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REPORT ON ECHO-INTEGRATOR SURVEYS FOR SPRAT UNDERTAKEN IN THE NORTH SEA DURING THE 1981-82 WINTER SEASON

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ABSTRACT

This report summarises results from the third series of ICES co-ordinated acoustic surveys for sprat undertaken by Scottish, Norwegian and English survey vessels in January-February 1982.

The Scottish survey covered an area extending between Flamborough Head (54°N) and the Moray Firth (58°10'N), offshore to 0°E, the Norwegian survey most of the central North Sea between 53°30'-57°30'N and 1°-8°E, and the English survey concentrated on the southern part of the North Sea between 51°20'-54°15'N, including the Wash and Thames Estuaries.

The survey results show a further decline in sprat population within the central North Sea (ICES Division IVb), particularly on the usual overwintering grounds along the Scottish east coast, north-east coast of England and deeper water pits south of the Dogger Bank. The population in the central North Sea was mainly composed of small (< 6 cm) 1-group fish and older fish were generally scarce. The only major concentrations found were in the Wash and Thames Estuaries. A widespread distribution of dispersed echo-traces in the central and eastern Southern Bight appeared to be mainly spent herring.

RÉSUME

Ce rapport donne un aperçu des résultats afférents à la troisième série des enquêtes acoustiques coordinées du CIEM relatives aux sprats et entreprises par des navires hydrographiques écossais, norvégiens et anglais, au cours de janvier et février 1982.

La zone d'observation de l'enquête écossaise s'étendait entre Flamborough Head (54° nord) et le Moray Firth (58°10' nord), jusqu'à une distance au large de la côte délimitée par la ligne 0° est; celle soumise à l'observation par le moyen de l'enquête norvégienne s'étendait sur la quasi-totalité de la mer du Nord centrale entre 53°30'/57°30" nord et 1°-8° est, tandis que l'enquête anglaise a concentré sur la partie sud de la mer du Nord entre 51°20'/54°15' nord, y compris les estuaires de la Tamise et du Wash.

Les résultats des enquêtes mettent en évidence une diminution ultérieure de la population chez les sprats à l-intérieur de la zone centrale de la mer du Nord (Division CIEM IV b), surtout aux fonds d'hivernage habituels le long de la côte est de l'Ecosse, la côte nord-est de l'Angleterre et les fosses d'eau plus profondes au sud du Dogger-bank. La population dans la mer du Nord centrale était composé essentiellement de petits poissons (<6 cm) du groupe 0, tandis que les poissons plus âgés n'apparaissaient que rarement. Les seules grandes concentrations qu'on a trouvées étaient localisées dans les estuaires de la Tamise et du Wash. Une distribution répandue des traces d'écho aux zones centrales et orientales du Southern Bight était pour la plupart apparémment des harengs épuisés par le frai.

INTRODUCTION

The acoustic surveys undertaken in January-February 1982 were the third in a series undertaken under ICES Council Resolution 4:26/1979 to assess stock levels of North Sea sprat independently from methods using catch data. The vessels employed and survey dates were as follows:

JOHAN HJORT (NORWAY)	6-23 JANUARY
EXPLORER (SCOTLAND)	11-29 JANUARY
CORELLA (ENGLAND)	25 JANUARY-9 FEBRUARY

A limited intership comparison was carried out between EXPLORER and CORELLA off Flamborough Head.

The Scottish survey concentrated within a coastal belt, 50 miles wide, between Flamborough Head and the Moray Firth (offshore to about 0°E), the Norwegian one covered the central North Sea between 53°30'-57°30'N and 1°-8°E, and the English survey covered the southern area between 51°20'-54°15'N, including the Wash and Thames Estuaries (see track charts (Figures 1,5,7)). There was some overlap between the English and Norwegian survey areas, and a small one between the English

and Scottish areas.

METHODS

Details of the survey equipment, methods of calibration and sampling gears used by each country are summarised in Table 1.

Compared with the previous year the basic equipment used on the English survey remained unchanged. The Scottish differed in the use of a ceramic transducer in place of a magneto-strictive unit, whilst the Norwegian system employed the new SIMRAD QD integrator in place of the previously used QM.

Improved techniques were also used for calibration of the echo-sounders and it is planned to introduce copper or tungsten carbide spheres for use as standard targets by all participating countries. In view of the diversity of equipment parameters, there is a continuing need for improved comparability checks.

A common target strength of -29 dB/kg was used to estimate the sprat biomass, and densities were raised to half ICES statistical rectangles (30 x 18 miles).

RESULTS

(1) English Survey

Figure 1 shows the survey track and positions of trawl stations made by FRV CORELLA. It also shows the station positions of G.O.V. and Isaacs-Kidd trawl hauls made by FRV CIROLANA during the International Young Fish Survey undertaken at the same time, and the general area within which CORELLA carried out mid-water trawling on her previous trip.

The results of these trawl hauls are summarised for the principal species caught, in Tables 2 to 4, and were used as a guide in apportioning the probable contribution of sprat to the total acoustic biomass within broader sub-areas, referred to a common target strength of -29 dB/kg.

The survey was interrupted by bad weather over the first few days, but conditions were generally good for the rest of the trip.

The only major concentrations of sprat located were within the Wash and inner reaches of the Thames Estuary. Offshore, traces were generally in the form of thinly dispersed layers, which in some areas consisted mainly of very small signals as recorded on the oscilloscope monitor. These could have been small 1-group sprat and 0-group herring as suggested by the results of Isaacs-Kidd trawl hauls (Table 6)

Commercial sprat fishing was taking place in the Wash and Thames,

and a fairly extensive spent herring fishery was underway off the Dutch coast in the eastern half of the Southern Bight.

The results of trawl hauls made over the survey area by mid-water and G.O.V. trawls (Tables 2-5) showed the principal species present were sprat, herring, whiting and cod.

A comparison of length and age distributions for samples taken by the different trawls off the Suffolk coast together with additional samples taken from the screens at Sizewell power station are shown in Figure 2. The larger trawl and power station samples are broadly similar in length and age distributions for fish over 8 cm length, with predominant modal lengths of 10.0-10.5 cm, but show a rather more variable representation of smaller fish, probably due to mesh selection factors. The Isaacs-Kidd trawl samples represent a component of very small 1-group fish, which barely register in the other samples, but these in turn show a very sparse representation of larger 1-group sprat and no older fish. This could be due to net avoidance by the larger fish, even though the hauls were made in darkness.

These samples are also of interest in that they show the length and age structure were similar over a fairly wide coastal belt ranging from the Sizewell cooling water intake, about 0.25 mile off the coast in a depth of around 5 metres, up to 10 miles off in 20-30 metres depth.

The length and age distributions from other parts of the survey area are shown in Figures 3 & 4 which also includes material from the Thames sprat fishery within the inner estuary, where CORELLA was unable to fish during the survey. The main differences are in the representation of 1-group fish (1981 year class), (3.0-8.5 cm), but most show a clear predominance of 2-group (1980 year class) with 3- and 4-group fish generally more strongly represented towards the English coast.

The G.O.V. trawl samples (Table 4) showed 1-group herring present in varying quantities, with relatively high proportions (30-65% by weight) within the northern half of the survey area, and lowest off the east coast of England. Samples from the Wash and Thames fishery showed a by-catch level around 5% by weight. The Isaacs-Kidd trawl samples (Table 6) also showed considerable differences in the proportion of 0-group herring present, ranging between about 10-96% by number, but with no clearly defined pattern of distribution.

2. Scottish Survey (J. I. EDWARDS and R. S. BAILEY)

The Scottish survey was carried out from 11-29 January by

FRV EXPLORER and covered the coastal water belt from the Moray Firth to Flamborough Head. The cruise track and positions of pelagic trawl hauls are shown in Figure 5. Equipment and other survey data are summarised in Table 1. The system was calibrated three times during the survey.

Allocation of biomass estimates to species was made using information from the trawl hauls which are summarised in Table 7. At each trawl station a haul was made with an International Young Gadoid Pelagic Trawl followed by an oblique tow between surface and bottom using an Isaacs-Kidd trawl.

The estimated biomass of sprats, herring and all sound scatterers combined are given in Table 8 for each half statistical rectangle, and a chart showing contoured densities of all sound scatterers is provided by Figure 6.

The estimated biomass of sprats for the entire survey area was 26,100 tonnes compared with 30,400 tonnes over the same area in 1981 (Bailey and Edwards, 1981). Using the proportion of each age group of sprats in the trawl hauls the biomass in 1982 was composed of 24,300 tonnes of 1-group sprats (1981 year class) and 1,800 tonnes of older sprats. Using the length compositions of each age group and an unpublished weight-length relationship these weights converted to numbers as follows:

1-group $26,200 \times 10^6$

2-group 220×10^6

The 1982 survey showed no evidence of high densities of sprats in the traditional areas of concentration in the Moray Firth, Firth of Forth and off the Tyne Estuary. Densities were also low in the area off Montrose (around 56°45'N) where substantial concentrations of 1-group were found in each of the previous four years. In the 1981-82 season, sprat fisheries failed to develop in any of these areas except on a very small scale, despite searching by a number of vessels. There is thus substantial agreement between the acoustic survey results and information from fishing vessels: sprat abundance was clearly very low.

The trawl hauls also contained a variable proportion of immature herring. The proportion of herring by weight (as a percentage of sprats and herring combined) was highest in the Montrose-Bell Rock area (34%), outer Moray Firth (31%) and Firth of Forth (25%), but relatively low in the inner Moray Firth (8%) and off Flamborough Head (0.1%). In all areas sampled 1-group sprats predominated, and the only stations where older sprats made up more than 5% of the catch in number were in the Firth of

Forth and immediately to the north.

Since the echotraces recorded during the survey were more diffuse than on previous surveys, it was not possible to extract from the analogue recorder the proportion of each echointegration attributable to clupeid shoals, and estimates thus had to rely entirely on the trawl hauls.

The Isaacs-Kidd trawl samples also indicated the presence of planktonic and other small organisms (e.g., small squid and herring larvae) not retained by the larger trawl. Since it was not possible to quantitatively compare samples taken by the two gears the proportion of acoustic signal contributed by the smaller organisms could not be assessed. These would thus have been included in the biomass estimate for sprat of 26,100 tonnes, which would reduce this figure, perhaps appreciably so.

