Baltic Committee

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REPORT OF THE

Study Group on Baltic Acoustic Data

Gdynia, Poland
6–8 April 1998

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International Council for the Exploration of the Sea
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1 TERMS OF REFERENCE

ICES Council Resolution C.Res. 1997/2:40

The Study Group on Baltic Acoustic Data [SGBAD] (Chairman: E.Götze, Germany) will meet in Gdynia, Poland from 6-8 April 1998 to:

a) compile and analyse results from all acoustic surveys carried out in 1997 (except SD 22-24 surveys on herring, which are reported to the HAWG);

b) prepare a first draft of a Manual for Baltic International Acoustic Surveys (BIAS);

c) establish an acoustic database BAD2 (for 1997 data), which includes information on ESDU and biological sampling processes. This database BAD2 should replace the existing database BAD1 for 1997 and the BAD1 database should be extended to cover the years 1989-1991.

SGBAD will report to the WGBFAS and to the Baltic and Resource Management Committees at the 1998 Annual Science Conference.

2 PARTICIPATION

The following members of the Study Group were present at the meeting in Gdynia 6-8 April 1997:

Mr E. Götze (Chairman)	Germany
Dr F. Arrhenius	Sweden
Dr W. Grygiel	Poland
Dr R. Grzebielec	Poland
Mr N. Hakansson	Sweden
Mr M. Kaczmarek	Poland
Mr N. Nazarov	Russia
Dr A. Orlowski	Poland
Mr V Severin	Russia
Dr F. Shvetsov	Latvia
Mr K.-J. Staehr	Denmark

3 DESCRIPTION AND RESULTS OF THE 1997 ACOUSTIC SURVEYS

In 1997 the following acoustic surveys were conducted during the time period October/November:

Vessel	Country	Area
ATLANTNIRO	Russia, Latvia	26,28
BALTICA	Poland	25,26 (parts 24)
SOLEA	Germany, Denmark	22,23,24 (parts21)

3.1 R/V AtlantNIRO

Russian and Latvian scientists carried out an acoustic survey aboard R/V „AtlantNIRO" in Subdivisions 26 and 28 from 12 - 31 October 1997. The integration covered 16419 square nautical miles and the integrated track was 1280 nautical miles.

The survey grid and position of the trawl hauls are shown in Figure 3.1.1.

The hydroacoustic equipment used was SIMRAD EK-500 echosounder working at 38kHz and the echointegrator system BI-500. The working speed of the vessel was 8 knots, the trawling speed was 4 knots. The integration interval was 1 Nm.

The equipment was calibrated against a standard copper sphere in the vicinity of the Baltiysk harbour in calm weather. The vessel has been set by means of 3 anchor lines. The calibration sphere was at the distance of 11,4 m from transducer surface. The integration and hauling were performed during the daytime.

R/V „AtlantNIRO" used the midwater trawl RT/TM 70/300 with a vertical opening 28 - 32 m and bar length in the codend of 6,5 mm. Totally 60 sample hauls were made.

The back scattered energy was allocated to species on the basis of the catch and its length composition, using the following target strength regression for clupeoids:

TS = 20,0 LogL (cm) - 71,2 dB.

The survey results are given in Tables 3.1.1 - 3.1.5.

3.2 R/V Baltica

The Polish acoustic survey was carried out by R/V BALTICA in the Polish EEZ in Sub-divisions 25 and 26 from 4-14 October, 1997.

The acoustic measurements were conducted both during day and night with EK400 echosounder and QD echointegrator. Echo deflection (mm), Sv values and layer thickness were transferred into a PC and stored on HDD for time intervals corresponding to a distance of 1 Nm (ESDU=1 Nm).The working speed of the vessel was 7-9 knots. The calibration constant was used the same as in previous year.

A modified midwater trawl WP53/64x4 with 11 mm bar length in the codend was used to collect biological samples. The trawling speed was 3-4 knots , and haul duration 30-60 minutes.

Fish numbers were estimated using the TS-length regressions:

clupeoids: TS=20logL-71.2
gadoids: TS=20logL-67.5

Total number of fish was divided into species and age groups according to the species and age composition of the catch. ALKs were made for each Sub-division for sprat and herring.

Data collected: 535 ESDU (88% of the total area of the Polish EEZ below 20 m depth, 44% of ICES SD25, 26 depth 10 m); 14 hauls; herring - length 14 sample (2438 ind.), age 13 sample; sprat - length 14 sample (3202 ind.), age 13 sample.

Acoustic track and trawl stations are presented in Figure 3.2.1. The survey statistics is given in Table 3.2.5. The calculated stock size and mean weight of herring and sprat per age group are given in Tables 3.2.1 - 3.2.4.

3.3 R/V Solea

A joint German-Danish acoustic survey was carried out with R/V „Solea“ from September 12th to October 2nd 1997. The survey covered the whole sub-divisions 22, 23, 24 and the southern part of the Kattegat. All investigations were performed at night as in the last years.

The acoustic equipment used was an echosounder EK500 connected to the Bergen-Integrator BI500. The transducer 38-26 was installed in a towed body. The towed body had a lateral distance of about 30m from the ship to decrease the influence of escape reactions of fish.

The cruise track was 1035 nm long and 48 Trawl hauls were carried out to identify the targets. From each haul samples were taken for the determination of length, weight and age. After the haul the hydrographic condition was investigated by an CTD-probe.

The s_a values for each stratum were converted into fish numbers using the TS-length regressions:

Clupeids:	TS = 20 log L (cm) - 71.2
Gadoids:	TS = 20 log L (cm) - 67.5

The estimation of abundance is presented in Tables 3.3.1-3.3.5. Cruise track and haul positions are depicted in Figure 3.3.1.

The abundance of herring was similar to the year before with a slight increasing of about 15 % in all subdivisions. However the sprat numbers in all subdivisions were increased by more than a factor of two approaching the long-term mean in this areas.

4 INTERCALIBRATIONS BETWEEN R/V *ARGOS* AND R/V *SOLEA*

4.1 Selectivity of trawl catches

The species and length composition in the trawl hauls have direct influence on the abundance estimate since the equivalent back-scattering area of the fish is species and size dependent. Different catch selectivity of different vessels and gear can therefore bias the result. It was recommended by the Baltic International Fish Survey Working Group in 1997 (ICES C.M. 1997/J:4) that studies are performed to investigate this possible source of variance. Therefore, selectivity data on trawl catches was obtained during a joint investigations of the Swedish and German R/V *Argos* and *Solea* in October 1997.

The German R/V *Solea* used the trawl called *Krake*, with a vertical opening of 10.5 m and a wing tip distance of 20 m. The mesh size in the cod-end was 10 mm. The Swedish R/V Argos used the trawls *Fotö* with a vertical opening of 14 - 17 m and the trawl *Macro* with a vertical opening of 17 - 22 m. Both Swedish trawl have had a mesh size of 21mm in the cod-end.

In appendix I an attempt was done to compare selectivity for a mix of herring and sprat in the Bornholm depth area. The analysis indicated that the selectivity for young fish was different between trawls. However, it seems to be possible to transpose the selectivity data obtained from commercial vessels by using a correction function to compensate the effect of selectivity of the trawl. The results we got are plausible. But it is also possible to correct data obtained with mesh sizes not much larger as the optimum size. In every case it is advisable to check the selectivity of the research trawl in the described way. In Appendix I (Figure 4) we can see, that the larger the trawl is the larger the portion of the larger fishes in the length distribution. This effect can't be explained by selectivity. So further research work is necessary.

4.2 Acoustic equipment

The result of the intercalibrations of the acoustic equipments in 1994 and 1996, indicate that there may be a systematic difference between R/V *Solea* and *Argos/Baltica*. The German R/V *Solea* S_a-values is generally about 1.5x higher. It is considered unlikely that the discrepancy between estimates are caused by problems in the acoustic equipment's (ICES C.M. 1997/J:4). However, the technical set-up on R/V *Solea* is different from the other research vessels and it is considered as one possible explanation for the higher S_a-values. Therefore it was recommended by the Baltic International Fish Survey Working Group in 1997 (ICES C.M. 1997/J:4) to conduct an intercalibration experiment between R/V *Solea* and *Argos* in October 1997.

A slightly modified acoustic intercalibration was performed between 1997-10-08-11 in the Bornholm depth area (see Appendix II). The operation took place in darkness and the vessels were steaming on parallel courses. A sampling interval of 0.1 N.M. was used for integration. The integration was started at 10m below water surface and 2-meter depth layers were stored so that 49 channels could be registered. The investigated water depth was > 90 meters (with large fish concentrations until 70 meters). The distance between the vessels varied between 0.1-0.3 N.M. The velocity was varied between 6-8 knots.

Two different towed transducers on R/V *Solea* and one hull-mounted on R/V *Argos* were used in the intercalibration experiments. The transducers used by R/V *Solea* showed higher S_a-values than the hull-mounted on *Argos*. The sideshifted transducer (20-60 m from the R/V *Solea*) varied between 1.4-2.5x higher values than the hull-mounted one used by R/V *Argos*. However, there was no statistically difference between the different transducers used by R/V *Solea*, except the second night. The main concentration of fish was recorded around 40-50 m but with smaller peaks around 15, 75 and 90 m in all three intercalibration experiments (see Appendix II). There were no statistically difference between the different tranducer down to 30 m water depth, but than sideshifted transducer was several magnitude higher between the water depths 35-75 m.

The two R/V *Argos* and *Solea* produce different noise in the water. Generally, there is a tendency to be higher effect of noise made by the larger ships. The fishes seem to show reactions if the vessels cross over the scattered layer. This reaction is dependent on the water depth and distance of the ship. Fish will react to noise stimuli by increasing their speed and swimming radially with a downward component away from an approaching vessel (Misund, 1997). Such swimming behaviour may result in a horizontal dilution of fish density in front of the vessel. There was no clear trend of the impact of noise from the ship with the result from the different transducers. The explanations and a simple conversion factor can not be done at this stage. So further investigation of present data set and future research work is necessary.

5 COMBINED RESULTS

The estimation of the abundance for herring and sprat were summarised from surveys in combined tables. The rectangles 3864, 3964 and 4063 are overlapping areas. Survey statistics for overlapping rectangles is given in Table 5.1. Herring abundance for overlapping rectangles is given in Table 5.2 and for sprat in Table 5.3. In column USED is indicated how data is used in the combined tables.

Estimated numbers of herring by age are found in Table 5.4 and of sprat in Table 5.5. Mean weights by age are found in Tables 5.6 and 5.7.

In ICES subdivision 25 only the southern part was covered. Experience from previous surveys show that the fish abundance is considerably higher in the northern part. The study group therefore recommends that results from this subdivision should not be used for assessment.

Results from the other Sub-divisions can be used as an index for the assessment of herring and sprat.

6 MANUAL FOR THE BALTIC INTERNATIONAL ACOUSTIC SURVEYS

A first draft of the Manual for the Baltic International Acoustic Surveys was distributed before the meeting to all members of the Study Group. This proposal was discussed and improved during the meeting. The new revision 0.8 of the manual is given as appendix III.

It was proposed that this manual should contain also auxiliary information concerning the acoustic survey. This information set will be elaborated and distributed until the next meeting.

The group has decided that the manual in the submitted form should be used as a rule for the execution and data analysis of the Baltic acoustic surveys in 1998.

The practical results in the work with the manual should be lead to improved rules and the information sets in order to prepare a new revision during the next meeting of the Study Group.

7 ACOUSTIC DATABASE

7.1 BAD1

At present the BAD1 contains data according to Table 7.1.1. Due to differences in instrumentation and unavailability of data it was decided that it is not relevant to extend this database further backwards in time than to 1991. It was also decided that the BAD1 should not be discontinued. Since obvious errors have been found in the present data it was decided that the data sets are to be circulated once more among the data providers to be checked and corrected. For surveys from 1990 and before, Sweden and Germany should attempt to provide data from their surveys in the BAD2 format as a first step.

7.2 Detailed data base (BAD2)

It was in the terms of reference for this meeting of the study group that a detailed data base for acoustic data and biological sampling for the Baltic International Acoustic Survey (BAD2) should be established.

A comparable data base are under construction for the results from the international co-ordinated acoustic survey for the North Sea and West of Scotland. The structure of this data base and plans for exchange format were presented to the study group by the coordinator, Karl-Johan Stæhr (see Appendix IV). This data base shall contain acoustic data as Sa values at the level of sampling interval. The data base shall be able to deal with Sa values for Herring, Sprat and Mixed layers. The biological information from trawl hauls shall be stored in a structure very near to the IBTS data base format.

The study group did find that the data base specified for the North Sea would also be suitable for the Baltic Sea. Not all data types specified for the North Sea is of the same importance for the data from the Baltic but the study group did find it important that the structure of the data base for the results from the acoustic surveys for both the Baltic and the North Sea are stored in the same format.

As the exchange format and procedures are under preparation for the data from the North Sea the study group did not find it suitable to develop this procedures parallel.

The study group therefore recommend that further work on a detailed data base for the results from the acoustic surveys in the Baltic are postponed until the data exchange format has been finally developed for the North Sea acoustic data base.

The study group recommend that the data from the 1998 international acoustic survey for the Baltic will be used as a test for the exchange of data from the individual national acoustic surveys to a coming data base. Data shall therefore be exchanged to Institute of Marine Research in Lysekil no later than two month before next years meeting of the Study Group on Baltic Acoustic Data.

8 RECOMMENDATIONS

1. The Results of the 1997 October survey can be used by the ICES WGBFAS, with comments and extrapolations provided.

2. The draft of the Manual for the International Acoustic Surveys, discussed and modified during the Meeting, is recommended to be used during the next surveys. A final version of the Manual have to be discussed during the SGBAD meeting in 1999.

3. The database BAD1 should be continued and contain data from 1991 and forwards.

4. The SG recommend that further work on the database BAD2 should be postponed until the structure of the North Sea acoustic database is established.

5. The Study Group should be continued in 1999 and will meet in Copenhagen for 3 days to:

   - compile data of acoustic surveys and experiments,
   - finalise the Manual for the Baltic International Acoustic Surveys,
   - evaluate the test database BAD2, delivered to Lysekil two months before the meeting.

6. All participants deliver the data from surveys to the Chairman two months before the meeting.

9 REFERENCES

Anon. 1997. Report of the Baltic International Fish Survey Working Group. ICES CM 1997/J:4, 52 pp.

Misund, O. A. 1997. Underwater acoustics in marine fisheries and fisheries research. Reviews in Fish Biology and Fisheries, 7, 1-34.

