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Monitoring the performance of the Common Fisheries Policy (STECF-16-03)

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Abstract

An ad hoc Expert Group on 'Monitoring the performance of the Common Fisheries Policy' composed of JRC experts was held on 1-5th February 2016 at JRC, Ispra, Italy. The ad hoc report was finalized and subsequently reviewed by the STECF by written procedure during March 2016.

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**SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES
(STECF)**

**MONITORING THE PERFORMANCE OF THE COMMON FISHERIES POLICY
(STECF-16-03)**

The STECF review and adoption of the report of the ad hoc Expert group to monitor the performance of the Common Fisheries Policy was undertaken during February 2016.

Background

Article 50 of the Common Fisheries Policy (CFP; Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013) stipulates:

"The Commission shall report annually to the European Parliament and to the Council on the progress on achieving maximum sustainable yield and on the situation of fish stocks, as early as possible following the adoption of the yearly Council Regulation fixing the fishing opportunities available in Union waters and, in certain non-Union waters, to Union vessels."

To facilitate such a report, an ad hoc Expert Group was convened from 1 - 5 February 2016 at JRC, Ispra, Italy to address the following Terms of Reference and to prepare a report for review by the STECF.

Terms of reference

STECF is requested to report on progress in achieving MSY objectives in line with CFP.

STECF Observations

The Report of the ad hoc Expert Group to the STECF is given in Annex I below.

STECF notes that to address the above Terms of Reference the ad hoc Expert group has to a large extent followed the protocol adopted by the STECF in November 2015 (Jardim et al, 2015). However, as a result of problems relating to the availability of stock assessments in the Mediterranean region, and to avoid producing misleading or erroneous trends for some indicators of CFP performance, the protocol was not strictly adhered to.

The problems identified primarily relate to the variation in number of Mediterranean stocks for which annual estimates of F and F_{MSY} were available. Consequently, only a

model-based indicator of F_{MSY} was computed for the Mediterranean region. Such model-based indicators were developed to deal with instability in the sampling frames, both in terms of the number and identity of stocks for which annual estimates of F_{MSY} were available.

ICES Area – trends in CFP monitoring indicators

Based on the results in the Report of the ad hoc Expert group, STECF notes the following:

The ICES area sampling frame

The stocks that are included in the sampling frame for the ICES area are those stocks for which ICES provides advice on fishing opportunities (TACs) and for which from the most recent ICES assessments, estimates for F/F_{MSY} were available. Over the period 2003-2014 the number of stocks in the sampling frame has remained relatively stable, ranging from 57 (2004) to 62 (2013).

Fishing mortality relative to F_{MSY}

Two indicators are presented in the report of the Expert group; the number of stocks for which fishing mortality is greater than F_{MSY} and the number of stocks for which fishing mortality is less than F_{MSY} . Over the period 2003-2014, the number of stocks in the sampling frame for which annual estimates of fishing mortality exceeded F_{MSY} shows an overall declining trend indicating a gradual reduction in exploitation rates for the ICES area. A similar declining trend can be observed for the regional analyses for the Baltic Sea, greater North Sea, Western waters and for widely distributed stocks. As expected, for the same areas, the number of stocks for which annual estimates of fishing mortality were less than F_{MSY} shows a generally increasing trend.

Trends in both indicators suggest a general reduction in exploitation rates for stocks in the ICES area. Nevertheless, in 2014, the number of stocks for which F exceeds F_{MSY} is about 50% of the total number of stocks for which this indicator can be computed.

Number of stocks outside safe biological limits

Over the period 2003-2014, the annual number of stocks assessed to be outside safe biological limits¹ (SBL) has varied between 28 and 38 stocks and overall shows a weakly declining trend, with a minimum in 2011. Correspondingly, the annual number of stocks assessed to be within SBL² varies between 15 and 25 stocks and shows a weakly increasing trend, with a maximum in 2011.

The number of stocks within SBL in 2014 is about 40% of the total number of stocks for which this indicator can be computed.

Ratio of F/F_{MSY}

The annual arithmetic mean ratio of F/F_{MSY} for all stocks in the sampling frame is used to indicate the trend in overall exploitation rate in the ICES area and by region. Over the period 2003-2013, the overall trend in the mean F/F_{MSY} ratio for the ICES area as a

¹ Outside safe biological limits means that SSB is less than B_{pa} (where B_{pa} is defined) or F is greater than F_{MSY} (where F_{MSY} is defined).

² Within safe biological limits means that SSB is greater than B_{pa} (where B_{pa} is defined) and F is less than F_{MSY} (where F_{MSY} is defined).

whole is downward. Similarly, a declining trend can also be observed for stocks in each of the regions; Baltic Sea, Greater North Sea, Western European waters and for widely distributed stocks. The model based indicator of the trend in F/F_{MSY} shows a similar downward trend over the same period.

In 2014, both the arithmetic mean and the model-based indicators show an increase in F/F_{MSY} of approximately 9% compared to 2013.

Although both indicators show similar trends, the annual arithmetic mean estimates are higher than the model-based estimates. The arithmetic mean indicator for F/F_{MSY} remains above a value of 1.0, while the median value for the model based indicator for F/F_{MSY} stabilizes around 1.0 after 2010. The difference between the two sets of indicator values is due to the fact that the arithmetic mean estimates are sensitive to outliers and are inflated by some large values (see Figure 12). The model based indicator deals with this problem by using a log link function in the Generalized Linear Mixed Model.

For the above reason, STECF considers that the model-based indicator values for F/F_{MSY} should be adopted as the benchmark indicator time-series. While the model-based time series indicates that the median exploitation rate for the stocks in the sampling frame is around the F_{MSY} target, such an observation does not mean that the F_{MSY} target has been reached for all stocks. It is important to note that for all stocks to be exploited at rates corresponding to F_{MSY} , the median value would need to be much lower than current estimates.

The above results are generally in line with those reported in the 2015 CFP monitoring report and indicate a reduction in overall exploitation rate for the ICES area. However, the annual estimates for each of the indicators differ slightly between years because of changes to the composition and number of stocks in the sampling frame.

Changes in coverage of advice

The EWG report lists the number and proportion of TACs for which scientific advice is provided by ICES.

STECF notes that in several cases, the boundaries of the stocks for which there are assessments are not aligned with TAC management areas. For example, northern hake is assessed as a single stock but the fishing opportunities for the stock are allocated over 5 different management areas, resulting in 5 TACs. Alternatively, a TAC is set for North Sea *Nephrops* which is assessed separately by functional unit, and three separate assessments are taken into account to arrive at a single TAC for all functional units combined. For the calculation of this indicator, a TAC was considered to be covered by a stock assessment, when at least one of its divisions matched the spatial distribution of a stock for which the required reference points have been estimated. Such an approach tends to overestimate the assessment coverage as the full spatial distribution of the stocks and management units is not accounted for.

STECF notes that for the EU coastal waters in the NE Atlantic, there are 238 TACs (combination of species and area), also referred to as "management units". Of which 58% are covered by stocks that have F/F_{MSY} estimates (59 stocks covering 138 management units) and 51% by stocks that have SSB/B_{REF} (52 stocks covering 121 management units).

Mediterranean area

The Mediterranean area sampling frame

According to the protocol for computing indicators for CFP monitoring (Jardim et al, 2015), the sampling frame for Mediterranean stocks should include stocks for species which are subject to a legal minimum conservation reference size (MCRS), as prescribed in ANNEX III of the Mediterranean Regulation (EC 1967/2006). While the expert group has adopted this definition, it is important to note that such an approach excludes stocks of some important commercial species which form the target species for some fisheries (e.g. all shrimps except *Parapenaeus longirostris*, anglerfish, octopus) which are routinely assessed and some species that are deemed not to be important fishery target species or that are never assessed, like many coastal species (*Diplodus* spp., *Pagrus* spp., *Polyprion*).

In detail, the sampling frame lists 27 species of which only 8 have been assessed at least once in all the STECF MED assessment EWGs (*Engraulis encrasicolus*, *Parapenaeus longirostris*, *Merluccius merluccius*, *Mullus* spp, *Nephrops norvegicus*, *Pagellus erythrinus*, *Sardina pilchardus* and *Solea vulgaris*). Furthermore, 6 species that are assessed (*Lophius budegassa*, *Aristeus antennatus*, *Aristaeomorpha foliacea*, *Spicara smaris*, *Squilla mantis* and *Micromesistius poutassou*) are excluded from the sampling frame.

STECF considers that the basis for the current sampling frame needs to be revised so that the results of assessments for a greater number of stocks can be incorporated in order to provide informative indicator values. Nevertheless, the number of stocks to be included needs to be kept to a manageable level to avoid overloading the already demanding workload of the EWG undertaking assessments for stocks in the Mediterranean. This issue needs to be addressed by the Mediterranean assessment EWG during 2016, in order to incorporate a revised sampling frame in the 2017 CFP indicators report.

STECF notes that because only 15 of the 30 stock assessments carried out in 2015 by STECF EWGs undertaking assessments of Mediterranean stocks have been reviewed and accepted by the STECF, of which only 2 fall within the sampling frame, the STECF agrees with the decision of the ad hoc Expert Group to exclude the results of 2014 from the time series used to compute the CFP monitoring indicators.

Due to the varying availability of stock assessment results over time for the Mediterranean area, some of the CFP monitoring indicators give a wholly misleading impression of any trends in such indicators over time. Using all of the stock assessments undertaken over the period 2003-2013 (data deliberately not shown), it appears that in the most recent year, the number of stocks for which F exceeds F_{MSY} has fallen dramatically. However, such an observation simply reflects the variation in the number of stock assessments carried out in different years throughout the time series 2003-2013 e.g. the results from 16-18 assessments were available for the years 2006-2012, but only 9 for 2013, the majority of which (8) indicated that F was above F_{MSY} . The STECF agrees with the ad hoc Expert Group that on the grounds that they are likely to give a misleading impression of the trend in the status of the stocks, it is not appropriate to compute the time series of annual values for the following indicators:

- Number of stocks for which F exceed F_{MSY} .
- Number of stocks for which F is equal to or less than F_{MSY} .
- Number of stocks outside safe biological limits.
- Number of stocks within safe biological limits

Hence, STECF considers that the only indicator likely to be indicative of the overall trend in exploitation status is the trend in the annual values for F/F_{MSY} from stock assessments

carried out in 2012-2014. For the reasons outlined in the section above concerning trends in F/F_{MSY} for the ICES stocks, STECF considers that the model-based estimates of F/F_{MSY} values are likely to be more representative of the overall trend in exploitation status for stocks in the Mediterranean and hence only the model-based series is presented in the report.

The results indicate that over the period 2003-2013, the annual values for F/F_{MSY} for all stocks combined shows a decline from 2003-2005 followed by a gradually increasing trend, indicating that the overall exploitation rate on those stocks included in the analysis has been slowly increasing since 2005. A further important observation is that the median values of the annual estimates of F/F_{MSY} are generally above 2.0 throughout the time period implying that overall fishing mortality rates need to be reduced by more than 50% if the F_{MSY} target is to be achieved.

STECF conclusions

STECF concludes that because of the issues raised by the expert group in relation to the existing protocol (Jardim, et al, 2015), together with additional methodological matters, there is a need for STECF to review procedures and methods ahead of the 2017 CFP monitoring report and revise the protocol accordingly.

STECF concludes that the approach of the ad hoc Expert group was appropriate and the Terms of Reference have been addressed appropriately. The Report is logically presented and STECF concludes that the data and information presented, although not as comprehensive as originally envisaged, represent the best currently available and can be used by the Commission as a basis to fulfil its obligations under Article 50 of the Common Fisheries Policy (Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013).