The estimated total biomass of all organisms combined (referred to a common target strength of -29 dB/kg) was only 63,900 tonnes, which would represent the absolute upper limit for sprat biomass.

(3) Norwegian Survey (S. IVERSEN)

This survey was undertaken by FRV JOHAN HJORT between 6-23 JANUARY 1982 and covered the central North Sea between 53°30'-57°30'N and 1°-8°E. The survey track and pelagic trawl stations are shown in Figure 7, whilst equipment and fishing gear details are given in Table 1.

Weather conditions were very favourable over most of the survey period. Echo-trace densities were generally low and took the form of thinly dispersed traces over the survey area. A high proportion of these appeared to be composed of small, 1-group sprat (3-6 cm) and 0-group herring (2.5-4.5 cm).

A representative selection of sprat length distributions from the pelagic trawl samples are shown in Figure 8, and these clearly show the predominance of small sprat.

The procedures for assessing the sprat component of the acoustic biomass were the same as in previous surveys (Aglen and Iversen 1980; Iversen, Aglen and Bakken 1981).

The distributions of sprat biomass by sub-rectangles are shown for 1-group and older sprat in Figure 9 (a & b).

INTERSHIP CALIBRATION

Only EXPLORER and CORELLA were eventually able to carry out an intership calibration experiment. This took place off Flamborough Head between 0930-1530 hours on 26 January, and was run over a distance of

51 nautical miles at a speed of 8 knots in calm conditions. CORELLA was positioned about 0.25 mile astern of EXPLORER off her port quarter. The integrators on the two vessels were set to cover comparable depth ranges (about 6 metres from the surface to 2 metres off the bottom), and the integrated range averaged 44 metres (S.D. 2.9 m) over the survey track. The echo-traces were very diffuse and mainly within the lower half of the water column. An analysis of the CORELLA records showed only 11% of the echo density contributed by signals in the 6-23 metre depth interval. EXPLORER had fished in this area the previous day and the trawl catch showed mainly small, 1-group sprat constituting about 84% by weight of the haul.

Integrator outputs were totalled at 6 minute intervals on the Scottish equipment and at one nautical mile intervals on the English. The results are presented as a time series for each vessel in Figure 10(a), and regressions between the two sets of results in Figure 10(b), with outputs converted to equivalent tonnes/km^2 referenced to a target strength of -29 dB/kg.

It is evident that the two systems produced similar relative density profiles along the survey track, but the Scottish results show densities consistently higher than the English, with a greater variance, and this difference tended to be larger at higher density levels. This is clearly shown in Figure 10(b) where there is a good linear relationship between density estimates, but the regression line shows a slope of two and an increasing divergence from proportionality with increasing density. The overall mean values for the two vessels over the survey track were as follows:

Vessel	Tonnes/km^2	S.D.	% Coeff. Var.
EXPLORER	13.77	4.95	35.9
CORELLA	7.84	2.18	27.8

('t' test on difference between means showed a significance level <0.01.)

These results thus show a considerable discrepancy between the estimates provided by the two sets of equipment and as yet there is no satisfactory explanation for the difference. Calibration procedures and conversion factors were thoroughly checked and the problem did not appear to lie in this area. Further comparisons will have to be made in an effort to resolve this problem.

RESULTS AND GENERAL CONCLUSIONS

The combined results from all three surveys are summarised in

Figure 11. This also shows comparative estimates from the overlap area between the English and Norwegian surveys within the heavily outlined sub-rectangles, with the Norwegian figures above. The Norwegian survey was undertaken about two weeks prior to the English one and the survey tracks were not the same.

At the time of the English survey trace densities were generally low in this region and predominantly a thinly dispersed non-shoaling type of very small fish. Overall densities (referred to T.S. -29 dB/kg) ranged mainly between 4-9 tonnes per n.mile^2 per sub-rectangle.

A comparison of the results on a sub-rectangle basis shows varying measures of agreement, although the overall summed totals for the whole overlap area were very similar, 12 x 10^3 tonnes for the Norwegian estimate and 12.5 x 10^3 tonnes for the English estimate.

The estimates for the Thames Estuary and Wash areas are likely to be minimal since the difficult nature of these regions makes it impossible to cover all the likely areas of sprat distribution. In the case of the Thames, at the time of the survey sprats were regularly appearing on the screens of West Thurrock power station, about 18 miles upriver from the limits of our survey, and many of the innermost channelways, where fishing had taken place, were also inaccessible. Similar problems arise in effectively covering the immediate coastal waters between the Wash and Thames where sprats are known to be present from local drift net fisheries and the large quantities appearing on the screens at Sizewell power station on the Suffolk coast.

A comparison of sprat biomass estimates within comparable areas for the 1981 and 1982 surveys is presented in Table 9.

The Norwegian results in 1982 show a decline in 2-group and older sprat within IVb(E&W), but a similar estimate for 1-group fish in the two years within IVb(E), and an increase for this age group in IVb(W).

The English and Scottish results show a marked decline in 1982 off the east coast of Scotland and Firth of Forth and in the offshore areas south of the Dogger Bank. In other regions the estimates were similar or less pronounced in difference.

Larger and older sprats were only found in any quantity south of about 54°N and mainly towards the east coast of England and in the Wash and Thames Estuaries.

Estimates of biomass for 1-group fish are the most problematic due to difficulties in quantitatively sampling this age-group (which falls mainly within the size range 3.0-8.5 cm), and lack of information on

likely target strengths for the very small fish.

The first results on in situ sprat target strength measurements undertaken on earlier English surveys have now been processed (Robinson 1982), and these show mean target strengths of -28.9 dB/kg at a mean length of 12.6 cm and mean weight of 15 g, amd -27.2 dB/kg for a mean length of 7.15 cm and weight 2.3 g. These estimates were considered accurate to ± 0.7 dB.

There is a suggestion here for target strength length dependence, but more data for other length groups is required before such a relationship can be confirmed.

The change in distribution of sprat within the North Sea first noted from surveys undertaken in the winter of 1979-80 (Aglen and Iversen, 1980) appears to have been maintained in 1982, with a further reduction in general abundance within ICES division IVb. This recent trend is clearly reflected by changes in the English coastal fisheries over recent seasons (Table 10).

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Table 1 Equipment parameters and survey data for sprat acoustic surveys undertaken in the North Sea Jan-Feb 1982

	Scotland	England	Norway
Echo Sounder	EK 38A (Simrad)	KH MS 44	EK 38A (Simrad)
Echo integrator	Aberdeen digital echo integrator	QM (Simrad)	QD integrator
Frequency	38 kHz	30 kHz	38 kHz
Transducer	Ceramic (in towed body)	Magneto-strictive (in towed body)	Ceramic (hull mounted)
Method of calibration	Tungsten carbide sphere	Triangulation	Copper sphere
Calibration Constant	25 tonnes/km^2 percent/TX	6.4 tonnes/km^2 per volt per n m tonnes	1 mm reading = 0.115 tonnes/ n mile^2 (20 dB gain in Int)
Units of Integration	15 min (every 2.5 miles at 10 knots)	per n mile	mm per nautical mile
Survey speed	approx 10 knots	approx 8 knots	10 knots
Integration limits	7 m from surface to 3 m above sea bed	5.5-6 m from surface within 1-2 m of bottom	8 m from surface within 0.5 m of bottom
Trawl	International Young Gadoid (10 mm codend)	800 mesh Engels (10 mm cod end cover)	'HARSTAD' pelagic trawl (10mm codend cover)
Towing speed	2.5-5 knots	3-4 knots *G.O.V. trawl	
Plankton Sampler	Isaac Kidd trawl	Isaacs Kidd from CIROLANA 2/82	None
Towing speed	2 knots	3 knots	

* G.O.V. trawl samples from CIROLANA 2/82

Table 2 CORELLA 1/1982 (6-17 Jan). Catch data from 28 random hauls made with 800 Engel trawl within rectangle bounded by 52°03'-52°-20'N, 02°30'-03°15'E

	No. of hauls	Total duration (hours)		Average catches per 3 hour tow (baskets)			
				Herring	Sprat	Whiting	Cod
Day	10	30		7.80	Ø	0.26	0.02
			(%)	(96.5)	(Ø)	(3.2)	(0.2)
Night	18	54		0.78	Ø	8.83	1.29
			(%)	(7.2)	(Ø)	(81.0)	(11.8)
Total	28	84		3.29	Ø	5.77	0.84
			(%)	(33.2)	(Ø)	(58.3)	(8.5)
% hauls with species present		Day		80.0	10.0	40.0	20.0
		Night		77.8	16.7	100.0	100.0
		Overall		78.6	14.3	78.6	71.4
Comparison with haul 90 from CIROLANA 2/82 (G.O.V. trawl) (8 Feb)							
Dusk haul		kg:-		21.0	0.0	216.5	24.0
		% :-		8.0	0.0	82.8	9.2

Table 3 CORELLA 2/1982 800 Engel Trawl Samples

Date	Sta. No.	Mid-tow position	Tow duration (min)	Principal Catch: Sprat	Herring	Whiting	Cod	
28. 1.82	5	53°01.7'N 00°25.1'E	40	4.75 tonnes	0.25 tonnes	Few	-	
1. 2.82	8	53°44.8'N 03°21.7'E	60	1/2 bucket	Nil	-	13f (large 100 cm+)	Many whitebait sprat meshed along net
5. 2.82	12	51°40.8'N 02°02.6'E	40	Nil	2 tonnes (large)	Few	-	
6. 2.82	14	51°32.1'N 01°24.0'E	30	1/3 bskt	Few (small)	1/3 bskt	-	" " "
7. 2.82	17	51°45.0'N 01°23.7'E	60	1/6 bskt	Few (small)	3/4 bskt (180f)	1 bskt (28f)	" " " " " "
8. 2.82	19	52°29.3'N 02°05.0'E	60	3/4 bskt	Nil	1 bskt	2f	" " "
9. 2.82	21	52°15.6'N 01°55.0'E	60	1/6 bskt	4f	3/4 bskt	-	" " "

