ICES WORKING GROUP ON SURVEYS ON ICHTHYOPLANKTON IN THE NORTH SEA AND ADJACENT SEAS (WGSINS; outputs from 2019 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) were to review Ichthyoplankton surveys undertaken for assessment purposes, coordinate the surveys in 2020, 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) were in autumn 2018 and early 2019 affected by severe technical problems of one of the research vessels. As a consequence, spatial information on larvae abundance around the Orkney/Shetlands and in the English Channel was too limited to be included in the herring assessment 2019. Only abundance data of the Buchan and Banks components were used.

The MIK net (Midwater Ring Net) sampling during the first quarter international bottom trawl survey in 2019 (Q1 IBTS) reported foraging herring larvae in higher quantities in the western part of the North Sea, the Southern Bight and in the Skagerrak. In the eastern part of the North Sea, the potential nurseries, abundance of larger larvae was very low, and virtually no larvae occurred in the German Bight. Simulations on sampling effort reduction showed the MIK index to be relatively stable, even when sampling is reduced by 50%, but such a reduction could be disadvantageous for representative sampling of less abundant species.

As an addition to the conventional MIK sampling, a sampling programme on herring larvae recruiting from the Downs stock component has been carried out during 2018 and 2019. The Downs recruitment survey (DRS) revealed larger quantities of foraging larvae, which are so far not integrated in the recruitment index of North Sea autumn spawning herring.

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

Several studies tried to utilize surveys to gather additional information. The Northern Irish MIK survey (NIMIK) usually provides recruitment information on gadoids, but also collect information on the wider ecosystem. As one example, a two decade long time-series of gelatinous zooplankton abundance and distribution in the Irish Sea has been built on survey catches.

A pilot study tried to use samples from the Q3 IBTS to establish a sprat recruitment index. Results from 2018 and 2019 indicate very promising potential, but wider area coverage would be beneficial. Thus participating countries are welcome to contribute to the ongoing study.

Analyses of three years of litter sampling during MIK surveys revealed sources of litter in the water column, and uses the MIK net flowmeters to quantify the amount. The samples may also provide insights into possible pathways of drifted material.

While progressing with the original survey objectives, WGSINS will continue to invest efforts in using herring larval surveys to provide additional information. WGSINS will summarize information on co-occurring fish larvae, and establish time-series to form the 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	1/3
Chair	Norbert Rohlf, Germany
Meeting venue(s) and dates	22-25 October 2019, Bremerhaven, Germany (10 participants)

1 Survey reviews

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

The IHLS in 2019

Four survey areas were covered within the framework of the International Herring Larval Surveys in the North Sea during the sampling period 2018/2019. 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 the second half of September and in the southern North Sea (SNS) in the second half of December 2018 (figure 1.1). The German survey contribution around the Orkneys started as scheduled, but after one day of sampling the research vessel had to face severe technical problems. There was no opportunity to conduct a safe journey any further, thus the survey had to be stopped after 28 plankton hauls. The vessel steamed back to Bremerhaven, where it is still in repair at the time of HAWG 2019. No charter vessel was available for the survey planned in early January 2019. As a consequence, the estimate for the Orkney/Shetland area is very low and biased due to the low area coverage, and no estimate for the Downs components is available in January 2019.

The survey contribution of The Netherlands in September 2018 were as planned and covered the Buchan and the central North Sea. The December survey in the Southern North Sea was conducted on board a smaller vessel, which turned out to be sensitive to more unfavourable weather conditions. Thus the area coverage is limited; no information about larvae abundance in the western part of the area under investigation is available.

No survey was planned for the second half of January 2019. Instead, an additional MIK sampling was undertaken in March/April in the German Bight and Skagerrak/Kattegat area. This sampling was established to shade light on the foraging and recruitment of herring larvae originating from the Downs stock component. The outcome is reported in section 1.2.

During the most recent benchmark of the North Sea herring assessment (ICES, WKPELA 2018), it was decided to use the Larvae Abundance Index (LAI) as direct input into the assessment model and to resolve spatial stock dynamics inside the model. However, only the estimates from the Buchan and central North Sea were included in the assessment. The biased estimates of the Orkney/Shetlands and the southern North Sea were excluded and not used as data input to the assessment at HAWG 2019.

At time of the WGSINS meeting, the 2019/2020 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		

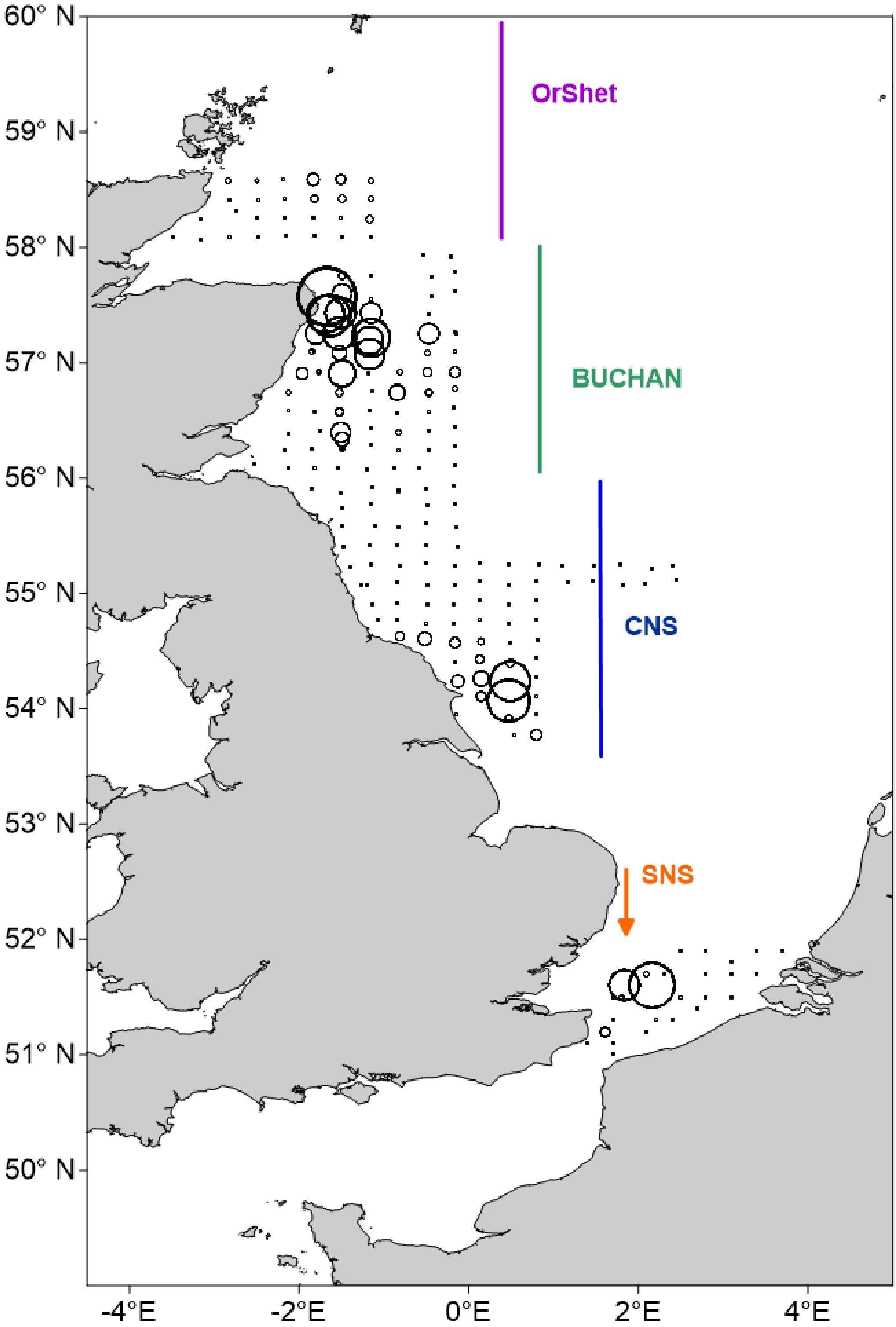

Figure 1.1.1: North Sea herring - Abundance of larvae < 10 mm (n/m²) in the Orkney/Shetland, Buchan, Central and Southern North Sea as obtained from the International Herring Larvae Surveys in autumn and winter 2018/2019 (maximum circle size = 3 500 n/m²). The survey around the Orkneys had to be stopped after 28 hauls due to technical problems of the research vessel.

Planning for the 2020 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 figure. 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 2nd 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 2020 (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 2020/21 IHLS surveys

Area / Period	01.–15.09.	16.–30.09.	01.–15.10.
Orkney/Shetlands	None	FRG	
Buchan	None	NL	
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 2019

In 2019 the Downs Recruitment Survey (DRS) was carried out following the IBTS-MIK protocol as much as possible, but the sampling was carried out both day and night, instead of only at night. Both Netherlands and Norway participated in the survey. Because of the day sampling a blue midwater ring trawl is used.

In total 75 stations were sampled, Norway samples 13 stations and Netherlands 62 (Figure 1.2.1). One haul of the Netherlands was invalid because the ring trawl hit the bottom. When later analysing the sample the larvae were too damaged. It was not possible to resample the station. Netherlands sampled from 15 - 19 April, Norway sampled 25 - 27 April.

Of all stations sampled 32 did not contain herring larvae (Figure 1.2.2). The stations on the two most northern transects did not contain herring larvae. So the northern border of the herring larvae distribution was found. Highest numbers of herring larvae were found in the southern stations. Herring larvae distribution was different in 2019 compared to 2018, and also total numbers found were lower.

