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**REPORT OF THE PLANNING GROUP FOR ACOUSTIC SURVEYS
IN SUB-AREA IV AND DIVISION IIIA**

Copenhagen, 3 April 1989

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1 INTRODUCTION

1.1 Participants

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O. Hagström	Sweden
E.Kirkegaard (Chairman)	Denmark

1.2 Terms of Reference

In accordance with C.Res.1988/2:11, the Planning Group for Acoustic Surveys in Sub-area IV and Division IIIa met at ICES Headquarters on 3 April 1989 to:

- a) review the results of acoustic surveys on herring carried out in 1988 in Sub-area IV and Division IIIa;
- b) coordinate the planning of herring acoustic surveys in Sub-area IV and Division IIIa in 1989.

2 REVIEW OF ACOUSTIC SURVEYS IN 1988

2.1 Summer Surveys

2.1.1 Scottish survey in northwestern North Sea

The survey by R/V "Scotia" was carried out in the area shown in Figure 2.1 from 6-23 July 1988. Intensity of coverage was greatest north of 59°N, the exact position of east-west tracks being chosen from random number tables.

Classification of echotraces was based on examination of the echosounder record combined with the results of trawl hauls. Allocation to species was not easy in some areas in 1988. In some areas, "herring-like" traces gave catches only of 0-group Norway pout, while in others, dense traces near the surface were not sampled by trawl. Of the estimated total of 3,022 million herring in the area surveyed, only 10.5% were based on echotraces that could confidently be ascribed to herring. The remainder were based on the composition of the nearest trawl hauls.

Calculation of numbers at length and age were based on poststratified areas of similar length composition, within each of which a single age-length key was used. Two areas were identified, one in the extreme north and west of the area surveyed where a higher proportion of large herring was found, and the rest of the area which contained mostly herring less than 30 cm in length.

In contrast to previous years, the distribution of herring extended into deep water along the edge of the continental shelf, so the survey area almost certainly failed to limit the total distribution of herring.

2.1.2 Norwegian survey in northern and central North Sea

During 24 June - 16 July, R/V "Eldjarn" covered the area shown in Figure 2.1. The integrator values were allocated to the categories: herring (1+), 0-group herring, sprat, fish in mixed pelagic recordings, fish in mixed recordings along bottom, and plankton. Along the slope towards deeper water in the northern and eastern areas, herring schools were recorded separate from other species in the upper 50 m. In the Fladen area, some of the herring occurred in mixed recordings along bottom, and the integrator values were allocated according to trawl catches. In the other areas, the allocation was based on identification of different types of traces. Some uncertainties were connected to the distinction between sprat and herring in Division IVb.

An estimate of 2,870 million spawners (499,000 t) was obtained in the covered part of Division IVa, and an estimate of 486 million spawners (60,000 t) was obtained in the covered part of Division IVb. Compared to the results in 1987, this represents a large increase in Division IVa and a large decrease in Division IVb.

2.1.3 Swedish survey in the northeastern North Sea, Skagerrak, and Kattegat

The Swedish survey was carried out by R/V "Argos" during the period 1-19 August 1988. The areas covered by the survey are shown in Figure 2.1. The integration was carried out using a Simrad EK 400 38 kHz sounder and a Nord 10 computer with the same integration program as used in the Norwegian survey. The methods and stratification used are the same as used in the Danish survey (see Section 2.1.4. for details). A total of 46 pelagic hauls were made during the survey.

Vertical counts showed that two main components of herring, autumn spawners from the North Sea and spring spawners from Division IIIa, Southwestern Baltic, were mixed in the surveyed area. The two components were separated using a modal length analysis and results were verified with vertebral counts for each component. The result of the split is shown in Table 2.1. The distribution of the two components by age groups are given in Figures 2.2-2.5.

Spring spawners dominated the 3-group and older in all of the surveyed area up to about 60° 20'N. The 2-group found in the North Sea part was mixed from the entrance of the Skagerrak up to about 59°N. The separation indicated that 71% of the 2-group were autumn spawners. This should be regarded as a minimum value as the VS count indicates that the separation is not complete.

All the 0- and 1-group in the survey area could be allocated to the North Sea autumn spawners.

Sonar observations during the survey showed that herring shoals were close to the surface both during day and night, especially in deeper waters. Avoidance reactions were frequently observed and the estimate of age group 3 and older herring could be too low.

2.1.4 Danish survey in central North Sea

During the period 21 July - 4 August, an acoustic survey was carried out by R/V "Dana" in the eastern North Sea. The area covered during the survey is shown in Figure 2.1.

