DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS
CEFAS, LOWESTOFT LABORATORY, SUFFOLK, ENGLAND

2005 RESEARCH VESSEL PROGRAMME

PROGRAMME: RV CEFAS ENDEAVOUR: CRUISE 16/05

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DURATION: 12th October – 23rd October 2005

LOCALITY: North Sea

AIMS:

1. To use acoustic & fishing survey methods to estimate the abundance and distribution of lesser sandeels (*Ammodytes marinus*) on sandeel fishing grounds on the North West Riff (Dogger Bank) & The Hills.

2. To use fishing survey methods to estimate the abundance and distribution of predatory fish feeding on sandeels on the sandeel fishing grounds on the North West Riff & The Hills.

3. To search for fish tagged during cruise END 05/05

4. To use fishing survey methods (Bongo net) to estimate the abundance and distribution of plankton on the sandeel fishing grounds on the North West Riff & The Hills.

5. To collect tissue samples from predatory fish for stable isotope analysis.

6. To use the dredge-mounted camera to assess seabed occupancy by sandeels during the day.

7. To collect samples of *Ammodytes marinus* for fatty acid analysis.

PLAN: (all times are British Summer Time)

Narrative

Eight of the scientific crew joined the Endeavour at North Shields at midday on Wednesday, 12th October (Chris Firmin was already aboard). Endeavour then steamed to The Hills (~54° 25' N, 1° 00' E). Surveying for sandeels and their predators commenced at 2300hrs the same evening. Surveying took place over established grids on the Hills and the North West Riff. Fisheries acoustics were operated during a morning shift (0700hrs-1200hrs). Trawling for predators started mid-way through the acoustics survey at approximately 1000hrs and was usually completed between 1900hrs and 2000hrs. Dredging for sandeels began shortly afterwards at 2000hrs, and was usually completed between 0300hrs and 0400hrs. The shift pattern operated almost continuously throughout the cruise. Bad weather interrupted work on the 18th October and 19th October. One fishing and six dredge stations were missed as a consequence. Bad weather and a tight schedule prevented any work being undertaken with the dredge-mounted camera. Surveying of the study area was completed on 22nd October at 1230hrs, whereupon Endeavour set a course for Lowestoft, arriving at 0000hrs on the 23rd October.

Results

1. To use acoustic & fishing survey methods to estimate the abundance and distribution of sandeels on sandeel fishing grounds on the North-West Riff (Dogger Bank) & The Hills.

a) Acoustic methods

Sandeel schools were identified using the Simrad EK60. Classification of acoustic 'marks' into species was based on their vertical position, location with

regards to bottom structure, shape and by comparing the 120 kHz and 38 kHz echograms. Due to absence of a swimbladder, sandeels show up stronger on the 120 kHz. This is in contrast to many other locally abundant species like clupeids and gadoids.

Only one sandeel school was found in Grid 2 and 89 in Grid 1. Applying standard methods, the biomass of sandeels on Grid 1 was calculated using sandeel weight (from dredge station) and a measured in situ target strength of -70.27 dB at 120kHz, obtained during the May survey. No biomass values of sandeels could be calculated for Grid 2. The drop in sandeel biomass of nearly 85% in Grid 1 and near-absence in Grid 2 is most likely due to large number of sandeels hibernating in the seabed. The distribution and number of sandeels and other fish schools in mid-water in the study area could therefore be estimated relatively easily (Table 1, Figure 1).