The length distribution of the herring larvae in the DRS was the same in 2019 compared to 2018 (Figure 1.2.3).

The index calculation still needs to be decided upon, but using the standard MIK calculation and full MIK areas, the DRS index is 50.1. Only using the actual area sampled gives an index of 39.0.

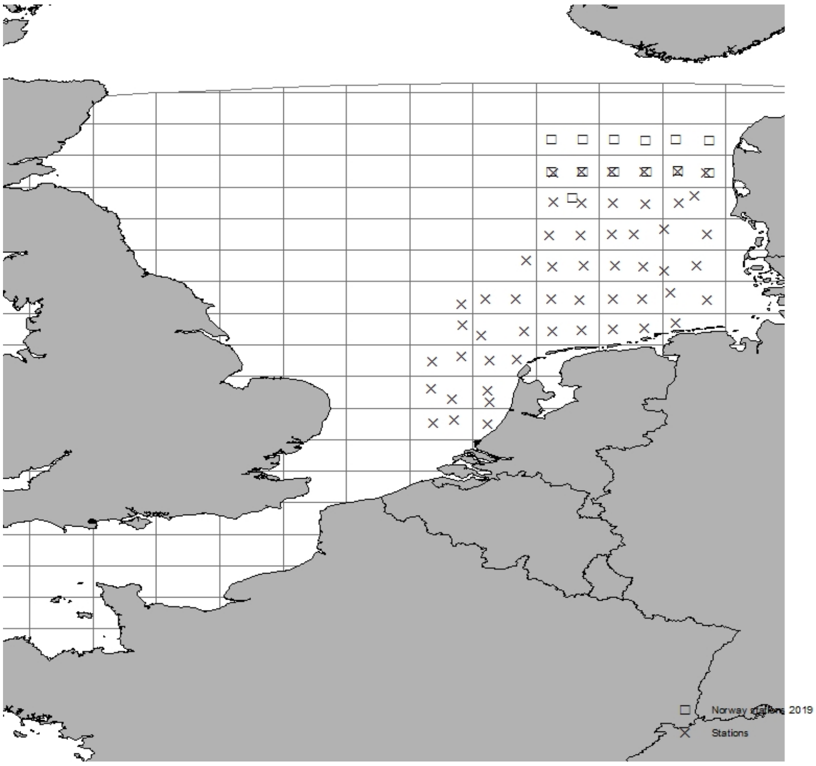

Figure 1.2.1: Sampled stations by country during the 2019 DRS (X Netherlands; □ Norway).

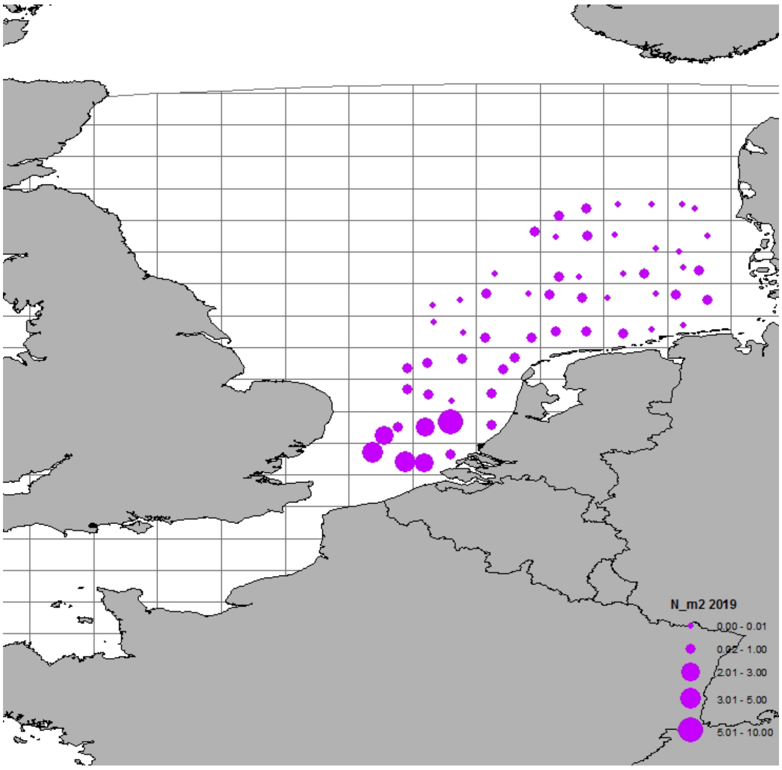

Figure 1.2.2: Herring larvae distribution by haul from the 2019 DRS.

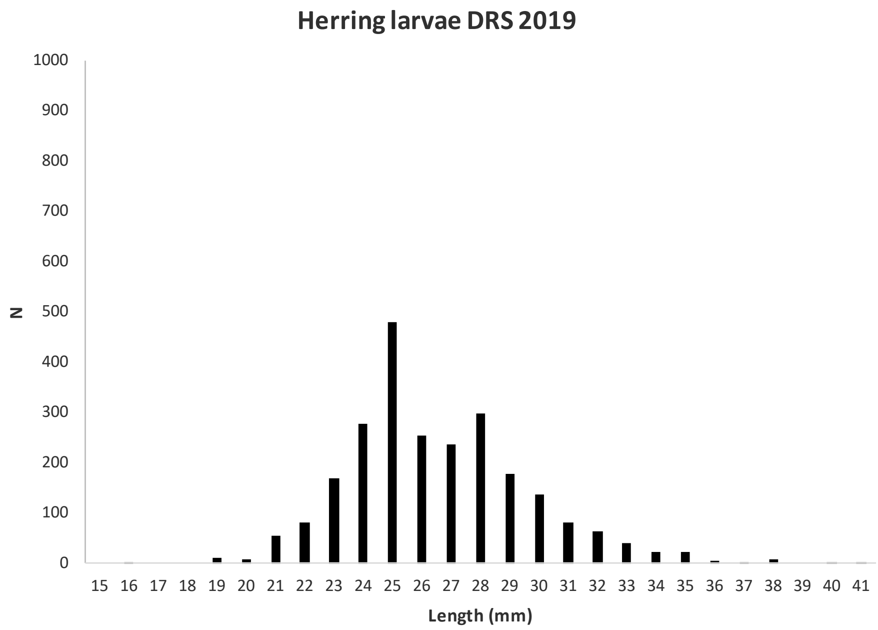

Figure 1.2.3: Herring larvae length distribution from the 2019 DRS.

Planning for the 2020 Downs Recruitment survey

Netherlands will carry out a Downs Recruitment survey from 20 - 24 April 2020. It is unclear at this stage if Norway will be able to participate in the 2020 DRS. The Danish fishing industry has applied for funding to also participate in the 2020 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 versus 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 2019 survey

Besides providing the time series of 1-ringer herring abundance indices in the North Sea from GOV catches carried out during day-time, the International Bottom Trawl Survey (IBTS) also provides abundance estimates for large herring larvae (0-ringers) of the 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, 637 depth-integrated hauls were completed with the MIK-net. With 85% of all possible MIK stations fished (Table 1.3.1), the coverage of the survey area was 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).

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	138	88	64
DK	88	87	99
FR	106	93	107
NL	114	122	105
NO	84	88	85
SW	60	60	100
UK-SCO	116	99	85
sum	706	637	85

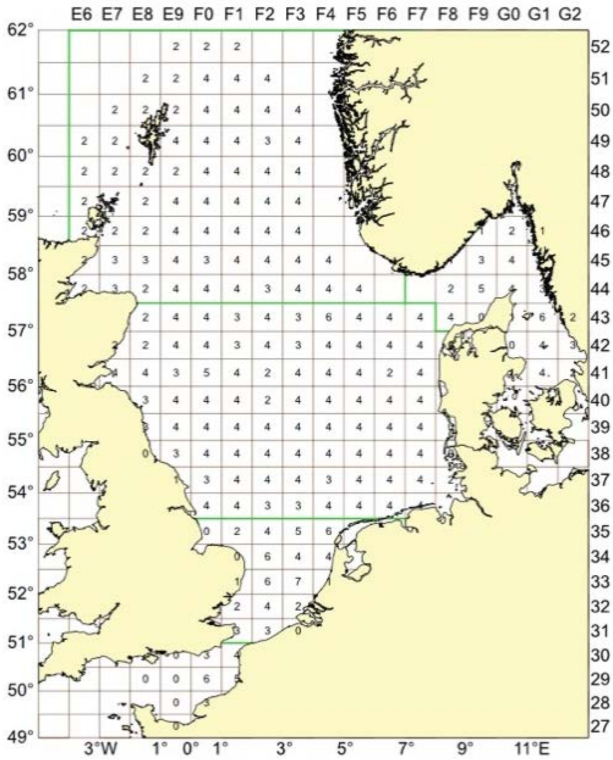

Figure 1.3.1: MIK sampling during IBTW Q1 2019 – numbers of MIK samples per each ICES rectangle.

The German vessel Walther Herwig III was unavailable this year due to necessary repairs. As a replacement Germany had to charter the Danish RV Dana, which was only available for 20 days instead of the planned 33 days, which would have been on hand under normal conditions. Due to the shorter available ship time and the shorter daylight duration in early January, Germany and Denmark had swapped their sampling area, and a priori reduced a number of hauls. Most of these hauls were covered by other countries.

