

WGALES 2016 REPORT

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Report of the Working Group on Atlantic Fish Larvae and Egg Surveys

17-21 October 2016

Thessaloniki, Greece



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Executive summary

The Working Group on Atlantic Fish Larvae and Egg Surveys (WGALES) met at the Aristotle University in Thessaloniki, Greece from 17 to 21 October 2016.

The meeting was attended by 23 participants from 12 countries (representing 14 different institutes).

The agenda included general WGALES business and two thematic sessions; 1. *“General presentations concerning egg and larvae surveys”* addressed general aspects related to surveys and the main issues concerned with egg and larvae, sampling and analyses and 2. *“Parameter estimation for and from egg and larvae surveys: evaluation of methodologies and its applicability for assessments”* mainly covered aspects and problems related to the adult fraction of the populations surveyed.

Fourteen presentations were delivered in session one. Studies were presented focusing on sampling methods and results concerning ichthyoplankton spatial and temporal distributions and variability. The status of the ICES Database for eggs and larvae was also presented as this is a valuable archive of ichthyoplankton data collected within the ICES area.

In the second session, 10 presentations were delivered, including two “key notes”. The focal discussions concerned the reproductive aspects which help in characterizing survey target species as determinate or indeterminate spawners and its implications on the methods involved in sampling and analyses. There were also presentations on developments in egg production estimation and discussions on the opportunity for using egg surveying for estimating production for more than one species concurrently.

Based on the two sessions the participants worked in two subgroups to discuss specific questions related to: (i) egg and larvae aspects and (ii) reproductive issues and adult parameter estimation during EPMs.

Subgroup (i) discussed clogging in samplers, providing quality indicators for samples and the addition of new summer/autumn ichthyoplankton sampling in the North Sea (attached to the 3rd Quarter IBTS). Net clogging should be quantified for all samples and the extent should be recorded. All databases holding ichthyoplankton data should record, at least qualitatively, the quality of the sampling i.e. reliability of the data. The addition of summer/autumn ichthyoplankton sampling can potentially provide valuable data on ichthyoplankton during this period when there are few recent data available and this information is most probably useful for ecosystem management considerations.

Subgroup (ii) addressed adult reproductive aspects and the adequate methodologies to correctly estimate the parameters needed for EPMs. Discussion led to a work plan, which will involve a large community of researchers, and will use key target species, in order to test methods which are thought to help in defining the spawning frequency of the individuals and thereafter assist in achieving spawning fraction estimates for the species populations irrespectively of their fecundity type being determinate or indeterminate. The accomplishment of such idea could be a major breakthrough as DEPM could be used for all species and therefore diminish substantially the sea time needed to conduct egg surveys currently using AEPM.

1 Administrative details

Working Group name

The Working Group on Atlantic Fish Larvae and Egg Surveys (WGALES)

Year of Appointment within the current cycle

2012

Reporting year within the current cycle

3

Chair(s)

Maria Manuel Angélico, Portugal

Richard Nash, Norway

Meeting venue

Thessaloniki, Greece

Meeting dates

17–21 October 2016

2 Terms of Reference, work plan and agenda

2.1 Terms of reference

| ToR | Description | Background | Science Plan topics addressed | Duration | Expected Deliverables |
|-----|--|---|-------------------------------|----------------------------------|--|
| a | Present current ichthyoplankton surveys in the light of their original purposes, with respect to design, estimation methods and challenges (including their potential as ecosystem surveys); | The activities of WGALES are vital for the delivery of state-of-the-art ichthyoplankton surveys, ensuring high standards and incorporating new techniques and developments for the future. WGALES will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence providing a platform from which to improve the assessments based on the ichthyoplankton surveys. WGALES fits into the ICES science plan sections 5.1 and 5.2. | 5.1, 5.2 | Years 1, 2, 3 (2014, 2016, 2018) | Report in 2014, 2016, 2018 |
| b | Present current understanding and future research needs of natural mortality of fish eggs and larvae in order to improve accuracy and precision of egg production and larvae abundance estimates of the ichthyoplankton surveys; | Use of natural mortality in egg production and larvae abundance estimates is limited. Current developments and use of natural mortality estimates to improve accuracy and precision of ichthyoplankton survey estimates. | 5.1, 5.2 | Year 1 (2014) | Report with review of developments and needs for future research of natural mortality of fish eggs and larvae. Suggestions on how natural mortality can be incorporated in egg production and larvae abundance estimates of the ichthyoplankton surveys. |
| c | Prepare a template for the ICES ichthyoplankton survey protocols | A new publication series of survey protocols on ICES surveys has been | | Year 1 (2014) | Survey protocol template for ICES ichthyoplankton |

| | | | | | |
|----|--|---|----------|--|--|
| | | initiated. No template exists for the ichthyoplankton survey protocols. | | | surveys. |
| d | Receive and act upon ToRs from Working Groups within the umbrella of ichthyoplankton surveys e.g. IBTSWG, WGACEGG, WGIPS, WGMEGS, WGEGBS2. | The activities of WGALES are vital for the delivery of state-of-the-art ichthyoplankton surveys, ensuring high standards and incorporating new techniques and developments for the future. WGALES will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence providing a platform from which to improve the assessments based on the ichthyoplankton surveys. | 5.1, 5.2 | Years 1, 2, 3).If necessary WGALES can react by correspondence on urgent ToR's from other ichthyoplankton surveys groups in 2013, 2015 and 2017. During the meeting in 2014 ToR's from ichthyoplankton survey groups from 2013 and 2014 will be addressed and reported on. | Report in 2014, 2016, 2018. Responses to specific requests from the ichthyoplankton Working Groups. |
| e | Present current understanding and future research needs for integrating ichthyoplankton data and methodologies into methodologies for assessing population sizes. Undertake investigations on streamlining and cost effective surveys and methodologies for the implementation of Egg Production Methods for estimating Spawning Stock Biomass | Ichthyoplankton surveys are often part of a larger and more encompassing set of studies which are aimed at determining population size e.g. Egg Production Methodologies. There is a need to review the various aspects of such research, as a complete study, to ensure the correct data are collected and there is a general understanding of how all the parts fit together to ensure complete and as accurate and precise as possible estimates of stock size are realised. | 5.1, 5.2 | Year 2, 3 (2016, 2018) | Report with review of methodologies and potential 'pitfalls' for undertaking multidisciplinary estimations of stock size which involve the use of ichthyoplankton surveys, and needs for future research for a better integration of fish egg and larvae data. |
| f. | Present and report on fish eggs and larval development and early life strategies in | The timing and type of ichthyoplankton survey needs to be tailored over spatial | 5.1, 5.2 | Year 3 (2018) | Report in 2018 on the life history strategies of |

| | | |
|------------------------------|---|---|
| boreal and tropical regions. | and temporal scales. Consideration also needs to be made for the taxonomy, egg and larvae mortality and development, stage duration (e.g. in relation to temperature, salinity, start of spawning season etc.). Other basic information needs to be also considered such as strategies of foraging larvae to cope with ambient conditions in different regions of the marine environment. Some of this information can also be obtained from the surveys providing an appropriate survey design is implemented. | fish eggs and larvae over a range of ecosystems. The report will suggest optimal sampling strategies for determining abundance, mortality, distribution and ecology of the early life history stages of fishes. |
|------------------------------|---|---|

2.2 Summary of Work plan

| | |
|-----------------------------|--|
| Year 1 (2013/14) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and then meet to address ToRs a, b, c and d. |
| Year 2 (2015/16) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and then meet to address ToRs a, d and e. |
| Year 3 (2017/18) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and work on developments in methodology in adult reproductive parameters (ToR e). The WG will then meet to address ToRs a, d, e and f. |

2.3 Adoption of the agenda

The adopted agenda addressed all terms of reference and can be found in Annex 2.

3 Summaries of thematic sessions (ToRs a, b, c, and d)

3.1 General presentations concerning egg and larvae surveys

This session consisted of a series of 14 diverse presentations. The abstracts for these talks are given in Annex 5 and a summary of the discussions concerning each of the presentations are given in Annex 6.

3.2 Parameter estimation for and from egg and larvae surveys: evaluation of methodologies and its applicability for assessments

This session consisted of a series of 10 varied presentations. The abstracts for these talks are given in Annex 5 and a summary of the discussions concerning each of the presentations are given in Annex 6.

3.3 Subgroup 1 - discussion on egg and larvae issues

Participants: Andrei Makarchouk, Bjorn Gunnarsson, Brendan O’Hea, Cindy van Damme, Franziska Bils, Jens Ulleweit, Maik Tiedemann, Matthias Kloppmann, Mohamed Abu El-Regal, Norbert Rohlf, Richard Nash

Three issues were discussed in this subgroup.

a. Issues with clogging in plankton nets

A first challenge is to detect the occurrence of clogging problems during surveys. This can mostly only be accomplished by synchronous readings of external and internal flowmeter devices. Although such installations might not be applicable to every gear set up, some way of real-time control on filter volumes is desirable to observe and possibly react to clogging issues. Whether a resampling of a particular station can occur (and if it makes sense) must be evaluated by the respective survey team.

Basically the potential causes for clogging differ slightly (e.g. abundance of gelatinous plankton, phytoplankton and algal blooms, resuspended sediments). Accordingly potential gear adjustments as e.g. selection of greater mesh sizes are not always useful to avoid clogging. However, by selecting differing mesh sizes to cope with clogging, care must be taken to not affect catch efficiency and time-series continuity. If clogging by gelatinous plankton are frequent problems in certain surveys, threatening the accomplishments of survey goals, technical adjustments to existing gear could be discussed with gear technologists. In some cases it might be necessary to change the gear type altogether (e.g. from Gulf Sampler to Multinet). However, every adjustment of survey design must be carefully evaluated in respect of data comparability and potential to be integrated in existing time-series.

Depending on the survey design and availability of time-series data on filtration volumes, it might be possible to identify certain ranges of average water volumes that could be used as reference value to identify clogging during an ongoing survey. Those values are specific to the certain sampling parameters (e.g. mesh size, tow speed, sample duration, depth profile) however, and cannot be applied as a correction factor for the volumetric abundance of organisms in a sample affected by clogging, since clogging will have affected catch efficiency.

Generally, use of plankton sampling gear, installation and application of flowmeters should follow scientifically accepted manuals.

If clogging events are detected, samples should be flagged accordingly. Data from clogged (or potentially clogged) samples should be flagged accordingly in reports and

datasets provided. If applicable, readings of external (reference) flowmeters should be provided.

With regards to indications of clogging, senior scientists should compare their sampling protocols with the ICES eggs and larvae database input format.

An update to the protocol (see section 4) and a recommendation were the outcomes of this discussion.

b. Quality Indicators for sampling

Generally, senior scientists must guarantee that sampling protocols are followed by all personnel involved in sampling and sample processing. Sampling protocols should include objectives on the background and reasons for protocol procedures. Sampling and sample processing personnel must be regularly trained and the level of skills must be maintained to meet the requirements for accomplishing sampling protocols. Regular quality checks and training courses should be conducted.

An accreditation system could be implemented for data providing institutes to identify and tag shortcomings in training of personnel and according data quality issues. However, it might be generally difficult to disentangle sampling and processing errors from variability of the survey conditions (weather etc.). Frequent workshops and training courses for personnel involved in surveys is to be encouraged.

c. Addition of late summer/autumn ichthyoplankton sampling in the North Sea (3rd Quarter IBTS)

Since the beginnings of fishery science in the early 1900s, comprehensive surveys for seasonal composition and abundance of fish early life stages throughout the course of the year were not accomplished. Those surveys can potentially add valuable data on e.g. flatfish recruitment and the ontogeny and distribution of expanding species (e.g. sardines, anchovy) that might be useful for future implementation in ecosystem based assessment strategies and studies on species interaction and basic ecology. Those surveys should be subject to careful evaluation after an initial phase (2–3 surveys). The surveys should be conducted following the full protocol.

