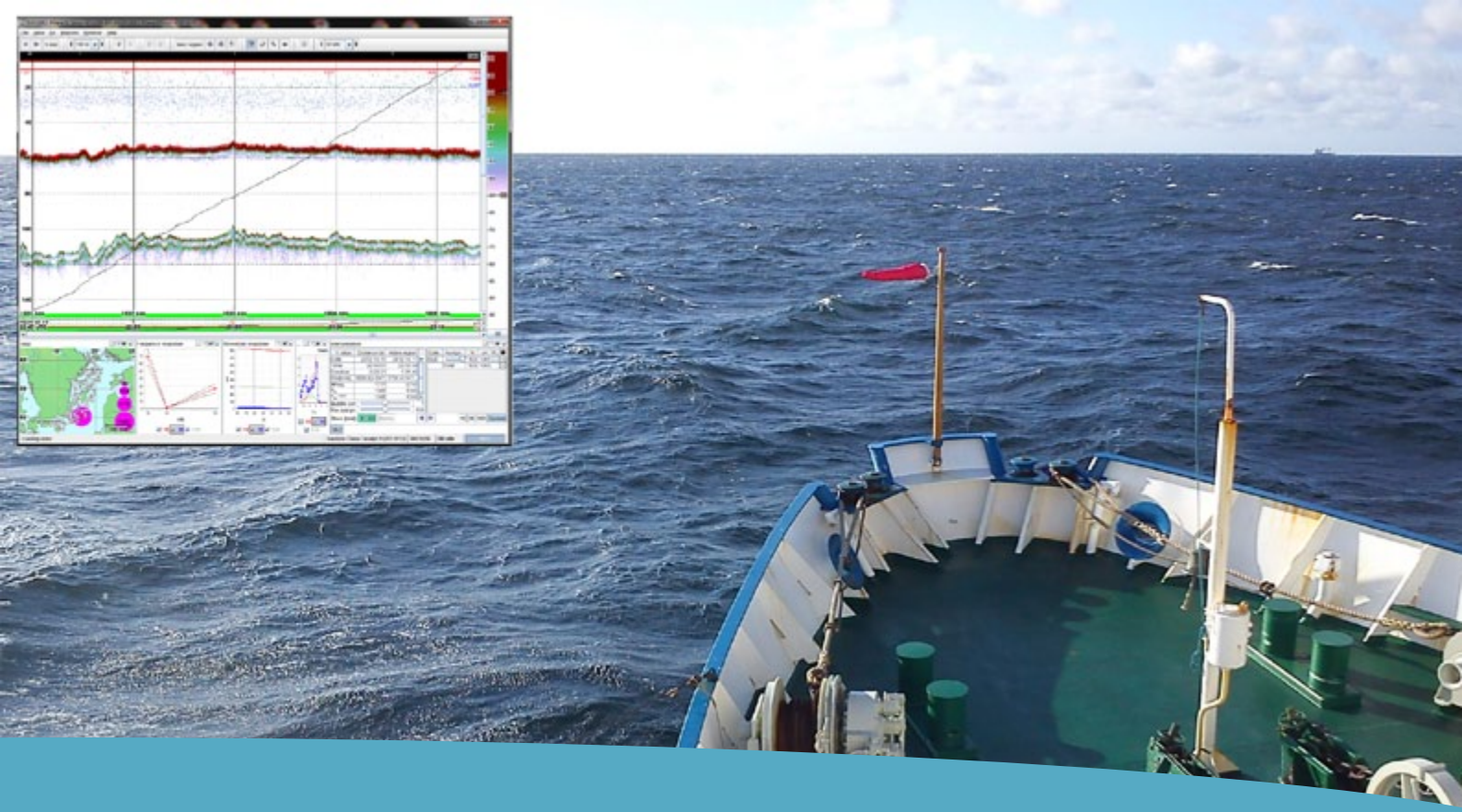

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Baltic International Acoustic Survey report, October 2012

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Baltic International Acoustic Survey report, October 2012

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Baltic International Acoustic Survey Report for R/V Dana

2012-10-05 - 2012-10-21

Niklas Larson
SLU - Institute of Marine Research, Lysekil, Sweden

Scientific Leader: Niklas Larson
Expedition Leader: Anders Svenson, Niklas Larson

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1 Svensk Sammanfattning

Internationellt koordinerade hydroakustiska surveyer har regelbundet genomförts av Havsfiskelaboratoriet i Lysekil sedan 1978 i Östersjön. Baltic International Acoustic Survey (BIAS), som utförs varje år i oktober, regleras under Europeiska Commissionens Data collection Framework (DCF) och är obligatorisk för varje medlemsland i EU runt Östersjön. Sverige ansvarar för subdivision(SD) 27 och för delar av 25, 26, 28 samt 29. Dessutom har Sverige sedan 2007 tillsammans med Finland täckt SD 30. Syftet med undersökningen är att bedöma sillbeståndet och resultaten rapporteras till Baltic International Fish Survey Working Group (WGBIFS) och Baltic Fisheries Assessment Working Group (WGBFAS), båda är arbetsgrupper inom International Council for the Exploration of the Sea (ICES). Från 2011 används det danska forskningsfartyget R/V Dana efter det att svenska R/V Argos, som dessförinnan användts sedan 1978, tagits ur bruk utan befintlig ersättare.

Årets expedition startade 2012-10-05 i Gåsöfjärden och slutade 2012-10-21 i Ystad. Under surveyen samlas akustisk rådata in från ett kalibrerat vetenskapligt ekolod[1] och pelagisk trålning utförs för att få information om art och längfördelning. Den akustiska rådatan efterbehandlas i en mjukvara som 2011 byttes till en nyare programvara, LSSS[2]. Trålfångsten analyseras vad gäller arter samt längder, dessutom tar man fram en åldersstruktur på målarterna i fångsten som i detta fallet är sill, skarpsill och torsk. Därefter sammanställs de akustiska värdena med resultatet av analysen utav trålfångsterna.

Deltagande länderna skickar årligen de som är vetenskapligt ansvariga för surveyen, samt eventuellt även expeditionsledarna, till arbetsgruppen WGBIFS. Där tas gemensamma riktlinjer och manualer fram och

[1] simrad.com
[2] Marec.no

resultaten från varje land kombineras i en gemensam databas som rapporteras till WGBFAS, vilka använder BIAS resultaten tillsammans med annan information i en modell för att uppskatta beståndet. Årets Svenska expedition innebar ett byte av plattform för standardsvängaren (38kHz) eftersom R/V Dana använder en släpad torpedliknande paravan. Resultatet från 2012 års svenska BIAS survey bedöms vara representativt för mängden sill och skarpsill i Östersjön för SD 25 - 29. Däremot i Bottenhavet (SD30) var man i år tvungen att köra expeditionen med halva täckningsgraden (endast finsk finansiering). Då man inte har följt manualen och den fastställda täckningsgraden så infattar 2012 års resultat från SD 30 en större osäkerhet, man kan även se att åldersfördelningen är avvikande för detta år och földaktligen måste årets resultat användas med försiktighet i beståndsmodeller samt eventuell vidare analys.

2 The Baltic International Acoustic Survey

International hydroacoustic surveys have been conducted in the Baltic Sea since 1978. The starting point was the cooperation between Institute of Marine Research (IMR) in Lysekil, Sweden and the Institute für Hochseefisherei und Fishverarbeitung in Rostock, German Democratic Republic in October 1978, which produced the first acoustic estimates of total biomass of herring and sprat in the Baltic Main basin (Håkansson et al., 1979). Since then there has been at least one annual hydroacoustic survey for herring and sprat stocks and results have been reported to ICES.

The Baltic International Acoustic Survey (BIAS), is mandatory for the countries that have exclusive economic zone (EEZ) in the Baltic Sea, and is a part of the Data Collection Framework as stipulated by the European Council and the Commission (Council Regulation (EC) No 199/2008 and the Commission DCF web page).

IMR in Lysekil is part of the Department of Aquatic Resources within Swedish University of Agricultural Sciences and is responsible for the Swedish part of the EU Data Collection Framework and surveys in the marine environment. The Institute assesses the status of the marine ecosystems, develops and provides biological advices for managers for the sustainable use of aquatic resources.

The BIAS survey in September/October are co-ordinated and managed by the ICES working group WGBIFS. The main objective of BIAS is to assess clupeoid resources in the Baltic Sea. The survey will provide data to the ICES Baltic Fisheries Assessment Working Group (WGBFAS). Since 2007 Finland and Sweden join together to additionally cover Bothnian Sea (ICES Subdivision 30).

3 Methods

3.1 Narrative

Due to that R/V Argos was taken out of order, Sweden rented R/V Dana for the 2011 and the 2012 BIAS survey. The scientific staff was a mix of Swedish and Finnish personnel similar or same as previous years, and the ship crew was Danish in the 2012 survey.

This year's calibration of the SIMRAD EK60 sounder was made at Gåsfjärden south of Västervik, 2012-10-05 to 2012-10-06, the location change occurred 2011 because the normal calibration site at Högön is inaccessible for Dana due to deeper draft. The first part of the cruise started 2012-10-06 from Gåsfjärden and ended 2012-10-15 in Oxelösund. ICES Subdivision 30 and part of 27 and 29 were covered. The

second part of the cruise started 2012-10-15 from Oxelösund and ended 2012-10-19 outside Grönhögen[3]. Parts of ICES Subdivision 27 and 28 were covered. The last part of the cruise started 2012-10-19 from Grönhögen and ended in Ystad 2012-10-21. Each stop was short (a few hours) and at each stop part of crew and scientific staff was exchanged. The total cruise covered ICES subdivision (SD) 27 and 30 as well as parts of SD 25, 26, 28 and 29.

3.2 Survey design

The stratification 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 are limited by the 10 m depth line. The aim is to use parallel transects spaced on regular rectangle basis at a maximum distance of 15 nautical miles and with a transect density of about 60 nautical miles per 1000 square nautical miles. The irregular shape of the survey area assigned to Sweden and the weather conditions makes it difficult to fulfill this aim. This year Sweden was unable to support the funding of the survey in SD30 due to economical difficulties within the DCF programme and therefore the coverage of the SD30 had to be based on Finnish funding only, which resulted in half the normal expedition time. Therfore the desicion was made at WGBIFS that each square in SD30 should be covered by half the distance in each square and half the number of hauls in each square compared to previous normal coverage.
The total area covered by the survey (SD25-30) was 38271 square nautical miles and the distance used for acoustic estimates was 2055 nautical miles (see the WGBIFS report[4] for more information). The cruise track and positions of trawl hauls is shown in figure 1.

3.3 Calibration

The SIMRAD EK60 echo sounder with the transducer ES38B was calibrated at Gåsfjärden 2012-10-05 according to the BIAS manual[5]. Values from the calibration were within required accuracy.