Table 4 CIROLANA 2/1982 G.O.V. Trawl Samples - Catch Data No/Wt per 30 minute haul
(stations in area covered by acoustic survey grid of CORELLA 2/1982) 6-12 Feb

ICES Rectangle	Station No.	Sprat		Herring		Whiting		Cod		Haddock		Total kg	% Wt Sprat	% Wt Herring
		Nos	Wt (kg)	Nos	Wt (kg)	Nos	Wt (kg)	Nos	Wt (kg)	Nos	Wt (kg)			
37/F4	76	7,431	44.5	105	2.6	418	40.0	4	0.8	111	10.5	98.4	45.2	2.6
37/F4	77	6,948	38.6	2,618	51.4	78	7.5	6	5.0	77	8.0	110.5	34.9	46.5
36/F4	78	557	3.2	2,902	112.3	338	20.5	8	34.0	3	1.5	171.5	1.9	65.5
32/F1	88	54	1.1	4	0.4	27	8.5	8	27.0	-	-	37.0	3.0	1.1
33/F1	89	352	2.7	-	-	47	11.0	7	17.0	-	-	30.7	8.8	0.0
33/F2	90	-	-	197	21.0	753	216.5	10	24.0	-	-	261.5	0.0	8.0
34/F2	93	225	2.5	-	-	138	29.0	3	4.0	-	-	35.5	7.0	0.0
35/F0	101	728	2.6	7	0.1	61	1.7	9	12.0	-	-	16.4	15.9	0.6
34/F1	102	14	0.1	1	Ø	15	6.0	4	1.1	-	-	7.2	1.4	Ø
35/F1	103	142	1.6	230	3.1	13	0.8	-	-	-	-	5.5	29.1	56.4
36/F1	104	126	1.4	160	2.8	13	0.3	-	-	-	-	4.5	31.1	62.2
36/F1	105	2,632	28.0	2,796	41.8	48	0.6	2	14.0	1	Ø	84.4	33.2	49.5
36/F2	110	1,714	14.3	2,621	45.2	130	8.5	6	58.5	-	-	126.5	11.3	35.7
36/F2	111	48	0.5	26	1.5	-	-	2	16.5	-	-	18.5	2.7	8.1
35/F2	112	7,266	68.1	4,620	51.9	13	0.2	5	51.5	-	-	171.7	39.7	30.2

(All hauls were made in daylight except 90 made at dusk)

Table 5 CIROLANA 2/1982 - G.O.V. Trawl Samples

Station No	No per hour				Mean length/age				% weight			
	1	2	3	4	1	2	3	4	1	2	3	4
76- 78	3425	5370	1164	-	7.9	10.2	11.7	-	16.2	62.8	21.0	-
110-112	60	4274	1605	77	7.0	10.7	11.7	14.2	0.2	63.3	33.4	3.0
103-105	-	1059	837	37	-	11.2	12.1	13.7	-	47.7	48.9	3.3
101	900	491	61	4	6.4	9.7	12.5	14.0	25.7	55.9	16.4	1.6
93	-	261	162	27	-	11.5	12.7	14.3	-	48.6	41.4	10.0
89	52	556	88	8	7.0	10.5	12.1	13.9	2.2	75.7	19.3	2.8
88	-	19	59	30	-	12.3	14.1	14.9	-	11.5	55.2	33.3
CORELLA 2/1982 - 800 Engel Trawl Samples												
5	8.3	480.9	149.4	44.8 ($x10^{-3}$)	7.7	10.4	13.1	14.5	0.3	50.5	33.4	14.0
19/21	488	1444	234	16	7.0	10.4	11.8	13.7	6.9	73.2	17.9	2.0
14/17	362	544	380	88	6.2	11.1	12.9	14.4	3.7	37.9	43.9	14.5
THAMES FISHERY - INNER ESTUARY (January)												
No/Landing ($x\ 10^{-3}$)	851	762	132	77	6.2	10.2	12.9	13.4	11.3	54.4	20.5	13.8
SIZEWELL POWER STATION SCREENS (Feb. 9-12)												
No.measured	468	1554	335	40	7.6	10.5	12.3	14.1	6.6	64.8	24.1	4.5

Table 6 CIROLANA 2/1982 Isaacs-Kidd Trawl Samples

Date	Sta. No	Sprat			Herring		%
		*No/Haul	$\bar{L}$ (cm)	S.D.	*No/Haul	$\bar{L}$ (cm)	Herring
5/2	72-73	27.6	5.08	1.18	18.9	3.66	40.6
6/2	74-75	6.4	4.48	1.31	30.6	3.42	82.7
11/2	108-109	31.6	4.09	0.69	3.4	3.26	9.7
11/2	106-107	9.1	3.74	0.53	31.8	3.13	77.8
9/2	97-98	3.3	2.91	0.28	90.7	3.41	96.5
9/2	99	2.6	3.25	-	10.5	3.50	80.2
9/2	96	2.9	3.25	-	17.2	3.73	85.6
8/2	92	2.5	3.25	-	2.5	4.05	50.0
7/2	80-81	22.1	3.60	0.43	7.1	3.67	24.3
7/2	82-83	54.5	3.52	0.42	56.5	3.63	50.9
7/2	84-85	53.8	4.02	0.85	11.2	4.00	17.2
7/2	86-87	8.3	5.76	1.35	1.4	3.55	14.4

(*No/haul standardised to 1 n.mile tow)

Table 7 Details of trawl hauls, EXPLORER, January 1982 (see Figure 5)

International Young Gadoid Pelagic Trawl

Haul Number	Date	Shooting Position	Sprat					Herring		Other Species
			Number		Weight (g)		As % of total	Number	Weight (g)	Weight (g)
			1-group	≥2-group	1-group	≥2-group				
1	12 Jan	56°08'N 01°44'W	0	0	0	0	-	0	0	0
2	13 Jan	56°30'N 02°25'W	37	9	80	47	0.7	1314	12026	6708
3	14 Jan	56°46'N 02°13'W	5436	743	9330	4639	49.7	1151	11918	2238
4	"	56°52'N 02°09'W	29900	123	51587	593	57.0	2295	23694	15623
5	15 Jan	57°46'N 02°07'W	494	12	1357	108	56.0	95	818	333
6	16 Jan	57°41'N 03°46'W	7376	1	16848	12	91.5	214	1499	65
7	"	57°37'N 03°54'W	709	0	1525	0	60.9	22	123	856
8	18 Jan	56°05'N 02°49'W	41	60	63	476	29.9	74	699	567
9	24 Jan	55°36'N 01°14'W	0	0	0	0	-	0	0	0
10	25 Jan	54°13'N 00°06'W	11473	16	9230	193	67.6	0	0	4507
11	"	54°06'N 00°03'E	6637	69	4634	596	84.2	2	12	971
12	27 Jan	56°09'N 02°50'W	2561	5	1213	43	93.0	13	95	0

Isaacs Kidd Midwater Trawl

Haul Number	Date	Shooting Position	Sprat		Herring larvae	
			No.	$\bar{L}$ (mm)	No.	$\bar{L}$ (mm)
1	12 Jan	56°09'N 01°49'W	0	-	0	-
2	13 Jan	56°30'N 02°21'W	1	32	154	32
3	14 Jan	56°45'N 02°15'W	9	52	4	45
4	"	56°48'N 02°12'W	2	43	1	36
5	15 Jan	57°45'N 02°12'W	0	-	3	27
6	16 Jan	57°42'N 03°43'W	0	-	1	24
7	"	57°39'N 03°49'W	0	-	0	-
8	18 Jan	57°06'N 02°43'W	4	44	234	34
9	24 Jan	55°37'N 01°18'W	0	-	0	-
10	25 Jan	55°16'N 00°03'E	51	42	64	37
11	"	54°07'N 00°10'E	275	48	228	34
12	27 Jan	56°07'N 02°44'W	1	42	7	38

Table 8 Estimated biomass (referred to -29 dB/kg) of sprats, herring and all sound scatterers combined in each half statistical rectangle, EXPLORER, January 1982

SW Corner of rectangle		No of 15 min integrator readings	Sea area of rectangle (km^2)	Trawl hauls used for species allocation	All species combined	Estimated biomass (t x 10^{-3})			Herring
Lat	Long					1-group	Sprat ⩾2-group	Total	
58°00'N	3°30'W	10	1055	-	0.79)				
"	3°00'W	8	1624	-	0.79)				
"	2°00'W	6	1624	-	0.95)	No relevant trawl hauls			
"	1°30'W	11	1624	-	0.88)				
"	1°00'W	2	1624	-	1.04)				
57°30'N	4°00'W	39	823	6, 7	1.49	1.30	+	1.31	0.12
"	3°30'W	26	988	6, 7	0.88	0.78	+	0.78	0.07
"	3°00'W	40	988	5	0.41	0.21	0.02	0.23	0.13
"	2°30'W	49	988	5	1.74	0.90	0.07	0.97	0.54
"	2°00'W	29	1318	5	0.79	0.41	0.03	0.44	0.25
"	1°30'W	8	1647	5	1.14	0.59	0.05	0.64	0.36
"	1°00'W	20	1647	5	1.14	0.59	0.05	0.64	0.36
57°00'N	2°30'W	7	166	2, 3, 4	0.16	0.07	+	0.08	0.05
"	2°00'W	44	1419	2, 3, 4	0.51	0.22	0.02	0.24	0.17
"	1°30'W	4	1670	2, 3, 4	0.88	0.39	0.03	0.42	0.30
"	1°00'W	22	1670	2, 3, 4	1.23	0.54	0.05	0.59	0.42
56°30'N	2°30'W	119	1269	2, 3, 4	1.01	0.44	0.04	0.48	0.35
"	2°00'W	99	1692	2, 3, 4	1.61	0.71	0.06	0.77	0.56
"	1°30'W	21	1692	2, 3, 4	0.95	0.42	0.04	0.45	0.33
"	1°00'W	29	1692	2, 3, 4	1.74	0.76	0.07	0.83	0.60
56°00'N	3°00'W	66	772	8, 12	1.17	0.47	0.19	0.66	0.30
"	2°30'W	112	1715	8, 12	1.55	0.63	0.25	0.88	0.39
"	2°00'W	53	1715	1	1.64	0.00	0.00	0.00	0.00
"	1°30'W	25	1715	1	3.67	0.00	0.00	0.00	0.00
"	1°00'W	27	1715	1	3.19	0.00	0.00	0.00	0.00
"	0°30'W	3	1715	1	1.96	0.00	0.00	0.00	0.00
55°30'N	2°00'W	25	1303	9	0.60	0.00	0.00	0.00	0.00
"	1°30'W	33	1737	9	1.99	0.00	0.00	0.00	0.00
"	1°00'W	9	1737	9	1.96	0.00	0.00	0.00	0.00
"	0°30'W	4	1737	9	1.52	0.00	0.00	0.00	0.00
55°00'N	1°30'W	30	1672	mean of 9 and (10+11)	1.39	0.48	0.03	0.50	0.00
"	1°00'W	14	1760	"	2.24	0.77	0.04	0.82	0.00
"	0°30'W	13	1760	"	2.40	0.83	0.05	0.87	0.00
54°30'N	1°30'W	14	713	10, 11	0.98	0.67	0.04	0.71	0.00
"	1°00'W	15	1603	10, 11	4.24	2.92	0.16	3.08	0.00
"	0°30'W	17	1782	10, 11	1.80	1.24	0.07	1.31	0.00
"	0°00'	12	1782	10, 11	2.75	1.89	0.11	2.00	0.00
54°00'N	0°30'W	37	1082	10, 11	2.24	1.54	0.09	1.63	0.00
"	0°00'	53	1804	10, 11	6.48	4.46	0.25	4.71	0.00

