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Report of the Workshop on North Sea herring larvae surveys, data needs and execution (WKHERLARS2)

15–17 November 2016

IJmuiden, The Netherlands

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Executive summary

The Workshop on North Sea herring larvae surveys, data needs and execution (WKHERLARS2) met on 15–17 November 2016 in IJmuiden, The Netherlands. The meeting aimed to review and evaluate the current herring larvae surveys (International Herring Larvae Surveys, IHLS, and the Midwater Ringnet Sampling during the International Bottom Trawl Survey of the 1st quarter, IBTS MIK). These surveys provide indices on the trends in SSB and 0-ringers (recruitment) for North Sea herring. The surveys were to be evaluated in the light of the needs for the management of North Sea herring. The meeting was co-chaired by Cindy van Damme, The Netherlands, and Richard D.M. Nash, Norway. In total 11 participants from 5 countries (representing 6 different institutes) participated in the meeting.

A series of six ToRs were addressed which are summarized as follows:

The review of information currently available from the two North Sea larvae surveys highlighted ways in which information currently obtained in the two surveys could be used to provide more robust indices of North Sea herring SSB and recruitment. There is a recommendation to look at the possibility of changing the timing in one survey period to generate a recruitment index for the Downs component of the stock and to adjust the method used to estimate the recruitment index so as to reduce uncertainty due to interannual variations in larval drift patterns.

Further investigations of the current surveys indicated that an increased usage of particle tracking models could provide a framework for estimating ingress of 6a (west of Scotland larvae) in to the northern North Sea. It may also be possible to generate a recruitment index for the 6aN portion of that stock. The particle tracking modelling can also be used to refine the recruitment indices for the North Sea stock, using interannual variations in hydrography. This will form part of a new algorithm for estimating the recruitment index.

An investigation of the timing of the surveys relative to hatching (SSB estimates) or when the year-class strength is apparent (recruitment index) also highlight the future use of particle tracking models and the need for periodic reviews on the timing and spatial coverage of the surveys. This is important due to the various components of the stock and their spatial and temporal differences in spawning and contribution to the stock dynamics.

The workshop established the valuable contribution of these two surveys toward the assessment and management of North Sea herring. There are also other data which could be made available of other exploited species along with input to an evaluation of the Ecosystem status (mainly pelagic) of the North Sea.

1 Opening of the meeting

1.1 Introduction

The Workshop on North Sea herring larvae surveys, data needs and execution (WKHERLARS2) met on 15–17 November 2016 in IJmuiden, The Netherlands. 11 participants from 5 countries (representing 6 different institutes) participated in the meeting. The participant list can be found in Annex 1.

The meeting aimed to review and evaluate the current herring larvae surveys (International Herring Larvae Surveys, IHLS, and the Midwater Ringnet Sampling during the International Bottom Trawl Survey of the 1st quarter, IBTS MIK). These surveys provide indices on the trends in SSB and 0-ringers (recruitment) for North Sea herring. The surveys were to be evaluated in the light of the needs for the management of North Sea herring.

Terms of Reference for the meeting were:

a) Review information currently available from the two North Sea larvae surveys (IHLS and IBTS MIK) which provide indices on the trends in SSB and O-ringers (recruitment);

    a) Spatial and temporal coverage of the surveys
    b) Methods for the estimation of indices
    c) Issues in the survey design and calculations procedures to provide these indices

b) Provide a framework for using the current surveys or alterations to the current surveys for robust estimates of SSB and recruitment for the whole North Sea herring stock (autumn and winter spawners);

    a) Survey methodology, temporal, and spatial coverage
    b) Methods for estimating the SSB (total and by component) and recruitment indices

c) Provide protocols for determining the spawning or hatching times of the various components in the North Sea herring stock. Resulting spawning and hatching dates will provide information for the timing of the surveys;

    a) The use of primary otolith increment analyses on 0-winter ringer fish to determine 'survivor's' hatch or spawning dates.

d) Provide protocols for incorporating links between empirical survey based data with dynamical modelling (particle tracking etc.) to address the spatial and temporal dynamics of herring larvae in the North Sea;

e) Document the contribution of each of the two surveys to the criteria for the establishment of the multi-annual Union programmes;

f) Provide protocols for additional data collection and/or studies that will add value as ecosystem level indicators using the IHLS and IBTS MIK surveys.

All ToRs were discussed in plenary. The ToRs are discussed in separate chapters.

