ICES WORKING GROUP ON SURVEYS ON ICHTHYOPLANKTON IN THE NORTH SEA AND ADJACENT SEAS (WGSINS; outputs from 2020 meeting)

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Contents

i Executive summary

The objectives of the Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS) was to review ichthyoplankton surveys undertaken for assessment purposes, coordinate the surveys in 2021, prepare data for archiving, provide quality assurance on species identification and identify additional objectives that can be achieved within the existing survey designs.

The international herring larvae surveys in the North Sea (IHLS) revealed small numbers of newly hatched larvae around the Orkneys in autumn 2019, while the other areas were more in line with preceding years.

The Midwater Ring Net (MIK) sampling during the first quarter international bottom trawl survey in 2020 (Q1 IBTS) reported higher abundance of foraging herring larvae in the potential nurseries in the southeast of the North Sea, compared to 2019. However, the overall abundance has increased only slightly and the MIK index is still on a low level. Sardine larvae were recorded for the first time in the Kattegat and in the vicinity of the Orkney/Shetland area. The latter may indicate at another intrusion path into the North Sea, apart from the know one through the English Channel.

A new molecular method to identify fish eggs, based on MIK samples, has recently been published. This method is not only less costly than DNA barcoding, it also delivers results much faster. It will be further developed by expanding the spectrogram database to a wider species scope.

The Rügen herring larvae survey (RHLS) considers the major spawning areas of western Baltic spring-spawning herring. There is still no substantial herring recruitment in the area.

The Northern Irish Herring Larvae survey monitored the vast majority of herring larvae in the eastern Irish Sea in the vicinity of the Douglas bank spawning ground and to the north of the Isla of Man. No larvae were detected on the Mourne ground.

A pilot study used samples from the Q3 IBTS to establish a sprat recruitment index of the North Sea. Results from 2018 to 2020 indicate very promising potential, but broader area coverage is necessary. Participants in the Q3 IBTS are encouraged to contribute in 2021.

The Downs recruitment survey (DRS) and the Northern Irish MIK survey (NIMIK) could not be conducted due to Covid-19 measures.

While progressing with the original survey objectives, WGSINS will continue to summarize information on co-occurring fish larvae, and establish time-series as a basis for further analyses of species distribution, abundance and, if possible, trends in recruitment.

ii Expert group information

Expert group name	Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS)
Expert group cycle	Multiannual
Year cycle started	2019
Reporting year in cycle	2/3
Chair	Norbert Rohlf, Germany
Meeting venue(s) and dates	01-04 December 2020, online meeting via WebEx (12 participants)

1 Survey reviews

1.1 The International Herring Larvae Surveys in the North Sea (IHLS)

The IHLS in 2019/2020

Six areas were covered within the framework of the International Herring Larval Surveys in the North Sea during the sampling period 2019/2020. They monitored the abundance and distribution of newly hatched herring larvae in the Orkney/Shetlands area, in the Buchan area and the central North Sea (CNS) in September and in the southern North Sea (SNS) in December 2019 and January 2020 (Figures 1.1 – 1.4).

The survey around the Orkneys revealed relatively small numbers of newly hatched larvae, while in the Buchan area and the central North Sea, quantities were much higher, in the same order of magnitude as in preceding years.

The surveys in the southern North Sea showed a peak in abundance in December. The abundance of newly hatched larvae in the southern North Sea is strikingly high in the first survey of the most recent sampling period, with newly hatched larvae occurring only in the western part of the survey area. However, the overall distribution of larvae and thus the main spawning area used by herring is not obviously different from preceding years. The abundance of young larvae is high when hatching started in December, but their spatial distribution is limited. With progressing spawning season also the spatial distribution gets broader.

No survey was planned for the second half of January 2020. Instead, an additional MIK sampling was planned to be undertaken in March/April 2020 in the German Bight. This sampling should shade light on the foraging and recruitment of herring larvae originating in the Downs stock component. Unfortunately, this survey had to be cancelled due to Covid-19 restrictions.

At time of the WGSINS meeting, the 2020/2021 campaign is still running. The surveys in September were conducted as scheduled, but no results are available yet. Plankton sorting and larvae length measurements are ongoing.

Table 1.1: Herring Larvae Abundance Time-Series (LAI) of larvae <10 mm long (<11 mm for the SNS), by standard sampling area and time periods. The number of larvae are expressed as mean number per ICES rectangle * 10^9

	Orkney/ Shetland		Buchan		Central North Sea			Southern North Sea		
Period/ Year	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Oct.	16-31 Dec.	1-15 Jan.	16-31 Jan.
1972	1133	4583	30		165	88	134	2	46	
1973	2029	822	3	4	492	830	1213			1
1974	758	421	101	284	81		1184		10	
1975	371	50	312			90	77	1	2	
1976	545	81		1	64	108			3	
1977	1133	221	124	32	520	262	89	1		
1978	3047	50		162	1406	81	269	33	3	
1979	2882	2362	197	10	662	131	507		111	89
1980	3534	720	21	1	317	188	9	247	129	40
1981	3667	277	3	12	903	235	119	1456		70
1982	2353	1116	340	257	86	64	1077	710	275	54
1983	2579	812	3647	768	1459	281	63	71	243	58
1984	1795	1912	2327	1853	688	2404	824	523	185	39
1985	5632	3432	2521	1812	130	13039	1794	1851	407	38
1986	3529	1842	3278	341	1611	6112	188	780	123	18
1987	7409	1848	2551	670	799	4927	1992	934	297	146
1988	7538	8832	6812	5248	5533	3808	1960	1679	162	112
1989	11477	5725	5879	692	1442	5010	2364	1514	2120	512
1990		10144	4590	2045	19955	1239	975	2552	1204	
1991	1021	2397		2032	4823	2110	1249	4400	873	
1992	189	4917		822	10	165	163	176	1616	
1993		66		174		685	85	1358	1103	
1994	26	1179				1464	44	537	595	
1995		8688					43	74	230	164
1996		809		184		564		337	675	691
1997		3611		23				9374	918	355
1998		8528		1490	205	66		1522	953	170

1999		4064		185	134	181	804	1260	344
2000		3352	28	83	376		7346	338	106
2001		11918		164	1604		971	5531	909
2002		6669		1038		3291	2008	260	925
2003		3199		2263	12018	3277	12048	3109	1116
2004		7055		3884	5545		7055	2052	4175
2005		3380		1364	5614		498	3999	4822
2006	6311	2312		280	2259		10858	2700	2106
2007		1753		1304	291		4443	2439	3854
2008	4978	6875		533	11201		8426	2317	4008
2009		7543		4629	4219		15295	14712	1689
2010		2362		1493	2317		7493	13230	8073
2011		3831		2839	17766		5461	6160	1215
2012		19552		5856	517		22768	11103	3285
2013		21282		8618	7354		5	9314	2957
2014		6604		5033	1149				1851
2015		9631		3496	3424		2011	1200	645
2016				3872	3288		20710	1442	1545
2017				5833	3965		10553	5880	
2018		102		1740	1509		1140		
2019	2488		5654	3794	10605		14082	5258	

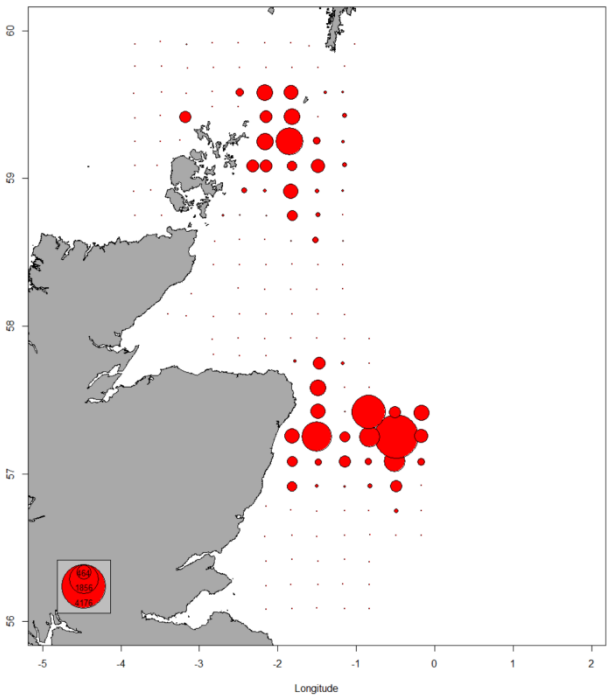

Figure 1.1: North Sea herring - Abundance of larvae < 10 mm (n/m²) in the Orkney/Shetlands and Buchan area, first half of September 2019 (maximum circle size = 4176 n/m²).

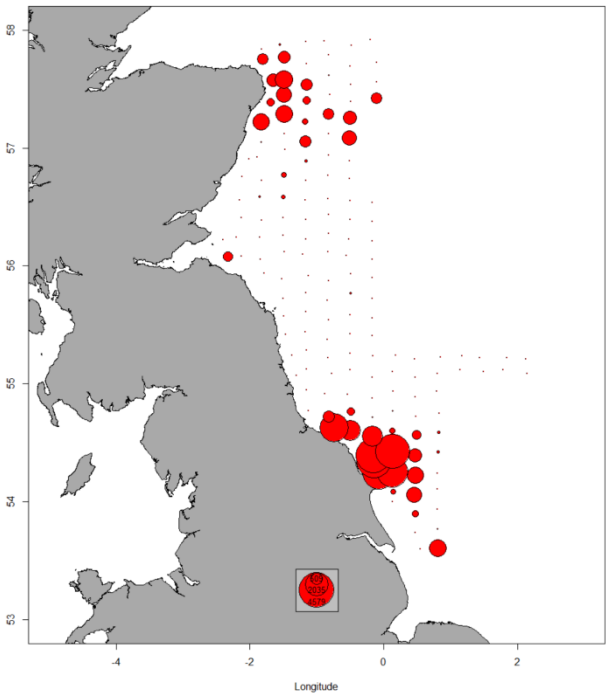

Figure 1.2: North Sea herring - Abundance of larvae < 10 mm (n/m²) in the Buchan and central North Sea area, second half of September 2019 (maximum circle size = 4579 n/m²).

