

Cruise report

RV "DANA" - Cruise 05/2021

Herring Acoustic Survey in the North Sea, Kattegat and Skagerrak
(HERAS)

21 June – 6 July 2021

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Cruise summary

Total days	16
Days of monitoring	11
Number of nautical miles monitored	2 445 + 152 miles for calibration
Number of trawl hauls	28
Number of CTD stations	27
Number of WP2 plankton stations	26
Fish catch in kg	27 975
Number of measured herring	11 348
Number of measured mackerel	2 352
Number of measured sprat	1 984
Number of species measured	48
Total number of measured fish	19 125
Number of herring frozen for age and stock-split	1 829
Number of sprat frozen for age	571

1 Background

This cruise is part of an international hydro acoustic survey for herring and sprat (HERAS) coordinated by the ICES Working Group of International Pelagic Surveys (WGIPS). The survey is carried out annually by national fisheries institutes from Scotland, Germany, Netherlands, Norway, Ireland and Denmark in the last week of June and the first 2 weeks of July.

Geographically it covers most of the continental shelf north of 52°N in the North Sea and to the west of Scotland and Ireland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Danish, Swedish and German coastline and to the west by the shelf edge at around 200 m depth.

The DTU National Institute of Aquatic Resources (DTU AQUA) has participated in the herring acoustic survey of the North Sea and adjacent waters with the responsibility for surveying the Skagerrak and Kattegat area since 1991. The 2021 cruise with R/V DANA, was conducted in the period June 24 June to July 6 2021, while calibration was done during June 21 to June 23 2021.

2 Objectives

The objective of the survey is to provide age aggregated abundance and biomass estimates as well as maturity levels and weight at age for the herring and sprat stocks covered by the survey. These indices are used in the assessments of sprat and herring stocks carried out in the ICES Herring Assessment Working Group (HAWG) and underpin the management of North Sea herring, Western Baltic Spring Spawning herring, Malin Shelf herring as well as sprat in the North Sea and Skagerrak.

In addition to hydro-acoustic estimates of sprat and herring abundance, the survey also collects information on hydrography and plankton abundance in the survey area to facilitate studies into drivers of herring and sprat abundance and distribution.

The following specific objectives were planned for cruise 05/2021 on Dana:

- Collect continuous hydro-acoustic measurements along pre-defined transects
- Carry out trawl sampling with bottom and pelagic trawls to verify species and size composition of acoustic registrations
- Collect biological samples of herring and sprat for further analysis of age, stock and maturity composition as well as individual lengths and weights
- Carry out hydrographic sampling along transects (Thermo-Salinograph measurements) and associated with fishing stations (CTD casts) for pelagic habitat description
- Collect plankton samples for water-column integrated dry weight estimates for pelagic habitat description

3 Survey Description and Results

3.1 Time table

21/6 kl 13:30	Departure from Hirtshals for calibration trip
21/6 kl 21:40	Arrive at Bornö and start calibration
23/6 kl 18:40	End calibration and depart from Bornö
24/6 kl 07:10	Arrive Hirtshals for crew change
24/6 kl 14:15	Departure Hirtshals for acoustic monitoring trip
25/6 kl 02:50	Port visit at Hanstholm for emergency disembarkation of cruise leader
25/6 kl 12:30	Start monitoring work
28/6 kl 10:15	Pause monitoring work to retrieve cruise leader from Hanstholm
28/6 kl 14:30	Resume monitoring work
06/7 kl 03:00	End monitoring work
06/7 kl 08:20	Arrive Hirtshals - end of trip

3.2 Survey participants

During calibration 21/6– 23/6 2021

Name	Section	Function
Torben Filt Jensen	DTU Aqua, Monitoring Hirtshals	Cruise leader
Ronny Sørensen	DTU Aqua, Monitoring Hirtshals	Technician
Christian Petersen	DTU Aqua, Monitoring Hirtshals	Technician

During acoustic monitoring 24/6 - 6/7-2021

Name	Section	Function
Susan Mærsk Lusseau	DTU Aqua, Monitoring Hirtshals	Cruise leader
Torben Filt Jensen	DTU Aqua, Monitoring Hirtshals	Acoustics, CTD
Annegrete D. Hansen	DTU Aqua, Monitoring Hirtshals	Acoustics, CTD
Ronny Sørensen	DTU Aqua, Monitoring Hirtshals	Technician, CTD
Helle Rasmussen	DTU Aqua, Monitoring Hirtshals	Fish lab, WP2
Thomas Møller	DTU Aqua, Monitoring Lyngby	Fish lab, WP2
Jesper Knudsen	DTU Aqua, Monitoring Hirtshals	Fish lab, WP2
Maria Jarnum	DTU Aqua, Monitoring Hirtshals	Fish lab, WP2
Rene Erlandsen	DTU Aqua, Monitoring Hirtshals	Fish lab, WP2
Signe Korte Pedersen	DTU Aqua, Monitoring Lyngby	Fish lab, WP2

3.3 Cruise Narrative

The survey on R/V Dana started on June 21st at 13:30 with departure from Hirtshals heading for Bornö in Gullmar Fjord, Sweden for calibration of the acoustic equipment. The vessel was anchored at Bornö in the Gullmar Fjord, Sweden June 21st at 21:40. The calibration was initiated in the early morning of June 22nd and continued until the evening of June 23th when Dana left Bornö. Dana arrived back in Hirtshals June 24th at 07:10 for exchange of the scientific crew.

Dana left Hirtshals at 14:15 again same day and steamed southwest towards the southern end of the most westerly transect (55° 00.00'N, 6° 06.75'E). Enroute to the first transect Dana made a stop in Hanstholm for the cruise leader to disembark to tend to a family emergency. Monitoring was started on June 25 at 12.30 UTC with a CTD deployment to determine the environmental settings for the EK60.

The North Sea (strata 151 and 152) was covered during the period June 25 – June 30. The transects in this area were not completed in a strict west towards east direction to minimise time lost to return to Hanstholm on the 28th June for the cruise leader to re-embark. The two transects to the west were completed first, then Dana moved to the most easterly transect in this strata and completed the last three transects in reverse order (east to west).

The outer Skagerrak (strata 41 and 42) was covered during June 30 - July 2. The Inner Skagerrak (Strata 31) and Kattegat (Strata 21) was covered in the period July 2 to 6th.

Fishing opportunities were restricted more than is usual for this survey by Swedish permit conditions in the Swedish parts of Kattegat and Skagerrak where trawling was not approved for several sections of transect in Swedish territory which is usually trawlable.

Due to time constraints the most southerly transect in Kattegat was cancelled and instead a smaller section of transect that had been abandoned due to heavy ships traffic in the traffic separation zone by Skagen in strata 31 was completed on the return journey to Hirtshals.

The acoustic integration was ended July 6 at 57° 46'N, 010° 46'E at 03.00 UTC and Dana arrived back in Hirtshals at 08:20 on July 6 2021.

3.4 Calibration

The echosounders were calibrated at Bornö in the Gullmar Fjord, Sweden, between June 21 - June 24 2021. The calibration was performed according to the procedures established for EK60 with three frequencies (18, 38 and 120 kHz). This was the second calibration of the year, the previous one just before a cruise to the Norwegian Sea in April. The calibration of the towed

body split-beam transducer at 38 kHz that is used for integration for abundance estimation was carried out against a 60mm copper sphere. The three hull-mounted split-beam transducers at 18, 38 and 120 kHz were carried out against a 38.1 mm tungsten sphere. The results were close to those from the previous calibration earlier in April, and for 38 kHz on the towed body close to results from previous years. The calibration and setup data for the EK60 38 kHz used during the survey are shown in Table 1.