3.4 Acoustic data collection

The acoustic sampling was performed around the clock. SIMRAD EK60 echo sounder with the 38 kHz transducer (ES38b) mounted on a towed body is used for the acoustic transect data collection, additionally a hull mounted 38 kHz transducer (ES38B) was used during the fishing stations (the towed body is taken aboard when fishing). The settings of the hydroacoustic equipment were as described in the BIAS manual. The post processing of the stored raw data was made using the software LSSS[6] for SD25 - SD29, Bothnian sea (SD30) was processed in Echoview[7]. The mean volume back scattering values (Sv) were integrated over 1 nautical mile elementary sampling units (ESDUs) from 10 m below the surface to the bottom. Contributions from air bubbles, bottom structures and scattering layers were removed from the echogram by using LSSS.

3.5 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that it is impossible to allocate the integrator readings to a single species. Therefore the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. In

[3] Position; Lat:56.2589, Lon:16.3933
[4] ICES CM 2012/SSGESST:02
[5] ICES CM 2012/SSGESST:02, Addendum 2
[6] www.marec.no/english/products.htm
[7] www.echoview.com

the case of lack of sample hauls within an individual ICES rectangle (due to gear problems, bad weather conditions or other limitations) a mean from hauls from neighboring rectangles was used. From these distributions the mean acoustic cross-section was calculated according to the target strength-length (TS) relationships (table 1).

Clupeoids	TS = 20 log L (cm) - 71.2	(ICES 1983/H:12)
Gadoids	TS = 20 log L (cm) - 67.5	(Foote et al. 1986)
Trachurus trachurus	TS = 20 log L (cm) - 73.0	(Misund, 1997 in Peña, 2007)
Fish without swim bladder	TS = 20 log L (cm) - 84.9	ICES CM2011/SSGESST:02,Addendum 2
Salmonids and 3-spined stickleback were assumed to have the same acoustic properties as herring.		

Table 1: Target strength-length (TS) relationships

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section s_A and the rectangle area, divided by the corresponding mean cross section σ. The total number was separated into different fish species according to the mean catch composition in the rectangle.

3.6 Hydrographic data

CTD casts were made with a "Seabird 9+" CTD when calibrating the acoustic instruments and whenever a haul was conducted, additional hydrographic data was collected on a selection of these stations.

3.7 Personnel

The participating scientific crew (table 2).

Bland, Barbara	IMR, Lysekil, Sweden	Acoustics
Iliç, Eva	IMR, Lysekil, Sweden	Fish sampling
Jernberg, Carina	IMR, Lysekil, Sweden	Fish sampling
Johansson, Jan-Erik	IMR, Lysekil, Sweden	Acoustics
Larson, Niklas	IMR, Lysekil, Sweden	Scientific & Expedition leader, Acoustics
Leiditz, Marie	IMR, Lysekil, Sweden	Fish sampling
Lövgren, Olof	IMR, Lysekil, Sweden	Acoustics
Palmen-Bratt, Anne-Marie	IMR, Lysekil, Sweden	Fish sampling
Rudolphi, Ann-Christin	IMR, Lysekil, Sweden	Fish sampling
Sjöberg, Rajlie	IMR, Lysekil, Sweden	Fish sampling
Svenson, Anders	IMR, Lysekil, Sweden	Expedition leader, Acoustics
Heimbrandt, Yvette	ICR, Öregrund, Sweden	Fish sampling
Kaljuste, Marju	ICR, Öregrund, Sweden	Fish sampling
Odelström, Anne	ICR, Öregrund, Sweden	Fish sampling
Tärnlund, Susanne	ICR, Öregrund, Sweden	Fish sampling
Harjunpää , Hannu	FGFRI, Finland	Fish sampling
Lilja, Juha	FGFRI, Finland	Expedition leader, Acoustics
Pönni, Jukka	FGFRI, Finland	Fish sampling
Saari, Tero	FGFRI, Finland	Fish sampling
Szaron, Jan	SMHI, Gothenburg	Oceanography

Table 2: Participating scientific crew

4 Results

4.1 Biological data

In total 71 trawl hauls were carried out, 15 in SD 25, 2 in SD 26, 15 in SD 27, 9 in SD 28, 10 hauls in SD 29 and 20 in SD 30. 4218 herrings and 2080 sprats were aged. Catch compositions by trawl haul is presented in Table 8 to 15. Length distributions for herring and sprat by ICES subdivision are shown in figures 2 to 13.

4.2 Acoustic data

The survey statistics concerning the survey area, the mean backscatter [s_A], the mean scattering cross section [σ], the estimated total number of fish, the percentages of herring, sprat and cod per Subdivision/rectangle are shown in Table 3.

4.3 Abundance estimates

The total abundances of herring and sprat by age group per rectangle are presented in Table 4 and 6. The corresponding mean weights by age group per rectangle are shown in Tables 5 and 7.

5 Discussion

The data collected during the survey should be considered as representative for the abundance of the pelagic species during the BIAS in 2012 for SD25 to 29. When using the results for SD30 in this years survey it should be noted that deviation has been made from the manual in the coverage of each square.

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Commission DCF web page:
http://datacollection.jrc.ec.europa.eu/dcf-legislation

7 Tables, map and figures

SD	RECT	AREA	SA	SIGMA	NTOT	HHer	HSpr	HCod
25	39G4	287.3	414.1	2.945	404.06	50.52	49.32	0.142
25	39G5	979.0	237.4	2.355	986.68	31.31	67.70	0.905
25	40G4	677.2	363.7	3.464	710.98	52.73	45.12	2.143
25	40G5	1012.9	828.8	2.710	3097.71	44.14	55.46	0.176
25	40G6	1013.0	370.2	2.455	1527.72	43.47	41.46	0.371
25	40G7	1013.0	427.6	2.128	2035.23	28.18	53.57	2.100
25	41G6	764.4	509.3	0.510	7637.41	6.84	2.64	0.013
25	41G7	1000.0	787.7	2.221	3546.66	33.35	49.60	0.841
26	41G8	1000.0	751.3	3.096	2426.46	80.29	17.84	0.793
27	42G6	266.0	715.5	0.653	2915.79	10.44	4.85	0.009
27	42G7	986.9	569.4	0.544	10320.88	5.80	3.54	0.006
27	43G7	913.8	479.8	0.429	10214.89	2.45	10.73	0.000
27	44G7	960.5	525.0	0.485	10394.27	8.72	6.82	0.000
27	44G8	456.6	514.3	0.711	3304.77	11.39	69.46	0.000
27	45G7	908.7	1201.4	0.798	13681.39	25.72	3.85	0.000
27	45G8	947.2	596.2	0.694	8134.55	14.12	8.98	0.000
27	46G8	884.8	821.4	1.188	6117.92	41.46	30.67	0.000
28	42G8	945.4	451.8	2.735	1561.64	76.48	13.97	0.104
28	43G8	296.2	2037.6	2.198	2745.45	55.62	27.59	0.203
28	43G9	973.7	569.0	1.257	4408.52	22.36	25.44	0.187
28	44G9	876.6	767.8	0.503	13382.27	1.05	11.92	0.019
28	45G9	924.5	741.3	0.884	7752.97	21.32	11.54	0.008
29	46G9	933.8	663.2	0.803	7711.68	13.73	51.17	0.000
29	46H0	933.8	619.3	1.159	4987.18	14.51	78.74	0.000
29	47G9	876.2	706.7	1.446	4283.35	39.76	41.27	0.000
29	47H0	920.3	1383.4	1.049	12136.81	16.16	74.66	0.000
29	48G9	772.8	666.1	1.177	4374.90	55.22	4.50	0.000
29	49G9	564.2	477.7	1.382	1950.36	57.12	26.79	0.000
30	50G7	403.1	348.9	2.258	622.94	94.13	0.28	0.000
30	50G8	833.4	555.7	1.989	2328.28	74.31	1.82	0.000
30	50G9	879.5	457.8	1.453	2771.89	67.81	10.83	0.000
30	50H0	795.1	631.1	1.623	3091.25	93.45	1.90	0.000
30	51G7	614.5	580.8	2.121	1682.70	87.95	0.53	0.000
30	51G8	863.7	545.3	1.963	2398.96	75.81	0.67	0.000
30	51G9	865.8	308.9	1.658	1613.62	59.11	0.06	0.000
30	51H0	865.7	697.1	0.987	6112.75	31.09	0.38	0.000
30	52G7	482.6	466.4	1.747	1288.15	59.57	0.59	0.000
30	52G8	852.0	343.7	2.724	1075.06	86.92	0.05	0.000
30	52G9	852.0	215.3	2.445	750.14	83.11	0.39	0.000
30	52H0	852.0	594.5	0.719	7039.41	15.89	0.02	0.000
30	53G8	838.1	398.5	2.139	1561.06	82.19	7.93	0.000
30	53G9	838.1	186.1	2.406	648.42	87.48	0.71	0.000
30	53H0	838.1	388.7	0.767	4248.60	24.72	0.95	0.000
30	54G8	642.2	461.3	2.055	1441.42	79.61	2.67	0.000
30	54G9	824.2	494.1	2.452	1661.00	86.04	0.41	0.000
30	54H0	727.9	897.6	1.715	3810.25	65.18	25.62	0.000
30	55G9	625.6	470.6	2.597	1133.75	94.75	1.68	0.000
30	55H0	688.6	487.5	1.747	1922.13	95.32	2.38	0.000