1.2 Background

Currently there are two larvae surveys which independently provide indices on the trends in SSB and 0-ringers (recruitment). The IHLS has changed over time and for the last decades is being run on a reduced spatial coverage. In addition, there is the perception that the spawning or hatching time of herring in, especially the southern North Sea is more variable if not changing. The 0-ringer IBTS MIK survey has remained largely unchanged over the past 20 years and provides a recruitment index for the autumn spawning component of the North Sea herring population. From the start, the way this index is calculated should ensure that if Downs larvae are present they would not influence the recruitment index. However, since the inception of the survey the Downs component has increased in its contribution to the North Sea herring stock and variations in spawning time and oceanographic conditions on an annual basis have led to variable and unknown quantities of Downs larvae probably being retained in the index. The problems with how to deal with the indices have become more acute over recent years.

The aim of this workshop is to review the current spatial and temporal coverage of the sampling in the IHLS and IBTS MIK and determine their ability to provide robust indices of the SSB and recruitment of the whole North Sea herring stock. In addition, the workshop will provide methods and protocols for estimating the indices that reflect the current demographics of the North Sea herring stock. The workshop will also suggest additional studies that will add value as ecosystem level indicators e.g. zooplankton and acoustic and the inclusion of modern dynamic approaches to put surveys and processes in spatial and temporal contexts e.g. physical oceanographic and particle tracking types models.

2 Adoption of the agenda

The agenda addressed all ToRs and can be found in Annex 2.

3 Review information currently available from the two North Sea larvae surveys (IHLS and IBTS MIK) which provide indices on the trends in SSB and 0-ringers (recruitment) (ToR a)

Matthias Kloppmann presented work he had undertaken intersessionally on improving the MIK index calculation. It has been shown over the years that the framework currently in place to calculate an annual index of recruitment may fail to be robust against yearly natural variation in the distribution of larvae. For example, usually entire stations with herring larval mean lengths smaller than 20 mm are excluded from the index calculation, but only if they appear below 54° North. However, in some years, large numbers of small larvae are found above this latitude and the index includes these while they are actually still considered to be outliers (belonging to the winter spawners rather than the usual autumn spawners targeted in the IBTS MIK survey). Therefore, the area where an exclusion rule takes effect in the index calculation needed to be extended to the entire area that would be affected by potential drift of the smaller winter-spawned larvae. Also, the threshold size of larvae could be adjusted to e.g. 18 mm as it turned out to have a better match to predicted recruits from the assessment model than the 20 mm recruitment based index. Biologically speaking, 18 mm is also a good cut-off point. At this length autumn and winter spawning herring larvae will have passed the critical development stages and highest and most variable larval mortality. The exclusion rule would only take effect on the numbers larvae smaller than the threshold, and not on entire stations.

The discussion focused on what the specific needs for the assessment model are, and how to improve the larval surveys (IHLS and IBTS MIK) to improve the information they provide to the understanding of the stock. Currently, the IHLS providing the LAI (turned into the SCAI) and the IBTS MIK survey providing the 0-ringer index (IBTS-0) are the two surveys with least impact on the assessment (Figure 3.1).

