I.O.S.

RRS DISCOVERY
CRUISE 114

16 October - 30 November 1980

Biological and physical investigation into the front between the Western and Eastern Atlantic Water south west of the Azores.

Cruise Report No 108

1981

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Institute of Oceanographic Sciences,
Brook Road,
Wormley, Godalming, Surrey,
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CONTENTS

CRUISE OBJECTIVES

1. To make a long transect of batfish observations southwards across the N.E. Atlantic to observe the latitudinal changes in the physical structure of the surface 300m.

2. To locate the boundary of the 18°C Sargasso Sea Water to the south-west of the Azores.

3. To investigate the physical and biological characteristics of the boundary, if it occurred as a clearly demarcated front.

4. To pick up a tide gauge laid during Cruise 112.

5. To lay current meter moorings for the benthic boundary layer experiment in the vicinity of the NEADS mooring site on the Madeiran Abyssal Plain.

PERSONNEL

M.V. Angel	PSO	IOSW
J. Badcock		IOSW
R. Bonner	2	"
E. Darlington	1	"
Mrs C Darter	2	"
P. Domanski		"
Mrs C Ellis		"
M. Fasham		"
J. Gould	2	"
M. Harris	2	"
P. Herring	2	"
Miss J Horton	1	"
S. Houghton		"
V. Lawford	1	"
R. Pollard	1	"
P.R. Pugh		"
H. Roe		"
J. Smithers		"
I. Waddington	2	"
R. Wallace	2	IOSW
R. Wild		IOSW
Prof. M. Wells	1	U. of Leeds
Miss L. Cabecadas	1	SMBA
Mrs N Robertson	1	"
P. Tett	1	"
M. Beney	2	RVS
R. Burnham	1	RVS
E. Cooper		RVS
R. Lloyd	2	RVS

SHIP'S OFFICERS

P.H. Maw	Master
K.Q. Avery 1	Mate
P. McDermott 2	"
J. Morse	2nd Officer
M. Barber	Chief Engineer
G. Batten	2nd Engineer
P. Parker	Elect. Engineer
P. Higginbottom	P.C.O.
F.S. Williams	Bosun
D. Knox	P.O.Deck
L. Cromwell	"

NARRATIVE

Leg 1.

The ship sailed at 1030/16.x, because of severe gales in the Western Approaches she anchored in Carmarthen Bay. It was not until 0700/18.x that she got underway again. Watches started at 1200/19.x soon after the shelf edge was crossed. At 1450-1800/19.x a batfish trial leg was run which identified a number of minor faults in the operating system that were soon corrected. Overnight the conducting cable on the electric winch was tensioned to 4600m. However, although the underlying cable was canvas wrapped, the unevenness of the loose coils resulted in irregular spooling so that when all the cable was on the drum it chaffed the disc brakes. The batfish was relaunched the following morning (0830/20.x) and the leg was terminated the following morning when a fault in the fluorometer started to seriously interfere with the measurement of the other parameters. It was redeployed at 1435/20.x without the fluorometer, but six hours later it developed a cable fault and had to be brought inboard again. While repairs were being made the ship continued to steam full speed on a course of 215°. The batfish was relaunched at 0445/22.x, and then ran continuously until 1500/27.x, giving five and a half days of excellent data. Throughout these runs hourly (or later two hourly) salinity samples were collected from the ship's pure sea water supply, at a time that coincided with when the batfish was at the top of its undulations. Occasional chlorophyll samples were taken to check the calibration of the fluorometer, and an autoanalyser was run continuously monitoring surface nitrate and silicate. At 0416/24.x the ship's course was altered from 215° to 245° so that the vessel would pass to the southeast of the Azores.

The long batfish run ended at 1500/27.x after the boundary between Eastern and Western Atlantic Water had been crossed initially in the vicinity of 33°50'N 29°W and then back into Eastern Atlantic Water at around 33°N 31°W. The batfish was retrieved in force 7 wind conditions which proved to be both difficult and dangerous because of the somewhat improvised handling system that we were forced to employ in using the ship's capstan. For the rest of the night of 27/28.x the ship remained hove to, partly because of the weather but also while the cable fault was repaired. Next morning (0945/28.x) the weather and sea conditions had moderated sufficiently to be able to launch the batfish, so once the ship had returned to the position at which the fault had developed the batfish was relaunched at 1330h. The ship steamed due South until the boundary was recrossed, and then the boundary was followed running north-easterly. The batfish was brought inboard at 1200/29.x and all the equipment removed from the poop-deck and the RMT 1+8M net system rigged. Meanwhile a shallow CTD dip was made to 300m and water bottle samples were collected to establish the nutrient, fluorescence and productivity profiles. A series of nets centred close to 33°N 30°W was conducted to study the day and night vertical distributions of organisms in the surface 800m of the Western Atlantic Water (Station 10222). Two more shallow CTD dips were made in the same area. The station was completed at 1400/31.x. A line of six shallow CTD stations combined with water bottles and pump profiles was sampled which transected the western boundary back into Eastern Atlantic Water.

In the Eastern Atlantic Water another series of net samples was taken to look at the vertical distribution of macroplankton and micronekton at station 10228 in the vicinity of 32°55'N 31°30'W. During the fourth set of samples a rigging error caused the gear to malfunction. More seriously during the sixth set of hauls the heel block on the starboard A frame seized and the sheave was damaged . Until repairs could be effected in Ponta Delgada all sampling had to be conducted over the port-side 'A' frame. The net sampling was completed at 1640/3.xi. Three CTD dips to 1500m were then made in each water type and in the boundary region. A leaking sensor held up the second dip for several hours. The batfish was redeployed in an attempt to locate a possible northern boundary to the Western Atlantic Water. It was brought inboard at 1920/4.xi and the PES fish was also brought in. The ship steamed for Sao Miguel in worsening conditions. The thermosalinograph indicated that the front was crossed at 0500/5.xi. After a most uncomfortable run the ship docked at Ponta Delgada in the Azores at 0800/6.xi. Professor Wells, Dr. R. Pollard, Dr. P. Tett, Mr. E. Darlington, Mr. V. Lawford, Mr. J. Burnham, Mrs N. Robertson, Miss J. Horton and Miss L. Cabecadas left the ship and Dr. P. Herring, Dr. J. Gould, Mr. M. Harris, Mr. I. Waddington, Mr. R. Wallace, Mr. R. Bonner, Mr. M. Beney, Mr. R. Lloyd and Mrs C. Darter joined.

While the ship was in port Mr. D. Gaunt and a representative of the manufacturers worked on the new midships winch.

Leg 2

The ship sailed from Ponta Delgada for the second leg at 0900/9.xi, and steered for 37°N 30°W. Initially XBT's were dropped every two hours, but by 0200/10.xi the weather had deteriorated and the ship was effectively hove to for the next 24 hours although still making some head way along the course. By 0800/3.xi the weather had moderated and the ship turned south to carry out an XBT survey along 30°W to establish the northern boundary of the Western Atlantic Water. The boundary was eventually located close to 35°N but the line of XBT's was continued south as far as 32°N. At 1300/12.xi the course was altered to 309° so that the position of the front in the region where much of the work on the first leg had been carried out could be re-established. The front had moved about 20 nautical miles to the west so that the start position for the Eastern Atlantic Water vertical series (Station 10228) was now in the front region. A series of RMT 1+8M samples was then collected as the ship steamed south along 31°30'W interspersed with XBT dips, which helped to establish the southern position of the front. The net samples began the investigation into possible faunal changes associated with the physical changes associated with moving from one water mass to another. The XBT's showed a well developed layer of 18°C water to the south which had not been present in the area where station 10222 was worked. Consequently it was decided to work another vertical miniseries in the vicinity of 32°N 31°30'W, where the water was more typically Western Atlantic. This series was completed by 1500/16.xi. The first biological current meter mooring (294) with current meters at 200, 700, and 1500m was laid on the 16.xi at the start position for the vertical series. A line of deep CTD's to 2000m was then worked back along 31°30'W at 10' intervals to 32°55'W. Since the hydrographic conditions implied the line of CTD's was running nearly parallel with the front the final CTD dip was at 33°N 31°47.5'W. This position was the start for a line of four stations worked across the front at which net samples were collected at specific depths or along specific isotherms to try to assess how much the vertical distribution patterns of the zooplankton and micronekton changed between the two water types. However, before the second station was worked the second biological mooring (295) was laid in Eastern Atlantic Water at 33°N 31°47.5'W. CTD's were also worked along the line. The line was completed by 1730/22.xi. Then after pressure testing the new stainless steel case for the fluorometer, the batfish was reassembled and relaunched. Sampling began at 0100/23.xi. The course steered returned back up the line of stations just sampled back to 33°17.5'N 31°53.9'W crossing the front back into Eastern Atlantic Water. The course was then changed to 069° so that another cut was made across the front into Western Atlantic Water again. At 1156/23.xi a toroid buoy was sighted at approximately 33°26.0'N 31°32.9'W but with the batfish deployed no attempt was made to approach it and identify it. After about another 120n.m.the front back into Eastern Atlantic Water was crossed, and at 0500/24.xi the batfish was retrieved. It was all inboard by 0606h and it was only a short distance to the position where the tide gauge (Station 10213) had been deployed on cruise 112. The release was operated without difficulty and the gauge surfaced at about 0800h. Its light and the calm sea conditions contributed to it being quickly located at the surface and recovered by 0822h.

The ship then set course for 33°N 22°W, and a series of XBT drops were made. During the daylight period of 25.xi three trial tows with a new flowmeter system and mounting position were made. Immediately after the last net was in, the ship hove to for wire tests of the acoustic release for the benthic boundary layer moorings. Wire tests were completed by 0140/26.xi and a short echo-sounding survey of the area around the proposed mooring site started. The discovery of a large bottom feature meant the orientation of the array was altered so the first mooring was not deployed until 1520/26.xi. Further wire tests of acoustic releases were carried out during the following night. At first light mooring deployment restarted and all the moorings were in position by 0100/28.xi. The 6mm conductor cable on the electric winch was then tensioned to 5212m with considerable difficulty because of the poor way it was wound on initially. A deep CTD station to 5127m achieved the down observation, but soon after hauling all signal was lost. The instrument was recovered and an unsuccessful attempt was made to cut off the inboard 500m. At 1900/28.xi course was set for the Azores and all scientific observations were stopped at 2000/28.xi. Weather conditions deteriorated rapidly but even so the ship docked at Ponta Delgada at 1000/30.xi.

BATFISH

Instrument Report (Lawford)

The batfish was deployed six times on the first leg of the cruise and once on the second totalling 193 and 28 hours of data collection respectively. Three of the runs on the first leg were terminated prematurely because of faults in the system. On two ocassions there was damage to the conductors in the towing cable at the fish end at the towing block, and once the cable inside the vehicle was damaged. Throughout the cruise the batfish was used in the yo-yo mode on the end of around 550m of faired cable. At speeds of 8 knots (4 $m.s^{-1}$) maximum and minimum depths of about 300 and 15m respectively were achieved with cycle times of around eleven minutes. The final run on leg 1 was a seven hour trial for a new simple tail unit that was built during the cruise. The unit which is cheaper, lighter and more easily repaired, proved to be a successful modification and it was used again for the 28h run on leg 2.

The batfish was launched and recovered in winds of up to force 7 and 8, however, considerable difficulties arose from the lack of a suitable capstan correctly sited. On one occasion the vehicle forcibly struck the ship's stern, but fortunately in the one orientation in which damage was slight and easily repaired. For both the final run on leg 1 and the leg 2 run the ship's crane was used instead of the Hiab which had to be unshipped for net operations. Although the launch and recovery was successful each time, conditions were very calm, and the use of the ship's crane is not to be recommended except in emergencies.

UK - Azores Section (Pollard)

The passage leg from Barry to the Azores was the first of four surveys planned for the next year. The scientific objective was to observe the physical structure of the top 300m using the IOS CTD/batfish system to describe longitudinal changes on the north-south run from 47°N to 35°N, and ultimately to describe seasonal changes also.

The tactical objective was to demonstrate that data reduction, calibration and display could be carried out within a few hours of data collection, making the repeated collection of such large quantities of data (50000 data cycles per hour for a week) a practical proposition.

It was clear from the outset that computer logging of the data would not be initially possible. The applications software had been substantially modified since previous cruises but could not be tested prior to sailing. This was because late delivery of hardware, basic software changes and insufficient manpower at RVS had allowed little access to the system. We were also one man short, as Duncan Collins had been taken ill at the end of the preceding trials cruise 113.

After a week of frantic program testing, computer logging, archiving and plotting were begun on day 299, in time for the survey south of the Azores, where real-time decisions were necessary. Even by the end of the first leg, however, sampling programs for the EM log and gyro, thermosalinograph, autoanalyser, and particle counter were not completed, and plans for the computer to merge data from different instruments had had to be abandoned as the PDP 11/34 seemed unable to handle the load.

Scientifically, the situation was retrieved by the Digidata magnetic tape interface, which logs CTD data and time in computer compatible format direct from the CTD deck unit. Later in the cruise, the Digidata tapes were read back into the PDP 11/34 raw CTD data file, allowing averaging, calibration and display by the normal real-time logging software. It took four hours to read back and process a six hour tape. In this mode, conductivity could be well calibrated from salinities measured from two-hourly bottle samples drawn from the sea-water supply. The evolution of the T/S curve along the entire track could thus be followed, and sample contour plots of temperature, salinity, sigmatheta, fluorescence and oxygen were obtained, along with vertical profiles and time series.

The availability of four VDU's, tectronix hardcopy, and an HP 7221 plotter were invaluable to provide plot output. The HP 7221 plotter could barely handle the demands made on it by contour plotting (character output) in the absence of an operational Calcomp 1038 drum plotter. Once the Calcomp is interfaced, the plotting can be much more sensibly managed. The hardcopy unit attached to a fast screen plotter is essential.

There are several conclusions to be drawn for the following batfish sections:-

(1) The surface salinometer must be operating and attached to the PDP 11/34. The bottle samples showed that the conductivity ratio changed several times through the cruise. However, the samples did not resolve shortlived changes apparent from the CTD records, which normally recovered within hours. On one occasions, severe fouling reduced calculated salinities by several parts per thousand for several hours. Thus:

(a) There must be adequate water flow to the thermosalinograph. The pump on cruise 114 could not handle the demands.

(b) The DTS interface must be completed.

(c) Water samples must be routinely drawn off the sea water supply to monitor the thermosalinograph and CTD calibrations.