Table 3: Survey statistics

SD	RECT	NSprTOT	NSpr0	NSpr1	NSpr2	NSpr3	NSpr4	NSpr5	NSpr6	NSpr7	NSpr8
25	39G4	199.30	0.00	27.00	39.86	31.29	87.86	5.14	6.64	0.00	1.50
25	39G5	667.95	1.66	47.60	286.20	121.51	152.59	38.34	5.20	14.86	0.00
25	40G4	320.80	14.59	48.41	0.60	87.33	110.31	5.93	8.49	0.00	45.14
25	40G5	1717.91	11.27	209.05	398.43	239.10	665.80	16.07	159.21	18.99	0.00
25	40G6	633.40	0.00	24.97	232.48	80.52	205.65	28.14	43.75	0.00	17.89
25	40G7	1090.18	2.15	121.47	216.68	188.00	401.08	138.89	18.12	3.80	0.00
25	41G6	201.55	178.42	8.10	2.52	0.00	4.28	0.00	6.43	0.00	1.81
25	41G7	1759.23	47.93	325.17	264.00	0.00	800.16	206.51	95.06	20.40	0.00
26	41G8	432.76	83.72	44.66	27.26	36.76	145.48	53.54	8.78	14.00	18.56
27	42G6	141.32	92.33	9.37	3.75	5.33	19.26	0.00	7.00	2.60	1.69
27	42G7	365.39	209.87	22.68	10.13	24.11	80.48	0.00	6.43	11.69	0.00
28	42G8	218.20	21.98	32.02	12.23	26.66	82.55	24.98	9.21	0.00	8.57
27	43G7	1095.89	988.07	36.20	11.47	21.14	24.11	5.75	0.00	0.00	9.14
28	43G8	757.51	77.30	108.22	42.51	92.76	288.32	87.35	30.92	0.00	30.15
28	43G9	1121.36	136.07	125.87	171.74	109.39	371.70	60.42	25.89	21.98	98.30
27	44G7	709.12	665.32	16.54	2.65	3.38	16.56	0.43	1.60	0.00	2.65
27	44G8	2295.41	2090.20	23.86	36.27	22.91	76.35	4.77	24.82	4.77	11.45
28	44G9	1595.54	670.62	214.29	300.82	50.32	236.72	31.05	20.95	70.77	0.00
27	45G7	526.46	439.60	7.86	7.43	11.41	46.11	7.27	0.00	0.00	6.78
27	45G8	730.50	563.71	41.92	36.84	7.96	56.02	13.65	0.00	6.12	4.26
28	45G9	894.81	280.06	217.73	159.11	39.50	145.11	34.93	9.60	0.00	8.76
27	46G8	1876.27	1484.67	100.94	57.08	0.00	134.88	4.65	24.80	17.97	51.30
29	46G9	3945.85	3283.36	241.64	91.16	95.87	162.94	31.71	0.00	21.79	17.38
29	46H0	3926.70	1813.98	642.41	491.99	343.65	505.09	47.17	0.00	76.44	5.97
29	47G9	1767.82	631.35	299.64	100.88	103.47	373.26	41.68	0.00	12.08	205.46
29	47H0	9061.17	3056.19	2401.98	875.96	631.00	1869.18	117.88	27.01	0.00	81.97
29	48G9	196.95	161.51	13.84	1.98	1.98	7.25	1.48	1.15	0.00	7.75
29	49G9	522.45	343.14	71.73	36.75	3.54	39.41	7.97	0.00	0.00	19.92
30	50G7	1.77	0.44	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.89
30	50G8	42.47	1.57	8.34	0.79	0.00	0.79	0.00	4.40	1.57	25.01
30	50G9	300.20	278.96	2.90	0.97	0.97	2.90	1.16	3.28	0.00	9.07
30	50H0	58.68	0.00	2.35	2.35	5.40	6.57	3.76	4.22	2.58	31.45
30	51G7	8.95	0.00	0.60	0.00	0.60	0.00	1.19	0.60	0.00	5.97
30	51G8	15.98	0.00	1.27	0.36	1.17	2.99	0.66	0.51	0.61	8.42
30	51G9	1.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.86
30	51H0	23.41	0.00	4.07	1.02	0.00	4.88	1.22	1.02	0.00	11.19
30	52G7	7.56	0.00	0.00	0.28	0.28	1.57	0.28	0.00	0.00	5.15
30	52G8	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
30	52G9	2.92	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00	1.67
30	52H0	1.63	0.00	0.54	0.00	0.00	0.00	0.00	0.54	0.00	0.54
30	53G8	123.80	0.62	19.66	9.21	5.85	4.73	8.71	6.35	0.00	68.68
30	53G9	4.62	0.00	1.07	0.00	0.00	1.07	0.36	0.71	0.00	1.42
30	53H0	40.50	0.00	1.23	0.00	1.60	2.09	0.00	10.19	0.00	25.41
30	54G8	38.55	1.03	6.68	0.00	4.93	2.36	2.67	3.39	1.75	15.73
30	54G9	6.86	0.00	0.00	0.00	0.00	0.00	0.00	1.53	0.00	5.34
30	54H0	976.15	0.00	73.71	10.96	29.88	61.76	14.94	153.39	78.69	552.82
30	55G9	19.02	0.48	2.85	1.90	0.67	2.28	0.00	2.28	0.00	8.56
30	55H0	45.74	0.00	4.20	5.25	0.00	9.50	0.00	1.40	0.00	25.39

Table 4: Estimated number (millions) of sprat

SD	RECT	WSpr0	WSpr1	WSpr2	WSpr3	WSpr4	WSpr5	WSpr6	WSpr7	WSpr8
25	39G4		12.86	13.60	15.00	16.75	18.00	18.00		18.00
25	39G5	3.00	11.38	15.73	16.60	18.10	17.00	19.67	19.50	
25	40G4	3.38	12.10	10.00	14.67	15.77	20.67	18.50		16.67
25	40G5	4.50	11.73	14.40	17.25	17.56	20.00	16.00	11.00	
25	40G6		12.60	14.89	15.33	17.50	18.75	16.50		19.00
25	40G7	6.00	11.60	15.40	15.80	17.09	18.33	19.00	20.00	
25	41G6	2.79	8.00	12.00		13.40		15.12		17.00
25	41G7	3.33	10.27	13.00		15.79	16.33	19.67	15.00	
26	41G8	3.48	10.67	13.50	15.00	15.55	13.67	16.50	18.50	17.00
27	42G6	2.79	8.65	9.75	13.33	14.40		14.50	15.00	17.00
27	42G7	2.59	9.55	9.67	13.33	14.44		14.00	15.00	
28	42G8	3.17	10.60	16.00	14.75	14.56	14.00	14.00		16.67
27	43G7	2.87	9.25	10.40	12.60	12.29	12.00			13.50
28	43G8	3.17	10.60	16.00	14.75	14.56	14.00	14.00		16.67
28	43G9	3.52	10.88	12.00	14.00	14.30	16.00	17.67	17.00	15.00
27	44G7	2.55	7.62	10.00	12.00	12.17	12.00	13.00		13.67
27	44G8	2.88	8.80	10.33	13.00	12.89	16.00	12.00	18.00	13.50
28	44G9	2.77	8.45	11.00	15.00	13.22	13.00	11.33	13.50	
27	45G7	2.86	8.75	10.50	12.00	11.88	13.67			13.00
27	45G8	2.33	9.33	11.40	10.00	13.92	14.33		12.50	12.00
28	45G9	3.12	8.36	11.14	12.00	14.10	13.67	14.00		16.00
27	46G8	2.84	8.42	10.75		12.70	15.50	12.50	12.00	13.25
29	46G9	2.50	9.15	11.00	11.50	13.00	14.00		12.00	14.33
29	46H0	2.90	9.42	12.33	12.25	14.58	13.00		14.00	16.00
29	47G9	2.97	8.10	10.50	13.33	12.93	13.00		13.00	11.60
29	47H0	2.55	7.94	10.00	11.67	13.20	11.00	16.00		14.00
29	48G9	2.54	8.54	10.50	9.50	12.00	13.00	15.00		12.57
29	49G9	3.00	8.43	9.83	11.00	11.89	12.33			12.50
30	50G7	2.00	11.00	10.00						15.00
30	50G8	3.00	10.70	11.00		13.00		13.67	13.00	13.71
30	50G9	2.50	8.00	9.00	11.00	13.33	12.00	12.33		13.00
30	50H0		10.00	12.00	12.50	12.00	13.50	14.00	14.00	14.76
30	51G7		11.00		17.00		12.50	13.00		14.60
30	51G8		10.60	11.00	11.00	12.60	14.50	13.00	9.50	14.20
30	51G9		11.00							15.00
30	51H0		10.50	11.00		13.00	13.00	16.00		12.89
30	52G7			10.00	13.00	13.20	11.00			14.79
30	52G8								16.00	
30	52G9							11.67		13.25
30	52H0		10.00					13.00		17.00
30	53G8	3.00	9.12	10.00	10.00	12.50	12.50	11.00		14.43
30	53G9		10.00			13.00	16.00	15.50		12.75
30	53H0		9.50		13.00	16.00		12.62		13.79
30	54G8	2.00	9.73		13.75	12.33	14.00	14.00	13.00	13.83
30	54G9							14.00		13.57
30	54H0		9.80	11.00	11.00	12.00	10.00	14.50	15.00	14.59
30	55G9	1.00	10.33	11.33	10.00	12.67		11.67		14.36
30	55H0		9.45	10.80		13.40		10.00		14.50

Table 5: Estimated mean weights (g) of sprat

SD	RECT	NHerTOT	NHer0	NHer1	NHer2	NHer3	NHer4	NHer5	NHer6	NHer7	NHer8
25	39G4	204.15	11.95	34.06	44.61	19.92	39.83	37.24	14.54	0.00	1.99
25	39G5	308.92	33.06	57.75	48.94	18.99	63.77	52.51	20.88	13.01	0.00
25	40G4	374.87	12.27	55.72	43.81	28.35	62.01	123.15	16.48	27.84	5.25
25	40G5	1367.44	14.53	108.45	139.21	169.80	490.58	352.22	24.83	27.48	40.35
25	40G6	664.14	3.39	26.04	166.38	42.57	130.32	162.81	68.97	54.75	8.90
25	40G7	573.50	1.21	33.28	17.41	76.87	193.71	171.85	34.72	34.68	9.77
25	41G6	522.65	44.61	37.18	20.32	42.84	159.98	158.70	25.16	31.94	1.92
25	41G7	1182.92	1.21	0.60	20.84	68.03	288.07	377.56	190.74	138.89	96.97
26	41G8	1948.09	3.74	5.74	0.00	253.00	390.06	847.57	205.75	71.13	171.12
27	42G6	304.44	7.47	38.97	8.43	39.57	83.36	98.68	18.03	5.41	4.51
27	42G7	598.27	7.38	104.75	21.23	98.92	122.93	207.82	28.84	0.00	6.40
28	42G8	1194.41	15.91	8.20	0.00	70.52	236.56	520.69	78.11	192.37	72.05
27	43G7	249.82	63.63	28.47	17.19	12.85	53.64	49.74	11.63	7.38	5.30
28	43G8	1527.16	55.94	26.85	0.00	111.88	303.19	660.09	88.38	205.86	74.96
28	43G9	985.62	2.93	34.88	0.00	100.64	343.95	324.53	119.62	23.16	35.91
27	44G7	906.33	494.39	88.78	45.00	100.69	137.05	18.12	14.23	6.51	1.57
27	44G8	376.34	147.97	37.05	13.52	61.75	96.01	16.55	1.17	2.33	0.00
28	44G9	140.24	79.35	8.08	0.00	13.61	22.36	14.18	1.45	1.22	0.00
27	45G7	3518.78	822.17	1188.98	317.88	275.14	461.68	434.33	8.66	0.00	9.94
27	45G8	1148.53	23.98	161.64	179.23	231.94	262.59	189.00	93.87	0.00	6.27
28	45G9	1653.29	465.77	98.68	34.99	436.95	331.42	227.61	20.19	20.19	17.49
27	46G8	2536.21	208.23	1188.38	105.93	635.20	220.45	146.33	15.99	5.05	10.66
29	46G9	1058.45	22.29	86.13	58.22	204.27	563.82	70.84	20.53	29.21	3.13
29	46H0	723.73	17.71	293.12	91.03	258.86	59.40	3.60	0.00	0.00	0.00
29	47G9	1703.01	41.50	363.32	69.98	550.94	453.63	189.32	31.53	0.00	2.78
29	47H0	1961.16	1148.23	603.96	45.64	102.21	59.72	1.40	0.00	0.00	0.00
29	48G9	2415.87	157.28	1975.48	148.48	70.46	51.59	12.58	0.00	0.00	0.00
29	49G9	1113.96	144.22	419.23	126.32	179.53	125.32	82.06	15.42	21.88	0.00
30	50G7	586.39	45.83	207.06	50.77	70.51	93.54	15.28	6.82	14.81	81.79
30	50G8	1730.11	0.00	524.05	214.17	207.48	221.53	246.97	260.35	4.02	51.54
30	50G9	1879.68	31.33	1111.05	460.45	39.34	185.78	22.59	29.14	0.00	0.00
30	50H0	2888.92	552.71	1623.95	486.61	88.89	54.70	62.68	0.00	5.70	13.68
30	51G7	1479.98	125.14	505.16	147.40	194.12	149.20	97.86	73.40	113.10	74.60
30	51G8	1818.70	0.00	491.95	293.36	152.60	432.03	234.13	131.70	23.69	59.23
30	51G9	953.83	0.00	140.68	162.02	241.72	135.45	58.36	55.31	111.50	48.78
30	51H0	1900.60	52.56	886.01	194.28	141.72	47.87	120.14	119.20	7.51	331.32
30	52G7	767.32	4.44	92.85	88.71	184.81	122.42	80.43	43.17	44.06	106.45
30	52G8	934.45	0.00	5.55	54.90	166.37	181.90	134.76	138.64	35.49	216.84
30	52G9	623.46	5.10	81.54	49.95	53.68	69.65	59.12	84.26	46.55	173.62
30	52H0	1118.81	3.75	335.64	183.21	156.18	17.27	70.21	73.96	49.93	228.64
30	53G8	1283.05	105.66	384.37	109.44	229.65	161.73	40.97	63.61	69.00	118.60
30	53G9	567.24	0.00	45.96	126.84	65.92	116.86	71.43	52.52	13.13	74.58
30	53H0	1050.45	72.01	689.66	104.67	50.11	10.39	30.81	28.95	19.30	44.54
30	54G8	1147.52	50.00	157.00	163.50	255.00	140.50	152.50	100.00	18.00	111.00
30	54G9	1429.18	0.00	61.68	192.01	309.29	198.09	76.45	190.27	214.59	186.79
30	54H0	2483.51	85.50	1843.96	244.42	101.91	54.41	22.46	36.27	41.46	53.11
30	55G9	1074.23	44.41	96.04	83.83	148.78	99.93	118.80	71.62	81.61	329.21
30	55H0	1832.24	118.73	1492.18	143.65	18.32	35.91	12.46	7.33	0.00	3.66