The acoustic data were collected using a Simrad EK 400 38 kHz sounder and a QD integrator. During the survey, 18 pelagic and 7 demersal trawl hauls were taken. The stratification used in the calculations was based on total depth within larger geographical units (sub-areas). Each sub-area was divided into up to six strata based on bottom depth.

For each stratum, a mean TS value per fish was estimated using species and length compositions of the trawl hauls taken in the stratum and published TS-length relationships. The total number of fish was then estimated using the mean area backscattering values, the area of the stratum, and the mean TS value. The number of fish was then allocated to species and length group using the composition of the trawl hauls. The TS-length relationships used are given in the text table below.

Species	TS - length relationship
Herring	TS = 20.0 log(L) - 71.2
Sprat	TS = 20.0 log(L) - 71.2
Horse mackerel	TS = 20.0 log(L) - 71.2
Mackerel	TS = 20.0 log(L) - 77.2
Gadoids	TS = 20.0 log(L) - 67.5

Herring and mackerel accounted for more than 70% of the total catches. Compared with previous years' surveys, the catch of horse mackerel was very low.

The estimated number of herring was 9,557 million (350,000 t). 1-ring fish dominated (60% in number), while the abundance of 0-ring herring was found to be very low compared with previous years.

2.1.5 Combined results of the summer surveys

The surveyed area was divided into six areas as shown in Figure 3.1. In areas where the surveys did not overlap, the combined results were taken as the sum of the results from the different surveys. No correction was made for uncovered areas.

Division IVa east was surveyed by R/V "Eldjarn" and R/V "Argos". To the area west of 2° E and the area north of 60° 30' N, the results from R/V "Eldjarn" were used, while the data from R/V "Argos" were taken as representing the herring found in the other part of the area. The distribution of herring might have changed during the 4-week period between the two surveys. The results, however, indicate a relatively stable distribution of the two components of herring present in the area. Spring spawners dominated along the Norwegian coast, while autumn spawners were found more to the west. The Swedish data on vertebral count (Table 2.1) indicate that all 2-ringers north of 59° N were autumn spawners, while the fish between 57° N and 59° N were a mixture of spring and

autumn spawners. For 3-ringers and older, the data indicated pure spring spawners south of $60^{\circ}30'N$. The data also showed that the abundance of spring spawners west of $2^{\circ}E$ was very low. The Planning Group decided to use the Swedish data on vertebral count to split the estimated number of herring in the area between $57^{\circ}N$ and $60^{\circ}30'N$ and east of $2^{\circ}E$ into autumn and spring spawners. The 2- and 3-ring autumn spawners were split into mature and immature fish using the Norwegian maturity data.

In Division IVb east, the results from R/V "Argos" were used for the most northern part, and the data from R/V "Dana" for the rest of the area. The estimates from R/V "Argos" were split into autumn and spring spawners. In the part covered by "Dana", no spring spawners were observed. As no information on maturity stage was available to the Planning Group, the Group decided to use the data from last year's survey, where all 2- and 3-ringers were found to be immature.

The combined results are given in Table 2.2 as estimated number of herring by age and area split into spring and autumn spawners. The geographical distribution of 0-, 1-, 2-, and 3+-ringers is shown in Figures 2.2-2.5. The mean weights at age are given in Table 2.3.

The combined spawning stock (autumn) estimate for the entire area is 5,442 million fish or 896,000 t. The total number of 1-ringers and 0-ringers was found to be 13,219 million and 12,032 million, respectively, including the estimates from the Skagerrak and Kattegat area. Compared with previous years, the estimated number of 0-ring herring is very low.

The estimated number of spring spawners is 2,454 million, of which 62% are 2-ringers.

The distribution of herring was found to be more northern than in previous years, and the survey area may not have covered the total distribution of herring.

2.2 Other Surveys

2.2.1 Norwegian survey in Skagerrak, Kattegat, and eastern part of Division IVb

During 11 November - 11 December, 1988, R/V "Eldjarn" covered Divisions IIIa and IVb east of $3^{\circ}E$. Acoustic estimates of herring are as follows:

Age	Millions	
	Div. IVb, east	Div. IIIa
0	1,495	2,257
1	297	2,803
2	32	54
3	4	23
4	2	5
5	-	-
6	-	-
7	-	-
Total	1,829	5,153
Biomass ('000 t)	49	234

These estimates are lower than the estimate from a similar survey in 1987, particularly those for 0-ringers. Only the estimate of 1-ringers in Division IIIa is at about the same level as in 1987.