References

Jardim, E., Mosqueira, I., Osio, G.C. and Scott, F. 2015. Common Fisheries Policy monitoring Protocol for computing indicators: EUR 27566 EN; doi:10.2788/560953

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ANNEX I - REPORT TO THE STECF

**AD HOC EXPERT GROUP on
Monitoring the Performance of the Common Fisheries
Policy**

Ispra, Italy, 1-5 February 2016

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

Report of the ad hoc Expert Group on monitoring the performance of the Common Fisheries Policy

Ernesto Jardim, Iago Mosqueira, Finlay Scott, Chato Osio, John Casey

JRC Ispra (IT), 10 March, 2016

Abstract

Indicators to monitor the implementation of the Common Fisheries Policy (CFP) were computed by an ad-hoc working group. These information formed the basis of STECF's advice to the European Commission about progress of the CFP in the Northeast Atlantic and Mediterranean European coastal waters. The indicators were computed following the adopted protocol. Calculations were carried out using publicly available datasets of stock assessment results, from ICES and STECF's expert working groups dealing with stock assessment in the Mediterranean region. The indicators computed for the Northeast Atlantic European coastal waters were: 'Number of stocks where fishing mortality exceeds F_{MSY} ', 'Number of stocks where fishing mortality is equal to or less than F_{MSY} ', 'Number of stocks outside safe biological limits', 'Number of stocks inside safe biological limits', 'Annual mean value of F/F_{MSY} ' and 'advice coverage'. For the Mediterranean the indicator 'Annual mean value of F/F_{MSY} ' was computed for the first time. A number of inconsistencies in the protocol were identified by the adhoc working group, which require attention from the STECF plenary.

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1 Introduction

The monitoring of the Common Fisheries Policy (European Parliament and Council of the European Union 2002a) implementation is of utmost importance for the European Union (EU).

The European Commission Scientific, Technical and Economic Committee for Fisheries (STECF), as the major scientific advisory body on fisheries policy to the European Commission (EC), has received the task of reporting on the CFP implementation through the publication of a series of indicators.

To make the process consistent and transparent STECF (STECF 2015a) approved a protocol for computing the required indicators (Annex B, (Jardim et al. 2015)), which was used to produce the indicators shown below.

1.1 Protocol inconsistencies

During the process of producing this report a number of inconsistencies were found, which are listed here for a future revision of the protocol.

- **Biological reference points** The protocol refers to B_{MSY} to compute Safe Biological Limits (SBL), but due to the limited number of estimates of B_{MSY} the Ad hoc group used B_{pa} , or proxies, to compute this indicator, in agreement with what was done last year. A mix of data was thus used to build this indicator: B_{pa} was used if available, followed by $B_{trigger}$, and if neither were available B_{lim} was used.
- **Mediterranean sampling frame** In the Mediterranean there are no TACs. Instead, the Mediterranean sampling frame is based on the stocks with minimum landing size as set in the Mediterranean Regulation (EC 1967/2006). However, this list of species includes species which are not managed to achieve MSY and leaves out important stocks, like shrimps, anglerfish, etc, which are regularly assessed. The full list of species included in the sampling frame are presented in Table 1, as well as the list of species identified by STECF EWG 14-23 (STECF 2014).
- **Proportion of stocks covered by assessments** This indicator is not described in the protocol although it's required, to evaluate the coverage of the sampling frame (TACs) by scientific advice. See the Methods section for details.

1.2 Terms of reference

1. STECF is requested to report on progress in achieving MSY objectives in line with CFP

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Table 1: Comparison of Species in the currently implemented sampling frame, based on Annex III of the EC 1967-2006, with the list of species proposed in EWG 14-23. The species assessed by STECF EWG MED are marked (*)

Sampling Frame based on EC 1967-2006	Species listed by EWG 14-23
Dicentrarchus labrax	Aristaeomorpha foliacea*
Diplodus annularis	Aristeus antennatus*
Diplodus puntazzo	Boops boops
Diplodus sargus	Chamelea gallina
Diplodus vulgaris	Coryphaena hippurus
Engraulis encrasicolus*	Eledone cirrosa
Epinephelus spp	Eledone moschata
Homarus gammarus	Engraulis encrasicolus*
Lithognathus mormyrus	Lepidopus caudatus
Merluccius merluccius*	Loligo vulgaris
Mullus spp*	Lophius budegassa*
Nephrops norvegicus*	Lophius piscatorius
Pagellus acarne	Merlangius merlangus
Pagellus bogaraveo	Merluccius merluccius*
Pagellus erythrinus*	Micromesistius poutassou*
Pagrus pagrus	Mullus barbatus*
Palinuridae	Mullus surmuletus*
Parapenaeus longirostris*	Nephrops norvegicus*
Pecten jacobaeus	Octopus vulgaris
Polyprion americanus	Pagellus erythrinus*
Sardina pilchardus*	Palinurus elephas
Scomber spp	Parapenaeus longirostris*
Solea vulgaris*	Penaeus kerathurus
Sparus aurata	Phycis blennoides
Trachurus spp	Raja clavata
Venerupis spp	Sardina pilchardus*
Venus spp	Sardinella aurita
	Scomber scombrus
	Scomber japonicus
	Sepia officinalis
	Solea vulgaris*
	Sparus aurata
	Spicara smaris*
	Squilla mantis*
	Trachurus mediterraneus
	Trachurus trachurus

2 Data & Methods

The methods applied and the definition of the sampling frames followed the protocol (Jardim et al. 2015) agreed by (STECF 2015a).

2.1 Data sources

The data sources used referred to the coastal waters of the EU in FAO areas 27 (Northeast Atlantic) and 37 (Mediterranean). The Mediterranean included GSAs 1,5,6,7,8,9,10,11, 15,16, 17,18,19, 20, 22, 23 and 25. The NE Atlantic included the ICES subareas “III”, “IV”, “VI” (excluding Norwegian waters of division IVa), “VII”, “VIII” and “IX”.

2.1.1 Stock assessment information

For the Mediterranean region the information were extracted from STECF Mediterranean Expert Working Group repositories (<https://stecf.jrc.ec.europa.eu/reports/medbs>). This was done through a manual process since the information is not available online in a database or a suitable form for scraping.

For the NE Atlantic the information was downloaded from the ICES website, using the available webservices (<http://standardgraphs.ices.dk>).

2.1.2 Management units information

For the Mediterranean area, the management units were defined by combining the species that have a minimum landing size (MLS) with the GSAs. Note that using the list of stocks with MLS leaves out important species which are of commercial interest.

For the NE Atlantic, management units are defined by TACs (fishing opportunities for a species or group of species in a specific area). The information regarding TACs in 2014 was downloaded from FIDES (<http://fides3.fish.cec.eu.int/>) reporting system. Note that to compute the indicators shown below the TAC definitions are needed, not the TAC value.

2.2 Differences from previous report

- **Computation of SBL** In the previous report (STECF 2015b), if one of the indicators (F/F_{MSY} or B/B_{ref}) was missing SBL was computed based on the one indicator available. Such approach was changed to avoid computing SBL for stocks which don't have the complete set of information needed. In this report if one of the indicators is missing SBL is not computed.
- **Proportion of stocks covered by assessments** Advice coverage was estimated as the fraction of the TACs that have matching information from stock assessments. The biological area that defines the spatial distribution of a stock does not necessarily match the TAC area. The area covered by a TAC can span more than one biological stock and a single biological stock can cover more than one TAC. To link the two sets of information the two definitions were mapped at the level of the ICES divisions. A TAC was considered to be covered by stock assessment when at least one of its divisions was within the biological stock area and the stock had biological reference points. This indicator is not described in the protocol and is experimental.

3 Northeast Atlantic (FAO 27)

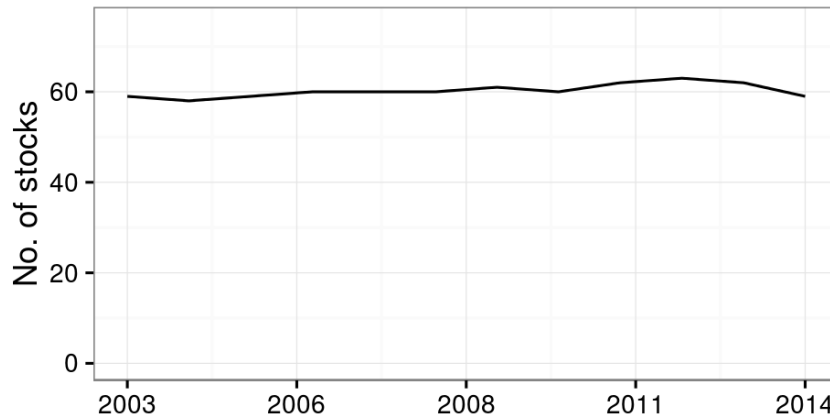


Figure 1: Number of stocks in the ICES area for which estimates of F/F_{MSY} are available by year.

Table 2: Number of stocks in the ICES area for which estimates of F/F_{MSY} are available by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	59	58	59	60	60	60	61	60	62	63	62	59
Baltic Sea	8	8	8	8	8	8	8	8	8	8	7	7
Greater North Sea	20	20	20	20	20	20	20	20	21	21	20	20
Western European	26	25	26	27	27	27	28	27	28	29	30	28
Widely distributed	5	5	5	5	5	5	5	5	5	5	5	4

3.1 Indicators of management performance

Estimates of relative stock status were only considered for the 2003 - 2014 period, as the first date marks the start of the previous CFP (European Parliament and Council of the European Union 2002b) and the second is the last year for which abundance and fishing mortality estimates are available from the 2015 stock assessment dataset.

3.1.1 Number of stocks where fishing mortality exceeds F_{MSY}

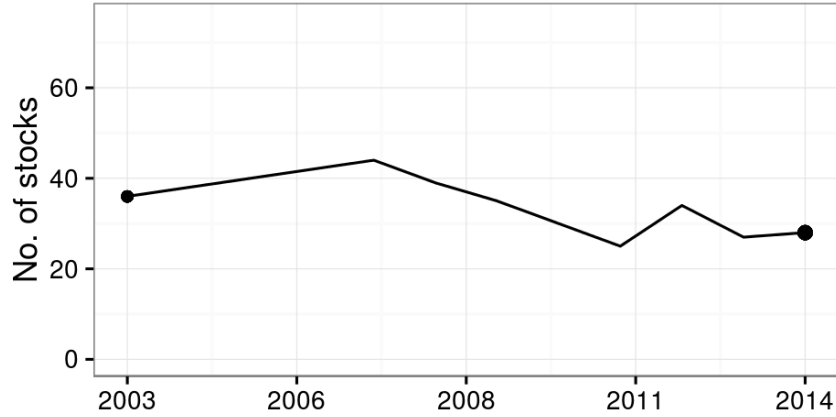


Figure 2: Number of stocks where fishing mortality (F) exceeds fishing mortality at MSY (F_{MSY}) by year.

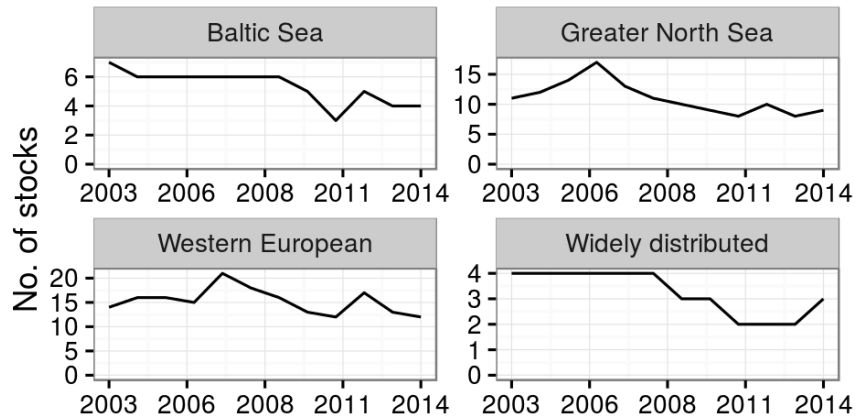


Figure 3: Number of stocks where fishing mortality (F) exceeds fishing mortality at MSY (F_{MSY}) by ecoregion and year.