Acoustic class	Grid 1	Grid 2
Sandeels	89	1
Clupeids	54	26
Other	151	46

Table 1. Number of schools recorded in the water column

Month of year	Grid 1	Grid 2
May	4,239	459
October	658	N/A

Table 2. Biomass (t) of sandeels in May and October

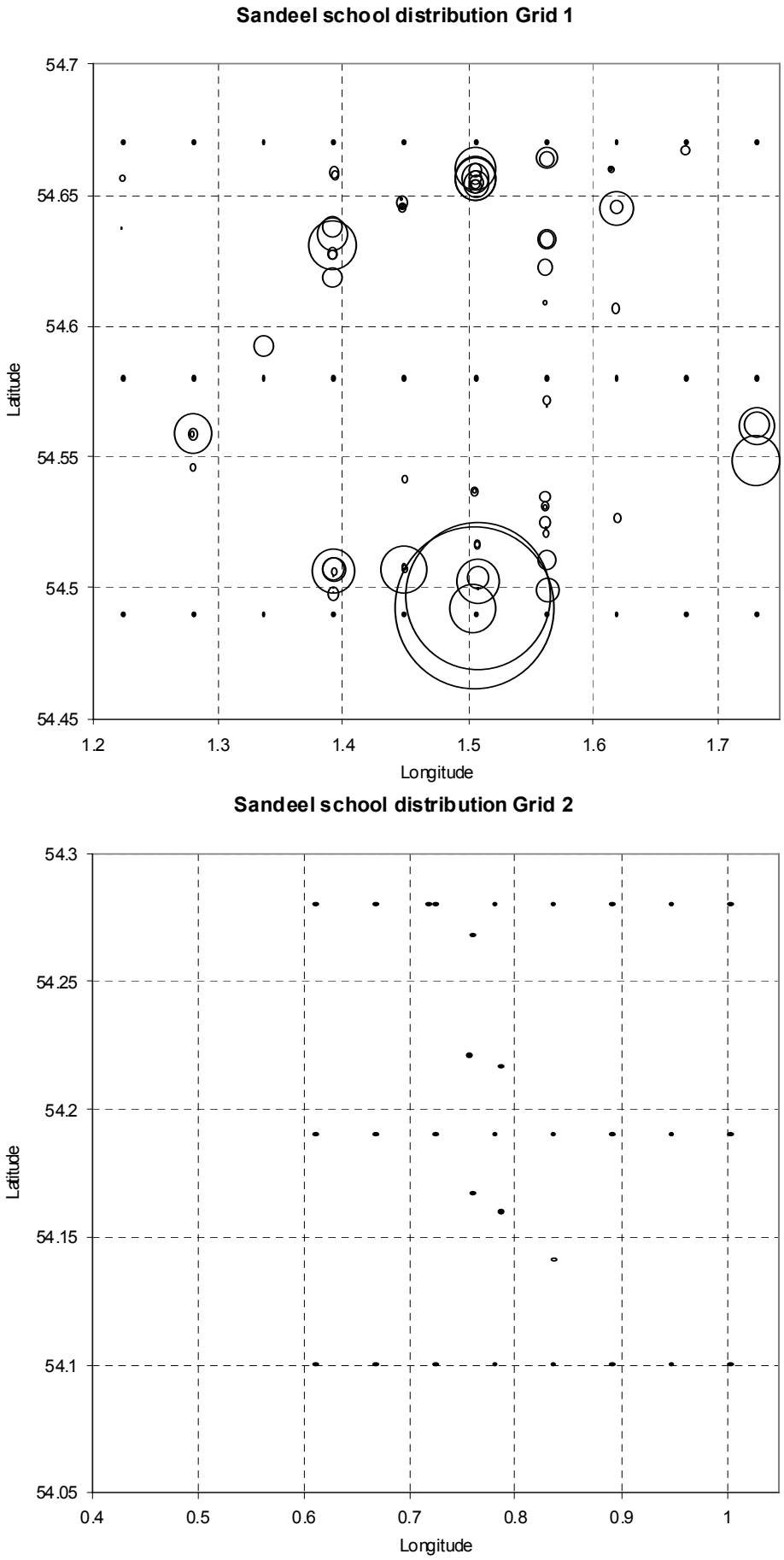

Figure 1. Sandeel school positions. Size proportional to acoustic backscatter.

b) Dredge methods

Each night, six stations were dredged, three of which were replicates of the first, third and fifth station of the night. In total, 80 dredge tows were undertaken (one tow was dropped from the schedule of the12th October, when time did not permit dredging at nine stations, and nine were dropped on the 18th October, when bad weather did not permit any dredging). Sandeels were caught in 75 of the 80 tows; 52 of the 54 stations. A total of 24kg of sandeels were caught in the dredge; catch size ranged from 0 to 884 individuals, with an average of 90 per tow. The relationship between sandeel length and weight is shown in Figure 2. There was no difference in this relationship between survey grids.