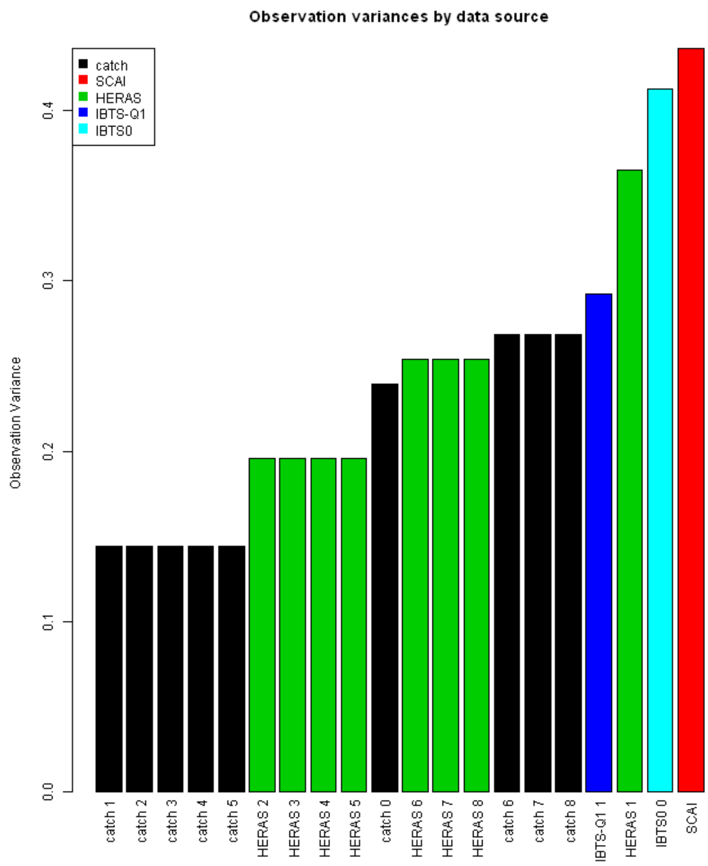

Figure 3.1. Observation variance (i.e. internal weighting) of the surveys (larger numbers indicate lower weight. The SCAI (in red) and MIK (IBTS0) in light-blue have the highest observation variance.

The MIK index is considered not to be representative of the Downs component (because the survey occurs prior to mortality events which determine the levels of survival for that year class and thus the abundance of larvae reflects the SSB rather than the recruitment), which may therefore cause a poorer fit in the assessment model where it is assumed to represent the entire stock. There were two suggested ways to deal with this: 1) to have a dedicated survey to target Downs recruits and 2) to have a simulation framework in place to relate the MIK index only to the autumn spawners and not the winter spawners (Downs component). The latter case would require intersessional work while for the first topic it was suggested to drop one week of surveying the Downs component in the IHLS (LAI) survey and use the ship time for the dedicated recruitment survey. The details of such a survey would need to be explored.

Some issues with the LAI survey were discussed as well, and for the assessment, the data are used to generate one time-series of spawning biomass, while also reflecting the changes in component densities. The index is generated following a state-space model approach and is thereafter treated as data again inside the assessment model. A better approach would be to simulate the SCAI dynamics inside the assessment model such that the LAI data can be used as input data to the assessment directly without the intermediate SCAI model fit. This suggestion is to be put forward to the North Sea herring benchmark.

Another issue with the IHLS survey is that not all the spawning is covered. Only one survey is carried out during the spawning season of the autumn spawners. For the

Downs three surveys are carried out, but this does also not cover the entire spawning season. Hence the high variance in the SCAI (Figure 3.1).

Summary of suggested ways forward:

- **Include IBTS-MIK newly hatched larvae information, which is currently unused, to supplement the LAI survey time-series (as an extension of the LAI survey weeks). In the past, small larvae in the MIK samples were not recorded by some survey participants. WKHERLARS2 recommends that Ifremer checks the older IBTS MIK samples and corrects the time-series of MIK larvae data with the newly hatched larvae.**
- **Evaluate the impact on the assessment trends of reducing the Downs LAI surveys to 2 weeks rather than three.**
    - **The remaining week would be relocated to a dedicated recruitment survey on Downs herring in spring.**
- **Evaluate whether a new calculation method of the MIK data results in improved model fitting.**
- **Use statistical models, including spatio-temporal correlation structures, to generate an improved index of recruitment.**

4 Provide a framework for using the current surveys or alterations to the current surveys for robust estimates of SSB and recruitment for the whole North Sea herring stock (ToR b)

Discussions started on ToR a (see Section 3) were continued on how to improve the MIK index and also utilize the MIK survey data more efficiently. A presentation by Richard Nash documented the possible drift of herring larvae from 6a North (west of Scotland) into the North Sea and where they could occur during the MIK survey. Occurrence of offspring of the west of Scotland herring stock in the North Sea have previously been shown from early larval drift work and had been proven by otolith analysis of larval herring and by tagging experiments on juvenile herring in the North Sea. Recent studies on otolith microchemistry and forward and back tracking of particle drift models also suggest that west of Scotland larvae can occur in the northern North Sea at the time of the North Sea IBTS MIK survey. Although the IBTS MIK survey does not cover the entire area where those herring larvae could occur, the IBTS MIK data could provide a recruitment index for the 6a North herring stock component, provided that the larvae could be reliably separated from herring larvae of North Sea origin. While it will not be possible to predict the absolute abundance of herring larvae of 6a North origin, forward tracking modelling of the dispersal of larvae of the different spawning components could be used to determine the proportional contribution of the single components to the mean abundance of herring by each ICES statistical rectangle. The approach could be utilized to adjust IBTS MIK survey results for the upcoming benchmark on the North Sea autumn spawning herring assessment.