(2) Thorough systems analysis is required to monitor and improve computer efficiency. In spite of hardware and software enhancements, the PDP 11/34 was unable to handle loads no greater than those previously achieved (on cruise 94, JASIN 1978 and Challenger 5/1979) and the substantially enhanced load envisaged had to be abandoned.

(3) More core is urgently required for cruise 116. Disk traffic caused by checkpointing severely reduced throughput, as no more than two programs could be held in the GEN partition simultaneously. A full load would require about twenty programs running about every minute. On cruise 114 no more than four or five could be handled.

(4) The CTD sampling program needs rewriting. At present up to half the data cycles come out as bad data.

(5) Calibrating and averaging programs need modification to avoid reinitialization every minute. This should reduce disk traffic substantially.

(6) Adequate RVS computer personnel are required to run both the PDP 11/34 and IBM 1800 systems. Two people (one hardware, one software) are insufficient while the PDP software is still under development.

Results in the vicinity of 34°N, 30°W (Fasham)

From the data obtained on the long batfish run from the Bay of Biscay, it could be seen that in the Eastern Atlantic the 15°C isotherm was always well above 300m. At around 34°N, 29°W there was a sharp transition to Western Atlantic Water during which both the 15°C and 16°C isotherms dropped below 300m and the surface salinity increased by 0.3‰, the whole change taking place over about 30 n.m. The T-S relationship showed a marked change above 200m with a considerable amount of interleaving. However, below 200m the T-S relationship was identical on either side of the front. The frontal zone was also marked by an increase in surface currents and the slope of the isopycnals and also a small increase in phytoplankton chlorophyll. This latter effect could be due to a slight shallowing of the pycnocline in the frontal zone.

Continuing the batfish run in a south-westerly direction it was found that around 33°N, 31°W there was a second front showing a reverse effect with a transition back from Western to Eastern Atlantic Water. This suggested either a detatched eddy of Western or Eastern Atlantic Water or a large meander of the front. During the remainder of the cruise a further four crossings of the front were made with the batfish and one using XBT's. Although the issue could not be definitely resolved the evidence favoured a meander.

MIDWATER SAMPLING

Nets (Roe)

The multiple RMT 1+8 system was used throughout the cruise except for three hauls with the ordinary combination net to test some new flowmeters. The RMT 1+8M was fished 57 times yielding 304 samples. On 19 occasions only the first and third pairs of nets were fished with the second being used as intermediates linking the layers of interest. This method precluded any contamination or blurring of samples between two different horizons. The gear worked very well; 12 samples were lost or contaminated and of these, 4 were due to bridles pulling prematurely out of the release gear, 1 to an RMT 1 tearing unaccountably and the remaining 7 to human error.

Most of the hauls were made at shallow depths and since there was usually a swell running the gear suffered considerable strain. Slight modifications will be necessary to the RMT 1 part of the system - stoppers and bar inserts are needed, and a return to the solid monitor cross is desirable for shallow use.

Gear handling on deck with the reduced ship's manning posed a few problems initially but once the necessity of maintaining tension on the warp whilst retrieving the net was appreciated by all there were no further difficulties. Six people are required on deck to handle the multiple net with comfort.

The low light level photometer (LLP) was used occasionally and worked well.

Net Monitors (Harris & Darlington)

In the past the thermistor temperature sensor has been positioned in the end-cap of the monitor. The location gave the thermistor maximum protection against physical damage, but reduced its ability to respond quickly to variations of seawater temperature. For this cruise the thermistor was mounted externally on the fin of the monitor reducing its thermal time constant down to one second and so providing a much more accurate record of temperature fluctuations, making it practical to try and follow isotherms with the net. Both J3 and J5 monitors were converted in this manner. The temperature calibration of J3 was compared with the CTD on a vertical wire and the temperature calibration modified.

The low light level photometer was used in conjunction with J3 and operated correctly during the time it was used.

Some mechanical trouble was experienced with the flow meters with the rotors becoming disengaged from their support spindles. Otherwise the net monitor system functioned correctly and effectively throughout the cruise.

Flow meters (Wild)

Trials with haul-effect flow meters were carried out on the RMT 1+8 system. This flow meter unit consists of a standard flow meter with the gear-head driven contactor replaced by an electronic circuit which counts pulses emitted by a 'hand-effect' diode. After 320 pulses it transmits a signal to the monitor and a short off-set is produced on the temperature trace. The magnets in the rotor are replaced by two rod magnets 180° apart mounted with opposed polarity. These two magnets act on the diode through the aluminium alloy pressure housing end-cap.

The purpose of the trials was to establish the feasibility of a change over to this type of meter which would be cheaper and easier to maintain. One of each type of meter was mounted on the monitor cross. The first trial was encouraging, in 34 minutes the haul-effect unit recorded 28½ units of flow and the standard unit 28. The second haul was inconclusive as the standard unit failed. However, the new unit functioned continuously. The third trial was to examine the practicality of mounting the flow meter in the monitor fin where it would be less vulnerable to physical damage when either launching or recovering the nets. For this experiment a haul-effect meter was fitted with a standard flow meter rotor fitted with four magnets set at 90°. The electron circuit was cast in araldite inside a section of streamlined aluminium alloy. The modified unit was then mounted centrally on the leading edge of the fin. A standard flow meter was attached to the cross. The results were disappointing. The fin mounted meter gave slow counts while the net system was closed and being hauled in and paid out. Once the nets were opened no counts occurred, partly because of a minor mechanical fault, but probably mainly because of the change in flow pattern that occurs when the nets open and the angle of the monitor changes, further investigations of these flow patterns are needed. The design and building of the electronics and its interfacing in the monitor was carried out by Mr. M. Harris and Mr. E. Darlington designed and built the electronics in the fin mounted unit.

Vertical Series (Angel)

Three sets of day and night vertical profiles of macrozooplankton and micronekton distribution down to 1100m were collected. One in Eastern Atlantic Water (station 10228), one in mixed water which was predominantly Western (station 10222) and the third in Western Atlantic Water (station 10233). The surface 200m was divided into the wind mixed zone, the region of the chlorophyll maximum as determined by the very consistent relationship between temperature and the fluorescence maximum within each water type, and from the base of the chlorophyll maximum to 200m. Below 200m the water column was sampled in 100m strata. Each tow was for one hour at 2kts. The RMT 8 sampler would filter in the region of 30,000m^3 of water during this period and the RMT 1 about 2500m^3. Ninety of the RMT 8 samples were volumed and sorted into major groups onboard, fish, decapods, euphausiids, chaetognaths and siphonophores. These groups dominated the standing crop, except when large Pyrosoma were caught. The low standing crop of medusae was particularly noticeable in the deep hauls in comparison with recent sampling carried out at higher latitudes (e.g. during

Discovery cruises 92 and 105).

The group data (Table 1a-f) shows firstly that there is a somewhat higher standing crop in the Eastern Atlantic Water, with greater numbers of fish, decapods and mysids being taken. Whereas euphausiids appeared to be equally abundant in both water types. Chaetognaths were only sorted from the night series at station 10233 where there was a striking maximum in chaetognath abundance between 200-500m dominated by one very large species Sagitta maxima. A total of 8730 chaetognaths were sorted from the one series.

The depth of the fish zone of maximum abundance dominated by Cyclothone braueri was at 400-600m in Eastern Atlantic Water but at 500-600m in Western Atlantic Water. However, the depth at which mysids became abundant (i.e. the top of the Eucopia unguiculata zone) was at 700m by day at all three stations.

The data from these series should provide information on how the community composition, structure and vertical distribution differs between the two water types. This information is the start point for the study of how the communities respond and interact in the region of the front.

TABLE 1

Displacment volumes of total samples in mℓs

a. Volumes in brackets are for Pyrosoma

	E. Atlantic Water		Intermediate Water		W. Atlantic Water	
	10228		10222		10233	
	Day	Night	Day	Night	Day	Night
Wind-mixed	80	200 (+460)	100	350 (+950)	60	210 (+100)
C. max	70	250	100	390	140	230
C.max-200m	120	170	100	180	130	95
200-300m	230	300	200	230	150	210
300-400m	200	210	140	180	120	300 (+300)
400-500m	240	290	180	180	120	230
500-600m	150	180	200 (+690)	210	120	190
600-700m	220	160	160 (+2860)	180	130	180
700-800m	300	150	270 (+380)	200	440	125
800-900m	230	125	N.S.	220	150	190
900-1000m	260	150	N.S.	140	180	120
1000-1100m	140	230	N.S.	140	200	200

b. Numbers of fish

	E. Atlantic Water		Intermediate Water		W. Atlantic Water	
	Day	Night	Day	Night	Day	Night
Wind-mixed	59	550	42	791	71	219
C.max	31	339	25	367	55	544
C.max-200m	12	99	41	89	14	135
200-300m	22	65	19	68	38	88
300-400m	52	90	42	106	58	113
400-500m	702	754	266	390	456	262
500-600m	941	1025	743	704	749	612
600-700m	484	600	308	470	515	323
700-800m	380	272	348	220	311	274
800-900m	176	159	N.S.	110	168	148
900-1000m	173	353	N.S.	118	122	146
1000-1100m	322	132	N.S.	141	253	230
TOTALS	3354	4438	1834	3574	2810	3094

c. Numbers of Decapods

Wind-mixed	124	272	47	225	59	267
C.max	13	478	4	162	12	140
C.max-200m	6	227	15	134	8	86
200-300m	3	60	3	54	3	46
300-400m	5	19	1	33	1	60
400-500m	14	33	31	18	11	47
500-600m	81	21	45	35	70	21
600-700m	72	21	62	23	71	14
700-800m	231	34	253	41	111	25
800-900m	83	36	N.S.	20	58	26
900-1000m	62	28	N.S.	21	35	32
1000-1100m	53	25	N.S.	10	54	41
TOTALS	747	1254	461	776	493	805

d. Numbers of Euphausiids

Wind-mixed	71	234	70	215	48	477
C.max	56	435	96	521	51	452
C.max-200m	82	587	143	669	177	578
200-300m	119	135	108	83	89	154
300-400m	131	111	58	106	54	104
400-500m	219	169	266	163	138	170
500-600m	293	197	127	82	246	117
600-700m	130	101	93	54	125	96
700-800m	415	281	309	71	336	249
800-900m	184	213	N.S.	14	248	98
900-1000m	110	208	N.S.	20	123	168
1000-1100m	105	178	N.S.	18	229	215
TOTALS	1915	2849	1270	2016	1864	2878

d. Number of mysids

	10228		10222		10233	
	Day	Night	Day	Night	Day	Night
Wind-mixed	0	0	0	0	0	0
C.max	0	0	0	0	0	3
C.max-200m	1	0	0	0	0	1
200-300m	0	0	0	0	0	0
300-400m	0	0	0	1	0	2
400-500m	0	1	0	1	0	0
500-600m	6	31	0	15	5	26
600-700m	0	27	2	25	4	14
700-800m	89	61	67	21	45	30
800-900m	154	100	N.S.	49	82	62
900-1000m	116	125	N.S.	80	87	130
1000-1100m	87	161	N.S.	69	147	122
TOTALS	453	506	69	261	370	390

f. Numbers of cephalopods

Wind-mixed	12	10	42	23	10	12
C.max	16	57	21	61	27	15
C.max-200m	12	8	24	27	7	9
200-300m	4	5	5	-	3	5
300-400m	-	2	2	5	1	2
400-500m	3	-	2	3	11	-
500-600m	-	1	12	-	5	1
600-700m	2	3	3	-	2	3
700-800m	7	4	10	-	5	4
800-900m	5	4	N.S.	-	8	4
900-1000m	3	-	N.S.	-	7	6
1000-1100m	2	-	N.S.	-	3	-
TOTALS	66	94	121	117	89	61

Samples in the region of the front (Angel)

A series of stations were worked along a transect crossing the front. A large series of nighttime tows were taken both in the wind-mixed layer and in the chlorophyll maximum to compare the distributions of vertical migrants. By day a few hauls were conducted following isolumes, light profiles were similar on both sides of the front so if light is the dominant physical parameter determining the vertical distribution of any species these samples would be similar in composition regardless of the position of the samples relative to the front. Then by night two depths were sampled, 200m and 300m and four isotherms were followed 17°C, 16°C, 15° and 14°C. Pairs of parameters were followed during each tow using the first and third nets of the multiple net system; the second nets being used as a link system. By day the 11°C and 12°C isotherms were followed and depths of 500m 600m and 700m. It is hoped that these samples will provide data on which species change dramatically across the front in abundance or vertical distribution, and also indicate which physical parameter is dominant in determining the vertical range of species occurring on both sides of the front. Some of the changes may not show up above the 'noise' created by sampling variability and so will not be amenable to future study during cruises 120 and 121. Hopefully there will be species that provide a clear enough signal that will be clearly recognisable above the sampling 'noise'. One advantage of following isotherms in the work area, is that there is so little variability in the T.S. relationship between temperatures of 9° and 16°C, that in effect the sampler is also following density surfaces.

Fishes (Badcock)

In that the species composition of samples fished to particular parameters was similar regardless of position relative to water mass type, the more usual approach of providing some interpretation through a cursory examination of samples was rendered invalid. However, the fishes taken at two stations, 10222 from so-called Western Water and 10228 from so-called Eastern Water, were identified and counted. Remarks and conclusions therefore are based entirely on these series data.

In many ways the two collections were very similar. They contained about 92 (Western) and 99 (Eastern) species, total 122, with 69 common to both. The predominant groups of fishes in both collections were the stomiatoids and myctophids and here the similarities, in terms of species present, were even more marked, with 66 species present in Western collections, 68 in Eastern, and 56 common to both.

By day mesopelagic fishes were encountered from 200m to the lower sampling depths but generally were centred below 400m in both waters. Indeed, with the majority of species intra-specific variation of depth distribution between the two series could not be detected, regardless of whether or not the species made diel vertical migrations. The possible exception may have been the relatively deep-dwelling Cyclothone microdon whose juvenile population centres may have existed 100m deeper in Western waters. Confirmation (or otherwise) should be possible through length-frequency analysis together with data from the second western series (St. 10233).

The main difference between these two collections are to be found in comparisons of catch rates for the predominant species. The catch rates for Cyclothone, emphatically C. braueri and C. microdon, and the hatchet-fish Argyropelecus hemigymnus, were considerably higher in eastern than western waters, whilst the converse situation arose for myctophids. The data for Cyclothone are more convincing than those for the others, if only because of their natural great abundance, their greater susceptibility to our sampling methods and in particular, their non-migratory tendencies which ease interpretation problems. On the other hand, it is interesting to note that for reasons at present even beyond speculation, the trans-Atlantic data collected in March 1973 show a reverse situation for C. braueri and C. microdon to that found here. For C. braueri high and low catches were consistently taken westwards and eastwards, respectively, of 34°W; a similar situation occurred at 39°W for C. microdon.