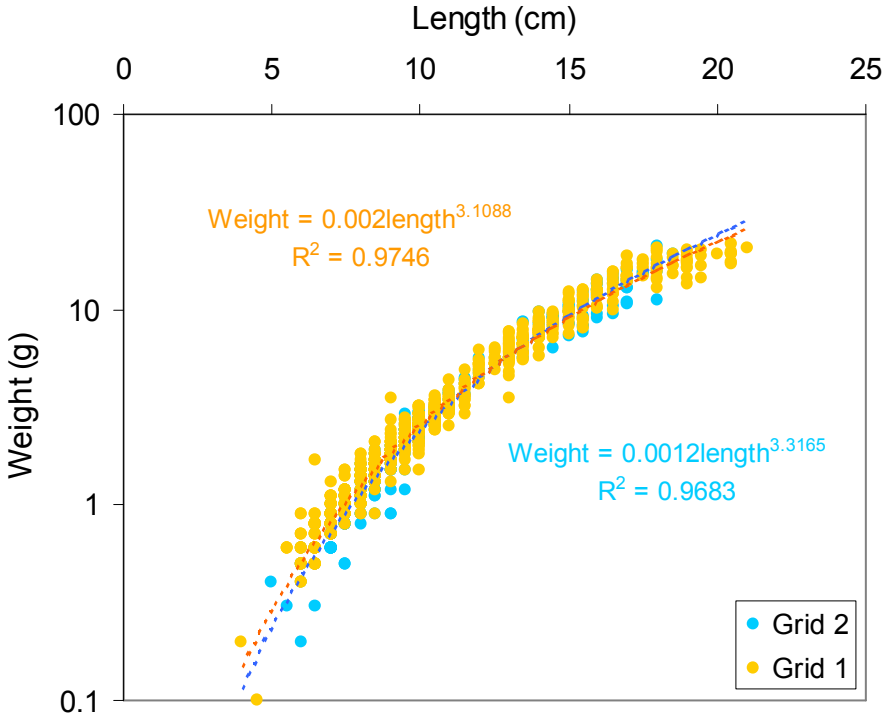

Figure 2. Length-weight relationship for dredge-caught sandeels.

Relative catch numbers and distribution of sandeels is shown in Figure 3. With one notable exception at station K-1 on grid 1, replicate tows were well correlated (R=0.70, $p<0.05$, rising to 0.94, $p<0.01$ if data from K-1 were

excluded). There was no significant difference between the number of sandeels caught at the same grid location (paired T-test, $p>0.05$). The length-frequency of sandeels on the different survey grids is shown in Figure 4a & b. Whilst overall catch was greater on grid-1 (shallower and heavily fished), the similarity in length-frequency by proportion suggests that the age-structure of sandeels populating the two grids is similar. This is in contrast to results from May this year, when larger sandeels were more frequently observed in grid-1, and smaller sandeels observed more frequently in grid-2. Differences in the catchability of larger sandeels between May and October may be responsible for this change, as may differential fishing mortality or migration.

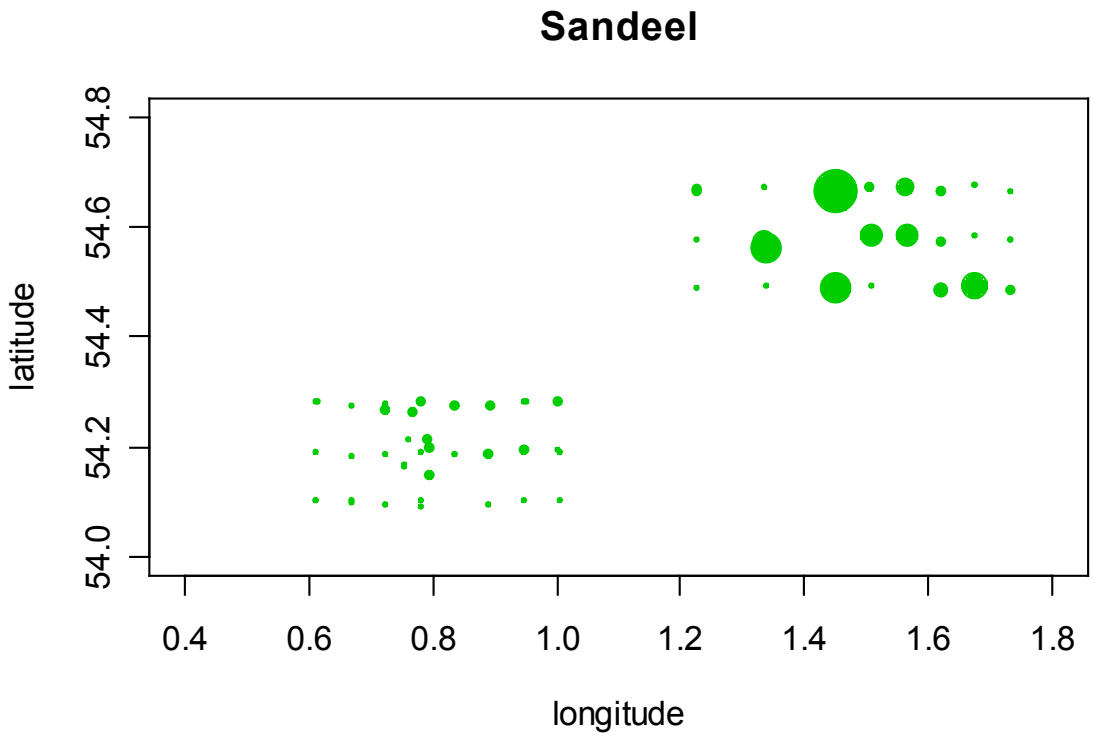

Figure 3. Plot of sandeel distribution (by weight)