3.4 Subgroup 2 - discussion on adult parameter estimation issues

Participants: Kostas Ganias, Olav Kjesbu, Maria Manuel Angélico, Tim Ward, Hannes Hoffle, Merete Fonn, Maria Krüger-Johnsen, Foivos Mouchlianitis

Introductory notes:

For the AEPM, the parameter of the adult survey that mostly needs to be addressed is potential annual fecundity. The two most important issues for the estimation of this parameter are:

- 1) the choice of the appropriate females (prespawning fish which have accumulated the whole number of the standing crop of oocytes), and
- 2) the correct assessment of subsequent fecundity losses in order to accurately estimate the realized fecundity.

The first task can be accomplished through a) following the seasonal evolution of the mean diameter of oocytes and b) assessing the shape of the oocyte size frequency distribution. This method works well for e.g. cod. However, the second task (as part of the common process of fecundity downregulation) is painstaking since it requires correct estimates of atretic intensity extrapolated to the entire spawning period

The most important deficiencies in applications of the AEPM are that:

- 1) the population/stock/species needs to be a determinate spawner. Otherwise the weight specific annual egg production from the adult survey will be an underestimate, and
- 2) the major logistical costs of the egg survey

There was consensus among the group that ideally the DEPM should be devised for all kind of spawners, both determinate and indeterminate.

Among the four parameters of the adult survey of the DEPM (sex ratio, mean weight, batch fecundity and spawning fraction) the parameter which mostly needs to be addressed is the spawning fraction.

Batch fecundity is not an issue for some species like sardine that display stable fecundity per weight values (temporarily, spatially). However, batch fecundity can vary significantly for some other species like anchovy. The latter is an extreme income breeder and the status of the adult prey fields at spawning might have severe effects on oocyte/egg production.

Ideally batch fecundity is estimated by the hydrated oocytes method. However, in cases where hydrated females are very scarce or even absent other stages can equally serve in batch fecundity estimations. This has been shown for some species like the anchovy and sardine whereas for other species like horse mackerel vitellogenic stages do not seem to work well. However, it is quite possible that the late migratory nucleus stage might be effective for horse mackerel; this is a task which needs to be explored in the near future.

Work plans:

The group has agreed that new methods should be developed for estimating the spawning fraction, alternative to the POF method. This method should be:

- able to be applied to any kind of spawner, determinate/indeterminate and
- more cost-effective and less labor intensive than the POF method

The group discussed the possibilities of developing/testing new methods based on estimating spawning intervals at individual levels instead of spawning fractions which are population estimates.

Four model species have been proposed: sardine and cod, as typical indeterminate and determinate spawners, respectively, and horse mackerel and mackerel which are commercially important species which are currently assessed through the AEPM (e.g. the MEGS survey). For horse mackerel of the southern stock (Finisterre-Gibraltar) the implementation of DEPM is underway but issues related to spawning fraction estimation have not been resolved yet.

New method developments will be based on collections of samples of ovarian tissue collected through national sampling programmes. The most important prerequisites are that:

- samples cover the entire period from the very onset of the reproductive season to at least the peak of spawning,
- there are series of histological specimens (HIST) and their respective pair of ovarian whole mounts (WM) (i.e. from the same individuals).

The group has agreed that the preservation means and the histological protocol of these samples is important but not prohibitive for further method developments.

This plan can lead to new estimates of spawning frequency that can be compared with historical estimates of spawning frequency either from field studies (Australian/Atlantic sardine) or from tank experiments (cod).

A series of innovative techniques and concepts have been suggested for the development of new methods.

The subgroup has decided to organize a skype meeting during December 2016 with all potential participants, from all institutes, in the work plan being considered.

Other notes from the discussion:

How to estimate spawning frequency besides the POFs method?

1) Experiments/Tasks:

- Conduct field studies for cod to compare results with the spawning frequency results from tank experiments
- Implement new techniques: (1) different staining, (2) pulse pen separator
- Time in the preservation solution should be checked
- Process old samples to have both WM and HIST samples for each individual

2) Requirements:

- Histological slides and WM samples should be analysed for the same individuals
- Should samples cover the whole spawning period? Maybe samples that cover the time just before the onset until the peak of the spawning period are enough.

3) Who is going to be involved?

Several institutes are willing to participate but details on the involvement of each institute and on the species to be considered are to be agreed. Participants will include **IMR** (Norway), **AUTH** (Greece), **AQUA-DTU** (Denmark), **IPMA** (Portugal), **AZTI** (Spain), **IEO** (Spain), **Wageningen Marine Research** (Netherlands) and **SARDI** (Australia). **IMR** (Norway) and **AUTH** (Greece) will lead the method development.

4) Species:

- The project should focus on 4 species: (1) sardine (indeterminate spawner), (2) cod (determinate spawner), (3) horse mackerel (indeterminate like spawner), (4) mackerel (determinate like spawner)

5) Schedule:

- The task should be completed during 2017 and results will be presented at the next WGALES meeting.

WGALES considers this effort to explore alternative ways for spawning fraction estimation very valuable and fully endorses it.

4 Template of ICES ichthyoplankton surveys protocols (ToR c and WKESST recommendation)

Template of ICES ichthyoplankton surveys protocols (ToR c and WKESST recommendation)

At the 2014 WGALES meeting a template for ICES ichthyoplankton survey protocols was developed and presented in the 2014 WGALES report. At this year's meeting, a presentation given by Cindy van Damme on clogging of plankton nets (see Annexes 5 and 6), concluded that clogging could result in serious over- and underestimation of fish egg and larvae abundances. Since clogging problems are, with one exception, never dealt with in most ICES egg and larvae protocols, it was decided not only to recommend that all plankton survey groups should check and revise their survey protocols accordingly, but that also the template for ichthyoplankton survey protocols should include clogging and data quality issues.

The updated template should, thus, read as follows:

General guide lines from SISP

- * Background
- * Comprehensive set of objectives
- * Survey sampling design
- * Observation methodology
- * Protocol for sampling gear and instrumentation
- * Protocol for collecting biological samples
- * Caveats
- * Analysis
- * Reporting Results
- * Survey summary sheet

WGALES recommends to include:

1. Background

- * Objectives
- * Some notes on the history of surveys (and method) and institutions (countries) involved
- * Target species and deliverables from survey (indices and its application)

2. Surveying

- * Area and period of survey
- * Sampling
 - o Egg, larvae
 - o Adults
 - o Hydrology
 - o Other (e.g. birds and mammals)

- o Gear and operation, design (pros and cons) and sampling at sea (e.g. subsampling, fish measurements, etc.), problems encountered during sampling (e.g. clogging) sample preservation

1. Sample processing

- * Egg, larvae (procedures for sorting, counting, identification, measurements, etc. equipment used); description of identification keys and scales of development for stages (including photos or schemes)

- * Adults (procedures for weighting, counting oocytes, histology, etc. equipment used); description of stages for maturation, atresia, oocyte development, POFs degeneration, measurements for fecundity, age reading, etc. (including photos or schemes)

2. Analyses of data

- * Egg, larvae

- * Clogging checks and according data flags

- * Adults, including markers and estimators (e.g. POFs, which cohorts), formulas, statistical approaches and parameter definition for particular functions, variance estimation, strata definition, software, etc. (pros and cons)

5. Products

- * Indices and its usage (which groups use the info and to what end)

- * Reports produced and where they are stored, periodicity (what to include in the report)

- * Data update and storage

5 Chair

Maria Manuel Angélico is due to step down at the beginning of 2017 as one of the chairs. All participants agreed that WGALES is an important group and should continue. However, the participants at the meeting were not available to take over the co-chairpersonship. Therefore, Richard Nash and Maria Manuel Angélico will recruit a new chair during 2017.

6 Next meetings

Next meeting of WGALES will be held in Vigo, Spain, on 22–26 October 2018.

If necessary WGALES will meet by correspondence to act upon urgent requests from ichthyoplankton survey groups (ToR c).

Specific Topics for the 2018 meeting:

Session 1

General topics on ichthyoplankton surveys

Session 2

Fish eggs and larval development and early life strategies in boreal and tropical regions.

The theme session focuses on all aspects of early life stages of ichthyoplankton like taxonomy, egg and larvae mortality and development, stage duration (e.g. in relation to temperature, salinity, start of spawning season etc.) and strategies of foraging larvae to cope with ambient conditions in different regions of the marine environment.

Session 3

Estimating spawning frequency using alternative methods to the postovulatory follicle (POF) method

This theme session focuses on the development of various methods for estimating the spawning frequency of multiple spawners in a less costly and labour-intensive manner than the standard POF method. This will also allow the application of the DEPM to boreal stocks with very low POF degeneration rates, which are otherwise assessed through the AEPM. It is foreseen that this theme session also will provide important 'spin-off' discussions on determinacy/indeterminacy issues and fecundity counting as such.

Annex 1: List of participants

| Name | Address | E-mail |
|-------------------------------|---|-------------------------------|
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|-------------------------|---|---------------------|
| Olav Kjesbu | Institute of Marine Research, Norway | olav.kjesbu@imr.no |
| Richard Nash (chair) | Institute of Marine Research, Norway | Richard.Nash@imr.no |
| Tim Ward | SARDI Aquatic Sciences Centre | tim.ward@sa.gov.au |

Annex 2: Agenda

WGALES Meeting agenda: Monday 17 – Friday 21 October 2016

Monday 17 October

| Time | | Presentation no. | Authors | Title/Topic |
|------|------------|------------------|---|---|
| 1400 | Opening | | MM, RDMN, KG | |
| 1430 | | <u>01</u> | <u>Norbert Rohlf</u> , Cindy van Damme | The International Herring Larvae Surveys in the North Sea (IHLS) |
| 1500 | | <u>02</u> | <u>Brendan O' Hea</u> | MEGS surveys 2016 |
| 1530 | | <u>03</u> | <u>Matthias Kloppmann</u> , Cindy van Damme, Richard Nash, Bastian Huwer, Christophe Loots | When (How?) things go wrong: How larval drift can distort stock abundance estimates |
| 1600 | Coffee | | | |
| 1630 | | <u>04</u> | <u>Carlos Pinto</u> | ICES Databases for Egg and larvae related surveys |
| 1700 | Discussion | | | |
| 1730 | End | | | |