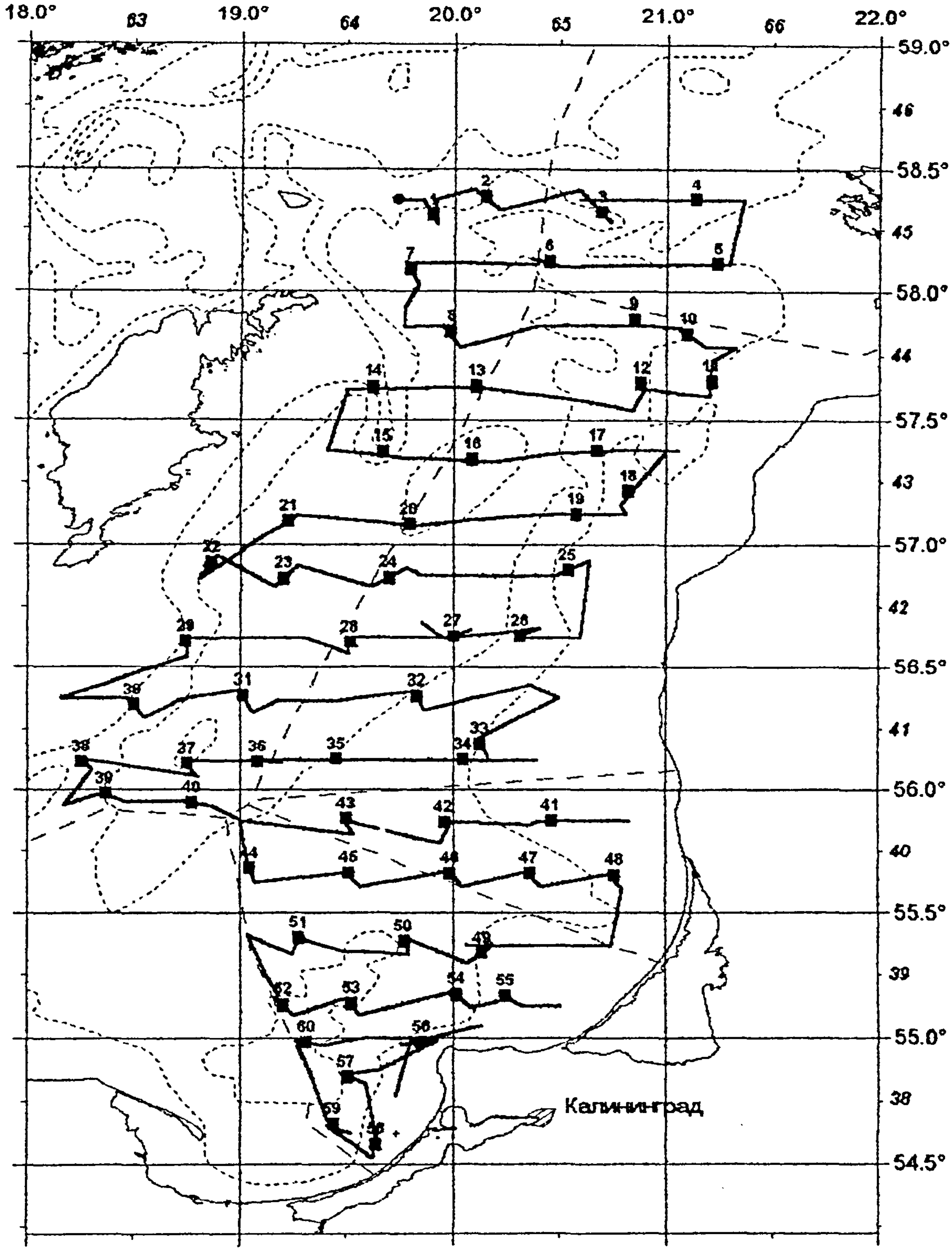

Figure 3.1.1 Cruise track and trawl stations R/V Atlantniro October 1997

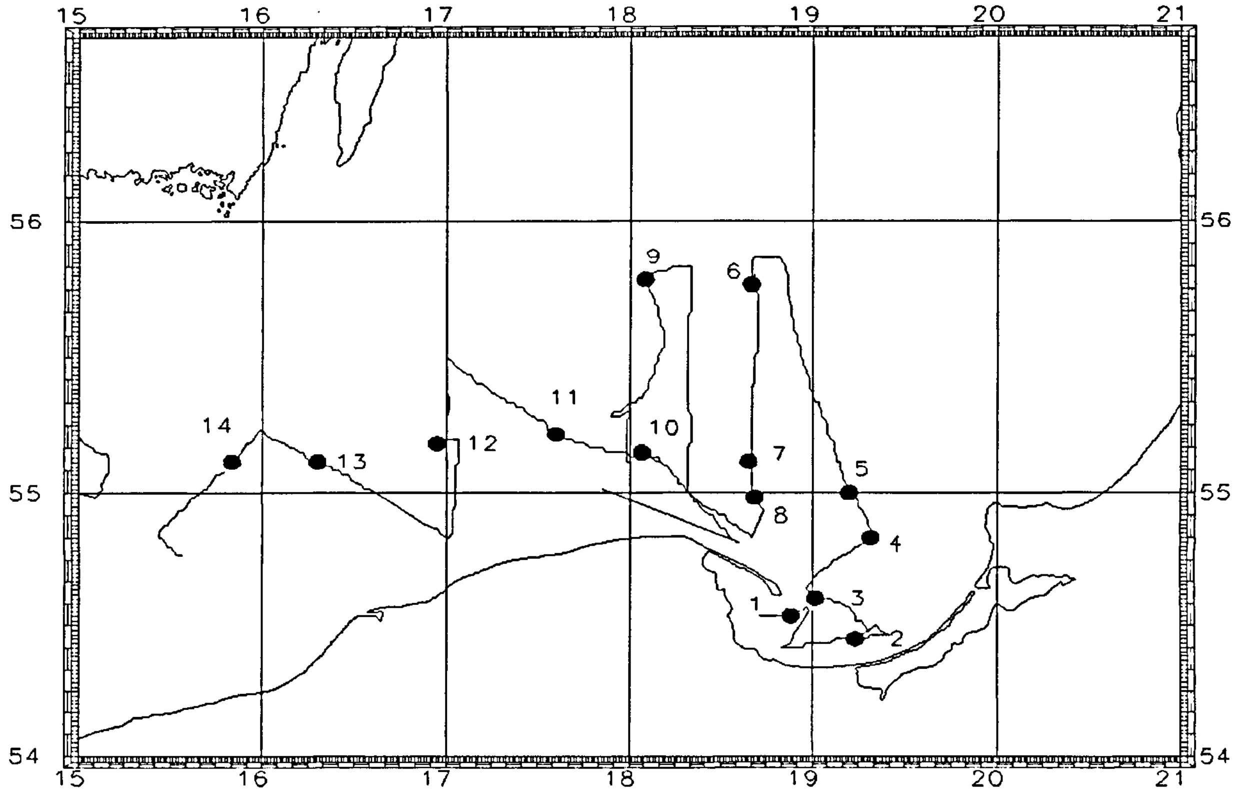

Figure 3.2.1 Cruise track and trawl stations R/V Baltica October 1997

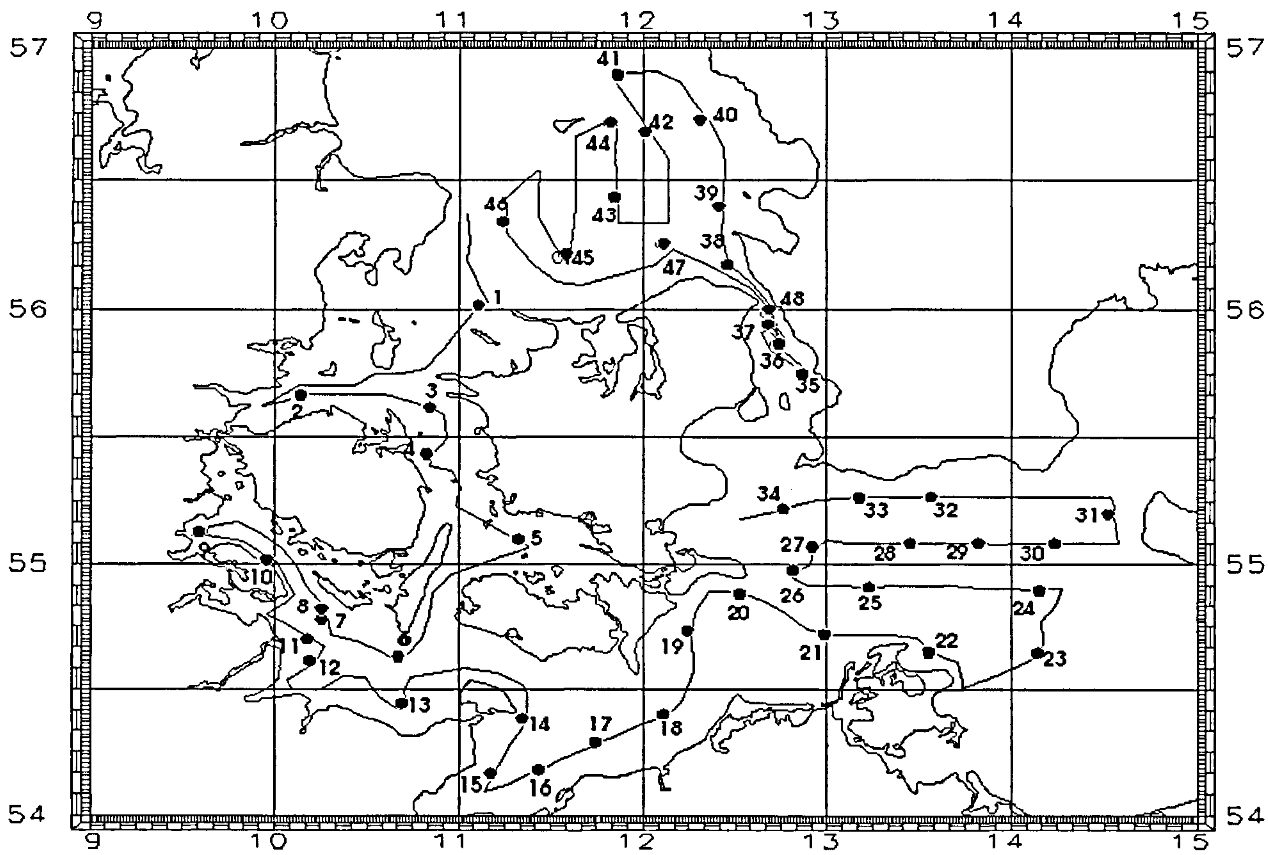

Figure 3.3.1 Cruise track and trawl stations R/V Solea October 1997

Table 3.1.1 Estimated numbers (millions) of herring r/v Atlantniro October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
26	3864	158	19	17	23	37	20	22	11	6	2	1	
26	3964	694	15	36	94	189	144	93	75	36	7	2	2
26	3965	496	235	50	54	52	48	22	18	7	6	2	1
26	4063	947		4	42	207	222	219	145	68	3	4	34
26	4064	881	19	39	160	214	197	127	68	32	23	2	
26	4065	453	16	83	110	106	60	34	30	6	2	0	4
26	4163	450		17	43	133	95	75	48	24	11	3	0
26	4164	130	0	6	12	42	28	20	11	8	3	0	0
26	4165	126	3	4	11	33	21	19	13	11	7	2	3
	SUM	4333	309	256	549	1012	834	631	420	198	63	16	44
28	4263	45	0	0	2	13	10	8	6	3	2	0	0
28	4264	142	0	0	6	51	32	27	15	7	4	0	1
28	4265	541	0	28	37	141	133	111	43	19	19	4	7
28	4364	175	0	1	7	76	38	36	12	4	1	0	0
28	4365	535	46	13	33	146	127	107	41	9	2	5	4
28	4366	261	29	7	18	76	62	44	15	4	0	3	3
28	4464	199	0	0	8	64	62	42	22	0	2	0	0
28	4465	533	0	0	22	190	138	100	72	11	0	0	0
28	4466	836	2	0	54	457	157	119	33	8	2	2	2
28	4564	284	0	0	9	138	74	29	17	11	6	0	0
28	4565	526	0	2	15	195	128	97	61	20	8	0	0
28	4566	164	3	3	10	77	38	18	9	4	1	0	1
	SUM	4241	81	54	220	1622	998	739	345	101	47	13	19

Table 3.1.2 Estimated mean weight (gram) of herring r/v Atlantniro October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
26	3864	36.3	7.3	24.0	35.6	37.6	39.8	48.1	53.9	55.7	72.0	53.3	
26	3964	38.7	9.1	21.9	32.3	32.8	40.2	45.2	53.5	57.0	45.2	62.8	95.0
26	3965	29.1	6.4	23.9	41.2	48.5	46.0	59.1	86.4	103.0	113.1	122.8	211.7
26	4063	35.8		21.7	29.7	26.9	31.2	36.5	40.0	37.1	49.7	61.3	99.3
26	4064	36.8	11.6	22.9	28.6	29.0	36.3	41.4	49.4	81.4	89.3	54.2	
26	4065	38.2	7.5	25.1	33.5	35.1	40.0	49.1	54.9	111.5	132.6	259.0	197.6
26	4163	31.5		23.1	29.3	26.2	27.6	30.8	38.4	49.4	67.5	83.2	90.3
26	4164	30.1	15.7	22.8	27.1	24.8	26.9	29.8	37.4	50.7	80.1	69.0	90.3
26	4165	40.5	7.3	22.8	28.9	25.6	27.9	32.8	41.5	57.4	106.7	104.9	223.7
28	4263	29.2			19.0	23.9	24.5	27.5	36.5	47.3	50.2		36.0
28	4264	26.3			19.2	22.7	24.2	25.5	33.2	43.5	50.2		36.0
28	4265	29.6	7.5	22.4	21.4	21.8	24.1	31.1	41.2	45.9	49.0	113.7	125.9
28	4364	23.0		19.0	18.8	21.7	23.5	24.1	27.1	27.1	46.0		
28	4365	27.5	7.5	24.7	25.4	23.5	26.0	26.1	27.7	70.8	32.0	156.6	237.4
28	4366	28.1	7.5	25.3	24.8	23.9	26.5	26.7	27.7	88.9		168.8	237.4
28	4464	22.4			16.3	19.7	22.0	25.0	27.0		40.0		
28	4465	21.5			14.5	19.6	21.8	22.5	25.2	24.9	157.0		
28	4466	19.8	4.0		14.8	17.6	21.0	22.5	22.8	36.1	82.0	81.5	175.0
28	4564	20.0			17.6	18.4	20.4	22.3	24.1	24.0	26.0		
28	4565	21.2		14.0	18.2	19.4	21.4	22.2	23.4	27.2	25.4		
28	4566	23.4	4.0	14.5	16.6	19.0	20.3	22.5	33.9	54.8	114.0		215.0

Table 3.1.3 Estimated numbers (millions) of sprat r/v Atlantniro October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
26	3864	5934	3477	48	1216	1016	159	5	14	0	0
26	3964	3641	66	99	2024	941	347	120	46	0	0
26	3965	8201	7024	184	787	139	59	7	2	0	0
26	4063	4825	304	70	1974	1501	623	237	71	45	0
26	4064	5546	3869	129	1066	311	100	51	20	1	0
26	4065	8089	3808	578	2558	826	168	106	46	0	0
26	4163	3094	512	11	656	1305	152	245	119	86	8
26	4164	4338	18	244	2236	1548	48	151	54	32	8
26	4165	3806	718	335	1571	869	102	48	100	63	0
	SUM	47474	19794	1697	14089	8455	1758	969	471	226	16
28	4263	4493	258	0	1638	1948	63	387	47	151	0
28	4264	4592	9	4	1929	2163	101	248	39	56	43
28	4265	3167	567	291	1304	800	0	133	9	44	17
28	4364	6306	97	171	2047	3152	49	462	131	126	71
28	4365	6147	1342	269	1945	1825	131	318	231	63	22
28	4366	3171	811	142	1041	825	74	157	88	17	15
28	4464	2015	613	73	435	685	28	154	0	28	0
28	4465	5884	1370	110	1773	2233	67	228	86	7	10
28	4466	5801	425	330	2134	2232	78	310	136	136	19
28	4564	2251	683	30	287	885	20	200	79	57	10
28	4565	8096	1694	172	1392	3717	57	478	248	190	147
28	4566	6962	2002	487	2077	2023	68	176	20	108	0
	SUM	58885	9872	2080	18004	22488	736	3252	1116	982	355