Table 9 North Sea Sprat - Acoustic Survey Biomass Estimates '000 tonnes (T.S. -29 dB/kg)

Norway	1981	1982
IVb (East of 3°E)		
1-Group	19.0	18.6
2-Group (& older)	6.5	3.7
IVb (West of 3°E to 1°E)		
1-Group	0.1	5.6
2-Group (& older)	1.2	0.3
England and Scotland (all age groups)		
Region		
Moray Firth	4.7	5.0
East coast of Scotland	9.2	3.9
Firth of Forth	9.0	1.5
North East coast of England (Farne Is.-Flamborough Head)	10.8	15.6
Wash Area	42.6	43.0
Skate Hole-Outer Silver Pit	36.7	6.0
Indefatigable Bank Area	22.7	4.1
Southern Bight (51°20'-53°30'N)	22.8	39.3
Thames Area	(1.8)*	(18.3)+

* The main areas of concentration where fishing took place were inaccessible to survey due to very shallow water

+ Again an underestimate due to accessibility problems in this area

Table 10 Seasonal landings (tonnes) by UK vessels from English coastal sprat fisheries

Coastal Sector	1978-79 (Nov-Feb)	1979-80 (Nov-Dec, NE Coast; Jan-Mar, Wash/Thames	1980-81 (Dec-Mar)	1981-82 (Dec-Mar)
Coquet-Tees Bay	22,984	10,516	-	-
Inner Silver Pit-Wash Approaches	603	-	-	-
Wash	782	645	1,378	2,961
Thames	-	886	14,616	10,678
Totals	24,369	12,047	15,994	13,639

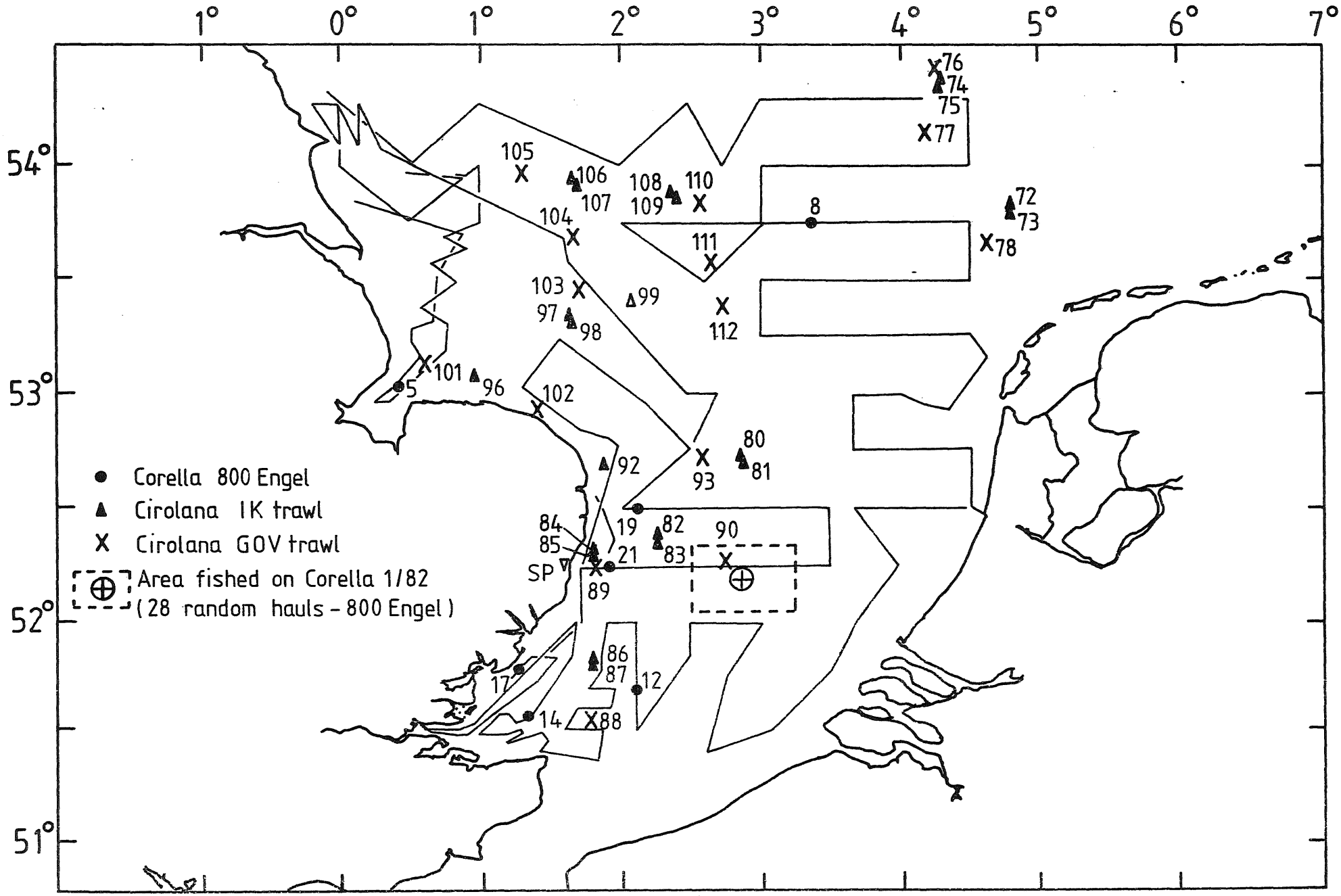


Figure 1 Track chart and fishing station positions for CORELLA Cruise 2/1982 with additional fishing positions for CORELLA 1/1982 and CIROLANA 2/1982.

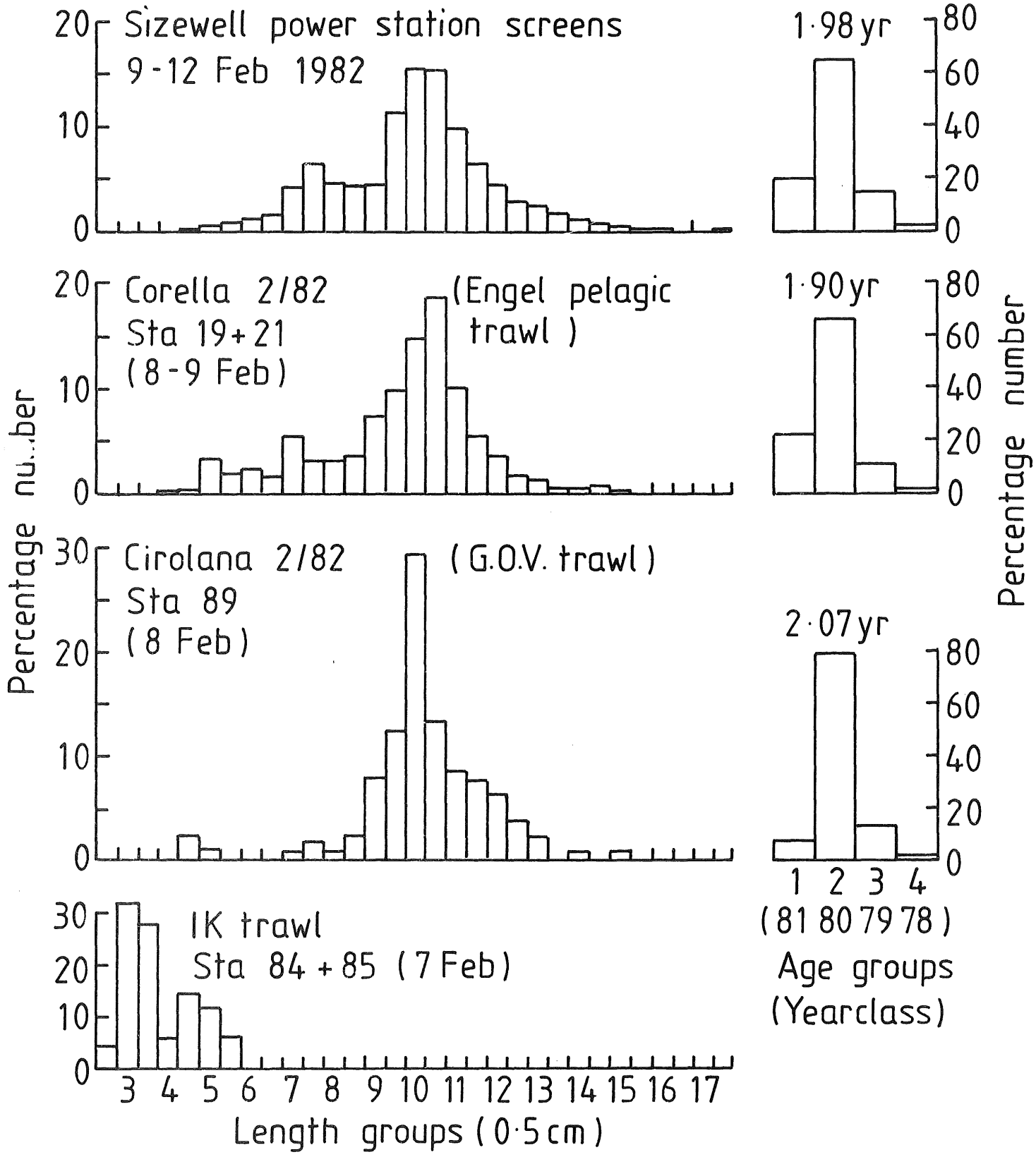


Figure 2 Length and age distributions of sprat taken on the screens of Sizewell Power Station and from research vessel samples off the Suffolk coast.