The second part of the discussion on ToR b was dedicated to the spatial and temporal coverage of the survey area by the different larval surveys.

The MIK manual requests that if possible in ICES rectangles 30F1, 32F2, 32F3, 33F2, and 33F3 (the eastern channel area) more than two hauls per participant should be undertaken. The question was raised why and whether it was still necessary to do those extra hauls. That guideline was originally introduced because of the exclusion rule in the MIK algorithm, where in those particular rectangles the number of valid hauls would have been reduced due to the high probability of the occurrence of highly abundant small herring larvae. Additional hauls would be necessary in order to obtain a sufficient sample number by rectangle. With a new MIK index algorithm, which uses the larval length information of each sample regardless of the larval mean length, additional hauls in those rectangles would no longer be necessary.

The 5 nautical miles rule for MIK sampling, which necessitates that all MIK samples should be taken at least 5 nautical miles away from the rectangle boundary was also discussed. That rule together with the necessary 10 nautical miles spacing between two stations sometimes impairs sampling if a rectangle intersects with land, industrial installations are present in the rectangle or a nation has to do more than two hauls in the same rectangle, while at the same time the rule also leaves 10 nautical miles wide unsampled corridors in the North Sea. In the following discussion the rationale of that rule was explained. It was highlighted, that the IBTS MIK survey design is a compromise between a traditional plankton survey design, which would follow evenly spaced stations on transects, and the IBTS bottom-trawling survey design, which follows more or less logistical considerations. The notion of a cruise leader to sample close to rectangle boundaries in order to save valuable ship's time and to optimize their survey output had lead, in some years, to an uneven representation of the total survey area. To prevent cruise leaders from this kind of survey optimization, the 5 NM rule was introduced. The group decided to leave the rule untouched.

Concerns were raised about the temporal course of sampling during the IBTS MIK survey, which followed the logistic requirements of a trawl survey rather than a systematic sampling scheme appropriate to plankton surveys. Considering larval drift and growth, possibilities are given that the same patch of larvae may be sampled several times during the course of the survey, e.g. a survey starting in the channel area and following the possible drift of larvae into the German Bight is most likely to sample the same patch of larvae several times, thus leading to erroneous abundance estimates. During that discussion, the question was also raised whether it would be possible to supply variance estimates for the MIK 0-ringer abundance index. It was pointed out, however, that although variance estimates on classical abundance indices might be valuable information, they would not add to the quality of assessment. Instead, the utilization of spatio-temporal statistical models would result in improved abundance estimates and residuals that could be directly used in the assessment.

Summary of suggested ways forward:

- **Particle drift modelling to predict numbers of 6a North herring larvae in the IBTS-MIK samples.**
    - **Correct MIK for presence of 6a North larvae**
    - **Check for possibility of creating 6a North recruitment index**
- **Adjust MIK manual with removing the request for extra sampling in the southern rectangles in the eastern channel area.**

5 Provide protocols for determining the spawning or hatching times of the various components in the North Sea herring stock. Resulting spawning and hatching dates will provide information for the timing of the surveys (ToR c)

Bastian Huwer presented preliminary results on the back calculation of hatching date from the otoliths of herring larvae collected in 2016 offshore of the Danish coast. Age–length relationship was determined from five larvae of 14–19 mm based on the number of increments from the core to the edge of the otoliths. This relationship was applied to the lengths of all larvae sampled in the Danish 2016 IBTS MIK survey and ended up with an estimated hatching date between October and February with a peak in December for larvae less than 20 mm and between July and December with a peak in October for larvae bigger than 20 mm. Estimated hatching for larvae smaller than 20 mm was consistent with the spawning time for the Downs subpopulation (winter spawners) which tends to confirm that these larvae belong to the Downs. However, it should be noted that this analysis was based on a very small subsample of only 5 larvae, and further otolith analyses would be required to corroborate the results. Nevertheless, this preliminary investigation showed that clearly visible increments are seen on the otoliths, and that further otolith analyses would be worthwhile and appropriate to determine larval hatch dates. Richard Nash also raised the question of whether the smaller larvae less than 20 mm could also come from the Dogger Bank and suggested that drift modelling could be used to determine whether or not this could be the case.