Table 6: Estimated number (millions) of herring

SD	RECT	WHer0	WHer1	WHer2	WHer3	WHer4	WHer5	WHer6	WHer7	WHer8
25	39G4	15.58	36.79	61.91	58.50	66.56	69.20	52.40		71.00
25	39G5	15.94	32.54	56.20	66.64	56.71	63.33	63.60	58.00	
25	40G4	15.59	30.73	60.67	55.50	56.93	58.04	70.75	62.60	97.67
25	40G5	13.60	29.07	56.29	63.71	59.48	58.63	74.33	72.00	60.00
25	40G6	18.86	29.62	52.36	50.88	50.56	58.81	56.25	65.40	81.33
25	40G7	19.00	33.00	38.67	43.36	51.70	58.83	66.57	70.57	84.50
25	41G6	5.39	21.61	33.00	34.38	41.05	54.82	51.75	62.60	63.00
25	41G7	4.50	17.00	55.00	39.86	41.93	50.89	49.44	71.60	70.60
26	41G8	15.00	27.00		37.20	44.80	45.17	52.50	46.50	56.86
27	42G6	6.00	20.91	31.25	30.29	40.29	50.41	50.00	59.67	52.00
27	42G7	5.10	21.79	26.00	29.90	39.73	46.89	48.60		52.00
28	42G8	7.50	20.25		32.50	33.77	42.05	54.60	49.83	53.50
27	43G7	4.85	18.83	25.60	26.75	38.56	44.06	48.50	51.00	64.50
28	43G8	7.50	20.25		32.50	33.77	40.00	54.75	48.00	53.50
28	43G9	5.60	23.33		32.60	35.07	39.83	45.38	42.00	50.80
27	44G7	5.13	18.31	31.67	27.33	36.67	42.60	51.14	57.00	46.00
27	44G8	4.11	17.83	29.00	23.64	28.61	32.50	37.00	36.50	
28	44G9	5.24	24.00		29.43	32.00	40.25	32.00	40.00	
27	45G7	4.55	17.53	22.00	28.80	31.25	34.55	34.00		43.00
27	45G8	4.50	17.50	24.67	31.40	29.70	36.17	41.20		38.00
28	45G9	5.09	19.91	26.00	29.27	37.54	40.20	43.00	47.50	44.00
27	46G8	4.36	15.25	26.67	24.43	36.08	34.11	33.00	43.00	29.00
29	46G9	4.73	16.18	18.50	26.20	27.83	36.20	36.00	29.00	47.00
29	46H0	5.00	17.95	24.00	27.00	30.89	30.00			
29	47G9	4.93	17.23	23.00	26.14	30.00	30.14	30.00		36.00
29	47H0	5.58	17.00	21.00	24.40	28.62	61.00			
29	48G9	4.91	14.45	22.62	24.17	24.20	34.00			
29	49G9	4.94	14.15	18.60	23.18	27.53	31.22	36.00	40.75	
30	50G7	8.47	14.40	20.33	25.56	31.00	38.00	32.00	36.00	52.89
30	50G8		15.17	22.75	25.88	30.29	31.78	33.55	43.00	49.93
30	50G9	5.50	12.40	19.42	26.00	24.73	28.00	20.00		
30	50H0	4.97	13.52	20.62	22.50	18.00	27.80		33.00	22.00
30	51G7	10.18	15.18	20.86	26.12	28.78	33.67	40.90	37.17	51.94
30	51G8		16.19	22.43	25.33	26.40	31.56	32.33	36.50	44.83
30	51G9		15.19	22.00	23.18	27.75	28.60	32.50	29.20	41.25
30	51H0	6.43	15.52	21.12	27.14	31.33	28.33	33.14	46.00	45.30
30	52G7	7.33	15.21	19.00	25.09	23.14	32.71	38.83	42.50	52.07
30	52G8		17.50	22.60	23.58	31.75	29.60	37.62	33.00	47.04
30	52G9	10.00	16.40	21.00	22.50	25.71	28.50	33.33	38.00	48.51
30	52H0	7.50	14.05	20.20	23.45	35.50	30.60	28.83	33.25	50.27
30	53G8	4.00	15.00	21.71	27.00	29.44	31.00	35.00	32.60	48.74
30	53G9		15.90	20.92	22.00	28.50	27.00	33.29	42.50	44.26
30	53H0	4.60	13.79	21.27	26.43	29.50	30.00	36.29	25.67	42.53
30	54G8	5.47	14.17	19.10	23.69	27.43	25.29	35.00	30.00	42.79
30	54G9		14.73	19.55	22.45	27.00	35.33	32.86	33.88	41.60
30	54H0	6.00	13.77	19.78	25.50	23.25	33.00	31.33	31.25	65.33
30	55G9	3.43	14.13	18.40	21.30	25.20	28.60	34.00	32.20	43.64
30	55H0	5.03	14.26	21.80	27.67	29.86	26.50	30.00		33.00

Table 7: Estimated mean weights (g) of herring

Species/Trawlnumber	1	3	5	7	9	11	13	15
Ammodytidae		0.05						
Clupea harengus	24.40	36.51	17.78	10.05	29.45	217.66	209.06	35.78
Coregonus lavaretus								
Cyclopterus lumpus	0.06			0.40	1.23	1.26	0.67	0.39
Enchelyopus cimbrius								
Entelurus aequoreus								
Gadus morhua								
Gasterosteus aculeatus	21.30	7.06	20.78	166.07	3.96	5.93	8.43	16.56
Hyperoplus lanceolatus								
Liparis liparis								
Merlangius merlangus								
Myoxocephalus quadricornis								
Nerophis ophidion	0.00			0.00				
Osmerus eperlanus								
Platichthys flesus				0.15				
Pomatoschistus								
Psetta maxima								
Pungitius pungitius	0.00	0.01	0.01	0.19	0.04	0.04	0.03	0.02
Salmo salar					1.40			
Sprattus sprattus	6.00	48.81	10.65	137.32	238.97	184.25	127.45	26.90
Zoarces viviparus								
Zoarcidae								

Table 8: Catch composition per haul

Species/Trawlnumber	17	19	21	23	25	27	29	31
Ammodytidae								
Clupea harengus	343.25	18.88	61.73	230.01	65.98	265.20	119.99	93.45
Coregonus lavaretus								
Cyclopterus lumpus	0.12	0.50	0.61					
Enchelyopus cimbrius								
Entelurus aequoreus								
Gadus morhua								
Gasterosteus aculeatus	16.05	4.22	5.60	6.18	2.65	2.95	23.42	82.27
Hyperoplus lanceolatus								
Liparis liparis							0.04	0.06
Merlangius merlangus								
Myoxocephalus quadricornis								
Nerophis ophidion			0.01		0.00			
Osmerus eperlanus								
Platichthys flesus								
Pomatoschistus								
Psetta maxima		0.38						
Pungitius pungitius	0.01	0.36	0.01	0.01		0.01		
Salmo salar		3.84			0.25			
Sprattus sprattus	63.26	1273.73	36.24	34.27	2.19	5.30	0.82	0.14
Zoarces viviparus								
Zoarcidae						0.04		

Table 9: Catch composition per haul. (continued)

Species/Trawlnumber	33	35	37	39	41	43	45	47
Ammodytidae								
Clupea harengus	65.10	97.18	190.28	140.59	134.72	97.47	78.81	68.49
Coregonus lavaretus								
Cyclopterus lumpus								
Enchelyopus cimbrius								
Entelurus aequoreus								
Gadus morhua								
Gasterosteus aculeatus	22.22	1.24	0.81	0.39	1.48	1.08	0.51	0.68
Hyperoplus lanceolatus								
Liparis liparis	0.17			0.33	0.50	0.10	0.03	0.05
Merlangius merlangus								
Myoxocephalus quadricornis								
Nerophis ophidion				0.00	0.00	0.00		
Osmerus eperlanus	0.02	2.42	0.48	0.17		0.24	0.03	
Platichthys flesus								
Pomatoschistus								
Psetta maxima								
Pungitius pungitius		0.00				0.03		
Salmo salar								
Sprattus sprattus	2.02	31.26	40.63	1.14	0.35	1.72	3.83	0.30
Zoarces viviparus								
Zoarcidae								