Table 3.1.4 Estimated mean weight (gram) of sprat r/v Atlantniro October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
26	3864	4.4	1.9	6.0	7.4	8.4	9.7	13.3	10.7		
26	3964	8.7	2.3	6.6	8.5	8.8	10.0	11.5	13.1		
26	3965	2.8	1.9	6.1	8.4	8.6	9.7	10.8	13.8		
26	4063	9.0	2.4	7.6	8.8	9.6	10.4	11.2	12.4	14.1	
26	4064	3.8	1.8	7.1	8.0	8.9	10.2	10.7	11.9	13.9	
26	4065	4.5	1.0	3.3	7.9	9.0	9.7	11.0	11.3		
26	4163	9.3	5.7	8.9	9.0	9.7	10.4	11.2	12.4	13.4	13.3
26	4164	8.5	2.3	7.4	8.3	8.8	9.5	9.9	10.6	10.1	10.5
26	4165	6.8	1.4	6.2	7.7	8.6	8.4	10.1	10.5	10.7	
28	4263	9.4	3.6		9.2	9.8	10.2	11.1	10.2	10.9	
28	4264	9.2	2.0	7.5	8.6	9.3	10.5	10.8	12.2	12.9	13.1
28	4265	7.1	1.7	6.6	8.0	8.7		9.7	11.5	11.8	13.0
28	4364	9.3	3.0	8.0	8.7	9.3	10.1	11.0	11.0	12.3	11.8
28	4365	7.4	2.0	6.8	8.5	9.0	9.9	10.3	10.6	11.7	13.5
28	4366	7.1	1.9	6.7	8.6	9.0	9.6	10.4	10.6	13.5	13.5
28	4464	7.2	2.8	7.6	9.0	9.1	8.1	10.4		12.0	
28	4465	7.5	2.3	7.0	8.6	9.3	9.5	10.1	10.2	10.8	12.8
28	4466	8.0	2.4	6.7	8.0	8.5	8.8	9.3	10.7	10.8	12.0
28	4564	7.2	2.6	7.2	8.1	8.9	9.8	10.4	10.7	11.3	11.6
28	4565	7.5	2.4	7.3	8.1	8.7	10.5	10.1	9.4	11.6	12.0
28	4566	6.7	2.7	6.7	8.1	8.7	10.0	10.3	10.0	10.7	

Table 3.1.5 Survey statistics r/v Atlantniro October 1997

ICES SD	ICES Rect.	Area (nm^2)	Sa (m^2/nm^2)	σ cm^2	N total (million)	herring (%)	sprat (%)
26	3864	450	1096.7	0.81	6093	2.6	97.4
26	3964	1032	659.4	1.57	4334	16.0	84.0
26	3965	855	681.5	0.67	8697	5.7	94.3
26	4063	1019	917.5	1.62	5771	16.4	83.6
26	4064	1019	643.3	1.02	6427	13.7	86.3
26	4065	918	893.3	0.96	8542	5.3	94.7
26	4163	797	671.4	1.51	3544	12.7	87.3
26	4164	1006	564	1.27	4468	2.9	97.1
26	4165	647	662.4	1.09	3932	3.2	96.8
28	4263	607	964.4	1.29	4538	1.0	99.0
28	4264	993	600.7	1.26	4734	3.0	97.0
28	4265	814	592.2	1.30	3708	14.6	85.4
28	4364	980	866.4	1.31	6481	2.7	97.3
28	4365	980	845.4	1.24	6681	8.0	92.0
28	4366	330	1247.9	1.20	3432	7.6	92.4
28	4464	322	831.9	1.21	2214	9.0	91.0
28	4465	967	816.2	1.23	6417	8.3	91.7
28	4466	680	1288.5	1.32	6638	12.6	87.4
28	4564	315	973.9	1.21	2535	11.2	88.8
28	4565	954	1093.5	1.21	8621	6.1	93.9
28	4566	734	1019.4	1.05	7126	2.3	97.7

Table 3.2.1 Estimated numbers (millions) of herring r/v Baltica October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
25	3860	655	137	78	58	174	104	58	25	14	8	0	0
25	3861	302	142	25	18	53	31	19	7	4	3	0	0
25	3862	147	70	20	7	27	15	5	2	1	1	0	0
25	3960	437	91	52	38	116	69	39	17	9	5	0	0
25	3961	1011	512	107	50	168	94	45	16	10	8	0	0
25	3962	754	358	102	35	137	76	27	10	5	4	0	0
	SUM	3307	1310	384	205	675	390	192	77	43	30	0	0
26	3763	92	60	12	4	8	3	2	1	1	0	0	0
26	3764	201	131	27	8	18	6	5	3	3	1	0	0
26	3863	703	179	71	85	146	74	78	39	23	8	0	2
26	3864	705	179	60	84	146	78	82	39	27	8	0	3
26	3963	475	124	58	58	109	45	47	18	10	4	0	1
26	3964	324	77	40	41	78	37	30	12	5	2	0	3
26	4063	485	20	59	80	158	71	61	20	10	4	0	1
	SUM	2985	770	326	360	662	314	305	133	79	27	0	9

Table 3.2.2 Estimated mean weight (gram) of herring r/v Baltica October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
25	3860	29.0	10.4	26.1	37.6	30.8	31.1	43.1	48.5	53.5	57.8	0.0	0.0
25	3861	22.6	9.8	26.3	38.5	31.4	32.1	38.4	42.8	49.4	55.2	0.0	0.0
25	3862	21.3	10.8	22.5	32.6	27.9	29.9	37.1	37.5	49.2	45.0	0.0	0.0
25	3960	29.0	10.4	26.1	37.6	30.8	31.1	43.1	48.5	53.5	57.8	0.0	0.0
25	3961	21.4	10.4	23.6	35.7	29.5	31.2	38.0	40.5	49.1	52.1	0.0	0.0
25	3962	21.3	10.8	22.5	32.6	27.9	29.9	37.1	37.5	49.2	45.0	0.0	0.0
26	3763	16.0	6.7	18.0	28.5	31.3	43.9	55.0	50.4	61.9	58.1	0.0	0.0
26	3764	16.0	6.7	18.0	28.5	31.3	43.9	55.0	50.4	60.9	58.1	0.0	0.0
26	3863	25.3	7.4	21.1	34.6	34.1	38.1	45.9	46.9	58.7	57.9	0.0	84.2
26	3864	33.8	7.1	21.8	35.0	34.3	37.5	47.7	48.9	67.2	57.2	0.0	92.0
26	3963	26.4	8.0	21.4	31.6	30.1	33.7	42.3	44.1	56.4	54.6	0.0	88.0
26	3964	26.5	7.6	21.5	32.7	30.4	32.3	36.1	38.0	49.4	43.8	0.0	96.6
26	4063	27.5	9.5	23.0	31.4	29.6	31.4	33.4	44.0	53.1	54.3	0.0	84.2

Table 3.2.3 Estimated numbers (millions) of sprat r/v Baltica October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
25	3860	795	25	18	161	332	167	73	19	0	0
25	3861	871	10	41	268	349	142	45	15	3	0
25	3862	815	9	44	323	294	100	36	9	1	0
25	3960	530	17	12	107	222	111	48	13	0	0
25	3961	4761	26	227	1519	1864	755	281	78	11	0
25	3962	4176	45	224	1652	1506	513	187	46	4	0
	SUM	11950	132	566	4030	4566	1788	670	178	19	0
26	3763	1573	512	60	663	296	36	6	0	0	0
26	3764	3423	1115	130	1443	645	78	12	1	0	0
26	3863	4530	1131	163	1972	1029	185	39	11	0	0
26	3864	8522	4521	176	2102	1334	300	72	18	0	0
26	3963	5456	397	166	2445	1741	500	153	46	8	0
26	3964	6004	127	258	3065	1965	453	112	25	0	0
26	4063	3248	6	85	1341	1199	424	144	50	0	0
	SUM	32756	7809	1037	13031	8209	1976	536	150	8	0

Table 3.2.4 Estimated mean weight (gram) of sprat r/v Baltica October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
25	3860	13.8	3.8	12.3	12.9	13.8	14.1	14.9	16.3	0.0	0.0
25	3861	13.1	3.3	11.9	12.0	13.1	14.4	15.6	17.8	19.7	0.0
25	3862	12.3	3.3	11.7	11.5	12.7	13.8	15.8	16.6	19.7	0.0
25	3960	13.8	3.8	12.3	12.9	13.8	14.1	14.9	16.3	0.0	0.0
25	3961	13.1	3.3	11.9	11.9	13.0	14.2	15.8	17.3	19.7	0.0
25	3962	12.3	3.3	11.7	11.5	12.7	13.8	15.8	16.6	19.7	0.0
26	3763	5.7	1.9	7.7	8.5	8.9	8.8	10.5	11.6	0.0	0.0
26	3764	5.7	1.9	7.7	8.5	8.9	8.8	10.5	11.6	0.0	0.0
26	3863	7.4	2.4	7.8	8.6	9.2	9.9	11.2	11.6	0.0	0.0
26	3864	4.6	2.2	8.0	8.9	9.5	10.2	10.9	10.8	0.0	0.0
26	3963	9.5	2.4	8.5	9.0	9.7	10.6	11.6	11.8	18.0	0.0
26	3964	8.9	2.8	8.1	8.9	9.5	10.2	10.8	10.8	0.0	0.0
26	4063	10.2	3.2	9.2	9.4	10.1	10.8	11.4	11.9	0.0	0.0

Table 3.2.5 Survey statistics r/v Baltica October 1997

ICES SD	ICES Rect.	Area (nm^2)	Sa (m^2/nm^2)	σ cm^2	N total (million)	herring (%)	sprat (%)
25	3860	1041.6	295	2.09	1470	44.6	54.3
25	3861	950.5	207	1.67	1178	26.0	74.0
25	3862	476.9	314	1.54	972	15.3	84.7
25	3960	980.4	210	2.09	985	44.6	54.3
25	3961	1032.2	910	1.62	5798	17.5	82.5
25	3962	1032.2	744	1.55	4955	15.3	84.7
26	3763	96	1612	0.93	1664	5.5	94.5
26	3764	153.3	2197	0.93	3622	5.5	94.5
26	3863	648.3	914	1.13	5244	13.4	86.6
26	3864	931	913	0.92	9239	7.6	92.4
26	3963	1032.2	748	1.30	5939	8.0	92.0
26	3964	1032.2	812	1.32	6350	5.1	94.9
26	4063	1019.3	568	1.55	3735	13.0	87.0

Table 3.3.1 Estimated numbers (millions) of herring r/v Solea October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
21	4156	168	3	125	37	4	0	0	0	0	0	0	0
21	4157	186	14	97	57	17	1	0	0	0	0	0	0
21	4256	339	0	200	123	16	0	0	0	0	0	0	0
21	4257	315	88	137	80	10	0	0	0	0	0	0	0
	SUM	1009	104	558	297	48	2	0	0	0	0	0	0
22	22a	81	60	20	0	0	0	0	0	0	0	0	0
22	22b	352	72	253	25	1	0	1	0	0	0	0	0
22	22c	227	146	75	5	0	0	0	0	0	0	0	0
22	22d	1056	658	367	27	1	0	1	1	1	0	0	0
	SUM	1717	937	716	58	2	0	2	1	1	0	0	0
23	4057	580	10	23	108	183	105	58	47	17	20	10	0
23	4157	64	5	19	28	10	1	0	0	0	0	0	0
	SUM	644	16	41	136	193	106	58	47	17	21	10	0
24	3757	439	334	89	9	4	0	1	1	0	0	0	0
24	3857	448	112	189	78	40	9	11	9	0	0	0	0
24	3858	1021	584	202	105	63	22	18	15	6	4	0	0
24	3859	569	322	139	53	32	4	9	7	2	2	0	0
24	3957	395	256	75	27	17	7	5	6	1	1	0	0
24	3958	468	368	55	21	13	3	4	3	0	0	0	0
24	3959	27	12	9	3	2	0	0	0	0	0	0	0
	SUM	3367	1988	758	297	170	46	49	42	10	8	0	0

Table 3.3.2 Estimated mean weight (gram) of herring r/v Solea October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
21	4156	49.5	21.2	48.0	55.4	64.9	36.7						
21	4157	48.1	12.7	47.2	55.6	71.0	89.5						
21	4256	55.2		51.8	58.7	71.9							
21	4257	42.3	10.9	50.9	58.6	70.9	36.7						
22	22a	16.9	10.3	35.9	40.4								
22	22b	38.5	19.9	42.2	51.9	70.4		75.3			77.3		
22	22c	19.2	8.8	37.3	46.1	70.1		75.3					
22	22d	20.7	11.3	34.8	44.3	70.8		83.2	139.0	85.7			
23	4057	134.4	10.3	47.1	78.3	122.7	155.9	186.8	186.8	189.2	220.5	240.2	
23	4157	52.7	10.0	43.1	62.4	60.7	65.6	159.4	186.6	83.6	71.2		
24	3757	16.1	10.4	31.1	54.3	49.6	52.8	40.5	61.9				
24	3857	37.4	9.7	34.1	56.6	60.9	94.6	73.8	74.6	116.6			
24	3858	29.3	7.8	34.0	57.6	72.5	108.2	107.0	115.7	145.0	206.5		
24	3859	26.9	9.9	34.3	57.9	70.6	76.1	61.3	76.0	94.3	224.0		
24	3957	26.8	11.1	33.3	56.6	81.2	117.5	101.9	103.8	134.2	211.4	252.0	
24	3958	17.9	9.3	34.5	53.9	62.5	95.3	92.2	122.4	160.5	178.0		
24	3959	26.9	8.7	34.4	53.6	50.5	52.8	40.5	61.8				

Table 3.3.3 Estimated numbers (millions) of sprat r/v Solea October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
21	4156	13	0	1	3	6	2	0	0	0	0
21	4157	1	0	0	0	0	0	0	0	0	0
21	4256	0	0	0	0	0	0	0	0	0	0
21	4257	2	0	0	0	0	1	0	0	0	0
	SUM	15	0	1	3	6	4	1	0	0	0
22	22a	408	408	0	0	0	0	0	0	0	0
22	22b	1	0	0	0	0	0	0	0	0	0
22	22c	29	16	2	3	6	2	0	0	0	0
22	22d	373	45	62	95	123	40	8	0	0	0
	SUM	811	469	64	99	129	41	9	0	0	0
23	4057	122	84	4	11	11	8	5	0	0	0
23	4157	2	0	0	0	1	0	0	0	0	0
	SUM	123	84	4	11	11	8	5	0	0	0
24	3757	508	167	61	91	131	36	14	8	0	0
24	3857	331	219	11	28	44	19	7	4	0	0
24	3858	1919	1278	150	177	223	67	15	10	0	0
24	3859	3665	2093	378	440	535	143	51	26	0	0
24	3957	171	37	11	39	57	18	6	3	0	0
24	3958	3319	1367	548	548	654	146	43	13	0	0
24	3959	2506	8	1085	664	614	100	28	8	0	0
	SUM	12420	5168	2243	1986	2258	529	165	70	0	0

Table 3.3.4 Estimated mean weight (gram) of sprat r/v Solea October 1997

SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
21	4156	20.2	7.5	12.3	20.0	21.0	22.1	24.5			
21	4157	20.2		16.0	18.9	19.8	23.8	26.5			
21	4256	21.1				21.1					
21	4257	23.5			23.5		23.5	23.5			
22	22a	2.4	2.4								
22	22b	15.2		13.5	15.8	17.7	18.9	18.9			
22	22c	10.9	4.2	15.8	18.2	19.4	19.7	18.9			
22	22d	16.2	4.8	15.8	17.4	18.5	19.6	18.2			
23	4057	9.1	4.4	11.3	16.1	23.6	22.3	22.7			
23	4157	18.9		13.0	19.4	20.4	20.2	23.5			
24	3757	11.1	4.3	11.5	14.5	14.9	16.2	17.2	18.5		
24	3857	7.6	3.6	10.6	15.1	15.7	16.6	18.1	18.1		
24	3858	6.9	3.2	11.4	14.4	15.0	15.8	16.4	17.9		
24	3859	8.4	4.1	11.6	14.3	14.9	15.9	17.0	17.6		
24	3957	12.7	3.5	12.8	15.1	15.3	16.2	17.2	17.2		
24	3958	9.4	3.0	12.0	14.0	14.6	15.6	16.0	16.7		
24	3959	12.9	4.1	12.0	13.1	13.9	14.7	15.0	17.9		