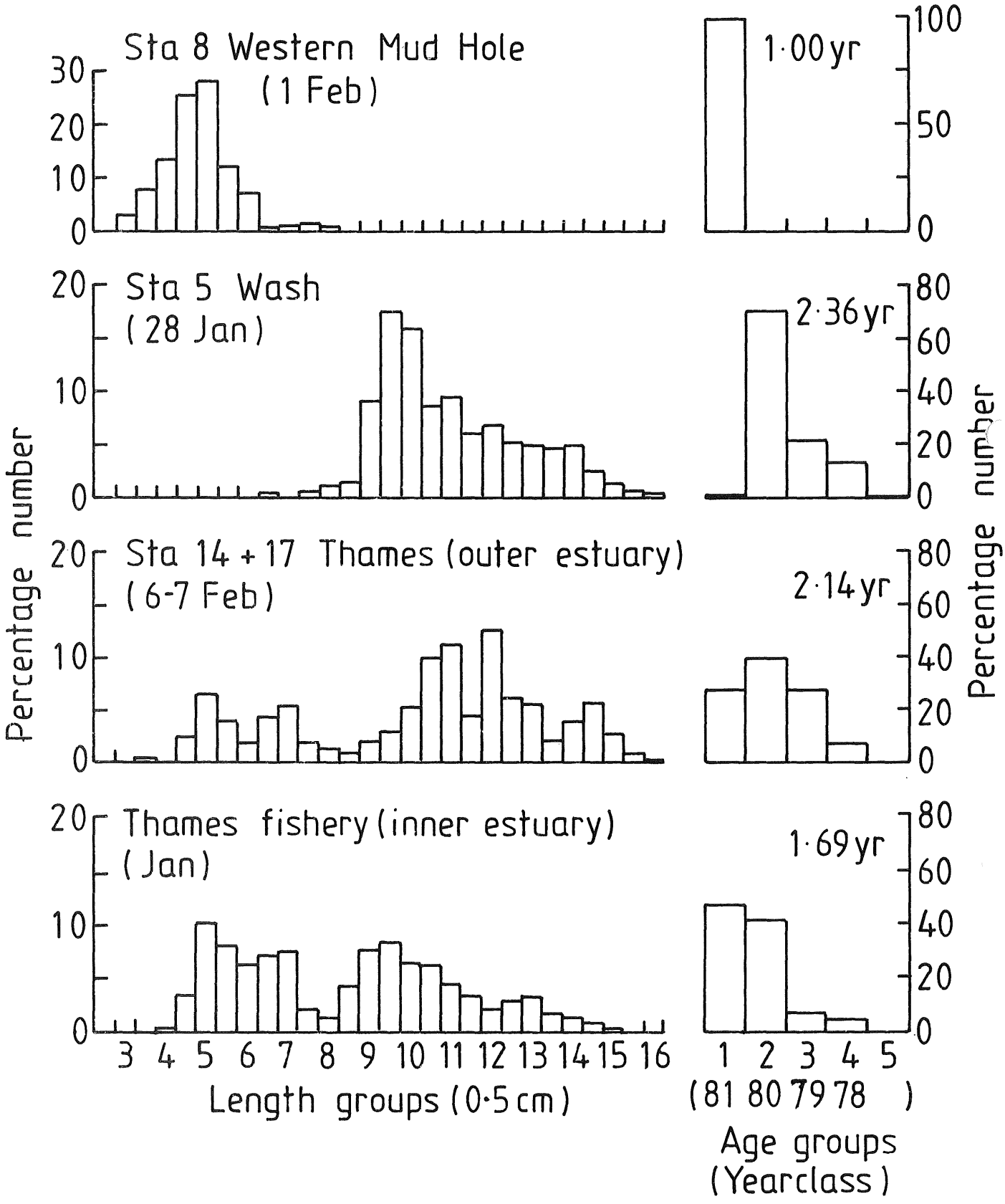


Figure 3 Length and age distributions of sprat from research vessel samples and the Thames sprat fishery.

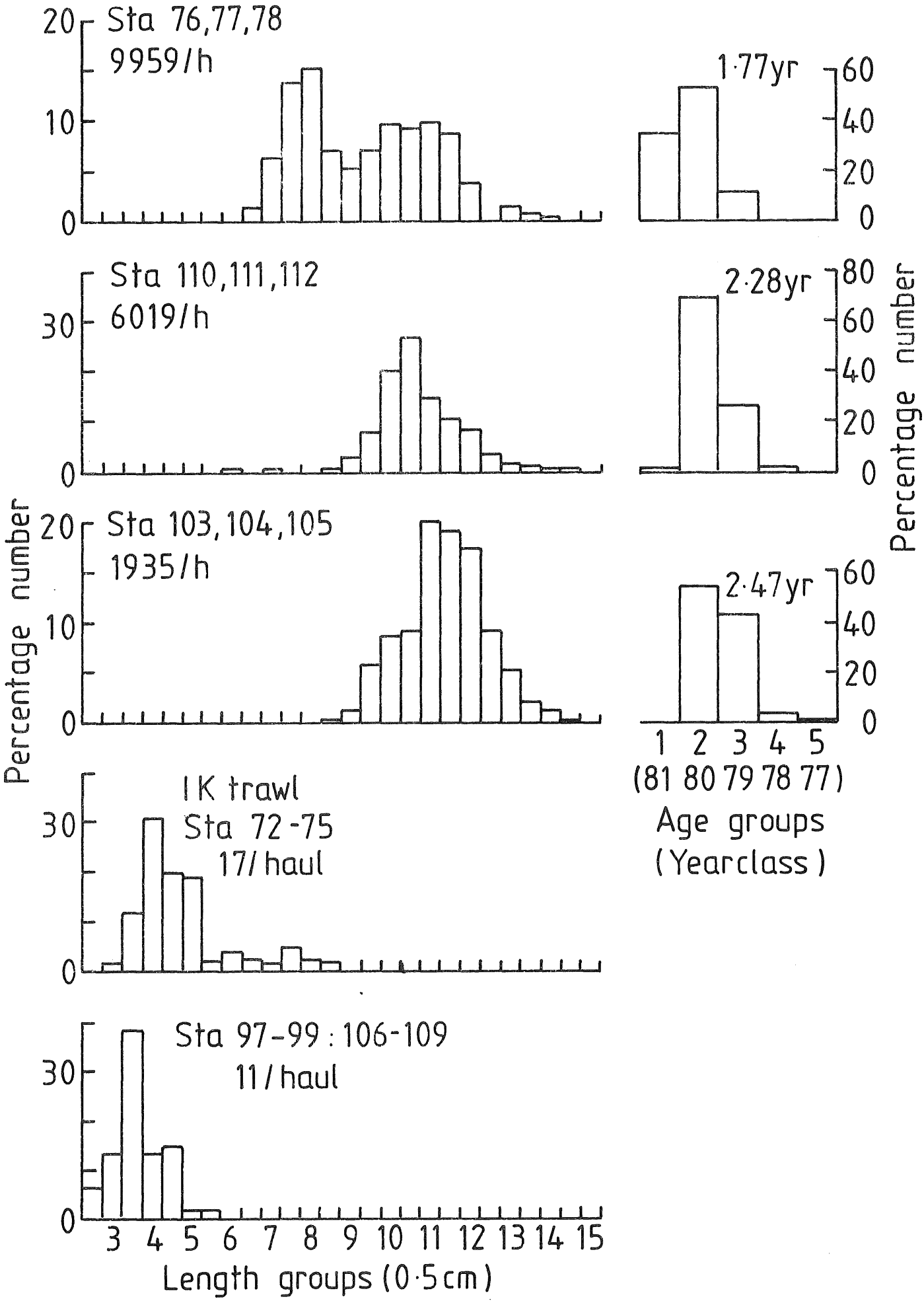


Figure 4 Length and age distributions of sprat samples taken by G.O.V. trawl on CIROLANA 2/1982.