3.5 Acoustic data collection

The survey covered about 2445 nautical miles resulting in 1105 nautical miles of integrated transect track for use in stock size calculation (Figure 1). Data for use in the abundance estimation were recorded using the 38 kHz transducer mounted in a towed paravane running at depths of 4 – 6 m, the depth depending on the sea state and sailing direction relative to the waves, and at a standard ship speed of 10 kn. Simultaneously, data from the 120 kHz and 18 kHz echosounders using hull-mounted transducers were also recorded. During trawling operations the paravane was secured on deck and acoustic data was recorded from hull-mounted transducers at 18, 38 and 120 kHz. Data recorded during trawling operations are not included in the abundance estimation process, it is collected to aid echotrace species verification.

The acoustic data were processed during the survey in Echoview to prepare the echograms for further scrutinization and analysis on shore. This included removing interference from surface turbulence, bottom structures and scattering layers from the echogram as well as removing the sections such as trawling and passage between transects (inter-transects) not used in the abundance estimate.

3.6 Biological Data - Trawl Hauls

During the 2021 survey 28 trawl hauls were conducted, 25 with a pelagic trawl anywhere between the surface and immediately above the bottom and 3 hauls with a demersal trawl. The geographical distribution of hauls and details on the hauls are in Figure 2 and Table 2. Catches by species are in Table 3. Length distributions of herring, mackerel and sprat by haul are in tables 4 to 6. Maps with catches of main pelagic species including herring and sprat in are in Figure 5.

The total catch for the survey was 28 tons. Herring was present in 24 hauls with a total catch of 19.0 tons or 68 % of the total catch. Totally 11 348 herring were measured and 1 829 frozen for age and stock splitting analysis back on land. Length distributions of herring per haul are in Table 4 and a map of catches in figure 5.

Sprat were present in 12 hauls with a total catch of 1.0 tons and 3.7 % of the total catch. Totally 1 984 sprat were measured and 571 were frozen for age determination back in the laboratory. Length distributions of sprat per haul are given in table 5 and a map of catches in figure 5.

Mackerel were present in 22 hauls with a total catch of 5.7 ton and 20.4 % of the total catch. A total of 2 352 mackerel were measured. Ages are not provided for mackerel in this survey. Length distributions of mackerel per haul are given in table 6 and a map of catches in figure 5.

3.7 Zooplankton

A total of 26 WP2 stations were completed. Information on the stations and distribution is given in Table 7 and Figure 4. Dry weight will be measured ashore for each of the three fractions 2000 µm, 1000 µm and 180 µm.

3.8 Hydrography

During the survey 28 CTD stations were completed. Information on the stations and distribution is given in Table 7 and Figure 3. Data from the CTD stations will be uploaded to the ICES hydrography database once quality control checks have been carried out.

3.9 Biomass estimates

Biomass estimates for herring (spring and autumn spawners) and sprat will be produced based on scrutiny of the acoustic integration, catch data and stock split of herring. The estimates will be finalised at the Post Cruise Meeting for the International Acoustic Survey in the North Sea, West of Scotland and Malin Shelf in Copenhagen, November 2021 and reported in the combined report to WGIPS in Belfast in January 2022.

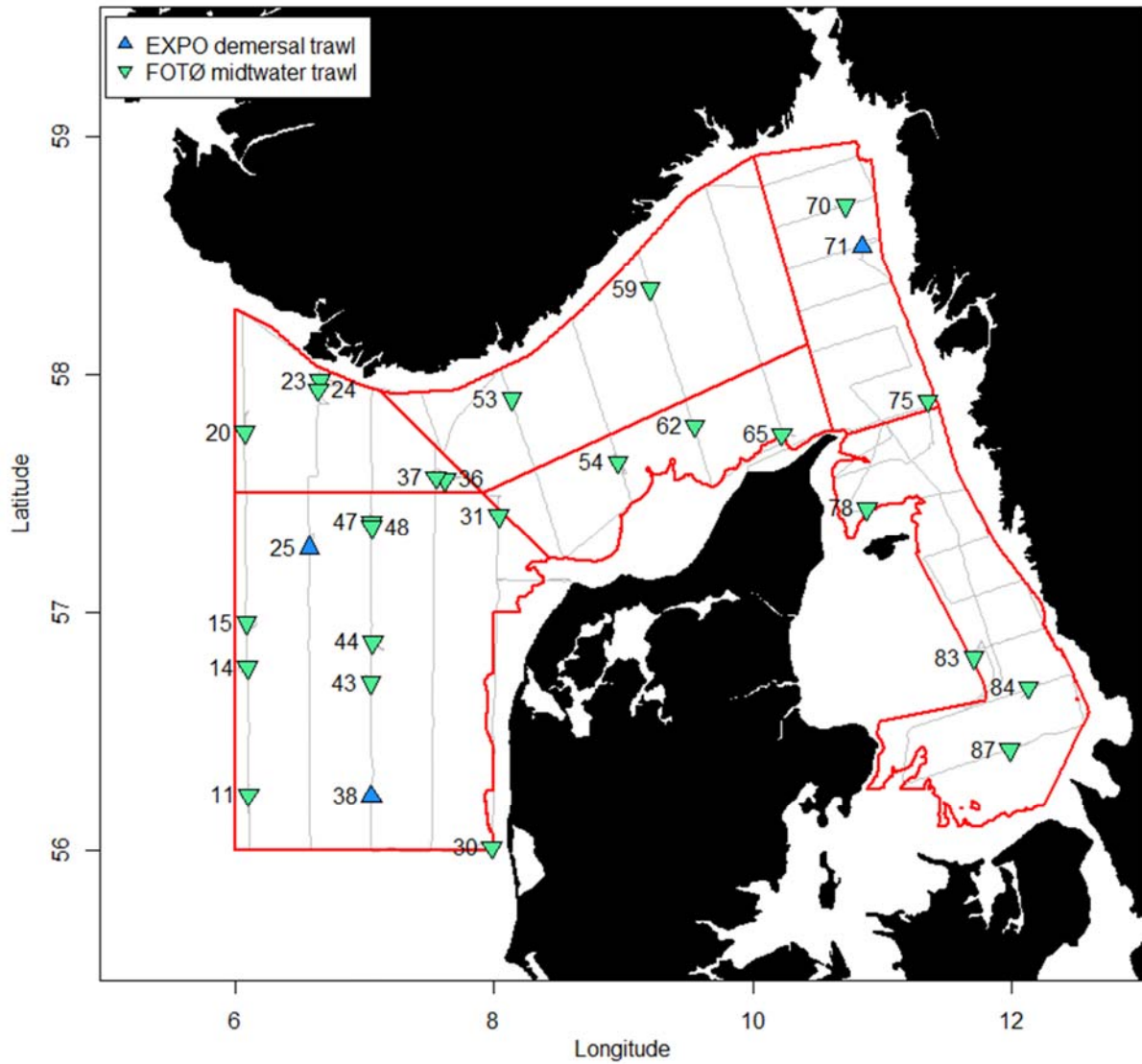


Figure 2. Vessel track and trawl stations during the Danish acoustic survey with R/V Dana in June-July 2021. Green triangles indicate stations with pelagic midwater Fotø trawl and blue triangles indicate locations where the Expo demersal trawl was used.

