



trials continued with VEMCO and CEFAS coded acoustic pingers deployed off the side of the ship. Both types of tag were successfully detected at a range of about 200m (no other ranges tested on this occasion).

The 29 April was spent fishing for cod. Twenty nine fish were tagged and released, 8 were tagged with coded acoustic pingers, which were placed surgically into the peritonea, and 21 were tagged with standard Petersen discs. A control pinger (code 80) was deployed on static gear (chain anchor, ~ 1.5 m for rope and a trawl float), at 1517 h at 53° 36.93' N 02° 11.15' E, about 180 m from the sonar buoy. In the evening trials were carried out with the CEFAS towed hydrophone. Although one pinger was successfully detected and decoded, the trials were abandoned when the "Chinese stocking" connection between the towing cable and the hydrophone parted. Due to the extremely rough nature of the seabed in the vicinity of the Hurdy Gurdy it was considered not to be prudent to attempt trawling for the lost gear.

CORYSTES subsequently steamed overnight to Bridlington and two scientific staff were put ashore the following morning (30 April). CORYSTES then steamed to the survey area on the sandeel fishing grounds on the North West Riff and commenced a 24 h acoustic survey of the water column and the sea bed sediment in a restricted area located at 54° 38.21' N 01° 34.45' E (the "micro grid") using dual frequency (38 & 120 kHz) EK500/QTC in an attempt to establish whether the method could detect sandeels buried in the sediment at night. Subsequently, at 2230 h on 1 May, the systematic survey of the sandeel fishing grounds commenced and continued without interruption until 0653 h on the 10 May.

CORYSTES then steamed to the south eastern corner of the sandeel survey grid to survey known wrecks for adult cod (Aim 6). Attempts to locate the wreck of the Annemarie Palm II, reported to be at 54° 27.12' N 01° 57.21' E, were unsuccessful and CORYSTES moved further south east to search for an unnamed wreck reported to be at 54° 23.00' N 02° 07.30' E. This wreck was successfully located at about 1410 h (10 May) and its position was confirmed as 54° 22.960' N 02° 07.427' E. At about 1600 h, and after an extensive survey of the wreck, fishing for cod by rod and line commenced and continued until about 2100 h, by which time 3 cod had been caught. One of these was tagged internally with a Mk 3 DST and released. CORYSTES then returned overnight to the western side of the sandeel survey grid (leg B).

The following morning (10 May) an intensive acoustic and under water camera survey of station B3 (54° 40.20' N 01° 06.75' E) commenced in order to describe daily pattern of sandeel emergence, changes in the acoustic properties of the sediment in relation to the presence/absence of sandeels, and the fine scale variation in sandeel distribution. This survey continued until 0730 h on 13 May when CORYSTES set sail for the Indefatigable Bank, arriving at the Hurdy Gurdy at 1540 h. The sonar buoy, previously deployed on 28 April, was relocated and the signals from several of the cod tagged with coded pingers were successfully detected. CORYSTES finally set sail for Lowestoft and 1555 h.

CORYSTES docked at 0220 h on 14 May.

#### *RESULTS:*

1. *Evaluation of VEMCO sonar buoy for detecting VEMCO coded acoustic tags in open sea conditions.* The VEMCO sonar buoy failed to log data successfully during trials despite several attempts to re-programme it. A replacement device will be available for trials on COR 5/01. Trials with VEMCO coded acoustic tags were more

successful, with tags being detected by the CEFAS sonar buoy at a range of about 200 m, exhaustive range trials however were not attempted on this occasion. Attempts to trial the CEFAS towed hydrophone were abandoned when the towing cable parted and the hydrophone was lost.