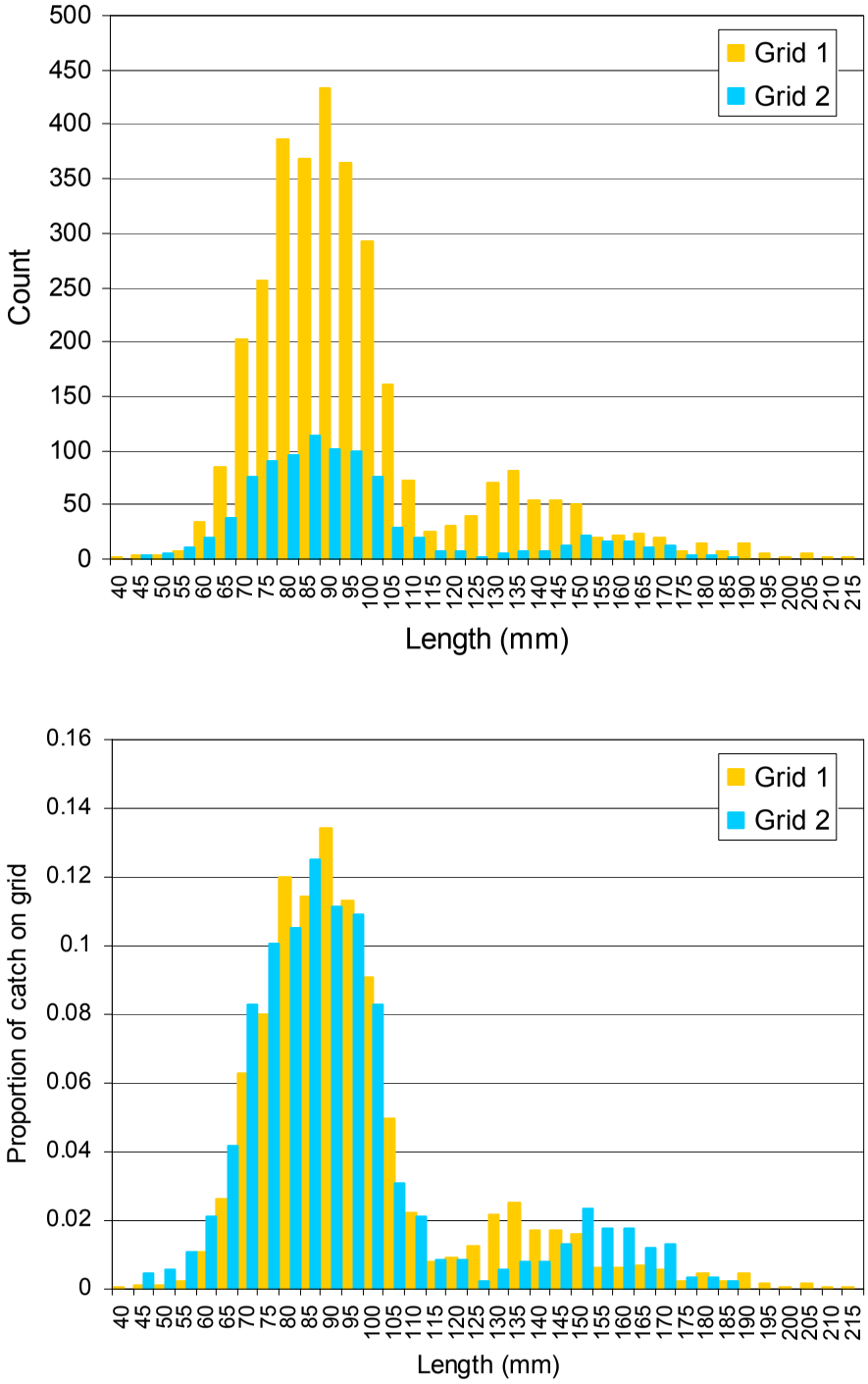

Figure 3 Plot of sandeel length frequencies.

2. To use fishing survey methods to estimate the abundance and distribution of predatory fish on the sandeel fishing grounds on the North West Riff & The Hills.

Trawl surveying for predatory fish was undertaken successfully at 58 stations. Over 40,000 fish were caught, weighing approximately 3.02 metric tonnes. Most abundant was dab (*Limanda limanda*), constituting nearly 60% of the catch by number and 53% by weight. Next most abundant was gurnard (15% by number, 4% of the weight), lesser weaver (12%, 10%) and whiting (7%, 12%). Figure 4 shows the rank-abundance of all species caught during the survey, and Figure 5 shows the relative distribution of the predatory fish on each survey grid.