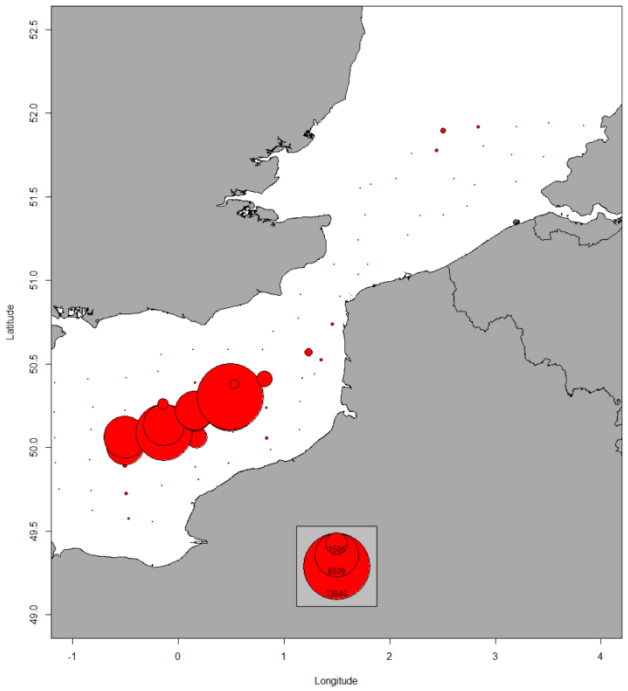

Figure 1.3: North Sea herring - Abundance of larvae < 11 mm (n/m²) in the Southern North Sea and English Channel, second half of December 2019 (maximum circle size = 13 546 n/m²).

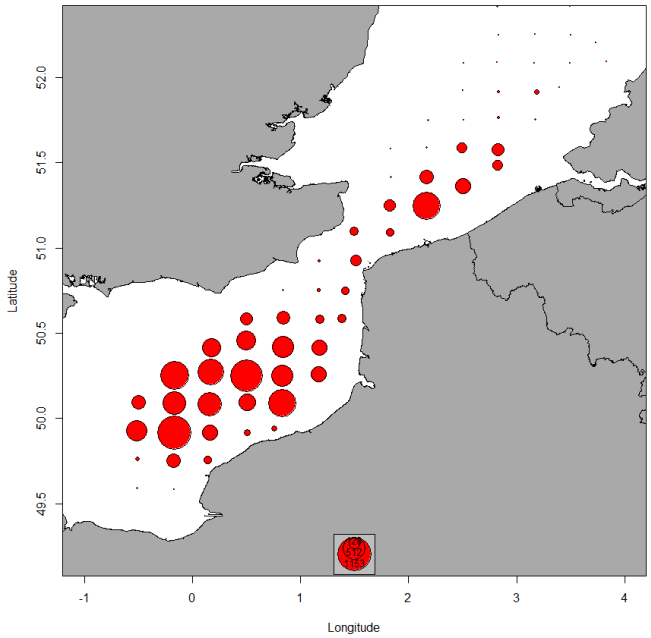

Figure1.4: North Sea herring - Abundance of larvae < 11 mm (n/m²) in the Southern North Sea and English Channel, first half of January 2020 (maximum circle size = 1153 n/m²).

Planning of the 2021 IHLS surveys

The IHLS surveys give information about herring larvae hatching success and larvae abundance on the main spawning grounds of North Sea autumn spawning herring. They also inform about the relative contribution of the different spawning components to the whole stock. In general, on four different spawning areas two (Orkney/Shetlands and Buchan) to three (Banks and Downs) sampling periods are needed monitoring the full spawning activity. This condition hasn't been met since the mid of the 1990s, when several participants left the larvae surveys and continued with acoustic surveys thereafter. Nowadays, only the Netherlands and Germany participate in the IHLS and it is only possible to cover some sets out of the 10.

Instead of the survey in the southern North Sea in the second half of January, an additional MIK-Survey, following foraging Downs herring larvae, was introduced and conducted since 2018. This additional survey shades lights into the recruitment of the Downs stock component and is also scheduled to take place in spring 2021 (see Section 1.2 below).

The plan of the upcoming campaign is given below.

Table 1.1.1: Areas and periods to be covered during the 2021 IHLS surveys

Area / Period	01.-15.09.	16.-30.09.	01.-15.10.
Orkney/Shetlands	None	FRG	
Buchan	None	NL / FRG	
Central	None	NL	None

Area/Period	16.-31.12.	01.-15.01.	16.-31.01.
Southern North Sea	NL	FRG	None

1.2 The Downs Recruitment Survey

The Downs Recruitment Survey in 2020

Due to Covid-19 measures the Netherlands could not carry out the Downs Recruitment Survey (DRS) in April 2020. As it is important to sample the larvae at the same length and development stage as in the MIK-sampling during IBTS-Q1 (see chapter 1.3) it was also not possible to move the survey to a later timing when it was possible to go to sea under Covid-19 measures.

Norway was able to survey in April 2020, but had technical problems and had to leave the DRS sampling. Thus, no DRS sampling was carried out in 2020.

Planning for the 2021 Downs Recruitment survey

Netherlands is planning to carry out a Downs Recruitment survey from 19 - 23 April 2021. It is unclear at this stage if Norway will be able to participate in the 2021 DRS. The Danish fishing industry has applied for funding to also participate in the 2021 survey. But at the time of the meeting it was not known if the budget would be granted.

Netherlands is planning to carry out an experiment prior to the DRS to investigate the effect of day vs. night sampling and the use of a blue net on the catchability of herring larvae.

1.3 The MIK sampling during the International Bottom Trawl Survey (IBTS-Q1)

MIK Results of the 2020 survey

Besides providing the time-series of 1-ringer herring abundance indices in the North Sea from GOV catches carried out during daytime, the International Bottom Trawl Survey (IBTS) also provides abundance estimates for large herring larvae (0-ringers) of autumn spawning stock components. The estimates come from night-time catches with a 2 m midwater ring-net trawl (MIK, ICES 2017). The total abundance of 0-ringers in the survey area is used as a recruitment index for the North Sea herring stock.

This year, 577 depth-integrated hauls were completed with the MIK-net. With 82% of all possible MIK stations fished (Table 1.3.1), the effort was less than in 2019, but the coverage of the survey area was still good with at least 2 hauls in most of the ICES rectangles in the Greater North Sea including Kattegat and Skagerrak (Figure 1.3.1). Some nations had problems with bad weather, particularly in February when sampling had to be reduced considerably. Germany, which again had to charter Danish RV Dana, didn't receive work permit for UK waters and had therefore commit their sampling to waters outside the British EEZ while other countries, i.e. chiefly Denmark and Norway, took over their rectangles there.

Table 1.3.1: Summary table of the MIK stations sampled during the North Sea IBTS Q1 in 2019

Country	Tows planned	Valid	% stations fished
DE	134	129	96
DK	92	65	71
FR	106	101	95
NL	114	90	79
NO	84	61	73
SW	60	41	68
UK-SCO	116	90	78
Sum	706	577	82

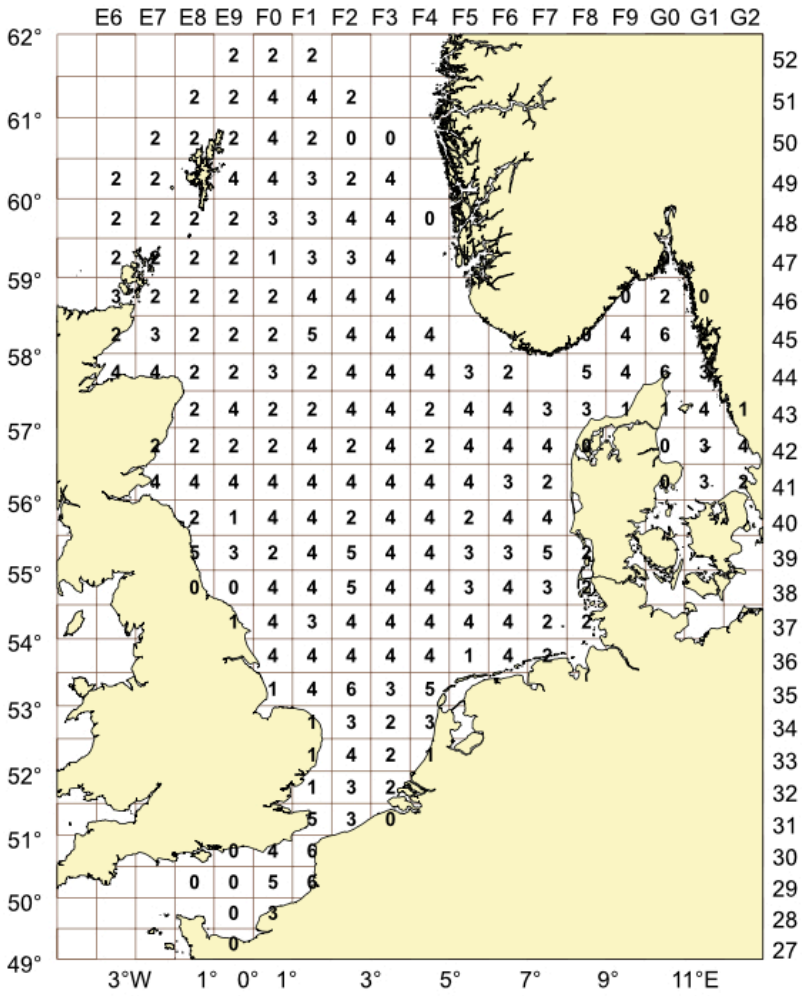

Figure 1.3.1: MIK sampling during IBTW Q1 2020 – numbers of MIK samples per each ICES rectangle.

Herring larvae distribution and abundance

Larvae measured between 5 and 38 mm standard length (SL). Again, and as in most years, the smallest larvae <10 mm were the most numerous. Larger larvae (>18 mm SL) were rarer, but were caught in slightly higher densities than last year. The smallest larvae were chiefly caught in 7.d and in the Southern Bight. The large larvae appeared in moderate to high quantities in both, the western and eastern parts of the North Sea. In the southeastern and eastern part of the North Sea, the potential nurseries, abundance of large herring larvae was much higher than last year.

The newly proposed rule was applied to the MIK herring larvae data time-series from 1992 onwards, where because of data quality issues all French data before 2008 were excluded. The 2020 index is 62.4.