3 HERRING ACOUSTIC SURVEYS IN 1989

3.1 Programmed Surveys

During the period 28 June - 7 August 1989, four ships are scheduled to carry out a survey of the North Sea north of 54°N and of Division IIIa. From the distribution of herring recorded in 1987 and 1988, the Planning Group recommends that (1) the survey area should be extended north over the edge of the continental shelf into water up to 300 m depth, and (2) the survey should be delimited in the south at 54°N.

The area of coverage by each country and the dates of the surveys are given in Figure 3.1.

3.2 Survey Strategy

It is proposed that the surveys should be carried out in the same way as in previous years. Counts of vertebral number will be made in the eastern parts of Division IVa and b to provide a basis for distinguishing North Sea autumn spawners from Baltic spring spawners.

Area		Age group				
		1	2	3	4	5
IVa E North	% autumn sp.	100	100			
	VS	56,46	56,21			
	mean length	215,00	245,28			
	% spring sp.			100	100	100
	VS			55,89	55,77	55,81
	mean length			250,65	277,95	281,71

Area		Age group				
		1	2	3	4	5
IVa E South	% autumn sp.	100	71			
	VS	56,57	56,34			
	mean length	209,84	245,34			
	% spring sp.		29	100	100	100
	VS		56,07	56,13	56,14	55,83
	mean length		208,24	258,89	277,88	285,43

Area		Age group				
		1	2	3	4	5
Skagerrak	% autumn sp.	100				
	VS	56,37				
	mean length	177,41				
	% spring sp.		100	100	100	100
	VS		56,03	55,80	55,68	55,66
	mean length		211,29	238,12	259,34	274,69

Area		Age group				
		1	2	3	4	5
Kattegat	% autumn sp.	100				
	VS	56,46				
	mean length	161,67				
	% spring sp.		100	100	100	100
	VS		55,89	55,77	56,00	55,60
	mean length		198,29	225,89	233,57	254,00

Table 2.1 The % autumn and spring spawners per age group and area, based on vertebral count.

Table 2.2 Estimated numbers of herring at age (millions) per spawning group and area.
 N = numbers; B = biomass ('000 t); I = immature; M = mature.

Age	IVa E			IVb E			Skagerrak		Kattegat		Total	
	IVa W	Sp	Au	IVb W	Sp	Au	Sp	Au	Sp	Au	Sp	Au
0	-	-	0.0	4651.0	-	3675.0	-	2097.3	-	1608.6	-	12031.9
1	19.0	-	162.4	552.2	-	5697.0	-	2871.4	-	3746.4	-	13219.4
2 I	778.9		198.1	275.0		192.8			-			1444.8
M	1857.1	152.3	549.7	350.0	42.0		843.4		473.9		1511.6	2756.8
3 I	156.0		2.5	19.0		1.0			-			178.5
M	1186.4	517.2	258.9	107.8	29.6		184.0		30.6		761.4	1553.1
4	403.8	63.6	107.4	15.0	3.0	2.0	20.1	-	-	-	86.7	528.2
5	267.3	66.2	74.3	7.0	1.4	-	6.2	-	1.8	-	74.2	348.3
6	143.3	12.2	28.8	2.0	0.7	-	5.8	-	-	-	18.0	174.1
7	34.0	1.0	8.6	0.8	-	-	-	-	-	-	1.0	43.4
8	18.2	1.2	4.9	-	-	-	-	-	-	-	1.2	23.1
9+	11.5	-	2.8	-	-	-	-	-	-	-	-	14.3
Total	4876.0	813.7	1398.4	5980.0	76.7	9564.8	1059.5	4968.7	506.3	5355.0	2454.0	32316.0
Spawn N	3922.0		1035.4	483.0		2.0						5442.0
Spawn B	661		175	61		0		0		0	116	895

