European Commission

JRC SCIENCE FOR POLICY REPORT

Scientific, Technical and Economic Committee for Fisheries (STECF) - Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-19-01)

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JRC116446

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PDF	ISBN	978-92-76-02913-7	ISSN 1831-9424	doi:10.2760/22641
STECF			ISSN 2467-0715	

Luxembourg: Publications Office of the European Union, 2019

How to cite: Scientific, Technical and Economic Committee for Fisheries (STECF) – Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-19-01). Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-02913-7, doi:10.2760/22641, JRC116446

Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. This report deals with monitoring the performance of the Common Fisheries Policy.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) - Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-19-01)

Background provided by the Commission

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."

Request to the STECF

STECF is requested to report on progress in achieving MSY objectives in line with the Common Fisheries Policy.

STECF observations

STECF notes that to address the above Terms of Reference a JRC Expert Group (EG) was convened to compile available assessment outputs and conduct the extensive analysis.

The EG output was presented in a comprehensive report accompanied by several detailed annexes providing: 1) CFP monitoring protocols as agreed by STECF (STECF, 2018a); 2a) R code for computing NE Atlantic indicators; 2b) R code for computing Mediterranean indicators, 3) ICES data quality issues corrected prior to the analysis and 4) URL links of the reports and stock advice sheets underpinning the analysis. The report and Annexes are available at: https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring

STECF notes that the report is clear and well laid out, transparently describing the analysis undertaken, cataloguing changes made in approach since the previous report (2018).

Based on the EWG18-15 STECF recommendations, the most significant changes in the 2019 approach were:

i) Actual estimates of $MSYB_{trigger}$[1] were used as a proxy for lower bound of B_{MSY}
ii) The following indicators were added to the core analysis:
   a. Number of stocks where $F>F_{MSY}$ OR $SSB<B_{MSY}$
   b. Number of stocks where $F \leq F_{MSY}$ AND $SSB \geq B_{MSY}$
   c. Time trend of F/F_{MSY} for stocks outside the EU waters in FAO 27
   d. Trend in SSB or biomass index for stocks of data category 3
   e. Time trend in average decadal recruitment
iii) Regional analysis of the Mediterranean & Black Sea indicators

Details of these changes and other points to note can be found in section 2 of the EG report.

The EG report then sets out results of the analysis for the Northeast Atlantic (NE Atlantic) and Mediterranean & Black Seas separately in Sections 3 and 4 (respectively). Based on these results STECF provides an overview of what is currently known regarding the achievement of the MSY objectives, drawing together the results from the different sea areas to provide a comparative

[1] There are 38 stocks assessed by ICES for which $MSYB_{trigger}$ was set at B_{pa} levels. For two stocks (hom.27.2a4a5b6a7ace-k8, pra.27.3a4a) ICES has explicitly estimated both reference points. For the remaining 36 stocks, ICES's default procedure is used to set $MSYB_{trigger}$ equal to B_{pa}. Following what was agreed by STECF (2018b), in this analysis for these 36 stocks $MSYB_{trigger}$ was set to unknown. Therefore, only 25 stocks are considered in the analysis of the number of stocks where $F>F_{MSY}$ or $SSB<MSYB_{trigger}$.

picture. In this report, "Northeast Atlantic" refers to all stocks in the FAO Area 27 inside and outside EU waters, and "Mediterranean & Black Seas" refers to all stocks in the FAO Area 37.

Trends towards the MSY objectives in the Northeast Atlantic and Mediterranean & Black Seas

The overview below describes the trends observed in the NE Atlantic and the Mediterranean & Black Seas for the periods 2003 to 2017 and 2003 to 2016 respectively, and applies to the stocks included in the reference list of stocks for these areas. The stocks are those with a full analytical assessment and also data limited in the NE Atlantic stocks (ICES category 3).

