



DTU Aqua – National Institute of Aquatic Resources – Technical University of Denmark

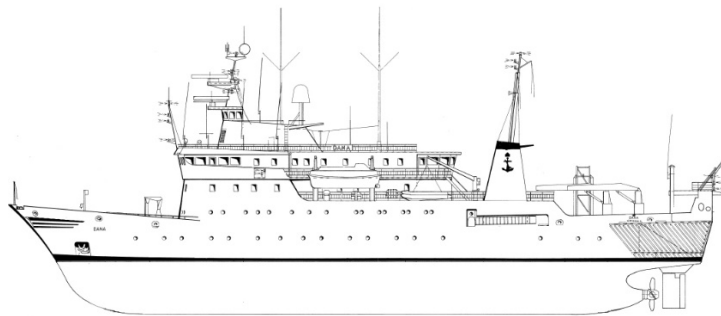
CRUISE REPORT

RV DANA

CRUISE NUMBER: 04 / 2021

”NORTH SEA MEGS 2021”

Mackerel egg survey in the North Sea



Bastian Huwer
DTU Aqua

Vessel: R/V DANA

Cruise dates: 31/05 – 11/06 2021

Cruise number: 04/2021

Cruise name: NORTH SEA MEGS 2021

Port of departure:	Hirtshals	Date:	31 May
Port of return:	Hirtshals	Date:	11 June
Other ports:	None	Date and justification:	n.a.

Participants

Name	Institute	Function and main tasks
Bastian Huwer	DTU Aqua Marine Living Resources	Cruise leader, plankton sorting, egg staging
Sakis Kroupis	Thünen Institut Bremerhaven	Egg staging
Dennis Ulrik Andersen	DTU Aqua Monitoring	Plankton sampling, fish lab
Gert Holst	DTU Aqua Monitoring	Plankton sampling (night)
Anne-Mette Kroner	DTU Aqua Monitoring	Gonad sampling & plankton sorting
Julie Josias Nielsen	DTU Aqua Marine Living Resources	Gonad sampling & plankton sorting
Jonna Tomkiewicz	DTU Aqua Marine Living Resources	Sampling EASIMACK project
Sofie Nissen	DTU Aqua Marine Living Resources	Sampling EASIMACK project
Sebastian Politis	DTU Aqua Marine Living Resources	Experiments EASIMACK & image analysis
Carla Torrents	DTU Aqua Marine Living Resources	Experiments EASIMACK project
Rune Garmund	DTU Aqua Oceans and Arctic	Gear test - NORDMAK project
Ronny Sørensen	DTU Aqua Monitoring	CTD, Technical support

Objectives

The survey is part of the Mackerel Egg Surveys (MEGS) which are carried out triennially and are coordinated by the ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). These surveys aim to investigate the spatial distribution and abundance of eggs, divided into different developmental stages (1A to 5). In particular the abundance of eggs in stage 1A is relevant, as this is needed for the further analyses. Furthermore, the fecundity of adult fish is investigated. The egg and adult data are then combined and applied in egg production methods, in order to provide fisheries-independent estimates of spawning stock biomass (SSB) indices.

More specifically, the present cruise DANA 04/2021 contributed to the mackerel egg survey in the North Sea (NS MEGS). Due to a lack of available vessel time, the survey area in the North Sea is usually covered one year later than the survey area in the Northeast Atlantic (NEA MEGS). The last NEA MEGS took place in 2019, i.e. the NS MEGS had actually been planned for 2020. However, due to the Covid-19 pandemic, the survey was postponed to 2021.

(NOTE: This procedure will be changed in the future, i.e. from 2022 onwards, both the NEA MEGS and the NS MEGS will be conducted in the same year.)

Furthermore, the NS MEGS had previously been conducted as an AEPM (annual egg production method) survey. However, in 2018 WGMEGS had decided to change the NS MEGS from an AEPM to a DEPM (Daily egg production method) survey. Therefore, the sampling strategy was changed as well to one full coverage of the whole North Sea during peak spawning time (in contrast to the previous AEPM survey, which sampled the main part of the spawning area several times over the spawning season).