2. *Cod tagging with coded acoustic tags.* 76 kHz coded acoustic pingers were surgically implanted into the peritonea of 8 cod (45 – 49 cm), which were retained in a deck tank overnight to ensure full recovery. These fish were released at 1610 h the following day (29 April), following the successful deployment of the sonar buoy on a hydrographic mooring. In order to test the long-term performance of the sonar buoy, a coded acoustic pinger was deployed on a near-bed mooring about 180 m from the buoy. Radio transmissions from the sonar buoy were monitored for a short period after the release. Although tag signals were frequently detected, decoding of the tag signal was not possible with the radio receiver (c.f. Cruise Report COR 8/00). The sonar buoy mooring was left in position for recovery on a later cruise.
3. *3iv. Other cod tagging:* In addition to the 8 cod tagged with coded pingers, a further 5 cod were tagged internally with Mk 3 data storage tags, and 37 cod were tagged with conventional Petersen discs. Release details are attached.
4. *Trials with an integrated EK500 / QTC acoustic system for surveying the seabed and water column simultaneously.* Integration of the Quester Tangent Sea View sediment classification system (QTC) with the dual frequency, split beam echo sounder (EK500) worked extremely well and was used throughout the cruise. This arrangement allows simultaneous surveying of the water column and the sea bed sediment, thereby halving the survey time.
5. *Estimation of the abundance and distribution of sandeels on sandeel fishing grounds on the western Dogger Bank* (This was a repeat of the surveys carried out on COR 5 & 8 in April and June 2000).

*i. Acoustic survey:* Acoustic survey methods were used to estimate the distribution and abundance of sandeels in mid-water in the study area (see Appendix A). The acoustic survey was carried out from 0400 h to about 1500 h each day between 2 and 9 May using the Simrad EK 500 dual frequency (38 & 120 kHz), split beam echo sounder with echo integration. Validation of echo sounder “marks” was carried out where possible by fishing with a semi-pelagic trawl. Good echo signals were obtained and numerous large sandeel shoals were located. In addition, the characteristics of a variety of fish shoals (1+group sandeels and sprats) were identified. A significant number of echo sounder data were successfully gathered for analysis of the abundance and distribution of sandeel shoals (Fig. 2a). Eight trawls were made through sandeel shoals, yielding catches of up to 47,000 fish. For each haul, fish in a 2-3 kg sample were counted, 200-250 of which were measured. Otoliths samples for age/length determinations (5 otoliths per 0.5 cm size class) and gut samples were taken on 2 occasions.

During the acoustic survey, plankton samples and CTD casts were made at regular intervals along the survey grid (see Appendix A).

On one occasion, trials were carried out with a towed underwater camera in an attempt to visualise sandeels in the water column. Although not exhaustive, trials indicated that at suitable towing speeds (~ 3-4 kt), sandeels avoid the towed gear and are not visualised. As a consequence, this approach appears not to be a practicable alternative to fishing as a method for validating the species composition of echo sounder “marks”.

*ii. Dredge survey:* Surveying for sandeels in the sea bed was carried out using a 1.2 m sandeel dredge from 2200 h to about 0430 h each night between 1 and 10 May. Six 10-minute tows were carried out at regularly spaced stations along each transect (Fig. 1), with one transect being surveyed each night (total of 54 stations). Sandeel catches ranged from 0 to 1131 fish per tow. All fish were counted and, where catches were <300 fish, measured. Where catches were well in excess of 200 sandeels, a sub-sample of about 230 fish were measured. Otoliths samples for age/length determinations (5 otoliths per 0.5 cm size class) were taken on 16 occasions. Sandeel length-frequency data is presented in Fig. 2 together with that obtained during the April survey in 2000 (COR 5/00).

6. *Description of sediment type in relation to sandeel distribution and abundance using QTC.* The Quester Tangent Sea-view (QTC) system in unsupervised mode was used in conjunction with the EK500 echo sounder (see 4 above) to survey the sea bed sediment in the study area from 0400 h to about 1500 h each day between 2 and 9 May. Subsequent analysis will identify the spatial distribution of similar sediment types and will be related to the distribution and abundance of sandeels as revealed by the acoustic and dredge surveys.

In addition to the main survey grid, small “micro-grids” (800 x 500 m) at the top of each main grid leg, and one at station B3, were surveyed in detail in an attempt to identify whether changes in the acoustic properties of different classes of sediment could be detected between day (when sandeel are absent) and night (when sandeels are present). Each micro-grid consisted of 9 legs, 500 m long (north to south) and 50 m apart. Each was surveyed several times in succession during daylight (between about 1500 h and 1800 h) and again several times during dusk and the early night (between 2000 h and 2200 h). Ground-truthing sediment type was carried out at selected sites in each micro-grid using a Day grab and, on several occasions at one station (B3), with an underwater camera sled. Although the results require further detailed analysis, clear evidence was obtained to indicate that QTC View can detect changes in the acoustic properties of certain sediment classes between day and night, and that these changes are consistent with the presence and absence of sandeels.