Tuesday 18 October

| Time | | Presentation no. | Authors | Title/Topic |
|------|--|------------------|---|---|
| 0900 | | <u>05</u> | <u>Richard Nash</u> <i>et al.</i> | Insights in to the winter spawning of fish in the North Sea – the MIKeyM programme attached to the ICES 1st Quarter IBTS. |
| 0930 | | <u>06</u> | <u>Franziska Bils</u> , Marta Moyano, Myron Peck | Making the most of the surveys: Implementing plankton sampling in ICES-coordinated herring larval surveys |
| 1000 | | <u>07</u> | <u>Richard Nash</u> <i>et al.</i> | Spatial and temporal variability of the ichthyoplankton of the northern North Sea – the IMR Pelagic Ecosystem |

| | | | Group research Group studies |
|------|------------|--|--|
| 1030 | Coffee | | |
| 1100 | <u>08</u> | <u>Mohamed Ahmed Abu El-Regal</u> | Governance of Red Sea reef fisheries based on egg and larvae surveys |
| 1130 | <u>09</u> | <u>Maik Tiedemann</u> , Luc Badji, Heino Fock | The Cape Verde Frontal Zone: A barrier for larval fish assemblages |
| 1200 | <u>10</u> | <u>Richard Nash</u> <i>et al.</i> | The late summer distribution of ichthyoplankton in the northern North Sea and potential insights in to the location of offshore nursery grounds. |
| 1230 | Lunch | | |
| 1400 | <u>11</u> | <u>Andrei Makarchouk</u> | Modelling the vertical distribution of sprat eggs in the changing conditions of the Eastern Baltic |
| 1430 | 12 | Nielja Knecht, Rainer Oeberst, Paul Kotterba, <u>Patrick Polte</u> | Effects of climate change on herring recruitment phenology in a Baltic Sea inshore retention area |
| 1500 | <u>13</u> | <u>Cindy J.G. van Damme</u> , Finlay Burns, Brendan O'Hea | Clogging of the net during ichthyoplankton samplings |
| 1530 | <u>14</u> | <u>Jens Ulleweit</u> , Matthias Kloppmann, Sakis Kroupis | Not all eggs sink: Revision of the spray technique |
| 1600 | Coffee | | |
| 1630 | Discussion | | |
| 1700 | Discussion | | |
| 1800 | End | | |

Wednesday 19 November

| Time | | Presentation no. | Authors | Title/Topic |
|------|---------|------------------|---|--|
| 0900 | Keynote | <u>15</u> | <u>Kostas Gantias</u> , Olav Sigurd Kjesbu | Revised lines of evidence and suggested methodology for better assessing fish fecundity type |
| 1000 | | <u>16</u> | <u>Hannes Höffle</u> , Frode Vikebø, Olav Sigurd Kjesbu | How do potential and actual fecundity compare? – Numerical loss and dispersal between vitellogenesis and egg sampling in northeast Arctic cod (<i>Gadus morhua</i>) |
| 1030 | Coffee | | | |
| 1100 | | 17 | Mouchlianitis F.A., Gantias K., Nunes C., Costa A.M., Angelico M.M. | A simple microscopic marker in the assessment of pre-ovulatory horse mackerel (<i>Trachurus trachurus</i>) ovaries |
| 1130 | | <u>18</u> | <u>Kostas Gantias</u> , Mouchlianitis Foivos-Alexandros, Nunes Cristina, Costa Ana- Maria, Angélico Maria- Manuel | Can indeterminate spawners cease recruiting oocytes during their spawning season? The case of horse mackerel (<i>Trachurus trachurus</i>) stock in the Atlantic Iberian waters |
| 1200 | | <u>19</u> | <u>Cristina Nunes</u> , Kostas Gantias, Ana Maria Costa, Daniel Pinto, Elisabete Henriques, Foivos Alexandros Mouchlianitis, Maria Manuel Angélico | Daily spawning periodicity in North-east Atlantic horse mackerel (<i>Trachurus trachurus</i>) |
| 1230 | Lunch | | | |
| 1300 | | | | |
| 1430 | | <u>20</u> | <u>Constantina Karlou-Riga</u> , Dimitra Petza, Dimitra Koulmpaloglou, Panagiotis Anastopoulos | Batch fecundity and reproductive strategy of picarel (<i>Spicara smaris</i> , L) in the Saronikos Gulf (Greece) |

| | | | |
|------|-------------|--|---|
| 1500 | <u>21</u> | <u>Tim Ward</u> , Jonathan Carroll, Rick McGarvey, Charles James | Recent developments in the estimation of daily egg production |
| 1530 | <u>22</u> | <u>Tim Ward</u> | Recent application of the daily egg production method to Jack Mackerel (<i>Trachurus novaezelandiae</i>) |
| 1600 | <u>23</u> | <u>Maria Manuel Angélico</u> , Elisabete Henriques, Cristina Nunes | Taking full advantage of surveys: concurrent DEPM sampling for sardine and horse-mackerel in southern and western Atlantic Iberian waters |
| 1630 | Coffee | | |
| 1700 | Discussions | | |
| 1800 | End | | |
| 2000 | Dinner | | |

Thursday 19 October

| Time | Presentation no. | Authors | Title/Topic |
|------|------------------|---------|--|
| 0900 | Excursion | | |
| 1300 | Lunch | | |
| 1430 | Plenary | | Summing up, discussions, subgroup work |
| 1600 | Coffee | | |
| 1630 | WGALES Business | | ToRs, next meeting etc. |
| 1730 | | | Report structure |
| 1800 | End | | |

Friday 20 October

| Time | Presentation no. | Authors | Title/Topic |
|------|------------------|---------|-----------------------------|
| 0900 | | | Report assembly and writing |
| 1200 | End | | |

Annex 3: WGALES multi annual ToRs

WGALES – Working Group on Atlantic Fish Larvae and Eggs Surveys

2012/MA2/SSGESST17

The **Working Group on Atlantic Fish Larvae and Eggs Surveys (WGALES)**, chaired by **to be determined**, and Richard D. M. Nash, Norway, will work on ToRs and generate deliverables as listed in the Table below.

| | Meeting dates | Venue | Reporting details | Comments (change in Chair, etc.) |
|-----------|----------------|----------------------|--|---|
| Year 2013 | Correspondence | Intersessional | Interim report by 5 January 2015 May 2013 to SSGESST (SSGIEOM) | Group is planning to meet face to face in 2 nd year – see below. |
| Year 2014 | 1–5 December | San Sebastian, Spain | Interim report by 5 January 2015 to SSGIEOM | Cindy Van Damme to be replaced by Richard Nash for the next meeting of WGALES |
| Year 2016 | 17–21 October | Thessaloniki, Greece | 2 nd Interim report by 1 December 2016 to SSGIEOM, SCICOM | Group is completing their second year of work, Maria Manuel Angélico to be replaced in 2017. |
| Year 2018 | 22-26 October | Vigo, Spain | Final report by 1 December 2018 to SSGIEOM | <i>This group will be finalizing their third year in 2018 as every second year the group is doing fieldwork</i> |

ToR descriptors

| ToR | Description | Background | Science Plan topics addressed | Duration | Expected Deliverables |
|-----|--|---|-------------------------------|----------------------------------|----------------------------|
| a | Present current ichthyoplankton surveys in the light of their original purposes, with respect to design, estimation methods and challenges (including their potential as ecosystem surveys); | The activities of WGALES are vital for the delivery of state-of-the-art ichthyoplankton surveys, ensuring high standards and incorporating new techniques and developments for the future. WGALES will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence | 5.1, 5.2 | Years 1, 2, 3 (2014, 2016, 2018) | Report in 2014, 2016, 2018 |

| | | | | | |
|---|--|--|----------|--|--|
| | | providing a platform from which to improve the assessments based on the ichthyoplankton surveys. WGALES fits into the ICES science plan sections 5.1 and 5.2. | | | |
| b | Present current understanding and future research needs of natural mortality of fish eggs and larvae in order to improve accuracy and precision of egg production and larvae abundance estimates of the ichthyoplankton surveys; | Use of natural mortality in egg production and larvae abundance estimates is limited. Current developments and use of natural mortality estimates to improve accuracy and precision of ichthyoplankton survey estimates. | 5.1, 5.2 | Year 1 (2014) | Report with review of developments and needs for future research of natural mortality of fish eggs and larvae. Suggestions on how natural mortality can be incorporated in egg production and larvae abundance estimates of the ichthyoplankton surveys. |
| c | Prepare a template for the ICES ichthyoplankton survey protocols | A new publication series of survey protocols on ICES surveys has been initiated. No template exists for the ichthyoplankton survey protocols. | | Year 1 (2014) | Survey protocol template for ICES ichthyoplankton surveys. |
| d | Receive and act upon ToRs from Working Groups within the umbrella of ichthyoplankton surveys e.g. IBTSWG, WGACEGG, WGIPS, WGMEGS, WGEGBS2. | The activities of WGALES are vital for the delivery of state-of-the-art ichthyoplankton surveys, ensuring high standards and incorporating new techniques and developments for the future. WGALES will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence providing a platform from which to improve the | 5.1, 5.2 | Years 1, 2, 3).If necessary WGALES can react by correspondence on urgent ToR's from other ichthyoplankton surveys groups in 2013, 2015 and 2017. During the meeting in 2014 ToR's from ichthyoplankton survey groups from 2013 and 2014 will be addressed and reported on. | Report in 2014, 2016, 2018. Responses to specific requests from the ichthyoplankton Working Groups. |

| | | assessments based on the ichthyoplankton surveys. | | | |
|----|--|---|----------|------------------------|--|
| e | Present current understanding and future research needs for integrating ichthyoplankton data and methodologies into methodologies for assessing population sizes. Undertake investigations on streamlining and cost effective surveys and methodologies for the implementation of Egg Production Methods for estimating Spawning Stock Biomass | Ichthyoplankton surveys are often part of a larger and more encompassing set of studies which are aimed at determining population size e.g. Egg Production Methodologies. There is a need to review the various aspects of such research, as a complete study, to ensure the correct data are collected and there is a general understanding of how all the parts fit together to ensure complete and as accurate and precise as possible estimates of stock size are realised. | 5.1, 5.2 | Year 2, 3 (2016, 2018) | Report with review of methodologies and potential 'pitfalls' for undertaking multidisciplinary estimations of stock size which involve the use of ichthyoplankton surveys, and needs for future research for a better integration of fish egg and larvae data. |
| f. | Present and report on fish eggs and larval development and early life strategies in boreal and tropical regions. | The timing and type of ichthyoplankton survey needs to be tailored over spatial and temporal scales. Consideration also needs to be made for the taxonomy, egg and larvae mortality and development, stage duration (e.g. in relation to temperature, salinity, start of spawning season etc.). Other basic information needs to be also considered such as strategies of foraging larvae to cope with ambient conditions in different regions of the marine environment. Some of this information can also be obtained from the surveys providing an appropriate survey design is implemented. | 5.1, 5.2 | Year 3 (2018) | Report in 2018 on the life history strategies of fish eggs and larvae over a range of ecosystems. The report will suggest optimal sampling strategies for determining abundance, mortality, distribution and ecology of the early life history stages of fishes. |

Summary of the Work Plan

| | |
|-----------------------------|--|
| Year 1 (2013/14) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and then meet to address ToRs a, b, c and d. |
| Year 2 (2015/16) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and then meet to address ToRs a, d and e. |
| Year 3 (2017/18) | WGALES will communicate by correspondence to act upon urgent Tor's from ichthyoplankton survey groups (ToR d) and work on developments in methodology in adult reproductive parameters (ToR e). The WG will then meet to address ToRs a, d, e and f. |

“Supporting information

| | |
|--|---|
| Priority | The activities of WGALES are vital for the delivery of state-of-the-art ichthyoplankton surveys, ensuring high standards and incorporating new techniques and developments for the future. WGALES will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence providing a platform from which to improve the assessments based on the ichthyoplankton surveys. WGALES fits into the ICES science plan sections 5.1 and 5.2. |
| Resource requirements | The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required is ICES secretariat support for reports. |
| Participants | The Group will be attended by members of ICES groups, WGMEGS, WGEGBS2, WGIPS, IBTSWG, WGACEGG and guests carrying out ichthyoplankton surveys in the non-ICES areas. |
| Secretariat facilities | ICES secretariat support for reports. |
| Financial | DCF funding is required to support the attendance of the meetings. |
| Linkages to ACOM and groups under ACOM | There are linkages with the advisory committees through the individual ichthyoplankton surveys groups. Through the review and standardization of the ichthyoplankton surveys the quality of the data for the assessments is ensured. |
| Linkages to other committees or groups | SCICOM and there is a very close working relationship with the all the groups of ichthyoplankton surveys, WGMEGS, WGEGBS2, WGIPS, IBTSWG, WGACEGG and their assessment groups, WGWIDE, HAWG, WGHANSA. |
| Linkages to other organizations | No formal linkages. |

