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Report of the Study Group on Standards in Ichthyoplankton Surveys (SGSIPS)

11-15 October 2010

IJmuiden, The Netherlands



ICES

International Council for
the Exploration of the Sea

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Executive summary

The Study Group on Standards in Ichthyoplankton Surveys (SGSIPS), chaired by Cindy van Damme, met for the first time from 11–15 October 2010 at IJmuiden, The Netherlands. The meeting started with an extensive overview of all international and national ichthyoplankton surveys carried out in the ICES area. This showed a diverse number of ichthyoplankton surveys using different plankton samplers and different objectives of the surveys. For all surveys a manual with standard protocols is available. Standardisation is important for all surveys. Although manuals are available, these can be difficult to find because most are published as an annex to a working group report. SGSIPS recommends that manuals be published as stand-alone reports with a version number and saved on the ICES website to be easily available to all.

Methods, techniques, considerations for survey design and statistical analyses were discussed during the meeting. These discussions were written up as part of this report but will also form the basis of a scientific manuscript *Standardizing ichthyoplankton surveys: review of methods* that will describe ichthyoplankton surveys carried out in the ICES area and methods used, as well as new developments both for sampling and statistical analysis. The writing of the manuscript will be continued by correspondence.

During the meeting also the archiving of ichthyoplankton survey data has been discussed. The action plan of WGDIM for amending the ICES Database was taken as starting point and recommendations for variables and ranges has been listed in this report.

SGSIPS will meet again in three years, in 2013, to check on the progress of the 2010 meeting recommendations and to ensure that all ichthyoplankton surveys are at least carried out once between SGSIPS meetings.

1 Opening of the meeting

The meeting started on 11 October 2010. Five institutes were represented (see Table 1.1) in IJmuiden. People from other countries, Spain, Portugal and United States expressed their interest in participating in the meeting but could not come because of financial problems. They have, however, contributed by sending presentations and contributing to the review paper.

The participant list is in Annex 1.

Table 1.1. Represented countries and institutes during SGSIPS 2010.

COUNTRY	INSTITUTE
Germany	vTI
Netherlands	IMARES
Norway	IMR
Portugal	IPIMAR
Spain	AZTI
Spain	IEO
UK-England	Cefas
UK-Scotland	MSS
United States	MOLA
United States	NOAA

2 Adoption of the agenda

The adopted agenda can be found in Annex 2.

The terms of reference for this meeting were:

- a) Compile an overview and critical analysis of the methodologies used and objectives of ichthyoplankton surveys in the ICES area;
- b) Compare and contrast the utility of methods, recent developments and techniques for the purpose of improving ichthyoplankton surveys and increase standardization;
- c) Review and comment on new developments in statistical analysis of ichthyoplankton surveys and the relevance of these techniques to specific objectives;
- d) Write a review paper for publication on the findings and synthesis of the above ToRs.

An extra discussion point during the meeting was the WGDIM fish egg and larval database action plan (ICES, 2010).

3 Methodologies and objectives of ichthyoplankton surveys in the ICES area (ToR a)

The meeting started with presentations of all the ichthyoplankton surveys carried out in the ICES area. Various gears are used in these surveys, Gulf type plankton torpedo's, Bongo, Pairovet, CALvet, CUFES and WP2 (Table 3.1). Objectives of the surveys range from egg and larvae distributions to egg or larvae productions used as an index or for calculating SSB.

Table 3.1. Ichthyoplankton surveys carried out in the ICES area.