7. *Identification of suitable sites in the vicinity of the sandeel survey area for tagging cod.* Two wreck locations provided by the Wreck Information Service of the UK Hydrographic Office were surveyed in the vicinity of the sandeel survey area (Fig. 1). At the first (the Annemarie Palm II, reported to be at 54° 27.12' N 01° 57.21' E) the search was unsuccessful and CORYSTES moved further south east to search for an unnamed wreck reported to be at 54° 23.00' N 02° 07.30' E. This wreck was successfully located and surveyed, its position was confirmed as 54° 22.960' N 02° 07.427' E. Fishing with hand lines yielded two small (~ 30 cm) and one large (65 cm) cod. The latter was tagged internally with a Mk3 DST and released. While

further sites will be investigated, this wreck appears potentially to be a good site for catching and tagging cod in the vicinity of the sandeel survey area during future cruises.

JD Metcalfe  
14 May 2001

SEEN IN DRAFT: R McCurry, (Master)  
A Lincoln, (Senior Fishing Mate)

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### **FIGURE CAPTIONS:**

**Figure 1.** The sandeel survey grid situated on the North West Riff.

**Figure 2a.** The distribution of sandeel shoals in mid-water by day in the survey area as revealed using the Simrad EK 500 dual frequency, split beam echo sounder.

In most cases, identification of sandeel shoals was subjective and based on the difference in target strength between 38 and 120 kHz, shoal shape, and shoal position in the water column. In some instances, species identification was confirmed by fishing on “marks” with a semi-pelagic trawl.

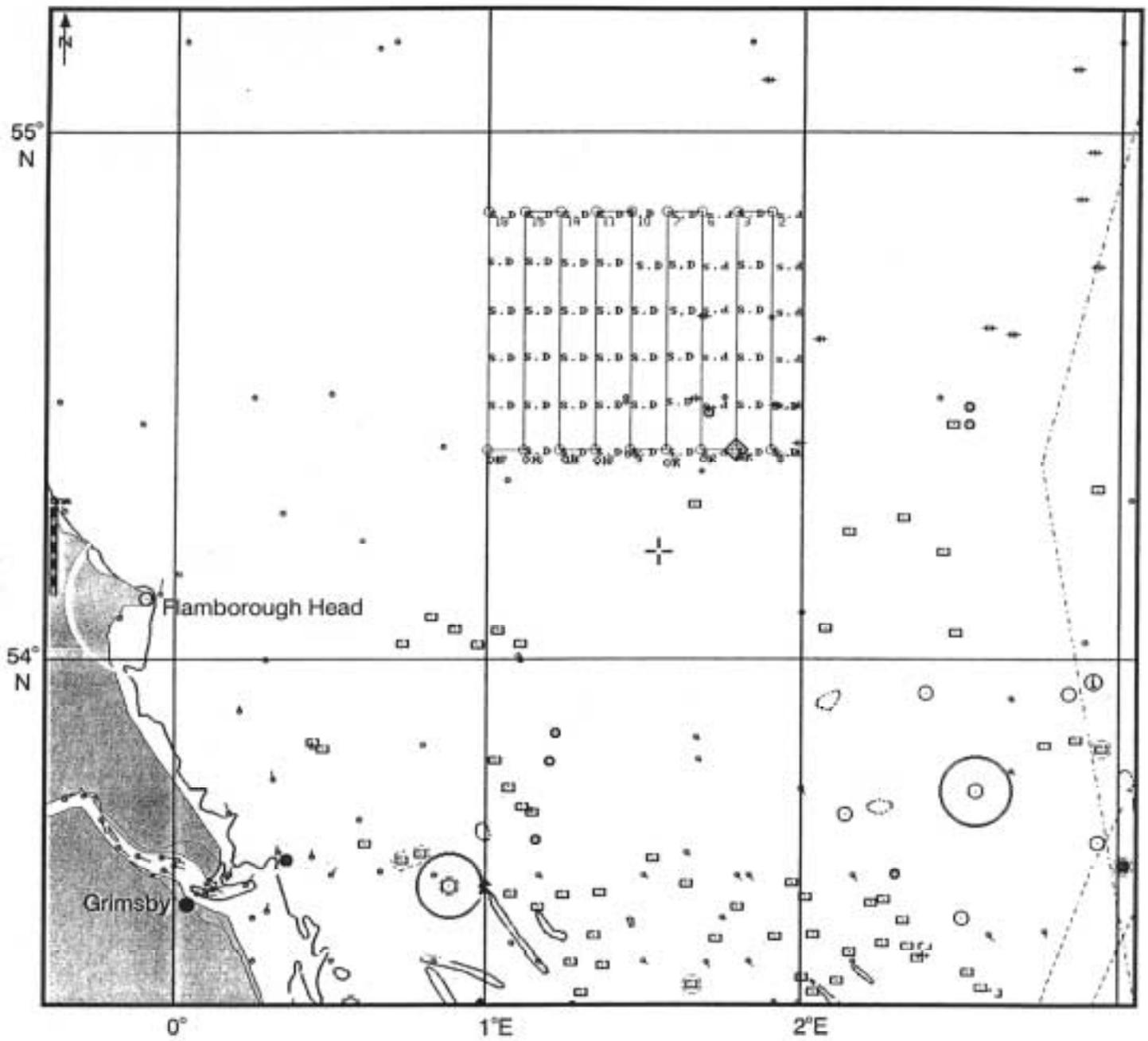
Symbol size is proportional to the relative size of the shoals based on the acoustic back-scatter (SA) values ( $\text{NASC m}^2/\text{nm}^2$ )