Annex 4: Recommendations

| Recommendation | Adressed to |
|---|---|
| All ichthyoplankton survey groups should check their survey manuals as to whether clogging and other data quality issues are dealt with and sufficient protocols are in place. Survey manuals should be revised accordingly. | IBTSWG, WGEGBS2, WGMEGS, WGIPS, WGACEGG |
| WGALES recommends exploration and testing of new methods for estimating spawning fraction alternative to the postovulatory follicle (POF) method. These methods should be more cost-effective and less labour-intensive and applicable to any kind of spawners. | WGEGBS2, WGMEGS, WGACEGG, WGFATHOM |
| If the IBTSWG decides to include plankton sampling into the 3 rd Quarter IBTS then it is advisable to contact and discuss the sampling strategy and protocols with WGALES before implementing a new sampling regime. | IBTSWG, WGISUR |

Annex 5: Abstracts of presentations

All presentations are housed on the WG SharePoint, with the exception of 08,

| Presentation no. | Name, Title, Abstract |
|------------------|--|
| 01 | <p>Norbert Rohlf¹ and Cindy van Damme</p> <p>¹Thünen-Institute (TI), Institute of Sea Fisheries, Federal Research Institute for Rural Areas, Forestry and Fisheries, Palmallee 9, 22767 Hamburg, Germany</p> <p><i>The International Herring Larvae Surveys in the North Sea (IHLS)</i></p> <p>Herring larval surveys have a long tradition in the North Sea. At spawning time in autumn and winter, newly hatched larvae are caught at the spawning grounds. ICES coordinates surveys started in 1967 and data on larval abundance at length and sampling location exist since 1972. The abundance of small larvae is used as an indirect estimator of North Sea herring spawning biomass.</p> <p>Here, we briefly describe the history of the International Herring Larvae Surveys in the North Sea and adjacent waters (IHLS), with focus on used methodologies and changes in survey design, report on spawning habitat conditions and summarize advantages and recent shortcomings in the IHLS. We will also present some thoughts and results when taking foraging larvae more into account compared to newly hatched ones.</p> |
| 02 | <p>Brendan O' Hea</p> <p>Marine Institute, Ireland</p> <p><i>MEGS surveys 2016</i></p> <p>WGMEGS coordinates the triennial mackerel and horse mackerel egg survey, which was carried out once again in 2016. The surveys were carried out by nine laboratories from eight participating countries with each participant being allotted a period and survey area. The survey was divided into eight periods from mid-January to mid-August and the sampling area stretched from Cadiz in the south to the Faroes in the north. Twenty one surveys were carried out in total. The data will be used to estimate the egg production of mackerel and horse mackerel over the entire survey period and area. Combining these figures with the fecundity of the females and the sex ratio of the population will give an estimate for the spawning-stock biomass. A preliminary biomass estimate was presented to WGWISE at the end of August for use in the stock assessment process. The final survey results will be produced by WGMEGS in April 2017.</p> |
| 03 | <p>Matthias Kloppmann¹, Cindy van Damme,, Richard Nash, Bastian Huwer, Christophe Loots</p> <p>¹Thünen-Institute (TI), Institute of Sea Fisheries, Federal Research Institute for Rural Areas, Forestry and Fisheries, Palmallee 9, 22767 Hamburg, Germany</p> <p><i>When (How?) things go wrong: How larval drift can distort stock abundance estimates</i></p> <p>For assessment purposes, marine ecosystems are often treated as closed systems. Particularly when recruitment is calculated based on larval abundance, unusual drift events can lead to erroneous results. The Mid Water Ringnet (MIK) Survey, undertaken during the 1st quarter International Bottom Trawl Survey, delivers a recruitment index for North Sea herring larvae. The index represents the offspring of the autumn spawning compo-</p> |

nents only, therefore, the MIK herring larvae index should not be influenced by larval abundances from the winter spawning Downs component, which often occur in large quantities in the southern part of the survey area. Another source of error is the intrusion of herring larvae originating in the west of Scotland. While the latter is currently of minor importance, the Downs larvae have to be reliably taken out from the index calculation. In order to achieve this, the index algorithm excludes all stations south of 54°N with mean larval lengths of less than 20 mm SL. In recent years, however, enhanced drift of small larvae of Downs origin northwards and beyond that latitude lead to the inclusion of large abundances of too small larvae in the index calculation. This resulted in a biased MIK index that should, otherwise, have been much lower.

04

Carlos Pinto

ICES Secretariat, Copenhagen, Denmark

Status of the Eggs and larvae database

ICES in cooperation with the various eggs working groups has tried to put focus on the Ichthyoplankton surveys in the latest years, and the online platform is a clear indication of this. We have promoted a workshop to develop the format of Eggs and Larvae, the users can screen their data online and request the upload of their data to the Eggs and Larvae database. We can now start discussing the possible outputs and services that we can develop to facilitate the Ichthyoplankton surveys community.

(<http://eggsandlarvae.ices.dk/>)

05

Richard Nash *et al.*

IMR, Bergen, Norway

Insights in to the winter spawning of fish in the North Sea – the MIKeyM programme attached to the ICES 1st Quarter IBTS

In 2012 sampling for fish eggs was started in conjunction with the ICES 1st Quarter IBTS. The standard sampling equipment consisted of one or two 20 cm diameter ringnets (325µm mesh) (MIKeyM) attached to the outside the standard 2 m diameter midwater ring trawl (MIK) which was deployed to sample herring larvae. Currently there is a requirement for all countries participating in the MIK sampling between January and March each year in the North Sea to undertake the MIKeyM sampling. The extent of the coverage and some of the results which can be obtained from this sampling programme will be shown. The advantages, problems and obstacles for this to be a fully successful sampling programme will be presented.

06

Franziska Bils, Marta Moyano and Myron Peck

University of Hamburg, Institute for Hydrobiology and Fisheries Science, Olbersweg 24, 22767 Hamburg, Germany

Making the most of the surveys: Implementing plankton sampling in ICES-coordinated herring larval surveys

Understanding the impact of key environmental variables on larval growth and survival of Atlantic herring (*Clupea harengus*) is essential to grasp recruitment variability. Among all factors, temperature and food are key factors for larvae from this species in the North Sea. However, little is known about feeding interactions and the planktonic environment that herring larvae experience prior to metamorphosis. In order to evaluate the feeding environment experienced by the larvae, and further resolve the microzooplankton-ichthyoplankton link, additional plankton sampling was added to several ICES-coordinated herring stock assessment surveys (Northern Irish Herring Larvae survey, NINEL; International Herring Larval Survey, IHLS; International Bottom Trawl Survey, IBTS) since 2012. Here two examples will be discussed. First, large-scale microzooplankton sampling during the IBTS 2014 revealed a homogenous community composition in the entire North Sea basin. But higher microzooplankton biomass was observed in the

southern North Sea, which may be important for winter-spawned larvae. Second, results from the NINEL survey were combined with modelling efforts, suggesting a supportive role of microzooplankton to larval nutrition. These results highlight the need to implement this size fraction into physiological Individual-Based Models. In summary, these routine surveys represent an ideal platform to gain further knowledge of long-term plankton dynamics in the North Sea, which are extremely relevant not only for understanding larval growth and survival but also for other modelling and ecosystem-based approaches. Ongoing work and the future for other potential collaborations will also be discussed.

07

Richard Nash *et al.*

IMR, Bergen, Norway

Spatial and temporal variability of the ichthyoplankton of the northern North Sea – the IMR Pelagic Ecosystem Group research Group studies

In April/May 2010 IMR concentrated sampling of four standard transects across the northern North Sea into one cruise and added sampling of fish eggs and larvae in to the standard hydrography, phyto and zooplankton sampling. In addition two process stations, which could last up to 48 hours, were also added to the cruise programme. The success of this pilot study resulted in similar cruises being undertaken from 2012 to the present. Over the years the survey has increased in the number of transects across the North Sea and now incorporates a series of transects within the Skagerrak. This survey provides detailed information on the physical water column structure, nutrients, chlorophyll a, phytoplankton and zooplankton (species and dry weights), fish eggs and larvae on an annual basis. In addition small-scale variability of fish egg and larvae distributions along with diel variability of vertical distribution is also obtained. Examples of the data obtained will be presented. Future plans and potential pitfall for this survey will also be presented.

08

Mohamed Ahmed Abu El-Regal

Marine Science Department, Faculty of Science, Port Said University, Port Said, Egypt

Governance of Red Sea reef fisheries based on egg and larvae surveys

As many species in the Red Sea are now overfished or even exploited, actions should be taken to protect the spawning stocks of these species. For these actions to be effective they should be built upon a solid scientific base that depends mainly on the determination of the spawning seasons and spawning and nursery grounds of the commercial species. This study is an attempt to utilize the larval stages of fish life to determine the spawning seasons, spawning grounds of some reef fish in the Red Sea. Fish larvae were collected from different areas along the Red Sea coast by plankton nets of different mesh size and different diameters. The collected larvae were divided into yolk-sac larvae, preflexion larvae and postflexion larvae and the existence of each stage was determined. Larvae of 120 reef fish taxa were collected and the time of occurrence of each taxon was used as indication of the spawning seasons. It was found that reef fish could be divided into 8 categories according to occurrence of their eggs and small larvae. Most of the reef fish spawn in the warmer months of the year (May to August). *Mulloides flavolineatus*, *Gerres oyena* were found to spawn in the warmer months. This study contains very valuable data on the spawning seasons of the reef fish in the Red Sea and should be considered by the decision-makers in the Red Sea. Most reef fish spawn away from the reef and only few species such as *Gerres oyena* was found to spawn close to the reef. Only few reef species settle to the reef while most settle either in mangroves or seagrasses. Many more studies on where and when reef fish lay their eggs and the dispersal patterns of the early stages of reef fish are required.

09

Maik Tiedemann¹, Luc Badji², Heino Fock¹

¹Thünen-Institute (TI), Institute of Sea Fisheries, Federal Research Institute for Rural Areas, Forestry and Fisheries, Palmallee 9, 22767 Hamburg, Germany

²Institut Fondamental d'Afrique Noire - Cheikh Anta Diop, Laboratoire de Biologie et d'Ecologie des Poissons en Afrique de l'Ouest (LABEP-AO), BP 206, Dakar, Sénégal

The Cape Verde Frontal Zone: A barrier for larval fish assemblages

Frontal zones can delimit the extent of larval fish transport. In the Atlantic the Cape Verde Frontal zone (CVFZ) is a transition between two distinct water masses, the colder and less saline South Atlantic Central Water (SACW) and the warmer and more saline North Atlantic Central Water (NACW). The transition of both water masses along the CVFZ might play a role as barrier for larval transport and can have implications to zoogeography, access to feeding grounds and population connectivity. For the first time, SACW and NACW associated spring larval fish assemblages were identified from the shelf to the open ocean along the CVFZ. We could identify species that either exclusively occurred in the NACW (e.g. *Dicologlossa cuneate*, *Sparidae* sp.1) or in the SACW (e.g. *Engraulis encrasiocolus*, *Bentosema glaciale*, *Myctophum punctatum*, *Helicolenus dactylopterus*) indicating favourable spawning in specific water masses. Only at the direct CVFZ transition a mix of the assemblages were occasionally observed due to a stationary anti-cyclonic eddy or interleaving and double diffusion. Our findings suggest that the flow pattern of the mayor currents transporting NACW and SACW delimit larval fish transport at the CVFZ influencing further habitat expansion of early life stages of fish.