Table 3: Number of stocks where fishing mortality (F) exceeds fishing mortality at MSY (F_{MSY}) by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	36	38	40	42	44	39	35	30	25	34	27	28
Baltic Sea	7	6	6	6	6	6	6	5	3	5	4	4
Greater North Sea	11	12	14	17	13	11	10	9	8	10	8	9
Western European	14	16	16	15	21	18	16	13	12	17	13	12
Widely distributed	4	4	4	4	4	4	3	3	2	2	2	3

3.1.2 Number of stocks where fishing mortality is equal to or less than F_{MSY}

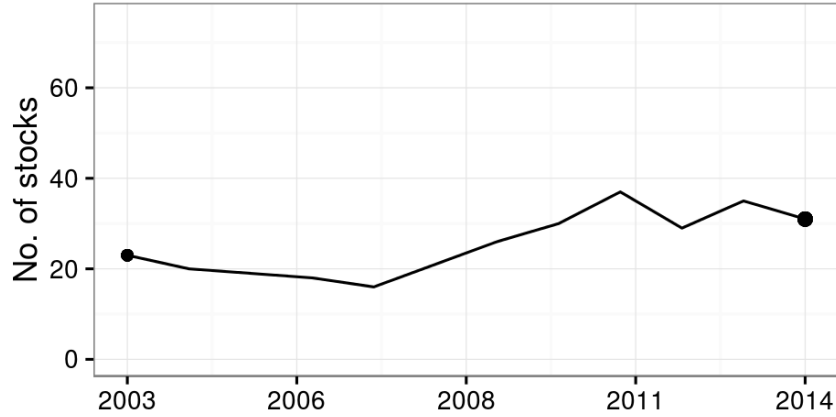


Figure 4: Number of stocks where fishing mortality (F) does not exceed fishing mortality at MSY (F_{MSY}) by year.

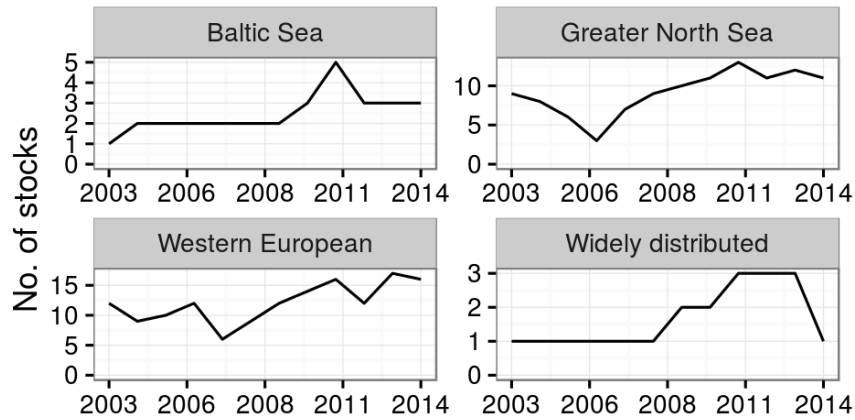


Figure 5: Number of stocks where fishing mortality (F) does not exceed fishing mortality at MSY (F_{MSY}) by ecoregion and year.

Table 4: Number of stocks where fishing mortality (F) does not exceed fishing mortality at MSY (F_{MSY}) by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	23	20	19	18	16	21	26	30	37	29	35	31
Baltic Sea	1	2	2	2	2	2	2	3	5	3	3	3
Greater North Sea	9	8	6	3	7	9	10	11	13	11	12	11
Western European	12	9	10	12	6	9	12	14	16	12	17	16
Widely distributed	1	1	1	1	1	1	2	2	3	3	3	1

3.1.3 Number of stocks outside safe biological limits

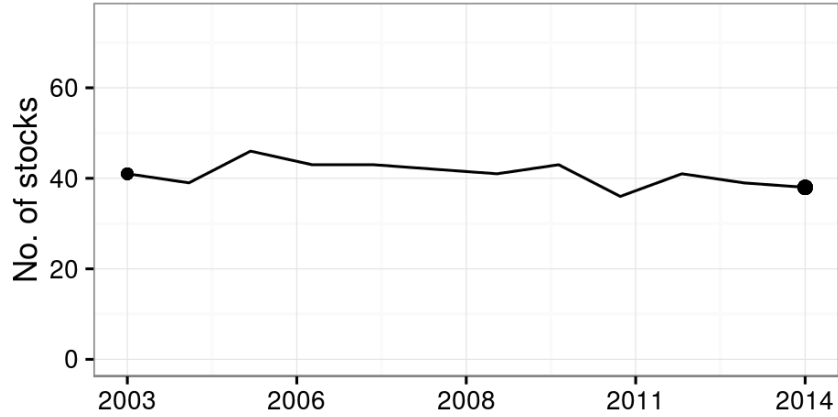


Figure 6: Number of stocks outside safe biological limits by year.

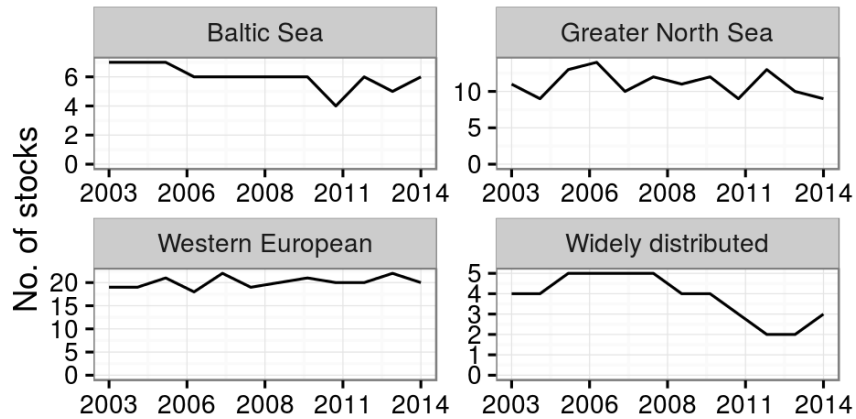


Figure 7: Number of stocks outside safe biological limits by ecoregion and year.

Table 5: Number of stocks outside safe biological limits by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	41	39	46	43	43	42	41	43	36	41	39	38
Baltic Sea	7	7	7	6	6	6	6	6	4	6	5	6
Greater North Sea	11	9	13	14	10	12	11	12	9	13	10	9
Western European	19	19	21	18	22	19	20	21	20	20	22	20
Widely distributed	4	4	5	5	5	5	4	4	3	2	2	3

3.1.4 Number of stocks inside safe biological limits

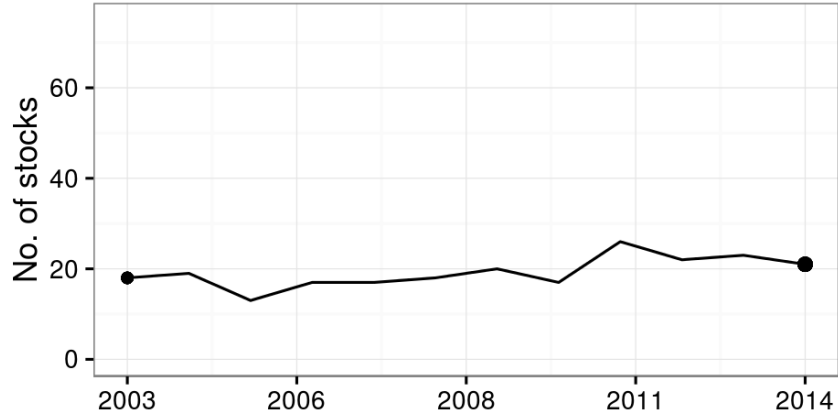


Figure 8: Number of stocks inside safe biological limits by year.

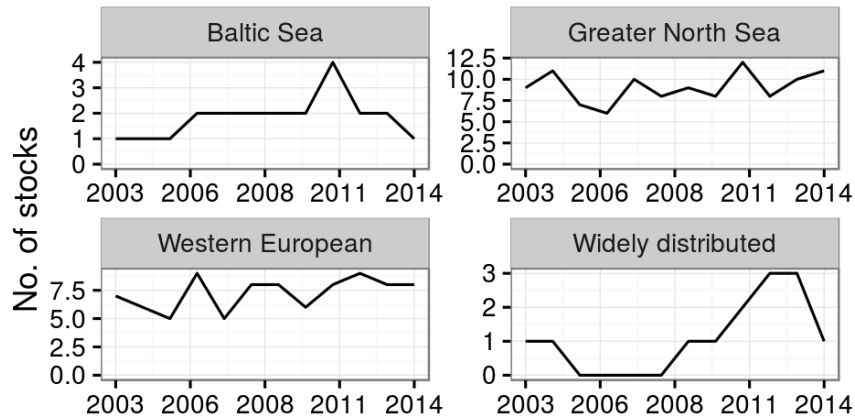


Figure 9: Number of stocks inside safe biological limits by ecoregion and year.

Table 6: Number of stocks inside safe biological limits by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	18	19	13	17	17	18	20	17	26	22	23	21
Baltic Sea	1	1	1	2	2	2	2	2	4	2	2	1
Greater North Sea	9	11	7	6	10	8	9	8	12	8	10	11
Western European	7	6	5	9	5	8	8	6	8	9	8	8
Widely distributed	1	1	0	0	0	0	1	1	2	3	3	1

3.1.5 Annual mean value of F/F_{MSY}

For this indicator, stocks for which fishing mortality was reported as an harvest rate, or managed under escapement strategies, were excluded.

Design based indicator

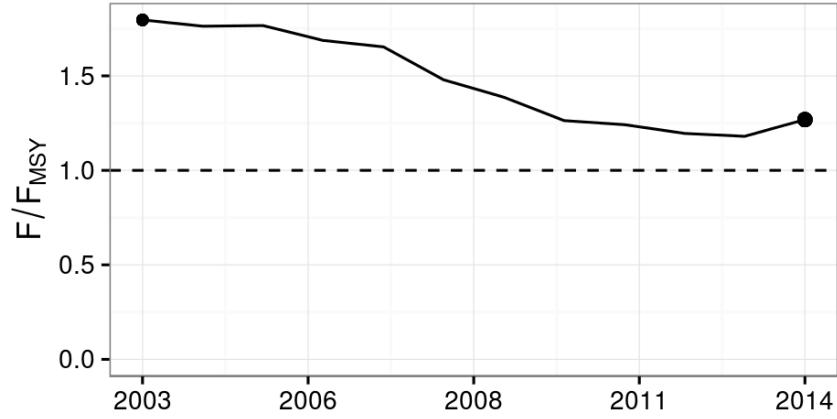


Figure 10: Arithmetic mean value of the F/F_{MSY} ratio by year.

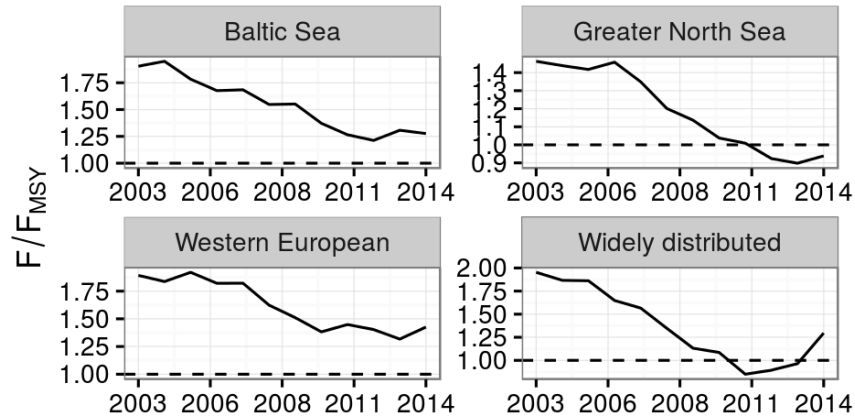


Figure 11: Arithmetic mean value of the F/F_{MSY} ratio by ecoregion and year.

Table 7: Arithmetic mean value of the F/F_{MSY} ratio by ecoregion and year.

Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALL	1.80	1.76	1.77	1.69	1.65	1.48	1.39	1.26	1.24	1.20	1.18	1.27
Baltic Sea	1.90	1.95	1.78	1.68	1.68	1.55	1.55	1.37	1.27	1.21	1.31	1.28
Greater North Sea	1.46	1.44	1.42	1.46	1.35	1.20	1.14	1.04	1.01	0.92	0.90	0.94
Western European	1.89	1.84	1.92	1.82	1.82	1.62	1.51	1.38	1.45	1.40	1.32	1.43
Widely distributed	1.95	1.87	1.86	1.65	1.57	1.35	1.13	1.09	0.85	0.89	0.96	1.30

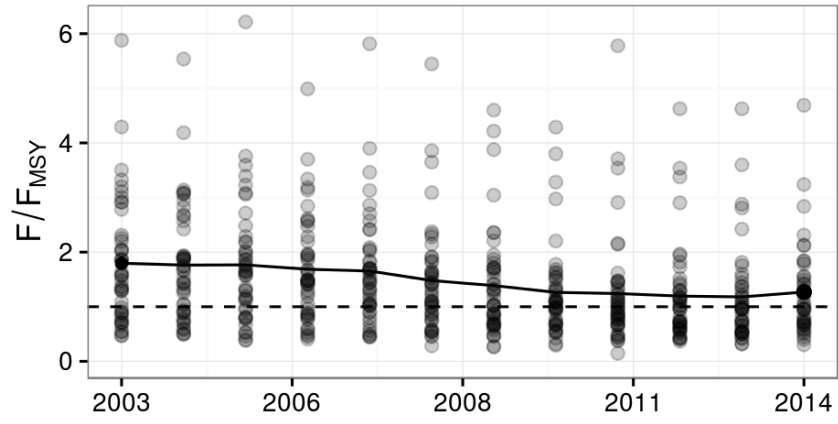


Figure 12: Scatterplot of F/F_{MSY} values and arithmetic mean by year.