Also, Germany had to conduct its survey 3 weeks earlier than when the area would normally be covered. While this early coverage may have consequences for the perception of herring larvae distribution, the abundance estimate (i.e. the MIK index) shouldn't be affected. Due to the low temperatures and low food abundance in the winter months, growth should be negligible to have any effect on the length-based selection for the index calculation. Mapping of herring larvae abundances by station also didn’t reveal any suspicious results with regard to any conspicuous changes in distribution and abundance (Figure 1.3.2).

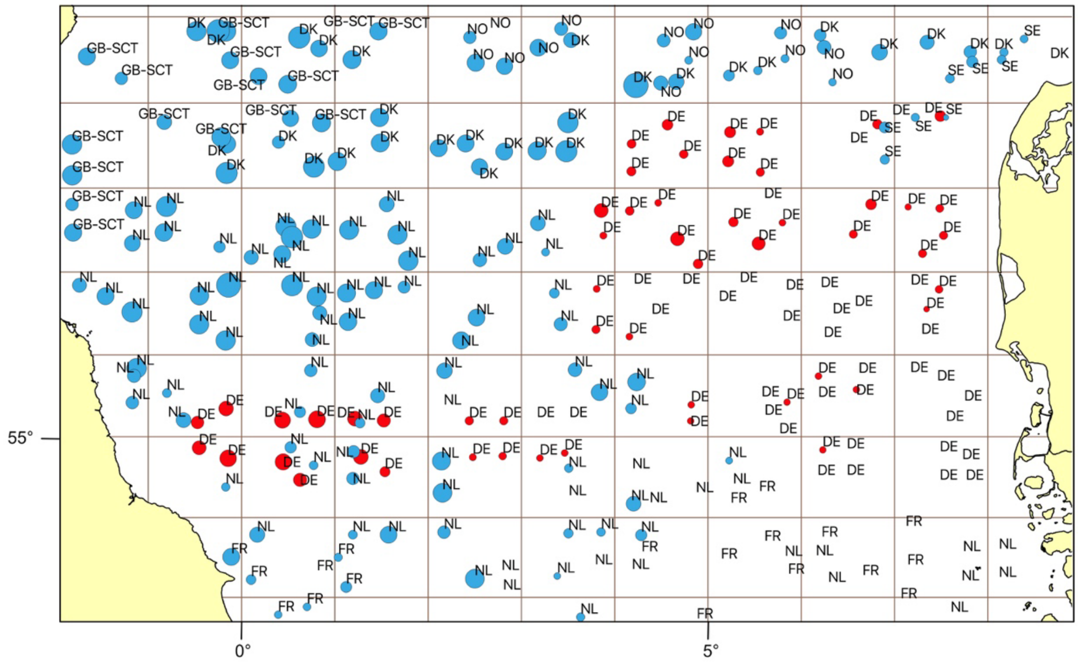

Figure 1.3.2: Abundance of herring larvae by station. Areas of filled circles illustrate densities in no m-2, the area of the largest circle represents a density of 1.09 m-2. All circles are scaled to the same order of magnitude of the square root transformed densities. Red dots correspond to German stations, which were samples about 3 weeks earlier than the rest of the stations.

Herring larvae distribution and abundance

Herring larvae measured between 5 and 36 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 and were caught in lower densities than in 2018 (Figure 1.3.3). The smallest larvae were chiefly caught in 7.d and in the Southern Bight. The large larvae appeared in moderate to high quantities only in the western part of the North Sea, in 3 rectangles of the Southern Bight and in the Skagerrak. In the eastern part of the North Sea, the potential nurseries, abundance of large herring larvae was very low, and virtually no larvae occurred in the German Bight (Figure 1.3.4).

The 2019 MIK-index, calculated as described in detail in MIK manual (ICES 2017), is 51.6.

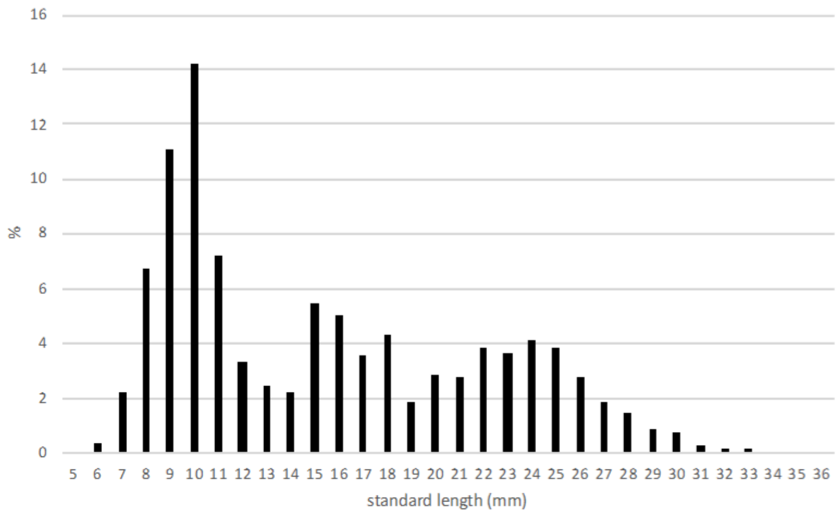

Figure 1.3.3: North Sea herring. Length distribution of all herring larvae caught during the 2019 Q1 IBTS.

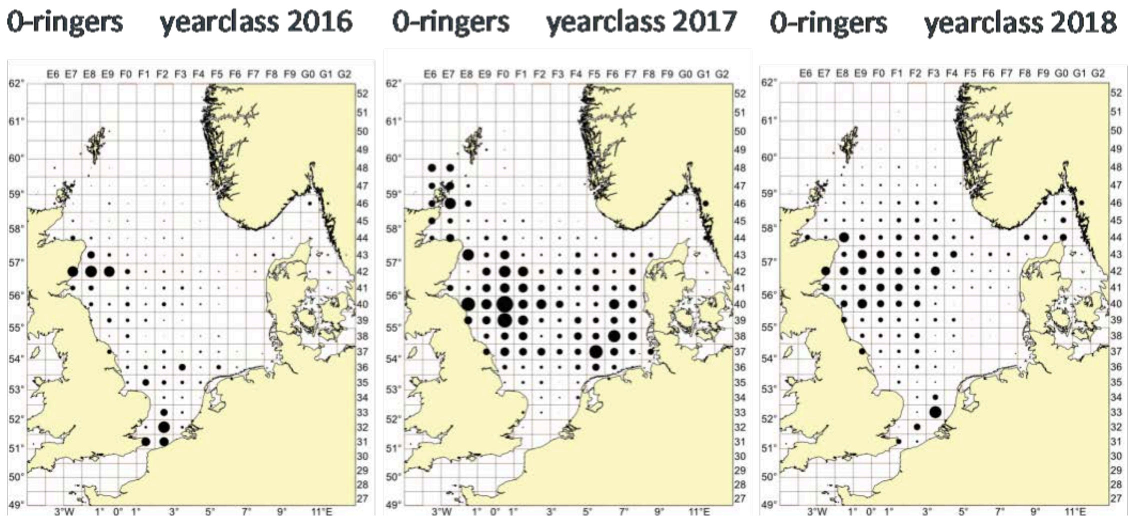

Figure 1.3.4: North Sea herring. Distribution of 0-ringer herring, year classes 2015 – 2017. Density estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in January/February 2016 -2018. Areas of filled circles illustrate densities in no m-2, the area of the largest 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

A puzzling result of the MIK survey was the occurrence of large sardine larvae in the samples. Sardine larvae occurred predominantly in the southern, the central eastern and the central western North Sea, particularly in areas where high abundances of herring larvae would be expected. In some stations, sardine larvae were the only clupeid larvae (Figure 1.3.5).

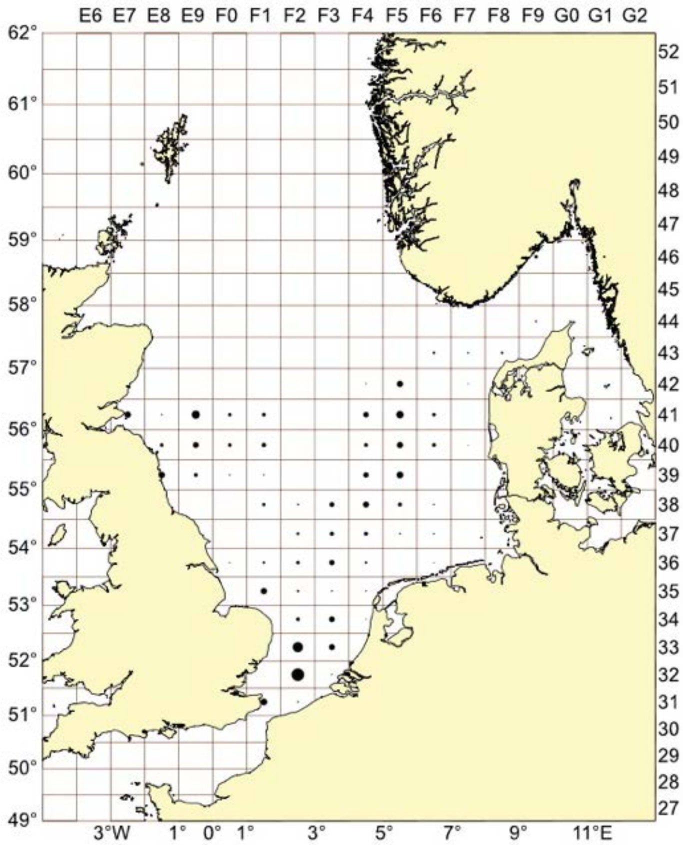

Figure 1.3.5: Distribution of sardine larvae by rectangle from MIK sampling during the Q1 IBTS 2019. Areas of filled circles illustrate densities in no m-2, the area of the largest circle represents a density of 0.30 m-2. All circles are scaled to the same order of magnitude of the square root transformed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

Coordination of the 2020 MIK sampling during Q1 IBTS

MIK sampling will be carried out during the night time of the 2020 Q1 IBTS. Germany will again have to carry out its IBTS participation on Danish RV Dana about 3 weeks earlier than normally. The IBTS Q1 survey coordinator will circulate the survey plan by end of November 2019. MIK participants are now requested to submit their data directly to the ICES fish egg and larvae database in due time (i.e. 7 – 10 days) before the HAWG meeting.