10

Richard Nash *et al.*

IMR, Bergen, Norway

The late summer distribution of ichthyoplankton in the northern North Sea and potential insights in to the location of offshore nursery grounds.

During July and August each year one or two standard transects across the northern North Sea are sampled, often in association with the ICES 3rd Quarter IBTS. Ichthyoplankton sampling with 2 m midwater ring trawls (MIK) is included as part of the standard sampling programme. These samples give an indication of the distribution of larvae in the summer and in conjunction with the April/May sampling provide insights in to the movement of larvae around the northern North Sea. These data, coupled with the standard IBTS sampling and the addition of relatively fine meshed 1m beam trawl sampling give insights in to the location of offshore nursery ground, especially for flatfish.

11

Andrei Makarchouk

Scientific Institute "BIOR", Fish Resources Research Department, 8 Daugavgrivas Street, Riga, LV-1048, Latvia.

Modelling the vertical distribution of sprat eggs in the changing conditions of the Eastern Baltic

Investigations of the vertical distribution of ichthyoplankton in the Gdańsk Deep and the Gotland Basin were performed with BIOMOC multiple opening/closing net in 1996–2000. Pelagic eggs of Baltic sprat were floating in the wide range of depths: eighty per cent of eggs were usually distributed in the water layers of 30–60 m thickness. The mean depth of them was generally decreasing during the spawning season. Generalized vertical distribution of sprat eggs relative to their mean specific gravity has been made. All the calculations were bound to determine density of water and specific gravity of sprat eggs, because salinity and temperature profiles were changing with time and place considerably. A simple model for the determination

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| | <p>of the mean depth of eggs was made taking into account only the temperature of water in the upper layer. The pattern of vertical distribution was determined in two steps: first, mean specific gravity of eggs was calculated dependently on the water temperature at 10 m depth, and second, generalized vertical distribution was plotted against real water density profile.</p> |
| 12 | <p>Nielja Knecht, Rainer Oeberst, Paul Kotterba, Patrick Polte <i>Effects of climate change on herring recruitment phenology in a Baltic Sea inshore retention area</i></p> <p>Despite improved spawning-stock biomass, the past decade saw a period of reduced recruitment of larval herring (<i>Clupea harengus</i>) in a major inshore larval retention area in the Western Baltic Sea. Hypothesizing a shift of optimal thermal periods for egg development and larval growth, we analysed a 20 year time-series of larval herring abundance data according to the seasonal setting of 1) on st of spawning season, 2) thermal viable hatch windows, 3) optimum growth windows and 4) response to steepness of seasonal temperature gradients. The results revealed that a temperature induced earlier beginning of the spawning period had negative impacts on the year-class strength of recruits. Both, optimum seasonal temperature windows and optimum growth windows occurred earlier during the past decade affecting early life stage mortality. Steep temperature leaps occurred more frequently than in former decades, also considered to negatively affect egg development and larval survival and triggering secondary temperature effects, such as fungal infestation of eggs and blooms of filamentous algae on benthic spawning beds. Although significant effects of seasonal temperature shifts on herring phenology could be identified, a suite of varying ecological cascades leads to relatively weak correlations between changes in the temperature regime and larval herring abundance.</p> <p>Present approaches deal with statistical methods to receive higher precision to visualize the impact of changing seasonal temperature regimes on herring recruitment.</p> |
| 13 | <p>Cindy J.G. van Damme¹, Finlay Burns and Brendan O’Hea ¹Wageningen Marine Research, PO Box 68, 1970 AB IJmuiden, The Netherlands</p> <p><i>Clogging of the net during ichthyoplankton samplings</i></p> <p>When there is lots of phytoplankton or small jellies in the water sampling ichthyoplankton can be a nightmare. In those cases it is usually clear that the net was not sampling correctly. During the 2016 mackerel and horse mackerel egg survey however, we were catching small numbers of eggs and larvae while expecting large numbers. Looking at the net, clogging did not seem an issue, but comparing internal and external flowmeter revolutions showed there was an issue with the volume water filtered.</p> <p>Most survey protocols do not give instructions to check for clogging and in case of serious clogging how to deal with the sample or data. If anything is considered it is usually the amount of water filtered but not the representativeness of the sample. Is clogging an issue or not that should be considered?</p> |
| 14 | <p>Jens Ulloweit¹, Matthias Kloppmann and Sakis Kroupis ¹Thünen-Institute (TI), Institute of Sea Fisheries, Federal Research Institute for Rural Areas, Forestry and Fisheries, Palmaille 9, 22767 Hamburg, Germany</p> <p><i>Not all eggs sink: Revision of the spray technique</i></p> <p>During the Mackerel and Horse Mackerel Egg Survey (MEGS), the spray technique is a widely accepted method to quickly remove almost all fish eggs from plankton samples. During the 2016 MEGS, the German participants also applied this method at their survey. After completion of the survey, all samples were re-examined to remove all remaining eggs by hand. It</p> |

| | |
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| | <p>turned out that on some stations, a large number of eggs were apparently not removed by the spray method. While disturbing at a first glance, identification and staging of the eggs showed that the major part of those were neither mackerel nor horse mackerel rather than belonging to other, non-target species. One of those species was <i>Maurolicus muelleri</i>, which eggs have a sculptured chorion offering high friction allowing air bubbles to lift them upwards with the other plankton. But also eggs of other species appeared to remain consistently with the plankton. The findings from the re-examination were experimentally validated with mackerel and other fish species eggs.</p> |
| 15 a,b,c | <p>Kostas Ganias¹ and Olav S. Kjesbu^{2,3}</p> <p>¹School of Biology, Aristotle University of Thessaloniki, 54 124, Thessaloniki Greece</p> <p>²Institute of Marine Research (IMR) and Hjort Centre for Marine Ecosystem Dynamics, PO Box 1870 Nordnes, N-5817 Bergen, Norway</p> <p>³Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biosciences, University of Oslo, PO Box 1066 Blindern, N-0316 Oslo, Norway</p> <p><i>Revised lines of evidence and suggested methodology for better assessing fish fecundity type</i></p> <p>Recent modelling studies and case-study applications confirm what was long speculated about the fecundity type of fish (e.g. Greer-Walker <i>et al.</i>, 1994), that this is strongly dependent on the relationship between oocyte growth period and the duration of the spawning period. More specifically fish stocks with oocyte growth periods longer than the spawning period are predicted to exhibit determinate fecundity which provides a fair justification for why cold water species with slow oocyte growth and limited spawning periods are determinate spawners and vice versa for temperate water species. Related to this, it has become increasingly clear that a species may display a continuum in fecundity type along latitudinal clines, i.e. fecundity type is a flexible rather than a fixed characteristic. This perspective offers a new/revised set of lines of evidence compared to the classic criteria originally developed by Hunter <i>et al.</i> (1992) for Dover sole (<i>Microstomus pacificus</i>), adopted by the scientific community for over almost a quarter of a century. Under this new revised scheme, seasonal drop in total fecundity, the existence of a hiatus in the oocyte frequency distribution or the lack of massive atresia do not necessarily imply determinacy. New modern techniques such as oocyte packing density theory (Kurita and Kjesbu, 2009) offer the possibility to address the fundamental dynamics of de novo oocyte recruitment by reliably quantifying primary oocyte production and thereby the underlying nature of the noted “pulses” of developing oocytes. Taken together we believe that revised concepts along with updated methodology may add further momentum to this important field of fecundity studies and thereby to the reproductive ecology of marine fish assessed by EPMs.</p> |
| 16 | <p>Hannes Höffle^{1,2}, Frode Vikebø¹ and Olav Sigurd Kjesbu^{1,3}</p> <p>¹Institute of Marine Research (IMR) and Hjort Centre for Marine Ecosystem Dynamics, PO Box 1870, NO-5817 Bergen, Norway</p> <p>²Queen’s University Belfast, School of Biological Sciences, Medical Biology Centre, 97 Lisburn Road, Belfast BT9 7BL, Northern Ireland</p> <p>³Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biosciences, University of Oslo, PO Box 1066, Blindern, NO-0316 Oslo, Norway.</p> <p><i>How do potential and actual fecundity compare? – Numerical loss and dispersal between vitellogenesis and egg sampling in northeast Arctic cod (<i>Gadus morhua</i>)</i></p> |

Delimiting spawning grounds is difficult due to large survey areas, mobility of fish and rapid dispersal of spawning products. While stock reproductive potential (SRP) of adult females can be estimated by either summing up their potential fecundities or by collating realized fecundity data from egg surveys, both approaches contain uncertainty. Depending on the chosen method, uncertainty partially stems from high egg mortality and dispersal rates, or the effects of atresia and non-normal size distribution. Here we employ a 27 years (1985–2012) long time-series to test for parallelism in the SRP of Northeast Arctic (NEA) cod as derived from total potential and total realized fecundity estimates. Results indicate a fairly good match between potential and realized fecundities for most years, on the spawning grounds between the Lofoten archipelago and the Norwegian mainland. On the outer shelf variability was higher throughout the observed period. On a fine scale, distribution patterns of potential and realized fecundity were most years significantly different, indicating rapid dispersal. Potential drivers for deviations between different methods of estimating SRP are discussed.

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A simple microscopic marker in the assessment of preovulatory horse mackerel (*Trachurus trachurus*) ovaries

The hydration stage of oocytes has been used extensively in pelagic spawners' reproductive biology analyses, such as the measuring of their batch fecundity and the assessment of their daily spawning pattern. In routine assessments the hydrated ovaries are analysed histologically a practice that is both expensive and time-consuming. The present study addresses the utility of a simple, microscopic marker in the assessment of preovulatory Atlantic horse mackerel (*Trachurus trachurus*), HOM, ovaries. The marker pertains to the appearance of ooplasmic oil drops in increasingly translucent hydrated oocytes and is easily perceivable in routine microscopic preparations of ovarian whole mounts like the ones used for fecundity calculations. This inexpensive and labour-efficient marker could be proved very helpful in daily spawning pattern assessment of HOM and other species, and for defining the appropriate sample for batch fecundity measurements.

