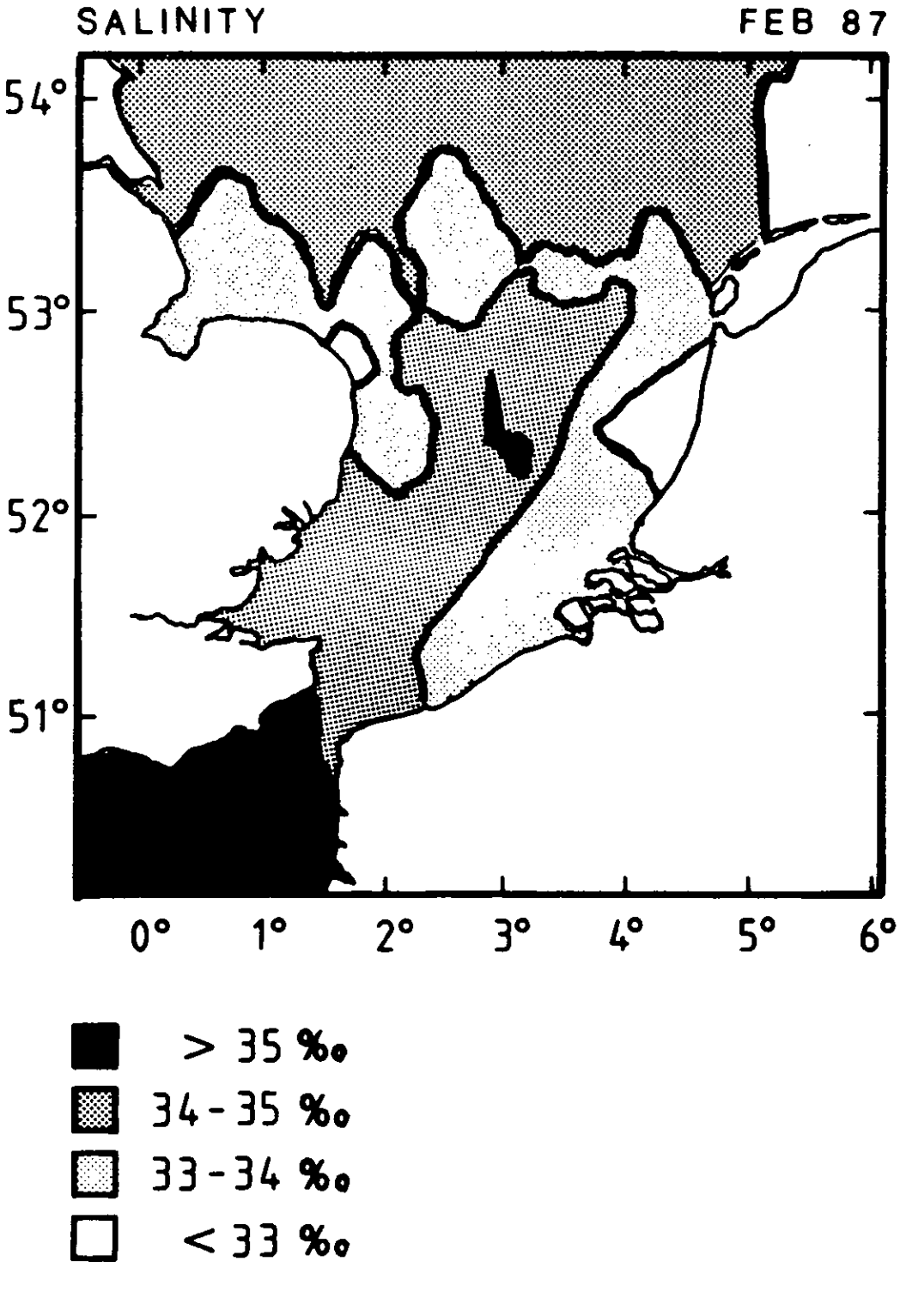
Primary Production

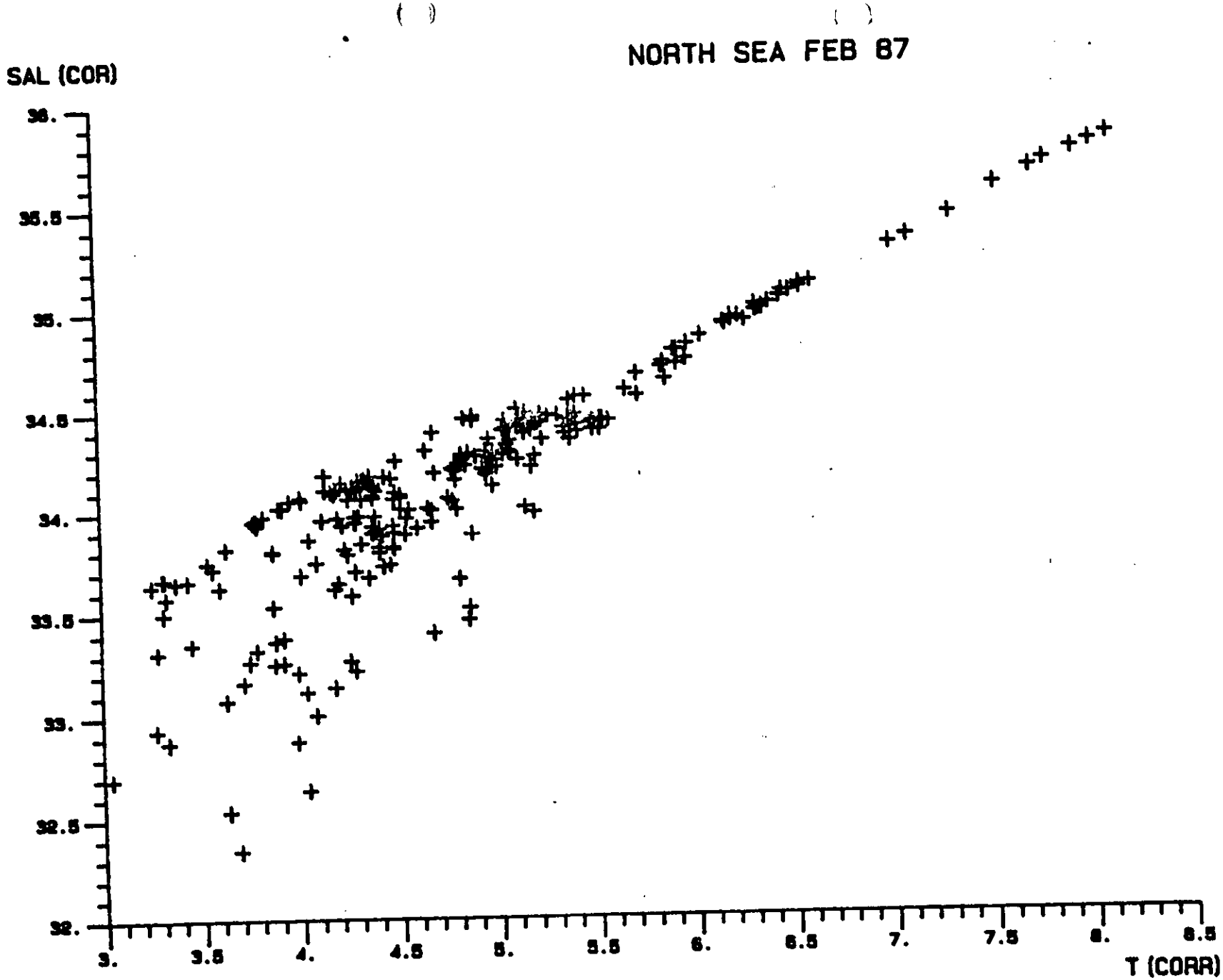
A total of forty-three surface and one in-situ estimation of primary production were carried out. In each case, carbon assimilation was divided into three size fractions. Primary production averaged approximately 20 mg C m^{-3} $d\mu$ (range 4-48). Highest production rates were observed in the region of the Dover Straits and outer Thames estuary and lower rates in the extreme North-east of the study area. (Fig. 5). The largest proportion of the primary production occurred in the >5µm fraction. The average production occurring in this fraction was 58% but was >70% in the North of the Study area. An average of 27% and 15% of the production occurred in the <5.0 >0.8µm and <0.8 >0.2µ fractions respectively. A marked exception to this pattern was observed in the Dover Straits where the average relative proportions of the primary production were >5µm-38%; <5 >0.8 µm - 41%; <0.8 >0.2 µm - 21%. This size-distribution of production is similar to that observed previously in the Celtic Sea during winter but why it should differ so markedly from that in the N. Sea is not known and warrants further investigation.