SURVEY	QUARTER	AREA	TARGET SPECIES	YEARS/FREQUENCY	TYPES OF EQUIPMENT	PURPOSE	NOTES
Plaice and cod eggs (WGEGBS)	1	North Sea	Cod, Plaice	2004, 2009	Gulf, Bongo	Egg distributions (spawning locations), plaice EP	International
Demersal, egg surveys	1	Irish Sea	Plaice and Cod	1995, 2000,2006, 2008,2010	Gulf	Eggs to EP to SSB	International, now England and Northern Ireland
International Herring Larvae Survey (PGIPS)	4 & 1	North Sea	Herring	1973- / Annual	Gulf	Larvae as SSB index	International
Northern Irish	4	Irish Sea	Herring	1993- / Annual	Gulf	Larvae as SSB index	Only Northern Ireland
Mackerel Egg (WGMEGS)	2	North Sea (North/Central)	Mackerel	Every 3 years	Gulf	Eggs to EP to SSB	International
Rügen Herring	1	IIIa, Baltic	Herring	1977 / Annual	Bongo	Larvae to recruitment	Only German
MIK	1	North Sea	Herring	1976- / Annual	MIK	Recruitment index	International
MIK	2	Irish Sea	Gadoids	1993- / Annual	MIK	Recruitment Index	Only Northern Ireland
North Sea CUFES	1	Southern North Sea/ English Channel	Eggs	2006- / Annual	CUFES, Vertical WP2	Eggs to EP, spawnign distribution	Only France, done in conjunction with IBTS.
Baltic eggs and larvae		Baltic (Bornholm Basin)	Cod eggs and larvae	Annual		EP	Denmark, Germany
Malformation in fish embryos	1	South-eastern North Sea	fish eggs	Annual since 1980s	1 m ringnet Horizontal tows at the surface	Catch live eggs to determine malformation rates in fish embryos	Only Germany

SURVEY	QUARTER	AREA	TARGET SPECIES	YEARS/ FREQUENCY	TYPES OF EQUIPMENT	PURPOSE	NOTES
Mackerel and Horse mackerel egg surveys	1-2-3	North-east Atlantic	Mackerel and Horse mackerel eggs	1992- / Every three years	CalVET Bongo 40 Gulf VII	Eggs to EP to SSB	International
Anchovy and Sardine acoustic survey (WGACEGG)	2	Biscay to the Gulf of Cadiz	Anchovy and Sardine eggs and larvae	Annual since 1995	CUFES	Acoustic Biomass	International
Sardine DEPM egg survey (WGACEGG)	1-2	Biscay to the Gulf of Cadiz	Sardine eggs	Every 3 years	Paironet	Eggs to EP to SSB	International
Anchovy DEPM egg survey (WGACEGG)	2	Biscay	Anchovy eggs	Annual	Paironet	Eggs to EP to SSB	Only Spain (AZTI)
Anchovy DEPM egg survey (WGACEGG)	3	Gulf of Cadiz	Anchovy eggs	Every 3 years	Paironet	Eggs to EP to SSB	Only Spain (IEO)
NVG Sild surveys	1 or 2	Norwegian coastal zone	Norwegian Spring Spawned herring	Annual since 1982	Gulf and Vertical hauls	Larvae	Only Norway
Herring	2	Stettin lagoon and Vistula lagoon	Herring larvae			Larvae	Poland
Barents sea surveys		Barents Sea					Rusland, Norway
ICAF	3,4,1	GB, GOM, SNE	Atlantic herring	1971-1977	Bongo	Various	USA
MARMAP	1,2,3,4	MAB, SNE, GB, GOM	Multi species	1977-1987	Bongo	Fixed / random stratified	USA
H-SL	4,1,2	SNE, GB	Atlantic herring and sand lance	1988-1994	Bongo	Fixed / random stratified	USA
GLOBEC - Broadscale	1,2	GB	Atlantic cod and haddock	1995-1999	Bongo	Fixed	USA
EcoMon	1,2,3,4	MAB, SNE, GB, GOM	Multi-species	1992-present	Bongo	Random stratified / fixed	USA
NS Year round survey	1,2,3,4	Southern North Sea	Eggs and larvae	2010-2011	Gulf VII	Eggs and larvae distribution	Only Netherlands