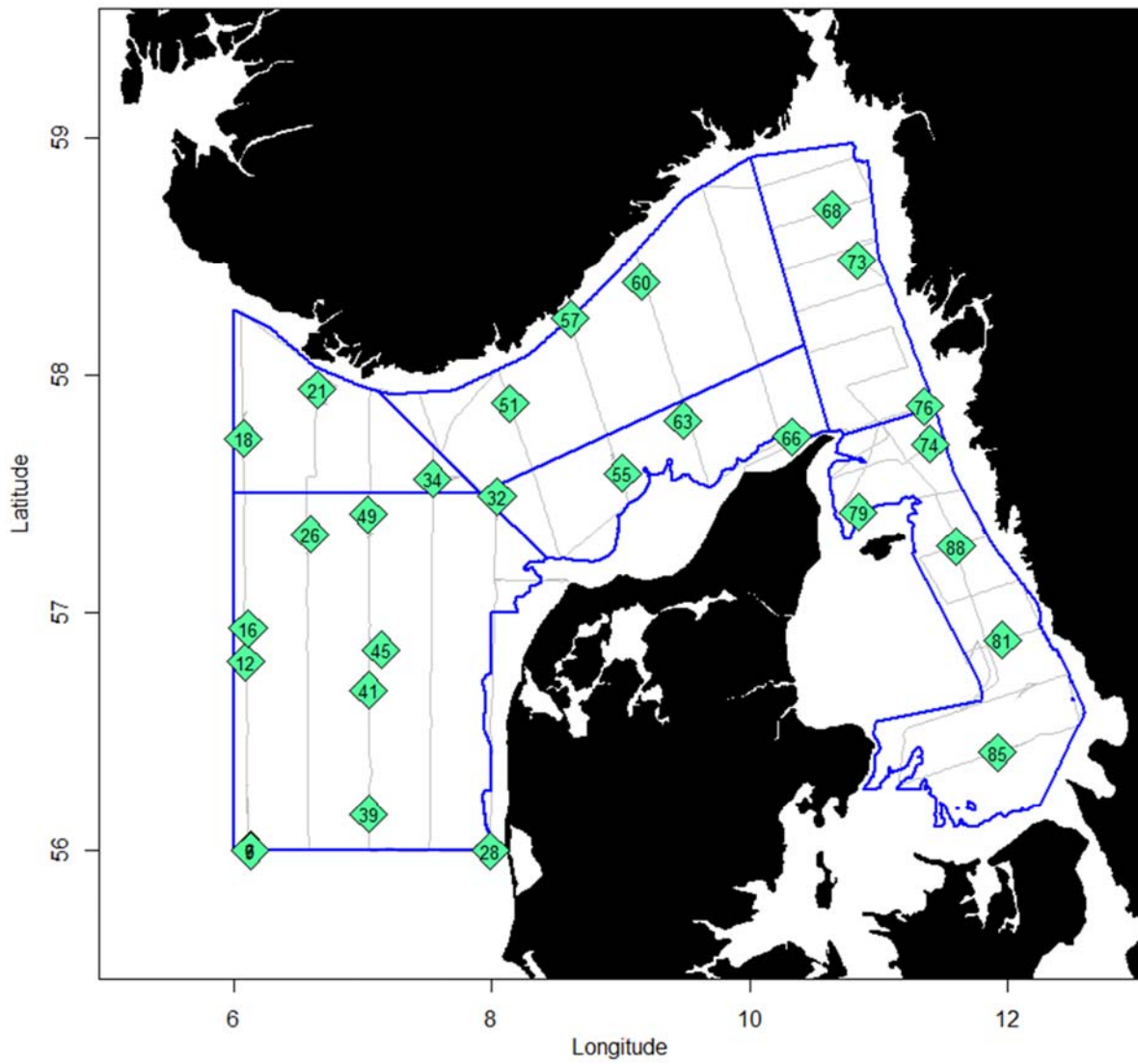


Figure 3. CTD stations during the Danish acoustic survey with R/V Dana in June-July 2021.

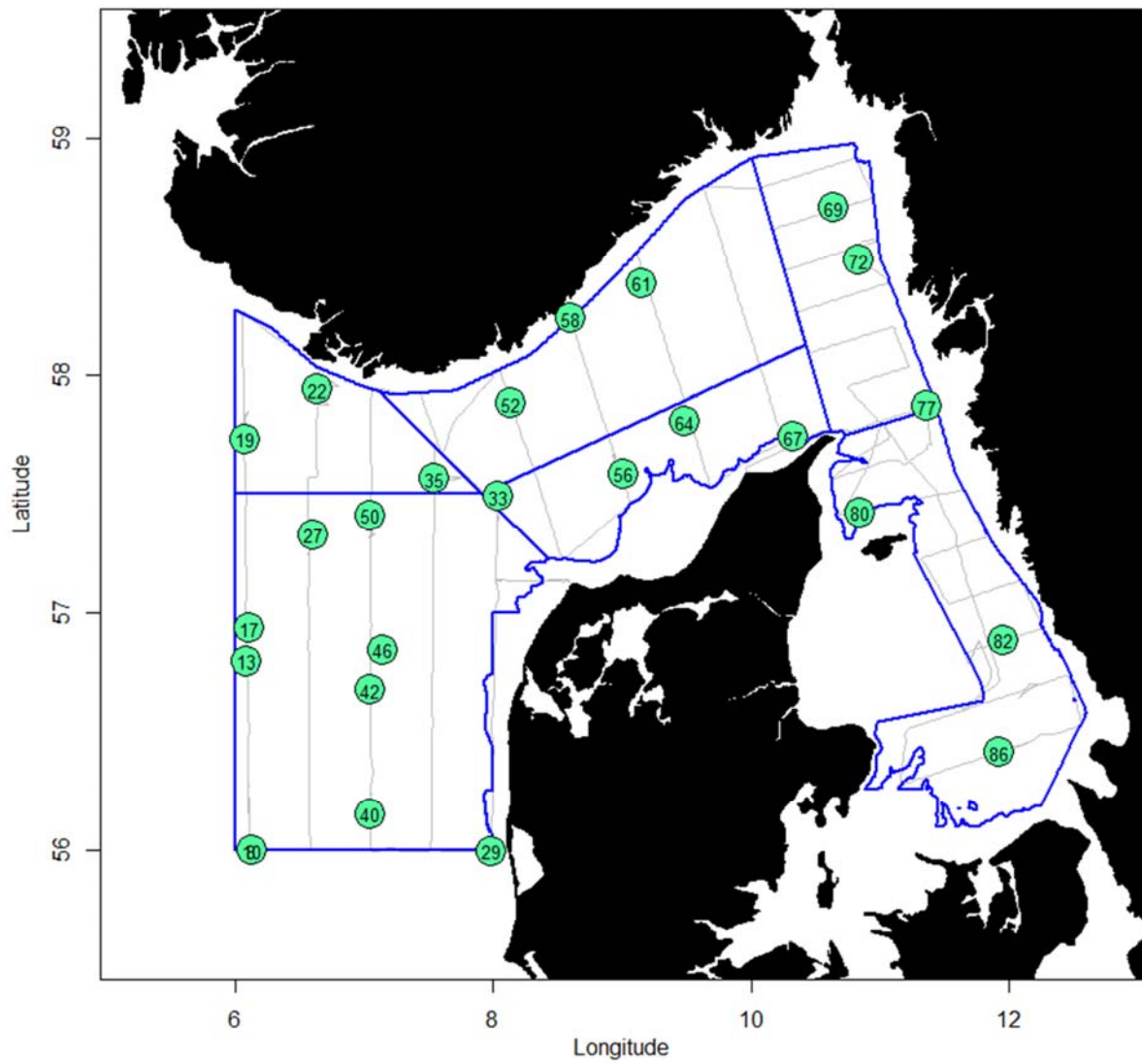


Figure 4. WP2 stations during the Danish acoustic survey with R/V Dana in June-July 2021.