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Can indeterminate spawners cease recruiting oocytes during their spawning season? The case of horse mackerel (*Trachurus trachurus*) stock in the Atlantic Iberian waters

According to the classic lines of evidence for determinate vs. indeterminate fecundity, the southern stock of Atlantic horse mackerel, HOM, was shown to exhibit mixed characteristics. Total fecundity dropped during the spawning season, there were reproductively active individuals with a distinct size hiatus between primary and secondary growth oocytes while no massive atresia was observed in late season spawners. All these characteristics matched with evidence for determinate fecundity. However, daily decrease rate of total fecundity was lower than daily specific fecundity by orders of magnitude which suggested that the stock of oocytes was replenished during the spawning period through de novo oocyte recruitment. In addition, the maximum number of batches in reproductively active females was

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| | <p>lower than the predicted annual number of spawnings. These results suggest that despite the aforementioned evidence for determinacy the fecundity of HOM is clearly indeterminate.</p> |
| 19 | <p>Cristina Nunes¹, Kostas Ganias², Ana Maria Costa¹, Daniel Pinto¹, Elisabete Henriques¹, Foivos Alexandros Mouchlianitis² and Maria Manuel Angélico¹</p> <p>¹Instituto Português do Mar e da Atmosfera (IPMA), Lisboa, Portugal ²School of Biology, Aristotle University of Thessaloniki, Greece</p> <p><i>Daily spawning periodicity in Northeast Atlantic horse mackerel (<i>Trachurus trachurus</i>)</i></p> <p>A diel pattern of ovulation and spawning is often present in marine fish, with many species producing planktonic eggs tending to spawn at sunset/darkness hours. The daily spawning behaviour of a given species is a key aspect of the reproductive biology with implications (potential sources of bias) for the application of the DEPM (eggs and adults sampling, eggs mortality modelling, daily spawning fraction estimation). This issue has been readdressed for the southern stock horse-mackerel (<i>Trachurus trachurus</i>, HOM), as part of a general investigation carried out mostly during the last decade in view of obtaining fisheries-independent SSB estimates for this stock from egg surveys. For that, plankton data from 14 surveys (1998 to 2014) and female samples from the 2010 and 2013 surveys were used. Overall results of both eggs and females argue strongly in favour of the existence of a daily spawning pattern for HOM. Spawning seems to take place mostly towards the end of the day (20:00-22:00 from eggs data, after 16:00 from adults data), though the extension of the spawning period is still not fully specified, and requires further investigation.</p> |
| 20 | <p>Constantina Karlou-Riga¹, Dimitra Petza², Dimitra Koulmpaloglou² and Panagiotis Anastopoulos²</p> <p>¹School of Biology, Aristotle University of Thessaloniki, Greece ²Ministry of Rural Development and Food, General Directorate, Greece</p> <p><i>Batch fecundity and reproductive strategy of picarel (<i>Spicara smaris</i>, L) in the Saronikos Gulf (Greece)</i></p> <p>During picarel's (<i>Spicara smaris</i>, L) peak of spawning season (April–May), the female spawned every 1.48 days. Relative batch fecundity of 336 oocytes g⁻¹ fish weight was estimated. No major α-atesia was noticed at the end of the season where only small females have been left for spawning. Six criteria were studied to examine whether picarel is a determinate or indeterminate spawner: No hiatus was observed at the oocyte size frequency distribution between the primary growth (PG) oocytes and the secondary growth (SG) oocytes. Total fecundity, the total number of SG oocytes and the number of early vitellogenic oocytes were constant throughout the season except of May. The mean diameter of oocytes that represent total fecundity remained constant during April sampling. The relative total fecundity was found equal to 1140 and 6357 oocytes g⁻¹ fish weight before the onset and at the peak of spawning respectively. The relative total fecundity was not varied between females with or without post-ovulatory follicles. The above indicators lead to the conclusion that picarel is most likely an indeterminate spawner.</p> |
| 21 | <p>Tim Ward, Jonathan Carroll, Rick McGarvey and Charles James</p> <p>SARDI Aquatic Sciences, PO Box 120 Henley Beach SA 5022</p> <p><i>Recent developments in the estimation of daily egg production</i></p> <p>An international workshop held in Australia in 2014 compared the application of the Daily Egg Production Method (DEPM) in two Australian and</p> |

several international fisheries. Since then, the DEPM has been applied and evaluated for several species off southern and eastern Australia, including Australian sardine (*Sardinops sagax*), Jack Mackerel (*Trachurus novaezelandiae*) and Blue Mackerel (*Scomber australisicus*). A dedicated research project was also undertaken during this period to investigate options for refining current approaches to estimating egg production, including some of those identified at the workshop. This talk uses data obtained from the recent surveys to provide preliminary assessments of: 1) a new technique for estimating spawning and development times using field data that may alleviate the need to conduct temperature development experiments and 2) the relative suitability of several statistical methods for estimating daily egg production using cross validation analyses. The talk will also present the results of computer simulations undertaken to evaluate options for optimizing plankton sampling procedures used to estimate egg production. Implications for improving estimates of spawning biomass obtained using the DEPM are discussed.

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Tim Ward

SARDI Aquatic Sciences, PO Box 120 Henley Beach SA 5022

Recent application of the daily egg production method to Jack Mackerel (*Trachurus novaezelandiae*)

Jack Mackerel (*Trachurus novaezelandiae*) is a key target species of the Australian Commonwealth Small Pelagic Fishery (SPF), which has been subject to extensive public scrutiny following an attempt to introduce a large factory-trawler. This study reports on the first dedicated application of the Daily Egg Production Method (DEPM) to Jack Mackerel. Large numbers of eggs and adults were sampled concurrently from the key spawning area off eastern Australia. The spawning biomass of Jack Mackerel off eastern Australia during January 2014 was estimated to be approximately 157,805 t (95% CI = 59,570 – 358,731). Sensitivity analyses indicate this estimate is robust to likely uncertainty in estimates of key parameters. The study established a method for sampling adult Jack Mackerel that appears to provide samples that are unbiased with respect to sex, spawning activity or size. Large fish were collected from both the inner shelf and shelf break; however, spawning fractions and egg densities were high inshore and low offshore. These findings suggest complex spatio-temporal patterns of spawning, contrasting previous studies that have suggested most spawning occurs at the shelf break (~200 m). Results were used to provide recommendations for optimizing future survey design. Perhaps most importantly, extending future adult surveys beyond the spawning area would address a major limitation of the DEPM, by providing estimates of the relative abundance of non-spawning adults outside the spawning area.

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Taking full advantage of surveys: concurrent DEPM sampling for sardine and horse-mackerel in southern and western Atlantic Iberian waters

Surveys dedicated to the Daily Egg Production Method (DEPM) are costly due to sampling requirements (spatial resolution and number of samples) and also owing to the time consuming, and skilled laboratorial work needed. Hence, DEPM surveys are often carried out on a triennial basis rather than yearly like the acoustic surveys. However, since the SSB estimates provided by DEPM are

used for assessment modelling along with the estimates from acoustic surveying it would be useful, for coherence during model fitting, that gap years could be minimized. In the Atlantic Iberian waters surveyed by IPMA (ICES divisions 9a) two DEPM surveys are conducted triennially (in winter-

early spring) one directed at sardine (*Sardina pilchardus*) and a second one applied to horse-mackerel (*Trachurus trachurus*). Additionally, each spring an acoustic survey takes place in the same region. Using the historic dataset available and recent re-analyses of egg samples for species other than the survey target ones, we explore the usefulness and limitations of using both current DEPM surveys for concurrently obtaining estimates for sardine and horse-mackerel. In addition, we discuss the potential to achieve egg production estimates during the annual acoustic surveys and the possibility of attaining, representative, average, adult parameters.

Annex 6: Sessions reports

WGALES Report from Monday 17-10-2016

Presentation 1: The International Herring Larvae Surveys in the North Sea (IHLS)

Norbert Rohlf presented information on the herring early larvae surveys, including the historical results and some of the potential problems and future potential directions. Spawning ground survey for newly hatched larvae for SSB estimation. Newly hatched larvae are not indicative of recruitment. Data in the ICES egg and larvae database. Nineties most North Sea countries moved from larvae survey to acoustics survey. Windspeeds are becoming a problem for sampling. No effect of time of day on the sampling of herring larvae. Medium sized larvae do not follow the increase of the newly hatched small larvae seen in recent years. Mortality has increased in the medium sized larvae. Larval drift measured through centre of gravity modelling.

Discussion:

Drift pattern parameterized, it is not a model, but just centre of gravity comparison. Modelling is needed to incorporate ecosystem parameters.

Downs component is doing better. Mixing in the adult stock, so can't recognize them in the adult stock.

Regime shift in the North Sea, but not seen in the IHLS data. Further data exploration is necessary to investigate regime shift. Wind (speed and direction) are probably important.

Recruitment failure, it is actually a decrease in survivorship.

Linear relationship between larvae and SSB shown, but the last years definitely not linear. SSB to egg production linear relationship depending on fish condition. Eggs are in layers on the bottom, layers haven't changed.

What changed in the survey when nations dropped out. Some parts could not be sampled anymore. But mostly what is left is just one point in the spawning season instead of a full coverage of the whole spawning season. Index is still used in the same way as it was before the nations dropped out. Assessment model has changed though from using a single numbers as index, while nowadays the raw data from IHLS is used in the assessment model.

Is the survey OK or compromised? Not change anything in the southern North Sea. More information needed in the northern North Sea. It is compromised, but from the assessment point of view it seems to still pick up the necessary signal.

Presentation 2: MEGS surveys 2016

Brendan O' Hea described results from the 2016 mackerel egg surveys. Peak mackerel spawning moving earlier in the recent period. Survey started earlier. However, the mackerel did not move down early this year. Lots of issues with survey coverage this year. Part of the survey carried out on pelagic commercial trawlers, paid by the industry. Peak spawning in the Western stock occurred late and in the north which was not expected. No peak in the southern stock. Drop in egg production and SSB, third lowest in the time-series. Horse mackerel egg production very low, 78% decrease.

Discussion:

CF factor: conversion factor from spawning fish only to total SSB.

Can the survey design be amended to deal with the unexpected changes. WGISDAA recommended to sample close to the main spawning areas. Predictive modelling by Mark Payne. Not all surveys work up their samples at sea.

Mark's (Payne) modelling using environmental data. Hasn't had time to do what he hoped to do.

Environmental data explaining the change in late spawning? Not yet checked.

Winter surveys were carried out in 2014-2015 to check the start of spawning. Still the spawning started later.

Using the commercial vessels went well for Ireland, Scotland and Netherlands. Cooperation was great.

Ecosystem surveys pushed: added value of this survey -> Hake eggs, blue whiting larvae, birds and cetacean counts. No time to stop to collect other samples.

Why a drop in the spawning? The survey was adequate. Other surveys (different parameters) show an increase.

Presentation 3: When (How?) things go wrong: How larval drift can distort stock abundance estimates

Matthias Kloppmann presented some of the current problems being faced in the estimation of a recruitment index for North Sea Autumn spawned herring. Larvae at a size they can swim and need big nets to catch the larvae. Sampling at night, so using a black net, so larvae are not scared away. Exclude small larvae, these are the winter spawned Downs larvae. They haven't passed the time of high and highly variable mortality. Data exclusion rule is only applied to the most southern part of the sampling area. Most recent years large numbers of larvae in the German Bight, stations were above the exclusion rule. Index high, because of the small larvae that needed to be included. Relationship between 0-ringer and 1-ringer abundance has declined after 2005. Index as recruitment indicator has become less reliable. New algorithm: use all stations and exclusion rule applied to the whole drift area of Down's larvae. Index calculation based on analyses of length composition and using drift models. Recalculate the complete time-series. New algorithm from 2008 onwards (previous data still needs to be checked) follows the old index, except for the last two years. Correlation between new algorithm and SAM SSB results is improved. Distribution of mean length. 2009 traditional distribution, small in the Channel, large German Bight. 2014 already small larvae in the German Bight area. 2016 is even more extreme, with small larvae in the German Bight.

Discussion:

Different development rates for the larvae that are spawned at different times. Would it be useful to put a development stage to the larvae? Developmental stage at size could give an indication on growth and mortality. NSS herring staging is done, but needed to compromise with the number of larvae that could be measured. What is the minimum number of larvae that needs to be measured?

Why do you exclude the small larvae: Decision made in the early years of the survey. Length is when the full skeleton are fully developed. In warm areas clupeids are fully developed at smaller length.