Simulations of effort reduction in MIK sampling during the Q1 IBTS

In the discussion on moving to integrated ecosystem assessment, the survey design of the IBTS is currently being reviewed by IBTSWG in cooperation with WGISDAA and WGISUR. It may become desirable for IBTSWG to adopt random stratified sampling instead of the current systematic sampling by ICES-rectangle. A supporting Workshop on Impacts of Planned Changes in the North Sea IBTS (WKNSIMP), was held in June to discuss those issues (ICES 2019).

The announcement of moving to stratified random sampling for the Q1 IBTS raised concerns among members of WGEGGS2/WGSINS, that these changes could negatively impact the night time MIK sampling. In order to investigate possible impacts, the following reductions in sampling effort on the results of the MIK survey were tested:

1. Effort reduction by rectangle
2. Overall reduction of sampling over the entire North Sea, irrespective of sub-area or rectangle
3. Overall reduction of sampling per each sub-area, irrespective of rectangle

Reduction was done by randomly selecting a subset of the stations per year from the currently available time series of MIK herring larvae data from 1992 to 2019. For each setup, 100 runs of calculating the index time series were done, and the mean, minimum and maximum values per each year were plotted for the resulting time series. Subsetting by rectangle and calculation of the index was done by either selecting 1 or 2 hauls, or by an overall reduction to 50 % of the available hauls.

Overall reduction of sampling by either the entire area or by subarea was done by randomly selecting 30, 50 or 70 % of all available hauls in those regions per year. For those setups, also two different methods of index calculation were selected: either by first aggregating the hauls by rectangle and then by sub-area, according to the MIK manual (ICES 2017), or by aggregating by sub-area only before raising the herring larvae abundance to the entire survey area.

Apart from the early years, 1992 – 1998, where the number of available stations was the lowest (230 – 400 hauls), a reduction of survey effort down to 50 % didn't appear to change the perception of the trends in the MIK index. MIK index trends appear to be relatively robust to effort reduction, irrespective of whether samples come from a systematic, stratified or non-stratified design, and how data are aggregated for index calculation. Furthermore, systematic sampling by rectangle didn't appear to have advantages over stratified sampling with regard to reduction in total variability (Figure 1.3.5).

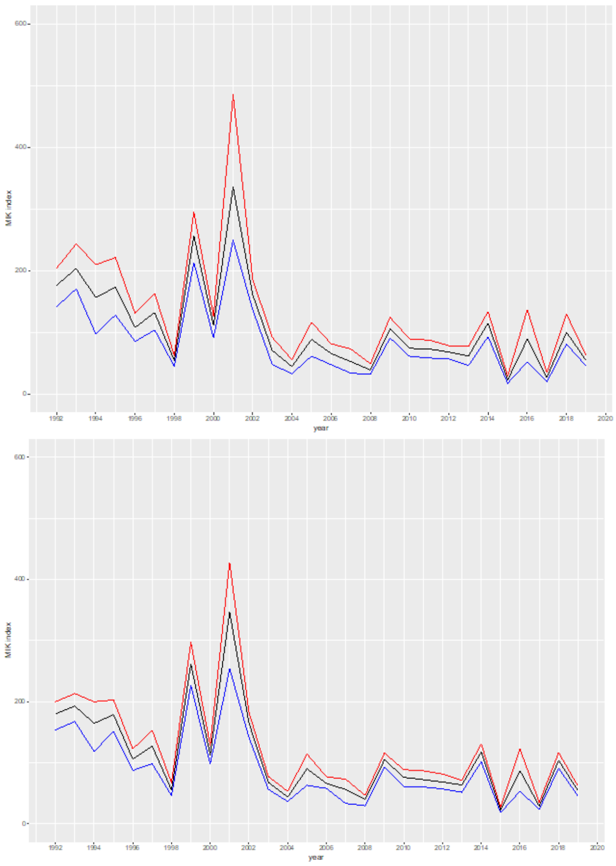

Figure 1.3.5: MIK index by randomly selecting 50 % hauls per subarea (left) and by randomly selecting 50 % hauls per rectangle (right), aggregated by subarea only; blue line minimum, red line maximum and black line the mean. The mean value also corresponds to the valid index time series.

As the MIK herring larvae abundance is used only as a relative index, the results on the assessment for North Sea herring are negligibly small, as trial runs using the results from the MIK index simulations showed (Figure 1.3.6).

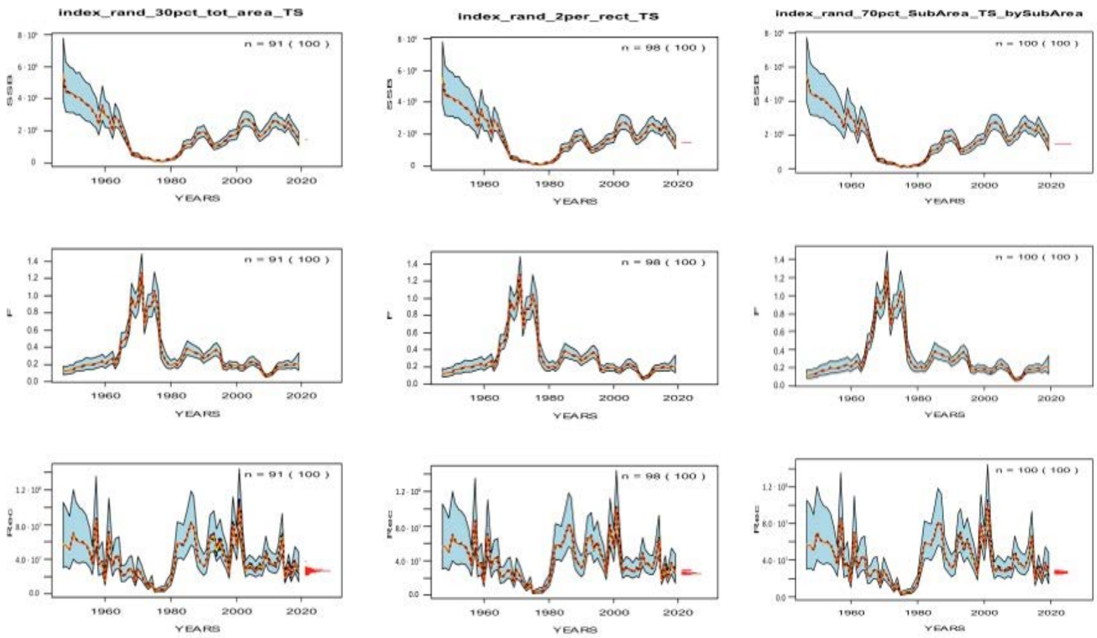

Figure 1.3.6: Three results of trial runs of SAM North Sea herring assessment using the results of the simulations with effort reduction in the MIK sampling. Examples show the results of randomly selecting 30 % of the samples from the total area, selecting 2 hauls per rectangle and selecting 70 % of the samples from each sub-area. The first 2 rows show the results for SSB and F, the bottom row the results for recruitment.

Those results clearly show that the effort in MIK sampling could be reduced if survey time is needed for other purposes, such as sampling for other ecosystem indicators during the IBTS, without risking impairing the time series. WKNSIMP therefore recommended to consider reduction of plankton sampling in order to enable participants to fully work up the ichthyoplankton or other plankters from the samples thereby producing additional valuable ecological information, and/or allow for the analysis of the accompanying MIKeyM-net sampling (ICES 2018). WGSINS was also requested to evaluate and redefine the objectives of the MIK and MIKeyM net sampling.

WGSINS concluded that indeed the objectives of both, the MIK and MIKeyM-net sampling, could be added. For future surveys it should be investigated if meaningful abundance indices could be produced for other clupeid larvae, chiefly sardine and sprat, for large larvae of sandeel and lemon sole from the MIK and for small sandeel larvae from the MIKeyM net. In liaison with the respective assessment working groups, HAWG and WGNSSK, it shall be investigated whether such index time series are useful for the assessment. However, WGSINS also concluded that the sampling effort shouldn't be reduced. The simulations on effort reduction were only tested for herring larvae, which are much more abundant in any year than most other fish larvae. Effort reduction could be disadvantageous for representative sampling of less abundant species. The effect of such a reduction need first to be tested before a final conclusion could be drawn.

The MIKeyM net sampling

Since 2012, eggs are collected along with the MIK sampling using the MIKeyM net (ICES, 2018). In 2019, 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 (see Fig. 1.3.7). 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 need to be sorted for fish eggs and larvae.