Model based indicator

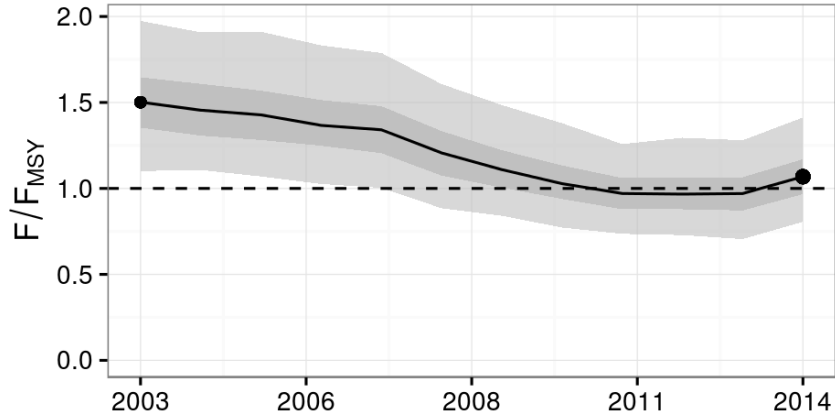


Figure 13: Modelled mean value of the F/F_{MSY} ratio by year.

Table 8: Quantiles of the estimated value of the F/F_{MSY} ratio by year.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2.5%	1.10	1.11	1.07	1.03	1.00	0.88	0.84	0.77	0.74	0.73	0.71	0.81
25%	1.35	1.31	1.28	1.25	1.21	1.07	1.01	0.94	0.88	0.88	0.87	0.97
50%	1.50	1.46	1.43	1.37	1.34	1.21	1.11	1.03	0.97	0.97	0.97	1.07
75%	1.65	1.61	1.57	1.51	1.48	1.33	1.22	1.13	1.06	1.06	1.07	1.17
97.5%	1.97	1.91	1.91	1.83	1.79	1.61	1.49	1.38	1.26	1.29	1.28	1.41

3.2 Indicators of advice coverage

This indicator is experimental and was not yet discussed by STECF.

Table 9: Number of stocks with F/F_{MSY} or B/B_{ref} , number of TAC units and proportion of TAC units which are covered by stock assessments.

	No	No TACs	Fraction of TACs with assessments
Stocks with F/FMSY estimate	59	238	0.58
Stocks with B/Bref estimate	52	238	0.51

4 Mediterranean (FAO 37)

The number of stocks assessed in the Mediterranean is not stable as not all stocks are assessed regularly and in some years the assessments had a particular focus on some species groups. During the study period the number of assessments in each year ranges from 9 to 18 stocks.

This situation renders the interpretation of the deterministic indicators misleading. With such differences in the number of stocks assessed each year, the trends in the indicators are confounded with the number of stocks available for their computation. As such, only the model based F/F_{MSY} indicator is shown, since it was purposely designed to cope with such problem.

It should be key in mind though, that a large number of stocks were not included in the analysis, due to:

- the application of the minimum landing size to define the sampling frame, which left out important stocks and their assessments;
- the gap between the last assessment EWG of 2015 and the next STECF Plenary (spring 2016), where the assessments have to be approved, which leaves out about half of the stocks assessed in 2015.

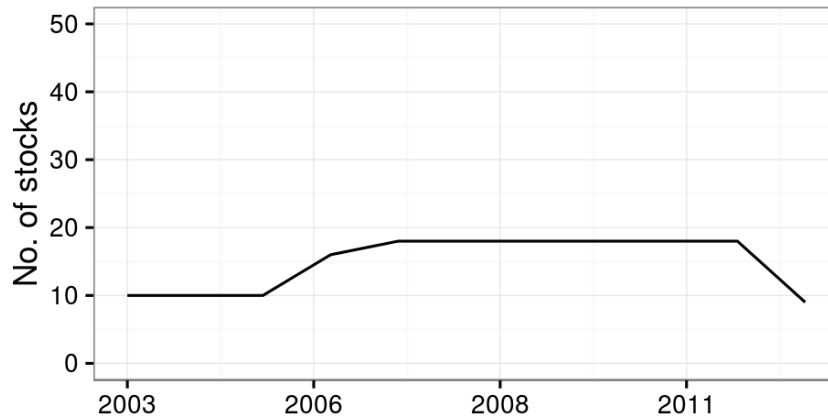


Figure 14: Number of stocks in the Mediterranean area for which estimates of F/F_{MSY} are available by year, and which have minimum landing size. These refers only to stocks in the European coastal waters (GSAs 1, 5, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, 20, 22, 23 and 25)

4.1 Indicators of management performance

4.1.1 Annual mean value of F/F_{MSY} - Model based indicator

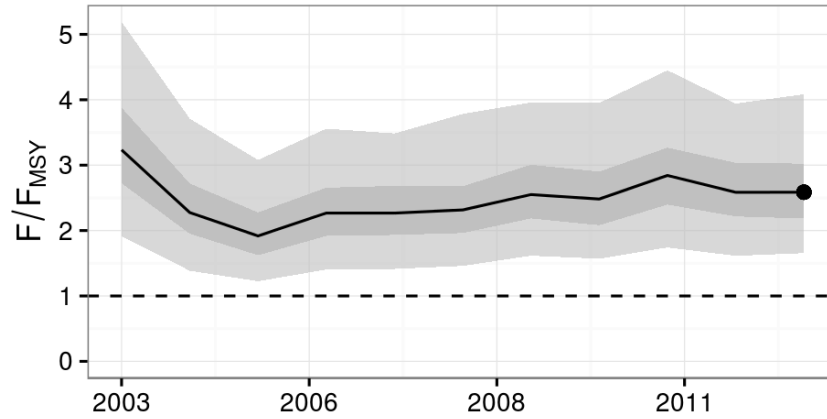


Figure 15: Modelled mean value of the F/F_{MSY} ratio by year.

Table 10: Quantiles of the estimated value of the F/F_{MSY} ratio by year.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2.5%	1.914	1.385	1.226	1.404	1.414	1.460	1.616	1.570	1.742	1.614	1.656
25%	2.725	1.952	1.623	1.918	1.934	1.963	2.186	2.083	2.397	2.217	2.185
50%	3.233	2.275	1.918	2.268	2.267	2.315	2.550	2.482	2.843	2.585	2.586
75%	3.879	2.719	2.276	2.655	2.683	2.678	3.006	2.901	3.267	3.035	3.023
97.5%	5.190	3.710	3.079	3.558	3.485	3.784	3.958	3.951	4.450	3.942	4.084

5 Status across all stocks in 2015

The list of stocks below includes stocks assessed between 2013 and 2015.

Region	Stock	Description	F ind	F status	SBL
Baltic Sea	cod-2224	Cod (<i>Gadus morhua</i>) in Subdivisions 22–24 (Western Baltic Sea)	3.24		
	cod-2532	Cod (<i>Gadus morhua</i>) in Subdivisions 25–32 (Eastern Baltic Sea)	0.81	•	
	her-3a22	Herring in Division IIIa and Subdivisions 22 - 24 (Western Baltic spring spawners)	0.82	•	•
	her-riga	Herring in Subdivision 28.1 (Gulf of Riga)	1.07		
	her-30	Herring in Subdivision 30 (Bothnian Sea)	1.03		
	her-2532-gor	Herring in Subdivisions 25 - 29 (excluding Gulf of Riga) and 32	0.72	•	
	ple-2123	Plaice in Subdivisions 21, 22, and 23 (Kattegat, Belts, and Sound)	0.50	•	
	spr-2232	Sprat in Subdivisions 22 - 32 (Baltic Sea)	1.57		
	cod-347d	Cod (<i>Gadus morhua</i>) in Subarea IV and Divisions VIIId and IIIa West (North Sea, Eastern Engl [...])	1.19		
	had-346a	Haddock in Subarea IV and Divisions IIIa West and VIa (North Sea, Skagerrak and West of Sc [...])	0.65	•	
	had-34	Haddock in Subarea IV (North Sea) and Division IIIa West (Skagerrak)	0.59	•	•
	her-47d3	Herring in Subarea IV and Divisions IIIa and VIIIId (North Sea autumn spawners)	0.75	•	•
	nep-3-4	Nephrops in Division IIIa (Skagerrak Kattegat, FU 3,4)	0.38	•	•
	nep-7	Nephrops in Division IVa (Fladen Ground, FU 7)	0.47	•	•
	nep-9	Nephrops in Division IVa (Moray Firth, FU 9)	1.25		
	nep-6	Nephrops in Division IVb (Farn Deep, FU 6)	1.60		
	nep-8	Nephrops in Division IVb (Firth of Forth, FU 8)	1.79		
	pan-sknd	Northern shrimp (<i>Pandalus borealis</i>) in Divisions IIIa West and IVa East (Skagerrak and Nor [...])	0.54	•	•
	nop-34-oct	Norway Pout in Subarea IV (North Sea) and IIIa (Skagerrak - Kattegat) - Autumn assessment	*	•	•
	ple-eche	Plaice in Division VIIIId (Eastern Channel)	0.45	•	•
ple-nsea	Plaice Subarea IV (North Sea)	0.95	•	•	
sai-3a46	Saithe in Subarea IV (North Sea) Division IIIa West (Skagerrak) and Subarea VI (West of Sc [...])	0.96	•	•	
san-ns3	Sandeel in the Central Eastern North Sea (SA 3)	*		•	
san-ns1	Sandeel in the Dogger Bank area (SA 1)	*		•	
san-ns2	Sandeel in the South Eastern North Sea (SA 2)	*		•	
sol-kask	Sole in Division IIIa and Subdivisions 22-24 (Skagerrak, Kattegat, and the Belts)	0.79	•		
sol-eche	Sole in Division VIIIId (Eastern Channel)	1.83			
sol-nsea	Sole in Subarea IV (North Sea)	1.27			
spr-nsea	Sprat in Subarea IV (North Sea)	*		•	
SOL-17	Common sole in GSA 17	3.00			
DPS-1	Deep-water rose shrimp in GSA 1	1.65			
DPS-10	Deep-water rose shrimp in GSA 10	1.33			
DPS-19	Deep-water rose shrimp in GSA 19	2.39			
DPS-5	Deep-water rose shrimp in GSA 5	1.10			
DPS-6	Deep-water rose shrimp in GSA 6	5.48			
DPS-9	Deep-water rose shrimp in GSA 9	0.97	•	•	
Mediterranean					