How long would a larvae need to drift from the Channel to the German Bight. Couple of weeks is enough. Caught up in a gyre they stay in a certain area for a long time. If they miss the gyres drift goes really quickly and for a long distance.

Trying to fix the index. Is the new algorithm the answer or should the survey be changed? MIK survey is too early for a recruitment index of Downs' larvae. IBTS is going to move to a stratified random sampling, this cannot be used for plankton sampling. Timing is also an issue. Each rectangle is not sampled at the same time. Germans share rectangles with the Danes. Germans did not find the small larvae, but the Danes one week later had lots of small larvae.

Presentation 4: Status of the Eggs and larvae database

Carlos Pinto explained the 'ins and outs' of the ICES Egg and Larvae Database.

Data archaeology: data recovery. In E&L database two records from 1853 than a huge jump to 1950's. Not able to recover data, but able to store the current collected data. ICES hosts the data.

WK in 2015 to define a common format for the data. Metadata needs to be delivered with the actual measurements. Current development of automatic submission.

Indicators for the assessment could be calculated automatically from the ICES E&L database.

Discussion:

Extremely important. Inputting old data because the old data files cannot be read anymore or data are all on paper. Access is a question.

Similar system in Australia, because all public collected data need to be available to the public.

How can data that are not connected to ICES going into the database. Who is quality checking the identification of the samples. ICES checks the data quality, but identification quality is with the people who submit the data.

Disclaimer with the data. User is responsible.

Next to the E&L database also a fecundity database being developed. Data should all be able to be pulled together.

Fecundity data in FishBase, but this is of variable quality and reliability. Fecundity data being collected is very specific.

Assessment models now are taking in reality raw data. But this needs reliable CV's etc.

In the Mediterranean a large database consists, but not everyone can access the data, it is limited and you need a password. This contains the raw data.

It is possible to see how often data are downloaded, but it would be interesting to see how often the data are used in publications.

You can see who downloaded the data.

Databases are useful we do need them!

WGALES Report from Tuesday 18-10-2016, morning

Presentation 5: Insights in to the winter spawning of fish in the North Sea – the MIKeyM program attached to the ICES 1st Quarter IBTS

Richard Nash gave an overview on the MIKeyM program and showed the extent of the coverage and some of the results. A history of the development of this program was given considering the first surveys in 2003/2004 and 2009 which were carried out as autonomous surveys until the collaboration with the Q1 IBTS in recent years. He also presented the advantages, problems and obstacles of the sampling program.

Discussion:

- Discussion on the deployment of samplers: It was clarified that the deployment is constantly monitored either by net sonar or probes.
- The future of MIKeyM program: Although the results of the survey have no direct input into management for assessment it fits well into the ecosystem approach. The program can also be seen embedded in the Natura 2000 directive. It may also help to answer potential management questions like understanding substock dynamics.

Presentation 6: Making the most of the surveys: Implementing plankton sampling in ICES-coordinated herring larval surveys

Franziska Bills presented results of the additional plankton sampling which were implemented on several ICES-coordinated herring stock assessment surveys since 2012 in order to understand the key environmental variables on larval growth and survival of Atlantic herring (*Clupea harengus*). The presentation concentrated on the results of the 2014 additional sampling on the IBTS Q1 in the North Sea and of the 2012 / 2013 NINEL survey in the Irish Sea.

Discussion:

- The importance of plankton components was discussed, e.g. protozoa plankton for first time of feeding.
- It was discussed which timing and surveys in terms of monitoring are the most important. This is depending on the point of view. For monitoring general ecological aspects the additional sampling during the IBTS give the best results as this survey has the broadest spatial coverage. However, if you are only interested in the herring larvae it is more important to have data near to the spawning time.
- The additional effort of the implemented additional plankton sampling was discussed. As most efficient for the larvae surveys the PUPnet is recommended. For the IBTS, water samples from the CTD rosettes are routinely taken and can be easily checked for plankton components.

Presentation 7: Spatial and temporal variability of the ichthyoplankton of the northern North Sea – the IMR Pelagic Ecosystem Group research Group studies

Richard Nash presented the activity of the IMR pelagic ecosystem research group regarding the sampling of standard transects across the northern North Sea as well as the sampling of some standard process stations. Detailed information on the physical water column structure, nutrients, chlorophyll a, phytoplankton and zooplankton (species and dry weights), fish eggs and larvae on an annual basis are obtained. Results

were presented for a variability of fish species regarding their abundance, vertical distribution etc.

Discussion:

- The funding of this studies was discussed. Here, the analysing of the samples (as the samples were already taken) was partly funded by the industry to get information on the location of spawning grounds in order to get permission for seismic works.
- In the same context it was stressed that it does make sense to “bank” and store samples for possible future analysis!

Presentation 8: Governance of Red Sea reef fisheries based on egg and larvae surveys

Mohamed Ahmed Abu El-Regal presented the Egyptian Red Sea egg and larvae surveys. Fish larvae are collected from different areas along the Red Sea coast with plankton nets of different mesh sizes and different diameters. Overall, larvae of 120 reef fish taxa were collected and the time of occurrence of each taxon is used as indication of the spawning season. Also the effort to utilize the results of the surveys for the management of the fisheries in the Red Sea was presented.

Discussion:

- It was discussed how possible cooperating partners can be found as at the moment the work is done alone. A scientific body like ICES does not exist in the area. No solution could be offered during the discussion.
- The status of fish stocks in the Red Sea is based on observations on fish markets and not on official landings data / assessments. These observations are giving indications that many fish stocks are decreasing. However, it was clarified that trustable scientific data are needed in order to convince the government on management measures. An advisory process needs to be implemented.
- It was discussed if the survey data are usable for management advice. Four datasets seem to be available but is not clear if they can be used for future advice.
- Additionally, it was discussed how the environmental impact of the tourist industry can be evaluated. Diversity studies were suggested comparing highly affected sites (reefs) with non-affected sites.

Presentation 9: The Cape Verde Frontal Zone: A barrier for larval fish assemblages

Maik Tiedemann presented the third part of his PhD-thesis regarding the distribution of fish larvae along the Cape Verde Frontal zone which is a transition between two distinct water masses, the colder and less saline South Atlantic Central Water and the warmer and more saline North Atlantic Central Water. The findings suggest that the flow pattern of the mayor currents delimit larval fish transport at the frontal zone influencing further habitat expansion of early life stages of fish.

Discussion:

- Fishing regulations in this area were discussed. No management is in force and all regulations are based on landings.

- Difference in behaviour of sardines and anchovies were discussed as they are the only fish which occur in both water masses.
- No egg data and data on adult fish are available.

Presentation 10: The late summer distribution of ichthyoplankton in the northern North Sea and potential insights in to the location of offshore nursery grounds.

Richard Nash presented the results the Norwegian sampling of one or two standard transects across the northern North Sea during July and August. These samples give an indication of the distribution of larvae in summer and in conjunction with the April/May sampling provide insights in to the movement of larvae around the northern North Sea. Within the presentation, the future of the summer plankton sampling was discussed in the light if it worth to try to convince the IBTS Q3 to undertake additional sampling on a regular basis like in Q1 (see also Presentation 05 and Section 3.3).

WGALES Report from Tuesday 18-10-2016, afternoon

Presentation 11: Modelling the vertical distribution of sprat eggs in the changing conditions of the Eastern Baltic

Andrei Makarchouk presented investigations of the vertical distribution of ichthyoplankton in the Gdańsk Deep and the Gotland Basin were performed with BIOMOC multiple opening/closing net in 1996–2000. Pelagic eggs of Baltic sprat were floating in the wide range of depths: eighty per cent of eggs were usually distributed in the water layers of 30 – 60 m thickness. The mean depth of them was generally decreasing during the spawning season. Generalized vertical distribution of sprat eggs relative to their mean specific gravity has been made. All the calculations were bound to determine density of water and specific gravity of sprat eggs, because salinity and temperature profiles were changing with time and place considerably. A simple model for the determination of the mean depth of eggs was made taking into account only the temperature of water in the upper layer. The pattern of vertical distribution was determined in two steps: first, mean specific gravity of eggs was calculated dependently on the water temperature at 10 m depth, and second, generalized vertical distribution was plotted against real water density profile.

A simple model to predict the specific gravity of Baltic sprat eggs based on the 10 m depth temperature distribution was presented. Results could be used to model the vertical distribution and potential mortality of eggs sinking below the oxycline.

During the brief discussion, the question was raised, whether the change of specific gravity of eggs during development was considered. The model, however, was only aimed at early stage egg vertical distribution and mortality.

Presentation 11: Potential effects of climate change on herring recruitment phenology in a Baltic Sea inshore retention area

Patrick Polte talked about herring larvae in the Baltic. Despite improved spawning-stock biomass, the past decade saw a period of reduced recruitment of larval herring (*Clupea harengus*) in a major inshore larval retention area in the Western Baltic Sea. Hypothesizing a shift of optimal thermal periods for egg development and larval growth, we analysed a 20 year time-series of larval herring abundance data according

to the seasonal setting of 1) onset of spawning season, 2) thermal viable hatch windows, 3) optimum growth windows and 4) response to steepness of seasonal temperature gradients. The results revealed that a temperature induced earlier beginning of the spawning period had negative impacts on the year-class strength of recruits. Both, optimum seasonal temperature windows and optimum growth windows occurred earlier during the past decade affecting early life stage mortality. Steep temperature leaps occurred more frequently than in former decades, also considered to negatively affect egg development and larval survival and triggering secondary temperature effects, such as fungal infestation of eggs and blooms of filamentous algae on benthic spawning beds. Although significant effects of seasonal temperature shifts on herring phenology could be identified, a suite of varying ecological cascades leads to relatively weak correlations between changes in the temperature regime and larval herring abundance. Present approaches deal with statistical methods to receive higher precision to visualize the impact of changing seasonal temperature regimes on herring recruitment.

A study on the different drivers of herring larvae phenology that could be used to explain differences in recruitment was presented.

Four drivers of herring phenology were investigated: a. Timing of spawning initiation, b. viable hatch window (temperature range 7 – 13 °C), c. optimum growth temperature threshold, and d. effects of steep temperature rise in the season

- a. negative correlation (the later the better)
- b. weak correlation: good year class seem to fall into viable hatch windows for egg laying, but there is no trend for the viable hatch window to change. Sensitive bottleneck
- c. no trend for optimum growth threshold (16°C)
- d. negatively correlated: the higher the frequencies of temperature leaps, the lower the recruitment

Presentation 13: Clogging of the net during ichthyoplankton samplings

Cindy van Damme detailed some of the problems related to net clogging during surveys. When there is lots of phytoplankton or small jellies in the water sampling ichthyoplankton can be a nightmare. In those cases it is usually clear that the net was not sampling correctly. During the 2016 mackerel and horse mackerel egg survey however, we were catching small numbers of eggs and larvae while expecting large numbers. Looking at the net, clogging did not seem an issue, but comparing internal and external flowmeter revolutions showed there was an issue with the volume water filtered.

Most survey protocols do not give instructions to check for clogging and in case of serious clogging how to deal with the sample or data. If anything is considered it is usually the amount of water filtered but not the representativeness of the sample. Is clogging an issue or not that should be considered?

An investigation on the difference of the residuals for external and internal flowmeters of the Gulf VII sampler from respective statistical models calculating prospective flowmeter revolutions from haul duration revealed that clogging appears to be more common in plankton sampling in certain years than expected. The question whether clogging should be considered as a major issue confounding representativeness of plankton sampling was raised as the major conclusion of the study.