4 Techniques for ichthyoplankton surveys and standardization (ToR b)

There are many factors which need to be considered when designing ichthyoplankton surveys, apart from the staffing and financial issues mentioned by Smith and Richardson (1977). The spatial and temporal distribution of sampling should be designed to ensure an adequate coverage of the target species and stages (eggs, larvae). The size, availability and facilities provided by the sampling vessel should also be considered at an early stage as this could seriously impact the area to be sampled, both in terms of spatial coverage (mean speed) and in its vulnerability to adverse weather (size). The vessel design or facilities might also affect the type of sampling gear selected although in most instances it is more likely to impact subsequent processing of samples rather than the sampling itself.

For estimation of Spawning Stock Biomass (SSB), or indices, from egg or larvae surveys it is critical that the whole spawning area is surveyed at least throughout the peak of the spawning season depending on the egg production method. It is useful if a set of rules is established in advance, in order to decide when to continue (or stop) sampling outside (or within) the planned survey area. This should ensure that the whole area of egg distribution is sampled with no effort wasted outside the spawning area.

The spatial resolution (density) of the planned sampling positions must also be appropriate to the expected spawning concentrations and subsequent drift of eggs and larvae. Helbig and Pepin (1998) recognized that 'realistic sampling plans cannot accommodate all the variability in the plankton and velocity fields' but that to attempt to do so is vitally important to best achieve the aims of each survey. They also recognized (Helbig and Pepin, 2002) that 'failure to account for advective and dispersive exchange during ichthyoplankton surveys can lead to inaccurate population estimates'.

For all surveys in the ICES area a manual with a strict protocol is written. For all surveys standardization of the sampling is important. However, most of the standard manuals are published as part of an ICES working group report and hence have no version number and are hard to find. In order to standardize surveys SGSIPS recommends to ICES that all (ichthyoplankton) survey manuals are published as a stand-alone document and that a folder be created on the ICES website that contains manuals of all (ichthyoplankton) surveys.

5 Statistical analysis of ichthyoplankton surveys (ToR c)

A special section will be written in the review paper (ToR d) on statistical analysis of the ichthyoplankton survey data.

Spatial and temporal distribution of eggs and larvae

Probably the simplest of surveys involves determining the distribution of eggs and larvae over both spatial and temporal scales. Whilst this does not involve the use of statistical procedures it does involve careful consideration of sampling strategy and the reproductive biology of the target species.

Determining spawning grounds

The determination of spawning grounds differs from determining the temporal and spatial distribution of eggs and larvae. Prior knowledge of likely spawning times and locations is required and there is probably a restriction of interest to only the very earliest of developmental stages. The use of the earliest stages of eggs for pelagic broadcast spawners and yolk-sac larvae for benthic spawners minimizes the effects of drift from the spawning grounds. An estimation of density used in conjunction with mapping techniques will indicate the location of the spawning grounds. If these surveys are being undertaken over relatively large geographical scales and a number of substock components there is a potential for a temporal shift in spawning time with latitude. In such cases it will be necessary to undertake a series of surveys to ensure all spawning components are covered at peak spawning times.

Egg abundance surveys for AEPM and DEPM

Both AEPM and DEPM have been used for the estimation of SSB. These methods involve the sampling of eggs over either regular survey grids or adaptive grid designs, although the sampling schedules and estimation methods differ between the methodologies. The AEPM requires a series of surveys covering the whole of the spawning season, ensuring that the beginning, peak and end of spawning are covered. The objective is to estimate the annual production of early stage eggs (Armstrong *et al.*, 2001). Various techniques are employed to produce annual egg production estimates, including a histogram technique, production curves or models (GAMs). Within ICES coordinated surveys the histogram method is most commonly used to estimate annual egg production.

The DEPM requires at least a single coverage of the spawning area during the peak of spawning. The objectives are to estimate the spawning area, and the daily eggs production per area (P_o) derived from exponential mortality egg model.

Additionally information on various adult parameters to estimate SSB from the annual or daily egg production are determined.

