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Report of the Workshop for Advancing Sexual Maturity Staging in Fish (WKASMSF)

30 April - 4 May 2018

ICES Headquarters, Copenhagen, Denmark

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Contents

Executive summary

The WKASMSF met 30 April – 4 May 2018 in Copenhagen, Denmark. 13 participants from eight countries (both ICES and GFCM countries) participated in the meeting. The meeting aimed to 1) prepare a historic overview of maturity scales used to collect and report maturity data to ICES, RDB and GFCM databases, 2) prepare conversion tables from the national and maturity staging workshop maturity scales to the internationally agreed maturity scale, 3) prepare an implementation plan for consistently reporting of maturity data in one international maturity staging scale, and 4) to review histological descriptions of maturity stages.

Historic overviews of maturity data reported were gathered from the ICES databases and from survey groups and national maturity stage coordinators for both ICES and GFCM areas. The ICES databases contain 13 different maturity scales, whereas from the survey groups and maturity stage coordinators over 70 different maturity staging scales were received. 13 different maturity staging scales were received from maturity stage coordinators adhering to GFCM. It is unclear whether maturity data uploaded to the ICES databases are properly converted to the selected uploaded scale.

In 2012 WKMATCH proposed one common maturity scale to be used for all species in the ICES areas. Since then maturity staging workshops have adopted this scale, which is also the scale that is suggested for the reporting. We present here the 'WKMATCH 2012 maturity scale revised'. The difference in this revised scale is that the coding is no longer in digits (1-6), but in letters (A-F). Most of the national maturity scales also use the digits suggested by WKMATCH, and this could potentially lead to misunderstandings, as people have difficulty to separate for example stage 5 from the national scale and stage 5 from the WKMATCH. Using letters solved this confusion considerably. For the GFCM areas, the GFCM-Data Collection Reference Framework (DCRF) presents the maturity scales to be used for reporting to the GFCM databases. These maturity scales have been adopted in 2015, and it is mandatory from 2018 onwards to report maturity data in these scales.

Using the information from the reports of the various maturity staging workshops, conversion tables to the 'WKMATCH 2012 maturity scale revised' were prepared. These tables should be used to convert the national maturity data before uploading to the international databases. Furthermore, conversion tables from those received from national maturity stage coordinators to the mandatory GFCM scales were prepared. Conversion tables from the 'WKMATCH 2012 maturity scale revised' and GFCM ones are also provided.

With the information above, it was possible to prepare an implementation plan for reporting maturity data in the 'WKMATCH 2012 maturity scale revised' to the ICES survey and commercial fisheries databases. Following these steps, it will be mandatory to report maturity data to ICES and RDB databases using the 'WKMATCH 2012 maturity scale revised' from the 1st January 2020. WGBIOP will be responsible for carrying out the implementation plan and any questions concerning maturity scale and data should be directed to WGBIOP.

For the GFCM areas, since 2018, it is mandatory in the DCRF to report maturity data in the maturity scales reported in the DCRF document.

WGBIOP will inform all survey groups, maturity stagers and data submitters of the implementation plan and the WKMATCH 2012 maturity scale revised'. WGBIOP will also prepare a handbook of maturity staging, collating maturity stage descriptions

from the workshop reports for the different species and combining these with histological descriptions and conversion tables. An atlas composed of macro and microscopic photos of a wide range of species included in the DCRF will be printed by FAO GFCM by summer 2018.

1 Introduction

The Workshop for advancing sexual maturity staging in fish (WKASMSF) met 30 April - 4 May 2018 in Copenhagen, Denmark. In total, 13 participants from eight countries attended the meeting (Annex 1).

Macroscopic stages of gonadal development are an essential feature in fish stock assessment to estimate the maturity ogive and Spawning-stock biomass (SSB). Since 2007, ICES has organized many maturity staging workshops for calibration and adopting internationally agreed maturity scales. This process was initiated with the Workshop on Sexual Maturity Sampling (WKMAT; ICES, 2007a). WKMAT proposed to use a 6-stage maturity scale, which would include the possibility to also report skipped spawning females and abnormal gonads. It is important to report these two stages since these fish will not participate in the current spawning period and do not produce offspring in the current spawning year.

Species-specific maturity staging workshops where held between 2007 and 2012; gadoids (WKMSCWHS; ICES 2007b), mackerel and horse mackerel (WKMSMAC; ICES 2007c), hake and monkfish (WKMSHM; ICES 2007d), small pelagics (WKSPMAT; ICES, 2008), crustaceans (WKMSC; ICES, 2009), elasmobranchs (WKMSEL; ICES 2010a), cephalopods (WKMCEPH; ICES 2010b), flatfish species (WKMSSPDF; ICES, 2010c), herring and sprat (WKMSHS; ICES, 2011), plaice, sole, flounder, dab, turbot and brill (WKMSSPDF2 & WKMSTB; ICES, 2012a, 2012b), and redfish and Greenland halibut (WKMSREGH; ICES, 2012c). These workshops all proposed variations of a 6-stage maturity scale.

In 2012, the Workshop for maturity staging chairs (WKMATCH; ICES, 2012d) was organized to review the proposed maturity scales. Most maturity stages adopted by the workshops were similar, but there were some differences with regards to the resting stage and skipped spawning. There is a huge biological difference between these two stages. The resting stage indicates that the fish has just spawned in the current spawning period, whereas the skipped spawning indicates the fish will not or did not participate in the current spawning period. WKMATCH proposed to include resting in stage 4, regressing/regenerating and keep stage 5 as omitted spawning. Omitted spawning was suggested because by the time of WKMATCH too many conflicting and unclear descriptions had been presented of skipped spawning.

Since WKMATCH, other maturity staging workshops were held on elasmobranchs (WKMSEL2; ICES, 2012e), gadoids (WKMSGAD; ICES, 2013), mackerel and horse mackerel (WKMSMAC2; ICES, 2015), and herring and sprat (WKMSHS2; ICES, in prep). These workshops used the WKMATCH proposed scale and stages for the calibration exercises and prepared the detailed descriptions of the stages for the specific species.

In addition, in 2017, the workshop on sexual maturity staging from histological tools (WKMATHIS, ICES in prep) was organized to prepare the histological descriptions of the macroscopic WKMATCH maturity scale. During this workshop, attended by both GFCM and ICES scientists, general histological descriptions of maturity stages for female and male teleosts, oviparous and viviparous elasmobranchs and cephalopods, as well as female crustaceans were prepared.

For GFCM areas, the macro maturity scales, together with some rules for achieving a more efficient maturity data collection, are laid down in the GFCM Data Collection Reference Framework (DCRF) since 2015. These GFCM-DCRF regulations have become mandatory since 2018. Before 2018, only size at first maturity data, to be used in

stock assessment workshops, were provided from samplings and on the base of the national maturity scales (mainly MEDITS scales). The GFCM-DCRF represents the first GFCM comprehensive framework for the collection and transmission of the fisheries-related data. The need to adopt a common acceptable maturity scale, as well as to establish objective criteria for the definition of each maturity stage, was considered a crucial issue in order to give a common tool for exchanging data and scientific information. Inside the document, it was also stressed that, whatever the maturity scales used by each country in their sampling process, the information gathered should be transmitted with reference to the maturity scales proposed inside the document. Macro maturity scales were reported for bony fish, elasmobranchs, crustaceans and cephalopods respectively. For some species groups, the GFCM-DCFR took into consideration and adopted the macroscopic scales approved during ICES workshops carried out over the years. Particularly, for crustaceans decapods, cephalopods and elasmobranchs the macroscopic maturity scales approved in the WKMSC (ICES, 2009), WKMSCEPH (ICES, 2010b) and WKMSEL2 (ICES, 2012) respectively, were adopted. For crustaceans stomatopods, the Froglia, 1996 scale, a maturity staging scale of 6 stages constructed only on the base of the female gonad characteristics, was considered. For bony fish, a macroscopic scale composed of 4 main stages on the base of the gonad dimensions and colour changes, the same used inside the MEDITS project, was adopted. An atlas composed of macroscopic and microscopic photos of a wide range of species included in the GFCM-DCRF subdivided in Osteichthyes, Chondrichthyes, Crustacean and Cephalopoda is going to be published by GFCM by summer 2018. This document is a useful tool to be used on board during surveys or when sampling commercial catches to define the maturity stages of species in order to reduce sources of error on maturity determination.

1.1 Reporting and calibration of maturity staging

The idea behind the internationally agreed WKMATCH maturity scale for the ICES areas and those adopted for the GFCM areas, has been and still is to create one common scale that all institutes can use for reporting their maturity data to the ICES and GFCM databases and to have a common scale to be used in calibration exercises. The WKMATCH scale has successfully been used in the calibrations (ICES, 2012e, 2013, 2015 and in prep.). However, it became also apparent from the calibration exercises that institutes where still reporting in their national scale to the ICES and RCG databases. In addition, almost all of the national scales were different from the WKMATCH proposed maturity scale. Only to the GFCM database, maturity data were reported in the required scale.

In the process of creating internationally agreed maturity scales, the step to inform the ICES data centre and RCGs and to ask for the implementation of the WKMATCH maturity scale in the ICES and RCG's databases was overlooked. As a result, the current maturity data uploaded to the international databases are based on various maturity scales that are subject to national interpretation. In addition, data uploaded to the GFCM databases are sometimes subject to confusion, due to a mismatch between the MEDITS agreed scales and the national scales.

The working group for biological parameters (WGBIOP) initiated the current WKASMSF in order to prepare an implementation plan for the WKMATCH scale and to define the steps needed to:

1. Implement the WKMATCH maturity scale in the ICES and RCG's databases and for all institutes to start reporting maturity data in the agreed international maturity scale, and

2. Construct conversion tables from WKMATCH and GFCM scales in order to allow exchange of data among ICES and GFCM scientists.

1.2 Terms of References

Terms of References for the WKASMSF are:

a) Prepare a historical overview of (national) maturity scales used for uploading sexual maturity staging data into the ICES and GFCM databases;

b) Create an overview, or prepare new, conversion tables from national maturity scales to the internationally agreed maturity scales;

c) Establish an implementation plan for the internationally agreed maturity scales of WKMATCH and GFCM, as the only scales for reporting to ICES and GFCM databases, respectively.

Expand general histological criteria, for validation of macroscopic maturity staging, as established by WKMATHIS for the different reproductive strategies in teleosts.

2 Adoption of the agenda

The agenda addressed all ToRs and can be found in Annex 2. The meeting started with an introduction to the workshop and state-of-the-art of maturity scales and data in the ICES and GFCM databases. This highlighted the problems with the reporting of maturity data. Based on the data brought by participants and information received from maturity coordinators, a historic overview of maturity scales in use was created. Based on WKMATCH 2012 (ICES, 2012d) the new common scale with coding was agreed. With this information an implementation plan was devised.

3 Historic overview of maturity scales in use (ToR a)

All survey groups and maturity stage coordinators have been asked to provide a historic overview of the maturity scales used for reporting to ICES and GFCM databases and commercial catches sampling programmes (RDB) prior to the meeting of WKASMSF. After the meeting survey groups and national maturity stage coordinators were contacted again to review, revise and add to the historic overview. This chapter gives the current status of the historic overview of maturity scales, which was available to WKASMSF at 1 June 2018. Missing information needs to be sent to WGBIOP to be able to comprise a full overview.

3.1 ICES areas

This chapter is split in the maturity data actually uploaded to the ICES databases (3.1.1) and the information received from survey groups and maturity stage coordinators (3.1.2). When comparing the information from both sources, there are differences to be found. It is unclear whether the data submitters converted the national to the ICES M6 scale before uploading to the ICES database or if the conversion has not taken place. In the latter option, maturity data in the ICES database could actually refer to the wrong scale.

3.1.1 Maturity scales in ICES databases and governance process

Maturity information is delivered to ICES databases from surveys (DATRAS and Acoustic DB) and commercial catches sampling programs (RDB). Maturity is reported with use of the variety of scales: 5 scales in DATRAS (http://vocab.ices.dk/?ref=361), 3 scales in the Acoustic DB (http://vocab.ices.dk/?ref=1481), and 13 scales in RDB (see Table 3.1.1). No overview or flagging of unreliable maturity data exists in any of the databases, and quality assurance is present only in the form of vocabulary checks. Detailed quality control is in hands of national submitters.

Historically, DATRAS surveys used simplified maturity codes (currently identified as M1 scale) and 4-stage scale (M4). In 2009, following the recommendations from WKMSCWHS-2007, IBTSWG recommended DATRAS to adopt a new 6-stage maturity scale (M6) for four gadoid species. With the number of workshops trying to adopt the 6-stage scale for the wide range of species, and following the need for a common maturity scale, DATRAS team has put an effort to adopt the M6 scale for reporting of all species from all surveys. However, there was a variety of issues with different working groups and submitters that lead to a diversified, potentially inconsistent, collection of maturity data in DATRAS. This was further complicated by introduction of the new revised scale by WKMATCH 2012, where some submitters started reporting maturity data in the new scale, but with M6 codes. Overview of the maturity scales used for reporting maturity in DATRAS per survey and country can be found in Table 3.1.2.

Acoustic DB has mainly maturity data reported as M6 with exception of Irish data for mackerel and boarfish. It is unclear whether the M6 scale is reported in this database is based on DATRAS stages, or WKMATCH 2012 stages.

RDB, steered by the RCGs, has a variety of international, national, and species-specific maturity scales that data providers select by their will, with no additional guidance.

Table 3.1.1. Maturity scales in the RDB for commercial sampling programs.

Code	Description
1-4	For herring. Used by ???
1-5	Common 1-5 stages for fishes
1-5AndAbnormal	Common 1-5 stages and with Abnormal as the 6th stage
1-5C	1-5 stages for crustaceans based on *Nephrops* biology
1-6	For herring. used by Latvia
1-8	1-8, used by ????
1-9	For herring. Used by Scotland.
Cod (1-5)	Used for cod
Halibut (1-5)	For Greenland halibut, used by J.Northw.Atl.Fish.Sci[1]
Nephrops (1-5)	Used for *Nephrops* by England
SCT-Crustacean Scale	Scottish *Nephrops* scale
Sebastes(1-5)	Requested by SGRS for redfish stocks and based on ICES (2003)
Swe(1-5)	Scale used by the Swedish coastal lab for flatfish

Table 3.1.2. Overview of the maturity scales used for reporting in DATRAS per survey and country.

Survey	Country	M1	M4	M6	M10	MRF6
BITS	DEN		1996-2003	2004-2018		
BITS	EST		1995-2011		2012-2017	
BITS	GFR		1991-2009		2010-2018	
BITS	LAT		1991-2007		2001-2018	
BITS	LTU		2004-2012	2011-2015	2015-2018	
BITS	POL		1991-2010		2001-2018	
BITS	RUS		1993-2011		2013-2018	
BITS	SWE		1991-2007		1994-1997; 2000-2018	
BTS	GFR		2008-2012			
BTS	NED		1993-2010	2016-2017		
BTS	NED					

[1] The current reference in the RDB does not give further information besides the journal name.

BTS-VIII	FRA		2013		
DYFS	NED		2003-2010	2010-2016	
EVHOE	FRA			2017	
FR-CGFS	FRA			2006-2017	
NIGFS	NI			2008-2017	
NS-IBTS	DEN	1985-1986	1993-1999	2000-2018	
NS-IBTS	ENG	1973-1990	1967-2003		
NS-IBTS	FRA	1982-1990	1992-2010	2011-2018	
NS-IBTS	GFR	1976-1990	1966-2015	2008-2018	
NS-IBTS	NED	1973-1990	1989-2010	2011-2018	
NS-IBTS	NOR	1971-1990	1971-2015	2004-2018	
NS-IBTS	SCO	1977-1990	1974-2013	2009-2018	
NS-IBTS	SWE		1972-2016	2006-2018	
NS-IBTS	USS	1982			
NS-IDPS	NOR				2013-2016
PT-IBTS	POR		2002-2008	2009-2016	
ROCKALL	SCO		2001-2012	2013-2015	
SP-ARSA	SPA			2003-2017	
SP-NORTH	SPA			2001-2017	
SP-PORC	SPA			2001-2016	
SWC-IBTS	SCO		1990-2013	2009-2017	

At present, the 'WKMATCH 2012 maturity scale revised' is not set up in any of ICES databases. Moreover, by the lack of expertise and a clear governance mechanism, ICES Data Centre has accepted all maturity scales suggested by data submitters or Survey Groups until now. Limited level of maturity recording/reporting guidance exists only in some of the survey manuals, linking to outdated sources. The present state of maturity reporting emphasizes the need of communicating the decisions from the maturity workshops to all actors collecting and using maturity data, and outlining of the governance mechanism for maturity-related decisions.