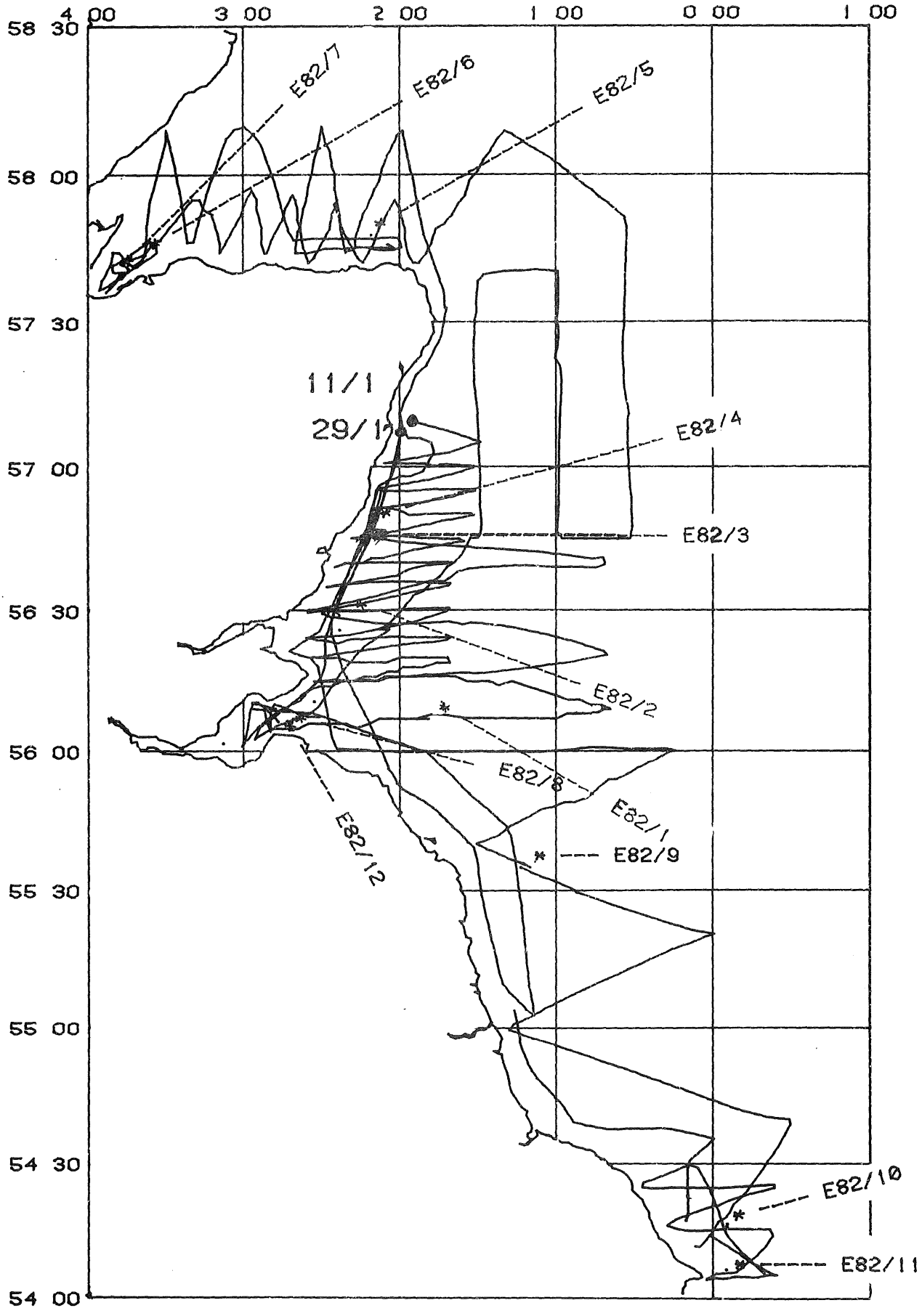


Figure 5 Track chart and fishing station positions for FRV EXPLORER, 11-29 January 1982.

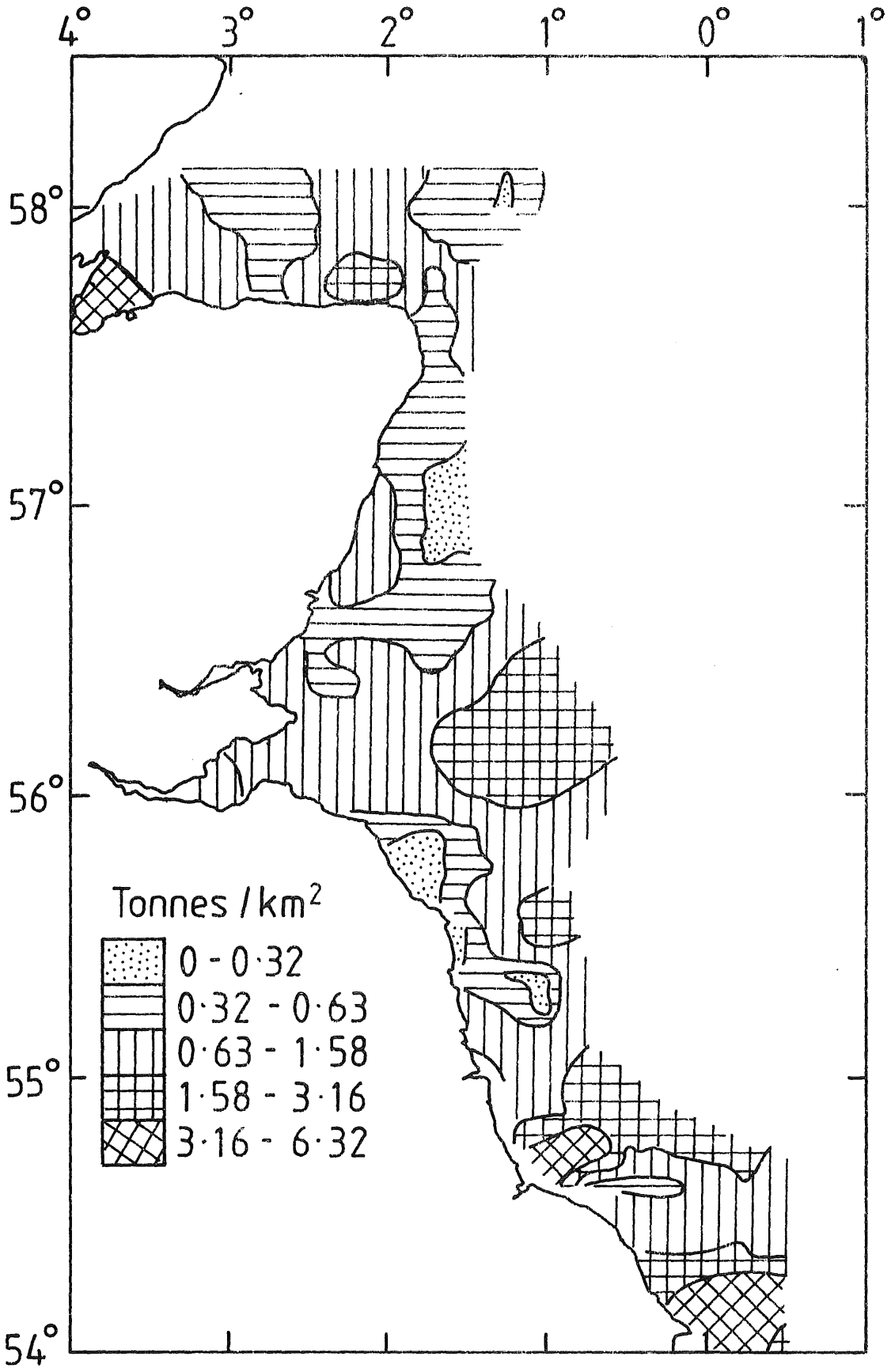


Figure 6 Total biomass density distributions recorded by FRV EXPLORER, 11-29 January 1982.

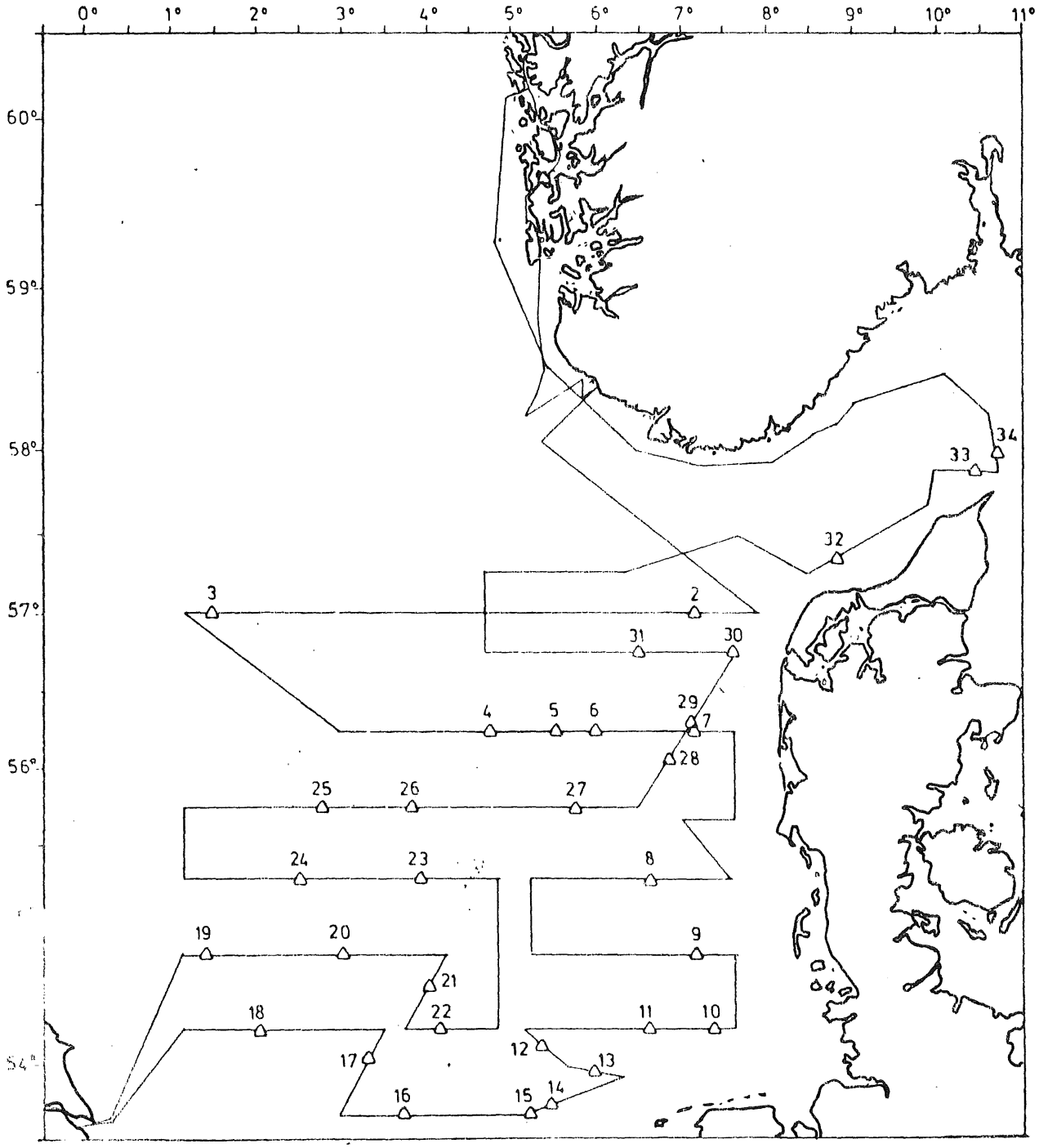


Figure 7 Track chart and fishing station positions for FRV JOHAN HJORT, 6-23 January 1982.