The present NS MEGS 2021 was conducted in close collaboration between The National Institute of Aquatic Resources, Denmark (DTU Aqua) and Wageningen Marine Research, The Netherlands (WUR). DTU Aqua covered approximately 1/3 of the survey area on RV DANA, while WUR covered approximately 2/3 of the area on RV TRIDENS.

On RV DANA, the sampling of fish eggs was carried out with a High Speed Plankton Sampler "Nackthai" with a mesh size of 500 µm. The amount of water filtered during each haul was measured with an electronic flowmeter. The gear was towed at 5 knots through the water, in a 'double oblique' haul from the surface to 5 m above the sea floor (or to a maximum depth of 200 m).

Adult fish samples were collected with FOTØ and EXPO trawls. The catch was sorted by species and the total weight per species was recorded. For mackerel, length distributions were recorded and samples of mackerel gonads for fecundity estimates as well as otoliths for age estimates were collected.

Further technical details about the MEGS sampling methods and sample analyses are described in the current version of the survey manual:

[https://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Survey%20Protocols%20\(SISP\)/SISP%206%20-%20MEGS%20V1.3.pdf](https://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Survey%20Protocols%20(SISP)/SISP%206%20-%20MEGS%20V1.3.pdf)

In addition to the MEGS standard program, the following additional tasks were conducted for the national Danish projects EASIMACK, NORDMAK & GenClim:

1. Sets of fishing hauls in different depths at the same position to investigate the vertical distribution of adult mackerel (EASIMACK).
2. Collection of additional mackerel gonads and other tissue samples (EASIMACK).
3. Experiment on mackerel egg development and test of an image analysis system (EASIMACK).
4. Collection of genetic samples of mackerel, anchovy and hake (EASIMACK & GenClim).
5. Test of an acoustic camera which was mounted on the fishing trawl (NORDMAK).

Itinerary

R/V Dana left Hirtshals on Monday May 31 around noon (local time). The field work started in the afternoon with a first fishing haul north-west of Hirtshals, and continued in the evening with the northernmost plankton sampling transect (see Fig. 1 to 3). Afterwards the field work continued on a 24-h basis along the plankton station transects. During daytime, the plankton sampling was interrupted in order to conduct fishing hauls targeting adult mackerel. R/V Dana returned to Hirtshals on Friday June 11 in the morning.

Very favorable weather conditions prevailed during the entire survey.

Achievements

Due to the excellent weather conditions, more stations than initially planned could be conducted. There were planned 89 standard Nackthai stations and it was possible to conduct 5 additional standard stations plus 3 further Nackthai hauls to collect eggs for genetic studies and an egg identification workshop. Concerning the fishing hauls for adults, 10 hauls were planned and it was possible to conduct 21 hauls.

In summary, the following activities were achieved:

97 Hauls with the high speed plankton sampler "Nackthai"

17 Fishing hauls with FOTØ trawl

4 Fishing hauls with EXPO trawl

10 CTD casts

Note: 94 of the 97 Nackthai hauls were standard hauls for the MEGS sampling, while 3 additional Nackthai hauls were conducted to collect eggs for genetic studies & an egg identification workshop.

Figures 2 and 3 show the sampling positions of the 94 standard Nackthai stations and all 21 fishing hauls, respectively.

Results

Standard MEGS sampling

A total of 7680 mackerel eggs were caught in the 94 standard Nackthai samples, and 4146 of these were stage 1A eggs (Table 1). The spatial distribution and abundance of stage 1A eggs is shown in Fig. 4. The station with the highest abundance of stage 1A mackerel eggs (Station ID 59, 640 stage 1A eggs*m⁻²) was located in the southwestern part of the survey area close to the UK coast. High abundances were also found in the south-eastern part of the study area, with several stations of around 100 stage 1A eggs*m⁻² and a maximum of 170 stage 1A eggs*m⁻² at station 46, as well as on the northernmost transect between stations 1 and 12 with a maximum of 225 stage 1A eggs*m⁻² on station 12. In contrast, only low abundances or no eggs at all were found in the central and north-western part of the survey area as well as in the Dogger Bank area.