3.1.2 Maturity scales reported to be used by institutes

In total, 72 different maturity scales are reported to be used (Annex 4). These scales use a variety of different stages, from 2 up to 10. In addition, the split between the stages can differ between the scales. Some institutes have adopted the internationally agreed maturity scales proposed by the ICES maturity staging workshops as their 'new' national scale. These scales seem to be reported to ICES as the ICES M6 scale (Table 3.2). However, for the maturity staging workshop organized from 2012 onwards the stage 5 in the maturity scales is actually 'omitted spawning' instead of 'Resting/Skip of spawning' as formulated in the ICES vocabulary (http://vocab.ices.dk/?ref=1481).

3.2 GFCM areas

3.2.1 Maturity scales reported to be used by institutes

Inside the GFCM, maturity information is delivered from surveys (MEDITS and MEDIAS) and commercial catches sampling programs (Tables 3.2.1 and 3.2.2). The countries reporting to GFCM (France, Spain, Italy, Greece and Cyprus) have provided their national scales used inside their laboratories.

In particular, four different macroscopic maturity scales for bony fish are used (Nikolsky (1976), ICCAT, MEDITS scale and Beullens *et al*., 1997 scale). The Nikolsky scale, composed of 6 stages, was used by Cyprus from 2005 to 2016 to provide the maturity data of *Boops boops, Mullus barbatus, Mullus surmuletus, Pagellus erythrinus,* and *Spicara smaris* coming from commercial catches (Table 3.2.1). Since 2017, Cypriot researchers replaced the Nikolsky scale with the MEDITS scale for bony fish. The maturity scale of bony fish, present over the years in the MEDITS handbook, was also used by Italy, Spain, Greece and France to estimate the maturity stages of demersal species inside the MEDITS project. The same scale was used by Italy to identify the maturity stages of bony fish in commercial samplings. The ICCAT scale (5 stages) was used by Cyprus to identify the maturity stages of big pelagic fish (*Thunnus alalunga, Thunnus thynnus, Xiphias gladius*) in commercial captures. The macroscopic maturity scale presented in Beullens *et al*. (1997), was utilized by Cyprus to identify the eel maturity stages in commercial captures. Regarding the identification of maturity stages of other group of species (Cephalopods, Crustaceans, Elasmobranchs), Italy, Spain, France, Greece and Cyprus used the macroscopic maturity scale present inside the MEDITS handbook over the years. The same scales were used by Italy for commercial captures. The reporting of maturity to the GFCM database started in 2015 but it has become mandatory from 2018. In any case, the GFCM maturity data will be updated from the countries in a database constructed on the base of the mandatory maturity scales structure. It will be impossible to update other maturity scales different from the ones imposed by the GFCM-DCRF.

Table 3.2.1 Overview of maturity scales used in commercial sampling programs in GFCM areas.

Country	Macroscale	Code	Species	years
Greece (HCMR)	Nikoslky, 1976	6	Blackbelly anglerfish, Common Pandora, European hake, Red mullet, Striped mullet, Picarels, mackerels, horse mackerel, bogue, sole, sardines, anchovies	from 2003 till now
GREECE (HCMR and FRI)	WKMSEL; ICES, 2010; WKMSEL2; ICES, 2012	Oviparous: 5 for males & 6 for females, Viviparous: 5 for males & 8 for females.	Elasmobranchs	Not available
GREECE (HCMR)	Empirical	4	Atlantic bluefin tuna, Swordfish, Albacore	
GREECE (HCMR)	WKMSC; ICES, 2009	5	red shrimps, rose shrimp , Norway lobster	From 2009
GREECE (HCMR)	WKMSCEPH, ICES 2010		Cephalopods	Since 2014
GREECE (FRI)	Beullens K et al., 1997. Aquaculture 153: 151-162	4	European eel	From 1997
CYPRUS (DFMR)	MEDITS scale Instruction Manual Version no. 9 (2017)	6	Boops boops, Mullus barbatus, Mullus surmuletus, Pagellus erythrinus, Spicara smaris	From 2017
CYPRUS (DFMR)	Nikoslky, 1976	6	Boops boops, Mullus barbatus, Mullus surmuletus, Pagellus erythrinus, Spicara smaris	From 2005-2016
CYPRUS (DFMR)	ICCAT scale	6	Thunnus alalunga, Thunnus thynnus, Xiphias gladius	Not available
ITALY	Medits Handbook, 1995,1999,2001	4	fish	1994-2006
ITALY	Medits Handbook, 2007,2012,2013, 2016,2017	4 main stages	Bony fish	from 2007 till now
ITALY	MEDITS Handbook, 1995,1999,2001	3	Cefalopods	1994-2006
ITALY	MEDITS Handbook, 1995,1999,2001	3	Crustaceans decapods	1994-2006
ITALY	MEDITS Handbook, 2007,2012,2013, 2016,2017	3 main stages	Crustaceans decapods	from 2007 till now
ITALY	MEDITS Handbook, 2007	4 main stages	Elasmobranches oviparous	from 2007 to 2011
ITALY	MEDITS Handbook, 2012,2013,2016,2017	4 main stages	Elasmobranches oviparous	from 2012 till now
ITALY	MEDITS Handbook, 2012	6 for females and 4 for males	Elasmobranches viviparous	from 2012 till now

Table 3.2.2 Overview of maturity scales used in surveys in GFCM areas.

Country	Survey /Macroscale*	Code	Species	years
Greece (HCMR)	WKMSEL; ICES, 2010; WKMSEL2; ICES, 2012	Oviparous: 5 for males & 6 for females, Viviparous: 5 for males & 8 for females.	Elasmobranchs	Not available
GREECE (HCMR and FRI)	Nikoslky, 1976	6	Blackbelly anglerfish, Common Pandora, European hake, Red mullet, Striped mullet, Picarels, mackerels, horse mackerel, bogue, sole, sardines, anchovies	from 2003 till now
GREECE (HCMR)	WKMSCEPH, ICES 2010	5	Cefalopods	Since 2014
GREECE (HCMR)	MEDIAS survey Nikosky(1976)	6	anchovy, sardine	from 2003 till now
ITA, CYPRUS (DFMR); GREECE (HCMR and FRI), SPAIN(IEO), FRANCE (IFREMER)	Medits Handbook, 1995,1999,2001	4	fish	1994-2006
ITA, CYPRUS (DFMR); GREECE (HCMR and FRI), SPAIN(IEO), FRANCE (IFREMER)	Medits Handbook, 2007,2012,2013, 2016,2017	4 main stages	Bony fish	from 2007 till now
ITA, CYPRUS (DFMR); GREECE (HCMR and FRI), SPAIN(IEO), FRANCE (IFREMER)	MEDITS Handbook, 1995,1999,2001	3	Cefalopods	1994-2006
ITA, GREECE (HCMR and FRI), SPAIN(IEO), FRANCE (IFREMER)	MEDITS Handbook, 1995,1999,2001	3	Crustaceans decapods	1994-2006
ITA, SPAIN, GFCM, CYPRUS (DFMR), GREECE (HCMR and FRI), SPAIN(IEO), FRANCE (IFREMER)	MEDITS Handbook, 2007,2012,2013, 2016,2017	3 main stages	Crustaceans decapods	from 2007 till now
ITA, GREECE (HCMR and FRI), CYPRUS (DFMR), SPAIN (IEO), FRANCE (IFREMER)	MEDITS Handbook, 2007	4 main stages	Elasmobranches oviparous	from 2007 to 2011

*When no specific survey name but only generic "survey" is reported, only the macroscopic maturity scale used is listed.

4 International maturity scale for reporting (ToR b)

Because of different requirements in the data collection programmes, two different international scales will be used; one for the sampling in the ICES areas and the other for sampling in the GFCM areas.

4.1 ICES areas

For the ICES areas a revised version of the WKMATCH (Table 3.3 in ICES, 2012d) will be the international scale for reporting and will be called 'WKMATCH 2012 maturity scale revised' (Table 4.1). The main difference between the WKMATCH and 'WKMATCH 2012 maturity scale revised' is the coding. WKMATCH uses numbers 1 to 6. This becomes confusing as many national scales use numbers as well. To avoid confusion the coding has been changed to A to F for the main stages, and Ba, Bb to Db for the possible sub-stages (Table 4.1). In addition, the states have been given coding, SI for sexually immature and SM for sexually mature. The stage in the 'WKMATCH 2012 maturity scale revised' makes the distinction between a specimen without gonad development (SI) and with gonad development (SM). Therefore, the stage abnormal has been included in the state SM, as from the descriptions in the maturity staging reports it is clear that these gonads have undergone development.

Care should be taken that the state SM does not imply that the specimen will or has taken part in the spawning in the current year. In the sub-stage Ba, the gonad has undergone development but it is unclear if it will spawn in the current year. Technically it has become mature, because of the gonad development, but it is either a specimen developing for the first-time or a species with a reproductive cycle longer than a year and in the first year of development and will not take part in the spawning in the current year. Also, specimens in stages E and F will not take part in the spawning in the current year.

The only fish actually spawning and reproducing in the current year are those in (sub)-stages Bb, C and D.

Table 4.1. WKMATCH 2012 maturity scale revised

State	Stage	Possible sub-stages
SI. Sexually immature	A. Immature	
SM. Sexually mature	B. Developing	Ba. Developing but functionally immature (first-time developer)
		Bb. Developing and functionally mature
	C. Spawning	Ca. Actively spawning
		Cb. Spawning capable
	D. Regressing/ Regenerating	Da. Regressing
		Db. Regenerating
	E. Omitted spawning	
	F. Abnormal	

The reproductive cycle in a given year can be described in a conceptual diagram of the reproductive status for each ovarian stage (Figure 4.1). In this diagram, the immature

(A) and developing (Ba) gonads have relatively low reproductive status. This is also the case for the ovary when in the regenerating (Db) stage, until early signs of reproductive activity during the developing (Bb) stage mark a rise in the reproductive status of the gonad. Within the period of reproductive activity, as marked by the presence of developing (Bb) ovaries, the reproductive status is relatively high, with short-term peaks occurring during the brief periods when final maturation of the oocytes takes place and spawning (Ca) occurs. This is followed by a drop in reproductive status during the brief post-spawning stage (Cb). However, if repeat spawning (batches) occurs over a short period (e.g. on consecutive days), then several peaks in reproductive status are observed.

Finally, at the end of the spawning season, the ovary enters the (spent) regressing (Da) stage marking a decrease in reproductive status followed by the regenerating (Db) ovary.

The presence of ovaries in regenerating stage (Db) also occur at other times during the annual cycle in some species, indicating that the duration of this stage is species (stock) specific due to environmental, social or biological factors. If an individual does not regenerate the gonad in time for the next spawning season and it is found during the next prespawning season without signs of maturation, it should be recorded as in the spawning omission stage (E). Abnormal ovaries and ovaries in spawning omission have low reproductive status throughout the whole spawning period.

Specimens with ovaries in the two stages E and F are sexually mature but their reproductive activity is impaired thus they are not contributing to the stock reproductive potential for the current spawning season.

Further, note the shaded area in Figure 4.1, which indicates the period prior to reproductive activity when sexually immature (A) and sexually mature regenerating (Db) ovaries may look quite similar and can therefore be confused. In contrast, these two stages are quite distinct soon after the reproductive period whilst the mature ovary still retains evidence of previous spawning.

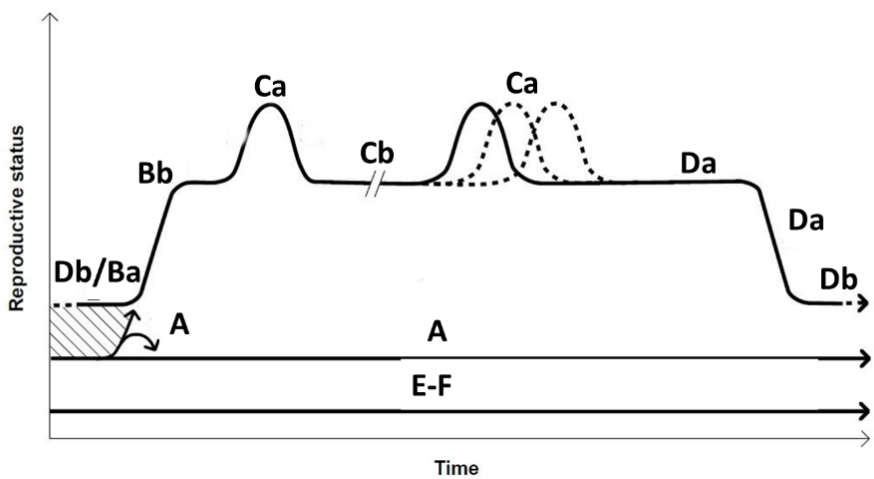

Figure 4.1. Developmental and maturation cycle of fish ovaries showing the relative reproductive status of each ovarian stage through time (one spawning season). Stages (A to F) represent the ovarian stages as detailed in the 'WKMATCH 2012 maturity scale revised ' (Table 4.1). The crosshatched area indicates the period when immature (stage A) and developing (stage B) ovaries are most difficult to tell apart. Modified from Mackie and Lewis, 2001.

4.2 GFCM areas

The macroscopic maturity scales, presented in the GFCM-DCRF, represent the in-ternationally agreed scales for reporting inside the GFCM. They are mostly based on the general aspect, shape, dimension, position and colour of the gonads. These scales are derived from knowledge and experience gained during different surveys and ongoing working groups, carried out in the Mediterranean and Black Sea area (Ungaro, 2008; ICES, 2010a, 2010b; SoleMon, 2011; Dimech et al., 2012; Medias Handbook, 2012; Med-its Handbook, 2013, 2016; Follesa et al., 2015). Specific mac-roscopic maturity scale for bony fish, Crustaceans, Cephalopods and Elasmobranchs respectively are reported. All macroscopic maturity scales in the DCRF have become mandatory since 2018.

For bony fish, a scale of four main stages should be used to report the maturity stages (Medits Handbook, 2013, 2016; Table 4.2.1). The stages (from 0 to 4) are based mainly on the relative volume, the consistency and the colour of the gonads, the presence of sperm in males and the presence and the degree of hydration of the eggs in females. The gonad colour changes with the progression of maturation de-velopment, and changes from pinkish/reddish (stage 1 and sub-stage 2a) to pinkish orange (stage 3) in females and from whitish (stage 1 and sub-stage 2a) to creamy (stage 3) in males. The dimension switches from being 1/3 - ½ of the body cavity in the immatures (stages 1) to be long from 2/3 (sub-stage 2c) to full length of the body cavity in the mature ones (stage 3). At the end of the spawning season, the ovary enters in post deposition stages (stage 4 subdivided in two sub-stages 4a and 4b) characterized by reddish progres-sively shrinking gonads. The eggs, visible by na-ked eye in the maturing (stage 2c) and mature stages (stage 3) respectively, only in the latter one escape freely from the abdo-men (stage 3). In line with the 'WKMATCH 2012 maturity scale revised', a distinction between specimens with-out gonad development (SI) and with gonad development (SM) is done. Care should be taken that the state SM does not imply that the specimen will or has tak-en part in the spawning in the current year. The sub-stage 2a defines the specimen that start for the first time the reproductive cycle, the gonad has undergone devel-opment but it is unclear if it will spawn in the current year. The sub-stage 2b repre-sents specimen that has finished a reproductive cycle and are preparing to start another one. At this stage the specimens are inactive mature, the gonad has under-gone development but it has taken part in the spawning in the current year. The only fish actually spawning and reproducing in the current year are those in (sub)-stages 2b, 2c, 3 and 4 (both sub-stages 4a and 4b).