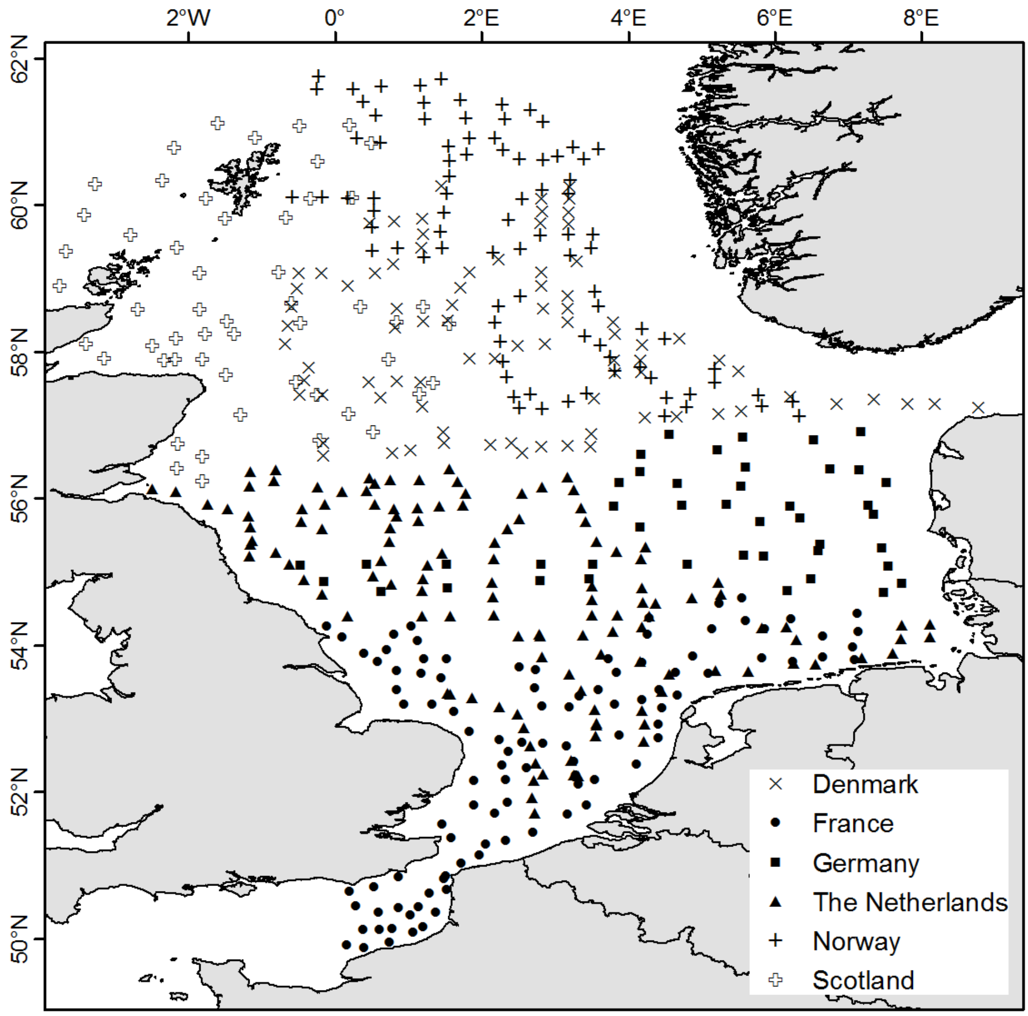

Fig 1.3.7 Location of MIKeyM samples for 2019 during the Q1 IBTS MIK survey.

Planning for the 2020 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 2020, 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 2020 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 2018

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 (Thünen-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 "FRV Clupea," a sampling grid including 35 stations is sampled weekly using Ichthyoplankton gear (Bongo-net, mesh sizes 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, ICES WD08). 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 for the Area South of 62ºN (HAWG).

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). The sum of N20 larvae caught over the investigation period in the entire area results in the N20 recruitment index for those herring that enter the fishery as adults two to three years later.

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.

The rationale for the N20 recruitment index is based on regular and strong correlations between the amount of larvae reaching a length of 20 mm (TL) in Greifswald Bay and abundance data of juveniles (1wr fish) as determined by the German autumn acoustic survey (GERAS) in the southern Baltic area (ICES subdivisions 21-24).

The correlation of both time series (N20/GERAS, 1-wr; 1992-2018 R^2=0.74) support the underlying hypotheses that i) major variability of the 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.

N20 index in 2018

With an estimated product of 1563 million larvae, the 2018 N20 recruitment index is close to the index value of the previous year and more than double as high as the record low of 2016 (Table 1.4.1, Figure 1.4.1). However, still the value is only in the range of about 1/5 of the time series mean therefore not countering the decreasing trend of larval production observed in the system during the past two decades.

The course of the winter/spring spawning season in 2018 is a particular example for potential effect of the preceding winter regime on reproductive success:

Sea surface temperatures (SST) in the bays, lagoons and estuaries of the WBS remained well above 4°C (considered spawning threshold, Klinkhardt 1996, Moll 2018) for most of the winter. Test-gillnet sampling on the early February control survey of the RHLS resulted in the presence of spawning herring in the system. In mid-February the temperatures dropped below 4°C and remained in the range 1-2°C until late April (!). During this period the fish interrupted the spawning process in the Bay and remained in spawning aggregations at the entrance to the spawning ground in the Pomeranian Bay. This is where the trawl net fishery had a successful season (fishers pers. comm.) while the gill net fishery on the spawning ground was postponed. Due to the unfavourable spawning conditions in the shallow water, herring either spawned on the exposed outer coast (images of shore litter with attached eggs sent by some fishermen) or developed severe atresia due to the extended starving period (greater than average portion of atresia reported by fishermen). If the eggs survived the cold water conditions (ca. 2°C) at the outer coast is unclear (threshold for successful egg development ca. 3°C, Peck et al. 2012). However, some minor larvae quantities were found during the RHLS during the cold water period in March.

When the temperatures finally allowed the continuation of the spawning process in Greifswald Bay, the seasonal temperatures increased so rapidly that 20°C water temperatures were reached in mid-May (!). Therefore, later hatching cohorts might have suffered by heat stress (Moyano et al. under review).

Altogether, the mild winter conditions with a late winter onset and steep spring temperature gradient might have limited reproductive success in 2018.

Additionally, on two dates in February and November control surveys were conducted testing for winter and autumn larvae respectively.

Both control surveys resulted in limited larvae abundance in Greifswald Bay. However, during February, regularly large (> 30mmTL), advanced stages are encountered. A case study including daily increment reads and otolith chemistry of those larvae indicate that early larval stages found in November and those advanced stages are originating from the same spawning cohort (Janke 2019). Validation of the findings by genetic analysis is in process.

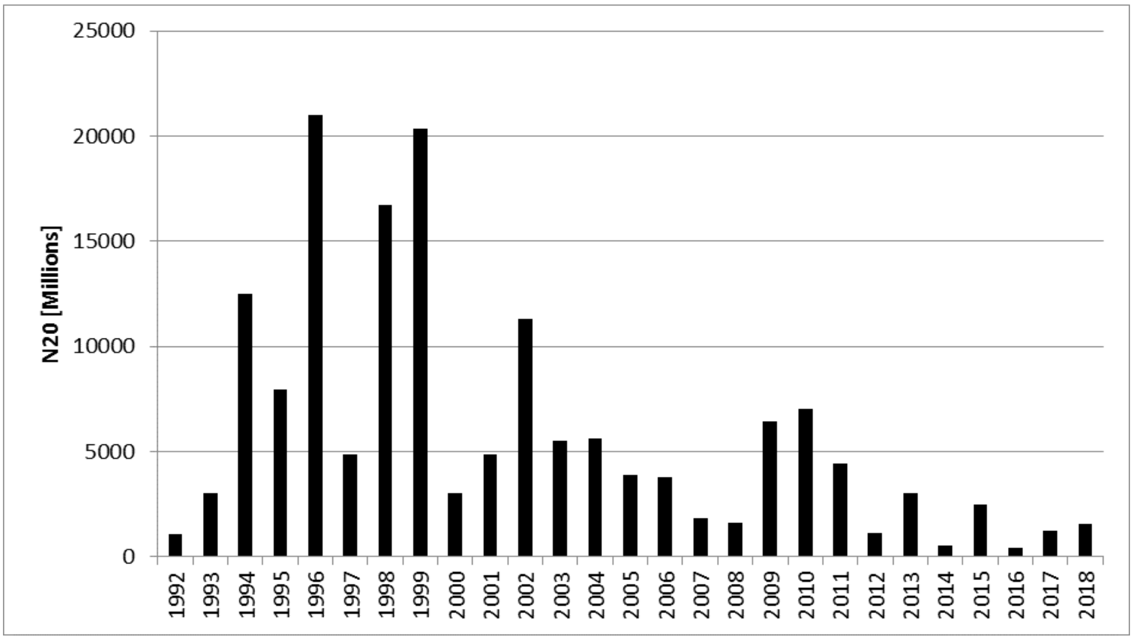

Figure 1.4.1: Validated RHLS time series with N20 index data presented as cumulative value of weekly mean abundance of 20 mm larvae in millions.

Table 1.4.1: N20 larval herring index for spring spawning herring of the Western Baltic Sea (WBSS), generated by RHLS data.

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			

Relation between N20 and GERAS 1-wr herring

After the record low N20 in 2016 the relation with the 1-group juveniles as monitored by the GERAS after the one-year growth phase was re-evaluated to see if the N20 in 2017 produces an outlier in this time series. The results indicate an even stronger correlation between N20 (2017) and GERAS 1-wr juveniles (2018). The low N20 years resulted in correspondingly low GERAS indices for the 1-wr juveniles (Fig. 2).