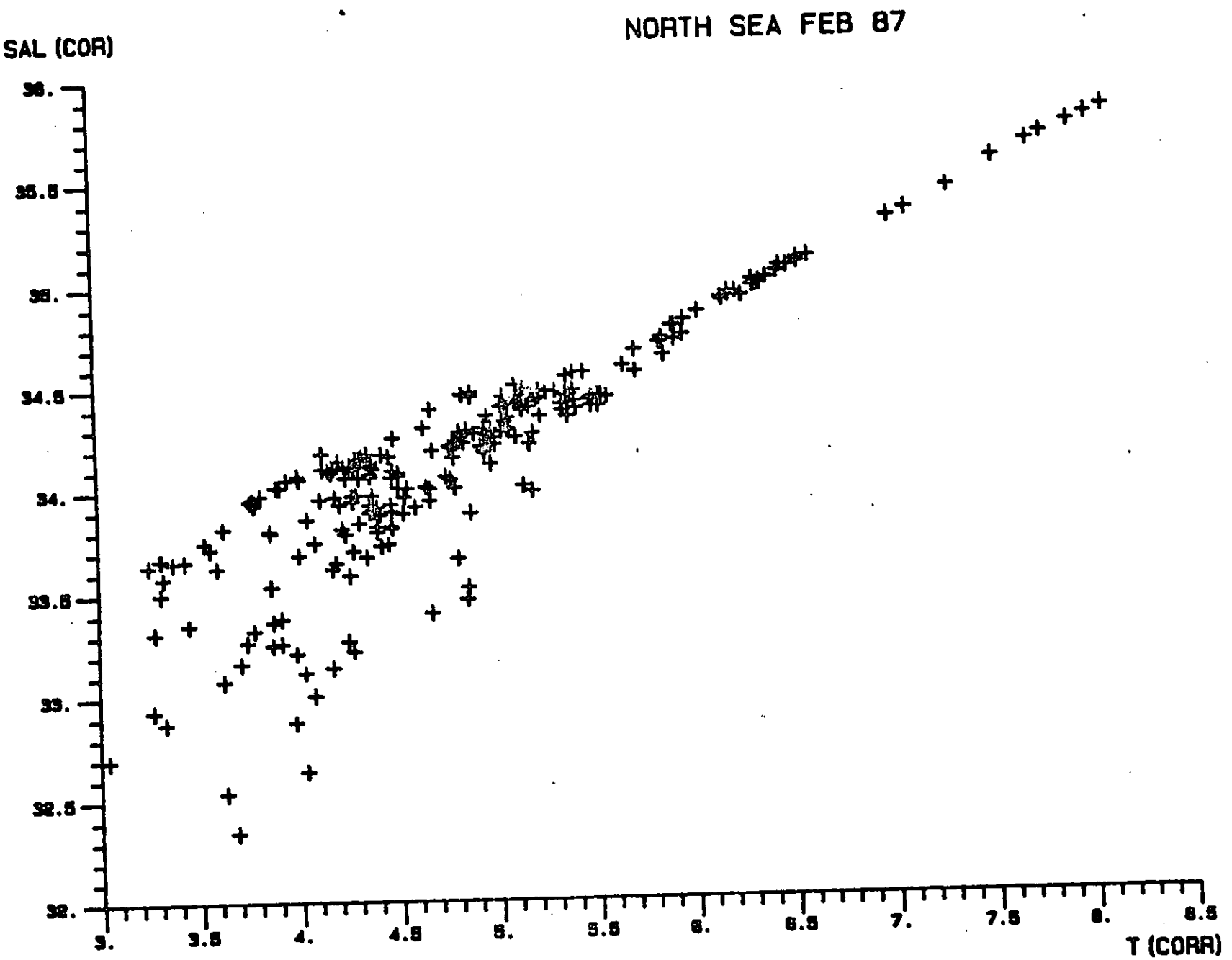
The depth integrated total production rate calculated from the in-situ incubation was approximately 10 mg. Cm^{-2} $d\mu$. The percentage occurring in each of the size fractions was >5 µ - 72%; <5 >0.8µm - 18%; <0.8 >0.2 µ - 10%. Simulated in-situ incubations at this site, carried out under a single light intensity, provided almost identical size fractionation data (71%, 18%, 11%). The simulated incubation gave a depth averaged production 20% higher than the depth averaged in-situ incubation. Using this conversion it will be possible to estimate, to a first approximation, the areal distribution of primary production. Similar data will be available for nitrogen assimilation rates.