**Figure 2b.** The distribution of sandeels in the sediment by night in the survey area as revealed using a 1.2 m sandeel dredge.

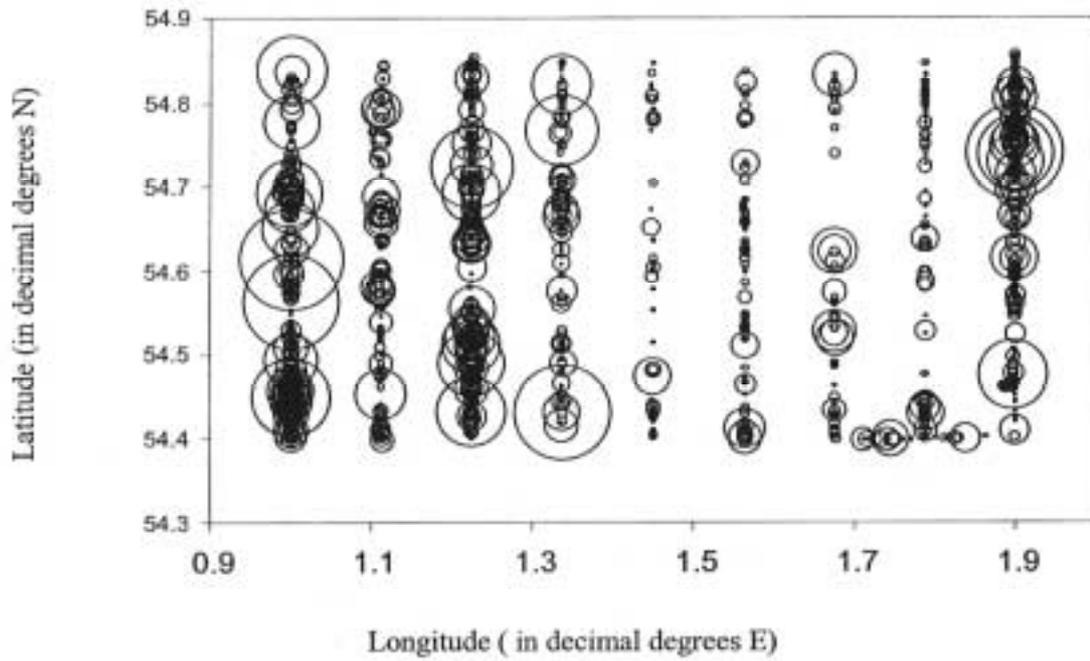
Symbol size is proportional to the relative density.

**Figure 3.** Length-frequency distribution of sandeels caught in dredge hauls during (a) the present cruise and (b) COR 5/00 (April 2000).