Continued on next page

Region	Stock	Description	F ind	F status	SBL
	ANE-17-18	European anchovy in GSA 17, 18	2.09		
	HKE-01-05-06-07	European hake in GSA 01, 05, 06, 07	3.62		
	HKE-09-10-11	European hake in GSA 09, 10, 11	4.27		
	HKE-18	European hake in GSA 18	5.76		
	HKE-19	European hake in GSA 19	6.20		
	PIL-17-18	European pilchard(=Sardine) in GSA 17, 18	2.32		
	PIL-6	European pilchard(=Sardine) in GSA 6	1.66		
	NEP-15-16	Norway lobster in GSA 15-16	0.75	•	•
	NEP-18	Norway lobster in GSA 18	6.08		
	NEP-5	Norway lobster in GSA 5	1.69		
	NEP-9	Norway lobster in GSA 9	2.03		
Western European	anb-8c9a	Black-bellied anglerfish (<i>Lophius budegassa</i>) in Divisions VIIIc and IXa (Cantabrian Sea, A [...])	0.59	•	•
	cod-7e-k	Cod (<i>Gadus morhua</i>) in Divisions VIIe-k (Western English Channel and Southern Celtic Seas)	1.79		
	cod-scow	Cod (<i>Gadus morhua</i>) in Division VIa (West of Scotland)	4.69		
	cod-iris	Cod (<i>Gadus morhua</i>) in Division VIIa (Irish Sea)	2.88		
	mgb-8c9a	Four-spot megrim (<i>Lepidorhombus boscii</i>) in Divisions VIIIc and IXa	2.31		
	had-7b-k	Haddock in Divisions VIIb,c,e-k	1.49		
	had-rock	Haddock in Division VIb (Rockall)	2.12		
	hke-soth	Hake in Division VIIIc and IXa (Southern stock)	2.84		
	her-67bc	Herring (<i>Clupea harengus</i>) in Divisions VIa and VIIIb,c (West of Scotland, West of Ireland)	0.58	•	
	her-vian	Herring in Division VIa (North)	1.07		
	het-nirs	Herring in Division VIIa North of 52° 30' N (Irish Sea)	0.95	•	
	het-irls	Herring in Division VIIa South of 52° 30' N and VIIIg,h,i,j,k (Celtic Sea and South of Ireland [...])	0.72	•	
	hom-soth	Horse mackerel (<i>Trachurus trachurus</i>) in Division IXa (Southern stock)	0.40	•	•
	meg-4a6a	Megrim (<i>Lepidorhombus spp</i>) in Divisions IVa and VIa	0.30	•	•
	mgw-8c9a	Megrim (<i>Lepidorhombus whiffiagonis</i>) in Divisions VIIIc and IXa	2.13		
	nep-11	Nephrops in Division VIa (North Minch, FU 11)	0.88	•	
	nep-12	Nephrops in Division VIa (South Minch, FU 12)	0.47	•	
	nep-19	Nephrops in Division VIIa,g,j (South East and West of IRL, FU 19)	0.48	•	•
	nep-14	Nephrops in Division VIIa (Irish Sea East, FU 14)	0.68	•	
	nep-15	Nephrops in Division VIIa (Irish Sea West, FU 15)	1.02		
	nep-17	Nephrops in Division VIIb (Aran Grounds, FU 17)	0.79	•	
	nep-16	Nephrops in Division VIIb,c,j,k (Porcupine Bank, FU 16)	0.58	•	•
	nep-13	Nephrops in the Firth of Clyde + Sound of Jura (FU 13)	1.38		
	nep-22	Nephrops in the Smalls (FU 22)	0.72	•	
	sol-celt	Sole in Divisions VIII, g (Celtic Sea)	1.41		

Continued on next page

Region	Stock	Description	F ind	F status	SBL
	sol-bisc	Sole in Divisions VIIa,b (Bay of Biscay)	1.85		
	sol-iris	Sole in Division VIIa (Irish Sea)	0.66	•	•
	sol-echw	Sole in Division VIIe (Western Channel)	0.70	•	•
	anp-8c9a	White anglerfish (<i>Lophius piscatorius</i>) in Divisions VIIIc and IXa (Cantabrian Sea, Atlantic [...])	1.32		
	whg-7e-k	Whiting in Division VIIIe-k	1.00	•	•
	bli-5b67	Blue ling (<i>Molva dypterygia</i>) in Subareas VI-VII and Division Vb (Celtic Seas, English Chan [...])	0.59	•	•
	whb-comb	Blue whiting in Subareas I-IX, XII and XIV (Combined stock)	1.43		
	hke-nrtn	Hake in Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d (Northern stock)	1.26		
	hom-west	Horse mackerel (<i>Trachurus trachurus</i>) in Divisions IIa, IVa, Vb, VIa, VIIa-c, e-k, VIII (We [...])	0.95	•	•
	mac-nea	Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning comp [...])	1.54		

Table 11: Stock status for all stocks in the sampling frame in 2013. Columns refer to stock description, value of the F_{2013}/F_{MSY} ratio (F_{ind}), F_{2013} lower than F_{MSY} (F_{status}), and whether the stock is inside safe biological limits (SBL). Stocks managed under escapement strategies dot not have an estimate of F/F_{MSY} (★)

Appendix A: Source code

5.1 Init

```
library(xtable)
library(reshape)
library(reshape2)
library(dplyr)
library(tidyr)
library(ggplot2)
library(lme4)
library(knitr)
theme_set(theme_bw())
opts_chunk$set(fig.width = 4.5, fig.height = 2.5, dpi = 210,
  fig.pos = "H", message = FALSE, warning = FALSE, echo = FALSE,
  cache = FALSE, tidy = TRUE, tidy.opts = list(width.cutoff = 60))
options(stringsAsFactors = FALSE, width = 60)
sc <- scale_x_continuous(breaks = seq(2003, 2014, length = 5))
load("data.RData")
```

5.2 Data loading and transformation

```
library(XML)
library(RCurl)
library(reshape)
library(reshape2)
library(dplyr)
library(tidyr)
options(stringsAsFactors=FALSE)

#=====
# Auxiliary functions
#=====

doit <- function(x){
  url <- "StandardGraphsWebServices.asmx/getSummaryTable?key="
  url <- paste0("http://standardgraphs.ices.dk/", url, x$key[1])
  obj <- getURL(url)
  obj <- xmlToList(xmlTreeParse(obj)$doc$children[[1]])
  df0 <- as.data.frame(apply(obj$lines, 1, as.numeric))
  df0 <- cbind(df0, do.call("cbind", obj[!names(obj) == "lines"]))
  url <- "StandardGraphsWebServices.asmx/getFishStockReferencePoints?key="
  url <- paste0("http://standardgraphs.ices.dk/", url, x$key)
  obj <- getURL(url)
  df0 <- cbind(df0, xmlToDataFrame(obj))
  df0 <- melt(df0, id.vars="Year")
  df0 <- cbind(df0, x)
  return(df0)
}

doitAreas <- function(x){
```

```

url <- paste("http://vocab.ices.dk/services/pox/GetCodeDetail/ices_stockcode/",
x$Key[1], sep="")
ox0 <- getURL(url)
ox0 <- xmlTreeParse(ox0)
ox0 <- xmlToList(ox0$doc$children$GetCodeDetailResponse$children$CodeDetail)
s0 <- data.frame(t(unlist(ox0[1:5])))
a0 <- do.call("rbind", lapply(lapply(ox0[7:length(ox0)], "[" , "Code"),
unlist))
a1 <- do.call("rbind", lapply(lapply(ox0[7:length(ox0)], "[" , "CodeType"),
unlist))
a0 <- a0[a1[, "CodeType.Key"]=="ICES_Area",]
p0 <- data.frame(t(unlist(ox0[[6]]$Code)))
s0 <- data.frame(s0, p0)
if(is.null(nrow(a0))){
  ox <- data.frame(s0, t(a0))
} else {
  s0 <- s0[rep(1, nrow(a0)),]
  ox <- cbind(s0, a0)
}
ox <- ox[,c("Key", "Description", "Description.1", "Code.Key",
"Code.Description")]
names(ox) <- c("stock", "stockDescription", "species", "area",
"areaDescription")
return(ox)
}

#####
# Mediterranean
#####
#=====
# Mediterranean stock assessment information
#=====
mmu <- read.csv("../data/medManagementUnits.csv")
mmu$manUnit <- paste(mmu$Stock, mmu$Area, sep="_")
mmu <- subset(mmu, !(Meeting %in% c("10-05_SG-MED 10-02", "2011-11_STECF 11-14")))

#=====
# Mediterranean management units (MLS) information
#=====
load("../data/Mediterranean_cfp2015.Rdata")
msa <- cfp2015
msa$stk <- paste(msa$Stock, msa$Area, sep="_")
msa$StockDescription <- paste(msa$Species, "in GSA", gsub("_", " ", msa$Area))

#####
# NE Atlantic
#####
#=====
# ICES stock assessment information
#=====
#-----
# get stocks list
#-----
url <- "StandardGraphsWebServices.asmx/getListStocks?year=0"

```

```

stks <- getURL(paste0("http://standardgraphs.ices.dk/", url))
stks <- xmlToDataFrame(stks)
# Remove unpublished,
stks <- subset(stks, Status!="Not Published")
# "Psetta maxima (historic name) North Sea"
stks <- subset(stks, SpeciesName!="Psetta maxima (historic name)")
# and Molva molva in Iceland
stks <- subset(stks, !(SpeciesName=="Molva molva" &
  EcoRegion=="Iceland and East Greenland"))
# and had-34 and had-scow, which were replaced by had-346a but were left in the db
stks <- subset(stks, !(FishStockName %in% c("had-34", "had-scow")))
# get most recent assessment
stks <- lapply(split(stks, as.character(stks$FishStockName)),
  function(x){
    subset(x, x$AssessmentYear==max(as.numeric(as.character(x$AssessmentYear))))
  })

#-----
# get stock summaries and reference points
#-----
stks <- lapply(stks, function(x) try(doit(x)))
stks <- do.call("rbind", stks[!unlist(lapply(stks, is , "try-error"))])
vars <- c("SSB", "SSB.nil", "landings", "F.nil", "F", "catches.nil", "catches",
  "discards.nil", "discards")
cond <- c("Fage", "FLim", "Fpa", "Bpa", "Blim", "FMSY", "MSYBtrigger", "units",
  "stockSizeDescription", "stockSizeUnits", "fishingPressureDescription",
  "fishingPressureUnits", "MSYBescapement", "Fmanagement", "Bmanagement")

# object
isa <- dcast(subset(stks, variable %in% c(vars, cond)), ... ~variable)
# set empty to NA
isa[isa==""] <- NA

# merge columns with ".nil" into the correct place
isa[is.na(isa$SSB), "SSB"] <- isa[is.na(isa$SSB), "SSB.nil"]
isa[is.na(isa$F), "F"] <- isa[is.na(isa$F), "F.nil"]
isa[is.na(isa$catches), "catches"] <- isa[is.na(isa$catches), "catches.nil"]
isa[is.na(isa$discards), "discards"] <- isa[is.na(isa$discards), "discards.nil"]
isa$SSB.nil <- isa$F.nil <- isa$catches.nil <- isa$discards.nil <- NULL

# fix codes for fishingPressureDescription
isa[!(isa$fishingPressureDescription %in% c("Fishing Pressure: F/FMSY",
  "Fishing Pressure: F", "Fishing pressure: Relative")), "fishingPressureDescription"] <-
  "Fishing Pressure: Harvest rate"

# fix codes for EcoRegion
isa[isa$EcoRegion=="North Sea", "EcoRegion"] <- "Greater North Sea"

# coerce some numerical variables
isa$SSB <- as.numeric(isa$SSB)
isa$F <- as.numeric(isa$F)
isa$FMSY <- as.numeric(isa$FMSY)
isa$Bpa <- as.numeric(isa$Bpa)
isa$Blim <- as.numeric(isa$Blim)

```

```

isa$MSYBtrigger <- as.numeric(isa$MSYBtrigger)
isa$MSYBescapement <- as.numeric(isa$MSYBescapement)

# consistency for FMSY when F reported has ratio
isa[isa$fishingPressureDescription == "Fishing Pressure: F/FMSY","FMSY"] <- 1
# drop "Fishing pressure: Relative" (relative to the mean, ICES dixit)
isa[isa$fishingPressureDescription == "Fishing pressure: Relative","FMSY"] <- NA

#####
# ICES Stock assessment units definition
#####
#-----
# get data
#-----
stkAreas <- xmlToDataFrame(
  getURL("http://vocab.ices.dk/services/pox/GetCodeList/ICES_STockCode")
)
stkAreas <- lapply(split(stkAreas, stkAreas$Key), function(x) try(doitAreas(x)))
stkAreas <- do.call("rbind", stkAreas)

#-----
# parse codes
#-----

# Subarea and Division
stkAreas$FAOArea <- 27
stkAreas$Subarea <- NA
stkAreas$Division <- NA
stkAreas$Subdivision <- NA

# Subarea codes in right order for parsing
sas <- c("XIV", "XIII", "XII", "XI", "IX", "X", "VIII", "VII", "VI", "IV", "V",
  "III", "II", "I")

rows <- seq(dim(stkAreas)[1])

for(i in sas) {
  # rows matching Subarea i
  idx <- grep(i, stkAreas$area[rows], fixed=TRUE)
  stkAreas[rows,]$Subarea[idx] <- i
  lst <- strsplit(sub(i, "", stkAreas[rows,]$area[idx]), "")
  stkAreas[rows,]$Division[idx] <- unlist(lapply(lst, "[", 1))
  stkAreas[rows,]$Subdivision[idx] <- unlist(lapply(lst, "[", 2))
  rows <- rows[!rows %in% rows[idx]]
}

# Baltic
idx <- !is.na(as.numeric(as.character(stkAreas$area)))
stkAreas[idx,"Subarea"] <- "III"
stkAreas[idx,"Division"] <- as.character(stkAreas[idx,"area"])
idx <- stkAreas$area %in% c("28-1", "28-2")
stkAreas[idx,"Subarea"] <- "III"
stkAreas[idx,"Division"] <- 28
stkAreas[idx,"Subdivision"] <- sub("28-", "", stkAreas[idx,"area"])