Table 10: Catch composition per haul. (continued)

Species/Trawlnumber	49	51	53	55	57	59	61	63	65
Ammodytidae									
Clupea harengus	94.93	60.50	77.70	144.35	65.80	165.90	175.15	125.67	132.98
Coregonus lavaretus								0.65	
Cyclopterus lumpus									
Enchelyopus cimbrius									
Entelurus aequoreus									
Gadus morhua									
Gasterosteus aculeatus	1.34	0.58	3.38	1.78	0.36	9.68	4.61	3.57	11.33
Hyperoplus lanceolatus									
Liparis liparis	0.07	0.53	0.18	0.06		0.28	0.55	0.22	
Merlangius merlangus									
Myoxocephalus quadricornis			0.08	0.04					
Nerophis ophidion									
Osmerus eperlanus					0.01	0.03			
Platichthys flesus									
Pomatoschistus									
Psetta maxima									
Pungitius pungitius							0.00	0.00	0.00
Salmo salar									
Sprattus sprattus	0.19	0.02	0.37	0.66	0.06	0.10	0.87	1.68	2.96
Zoarces viviparus							0.00		
Zoarcidae					0.01				

Table 11: Catch composition per haul. (continued)

Species/Trawlnumber	67	69	71	73	75	77	79	81	83
Ammodytidae			0.01						
Clupea harengus	254.92	1455.17	95.92	80.65	1.07	52.05	65.06	408.77	290.67
Coregonus lavaretus									
Cyclopterus lumpus	0.55	0.28	0.34		0.28	0.15	0.78	0.16	0.52
Enchelyopus cimbrius									
Entelurus aequoreus									
Gadus morhua									
Gasterosteus aculeatus	10.03	23.48	42.19	44.02	48.99	65.22	119.23	68.41	70.38
Hyperoplus lanceolatus		0.23	0.01				0.01		
Liparis liparis									
Merlangius merlangus									
Myoxocephalus quadricornis									
Nerophis ophidion									
Osmerus eperlanus									
Platichthys flesus		0.12				0.23			
Pomatoschistus									
Psetta maxima									
Pungitius pungitius	0.02			0.01	0.02	0.02	0.01		0.04
Salmo salar									
Sprattus sprattus	154.95	140.51	80.96	2.02	21.21	2.39	3.04	16.81	3.55
Zoarces viviparus									
Zoarcidae									

Table 12: Catch composition per haul. (continued)

Species/Trawlnumber	85	87	89	91	93	95	97	99	101
Ammodytidae									0.00
Clupea harengus	330.94	10.97	1.44	30.35	315.16	929.28	2054.96	168.36	262.17
Coregonus lavaretus									
Cyclopterus lumpus		0.26	0.24	0.66	0.89	0.79		0.21	0.55
Enchelyopus cimbrius					0.01				
Entelurus aequoreus	0.00								
Gadus morhua	0.15	0.18	0.03	0.04	0.07	0.30	0.28	0.07	0.25
Gasterosteus aculeatus	34.63	72.64	106.65	41.08	19.65	16.81	2.57	0.21	0.02
Hyperoplus lanceolatus	0.01				0.11	0.05		0.02	
Liparis liparis									
Merlangius merlangus									
Myoxocephalus quadricornis									
Nerophis ophidion									
Osmerus eperlanus									
Platichthys flesus	0.26					0.26	0.15		
Pomatoschistus									
Psetta maxima									
Pungitius pungitius		0.06	0.16	0.04	0.01				
Salmo salar			1.90						
Sprattus sprattus	19.18	19.16	76.20	141.81	31.80	158.79	2.39	1.29	35.43
Zoarces viviparus									
Zoarcidae									

Table 13: Catch composition per haul. (continued)

Species/Trawlnumber	103	105	107	109	110	112	114	116	118
Ammodytidae								0.00	0.00
Clupea harengus	528.17	12.34	0.37	0.16	184.61	171.81	316.16	132.10	110.34
Coregonus lavaretus									
Cyclopterus lumpus	0.68	0.12	0.08	0.30	0.13	1.27	0.14		
Enchelyopus cimbrius						0.01		0.00	
Entelurus aequoreus									
Gadus morhua	22.82		0.01		0.18	0.01	0.11	0.03	14.93
Gasterosteus aculeatus	0.16	53.23	61.93	110.95	44.74	90.50	165.92	1.53	0.24
Hyperoplus lanceolatus						0.02			
Liparis liparis									
Merlangius merlangus									
Myoxocephalus quadricornis									
Nerophis ophidion									
Osmerus eperlanus									
Platichthys flesus	0.26				0.21	0.12	0.23		0.37
Pomatoschistus	0.02	0.02	0.00					0.00	0.80
Psetta maxima									
Pungitius pungitius		0.07	0.06	0.10		0.03			
Salmo salar									
Sprattus sprattus	72.13	647.95	4.07	1.72	18.25	10.32	5.39	1.16	57.82
Zoarces viviparus									
Zoarcidae									

Table 14: Catch composition per haul. (continued)

Species/Trawlnumber	120	122	125	126	128	130	132	134	136
Ammodytidae				0.01	0.00	0.02			
Clupea harengus	337.48	38.85	98.10	135.73	68.35	797.63	230.81	291.10	263.85
Coregonus lavaretus									
Cyclopterus lumpus				0.53	0.37	0.28	0.58		
Enchelyopus cimbrius	0.01								
Entelurus aequoreus									
Gadus morhua	35.04			0.14	0.01	0.80	0.02	143.60	0.99
Gasterosteus aculeatus		0.00			0.01				
Hyperoplus lanceolatus									
Liparis liparis									
Merlangius merlangus									0.17
Myoxocephalus quadricornis									
Nerophis ophidion									
Osmerus eperlanus									
Platichthys flesus	0.14								
Pomatoschistus	0.01	0.00							
Psetta maxima									
Pungitius pungitius									
Salmo salar									
Sprattus sprattus	199.37	58.23	53.76	128.65	44.40	165.91	91.76	48.03	72.55
Zoarces viviparus									
Zoarcidae									

Table 15: Catch composition per haul. (continued)

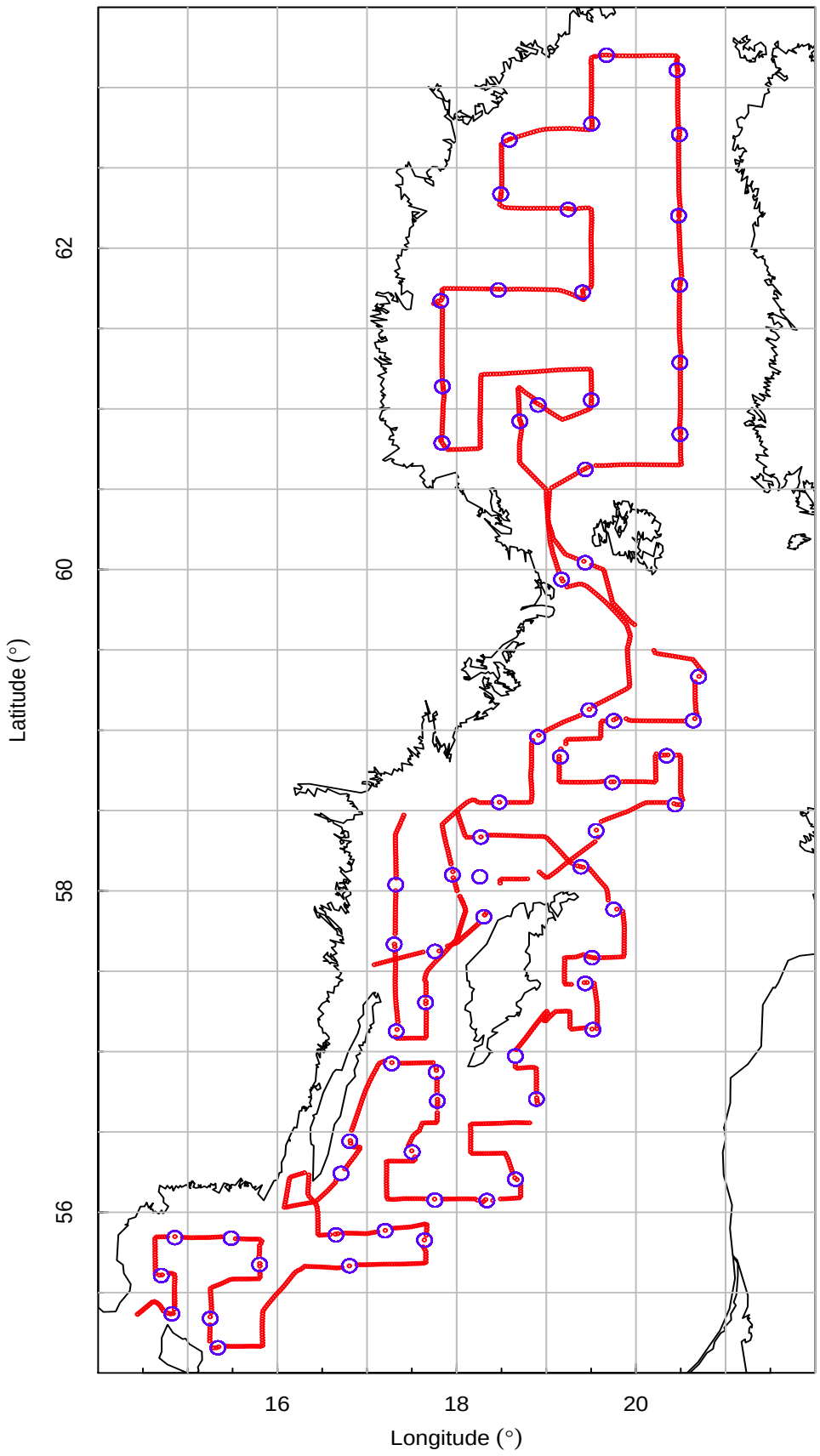
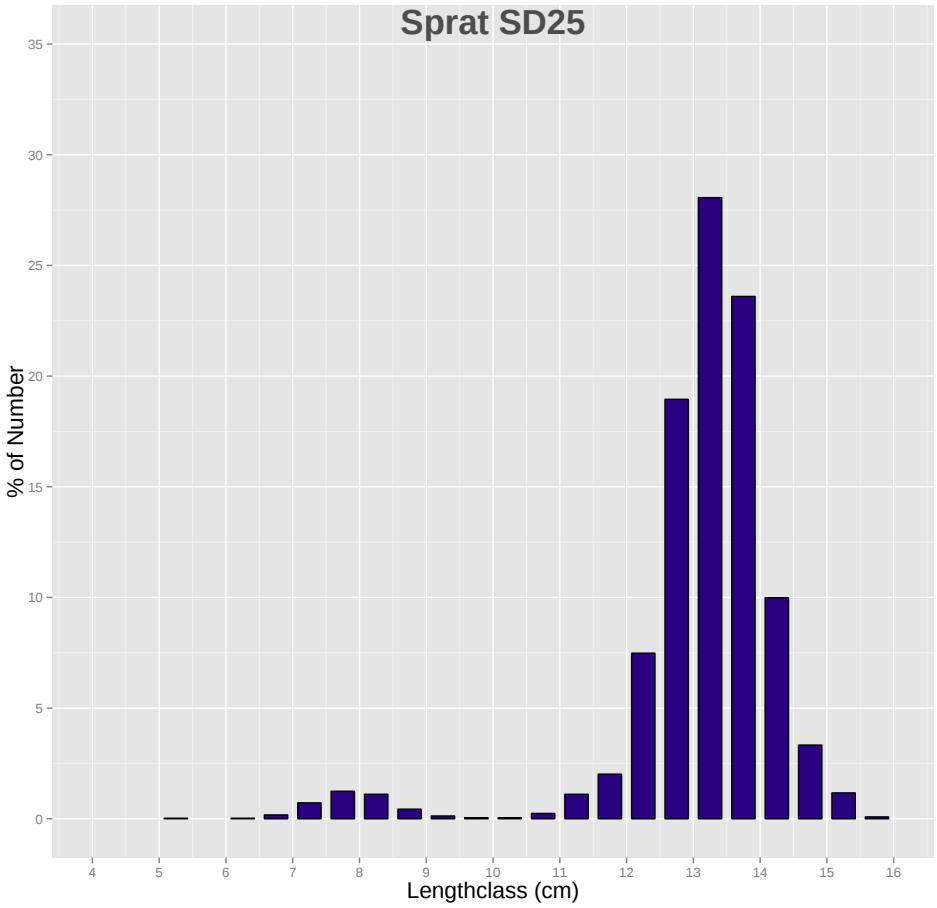