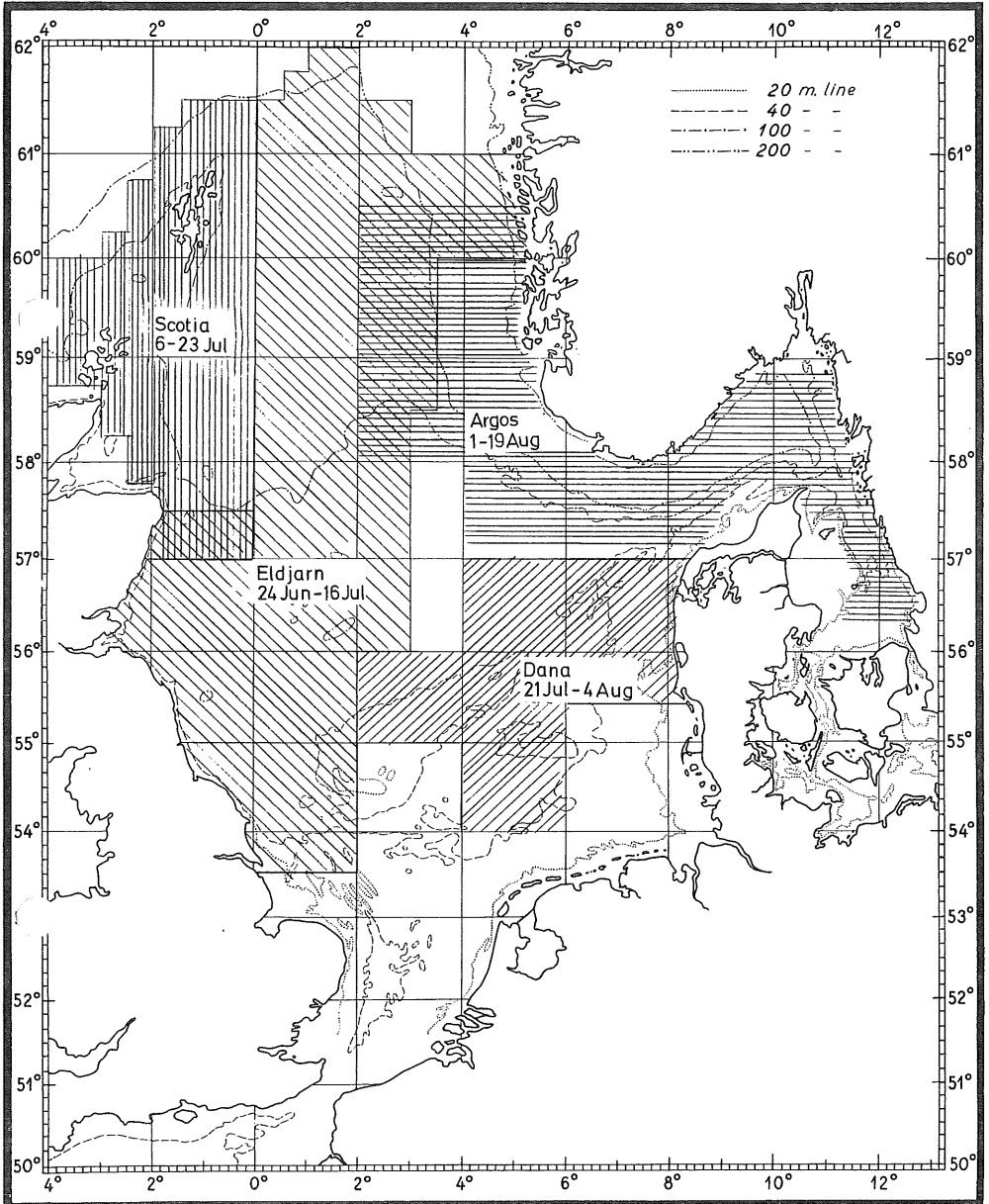


Figure 2.1 The areas covered during the four surveys.