Myctophids were taken in relatively low numbers and, in particular, the validity of compared catch rates must be in doubt. The majority of species were full migrants, ones to encountered in the upper 100m by nights; differences in night catch rates in this layer were slight. Myctophids are more active than Cyclothone, more capable of net evasion and some species are known to form aggregations by day. Regardless of how consistent the present data may appear, the question must arise as to whether the tows made were long enough to make valid catch rate comparisons.

As a tentative conclusion one may state that differences were found in these two collections which may indicate a mesopelagic faunal change in an area where the physical structure of the upper layers is known to change. Hopefully the remaining samples will add positive evidence and, more important, help identify the problems that need resolving.

Siphonophores (Pugh)

During the cruise attention was focussed on identifying the siphonophores from two series of hauls; one made in the Eastern Atlantic Water (EAW, St.10228), and one in the Western Atlantic Water (WAW, St.10222), to try to establish whether distinctive populations could be recognized. Unfortunately there was not time to study all the material but most of the samples from the top 500m were investigated. The preliminary conclusions from this study show that there are relative differences in the abundance of certain species in the two water masses. Eudoxoides mitra appeared to be more abundant in the EAW, which contrasts with some earlier work, done in 1973, where this species was found to be more abundant in the WAW. Hippopodius hippopus showed the most notable change across the boundary between the two water masses and was considerably more abundant in the EAW. This again is interesting as the earlier studies indicated that there was little difference in numbers between the two water masses. A cursory glance at the series of hauls made through the boundary region at a depth of 50m showed also a rapid decline in the numbers of this species as the WAW was approached. Although the numbers of several species, e.g. Chelophyes appendiculata, were similar in both water masses there was a distinct difference in their daytime depth distribution. The animals tended to migrate to deeper depths in the WAW than in the EAW, which may be consistent with the greater depth of certain isotherms in the former water mass. This is an interesting point as little is known about the factors which might control the depth distribution of siphonophores. In addition, the population of siphonophores, particularly in the WAW, was considered to be quite young as, for instance, very few posterior nectophores of C. appendiculata were found, and the animals appeared to be monogastric. Also there were very few eudoxids, or reproductive stages, present in the samples. Many hippopodid larval nectophores also were present. Whether this represents a seasonality in the life history of the animals or whether the recently developed population is an outcome of some change in or the presence of the boundary region is not clear, and it will be of interest to compare the present results with those derived from the sampling programme to be carried out next year, in a different season.

NUTRIENTS AND CHLOROPHYLL

Autoanalyser and profiles (Tett, Robertson and Cabecadas)

A Technicon II 2-channel autoanalyser connected to the nontoxic seawater supply was operated between 20 October 1980 (approximately 46°N 11°W) and 29 October 1980 (apprxomately 33°N 30°W). Nitrate and silicate were measured. Various problems, some associated with the ship's motion in rough weather, reduced precision or eliminated one channel or the other, for about 25% of this time. There was little obvious variation in the concentration of the nutrients, with nitrate always below 0.2 mg-at N m^{-3} after 21 October and silicate always between 1 and 2 mg-at Si m^{-3} after this date. The instrument

Table 2

STATIONS SAMPLED FOR NUTRIENTS AND CHLOROPHYLL

Station	Date	Time	Depth range (m)	N	Si	Chl
10221	29 Oct	1400	0-300	X	-	X
10223	31 Oct	1900	11-292	X	X	X
10224	31 Oct	2345	0-300	X	X	-
10225	1 Nov	0330	0-300	X	-	-
10226	1 Nov	0500	0-300	X	-	-
10227	1 Nov	1000	6-320	X	-	X
10228	1 Nov	1300	5-299	X	X	X
10229	3 Nov	2000	5-1500	X	X	-
10230	4 Nov	0700	5-1500	X	-	-
10231	4 Nov		5-1500	X	-	-

was later used to measure nutrients in water bottle samples taken at the stations listed in table 2.

Phytoplankton chlorophyll-a and pheopigments were measured fluorometrically after extraction into acteone. Samples from the nontoxic seawater supply were measured to calibrate fluorometers connected to this supply and measuring *in vivo* fluorescence, and also to calibrate the batfish fluorometer. Chlorophyll and pheopigments were also measured in water bottle samples at stations listed in table 2, and used to calibrate the underwater fluorometer used for profiles at these and other stations. Chlorophyll-a ranged from 0.02 to 0.08 mg m^{-3} at the surface to a maximum of about 0.25 mg m^{-3} in the upper thermocline. Pheopigments reached maxima of about 0.30 mg m^{-3} just below the chlorophyll maximum.

Photosynthetic rates were measured, using the carbon-14 method, in water taken from the surface at stations 10222 (30 October '80) and 10228 (2 November '80), and from the upper thermocline at stations 10223 (95m on 31 October '80) and 10228 (109m on 1 November '80). Subsamples were incubated for 2, 4 or 24 hours in a 6-compartment constant temperature bath exposed to a range of artificial illumination, with the aim of estimating the parameters of a photosynthesis-light model.

These parameters and the nutrient data will be used with measurements of surface illumination and water column optical attenuation, to predict the distribution of phytoplankton biomass in the water column, for comparison with chlorophyll profiles observed at stations in Eastern and Western Atlantic Water.

Fluorescence and particle studies (Pugh)

Throughout the cruise the chlorophyll *a* fluorescence levels were very low in the surface waters and the concentration of chlorophyll rarely exceeded 0.1 mg/m. Sub-surface fluorescence peaks were, however, noted and these are reported on elsewhere in this report. Some experiments were carried out to investigate to what extent the fluorescence levels might be enhanced by the addition of the weed-killer, DCMU. A small and consistent enhancement was achieved which apparently did not vary according to the time of day or to the type of water mass being sampled. These experiments were discontinued on the second leg of the cruise, but probably deserve further attention particularly if greater variability in the fluorescence levels are found during next year's cruise. The particle counting results proved disappointing and disturbing. The software which should have enabled the computer to sample the data was, unfortunately, never completed and the results could only be printed out on paper tape. However, the uniformly low concentrations of particles were not consistent with a rapid sampling regime. Two new 'high concentration' sensors were used during the cruise, although most attention was paid to the one which sized particles in the range 2.5 -150μm. Some very strange results were obtained from this sensor whilst vertically profiling using the submersible pump. No matter what the fluorescence level, the counts increased dramatically after a few minutes with no rhyme or reason. Such peculiarities in the instrumentation remain to be explained.

MOORING OPERATIONS

General (Gould, Harris, Waddington, Wallace, Bonner)

A total of eight moorings and a bottom mounted tripod were deployed. These have IOS(W) mooring numbers 294-302 and are described in table 3. Six moorings were of the near bottom type and together with the tripod made up an array within which benthic studies on cruise 117 will be carried out. The central mooring of the array could not be deployed owing to the late arrival of VACM Batteries in the Azores. The other two moorings were full depth moorings deployed on either wide of the front found in the biological/physical mesoscale experiment. All the mooring deployments were uneventful with the double barrelled winch now driven from the ring main working very well. The reduced noise levels and the modifications to the hydraulics made during the cruise have greatly improved the ease of operation of this winch.

TABLE 3 MOORING DEPLOYMENTS

IOS no.	Date/time	Lat °N	Long °W	Water depth m	Instrument depth m
294	16.xi.80/2024	32 00.36	31 29.98	4050	200,703,1510 ,
295	19.xi.80/1142	33 01.41	31 47.80	3737	200,703,1510
296	26.xi.80/1659	33 04.98	21 58.42	5283	5273,5174,4632
297	26.xi.80/2047	33 10.86	21 58.34	5289	5288
298	27.xi.80/1028	33 09.96	21 56.77	5286	5276, 5176
299	27.xi.80/1154	33 13.03	22 00.21	5300	5290,5189,4645

IOS no.	Date/time	Lat °N	Long °W	Water depth m	Instrument depth m
300	27.xi.80/1434	33 10.03	22 06.37	5300	5290,5189,4645
301	27.xi.80/1740	32 54.11	21 59.56	5275	5265, 5165
302	28.xi.80/0052	33 09.53	22 17.35	5333	5323, 5222

Acoustic Command Units (Harris)

All of the acoustic command releases were tested at the depth they were going to be used, prior to being deployed on the VACM/camera tripod and eight current meter moorings. Two out of the ten releases that were "wire tested" failed to operate correctly. In both instances the fault was due to damaged insulation on internal conductor leads. This fault, once located, was easily repaired.

All of the time relases and two transponders operated correctly during the operation of laying the moorings.

BIOLUMINESCENCE (Herring)

Experimental feeding of *Oplophorus* with ^{14}C labelled tyrosine has been undertaken in order to establish whether this decapod is capable of synthesizing its own luciferin from the amino-acid precursors or whether it needs to ingest it pre-formed in the diet. Other observations on *Oplophorus* have shown that most of the photophores have some degree of rotational capability but it has not been possible to relate the degree of rotation to the animals' orientation or to the direction of illumination.

A number of cephalopods have been studied, in particular the lycoteuthids *Selenoteuthis* and *Lampadioteuthis*. Emission spectra have been obtained from the photophores of these genera and from the cranchids *Bathothauma*, *Coryneteuthis* and *Galiteuthis*. Among the fishes the capture of specimens of *Aristostomias* and *Pachystomias* have provided opportunity for further investigation of these red-emitting genera. Fluorescence microscopy of the glandular luminescence of the copepod genus *Euaugaptilus* and the ostracod genus *Conchoecia* has shown the extent of the glandular material and localised it clearly in several species. Further image intensification studies have been made of the scyphozoan *Atolla* and of *Oplophorus* and *Selenoteuthis* luminescence. Material from a number of species has been fixed for subsequent investigation of the photophore structure. In addition samples of red and white muscle from species of *Chauliodus*, *Argyropelecus* and *Cyclothone* have been fixed for ultrastructural analysis by Dr. I. Johnston, University of St Andrews.

SHIP SYSTEMS

Foreward Ring Main (Wallace and Bonner)

This was the first cruise on which the foreward ring main hydraulic system could be used both to lay moorings with the double-barrelled capstan and to power the new midships winch. The ring main gave no trouble when laying moorings. There was no heat problem, as found previously, since the addition of a new cooler system. The problem of contamination of the oil also appears to have been overcome by the modification of the filter system. The ring main could only be used to power the new midships winch for testing purposes, but this revealed no further problems. The ring main system was run for a total of 18 hours.

Note added by PSO. The noise levels produced by the motor driving the ring main are still unacceptable in the foreward scientific accommodation.

Midships Winch (Wallace and Bonner)

A lot of work was achieved on the new midships winch which had been installed in Barry just prior to the ship sailing. The electric cables were put into conduit to protect them. The slip ring fitted and wired up to the electronics laboratory. The whole system was tested for electrical continuity and found to be in order. The A-frame sheave was fitted with the load cell shackle, and the complete assembly was installed on the A-frame, wired up and successfully tested.

The trip mechanism, made according to the drawings provided, was fitted one metre below the sheave. When tested, however, it was found that the mechanism rode up the wire when hauling in and hit the sheave. The hole in the trip was increased in diameter and the weight of the mechanism increased by attaching brass side pieces. On retesting the modified trip worked well. When the wire was hauled in at full speed and the trip activated, the winch stopped instantly.

When the traverse encoder was wired in, it failed to work because of an electronics fault. No hydraulics faults were found, and the winch was run for a total of five hours under no load conditions.

PERSONAL REPORT (Wells, NERC Consultant on Shipborne Computing)

I am at present on a short secondment from my normal post as Director of Computing Services at Leeds University, to allow me to carry out a consultancy study on the future development of Shipborne Computing within NERC. Such a study must include spending some time at sea, in order to reach at least some understanding of the problems involved in the use of computers on board a ship. Pressure of work had precluded my joining an earlier cruise in January/February of 1980; the first leg of Discovery cruise 114, from Barry to the Azores was judged to be directly relevant to my study, since it included substantial computing in processing 'Batfish' data. My own involvement can be classified at three levels

(i) as a member of a team responsible for general-purpose computing on the cruise, with especial emphasis on Batfish data capture and reduction,

(ii) as a worker in my own right, carrying out projects which might be expected to contribute to the overall computing environment,

(iii) as a general observer of the whole approach to shipborne computing, seeking to improve my understanding in the area of my consultancy study.

In summary the results that I achieved, again under these same three headings were

(i) team member - very little! My net contribution to the Batfish computing was quite negligible, due largely to certain physical discomforts associated with the movement of the ship. Despite my good intentions, I managed to be present on only two of the 0400 to 0800 shifts, and my attendance at 1600 to 2000 shifts was also of a rather transient nature.

(ii) single worker - considerable, though less than I might have hoped. I was directly involved in three major pieces of work, two of which reached more or less satisfactory conclusions:

(a) a rebuild of the RSX 11M operating system was completed by John Burnham amd myself during the time that Discovery was hove to in the Bristol Channel. Among other improvements to the previous versions it was intended that this rebuild would allow the amount of core memory in use to be extended; a subsequent attempt to introduce more memory was frustrated by the physical limitations of the available hardware.

(b) development of a program to estimate the unused CPU time on the PDP11/34. This program is working in a prerelease version, which has demonstrated the validity of the approach; the program requires some further development and the production of documentation before it can be regarded as fully completed, and I am arranging for these aspects to be carried out at Barry by myself.

(c) development of a hardware method of estimating the fraction of time that the PDP 11/34 spends in supervisor state. The work is fully documented; no attempt was made to carry out the modification at sea as it involves very minor interference with the back-wiring of the CPU and it was rightly judged that the consequences of any damage in the middle of a cruise were not worth the risk. Again, I hope to complete this work during a visit to Barry.

(iii) general observer - invaluable. My attempts at working on the projects in (ii), under the physical conditions (both external and internal) imposed by being at sea, gave me an insight of the nature of the problems of working on board a ship that I could not have otherwise gained.

I would like to take this opportunity of recording my thanks to the crew and scientific staff of Discovery for their patience and help during the cruise; I shall remember them with gratitude when other, more painful memories, have long since faded.