Figure 1: cruise track(red), positions of trawl hauls (blue) and survey grid (ICES squares)(grey)



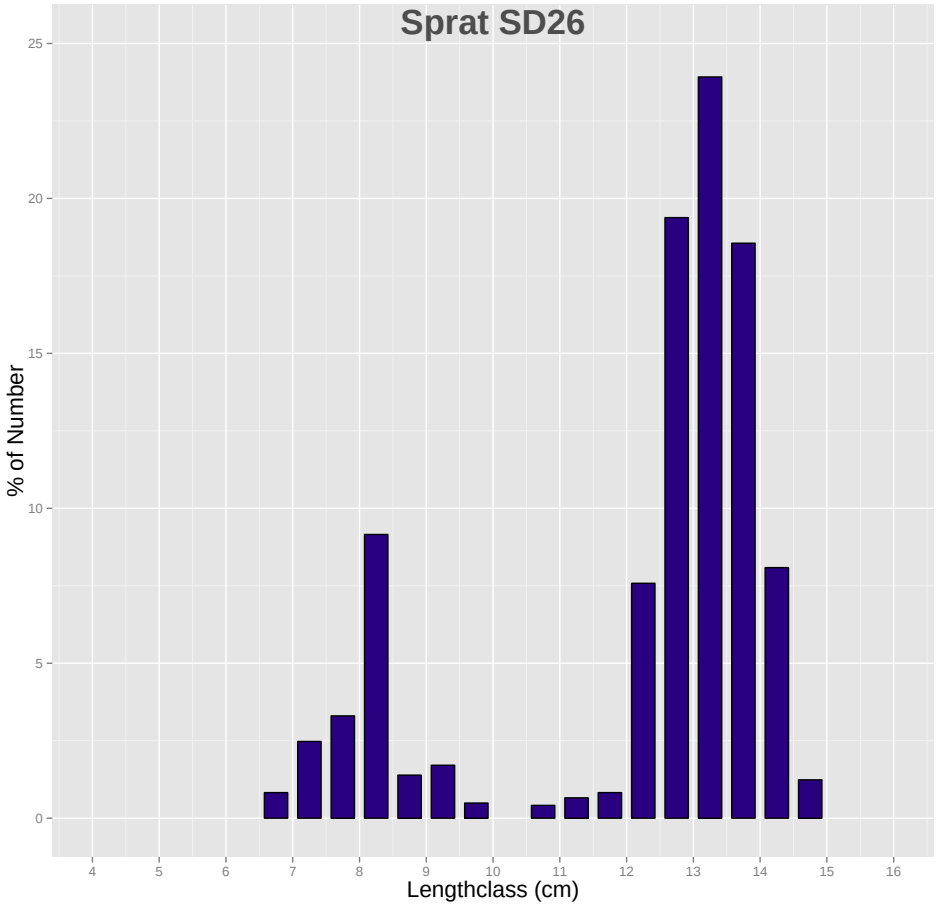
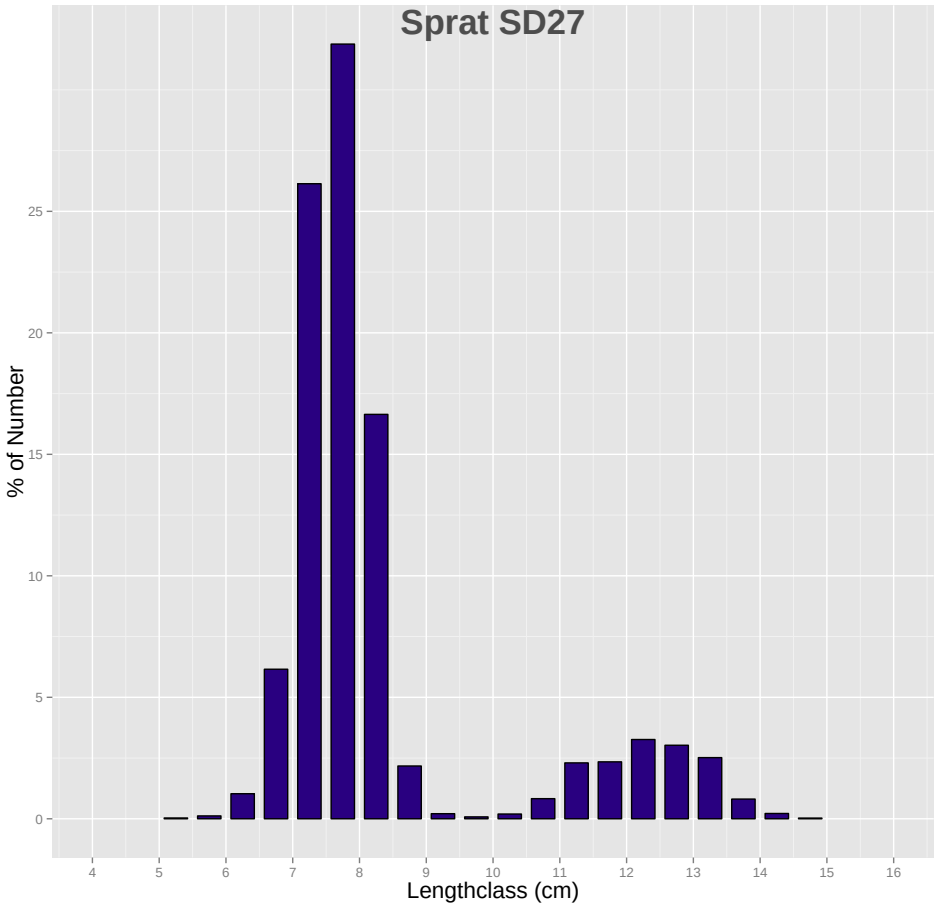


Figure 3: Length distribution of sprat



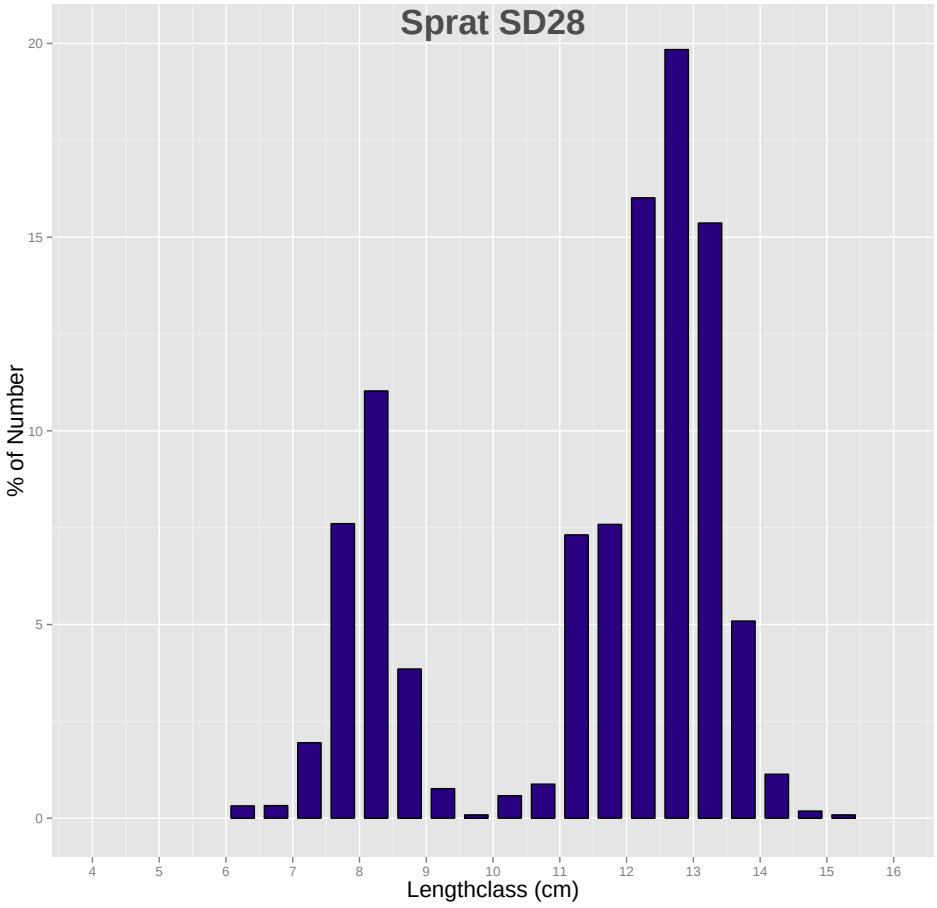
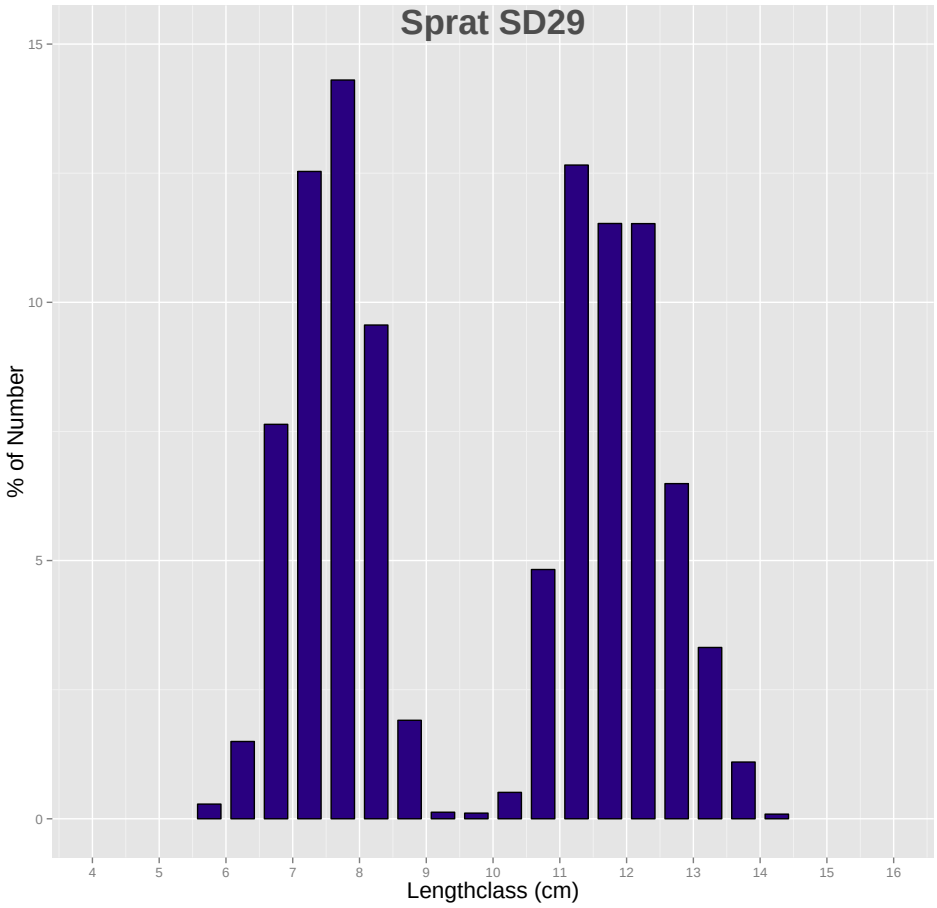