In the fishery trawl hauls, a total of 20 different fish species were caught, as well as squid, jellyfish and other invertebrates (Table 2). A total of 3838.8 kg mackerel were caught, including 2 very large catches of 1745 kg on station 65 and 1321 kg on station 77. Besides mackerel, the 7 most abundant species by weight were herring, sprat, haddock, whiting, grey gurnard, dab and Raitt's sandeel, while the 12 remaining species only occurred in relatively small numbers. Table 2 also provides an overview of the total weights caught per species, as well as information on how many trawl stations each species occurred, both for the FOTØ and EXPO trawls individually and for both trawl types combined. It is noteworthy that several stations contained large numbers of small juvenile whiting and haddock.

Table 3 provides an overview of the trawl stations including positions as well as weights per species per station. However, only species with a total catch of more than 30 kg are included individually, whereas a combined weight is provided for all other species.

A total of 1682 mackerel were measured for length frequency distributions. For the standard MEGS adult sampling program, individual measurements (pinched tail length, standard length, weight, sex and maturity stage as well as for non-juvenile females also gutted weight, gonad weight and liver weight) were recorded for a total of 817 mackerel, and suitable gonad samples for fecundity estimates could be obtained from 119 of these.

Additional tasks

In addition to the standard MEGS adult sampling, single fish information and various samples of gonads and other tissues were obtained from 249 mackerel for the EASIMACK project. Of these, 121 fish were suitable for the description of the reproductive cycle. For fecundity estimates via stereology, a total of 102 fish were suitable, and of these 32 fish were also used for a comparison of methods to estimate fecundity (stereology vs. autodiometric method). In addition, from 152 of the adult mackerel, samples were collected for genetic analyses.

On 6 fishing positions, fishing hauls were conducted at the same position but in different depths, in order to investigate the vertical distribution of adult mackerel for the EASIMACK project. On 4 positions sets of 2 hauls were conducted (stations 8 & 10, 75 & 77, 91 & 92 and 114 & 115) and on 2 positions sets of 3 hauls were conducted (stations 33, 34 & 36 and 123, 124 & 125). See also figure 3 for the location of sampling positions.

Furthermore, an experiment on mackerel egg development times at different temperatures as well as a test of an image analysis system for egg staging was conducted for the EASIMACK project.

For the NORDMAK project, an acoustic camera which was mounted on the fishing trawl was tested. The camera was attached during the majority of the conducted hauls, but had to be skipped on a few hauls due to technical issues.

Genetic samples of anchovy were collected for the GenClim project. Unfortunately, no genetic samples from hake could be collected, as no hake were caught during the survey at all.