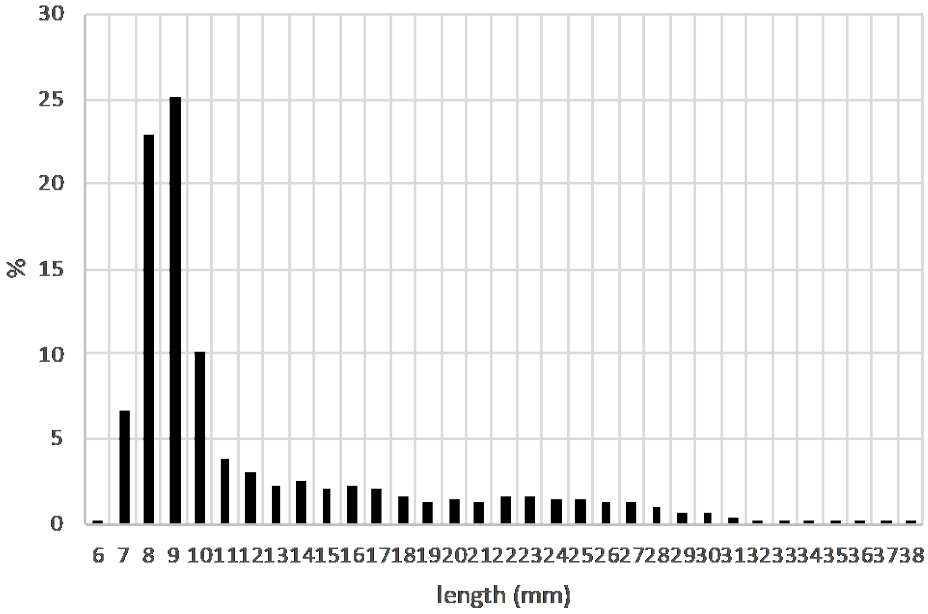

Figure 1.3.3: North Sea herring. Length distribution of all herring larvae caught during the 2019 Q1 IBTS.

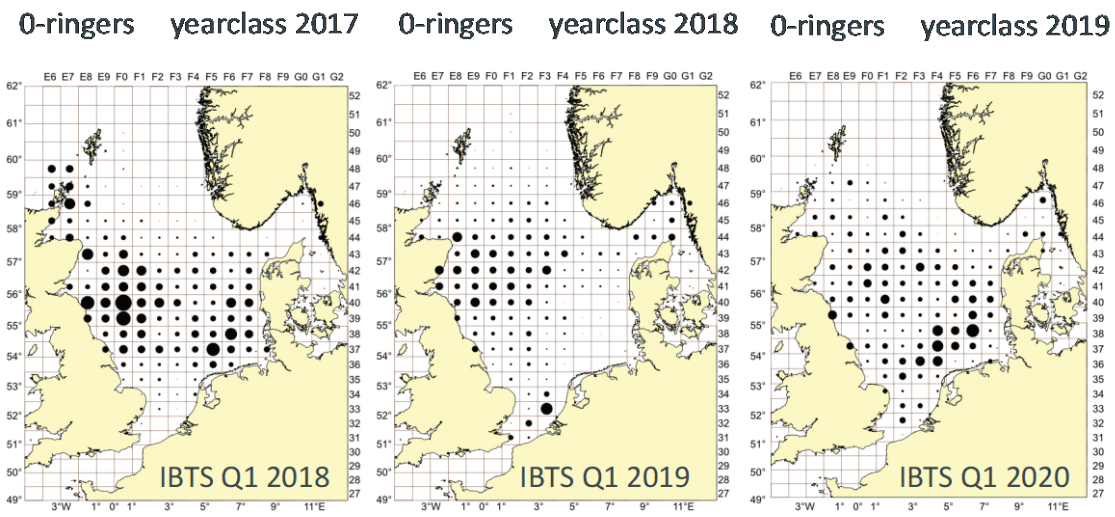

Figure 1.3.4: North Sea herring. Distribution of 0-ringer herring, year classes 2015 – 2017. Density estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in January/February 2016 -2018. Areas of filled circles illustrate densities in no m-2, the area of the largest circle represents a density of 1.83 m-2. All circles are scaled to the same order of magnitude of the square root transformed densities.

Sardine larvae

It appears noteworthy that again a large number of sardine larvae were found in the samples. With an abundance of 7.4 * 10^9, sardine larvae made up 11.9 % compared to the herring larvae abundance estimate in the entire North Sea, Channel and Kattegat/Skagerrak. Most sardine larvae occurred in the southern and southeastern North Sea, and in the Skagerrak. However, for the first time, sardine larvae were recorded in the Kattegat and in the vicinity of the Orkney/Shetland area. The latter may indicate at another intrusion path into the North Sea, apart from the know one through the channel (Figure 1.3.5).

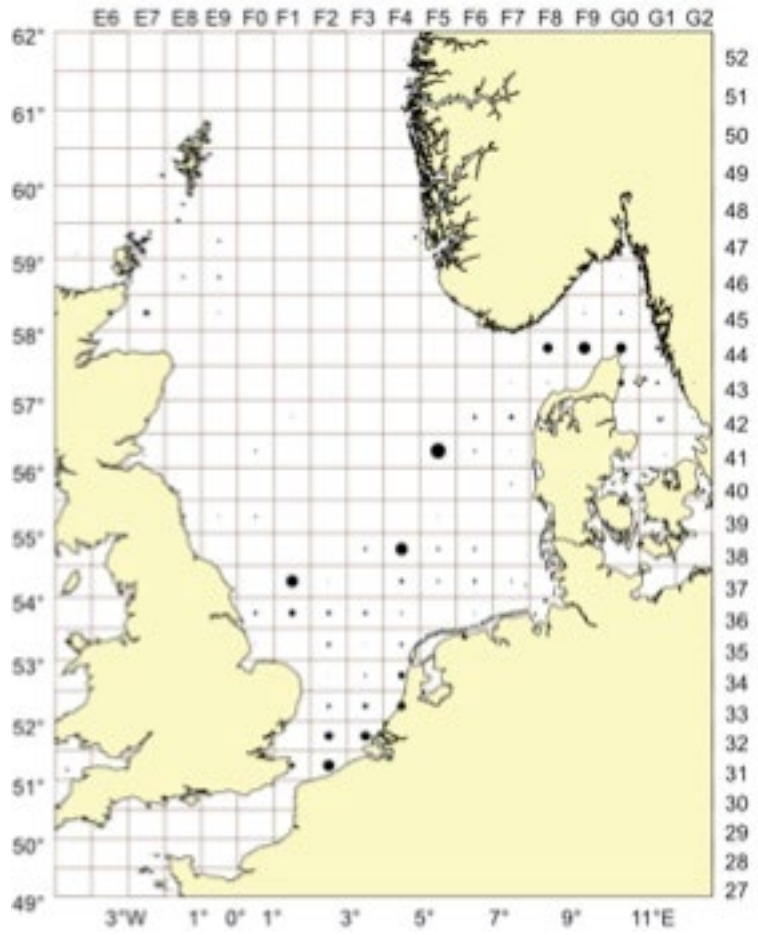

Figure 1.3.5: Distribution of sardine larvae by rectangle from MIK sampling during the Q1 IBTS 2019. Areas of filled circles illustrate densities in no m-2, the area of the largest circle represents a density of 0.30 m-2. All circles are scaled to the same order of magnitude of the square root transformed densities.

Coordination of the 2021 MIK sampling during Q1 IBTS

MIK sampling will be carried out during the night-time of the 2021 Q1 IBTS. The IBTS Q1 survey coordinator will circulate the survey plan by mid December 2020. MIK participants are now requested to submit their data directly to the ICES fish egg and larvae database by 9th March 2021 latest.

The MIKeyM net sampling

Since 2012, eggs are collected along with the MIK sampling using the MIKeyM net (ICES, 2018). In 2020, MIKeyM (MM) samples were obtained by six of the countries participating in the 1st Quarter IBTS. MM samples were taken with every MIK samples when possible. The extent of sample analyses completed thus far varied between institutes ranging from fish eggs identified where possible, staged and measured to the samples still needing to be sorted for fish eggs and larvae.

Planning for the 2021 survey

As in previous years, MIKeyM net sampling is planned to be carried out along-side MIK sampling during the first quarter IBTS in the North Sea. For 2021, all institutes are asked to carry out at least 2 MIKeyM net hauls (1 with every MIK haul) in each ICES statistical rectangle. However, there is no requirement for these samples to be worked up this year. The intention is to retain a

reservoir of samples that can be used if interesting questions arise concerning egg and larvae distributions in the North Sea and Skagerrak in 2021 or there is a need for an uninterrupted time-series of egg or larvae data. These samples should be stored at the respective institutes. Those institutes with sufficient resources will work up their samples and inform the rest of the group as to what they have done. The intention, as in previous years is that every other haul per rectangle should be worked up according to the MIKeyM manual. The remaining plankton can then be discarded. As with the above, all samples that are not sorted for fish eggs and larvae shall be stored at the respective institutes. In addition, the WG will consider a suitable time frame for retaining these samples for future analyses.

Sweden will be requested to undertake MIKeyM sampling so as to provide coverage of the Skagerrak area.

1.4 The Western Baltic Rügen Herring Larvae Survey (RHLS)

The RHLS surveys in 2019

The waters of Greifswald Bay (ICES area 24) are considered a major spawning area of Western Baltic spring-spawning (WBSS) herring. The German Thünen Institute of Baltic Sea Fisheries (TI-OF), Rostock, and its predecessor monitors the density of herring larvae as a vector of recruitment success since 1977 within the framework of the Rügen Herring Larvae Survey (RHLS). It delivers a unique high-resolution dataset on the herring larvae ecology in the Western Baltic, both temporally and spatially. Onboard the research vessel CLUPEA, a sampling grid including 35 stations is sampled weekly using ichthyoplankton gear (Bongo-net, mesh size 335 μm) during the main reproduction period from March to June. The weekly assessment of the entire sampling area is conducted within two days (detailed description of the survey design can be found in Polte 2013). The collected data provide an important baseline for detailed investigations of spawning and recruitment ecology of WBSS herring spawning components. As a fishery-independent indicator of stock development, the recruitment index is incorporated into the assessment of the ICES Herring Assessment Working Group (HAWG).

The rationale for the *N20* recruitment index is based on strong correlations between the amount of larvae reaching a length of 20 mm (TL) in Greifswald Bay and abundance data of juveniles (1-wr and 2-wr fish) as determined by acoustic surveys in the Arkona and Belt Seas (GERAS).

This correlation supports the underlying hypotheses that i) major variability of natural mortality occurs at early life stages before larvae reach a total length of 20 mm and ii) larval herring production in Greifswald Bay is an adequate proxy for annual recruitment strength of the WBSS herring stock.

The *N20* recruitment index is calculated every year based on data obtained from the RHLS. This is done by estimating weekly growth of larvae for seasonal temperature change and taking the sum of larvae reaching 20 mm by every survey week until the end of the investigation period. On the spatial scale, the 35 sampling stations are assigned to 5 strata and mean values of stations for each stratum are extrapolated to the strata area (for details see Oeberst et. al 2009).