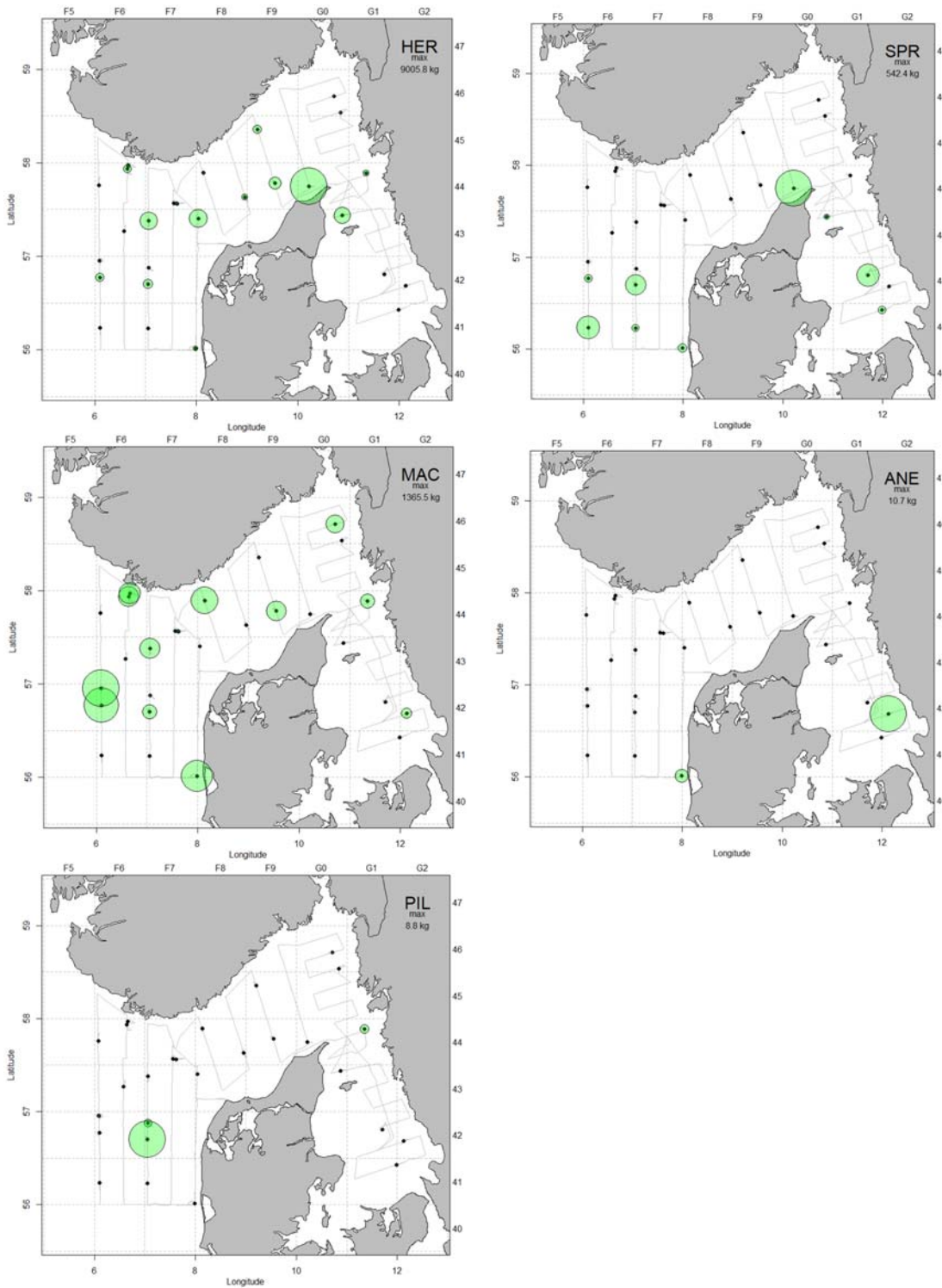


Figure 5. Catches of main pelagic species during the Danish acoustic survey with R/V Dana in June-July 2021. Black circles indicate trawl positions, green circles catches with the size of bubble representing the size of the catch. Catches are not to scale between plots, largest catch for each species is annotated on each map.

Table 1. Simrad EK60 and analysis settings used during the Herring Acoustic Survey with R/V Dana in June-July 2021

Transceiver Menu	
Frequency	38 kHz
Sound speed (North Sea and Skagerrak)	1487.9 m.s ⁻¹
Sound speed (Kattegat)	1492.8 m.s ⁻¹
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Transducer Sv gain	25.42 dB
3 dB Beamwidth	6.85°
Calibration details	
TS of sphere	-33.53 dB
Range to sphere in calibration	10.0 m
Measured NASC value for calibration	31900 m ² /nmi ²
Calibration factor for NASCs	1.00
Absorption coeff	6.355 dB/km
Log Menu	
Distance	1.0 n.mi. using GPS-speed
Operation Menu	
Ping interval	1 s external trig
Analysis settings	
Bottom margin (backstep)	1.0 m
Integration start (absolute) depth	7 - 9 m
Range of thresholds used	-70 dB

TABLE 2. TRAWL HAULS DETAILS FOR THE DANISH ACOUSTIC SURVEY WITH R/V DANA IN JUNE-JULY 2021.