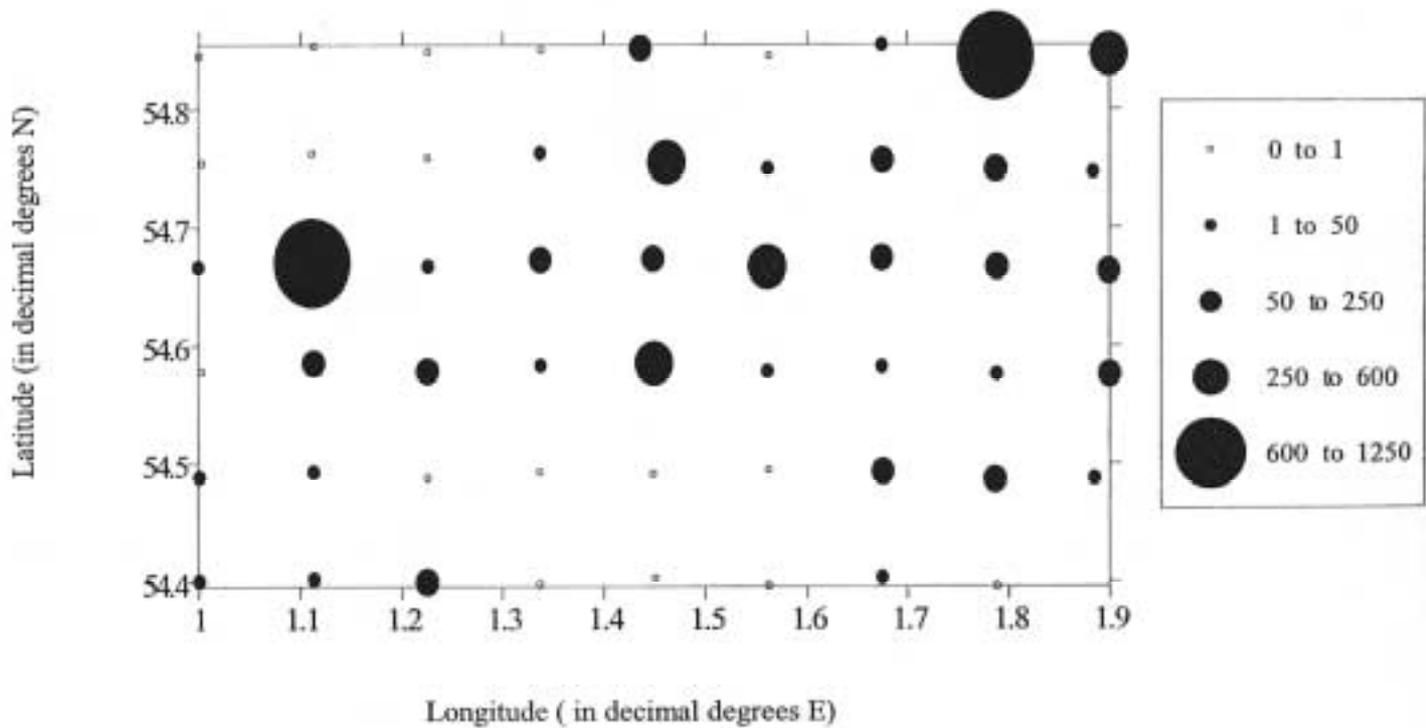
Fig. 1

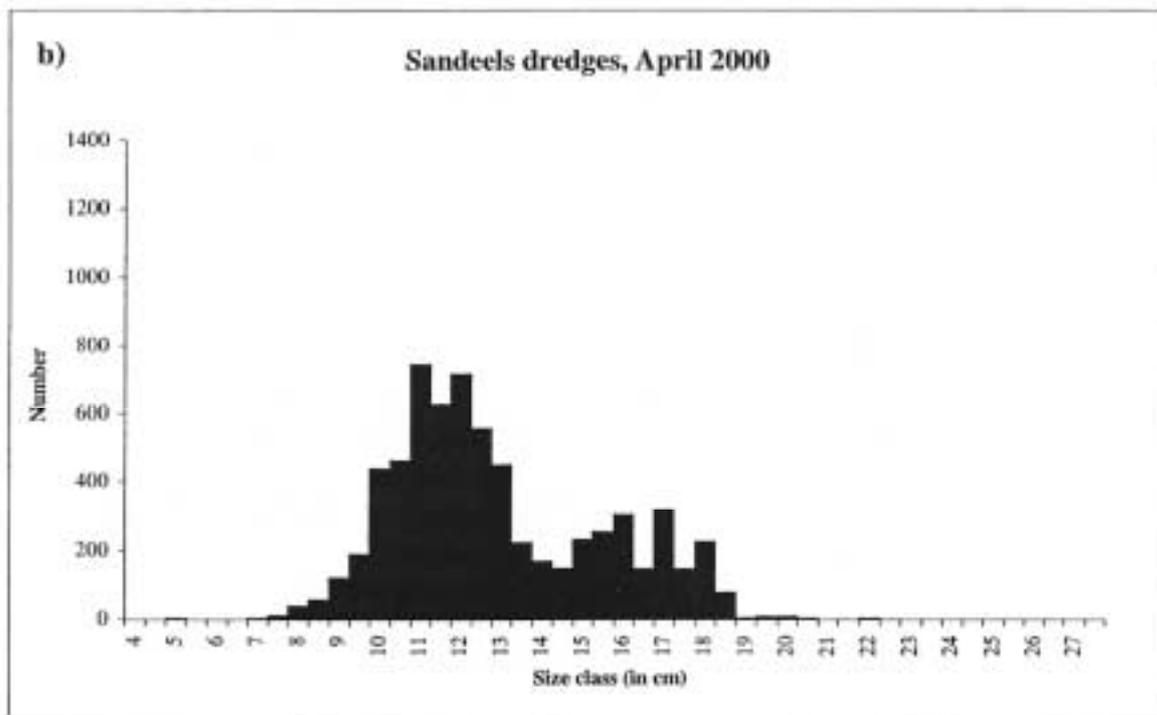
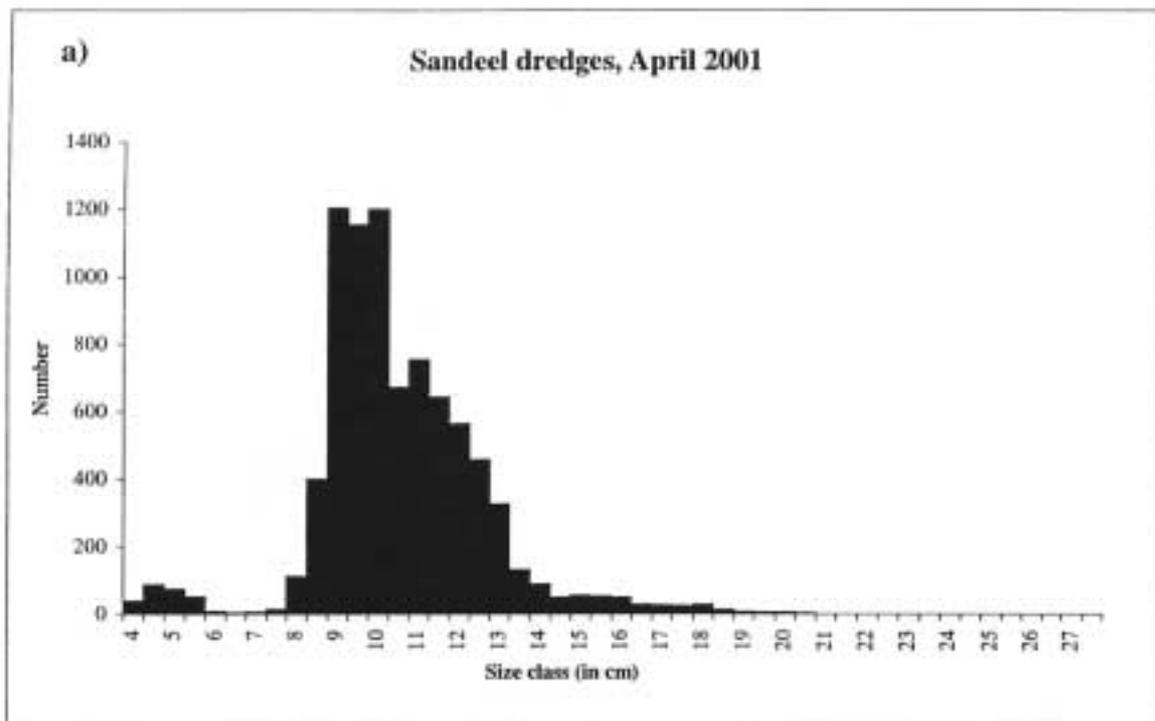


a)



b)





## APPENDIX A

### SANDEEL SURVEY

The survey area.

The survey grid was located on the North West Riff, at the south western end of the Dogger Bank. The grid consisted of 9 legs, each 27 nm (49.22 km) long, running north-south from 54° 51'N to 54° 24'N. East-west, the legs ran 6.75' (12.49 km) apart from 01° 00'E to 01° 54'E. Each leg was labelled (A to I) from the west, and 6 plankton/dredge stations were located, 5.4' (10 km) apart, along each leg and numbered (1 to 6) from north to south (Fig. 2).