During the following discussion it was concluded that while it will be difficult to quantify the amount of clogging and its impact on the results, the occurrence of clogging should be noted and resulting data flagged accordingly. Survey manuals should acknowledge the occurrence of clogging and provide protocols for treatment of such cases. Survey WGs need to be made aware of the lack of such protocols.

Presentation 14: Not all eggs sink: Revision of the spray technique

Jens Ulleweit highlighted potential problems with the spray technique for separating eggs out of plankton samples. During the Mackerel and Horse Mackerel Egg Survey (MEGS), the spray technique is a widely accepted method to quickly remove almost all fish eggs from plankton samples. During the 2016 MEGS, the German participants also applied this method at their survey. After completion of the survey, all samples were re-examined to remove all remaining eggs by hand. It turned out that on some stations, a large number of eggs were apparently not removed by the spray method. While disturbing at a first glance, identification and staging of the eggs showed that the major part of those were neither mackerel nor horse mackerel rather than belonging to other, non-target species. One of those species was *Maurolicus muelleri*, which eggs have a sculptured chorion offering high friction allowing air bubbles to lift them upwards with the other plankton. But also eggs of other species appeared to remain consistently with the plankton. The findings from the re-examination were experimentally validated with mackerel and other fish species eggs.

The presentation revealed that not only eggs with sculptured chorions like those of *Maurolicus muelleri* stay afloat but also those of hake (*Merluccius merluccius*) with their hydrofugal surface. The spray method may, thus, also function as a method to reliably separate hake eggs from mackerel and horse mackerel eggs.

In the following discussion the question was raised whether these findings have implications for the current survey methodologies for sorting the plankton samples. It was concluded that on the contrary the spray method was confirmed as a reliable method for extracting mackerel and possibly also horse mackerel eggs from the samples while at the same time separating hake eggs, which could be easily confused with both species, from them.

WGALES Report from Wednesday 19-10-2016, morning

Presentation 15a,b and c: Revised lines of evidence and suggested methodology for better assessing fish fecundity type

Kostas Ganas and Olav Kjesbu alternated in their presentations to cover what was a relatively large subject.

In the first presentation related to the session on fish fecundity, Kostas Ganas introduced into this field of research giving a historic overview on the lines of evidence and methodologies assessing fish fecundity type. He presented several case studies describing four classical lines of evidence. Kostas explained a conceptual model for the regulation on the fecundity type and presented simulations for deterministic and stochastic scenarios. From this concept, there is strong evidence that determinacy resp. indeterminacy in the fecundity type of a fish stock is related to the time it takes for oocyte growth and development vs. the duration of the spawning season. Thus, fish stocks with slow oocyte growth and short spawning seasons are predicted to exhibit determinate fecundity and vice versa.

Comments: Is batch development generally determined in the period from first vitellogenesis to the start of spawning? Kostas: the model has to be regarded as a general concept. It has to be proven and underpinned by dedicated research. The model assumptions have somehow to be brought closer to reality.

Is there something like massive atresia? What is massive? Kostas showed some pictures where more or less all oocytes showed atresia.

What are practical consequences of the concept? The relation to the spawning habitats or areas (like in tropical fish). Southern fish stocks are often more indeterminate like, while northern stocks more determined like.

Discussion on atresia and species flexibility to atresia. Atresia should not be regarded as the end of the spawning season. There are other keys that can trigger atresia.

Annual fecundity is total number of eggs spawned in one season by an individual spawner. In the concept, it is more the potential fecundity, e.g. the number of eggs spawned of the standing stock.

In the second part of the presentation on lines of evidence, Olav Kjesbu talked about “Early oocyte recruitment” and how to count oocytes. He presented and compared different 3-D fecundity methods and claimed two of these as being more reliable (Weibel & Gomez and the Oocyte Packing Density Theory).

Comments: Some discussion on the ovarian development of European anchovy. Concerning uncertainty in relation to total numbers, Olav stated that there is no serious problem in the OPD method. Estimates are very precise when comparing the number of particles per gramme of ovary to manually counted numbers of ovaries.

The third talk in this part, given by Kostas, related fecundity pattern to fish biology and ecology. When comparing 68 different fish stocks, duration of the spawning season shortened with increasing latitude, both in the northern and the southern hemisphere. This is guided by a trend in the type of fish fecundity, with more determinate fish stock in boreal and less in tropical waters.

Comments: Discussion on the impact of temperature on oocyte growth and oocyte growth variation. Some fish spawn on very large latitudinal gradients. Is this reflected in the concept? It is of importance to distinguish between the individual fish level and the stock level. Can fish adapt their number of batches in relation to latitude? No clear answer yet.

Presentation 16: How do potential and actual fecundity compare? – Numerical loss and dispersal between vitellogenesis and egg sampling in northeast Arctic cod (*Gadus morhua*)

Hannes Höffle compared in his talk the number of potential fecundity to the number of actual fecundity (e.g. eggs found in the sea) in northeast arctic cod. Results indicated a good match of potential and realized fecundity estimates in 27 years’ time-series for most years and areas, while spawning grounds at the outer shelf showed higher variability throughout the observed period. Differences in numbers declined with larger median fish size and increased with temperature.

Comments: were mostly related to GAMMs. Autocorrelation is not incorporated in the model used. As a general aspect, autocorrelation should be tested in GAMMs and was used as one variable in the setup. Spatial data are often autocorrelated. Concerning the effect of temperature on the variability, egg mortality was regarded as more influential as Atresia.

Presentation 18: Can indeterminate spawners cease recruiting oocytes during their spawning season? The case of horse mackerel (*Trachurus trachurus*) stock in the Atlantic Iberian waters

Kostas Ganiyas gave insights into the details of fecundity type in Atlantic horse mackerel (*Trachurus trachurus*). The southern stock of Atlantic horse mackerel was shown to exhibit mixed characteristics of spawning type. Total fecundity dropped during the spawning season, reproductively active individuals with a distinct size hiatus between primary and secondary growth oocytes while no massive atresia was observed in late season spawners. These criteria would suggest a determinate spawner type. However, daily decrease rate of total fecundity was much lower than daily specific fecundity which suggested that the stock of oocytes was replenished during the spawning period through *de novo* oocyte recruitment. In addition, the maximum number of batches found in reproductively active females was lower than the predicted annual number. These results suggest evidence for indeterminacy in horse mackerel.

Comments: What is the benefit in characterizing fish as indeterminate or determinate spawners? Is the terminology not misleading, if these things are too complex? In theory, fecundity cannot be a continuum. What is the right time to determinate fecundity resp. when should these data been sampled?

Presentation 19: Daily spawning periodicity in Northeast Atlantic horse mackerel (*Trachurus trachurus*)

In her presentation via skype, Cristina Nunes readdressed the daily spawning behaviour in horse mackerel. Overall results of both eggs and adults indicate a daily synchronicity in spawning pattern. Spawning is most likely to occur in late afternoon / early evening, which is also related to the highest probability of occurrence of Stage I eggs (06:00 to 07:00 pm). Females with hydrated eggs are not observed before 04:00 pm and there are indications found that suggests the presence of daily (eggs) cohorts. However, this is work in progress and will be further investigated.

Comments: Possible relationship with the lunar cycle.

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Presentation 17: A simple microscopic marker in the assessment of preovulatory Horse mackerel (*Trachurus trachurus*) ovaries

Foivos Mouchlianitis talked about microscopic markers for horse mackerel ovaries. Ovaries can be divided into those displaying oil droplets, OD, and those with no oil droplets, NOD. NOD ovaries prevailed between 07:00 – 11:00 with OD ovaries appearing later in the day. The critical time for NOD to OD transition was calculated to be 11:48. Mean oocyte diameter was greater in OD ovaries compared to NOD ovaries

Discussion – did he validate samples histologically – not validated histologically.

Presentation 20: Batch fecundity and reproductive strategy of Picarel (*Spicara smaris*, L) in the Saronikos Gulf (Greece)

Constantina Karlou-Riga presented information on the batch fecundity of the picarel which is a protogenous fish showing sexual dimorphism. Spawning occurred from March to May. Only small females left to spawn in May. Females want to finish spawning so they increase their spawning rate. Small females in May have similar mean size as April 15th. Atresia was found in very few samples, and only in May.

Discussion – is there a good relationship between batch fecundity and female weight.

- Size of female in protogenous fish isn't an important in fecundity

- last graph. Seasonal pattern. Is this spawning rate or generation rate of POF? Ans) Could be spawning rate as season is ending.

- the fish are most likely indeterminate.

- Any explanation for the high MN in last slide during the season. No explanation.

Presentation 21: Recent developments in the estimation of daily egg production

Tim Ward gave insights in to the surveys that have been running for 18 years off the south Australian coast. Samples collected using a Calvet sampler. They use a 10 stage egg development. Also survey for Jack mackerel, blue mackerel and two populations of sardine off the east coast. They use an *in-situ* temperature-based egg ageing method, this reduces the need for a lab based temperature-egg development experiments. They need to look at a different sampling method to sample areas or transects rather than vertical samples.

Classic statistical models look ok for data analysis, constrained GAM is not great, unconstrained GAMs gives very strange results.

Discussion – egg development time by different temps. Are fish always targeting same temp regime? Some evidence of differences between fish from north and south. May be more than one spawning group. Hope to test using genetics from samples.

- What depth do they spawn at? 70m seems to be it, eggs float to the surface.

- Is temp at depth an issue rather than depth? Probably is.

- can keep temp under control in egg incubation experiments. Might need to look at temp at depth rather than continuing current work using surface temp

- Have you looked at zero inflated models? Yes

- is there much benefit from bootstrapping? It issued to get uncertainty around the estimates. Used as exploration exercise to see how models are performing and see which is best.

- what do you report at the moment? For management log – normal is best. Now use the mean of the 4 best models as they are all reasonably similar.

Presentation 22: Recent application of the daily egg production method to Jack mackerel (*Trachurus novaezelandiae*)

Tim Ward highlighted the problems collecting midwater adult samples and therefore demersal samples are collected using a high headline net. Samples are collected during daytime. Previously most spawning found at Shelf break but now appears to be moving further offshore. DEPM does not provide information on abundance of non-spawning adults outside the spawning area. Extending adult surveys beyond the spawning area may provide estimates of the distribution and relative abundance of adults across the entire range of the population

Discussion – couldn't get similar samples off Africa.

- get most samples from commercial vessels as the RV hasn't the speed to catch HOM.
- does that some times.

- Bear in mind selectivity of different gears. Also try to get samples across the day to look at spawning fraction

Presentation 23: Taking full advantage of surveys: concurrent DEPM sampling for sardine and Horse mackerel in southern and western Atlantic Iberian waters

Maria Manuel Angelico detailed the two surveys for sardine, *Sardina pilachrdus*, and horse mackerel, *Trachurus trachurus*. Sampling grids and strategies are very similar. Adult sampling for each species takes place in slightly different areas but extra days could be added to each survey to sample both species. The advantage of this approach is that an SSB estimate could be derived for a species outside its survey year. Also egg data collected by CUFES systems during acoustics surveys could be used to derive Egg Production estimation however as this sampler collects eggs only from the top 3-5 m, total abundance would need to be modelled following the approach of Petitgas *et al.*

Discussion – some people are used to dealing with uncertainties from the data. Problem will be around spawning fraction. – the sardine spawning fraction becoming less noisy in recent years. Work done without funding so far.

- where can extra funding come from? – new DCF funding can be spent as national lab decides.