For Crustacean decapods, a five-stage scale (ICES, 2010a) has been chosen to report the maturity stages of the most common species (Aristeus antennatus, Aristaeomor-pha foliacea, Parapenaeus longirostris, Nephrops norvegicus) (Table 4.2.2). The maturity stages can be determined by examining the colouring and appearance of ovary lobes (females) and the fusion degree of the petasma, presence/absence of the spermatic masses on seminal ampullae and the dimension of the rostrum (males). Specific details in the development and maturing of the different species gonads were done.

The maturity scale proposed by Froglia (1996) was chosen to report maturity stages of stomatopods (i.e. Squilla mantis; Table 4.2.3). Taking into account the difficulties in detailing the maturity condition of gonads in males at macroscopic level, only maturity scales for females were presented in the DCRF. The maturity stages can be determined on the base of ovary aspect and the colour of the 6th-8th sternites. In line with the 'WKMATCH 2012 maturity scale revised', a distinction between a specimen without gonad development (SI) and with gonad development (SM) was done for both Deca-pods and Stomatopods. The only specimens actually spawning and reproducing in the current year are those from stages 2 to 5 for both Decapods and Stomatopods.

A three main stages scale of maturity (Medits Handbook, 2013, 2016) should be used to report the maturity in cephalopods (Table 4.2.4). This scale is based on the development (or size, colouring and appearance) of ovary and nidamental glands in females and the development of testis and spermatophoric complex, including the Needham's sac in males. Specific egg dimension and spermatofore develop-ment are reported for the main target species. In line with the 'WKMATCH 2012 maturity scale revised', a distinction between a specimen without gonad develop-ment (SI) and with gonad development (SM) was done. Care should be taken that the state SM does not imply that the specimen will or has taken part in the spawn-ing in the current year. As reported for bony fish, the sub-stage 2a defines the spec-imens that start for the first time the reproductive cycle, the gonad has undergone development but it is unclear if it will spawn in the current year. The sub-stage 2b represents specimens that have finished a reproductive cycle and are preparing to start another one. At this stage the specimens are inactive mature, the gonad has undergone development but it has taken part in the spawning in the current year. The only cephalopods actually spawning and reproducing in the current year are those from stages 2b to 3b.

The maturity scales approved during WKMSEL2 (ICES, 2013) have been chosen to report the maturity stages of the most common elasmobranchs: one for oviparous and another one for viviparous species. These scales are based on the development (or size, colouring and appearance) of ovary and nidamental glands in females, and the development of testis and spermatophoric complex, including the Need-ham's sac in males (Tables 4.2.5 and 4.2.6). The oviparous scale is subdivided in four main stages for males (1,2, 3a,3b, 4) and 4 main stages for females (1,2,3a,3b,4a,4b). In the oviparous scale, the stage 2 developing represents the ado-lescent specimens that are maturing for the first time separately from the adult specimens of the sub-stage 4b. The stage 4a regenerating is macroscopically similar to stage 2 developing but it represents the specimens that are beginning a new cycle and have already spawned at least once. In oviparous elasmobranchs, the differen-tiation of testes usually anticipates the full development of claspers (asynchronous development), which rigidity is a condition necessary but not enough for the de-termination of the maturity stage. Moreover, in case the specimen is resting (stage 4), the complete development of claspers is coupled with testes small and empty. Also in the last situation, not observing the testes status could lead to the wrong evaluation of the maturity stage. In general, when the claspers are smaller than pelvic fins it is considered stage 1 immature, and when claspers reach or surpass the length of pelvic fins it is considered stage 2 developing. In line with the 'WKMATCH 2012 maturity scale revised', also for this macroscale, a distinction between a specimen without gonad development (SI) and with gonad development (SM) was done. In the case of the oviparous species, the only specimens actually spawning and reproducing in the current year are those from stages 3 to 4.

In viviparous elasmobranchs, six different main stages are identified for females and four for males. In females, maternal stages are defined (4a-4c) on the base of the state of yolk-sac, particularly its segmentation. The stage 5 post-partum fol-lows the maternal stages. Typically, viviparous species, due to their determinate fecundity, in stage 5 post-partum do not have follicle development, which is the main difference from stage 6 regenerating. In stage 6, in fact, the ovary starts to produce the next generation of follicles, and several small yellow follicles are visi-ble. The Stage 6 regenerating can also be mistaken with stage 2 developing, but the former refers to those females that are maturing not for the first time, being distin-guishable from the latter by their enlarged and flaccid uterus and well developed oviducal gland. The macroscopic stages of males are similar to that of oviparous elasmobranchs. Also in the case of viviparous

elasmobranchs, a distinction between a specimen without gonad development (SI) and with gonad development (SM) was done. In this case, the only specimens actually spawning and reproducing in the current year are those from stages 3 to 4 for males and 3 to 6 for females.

Table 4.2.1. GFCM macroscopic maturity scale for bony fish

State	Stages	Maturation state	Reproductive apparatus aspect	
	0	UNDETERMINED	Sex not distinguished by naked eye. Gonads very small and translucent, almost transparent. Sex undetermined.	
			Females	*Males*
SI. Sexually immature	**1**	IMMATURE-VIRGIN	Small pinkish and translucent ovary shorter than 1/3 of body cavity. Eggs not visible to naked eye.	Thin and whitish testis shorter than 1/3 of body cavity.
SM. Sexually mature	**2a**	VIRGIN-DEVELOPING	Small pinkish/reddish ovary shorter than 1/2 of body cavity. Eggs not visible to naked eye.	Thin whitish testis shorter than 1/2 of body cavity.
	2b	RECOVERING	Pinkish-reddish/reddish-orange and translucent ovary; length about 1/2 of body cavity. Blood vessels visible. Eggs not visible to naked eye.	Whitish/pinkish testis, more or less symmetrical; length about 1/2 of body cavity.
	2c	MATURING	Ovary pinkish-yellow in colour with granular appearance; length about 2/3 of body cavity. Eggs are visible to naked eye through the *ovaric tunica*, which is not yet translucent. Under light pressure, eggs are not expelled.	Whitish to creamy testis; length about 2/3 of body cavity. Under light pressure, sperm is not expelled.
	3	MATURE/SPAWNER	Ovary orange-pink in colour, with conspicuous superficial blood vessels; length from 2/3 to full length of body cavity. Large transparent, ripe eggs are clearly visible and could be expelled under light pressure. In more advanced conditions, eggs escape freely.	Whitish-creamy soft testis; length from 2/3 to full length of body cavity. Under light pressure, sperm could be expelled. In more advanced conditions, sperm escapes freely.
	4a	SPENT	Reddish ovary shrunk to about 1/2 length of body cavity. Flaccid ovaric walls; ovary may contain remnants of disintegrating opaque and/or translucent eggs.	Bloodshot and flabby testis shrunk to about 1/2 length of body cavity.
	4b	RESTING	Pinkish and translucent ovary; length about 1/3 of body cavity. Eggs not visible to naked eye.	Whitish/pinkish testis, more or less symmetrical; length about 1/3 of body cavity.

Table 4.2.2. GFCM macroscopic maturity scale of Crustacean decapoda.

State	Stages	Maturation state	Reproductive apparatus aspect				
			Colouring of fresh ovary	*Parapenaeus longirostris*	*Aristaeomorpha foliacea*	*Aristeus antennatus*	*Nephrops norvegicus*
SI. Sexually immature	**1**	Immature	whitish or translucid	Ovaries not visible without dissection. The ovaries are thin and translucent with a tubular appearance adherent to the dorsal portion of the stomach, not extending to the abdomen.	Ovaries not visible without dissection. The ovaries are thin and translucent with a tubular appearance adherent to the laterals of the stomach, not extending to the abdomen.	Ovaries not visible without dissection. The ovaries are thin and translucent with a tubular appearance adherent to the laterals of the stomach, not extending to the abdomen.	Ovaries not visible without dissection. The ovaries are translucent, thin and threadlike.
SM. Sexually mature	**2**	**Developing/Resting /Recovering**	***A. foliacea*: flesh coloured; *A. antennatus:* ivory coloured with orange pink-violet dotting; *N. norvegicus*: cream; *P. longirostris*: cream orange;**	**Ovaries are barely visible without dissection. The cephalic lobes start to cover the sides while the abdominal extensions occupy all somites.**	**Ovaries barely visible without dissection. Cephalic lobes small but distinguishable. The gonad generally extends up to 3rd abdominal somite.**	**Ovaries barely visible without dissection. Cephalic lobes small but distinguishable. The gonad extends to the full length of the abdomen.**	**Ovaries barely visible without dissection. The gonads extends up to the 1st somite of the abdomen and have a granular appearance.**
	3	**Maturing**	***A. foliacea*: light and dark grey; *A. antennatus:* lilla; *N. norvegicus*: light green; *P. longirostris*: light green or grey green;**	**Ovaries are clearly visible through integument. Ovaries developed and turgid, with cephalic lobes and abdominal extensions occupying the entirely the dorsal portion. The gonads appear granular.**	**Ovaries are clearly visible through integument. Ovaries developed and turgid, with evident cephalic lobes. The gonad generally extends to the 4th abdominal somite**	**Ovaries are clearly visible through integument. Cephalic and abdominal extensions are well developed and turgid.**	**Ovaries are clearly visible through integument. The gonad occupies one third of the cephalotoracic space. The gonads extend up to the 1st somite of the abdomen.**
	4	**Mature**	***A. foliacea*: black; *A. antennatus:* violet; *N. norvegicus*: dark grey; *P. longirostris*: brightgreen or olive green;**	**Turgid ovaries extending to the whole dorsal area. Lobes and extensions well developed. Eggs well visible.**	**Turgid ovaries extending to the whole dorsal area. Lobes well developed and abdominal extensions may reach the 5th somite. Eggs well visible.**	**Turgid ovaries occupying the whole dorsal area. Lobes and abdominal extensions well developed. Eggs well visible.**	**Turgid ovaries occupying the whole dorsal cephalotoracic space and extending up to the 2nd somite. Eggs visible.**
	5	**Spent**	**uncoloured**	**Ovaries after spawning are fully extended but loose turgidity becoming flaccid.**	**Ovaries large but flaccid with blackish spots.**	**Ovaries large but flaccid with purple spots.**	**Ovaries flaccid with green spots. Re-absorption of ovarian material. Most likely with green eggs on pleopods.**

Table 4.2.3. GFCM macroscopic maturity scale of Crustacean stomatopoda

State	Stage	Maturation state	Reproductive apparatus aspect
SI	0	IMMATURE	ovaries filamentous and hyaline; 6th-8th sternites hyaline
SM. Sexually mature	1	QUIESCENT	filamentous ovaries with evident brown dots (chromatophores), 6th-8th sternites hyaline
	2	EARLY MATURATION	narrow yellow ovaries, 6th-8th sternites whitish
	3	MATURATION	yellow ovaries extending up to half of abdomen width, not visible through cutile on the ventral side of telson, 6th-8th sternites white.
	4	RIPE	yellow ovaries extending over half abdominal width, visible through cutile on the ventral side of telson, 6th-8th sternites milky white.
	5	SPENT	similar to quiescent ovaries, sometime with fewyellow dots, but 6th-8th sternites still white.

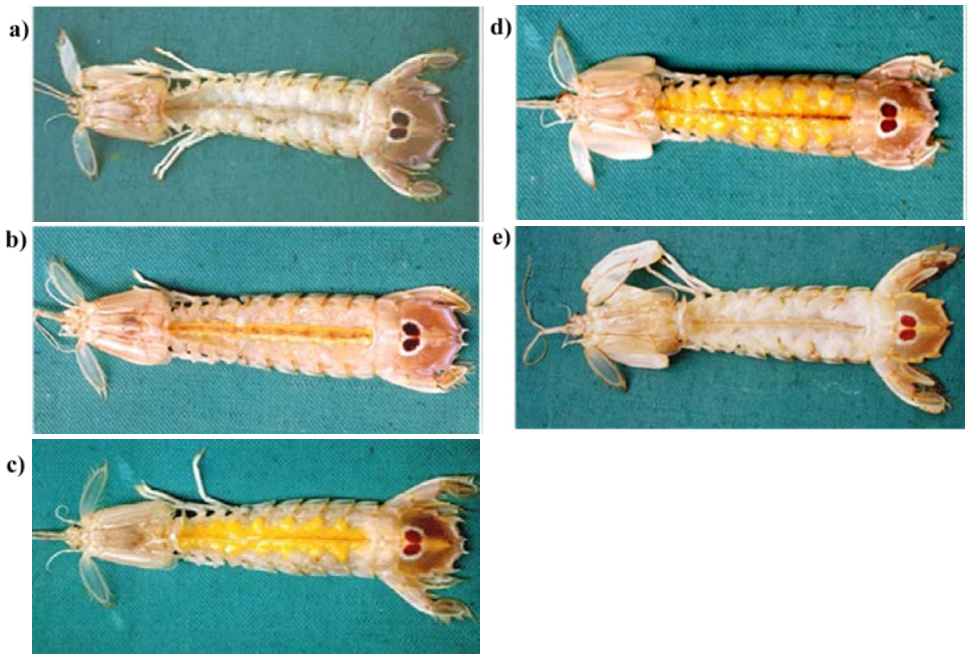

Figure 4.2.1. Illustrations showing the sexual macroscopic determination of sex in *Squilla mantis* females, ovaries a) immature b) early maturation c) advanced maturation d) ripe e) spent (source: SoleMon, 2011).

Table 4.2.4. GFCM macroscopic maturity scale of Cephalopods.