CRUISE STATISTICS

	Leg 1	Leg 2
Batfish data	193hrs	28h
CTD 150m with light meter	1	0
100m with pump	4	0
300m	9	0
1500m	3	0
2000m	0	12
5000m	0	1
XBT's	0	73
RMT 1+8 samples		
macroplankton	51	98
micronekton	51*	95*
Moorings		
laid	0	9
retrieved	0	1
Autoanalyser		
surface nutrients	9 days	0

Profiles		
nitrate	10	0
silicate	4	0
chlorophyll	4	0
light	3	1

* Ninety of these samples were volumed and part sorted on board.

XBT DATA

XBT No.	Day	Time Z	Maximum depth m	Lat. °N	Long °W
1	314	1220	520	37 40.9	25 47.9
2	314	1405	540	37.3	26 04.2
3	314	1559	490	33.9	23.8
4	314	1755	536	33.1	43.7
5	314	2000	280	31.1	27 04.4
6	314	2200	538	28.4	23.5
7	315	0000	197	25.5	43.1
8	315	0202	70	22.6	28 01.7
9	315	0412	282	20.6	18.0
10	315	0626	169	18.0	28.4
11	315	0958	523	13.3	40.1
12	315	1800	180	09.6	29 07.4
13	316	0000	537	05.1	30.7
14	316	0600	537	05.3	49.9
15	316	0957	546	36 44.0	30 00.2
16	316	1158	520	21.8	29 59.8
17	316	1302	536	10.4	59.8
18	316	1402	525	35 59.5	59.5
19	316	1503	543	48.0	59.3
20	316	1600	425	37.9	59.1
21	316	1800	543	16.5	58.7
22	316	2000	542	34 55.0	30 00.0
23	316	2200	582	35.2	00.0
24	317	0010	760+	12.8	29 59.6
25	317	0200	760+	33 54.6	59.3
26	317	0400	760+	33.8	30 00.0
27	317	0600	760+	12.2	00.7
28	317	0800	760+	32 50.9	00.4
29	317	1000	760+	29.9	29 59.8
30	317	1200	760+	09.5	30 00.3
31	317	1300	192	31 59.6	29 59.8
32	317	1400	760+	32 05.8	30 09.2
33	317	1600	760+	19.9	27.8
34	317	1800	760+	33.3	46.4
35	317	2000	760+	46.0	31 05.5
36	317	2100	760+	51.3	16.4
37	317	2200	760+	58.3	26.3
38	317	2300	760+	33 04.3	36.4
39	318	0344	760+	00.5	34.6
40	318	0721	760+	32 54.8	31.4
41	318	1208	760+	32 48.3	31 29.4
42	318	1350	760+	35.1	30.7

XBT No.	Day	Time Z	Maximum depth m	Lat. °N	Long. °W
43	318	1895	760+	32 28.3	31 29.7
44	318	2013	760+	49.3	29.9
45	319	0121	760+	35.0	29.7
46	319	0530	760+	20.8	29.7
47	319	0906	760+	07.2	29.2
48	319	0957	760+	00.0	29.7
49	319	1832	760+	31 50.0	36.4
50	320	0535	365	59.3	51.0
51	320	1427	760+	32 01.3	30.8
52	322	1230	760+	54.9	29.8
53	322	1335	760+	54.9	41.3
54	322	1405	760+	54.0	47.0
55	322	1440	760+	59.8	47.5
56	323	1210	760+	33 09.3	53.9
57	325	1840	760+	32 55.0	17.8
58	326	1602	315	35.8	00.5
59	329	1100	760+	34 07.8	28 21.7
60	329	1300	760+?	03.3	27 55.6
61	329	1500	760+?	01.1	29.3
62	329	1700	760+	33 56.0	04.0
63	329	1900	760+	50.2	26 38.8
64	329	2054	760+	44.3	15.3
65	329	2156	760+	41.3	02.5
66	330	0000	407	38.5	25 35.7
67	330	0100	760+	36.5	22.8
68	330	0300	760+?	32.2	24 17.1
69	330	0500	760+	26.7	32.0
70	330	0700	760+	21.4	07.9
71	330	0825	760+	19.2	23 49.5
72	330	0900	760+	18.1	41.8
73	331	0145	760+	10.4	01.9

SUMMARY

Cruise 114 was surprisingly successful. When we sailed we were not at all certain whether we would find a clear boundary and if one existed exactly where to look. Finding it so easily was a tribute to the power of the batfish as a tool for physical oceanography. Defining exactly what sort of feature we studied, whether it was a meander or an eddy, was beyond our capabilities in the time available, although we are reasonably sure it was a meander in a very extensive frontal system. The samples we gathered should provide us with information on the structure of the biological communities in the two outer types and the how the communities are affected by the very different thermal structure. Hopefully sufficient data can be extracted from the samples so that there is some feed back into the design of the sampling for cruises 120 and 121 when we plan to revisit the area in May and June 1981.

ACKNOWLEDGEMENTS

As always the success of a cruise is greatly contributed by the professionalism and patience of the ship's personnel. It gives me great pleasure to acknowledge the help of the whole ship's complement under the direction of Captain P. Maw, first officers K. Avery and P. MacDermott, and Chief Engineer M. Barber. It is appropriate to recognise particularly the efforts of those involved in the day and night operation of the nets L. Cromwell (PO Deck), D. Knox (PO Deck), C. Vrettos (AB) and D. Gittins (AB).

STATION LISTS

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10221	29/10	32 58.5N	30 0.9W	MS	0- 300	1400-1430	10 WATER BOTTLES	3180
# 1		32 58.7N	30 0.8W			DAY		
10222	29/10	33 3.8N	30 2.5W	RMT1M-1	800- 900	2016-2116		
# 1		33 5.2N	30 4.2W	RMT8M-1		NIGHT	FLOW DIST. 3.01 KM.	
10222	29/10	33 5.2N	30 4.2W	RMT1M-2	900-1000	2116-2216		
# 2		33 6.5N	30 6.0W	RMT8M-2		NIGHT	FLOW DIST. 3.06 KM.	
10222	29/10	33 6.5N	30 6.0W	RMT1M-3	1000-1100	2216-2316		
# 3		33 8.0N	30 7.9W	RMT8M-3		NIGHT	FLOW DIST. 3.15 KM.	
10222	30/10	33 6.2N	30 4.7W	RMT1M-1	495- 600	0337-0438		
# 4		33 8.0N	30 6.9W	RMT8M-1		NIGHT	FLOW DIST. 4.21 KM.	
10222	30/10	33 7.9N	30 6.9W	RMT1M-2	600- 700	0438-0538		
# 5		33 9.6N	30 8.6W	RMT8M-2		NIGHT	FLOW DIST. 3.60 KM.	
10222	30/10	33 9.5N	30 8.6W	RMT1M-3	700- 800	0538-0638		
# 6		33 11.2N	30 10.2W	RMT8M-3		NIGHT	FLOW DIST. 3.34 KM.	
10222	30/10	33 3.8N	30 0.2W	RMT1M-1	500- 600	0918-1018		
# 7		33 5.6N	30 2.5W	RMT8M-1		DAY	FLOW DIST. 3.42 KM.	
10222	30/10	33 5.5N	30 2.5W	RMT1M-2	600- 700	1018-1118		
# 8		33 7.1N	30 4.2W	RMT8M-2		DAY	FLOW DIST. 3.87 KM.	
10222	30/10	33 7.0N	30 4.2W	RMT1M-3	700- 800	1118-1218		
# 9		33 8.5N	30 5.9W	RMT8M-3		DAY	FLOW DIST. 3.42 KM.	
10222	30/10	33 4.4N	30 1.9W	RMT1M-1	200- 305	1415-1515		
# 10		33 6.1N	30 3.7W	RMT8M-1		DAY	FLOW DIST. 3.64 KM.	
10222	30/10	33 6.1N	30 3.7W	RMT1M-2	300- 400	1515-1615		
# 11		33 7.9N	30 5.1W	RMT8M-2		DAY	FLOW DIST. 3.42 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10222	30/10	33 7.9N	30 5.1W	RMT1M-3	400- 500	1615-1715		
# 12		33 9.6N	30 6.6W	RMT8M-3		DAY	FLOW DIST. 3.37 KM.	
10222	30/10	33 9.2N	29 58.1W	RMT1M-1	200- 300	2105-2206		
# 13		33 8.7N	30 0.7W	RMT8M-1		NIGHT	FLOW DIST. 4.17 KM.	
10222	30/10	33 8.7N	30 0.6W	RMT1M-2	300- 400	2206-2306		
# 14		33 8.2N	30 3.3W	RMT8M-2		NIGHT	FLOW DIST. 4.35 KM.	
10222	30/10	33 8.2N	30 3.2W	RMT1M-3	400- 500	2306-0006		
# 15	31/10	33 7.8N	30 5.9W	RMT8M-3		NIGHT	FLOW DIST. 4.17 KM.	
10222	31/10	33 6.3N	30 1.4W	RMT1M-1	10- 105	0206-0306	FISHED ABOVE 20'C ISOTHERM	
# 16		33 4.5N	30 2.9W	RMT8M-1		NIGHT	FLOW DIST. 3.64 KM.	
10222	31/10	33 4.5N	30 2.9W	RMT1M-2	105- 160	0306-0410	FISHED IN CHLOROPHYLL MAXIMUM	
# 17		33 3.0N	30 4.6W	RMT8M-2		NIGHT	FLOW DIST. 3.77 KM.	
10222	31/10	33 3.1N	30 4.6W	RMT1M-3	160- 200	0410-0510	FISHED BELOW 18'C ISOTHERM	
# 18		33 1.5N	30 6.1W	RMT8M-3		NIGHT	FLOW DIST. 4.08 KM.	
10222	31/10	33 5.0N	30 5.1W	CTD	0- 324	0615-0705	WB @ STANDARD DEPTHS	
# 19		33 5.0N	30 5.0W	MS		NIGHT		
10222	31/10	33 0.1N	29 59.4W	CTD	0- 323	0816-0838	WB @ STANDARD DEPTHS	
# 20		33 0.1N	29 59.2W	MS		DAWN		
10222	31/10	33 5.4N	30 1.4W	RMT1M-1	20- 120	1032-1132	FISHED ABOVE 20'C ISOTHERM	
# 21		33 3.2N	30 1.5W	RMT8M-1		DAY	FLOW DIST. 3.44 KM.	
10222	31/10	33 3.3N	30 1.5W	RMT1M-2	100- 180	1132-1232	FISHED IN CHLOROPHYLL MAXIMUM	
# 22		33 0.9N	30 1.8W	RMT8M-2		DAY	FLOW DIST. 3.73 KM.	
10222	31/10	33 1.0N	30 1.8W	RMT1M-3	130- 205	1232-1332	FISHED BELOW 18.7'C ISOTHERM	
# 23		32 58.6N	30 2.2W	RMT8M-3		DAY	FLOW DIST. 3.57 KM.	

STN.	DATE 1980	POSITION LAT LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10223 # 1	31/10	32 49.4N 29 59.6W 32 48.2N 29 59.6W	CTD MS UFL LMD	0- 100	1535-1658 DAY	PUMPING AND PARTICLE COUNTING	
10223 # 2	31/10	32 47.2N 30 1.2W 32 47.1N 30 1.4W	CTD MS UFL	0- 319	1831-1857 DUSK	WB @ STANDARD DEPTHS	
10224 # 1	31/10	32 52.6N 30 19.2W 32 52.5N 30 19.2W	CTD MS UFL FL	0- 130	2143-2220 NIGHT	PUMPING AND PARTICLE COUNTING	
10224 # 2	31/10	32 50.7N 30 17.7W 32 50.5N 30 17.6W	CTD MS UFL	0- 300	2315-2342 NIGHT	WB @ STANDARD DEPTHS	
10225 # 1	1/11	32 52.0N 30 36.7W 32 52.1N 30 36.7W	CTD MS UFL	0- 303	0212-0236 NIGHT	WB @ STANDARD DEPTHS	
10226 # 1	1/11	32 53.5N 30 54.1W 32 53.8N 30 53.9W	CTD MS UFL	0- 302	0433-0458 NIGHT	WB @ STANDARD DEPTHS	
10226 # 2	1/11	32 55.7N 30 54.5W 32 56.2N 30 54.5W	CTD MS UFL FL	0- 130	0646-0708 NIGHT	PUMPING AND PARTICLE COUNTING	
10227 # 1	1/11	32 54.5N 31 12.2W 32 55.0N 31 11.9W	CTD MS UFL	0- 320	0907-0951 DAY	WB @ STANDARD DEPTHS	
10228 # 1	1/11	32 55.5N 31 28.5W 32 55.8N 31 28.5W	CTD MS UFL	0- 322	1234-1310 DAY	WB @ STANDARD DEPTHS	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10228 # 2	1/11	32 56.1N 32 56.4N	31 28.5W 31 28.4W	CTD MS UFL LMD	0- 176	1345-1409 DAY	WB @ STANDARD DEPTHS	
10228 # 3	1/11	32 58.1N 33 0.8N	31 28.1W 31 27.7W	RMT1M-1 RMT8M-1	500- 605	1448-1548 DAY	FLOW DIST. 3.55 KM.	
10228 # 4	1/11	33 0.7N 33 3.4N	31 27.7W 31 27.3W	RMT1M-2 RMT8M-2	600- 705	1548-1648 DAY	FLOW DIST. 4.04 KM.	
10228 # 5	1/11	33 3.3N 33 5.4N	31 27.3W 31 27.3W	RMT1M-3 RMT8M-3	705- 805	1648-1748 DAY	FLOW DIST. 3.34 KM.	
10228 # 6	1/11	32 58.7N 33 1.3N	31 28.2W 31 28.2W	RMT1M-1 RMT8M-1	800- 900	2016-2116 NIGHT	FLOW DIST. 3.19 KM.	
10228 # 7	1/11	33 1.2N 33 3.7N	31 28.2W 31 28.5W	RMT1M-2 RMT8M-2	900-1000	2116-2216 NIGHT	FLOW DIST. 3.37 KM.	
10228 # 8	1/11	33 3.6N 33 6.1N	31 28.5W 31 28.8W	RMT1M-3 RMT8M-3	1000-1100	2216-2316 NIGHT	FLOW DIST. 3.69 KM.	
10228 # 9	2/11	33 1.9N 33 0.6N	31 33.9W 31 31.5W	RMT1M-1 RMT8M-1	500- 600	0202-0302 NIGHT	FLOW DIST. 3.30 KM.	
10228 # 10	2/11	33 0.6N 32 59.4N	31 31.6W 31 29.3W	RMT1M-2 RMT8M-2	600- 700	0302-0402 NIGHT	FLOW DIST. 3.78 KM.	
10228 # 11	2/11	32 59.4N 32 58.5N	31 29.4W 31 27.2W	RMT1M-3 RMT8M-3	700- 800	0402-0502 NIGHT	FLOW DIST. 3.89 KM.	
10228 # 12	2/11	33 5.6N 33 5.1N	31 33.7W 31 31.0W	RMT1M-1 RMT8M-1	200- 300	0925-1025 DAY	RMT8 FAILED TO CLOSE COMPLETELY FLOW DIST. 3.46 KM.	
10228 # 13	2/11	33 5.1N 33 4.5N	31 31.0W 31 28.4W	RMT1M-2 RMT8M-2	300- 400	1025-1125 DAY	RMT8 COULD NOT OPEN COMPLETELY FLOW DIST. 3.89 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10228	2/11	33 4.5N	31 28.4W	RMT1M-3	400- 505	1125-1225	RMT8 COULD NOT OPEN COMPLETELY	
# 14		33 3.8N	31 25.7W	RMT8M-3		DAY	FLOW DIST. 4.13 KM.	
10228	2/11	33 4.3N	31 24.9W	RMT1M-1	10- 115	1333-1433	FISHED ABOVE 19'C ISOTHERM	
# 15		33 6.4N	31 25.8W	RMT8M-1		DAY	FLOW DIST. 3.51 KM.	
10228	2/11	33 6.4N	31 25.8W	RMT1M-2	80- 130	1433-1533	FISHED AROUND 19'C ISOTHERM	
# 16		33 8.5N	31 26.8W	RMT8M-2		DAY	FLOW DIST. 2.97 KM.	
10228	2/11	33 8.5N	31 26.8W	RMT1M-3	128- 200	1533-1633	FISHED BELOW 17'C ISOTHERM	
# 17		33 10.4N	31 28.0W	RMT8M-3		DAY	FLOW DIST. 3.24 KM.	
10228	2/11	33 10.1N	31 28.1W	RMT1M-1	5- 350	1711-1737	OBLIQUE	
# 18		33 9.1N	31 27.4W	RMT8M-1		DAY	FLOW DIST. 1.60 KM.	
10228	2/11	33 9.1N	31 27.4W	RMT1M-2	350- 650	1737-1804	OBLIQUE	
# 19		33 7.9N	31 26.8W	RMT8M-2		DAY	FLOW DIST. 1.60 KM.	
10228	2/11	33 8.0N	31 26.8W	RMT1M-3	650-1000	1804-1851	OBLIQUE	
# 20		33 5.7N	31 25.8W	RMT8M-3		DUSK	FLOW DIST. 2.95 KM.	
10228	2/11	32 56.2N	31 31.0W	RMT1M-1	200- 300	2203-2303		
# 21		32 58.5N	31 32.6W	RMT8M-1		NIGHT	FLOW DIST. 3.87 KM.	
10228	2/11	32 58.5N	31 32.6W	RMT1M-2	300- 400	2303-0004		
# 22	3/11	33 0.7N	31 34.1W	RMT8M-2		NIGHT	FLOW DIST. 4.00 KM.	
10228	3/11	33 0.6N	31 34.0W	RMT1M-3	400- 500	0004-0104		
# 23		33 2.7N	31 35.6W	RMT8M-3		NIGHT	FLOW DIST. 3.80 KM.	
10228	3/11	32 55.4N	31 30.6W	RMT1M-1	10- 120	0259-0359	FISHED ABOVE 19'C ISOTHERM	
# 24		32 57.4N	31 32.1W	RMT8M-1		NIGHT	FLOW DIST. 4.01 KM.	
10228	3/11	32 57.4N	31 32.1W	RMT1M-2	90- 140	0359-0459	FISHED ABOUT 18'C ISOTHERM	
# 25		32 59.7N	31 34.5W	RMT8M-2		NIGHT	FLOW DIST. 4.19 KM.	