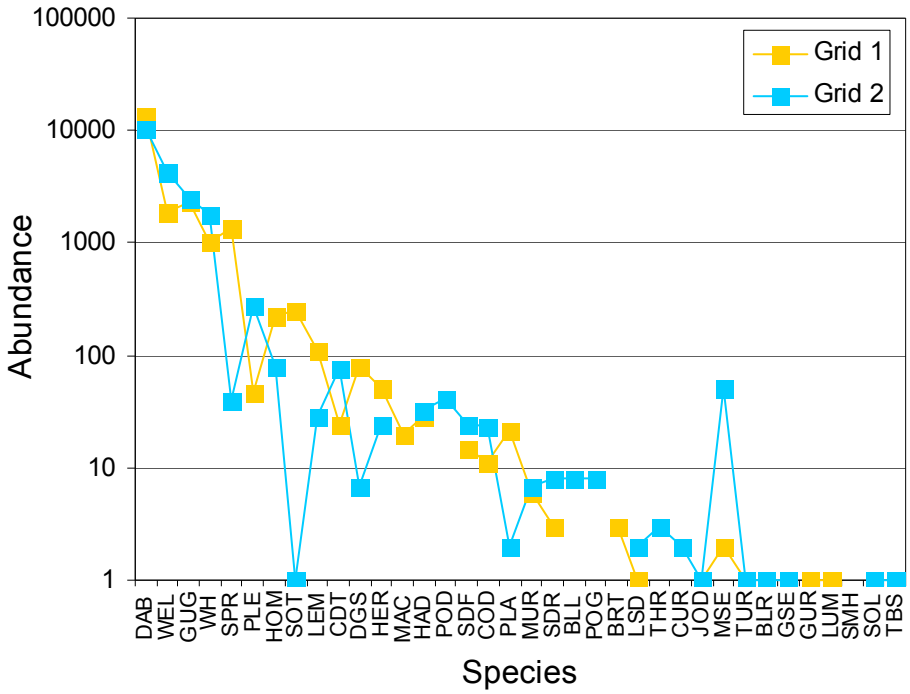

Figure 4. Rank-abundance of predators on each survey grid.