The discussion centred on the information that would and should be a part of WKSIDAC (Workshop on stock identification and allocation of catches of herring to stocks). In regard to the larvae surveys the main issues were to be able to identify and determine the contribution of the various components to the recruitment indices and where possible the catch composition. The surveys in consideration are the 3Q IBTS, 1Q IBTS and HERAS. Here there is a necessity to be able to, at least, identify individuals to their autumn spawning (Orkney/Shetland, Buchan, Banks) and winter spawning (Downs) components. If it is possible to further split the autumn spawning component into the three subcomponents (Orkney/Shetland, Buchan and Banks) this would be a welcome addition. In regard to the catches, the ability to split the catches in to at least the two components is desirable so that the assessment can work with both. The identification of components will ideally be applicable to the historical and archived samples and thus data.

Richard Nash also presented some results on the back calculation of hatching date for herring larvae, based on larval lengths and assumed growth rates, in the Orkney-Shetland area in 2013, 2014, and 2015. He showed that the hatching date can go until November which raised the question of the IHLS survey time. Larval abundances obtained from the IHLS are probably an underestimate and this should be borne in mind when working with these data.

Hence, otoliths could be used to back calculate the hatching date for herring larvae in order to adapt time of the two main herring larval surveys (MIK IBTS and IHLS). However, since increments counting on the otoliths remains time consuming, it cannot be performed each year but only for one or two years.

Other less time consuming approaches including shape analysis and the optical density at the centre of the otoliths could also be used to separate autumn spawners from winter spawners. Both techniques could be performed on recruits of the year to evaluate contribution of the Downs component and for possible adjustment of the MIK recruitment index.

Summary of suggested ways forward:

- **Particle track modelling to check whether the unusual, intermediate sized larvae in the 2016 0-wr IBTS (MIK) could originate in the Dogger Bank area rather than Downs.**
- **WKHERLARS2 recommends DTU Aqua to carry out otolith back calculations for the MIK larvae in the samples from 2005 and 2016. In both years large numbers of larvae were found in the MIK samples in the German Bight, but the size of the larvae differed.**
- **When larvae indices are separated for the different spawning stocks (autumn and winter spawners), there will also be a need for separating larger herring from the surveys (IBTS Q1, IBTS Q3 and HERAS) and market samplings in order to provide stock assessment information on the separate stocks.**
- **WKHERLARS2 recommends that IMR and Thuenen investigate the hatch date and length–frequency of the larvae in the MIK sampling carried out in Q3 and November.**
- **Hatch time distributions:**
    - **Collate archived and newly caught 0-wr herring otoliths from IBTS Q3 best covering nursery areas and reflecting the recruiting year classes.**
    - **Produce standardized images of 0-wr otoliths**
    - **Subsample otoliths for grinding/polishing to reveal daily increments from core to edge**
    - **Analyse increment pattern and estimate individual hatch date. And use these individuals as baseline for hatch period estimation based on otolith shape and optical characteristics.**
    - **Analyse fish metrics and otolith image series with appropriate statistics to produce annual hatch time distributions for herring in the North Sea.**

6 Provide protocols for incorporating links between empirical survey based data with dynamical modelling to address the spatial and temporal dynamics of herring larvae in the North Sea (ToR d)

The discussion focused on the modelling carried out by IMR, Norway, and Deltares, The Netherlands in combination with Wageningen Marine Research, The Netherlands. Rationale for the modelling exercises is to spatially link larvae locations and their origins in the North Sea. The different spawning grounds in the North Sea and surrounding areas are distinct. Spawning starts up in the North in the North Sea in autumn, progressing to the late winter in the South. North Sea larvae spawned in autumn and winter drift to the coastal areas in the German Bight. Some larvae remain on the UK coast, however, this is a relatively small proportion of the 0-ringers in the North Sea and Skagerrak. Some larvae from the west of Scotland (6a) spawning ground drift into the North Sea as well.

Large interannual differences occur in larval drift and also in recruitment. The particle tracking modelling undertaken by IMR assumes only passive particle drift, but no behaviour. The particles are distributed through the water column which is fully mixed at this time of the year. Forward tracking indicates where larvae end up from the spawning grounds. Back tracking was utilized to check where the larvae in the IBTS MIK can originate from.