Larvae abundance surveys for SSB indices

In some species the abundance or production of larvae are used as an index of SSB. It is important that only the early (yolksac) larvae stages are used. If species have discrete spawning grounds or a large spawning area it will be necessary for the sampling to be undertaken in each area at the time when peak hatching is likely to occur. Densities of early stage larvae are summed to give an index of abundance. For North Sea herring these data have always been estimated by nominal spawning area and summed to give the overall index but recently Payne (2010) reassessed these data and

has produced a more robust index, the spawning component abundance index (SCAI) which provides abundances related each of the main spawning components. If the survey coverage is more extensive a Larvae Production Estimate (LPE) can be produced (Heath, 1992). Using this technique the numbers of larvae at hatch are estimated using assumed growth and mortality rates to project back to a hatch date.

Larvae abundance surveys for recruitment indices

Abundances of later stage larvae are used to provide an index of recruitment. In these situations early life history processes have determined the ultimate year-class strength and later processes are simply altering the absolute abundance of individuals.

6 Review paper on developments in ichthyoplankton surveys (ToR d)

The outline of the proposed review paper is given in Annex 5. The paper will address all of the ToR's a, b and c. The timeline for the manuscript is to have all information of the individual surveys collected by the 1 November. The deadline for the first draft of the paper is 15 December. We intend to submit the paper to a peer reviewed journal.

The writing of the manuscript will be continued by correspondence.

7 WGDIM Egg and larval database action plan

The collection of the data are usually organized by international survey expert groups and the data are stored at the national institutes. In most cases, an expert group keeps a copy of the combined data to be able to supply the assessment working groups with the information needed. The information is available to participants of the expert group, but it is not accessible to the wider marine community.

Currently, there are a number of datasets which are coordinated by ICES groups and used in stock assessments but not readily available to the wider marine community. These are:

- mackerel and horse mackerel eggs Northeast Atlantic (WGMEGS);
- cod and plaice eggs North Sea (WGEGGS);
- herring larvae North Sea, herring larvae Western Baltic (both WGIPS);
- herring larvae North Sea (MIK-IBTSWG).

The data templates of the above datasets contain most of the variables to create the main data structure. However, some variables change between, but not within surveys and are missing from the individual data templates:

- Meshsize (μm)
- Flowmeter type
- Fixation of the sample
- Which sub-sampler was used
- Type of CTD

Some institutes have a direct output of filtered volume, whereas in others this has to be calculated from flowmeter readings. Therefore, volume should be kept as a variable but every institute should provide an explanation of the calculation. Flowmeter revolution counts and calibration factors should be kept by the individual institutes.

Both temperature and salinity are (can be) measured during the whole plankton tow by instruments attached to the sampler. Institutes should provide salinity and temperature data when they are collected from both the up- and down cast. If salinity is measured each institute should provide an explanation of its calculation.

The use of development stage systems and stage duration models for eggs and/or larvae differ between surveys, species and institutes. Each institute should provide a description of which development stage system and stage duration models they are using. Development stage should be entered as a numerical value.

Temperature, salinity, stage duration and development systems should be provided and stored in a descriptor file. These descriptor files should have standard descriptions for each of the calculations and staging systems.

There are other survey groups that hold appropriate data which could be uploaded to the ICES database following the above templates. However, participants in these other survey groups need to check with their individual institutes whether it is possible to upload the data into a database, because there will be open access to the raw data.

Most of the surveys are directed at target species but data on non-target species are also collected. However, the data collection of the other species is not ICES coordinated. SGSIPS recommends that WGDIM sends a request to institutes involved for

information on non-target species and environmental variables collected during the surveys to get an overview of potentially available data.