Date dd-mm-yy	Haul no.	Time UTC	ICES Square	Position		Trawl Direction deg.	Wire length m	Trawl type	Headline depth	Bottom depth m	Total catch kg	Main Fish Species by weight	Trawling speed Kn	Trawling duration min.	Wind speed m/s	Sea state	Trawling distance NM
				Latitude	Longitude												
25-06-21	11	14:49	41F6	56.14.080 N	006.06.303 E	181	440	FOTØ	14	46	322	Sprat, Herring, Grey gurnard, Whiting	4.2	60	6.5	2	4.2
25-06-21	14	21:31	42F6	56.46.197 N	006.05.814 E	180	320	FOTØ	0	53	1722	Mackerel, Herring	4.6	60	2.7	2	4.5
26-06-21	15	00:27	42F6	56.57.349 N	006.05.509 E	360	300	FOTØ	0	58	1410	Mackerel, Herring	4.9	60	3.2	2	5.1
26-06-21	20	11:07	44F6	57.45.474 N	006.04.603 E	3	1100	FOTØ	200	266	680	Blue whiting	4.3	60	11.5	2	4.4
26-06-21	23	22:20	44F6	57.58.355 N	006.39.423 E	56	350	FOTØ	0	391	688	Mackerel, Herring, Dogfish	4.3	60	11.5	2	4.4
27-06-21	24	00:25	44F6	57.56.157 N	006.38.629 E	204	320	FOTØ	0	369	910	Herring, Mackerel	4.8	60	17.3	2	4.9
27-06-21	25	08:36	43F6	57.16.312 N	006.34.554 E	357	450	EXPO	68	79	49	Haddock, Saithe, Whiting, Norway pout	4.4	40	15.2	6	3.0
27-06-21	30	23:05	41F7	56.00.853 N	007.58.945 E	342	220	FOTØ	0	23	1226	Mackerel, Herring, Sprat	5.3	60	6.2	6	4.9
28-06-21	31	15:09	43F8	57.24.365 N	008.02.149 E	349	650	FOTØ	70	111	2537	Herring, Norway pout	4.3	60	11.7	6	4.3
28-06-21	36	22:01	44F7	57.33.635 N	007.37.475 E	104	250	FOTØ	10	251	410	Blue whiting, Herring, Mackerel	4.5	60	13.5	6	4.4
29-06-21	37	00:29	44F7	57.34.065 N	007.33.062 E	291	380	FOTØ	0	279	16	Blue whiting, Herring, Lumpsucker	4.8	61	13.7	6	4.9
29-06-21	38	15:51	41F7	56.13.768 N	007.03.283 E	182	280	EXPO	27	35	93	Sprat, Herring, Gurnard, Common dab	3.9	61	8.9	3	4.0
29-06-21	43	21:36	42F7	56.42.287 N	007.02.873 E	1	300	FOTØ	0	40	1062	Herring, Mackerel, Sprat	4.4	30	10.4	3	2.3
30-06-21	44	01:00	42F7	56.52.578 N	007.03.936 E	165	200	FOTØ	7	37	18	Mackerel, Grey gurnard, Pilchard	4.8	30	10.1	3	2.4
30-06-21	47	06:48	43F7	57.22.834 N	007.03.337 E	182	400	FOTØ	7	94	2515	Herring, Mackerel	4.6	28	9.6	3	2.1
30-06-21	48	09:13	43F7	57.21.569 N	007.03.329 E	357	690	FOTØ	75	104	0	-	4.3	30	13.3	5	2.3
30-06-21	53	21:49	44F8	57.53.789 N	008.08.309 E	15	350	FOTØ	0	498	850	Mackerel, Herring, Blue whiting	4.7	45	5.8	5	3.7
01-07-21	54	07:09	44F8	57.37.976 N	008.57.269 E	145	500	FOTØ	45	60	350	Herring, Whiting, Haddock	4.8	29	13.5	5	2.3
01-07-21	59	18:30	45F9	58.21.474 N	009.12.347 E	346	440	FOTØ	9	410	500	Herring, Mackerel	4.2	30	9.6	5	2.1
02-07-21	62	00:21	44F9	57.46.996 N	009.33.063 E	8	300	FOTØ	0	44	1458	Herring, Mackerel	4.7	30	8.7	5	2.3
02-07-21	65	06:45	44G0	57.44.985 N	010.13.369 E	123	490	FOTØ	52	77	9694	Herring, Sprat	4.7	30	6.2	2	2.3
02-07-21	70	21:40	46G0	58.42.630 N	010.42.779 E	76	320	FOTØ	4	83	420	Mackrel, Herring	4.4	30	0.3	2	2.3
03-07-21	71	04:46	46G0	58.32.231 N	010.50.685 E	184	600	EXPO	86	95	151	Herring, Norway pout	4.6	31	3.1	0	2.4
03-07-21	75	23:03	44G1	57.53.359 N	011.20.793 E	334	300	FOTØ	5	80	535	Herring, Mackerel	4.8	30	4.6	0	2.4
04-07-21	78	06:17	43G0	57.26.273 N	010.52.800 E	231	250	FOTØ	6	34	1873	Herring	4.8	13	3.5	0	1.0
04-07-21	83	20:52	42G1	56.48.631 N	011.42.221 E	21	370	FOTØ	5	45	290	Sprat, Greater Weever, Herring	4.0	60	2.8	0	4.1
05-07-21	84	03:03	42G2	56.41.093 N	012.07.599 E	216	300	FOTØ	0	36	157	Mackerel, Anchovy	4.6	29	8.9	3	2.1
05-07-21	87	10:22	41G1	56.25.554 N	011.58.890 E	69	300	FOTØ	3	33	81	Sprat, Greater weever, Mackerel	4.2	60	5.6	3	4.2

TABLE 3. CATCH COMPOSITION IN TRAWL HAULS FOR THE DANISH ACOUSTIC SURVEY WITH R/V DANA IN JUNE –JULY 2021

			Stratum	151	151	151	152	152	152	151	151	151	152	152	152	151	151
			Station	11	14	15	20	23	24	25	30	31	36	37	38	43	44
			ICES sq.	41F6	42F6	42F6	44F6	44F6	44F6	43F6	41F7	43F8	44F7	44F7	41F7	42F7	42F7
			Gear	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ
			Headline depth	14	0	0	200	0	0	68	0	70	10	0	27	0	7
			Total depth	46.3	53.15	57.9	265.75	391.45	368.5	79.45	23.45	110.95	251.4	278.5	34.5	39.65	36.75
			Day/Night	Day	Night	Night	Day	Night	Night	Day	Night	Day	Night	Night	Day	Night	Night
% of catches	Common Name	Scientific Name	Total catch (kg)	321.998	1722.001	1409.990	679.998	688.027	910.007	49.387	1226.431	2536.990	409.986	16.413	93.003	1061.999	18.314
67.99	Herring	Clupea harengus	19020.137	35.196	484.364	43.035		127.185	448.569	0.716	208.772	2186.830	126.086		17.424	651.284	
20.41	Mackerel	Scomber scombrus	5711.026		1207.043	1365.453		470.633	429.338		974.597	0.087	17.654	0.209		212.681	15.418
3.68	Sprat	Sprattus sprattus	1029.449	228.123	26.559						32.033				22.148	179.134	
3.13	Blue whiting	Micromesistius poutassou	875.052				626.609						232.607	1.937			
1.40	Norway pout	Trisopterus esmarkii	392.326				0.039			2.355		337.823					
1.09	Scyphozoans	Scyphozoa	305.949	5.288	0.570	0.101	0.026	16.378	11.761		3.267		29.603	14.170	20.080	2.893	
0.70	Haddock	Melanogrammus aeglefinus	197.071	0.240						29.784		3.170			2.500	0.370	
0.43	Spiny dogfish	Squalus acanthias	121.665					69.929	4.775								
0.25	Whiting	Merlangius merlangus	69.394	24.003						6.020		7.520			0.342		0.071
0.18	Greater weever fish	Trachinus draco	51.622														
0.12	Saithe	Pollachius virens	34.012				23.450				8.260						
0.10	Grey gurnard	Eutrigla gurnardus	26.795	29.098	2.820	0.814				0.282	1.229				13.502	6.360	2.378
0.06	Garfish	Belone belone	18.054		0.590	0.254				11.290		1.742				0.358	
0.06	Silver smelts	Argentina	17.531				17.531										
0.06	Lumpfish	Cyclopterus lumpus	17.120				0.714			3.675			1.820	0.097			
0.06	Hake	Merluccius merluccius	16.173				7.375					2.900		2.035		1.476	
0.05	Krill	Euphausiidae	14.523				1.633										
0.04	Common dab	Limanda limanda	12.576							0.474					12.102		
0.04	Anchovy	Engraulis encrasicolus	12.276		0.032	0.036						1.452			0.016	0.071	
0.04	Pilchard	Sardina pilchardus	9.979			0.111										8.812	0.430
0.03	Cod	Gadus morhua	7.104							1.185		1.047					
0.01	Southern shortfin Squid	Illex coindetii	3.019	0.050				1.436	0.519		0.053		0.182				
0.01	Salmon	Salmo salar	2.466					2.466									
0.01	Pearlside	Maurolucus muelleri	2.350				2.268										
0.01	Plaice	Pleuronectes platessa	2.190												2.190		
0.01	Northern squid	Loligo forbesii	1.665										0.344				
0.00	Greater sandeel	Hyperoplus lanceolatus	0.818												0.780		
0.00	European squid	Loligo vulgaris	0.362										0.168				
0.00	Monk	Lophius piscatorius	0.315			0.161											
0.00	Lemon sole	Microstomus kitt	0.292							0.292							
0.00	Kroyer's lantern fish	Notoscopelus elongatus	0.285				0.285										
0.00	Sandeel	Ammodytes marinus	0.240												0.240		
0.00	Tub gurnard	Chelidonichthys lucerna	0.178									0.178					
0.00	American plaice	Hippoglossoides platessoides	0.170												0.170		
0.00	Sea trout	Salmo trutta	0.110									0.110					
0.00	European common squid	Alloteuthis subulata	0.099		0.023	0.025						0.008				0.036	
0.00	Horse mackerel	Trachurus trachurus	0.086									0.086					
0.00	Lesser flying squid	Todaropsis eblanae	0.079						0.079								
0.00	Poor-cod	Trisopterus minutus	0.051														
0.00	Velvet belly	Etmopterus spinax	0.035				0.035										
0.00	Pencil Squids	Loliginidae	0.033							0.019							0.014
0.00	Silvery pout	Gadiculus argenteus	0.033				0.033										
0.00	Solenette	Buglossidium luteum	0.025									0.004			0.021		
0.00	Four-bearded rockling	Enchelyopus cimbrius	0.011												0.011		
0.00	Atlantic bobtail squid	Sepiella atlantica	0.003														0.003
100.00			27974.747	321.998	1722.001	1409.990	679.998	688.027	910.007	49.387	1226.431	2536.990	409.986	16.413	93.003	1061.999	18.314