Calculation procedures have been reviewed and re-established in 2007 and the recalculated index for the time-series from 1992 onwards is used by HAWG since 2008 as 0-group recruitment index for the assessment of Western Baltic Spring-spawning herring.

N20 index in 2019

The regular Rügen-herring larvae survey started on March 11th and was conducted until June 26th, over a 17-week period.

With an estimated product of **1317** million larvae, the 2019 N20 recruitment index is in similar dimensions as the previous year and more than double as high as the record low of 2016 (Table 1.4.1, Figure 1.4.1). However, the value is only in the range of about 1/5 of the time-series mean thus not countering the decreasing trend of larval production observed in the system during the past two decades.

2019 additional survey observations

Additionally, on two dates in February (start Feb 26nd) and November (start Nov 11th) control surveys were conducted testing for winter and autumn larvae respectively. Using the standard Bongo net and a 1550 µm CalCofi net the presence of advanced larvae stages in the system was investigated (Polte *et al*. 2017). During February limited numbers of post-flexion larvae assigned to herring spawning in November 2018 by otolith microstructure analysis were detected (Janke 2019). In November 2019, no larvae were found in Greifswald Bay in samples taken with both sampling gear. However, scientific gill net sampling for spawning fish during November 2019 resulted in about 10% of herring present in the system at maturity stage ≥ 5

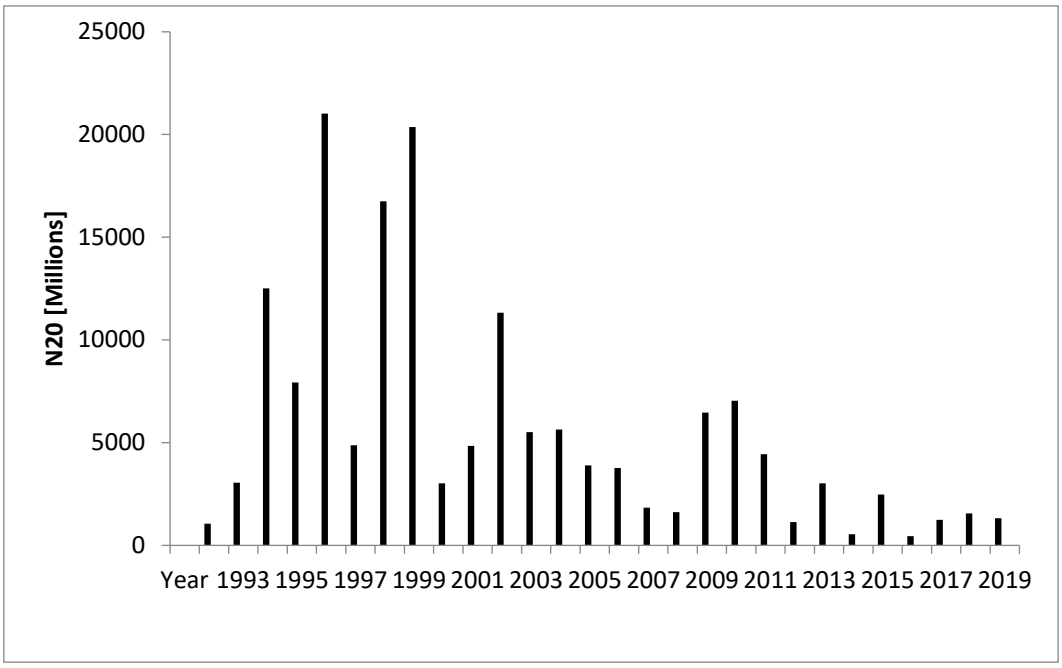

Figure 1.4.1: Validated RHLS time-series with N20 index data presented as cumulative value of weekly mean abundance of 20 mm larvae in millions.

Table 1.4.1: N20 larval herring index for spring-spawning herring of the Western Baltic Sea (WBSS).

Year	N20	Year	N20
1992	1060	2006	3774
1993	3044	2007	1829
1994	12515	2008	1622
1995	7930	2009	6464
1996	21012	2010	7037
1997	4872	2011	4444

1998	16743	2012	1140
1999	20364	2013	3021
2000	3026	2014	539
2001	4845	2015	2478
2002	11324	2016	442
2003	5507	2017	1247
2004	5640	2018	1563
2005	3887	2019	1317

Revision of the relation between N20 and GERAS 1-wr herring after years with low larvae production

After multiple years with the record low N20 (2014,2016), the relation with the 1-group juveniles as monitored by the German hydroacoustic survey (GERAS) was re-evaluated to see if recent years with extremely low larvae production are reflected in the abundance of 1-wr juveniles on the scale of the western Baltic Sea. The results reveal an unchanged and strong correlation between N20 and GERAS 1-wr juveniles. The low N20 years resulted in correspondingly low GERAS indices for the 1-wr juveniles (Figure1.4.2).

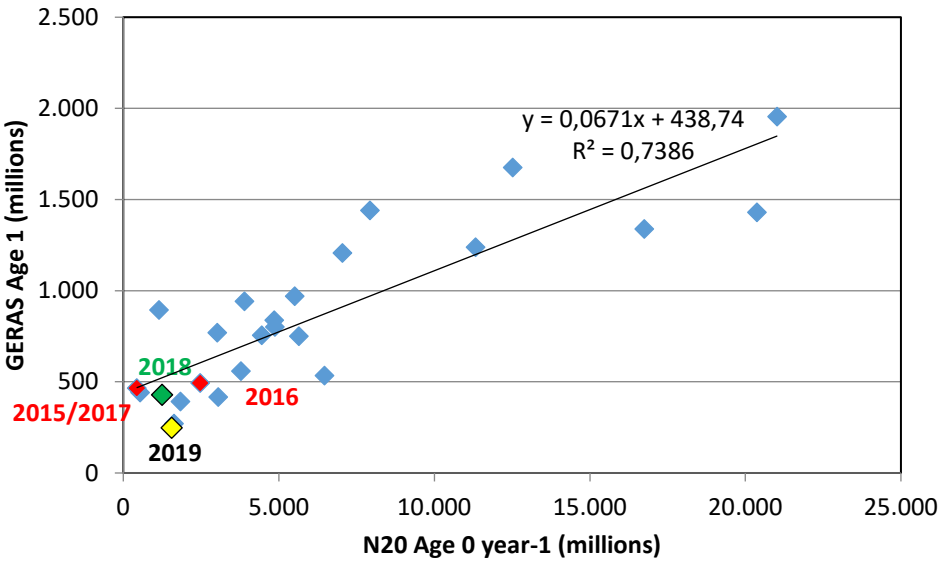

Figure 1.4.2: Correlation of N20 larvae index (1993-2018) with the 1-wr herring from GERAS (1994-2019). Note: The one-year lag phase between indices. E.g. the exceptionally low N20 year 2016 is represented by the GERAS 1-wr index 2017.

1.5 The Northern Irish Herring Larvae Survey (NINEL)

Herring larvae surveys of the northern Irish Sea (ICES area 7aN) have been carried out by the Agri-Food and Biosciences Institute (AFBI), formerly the Department of Agriculture and Rural Development for Northern Ireland (DARD), in November each year since 1993. The surveys are carried on-board the RV "Corystes" since 2005 and prior to that on the smaller RV "Lough

Foyle". Sampling is carried out on a systematic grid of stations covering the spawning grounds and surrounding regions throughout the north Irish Sea (Figure 1.5.1). Larvae are sampled using a Gulf-VII high-speed plankton sampler with 280μm net and on-board Valeport Midas+ CTD. Mean catch-rates (nos.m-2) are calculated over stations and strata to give area specific indices of abundance. Larval production rates and birth-date distributions are computed based on the mean density of larvae by length class. A growth rate of 0.35 mm per day and instantaneous mortality of 0.14 per day are assumed based on estimates made in 1993–1997. The index has been historically used as an indicator of spawning-stock biomass (SSB) in the assessment of Irish Sea herring by the ICES Herring Assessment Working Group (HAWG). The assessment of this stock was benchmarked in 2012 and issues concerning the survey raised. Subsequently the use of the survey in the stock assessment has ceased.

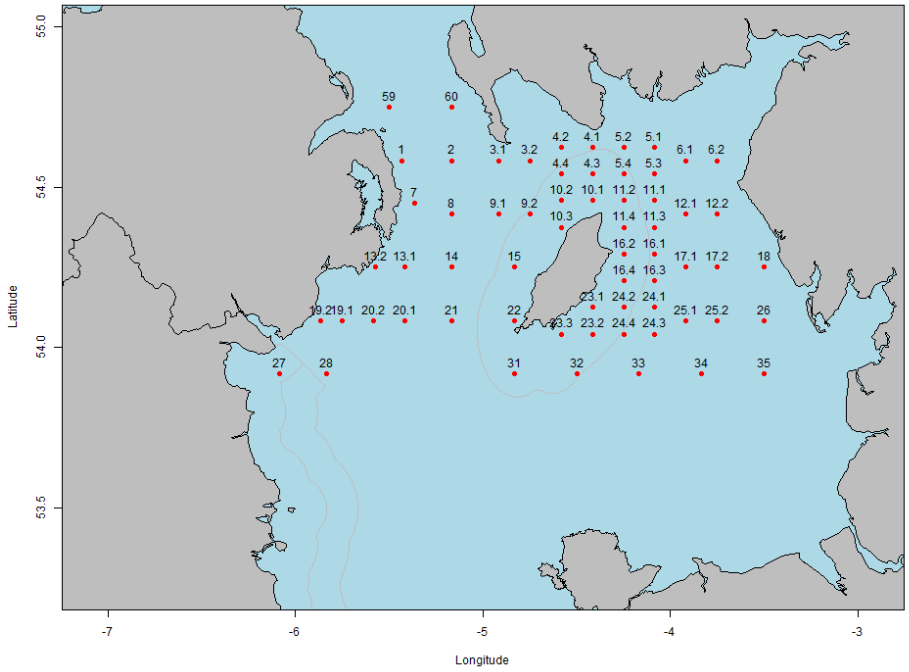

Figure 1.5.1: Station positions for north Irish Sea herring larvae survey (NINEL).

Survey Results in 2019

The NINEL survey was completed during 10-17th November with a total of 61 GulfVII and 16 MIK Net stations sampled. 3220 clupeoid larvae (assumed to be mainly herring larvae) were picked from samples and measured freshly at sea providing information on spawning areas, growth rates and abundance. Depth profiles of salinity and temperature were collected at all stations, and remaining plankton samples preserved.