Table 3.3.5 Survey statistics r/v Solea October 1997

ICES SD	ICES Rect.	Area (nm^2)	Sa (m^2/nm^2)	σ cm^2	N total (million)	herring (%)	sprat (%)
21	4156	985	70	3.53	195	86.2	6.4
21	4157	485	147	2.86	249	74.7	0.2
21	4256	987	141	2.97	469	72.4	0.1
21	4257	659	197	1.13	1151	27.4	0.1
22	22a	1297	48	0.55	1123	7.2	36.3
22	22b	1694	69	2.54	460	76.6	0.1
22	22c	1086	102	3.31	335	67.9	8.6
22	22d	1102	288	2.18	1454	72.7	25.7
23	4057	195	2190	6.04	707	82.1	17.2
23	4157	56	445	3.80	66	97.2	2.5
24	3757	205	715	1.52	964	45.5	52.7
24	3857	853	196	2.04	818	54.8	40.5
24	3858	882	602	1.59	3340	30.6	57.5
24	3859	1036	568	1.37	4296	13.3	85.3
24	3957	438	287	2.16	581	68.0	29.5
24	3958	780	629	1.22	4036	11.6	82.2
24	3959	529	723	1.51	2537	1.1	98.8

Table 5.1. Survey statistics for overlaping area

Vessel	ICES SD	ICES Rect.	Area (nm²)	Sa (m²/nm²)	σ cm²	N total (million)	herring (%)	sprat (%)
Atlantniro	26	3864	450	1096.7	0.81	6093	2.6	97.4
Baltica	26	3864	931	913	0.92	9239	7.6	92.4
Atlantniro	26	3964	1032	659.4	1.57	4334	16.0	84.0
Baltica	26	3964	1032.2	812	1.32	6350	5.1	94.9
Atlantniro	26	4063	1019	917.5	1.62	5771	16.4	83.6
Baltica	26	4063	1019.3	568	1.55	3735	13.0	87.0

Table 5.2. Herring abundance for overlaping rectangles

Vessel	SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	USED
Atlantniro	26	3864	158	19	17	23	37	20	22	11	6	2	1		Atlantniro
Baltica	26	3864	705	179	60	84	146	78	82	39	27	8	0	3	+1/2 Baltica
Atlantniro	26	3964	694	15	36	94	189	144	93	75	36	7	2	2	Atlantniro
Baltica	26	3964	324	77	40	41	78	37	30	12	5	2	0	3	
Atlantniro	26	4063	947		4	42	207	222	219	145	68	3	4	34	average
Baltica	26	4063	485	20	59	80	158	71	61	20	10	4	0	1	

Table 5.3. Sprat abundance for overlaping rectangles

Vessel	SD	rect	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	USED
Atlantniro	26	3864	5934	3477	48	1216	1016	159	5	14	0	0	Atlantniro
Baltica	26	3864	8522	4521	176	2102	1334	300	72	18	0	0	+1/2 Baltica
Atlantniro	26	3964	3641	66	99	2024	941	347	120	46	0	0	Atlantniro
Baltica	26	3964	6004	127	258	3065	1965	453	112	25	0	0	
Atlantniro	26	4063	4825	304	70	1974	1501	623	237	71	45	0	average
Baltica	26	4063	3248	6	85	1341	1199	424	144	50	0	0	

Table 5.4 Estimated number of herring (Hydroacoustic surveys, October 1997)

SD	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
25	3307	1310	384	205	675	390	192	77	43	30	0	0
26	6128	1095	532	820	1357	911	674	415	207	79	12	17
28	4241	81	54	220	1622	998	739	345	101	47	13	19

Table 5.5. Estimated number of sprat (Hydroacoustic surveys, October 1997)

SD	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
22	811	469	64	99	129	41	9	0	0	0
23	123	84	4	11	11	8	5	0	0	0
24	12420	5168	2243	1986	2258	529	165	70	0	0
25	11950	132	566	4030	4566	1788	670	178	19	0
26	65929	25060	2311	21346	12682	2608	1167	527	211	16
28	58885	9872	2080	18004	22488	736	3252	1116	982	355

Table 5.6. Estimated mean weight of herring (Hydroacoustic surveys, October 1997)

SD	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10
25	24.0	10.5	24.3	36.2	29.8	30.9	40.4	44.6	51.6	53.9	0.0	0.0
26	32.0	7.2	22.4	32.3	31.1	35.1	40.6	46.9	57.4	75.5	82.0	114.1
28	23.7	7.3	22.6	19.1	19.9	22.8	24.9	27.9	40.1	44.8	138.0	168.9

Table 5.7. Estimated mean weight of sprat (Hydroacoustic survey, October 1997)

SD	total	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
22	9.1	2.7	15.8	17.4	18.5	19.6	18.2	0.0	0.0	0.0
23	9.2	4.4	11.4	16.2	23.4	22.2	22.7	0.0	0.0	0.0
24	9.5	3.6	11.9	13.9	14.6	15.6	16.4	17.6	0.0	0.0
25	12.8	3.5	11.8	11.8	13.0	14.1	15.6	16.9	19.7	0.0
26	6.4	1.9	6.5	8.5	9.3	10.2	11.0	11.6	12.5	11.9
28	7.8	2.4	6.9	8.5	9.0	9.8	10.4	10.4	11.5	12.3

Table 7.1.1 BAD1 contents

CCODE	SHIP	YEAR
BAP91	Baltijas Petnieks	1991
SOL91	Solea	1991
ARG92	Argos	1992
MON92	Monokristal	1992
SOL92	Solea	1992
BAP93	Baltijas Petnieks	1993
SOL93	Solea	1993
ARG94	Argos	1994
BAL94	Baltica	1994
MON94	Monokristal	1994
SOL94	Solea	1994
BAL95	Baltica	1995
MON95	Monokristal	1995
SOL95	Solea	1995
ARG96	Argos	1996
ATL96	Atlantniro	1996
BAL96	Baltica	1996
SOL96	Solea	1996
ATL97	Atlantniro	1997
BAL97	Baltica	1997
SOL97	Solea	1997

Appendix I
Working paper
Study Group on Baltic Acoustic Data 1998

Selectivity of research trawls

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Selectivity of research trawls

Selectivity of trawls for the commercial fleet is well investigated for many species and trawl types. However there are no selectivity data for research trawls with very small mesh sizes in the codend. One of the traditional methods to measure the selectivity of a trawl is to cover the commercial codend with a small mesh codend designed to catch all fishes and to count and calculate the ratio the fishes caught in both codends. An other method is to use a twin trawl rig. To measure the selectivity of research trawls with traditional methods is difficult. No material is available to cover a research trawl codend with already small meshes with a codend of even smaller mesh size. It is expensive to design and build a twin trawl rig. Only to check if a codend of a research trawl is usable for certain the task, it is often sufficient to transpose the results from selectivity measurements of commercial trawls to the research trawls. This paper shows results applying commercial selectivity data on data obtained during a joint investigations of the Swedish and German research vessels „Argos“ and „Solea“ in the Baltic.

Selectivity function

As well known, every trawl has selective properties. The selectivity depends on the mesh size of the codend as the main selective component. A good summary of existing data is given in [1]. Main parameters of selectivity are the selection factor, the selection ratio and the selection range.

$$selection\ factor = \frac{l_{50}}{codend\ mesh\ size}$$

$$selection\ range = l_{75} - l_{25}$$

$$selection\ ratio = \frac{selection\ range}{codend\ mesh\ size}$$

l_{50} is the length of fish which has a 50 per cent chance of being caught. The same applies to l_{25} and l_{75}. All measurements of determination of selectivity are carried out in 1 cm classes below. There are several formulas to express the dependence of retention of fish in the codend with length of fish. For the complicated selectivity formula developed in the Marine Laboratory Aberdeen the necessary constants are not known, so here we want to use the logistic equation.

$$p(l) = \frac{1}{1 + e^{-(a+bl)}}$$

In this equation p(l) is the ratio of fish at the length l caught from the fishes in that volume with length l. The parameters of the function a and b can derived as:

$$b = \frac{2\ln 3}{l_{75} - l_{25}}$$

$$a = -b\, l_{50}$$

From the literature [1] only two data sets obtained with bottom trawls are available. The average selection factor was 4.14 and the selection range 30 mm. More recent measurements of herring selectivity with commercial vessels and midwater trawls gave a selection factor in the range 3.9 to 4.4 with an average of 4.18. The selection range was generally wider from 34 mm to 5.1 mm and with an average of 4.0 mm. The selectivity functions were investigated for commercial trawls with a mesh size of about 40 mm. The scientists busy with stock management base on the assumption that the selection range is constant and not dependent on the mesh size. If the mesh size is changed only by small range it is sufficient and leads to more easy formulas, but for larger variations of the mesh size it is more plausible to assume that the selection ratio is constant. These results of the more recent measurements are used to transpose them to a smaller mesh size.

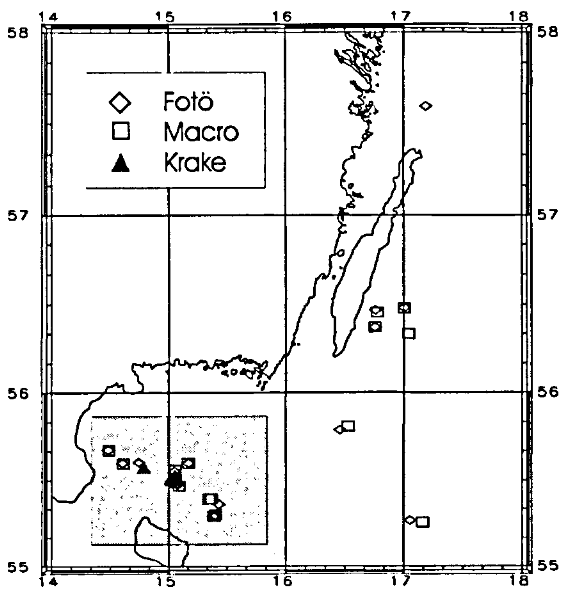
Correction function

The correction function is used to compensate the selectivity effect of the trawl. To design the correction function a selectivity function was calculated, taking into account that the selectivity measurements are carried out with 1 cm length groups. To get an as much as possible accurate curve 1 mm classes were used in the first step. These length groups were integrated to 0.5 cm groups as used during the catch comparision. The inverse function of the so calculated selectivity function is the correction function. The product of selectivity function and correction function is 1 for every length group.

Used Trawls

The German vessel „Solea" used the trawl called „Krake", with a vertical opening of 10,5 m and a wing tip distance of 20 m. The mesh size in the codend was 10 mm. The Swedish vessel „Argos" used the trawls „Fotö" with a vertical opening of 14 - 17 m and the trawl „Macro" with a vertical opening of 17 - 22 m. Both Swedish trawls had a mesh size of 21mm in the codend.

Area of investigation



The comparision of catches was only a part of the cruises of both vessels combined with an intercalibration of the echo integrating equipment of both vessels. So the time for fishing was limited, because the Swedish vessel had to fish alternately with two trawls. To have more data and to get better estimations of the mean length distribution of fish, catches were included even they were obtained some days before the joint part of the cruises by the FRV „Argos". The area of investigation was located between the Swedish Coast and the island Bornholm. Catches obtained by the Swedish vessel outside the marked area were excluded from the investigations because they have a quite big distance to marked area. It is not possible to assume that the length distribution is not varying over this distance.

Data

Within the marked area 8 trawl stations were carried out by the Swedish vessel with the trawl „Fotö" and 11 with the „Macro". The German vessel carried out 5 hauls with the trawl „Krake". For the analysis of data, the length distributions for herring and sprat were summarised and normalised. Even the shape of herring and sprat is not exactly the same selectivity data of herring were applied to sprat because no selectivity data for sprat were available. From bigger catches subsamples were taken. From every haul between 260 and 620 were measured. The lowest length was 5.5 cm and the measured maximum length was 30.0 cm.

Results

Based on the data of selectivity measurements of commercial trawl the selectivity of the used research trawls were estimated. A selection factor of 4.18 and a selection ratio of 1 was assumed. For the trawl „Krake" the estimated l_{50} was 3.9 cm. The l_{25} was 3.2 cm and the l_{75} was 4.2 cm and the selection range was 1 cm. The parameter of the selection curve were a = - 8.09 and b = 2.20.

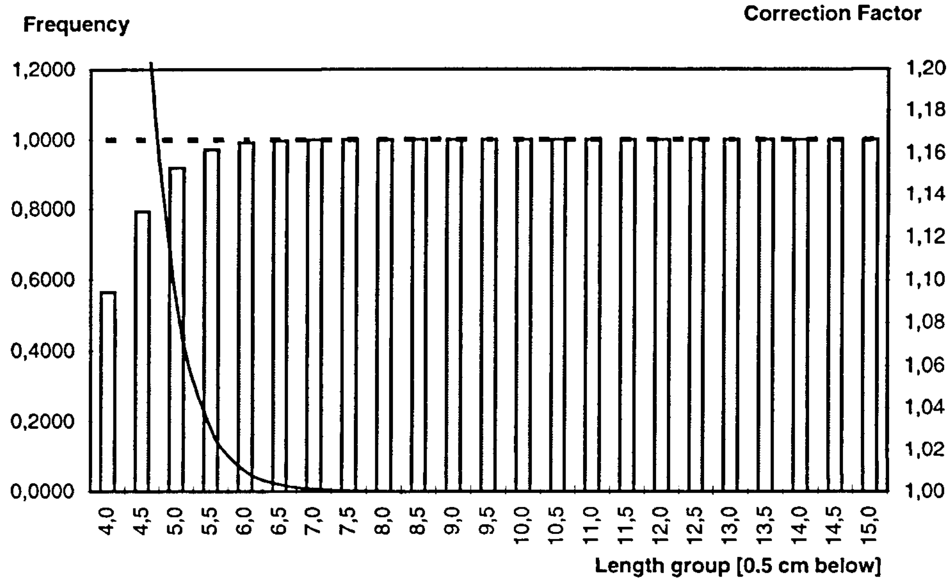


Figure 1: Selection and correction function of the trawl „Krake"

For the trawls „Fotö" and „Macro" the estimated l_{50} was 8.5 cm and the selection range was 2.1 cm. The l_{25} was 7.2 cm and the l_{75} was 9.3 cm. The parameters of the selection curve were a = - 8.66 and b = 1.05.

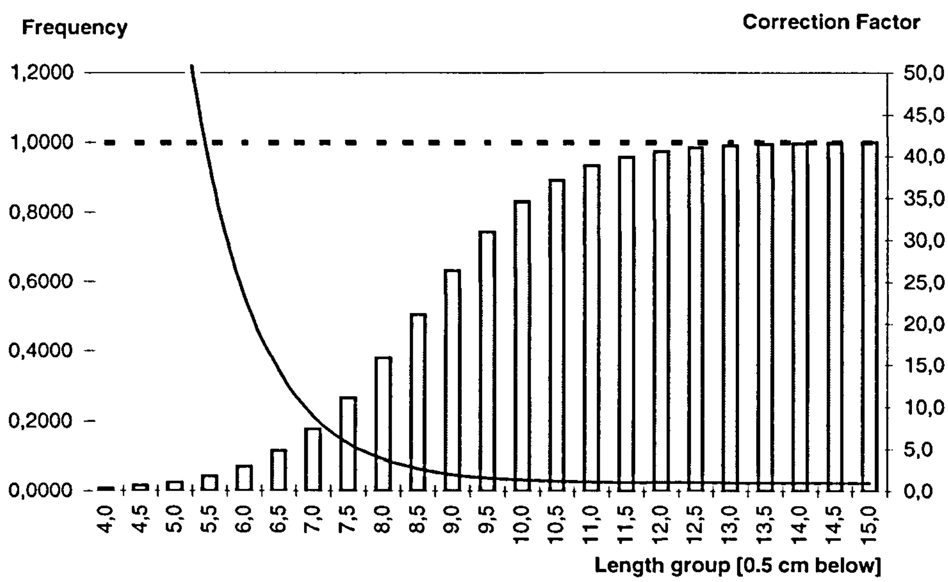


Figure 2: Selection and correction function of the trawls „Fotö" and „Macro"

The differences in selectivity are also visible in the length distribution of the species caught with the different trawls.