```

```

#=====
# TAC units
#=====
#-----
# merge areas and species definitions into TAC Quotas
#-----

# TAC Quotas
tac <- read.csv("../data/TacQuotas20160125095252.csv", sep=";", header=TRUE)

# Areas
area <- read.csv("../data/STOCKS_v3_4.tab", sep="\t", header=TRUE,
  stringsAsFactors=FALSE)
area$Area <- area$STOCK_ID
area$nc <- nchar(area$STOCK_ID)
area$Area <- substr(area$Area, 5, area$nc)
area$Description <- area$Stock_Area
area <- subset(area, Year_ID==2014)
area <- unique(area[,c("Area", "Description")])
area <- do.call("rbind", lapply(split(area, area$Area), "[", i=1, j=1:2))

# Bring area into tac
tac <- merge(tac, area[,c("Area", "Description")])

# Species
species <- read.csv("../data/species_headers_20160125.xls", sep="\t", header=TRUE)
colnames(species)[colnames(species) == "Description"] <- "species_desc"

tac <- merge(tac, species[,c("Species", "species_desc", "Latin.name")])

# We want tac$Stock.Group to be T-Baltic, T-WWN and T-DSS
tacsub <- tac[tac$Stock.Group %in% c("T-BALTIC", "T-WWN", "T-DSS"),]

#-----
# The breakdown of the management unit areas into FAO/ICES
# areas had to be done manually. The source data was in
# "tacDefs.csv" and the results in
# "TacQuotas20160125095252-AreasSelected_WWN_Baltic.csv".
#-----
# INPUT: CSV file of TAC areas
# Empty strings as NA

inp <- read.csv('../data/TacQuotas20160222-AreasSelected_WWN_Baltic_DSS.csv',
  stringsAsFactors=FALSE, na.strings="", sep=';')
# Drop NAs in VAR, SAD (all NAs in ICES1-18)
itac <- gather(inp, "VAR", "SAD", 13:30, na.rm=TRUE)
itac <- select(itac, Species, Area, Latin.name, SAD)

# HACK: Delete "NA" from Latin.name
itac$Latin.name[itac$Latin.name == "NA"] <- ""

# Subarea and Division
itac$FAOArea <- 27
itac$Subarea <- ""

```

```

itac$Division <- ""

# Subarea codes in right order for parsing
sas <- c("XIV", "XIII", "XII", "XI", "IX", "X", "VIII", "VII", "VI", "IV", "V",
        "III", "II", "I")
rows <- seq(dim(itac)[1])

for(i in sas) {
  # rows matching Subarea i
  idx <- grep(i, itac$SAD[rows], fixed=TRUE)
  itac[rows,]$Subarea[idx] <- i
  itac[rows,]$Division[idx] <- sub(i, "", itac[rows,]$SAD[idx])
  rows <- rows[!rows %in% rows[idx]]
}

# Divisions by Subarea
divs <- list(I=2, II=2, III=4, IV=3, V=2, VI=2, VII=10, VIII=5, IX=2, X=2,
            XI=0, XII=3, XIII=0, XIV=2)
divs <- lapply(divs, function(x) letters[-9][seq(length=x)])

# BUT ICES 22-32 for Baltic (III)
divs[['III']] <- as.character(seq(22,32))

# EXPAND all subarea divisions
idx <- itac$Division == ""
sub <- itac[idx,]
res <- vector('list', length=nrow(sub))

for (i in seq(nrow(sub))) {
  ds <- divs[[sub[i,'Subarea']]]
  res[[i]] <- suppressWarnings(cbind(sub[i, -7], Division=ds))
}
res <- Reduce('rbind', res)

# JOIN res and !sub
itac <- rbind(res, itac[!idx,])

# asterisk? special = T/F
itac$special <- grepl('*', itac$Area, fixed=TRUE)

# fix name
itac[itac$Latin.name=="Merlangius merlangus, Pollachius pollachius" &
      !is.na(itac$Latin.name),"Latin.name"] <- "Merlangius merlangus"

#=====
# Merging ICES and EU Mediterranean datasets
#=====
#-----
# Stock assessment summaries
#-----
sa <- isa

# fix ecoregion
sa[sa$EcoRegion %in% c("Bay of Biscay and Iberian Sea",

```

```

    "Celtic Sea and West of Scotland"), "EcoRegion"] <- "Western European"
sa[sa$EcoRegion=="Widely distributed and migratory stocks",
  "EcoRegion"] <- "Widely distributed"
sa[sa$EcoRegion %in% c("Iceland and East Greenland",
  "Barents Sea and Norwegian Sea", "Faroe Plateau Ecosystem"),
  "EcoRegion"] <- "Other"
# stocks in the western channel are wrongly classified in
# western waters, must be Greater North Sea
sa[grep("echw", sa$FishStockName), "EcoRegion"] <- "Greater North Sea"

# add Med
df0 <- sa[1:nrow(msa),]
df0[] <- NA
df0[,c("Year", "FishStockName", "StockDescription", "SSB", "F", "AssessmentYear", "FMSY",
  "SpeciesName", "landings")] <- msa[,c("year", "stk", "StockDescription", "SSB", "F",
  "asses_year", "Fref", "Scientific_name", "Landings")]
df0$EcoRegion <- "Mediterranean"
# all stocks in the list have analytical assessments
df0$fishingPressureDescription <- "Fishing Pressure: F"
sa <- rbind(sa, df0)

#####
# Filtering and processing data
#####
#=====
# Bref
#=====
# Blim << MSYBtrigger << Bpa as Bref
sa$Bref <- sa$Blim
sa$Bref[!is.na(sa$MSYBtrigger)] <- sa$MSYBtrigger[!is.na(sa$MSYBtrigger)]
sa$Bref[!is.na(sa$Bpa)] <- sa$Bpa[!is.na(sa$Bpa)]
# B escapment as Bref for relevant stocks
sa$Bref[!is.na(sa$MSYBescapement)] <- sa$MSYBescapement[!is.na(sa$MSYBescapement)]
sa$Bref <- as.numeric(sa$Bref)
# set 0 as NA
sa$Bref[sa$Bref==0] <- NA

#=====
# Fref
#=====
sa$Fref <- sa$FMSY
# no Fref f B escapment
sa$Fref[!is.na(sa$MSYBescapement)] <- NA
sa$Fref <- as.numeric(sa$Fref)
sa$Fref[sa$Fref==0] <- NA

#=====
# COMPUTE F/Fref and B/Bref | year + stock
#=====
sa <- transform(sa, indF = F/Fref, indB=SSB/Bref)
# in case of escapment strategy MSY evaluated by SSB ~ Blim/Bpa/etc
sa$indF[!is.na(sa$MSYBescapement)] <- sa$Bref[!is.na(sa$MSYBescapement)] /
  sa$SSB[!is.na(sa$MSYBescapement)]
sa <- transform(sa, sfFind=!is.na(indF))

```



```

#####
# COMPUTE SBL | year + FishStock
#####
sa$SBL <- !(sa$indF > 1 | sa$indB < 1)
# if one is NA SBL can't be inferred
sa$SBL[is.na(sa$indF) | is.na(sa$indB)] <- NA

#####
# Mapping management units (TAC or MLS) with stock
# assessment units
#####
#-----
# ICES info
#-----
isu <- subset(stkAreas, stock %in% unique(sa[sa$sfFind,]$FishStockName))
# create genus field
isu$genus <- unlist(lapply(strsplit(as.character(isu$species), " "), "[", 1))

#-----
# TAC info
#-----
# remove special conditions and species NA
imu <- itac[!itac$special,]
imu <- imu[!is.na(imu$Latin.name),]
# some genus need correction
imu[imu$Latin.name == "Caproidae", "Latin.name"] <- "Capros"
imu[imu$Latin.name == "Lophiidae", "Latin.name"] <- "Lophius"
# create genus field
imu$genus <- unlist(lapply(strsplit(imu$Latin.name, " "), "[", 1))
# create tacUnit field
imu <- transform(imu, tacUnit = paste(Species, Area, sep=":"))
# remove TACs that are not set by the EU
v0 <- c("COD:2A3AX4", "COD:5W6-14", "COD:GRL1", "COD:GRL2", "COD:GRL3", "COD:GRL4",
      "HAD:2AC4.", "HAD:5BC6A.", "USK:1214EI", "USK:1214EI", "USK:1214EI", "USK:1214EI",
      "USK:1214EI", "USK:1214EI")
imu <- subset(imu, !(tacUnit %in% v0))

#-----
# merge
#-----
imu <- lapply(split(imu, imu$Latin.name), function(x){
  spp <- tolower(sub(" ", "", x$Latin.name[1]))
  aa <- unique(isu[tolower(sub(" ", "", isu$species)) == spp,
c("stock", "Subarea", "Division")])
  # need to deal with more than one stock assessment for a single tac unit
  aa <- cast(aa, Subarea + Division ~ ., paste, collapse=";", value="stock")
  aa <- as.data.frame(aa)
  names(aa) <- c("Subarea", "Division", "stock")
  # combine
  x <- merge(x, aa, all.x=TRUE)
  x[,"subareaAssessed"] <- FALSE
  x[,"genusAssessed"] <- FALSE
  x[x$Subarea %in% aa$Subarea, "subareaAssessed"] <- TRUE
})

```

```

xx <- x[!x$subareaAssessed,]
if(nrow(xx) > 1 & !all(xx$Latin.name %in% c("Pollachius pollachius", "Pollachius virens"))){
  xx$stock <- NULL
  gen <- tolower(xx$genus[1])
  aa <- unique(isu[tolower(isu$genus) == gen, c("stock", "Subarea", "Division")])
  # need to deal with more than one stock assessment for a single tac unit
  aa <- cast(aa, Subarea + Division ~ ., paste, collapse=";", value="stock")
  aa <- as.data.frame(aa)
  names(aa) <- c("Subarea", "Division", "stock")
  xx <- merge(xx, aa, all.x=TRUE)
  xx[xx$Subarea %in% aa$Subarea, "subareaAssessed"] <- TRUE
  # in these cases the TAC unit combines spp so assessment is at genus level
  xx[xx$Subarea %in% aa$Subarea, "genusAssessed"] <- TRUE
  x <- rbind(x[x$subareaAssessed,], xx)
}
x[, "divisionAssessed"] <- !is.na(x$stock)
x
})

imu <- do.call("rbind", imu)

#####
# Merging ICES and EU Mediterranean datasets
#####
#-----
# Stock assessment coverage
#-----
# add EcoRegion
mu <- imu[, c("Latin.name", "genus", "Species", "FAOArea", "Subarea",
             "Division", "Area", "tacUnit", "subareaAssessed", "genusAssessed",
             "divisionAssessed", "stock")]
mu[, "EcoRegion"] <- "Other"
mu[mu$Subarea=="III", "EcoRegion"] <- "Baltic Sea"
mu[mu$Subarea=="IV" | (mu$Subarea=="III" & mu$Division=="a") | (mu$Subarea=="VII" &
mu$Division=="d") | (mu$Subarea=="VII" &
mu$Division=="e"), "EcoRegion"] <- "Greater North Sea"
mu[mu$Subarea %in% c("VI", "VII", "VIII", "IX"),
"EcoRegion"] <- "Western European"
mu[mu$stock %in% unique(subset(isa,
EcoRegion=="Widely distributed and migratory stocks")$FishStockName),
"EcoRegion"] <- "Widely distributed"

df0 <- mu[1:nrow(mmu),]
df0$FAOArea <- 37
df0$EcoRegion <- "Mediterranean"
df0$genus <- df0$Division <- df0$divisionAssessed <- NA
df0[, c("Latin.name", "Species", "Subarea", "tacUnit", "subareaAssessed",
"genusAssessed", "stock")] <- mmu[, c("Scientific_name", "Stock", "Area",
"manUnit", "Assessed", "genusAssessed", "Stock_Assessed_GSAs")]
# note that in the Med the management area matches the FAO subarea (GSA)
df0$Area <- df0$Subarea
mu <- rbind(mu, df0)
# fix some names to be more explicit and/or short
names(mu) <- c("spp.latin", "genus", "spp.fao", "FAOArea", "subarea",