Stock status in the NE Atlantic

The indicators provided by the JRC EG show that stocks status has significantly improved (Figure 1) but also that many stocks are still overexploited in the NE Atlantic, and that the rate of progress has slowed in the last few years. In the NE Atlantic, among the 64 to 70 stocks which are fully assessed, the proportion of overexploited stocks (i.e. $F>F_{MSY}$, blue line) decreased from around 75% to close to 40%, over the last ten years, although in recent years the decreased was less pronounced. The proportion of stocks outside the safe biological limits ($F>F_{pa}$ or $B<B_{pa}$, orange line), computed for the 46 stocks for which both reference points are available, follows the same decreasing trend, from 65% in 2003 to around 35% in 2017.

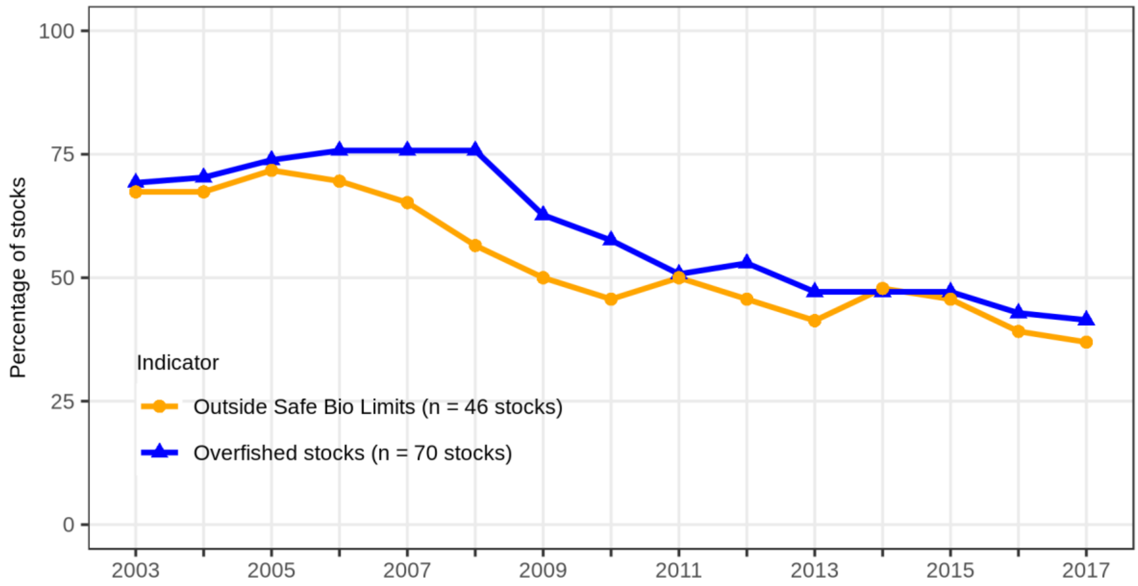

Figure 1. Trends in stock status in the Northeast Atlantic 2003-2017. Two indicators are presented: blue line: the proportion of overexploited stocks ($F>F_{MSY}$) within the sampling frame (64 to 70 stocks fully assessed, depending on year) and orange line: the proportion of stocks outside safe biological limits ($F>F_{pa}$ or $B<B_{pa}$) (out of a total of 46 stocks).

STECF notes that the indicator of the number of stocks where $F>F_{MSY}$ or $SSB<MSYB_{trigger}$ is based on comparatively few stocks (25 stocks). This makes the results unstable from year to year, and thus need to be taken with care. For this reason STECF decided not to present the results in Figure 1. STECF notes nevertheless that the indicator shows a variable trend, although showing a decrease from around 60% until 2009 to around 40% after 2013. Finally, STECF notes that the number or proportion of stocks above/below B_{MSY} is still unknown, because an estimate of B_{MSY} is only provided by ICES for very few stocks.

It is important to note, however, that in 2017 6 stocks managed according to F_{MSY} are still outside safe biological limits, or conversely 12 stocks inside safe biological limits are still overfished, while 18 have an unknown level of biomass (Table 1).

Table 1 Number of stocks overfished ($F>F_{MSY}$), or not overfished ($F \leq F_{MSY}$), and inside ($F \leq F_{pa}$ and $B \geq B_{pa}$) and outside ($F>F_{pa}$ or $B<B_{pa}$) safe biological limits (SBL) in 2017 in the NE Atlantic.