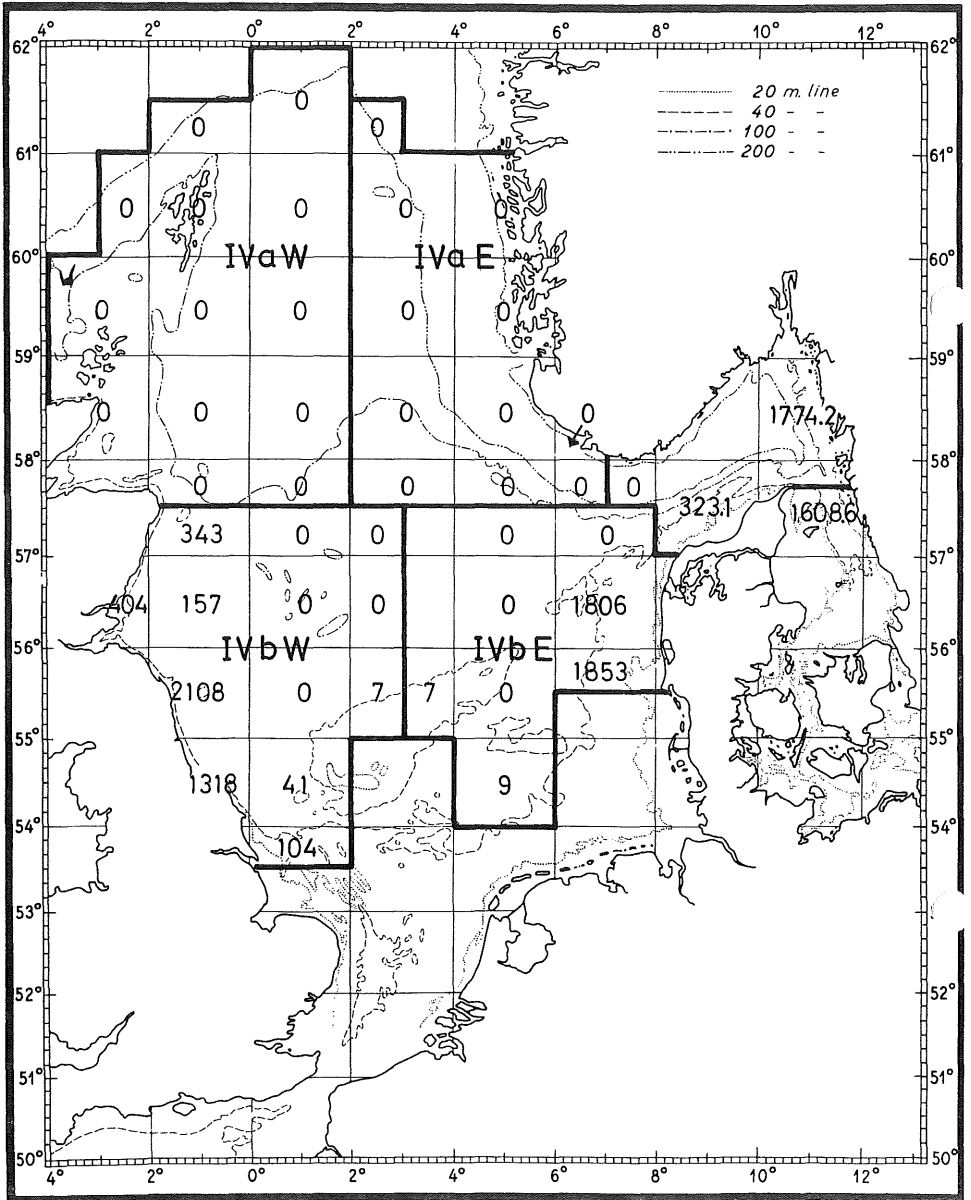


Figure 2.2 Estimated numbers (millions) of 0-ring herring.