8 References

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Annex 1: List of participants

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Annex 2: Agenda

Monday 15 October

10:00 Introduction

10:15 Agenda

10:30 Survey presentations

- | | |
|---------------------------------|---------------------------------|
| • WGMEGGS | Jens Ulleweit |
| • Irish Sea egg production | Steve Milligan |
| • Plankton survey NW Atlantic | Jon Hare |
| • NSSH larvae survey | Richard Nash |
| • Eggs and larvae Norwegian Sea | Richard Nash |
| • NS herring larvae survey | Mark Dickey-Collas |
| • WGNAPES | Matthias Kloppmann |
| • MIK-IBTS | Robert Watret / Lynette Ritchie |
| • Anchovy/Sardine | Andres Uriarte |
| • WGEGGS | Cindy van Damme |
| • NS egg and larvae survey | Cindy van Damme |
| • Horse mackerel DEPM | Maria Manuel Angélico |

12:30 Lunch

13:30 Continue presentations

17:00 End of day

Tuesday 16 October

09:00 Ichthyoplankton survey data and WGDIM

12:30 Lunch

13:30 Setup ichthyoplankton paper (example Heath 1992)

17:00 End of day

Wednesday 17 October

09:00 Paper writing

12:30 Lunch

13:30 Paper writing

17:00 End of day

19:00 Diner

Thursday 18 October

09:00 Paper writing

12:30 Lunch

13:30 Future of SGSIPS and recommendations report

17:00 End of day

Friday 19 October

09:00 Report discussions and deadlines paper

12:30 End of meeting

Annex 3: SGSIPS terms of reference for the next meeting

The **Study Group on Standards in Ichthyoplankton Surveys** (SGSIPS) chaired by Cindy van Damme, The Netherlands, will meet in Lisbon, Portugal, 20–22 November 2013 to:

- a) Compile an overview and critical analysis of the methodologies used and objectives of ichthyoplankton surveys in the ICES area;
- b) Compare and contrast the utility of methods, recent developments and techniques for the purpose of improving ichthyoplankton surveys and increase standardization;
- c) Review and comment on new developments in statistical analysis of ichthyoplankton surveys and the relevance of these techniques to specific objectives;
- d) Review progress on the recommendations made by SGSIPS 2010.

SGSIPS will report by 15 January 2014 (via SSGESST) to the attention of SCICOM and ACOM.

Supporting Information

Priority	The activities of this Group are important and will lead to the cross fertilization of ideas, methodologies, developments and standardization of ichthyoplankton surveys in the ICES area. Hence the assessments based on the individual ichthyoplankton surveys can be improved.
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Scientific justification	<p>There are a number of ichthyoplankton surveys currently conducted in the ICES area, primarily for providing information that can be used in stock assessments. The surveys are targeted at a number of species such as plaice, cod, herring, anchovy, sardine, mackerel and horse mackerel. The surveys are targeted at sampling either eggs or larvae and use a variety of types of sampling equipment with a range of sampling protocols. In addition, the surveys are either national programmes or consist of a variety of levels of international cooperation.</p> <p>The surveys have a variety of goals, and with them come a variety of levels of complexity in the sampling programmes. There are a number of herring larvae surveys where the abundance of larvae is used as an index of the Spawning Stock Biomass (SSB) i.e. North Sea Autumn Spawning, Irish Sea Autumn Spawning and Norwegian Spring-spawning herring. In one instance (Rügen herring in IIIa) the production of young herring larvae is used as an index of herring recruitment. In this case assumptions need to be made on larvae growth and mortality rates.</p> <p>There are also a number of egg surveys that are used to provide indices of SSB. The surveys currently undertaken involve anchovy, sardine, mackerel, horse mackerel, cod and plaice in areas such as the western margin of the northeastern Atlantic, the Bay of Biscay to off Cadiz, North and Irish Seas. In these surveys the egg abundances are used to estimate egg productions and through estimates of fecundity back to the SSB. These techniques involve a greater level of data as they require not only pelagic egg data but also information on the reproductive potential of individuals in the stock. These analyses often come under the heading of Annual Egg Production (AEP) or Daily Egg Production (DEP) Methods. As with larvae production methodology these techniques also require information or assumptions on egg development rates and egg mortalities.</p> <p>There is a need for the various groups working on ichthyoplankton surveys to communicate on a number of topics. These include discussions on developments and problems in sampling, sampling equipment, protocols and data archiving and formats. There is also a need to keep informed on new or novel techniques for e.g. species identification using e.g. genetic probes or automated procedures. A number of these surveys are being undertaken at a regional level and as such there is also a need to bring people together so that surveys are not undertaken in isolation. Experience gained in one area can be transferred to others and there can be some semblance of standardization across all similar surveys.</p> <p>The first meeting of the group was in 2010 and produced recommendations for standardizing ichthyoplankton surveys and the storage of data in the ICES database. The meeting in 2013 will check on progress of the 2010 recommendations and the storage of data. Most surveys are conducted annually but the mackerel egg survey triennially. A meeting in 2013 would ensure that all surveys have been carried out at least once after the 2010 SGSIPS meeting.</p> <p>The group will provide coordination that ensures that every three years the group (encompassing all regional and species based ichthyoplankton survey planning, working and study groups) meets. The final product for this group will be the cross fertilization of ideas and standards for ichthyoplankton surveys in the ICES area.</p>
Resource requirements	ICES secretariat support for reports only.
Participants	Members of ICES groups, WGMEGS, WGEGGS, WGIPS, IBTSWG, WGACEGG support this group.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	SCICOM