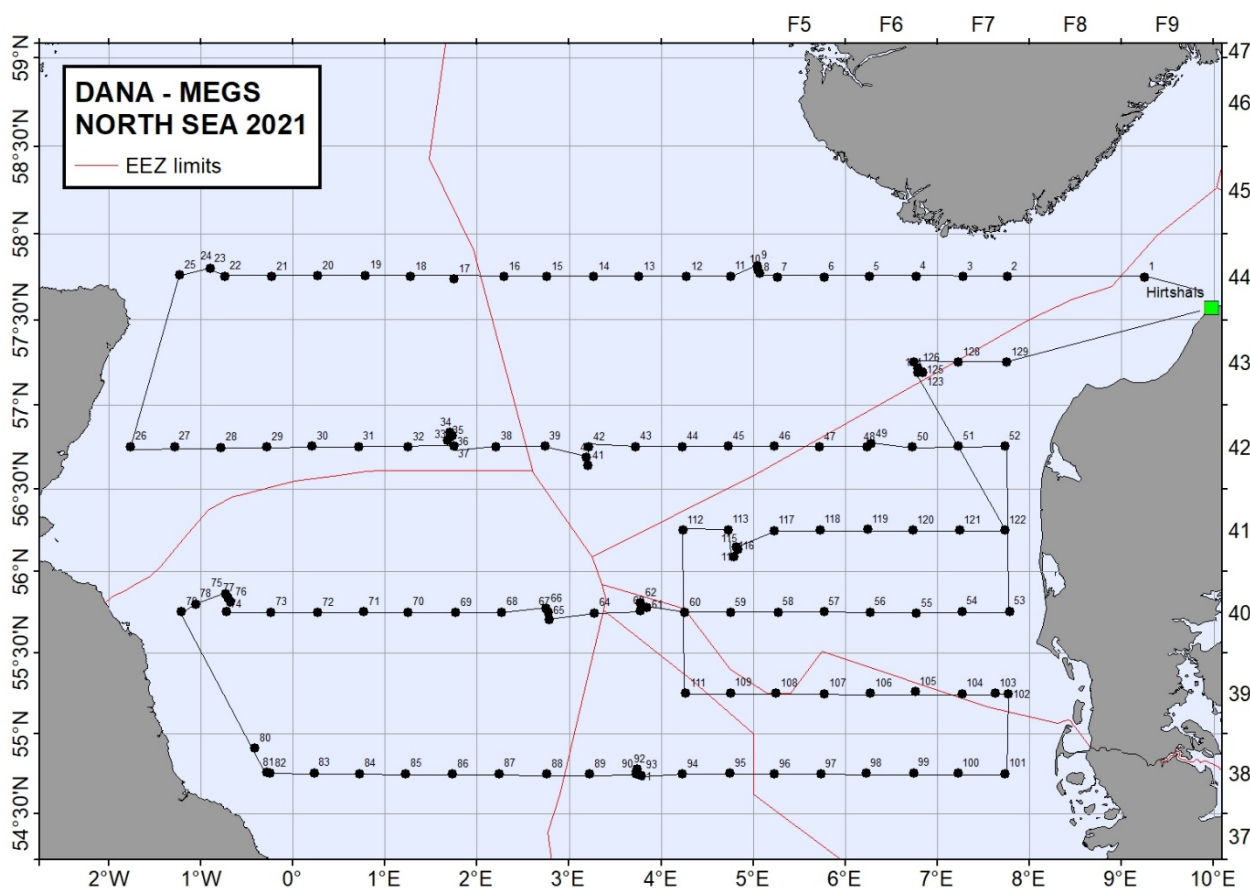


Fig. 1: Cruise track and sampling locations.