As in previous years the vast majority of herring larvae were captured in the eastern Irish Sea in the vicinity of the Douglas bank spawning ground and to the north of the Isla of Man (Figure 1.5.2). No larvae were detected on the Mourne ground.

Additional tows were made with a MIK net to check for the presence of larger (older) larvae in the sampling region which may have been avoiding the GulfVII sampler. The length frequency of larvae captured with the MIK net gear overlapped with those from the GulfVII, providing evidence that the GulfVII sampler was capturing all available sizes of the cohort from recent spawning in the area.

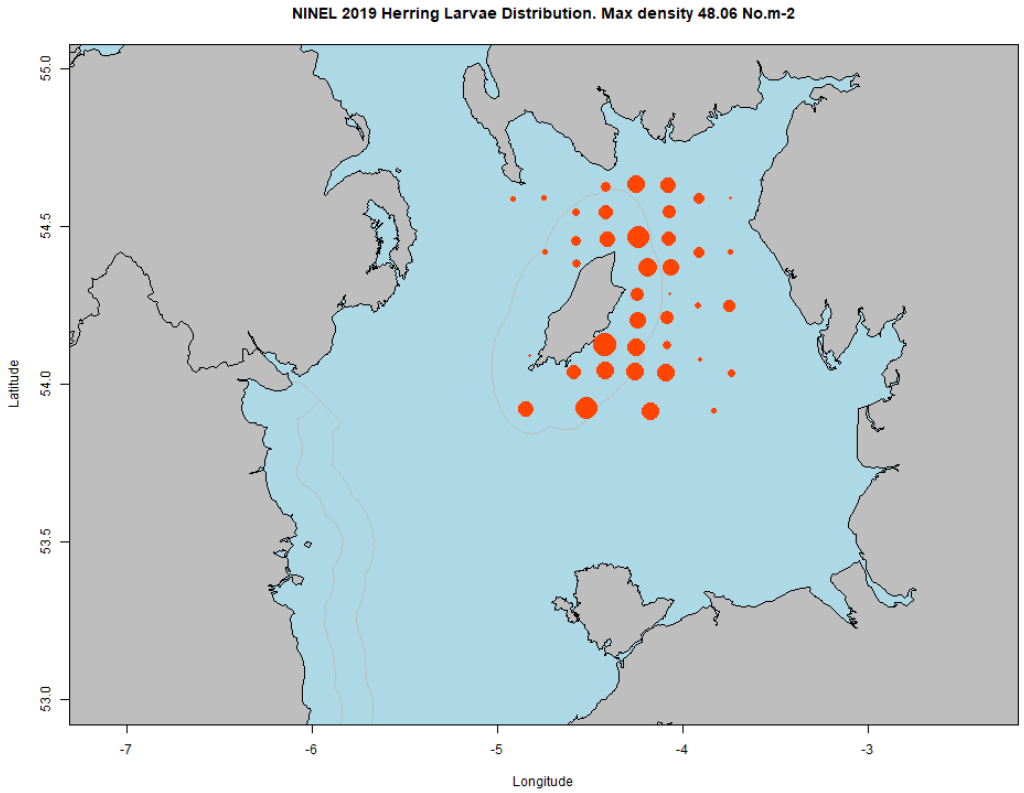

Figure 1.5.2: Distribution of herring larvae captured during 2019 north Irish Sea herring larvae survey (NINEL) using GulfVII. Maximum density 48.06 no.m^{-2}.

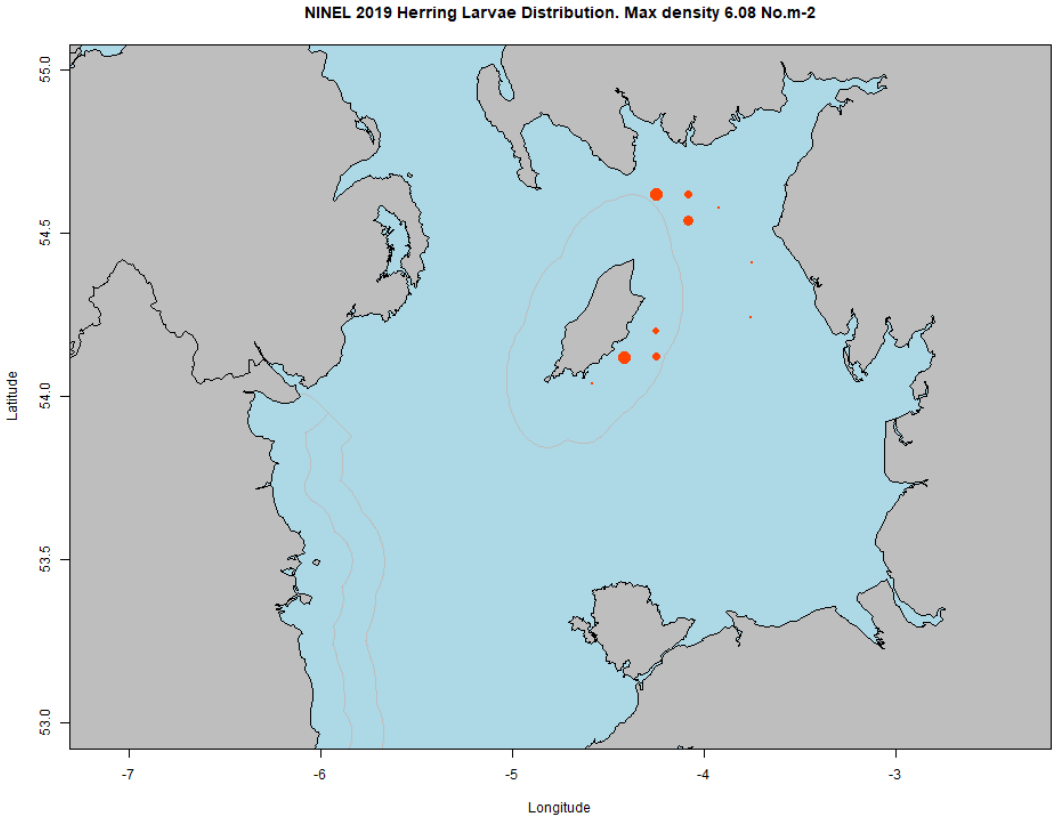

Figure 1.5.3: Distribution of herring larvae captured during 2019 north Irish Sea herring larvae survey (NINEL) using 2m Ring Net. Maximum density 6.08 no.m-2.

Figure 1.5.4: Length frequency of clupeoid larvae removed from GulfVII (blue) and MIK net (red) samples, total per strata.

1.6 The UK (Northern Irish) MIK Survey (NIMIK)

The survey previously used a Methot-Isaacs–Kidd frame trawl to target pelagic juvenile gadoids (whiting, cod, haddock) in the Irish Sea between 1993 -2018. The Methot-Isaacs–Kidd frame was replaced with a midwater ring net in 2019 (ICES, 2013). The survey is a stratified design and takes place in May and June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers per unit sea area (nos.m^{-2}). The MIK net is deployed during the hours of darkness (max. 30 mins $\pm$ hr sunset). During daylight hours a Gulf-VII high speed plankton sampler with on-board Valeport Midas+ CTD is deployed. Density and distribution data on larval fish, zooplankton and water structure properties (SST, salinity, chlorophyll a) are recorded. While the main objective of the survey is to provide recruitment information on gadoids, the survey provides the opportunity and tools to collect valuable information on the wider ecosystem. For example, data collected on the survey has provided the basis for the development of a 20+ year time-series of gelatinous zooplankton abundance in the Irish Sea. Since 2018 a standard WP2 frame with side floats for neuston sampling (333 µm mesh size) has been deployed for the study of marine micro plastics at a number of the Gulf stations.

Unfortunately the NIMIK survey did not take place in 2020 due to covid restrictions.

1.7 A pilot survey on the feasibility of establishing a sprat recruitment index based on larval sampling during Q3 IBTS surveys

Sprat is a short-lived species, and the sprat stock in the North Sea is dominated by young fish. Thus, the size of the stock is driven to a large degree by the recruiting year class, and catches are mainly composed by 1 year old fish (up to ~80%). Sprat is an important forage fish and represents a major food source for many other fish species as well as sea birds and mammals. It is therefore a highly relevant species in multispecies approaches to fisheries management. An analytical assessment of sprat was established some years ago, however the availability and quality of data for the assessment are relatively poor and the assessment of and advice for the North Sea sprat stock needs to be improved. There is currently no information available on young-of-the-year (0-group) sprat for possible use in short term forecasts or for use in the stock assessment model. However, such information could be very useful, in particular because sprat is a short-lived species that matures early.

The aim of the present study is - by conducting a series of pilot surveys - to evaluate the feasibility of establishing a sprat recruitment index based on larval sampling on the Q3 IBTS surveys and to contribute generally to a better understanding of the biology, ecology and distribution of the North Sea sprat stock. Thus, the basic idea is to follow similar procedures as the MIK herring larvae surveys during the Q1 IBTS. These surveys are targeting relatively large larvae (2 to 3 cm) and the abundance of these has shown to relate to later recruitment to the stock, thus providing a recruitment index for autumn spawning herring in the North Sea.

The specific aims of the sprat larvae pilot surveys were to investigate whether:

- sprat larvae can be caught in appropriate numbers with a midwater ring net during night-time on the Q3 IBTS
- main spawning activity of sprat is finished well before the time of the survey
- there are significant differences in catchability during daylight vs. night-time hours
- the MIK sampling can effectively be incorporated into the standard routines during Q3 IBTS
- the sampling can cover the relevant areas of major sprat larvae occurrence
- sampled larvae can be expected representative for the entire year class
- sampled larvae are of sizes for which the following mortality is relatively constant and that abundances thus provide a reliable recruitment index

Three pilot surveys were conducted in July/August 2018, 2019 and 2020, targeting sprat larvae by sampling using a MIK net. The surveys in 2018 and 2019 were conducted by DTU Aqua, Denmark in the framework of the project "BEBRIS - Maintaining a sustainable sprat fishery in the North Sea". The survey in 2020 was conducted by DTU Aqua in the follow-up project "PELA – Pelagic species" and by the Thünen Institute of Sea Fisheries in Bremerhaven, Germany. Sampling was conducted during night-time on the Q3 IBTS. In 2018 and 2019, 66 and 61 valid standard hauls (plus several additional hauls for gear tests etc.) were conducted, respectively. In 2020, a total of 128 hauls was conducted (68 by Denmark and 60 by Germany).