	Below F_{MSY}	**Above F_{MSY}**
Inside SBL	17	12
Outside SBL	6	11
Unknown	18	6

STECF continues to observe that the recent slope of the indicators suggests that progress until 2017 has been too slow to allow all stocks to be maintained or restored to at least B_{pa} & $MSYB_{trigger}$, and managed according to F_{MSY} by 2020.

Stock Status in the Mediterranean & Black Seas

In the Mediterranean & Black Seas, the variable number of stocks contributing information in the early part of the time series renders the calculation of a robust indicator difficult and potentially misleading. For the present STECF has utilised the summary Table 25 in the EG report to compute the F status for 2016 (last year in Mediterranean stock assessments). Out of 47 stocks, only around 13% (6 stocks) are not overfished, the majority are overfished.

Trends in the fishing pressure (Ratio of F/F_{MSY})

As agreed by STECF (2018a) the Expert Group computed the trends in fishing pressure using a robust statistical model (Generalised Linear Mixed Effects Model, GLMM) accounting for the variability of trends across stocks and including the computation of a confidence interval around the median. A large confidence interval means that different stocks have different trends. Because this is a model-based indicator, and because the number of stocks is slightly different from last year, small differences in the resulting outcomes compared to last year's report should not be over interpreted.

This indicator can be used for regional comparison between the NE Atlantic and Mediterranean & Black Seas. In the NE Atlantic, the model-based indicator of the fishing pressure (F/F_{MSY}) shows an overall downward trend over the period 2003-2017 (Figure 2). In the early 2000s, the median fishing mortality was more than 1.5 times larger than F_{MSY}, but this has reduced and has now stabilised around 1.0. Reaching F_{MSY} for *most* stocks in the analysis would require the upper bound of the confidence interval in Figure 19 in the EWG report to be around 1. STECF also notes that this indicator of fishing pressure has stabilised near the value of 1 since 2011.

The same model-based indicator was computed by the EG for an additional set of 11 stocks located in the NE Atlantic, but outside EU waters. This indicator seems to confirm the positive overall trend observed in EU waters until 2014, with the median value of the F/F_{MSY} indicator closely tracking that produced for EU waters. After 2014 however, the indicator seems to show an increasing number of stocks exploited above F_{MSY}, and in contrast with the results in the previous report that continued to show a decreasing trend. STECF notes that the indicator for NE Atlantic stocks outside EU waters is based on comparatively few stocks, and where uncertainty is high (see Figure 21 in the EW report). This makes the results unstable from year to year, and thus need to be taken with care.

In contrast, the indicator computed for stocks from the Mediterranean & Black Seas has remained at a very high level during the whole 2003-2016 period. After the observed peak in 2011 where F/F_{MSY} has reached its highest historical level, there is a somewhat decreasing trend in overexploited stocks. Nevertheless, the value of F/F_{MSY} varies around 2.3 indicating that the stocks are being exploited on average at rates well above the F_{MSY} CFP objective.