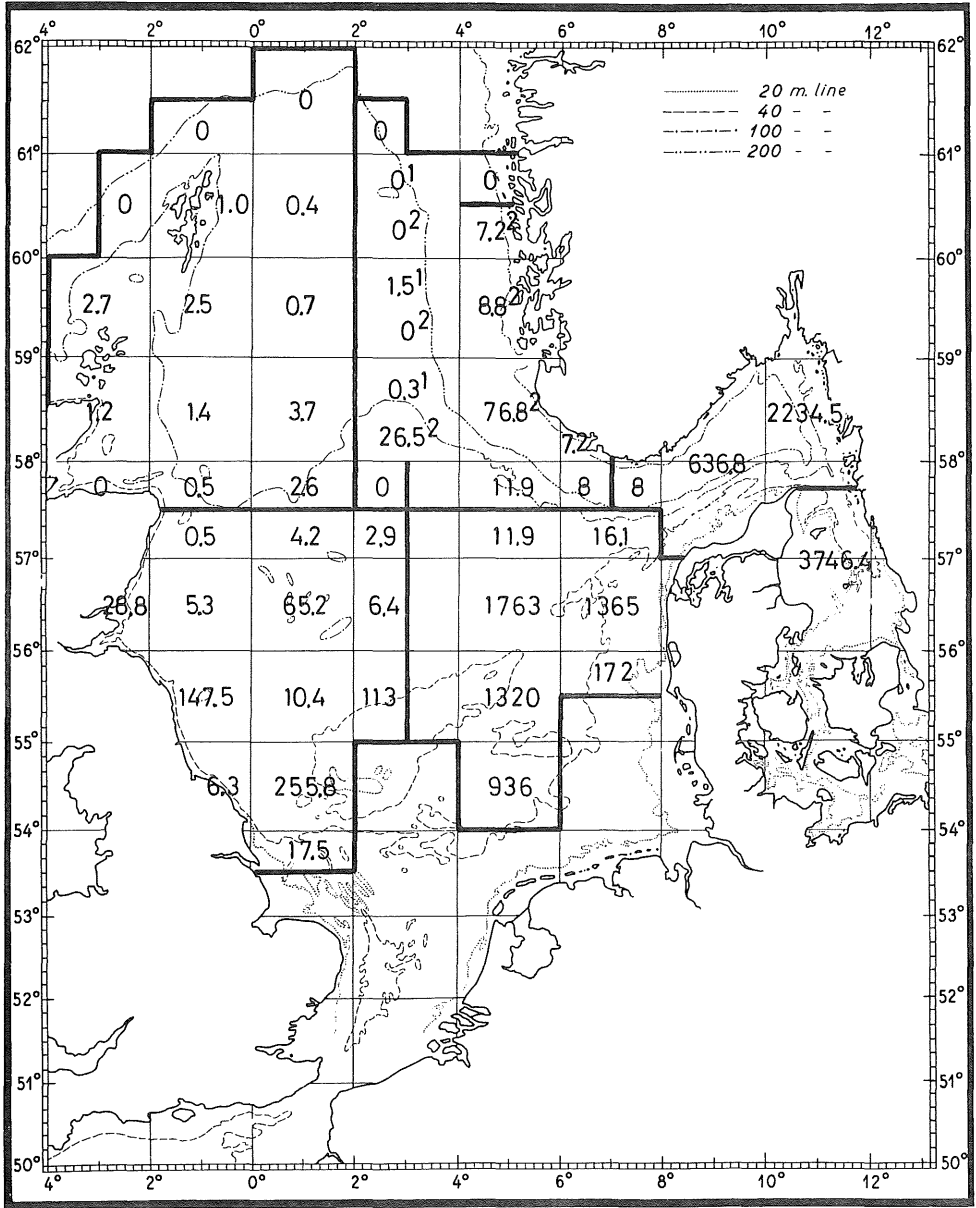


Figure 2.3 Estimated numbers (millions) of 1-ring herring .
¹Norwegian estimate.
²Swedish estimate.