State	Stages	Maturation state	Reproductive apparatus aspect	Sex
	0	Undetermined	Sex not distinguished by naked eye. Sex undetermined.	U
SI. Sexually immature	**1**	Immature-Virgin	Small and translucent Nidamental glands (NG)/Oviducal glands (OG). Ovary is semi-transparent, stringy and lacking granular structure. Small semi-transparent NG/OG. Oviduct meander not visible. Total absence of spermatophores.	F
			Testis small. Spermatophoric complex (SC) semi-transparent; Vas deferens not visible. Penis appears as a small prominence of SC.	M
SM. Sexually mature	**2a**	Developing	NG/OVG enlarged. NG covering some internal organs. Whitish ovary with granular structure clearly visible, not reaching the posterior half of the mantle cavity. Oviduct meander clearly visible. Eggs very small. Absence of spermatophores.	F
			Enlarged testis with structure not clearly visible. Vas deferens is whitish or white and the spermatophoric organ has white streak.	M
	2b	Maturing	Large NG covering the viscera below. Ovary occupies the whole posterior half of mantle cavity, containing reticulated oocytes of all sizes tightly packed and probably a few ripe ova at its proximal part. Oviducts fully developed but empty. Maturing eggs visible to naked eye. Few spermatophores.	F
			Vas deferens is white, meandering, enlarged. Needham's sac (SS) with structure less whitish particles inside. Normally the Needham's sac is without functional spermatophores, but sometimes some immature/abortive ones could occur. Testis tight, crispy, with visible structure.	M
	3a	Mature	Large NG as previously. Ovary containing higher percentage of large reticulated eggs and some large ripe ova with smooth surface. In Teuthoidea ripe ova in oviducts. Eggs medium and big, and visible both in oviducts and in the ovary. Well-developed spermatophores.	F
			Testis as before. Spermatophores packed in the Needham's sac.	M
	3b	Spent	NG/OG large but soft and running. Ovary shrunk and flaccid, with only immature oocytes attached to the central tissue and a few loose large ova in the coelom. In Teuthoidea, oviduct may contain some mature ova but are no longer packed.	F
			Disintegrating spermatophores in the Needham's sac and the penis.	M

Table 4.2.5. GFCM macroscopic maturity scale of viviparous elasmobranchs

viviparous elasmobranchs		Females			Males		
State	MATURATION STATE	STAGES	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT	STAGES	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT
SI. Sexually immature	IMMATURE	**1**	IMMATURE	Ovaries: small and whitish; undistinguishable ovarian follicles. Oviducal gland: often not visible. In some species, a thickening of the uteri where the gland will develop may be visible. Uteri: thread-like and narrow.	**1**	IMMATURE	Claspers: flexible, non-calcified and usually shorter than pelvic fins. Testes: small and undeveloped. Ducts: straight and thread-like.
		2	DEVELOPING	Ovaries: follicles of different stages of development. Some small and medium-sized yolked follicles may be present. Oviducal gland: distinguishable and developing. Uteri: enlarging.	**2**	DEVELOPING	Claspers: flexible, partially calcified and as long as or longer than pelvic fins. Testes: developing and may start to segment in sharks; in rays lobules clearly visible but do not occupy the whole surface. Ducts: developing and beginning to coil.
SM. Sexually mature	MATURE	**3**	CAPABLE OF REPRODUCTION	Ovaries: presence of large yolked follicles ready to be ovulated. Oviducal glands: fully developed Uteri: fully developed.	3a	CAPABLE OF REPRODUCTION	Claspers: rigid, fully calcified, and longer than pelvic fins. Testes: fully developed; for some shark species testes are fully segmented. Ducts: tightly coiled and filled with sperm.
					3b	ACTIVE	Claspers: similar to stage 3a, however with clasper glands dilated, sometimes swollen. Sperm may be present in clasper groove or glands. Testes: similar to stage 3a. Ducts: sperm observed inside after a cut or flowing out of the cloaca on pressure.
					4	REGRESSING	Claspers: fully formed, similar to stage 3. Testes shrunken and flaccid, (in skates, with few visible lobules). On pressure, sperm does not flow. Sperm ducts: empty and flaccid. Seminal vesicle developed but empty.

viviparous elasmobranchs		Females			Males		
State	MATURATION STATE	STAGES	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT	STAGES	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT
SM. Sexually mature	MATERNAL	**4a**	**EARLY PREGNANCY**	**Uteri: well filled and rounded with yolk content (usually candle shaped). Embryos cannot be observed.**	-	-	-
		4b	**MID PREGNANCY**	**Uteri: well filled and rounded. Embryos are always visible, small and with a relatively large yolk sac.**	-	-	-
		4c	**LATE PREGNANCY**	**Uteri: embryos fully formed, yolk sacs reduced or absent.**	-	-	-
		5	**POST-PARTUM**	**Ovaries: shrunken without follicle development and with atretic (degenerating) follicles. Uteri: enlarged and flaccid.**	-	-	-
	MATURE	**6**	**REGENERATING**	**Ovaries: large with small and medium- sized yolked follicles. Pre-ovulatory follicles absent. Atretic follicles may be present. Oviducal glands: fully developed but may be reduced in size. Uteri: enlarged.**	-	-	-

Table 4.2.6. GFCM macroscopic maturity scale of oviparous elasmobranchs.

oviparous elasmobranchs		Females		Males	
STATE	STAGES	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT	MATURATION STATE	REPRODUCTIVE APPARATUS ASPECT
SI. Sexually immature	**1**	IMMATURE	Ovaries: small and whitish. Undistinguishable ovarian follicles. Oviducal gland often not visible. In some species, a thickening of the uteri where the gland will develop may be visible. Uteri: thread-like and narrow.	IMMATURE	Claspers: flexible, non-calcified and shorter than pelvic fins. Testes: small and undeveloped (in skates, sometimes with visible lobules). Ducts: straight and thread-like.
	2	DEVELOPING	Ovaries: follicles of different stages of development. Some small and medium-sized yolked follicles may be present. Oviducal gland: distinguishable and developing. Uteri: enlarging.	DEVELOPING	Claspers: flexible, partially calcified and usually as long as or longer than pelvic fins. Testes: developing (in skates, lobules clearly visible but not fully developed). Ducts: developing and beginning to coil.
SM. Sexually mature	**3a**	CAPABLE OF REPRODUCTION	Ovaries: presence of large yolked follicles ready to be ovulated. Oviducal glands: fully developed. Uteri: fully developed.	CAPABLE OF REPRODUCTION	Claspers: rigid, fully calcified, and longer than pelvic fins (in some sharks they may only be as long as the pelvic fins). Testes: fully developed (in skates, with fully formed lobules). Ducts: tightly coiled and filled with sperm.
	3b	EGG LAYING	Uteri: presence of egg capsules.	ACTIVE	Claspers: similar to stage 3a, however with clasper glands dilated, sometimes swollen and reddish. Sperm may be present in clasper groove or glands. Testes: similar to stage 3a. Ducts: sperm observed inside (after a cut) or flowing out of the cloaca on pressure.
	4a	POST-LAYING	Ovaries: flaccid with few follicles of different sizes. Few large vitellogenic follicles entering atresia. POFs and atretic follicles may be visible. Oviducal glands: fully developed but may be reduced in size. Uteri: enlarged and flaccid.	REGRESSING	Claspers: fully formed, similar to stage 3. Testes shrunken and flaccid, (in skates, with few visible lobules). On pressure sperm does not flow. Sperm ducts: empty and flaccid.
	4b	REGENERATING	Ovaries: large with small and medium-sized yolked follicles. Pre-ovulatory follicles absent. Oviducal glands: fully developed but may be reduced in size. Uteri: enlarged.	-	-

5 Conversion of national scales to international maturity scale (ToR b)

All survey groups and maturity stage coordinators were asked to provide a historic overview of the maturity scales used for reporting to ICES and GFCM databases and commercial catches sampling programmes (RDB) prior to the WKASMSF meeting. During the meeting, conversion tables were created with the information available. After the meeting, survey groups and maturity stage coordinators were contacted again to review, revise and add to the conversion tables. This chapter gives the current status of the conversion tables. Missing information needs to be sent to WGBIOP to be able to comprise a full overview.

The conversion tables provided in this chapter need to be followed to correctly convert the institute maturity data to the 'WKMATCH 2012 maturity scale revised'. This conversion should be carried out before the maturity data are uploaded to the ICES and GFCM databases.

5.1 ICES areas

5.1.1 ICES M6 maturity scale

The M6 maturity scale was introduced in the ICES database upon request from the IBTSWG (see chapter 3.1.1). This scale is different from the 'WKMATCH 2012 maturity scale revised' in stage 65 (Figure 5.1). Resting is different from omitted spawning in the sense that the resting fish has reproduced in the current spawning year and the omitted spawner has or will not.

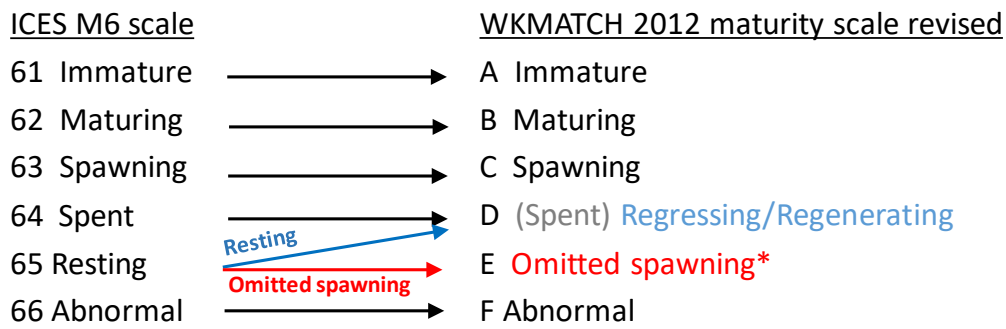

Figure 5.1. Comparing the M6 scale in the ICES DATRAS database with the WKMATCH 2012 maturity scale revised'. Spent can be both regressing and regenerating depending on the species, but resting is in the spawning sense different from omitted spawning. (* Omitted spawning was previously referred to as skipped spawning.)

The conversion of the first four stages (61 to 64 and 66) of the ICES M6 scale to the new WKMATCH 2012 maturity scale revised (A to D and F) is pretty straightforward (Figure 5.1). The only challenge is stage 65 (Resting). Biologically speaking after the spawning season the gonad is first regressing and thereafter regenerating, where regressing is synonymous of spent while regenerating is synonymous of resting. The duration of this process varies among species and/or stocks and depends on the biology as well as the environment. The transition of a gonad from regeneration to the start of maturation requires time and if an individual is found during the prespawning season in the regenerating stage, it is most probably not going to take part in the current spawning season. This phenomenon is known as spawning omission (Rideout & Tomkiewicz, 2011; ICES, 2012d) and the individual has to be recorded in stage E. Specimens in this stage are sexually mature but will not contribute to the current spawning season thus have to be excluded from the estimation of the maturity ogives and SSB. The table

above shows that when using the ICES M6 scale those specimens are recorded in the resting stage (65); if this stage is recorded during the spawning or in the immediate post-spawning season the individual is included in the estimation of the SSB while if this stage is recorded during the prespawning (where no spent individuals are observed yet) the specimen has to be excluded from the SSB. Stage 65 is thus including a mixture of individuals in regeneration and spawning omission stages whose historical conversion can be applied taking into consideration the stock specific temporal development in relation to the sampling time.

This plastic response of fishes to low levels of stored energy or unsuitable environmental conditions is sufficiently widespread and of a magnitude to be of concern to stock assessment and management, especially for long-lived species. This justifies the creation of a separate stage for recording gonads in this condition.

5.1.2 Conversion from national and maturity staging workshop scales

Maturity staging workshop scales were converted to the 'WKMATCH 2012 maturity scale revised' (Annex 6). Some maturity staging workshops and survey manuals give conversion tables from the national scales to the internationally agreed scales. The conversion to the 'WKMATCH 2012 maturity scale revised' is added to these tables (Annex 6).

5.2 GFCM areas

Maturity scales mainly used by the different countries inside their laboratories were converted in the GFCM ones (Annex 7). Only the Beullens *et al.*, 1997 scale was not converted because not enough information was available to do this.

5.3 ICES versus GFCM

The conversion tables from the 'WKMATCH 2012 maturity scale revised' to the GFCM scales for reporting to ICES and GFCM databases respectively, are presented below.

Table 5.3.1. Conversion table from the GFCM bony fish macroscopic maturity scale and the 'WKMATCH 2012 maturity scale revised'.

GFCM SCALE Bony fish	WKMATCH 2012 maturity scale revised
1. IMMATURE / VIRGIN	A. IMMATURE
2a. VIRGIN DEVELOPING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
2b. RECOVERING	Bb. DEVELOPING AND FUNCTIONALLY MATURE
2c. MATURING	C. SPAWNING
3. MATURE / SPAWNER	
4a. SPENT	Da. REGRESSING
4b. RESTING	Db. REGENERATING
	E. OMITTED SPAWNING
	F. ABNORMAL

Table 5.3.2. Conversion table from the GFCM Crustaceans scales to the 'WKMATCH 2012 maturity scale revised'.

GFCM Crustaceans Stomatopods	GFCM Crustaceans Decapods	WKMATCH 2012 maturity scale revised
0. IMMATURE	1. IMMATURE	A. IMMATURE
2. EARLY MATURATION	2. DEVELOPING-RESTING-RECOVERING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
1. QUIESCENT		Bb. DEVELOPING AND FUNCTIONALLY MATURE
3. MATURATION	3. MATURING	C. SPAWNING
4. RIPE	4. MATURE	
5. SPENT	5. SPENT	Da. REGRESSING
	2. DEVELOPING-RESTING-RECOVERING	Db. REGENERATING
		E. OMITTED SPAWNING
		F. ABNORMAL

Table 5.3.3. Conversion table from the GFCM Cephalopods scale to the 'WKMATCH 2012 maturity scale revised'.

GFCM Cephalopods	new WKMATCH 2012 maturity scale revised
1. IMMATURE VIRGIN	A. IMMATURE
2a. DEVELOPING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
2b. MATURING	Bb. DEVELOPING AND FUNCTIONALLY MATURE
3a. MATURE	C. SPAWNING
3b. SPENT	Da. REGRESSING
	Db. REGENERATING
	E. OMITTED SPAWNING
	F. ABNORMAL

Table 5.3.4. Conversion table from the GFCM oviparous elasmobranchs scale to the 'WKMATCH 2012 maturity scale revised'.

GFCM oviparous elasmobranch	WKMATCH 2012 maturity scale revised
1. IMMATURE-VIRGIN	A. IMMATURE
2. MATURING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
	Bb. DEVELOPING AND FUNCTIONALLY MATURE
3a. MATURE	C. SPAWNING
3b. MATURE/EXTRUDING-ACTIVE	
4a. RESTING	Da. REGRESSING
4b. REGENERATING*	Db. REGENERATING
* only for female	E. OMITTED SPAWNING
	F. ABNORMAL

Table 5.3.5. Conversion table from the GFCM viviparous elasmobranchs scale to the 'WKMATCH 2012 maturity scale revised'.

GFCM viviparous elasmobranch	WKMATCH 2012 maturity scale revised
1. IMMATURE	A. IMMATURE
2. DEVELOPING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
	Bb. DEVELOPING AND FUNCTIONALLY MATURE
3.CAPABLE OF REPRODUCTION * 3A. CAPABLE OF REPRODUCTION +	C. SPAWNING
5. POST PARTUM* / 4. REGRESSING +	Da. REGRESSING
6. REGENERATING* / 4. REGRESSING +	Db. REGENERATING
	E. OMITTED SPAWNING
	F. ABNORMAL

* only for female
+ only for males

6 Conversion of historic maturity data (ToR b)

From the conversion tables in chapter 5 it can be concluded that for part of the historic data it is possible to convert to the 'WKMATCH 2012 maturity scale revised'. For other maturity scales there is overlap of the historic stage with two or more (sub)-stages in the 'WKMATCH 2012 maturity scale revised'. Without an image or the actual gonad, it will be impossible to convert these overlapping historic stages to the 'WKMATCH 2012 maturity scale revised'.

WKASMSF recommends to:

- Convert the historic data when possible.
- Add a column maturity scale to the databases where the actual reported maturity scale is reported. This is needed to prevent confusion when maturity data collected before 2012 is converted into the 'WKMATCH 2012 maturity scale revised'.
- Although it is not possible to convert all historic data, it is still necessary that the 'WKMATCH 2012 maturity scale revised' be used for reporting from 01-01-2020, because the information in the national scales can be retained in the 'WKMATCH 2012 maturity scale revised'. The division in stages is different but the biological data are the same.

6.1 ICES areas

From the conversion tables (see chapter 5) it is evident that historic data using the following maturity scales cannot be converted to the 'WKMATCH 2012 maturity scale revised' without looking at the actual gonad:

- Maturity key for cod based on Maier (1908) and revised by Tomkiewicz *et al*. (2002)
- WKMSHM scales for hake (ICES, 2007d)
- WKSPMAT scales for sardine and anchovy (ICES, 2008)
- WKMSSPDF for sole, plaice, dab and flounder (ICES, 2010c)
- WKMSHS for herring and sprat (ICES, 2011)
- WKMSCWHS for cod, whiting, haddock and saithe (ICES, 2007b)

6.2 GFCM area

All macroscopic maturity scales used for surveys and commercial catches samplings have been converted to the international macroscopic maturity scales presented in the GFCM-DCRF (see chapter 5), with the exception of the Beullens *et al*. (1997) scale. Therefore, there is no problem to convert historic data reported to the GFCM databases.

7 Implementing international maturity scale for reporting (ToR c)

An implementation plan for reporting in the 'WKMATCH 2012 maturity scale revised' was developed during the meeting of WKASMSF for the ICES areas. The goal is that from 01-01-2020 maturity will be reported in the 'WKMATCH 2012 maturity scale revised' to all ICES databases collecting maturity data. For GFCM, the reporting in the scales described in the GFCM-DCRF are already mandatory since 2018.