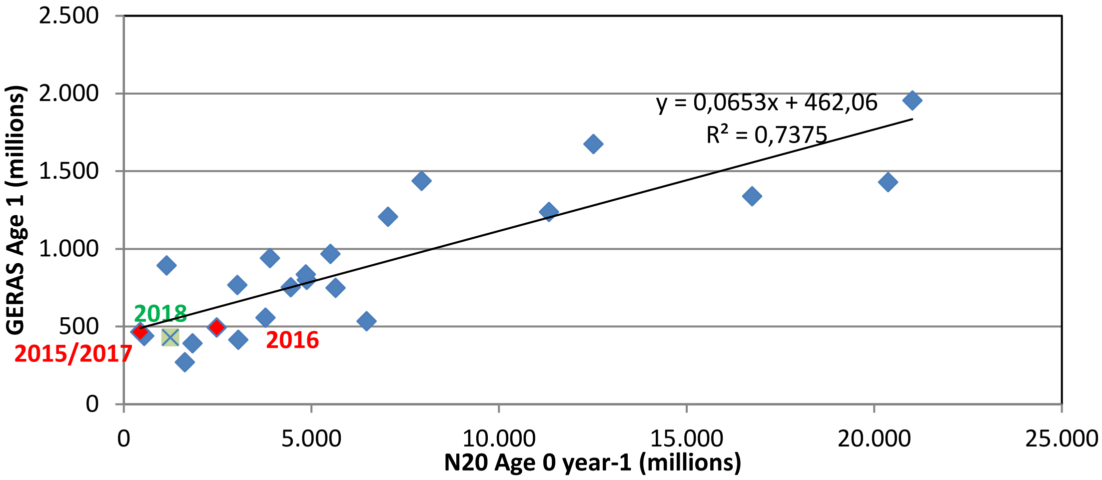

Figure 1.4.2: Correlation of 1-wr herring from GERAS (1993-2018) with the N20 larvae index (1992-2017). Note: The one-year lag phase between indices. E.g. the exceptionally low N20 year 2016 is represented by the GERAS 1-wr index 2017.

1.5 The Northern Irish Herring Larvae Survey (NINEL)

Herring larvae surveys of the northern Irish Sea (ICES area 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 are carried on 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 day-1 and instantaneous mortality of 0.14 day-1 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.

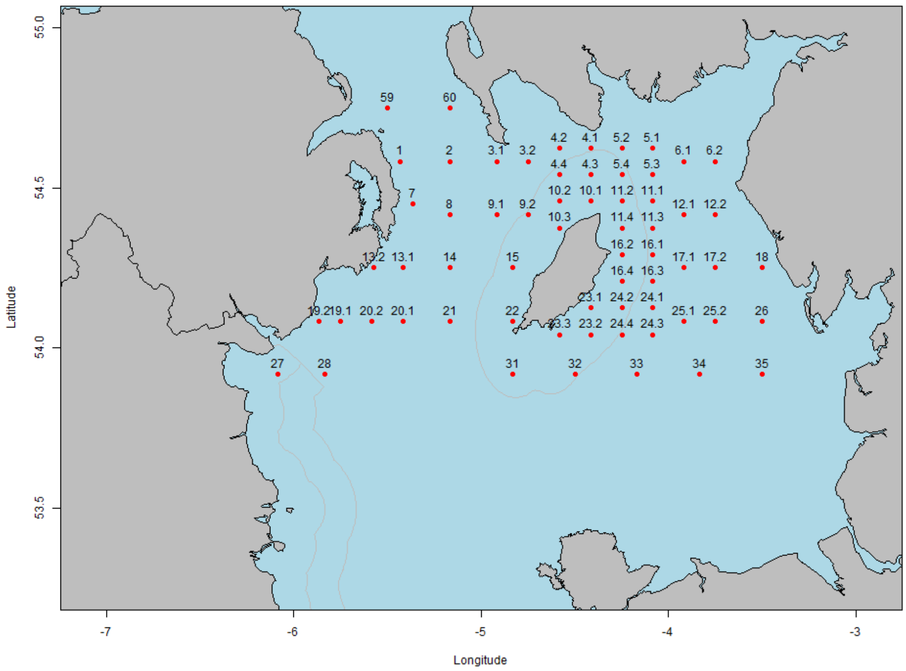

Figure 1.5.1: Station positions for north Irish Sea herring larvae survey (NINEL).

Survey Results in 2018

The survey was completed successfully with a total of 64 stations sampled. 1176 herring larvae were identified and measured providing information on spawning areas, growth rates and abundance. Depth profiles of salinity and temperature were collected at all stations, and plankton samples preserved. The survey was delayed by approximately 2 weeks compared to previous years due to essential maintenance of the vessel. While this late departure resulted in the capture of fewer dense patches of newly hatched larvae stages, later stages of herring larvae were prevalent throughout the area. This pattern of larval spatial distribution and length frequency suggests that the main hatching period had probably occurred earlier. In previous years there is evidence that hatching is more intense during the beginning of November, with a high prevalence of smaller, yolk sac larvae. 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 island, albeit with lower peak numbers and more extensive drift eastwards (Figure 1.5.2). As in previous years lower numbers of larvae were detected on the Mourne ground, despite evidence of extensive spawning activity in the region 3 weeks earlier

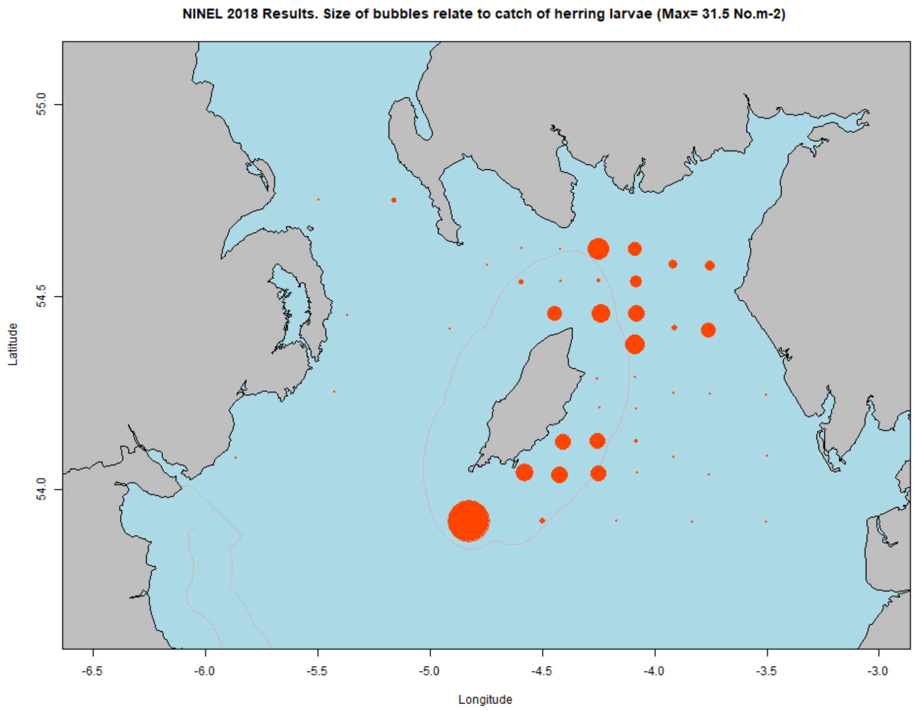

Figure 1.5.2: Distribution of herring larvae captured during 2018 north Irish Sea herring larvae survey (NINEL). Maximum density 31.5 no.m^{-2}.

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

An overview of the UK (Northern Ireland) MIK survey (previously Methot–Isaacs–Kidd Survey). 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 (for station grid see Figure 1.6.1). 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. 30mins± 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. See Figure 1.6.2 for the station grid. 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 (333µm mesh) has been deployed for the study of marine micro plastics at a number of the Gulf stations.

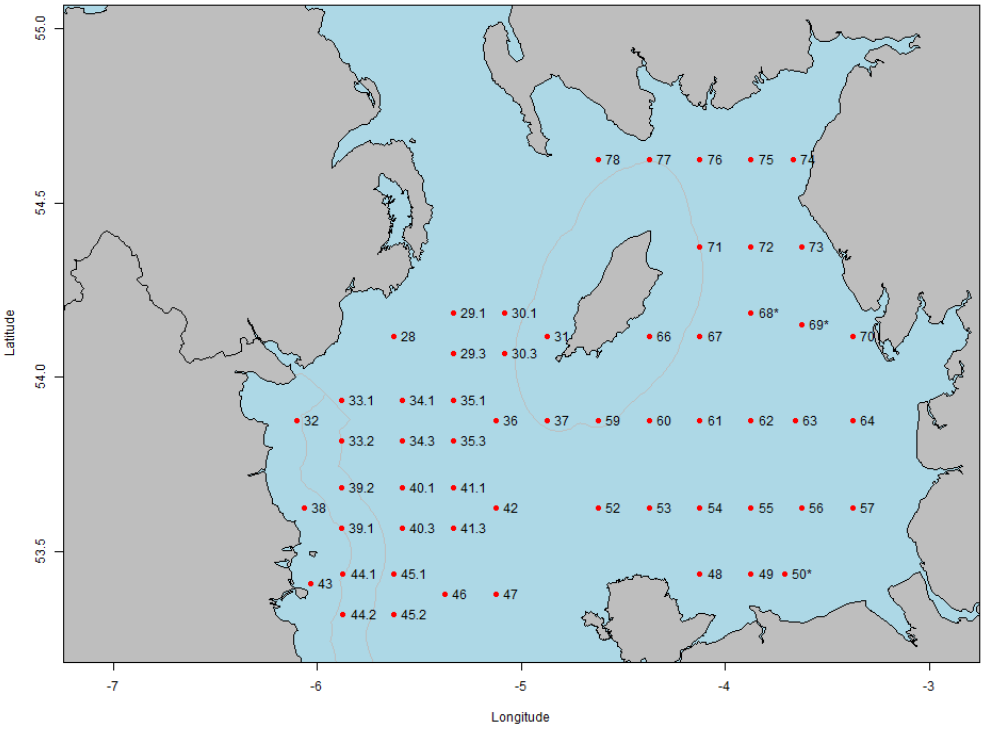

Figure 1.6.1: Station positions for deployment of MIK net during NIMIK Survey.