The gear in use during the two pilot surveys in 2018 and 2019 was a MIK net with a ring of 2 meter diameter. During the first hauls in the 2018 survey, a net with a mesh size of 1.6 mm was used. However, as there were many relatively small larvae in the first samples, the mesh size was changed to 1.0 mm during the remainder of the 2018 survey and the same 1.0 mm mesh size was also used during the 2019 survey. In order to be directly comparable with the additional

samples collected by the Thünen Institute, a mesh size of 1.6 mm was used in 2020 (which is also the standard mesh size on the Q1 MIK-IBTS herring larvae surveys). In addition, a small MIKeyM net (20 cm Ø, 500 μm mesh size) was attached to the MIK ring on the Danish surveys. This was done in order to test if there still are eggs and/or very small larvae in the area during the time of the Q3 IBTS surveys, which would indicate that the seasonal spawning activity has not finished yet. The gear was equipped with a depth sensor and was deployed in a double-oblique haul from the surface to 5 meter above the sea-floor (measured from the lower end of the MIK ring). Fishing speed was 3 knots through the water, and the wire was paid out at a speed of 25 metres per minute (= 0.4 ms^{-1}) and retrieved at 15 metres per minute (= 0.25 ms^{-1}). Both the MIK and the MIKeyM were equipped with flowmeters to record the volume of filtered water.

With few exceptions, clupeid larvae were found on all sampling stations in the three years investigated, and abundances were generally relatively high, with many stations yielding several hundreds of larvae. However, in all three years the clupeid larvae not only contained sprat but also sardine larvae in high abundances, with sprat larvae mainly occurring in the northern part of the study area while sardine larvae were most abundant in the south. This shows that careful identification procedures to species level are mandatory.

The samples collected with the MIKeyM nets contained relatively little sample material, and many samples could thus be checked for the presence of eggs directly during the surveys. These analyses did not suggest any catches of sprat eggs, indicating that sprat spawning activity had been finished and larvae had hatched well before the time of the surveys, and that the surveys are thus covering the total larval production.

Tests conducted in 2018 revealed that there is a significant difference in catchability between day and night hauls, with considerably smaller numbers of clupeid larvae caught during daylight hours than during darkness. Thus, larval sampling will have to be restricted to the period of complete darkness, and while the MIK sampling can be incorporated into the standard routines during the Q3 IBTS, this limits the time available for larvae sampling to approximately 7 to 8 hours per night. This means that a regular sprat larvae survey during the Q3 IBTS would require international collaboration to achieve a sufficient spatial coverage of the relevant areas.

The larvae had a broad size range from approx. 6 mm to juvenile fish of 4-5 cm with very similar size frequency distributions for the two species, but the majority of larvae were in a size range between 12 and 20 mm. This means that the sprat larvae caught during the Q3 IBTS are below the target size of the herring larvae of North Sea autumn spawners during the Q1 surveys, but above the size range of the smaller "Downs" herring larvae. Therefore, there may still be relatively high between-year variability in mortality and a link between larval abundances and later recruitment may not yet be established for these size ranges. On the other hand, sprat larvae are generally smaller than herring larvae at any given developmental stage. Thus, the larvae in the observed size range may actually already indicate recruitment, but this requires further analyses and a longer time-series.

In summary, the pilot surveys illustrate that this kind of larvae survey during night-time of the Q3 IBTS has the potential to provide larval abundance estimates and potentially a recruitment index for North Sea sprat. However, additional surveys will be necessary to provide further yearly observations and more data for the modelling of recruitment patterns. DTU Aqua will therefore continue the pilot surveys in 2021. However, a better area coverage than obtainable by the Danish survey with RV DANA alone would be advisable, and other nations participating in the Q3 IBTS are encouraged to contribute to this planned pilot survey in 2021 and potentially also in the years beyond. During WGSINS 2020, both Germany and Sweden agreed to investigate if they are able to contribute in 2021.

It is noteworthy that in addition to sprat and sardine, a number of larvae of other fish species were caught in the MIK. The more abundant species were mackerel, horse mackerel, sandeel, gurnards and lemon sole, scaldfish and several other flatfish, as well as some other, non-

commercial species, e.g. gobies, crystal goby, rocklings, pipefish, dragonets and greater weever. In addition, a limited number of larger gadoid larvae and/or pelagic juveniles were caught. Concerning mackerel larvae, there was a tendency of higher catches in the northern part of the sampling area, whereas horse mackerel dominated in the southern part. The larvae of other species from the 2018 and 2019 surveys were analysed in the framework of a master thesis at DTU Aqua.

1.8 Investigations on recently hatched sandeel larvae in MIKeyM samples collected during the Q1 MIK-IBTS surveys

Several sandeel species are found in the North Sea, with Raitt's sandeel (*Ammodytes marinus*) being by far the most common. Being a major prey for predatory fish, seabirds and mammals, this species is one of the most important forage fish in the North Sea and is also supporting one of the largest single species fisheries in that area. Due to its high ecological and economical importance, a relatively large body of research exists about the species, covering various aspects. However, there is only limited knowledge of the spawning ecology, which may be due to the unique life cycle. From late summer to autumn, the adults and newly recruited juveniles are burying into the sediment where they are overwintering for several months, utilizing specific areas with suitable sediment. Spawning is also taking place in these areas during winter, when the adults are briefly leaving the sediment to deposit demersal eggs on or even in the sediment. Thus, the eggs are more or less impossible to sample, and knowledge of the occurrence and intensity of spawning activity in the different sandeel areas is largely lacking.

The project PELA, which is currently conducted by DTU Aqua, is aiming to close this knowledge gap by mapping the spatial distribution and abundance of recently hatched larvae as an indicator for spawning activity. The analyses are making use of samples collected with a so called "MIKeyM net", a small ring net with a diameter of 20 cm and a mesh size of 335 µm, which is attached to the larger MIK ring on the annual herring larvae surveys which are conducted at night-time during the Q1 IBTS. The use of this additional MIKeyM net was introduced some years ago by ICES WGEGGS2, with the aim to obtain information on the occurrence and distribution of cod and plaice eggs. However, it was noticed that the samples also contain very small sandeel larvae, which gave rise to the present study. Larvae of sandeel and other fish species are sorted from the samples and counted, and sandeel larvae are scanned and length measurements conducted with an image analysis system. The analyses were planned to start in spring 2020, but had to be postponed to September 2020 due to the Covid-19 pandemic. Therefore, only results of Danish samples from 2015 and 2016 and some preliminary results from 2017 could be presented during WGSINS 2020.

These first results show that the majority of sandeel larvae in the samples are only about 5 to 6 mm. As the hatch size of *A. marinus* is approx. 5.5 mm, the sampled larvae can be considered to have hatched very recently, i.e. they have not drifted very far and should indeed provide an indication for spawning areas. This is also supported by maps of the spatial distribution of larvae, which only show considerable larval abundances in the immediate vicinity of the known sandeel burying areas. Furthermore, high larval abundances were found in the Dogger Bank area as well as in the Horns Reef area west of Denmark in both 2015 and 2016, indicating that these are major spawning areas. In contrast, in the central area at "Elbow Spit" no larvae were found in 2015 and only relatively few in 2016, which may indicate that this is an area of minor importance for spawning.

However, these are only preliminary results from the first analyses of Danish samples, which only cover part of the relevant areas. Therefore, it is planned to include additional samples from other nations in order to improve the spatial coverage. Samples from Germany, Norway and the Netherlands were already shipped to DTU Aqua for analysis. Besides, France is able to provide additional data on sandeel larvae from their own zooscan and zoocam analyses. The plan is to

analyse a total of approximately 1000 samples from 6 years (2015-2020), prioritizing however years with contrasting recruitment (2015 & 2017 very poor, 2016 exceptionally high, 2019 very good recruitment).

The specific aims of the study are to investigate which of the adult burying areas are actually used for spawning, if the area utilization is consistent between years or if there are interannual differences, and if there are differences in larval abundance between years. Besides, by comparing these larvae results with results from dredge surveys aiming at the buried adults and juveniles, it is planned to investigate if the sandeel are utilizing different areas for overwintering, spawning and foraging, and how they are moving between different areas throughout the year. In addition, it is planned to utilize data on sediment samples from the dredge surveys to analyse if the sandeel prefer different sediment types for overwintering and for spawning. Furthermore, as the burying areas are located in different management areas, another aim is to gather more information if sandeel in a specific management area are also reproducing and recruiting in that area, or if they are migrating there from other management areas. This will be supported by genetic analyses of larvae and adults, and potentially also by hydrodynamic modelling. Finally, it is also planned to investigate if there is any connection between larval abundance and recruitment or stock size.

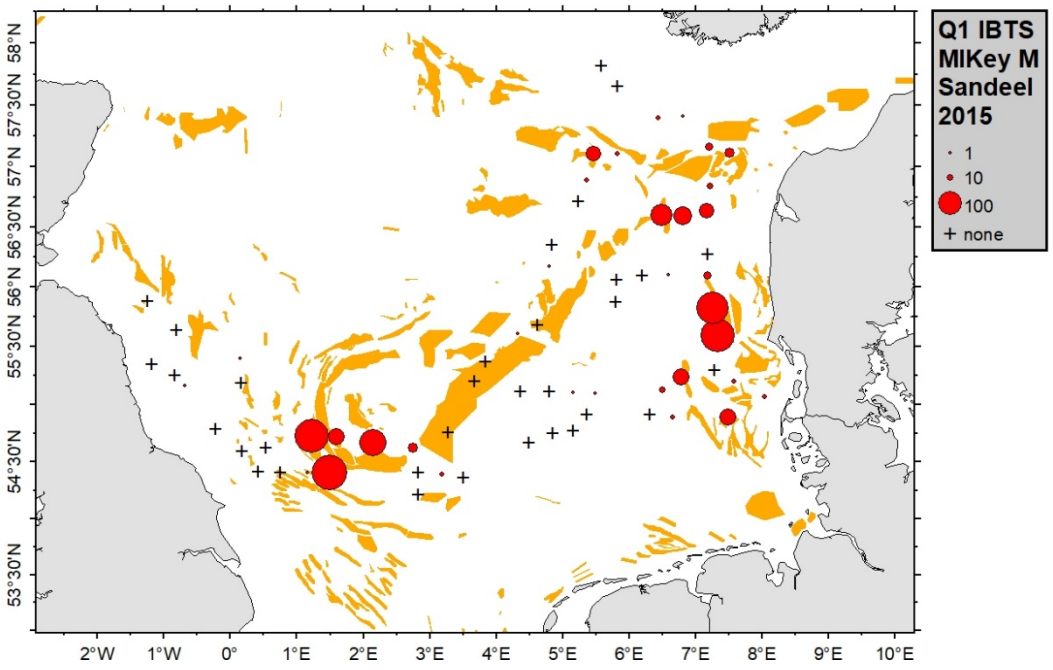

Figure 1.8.1: Numbers of caught sandeel larvae in Danish MIKeyM samples in 2015 (red bubbles; preliminary results) and known sandeel habitats for burying behaviour of adults (orange).