A group of larvae in a particular area in a MIK sample can come from different spawning grounds and the degree of mixing will vary between years. Forward tracking to the date of the survey, gives an idea of which larvae can be found at the positions of the IBTS MIK survey. Back tracking of the larvae from the sampling positions shows where they might have originated. Forward and back tracking show congruent results. Otolith micro-chemistry is used as a check. There is a clear distinction in the micro-chemistry signal between the spawning components.

Releases for the forward tracking are taken using the SSB and fecundity estimate to give a relative number of larvae coming from a spawning ground. This information is needed to identify were the larvae originate from in the MIK recruitment index. Major issue is to split the Downs winter spawners from the autumn spawners.

MIK index problem: The MIK index data form a recruitment index for autumn spawners. Small Downs larvae need to be excluded because they have not passed the high mortality period yet and thus cannot be used to predict recruitment. A potential new algorithm for estimating a recruitment index will include modelling for necessary modifications of critical input variables, which determine the excluding rules for Downs larvae.

How far does the IMR/ROMS model already cover and how much could the Deltares model add?

The 1.6 x 1.6 km grid model used by IMR for investigating egg and larvae drift in the North Sea covers the whole North Sea but is too expensive to be run on a yearly basis. The Deltares model covers a large part of the North Sea, but not the northern part. The Deltares model however is run on a regular basis. It has a 3D hydrodynamic model incorporated. In the particle tracking model there is the possibility to add behaviour (as done in the plaice, sole, and herring modelling by Dickey-Collas *et al.*, 2009). It is unclear if a 3D model covering the whole North Sea currently exists. For the modelling of the Downs larvae drift the Deltares model would be suitable. Simulations for 5–6 years have been done for microplastics showing significant differences between the years. However and consequently, for microplastics no active vertical migration behaviour was assumed. For fish larvae, behaviour of larvae is essential to be added in the model. This has already been developed for the previous herring larvae modelling (Dickey-Collas *et al*., 2009). Growth is essential, whereas mortality is too difficult to program.

Can the meteorological data needed for the hydrodynamic forcing be updated on a yearly basis for use in the MIK index calculation? Hydrodynamics is the main issue for the timing when the model can be run. A preliminary MIK index for the 2016 year class would be calculated in March 2017. For the final MIK 2016 year class recruitment index hydrodynamical model data are needed for the period November 2016 to 1 April 2017. Therefore, the November 2016–April 2017 would need to be run before March 2018 to provide the spatial distribution of Downs larvae to be able to estimate the final MIK recruitment index (excluding Downs larvae) for the 2016 year class.

Deltares model also includes detailed river run-off, which is probably missing or not as detailed in the coarser scaled ROMS model.

Start positions of the newly hatched larvae are easy to determine because the positions of the gravel beds are known. It is however not always known whether the actual spawning bed is used in a certain year. The earlier herring model used a specific shape as spawning ground. For the new modelling the information from the IHLS Downs surveys would need to be used as starting points.

High resolution Norwegian model (1.6 x 1.6km grid): at present, setup primarily for gadoids. Starting dates February-April. Drift model has full IBM, estimating growth based on prey, vertical migration, etc. Intention is to back-track from ichthyoplankton surveys to the hatching point. It has been run for 2012, 2013, and 2014. This model could be utilized for herring but this species is currently not a priority for runs to be undertaken in the foreseeable future.

Summary of suggested ways forward:

- **WKHERLARS2 recommends Wageningen Marine Research and Deltares apply for funding to carry out the Downs larvae modelling from the spawning areas until the larvae reach 30 mm. In 2005, the 0- and 1-ringer indices diverged i.e. went in opposite directions. The modelling should ideally be carried out from 2000 onwards. Currently the older MIK data have too many issues with length measurements and subsampling.**
    - **With these data the new MIK index algorithm can be calculated for the time-series from 2000 onwards.**
    - **This information is also necessary to decide where and when the new proposed Downs recruits survey should be carried out.**

7 Document the contribution of each of the two surveys to the criteria for the establishment of the multi-annual Union programmes (ToR e)