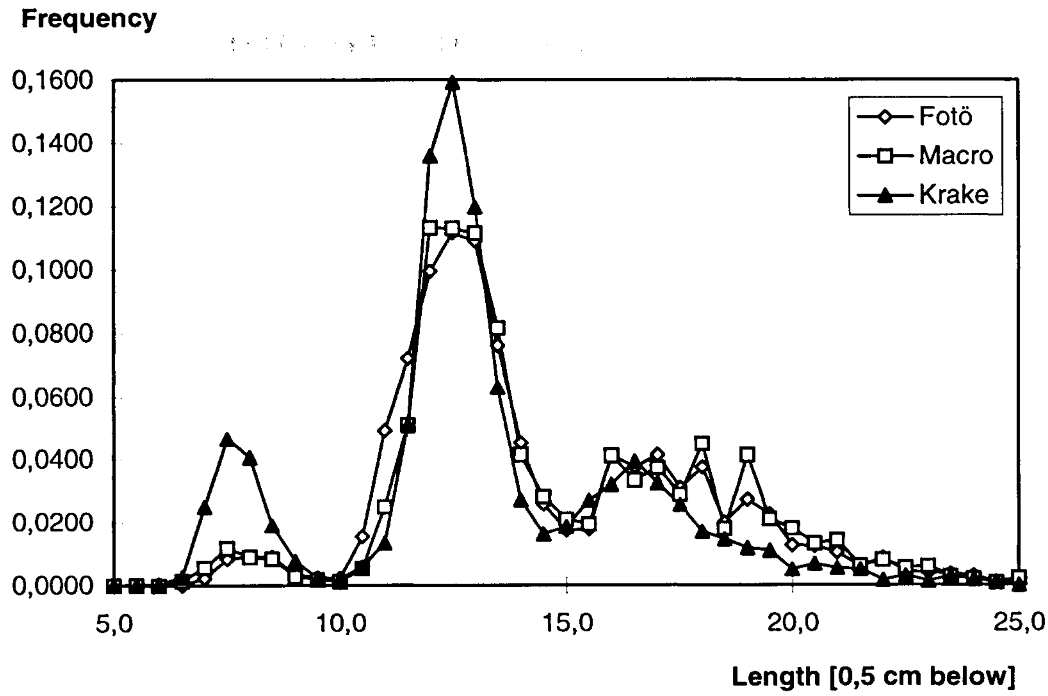


Figure 3: Length distribution of used trawls (Mix sprat and herring)

After correcting the length distribution of the trawls „Fotö" and „Macro" we get the following picture:

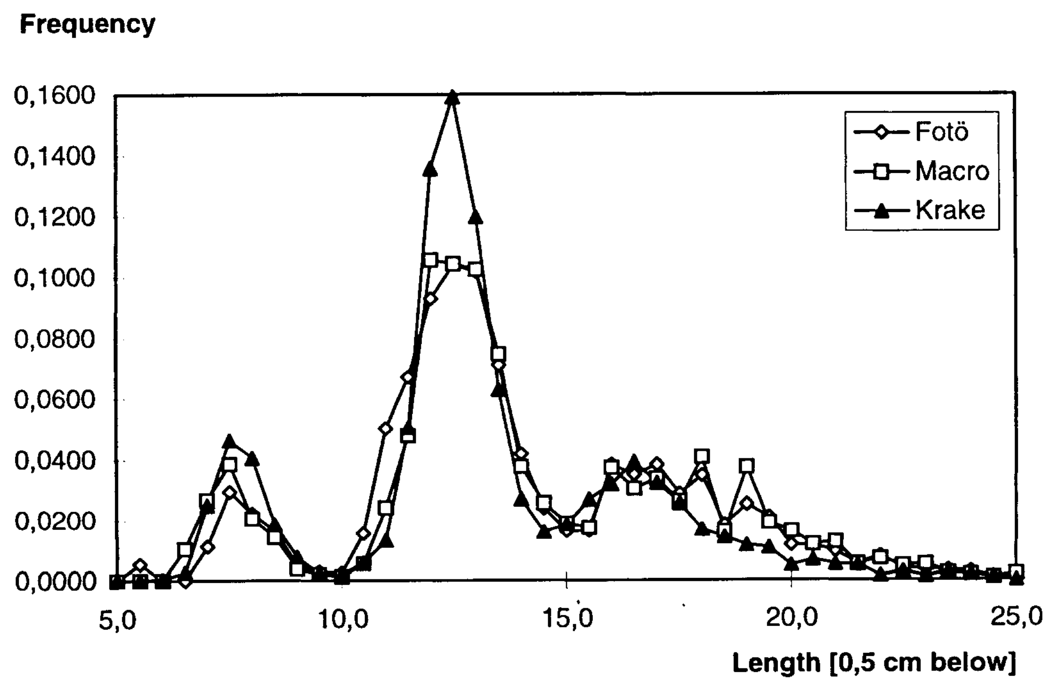


Figure 4: Corrected length distribution of used trawls (Mix sprat and herring)

Conclusion

It seems to be possible to transpose the selectivity data obtained from commercial vessels. The results we got are plausible. For research trawls during the hydroacoustic surveys in autumn in the Baltic Sea a mesh size of about 10 mm in the codend should be used. During this time the smallest fishes of the 0 group are 6 cm long. For this length group the error due to selectivity is about 2 %. But it is also possible to correct data obtained with mesh sizes not much larger than optimum size. The mean length for the catches caught with the trawl „Fotö" was changing after compensating the selectivity from 14.37 cm to 13.93 cm for the mix of herring and sprat. For the trawl „Macro" the mean length changed from 14,63 cm to 14,03 cm. The mean length for the „Krake" did not change because no compensation tucked place. Due to the compensation of the selectivity we did not get the true length distribution, but a step in the right direction was gone. In every case it is advisable to check the selectivity of the research trawl in the described way. In Figure 4 we can see, that as larger the trawl as larger is the portion of the larger fishes in the length distribution. This effect can't be explained by selectivity. So further research work is necessary.

Literature

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Study contract No. 1991/15 - Danish Institut for Fisheries Technology and Aquaculture

Appnedix II
Working paper
Study Group on Baltic Acoustic Data
Gdynia, Poland, April 1998.

Intercalibration of the S_a-values between R/V *Argos* and *Solea*

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Introduction

When more than one ship are engaged on an acoustic survey, the performance of their equipment should be compared by means of an inter-ship calibration (Røttingen, 1978; MacLennan and Simmonds, 1991). This is done by the ships steaming in close formation while series of paired echo integrator readings is obtained. The result of the intercalibrations of the acoustic equipments in 1994 and 1996 in the Baltic, indicate that there may be a systematic difference between R/V *Solea* and *Argos/Baltica*. The German R/V *Solea* S_a-values were generally about 1.5x higher. It is considered unlikely that the discrepancy between estimates are caused by problems in the acoustic equipment's (ICES C.M. 1997/J:4). However, the technical set-up on R/V *Solea* is different from the other research vessels and it is considered as one possible explanation for the higher S_a-values. Therefore it was recommended by the Baltic International Fish Survey Working Group in 1997 (ICES C.M. 1997/J:4) to conduct an intercalibration experiment between R/V *Solea* and *Argos* in October 1997.

Methods

Acoustic registrations

The acoustic recordings were done by;

a) a hull-mounted (*HM*) 38 kHz (ES-38B) Simrad transducer onboard R/V *Argos*,

b) and two 38 kHz Simrad transducers towed simultaneously by R/V *Solea*
   - 38-29/25E echo-sounder side-shifted (*SS*) between 20-60 m on starboard side depending on the working speed and
   - ES-38B (*TB*) about 3-m away from the hull on port side.

The two towed bodies on R/V *Solea* permitted a working speed of maximum 8 knots due to weather conditions and wave actions. Post-processing and allocation of area back-scattering strength (S_a) was done by Bergen Echo Integrator (BEI). The characteristics applied for the echo sounder is presented in Table 1.

The equipment of R/V *Argos* was calibrated directly before and R/V *Solea* directly after the survey and against a standard copper sphere.

The technical set-up

Investigated factors in this investigation were;

a) noise level of the vessels depending on the velocity;
b) water depth;
c) distance between the vessels.

Experimental design

Night 1. Analysis of the factor a) and b)
Inter-calibration at night
Water depth > 90 meters (with large fish concentrations until 70 meters)
Parallel cruise, distance between the vessels 0.1 nautical mile
The same acoustic equipment settings
Hydrographical samples
Pelagic trawling in the same layers to observe the species composition
Investigation distances up to 100-150 nautical miles if possible
Constant velocity – 8 knots

Night 2. As night 1 except
Distance between the vessels 0.3 nautical mile

Night 3. As night 1 except

Constant velocity = 6 knots

A sampling interval of 0.1 nautical mile was used for the echo integration. The integration was started at 10 m below water surface and the S_a-values were stored by 2-m depth layers.

Transects

The combined inter-ship calibration commenced at N 55° 28′ E 15° 08′, October 8, and progressed in a southwesterly direction (Fig. 1). After approximately 4 hours the survey vessels turned 180° and went back along the same transect (Table 2). The same track was used during the following two nights. The use of the survey track was decided as a valid method of using two vessels surveying the same area with high density scattering layers and water depth over 90 m and enough Elementary Distance sampling Units (ESDU). Threshold for the echogram was set to –80 dB. Normally survey settings were used for all other parameters (Table 1).

Statistical analyses

The statistical analysis was performed using Statistica (1995) as statistical computer package and Sokal and Rohlf (1981) as bibliographic reference. However, we will above all mention two different methods used in this study.

a) Gabriel′ approximate method for the comparison of regression coefficient

This procedure is performed to test if two or more regression coefficient (slope) of a regression line is statistically different from each other. In this case, the regression coefficient whose the 95% comparison intervals do not overlap are considered significantly different.

b) Tukey honest-test for significant differences

A post-hoc procedure is used when after obtaining a statistically significant test from the ANOVA routine, one wants to know which means contributed to the effect, that is, which groups were different from each other.

Results

The weather conditions were favourable for acoustic registrations during the first two nights. However, during the last night we had to stop after 30 nautical miles due to stormy conditions (Table 2).

Herring and sprat were the dominant species in the water column. A detail study of the trawl catches will be presented in another working paper from the same study ("Selectivity of research trawls").

The sequence and the accumulated S_a-values were plotted for all three nights (Fig. 2-3). Both the transducers used by R/V *Solea* showed higher S_a-values than the hull-mounted on *Argos*. To obtain regression relationships, each data set was regressed on the other using the slope from the regression and the slope estimated with zero intercept. The side-shifted transducer (20-60 m from the R/V *Solea*) showed between 1.4-2.5x higher S_a-values than the hull-mounted one used by R/V *Argos*. The transducer about 3-m away from the hull showed between 1.2-1.7x higher values than the hull-mounted one used by R/V *Argos* (Fig. 4). However, there was no statistically difference with zero intercept between the different transducers used by R/V *Solea*, except the second night (Fig. 4). The result showed that during the first night, there were no statistically difference between the regression of slopes between the two towed transducers and the side-shifted and hull-mounted ones (Fig. 5). However, during the second and third night, the relationship between the towed transducers was always statistically different between each regressed separately against the hull-mounted one on R/V *Argos*.

The result of the calculated average S_a-values per 4-m depth interval is given in Figure 6. The main concentration of fish was recorded around 40-50m but with smaller peaks around 15, 75 and 90 m on all three inter-calibration experiments. There was no statistically difference between the transducer down to 30-m water depth using the Tukey honest-test for significant differences. However, the side-shifted transducer was several magnitude higher than the hull-mounted between the water depths 35-75 m (Table 3).

Discussion

The comparison indicated that the S_a-values of R/V *Solea* transducers were correlated in two out of three experiments. However, the transducers on the German R/V showed generally much higher S_a-values than the one estimated on the larger R/V *Argos*. Earlier results between these two research vessels, have showed values around 150 % higher S_a-values ((ICES C.M. 1995/Assess:17; ICES C.M. 1997/J:4) compared with the range of 140-250 % from this investigation.

The two vessels *Argos* and *Solea* produce different noise in the water. The fishes may show reactions if the vessels cross over the scattered layer. The size of the vessel have been quantified to vary the fright reaction from 40% to 90% for small research vessels (Misund, 1997) and avoidance reactions increases with the vessel size (Olsen *et al.*, 1983). Fish will react to noise stimuli by increasing their speed and swimming radically with a down ward component away from an approaching vessel. This sudden avoidance can affect acoustic stock assessment, and by lower target strength than predicted because the fish are tilted downwards (Nakken and Olsen, 1977). The strength of the reactions depends upon the depth of the fish, the size of the vessel and vessel speed (Misund, 1997).

Misund and Aglen (1992) have also observed that schools of herring and sprat in the North Sea tend to be guided and swim in the same direction as the approaching survey vessel. Because of shadowing effect by the hull, there will be lobes of maximum intensity to each side of the vessel (Misund *et al.*, 1996). Soria *et al.* (1996) interpret an overrepresentation of schools detected 40-70m to the side of the vessel by sonar to have been caused by lateral avoidance in front of a vessel

Some settings were different between the transducers. The major one was the difference in absorption coefficient. However, this will not give any major problem in shallow areas like the Baltic Sea. It may lead to errors of about 10 % in the deepest channels. The over all error is then below 4-5% if the targets are more or less evenly distributed.

Finally, it was considered unlikely that the discrepancy between S_a-values estimates were caused by problematic in the acoustic equipment. All echo sounders were calibrated using the standard target method.

Conclusions

There was no clear trend of the impact of noise from the ship with the result from this study, but the transducer used by R/V Solea gave higher S_a-values. The explanations and a simple conversion factor can not be done at this stage. So further investigation of present data set and future research work is necessary.

Acknowledgements

We are grateful to Rainer Oeberst for valuable input on the experimental set-up.