1.9 Marine Litter sampling during the Q1 MIK-IBTS and other MIK surveys

DTU AQUA - Denmark has been collecting data of marine litter from standard MIK samples during the Q1 IBTS from 2014-2016, and first results were presented at the 2016 WGEGGS2 in Hamburg, Germany. Given the information on spatial distribution and composition of different litter types that may be obtained from these litter samples, the group agreed that this additional sampling was worthwhile, and from 2017 it was possible to convince all nations participating in the Q1 IBTS to contribute to this effort. For this purpose and in order to standardize methodology, a manual and a MIK litter protocol sheet were developed and distributed to the MIK survey

participants. As all nations are participating, the spatial coverage is basically identical with the MIK coverage. Marine litter was sorted from the MIK samples, classified in different categories and the litter items were collected in plastic bags by station and taken ashore for more detailed analyses. Preliminary results of the 2017 MIK litter sampling were presented at the 2017 WGEGGS2 in Boulogne-sur-Mer and the 2018 WGEGGS2 in Ijmuiden. Further in-depth sample and data analyses were initially hampered by a lack of funding. However, in summer 2018 DTU Aqua was able to obtain funding for detailed analyses by the Danish VELUX Foundation in the project MARLINS (Marine Litter in the water column of the North Sea). This project and updated preliminary results were presented at WGSINS 2019.

The MARLINS project was supposed to be running from fall 2018 to fall 2020, aiming to analyse all available MIK litter samples from 2014-2020, i.e. both from the Q1 MIK-IBTS herring larvae surveys, the recently implemented Dutch MIK Downs recruitment surveys and the Danish MIK pilot surveys for sprat larvae during the Q3 IBTS. Until early spring 2020, the project was well on track, and it was planned to present more or less final project results at WGSINS 2020. However, due to the Covid-19 pandemic, the analyses were unfortunately considerably delayed. This was due to a lock-down in Denmark and the closing of labs at DTU during spring/summer 2020, difficulties to ship the 2020 samples from several other survey participants to DTU Aqua, and various other issues. Therefore, no updated results could be presented at WGSINS 2020, and only a short update on this Covid-19 related delay was given.

Fortunately, the VELUX Foundation has great understanding for the unprecedented challenges caused by the Covid-19 pandemic, and agreed to extend the MARLINS project period until fall 2021. Thus, it can be expected that final project results can be presented at WGSINS 2021.

So far, there is no additional funding available to continue the detailed MIK litter analyses from 2021 onwards. However, in contrast to many other studies on marine litter which are usually based on beach surveys, bottom trawling or sampling in surface waters, the MIK net is sampling the entire water column, filtering large volumes of water. Besides, the MIK survey covers a large area and the amount of litter can be quantified as flowmeter data are available anyhow, whereas many other marine litter studies are spatially restricted and qualitative or semi-quantitative. Furthermore, the sampling of marine litter from MIK samples does not require any additional vessel time. Thus, the MIK survey can provide unique and valuable data on the occurrence, distribution and abundance of free-floating marine litter in the entire North Sea area, as well as indications of potential sources and transport pathways. Therefore, WGSINS agreed that it is worthwhile to continue the MIK litter sampling in the future, and to investigate options for the future funding of the MIK litter analyses.

2 Data handling

2.1 ICES eggs and larvae database

For most of the surveys routinely dealt with in WGSINS, the ICES egg and larvae database (E+L, http://ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx) is the tool to store information about larvae abundance per station and relevant haul information. Upload of annual survey results is the responsibility of the national data submitter.

Besides archiving the data, it would be beneficial including code and procedures for the index calculation also in E+L framework on Github. This process is nearly finished for the MIK index. For the IHLS, the code producing the abundance index has to be transferred from SAS into R scripts first. Results must then be compared to the historic time-series. Of course this need some time, and will not be ready until the next HAWG meeting in March, but it is to be hoped become available until next WGSINS meeting in December 2021.
Procedures used in the Rügen and the northern Irish survey index calculation rely on data which are so far not part of the E+L database (e.g. growth rate per day, mortality rates). These surveys will continue archiving their results in the E+L, but actually not for their calculations. This may change in the long run.

Data quality checks are done by each contributor prior to data upload. However, participants identified several items as a kind of "wish list" where code should be implemented prior to the inclusion of data into E+L. These scripts should check the spatial and temporal data integrity (e.g. points on land, consistency in date and time) and logic in the datasets (e.g. water and sampler depth, volume filtered in relation to haul duration, station position in relation the ICES rectangle, night-time sampling in IBTS Q1, subsample size in relation to total sample size). There is also a need to check on larvae length and measurement unit. According to the survey protocol, larvae length in the IHLS should be limited to 24 mm (which serves as plus group), while in the MIK, this threshold should be at 45 mm fish length.

These requests will be put forward to the datacenter via Github (https://github.com/ices-tools-dev/EggsAndLarvae). Further progress will then be documented there.

Participants in the surveys are encouraged to update the fact sheets and meta information on the eggs and larvae website whenever needed.

2.2 Additional Data products

Apart from the data needed for the original surveys objectives (e.g. calculating indices for assessment purposes), Ichthyoplankton surveys can provide additional information on e.g. the spatial and temporal distribution of other fish eggs and larvae, co-occurring in the catches. For some of these species, this will be the only source of information about their plankton life, because they are not of high commercial value and thus not part of any dedicated survey program.

Additional sampling and sorting of fish larvae (other than herring), was discussed and coordinated between participants in the MIK surveys. Analyses of fish larvae of the 1Q IBTS/MIK sampling is requested for at least lemon sole, sardine and sandeel, while details on sprat, sardine, mackerel, horse mackerel, lemon sole and red mullet larvae are wanted from the 3Q sampling. The collection of material for species identification will be continued.

Additional data products are also available with regards to the marine litter monitoring in some of the MIK surveys and on the distribution of jellyfish in the northern Irish Sea.

2.3 Species identification

A dedicated workshop on the identification of clupeid fish larvae was planned to take place in Bremerhaven in September 2020 (WKIDCLUP2, 31.08.- 04.09.20). Due to Covid-19 pandemic related international travel restrictions, the workshop had to be postponed to 2021. New dates will be 30.08.-03.09.2021 in Bremerhaven.
However, and as an add-on, in order to provide potential participants with urgently needed advice for clupeid larvae identification, a video conference was scheduled instead for 1 – 2 September 2020, with shortened terms of reference list. This was also done in order to test this format for future workshops on ichthyoplankton identification. The meeting was chaired by Matthias Kloppmann, Germany. In total 27 persons representing 13 institutes from 11 countries participated in the video workshop.

The majority of the time at the workshop was spent identifying fish larvae. For this, prior to the workshop, the WebApp SmartDots (http://ices.dk/data/tools/Pages/smartdots.aspx) was adapted to be utilized for ichthyoplankton identification based on images. The results from the identification trials were analysed in the traditional way using modified Excel tables built by Guus Eltink. Overall agreement in identifying clupeid and discriminating them from other, non-clupeid larvae, among all participants was 81.7 %. Agreement for herring larvae was 86 %, for sprat 80 %, for sardine 86 % and for anchovy 71 %. Subsequent analysis of the myotome counts, which was also facilitated through the SmartDots WebApp, showed that particularly in those specimens that showed low agreement in correct identification, variation of counts was high.

Overall, the WebApi SmartDots proved to be very useful for holding such events like WKIDCLUP2. Once all images of larvae were available, it was rather easy to upload them to the SmartDots server. During the workshop, and also through feedback of the participants, it was apparent that no one had serious technical problems or problems with annotating the images. Support through ICES and the SmartDots support team was excellent.

Ichthyoplankton identification by molecular methods

A new molecular method, utilizing Matrix Assisted LaserDesorption/Ionization Time-Of-Flight Mass Spectrometry (MALDI-TOF MS) of the egg's proteome, was developed, tested and a MALDI-TOF MS reference library was set up (see also the last WGEGGS2 report, ICES 2019). This library was then used to successfully identify fish eggs sampled during the 2018 Q1 IBTS. The method and first results have recently been published (Rossel *et al*. 2021). This method is not only less costly than DNA barcoding, it also delivers results much faster. The method will be further developed by expanding the currently existing spectogram database to a wider species scope so that the method could be utilized by egg surveys targetting other fish species. Also, a protocol for a standard operational procedure for preparing fish eggs at surveys for proteomics will be prepared.

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Annex 1: List of participants

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Annex 2: Resolutions

2018/MA2/EOSG09 The **Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS),** chaired by Norbert Rohlf, Germany, and will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2019	22 – 25 October	Bremerhaven, Germany	Interim report by 15 December 2019	
Year 2020	01 – 04 December	By Correspondence/ Online meeting	Interim report by 15 January 2021	
Year 2021	30 November – 02 December	Belfast, Northern Ireland	Final report by 13 January 2022	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Planning and execution of North Sea and adjacent seas ichthyplankton surveys used for assessment and management purposes	Ichthyoplankton surveys in the North Sea and adjacent Seas deliver abundance data of early life history stages for fish SSB and/or recruitment for assessment of several fish stocks.	3.1, 3.2, 5.2	year 1, 2, 3	Survey Plan
b	Provide quality assurance of the survey indices time series to assessment working groups	Consistency in generation of data is a cruicial prerequisite for the use of a time series in the assessment.	3.1, 3.2, 5.2	year 1, 2, 3	
c	Prepare a manual for ichthyoplankton surveys in the North Sea and adjacent seas	A manual that describes the standard procedures of ichthyoplankton surveys and their necessary adaptations to the survey specific objectives needs to be in place and reviewed regularly.	3.1, 3.2	year 3	SISP manual on standards in ichthyoplankton surveys
d	Provide quality assurance of ichthyoplankton identification, including molecular methods	The accurate identification of ichthyoplankton and the developmental stages is crucial for species specific abundance estimates.	3.1, 3.2	year 1, 2, 3	

e	Standardization of sampling and sample processing procedures	Standards of sampling and sample processing procedures need to be optimized w.r.t. efficiency	3.1	year 1, 2, 3	
f	Prepare data for archiving in the ICES eggs and larvae database	WGSINS data need to be prepared and uploaded to the ICES eggs and larvae database by each institute	3.2	year 1, 2, 3	Updated dataset om the ICES egg and larval databse
g	Assess possibilities for the different ichthyoplankton surveys to supply data for the implementation of ecosystem approach to fisheries management	Ichthyoplankton surveys are able to provide additional data than needed for the original survey objectives. The acquisition of additional data has to be assessed w.r.t. feasibility of new survey objectives.	3.1, 3.3	year 1, year 2, year 3	Review any additional objectives that are proposed for the different ichthyoplankton surveys in the North Sea and adjacent seas.