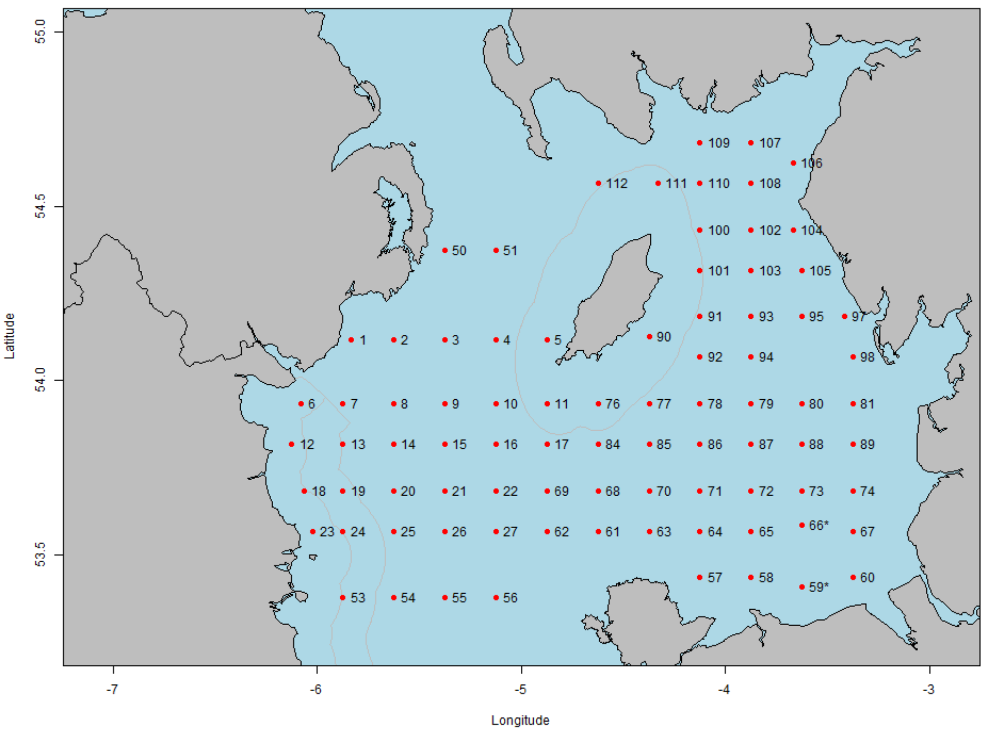

Figure 1.6.2: Station positions for deployment of Gulf-VII high speed plankton sampler during the NIMIK Survey.

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

Background

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 need to be improved. There is presently 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 potentially be very useful, in particular because sprat is a short-lived species that matures early.

With the aim of improving our knowledge on 0-group sprat in the North Sea, two pilot surveys targeting sprat larvae were conducted by DTU Aqua, Denmark, in the framework of the project "BEBRIS - Maintaining a sustainable sprat fishery in the North Sea", funded by the European Maritime and Fisheries Foundation and the Ministry of Environment and Food of Denmark (grant ID: 33113-B-17-091). Sampling was conducted during nighttime in August 2018 and 2019 on the Danish Q3 IBTS onboard RV DANA. The overall goal of these surveys was to evaluate the feasibility of establishing a sprat recruitment index based on larval sampling on the Q3 IBTS surveys. 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 3cm) 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 MIK net during nighttime on the Q3 IBTS
- 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
- main spawning activity of sprat is finished well before the time of the survey
- there are significant differences in catchability during daylight vs. nighttime hours
- 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

Survey description

The gear in use during the two pilot surveys in August 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 addition, a small MIKeyM net (20 cm Ø, 500 µm mesh size) was attached to the MIK ring 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.

Preliminary results and outlook

In 2018, a total of 66 valid MIK hauls were conducted for larval abundance estimation while 14 additional hauls were used for tests of catchability between day and night or between different mesh sizes. For these tests hauls were conducted at the same position. Clupeid larvae were observed in all hauls except for two stations north of Jutland. The catch of clupeid larvae per station reached several hundred larvae and more, with 11 stations yielding more than 1000 larvae, two of which contained 2200 and 4700 larvae. In total, more than 30000 clupeid larvae were caught. Concerning the size of clupeid larvae, a broad size range from approx. 6 mm to juvenile fish of 4-5 cm was caught.

In 2019, a total of 66 valid MIK hauls were conducted. Detailed laboratory analyses of the sample material are still ongoing (status November 2019). However, first estimates indicate that the number of clupeid larvae was somewhat lower than in 2018. Laboratory analyses have further shown that in both 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 of the MIKeyM nets await further, detailed analysis in the laboratory, but preliminary checks during the surveys did not suggest any catches of sprat eggs. This indicates that sprat spawning activity had been finished well before the time of the survey, that all larvae have hatched and that the surveys are thus covering the total larval production. However, on some stations high numbers of relatively small larvae were caught, in particular in 2018 along the Danish coast. For such small larvae one could still expect high between-year variability in subsequent mortality, i.e. a linkage to recruitment may not yet be established for these size ranges. Therefore, analyses of size-frequencies and modelling of size related mortalities would be necessary to evaluate the potential of the surveys for providing a suitable recruitment index for sprat.

Catchability tests between day and night hauls showed significant differences, with considerably lower numbers of clupeid larvae caught during daylight hours than during darkness. Thus, for a potential regular sprat larvae survey during the Q3 IBTS, larval sampling will have to be restricted to the period of complete darkness.

In summary, our experience from the 2018 and 2019 pilot surveys illustrates that this kind of larvae survey during nighttime 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 modelling recruitment patterns. DTU Aqua will continue the pilot surveys in 2020 and 2021 in a follow-up project. However, a better area coverage than obtainable by the Dana survey alone would be advisable, and other nations participating in the Q3 IBTS are encouraged to contribute to these planned pilot surveys in 2020 and 2021. During WGSINS 2019, both Germany and Sweden have indicated that they will investigate possibilities to contribute to the pilot surveys in 2020 and 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 & several other flatfish, as well as several other, non-commercial species, e.g. gobies, crystal goby, rocklings, pipefish, dragonets and greater weaver. 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. These other species are presently being analyzed in the framework of a master thesis at DTU Aqua, with results expected to become available in the near beginning of 2020.

1.8 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 collected during the Q1 IBTS from 2014-2016, and first results were presented at the 2016 WGEGGS2 meeting 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 prior to the 2017 IBTS. 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 new project and updated preliminary results were presented at WGSINS 2019.

MARLINS will be running from fall 2018 to fall 2020, and will allow to analyze all existing Q1 MIK-IBTS litter samples from 2014-2018 as well as newly incoming samples from 2019 and 2020. In addition to these, also samples collected during the recently implemented Dutch MIK Downs recruitment survey and the Danish MIK pilot surveys for sprat larvae during the Q3 IBTS will be analyzed, which may provide some valuable information about seasonal patterns in marine litter occurrence, abundance and composition.

Until WGSINS 2019, the Q1 MIK-IBTS samples from 2017, 2018 and partly 2019 were analyzed. The individual litter items were classified into different categories and their color and if available any print or label was noted, as this can give important information about the source of the litter. Furthermore, the items were weighed and their size was measured, depending on the category either with a ruler (e.g. monofilaments, rope etc.) or by scanning the items and determining their size/area with an image analysis system (e.g. foils). In addition, for selected categories, also the thickness of the items was measured with a micrometer screw.

Plastic was by far the most frequent type of litter, comprising e.g. 92% of all items in 2017. The most frequently occurring litter items were plastic monofilaments and plastic foils, followed by plastic pieces, synthetic rope and a variety of less frequent categories, including plastic fibres, fishing line, polystyrene, paint, metal, paper, natural rope and wood. Stations containing litter were mainly located in the south and the east of the survey area, whereas only very few stations in the northwest contained litter. Also the amount of litter (number of items per station) in 2017 showed a distinct spatial distribution pattern, with hotspots in the English Channel, along the west coast of Denmark and in Skagerrak. This pattern was particularly evident for monofilaments, plastic foils and plastic pieces, whereas synthetic rope was more evenly distributed over the entire southern North Sea. Data for 2018 and 2019 are not yet analyzed in detail, but preliminary results indicate a similar composition and distribution pattern as in 2017. Based on the distinct spatial distribution of monofilaments, the prevailing circulation in the area, as well as available literature on Danish beach surveys and on the spatial intensity of beam trawling, the use of so called "dolly ropes" seems to be one of the main sources of this litter type. Additionally, the color of the plastic filaments points to this source as well, as dolly ropes are usually orange or blue, and ca. 35% of all plastic filaments in the samples in 2017 were also either orange or blue. Other dominant colors of monofilaments were green (28%), white (12%), black (8%) and clear (8%). The majority of monofilaments had a length of 1-5 cm, but also filaments of 5-20 cm length were frequently observed, as well as some even larger ones from 30 to 70 and one of 118 cm.