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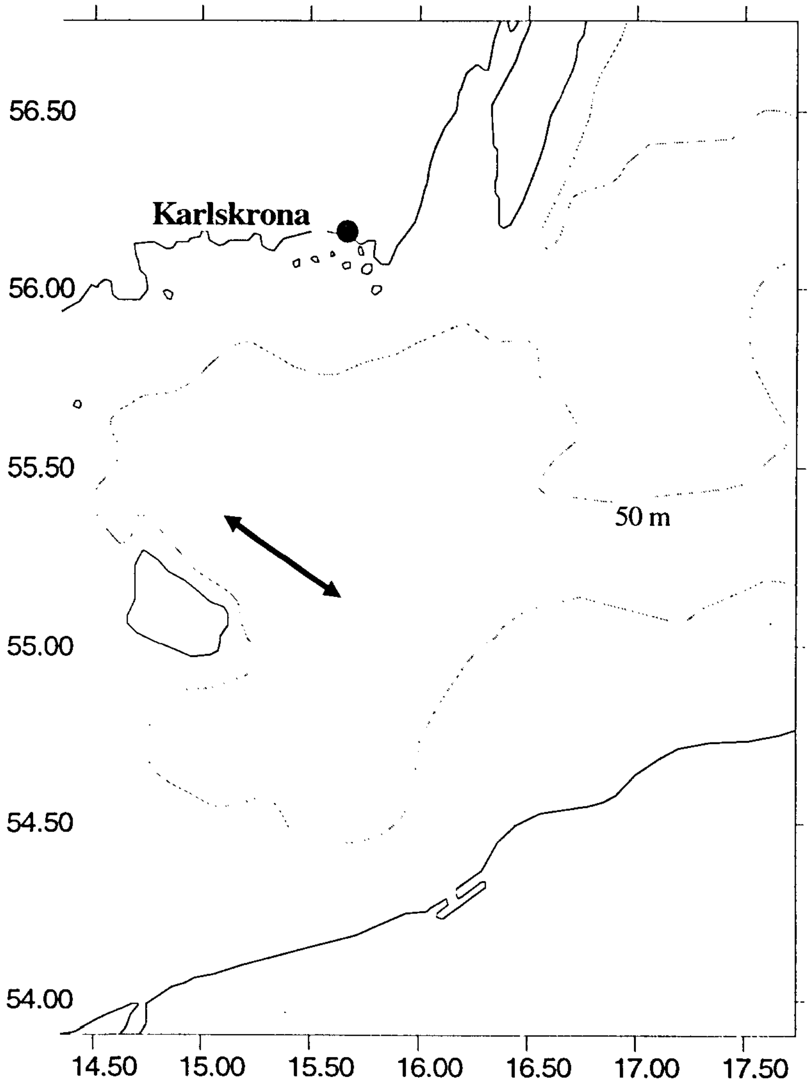

Figure 1. Cruise track for the inter-calibration of acoustic equipments between R/V *Argos* and *Solea* in October 1997.

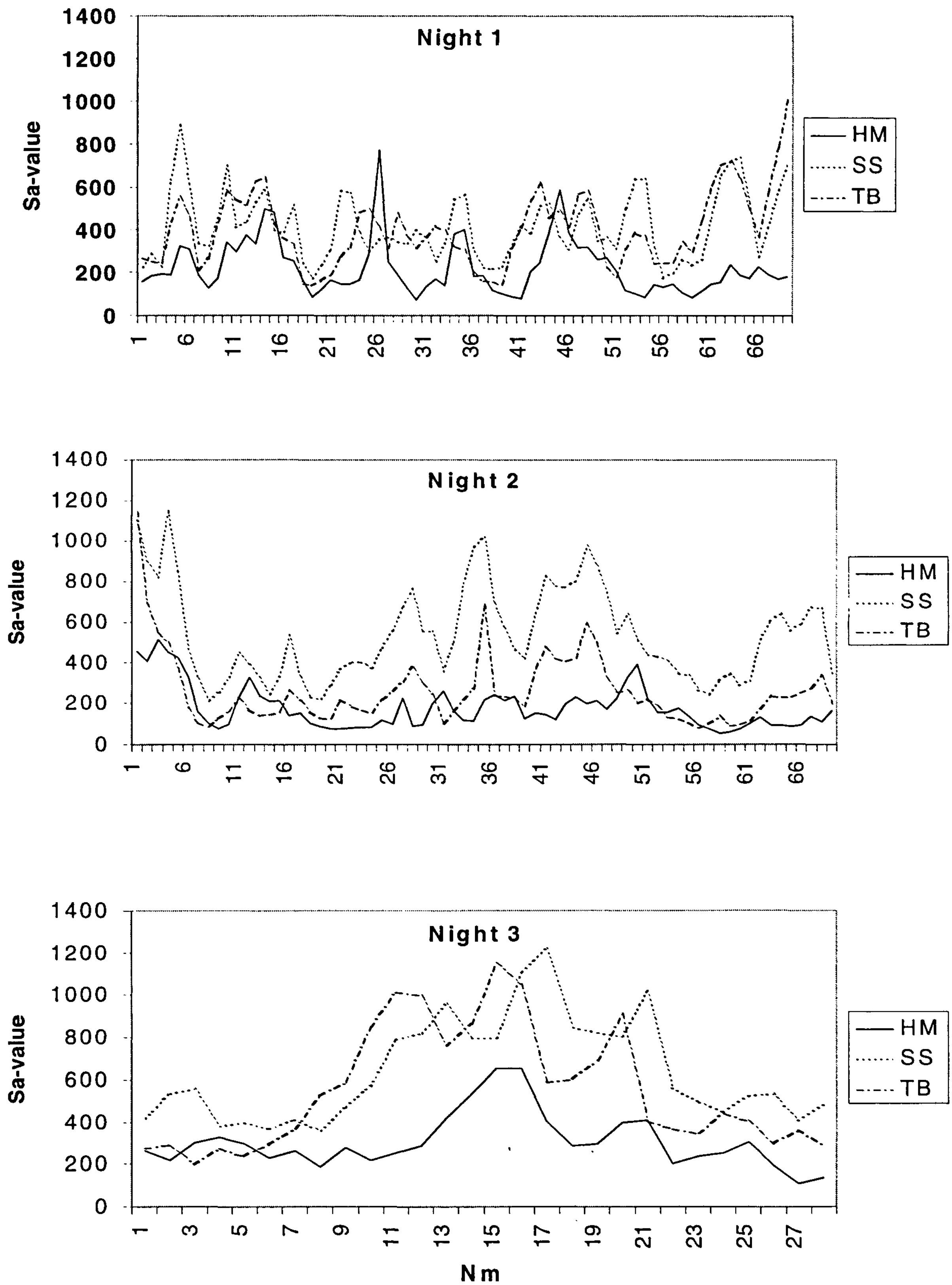

Figure 2. Sequence of echo integrator vlaues (s_a) per nautical mil for the whole water column on three experimental set ups (nights) in October 1997.

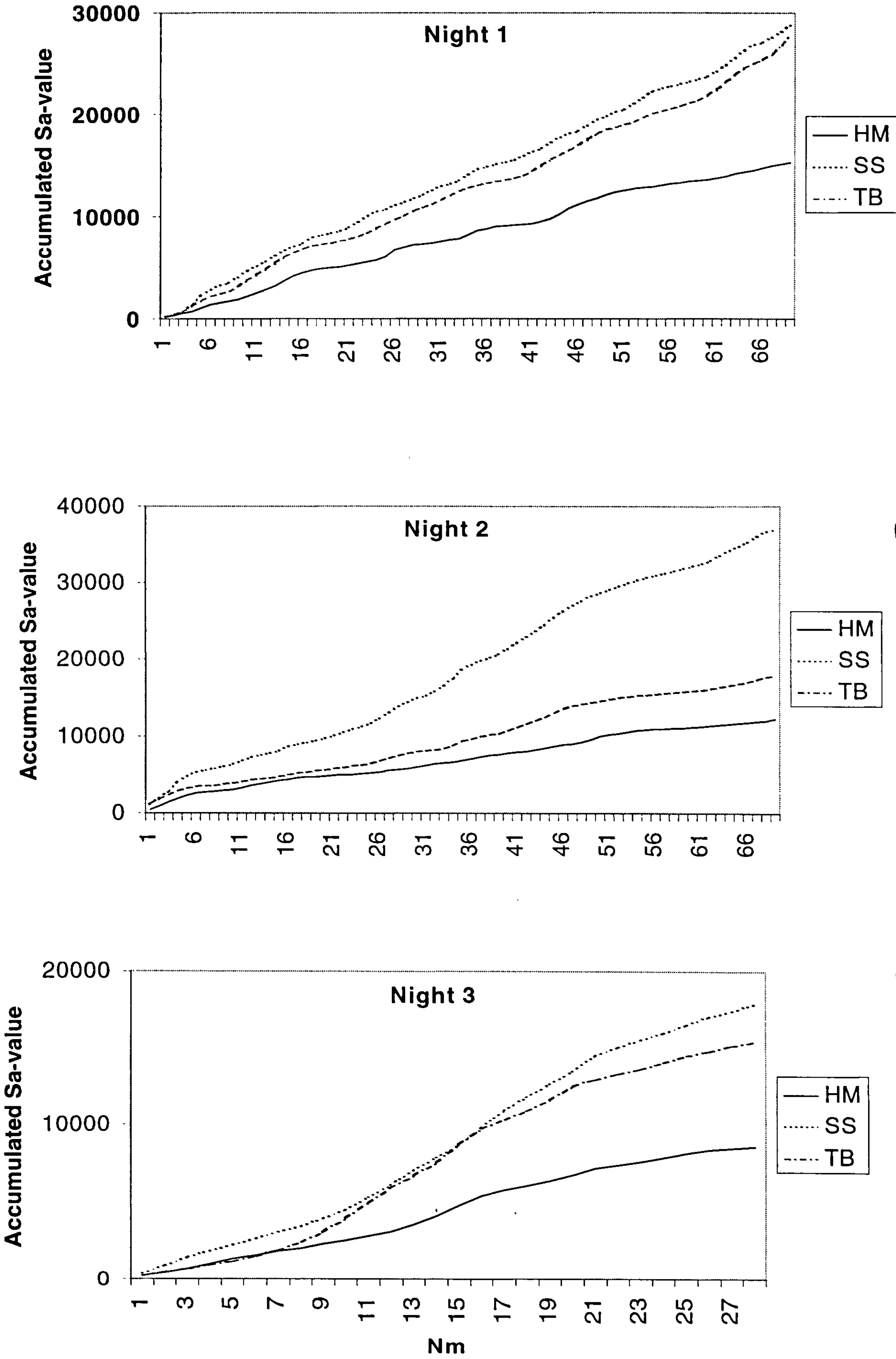

Figure 3. Accumulated echo integrator values (S_a) per average 1.0 nautical mile for the whole water column for the three experimental set-ups in October 1997.

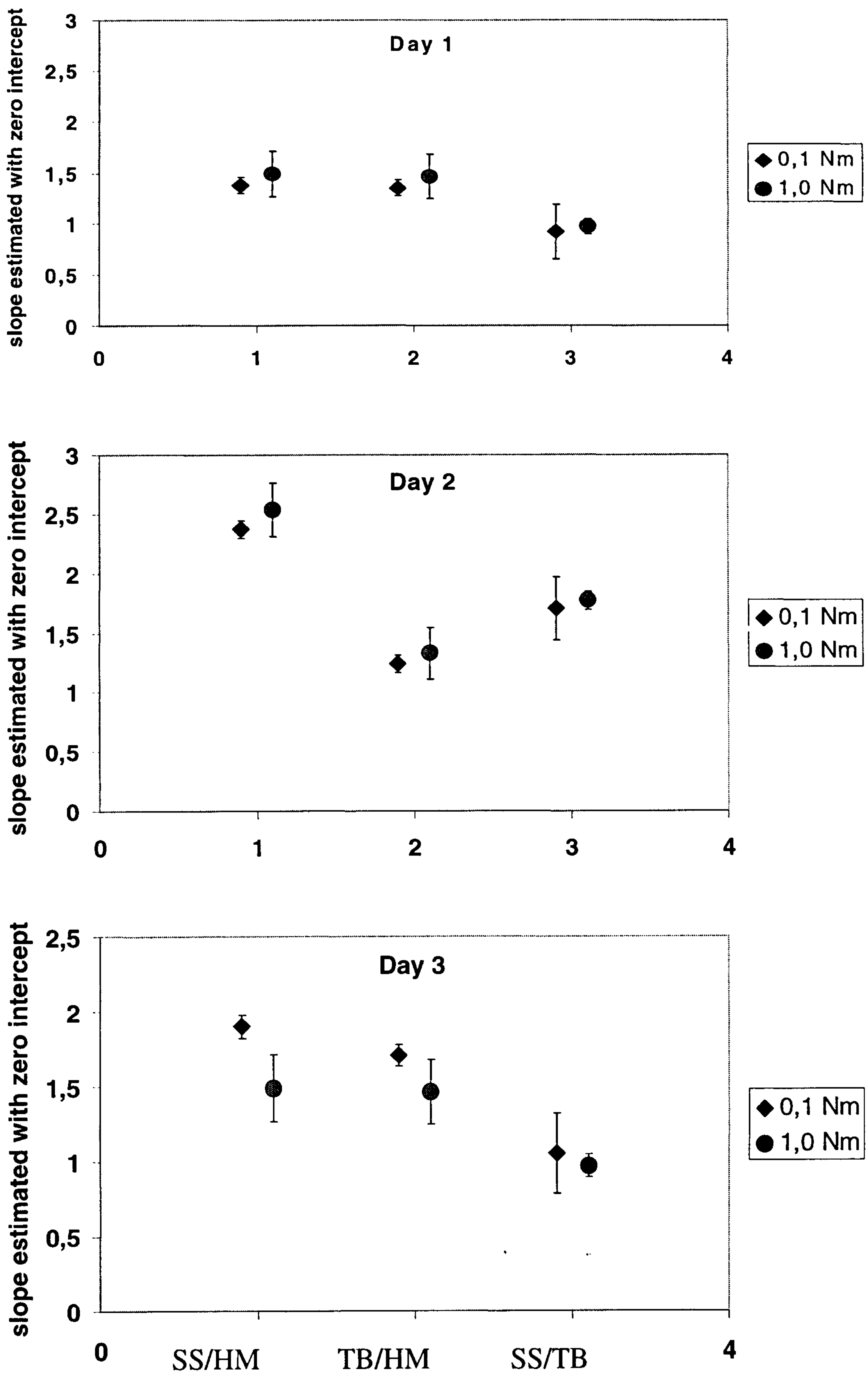

Figure 4. Regression analysis on the slope estimates with zero intercept (± 95% confidence intervals) using Gabriel's approximate method on values from each 0.1 nautical mile and 1.0 nautical mile, respectively. The data were divided into three different experimental set ups; Solea (Side-Shifted) *SS*/Argos (Hull-mounted) *HM*, Solea (Towed body (*TB*), 3-m away from the hull)/Argos *HM* and Solea *SS/TB*. The line is the 1:1 relation.