STN.	DATE 1980	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10228	3/11	32 59.7N	31 34.5W	RMT1M-3	120- 200	0459-0559	FISHED BELOW 17'C ISOTHERM	
# 26		33 2.0N	31 36.2W	RMT8M-3		NIGHT	FLOW DIST. 4.01 KM.	
10228	3/11	32 55.2N	31 30.1W	CTD	0- 130	0730-0800	PARTICLE COUNTING	
# 27		32 55.8N	31 29.8W	UFL		DAWN		
				FL				
				PUMP				
10228	3/11	32 58.7N	31 31.1W	RMT1M-1	800- 900	0926-1026		
# 28		33 1.1N	31 32.4W	RMT8M-1		DAY	FLOW DIST. 3.33 KM.	
10228	3/11	33 1.1N	31 32.4W	RMT1M-2	900-1000	1026-1126		
# 29		33 3.0N	31 32.6W	RMT8M-2		DAY	FLOW DIST. 3.37 KM.	
10228	3/11	33 3.0N	31 32.6W	RMT1M-3	995-1100	1126-1226		
# 30		33 5.0N	31 33.2W	RMT8M-3		DAY	FLOW DIST. 2.97 KM.	
10228	3/11	33 4.3N	31 31.8W	RMT1M-1	205- 300	1340-1440		
# 31		33 3.0N	31 29.4W	RMT8M-1		DAY	FLOW DIST. 4.26 KM.	
10228	3/11	33 3.0N	31 29.4W	RMT1M-2	300- 400	1440-1540		
# 32		33 0.5N	31 27.2W	RMT8M-2		DAY	FLOW DIST. 4.00 KM.	
10228	3/11	33 0.5N	31 27.2W	RMT1M-3	390- 505	1540-1640		
# 33		32 59.1N	31 25.6W	RMT8M-3		DAY	FLOW DIST. 3.84 KM.	
10229	3/11	32 55.4N	31 30.7W	CTD	0-1500	1933-2044	WB @ STANDARD DEPTHS	
# 1		32 55.8N	31 31.1W	MS		DUSK		
10230	4/11	32 54.1N	31 11.1W	CTD	0-1500	0656-0755	WB @ STANDARD DEPTHS	
# 1		32 54.7N	31 10.6W	MS		DAWN		
10231	4/11	32 53.0N	30 54.6W	CTD	0-1500	0930-1100	WB @ STANDARD DEPTHS	
# 1		32 53.0N	30 53.9W	MS		DAY		

STN.	DATE 1980	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10232 # 1	13/11	33 5.4N 33 3.9N	31 37.7W 31 36.5W	RMT1M-1 RMT8M-1	43- 65	0027-0127 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.69 KM.	
10232 # 2	13/11	33 3.9N 33 2.4N	31 36.5W 31 35.7W	RMT1M-2 RMT8M-2	45- 55	0127-0227 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.69 KM.	
10232 # 3	13/11	33 2.4N 33 0.9N	31 35.7W 31 34.8W	RMT1M-3 RMT8M-3	48- 53	0227-0327 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.60 KM.	
10232 # 4	13/11	32 59.8N 32 58.3N	31 34.2W 31 33.3W	RMT1M-1 RMT8M-1	45- 55	0405-0505 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.64 KM.	
10232 # 5	13/11	32 58.3N 32 56.7N	31 33.3W 31 32.5W	RMT1M-2 RMT8M-2	49- 55	0505-0605 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.67 KM.	
10232 # 6	13/11	32 56.7N 32 55.2N	31 32.5W 31 31.6W	RMT1M-3 RMT8M-3	47- 51	0605-0705 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.51 KM.	
10232 # 7	13/11	32 53.3N 32 51.5N	31 30.9W 31 30.3W	RMT1M-1 RMT8M-1 LLP	420- 530	0834-0938 DAY	105-113 DB FLOW DIST. 3.52 KM.	
10232 # 8	13/11	32 51.5N 32 50.0N	31 30.3W 31 29.8W	RMT1M-2 RMT8M-2 LLP	440- 545	0938-1039 DAY	98-105 DB FLOW DIST. 3.23 KM.	
10232 # 9	13/11	32 50.0N 32 48.8N	31 29.8W 31 29.5W	RMT1M-3 RMT8M-3 LLP	530- 610	1039-1139 DAY	103-115 DB FLOW DIST. 3.19 KM.	
10232 # 10	13/11	32 34.3N 32 32.7N	31 30.0W 31 30.1W	RMT1M-1 RMT8M-1 LLP	490- 550	1434-1532 DAY	97-106 DB FLOW DIST. 3.01 KM.	
10232 # 11	13/11	32 32.7N 32 30.9N	31 30.0W 31 29.9W	RMT1M-2 RMT8M-2 LLP	540- 610	1532-1632 DAY	104-117 DB FLOW DIST. 3.53 KM.	