TABLE 3. CONTINUED.

			Stratum	151	151	41	42	41	42	42	31	71	31	21	21	21	21
			Station	47	48	53	54	59	62	65	70	71	75	78	83	84	87
			ICES sq.	43F7	43F7	44F8	44F8	45F9	44F9	44G0	46G0	46G0	44G1	43G0	42G1	42G2	41G1
			Gear	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ
			Headline depth	7	75	0	45	9	0	52	4	86	5	6	5	0	3
			Total depth	94.35	104.05	498.15	59.55	410	44.15	76.8	83.3	94.55	80.05	33.85	45.25	35.55	32.6
			Day/Night	Day	Day	Night	Day	Day	Night	Day	Night	Day	Night	Day	Night	Day	Day
% of catches	Common Name	Scientific Name	Total catch (kg)	2515.013	0.000	849.992	349.998	500.005	1457.993	9693.992	420.003	151.003	535.011	1873.001	290.003	157.487	80.700
67.99	Herring	Clupea harengus	19020.137	2096.094		42.334	277.921	487.092	1017.091	9005.779	68.999	99.564	284.883	1813.514	14.482	0.647	1.835
20.41	Mackerel	Scomber scombrus	5711.026	413.698		732.591	0.487	7.588	398.953	1.609	327.983		206.662	1.510	7.344	121.421	5.110
3.68	Sprat	Sprattus sprattus	1029.449			0.206				542.394		0.007	0.030	13.914	214.483		25.099
3.13	Blue whiting	Micromesistius poutassou	875.052			13.899											
1.40	Norway pout	Trisopterus esmarkii	392.326							2.970	0.784	48.355					
1.09	Scyphozoans	Scyphozoa	305.949	2.010		59.836	0.525	2.099	23.441		9.105	1.888	40.137		17.336	17.430	33.860
0.70	Haddock	Melanogrammus aeglefinus	197.071				31.780		6.640	122.698		0.128					
0.43	Spiny dogfish	Squalus acanthias	121.665			0.201								41.830		4.700	0.230
0.25	Whiting	Merlangius merlangus	69.394			0.051	33.613		6.876	14.020		0.691	0.016	0.045	0.110		0.019
0.18	Greater weever fish	Trachinus draco	51.622										0.344	2.150	36.248	2.480	10.400
0.12	Saithe	Pollachius virens	34.012				0.414			1.474	0.140	0.274					
0.10	Grey gurnard	Eutrigla gurnardus	26.795	1.461				0.108									0.661
0.06	Garfish	Belone belone	18.054			0.301	0.363	0.166	3.580								
0.06	Silver smelts	Argentina	17.531														
0.06	Lumpfish	Cyclopterus lumpus	17.120	1.595		0.778		2.951					1.896			0.108	3.486
0.06	Hake	Merluccius merluccius	16.173				1.330			1.057							
0.05	Krill	Euphausiidae	14.523								12.890						
0.04	Common dab	Limanda limanda	12.576														
0.04	Anchovy	Engraulis encrasicolus	12.276													10.701	
0.04	Pilchard	Sardina pilchardus	9.979								0.089		0.537				
0.03	Cod	Gadus morhua	7.104			3.330				1.528		0.014					
0.01	Southern shortfin Squid	Illex coindetii	3.019						0.605	0.101	0.015		0.108				
0.01	Salmon	Salmo salar	2.466														
0.01	Pearlside	Mauroliscus muelleri	2.350									0.082					
0.01	Plaice	Pleuronectes platessa	2.190														
0.01	Northern squid	Loligo forbesii	1.665						0.613	0.310			0.398				
0.00	Greater sandeel	Hyperoplus lanceolatus	0.818											0.038			
0.00	European squid	Loligo vulgaris	0.362						0.194								
0.00	Monk	Lophius piscatorius	0.315	0.154													
0.00	Lemon sole	Microstomus kitt	0.292														
0.00	Kroyer's lantern fish	Notoscopelus elongatus	0.285														
0.00	Sandeel	Ammodytes marinus	0.240														
0.00	Tub gurnard	Chelidonichthys lucerna	0.178														
0.00	American plaice	Hippoglossoides platessoides	0.170														
0.00	Sea trout	Salmo trutta	0.110														
0.00	European common squid	Alloteuthis subulata	0.099				0.030										
0.00	Horse mackerel	Trachurus trachurus	0.086														
0.00	Lesser flying squid	Todaropsis eblanae	0.079														
0.00	Poor-cod	Trisopterus minutus	0.051							0.051							
0.00	Velvet belly	Etmopterus spinax	0.035														
0.00	Pencil Squids	Loliginidae	0.033														
0.00	Silvery pout	Gadiculus argenteus	0.033														
0.00	Solenette	Buglossidium luteum	0.025														
0.00	Four-bearded rockling	Enchelyopus cimbrius	0.011														
0.00	Atlantic bobtail squid	Sepiola atlantica	0.003														
100.00			27974.747	2515.013	0.000	849.992	349.998	500.005	1457.993	9693.992	420.003	151.003	535.011	1873.001	290.003	157.487	80.700

Table 4. Raised length distribution of herring by haul for the Danish acoustic survey with R/V Dana in June-July 2021.