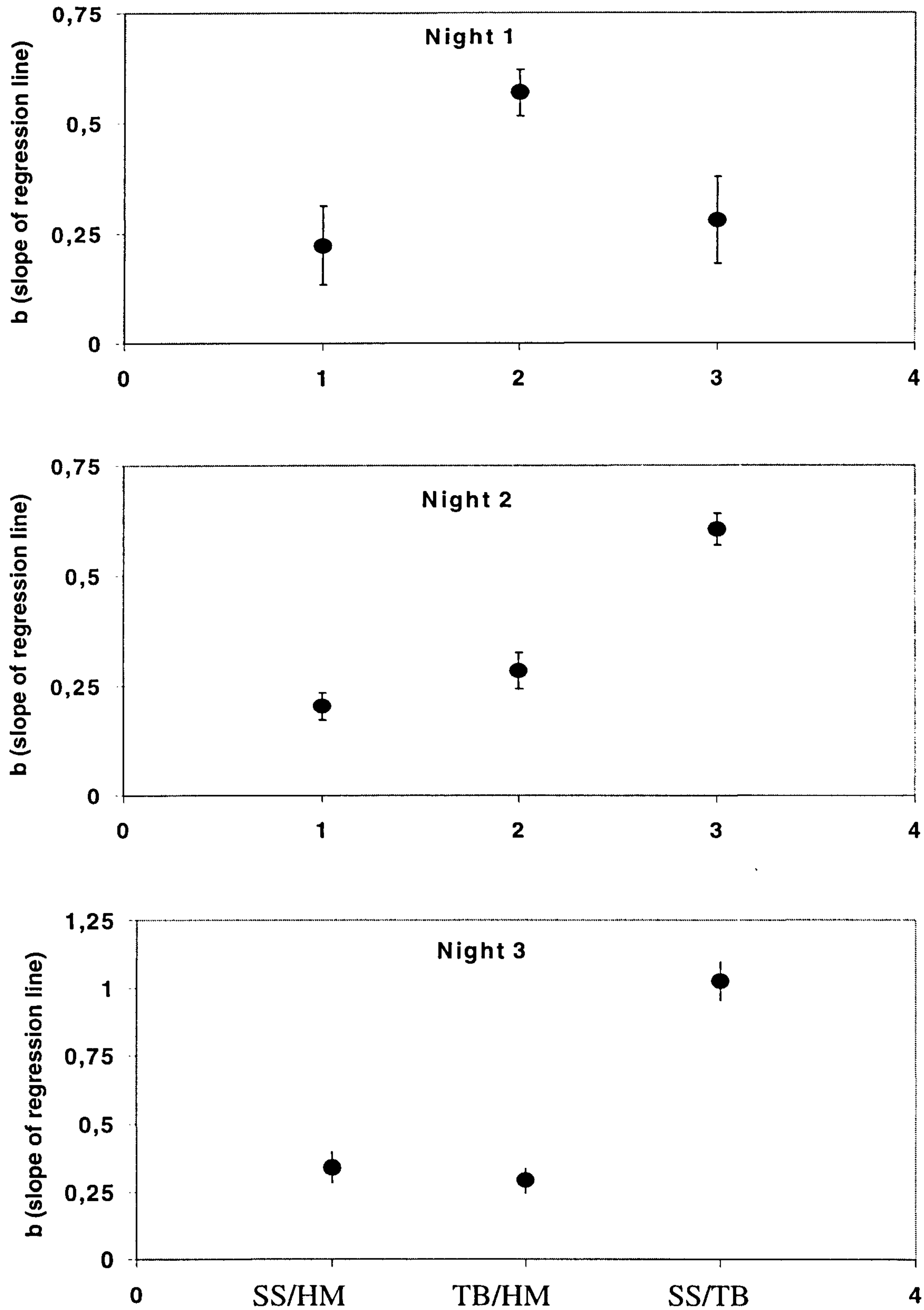

Figure 5. Regression analysis of the S_a-values per 0.1 nautical mile presented as the averaged value (b) of slope of the regression line (±95% confidence intervals). The data were divided into three different experimental set ups; Solea (Side-Shifted) *SS*/Argos (Hull-mounted) *HM*, Solea (Towed body (*TB*), 3-m away from the hull) Argos *HM* and Solea *SS/TB*. The line is the 1:1 relation.

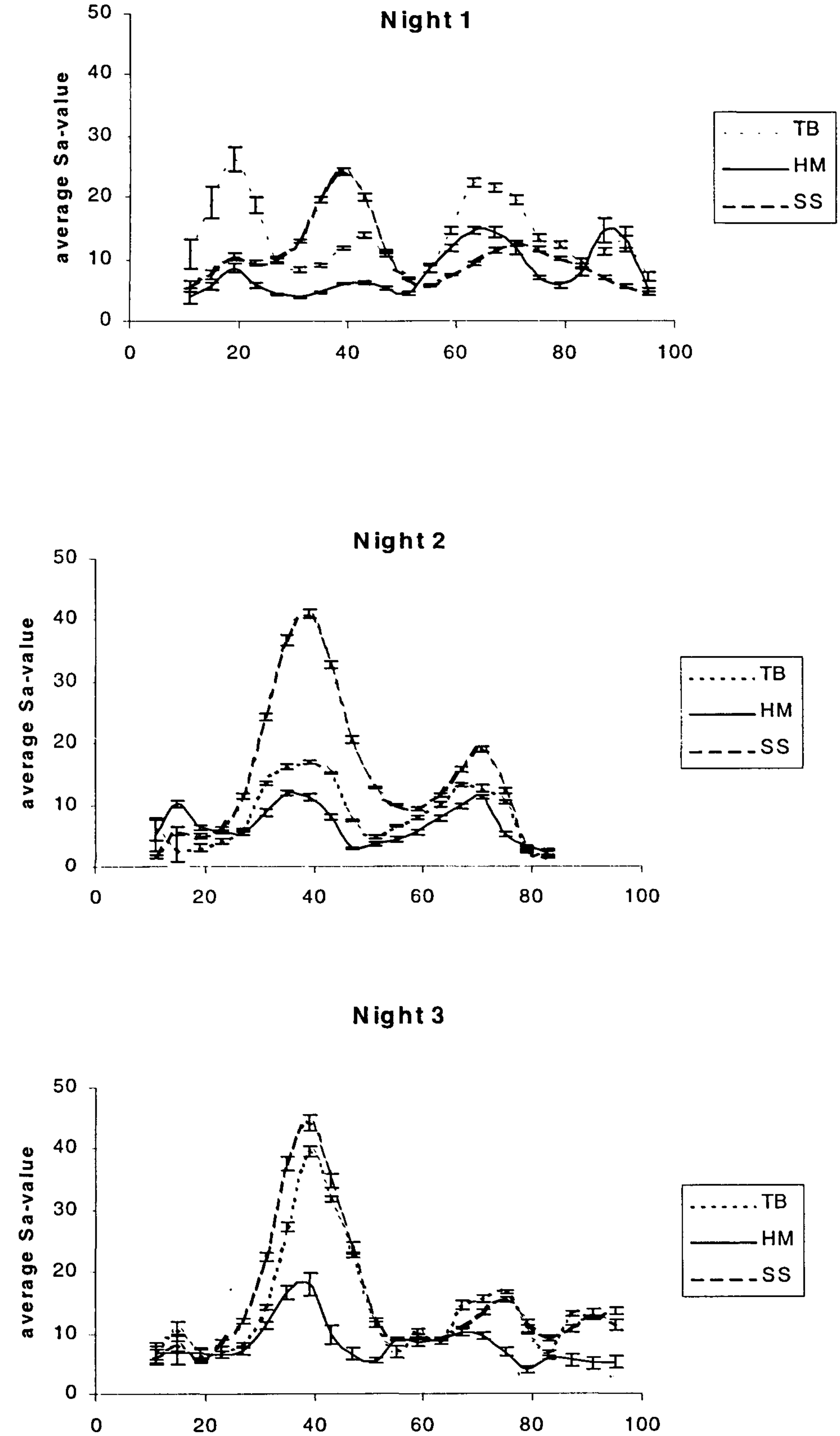

Figure 6. The averaged Sa-values per 4-m depth intervals (± Standard error) for R/V *Argos* hull-mounted (*HM*) and R/V Solea side-shifted (*SS*) and towed bodied (*TB*) transducer for all the three experimental set ups (Night 1 to 3).

MANUAL
FOR THE BALTIC INTERNATIONAL ACOUSTIC SURVEYS
(BIAS)

1. INTRODUCTION

Hydroacoustic surveys have been conducted in the Baltic Sea internationally since 1978. The starting point was the cooperation between Sweden and the German Democratic Republic in October 1978, which produced the first acoustic estimates of total biomass of herring and sprat in the Baltic Main basin (Hakansson et al. 1979). Since then there has been at least one annual hydroacoustic survey for Baltic herring and sprat stocks mainly for assessment purposes and results have been reported in journals to the Planning Group for Hydroacoustic Surveys in the Baltic and to ICES Annual Science Conferences (Anon. 1994a, 1995a, 199b, Hagström et al. 1991).

At the ICES Annual Science Conference in September 1997, the Baltic Fish Committee decided, that a manual to be used at international acoustic trawl surveys in the Baltic area should be elaborated. This manual should in its context follow the format of the manual used for the Baltic International Trawl Surveys (BITS).

The objective of the Baltic International Acoustic Surveys (BIAS) program is to standardize survey design, acoustic measurements, fishing method and data analysis throughout all national surveys where data are used as indices for assessment purposes.

The present manual applies to all hydroacoustic pelagic trawl surveys that are conducted within the framework of the BIAS. The standard sampling procedures should be uniform for all surveys.

In order to obtain a standardization for all ICES acoustic surveys some demands from the Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI (Anon, 1994) are adopted.

2. SURVEY DESIGN

2.1 Area of observation

It is assumed that the effective acoustic surveys cover only the area below 10m depth in each stratum.

2.2 Stratification

The stratification in the Baltic is based on ICES statistical rectangles with a range of 0.5 degrees in latitude and 1 degree in longitude.

The areas of all strata limited by the 10 m depth line are given in table 2.2

2.3 Transects

Parallel transects are spaced on regular rectangle basis at a maximum distance of 15 nautical miles.

The transect density shall be about 60 nm per 1000 nm^2.

In the vicinity of islands and in sounds the strategy of parallel transects leads to an unsuitable coverage of the survey area. In this case a zig-zag course should be used to achieve a regular covering. The length of the survey track should be chosen proportional to the parallel case.

2.4 Observation time

The acoustic surveys in the Baltic Sea (including Sub-divisions 21-32) are carried out in October. It is assumed that during this time of the year there is little or no emigration or immigration so that the estimates are representing a good 'snapshot' of the resources.

In the shallow water areas of the Western Baltic a great part of the fish concentrations are close to the bottom during daytime and therefore not visible for the echosounder. This leads to an underestimation of fish. Therefore the survey can be carried out only during nighttime.

3. ACOUSTIC MEASUREMENTS

3.1 Equipment

The standard equipment used for the survey are the echosounder SIMRAD EK/EY-500 or SIMRAD EK-400.

The standard frequency used for the survey is 38 kHz.

3.2 Instrument settings

A whole string of instrument settings can influence the acoustic measurements in a dangerous way. Particularly the right calibration settings in the ***Transceiver Menu*** are essential for the correct function of the acoustic device:

Max. Power
2-Way Beam Angle
Sv Transd. Gain
TS Transd. Gain

Additional in the split-beam case:

Angle Sens.Along
Angle Sens.Athw.
3dB Beamw.Along
3dB Beamw.Athw.
Alongship Offset
Athw.ship Offset

The following ***Transceiver Menu*** settings are recommended:

Absorption coef.	3 dBkm
Pulse Length	Medium
Bandwidth	Wide

and in the ***Layer Menu***:

Threshold	-60 dB
Bottom margin	0.5 m

It is recommended to record this settings regularly to have a log about the main function of the acoustic measuring system.

It is also recommended that each year the same settings (Min Sv = -60dB) are used for the printer in order to facilitate comparison of echogrammes.

3.3 Sampling unit

The Elementary Sampling Distance Unit (ESDU) is the length of cruise track along which acoustic measurements are averaged to give one sample. It is recommended to use in the Baltic the averaging unit of 1 nm.

3.4 Calibration

A calibration of the transducer is conducted at least once during the survey. If possible, the transducer is calibrated both at the beginning and the end of the survey. Calibration procedures are described in Foote et al. (1987) and in the EK 500 manual.

4. FISHERY

4.1 Gear

Trawling is done with different pelagic gear in the midwater as well as in the near bottom. The collection of the trawl gears used in Baltic Acoustic Surveys is given in table 4.1

The stretched mesh size in the codend of the trawl shall be 20 mm.

4.2 Method

The collection of biological samples in the Baltic is done to determine the species composition and length, age and weight distributions of target species detected by the echosounder system.

It is recommended to sample a minimum of 2 hauls per stratum.

Standard fishing speed is 3–4.5 knots.

Each haul is recommended to last for 30 minutes.

4.3 Samples

4.3.1 Species composition

In principal the total catch shall be sorted into **all species**. The weight of the total catch and the weight per species shall be registered.

If the catch consists of a mixture of Clupeoids and few larger species the total catch can be sorted into species for the larger fish species and a mixture of Clupeoids. The total weight per species for the larger species and the total weight of the mixture of Clupeoids for the total catch shall be registered.

A subsample of at least 100 kg of the mixture of Clupeoids shall be sorted for the estimation of the species composition of Clupeoids in the mixture. The weight of the subsample, and the total weight per species in the subsample shall be registered.

4.3.2 Length composition

Length distributions are recorded for all fish species caught. Length is defined as total length (measured from tip of snout to tip of caudal fin). Length is measured to 0.5 cm below for herring and sprat, and to 1 cm below for all other species.

In case the catch of a certain species is too large to measure all individuals, a sub-sample may be taken which should contain at least 100 specimens of the main species (herring and sprat). For other species at least 50 specimens should be measured.

If a certain species (notably herring) is caught in two clearly distinct size groups, each of these size groups should be sampled separately by measuring at least 100 fish from each of them. In case of large catches of herring (n > 1000), the subsamples should be doubled with the minimum size given above.

Certain related species that are hard to distinguish from one another may be grouped by genus or larger taxonomic unit.

4.3.3 Weight distribution

The mean weight per length group for herring and sprat shall be measured for each trawl haul.

Herring and sprat shall be sorted into 0.5 cm length groups and weighted.

The total weight of the sample used for length-weight distribution for a given species shall be registered together with the number and sample weight per length group.

4.3.4 Age distribution

Otolith samples are collected within each ICES Sub-division. For all species the same areas are used.

If otolith samples are to be taken of the 2 target species herring and sprat the number of otoliths per length-class are not fixed by a constant figure. Nevertheless the following minimum sampling levels should be maintained for each sampling area:

- herring : 5 otoliths per 0.5 cm length-class
- sprat : 5 otoliths per 0.5 cm length-class for l<10cm
  10 otoliths per 0.5 cm length-class for l>10cm

For the smallest size groups, that presumably contain only one age group, the number of otoliths per length class may be reduced.

It is recommended that each country collect otoliths by each haul, so the otolith sampling are distributed all over the Sub-Divisions.

4.4 Environmental data

Environmental data should be measured. For further specifications they should contact the ICES Hydrographer.

5. DATA ANALYSIS

5.1 Species composition

Trawl catches within each stratum are combined to give an average species composition of the catch. Each trawl catch is given equal weight, unless it is decided that a catch is not representative for the fish concentrations sampled. In this case, the catch is not used. The species frequency f_i of species i can be estimated by

$$f_i = \frac{1}{M}\sum_{k=1}^{M}\frac{n_{ik}}{N_k} \qquad (5.1)$$

where n_{ik} the fish number of species i in the trawl k and N_k the total fish number in this haul.

5.2 Length distribution

It is assumed that catch rates are poorly related to abundance. In this case each trawl catch is given equal weight. Very small samples are considered as non representative and excluded from the calculation. We find the length frequency f_{ij} in the length class j as the mean over all M_i trawl catches containing the species i

$$f_{ij} = \frac{1}{M_i}\sum_{k=1}^{M_i}\frac{n_{ijk}}{N_{ik}} \qquad (5.2)$$

where n_{ijk} the number of fish within the length class j and N_{ik} the total number of species i in the haul k.

5.3 Age distribution

All sampled otoliths within each Sub-division are assumed to be representative for the species age distribution within this area. The age-length-key in this Sub-division indicates the frequencies f_{aj} or the normalized quantities q_{aj} with the age a in the length class j. The multiplication of the normalized age length matrix $A=(q_{aj})$ for the whole Sub-division with the length vector $L=(f_j)$ from a specific stratum results in the age distribution f_a for this stratum.

$$f_a = \sum_j q_{aj} \cdot f_j \qquad (5.3)$$

5.4 Weight distribution

For the calculation of the weight distribution per age group W_a we use also the normalized age-length-key q_{aj} (see 5.3) and the mean weight per length group W_j.

$$W_a = \sum_j q_{aj} \cdot f_j \cdot W_j \qquad (5.4)$$

5.5 Lack of sample hauls

In the case of lack of sample hauls inside individual ICES rectangle (small bottom depth, weather or other limitations) - sample hauls made in the vicinity are allowed to be taken into account.

5.6 Allocation of records

In the Baltic Sea including the area in Kattegat and Skagerrak herring and sprat normally cannot be distinguished from other species by visual inspection of the echogramme. Both herring and sprat tend to be distributed in scattering layers or in pelagic layers of small schools, and it is not possible to ascribe values to typical herring schools.