```

```

"division", "manArea", "manUnit", "subareaAssessed", "genusAssessed",
"divisionAssessed", "stockUnit", "EcoRegion")

#=====
# Mediterranean Sampling Frame
#=====
msf <- read.csv("../data/Med_Sampling_Frames_Comparison.csv")
msf <- msf[,c(1,2)]
names(msf) <- c("Sampling Frame based on EC 1967-2006", "Species listed by EWG 14-23")

#=====
# Clean and save
#=====

save(mu, sa, msf, file="data.RData")

```

5.3 Northeast Atlantic (ICES area)

```

# remove some stocks and years
# note that lin-icel and her-noss are widely distributed stock and end up on the list
# other noneu stocks will be dropped by not selecting eco region "other"
stks <- unique(as.character(mu$stockUnit))
stks <- unlist(strsplit(stks, ";"))
stks <- stks[!is.na(stks) & !(stks %in% c("lin-icel", "her-noss"))]
# only EU areas
ieu <- c("Western European", "Widely distributed", "Baltic Sea", "Greater North Sea")
# sa in time
saeu <- sa[is.na(sa$indF) & sa$EcoRegion %in% ieu & sa$Year>=2003
  & sa$Year<2015 & sa$FishStockName %in% stks,]
ggplot(saeu %>%
  group_by(Year) %>% summarise(stk=length(FishStockName)),
  aes(x=Year, y=stk)) + geom_line() + ylab("No. of stocks") +
  xlab("") + ylim(c(0,75)) + sc
nStks <- rbind_list(
  # find by year
  saeu %>% group_by(year=Year) %>%
  summarise(Region='ALL', N=length(FishStockName)),
  # find by region
  saeu %>% group_by(Region=EcoRegion, year=Year) %>%
  summarise(N=length(FishStockName)))

```

5.3.1 Number of stocks where fishing mortality exceeds F_{MSY}

```

fInda <- rbind_list(
  # find by year
  saeu %>% group_by(year=Year) %>%
  summarise(Region='ALL', N=sum(indF>1, na.rm=TRUE)),
  # find by region
  saeu %>% group_by(Region=EcoRegion, year=Year) %>%
  summarise(N=sum(indF>1, na.rm=TRUE)))
ggplot(filter(fInda, Region=='ALL'), aes(x=year, y=N)) + geom_line() +

```

```

    expand_limits(y=0) + geom_point(aes(x=2003, y=N[1])) +
    geom_point(aes(x=2014, y=N[length(N)]), size=2) +
    ylab("No. of stocks") + xlab("") + ylim(c(0,75)) + sc
ggplot(filter(fInda, Region != 'ALL'), aes(x=year, y=N)) + geom_line() +
  facet_wrap(~Region, scales='free') +
  ylab("No. of stocks") + xlab("") +
  sc + ylim(0, NA)

```

5.3.2 Number of stocks where fishing mortality is equal to or less than F_{MSY}

```

fIndb <- rbind_list(
  # find by year
  saeu %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(indF<=1, na.rm=TRUE)),
  # find by region
  saeu %>% group_by(Region=EcoRegion, year=Year) %>%
    summarise(N=sum(indF<=1, na.rm=TRUE)))
ggplot(filter(fIndb, Region=='ALL'), aes(x=year, y=N)) + geom_line() +
  expand_limits(y=0) + geom_point(aes(x=2003, y=N[1])) +
  geom_point(aes(x=2014, y=N[length(N)]), size=2) +
  ylab("No. of stocks") + xlab("") + ylim(c(0,75)) + sc
ggplot(filter(fIndb, Region != 'ALL'), aes(x=year, y=N)) + geom_line() +
  facet_wrap(~Region, scales='free') +
  ylab("No. of stocks") + xlab("") +
  sc + ylim(0, NA)

```

5.3.3 Number of stocks outside safe biological limits

```

fIndc <- rbind_list(
  # find by year
  saeu %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(!SBL, na.rm=TRUE)),
  # find by region
  saeu %>% group_by(Region=EcoRegion, year=Year) %>% summarise(N=sum(!SBL,
    na.rm=TRUE)))
ggplot(filter(fIndc, Region=='ALL'), aes(x=year, y=N)) + geom_line() +
  expand_limits(y=0) + geom_point(aes(x=2003, y=N[1])) +
  geom_point(aes(x=2014, y=N[length(N)]), size=2) +
  ylab("No. of stocks") + xlab("") + ylim(c(0,75)) + sc
ggplot(filter(fIndc, Region != 'ALL'), aes(x=year, y=N)) + geom_line() +
  facet_wrap(~Region, scales='free') +
  ylab("No. of stocks") + xlab("") +
  sc + ylim(0, NA)

```

5.3.4 Number of stocks inside safe biological limits

```

fIndd <- rbind_list(
  # find by year
  saeu %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(SBL, na.rm=TRUE)),
  # find by region
  saeu %>% group_by(Region=EcoRegion, year=Year) %>% summarise(N=sum(SBL,

```

```

      na.rm=TRUE)))
ggplot(filter(fIndd, Region=='ALL'), aes(x=year, y=N)) + geom_line() +
  expand_limits(y=0) + geom_point(aes(x=2003, y=N[1])) +
  geom_point(aes(x=2014, y=N[length(N)]), size=2) +
  ylab("No. of stocks") + xlab("") + ylim(c(0,75)) + sc
ggplot(filter(fIndd, Region != 'ALL'), aes(x=year, y=N)) + geom_line() +
  facet_wrap(~Region, scales='free') +
  ylab("No. of stocks") + xlab("") +
  sc + ylim(0, NA)

```

5.3.5 Annual mean value of F/F_{MSY}

```

idx <- saeu$fishingPressureDescription %in%
  c("Fishing Pressure: F/FMSY", "Fishing Pressure: F")
idx <- idx & is.na(saeu$MSYBescapement)

fInde <- rbind_list(
  # find by year
  saeu[idx,] %>% group_by(year=Year) %>% summarise(Region='ALL',
    F=mean(indF, na.rm=TRUE)),
  # find by region
  saeu[idx,] %>% group_by(Region=EcoRegion,
    year=Year) %>% summarise(F=mean(indF, na.rm=TRUE)))
ggplot(filter(fInde, Region=='ALL'), aes(x=year, y=F)) + geom_line() +
  expand_limits(y=0) + geom_point(aes(x=2003, y=F[1])) +
  geom_point(aes(x=2014, y=F[length(F)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(F/F[MSY])) + xlab("") + sc
ggplot(filter(fInde, Region != 'ALL'), aes(x=year, y=F)) + geom_line() +
  facet_wrap(~Region, scales='free') +
  ylab(expression(F/F[MSY])) + xlab("") +
  geom_hline(aes(yintercept=1), linetype=2) + sc
ggplot(filter(fInde, Region=='ALL'), aes(x=year, y=F)) + geom_line() +
  expand_limits(y=0) + geom_point(aes(x=2003, y=F[1])) +
  geom_point(aes(x=2014, y=F[length(F)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(F/F[MSY])) + xlab("") +
  geom_point(data=saeu[idx,], aes(x=Year, y=indF), alpha=0.2,
    shape=19, size=2) + sc
ifit <- glmer(indF ~ factor(Year) + (1|FishStockName), data = saeu[idx,],
  family = Gamma("log"))
ifit.bs <- bootMer(ifit, FUN=function(x) predict(x, re.form=~0, type="response"), 500,
  parallel="multicore", ncpus=20, seed=1234)
ifitm <- ifit.bs$t[,1:12]
ifitq <- apply(ifitm, 2, quantile, c(0.025, 0.25, 0.50, 0.75, 0.975), na.rm=TRUE)
ifitq <- cbind(Year=unique(saeu[idx,]$Year), as.data.frame(t(ifitq)))
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) + expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +

```

```
ylab(expression(F/F[MSY])) + xlab("") +
theme(legend.position = "none") + sc
```

5.3.6 Indicators of changes in advice coverage

```
# coastal EU waters
mueu <- mu[mu$subarea %in% c("III", "IV", "VI", "VII", "VIII",
  "IX") & mu$manArea != "O4-N.", ]
i41a <- lapply(split(mueu, mueu$manUnit), function(x) {
  y <- x[1, c("spp.latin", "manUnit", "subareaAssessed", "EcoRegion")]
  y$subareaAssessed <- sum(x$subareaAssessed) > 0
  y
})
i41a <- do.call("rbind", i41a)
psa <- mean(i41a$subareaAssessed)
nsa <- sum(i41a$subareaAssessed)
n <- nrow(i41a)

# number of stocks with B/Bref
saeu. <- sa[!is.na(sa$indB) & sa$EcoRegion %in% ieu & sa$Year ==
  2014 & sa$FishStockName %in% stks, ]
nf <- nrow(saeu[saeu$Year == 2014, ])
nb <- nrow(saeu.)

df0 <- data.frame(c(nf, nb), c(n, n), c(psa, nb/nf * psa))
dimnames(df0) <- list(c("Stocks with F/FMSY estimate", "Stocks with B/Bref estimate"),
  c("No", "No TACs", "Fraction of TACs with assessments"))
```

5.4 Mediterranean (European area)

5.4.1 Sampling frame

```
ggplot(sam %>% group_by(Year) %>% summarise(stk = length(FishStockName)),
  aes(x = Year, y = stk)) + geom_line() + ylab("No. of stocks") +
  xlab("") + ylim(c(0, 50)) + sc
```

5.4.2 Indicators of management performance

```
sam <- sa[!is.na(sa$indF) & sa$EcoRegion=="Mediterranean" & sa$Year>=2003 &
  sa$Year<2014 & sa$FishStockName %in% stks & sa$AssessmentYear %in% c("2015", "2014", "2013"),]
mnStks <- sam %>% group_by(Year) %>% summarise(stk=length(FishStockName))
#####
# Number of stocks where fishing mortality exceeds Fmsy
#####
fInda <- rbind_list(
  # find by year
  sam %>% group_by(year=Year) %>%
  summarise(Region='ALL', N=sum(indF>1, na.rm=TRUE)))

mt31 <- dcast(filter(fInda, year > 2002), Region~year, value.var='N')
mt31 <- cbind(Indicator="No. stocks F > FMSY", mt31[,-1])
```

```

#=====
# Number of stocks where fishing mortality is equal to or less than Fmsy
#=====
fIndb <- rbind_list(
  # find by year
  sam %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(indF<=1, na.rm=TRUE)))

mt32 <- dcast(filter(fIndb, year > 2002), Region~year, value.var='N')
mt32 <- cbind(Indicator="No. stocks F <= FMSY", mt32[,-1])

#=====
# Number of stocks outside safe biological limits
#=====
fIndc <- rbind_list(
  # find by year
  sam %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(!SBL, na.rm=TRUE)))

mt33 <- dcast(filter(fIndc, year > 2002), Region~year, value.var='N')
mt33 <- cbind(Indicator="No. stocks outside SBL", mt33[,-1])

#=====
# Number of stocks inside safe biological limits
#=====
fIndd <- rbind_list(
  # find by year
  sam %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=sum(SBL, na.rm=TRUE)))

mt34 <- dcast(filter(fIndd, year > 2002), Region~year, value.var='N')
mt34 <- cbind(Indicator="No. stocks inside SBL", mt34[,-1])

#=====
# Annual mean value of $F / F_{MSY}$
#=====
idx <- sam$fishingPressureDescription %in% c("Fishing Pressure: F/FMSY", "Fishing Pressure: F")
idx <- idx & is.na(sam$MSYBescapement)

fInde <- rbind_list(
  # find by year
  sam[idx,] %>% group_by(year=Year) %>% summarise(Region='ALL',
    F=mean(indF, na.rm=TRUE)))

mt35 <- dcast(filter(fInde, year > 2002), Region~year, value.var='F')
mt35 <- cbind(Indicator="Mean value F/FMSY", mt35[,-1])

# No. of stocks with SA

fIndf <- rbind_list(
  # find by year
  sam[idx,] %>% group_by(year=Year) %>% summarise(Region='ALL',
    N=length(indF)))