7.1 ICES areas

For the implementation plan for reporting in the 'WKMATCH 2012 maturity scale revised' in the ICES areas, 16 different steps have been identified:

1. Suggest a **template** for conversion tables from national scales to the 'WKMATCH 2012 maturity scale revised' (carried out at WKASMSF)
2. **List** of historic scales and references (WKASMSF prepared a list with the data made available, see chapter 3)
3. Prepare **conversion tables** with data available (WKASMSF prepared conversion tables, see chapter 5)
4. Recommend to the **ICES Data Centre and RCGs** to create the 'WKMATCH 2012 maturity scale revised' in databases (surveys and commercial catches), and to use them instead of all the historic ones for new submissions from 01-01-2020 (see Annex 3).
5. Prepare **category 1 resolution** for CRR Handbook on maturity scales and descriptions by species (see chapter 11 and Annex 8)
6. Send the conversion tables and template to the **national maturity coordinators and stagers** (supported by a WKASMSF recommendation) to check and add to by WGBIOP 2018 (carried out by WKASMSF)
7. WGBIOP should **review, revise and approve** conversion tables for national labs data submissions (October 2018)
8. WGBIOP should prepare a WebEx, online course or exchange for **instruction of maturity stagers** on the WKMATCH 2012 maturity scale, documentation should also be made available on the WGBIOP data quality assurance repository. This should be given in 2019.
9. **Training and instruction** for maturity stagers (October 2019)
10. Inform all **survey groups** of the 'WKMATCH 2012 maturity scale revised' and implementation and get their approval (WGBIOP in October 2018)
11. Inform all **data submitters** of 'WKMATCH 2012 maturity scale revised' and implementation and send them conversion tables overview (WGBIOP in October 2019)
12. **ICES Data Centre** creates the 'WKMATCH 2012 maturity scale revised' in all relevant DBs (DATRAS, Acoustic, RESDB, etc.) and ready for data reporting with the new scale (as soon as possible but latest November 2019)
13. WGBIOP should recommend **quality control rules** for maturity data upload if possible (by species or survey) (October 2019)
14. Data submissions with use of the 'WKMATCH 2012 maturity scale revised' only, for all species from **01-01- 2020** onwards; historical data should be revised when possible (see chapter 6)
15. **All feedback** if needed, should be addressed to WGBIOP
16. **CRR Handbook** on maturity scales and descriptions by species (WGBIOP by December 2020)

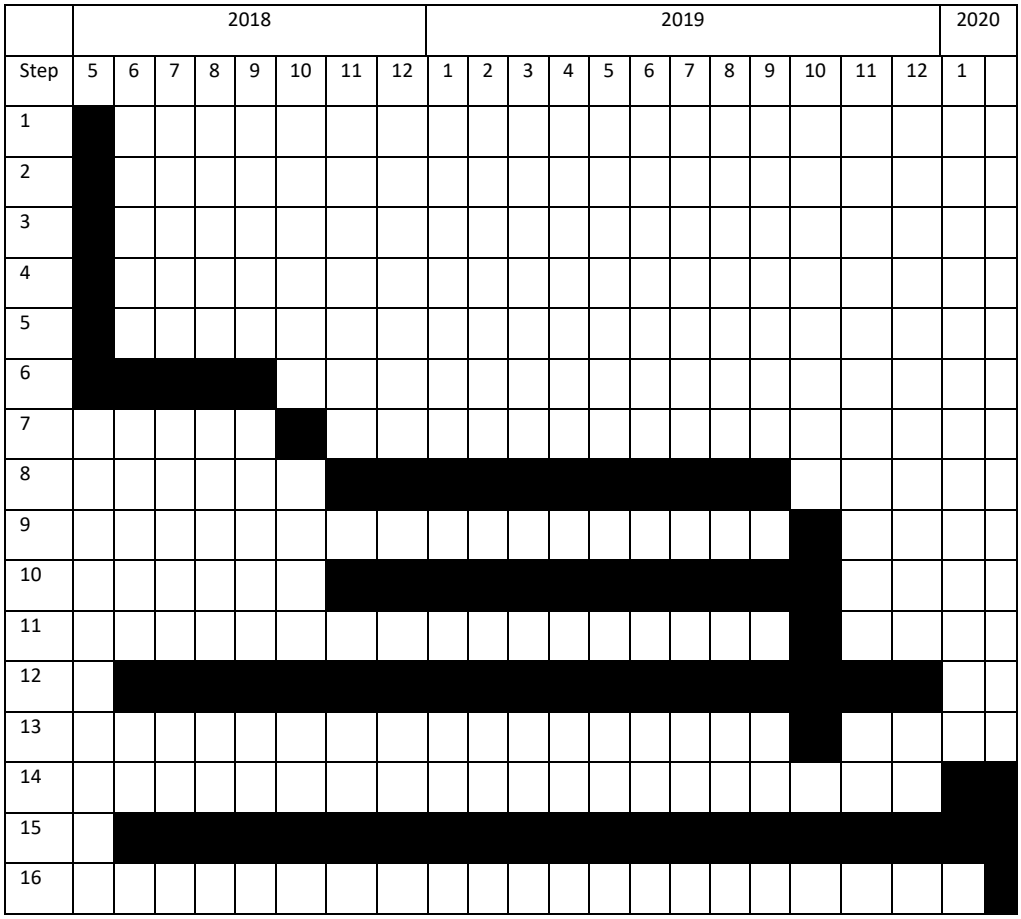

Figure 7.1. Timeline for the various steps in the implementation plan. For descriptions of the steps see above.

7.2 GFCM areas

For GFCM the reporting of the scales described in the GFCM-DCRF are already mandatory since 2018. The GFCM maturity data should be updated from the CPCs in a database constructed based on the mandatory maturity scales structure.

8 Responsibilities with regard to maturity scales and data

WGBIOP

WGBIOP is responsible for quality control of biological parameters, including maturity staging. Members of this group are leading experts in reproductive biology and development of gonads in fish and other commercial species. Any questions or concerns about maturity staging, both in the ICES and GFCM areas, should be addressed to WGBIOP in the form of a recommendation.

Request with regards to maturity scales and data

Requests with regards to maturity scale and data concerning the ICES and GFCM databases should be sent to WGBIOP for review before they can be sent on to the data centre. The ICES and GFCM data centres do not have the necessary maturity staging expertise to decide if changes to the databases are appropriate or not.

ICES data centre

ICES Data Centre is responsible for practical implementation of maturity scales in ICES databases collecting this biological parameter, and for respective quality control of the data submissions, based on recommendations from WGBIOP. ICES Data Centre will not create new maturity scales based on user requests. Similar requests should be directed for revision by WGBIOP instead. Where possible, ICES Data Centre can provide tools for converting national maturity scales to the 'WKMATCH 2012 maturity scale revised'.

GFCM data centre

The reporting of the GFCM macroscopic maturity scales in the GFCM databases have started from 2015 at arbitrary level. From 2015 to 2018, the maturity data have been updated from the countries in a database constructed on the base of the mandatory maturity scales structure. Since 2018 the reporting is mandatory. Each country has to follow what is directed in the GFCM-DCRF to update their data in the GFCM databases.

9 Calculation of maturity ogives

9.1 ICES areas

The use of the 'WKMATCH 2012 maturity scale revised' will have an impact on the calculation of the maturity ogives. In the past omitted spawners (stage E) and fish with abnormal gonads (stage F) were either included in the other stages or not reported at all. It varies by species and surveys how this was handled, but in most cases, the manuals of the surveys do not describe how to deal with omitted spawning and abnormal gonads in fish. Fish in stages E and F are reproductively hampered and do not participate in the current spawning. The omitted spawning stage is different from the actual resting stage. The resting stage is a fish that has participated in the current spawning season, has just recovered from this year's spawning event, and has a short resting period before starting vitellogenesis again.

9.1.1 How to deal with omitted spawning and abnormal gonads for the calculation of the maturity ogive

WKASMSF recommends excluding stage E and F from the estimation of the maturity ogive. For various reasons these fish have hinders with their reproduction and do not participate in the current spawning season. Biologically these fish are mature as they have gonad development or have at least spawned once in their lifetime, but as they do not participate in the current spawning season, they should not be included in the maturity ogive of the current year.

Compared to historic maturity data in the 'WKMATCH 2012 maturity scale revised' there will be information available on the state of the reproduction of the stock, that was not available before. If there appear large numbers of stages E and F fish in the stock this is an indication of reproductive problems of the stock and could have implications for recruitment.

Below we describe the effect on maturity ogive calculation depending on the way the maturity data were collected in the past.

9.1.2 Not reported omitted spawning and abnormal gonads

If in the past omitted spawners and fish with abnormal gonads were not recorded, there was no overestimation of the mature part of the stock. The maturity ogive was assessed correctly. Excluding the omitted spawning fish (stage E) and those with abnormal gonads (stage F) reported in the 'WKMATCH 2012 maturity scale revised' will result in the same estimation of the maturity ogive as has been done in the past.

9.1.3 Including omitted spawning and abnormal gonads in the other maturity stages

If in the past omitted spawners and fish with abnormal gonads were included in the other maturity stages, there was an overestimation of the actual mature part of the stock. Excluding the omitted spawning fish (stage E) and those with abnormal gonads (stage F) reported in the 'WKMATCH 2012 maturity scale revised' will result in a different estimation of the maturity ogive compared to the estimations in the past.

9.2 GFCM areas

The recording of the maturity stage at the time of observation is an important biological parameter to be used in the calculation of maturity ogives (and therefore of SSB). The sustainable management and exploitation of fish resources are linked to the Stock Reproductive Potential concept that, in stock-assessment, appears to be essential to sev-

eral commercially important demersal or semi-demersal species. This concept is emphasized in the GFCM-DCRF where the need to adopt a common acceptable maturity scale, as well as to establish objective criteria for the definition of each maturity stage, is considered a crucial issue in order to give a common tool for exchanging data and scientific information. Generally, when maturity data are used for maturity ogive estimation, one important issues should be taken into consideration: the macroscopic misclassification of resting females as immature or virgin developing and recovering. During the regenerating phase within the reproductive cycle only histology produce reliable results and not without difficulties. However, in order to avoid classifying resting individuals as immature, it is most important to use individuals collected during the peak of the reproductive season, when resting individuals are scarce. To avoid such classically occurring pitfalls, WKASMSF underline, for each group of species (bony fish, Elasmobranchs, Crustaceans and Cephalopods), the stages that participate in the current spawning season and should be included in the mature portion when the maturity ogive is constructed (see chapter 4, paragraph 4.2).

10 Histological criteria for maturity staging (ToR d)

Histological criteria from WKMATHIS (ICES, in prep) were revised. These revi-sions have been integrated in the WKMATHIS report. These histological descrip-tions will also be incorporated in the proposed Handbook on maturity staging (see chapter 11).

11 Proposal for CRR Handbook on maturity staging of fish species in the ICES area

Various maturity staging workshops have been held (see overview in chapter 1) preparing specific descriptions of the WKMATCH 2012 maturity scale stages for the different fish species. As maturity data are essential to stock assessment having one concise overview of the state-of-the-art of maturity stage descriptions of the key species is important. Creating a handbook on maturity staging of fish species in the ICES area allows for peer review and increase quality of the work done by the maturity staging workshops. WKASMSF proposes to publish the handbook as a CRR. The draft resolution for the CRR can be found in Annex 8.

The proposed CRR handbook represents a collation of the state-of-the-art scientific work on the maturity staging of commercially exploited fish species across Europe. This manual should represent a useful tool to be used on board during surveys or when sampling commercial catches to define the maturity stages of species in order to reduce sources of error on maturity determination. Improving precision in maturity staging is extremely important for many species and the information from the workshops should be more easily and widely available. The proposed CRR will also enhance the correct reporting of maturity data to international databases.

The CRR will contain a general introduction to maturity staging and the WKMATCH 2012 maturity scale revised during WKASMSF 2018, followed by a series of chapters with descriptions of the maturity stages for different species (within gadoids, small pelagic species, flatfish, etc.). Each chapter will contain an introduction describing the species reproduction, most relevant references present in literature on spawning period and size at first maturity, descriptions of the maturity stages for females and males and histological descriptions for validating the maturity staging when available.

The suggested CRR will be produced in several steps prior to submission:

1. Authors of chapters are invited by the editors after WKASMSF and the author list will be finalized at WGBIOP (October 2018) and asked to produce draft text prior to the WGBIOP in 2019.
2. During WGBIOP 2019 the chapters are reviewed.
3. Authors submit their adjusted chapters to the editors by January 2020.
4. Editors circulate draft in April 2020.
5. Comments on the draft will be incorporated in the final draft at WGBIOP 2020.
6. Submission of final draft by December 2020.

Proposed editors for the CRR are Cindy van Damme, Maria Cristina Follesa and Francesca Vitale.

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WKASMSF participants, from left to right standing: Jelena, Diana, Ana, Tero, Paola, Francesca, Anna, Jerome, Carina; sitting: Cristina and Cindy.

Annex 2: Agenda

Monday 30 April

13:00 Welcome and introduction to ICES HQ

13:30 Introductions, start of the meeting etc.

13:45 Setup of the workshop

14:00 Maturity scales in the ICES database (Anna)

14:30 Maturity scales in the GFCM database (Cristina)

15:00 Tea break

15:15 Historical overview of maturity scales

17:30 End of day

Tuesday 1 May

9:00 WKMATCH maturity scale and maturity workshops (Cindy)

9:30 MEDITS maturity scale (Cristina)

10:00 Coffee break

10:30 Subgroups: Steps needed for implementation of WKMATCH and MEDITS as reporting scales (bullet points)

12:30 Lunch

13:30 Plenary: Steps needed for implementation of WKMATCH and MEDITS as reporting scales (bullet points)

15:00 Tea break

15:30 Subgroups: Elaborate steps for implementation plan

17:30 End of day

Wednesday 2 May

9:00 Plenary: Elaborate steps for implementation plan

10:30 Coffee break

11:00 Plenary: Elaborate steps for implementation plan

12:30 Lunch

13:30 Subgroups: conversion tables and expanding general histological criteria

15:00 Tea break

15:30 Subgroups: conversion tables and expanding general histological criteria

17:00 Report back from subgroups

17:30 End of day

Thursday 3 May

9:00 Plenary: Discuss implementation plan

10:30 Coffee break

11:00 Plenary: Discuss implementation plan

12:30 Lunch

13:30 Subgroups: conversion tables and expanding general histological criteria

15:00 Tea break

15:30 Plenary: Finalize conversion tables and general histological criteria

17:30 End of day

Friday 4 May

9:00 Final discussion on implementation plan

10:30 Coffee break

10:45 Recommendations, follow up, report writing etc.