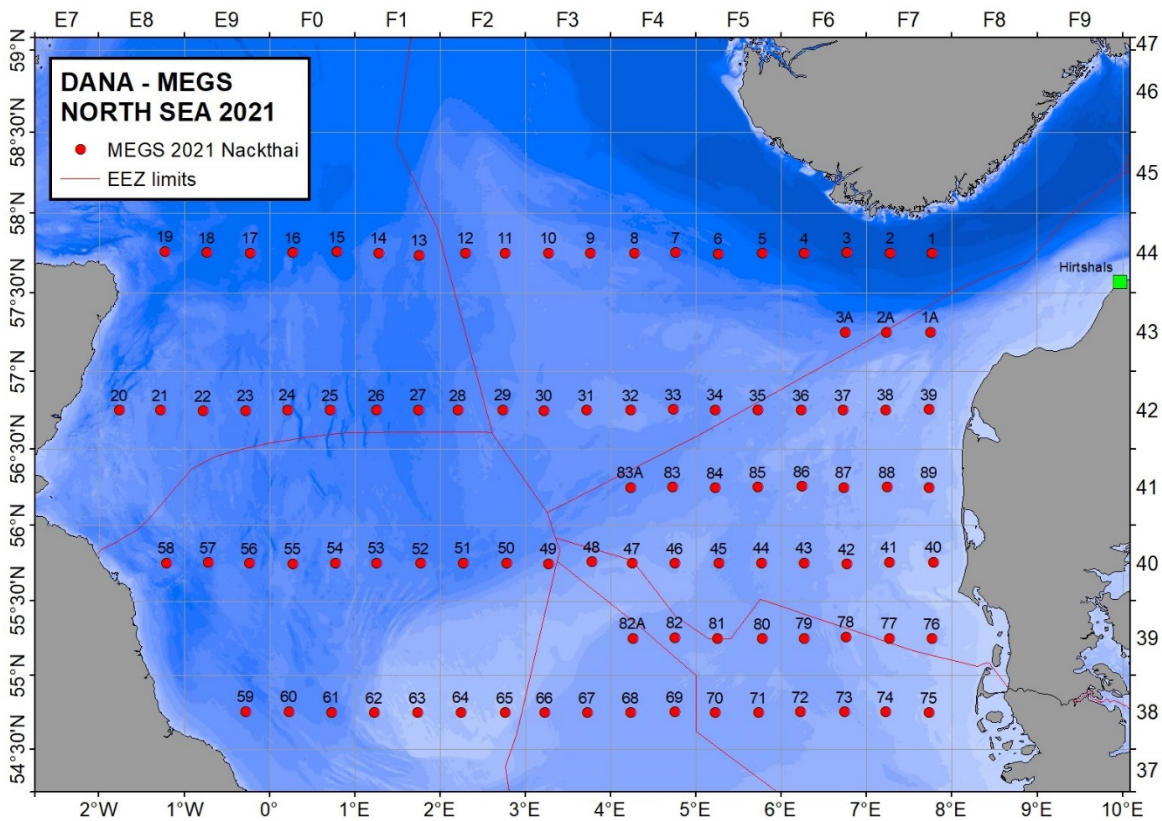


Fig. 2: Sampling locations of the 94 standard Nackthai hauls. Stations 1A, 2A, 3A, 82A and 83A are stations that could be sampled in addition to the 89 planned stations due to the excellent weather conditions. Furthermore, 3 additional Nackthai hauls were conducted to obtain egg samples for genetic analyses and an egg identification workshop (sampling positions not shown on map).