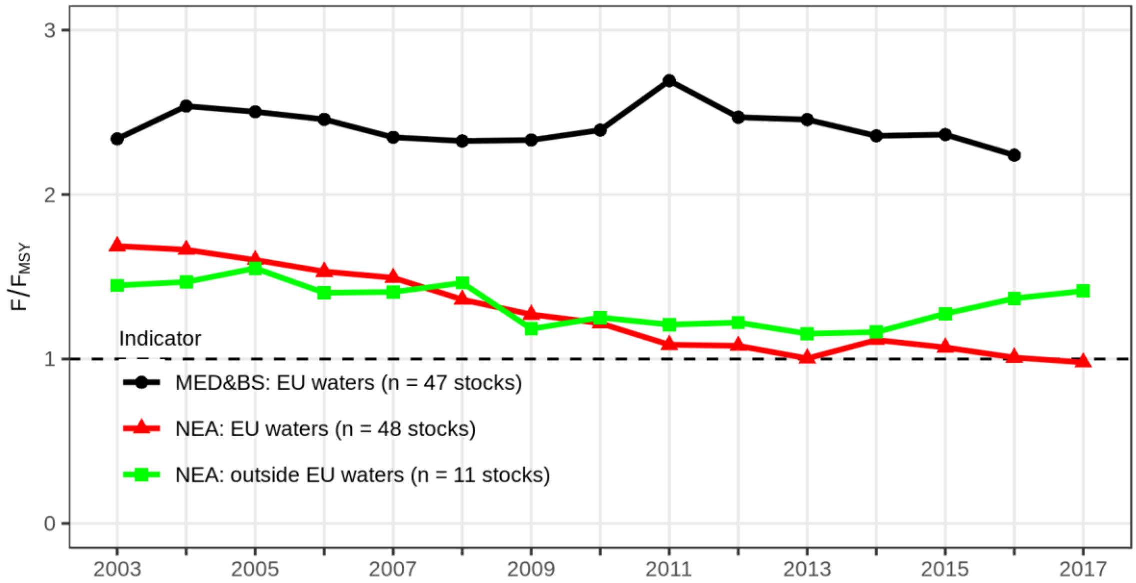

Figure 2. Trends in fishing pressure. Three model based indicators F/FMSY are presented (all referring to the median value of the model): one for 48 EU stocks with appropriate information in the NE Atlantic (red line); one for an additional set of 11 stocks also located in the NE Atlantic but outside EU waters (green line), and one for the 47 assessed stocks from the Mediterranean & Black Seas (black line).

Trends in Biomass

The model-based indicator of the trend in biomass shows improvement in the NE Atlantic and particularly for data limited stocks (ICES category 3 stocks), but not in the Mediterranean & Black Seas (Figure 3). In the NE Atlantic the biomass has been generally increasing since 2007, and was in 2017 on average around 36% higher than in 2003. In the Mediterranean & Black Seas the situation is essentially unchanged since the start of the series in 2003, although since 2012 there is a somewhat increase in biomass. STECF notes however the large uncertainty associated to this indicator (see Figure 30 in the EW report).

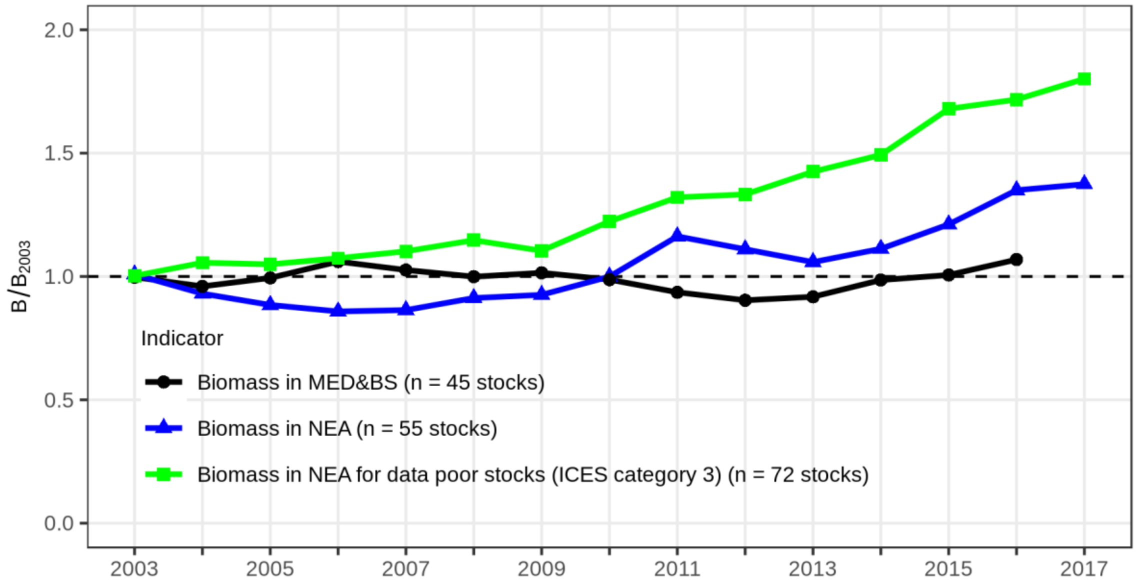

Figure 3. Trends in the indicators of stock biomass (median values of the model-based estimates relative to 2003). Three indicators are presented: one for the NE Atlantic (55 stocks considered, blue line); one for the Mediterranean & Black Seas (45 stocks, black line); and one for data limited stocks (ICES category 3, 72 stocks, green line).