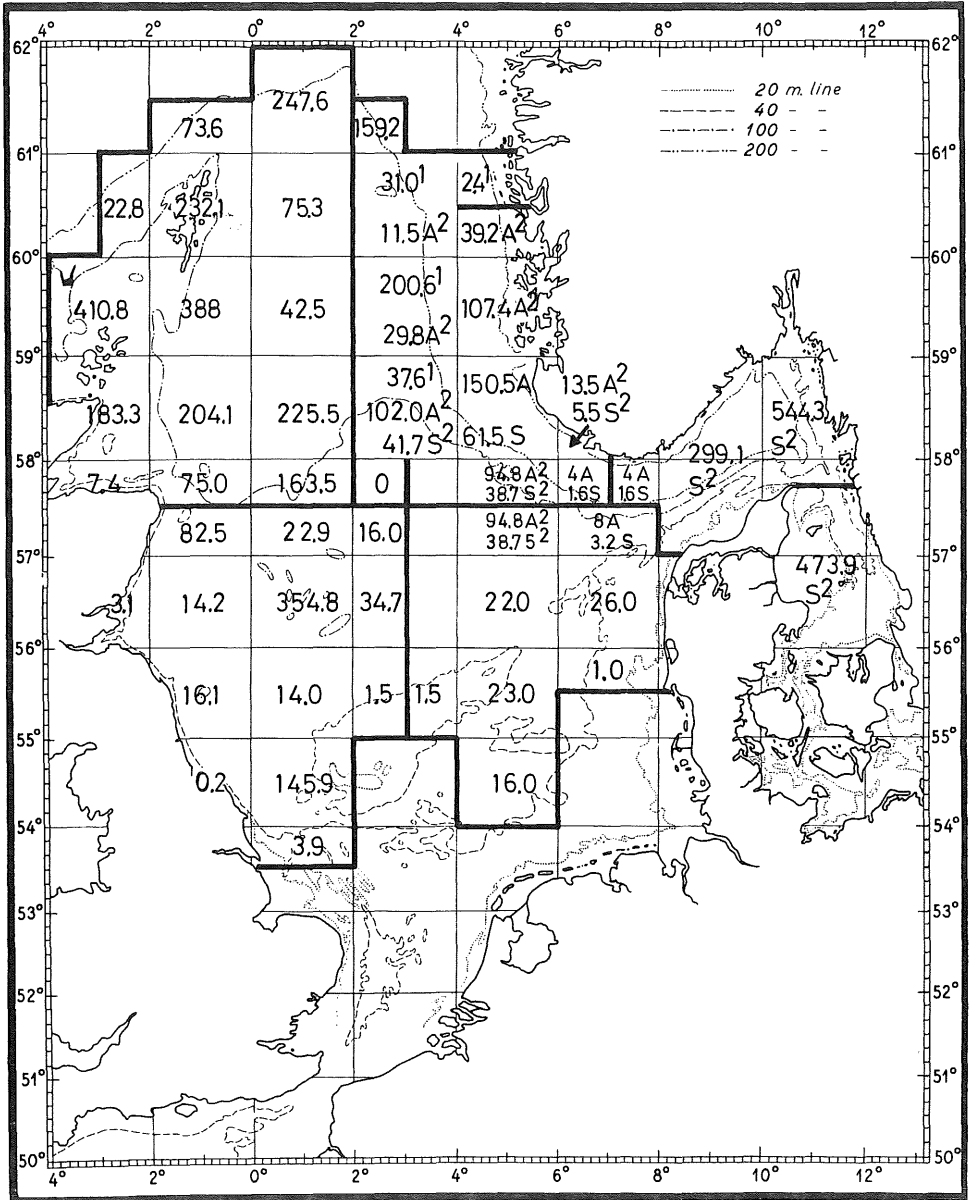


Figure 2.4 Estimated numbers (millions) of 2-ringers.

¹Norwegian data.

²Swedish data.

A: Autumn spawners.

S: Spring spawners.

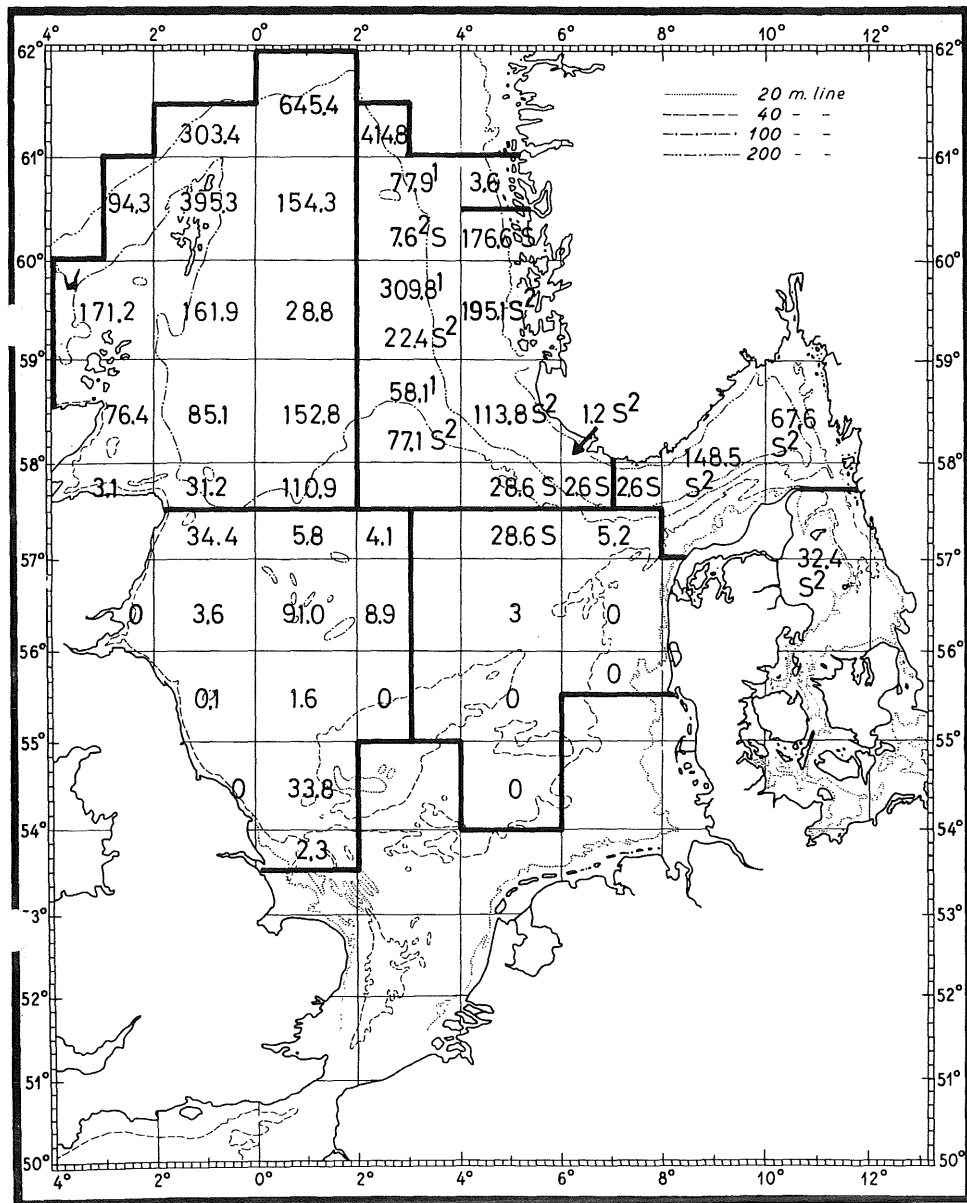


Figure 2.5 Estimated numbers (millions) of 3+-ringers.