Linkages to other committees or groups	There is a very close working relationship with all the groups of ichthyoplankton surveys, WGMEGS, WGEGGS, WGIPS, IBTSWG, WGACEGG.
Linkages to other organizations	No formal linkages.

Annex 4: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. SGSIPS recommends to meet again in 2013 to check on the progress of the 2010 meeting recommendations. Meeting in 2013 would ensure all ichthyoplankton surveys are carried at least once between the SGSIPS meetings	SSGESST, SCICOM, ACOM, SGSIPS
2. SGSIPS recommends the production of tables with survey information to provide insight into the variation between institutes within the different surveys and include these in the survey manual with the intention of providing a basis for the standardization of the surveys. The tables should be provided to SGSIPS prior to the November 2013 meeting.	SSGESST, WGMEGS, WGEGGS, WGIPS, IBTSWG, WGACEGG
3. Manuals of the different ichthyoplankton surveys should be standardized and regularly updated. These manuals should be produced as stand-alone reports accesible to anyone rather than an annex in the coordination group reports	PUBCOM, SSGESST, WGMEGS, WGEGGS, WGIPS, IBTSWG, WGACEGG
4. SGSIPS recommends to create a folder on the ICES website to store (ichthyoplankton) survey manuals in order to have easy access to all (ichthyoplankton) survey manuals.	PUBCOM, ICES secretariat
5. SGSIPS recommends that hydrographic measurements are taken with every plankton haul, preferably with a data logger on the net. If this is not possible, hydrographic measurements should be taken on station with a vertical CTD-cast immediately before or after the plankton haul.	SSGESST, WGMEGS, WGEGGS, WGIPS, IBTSWG, WGACEGG
6. SGSIPS recommends that WGDIM sends a request to institutes involved for information on non-target species and environmental variables collected during the surveys to get an overview of potentially available data.	WGDIM
7. To analyse and compare IHLS and MIK-net survey data to provide information on the origin of the larvae in the MIK samples.	WGIPS, IBTSWG and MSML

Annex 5: Proposed outline of the review manuscript

Working title: Standardizing ichthyoplankton surveys: review of methods

- 1) Introduction
- 2) Terminology
- 3) Objectives of the field research
- 4) Survey design and sampling strategies
- 5) Methods of research
- 6) Sample preservation
- 7) Analysis of samples
- 8) Data handling and storage
- 9) Statistical analysis
- 10) Assessment
- 11) Added value
- 12) Conclusions