13:00 End of the workshop

Annex 3: Recommendations

RECOMMENDATION	ADRESSED TO
1. WKASMSF recommends to implement the 'WKMATCH 2012 maturity scale revised' (as described in chapter 4) in the ICES and RCG databases following the implementation plan (as described in chapter 7), and use this as the only scale for data submissions from 01-01-2020.	ICES data centre, RCG's, WGBIOP, ACOM, SCICOM
2. The GFCM countries have to implement the maturity scales reported in DCRF as mandatory since 2018.	WGBIOP
3. WKASMSF recommends to: 1. Prepare and give instructions for the 'WKMATCH 2012 maturity scale revised' in Q3 2019 and make the instruction document available on the repository 2. Inform survey groups, maturity stagers and data submitters of the 'WKMATCH 2012 maturity scale revised' and implementation from 01-01-2020 3. Inform survey groups, maturity stagers and data submitters of the presence in the DCRF of the macroscopic maturity scales are mandatory since 2018 4. Review, revise and approve conversion tables from national to 'WKMATCH 2012 maturity scale revised' scales and from national scales to GFCM scales. 5. Prepare documentation on maturity data specifically for data submitters and data users. 6. Prepare CRR handbook on maturity staging (see chapter 11 and Annex 8)	WGBIOP
4. WKASMSF recommends to adopt the 'WKMATCH 2012 maturity scale revised' and approve the implementation plan (presented in chapter 7). Approval should be sent to WGBIOP. (Note that all requests with regards to maturity scales or stages in the ICES, RCG and GFCM databases should be directed, in the form of a recommendation, to WGBIOP for approval.)	WGBIFS, WGMEGS, WGACEGG, WKNEPS, PGDATA, WGBIOP, WGIDEEPS, WGNEACS, WGBEAM, WGCATCH, WGALES, IBTSWG, WGIPS, ICES data centre, RCG's
5. All survey groups should update their manuals with the correct references (see chapter 4 in this report) and include or update the conversion table for the national maturity scales.	WGBIFS, WGMEGS, WGACEGG, WKNEPS, PGDATA, WGBIOP, WGIDEEPS, WGNEACS, WGBEAM, WGCATCH, WGALES, IBTSWG, WGIPS, ICES data centre, RCG's
6. Insert a field 'maturity scale' in DATRAS format showing the maturity scale used for the submitted maturity stages.	ICES data centre, DATRAS governance group
7. WKASMSF recommends to follow the suggested method of estimation of the maturity ogive (see chapter 9) for the 'WKMATCH 2012 maturity scale revised' and GFCM scales.	ACOM, ICES data centre, RCG's, WGBIOP

Annex 4: Overview of maturity scales used in ICES areas

The description of the various maturity scales can be found on the ICES WGBIOP repository.

Survey	Country	Maturity scale used	Period used	Remarks
BIAS	FI	ICES M6	2014 till present	ICES Acoustic trawl surveys database, biotic
BIAS	FI	Based on ICES Bergen 1962, Adjusted and agreed with Sweden	2014 till present	ICES Acoustic trawl surveys database, biotic, reported as M6.
BIAS	SWE	ICES Bergen 1962 modified (9 stages)	1-1-1995 till present	Maturity scale/ICES Herring Committee Working group Bergen, Norway 1962 For Baltic herring stage 8 is divided since 2012 into 8a and 8b to describe transition in resting-recovery-rematuring and to separate first spawner from re-spawner. *Incomplete maturity data for acoustical surveys 1978-1994* *Maturity taken for cod from 2012*
BIAS	LT	ICES M6	2011 till present	ICES Acoustic trawl surveys database, biotic
BIAS	LT	Pravdin, 1966; Aleksejev,Alekseja, 1996	2005-2011	
BITS	DK	10pt	1997 to present	
BITS	DK	6pt	2014 to present	It is not certain when exactly we changed to the 6pt scale.

				Our new database came into use in May 2014, resulting in some missing and incorrect entries
BITS	DK		2012 - 2014	Our database entries are not reliable
BITS	LT	ICES M6	2005 till present	DATRAS
BOCADEVA (DEPM; triennial)	SPA	Pinto and Andreu, 1957	01/01/2005 till 31/12/2008	
BOCADEVA (DEPM; triennial)	SPA	WKSPMAT, 2008	01/01/2011 till present	
BOCADEVA (DEPM; triennial)	SPA	Walsh *et al*. (1990)	01/01/2005 till present	
BTS	NL	WKMATCH	1-1-2011 till present	
BTS	NL	RIVO new 4 scale	1-1-2000 till 1-1-2011	
BTS	NL	RIVO 7 scale	before 1-1-2000	
BTS	NL	RIVO 8 scale	before 1-1-2000	
BTS	NL	RIVO 4 scale	before 1-1-2000	
CAREVA (Triennial mackerel and horse mackerel)	SPA	Walsh *et al*. (1990)	1992 till present	
JUREVA (Triennial mackerel and horse mackerel)	SPA	Walsh *et al*. (1990)	1992 till present	
Commercial sampling	SPA	WKMSHM (2007)	1-1-2008 till present	
Commercial sampling	SPA	BIOSDEF project	1-1-1996 till present	
Commercial sampling	SCO	Walsh, 1990	All previous and up to present	Walsh, 1990 scale used in national MSS database.
Commercial sampling	SCO	National MSS 8(+1) stage scale	All previous and up to present	MSS 8 (+1) stage herring scale used in national MSS IBTS database.
Commercial sampling	SCO	MSS 4 stage scale	All previous and up to present	MSS 4 stage used in national MSS database

Commercial sampling	SPA	BIOSDEF project	2015 till present	
Commercial sampling	SPA	WKSPMAT, 2008	01/01/2009 till present	
Commercial sampling	SPA	Pinto and Andreu, 1957	01/01/1989 till 31/12/2008	
Commercial sampling	SPA	Mendoça *et al.*, 2006	2009 till present	
Commercial sampling	SPA	Delgado M., Silva L., Juárez A. (2013)	till present	
Commercial sampling	SPA		2010 till present	Histology. Not possible Macro-scopic sex and macroscopic maturity stages in *C. con*ger.
Commercial sampling	SPA	BIOSDEF project	1990-2014	
Commercial sampling	SPA	WKMSGAD	2015 till present	
Commercial sampling	SPA	BIOSDEF project	2009 till present	
Commercial sampling	SPA	Holden & Raitt (1974) ; Krug (1994)	2003 till present	
Commercial sampling	SPA	BIOSDEF project	2011-2016	
Commercial sampling	SPA	BIOSDEF project	2009 till present	
Commercial sampling	PT	Brown-Peterson et al., 2011	till present	
Commercial sampling	PT	Gordo et al., 2000	till present	
Commercial sampling	PT	Gonçalves, 1993	till present	
Commercial sampling	PT	Boyle and Ngoile, 1993	till present	
Commercial sampling	PT	Sobral, 1985	till present	
Commercial sampling	GFR	IBTS scale	since 2012	
Commercial sampling	GFR	IBTS scale	until 2011	
Commercial sampling	GFR		till present	

Commercial sampling	NL	WKMATCH	1-1-2011 till present	
Commercial sampling	NL	2-scale?	till present	Only males
Commercial sampling	NL	3-scale?	till present	Only females
Commercial sampling	NL	RIVO new 4 scale	1-1-2000 till 1-1-2011	
Commercial sampling	NL	RIVO 8 scale	1-1-2000 till 1-1-2011	
Commercial sampling	NL	RIVO 8 scale	before 1-1-2000	
Commercial sampling	NL	RIVO 4 scale	before 1-1-2000	
Commercial sampling	NL	RIVO 7 scale	before 1-1-2000	
Commercial sampling	NL	RIVO 8 scale	before 1-1-2000	
Commercial sampling	FI	DTU- Aqua, Herring	2009 till present	ICES RDB
Commercial sampling	FI	standard MATKEY 5 (BITS)	2009-2011	ICES RDB, since 2012 because of the small quota, no individual sampling on commercial catches
Commercial sampling	SWE	ICES Bergen 1962 modified (9 stages)	*since before 1960*	Maturity scale/ICES Herring Committee Working group Bergen, Norway 1962 For Baltic herring stage 8 is divided since 2012 into 8a and 8b to describe transition in resting-recovery-rematuring and to separate first spawner from re-spawner.

Commercial sampling	SWE	ICES Bergen 1962 modified (9 stages)	1-1-2005	Maturity scale/ICES Herring Committee Working group Bergen, Norway 1962
Commercial sampling	SWE	IMR Sweden	1-1-1989	Maturity scale defined by Mats Ulmestrand, Institute of Marine Research, Lysekil Only females
Commercial sampling	SWE	Krøyer 1838	*since before 1970*	Maturity scale/*Pandalus borealis*, Henrik Nikolaj Krøyer 1838, Denmark
Commercial sampling	LT	ICES M6	2011 till present	DATRAS
Commercial sampling	BE	0-7 (from 2004 - 2008)	01/01/2004 till 31/12/2008	
Commercial sampling	BE	0-9 (from 2009 - 2010)	01/01/2009 till 31/12/2010	
Commercial sampling	BE	1-6 (from 2011 - onwards)	from 01/01/2011	
Commercial sampling (annual))	SPA	WKMSC (2009)	01/01/2010 till present	
Commercial sampling (triennial)	SPA	WKMSHM (2007)	01/01/2008 till present	
Commercial sampling (triennial)	SPA	Lipinski M. (1979)	till 31/12/2010	
Commercial sampling (triennial)	SPA	WKMSCEPH (2010)	01/01/2011 till present	
Commercial sampling (triennial)	SPA	Guerra (1975)	till 31/12/2010	
Commercial sampling (triennial)	SPA	Bakhayokho M. (1983) y Perales-Raya (2001)	till 31/12/2010	
Commercial Sampling N NW Spain	SPA	Andreu, 1950	Before 1990	

Commercial Sampling N NW Spain	SPA	Walsh *et al*. (1990)	1990-2008	
Commercial Sampling N NW Spain	SPA	Pinto and Andreu, 1957	2009 till present	
Commercial Sampling N NW Spain	SPA	Macer, 1976	Before 1990	
Commercial Sampling N NW Spain	SPA	WKSPMAT, 2008	2009 till present	
Crustaceans surveys	PT	ICES, 2009	till present	Only females
DFS	NL	none	1-1-2011 till present	No maturities taken since 2011, ICES WKs (WKMSSPDF and WKMSTB) recommend to only take maturity 3 months prior and during spawning and this survey is outside that period.
DFS	NL	RIVO new 4 scale	1-1-2000 till 1-1-2011	
DFS	NL	RIVO 7 scale	before 1-1-2000	
DFS	NL	RIVO 8 scale	before 1-1-2000	
DFS	NL	RIVO 4 scale	before 1-1-2000	
DredgeSurvey	DK	Macer - 6pt	2006 to present	
DYFS	GFR		till present	
ECOCADIZ (acoustics)	SPA	Pinto and Andreu, 1957	01/01/2004 till 31/12/2008	
ECOCADIZ (acoustics)	SPA	WKSPMAT, 2008	01/01/2009 till present	
ECOCADIZ (acoustics)	SPA	Walsh *et al*. (1990)	01/01/2004 till present	
ECOCADIZ-RECLUTAS (acoustics)	SPA	WKSPMAT, 2008	01/10/2012 till present	
ECOCADIZ-RECLUTAS (acoustics)	SPA	Walsh *et al*. (1990)	01/01/2012 till present	

HERAS	SCO	National MSS 8(+1) stage scale	All previous and up to present	MSS 8 stage herring scale used in national MSS IBTS database. Mapped to 4 stages in following way for submission to DATRAS. 1 +2 = Stage1, stages 3+4+5 = Stage 2, 6= Stage 3, 7+8=Stage 4.
HERAS	DK	8pt	1995 to present	
HERAS	DK	8pt	1995 to present	
IBTS	DK	6pt	2016 to present	It is not certain when exactly we changed from the 4pt to the 6pt scale. Our new database came into use in May 2014, resulting in some missing and incorrect entries
IBTS	DK	4pt	prior to 2016	It is not certain when exactly we changed from the 4pt to the 6pt scale. Our new database came into use in May 2014, resulting in some missing and incorrect entries
IBTS	DK	8pt	1995 to present	
IBTS	DK	6pt	From Q3 2015	
IBTS	DK	4pt	Prior to Q3 2015	
IBTS	PT	Holden and Raitt, 1974	till present	
IBTS	GFR	IBTS scale	2012 till present	
IBTS	NL	WKMATCH	1-1-2011 till present	
IBTS	NL	RIVO new 4 scale	1-1-2000 till 1-1-2011	
IBTS	NL	RIVO 8 scale	before 1-1-2000	
IBTS	NL	RIVO 4 scale	before 1-1-2000	
IBTS	NL	RIVO 7 scale	before 1-1-2000	

IBTS	NL	2-scale?	till present	Not regularly taken
IBTS	SWE	ICES Bergen 1962 modified (9 stages)	1-1-2005 till present	Maturity scale/ICES Herring Committee Working group Bergen, Norway 1962
IBTS	SWE	IMR Sweden	1-1-1989 till present	Maturity scale defined by Mats Ulmestrand, Institute of Marine Research, Lysekil. Only females
All IBTS surveys (North Sea, Western and Rockall)	SCO	MSS 4 stage scale	1993 - 2008	Not routinely collected and broadly speaking map to the WKMATCH scale but without 2 additional stages for skipped and abnormal. Elasmobranchs maturities collected at sea but not submitted to DATRAS. Tend to only provide 1=Immature and 2=Mature for males using external criteria only
All IBTS surveys (North Sea, Western and Rockall)	SCO	MSS 4 stage scale	2009 - present	Same as above but with prefix of 6. Not routinely collected and broadly speaking map to the WKMATCH scale and using the additional 2 stages for skipped and abnormal. Elasmobranchs maturities collected at sea but not submitted to DATRAS.

				Tend to only provide 1=Immature and 2=Mature for males using external criteria only.
All MSS IBTS - (Nsea, West Coast IBTS Surveys) Q1, Q3, Q4	SCO	National MSS 8(+1) stage scale	All previous and up to present	MSS 8 stage herring scale used in national MSS IBTS database. Mapped to 4 stages in following way for submission to DATRAS. 1 +2 = Stage1, stages 3+4+5 = Stage 2, 6= Stage 3, 7+8=Stage 4.
All MSS IBTS (Nsea, West Coast, Q1, Q3, Q4	SCO	MSS mapped 4 stage scale	Q3 2013 - Present	Condensed from the 9 (8+1) stage MSS herring scale. Submitted to DATRAS. MSS only submit 61 - 64 stages for its IBTS surveys and do not submit info on skipped or abnormal gonads. See below for mapping of 8 stage to 4 stage.
All MSS IBTS (Nsea, West Coast, Rockall Q1,Q2, Q3	SCO	MSS mapped 4 stage scale	1974 - Q1 2013	Condensed from the 8stage MSS herring scale. Submitted to DATRAS. See below for mapping.
IBTS - Nsea Q1	SCO	MSS gadoid 2 stage	1983 - 1988, 1990	Submitted to DATRAS
IBTS - Nsea Q1	SCO	MSS gadoid 2 stage	1980 - 1988, 1990	Submitted to DATRAS

IBTS - Nsea Q1,Q2, Q3	SCO	WKMSMAC 2007	Q3 2013 - Present	Condensed from the 6 stage Walsh scale. Submitted to DATRAS. Only change in this species compared to previous submissions were that MSS changed from this point for all maturity data submitted were prefixed with a 6. MSS only submit 61 - 64 stages for its IBTS surveys and do not submit info on skipped or abnormal gonads.
IBTS - Nsea Q1,Q2, Q3	SCO	WKMSMAC 2007	2004 - Q1 2013	Condensed from the 6 stage Walsh scale. Submitted to DATRAS. MSS only submit 1 - 4 stages for its IBTS surveys and do not submit info on skipped or abnormal gonads for mackerel.
IBTS - Nsea, West Coast IBTS Surveys Q1, Q3, Q4	SCO	Walsh Scale	2005 -Present	Mackerel maturity data collected on national database in this way. Maps from 6 stage Walsh Scale to 4 stage DATRAS in following way, 1=stage 1, 2, 3 = stage 2, 4+5 = stage 3, 6=stages 4.
IBTS - Nsea, West Coast, Rockall Q1,Q2, Q3, Q4	SCO	MSS 4 stage scale	1992 - 2008	Submitted to DATRAS