STN	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10232 # 12	13/11	32 31.0N 32 29.1N	31 29.9W 31 30.2W	RMT1M-3 RMT8M-3 LLP	485- 550	1632-1732 DAY	96-106 DB FLOW DIST. 3.78 KM.	
10232 # 13	13/11	32 48.1N 32 46.5N	31 29.1W 31 28.2W	RMT1M-1 RMT8M-1	40- 86	2054-2154 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 3.60 KM.	
10232 # 14	13/11	32 46.6N 32 45.2N	31 28.2W 31 27.8W	RMT1M-2 RMT8M-2	63- 90	2154-2254 NIGHT	FISHED AT BASE OF THERMOCLINE FLOW DIST. 3.57 KM.	
10232 # 15	13/11	32 45.2N 32 43.9N	31 27.8W 31 27.5W	RMT1M-3 RMT8M-3	73- 92	2254-2354 NIGHT	FISHED AT BASE OF THERMOCLINE FLOW DIST. 3.34 KM.	
10232 # 16	14/11	32 34.0N 32 32.1N	31 29.5W 31 29.0W	RMT1M-1 RMT8M-1	45- 60	0157-0257 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 4.00 KM.	
10232 # 17	14/11	32 31.9N 32 30.2N	31 28.9W 31 28.1W	RMT1M-3 RMT8M-3	60- 80	0306-0406 NIGHT	FISHED AT BASE OF THERMOCLINE FLOW DIST. 4.40 KM.	
10232 # 18	14/11	32 20.3N 32 19.1N	31 29.6W 31 29.2W	RMT1M-1 RMT8M-1	48- 58	0547-0637 NIGHT	FISHED ABOVE THERMOCLINE FLOW DIST. 2.88 KM.	
10232 # 19	14/11	32 18.9N 32 17.7N	31 29.1W 31 28.2W	RMT1M-3 RMT8M-3	70- 99	0645-0735 NIGHT	FISHED AT BASE OF THERMOCLINE FLOW DIST. 3.56 KM.	
10233 # 1	14/11	31 59.4N 31 58.2N	31 30.2W 31 31.4W	RMT1M-1 RMT8M-1 LLP	200- 303	1034-1134 DAY	65-76 DB FLOW DIST. 3.12 KM.	
10233 # 2	14/11	31 58.2N 31 56.7N	31 31.3W 31 32.6W	RMT1M-2 RMT8M-2 LLP	295- 400	1134-1234 DAY	74-85 DB FLOW DIST. 3.37 KM.	
10233 # 3	14/11	31 56.7N 31 55.1N	31 32.5W 31 33.7W	RMT1M-3 RMT8M-3 LLP	400- 500	1234-1334 DAY	85-95 DB FLOW DIST. 3.55 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10233 # 4	14/11	31 56.2N 31 54.4N	31 32.6W 31 33.5W	RMT1M-1 RMT8M-1 LLP	500- 600	1451-1551 DAY	FLOW DIST. 3.39 KM.	
10233 # 5	14/11	31 54.4N 31 52.7N	31 33.5W 31 34.5W	RMT1M-2 RMT8M-2 LLP	600- 700	1551-1651 DAY	FLOW DIST. 3.82 KM.	
10233 # 6	14/11	31 52.7N 31 50.9N	31 34.5W 31 35.5W	RMT1M-3 RMT8M-3 LLP	700- 800	1651-1751 DAY	FLOW DIST. 3.87 KM.	
10233 # 7	14/11	31 59.8N 32 0.2N	31 33.3W 31 35.8W	RMT1M-1 RMT8M-1	800- 900	2110-2210 NIGHT	FLOW DIST. 3.17 KM.	
10233 # 8	14/11	32 0.2N 32 0.5N	31 35.7W 31 38.2W	RMT1M-2 RMT8M-2	900-1002	2210-2310 NIGHT	NO FLOW	
10233 # 9	14/11 15/11	32 0.5N 32 0.8N	31 38.1W 31 40.5W	RMT1M-3 RMT8M-3	1000-1100	2310-0010 NIGHT	NO FLOW	
10233 # 10	15/11	32 1.4N 32 1.1N	31 44.1W 31 46.0W	RMT1M-1 RMT8M-1	500- 600	0207-0307 NIGHT	FLOW DIST. 2.92 KM.	
10233 # 11	15/11	32 1.1N 32 0.4N	31 46.0W 31 48.4W	RMT1M-2 RMT8M-2	600- 700	0307-0409 NIGHT	FLOW DIST. 3.19 KM.	
10233 # 12	15/11	32 0.4N 31 59.4N	31 48.4W 31 50.5W	RMT1M-3 RMT8M-3	700- 800	0409-0509 NIGHT	FLOW DIST. 3.73 KM.	
10233 # 13	15/11	32 1.3N 32 1.6N	31 31.4W 31 34.1W	RMT1M-1 RMT8M-1	795- 890	0936-1036 DAY	RMT8 NETS TANGLED - CATCH DISCARDED FLOW DIST. 3.19 KM.	
10233 # 14	15/11	32 1.5N 32 1.9N	31 34.0W 31 36.4W	RMT1M-2 RMT8M-2	885-1000	1036-1136 DAY	RMT8 NETS TANGLED - CATCH DISCARDED FLOW DIST. 3.42 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10233	15/11	32 1.9N	31 36.4W	RMT1M-3	995-1100	1136-1236	RMT8 NETS TANGLED - CATCH DISCARDED	
# 15		32 1.7N	31 38.7W	RMT8M-3		DAY	FLOW DIST. 3.09 KM.	
10233	15/11	32 0.9N	31 30.7W	RMT1M-1	0- 70	1447-1549	FISHED ABOVE THERMOCLINE	
# 16		32 0.1N	31 32.9W	RMT8M-1		DAY	FLOW DIST. 4.17 KM.	
10233	15/11	32 0.1N	31 32.9W	RMT1M-2	65- 97	1549-1650	FISHED AROUND 19'C ISOTHERM	
# 17		31 59.6N	31 35.3W	RMT8M-2		DAY	FLOW DIST. 4.37 KM.	
10233	15/11	31 59.6N	31 35.2W	RMT1M-3	90- 200	1650-1750	FISHED BELOW 18.5'C ISOTHERM	
# 18		31 59.1N	31 37.6W	RMT8M-3		DAY	FLOW DIST. 4.01 KM.	
10233	15/11	32 0.8N	31 31.7W	RMT1M-1	185- 300	2019-2119		
# 19		32 1.4N	31 34.3W	RMT8M-1		NIGHT	FLOW DIST. 3.75 KM.	
10233	15/11	32 1.4N	31 34.3W	RMT1M-2	300- 400	2119-2219		
# 20		32 2.1N	31 36.7W	RMT8M-2		NIGHT	FLOW DIST. 4.00 KM.	
10233	15/11	32 2.1N	31 36.7W	RMT1M-3	400- 500	2219-2319		
# 21		32 2.6N	31 38.7W	RMT8M-3		NIGHT	FLOW DIST. 3.19 KM.	
10233	16/11	32 2.9N	31 40.5W	RMT1M-1	10- 90	0000-0100	FISHED ABOVE THERMOCLINE	
# 22		32 3.3N	31 42.8W	RMT8M-1		NIGHT	FLOW DIST. 3.55 KM.	
10233	16/11	32 3.3N	31 42.7W	RMT1M-2	80- 105	0100-0200	FISHED AROUND 19'C ISOTHERM	
# 23		32 3.6N	31 45.2W	RMT8M-2		NIGHT	FLOW DIST. 3.76 KM.	
10233	16/11	32 3.6N	31 45.1W	RMT1M-3	95- 200	0200-0300	FISHED BELOW 18.5'C ISOTHERM	
# 24		32 4.0N	31 47.4W	RMT8M-3		NIGHT	FLOW DIST. 3.76 KM.	
10233	16/11	32 0.4N	31 29.4W	CTD	0-2000	0512-0623		4180
# 25		32 0.8N	31 28.9W	MS		NIGHT		
10233	16/11	32 2.7N	31 29.6W	RMT1M-1	800- 910	1149-1249		
# 26		32 2.5N	31 31.9W	RMT8M-1		DAY	FLOW DIST. 2.70 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10233	16/11	32 2.5N	31 31.9W	RMT1M-2	900-1000	1249-1349		
# 27		32 2.1N	31 34.2W	RMT8M-2		DAY	FLOW DIST. 3.21 KM.	
10233	16/11	32 2.1N	31 34.2W	RMT1M-3	1000-1100	1349-1449		
# 28		32 1.7N	31 36.6W	RMT8M-3		DAY	FLOW DIST. 3.26 KM.	
10233	16/11	32 0.4N	31 30.0W	CM	200-1600	2024-	MOORING NO.294 -CM @ 200,800,1600 M.	4050
# 29								
10234	16/11	32 5.4N	31 29.7W	CTD	0-2000	2251-2359		4230
# 1		32 5.7N	31 29.3W			NIGHT		
10235	17/11	32 15.2N	31 30.4W	CTD	0-2000	0120-0230		3735
# 1		32 15.7N	31 30.1W	WB 1		NIGHT		
10236	17/11	32 25.7N	31 30.4W	CTD	0-2000	0401-0528		3592
# 1		32 26.5N	31 29.9W	MS		NIGHT		
10237	17/11	32 34.9N	31 30.2W	CTD	0-2000	0638-0755		3820
# 1		32 35.7N	31 29.6W	MS		DAWN		
10238	17/11	32 45.7N	31 29.5W	CTD	0-2000	0909-1018		3726
# 1		32 46.6N	31 29.4W	MS		DAY		
10239	17/11	32 55.0N	31 29.8W	CTD	0-2000	1128-1228		3670
# 1		32 55.7N	31 29.8W	MS		DAY		
10240	17/11	33 9.0N	31 47.3W	CTD	0-2000	1543-1648		3701
# 1		33 9.6N	31 47.2W	MS		DAY		
10240	17/11	33 10.1N	31 47.1W	CTD	0- 778	1742-1845	MONITOR J3 CALIBRATION	
# 2		33 11.0N	31 47.1W	MS		DAY		
				LLP				
10241	17/11	33 11.8N	31 47.8W	RMT1M-1	90- 110	2013-2113	FISHED AROUND 19'C ISOTHERM	
# 1		33 11.1N	31 50.3W	RMT8M-1		NIGHT	FLOW DIST. 3.87 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10241	17/11	33 11.1N	31 50.3W	RMT1M-2	80- 95	2113-2213	FISHED AROUND 19'C ISOTHERM	
# 2		33 10.4N	31 53.3W	RMT8M-2		NIGHT	FLOW DIST. 3.91 KM.	
10241	17/11	33 10.4N	31 53.3W	RMT1M-3	82- 100	2213-2313	FISHED AROUND 19'C ISOTHERM	
# 3		33 9.9N	31 55.8W	RMT8M-3		NIGHT	FLOW DIST. 3.96 KM.	
10241	18/11	33 11.1N	31 46.9W	RMT1M-1	85- 100	0049-0148	FISHED AROUND 19'C ISOTHERM	
# 4		33 11.2N	31 49.4W	RMT8M-1		NIGHT	FLOW DIST. 3.69 KM.	
10241	18/11	33 11.2N	31 49.3W	RMT1M-2	75- 95	0148-0248	FISHED AROUND 19'C ISOTHERM	
# 5		33 11.3N	31 52.0W	RMT8M-2		NIGHT	FLOW DIST. 3.64 KM.	
10241	16/11	33 11.3N	31 51.9W	RMT1M-3	85- 95	0248-0348	FISHED AROUND 19'C ISOTHERM	
# 6		33 11.3N	31 54.4W	RMT8M-3		NIGHT	FLOW DIST. 3.87 KM.	
10241	18/11	33 11.3N	31 48.4W	RMT1M-1	70- 95	0518-0618	FISHED AROUND 19'C ISOTHERM	
# 7		33 11.1N	31 50.6W	RMT8M-1		NIGHT	FLOW DIST. 3.51 KM.	
10241	18/11	33 11.1N	31 50.6W	RMT1M-2	68- 88	0618-0718	FISHED AROUND 19'C ISOTHERM	
# 8		33 11.1N	31 52.6W	RMT8M-2		NIGHT	FLOW DIST. 3.67 KM.	
10241	18/11	33 10.9N	31 47.4W	RMT1M-1	410- 550	0935-1035	FISHED AROUND 12'C ISOTHERM	
# 9		33 10.4N	31 49.8W	RMT8M-1		DAY	FLOW DIST. 3.12 KM.	
10241	18/11	33 10.4N	31 49.9W	RMT1M-3	540- 590	1038-1138	FISHED AROUND 11'C ISOTHERM	
# 10		33 9.7N	31 52.4W	RMT8M-3		DAY	FLOW DIST. 3.64 KM.	
10241	18/11	33 11.6N	31 48.5W	RMT1M-1	460- 550	1321-1419		
# 11		33 10.8N	31 50.8W	RMT8M-1		DAY	FLOW DIST. 3.69 KM.	
10241	18/11	33 10.8N	31 50.8W	RMT1M-2	550- 680	1419-1517		
# 12		33 9.8N	31 53.0W	RMT8M-2		DAY	FLOW DIST. 3.96 KM.	
10241	18/11	33 9.8N	31 53.0W	RMT1M-3	680- 720	1517-1617		
# 13		33 8.9N	31 55.8W	RMT8M-3		DAY	FLOW DIST. 3.96 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10241	18/11	33 11.7N	31 47.4W	CTD	0-2000	1805-1910		3563
# 14		33 11.5N	31 47.6W	MS		DUSK		
10241	18/11	33 11.1N	31 48.1W	RMT1M-1	185- 250	2007-2107	FISHED AROUND 15'C ISOTHERM	
# 15		33 10.2N	31 49.8W	RMT8M-1		NIGHT	FLOW DIST. 3.51 KM.	
10241	18/11	33 10.0N	31 50.1W	RMT1M-3	255- 295	2117-2217	FISHED AROUND 14'C ISOTHERM	
# 16		33 8.8N	31 51.6W	RMT8M-3		NIGHT	FLOW DIST. 3.67 KM.	
10241	18/11	33 11.8N	31 48.5W	RMT1M-1	90- 140	2343-0043	FISHED AROUND 17'C ISOTHERM	
# 17	19/11	33 11.7N	31 50.7W	RMT8M-1		NIGHT	FLOW DIST. 3.85 KM.	
10241	19/11	33 11.7N	31 50.9W	RMT1M-3	145- 190	0050-0150	FISHED AROUND 16'C ISOTHERM	
# 18		33 11.3N	31 53.1W	RMT8M-3		NIGHT	FLOW DIST. 3.71 KM.	
10241	19/11	33 11.8N	31 48.8W	RMT1M-1	195- 210	0314-0414		
# 19		33 10.8N	31 50.9W	RMT8M-1		NIGHT	FLOW DIST. 3.37 KM.	
10241	19/11	33 10.7N	31 51.1W	RMT1M-3	290- 305	0424-0524		
# 20		33 9.9N	31 54.1W	RMT8M-3		NIGHT	FLOW DIST. 3.78 KM.	
10242	19/11	33 1.6N	31 47.7W	CM	200-1600	1140-	MOORING NO.295 -CM @ 200,800,1600 M.	3737
# 0								
10243	19/11	33 2.9N	31 30.0W	RMT1M-1	485- 590	1402-1502	FISHED AROUND 12'C ISOTHERM	
# 1		33 5.5N	31 30.8W	RMT8M-1		DAY	FLOW DIST. 3.91 KM.	
10243	19/11	33 5.6N	31 30.9W	RMT1M-3	575- 640	1506-1606	FISHED AROUND 11'C ISOTHERM	
# 2		33 8.3N	31 32.0W	RMT8M-3		DAY	FLOW DIST. 3.96 KM.	
10243	19/11	33 0.2N	31 30.6W	CTD	0-2000	1751-1901		
# 3		33 0.7N	31 30.8W	MS		DUSK		
10243	19/11	33 1.6N	31 31.4W	RMT1M-1	225- 300	2013-2113	FISHED AROUND 15'C ISOTHERM	
# 4		33 4.2N	31 32.5W	RMT8M-1		NIGHT	FLOW DIST. 3.69 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10243 # 5	19/11	33 4.6N 33 7.3N	31 32.6W 31 33.6W	RMT1M-3 RMT8M-3	295- 340	2122-2222 NIGHT	FISHED 14'C ISOTHERM - RMT1 NET TORN FLOW DIST. 4.08 KM.	
10243 # 6	20/11	33 1.4N 33 4.2N	31 30.3W 31 30.9W	RMT1M-1 RMT8M-1	140- 185	0012-0112 NIGHT	FISHED AROUND 17'C ISOTHERM FLOW DIST. 3.55 KM.	
10243 # 7	20/11	33 4.2N 33 7.1N	31 30.9W 31 31.2W	RMT1M-3 RMT8M-3	170- 195	0116-0216 NIGHT	FISHED 16'C ISOTHERM - RMT1 NET TORN FLOW DIST. 4.14 KM.	
10243 # 8	20/11	33 2.0N 33 4.4N	31 31.6W 31 33.1W	RMT1M-1 RMT8M-1	190- 215	0425-0525 NIGHT	FLOW DIST. 3.89 KM.	
10243 # 9	20/11	33 4.8N 33 7.4N	31 33.4W 31 34.9W	RMT1M-3 RMT8M-3	295- 315	0536-0636 NIGHT	FLOW DIST. 4.13 KM.	
10243 # 10	20/11	33 2.0N 33 5.0N	31 30.4W 31 31.6W	RMT1M-1 RMT8M-1	485- 550	0947-1049 DAY	FLOW DIST. 4.21 KM.	
10243 # 11	20/11	33 5.0N 33 7.7N	31 31.6W 31 32.2W	RMT1M-2 RMT8M-2	550- 650	1049-1146 DAY	FLOW DIST. 4.08 KM.	
10243 # 12	20/11	33 7.6N 33 10.3N	31 32.1W 31 32.6W	RMT1M-3 RMT8M-3	650- 720	1146-1246 DAY	FLOW DIST. 4.17 KM.	
10244 # 1	20/11	32 50.4N 32 52.2N	31 15.1W 31 16.2W	RMT1M-1 RMT8M-1	560- 620	1637-1720 DAY	FISHED AROUND 12'C ISOTHERM FLOW DIST. 2.62 KM.	
10244 # 2	20/11	32 52.4N 32 53.8N	31 16.4W 31 17.1W	RMT1M-3 RMT8M-3	665- 700	1727-1802 DAY	FISHED AROUND 11'C ISOTHERM FLOW DIST. 2.46 KM.	
10244 # 3	20/11	32 51.0N 32 53.6N	31 13.5W 31 13.9W	RMT1M-1 RMT8M-1	315- 360	2043-2143 NIGHT	FISHED AROUND 15'C ISOTHERM FLOW DIST. 3.96 KM.	
10244 # 4	20/11	32 53.9N 32 56.3N	31 14.0W 31 14.5W	RMT1M-3 RMT8M-3	390- 405	2150-2250 NIGHT	FISHED AROUND 14'C ISOTHERM FLOW DIST. 3.94 KM.	

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10244 # 5	21/11	32 49.6N 32 51.7N	31 14.8W 31 16.5W	RMT1M-1 RMT8M-1	200- 240	0045-0145 NIGHT	FISHED AROUND 17'C ISOTHERM FLOW DIST. 3.64 KM.	
10244 # 6	21/11	32 52.0N 32 54.1N	31 16.8W 31 18.6W	RMT1M-3 RMT8M-3	265- 295	0156-0256 NIGHT	FISHED AROUND 16'C ISOTHERM FLOW DIST. 4.01 KM.	
10244 # 7	21/11	32 49.6N 32 51.8N	31 15.1W 31 17.9W	RMT1M-1 RMT8M-1 RMT1M-2 RMT8M-2	190- 300	0438-0546 NIGHT	NET2 OPENED PREMATURELY-SEE BIO LOG. FLOW DIST. 4.55 KM.	
10244 # 8	21/11	32 51.7N 32 53.8N	31 17.8W 31 20.1W	RMT1M-3 RMT8M-3	290- 310	0546-0646 NIGHT	FLOW DIST. 4.26 KM.	
10244 # 9	21/11	32 49.1N 32 49.6N	31 13.6W 31 12.8W	CTD MS	0-2000	0812-0935 DAWN		
10244 # 10	21/11	32 48.2N 32 47.3N	31 14.9W 31 16.8W	RMT1M-1 RMT8M-1	480- 550	1035-1134 DAY	FLOW DIST. 2.99 KM.	
10244 # 11	21/11	32 47.4N 32 45.7N	31 16.6W 31 19.6W	RMT1M-2 RMT8M-2	550- 610	1134-1234 DAY	FLOW DIST. 3.06 KM.	
10244 # 12	21/11	32 45.7N 32 44.0N	31 19.6W 31 22.6W	RMT1M-3 RMT8M-3	610- 720	1234-1334 DAY	FLOW DIST. 3.06 KM.	
10245 # 1	21/11	32 25.7N 32 25.6N	30 39.9W 30 39.1W	CTD MS	0-2000	1805-1940 DUSK		
10245 # 2	21/11	32 25.8N 32 25.8N	30 40.7W 30 43.3W	RMT1M-1 RMT8M-1 RMT1M-2 RMT8M-2	330- 380	2010-2110 NIGHT	NET2 OPENED PREMATURELY-SEE BIO LOG. FLOW DIST. 3.60 KM.	
10245 # 3	21/11	32 25.7N 32 25.2N	30 43.6W 30 45.9W	RMT1M-3 RMT8M-3	400- 435	2117-2217 NIGHT	FISHED AROUND 14'C ISOTHERM FLOW DIST. 4.04 KM.	