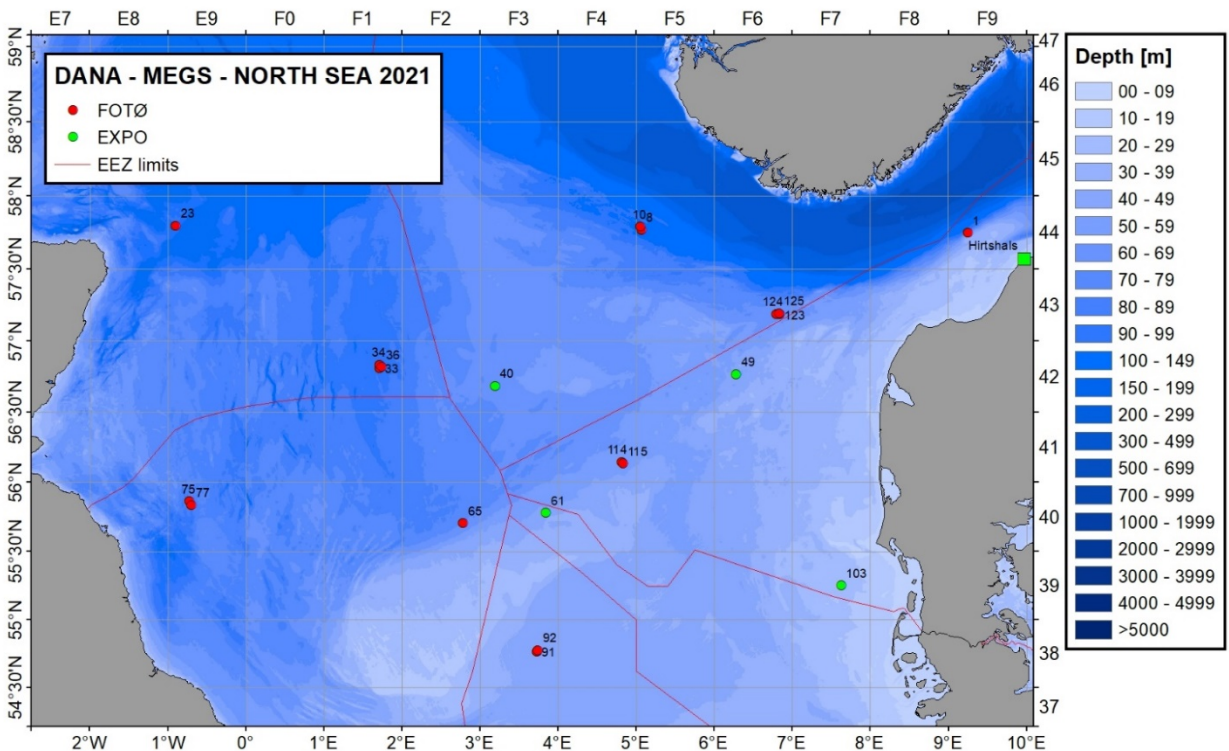


Fig. 3: Sampling locations of the 17 FOTØ hauls (red dots) and the 4 EXPO hauls (green dots). Note that some of the symbols are overlapping, as in some cases several hauls were conducted at the same position but in different depths, in order to investigate the vertical distribution of the adult mackerel.

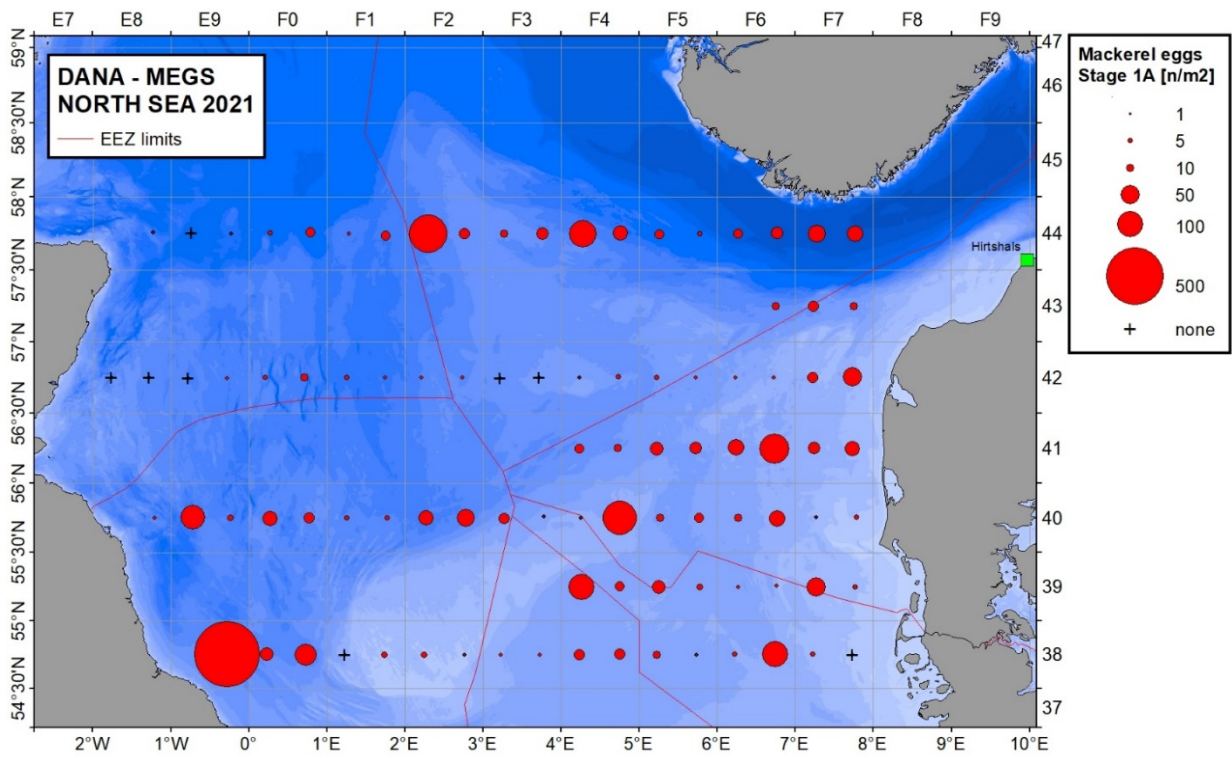


Fig. 4: Spatial distribution and abundance of stage 1A mackerel eggs.

Table 1: Numbers of caught mackerel eggs per stage and in total.

Stage	1A	1B	2	3	4	5	ALL
SUM	4146	489	887	1466	641	51	7680

Table 2: Species list with total weights caught and numbers of hauls in which the species occurred.