Finally, the average decadal recruitment indicator shows decreasing trend until 2012 and an inversion afterwards, which may reflect an increase in stock's production. However, the characteristics of the indicator, a decadal ratio, make it difficult to clearly interpret these results. For example the 2017's decadal recruitment for a single stock is the ratio between the average recruitment from 2008 to 2017 over the average recruitment from 1998 to 2007. Yearly decadal recruitment ratios for each stock constitute the dataset used to fit the model, of which predictions are afterwards scaled to 2003 (check the protocol in Annex 1 of the EW report for more details; Figure 4).

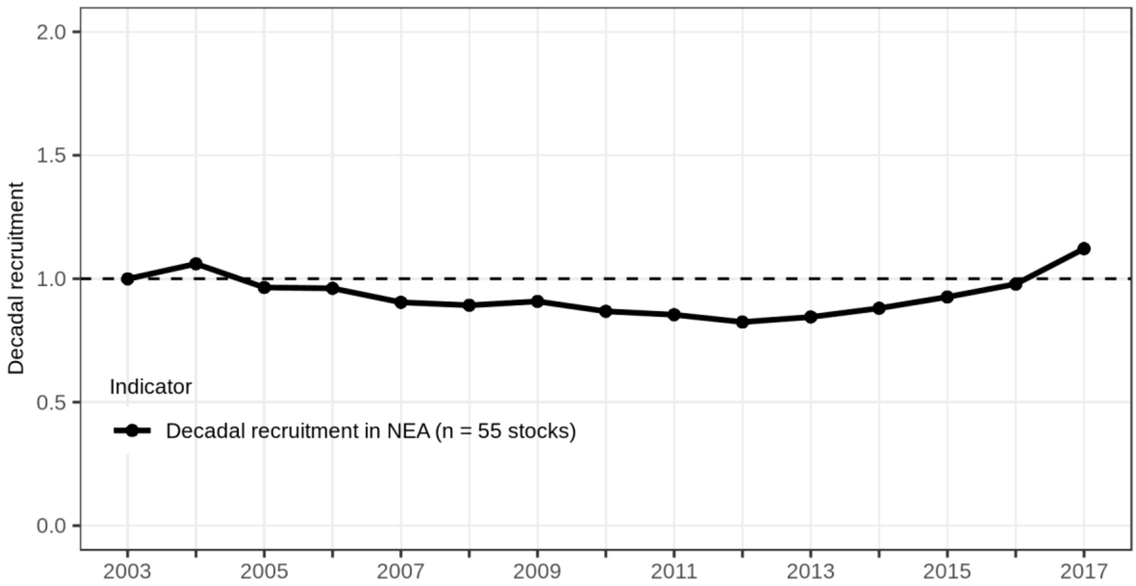

Figure 4. Trend in decadal recruitment scaled to 2003 in the Northeast Atlantic area (based on 55 stocks).

Trends per Ecoregion

The EG provides some information and figures broken down by Ecoregion for the NE Atlantic and the Mediterranean & Black Seas. STECF notes however the large uncertainty associated to these indicators, particularly in the Mediterranean & Black Seas, making the results unstable from year to year and thus should be taken with care. The main trends are summarised here.

In all ICES Ecoregions the overall fishing pressure has decreased and the status of stocks has improved compared to the start of the time series. Nevertheless, in three out of five regions the decreasing trend in exploitation has been reversed (Baltic Sea and Celtic Sea) or stalled (NE Atlantic widely distributed stocks) in the recent years, while the Bay of Biscay & Iberia area show a considerable increase in biomass, followed by the NE Atlantic widely distributed stocks. In 2017, the proportion of overexploited stocks ranged between to 33% - 88% across the different Ecoregions, while the modelled estimate of the F/F_{MSY} ratio for 2017 was between 0.86 and 1.22.