¹Norwegian data.

²Swedish data.

A: Autumn spawners.

B: Spring spawners.

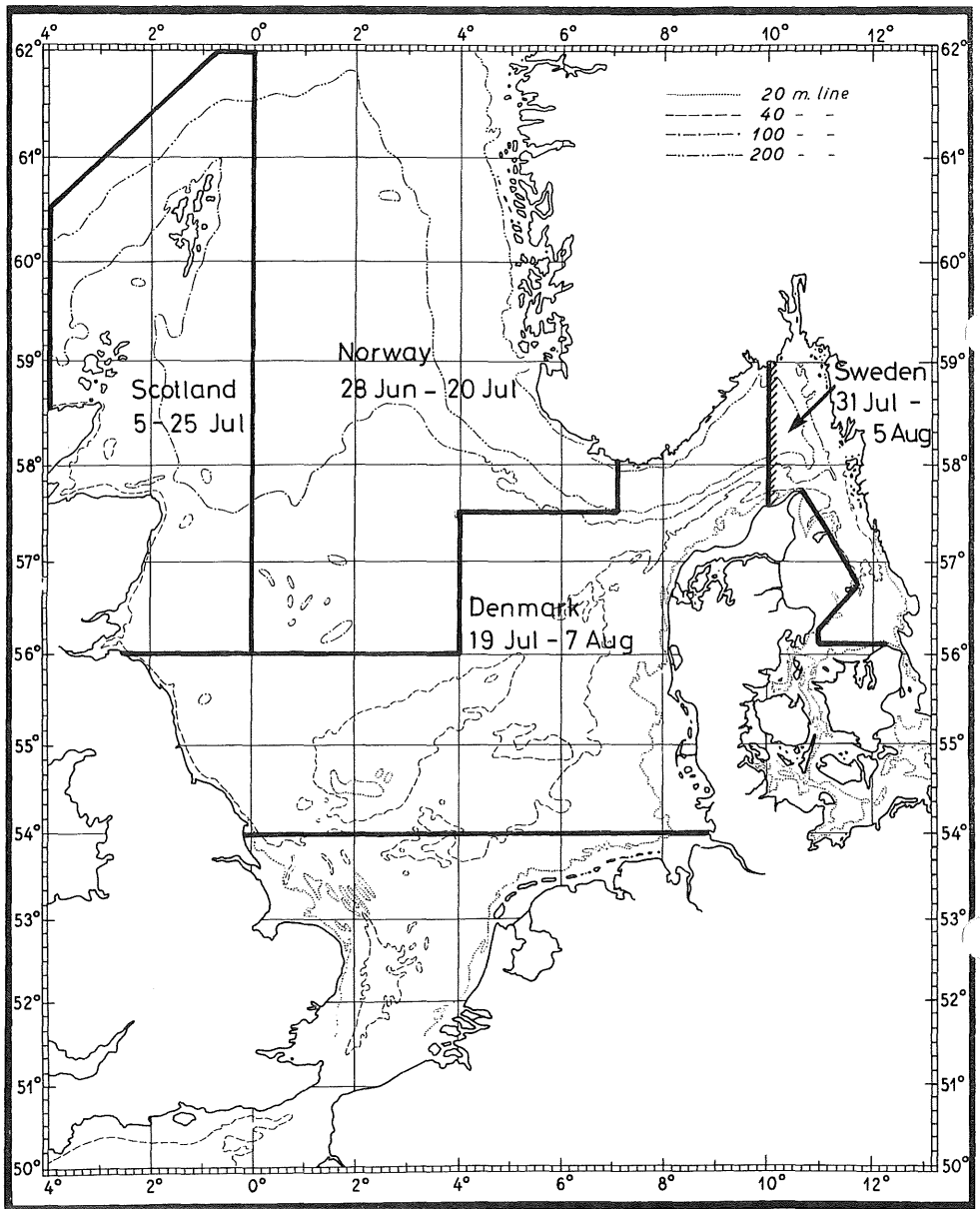


Figure 3.1 Areas and dates of surveys in the period June-August 1989.