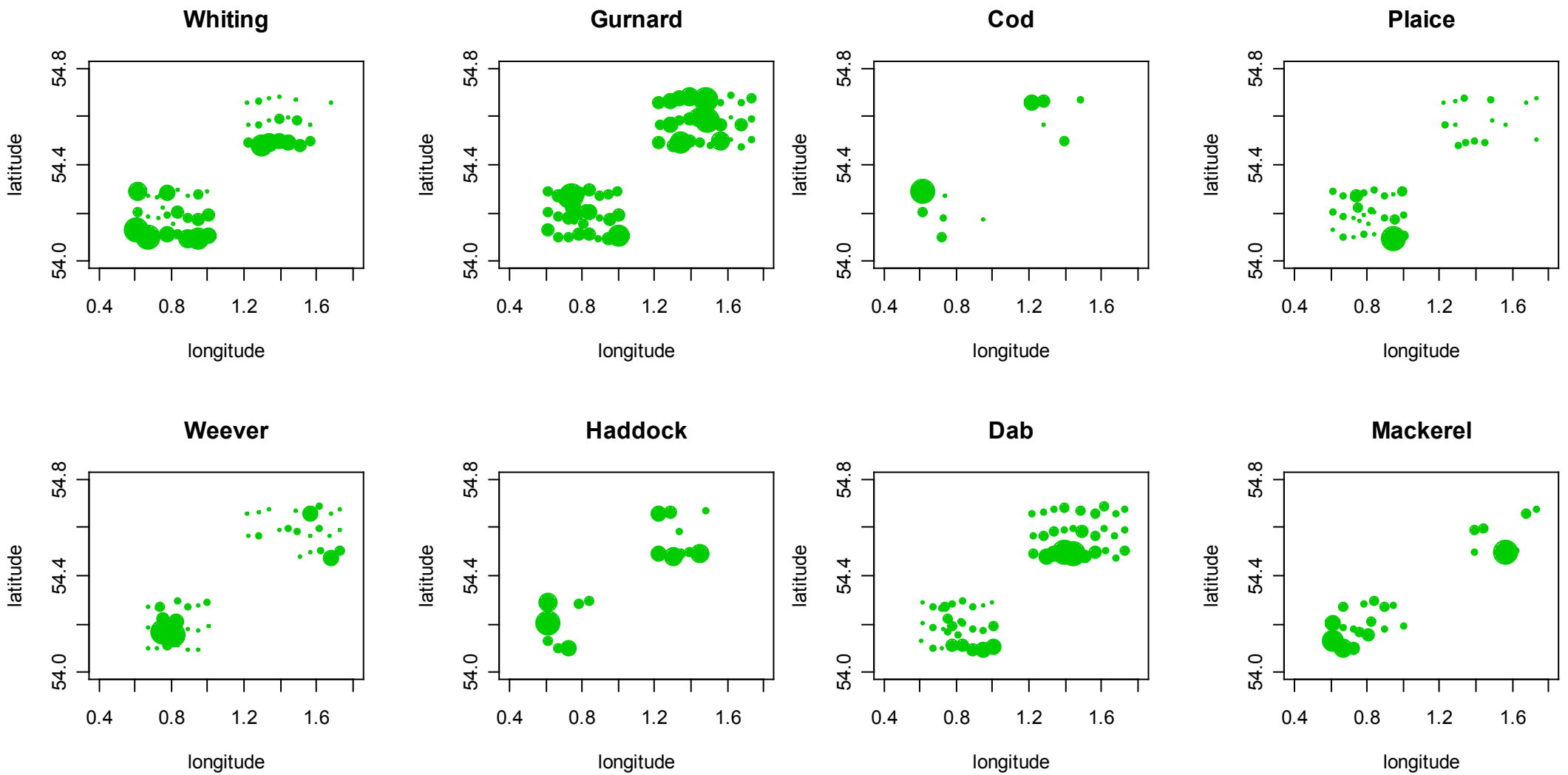

Figure 5. The relative catches and distribution of the eight most common predatory fish species.

Analysis of the gut contents of predatory fish revealed that a greater proportion of predation on fish occurred on grid 1 (Figure 6; Table 3a & b), where the majority of sandeels were found in the water column and in the sediment. Other significant prey items in the diets of the predatory fish sampled were pelagic and benthic crustaceans (gurnards and mackerel), bivalves (plaice) and echinoids (haddock).

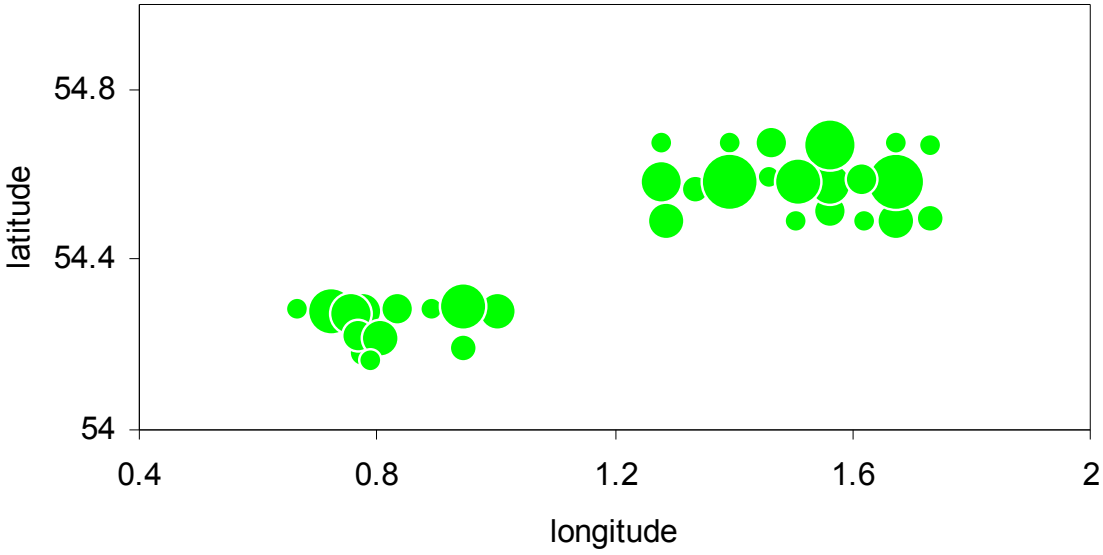

Figure 6. Incidence of predation on sandeels.

Species	Code	Grid 1			
		Number of empty stomachs	% empty stomachs	Stomachs with sandeels	% stomachs with sandeels
Cod	COD	2	18	1	9
Dab	DAB	18	36	4	8
Grey gurnard	GUG	190	40	30	6
Haddock	HAD	11	38	0	0
Lemon sole	LEM	19	35	0	0
Mackerel	MAC	4	27	4	27
Red Mullet	MUR	1	17	0	0
Plaice	PLE	10	23	0	0
Lesser weever	WEL	133	70	10	5
Whiting	WHG	46	25	9	5
	Total	436	41	58	5

Species	Code	Grid 2			
		Number of empty stomachs	% empty stomachs	Stomachs with sandeels	% stomachs with sandeels
Cod	COD	6	26	0	0
Dab	DAB	17	53	0	0
Grey gurnard	GUG	271	50	7	1
Haddock	HAD	5	16	0	0
Lemon sole	LEM	6	38	0	0
Mackerel	MAC	15	36	1	2
Red Mullet	MUR	1	17	0	0
Plaice	PLE	53	28	7	4
Lesser weever	WEL	127	77	16	10
Whiting	WHG	127	42	8	3
	Total	636	46	39	3

Table 3. Stomach sampling and predation on sandeels

3. To search for fish tagged during cruise END 05/05

Despite trawling an area of ~3,200,000 metres during the cruise in the areas where tagged fish were released in April 2005, no tagged fish were caught during the cruise.