Species allocation is then based entirely upon trawl catch composition. The estimates of total fish density are then allocated to species and age groups according to the trawl catch composition in that stratum.

5.7 Target strength of an individual fish

The mean cross section σ of an individual fish of species i should be derived from a function which describes the length-dependence of the target-strength.

$$TS = a_i + b_i \cdot \log L \qquad (5.7.1)$$

a_i and b_i are constants for the i'th species and L is the length of the individual fish in cm.
The equivalent formula for the cross-section is:

$$\sigma_{ij} = 10^{a_i/10} \cdot L_j^{b_i/10} \qquad (5.7.2)$$

Normally we assume a quadratic relationship, that means b_i is 20. Than we get the simple formula:

$$\sigma_{ij} = d_i \cdot L_j^2 \qquad (5.7.3)$$

The parameters a, b and d are listed in table 5.7 for different species.

5.8 Estimation of the mean cross section in the stratum

The basis for the estimation of total fish density F from the measured area scattering cross section S_a is the conversion factor c.

$$F = S_a \cdot c = \frac{S_a}{<\sigma>} \qquad (5.8.1)$$

The mean cross section <σ> in the stratum is dependent from the species composition and the length distributions of all species. From formula 5.7.3 we get the corresponding cross section $<\sigma_i>$

$$<\sigma_i> = \sum_j f_{ij} \cdot d_i \cdot L_j^2 \qquad (5.8.2)$$

where L_j is the mid point of the j-th length class and f_{ij} the respective frequency.
It follows that the mean cross section in the stratum can be estimated as the weighted mean of all species related cross sections $<\sigma_i>$:

$$<\sigma> = \sum f_i \sigma_i = \sum_i f_i \sum_j f_{ij} d_i L_j^2 \qquad (5.8.3)$$

5.9 Abundance estimation

The total number of fish in the stratum has to be estimated as:

$$N = F \cdot A = \frac{S_a}{<\sigma>} \cdot A \qquad (5.9.1)$$

This total abundance is splitted into species classes N_i by

$$N_i = N \cdot f_i \qquad (5.9.2)$$

especially in abundance of herring N_h and sprat N_s.

The abundance of the species i is divided into age-classes, $N_{a,i}$ according to the age distribution $f_{i,a}$ in each stratum

$$N_{ia} = N_i \cdot f_{ia} \cdot \qquad (5.9.3)$$

5.10 Biomass estimation

The biomass Q_{ia} for the species i and the age group a is calculated from the abundance N_{ia} and the mean weight per age group

$$Q_{ai} = N_{ai} \cdot W_a \qquad (5.10.1)$$

6. DATA EXCHANGE AND DATABASE

6.1 Exchange of survey results

The main results of BIAS should be summarized and reported to the Acoustic Survey coordinator not later as January of the next year. These results are intended for the information of the Assessment Groups and should contain the following documents :

- the map of the cruise track and the fishery stations (with a listing of the track and haul positions)
- a short description of the survey
- the table of the basic values for the abundance estimation (survey statistics)
- tables of the abundance of herring and sprat per age group
- tables of the mean weights of herring and sprat per age group

The standard exchange format for the documents is described in table 6.1.

6.2 BAD1

The database BAD1 is the collection of results from the Baltic International Acoustic Surveys (BIAS). The sampling unit is the stratum (see 2.2). The contents of the database are similar to the standard data exchange format (6.1) for the BIAS. The database BAD1 consists of the following six tables:

- AH Abundance (in millions) of herring per age group
- AS Abundance (in millions) of sprat per age group
- ST Basic values for the computation of the abundance
- SU Description of the different surveys
- WH Mean weights of herring per age group
- WS Mean weights of sprat per age group

The inner structure of the tables is summarized in table 6.2. The Acoustic Survey coordinator is responsible for the update of the database.

Appendix IV

Working paper
Study Group on Baltic Acoustic Data 1998
Gdynia, Poland, April 1998
HERSUR project

International database for acoustic data and biological sampling data for surveys in the North Sea and west of Scotland
Proposal for a database structure and database exchange format

Ver, 3.0

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The development of a database for acoustic data and biological sampling data from the international acoustic survey for Herring in the North Sea and west of Scotland was a part of the EU founded project ECHOHER.

To initiate this work a visit to the involved institutes was planned to identify present formats for the national acoustic data, expectations in relation to an international database and resource problems involved in delivering data to an international database to various levels of aggregation.

This visit to involved institutes was conducted 13. to 18. January 1997. As Norway is a very important participant in the acoustic survey for Herring in the North Sea it was decided to visit the institute in Bergen even though Norway is not participating in the ECHOHER-project.

This paper present the information collected on the formats for national acoustic data, expectations in relation to an international database and resource problems involved in delivering data to an international database to various levels of aggregation.

A proposal for a for a database structure and database exchange format based on the discussions in the Planning Group for Herring Surveys, Aberdeen 1997 are presented.

National data formats and data processing.

Norway:

In Norway acoustic data are normally collected on 5 NM interval basis. Data are processed by the Bergen Integrator and echos are normally allocated to species (scrutinizing). In some years (mid 80) the data processing to stock estimate has been made based on mixed layers using the mean TS calculated from the species composition in the catch. The reason for this has been the behaviour of the Herring as they in these years were standing very near to the bottom.

Only back scattering allocated to Herring are stored in a national database. The actual calculation of stock size is made in Excel based on data transferred from the Bergen integrator and a fishery database.

Data back to the beginning of the acoustic surveys for Herring in the North Sea in 1983 should be on a computer based media and a transfer to another database format should be possible without large effort, but additional data wanted for the international database might demand resources (Rolf J. Korneliusen pers.com.).

The fishery hauls made during the acoustic survey for identification of the species observed are carried out as standard trawl hauls due to a national described standard (ref....) the results are stored in a national database as ASCII files. Length and age keys are made for each trawl haul. Key for splitting into spring and autumn spawners are made for larger areas based on vertebrate counting. During later years split on spring and autumn spawners is based on maturity.

The Netherlands:

In The Netherlands acoustical data are sampled and scrutinized by the Bergen integrator. The normal sampling interval are 5 NM, but it can defer. Normally the echoes are allocated to species and classified in groups, Herring, properly Herring, properly not Herring, etc.. Some areas has to be taken as mixed layers, but these areas only account for a low proportion of the Sa. Normally 500 acoustic samples are stored during a survey. The biomass calculation are made in a spread sheet.

For 1996 all data on Sa per sampling interval are stored on an electronic media downloaded from the Bergen Integrator. These data should therefore be very easily transferable to a new data format but additional data has to be added by hand. For the years before 1996 back to 1987 data are only as mean Sa pr square in tables and in some extend as Sa pr 5 NM or 10 NM exist back to 1991 written on maps with the survey track. Typing of this data into the database will be very time consuming.

Acoustic data and fishery are normally only made during day time. The trawl hauls are processed due to a national standard with length-age keys from every trawl haul. All biological data are stored in a national database as ASCII files. There will be biological data concerning these surveys further back than 1991 as The Netherlands at that time were doing fishery in connection to the Scottish acoustic measurements. All fishery data should be direct convertible into the IBTS data format.

Scotland:

The Scottish allocate the measured Sa values to species and classify the echoes in different groups as Herring, properly Herring , properly not Herring, shoals, mixed layers ....
Acoustic data are collected along the transect for each 2.5 NM. With this sampling frequency the North Sea survey will result in around 1000 observations and the survey west of Scotland will result in around 1000 observations.

The stock estimation are made in a database, Smart, where both biological as acoustic data are contained.

Fishery are only made during day time when changes in the structure are observed or when doubt in allocation to species appear. The trawl hauls are processed due to a national standard containing full information on all species in the haul. Length-age keys are made for every haul and are used for areal stratification.

The Scottish acoustic data as well as biological data are accessible on an electronic media back to 1987. These data should very easily be transformed into the format of an international database, but additional data may have to be typed into the database which might be very time consuming.

Denmark:

In Denmark acoustic data are collected on a 1 NM interval basis. Sa values are only collected for mixed layers, and the species composition and length frequencies from the trawl hauls are used calculation of the mean TS connected to the data record.

The stock size calculations are made connected to a fixed area stratification where larger areas are divided into a finer structure due to the total depth. The acoustic sampling intervals are allocated to the strata due to the mean total depth during the sampling distance.

Danish acoustic data are stored on electronic media and easily transferred from 1992 and onwards. For the years before 1992 data are stored as more or less raw data on electronic media not accessible by the institute.

Fishery is only performed during dark on disperse layers. Trawl stations are distributed in a way that all strata (based on total depth) are covered.

All trawl hauls are handled due to national standard. Length frequencies are made for all species and length-age frequencies are made for all target species. Split on autumn or spring spawners are made based on vertebrate in previous years and based on otolith micro structures since 1996.

The Danish fishery data are stored in a database in a format which can be transformed into a IBTS type database format.

Database structure:

The general opinion among the national acoustic groups visited during the trip was that a database was needed and the Sa values should be stored on the level of the sampling interval.

It was also agreed that the biological information from the trawl hauls should be stored in a structure very near to the IBTS database format.

All the national groups did have specific wishes to information to be contained in the database due to national ways of doing the stock estimation.

The following information was requested to be contained in the database by the different national groups.

Norway:

The Norwegian group wants information on the depth of the main concentration of herring for each sampling interval to be contained in the data record. The reason for this is recent studies on the correlation between swimming depth and TS of herring which indicate large differences in the TS due to the swimming depth. It is expected that this correlation of TS to the depth could be of high importance to the estimated stock size.

The Netherlands:

By the Dutch it was requested that the method used in classification of the acoustic signals from a given sampling interval should be contained in the database record (herring, properly herring, properly not herring). They were of the opinion that the fishing strategy used in the area for classification should be contained in the data records as well, shoal "hunting" or fishery in mixed layers and fishery day or night.

The database should contain information on sprat as well as herring.

The Sa values stored should be corrected for calibration parameters and a reference to the trawl haul used for the scruntinisation of the acoustic signal in the sampling interval should be contained in the database record.

It was also found that it should be possible to mention the quality of the echograms used for the calcification in a given sampling interval as a code.

Scotland:

The group in Aberdeen also found that the database should contain data for both sprat and herring.

It should be possible to have several Sa values referring to different classifications for each sampling interval and it should be possible to allocate a mean depth of the concentration referring to the classification.

A reference to the a group of trawl hauls used for scruntinisation should be contained in the data record.

The start position of the sampling intervals should be given in decimal degrees.
For the different surveys a text file should be contained in the database. This text file should be used for information on the quality of the survey and major changes in survey methods.

Denmark:

From the Danish side information on the mean depth in a sampling interval was needed in the database record as this information was used for depth stratification.

It was found that information on sounder frequency should be contained in the data record.

These national wishes for data to be contained in the database should be covered by the following proposal for data types in the database and record for exchange of national data to the database.

Specification of data types in the acoustic records:

Country	The alpha codes for countries used by the IBTS database (ICES CM1996/H:1), 3 positions.
Ship	The alpha/numeric codes for ship used by the IBTS database (ICES CM1996/H:1), 4 positions.
Cruise no	The national cruise number, numeric 4 positions
Date	yyyymmdd
Time	Time of the day has to be given in UTC, hhmm
Log counter	Identification of sampling interval, numeric, 5 positions
Frequency	Frequency of the echosounder used, numeric, 3 positions
Distance/time	Sampling method used, time or distance, D or T, alpha 1 position.
Sampling freq.	The size of the sampling interval in NM or minutes, numeric, 4 positions XX.X
Position	The position for the starting point of the sampling interval in decimal degrees. E/W = +/- and N/S = +/-
Mean depth	Mean total ground depth in sampling interval in M below surface, numeric 4 positions
Species code	The numeric codes for species used by the IBTS database (ICES CM1996/H:1), 10 positions (herring or sprat). MIXED has to be added to the list of species codes. There has to be made separate records for herring and sprat for the same sampling interval.
Sa	Sa corrected for calibration parameters in m^2 pr. nm, alphanumeric in exponential notation, XXX.XXXXE XXX. When Sa are allocated to herring and sprat 0 values shall be included.
Species depth	The mean depth of the concentrations of herring, sprat or mixed layer, as more layers can be present in the same area this has to be presented in separate records.
Classification	Classification of echo traces, numeric 1 position: 1 Herring/sprat 2 May be herring/sprat 3 Properly not herring/sprat 4 Mixed 5 6
Haul ref.	The number of the haul or the group of hauls used in the classification of the echo signals in the sampling interval. Alpha-numeric 3 positions. If single haul identical with the haul number in the IBTS database format (ICES CM1996/H:1). If a group of hauls given with GXX referring to a table given in an other file.

Specification of data types in the fisheries records:

All the national groups agreed that all biological data should be stored in a database structure very near to the IBTS database structure (ICES CM1996/H:1). It is important that the database contain information on all species in the trawl hauls with length frequencies for all species especially in areas where mixed layers are used for stock estimation.

The IBTS database format has to be changed to be used for pelagic trawling as information on trawling depth are not in the present record. Furthermore, the IBTS database format only allow total depth down to 300 m and net opening up to 10 m. Some adjustments of record type 1 and 1A has therefore to be done. Furthermore, the list of codes for countries and ships and gears has to be expanded.

As different fishing strategy are used in the fishery in different areas and by different countries
a record describing the fishery method used are therefore needed in the record structure of part of the data base containing the biological data. The record type described below is suggested to be incorporated in the IBTS data base record type 1A:

Fishing strategy Description of the strategy used in the fishery, alphanumeric, 2 positions,
D/N/BX
D Day fishery only
N Night fishery only
B Both day and night fishery
1 Trawling on mixed layers
2 Trawling on shoals
3 Shoals hunting
4 Gillnet fishery
5 ...
6

These changes have to be accepted by ICES if they shall run the database in the future.

Regarding the length frequency keys it is suggested that the length/age keys are used as given in record type 3.

The demands for information on single fish as maturity and autumn/spring spawner should be covered by record type 4 in the IBTS database format.

Future work on the data base:

The work on the construction of the data base for the international acoustic surveys in the North Sea and west of Scotland will be continued in the EU founded HERSUR project.

The exchange of data and the construction of the data base will be made by the Danish Institute for Fisheries Research.

As a first test of the exchange format for the acoustic data from all national acoustic surveys conducted in the North Sea in 1997 will be exchanged as a test in the late spring 1998.

During the spring 1998 contact will be made with ICES to prepare the needed changes in the IBTS format to cover the need for storage of biological data from the pelagic trawling connected to the acoustic surveys. This work has to be coordinated with the work done for the Baltic by the Study Group on Baltic Acoustic Data .

During 1998 the platform for the data base shall be decided and the data for the as many years as possible from the North Sea incorporated in the data base.

The choice of data base platform shall take the following assumptions into consideration:

- It shall be possible to export the data base data from the host to the national laboratories for further studies in a form that can be handled in a Windows environment.
- It shall be preferred that the same record structure and platform are used both for the North Sea and the Baltic Sea
- It shall aim for a transferee of the location of the data base for the ICES in a couple of years, this hosting may be based on EU findings

Record for data exchange to the database

In the record for data exchange duplicates of information are used to prevent mistakes in the exchange procedure. In the final database groups of data types can be grouped in keys.

Cruise info record

Country
Ship
Cruise no.
Year
Date of cruise start
Date of cruise end
Geographic area (corner positions)
Contact persons
- Acoustics
- Fisheries

Instrumentation
- Sounder
- Frequency

Sa record

Country
Ship
Cruise no.
Log counter
Date
Time
Distance/time
Sampling frequency
Position
Mean depth
Species code
Sa
Species depth
Classification
Haul ref.

Fisheries records

For the fisheries data the already existing exchange formats with some additions.

Appendix V
The ICES Study Group on Baltic Acoustic Data

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