The group discussed to what degree the surveys contribute to the following criteria for the establishment of the multi-annual Union programs:

a) Information needs for management of the Common Fisheries Policy

Both herring larvae surveys provide information which is directly utilized in the stock assessment of North Sea herring. The IHLS provides an SSB estimate of the different spawning stock components, the IBTS MIK survey a recruitment estimate for autumn spawners.
Furthermore, there is a specific request from the Benchmark Workshop on Sandeel (WKSAND 2016; report not yet available) to provide information on distribution and abundance of sandeel larvae from the IBTS MIK survey, either from the MIK samples or from the MIKeyM samples.
Data on distribution and abundance of late larvae of lemon sole (*Microstomus kitt*) may also provide valuable input to the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). In particular as lemon sole has been defined as a category 3 species according to the ICES guidelines for data limited stocks.
In addition, the IHLS and the IBTS MIK/MIKeyM survey have a potential to provide a variety of additional data and information on various other fish larvae and juveniles, meso- and macrozooplankton as well as jellyfish which may be useful in relation to aspects such as prey fields for fish, predators on fish early life stages, biodiversity and ecosystem functioning.

b) Information needs arising from internationally agreed coordination and harmonization

No contribution to this criterion.

c) Information needs for the evaluation of management plans, including the monitoring of ecosystem variables

The group discussed which additional data could be collected during the surveys and how additional data collection during the surveys could be better coordinated and implemented. Examples for additional data collections include distribution and abundance estimates of fish larvae other than the target species (herring), zooplankton analyses (e.g. via zooscan/zoocam), analyses of distribution and abundance of jellyfish and marine litter and additional sampling of microzooplankton via PUPnets (attached to Gulf VII high-speed plankton samplers) and/or water bottles on a rosette sampler attached to a CTD. For a detailed list of potential additional data collections from the surveys see section 8 (ToR f).

d) Information needs for a sufficient coverage of stock areas

This topic was discussed in detail during the first two days of the workshop. Briefly, the main issue that was identified is the fact that the Downs component is not adequately covered by the IBTS MIK survey, leading to the suggestion of converting one of the three IHLS surveys in the English Channel into a MIK survey during March/April to sample larvae of the Downs component in a comparable size range to the Orkney/Shetland, Buchan and Banks larvae collected during the regular IBTS MIK survey, i.e. at a size where larval mortality that shapes year-class strength has already occurred. For a full discussion of these issues see sections 3 (ToR a) and 4 (ToR b).

e) Avoidance of duplication between surveys and avoidance of disrupting the time-series of survey data

The two herring larvae surveys provide essentially different types of information. While the IHLS provides a SSB estimate, the IBTS MIK survey provides a recruitment estimate. As such, there is no duplication between the two surveys. Except for the suggested conversion of one of the three IHLS surveys in the English Channel into a MIK survey, the surveys should be maintained in their present form in order not to disrupt the time-series. The current survey effort should not be reduced in order not to impair the time-series. The IBTSWG is recommended to maintain the coverage of the English Channel as the larvae of the Downs component sampled during the IBTS MIK survey will supplement the larval sampling conducted during the IHLS.

8 Provide protocols for additional data collection and/or studies that will add value as ecosystem level indicators using the IHLS and IBTS MIK surveys (ToR f)

The group discussed additional data collections which may be conducted during the IHLS and IBTS MIK surveys, including also the MIKeyM net. The information is collated by gear type:

Potential additional data collections from MIK

- Fish larvae demographics, other than the target species herring (biodiversity)
- Macrozooplankton (biodiversity, ecosystem functioning/trophic interactions: prey fields for fish, e.g. euphausiids which are regularly caught in MIK and are a principal prey for saithe *Pollachius virens*)
- Jellyfish (biodiversity, ecosystem functioning: potential predators on zoo- and ichthyoplankton)
- Eel larvae (already sampled and reported to ICES)
- Lemon sole (*Microstomus kitt*) larvae (management, recruitment index)
- Sandeel (*Ammodytes* spp) larvae (request from WKSAND: management, small larvae: identification of spawning areas and utilization of spawning areas between years; small and larger larvae: drift modelling, analyses of connectivity)
- Sardine (*Sardina pilchardus*) and plaice (*Pleuronectes platessa*) larvae in southern survey areas (input for drift modelling, analyses of connectivity)
- Cephalopods/bobtail squids (biodiversity)
- Pearlsides (*Maurolicus muelleri*), crystal (*Crystallogobius linearis*) and transparent (*Aphia minuta*) goby (biodiversity)
- Marine litter

Potential additional data collections from MIKeyM

- Eggs (identification of spawning grounds, in particular interannual stability in utilization of cod (*Gadus morhua*) and plaice spawning grounds, input for biophysical modelling)
- Winter-spawned fish larvae (input for biophysical modelling)
- Sandeel larvae (request from WKSAND: management, small larvae: identification of spawning areas and utilization of spawning areas between years; small and larger larvae: drift modelling, analyses of connectivity)
- Mesozooplankton (biodiversity, trophic interactions: prey fields for larval and adult fish)
- Microplastics (size: 335 μm and above)