4. To use standard methods (Bongo net) to estimate the abundance and distribution of plankton on the sandeel fishing grounds on the North West Riff & The Hills.

Plankton dips were undertaken successfully at 60 stations and samples stored in formaldehyde. In general, samples on grid 2 contained high quantities of ctenophores- and other zooplankton (copepods & chaetognaths). Examination of the acoustic data suggested the water column throughout grid 1 was heavily populated with ctenophores and other gelatinous zooplankton. In contrast, samples from grid 1 did not contain many ctenophores. Samples will be worked up at the Lowestoft laboratory to determine plankton mass and composition.

5. To collect tissue samples from predatory fish for stable isotope analysis.

450 muscle samples from predatory fish were collected (Table 4).

Species	Code	Grid 1		Grid 2		Number of Stomachs
		Number stomachs	Muscle samples	Number stomachs	Muscle samples	
Brill	BLL	0	0	5	5	5
Cod	COD	11	10	23	16	34
Cuckoo Ray	CUR	0	0	1	0	1
Dab	DAB	50	22	32	11	82
Greater Sandeel	GSE	0	0	1	1	1
Spurdog	DGS	5	5	0	0	5
Grey Gurnard	GUG	473	67	545	50	1018
Red Gurnard	GUR	1	1	0	0	1
Haddock	HAD	29	15	32	11	61
Herring	HER	0	0	1	0	1
Horse Mackerel	HOM	1	1	1	1	2
John Dory	JOD	1	1	1	1	2
Lemon Sole	LEM	55	10	16	7	71
Mackerel	MAC	15	16	42	17	57
Red Mullet	MUR	6	6	6	6	12
Plaice	PLE	43	20	191	27	234
Smoothound	SMH	0	0	1	1	1
Turbot	TUR	1	1	1	1	2
Lesser Weever	WEL	190	34	166	22	356
Whiting	WHG	181	36	305	29	486
Grand Total		1062	245	1370	206	2432

Table 4. Total number of stomach examined and muscle samples taken.

6. To use the dredge-mounted camera to assess seabed occupancy by sandeels during the day.

There was no opportunity to use the dredge camera due to the tight schedule and sea-state.

7. To collect samples of Ammodytes marinus for fatty acid analysis.

Four samples of sandeels were taken for analysis; approximately 50 lesser sandeels were taken from three dredge stations in grid 1, and approximately 10 smooth sandeels were taken from one dredge station in grid 1.

Distribution list:

Basic list + D. Righton (SIC), J. van der Kooij (2IC), K. Sullivan, C. Mills, J. Pinnegar, Chris Firmin, Georg Engelhard, Sophy McCully, K. Lees, Eastern Region and Northeastern Region Sea Fisheries District, Sea Fisheries Inspectorate.

The survey strategy and fish sampling.

The survey took place on the west side of the Dogger Bank, on and around the shoals of the North West Riff. Two survey grids (Figure x), each containing 48 stations, were sampled independently. Grid 2 (54 6.0 N, 0 36.708 E to 54 16.8 N, 1 0.186 E) on the Hills in a relatively unfished area, and Grid 2 (54 29.4 N, 1 13.489 E to 54 40.2, 1 43.884 E) on the south western edge of the Dogger bank, usually heavily fished by Danish sandeel vessels. Survey legs each 10.8 nm (20 km) long, spaced 1.9 nm apart (3.6 km) running north-south, with sampling stations space every 5.4 nm apart were defined for each grid. Grid legs were surveyed alternately (i.e, C, E, G, I). Surveying began on the western-most side of Grid 2, moving eastwards towards the eastern-most point of Grid 1, then turning back and surveying the alternate legs skipped first time round. Grid 1 was therefore completed in full before surveying finished on Grid 2.

Acoustic surveying for fish shoals was carried out using a split beam, dual frequency (38 & 120 kHz) scientific echosounder (EK60, Simrad) starting at 0600 h GMT (just before dawn) and proceeding at speeds of between 4 and 8 kts depending on weather. Ten minutes prior each sampling station, observations of birds numbers and activity was recorded. At each sampling station, CTD casts were taken in combination with plankton hauls made with a 0.5 m ring net (60 mpi) at each plankton station. Due to limited daylight hours, the second transect was used for both acoustics as well as the granton from the 16th October.

Following each acoustic survey, the sampling stations were sampled for potential sandeel predators (groundfish) using a standard Granton trawl with a 12 mm mesh liner, towed at 4 kts for 20 minutes through each trawl station. Starting at 22:00 hrs, each station was subsequently sampled using a 1.2 m sandeel dredge, towed for approximately 10 minutes at 3 to 4 kt. 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.