STN.	DATE 1980	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M
10245	22/11	32 26.1N	30 41.7W	RMT1M-1	230- 250	0014-0114	FISHED AROUND 17'C ISOTHERM	
# 4		32 26.3N	30 44.1W	RMT8M-1		NIGHT	FLOW DIST. 4.00 KM.	
10245	22/11	32 26.4N	30 44.4W	RMT1M-3	310- 340	0122-0222	FISHED AROUND 16'C ISOTHERM	
# 5		32 26.5N	30 47.0W	RMT8M-3		NIGHT	FLOW DIST. 4.08 KM.	
10245	22/11	32 26.5N	30 41.2W	RMT1M-1	195- 210	0406-0506		
# 6		32 27.2N	30 43.6W	RMT8M-1		NIGHT	FLOW DIST. 3.82 KM.	
10245	22/11	32 27.3N	30 43.9W	RMT1M-3	292- 305	0515-0615		
# 7		32 27.9N	30 46.6W	RMT8M-3		NIGHT	FLOW DIST. 4.06 KM	
10245	22/11	32 27.8N	30 40.4W	RMT1M-1	580- 660	0955-1055	FISHED AROUND 12'C ISOTHERM	
# 8		32 29.8N	30 41.9W	RMT8M-1		DAY	FLOW DIST. 3.75 KM.	
10245	22/11	32 30.0N	30 42.1W	RMT1M-3	680- 710	1103-1203	FISHED AROUND 11'C ISOTHERM	
# 9		32 32.0N	30 43.7W	RMT8M-3		DAY	FLOW DIST. 4.01 KM.	
10245	22/11	32 26.2N	30 40.8W	RMT1M-1	480- 550	1428-1526		
# 10		32 27.6N	30 42.8W	RMT8M-1		DAY	FLOW DIST. 3.37 KM.	
10245	22/11	32 27.5N	30 42 8W	RMT1M-2	550- 650	1526-1627		
# 11		32 28.8N	30 45.2W	RMT8M-2		DAY	FLOW DIST. 3.91 KM.	
10245	22/11	32 28.8N	30 45.2W	RMT1M-3	650- 715	1627-1727		
# 12		32 29.9N	30 47.6W	RMT8M-3		DAY	FLOW DIST 3.98 KM.	
10246	25/11	33 16.1N	23 29.0W	RMT 1	390- 520	1045-1129	HALL EFFECT FLOW DIST. 2.29 KM.	
# 1		33 15.7N	23 27.1W	RMT 8		DAY	FLOW DIST. 2.50 KM.	
10246	25/11	33 15.2N	23 22.4W	RMT 1	845-1100	1311-1516	HALL EFFECT FLOW DIST. 6.81 KM.	
# 2		33 14.5N	23 17.2W	RMT 8		DAY		
10246	25/11	33 12.2N	23 4.5W	RMT 1	647- 790	1716-1816		
# 3		33 11.5N	23 2.3W	RMT 8		DAY		

STN.	DATE 1980	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
10247 # 0	26/11	33 5.1N	21 58.4W	CM	4632-5273	1659-	MOORING 296 - CM @ 4632, 5174, 5273 M.	5283
10248 # 0	26/11	33 9.2N	21 57.2W		5288-5288	2047-	MOORING 297 - TRIPOD, VACM & CAMERA	5289
10249 # 0	27/11	33 13.0N	22 0.0W	CM	5176-5276	1028-	MOORING 298 - CM @ 5176 & 5276 M.	5286
10250 # 0	27/11	33 13.1N	22 0.5W	CM	4645-5290	1154-	MOORING 299 - CM @ 4645, 5189, 5290 M.	5300
10251 # 0	27/11	33 10.0N	22 6.0W	CM	4645-5290	1434-	MOORING 300 - CM @ 4645, 5189, 5290 M.	5300
10252 # 0	27/11	32 54.2N	21 59.3W	CM	5165-5265	1740-	MOORING 301 - CM @ 5165 & 5265 M.	5275
10253 # 0	28/11	33 9.0N	22 16.5W	CM	5222-5323	0052-	MOORING 302 - CM @ 5222 & 5323 M.	5333
10254 # 0	28/11	32 59.9N 32 59.7N	22 9.3W 22 8.9W	CTD MS	0-5111	0900-1107	SIGNAL LOST DUE TO CONDUCTOR BREAK	5236

FIGURE CAPTIONS

1. General track charts showing batfish track and the positions of the two main working areas A & B.
2. Positions of RMT 1+8M stations within work area A.
3. Positions of XBT positions within work area A.
4. Batfish tracks within work area A.
5. Positions of CTD dips and of moorings in work area A.
6. Positions of CTD dip and of moorings in work area B.

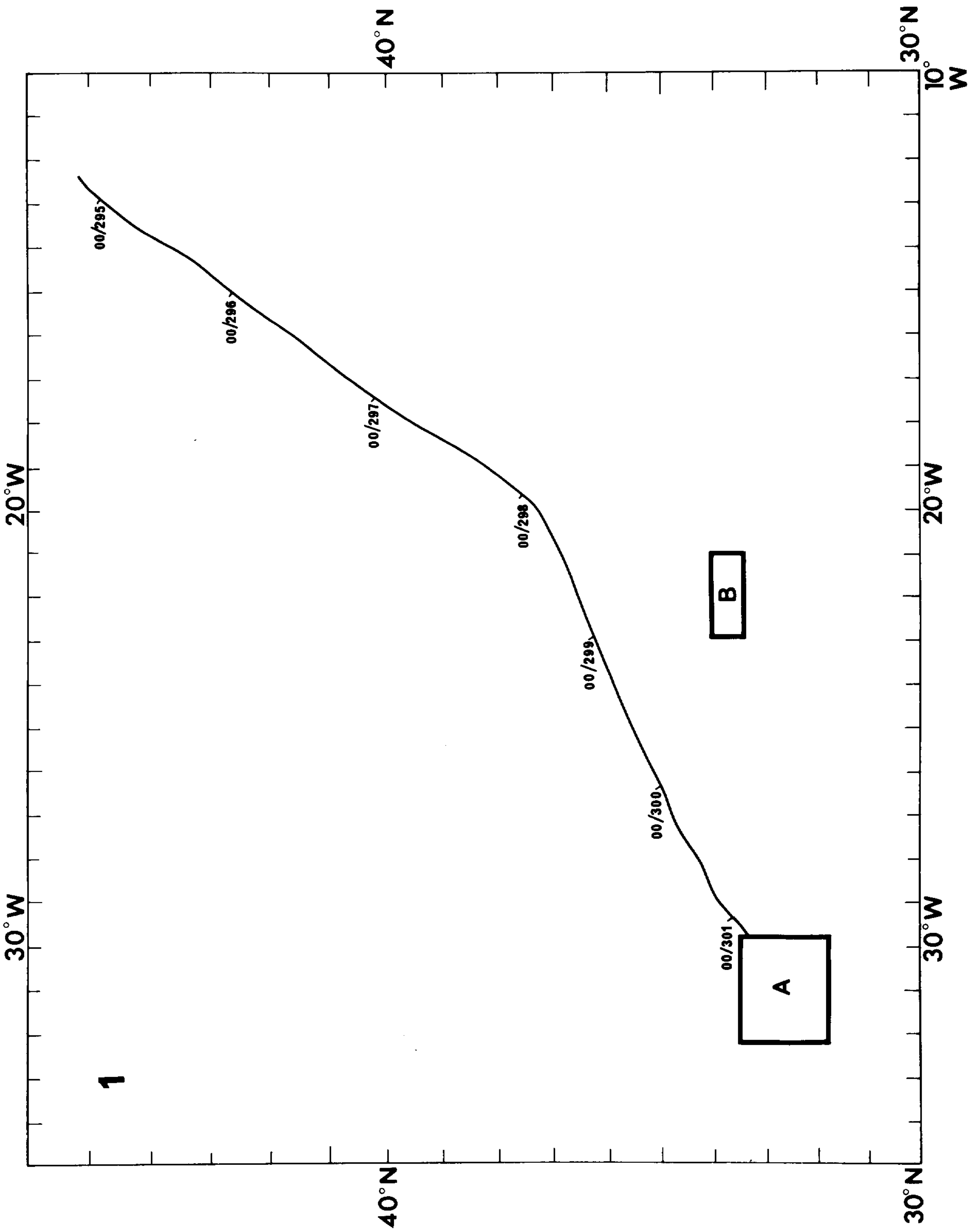
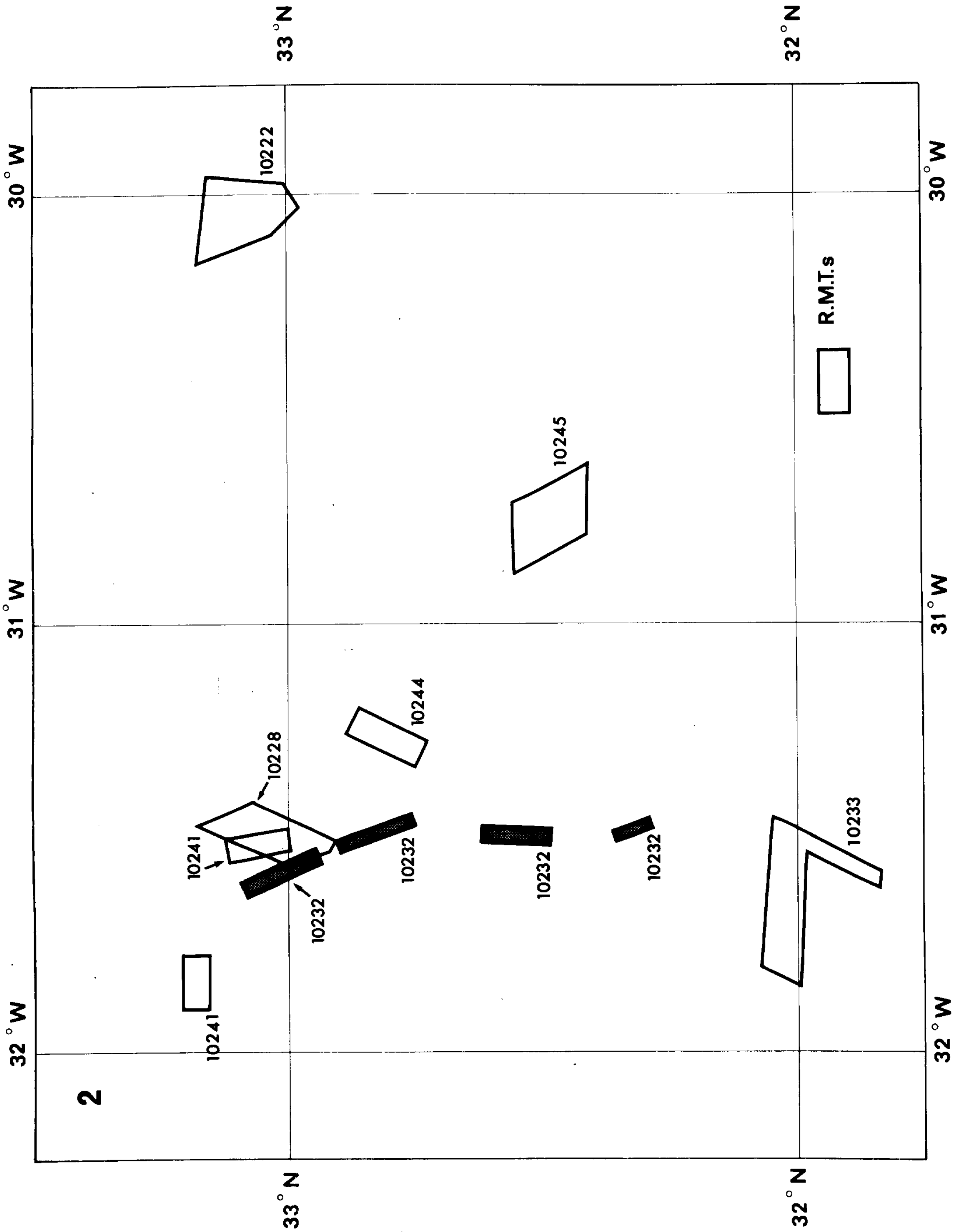

40°N
30°N
10° W
20°W
30°W
00/295
00/296
00/297
00/298
00/299
00/300
00/301
A
B
1

Figure 1.



2
33° N
32° N
30° W
31° W
32° W
10222
10245
10244
10228
10241
10232
10233
R.M.T.s

Figure 2.