IBTS - Nsea, West Coast, Rockall Q1,Q2, Q3, Q4	SCO	WKMSCWHS	2009 - Present	Submitted to DATRAS. Same as above but with prefix of 6
ARSA_Marzo (IBTS 1th quarter)	SPA	WKMSHM (2007)	01/01/2008 till present	Before 2008 is unknown
ARSA_Marzo (IBTS 1th quarter)	SPA	Lipinski M. (1979)	till 31/12/2010	
ARSA_Marzo (IBTS 1th quarter)	SPA	WKMSCEPH (2010)	01/01/2011 till present	
ARSA_Marzo (IBTS 1th quarter)	SPA	WKMSC (2009)	01/01/2010 till present	
ARSA_Marzo (IBTS 1th quarter)	SPA	Guerra (1975)	till 31/12/2010	
ARSA_Marzo (IBTS 1th quarter)	SPA	Bakhayokho M. (1983) y Perales-Raya (2001)	till 31/12/2010	
ARSA_Nov (IBTS 4th quarter)	SPA	WKMSHM (2007)	01/01/2008 till present	
ARSA_Nov (IBTS 4th quarter)	SPA	Lipinski M. (1979)	till 31/12/2010	
ARSA_Nov (IBTS 4th quarter)	SPA	WKMSCEPH (2010)	01/01/2011 till present	
ARSA_Nov (IBTS 4th quarter)	SPA	WKMSC (2009)	01/01/2010 till present	Before 2008 is unknown
ARSA_Nov (IBTS 4th quarter)	SPA	Guerra (1975)	till 31/12/2010	
ARSA_Nov (IBTS 4th quarter)	SPA	Bakhayokho M. (1983) y Perales-Raya (2001)	till 31/12/2010	
DEMERSALES (IBTS)	SPA	Walsh *et al*. (1990)	1997-2008	
DEMERSALES (IBTS)	SPA	WKSPMAT, 2008	2009 till present	
DEMERSALES (IBTS)	SPA	WKMSHM (2007)	1-1-2008 till present	
DEMERSALES (IBTS)	SPA	Mendoça *et al*., 2006	2009 till present	
DEMERSALES (IBTS)	SPA	Walsh *et al*. (1990)	1990-2008	
DEMERSALES (IBTS)	SPA	Pinto and Andreu, 1957	2009 till present	

DEMERSALES (IBTS)	SPA		2010 till present	Histology. Not possible Macroscopic sex and macroscopic maturity stages in *C. conger*.
DEMERSALES (IBTS)	SPA	BIOSDEF project	1-1-1996 till present	
DEMERSALES (IBTS)	SPA	BIOSDEF project	1990-2014	
DEMERSALES (IBTS)	SPA	WKMSGAD	2015 till present	
DEMERSALES (IBTS)	SPA	BIOSDEF project	2009 till present	
DEMERSALES (IBTS)	SPA	Macer, 1976	Before 1990	
DEMERSALES (IBTS)	SPA	Walsh *et al*. (1990)	1990 till present	
DEMERSALES (IBTS)	SPA	WKMSHM (2007)	1-1-2008 till present	
DEMERSALES (IBTS)	SPA	BIOSDEF project	2009 till present	
DEMERSALES (IBTS)	SPA	BIOSDEF project	2015 till present	
IBTS + Acoustic surveys + Commercial sampling	PT	Soares et al., 2009	till present	
IBTS + Commercial sampling	PT	Walsh et al., 1990	till present	
IBTS + Commercial sampling	PT	Holden and Raitt, 1974	till present	
IBTS + Commercial sampling	PT	Boyle and Ngoile, 1993	till present	
IBTS + Crustaceans surveys + Acoustic surveys + Commercial sampling	PT	Walsh et al., 1990	till present	
IBTS + Crustaceans surveys + Commercial sampling	PT	ICES, 2007	2007 till present	

IBTS + Crustaceans surveys + Commercial sampling	PT	Protocolos PNAB	till present
IBTS + Crustaceans surveys + Commercial sampling	PT	Azevedo and Duarte, 1997	till present
IBTS + Crustaceans surveys + Commercial sampling	PT	Godinho et al., 2001	2001 till present
IBTS + Crustaceans surveys + Commercial sampling	PT	ICES, 2013	till present
IBTS, BTS	GFR	IBTS scale	until 2011
IBTS, BTS, HERAS, DYFS, GSBTS, GASEEZ, GGS	GFR	IBTS scale	2012 till present
IESNS	DK	8pt	2004 (when cruise stared) to present
IESNS	DK	6pt	2004 (when cruise stared) to present
IGFS (WIBTS), IAMS (WIBTS), Deepwater survey	IE	NIWA	2005 till present
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Flatfish	2003 till present
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Gadoids	2003 till present
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Herring	2003 till present
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Horse mackerel	2003 till present
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Mackerel	2003 till present

IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	MI Monkfish	2003 till present	
IGFS (WIBTS), IAMS (WIBTS), IBES (WGBEAM), BSS	IE	Rays-Skates	2003 till present	
KASU	DK	10pt	From Q3 2014 to present	
KASU	DK	8pt	1996 to Q3 2014	
KASU	DK	6pt	From Q3 2015 to present	
KASU	DK	8pt	prior to 2015	database entries are unreliable
MEGS	GFR	Walsh	since 1990ies	
PELACUS	SPA	Andreu, 1950	Before 1990	
PELACUS	SPA	Walsh *et al*. (1990)	1990-2008	
PELACUS	SPA	Pinto and Andreu, 1957	2009 till present	
PELACUS	SPA	Walsh *et al*. (1990)	2011 till present	
PELACUS	SPA	BIOSDEF project	2003-2014	
PELACUS	SPA	WKMSGAD	2015 till present	
PELACUS	SPA	Macer, 1976	Before 1990	
PELACUS	SPA	Walsh *et al*. (1990)	1990 till present	
PELACUS	SPA	Pinto and Andreu, 1957	Before 2008	
PELACUS	SPA	WKSPMAT, 2008	2009 till present	
PORCUPINE (IBTS)	SPA	WKMSHM (2007)	1-1-2008 till present	
PORCUPINE (IBTS)	SPA	Mendoça *et al.*, 2006	2009 till present	
PORCUPINE (IBTS)	SPA		2010 till present	Histology. Not possible Macro-scopic sex and macroscopic maturity stages in *C. con*ger.
PORCUPINE (IBTS)	SPA	BIOSDEF project	1-1-1996 till present	
PORCUPINE (IBTS)	SPA	BIOSDEF project	2001-2014	
PORCUPINE (IBTS)	SPA	WKMSGAD	2015 till present	
PORCUPINE (IBTS)	SPA	BIOSDEF project	2009 till present	

PORCUPINE (IBTS)	SPA	Walsh *et al*. (1990)	2010 till present	
PORCUPINE (IBTS)	SPA	BIOSDEF project	1-1-1996 till present	
PORCUPINE (IBTS)	SPA	WKMSHM (2007)	1-1-2008 till present	
REDTAS, REDNOR	GFR	SGRS	till present	
SNS	NL	none	1-1-2011 till present	No maturities taken since 2011, ICES WKs (WKMSSPDF and WKMSTB) recommend to only take maturity 3 months prior and during spawning and this survey is outside that period.
SNS	NL	RIVO new 4 scale	1-1-2000 till 1-1-2011	
SNS	NL	RIVO 7 scale	before 1-1-2000	
SNS	NL	RIVO 8 scale	before 1-1-2000	
SNS	NL	RIVO 4 scale	before 1-1-2000	

Annex 5: Overview of maturity scales used in GFCM areas

The description of the various maturity scales can be found on the ICES WGBIOP repository.

Survey	Country	Maturity scale used	Period used	Remarks
surveys & commercial sampling (GSAs 22 & 20)	GR	Nikosky(1976) possible compatibility with the stages of WKMATCH(2012)	2003 till present	
commercial sampling	CY	Medits scale	2017 till present	
commercial sampling	CY	Nikolsky	2005-2016	
commercial sampling	CY	ICCAT scale	Not available	
Commercial sampling, trawlers	GR	ICES WKMSC	The ICES WKMSC was held on 19-23 October 2009	Histological validations and stage descriptions were also illustrated and discussed compared with the macroscopical view of the gonads. The common analyses were mainly focused to females because maturity in male decapods cannot be readily determined from macroscopic examination of gonads and associated structures, and few such studies have been documented.

MEDIAS surveys	GR	Nikosky(1976) possible compatibility with the stages of a new guide-line	2003 till present	
MEDITS	Spain	MEDITS Handbooks over the years	1994 till 2017	
MEDITS	France	MEDITS Handbooks over the years	1994 till 2017	
MEDITS surveys	GR	Medits scale	1994 till 2017	
Medits survey	CY	Medits scales		The number of stages in the Medits scales may differ within the years, in accordance with Medits Manuals.
surveys & commercial sampling (GSAs 22 & 20)	GR	WKMSEL 2010 % WKMSEL 2012	2010 till present	
surveys & commercial sampling (GSAs 22 & 20)	GR	ICES WKMSCEPH 2010	Since 2014	
Medits survey	IT	*BONY FISH* Medits Handbook, 1995,1999,2001	1994-2006	
Medits survey	IT	CRUSTACEANS DECAPODS[4]Medits Handbook, 1995,1999,2001	1994-2006	
Medits survey	IT	*BONY FISH* Medits Handbook, 2007,2012,2013,2016,2017	2007 till present	
Medits survey	IT	*CEFALOPODS* Medits Handbook, 1995,1999,2001	1994-2006	
Medits survey	IT	CRUSTACEANS DECAPODS[4] Medits Handbook, 2007,2012,2013, 2016,2017	2007 till present	
Medits survey	IT	*CEFALOPODS* Medits Handbook, 2007	2007 till present	

Medits survey	IT	*Viviparous elasmobranchs* Medits Handbook, 1994-2006	1994-2006
Medits survey	IT	*Viviparous elasmobranchs* Medits Handbook, 2007, 2012,2013, 2016,2017	2007 till present
Medits survey	IT	*Oviparous elasmobranchs* Medits Handbook, 1994-2006	1994-2006
Medits survey	IT	*Oviparous elasmobranchs* Medits Handbook 2007	2007
Medits survey	IT	*Oviparous elasmobranchs* Medits Handbook 2012, 2013, 2016, 2017	2008 till present
surveys & commercial sampling	GR	Nikosky(1976) possible compatibility with the stages of WKMATCH(2012)	2003 till present
surveys & commercial sampling	GFCM	Bony fish Medits Hand-book, 2013, 2016,2017 or GFCM, 2018	2015
surveys & commercial sampling	GFCM	Crustaceans decapods ICES 2010 or GFCM, 2018	2015
surveys & commercial sampling	GFCM	Crustaceans stomato-pods Froglia,1996 or GFCM, 2018	2015
surveys & commercial sampling	GFCM	Elasmobranchs, ICES, 2012 or GFCM, 2018	2015
	GR	Empirical 4 stages	

Annex 6: Conversion tables for the ICES areas

Female maturity scales of the ICES maturity staging Workshops since 2007 with conversion to the WKMATCH 2012 maturity scale revised. *Bold letters are the WKMATCH 2012 maturity scale revised stages.

WK	SPECIES	Codes															
WKMAT	General	**A**	Virgin	**B**	Developing			**C**	Spawning			**Da/Db**	Spent/ Recovery	**E**	Omitted spawn-ing		
Standardized		**A**	Immature	**Ba**	Developing	**Cb**	Spawning ca-pable	**Ca**	Actively Spawning			**Da/Db**	Regressing/ Regenerating				
WKMSCWHS	Cod	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Whiting	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Haddock	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Saithe	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**E**	Resting/ Skip spawning	**F**	Abnormal
WKMSHM	Hake	**A/Db**	Immature/ Resting	**Ba/ Bb**	Developing/ Maturing			**Ca**	Hydrated Spawning	**Cb**	Partly spawning	**D**	Post-spawning				
WKMSHM	Monk	**A**	Immature	**Ba/ E**	Developing/ Resting	**Bb**	Pre-Spawning	**C**	Spawning			**D**	Post-spawning				
WKMSHMAC	Mackerel	**A**	Immature	**Ba**	Early ripening	**Bb**	Late ripening	**D**	Ripe	**Da**	Partly spent	**Da/Db**	Spent/ Recovery				
WKMSHMAC	Horse mackerel	**A**	Immature	**Ba**	Early ripening	**Bb**	Late ripening	**D**	Ripe	**Da**	Partly spent	**Da/Db**	Spent/ Recovery				
WKSPMAT	Sardine	**A/Db**	Immature/ Resting	**Ba**	Developing	**C**	Imminent spawning	**C**	Spawning	**C**	Partial post-spawning	**Da**	Spent				
WKSPMAT	Anchovy	**A/Db**	Immature/ Resting	**Ba**	Developing	**C**	Imminent spawning	**C**	Spawning	**C**	Partial post-spawning	**Da**	Spent				
WKMSSPDF	Sole	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal

WK	SPECIES	Codes															
WKMSSPDF	Plaice	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSSPDF	Dab	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSSPDF	Flounder	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E.**	Resting/ Skip spawning	**F**	Abnormal
WKMSHS	Herring	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSHS	Sprat	**A**	Immature	**Bb**	Maturing	**Cb**	Spawning in-active	**Ca**	Spawning active	**?**	Cessation	**Db**	Recovering	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSTB	Turbot	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**E**	Skip spawning	**F**	Abnormal
WKMSTB	Brill	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**E**	Skip spawning	**F**	Abnormal
WKMSREGH	Greenland halibut	**A**	Immature	**Ba**	Mature, func-tionally imma-ture	**Bb**	Mature	**Bb**	Mature late	**C**	Spawning			**D**	Regressing/ Regenerating		
WKMSREGH	Redfish	**A**	Immature	**E**	Skip spawning	**Bb**	Maturing	**B**	Mature/ Fertilized	**C**	Parturition			**D**	Regressing/ Regenerating		

Male maturity scales of the ICES maturity staging Workshops since 2007 with conversion to the WKMATCH 2012 maturity scale revised. *Bold letters are the WKMATCH 2012 maturity scale revised stages.

WK	SPECIES	Codes															
WKMAT	General	**A**	Virgin	**Bb**	Maturing			**C**	Spawning			**Da/Db**	Spent/ Recovery	**E**	Omitted spawn-ing		
Standardized		**A**	Immature	**Ba**	Developing	**Cb**	Spawning ca-pable	**Ca**	Actively Spawning			**Da/Db**	Regressing/ Re-generating				
WKMSCWHS	Cod	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Whiting	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Haddock	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSCWHS	Saithe	**A**	Immature	**Bb**	Maturing			**C**	Spawning			**D**	Spent	**Db/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSHM	Hake	**A/Db**	Immature/ Resting	**Ba/ Bb**	Developing/ Maturing			**C**	Spawning			**Da**	Post-spawning				
WKMSHM	Monk	**A**	Immature	**Ba/ Db**	Developing/ Resting	**B**	Pre-Spawning	**C**	Spawning			**Da**	Post-spawning				
WKMSHMAC	Mackerel	**A**	Immature	**Ba**	Early ripening	**Bb**	Late ripening	**Bb**	Ripe	**Cb**	Partly spent	**Da/Db**	Spent/ Recovery				
WKMSHMAC	Horse mackerel	**A**	Immature	**Ba**	Early ripening	**Bb**	Late ripening	**Bb**	Ripe	**Cb**	Partly spent	**Da/Db**	Spent/ Recovery				
WKSPMAT	Sardine	**A/Db**	Immature/ Resting	**B**	Developing	**C**	Imminent spawning	**C**	Spawning	**Cb or Da?**	Partial post-spawning	**Da**	Spent				
WKSPMAT	Anchovy	**A/Db**	Immature/ Resting	**B**	Developing	**C**	Imminent spawning	**C**	Spawning	**Cb or Da?**	Partial post-spawning	**Da**	Spent				
WKMSSPDF	Sole	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**D/E**	Resting/ Skip spawning	**F**	Abnormal

WK	SPECIES	Codes															
WKMSSPDF	Plaice	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**D/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSSPDF	Dab	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**D/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSSPDF	Flounder	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**D/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSHS	Herring	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent				
WKMSHS	Sprat	**A**	Immature	**B**	Maturing	**Cb**	Spawning in-active	**Ca**	Spawning active	**D**	Cessation	**D**	Recovering	**D/E**	Resting/ Skip spawning	**F**	Abnormal
WKMSTB	Turbot	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**E**		**F**	Abnormal
WKMSTB	Brill	**A**	Immature	**B**	Maturing			**C**	Spawning			**D**	Spent	**E**		**F**	Abnormal
WKMSREGH	Greenland halibut	Not defined															
WKMSREGH	Redfish	Not defined															