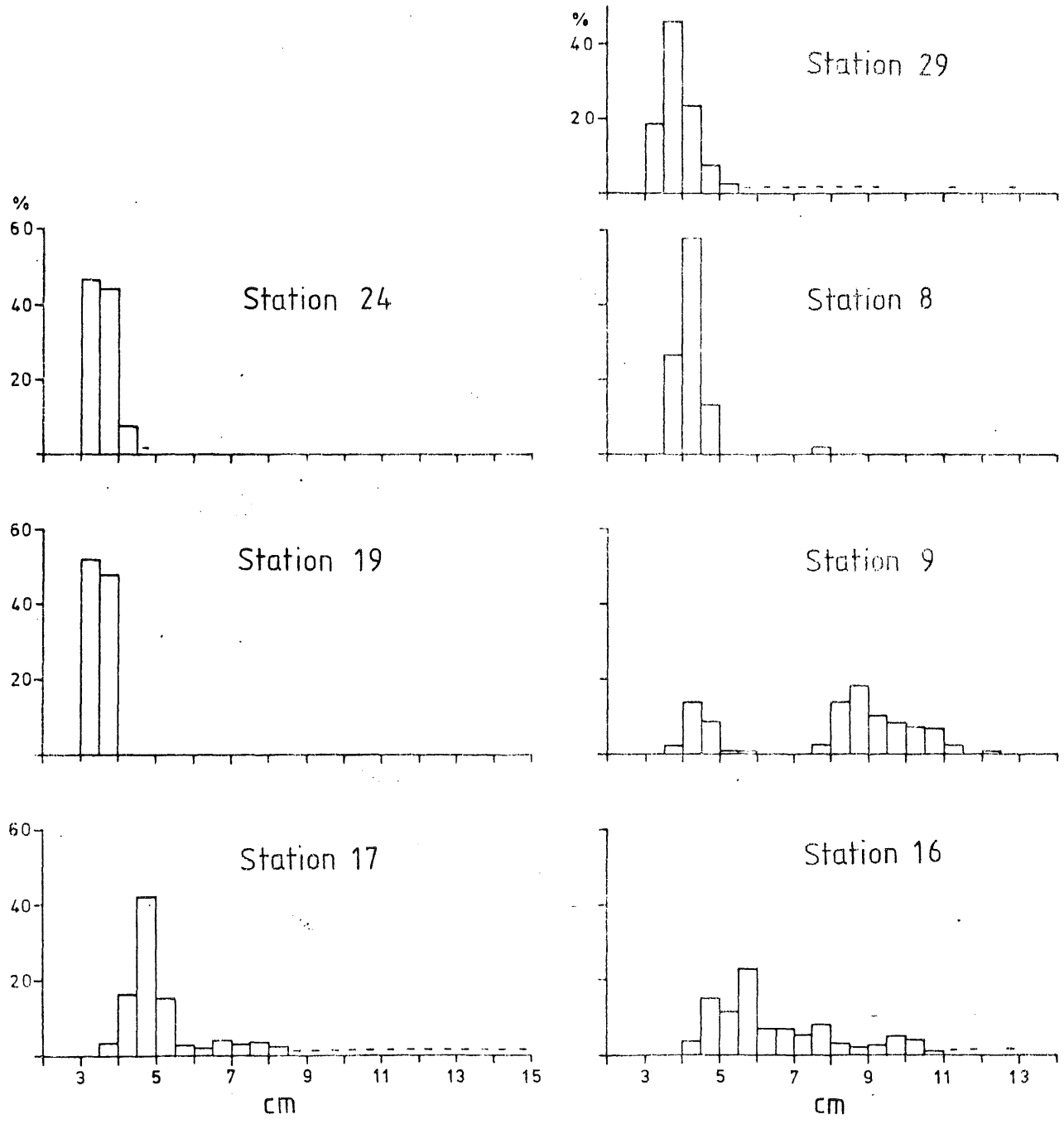


Figure 8 Length distributions of sprat from selected trawl stations for JOHAN HJORT, 6-23 January 1982.

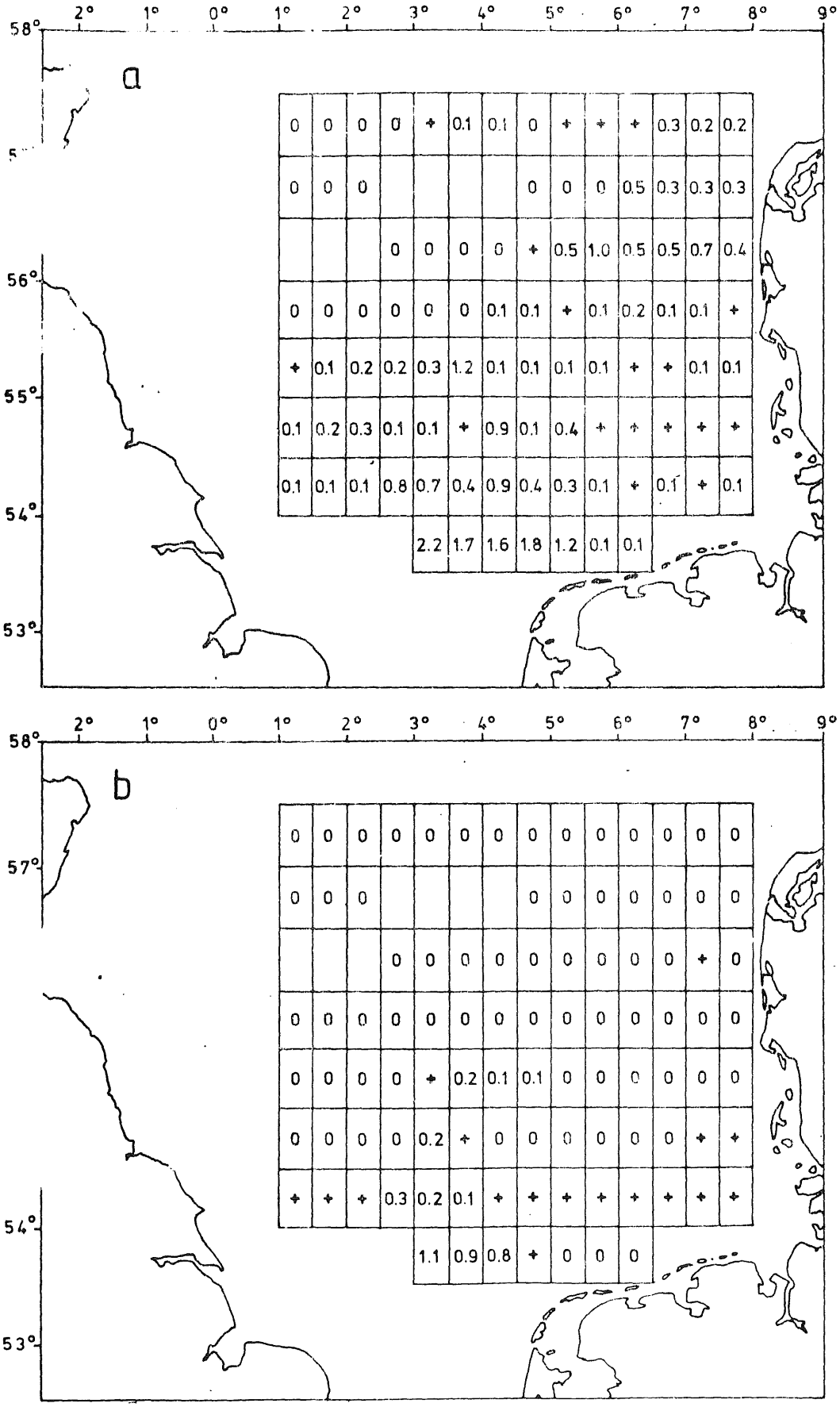


Figure 9(a&b) Results of Norwegian survey showing sprat biomass estimates (,000 tonnes) based on TS = 29 dB/kg
(+ = < 50 t)
(a) 1-group sprat
(b) older sprat