The feeding habits of the most abundant predatory fish (whiting, haddock, cod, gurnard, weever, mackerel, plaice and greater sandeel)were investigated at each station. Five fish in each 5cm length class were taken from the total catch and their gut contents identified and weighed. Muscle samples were taken from a sub-sample of the predators for isotopic analysis.

A dredge survey for sandeels was undertaken during hours of darkness (1900 to 0500). The survey was carried out using a 1.2 m sandeel dredge from 2000 h to about 0300 h each night. 10-minute tows were carried out at each dredge station. Sandeels were counted as whole fish or heads, heads were subsequently discarded and only whole fish measured or weighed. 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.

Processing and recording

All samples were recorded adhering to defined protocols. Fish lengths and weights were entered directly into a database using the CEFAS Electronic Data Collection system. Other data were entered in to a central database and quality controlled by subsequent independent checking.

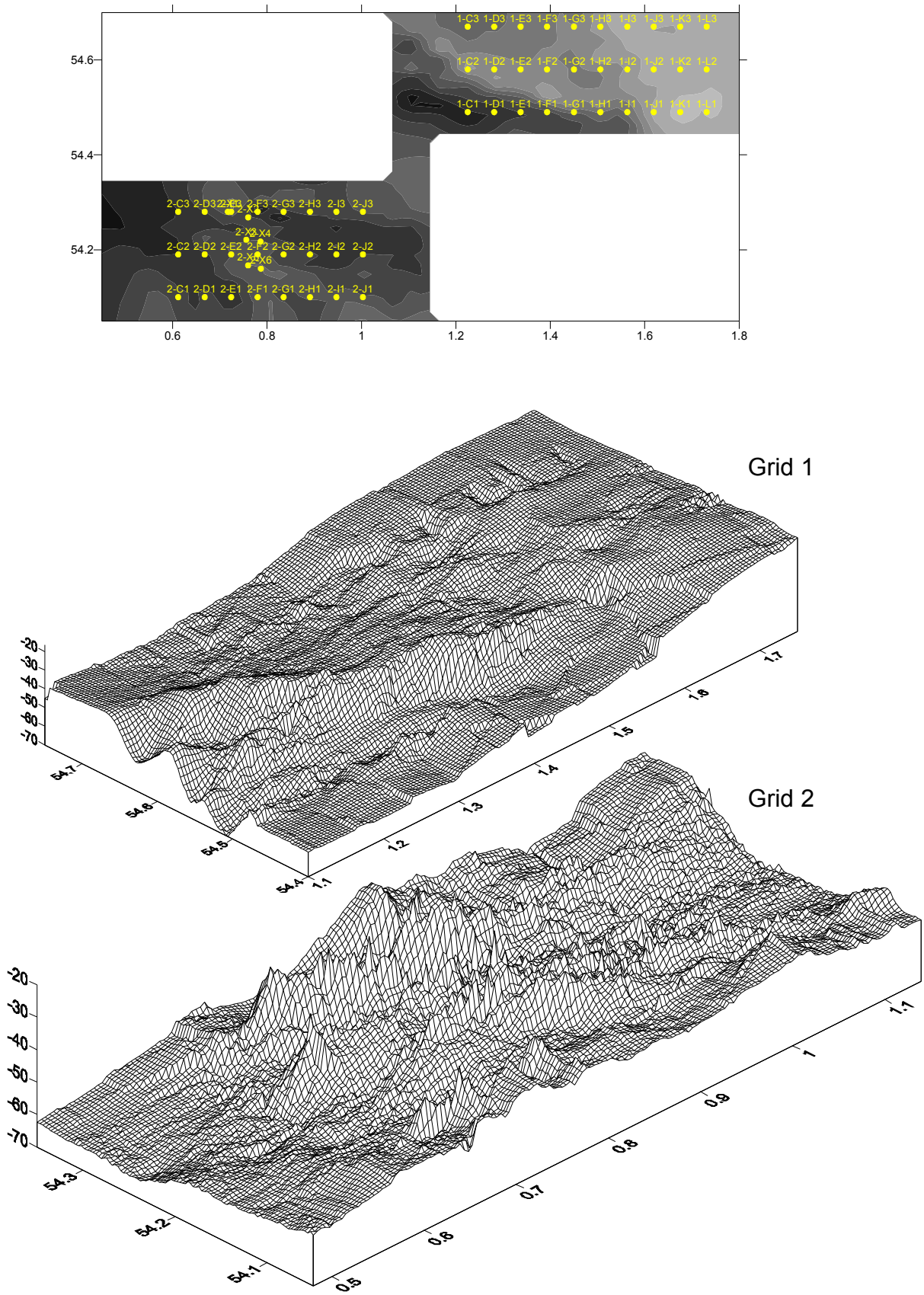

Figure . The survey area, showing the location of the survey grids and their bathymetry.