Herring maturity scale conversions from national to international scales, from ICES, 2011a

WKMSHS maturity scale	Denmark	England	Estonia	Finland	Faroe Islands	Germany	Iceland	Ireland	Latvia	Netherlands	Norway	Polen	Scotland	Sweden	WKMATCH 2012 maturity scale revised
Ia	I	I	I	I	I	I	I	I	I	I	I	I	I	I	**A**
Ib	II	I	I	II	II	II	II	II	II	I	II	II	II	II	**A**
IIa	III	II	III	III	III	III	III	III	III	II	III-V	III	III	III	**B** (Ba)
IIb	IV	III	III	IV	IV	IV	IV	IV	IV	II	III-V	IV	IV	IV	**B** (Bb)
IIIa	V	IV-V	V	V	V	V	V	V	V	III	VI	V	V	V	**C** (Ca)
IIIb	VI	VI	V	VI	VI	VI-VII	VI	VI	V	III	VI	VI	VI	VI	**C** (Cb)
IV	VII	VII.I-VII.II	VI	VII	VII	VIII	VII	VII	VI	IV	VII	VII	VII	VII	**D** (Da)
Va	-	VIII	II	-	VIII	II	VIII	VIII	II	V	VIII	VIII	VIII	VIIIa	**D** (Da)
Vb Resting	-	VIII	II	-	VIII	II	VIII	VIII	II	V	VIII	VIII	VIII	VIIIb	**D** (Db)
Vb Skipped spawning	-	VIII	II	-	VIII	II	VIII	VIII	II	V	VIII	VIII	VIII		**E**
VI	-	A	-	-	-	IX	-	-	-	VI	-	IX	-	IX	**F**

Sprat maturity scale conversions from national to international scales from ICES, 2011a

WKMSHS maturity scale	Denmark	Germany	England	Finland	Lithuania	Latvia	Netherlands	Norway	Polen	Sweden	WKMATCH 2012 maturity scale revised
I	I	I	I	I	I	I	I	I	I	I	**A**
II	II	II	II	II	II-III	II+VI.2	II	II	II	II	**B**
IIIa	III	III-V	III-V	III	IV+VI.3+VI.4	III-IV+ VI.3-VI.4	III	III-V	III-V	III-V	**C** (Cb)
IIIb	III	VI-VII	VI	III	V	V	III	VI	VI	VI	**C** (Ca)
IVa	IV	VIII	VII.1	IV	VI.2	VI.2	IV	VII	VII	VII	**D** (Da)
IVb	IV	-	VII.2-VIII	IV	VI.2	VI.2	IV	VII	VIII	VIII	**D** (Db)
V	-	II	-	-	-	VI.2	V	VIII	-	VIII	**D** (Db)
											E
VI	-	IX	A	-	-	-	VI	-	IX	IX	**F**

Walsh scale for mackerel and horse mackerel (Walsh *et al.* 1990) conversions

Name	State	Female	Male	WKMATCH 2012 revised stage
Immature	Immature	Gonads small. Ovaries wine red and clear, torpedo shaped	Gonads small. Male pale, flattened and transparent	A
Mature	Maturing	Gonads occupying 1/4 to 3/4 body cavity. Opaque eggs visible in ovaries giving pale pink to yellowish coloration, largest	Gonads occupying 1/4 to 3/4 body cavity. Testes off-white, milt not running	B (Ba)
Mature	Maturing	Gonads occupying largest eggs may have oil globules. 3/4 to almost filing body cavity. Ovaries yellow to orange.	Gonads occupying 3/4 to almost filing body cavity. Testes creamy white.	B (Bb)
Mature	Spawning	Ovaries characterized by externally visible hyaline eggs no matter how early the stage of hydration. Ovary size variable	Testes filling body cavity, milt freely running	C (Ca)
Mature	Spawning	Gonads occupying 3/4 to <1/4 body cavity. Ovaries slacker than in stage 3 and often bloodshot.	Gonads occupying 3/4 to < 1/4 body cavity. Testes with free running milt and shrivelled at anus end.	C (Cb)
Mature	Spent/Recovery	Gonads occupying 1/4 or less of body cavity. Ovaries reddish and often murky in appearance, sometimes with a scattering or patch of opaque eggs	Gonads occupying 1/4 or less of body cavity. Testes opaque with brownish hit and no trace of milt.	D

Scomber scombrus **maturity scale conversions from national to international scales from ICES, 2015**

WKMSMAC2 maturity scale		**Walsh**	**Walsh *et al.* (IPMA,IMAR,IEO)**	**Walsh *et al.* (AZTI)**	**IMR**	**WKMATCH 2012 revised stage**
Immature	1	1	1	*1*	1-2	**A**
Developing	2	2-3	2-3	*2*	3-4	**B**
Spawning	3	4-5	4-5	*3-4-5*	5-6	**C**
Regressing Regenerating	4	6	6	*6*	7-8	**D**
Omitted spawning	5					**E**
Abnormal	6				9	**F**

Scomber colias **maturity scale conversions from national to international scales from ICES, 2015**

WKMSMAC2 maturity scale		**Walsh**	***Walsh et al.* (IPMA,IMAR,IEO)**	***Walsh et al.* (AZTI)**	**IMR**	**WKMATCH 2012 revised stage**
Immature	1	1	*1*	1-2	1-2a	**A**
Developing	2	2-3	*2*	3-4	2c	**B**
Spawning	3	4-5	*3-4-5*	5-6	3	**C**
Regressing Regenerating	4	6	*6*	7-8	4a-4b-2b	**D**
Omitted spawning	5					**E**
Abnormal	6			9		**F**

Trachurus trachurus **maturity scale conversions from national to international scales from ICES, 2015**

WKMSMAC2 maturity scale		**Walsh**	**Walsh *et al.* (IPMA,IMAR,IEO)**	**Walsh *et al.* (AZTI)**	**IMR**	**WKMATCH 2012 revised stage**
Immature	1	1	1-2a	*1*	1-2a	A
Developing	2	2	3	*2*	2c	B
Spawning	3	3-4-5	4	*3-4-5*	3	C
Regressing Regenerating	4	6	5-6	*6*	4a-4b-2b	D
Omitted spawning	5					E
Abnormal	6					F

Trachurus mediterraneus **maturity scale conversions from national to international scales from ICES, 2015**

WKMSMAC2 maturity scale		**Walsh**	**WKSPMAT maturity scale**	**Walsh *et al.*** (AZTI)	**WKMATCH 2012 revised stage**
Immature	1	1	1-2a	*1*	**A**
Developing	2	2	3	*2*	**B**
Spawning	3	3-4-5	4	*3-4-5*	**C**
Regressing Re-generating	4	6	5-6	*6*	**D**
Omitted spawning	5				**E**
Abnormal	6				**F**

Annex 7: Conversion tables for the GFCM areas

CONVERSION OF MATURITY SCALES - BONY FISH

<table>
<tr><th>ICCAT (big pelagics)</th><th>NIKOLSKY</th><th>MEDITS 1994-2006</th><th>MEDITS 2007-2018 / GFCM SCALE</th><th>WKMATCH SCALE</th></tr>
<tr><td>1. IMMATURE</td><td>1. IMMATURE</td><td>1. IMMATURE</td><td>1. IMMATURE / VIRGIN</td><td>A. IMMATURE</td></tr>
<tr><td rowspan="2">2. EARLY MATURING</td><td rowspan="2">3. DEVELOPING</td><td rowspan="2">2. MATURING</td><td>2a. VIRGIN DEVELOPING</td><td>Ba. DEVELOPING BUT FUNCTIONALLY IMMA-TURE</td></tr>
<tr><td>2b. RECOVERING</td><td>Bb. DEVELOPING AND FUNCTIONALLY MATURE</td></tr>
<tr><td>3. MATURING</td><td>4. MATURING</td><td rowspan="2">3. SPAWNING</td><td>2c. MATURING</td><td rowspan="2">C. SPAWNING</td></tr>
<tr><td>4. RIPE</td><td>5. MATURE</td><td>3.MATURE / SPAWNER</td></tr>
<tr><td rowspan="2">5. SPENT</td><td>6. SPENT</td><td rowspan="2">4. POST-SPAWNNG</td><td>4a. SPENT</td><td>Da. REGRESSING</td></tr>
<tr><td>2. RESTING</td><td>4b. RESTING</td><td>Db. REGENERATING</td></tr>
<tr><td></td><td></td><td></td><td></td><td>E. OMITTED SPAWNING</td></tr>
<tr><td></td><td></td><td></td><td></td><td>F. ABNORMAL</td></tr>
</table>

CONVERSION OF MATURITY SCALES - CRUSTACEANS

<table>
<tr><th>GFCM
CRUSTACEANS STOMATO-PODS</th><th>GFCM
CRUSTACEANS DECAPODS</th><th>MEDITS 1994-2006</th><th>MEDITS 2007-2018</th><th>WKMATCH SCALE</th></tr>
<tr><td>0. IMMATURE</td><td>1. IMMATURE</td><td>1. IMMATURE</td><td>1. IMMATURE VIRGIN</td><td>A. IMMATURE</td></tr>
<tr><td rowspan="2">2. EARLY MATURATION</td><td rowspan="2">2. DEVELOPING-RESTING-RECOVERING</td><td rowspan="5">2. MATURING</td><td>2a. VIRGIN DEVELOPING</td><td>Ba. DEVELOPING BUT FUNCTIONALLY IMMA-TURE</td></tr>
<tr><td>2b. RECOVERING</td><td>Bb. DEVELOPING AND FUNCTIONALLY MATURE</td></tr>
<tr><td>1. QUIESCENT</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. MATURATION</td><td>3. MATURING</td><td>2c. MATURING OR ALMOST MATURE</td><td rowspan="2">C. SPAWNING</td></tr>
<tr><td>4. RIPE</td><td>4. MATURE</td><td>2d. MATURE</td><td></td></tr>
<tr><td>5. SPENT</td><td>5. SPENT</td><td rowspan="4"></td><td rowspan="3">2e. RESTING ADULT</td><td>Da. REGRESSING</td></tr>
<tr><td></td><td>2. DEVELOPING-RESTING-RECOVERING</td><td>Db. REGENERATING</td></tr>
<tr><td></td><td></td><td>E. OMITTED SPAWNING</td></tr>
<tr><td></td><td></td><td></td><td>F. ABNORMAL</td></tr>
<tr><td></td><td></td><td>3.External eggs</td><td>3. BERRIED</td><td></td></tr>
</table>

CONVERSION OF MATURITY SCALE – CEPHALOPODS

MEDITS 1994-2006	MEDITS 2007-2018 and GFCM	WKMATCH SCALE
1. IMMATURE	1. IMMATURE VIRGIN	A. IMMATURE
	2a. DEVELOPING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
2. MATURING	2b. MATURING	Bb. DEVELOPING AND FUNCTIONALLY MATURE
3. MATURE	3a. MATURE	C. SPAWNING
	3b. SPENT	Da. REGRESSING
		Db. REGENERATING
		E. OMITTED SPAWNING
		F. ABNORMAL

CONVERSION OF MATURITY SCALE - OVIPAROUS ELASMOBRANCHS

MEDITS 2008-2018 and GFCM	MEDITS 2007	MEDITS 1994-2006	WKMATCH SCALE
1. IMMATURE-VIRGIN	1. IMMATURE VIRGIN	1. IMMATURE	A. IMMATURE
2. MATURING	2. MATURING	2. MATURING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
			Bb. DEVELOPING AND FUNCTIONALLY MATURE
3a. MATURE	3a. MATURE	3. SPAWNING	C. SPAWNING
3b. MATURE/EXTRUDING-AC-TIVE	3b. MATURE/ EXTRUDING-ACTIVE		
4a. RESTING	4. RESTING	4. POST-SPAWNNG	Da. REGRESSING
4b. REGENERATING*			Db. REGENERATING
			E. OMITTED SPAWNING
			F. ABNORMAL

* only for female

CONVERSION OF MATURITY SCALES *VIVIPAROUS ELASMOBRANCHS*

GFCM	MEDITS 2007-2018	MEDITS 1994-2006	WKMATCH SCALE
1. IMMATURE	1. IMMATURE	1. IMMATURE	A. IMMATURE
2. DEVELOPING	2. DEVELOPING	2. MATURING	Ba. DEVELOPING BUT FUNCTIONALLY IMMATURE
	3A. SPAWNING CAPABLE + CAPABLE TO REPRODUCE *		Bb. DEVELOPING AND FUNCTIONALLY MATURE
3.CAPABLE OF REPRODUCTION * 3A. CAPABLE OF REPRODUC-TION +	3B. ACTIVELY SPAWNING + / EARLY PREGRNANCY * 3C. MID PREGRNANCY; 3D. LATE PREGNANCY *	3. SPAWNING	C. SPAWNING
5. POST PARTUM* / 4. REGRESSING +	4. REGRESSING + / 4A. REGRESSING *	4. POST-SPAWNNG	Da. REGRESSING
6. REGENERATING* / 4. REGRESSING +	4B. REGENERATING *		Db. REGENERATING
			E. OMITTED SPAWNING
			F. ABNORMAL

* only for female
\+ only for males

* only for female
\+ only for males

Annex 8: Draft Resolution for an ICES Internal Publication

A Handbook on maturity staging of fish in the ICES areas, edited by Cindy van Damme (The Netherlands), Maria Cristina Follesa (Italy) and Francesca Vitale (Sweden) and reviewed and approved by members of WGBIOP, comprising of a collation of maturity staging protocols (based on ICES maturity staging work-shops), will be published in the ICES Cooperative Research Report series. The estimated number of pages is indefinite.

The editors agree to submit the final draft of the proposed publication by 31 December 2020.

Supporting information

Priority:	The proposed Cooperative Research Report presents will compile and synthesis the state-of-the-art of knowledge for key species, and will scrutinize by peer review work carried out by maturity staging workshops and thus increase quality. The CRR will provide a comprehensive manual on maturity staging with species-specific descriptions and representative images. This will facilitate quality assured maturity staging in an international context.
Scientific justification:	The forthcoming ICES Cooperative Research Report represents a collation of the state-of-the-art scientific work on the maturity staging of commercially exploited fish species across Europe. This manual should represent a useful tool to be used on board to define the maturity stages of species in order to reduce sources of error on maturity determination. Improving precision in maturity determination is extremely important for many species and the information in existing workshop re-ports should be more widely and easily available. Given the wide span maturity stage descriptions already existing within the ICES community, the collation of these protocols would provide a useful resource to the ICES community and will increase the quality of maturity staging.
Linkages to advisory committees:	This report arises from the science side (through WKASMSF and WGBIOP). Maturity data are essential to stock assessments and as illustrated by WKASMSF and WGBIOP it is important that maturity data be reported in one internationally agreed scale.
Linkages to other committees or groups:	It is expected that the CRR will be of interest to a range of end-users both within ICES and outside, those collecting and reporting maturity data, but also those that make use of maturity data.
Linkages to other organizations:	GFCM
Draft outline of publication:	The CRR will contain a general introduction to maturity staging and the WKMATCH 2012 maturity scale revised at WKASMSF, followed by a series of chapters with descriptions of the maturity stages for different species (within gadoids, small pelagic species, flatfish, etc.). Each chapter will contain an introduction describing the species' reproduction, most relevant references present in literature on spawning period and size at first maturity, descriptions of the maturity stages for females and males and histological descriptions for validating the maturity staging.
Resource requirements:	The material in the report will be fairly straightforward, as it will collate information from maturity staging workshops. There will be a large number of images in the report illustrating the stage descriptions for the various species.
Participants:	Approximately six months work is required by the editors to finalize this draft. The editorial work will be carried out under WGBIOP and intersessional.
Secretariat facilities:	About two months of the services of Secretariat Professional and General Staff will be required
Financial:	Associated production and publication costs.
Promotion:	The CRR can be promoted at international reproductive biology symposia such as International Symposium Reproductive Physiology of Fish (ISRPF)