Station	11	14	15	23	24	25	30	31	36	38	43	47	53	54	59	62	65	70	71	75	78	83	84	87	
Stratum	151	151	151	152	152	151	151	151	152	152	151	151	41	42	41	42	42	31	31	31	21	21	21	21	21
ICES sq.	41F6	42F6	42F6	44F6	44F6	43F6	41F7	43F8	44F7	41F7	42F7	43F7	44F8	44F8	45F9	44F9	44G0	46G0	46G0	44G1	43G0	42G1	42G2	41G1	
Gear	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	
Fishing depth	14					68																			
Total depth	46	53	58	391	369	79	23	110.95	251.4	10	40	94	498	60	410	44	52	4	86	5	6	5	36	3	
Day/Night	Day	Night	Night	Night	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Day	Day	
Total catch (kg)	321.998	1722.001	1409.990	688.027	910.007	49.387	1226.431	2536.990	409.986	93.003	1061.999	2515.013	849.992	349.998	500.005	1457.993	9693.992	420.003	151.003	535.011	1873.001	290.003	157.487	80.700	
Total weight herring (kg)	35.196	484.364	43.035	127.185	448.569	0.716	208.772	2186.630	126.086	17.424	651.284	2096.094	42.334	277.921	487.092	1017.091	9005.779	68.999	99.558	284.883	1813.514	14.482	0.647	1.835	
Subsample weight herring (kg)	12.000	15.744	22.674	43.099	44.426	0.716	1.074	61.878	34.544	1.656	14.354	56.182	42.334	20.776	47.928	19.636	18.569	24.713	22.073	14.068	2.856	14.482	0.647	1.835	
5							194																		
5.5							972														348				
6							5832				284										753		2		
6.5							15940				1168								1		2607		1		
7							24493				1126										4924		3		
7.5							21771				1063										11640		1		
8							14968				1052										19885				
8.5							5637				694										24250		1		
9							194				231										11640		4		
9.5							194				42										5335		2		
10																					1455		2		
10.5																					1		1		
11							194				45										2910		1		
11.5											408										2425		1		
12											1089										4850				
12.5	3										2813										4850				
13	9	31									4401										8245				
13.5	65	154									3947										3880				
14	238	492									11										1940				
14.5	425	1077									42										970				
15	320	1938									2314										485				
15.5	150	2215									11										2910				
16	120	1907									35										107				
16.5	47	1600									106										817				
17	29	1200									801										67				
17.5	23	1569									2050										259				
18		1446									907										2434				
18.5		769									4559										32864				
19		185									1180										7303				
19.5		92									544										64019				
20		123									544										128				
20.5		31									5549										425				
21											5372										2204				
21.5											544										947				
22											37										10670				
22.5											373										472				
23											363										254				
23.5											49										4850				
24											1082										208				
24.5											7										109				
25											4700										593				
25.5											3216										219				
26											2120										109				
26.5											1484										55				
27											26										73				
27.5											26										18				
28											1166										11				
28.5											37										3				
29											919										52				
29.5											80										386				
30											97										52				
30.5											807										488				
31											2537										52				
31.5											2313										485				
Number measured	487	482	456	535	472	9	465	974	249	546	625	528	594	568	592	450	664	510	496	680	525	412	9	20	
Raised number	1428	14829	865	1579	4766	9	90390	34422	909	5745	28358	19699	594	7598	6016	23306	322033	1424	2184	25056	333367	412	9	20	
Mean length (cm)	14.9	16.3	18.6	21.5	22.3	21.4	7.2	19.5	24.8	7.5	14.4	22.4	20.8	17.0	21.4	18.0	14.8	18.6	18.1	10.0	9.1	16.8	20.9	22.6	

Table 5. Raised length distribution of sprat by haul for the Danish acoustic survey with R/V Dana in June-July 2021.

Station	11	14	30	38	43	54	65	71	75	78	83	87
Stratum	151	151	151	152	151	42	42	71	31	21	21	21
ICES sq.	41F6	42F6	41F7	41F7	42F7	44F8	44G0	46G0	44G1	43G0	42G1	41G1
Gear	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	EXPO	FOTØ	FOTØ	FOTØ	FOTØ
Fishing depth	14	0	0	27	0	45	52	86	5	6	5	3
Total depth	46.3	53.15	23.45	34.5	39.65	59.55	76.8	94.55	80.05	33.85	45.25	32.6
Day/Night	Day	Night	Night	Day	Night	Day	Day	Day	Night	Day	Night	Day
Total catch (kg)	321.998	1722.001	1226.431	93.003	1061.999	349.998	9693.992	151.003	535.011	1873.001	290.003	80.700
Total weight sprat (kg)	228.123	26.559	32.033	22.148	179.134	0.206	542.394	0.007	0.030	13.914	214.483	25.099
Subsample weight sprat (kg)	2.300	2.402	2.598	1.716	1.958	0.096	1.986	0.007	0.030	0.415	2.636	3.868
5.5								1				
6								1				
6.5								1				
7								1				
7.5												
8			12	13	183		273					
8.5			62	207	1281		1639				244	
9			210	813	4208		11197			34	1383	
9.5	99		863	1536	5032		13929			34	3906	
10	2876		1862	465	3111		11197			67	4882	
10.5	6645	66	752	39	1921		11197			101	3580	6
11	4959	144	210	26	2287	2	5189			134	2360	78
11.5	3670	188		26	1921	2	3277			34	1953	156
12	1884	520	25	13	640		1639			67	895	461
12.5	1289	553			274	9	819			134	895	454
13	198	343			457		546			101	651	337
13.5		111		26		2	273			67	325	91
14		22					273			67	570	65
14.5										67	81	6
15									1		81	
15.5										34		
Number measured	218	176	324	245	233	7	225	4	1	28	268	255
Raised number	21622	1946	3995	3162	21317	15	61450	4	1	939	21806	1655
Mean length (cm)	11.0	12.3	10.0	9.5	10.0	12.3	10.1	6.3	15.0	12.1	10.6	12.4

Table 6. Raised length distribution of mackerel by haul for the Danish acoustic survey with R/V Dana in June-July 2021.

Station	14	15	23	24	30	31	36	37	43	44	47	53	54	59	62	65	70	75	78	83	84	87
Stratum	151	151	152	152	151	151	152	152	151	151	151	41	42	41	42	42	31	31	21	21	21	21
ICES sq.	42F6	42F6	44F6	44F6	41F7	43F8	44F7	44F7	42F7	42F7	43F7	44F8	44F8	45F9	44F9	44G0	46G0	44G1	43G0	42G1	42G2	41G1
Gear	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ	FOTØ
Fishing depth	0	0	0	0	0	70	10	0	0	7	7	0	45	9	0	52	4	5	6	5	0	3
Total depth	53.15	57.9	391.45	368.5	23.45	110.95	251.4	278.5	39.65	36.75	94.35	498.15	59.55	410	44.15	76.8	83.3	80.05	33.85	45.25	35.55	32.6
Day/Night	Night	Night	Night	Night	Night	Day	Night	Night	Night	Night	Day	Night	Day	Day	Night	Day	Night	Night	Day	Night	Day	Day
Total catch (kg)	1722.001	1409.990	688.027	910.007	1226.431	2536.990	409.986	16.413	1061.999	18.314	2515.013	849.992	349.998	500.005	1457.993	9693.992	420.003	535.011	1873.001	290.003	157.487	80.700
Total weight mackerel (kg)	1207.043	1365.453	470.633	429.338	974.597	0.087	17.654	0.209	212.681	15.418	413.698	732.591	0.487	7.588	398.953	1.609	327.983	206.662	1.510	7.344	121.421	5.110
Subsample weight mackerel (kg)	16.436	11.500	30.034	40.866	24.809	0.087	17.654	0.209	16.100	15.418	19.897	14.990	0.487	7.588	12.594	1.609	14.646	14.901	1.510	7.344	15.635	5.110
19					39				13									14		1		3
20	147	119			314					3		147		1	63		45	28		3	109	1
21	588	356		74	1061		4		106	7	166	1466		9	127		291	333		9	621	15
22	2350	2493	157	294	2239	1	15		423	36	936	2541		15	1140	1	963	957	1	23	474	18
23	3011	3325	595	840	3064		19	2	410	25	1975	2101		28	1806		1030	693	1	19	217	11
24	1469	4868	470	1051	1179		7		145	6	541	440		9	539		291	125		1	39	
25	441	831	188	252	629		2		26	1	187	195			32		22			2	8	2
26	367	119	16	42	39					1	21	98										
27		119	16	11	79				26	2							32					
28	147		157	63	118				66	3	62	49						22			8	1
29		237	110	32	39		1		40	2	21						63	22	14	1	3	1
30	294		78		39				26	4		98			1		32	90	14	1	2	
31	73		16						13								32	22				1
32		119	110	42	39				26	1	42	49					32					
33	73		78	53	39		4		26	3		49						22	14		1	
34			141	53	39		7		13	2							22	14				1
35	73		94	63			2			6	21											
36	73		94	74			3												14			
37	73		78	53	79		1		40	1		49					1	22		1	1	
38	147		47	42			4		13	3				1						1	1	
39			31	11			4		13				1	1			2	45				
40	73			11			1		13					1								
41							2		13													
42							1															
43																						
44																						
45																						
46							1															
Number measured	128	106	158	291	230	1	78	2	110	106	191	149	1	66	123	4	130	160	6	68	190	54
Raised number	9400	12586	2476	3057	9035	1	78	2	1453	106	3971	7282	1	66	3896	4	2911	2219	6	68	1476	54
Mean length (cm)	24.1	23.5	27.4	25.2	23.1	22.0	28.2	23.0	24.8	25.0	23.2	22.7	39.0	23.4	23.1	34.3	23.4	22.6	29.8	23.6	21.7	22.5