Figure 5: Length distribution of sprat



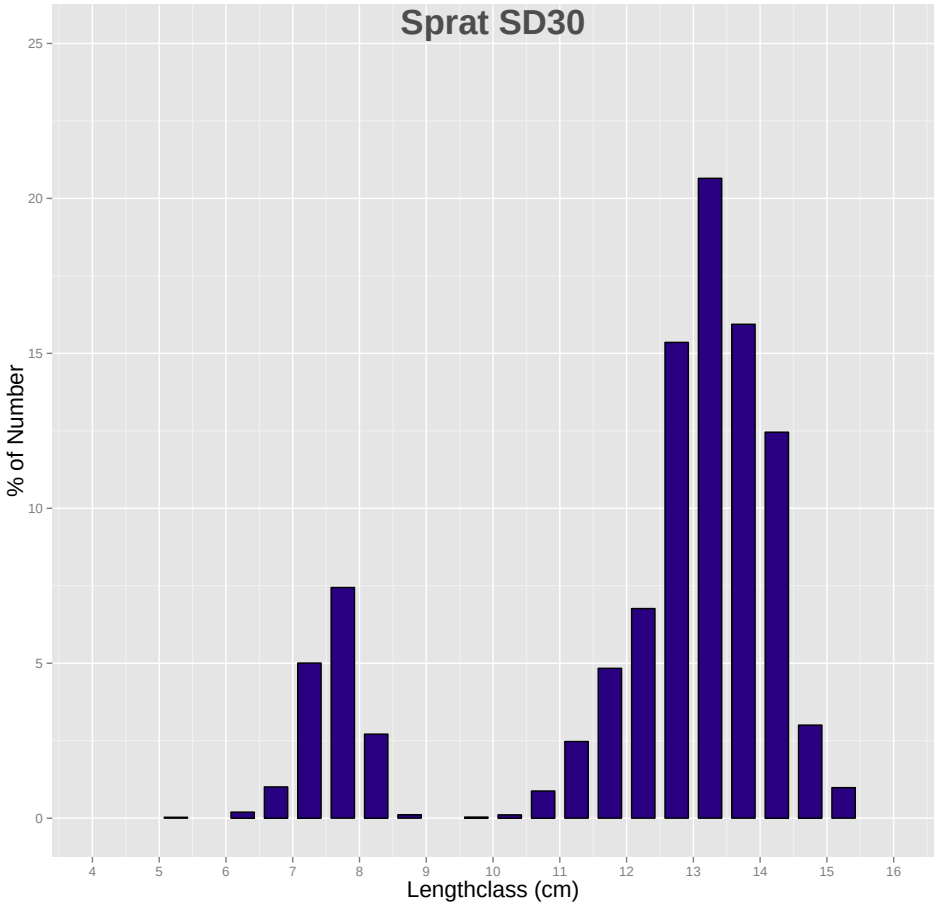
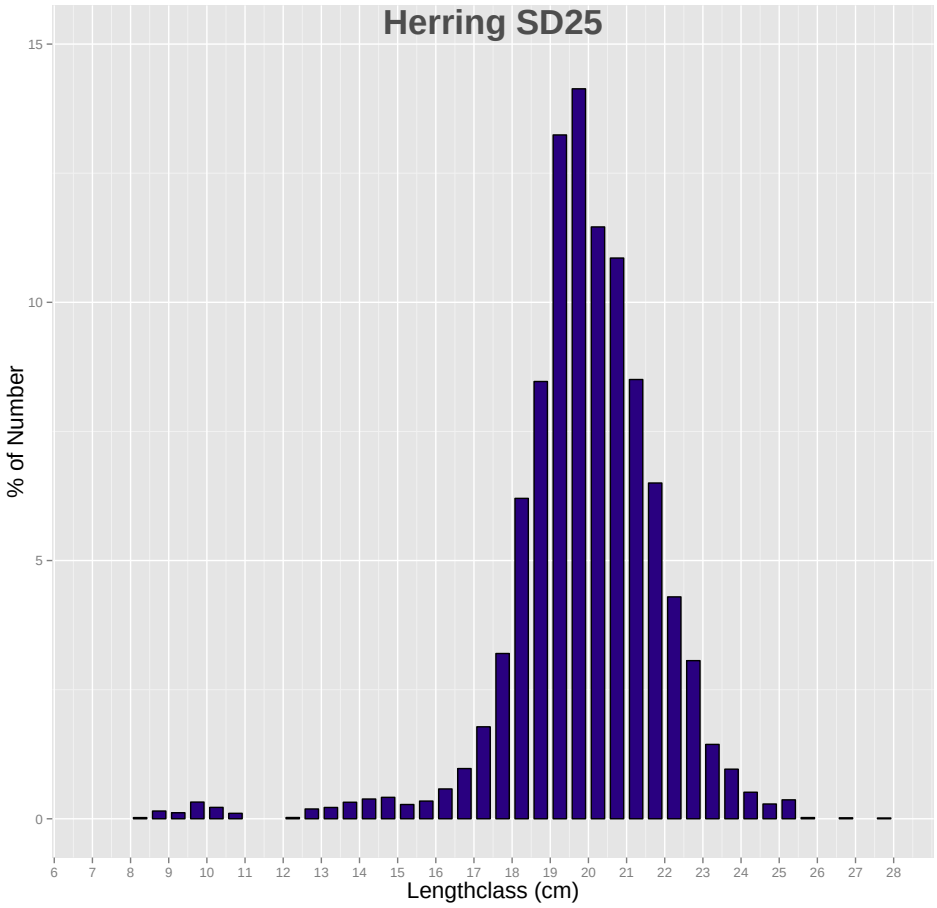


Figure 7: Length distribution of sprat



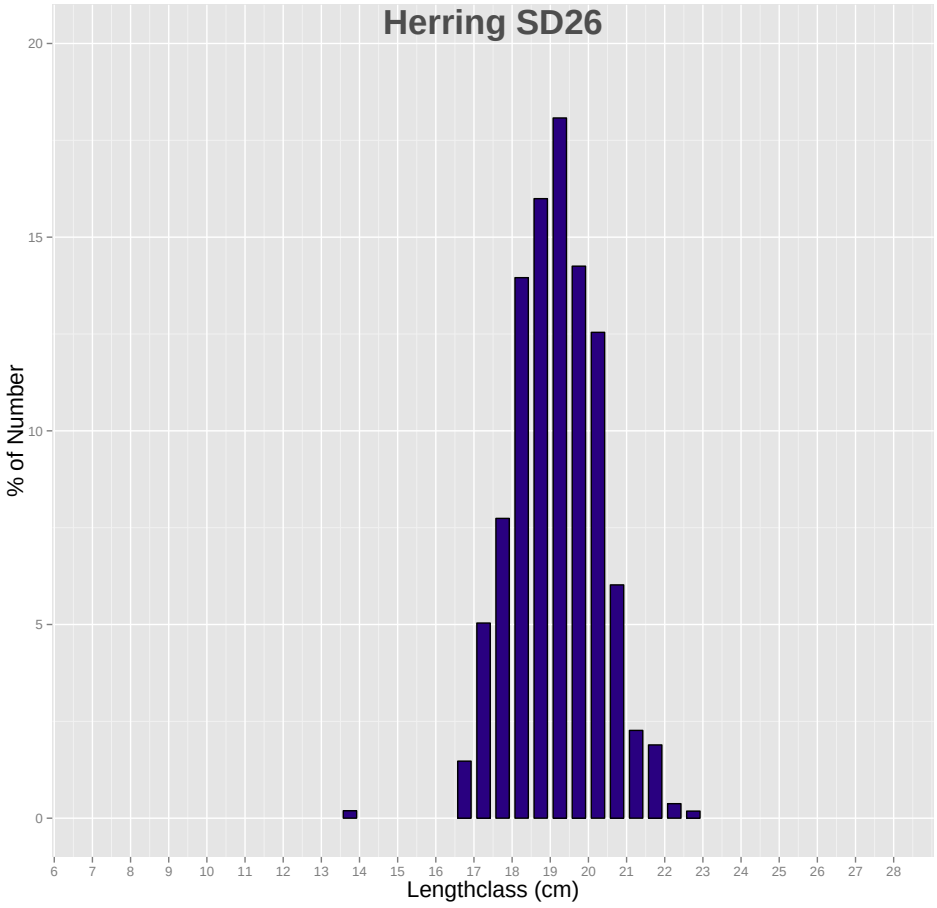
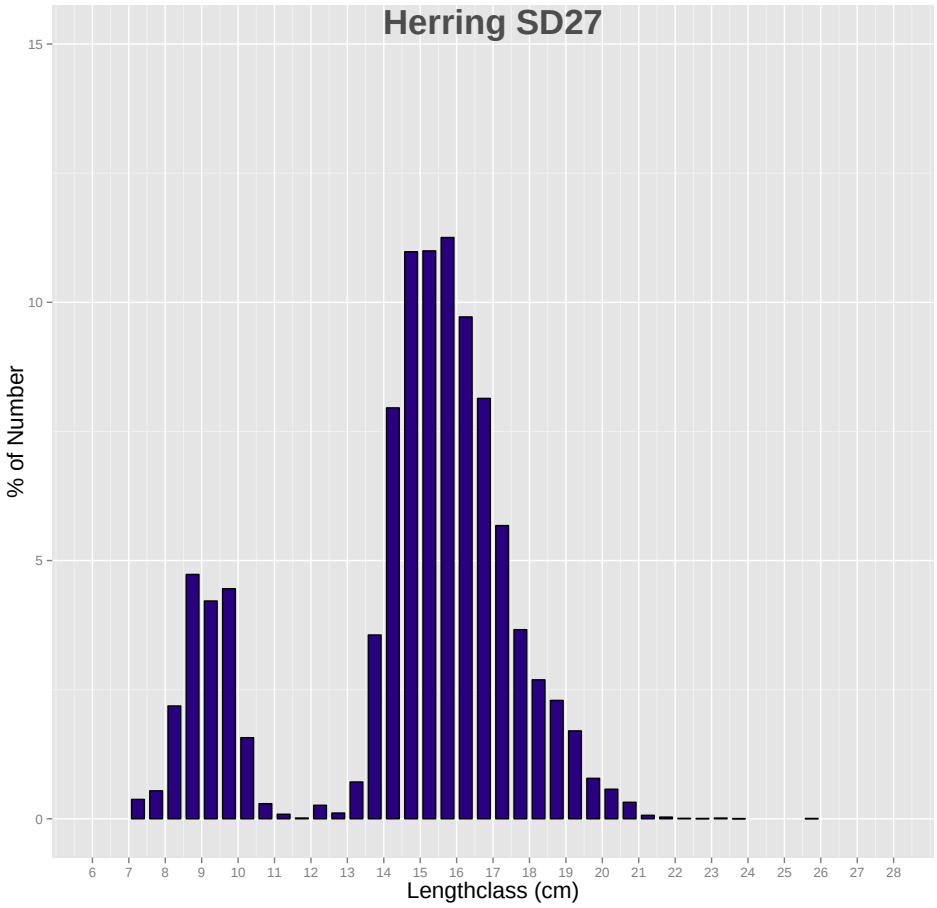