#### **The survey strategy.**

Grid legs were surveyed alternately, starting from the east (i.e. in order: I, G, E, C, A, then H, F, D, B) with the grid area being covered twice during the survey period. Acoustic surveying for fish shoals was carried out using a split beam, dual frequency (38 & 120 kHz) scientific echosounder (EK500, Simrad) between 0500 h (just after dawn in late April/ early May) and about 1400h at speeds of between 5 and 7 kts depending on weather. Fishing on marks using a semi-pelagic trawl with a 6 mm mesh liner was carried out to confirm shoal identification by species, where possible. Plankton hauls were taken with a 0.5 m ring net (200 mpi) at each plankton/dredge station. By combining the EK500 echo sounder output with the Qester Tangent Sea-view (QTC) seabed classification system, acoustic surveys of the sea bed sediment could be carried out at the same time.

Following each acoustic survey, the grid leg was surveyed for sandeels using a 1.2 m scallop dredge specifically modified to catch sandeels buried in the sediment. Dredge surveys were carried out along each leg between 2200 h and about 0400 h the following day. The dredge was towed for approximately 10 minutes at 3-4 kt at each plankton/dredge station. Accurate estimates of the duration of each tow were obtained from a temperature and depth recording data storage tag, programmed to record data every 10 s, attached to the head of the dredge.

Weather permitting, this survey strategy allowed both the acoustic and dredge surveys to be performed along each leg in a single 24 h period.

Processing of fish catches.

Trawl and dredge catches were processed in essentially the same manner.

**Sandeels** were counted as whole fish or heads, heads were subsequently discarded and only whole fish measured or weighed.

- i. *Small catches (< 200 whole fish)*. All fish were counted and measured (to the nearest 5 mm below, i.e. 12.3 mm = 12 mm and 12.8 mm = 12.5 mm).
- ii. *Moderate catches (200 - 1000 whole fish)*. The catch was counted and a sample of approximately 200 fish measured. Otoliths were taken from 5 fish from each 5 mm size class.
- iii. *Large catches (>1000 whole fish)*. The catch was weighed and a sub-sample (2-3 kg) was weighed and counted. Approximately 200 of these fish were measured and otoliths taken from 5 fish from each 5 mm size class. The sub-sample weight was subsequently used to raise to total weight of the catch to total numbers of fish.

**Other species** were either counted directly (small catches), or numbers were calculated by raising the total weight of the catch by the number in a weighed sub-sample. A note was also made of the typical benthic fauna associated with the catch in the dredge.

**Plankton samples** were stored in 4% buffered formalin and stored for later analysis.

## Release of tagged fish (times are BST)

Tagged cod were released at sea on three occasions during the cruise.

Twenty nine cod were released on 29 April. Eight were tagged internally with coded acoustic pingers and externally with Petersen discs. A further 21 were tagged with Petersen discs alone. Release details are as follows:

Release date and time: 29 April 2001, 1610 h  
Release location: 53° 36.93'N 02° 11.14'E

Pinger code	Petersen tag N°	Fish length (cm)
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17	E80 6900	47
6	E69 8301	48
8	E69 8302	49
7	E69 8303	46

Pinger code	Petersen tag N°	Fish length (cm)
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16	E69 8304	49
4	E69 8305	45
3	E69 8307	48
2	E69 8308	48

Petersen tag N°	Fish length (cm)	Petersen tag N°	Fish length (cm)
E69 8306	43	E69 8318	40
E69 8309	42	E69 8319	40
E69 8310	43	E69 8320	39
E69 8311	42	E69 8321	42
E69 8312	42	E69 8322	42
E69 8313	41	E69 8323	41
E69 8314	41	E69 8324	42
E69 8315	39	E69 8325	41
E69 8316	40	E69 8326	45
E69 8317	45	E69 8327	44
E69 8328	44		

One cod, tagged internally with Mk 3 data storage tags with external spaghetti marker, was released on 10 May. This fish was caught by hand line on a wreck at the release position. Release details are as follows:

Release date and time: 10 May 2001, 1940 h  
Release location: 54° 22.943'N 02° 07.438'E

DST N°	Fish Length (cm)
2889	65

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