Species	Weight [kg]	Number of hauls with occurrence of the species		
		Total (21 hauls)	FOTØ (17 hauls)	EXPO (4 hauls)
Mackerel	3838.810	18	15	3
Herring	1037.385	11	7	4
Sprat	667.626	7	4	3
Haddock	441.612	12	9	3
Whiting	299.812	16	12	4
Grey gurnard	72.750	14	10	4
Dab	32.022	6	2	4
Raitt's Sandeel	31.073	5	4	1
Lumpfish	6.260	4	4	0
Lemon sole	3.240	3	0	3
Plaice	2.900	2	0	2
Sardine	2.013	7	5	2
Long rough dab	1.445	3	0	3
Saithe	0.800	1	0	1
Norway pout	0.743	1	1	0
Cod	0.493	1	1	0
Anchovy	0.480	1	0	1
Thorny skate	0.115	1	0	1
Greater sandeel	0.034	1	0	1
Wolffish	0.002	1	1	0
Lion's mane jellyfish	49.160	5	3	2
Moon jellyfish	2.721	5	5	0
Squid	0.522	4	4	0
Invertebrates	2.032	3	0	3
SUM FISH	6439.615			
SUM ALL	6494.050			

Table 3: Overview of trawl stations including positions as well as weights per species per stations. Note that only species with a total catch of more than 30 kg are included individually, whereas a combined weight is provided for all other species.

Haul nr	Station nr	Trawl type	LatDec	LonDec	Mackerel	Herring	Sprat	Haddock	Whiting	Grey gurnard	Dab	Raitt's Sandeel	Other fish species	Squid	Jellyfish	Invertebrates
1	1	FOTØ	57.7476	9.2522	25.460	70.040		0.055	0.028	3.410			2.268		26.87	
2	8	FOTØ	57.7703	5.0691	248.480	116.260				2.820			2.416			
3	10	FOTØ	57.7901	5.0506	34.740	1.480		1.200								
4	23	FOTØ	57.7963	-0.8994	0.366											
5	33	FOTØ	56.8093	1.7121	29.750			0.068	0.318			13.410	0.002	0.21		
6	34	FOTØ	56.8355	1.7105	10.280			0.157	0.264			15.160		0.23		
7	36	FOTØ	56.8184	1.7351				0.008	0.376			2.280		0.01	0.02	
8	40	EXPO	56.6858	3.1917	8.420	0.238		146.820	91.105	2.120	21.950		4.531			
9	49	EXPO	56.7670	6.2793	1.440	1.380	0.020	28.500	98.310	8.560	4.560		1.970		0.81	1.72
10	61	EXPO	55.7797	3.8426		796.667	194.399	25.000	13.677	3.460	3.520		2.975			0.30
11	65	FOTØ	55.7056	2.7815	1745.000			99.160	68.620	5.040	0.060		1.440			
12	75	FOTØ	55.8637	-0.7248	1.134		0.024					0.003				
13	77	FOTØ	55.8371	-0.7049	1321.440	30.660		112.420	17.730				0.743			
14	91	FOTØ	54.7640	3.7269	65.740	0.040	415.910	0.094	0.002	3.660	0.052				10.50	
15	92	FOTØ	54.7767	3.7369	29.545		47.520		0.014	6.540			0.760		3.12	
16	103	EXPO	55.2523	7.6278	31.881	4.660	9.740		0.375	0.640	1.880	0.220	0.600		7.86	0.01
17	114	FOTØ	56.1464	4.8145	0.415		0.013		0.006	6.720					0.20	
18	115	FOTØ	56.1337	4.8344	38.229				0.003	24.270			0.116			
19	123	FOTØ	57.1894	6.8386		6.690		28.130	8.970	1.600			0.493	0.09	0.21	
20	124	FOTØ	57.1883	6.7926	245.940	9.270				1.190			0.211		0.67	
21	125	FOTØ	57.1934	6.8335	0.550			0.000	0.014	2.720					1.62	
				SUM	3838.810	1037.385	667.626	441.612	299.812	72.750	32.022	31.073	18.525	0.52	51.88	2.03