Figure 9: Length distribution of herring



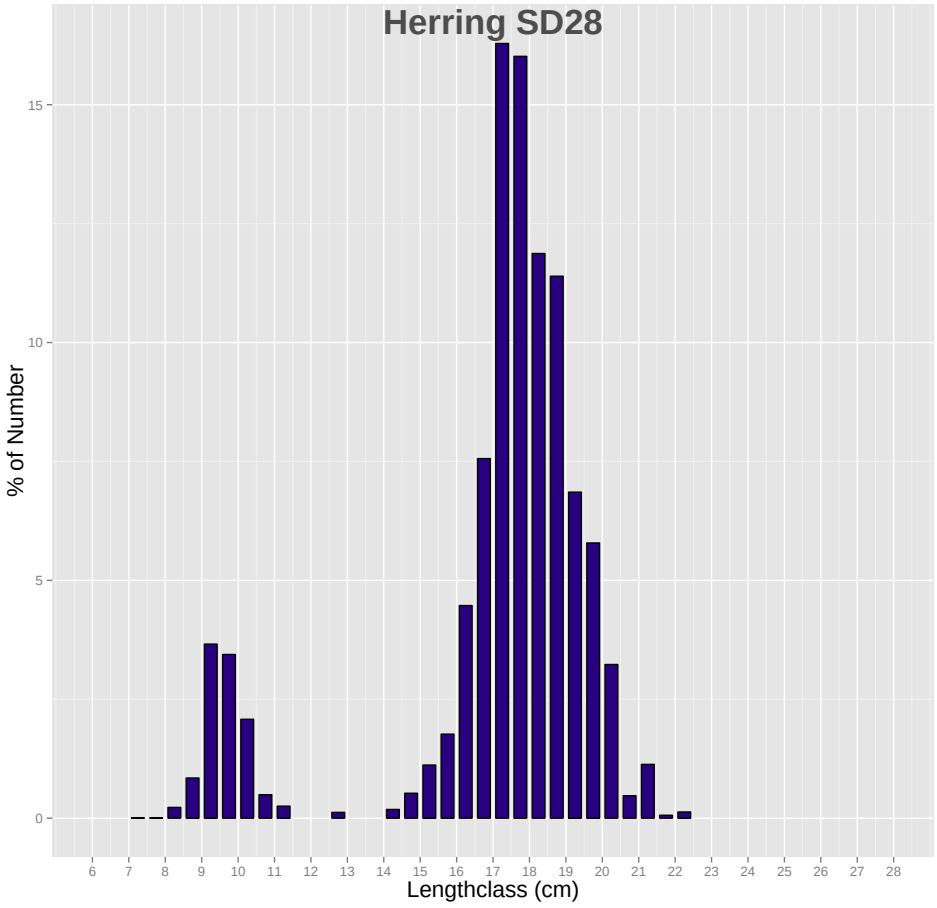
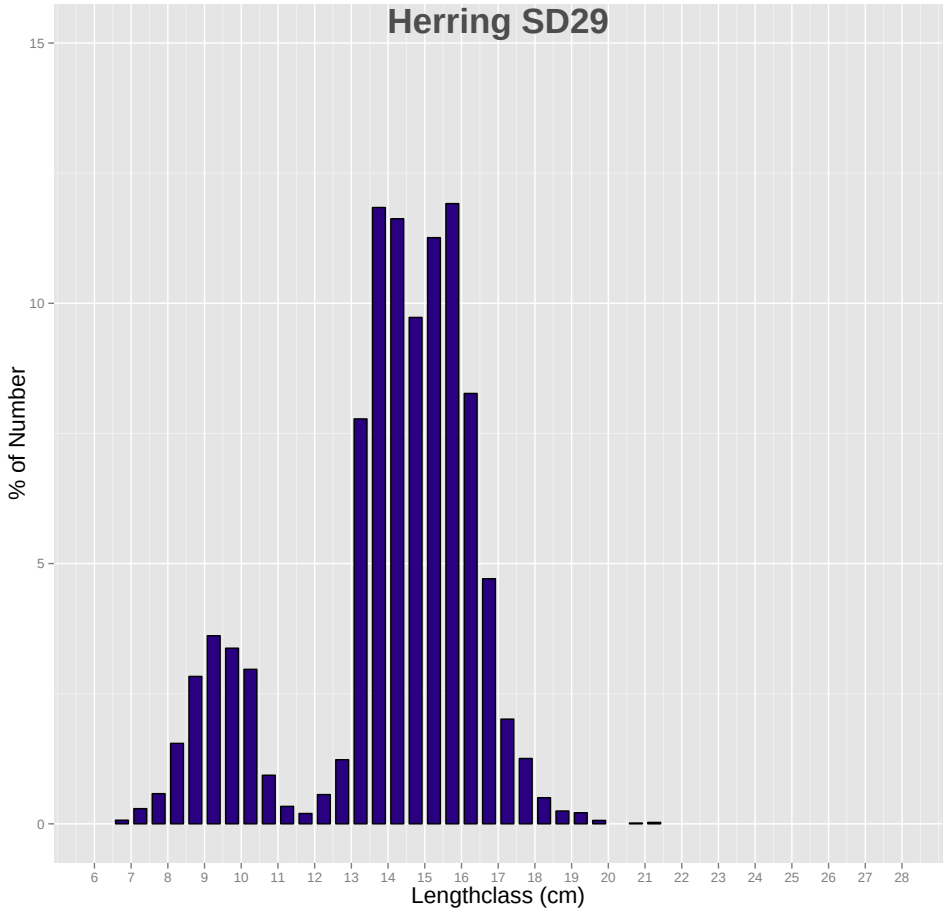


Figure 11: Length distribution of herring



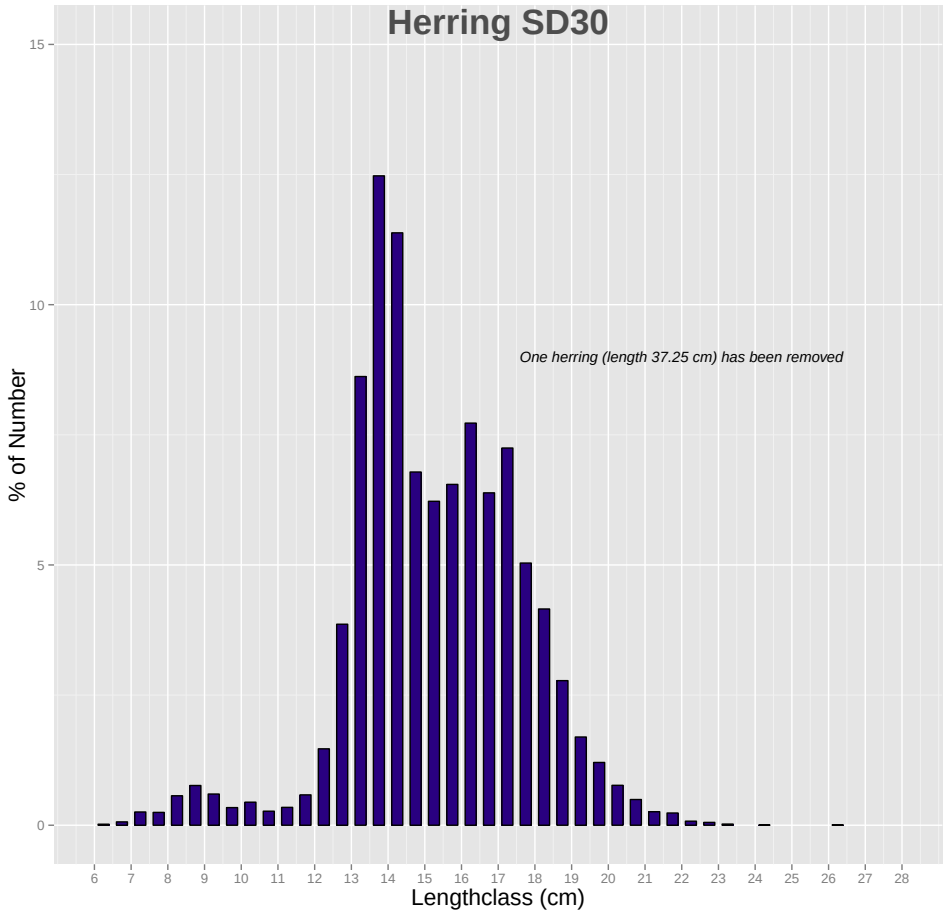


Figure 13: Length distribution of herring