```

```
mt30 <- dcast(filter(fIndf, year > 2002), Region~year, value.var='N')
mt30 <- cbind(Indicator="No. stocks assessed", mt30[,-1])
```

5.4.3 Annual mean value of F/F_{MSY} - model based indicator

```
mfit <- glmer(indF ~ factor(Year) + (1 | FishStockName), data = sam[idx,
], family = Gamma("log"))
sam[idx, "indFm"] <- predict(mfit, re.form = ~0, type = "response")
mfit.bs <- bootMer(mfit, FUN = function(x) predict(x, re.form = ~0,
type = "response"), 500, parallel = "multicore", ncpus = 20,
seed = 1234)
mfitm <- mfit.bs$t[, 1:11]
mfitq <- apply(mfitm, 2, quantile, c(0.025, 0.25, 0.5, 0.75,
0.975), na.rm = TRUE)
mfitq <- cbind(Year = unique(sam[idx, ]$Year), as.data.frame(t(mfitq)))
ggplot(mfitq, aes(x = Year)) + geom_ribbon(aes(ymin = `2.5%`,
ymax = `97.5%`), fill = "gray", alpha = 0.6) + geom_ribbon(aes(ymin = `25%`,
ymax = `75%`), fill = "gray", alpha = 0.95) + geom_line(aes(y = `50%`)) +
expand_limits(y = 0) + geom_point(aes(x = Year[length(Year)],
y = `50%`[length(`50%`)]), size = 2) + geom_hline(yintercept = 1,
linetype = 2) + ylab(expression(F/F[MSY])) + xlab("") + theme(legend.position = "none") +
sc
```


Appendix B: Common Fisheries Policy Monitoring - Protocol for computing indicators



JRC SCIENCE FOR POLICY REPORT

Common Fisheries Policy Monitoring Protocol for computing indicators

Ernesto Jardim, Iago Mosqueira, Giacomo
Chato Osio and Finlay Scott

2015

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Abstract:

Common Fisheries Policy Monitoring - Protocol for computing indicators

This document presents the protocol to compute indicators for monitoring the Common Fisheries Policy. A set of indicators both design-based and model-based are described mathematically. The list of stocks that should form the dataset on which the indicators are computed is also described as well as a set of rules to update the stocks' lists when needed. The protocol was presented and approved by the STECF's 2015 winter plenary (STECF-PLN-15-03).

Common Fisheries Policy Monitoring Protocol for computing indicators

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1 Introduction

The monitoring of the Common Fisheries Policy (CFP, Reg (EU) 1380/2013) implementation is of utmost importance for the European Union (EU), European Commission (EC) and its Directorate-General for Maritime Affairs and Fisheries (DG MARE).

The EC's Scientific, Technical and Economic Committee for Fisheries (STECF), as the major scientific advisory body on fisheries policy to the EC, has received the task of reporting on the CFP implementation through the publication of a series of indicators.

To make the process as consistent as possible the following set of rules were developed to serve as the protocol for computing the required indicators, this way contributing to the transparency of the process.

The protocol is split in three sections:

1. Selection of stocks - describe the current list of stocks used to compute the indicators and updating rules;
2. Indicators of management performance - description of the indicators, computation and presentation;
3. Indicators of changes in advice coverage - description of the indicators, computation and presentation.

The ToRs given to [STECF 15-04](#) set the basis of the work carried out to build the indicators, which are transcribed below for reference:

1. Determine, on the basis of the most recently available fish stock assessments, a list of fish stocks for monitoring the past performance of the Common Fisheries Policy according to the following criteria:
 - Quantitative assessments as used in the provision of formal quantitative advice on fishing mortality with respect to F_{MSY} .
 - Stocks in European Union waters, shared stocks which are jointly managed by the EU with nearby states, and stocks in international waters or third country waters that are fished by the EU and managed by an RFMO where the EU is a member of the decision making body.
2. For stocks within the sampling frame defined above, calculate the following annual quantities as far back in time as the data remain representative:
 - Number of stocks where fishing mortality exceeds F_{MSY} ¹
 - Number of stocks where fishing mortality is equal to or less than F_{MSY} ²
 - Number of stocks outside safe biological limits
 - Number of stocks inside safe biological limits
 - The arithmetic average value of F/F_{MSY}
 - Number of stocks for which the state of the stock is unknown with respect to safe biological limits

For the purposes of this term of reference, "outside safe biological limits" means that SSB is less than B_{PA} (where B_{PA} is defined), OR F is greater than F_{PA} (where F_{PA} is defined) for the year in question.

Estimates should be provided separately for the Baltic Sea, the North Sea, Western Waters, for each area covered by RFMOs other than NEAFC. Parameter F should also be reported for the combined area of the Baltic Sea, North Sea and Western Waters. The list of stocks should be provided together with a mention of whether the stock is fished above or below F_{MSY} .

¹Including, for short-lived species managed according to a biomass-escapement strategy, the number of stocks where the resulting biomass was less than the escapement biomass corresponding to MSY fishing.

²Including, for short-lived species managed according to a biomass-escapement strategy, the number of stocks where the resulting biomass was equal to or higher than the escapement biomass corresponding to MSY fishing.

3. For the purpose of assessing changes over time in the coverage of advice on TACs with respect to scientific advice concerning the northeast Atlantic:
 - define a sampling frame based on a large subset of TACs of EU interest that is stable over time;
 - assess the number and proportion of those TACs that are subject to scientific advice concerning:
 - the fishing mortality compared to F_{MSY}
 - the state with respect to Safe Biological Limits, as defined above

For the purposes of this exercise, a group of TACs covering one biological stock should be counted once only. For a TAC which covers several stocks, the biological state of the most abundant stock (by comparison with other stocks over an extended and representative period) should be taken into account.

The Commission services will provide STECF with an initial analysis for the purposes of the assessment under point 3.

1.1 Scope

The monitoring of the CFP should cover all areas where fleets operate under the flag of any EU member state. However, due to limitations on data and the mitigated responsibility of the EU on management decisions on waters outside the EU EEZ (Exclusive Economic Zone), the analysis will focus on stocks within the EU EEZ and some important shared stocks.

The analysis will have two perspectives, a global EU level lookout complemented with a regional overview, where the indicators are computed at a regional level for the:

- Baltic Sea
- Greater North Sea
- Western European
- Mediterranean
- Black Seas
- Widely distributed

1.2 Data sources

All indicators are computed using results from single species quantitative stock assessments. In detail, time series of fishing mortality, spawning stock biomass and the adopted reference points are required from ICES³, GFCM⁴ and STECF.

Results from surplus production models and delay difference models, which are mostly reported as ratios between F and F_{MSY} and/or B over B_{MSY} , are also included in the analysis.

Results from pseudo-cohort analysis are not included. These models don't estimate time series of fishing mortality or spawning stock biomass.

³International Council for the Exploration of the Sea

⁴General Fisheries Commission for the Mediterranean

2 Selection of stocks

2.1 List of stocks to monitor

The list of stocks to be used for computing the indicators, has to include those that are subject to direct management from the EU, as such better reflecting changes in stock status due to the CFP implementation.

Because of the differences in the nature and availability of data and information in different regions, region-specific lists of stocks were adopted.

The lists of stocks are:

- Northeast Atlantic (FAO area 27) - The list of stocks comprises all stocks subject to a TAC.
- Mediterranean and Black Seas (FAO area 37) - The list of stocks comprises all stocks subject to a minimum conservation reference size.

For the indicator "Annual mean value of F/F_{MSY} " (Section 3.5), stocks managed under escapement strategies and stocks for which fishing mortality was reported as a harvest rate are not included.

2.2 Updating rules

Due to changes in scientific knowledge, mostly related with spatial boundaries of stock units, the list of stocks may need to be adjusted in the future. These changes can have an impact on the quantification of the effects of the CFP's implementation. Although the impact is expected to be small as stock units changes shouldn't be numerous, and shouldn't unduly affect the overall perspective on trends in time of the indicators.

The following rules should be used to update the sampling frames:

- The updates consider the stock units existing in the reported year. Exploratory assessments or assessments not yet approved by the advisory bodies are not considered.
- When several stocks are merged in a single stock, the individual stocks must be removed from the list and the new stock added.
- When a stock is split in two (or more), the aggregated stock must be removed and the new ones added to the list.
- Stocks that cross regions will be allocated to the region where most of the stock's biomass exists.

3 Indicators of management performance

The analysis will use the following definitions:

- f represents fishing mortality;
- b represents biomass or spawning stock biomass;
- F^{MSY} represents fishing mortality that produces catches at the level of MSY in an equilibrium situation, or a proxy;
- B^{REF} the biomass reference value, *e.g.* the biomass that produces MSY when fished at F^{MSY} , but also any other relevant proxy considered by the scientific advice body;
- indices:
 - $j = 1 \dots N$ indexes stocks where N is the number of stocks in the sampling frame;
 - $t = 1 \dots T$ indexes years where T is the number of years in the reported time series;

- operations:
 - \vee stands for "or" in boolean logic;
 - \wedge stands for "and" in boolean logic;
- models:
 - u is a random effect;
 - s is a thin plate regression spline;
 - y is a fixed effect on year.

3.1 Number of stocks where fishing mortality exceeds Fmsy

$$I_t^1 = \sum_{j=1}^{j=N} (f_{jt} > F_j^{MSY})$$

3.2 Number of stocks where fishing mortality is equal to or less than Fmsy

$$I_t^2 = \sum_{j=1}^{j=N} (f_{jt} \leq F_j^{MSY})$$

3.3 Number of stocks outside safe biological limits

$$I_y^3 = \sum_{j=1}^{j=N} (f_{jt} > F_j^{MSY} \vee b_{jt} < B_j^{REF})$$

3.4 Number of stocks inside safe biological limits

$$I_t^4 = \sum_{j=1}^{j=N} (f_{jt} \leq F_j^{MSY} \wedge b_{jt} \geq B_j^{REF})$$

3.5 Annual mean value of F/F_{MSY}

This indicator can have two forms, a design-based form

$$I_t^5 = N^{-1} \sum_{j=1}^{j=N} \frac{f_{jt}}{F_j^{MSY}}$$

or a model-based form, build using a LMM⁵. The indicator is build using the model predictions to compute the values of F/F_{MSY} .

$$z_{jt} = \frac{f_{jt}}{F_{MSY}}$$

$$z_{jt} = \beta_0 + y_t + u_j + \sigma_{jt}^2$$

This model was tested in a simulation study⁶ and in an application to Mediterranean stocks⁷. The tests showed that the chosen model was the stablest estimating the mean.

⁵Linear Mixed Model

⁶Coilin Minto. 2015. Testing model based indicators for monitoring the CFP performance. Ad-hoc contract report. pp

14

⁷Chato-Osio, G., Jardim, E., Minto, C., Scott, F. and Patterson, K. 2015. Model based CFP indicators, F/F_{msy} and SSB. Mediterranean region case study. JRC Technical Report No XX, pp 26.

4 Indicators of changes in advice coverage

4.1 Number of stocks for which estimates exist of $(\frac{F}{F^{MSY}})$

$$I_t^6 = \sum_{j=1}^{j=N} (\frac{f_{jt}}{F_j^{MSY}} > 0 \wedge \frac{f_{jt}}{F_j^{MSY}} < \infty)$$

4.2 Number of stocks for which estimates exist of $(\frac{B}{B^{REF}})$

$$I_t^7 = \sum_{j=1}^{j=N} (\frac{b_{jt}}{B_j^{REF}} > 0 \wedge \frac{b_{jt}}{B_j^{REF}} < \infty)$$

5 Transparency

Changes or additions to this protocol shall be approved by STECF.

To promote transparency of scientific advice and allow the public in general and stakeholders in particular, to have access to the data and analysis carried out, all code and data must be published online once approved by STECF.

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