Summary of the Work Plan

Year 1	Plan and execute the International Herring Larvae Survey (IHLS), the Rügen Herring Larvae Survey (RHLS), the Baltic Ichthyoplankton Survey (BIS), MIK Surveys in the North Sea (MIK), the Northern Ireland Method Isaacs–Kidd Survey (NIMIK), and the Irish Sea Herring Larvae Survey (ISHLS)
Year 2	Plan and execute the IHLS, the RHLS, the BIS, the MIK, the NIMIK, ISHLS
Year 3	Plan and execute the IHLS, the RHLS, the BIS, the MIK, the NIMIK, ISHLS

Supporting information

Priority	This working group is important for the fisheries advisory process. The different ichthyoplankton surveys in the North Sea and adjacent seas provide important fishery-independent stock and/or recruitment data used in the assessment for herring stocks in the North and Baltic Seas as well as for cod in the Baltic and the Irish Sea, as well as for haddock in the Irish Sea and informs management of whiting in the Irish Sea.
Resource requirements	None.
Participants	The Group is normally attended by some 8 – 15 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	HAWG, WGCSE, WGBFAS
Linkages to other committees or groups	EOSG, WGBIOP, IBTSWG, WGALES, WGML, WGZE
Linkages to other organizations	None

Annex 3: Survey Summary Sheets

Germany – Rügen herring larvae survey (RHLS)

Nation:	Germany	Vessel:	CLUPEA
Survey:	334	Dates:	26.02.-28.06.2019

Cruise	Target herring population is the Western Baltic spring-spawning herring. The main aim is to monitor the spawning activity and larval production in a major spawning area, the Greifswald Bay as an indicator of reproductive success in the coastal Baltic Sea. Target data are a high-resolution spatial and temporal records of the larval abundance (35 stations/week) during the entire spawning period as well as hydrographic data (temperature, salinity and oxygen). Weekly mean abundance of larva is summarized in an annual index value (N20) expressing the sum of larvae reaching a critical length of 20 mm by the end of the reproduction season. The collected data are stored nationally and in the ICES Fish Eggs and Larvae dataset.
Gear details:	Bongo net (0.6m diameter) of 335 µm mesh, HYDROBIOS-electronic flowmeters
Notes from survey (e.g. problems, additional work etc.):	The Rügen Herring Larvae Survey (RHLS) in the western Baltic (ICES area IIId/24) took place during 17 weeks from February-June. The second week from Mar 4th on had to be cancelled due to storm. In total 540 stations were achieved of the 595 planned stations, 50 (3 days at sea) had to be cancelled due to bad weather conditions. Additionally, one sampling week in November (36 stations) were added to the survey to control for densities of autumn larvae. Hence, a total of 576 sampled stations were achieved including autumn sampling. On each station a vertical CTD-profile was taken (T, Sal, DO2, turbidity, Chl a-fluorescence). Vertical Zooplankton samples (55µm, 200µm) were taken weekly on a grid of 5 stations throughout the Bay.
Number of fish species recorded and notes on any rare species or unusual catches:	Samples are processed for herring larvae exclusively. Remaining samples are stored for potential future processing of other species. Zooplankton samples (55 µm, 200 µm mesh) are taken on 5 stations/week.

Stations fished

ICES Divisions	Strat.	Gear	Towsplanned	Valid	Add.	Inv.	% stations fished	comments
24	N/A	Bongo	595	576(total) 540 (for N20)	36	50	97 % 91 %	

Strat: strata; Add: Additional tows; inv: Invalid

UK(NI) NIMIK – Irish Sea MIK Net survey

Nation:	UK(NI)	Vessel:	RV Corystes
Survey:	NIMIK	Dates:	NA

Cruise	MIK net surveys of the Irish Sea (ICES area VIIaN) have been carried out by the Agri-Food and Biosciences Institute (AFBI), formerly the Department of Agriculture and Rural Development for Northern Ireland (DARD), in spring/early summer each year since 1993. The surveys have been carried out onboard the RV "Corystes" since 2005, and prior to that on the smaller RV "Lough Foyle". Sampling is carried out on a systematic grid of stations covering the main nursery ground of juvenile gadoids (cod (*Gadus morhua)*, whiting (*Merlangius merlangus*) and haddock (*Melanogrammus aeglefinus*) in the western Irish Sea. From 2006 additional sampling in the eastern Irish Sea has also taken place. While the MIK net is deployed during the hours of darkness (30±mins) a GULFVII high speed plankton sampler is deployed during the day to sample zooplankton and ichthyoplankton. Catches of cod, haddock and whiting from the MIK net survey are reported to WGCSE. Since 2018 Neuston sampling for marine litter (micro/macro) have been included in the survey.
Gear details:	GulfVII high-speed plankton sampler fitted with 280µm/425µm mesh net dependent on clogging. A Valeport MIDAS+CTD system is fitted providing flow rates of internal and external Valeport model 002 current meters with 50mm diameter impellers, depth, temperature and salinity profiles. A Seabird SBE19plus CTD is also carried recording depth, temperature, salinity and fluorescence. Between 1993-2018 a $5m^2$ square frame mid water trawl with modified Isaacs–Kidd depressor was deployed. In 2019 a 2 metre diameter midwater ring net replaced this gear. Scanmar sensors are fitted to the MIK frame to provide depth and monitor deployment. A General Oceanics mechanical standard flowmeter records internal flow rates. From 2018 a WP2 net with side floats for neuston sampling fitted with 333µm mesh and internal flowmeter (General Oceanics mechanical standard) has been deployed at GULFVII stations.
Notes from survey (e.g. problems, additional work etc.):	The 2020 survey did not take place due to covid restrictions and their impact on staff working procedures and vessel operations.
Number of fish species recorded and notes on any rare species or unusual catches:	NA

North Sea Quarter 1 IBTS-MIK (IBTS1Q)

Nation:	Vessel:	Dates
Germany	Dana	10 January – 7 February 2020
France	Thalassa II	10 – 31 January 2020
Netherlands	Tridens 2	20 January – 20 February 2020
Sweden	Svea	24 January – 5 February 2020
Scotland	Scotia	24 January – 11 February 2020
Norway	GO Sars	7 February – 3 March 2020
Denmark	Dana	10 – 28 February

Cruise	North Sea MIK survey aims to conduct plankton net tows with a 2 m ring trawl to determine the abundance of late North Sea herring larvae. Work is carried out at night-time during the Q1 IBTS
Gear details:	Night-time plankton catches are carried out with the standard midwater ring net (MIK).
Notes from survey (e.g. problems, additional work etc.):	The German vessel Walther Herwig was again unavailable this year due to necessary repairs. As a replacement they have chartered the Danish vessel Dana, which was, however, only available in January and beginning of February. Also, Germany didn't receive the permit to work in British waters and had, therefor, to abandon their commitment there, working other rectangles in German, Norwegian and Danish waters instead. Most of their hauls in British waters were covered by other countries. Due to the change in ship the Germans had to start their survey already in the second week of January, which is 2 weeks earlier than when the area would normally be covered. Sweden wasn't able to work there area 4 rectangles because of problems with their vessel. February sampling was hampered by severe weather. Coverage of the sampling area was, however, with 577 MIK hauls sufficient
Number of fish species recorded and notes on any rare species or unusual catches:	Again, above-average catches of sardine larvae were found specifically in the German Bight area, in the Skagerrak and northeast of Scotland.

Stations fished (aims: to complete 706 MIK tows per year)

ICES Divisions	Strat.	Gear	Tows planned	Valid	Add.	Inv.	% stations fished	comments
3a	N/A	MIK	52	54	0	0	104 %	
4	N/A	MIK	634	498	0	0	79 %	
7d	N/A	MIK	20	25	0	0	125 %	
total	N/A	MIK	706	577	0	0	82 %	

UK(NI) NINEL – Irish Sea Herring larvae survey

Nation:	UK(NI)	Vessel:	RV Corystes
Survey:	NINEL	Dates:	10- 17 November 2019

Cruise	Herring larvae surveys of the northern Irish Sea (ICES area VIIaN) have been carried out by the Agri-Food and Biosciences Institute (AFBI), formerly the Department of Agriculture and Rural Development for Northern Ireland (DARD), in November each year since 1993. The surveys have been carried out onboard the RV "Corystes" since 2005, and prior to that on the smaller RV "Lough Foyle". Sampling is carried out on a systematic grid of stations covering the spawning grounds and surrounding regions in the NE and NW Irish Sea (Figure 3.1.3.1). Mean catch-rates (nos.m-2) are calculated over stations to give separate indices of abundance for the NE and NW Irish Sea. Larval production rates (standardized to a larva of 6 mm), and birth-date distributions, are computed based on the mean density of larvae by length class. A growth rate of 0.35 mm day-1 and instantaneous mortality of 0.14 day-1 are assumed based on estimates made in 1993–1997.
Gear details:	Sampling is conducted using a Gulf-VII high-speed plankton sampler fitted with 280µm mesh net. A Valeport MIDAS+CTD system is fitted providing flow rates of internal and external Valeport model 002 current meters with 50mm diameter impellers, depth, temperature and salinity profiles. A Seabird SBE19plus CTD is also carried recording depth, temperature, salinity and fluorescence. A 2m ring net (MIK net) was also deployed at 16 stations.
Notes from survey (e.g. problems, additional work etc.):	The survey was completed successfully with a total of 61 GulfVII and 16 MIK net stations sampled. Depth profiles of salinity and temperature were collected at all stations, and zooplankton samples preserved in 4% formalin.
Number of fish species recorded and notes on any rare species or unusual catches:	3220 clupeoid larvae were measured (TLmm) and preserved in alcohol.