In contrast to many other studies on marine litter which are usually based on either beach surveys, bottom trawling or sampling in surface waters, the MIK net is sampling the entire water column, filtering large volumes of water. The sampling of marine litter from MIK samples does not require any additional vessel time, and the sorting and registration of litter items requires relatively little additional effort as many samples in offshore areas contain no or only few items. Furthermore, the amount of litter can be quantified as flowmeter data are available anyhow, whereas many other marine litter studies are qualitative or semi-quantitative, and the MIK survey covers a large area. Thus, the MIK survey has a high potential to provide a holistic view of the occurrence, distribution and abundance, as well as potential sources and transport pathways, of free-floating marine litter in the entire North Sea area. Given the preliminary results presented at WGSINS, the group agreed that it is worthwhile to continue the MIK litter sampling in the future.

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 is already the tool for Ichthyoplankton and station data storage. The Northern Irish survey data have to be included as well as the historic MIK data prior to 2008.

In a web-conference during the WGSINS meeting together with the ICES datacenter, some aspects on data storage were discussed and clarified.

Upload of annual survey results is either in the responsibility of the national data submitter (NIRLS, NIMIK, RHLS) or the survey coordinator (IHLS, MIK). Quality checks should be implemented by each contributor prior to data upload. However, there is already some code implemented checking for spatial and temporal integrity of the data (e.g., points on land, consistency in date and time) and logic in the data sets (e.g., water and sampler depth, volume filtered, haul duration and distance etc.). These checks will be run before the data are integrated into the eggs and larvae database. The data portal provides a file template as well as specifications of the file format of the haul meta-information and the eggs and larvae measurements.

There was consensus in using a Github system for communication and code sharing. The link is https://github.com/ices-tools-dev/EggsAndLarvae. Any issues or suggestions for development should be placed under the issue section, where they can be picked up by the datacenter. Further progress will then be documented on the Github.

Two requests were put forward to the datacenter at the web-conference. One is to include an additional column in the eggs and larvae database denoting the ICES rectangle each specific station was taken in (“StatRec”). The other is to develop a quality check on larvae length and measurement unit. As far as the international herring larvae dataset is concerned, it should be blocked to upload data reporting larvae length above 24 mm, while in the MIK, this threshold should be at 60 mm fish length.

Participants in the surveys are encouraged to update the fact sheets in the eggs and larvae website prior to the next WGSINS meeting.

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.

Several species were identified during the meeting for which data are already available, at least in recent years. These include herring, sprat, anchovy and sardines as well as lemon sole, horse mackerel, eels, sandeels and red mullets. Most of these species are identified down to the genius or species level in the MIK surveys, and a time-series should be built up on these data, ranging from 2017 to 2021. This time-series form the basis for further analyses on species distribution, abundance and possibly trends in recruitment.

In the German IHLS data, a collection of data on “other than herring” larvae is available for the period 2009-2018. Some examples of larvae distribution maps were presented (Figure 2.2.1). These data will be added when the MIK data-series is complete.

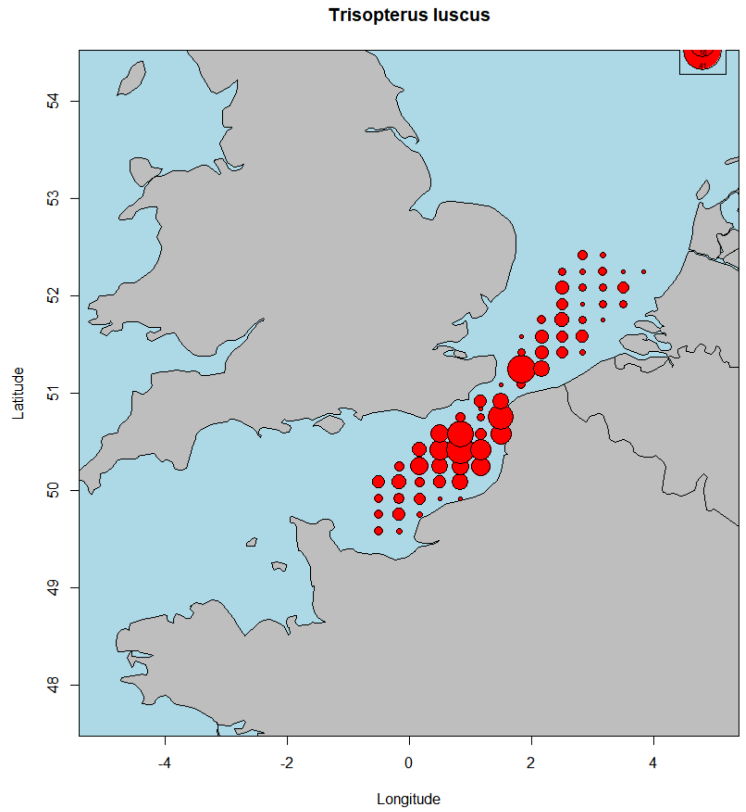

Figure 2.2.1: Distribution and abundance of *Trisopterus luscus* larvae (pouting) as obtained in the herring larvae surveys in January. The bubble size is relative to the sum of all *Trisopterus luscus* larvae per station (n/m2) caught in the period January 2009-2018.

2.3 Species identification

The accurate identification of ichthyoplankton and the developmental stages is crucial for species specific abundance estimates. Working group members introduced themselves in the different guidelines, routines and systems the national institutes` uses for fish larvae identification and measurements. Participants shared and exchanged photographs of key features for single taxa identification.

Participants found it very useful getting access to this information. However, guides used by the national labs are often built on practical reasons, commonly written in national language. Their sources are not always well documented. To make better use of their potential, they will be translated, quality checked and presented again at the next meeting.

A dedicated workshop on the identification of clupeid fish larvae will take place in Bremerhaven in September 2020 (WKIDCLUP2, 31.08.- 04.09.20). This workshop will focus on species identification of samples collected during the MIK and herring larvae surveys.

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Annex 2: Resolutions

The Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS), chaired by Norbert Rohlf, Germany, 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	Belfast, Northern Ireland	Interim report by 15 December	Shifted from October to December
Year 2021	TBD October	TBD	Final report by 15 December	

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 on 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

Annex 3: Survey Summary Sheets

Germany – Rügen herring larvae survey (RHLS)

Nation:	**Germany**	**Vessel:**	**CLUPEA**
Survey:	323	Dates:	19.03.-01.07.2018

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 flow-meters
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 15 weeks from March-June. Of the 525 planned stations, 50 (3 days at sea) had to be cancelled due to bad weather conditions. However, one additional station was sampled every week to gain increased spatial coverage toward the mouth of the major river draining into the system. Additionally, one sampling week in February and one week in November (72 stations respectively) were added to the survey to control for densities of winter and fall larvae respectively. Hence, with 562 sampled stations the number of achieved stations exceeded the planned target. On each station a vertical CTD-profile was taken (T, Sal, DO2, turbidity, Chl a-fluorescence).
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	525	562(total) 475 (for N20)	72	50	107 % 90 %	

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

UK(NI) NIMIK – Irish Sea MIK Net survey

Nation:	**UK(NI)**	**Vessel:**	**RV Corystes**
Survey:	NIMIK	Dates:	19-24th May, 26th May–5th June 2019

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 the 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 2019 survey was completed with a total of 118 GulfVII, 87 MIK and 78 neuston deployments. Depth profiles of salinity, temperature and fluorescence were collected at all GulfVII stations, and zooplankton samples preserved in 4% formalin. Neuston samples were preserved in alcohol.
Number of fish species recorded and notes on any rare species or unusual catches:	4754 fish larvae were identified from GulfVII samples while the MIK net tows resulted in the capture of 1361 juvenile fish also identified to species.

UK(NI) NINEL – Irish Sea Herring larvae survey

Nation:	**UK(NI)**	**Vessel:**	**RV Corystes**
Survey:	NINEL	Dates:	18- 22 November 2018

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.
Notes from survey (e.g. problems, additional work etc.):	The survey was completed successfully with a total of 64 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:	1176 herring larvae were measured (TLmm) and preserved in alcohol.

Germany – North Sea Quarter 1 IBTS-MIK (IBTS1Q – GER)

Nation:	**Germany**	**Vessel:**	**Walther Herwig III**
Survey:	Dana 01_2019	Dates:	03 January – 22 January 2019

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 unavailable this year due to necessary repairs. As a replacement they have chartered the Danish vessel Dana, which was, however, only available for 20 days instead of the normally planned 33 days. Due to shorter available ship time and the shorter daylight duration in early January, the Germans and Danes have swapped their sampling area, and a priori reduced a number of hauls. Most of these hauls are covered by other countries. Due to the change in ship the Germans had to start their survey already in the first week of January, which is 3 weeks earlier than when the area would normally be covered.
Number of fish species recorded and notes on any rare species or unusual catches:	above-average catches of sardine larvae were found specifically in the German Bight area (where herring larvae were lacking).

Stations fished (aims: to complete 150 MIK tows per year)

ICES Divisions	**Strat.**	**Gear**	**Towsplanned**	**Valid**	**Add.**	**Inv.**	**% stations fished**	**comments**
IV	N/A	MIK	138	88	0	0	64 %	

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