Table 7. CTD station details for the Danish acoustic survey with R/V Dana in June-July 2021.

Stat. no.	Date dd-mm-yy	Time UTC	ICES Square	Position		Bottom depth m	Wind speed m/s	Seastate	Associated fishery station
				Latitude	Longitude				
9	25-06-21	11:36	41F6	56.00.045 N	006.07.913 E	47	6.6	3	-
12	25-06-21	20:31	42F6	56.47.692 N	006.05.536 E	54	3.89	2	14
16	26-06-21	01:47	42F6	56.56.058 N	006.06.741 E	57	1.85	2	15
18	26-06-21	10:06	44F6	57.43.918 N	006.04.608 E	225	6.6	2	20
21	26-06-21	20:37	44F6	57.56.346 N	006.38.886 E	374	16	2	23
26	27-06-21	09:38	43F6	57.19.714 N	006.35.670 E	78	13.55	6	25
28	27-06-21	22:24	40F7	55.59.980 N	007.59.274 E	23	5.39	6	30
32	28-06-21	16:42	43F8	57.29.406 N	008.02.457 E	148	10.04	6	31
34	28-06-21	20:38	44F7	57.33.852 N	007.32.557 E	266	14.53	6	36
39	29-06-21	17:13	41F7	56.09.208 N	007.02.876 E	35	7.72	3	38
41	29-06-21	20:51	42F7	56.40.552 N	007.02.757 E	40	8.27	3	41
45	30-06-21	01:52	42F7	56.50.706 N	007.08.633 E	38	8.98	3	44
49	30-06-21	10:21	43F7	57.24.850 N	007.02.490 E	120	11.76	5	48
51	30-06-21	20:49	44F8	57.52.915 N	008.08.457 E	497	5.98	5	53
55	01-07-21	08:07	44F9	57.35.126 N	009.00.676 E	40	14.2	5	54
57	01-07-21	13:14	45F8	58.14.269 N	008.36.435 E	165	11.16	5	-
60	01-07-21	19:23	45F9	58.23.574 N	009.09.382 E	407	10.41	5	59
63	02-07-21	01:10	44F9	57.48.462 N	009.28.907 E	57	8.33	5	63
66	02-07-21	07:45	44G0	57.44.482 N	010.19.492 E	65	5.54	2	65
68	02-07-21	20:36	46G0	58.41.951 N	010.38.215 E	103	6.66	2	70
73	03-07-21	05:56	45G0	58.29.016 N	010.49.660 E	109	1.97	0	71
74	03-07-21	21:36	44G1	57.42.473 N	011.23.604 E	89	5.76	0	-
76	04-07-21	00:16	44G1	57.52.205 N	011.21.210 E	65	5.26	0	75
79	04-07-21	06:54	43G0	57.25.415 N	010.50.345 E	34	3.84	0	78
81	04-07-21	18:24	42G1	56.53.041 N	011.57.190 E	42	2.01	0	83
85	05-07-21	09:01	41G1	56.24.821 N	011.55.041 E	33	5.79	3	87
88	05-07-21	22:22	43G1	57.16.760 N	011.35.789 E	76	6.93	3	-

Table 8. WP2 station details for the Danish acoustic survey with R/V Dana in June-July 2021.

Station no.	Date dd-mm-yy	Time UTC	ICES Square	Position		Bottom depth m	Wind speed m/s	Seastate
				Latitude	Longitude			
8	25-06-21	11:25	41F6	56.00.062 N	006.07.881 E	46.8	6.51	3
10	25-06-21	11:49	41F6	56.00.033 N	006.07.878 E	46.9	6.57	3
13	25-06-21	20:44	42F6	56.47.762 N	006.05.610 E	53.3	3.17	2
17	26-06-21	02:03	42F6	56.56.061 N	006.06.691 E	56.8	1.89	2
19	26-06-21	10:29	44F6	57.43.943 N	006.04.633 E	225.7	7.05	2
22	26-06-21	20:58	44F6	57.56.419 N	006.38.725 E	373.2	15.68	2
27	27-06-21	09:54	43F6	57.19.778 N	006.36.294 E	78	13.88	6
29	27-06-21	22:35	40F7	55.59.888 N	007.59.277 E	22.1	4.65	6
33	28-06-21	17:03	43F8	57.29.453 N	008.02.692 E	147.6	12.19	6
35	28-06-21	21:04	44F7	57.34.018 N	007.32.899 E	270.4	14.2	6
40	29-06-21	17:25	41F7	56.09.272 N	007.03.111 E	34.2	8.51	3
42	29-06-21	21:02	42F7	56.40.606 N	007.02.819 E	40	9.02	3
46	30-06-21	02:03	42F7	56.50.661 N	007.08.976 E	39.4	8.12	3
50	30-06-21	10:41	43F7	57.24.680 N	007.02.914 E	117.7	14.08	5
52	30-06-21	21:10	44F8	57.52.808 N	008.08.196 E	500.2	6.49	5
56	01-07-21	08:22	44F9	57.35.103 N	009.00.952 E	41.7	14.33	5
58	01-07-21	13:53	45F8	58.14.262 N	008.36.405 E	168.7	10.64	5
61	01-07-21	19:45	45F9	58.23.158 N	009.09.365 E	395.2	9.53	5
64	02-07-21	01:24	44F9	57.48.349 N	009.28.976 E	55	8.05	5
67	02-07-21	08:02	44G0	57.44.535 N	010.19.556 E	67.2	6.89	2
69	02-07-21	20:56	46G0	58.42.245 N	010.38.061 E	102.5	6.71	2
72	03-07-21	05:44	45G0	58.28.926 N	010.49.838 E	108.5	2.4	0
77	04-07-21	00:30	44G1	57.52.171 N	011.21.332 E	64.1	5.77	0
80	04-07-21	07:05	43G0	57.25.435 N	010.50.249 E	34.2	3.34	0
82	04-07-21	18:39	42G1	56.53.043 N	011.57.093 E	41.6	1.52	0
86	05-07-21	09:12	41G1	56.24.847 N	011.55.122 E	33.2	5.46	3