Potential additional data collections from IHLS / Gulf VII

- Eggs (identification of spawning grounds, in particular interannual stability in utilization of cod and plaice spawning grounds, input for biophysical modelling)
- Winter-spawned fish larvae (input for biophysical modelling)

- Sandeel larvae (request from WKSAND: management, small larvae: identification of spawning areas and utilization of spawning areas between years; small and larger larvae: drift modelling, analyses of connectivity)
- Mesozooplankton (biodiversity, trophic interactions: prey fields for larval and adult fish)
- Microplastics (size: 280 µm and above)
- PUP net (52 µm) and/or water bottles for microzooplankton (biodiversity, larval prey fields)
- Pelagic trawl hauls for adult herring and other fish (adult herring for genetics, maturity, fecundity)
- Observers for marine mammals and birds (in contrast to fishery surveys, during the larval survey birds are not attracted to the vessel by the fishing activity)

9 References

Dickey-Collas, M.; Bolle, L.J.; Beek, J.K.L. van; Erftemeijer, P.L.A. (2009) Variability in transport of fish eggs and larvae (II): effects of hydrodynamics on the transport of Downs herring larvae. MEPS 390, 183-194.

Annex 1: List of participants

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Annex 2: Agenda

Tuesday 15 November

10:00 Introduction

10:30 Review information currently available from the two North Sea larvae surveys (IHLS and IBTS MIK) which provide indices on the trends in SSB and O-ringers (recruitment).

- Including on overview of the needs from HAWG (Herring Assessment Working Group for the Area South of 62ºN)

13:30 Provide a framework for using the current surveys or alterations to the current surveys for robust estimates of SSB and recruitment for the whole North Sea herring stock (autumn and winter spawners).

- Including HAWG

17:30 End of day

Wednesday 16 November

9:00 Provide protocols for determining the spawning or hatching times of the various components in the North Sea herring stock. Resulting spawning and hatching dates will provide information for the timing of the surveys.

13:30 Provide protocols for incorporating links between empirical survey based data with dynamical modelling (particle tracking etc) to address the spatial and temporal dynamics of herring larvae in the North Sea.

- Also discussion with Deltares

17:30 End of day

Thursday 17 November

9:00 Document the contribution of each of the two surveys to the criteria for the establishment of the multi-annual Union programmes.

13:30 Provide protocols for additional data collection and/or studies that will add value as ecosystem level indicators using the IHLS and IBTS MIK surveys.

16:00 Finish meeting

Annex 3: Recommendations

Recommendation	Adressed to
1. WKHERLARS2 recommends that the LAI (SCAI) index be improved by adding information of the newly hatched herring larvae from the IBTS MIK survey. It is therefor essential that: 1. the IBTS MIK sampling in the English Channel is continued and 2. that the newly hatched larvae data are reported from the historic samples.	WGIPS, WGALES, IBTSWG
2. WKHERLARS2 recommends that the MIK index be improved by: 1. Calculation using the new proposed algorithm and 2. Using particle tracking modelling to be able to remove 6a and Downs herring larvae.	WGALES, IBTSWG
3. WKHERLARS2 recommends that a new recruiment index is etablished for: 1. Downs herring by establishing a new recruit survey in spring 2. 6a North from the IBTS MIK sampling	WGALES, IBTSWG
4. WKHERLARS2 recommends to sort, measure, and identify other larvae from the MIK and MIKeyM samples, specifically for: 1. Sandeel, as this will aid for the sandeel assessment 2. Lemon sole, as this can directly be used by the WGNSSK for the assessment	IBTSWG, WGNSSK, WGEGGS2, HAWG
5. WKHERLARS2 recommends the collection of otoliths from young fish caught in the Acoustic survey (HERAS), 3rd Quarter IBTS and the IMR transect sampling in November/December for baseline samples to be used in WKISDA: 1. 0- and 1-wr herring otoliths for shape analyses and optical density of the core area (HERAS) 2. 0- and 1-wr herring otoliths for shape analyses and optical density of the core area (3QIBTS) 3. 0-wr larvae from the northern North Sea.	IBTSWG, WGIPS