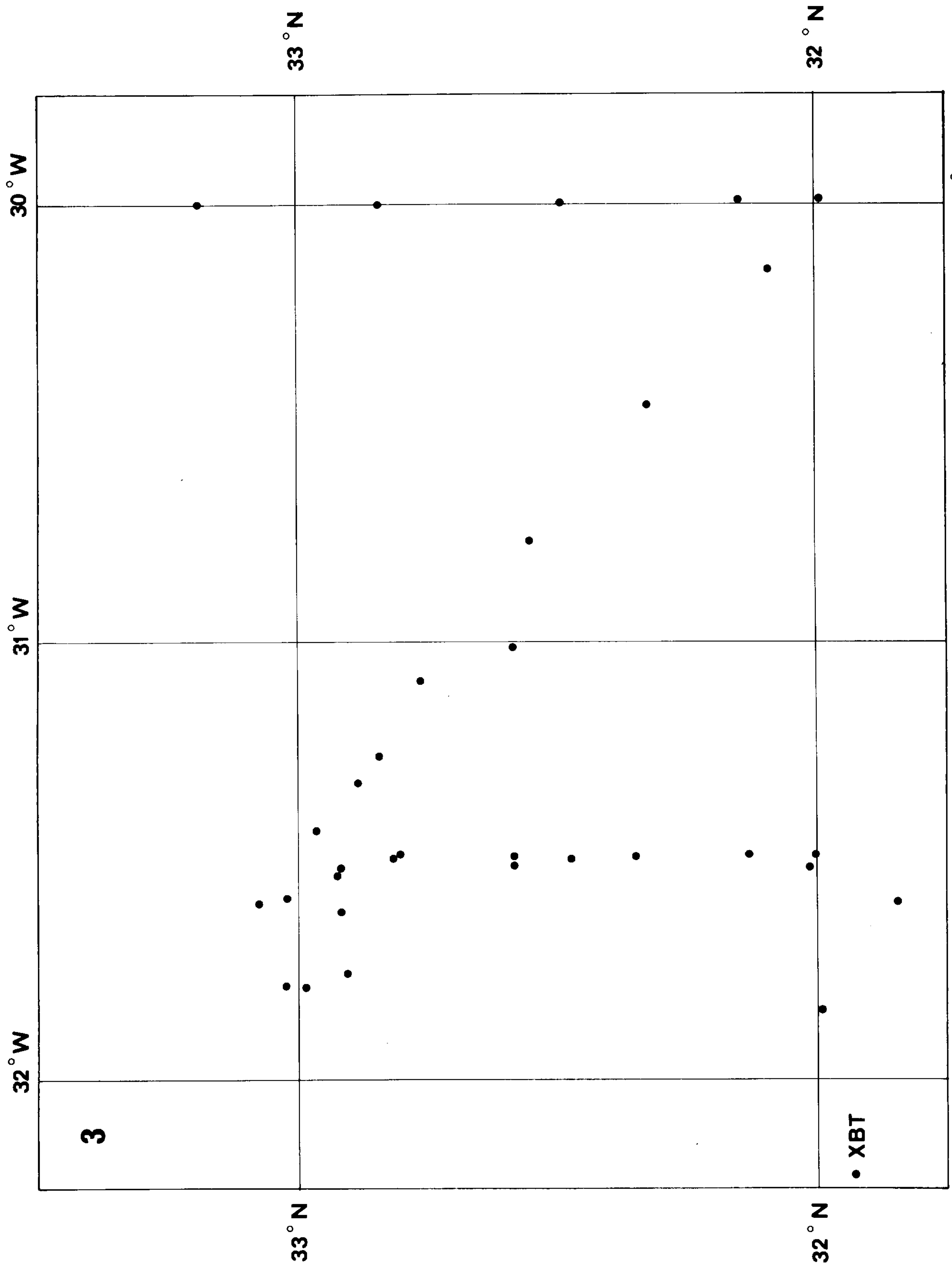


Figure 3.

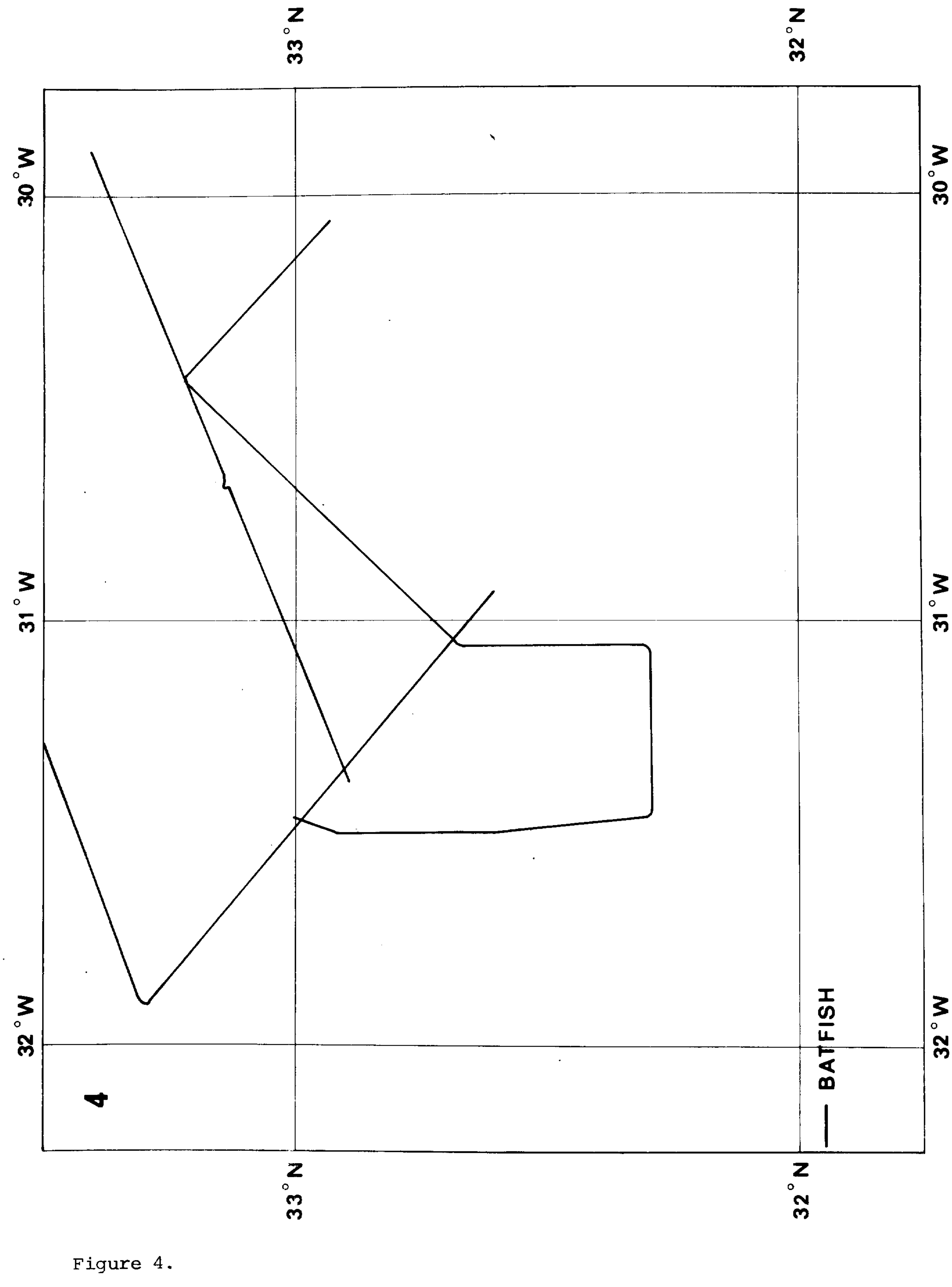


Figure 4.

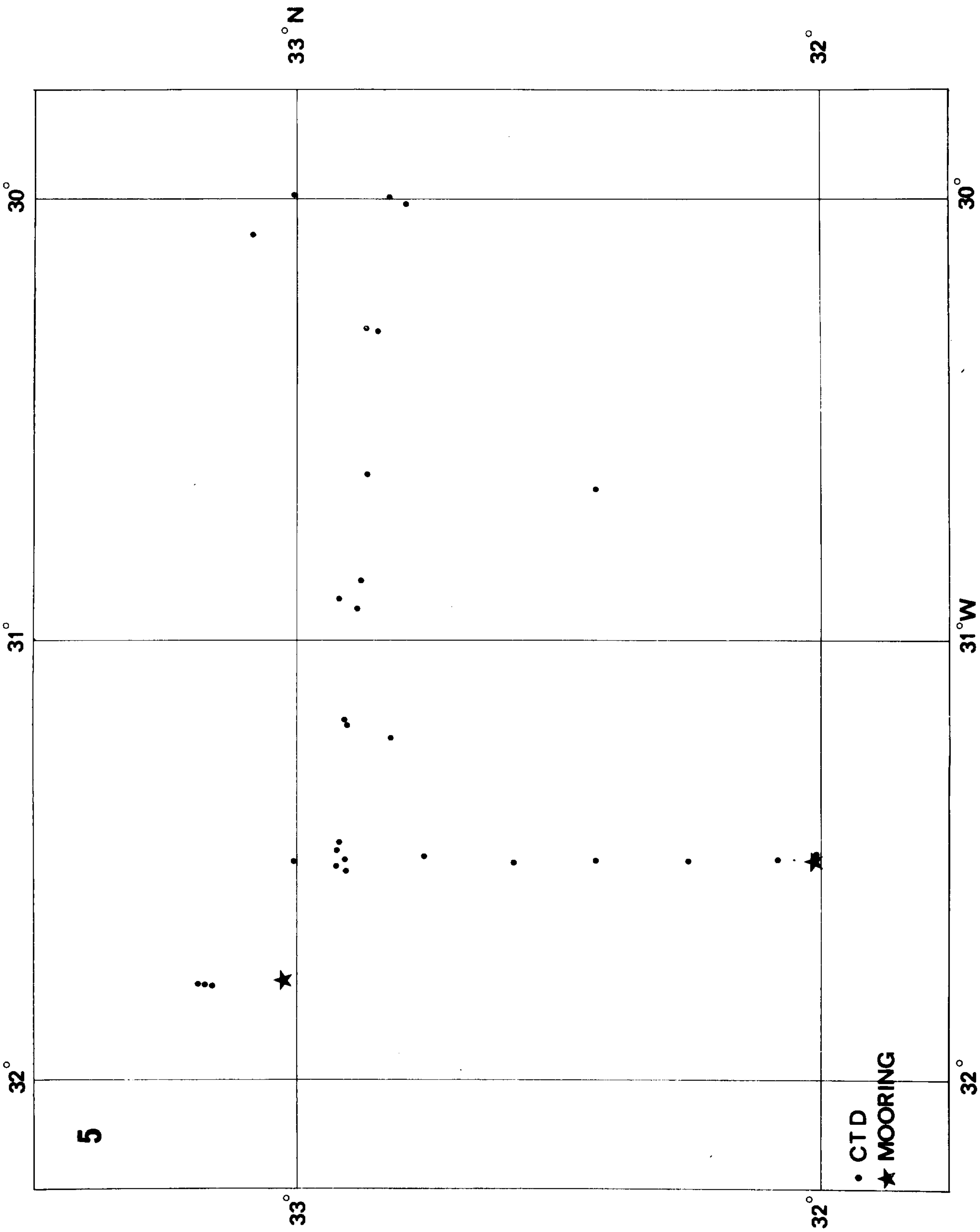


Figure 5.

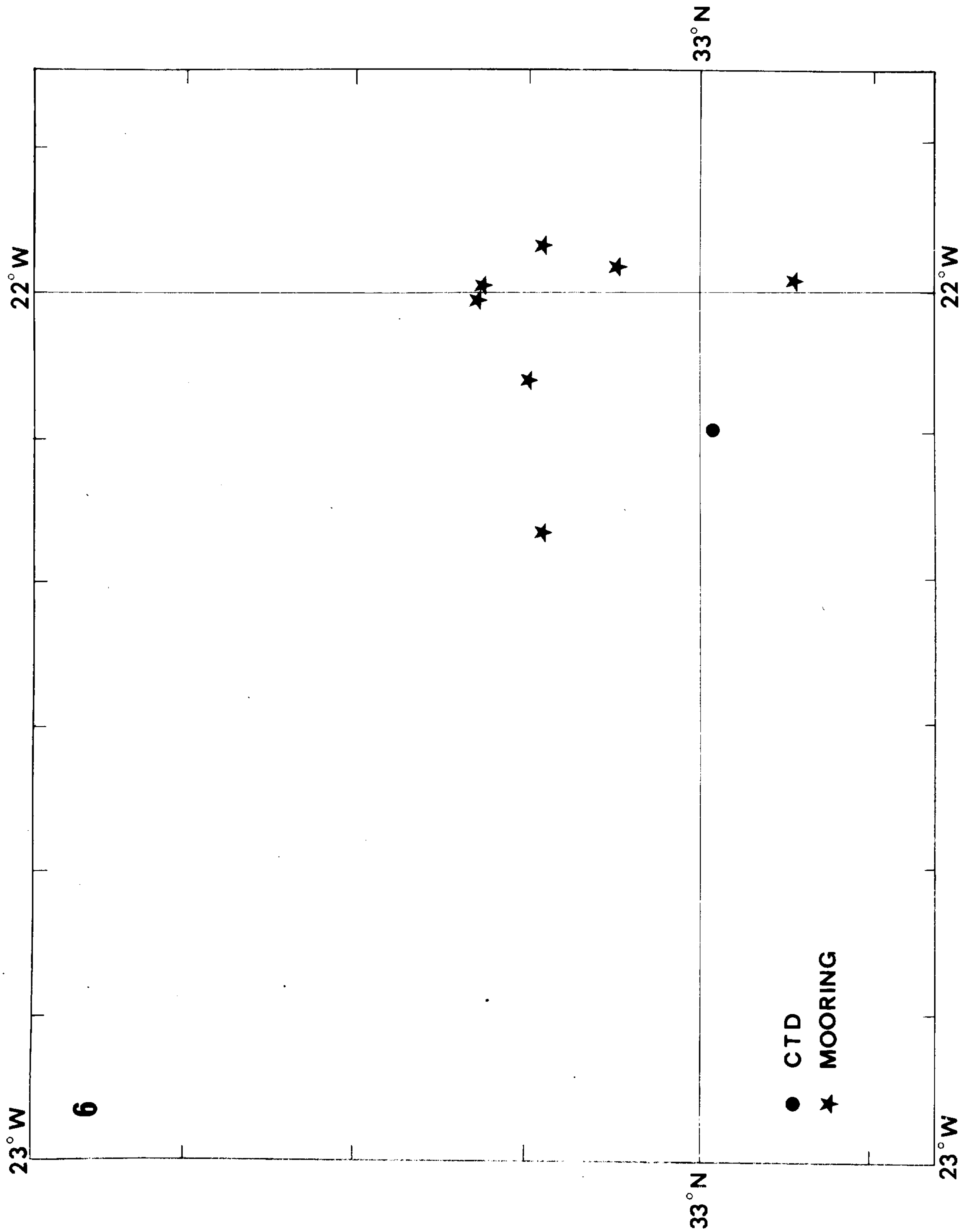


Figure 6.