CRUISE TRACK
RRS FREDERICK RUSSELL
FEB 87
54°
53°
52°
51°
0°
1°
2°
3°
4°
5°
6°
6'
PART I
PART II
UOR TOWS


SURFACE TEMPERATURE
FEB 87
54°
53°
52°
51°
0°
1°
2°
3°
4°
5°
6°
>7°C
6-7°C
5-6°C
4-5°C
<4°C


SALINITY
FEB 87
54°
53°
52°
51°
0°
1°
2°
3°
4°
5°
6°
> 35 ‰
34 - 35 ‰
33 - 34 ‰
< 33 ‰


NORTH SEA FEB 87
SAL (COR)
36.
35.5
35.
34.5
34.
33.5
33.
32.5
32.
3.
3.5
4.
4.5
5.
5.5
6.
6.5
7.
7.5
8.
8.5
T (CORR)


NORTH SEA FEB 87
SAL (COR)
35.
35.5
35.
34.5
34.
33.5
33.
32.5
32.
3.
3.5
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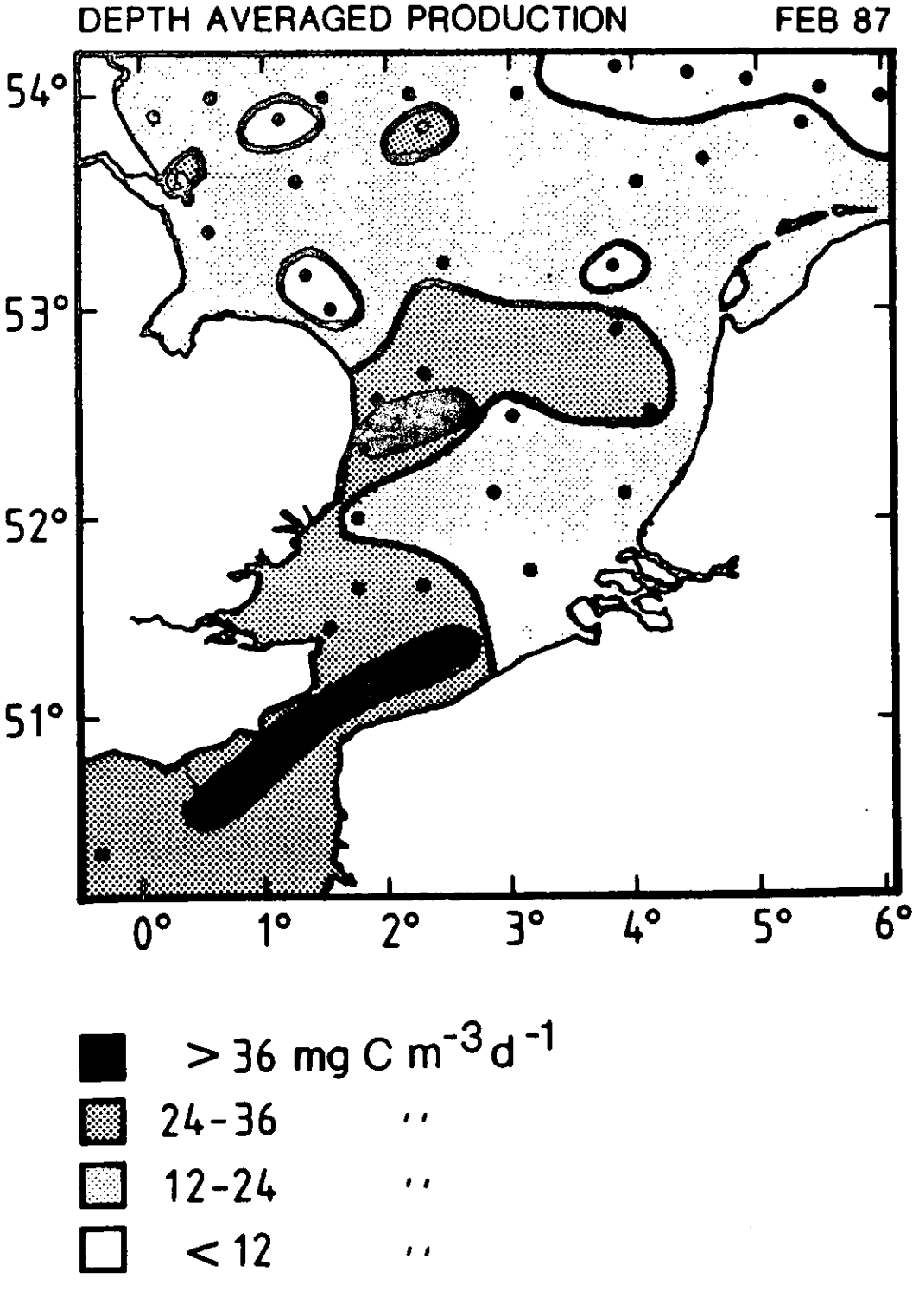
4.5
5.
5.5
6.
6.5
7.
7.5
8.
8.5
T (CORR)


DEPTH AVERAGED PRODUCTION
FEB 87
54°
53°
52°
51°
0°
1°
2°
3°
4°
5°
6°
> 36 mg C m-3 d-1
24-36 ''
12-24 ''
< 12 ''