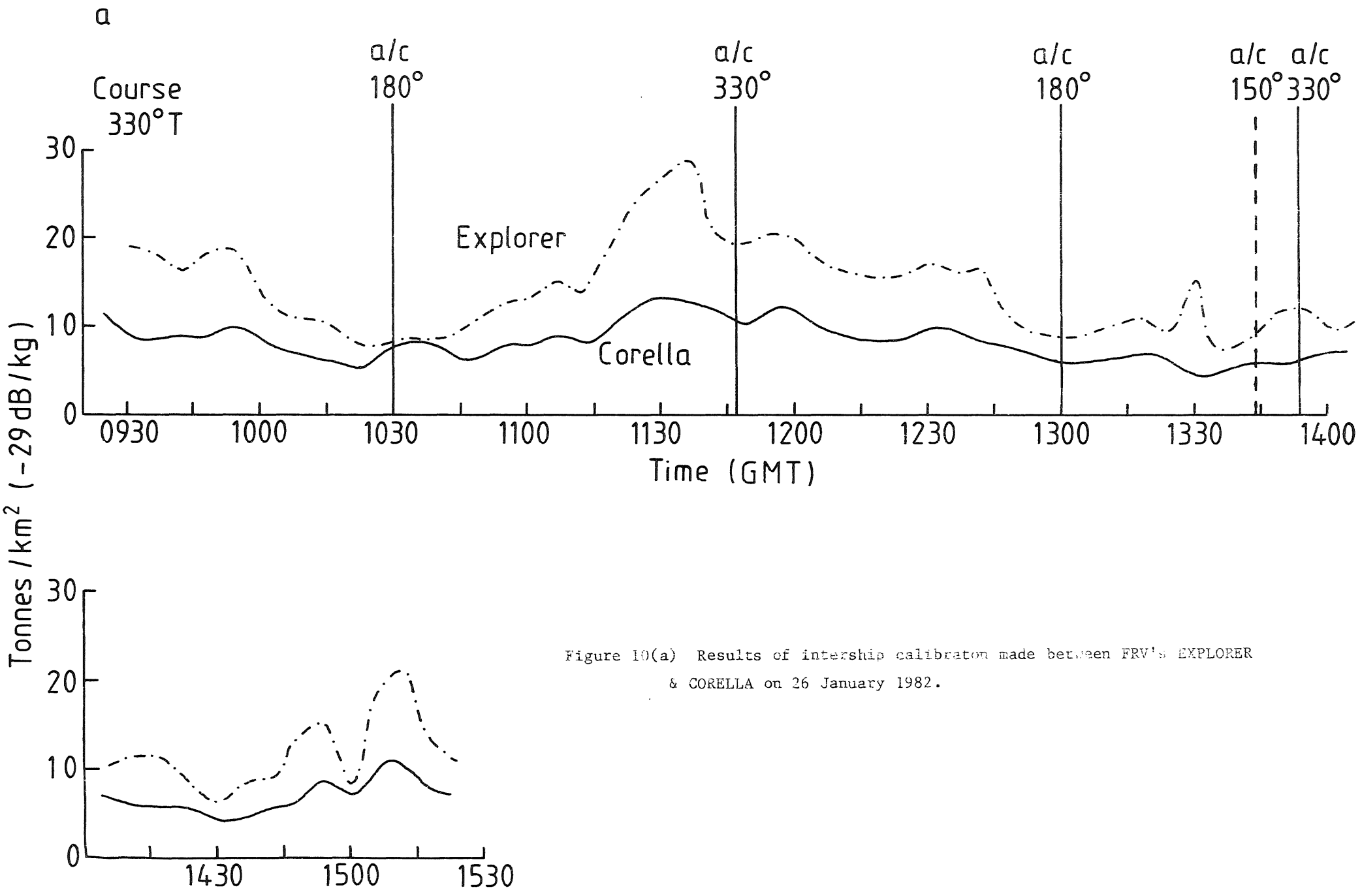


Figure 10(a) Results of intership calibraton made between FRV's EXPLORER & CORELLA on 26 January 1982.

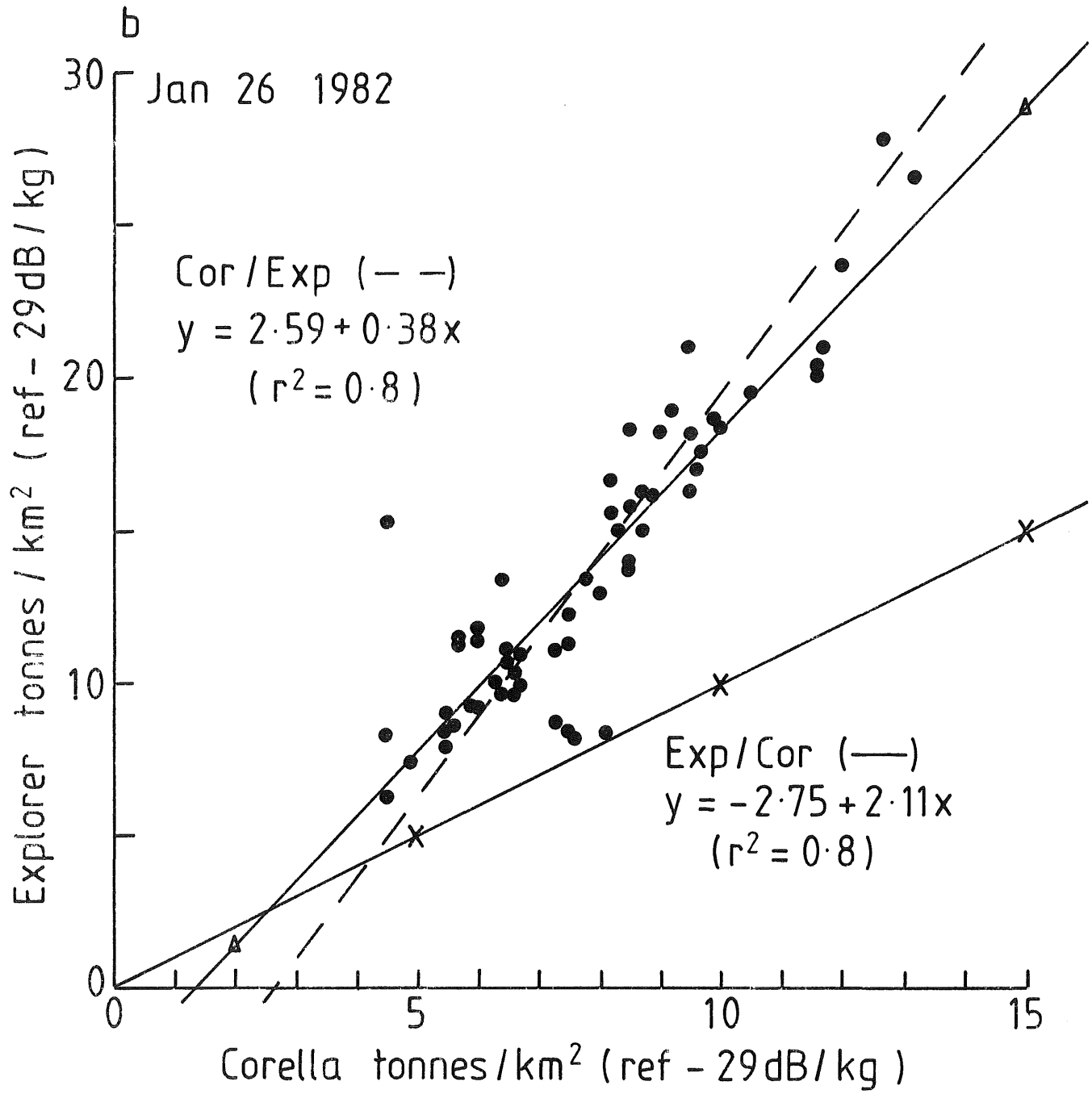
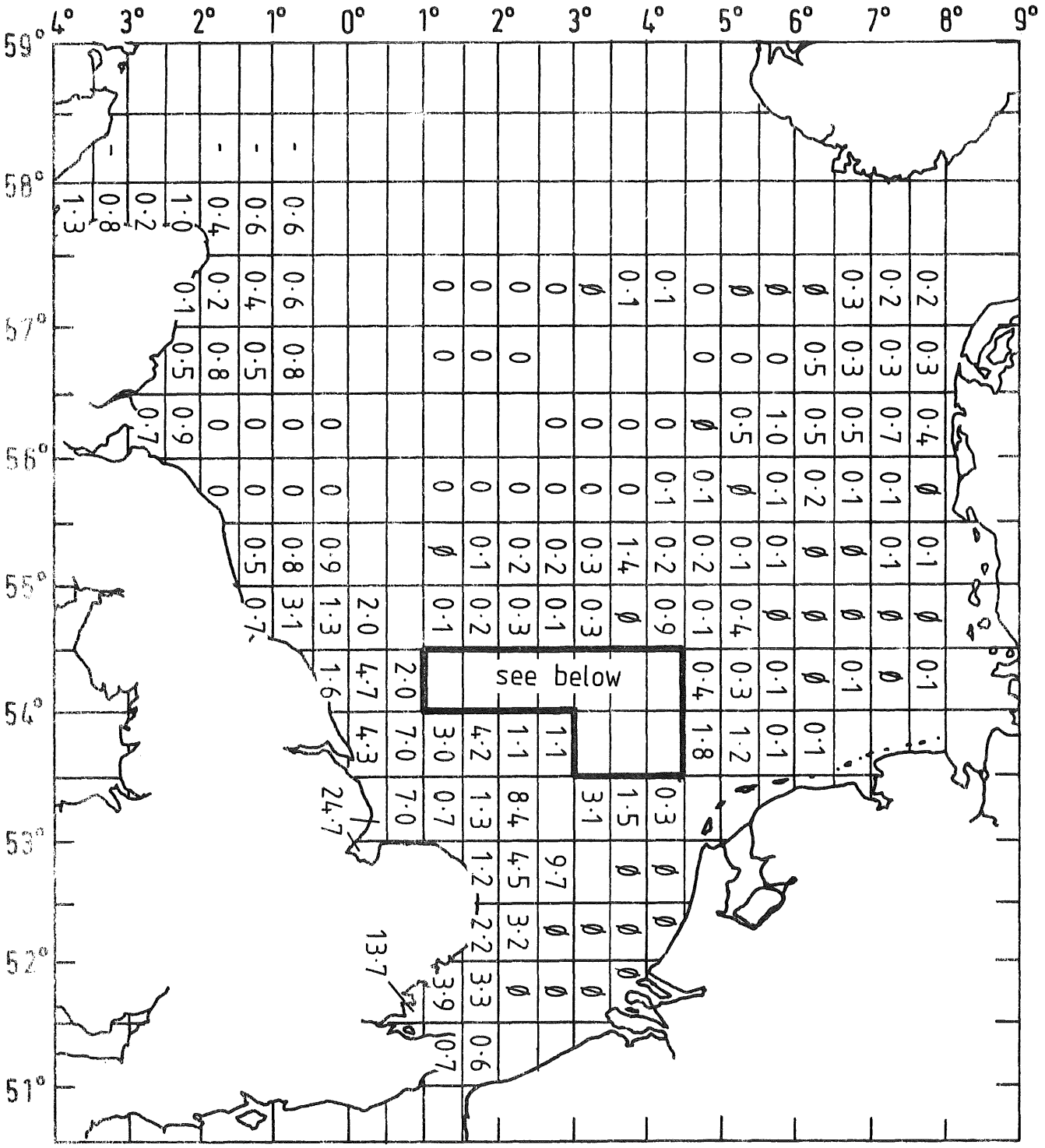


Figure 10(b) Regressions of intership calibration results.



0·1	0·1	0·1	1·1	0·9	0·5	0·9
1·3	1·8	1·5	1·4	1·0	0·8	0·9
				3·3	2·6	2·4
				1·9	0·8	1·1

Figure 11 Sprat biomass estimates (,000 tonnes) of all age groups for combined Scottish, Norwegian and English surveys.