Coverage of the scientific advice

Coverage of biological stocks by the CFP monitoring

The analyses of the progress in achieving MSY objectives in the NE Atlantic should consider all stocks with advice provided by ICES, on the condition of being distributed in EU waters, at least partially. Based on the ICES database accessed for the analysis, ICES provides scientific advice for 247 biological stocks included in EU waters (at least in part). Of these, 147 stocks (60%) are data limited, without an estimate of MSY reference points (ICES category 3 and above, Table 2).

Table 2. Numbers of stocks assessed by ICES for different stock categories in different areas. Note that not all of these stocks are managed by TACs, and as such, numbers are higher than those used in the CFP monitoring analysis.

	ICES Stock Category						Total
	1	2	3	4	5	6	
Arctic Ocean	12	1	8	0	3	3	27
Azores	0	0	2	0	1	1	4
Baltic Sea	8	0	9	1	0	0	18
BoBiscay & Iberia	12	1	18	1	8	5	45
Celtic Seas	27	0	19	1	13	10	70
Faroes	3	0	1	0	0	0	4
Greater North Sea	22	0	14	5	7	3	51
Greater Northern	0	0	1	0	0	0	1
Greenland Sea	5	0	3	0	0	1	9
Iceland Sea	1	0	0	0	1	0	2
NE Atlantic widely distributed stocks	7	1	7	0	1	0	16
Total	97	3	82	8	34	23	247

The present CFP monitoring analysis is focused on stocks with a TAC and for which estimates of fishing mortality, biomass and biological reference points are available. As detailed in the EGs technical reports, not all indicators can be calculated for all stocks in all years, and the EG was able to compute indicators for 70 to 115 stocks of category 1 depending on indicators, years and areas, and 72 stocks of category 3. These stocks represent the vast majority of catches but a large number of biological stocks present in EU waters are still not included in the CFP monitoring.

In the Mediterranean region, the EG selected 230 stocks (Species/GSA) in the sampling frame (Mannini et.al 2017), of which 47 (20%) have been covered by a stock assessment in recent years. In the Mediterranean region, stocks status and trends can be monitored only for a minority of stocks.

Coverage of TAC regulation by scientific advice

According to the EG report, STECF notes that 156 TACs (combination of species and fishing management zones) were in place in 2017 in the EU waters of the NE Atlantic.

STECF underlines that in many cases, the boundaries of the TAC management areas are not aligned with the biological limits of stocks used in ICES assessments. The EG therefore computed an indicator of advice coverage, where a TAC is considered to be “covered” by a stock assessment when at least one of its divisions matched the spatial distribution of a stock for which reference points have been estimated from an ICES full assessment. Based on this indicator, 55% among the 156 TACs are covered, at least partially, by stock assessments that provide estimates of F_{MSY} (or a proxy), 50% by stock assessments that have B_{pa}, but only 20% by stock assessments that provide estimates of $MSYB_{trigger}$.

Additionally, STECF notes that, using this index, some TACs can be considered as “covered” even if they relate to several assessments contributing to a single TAC (e.g. *Nephrops* functional units in the North Sea) or to a scientific advice covering a different (but partially common) area (e.g. whiting in the Bay of Biscay). Thus, such an approach overestimates the spatial coverage of advice (i.e. the proportion of TACs based on a single and aligned assessment). This means that a large number of TACs are still imperfectly covered by scientific advice based on F_{MSY} or $MSYB_{trigger}$ reference values.

Ongoing developments

STECF notes that work will continue in 2019 to develop further several experimental indicators identified in the EWG 18-15, to allow for the coverage of the CFP monitoring report to be expanded in the future.

STECF conclusions

STECF acknowledges that monitoring the performance of the CFP requires significant effort in order to provide a comprehensive picture. The process presents a number of methodological challenges due to the annual variability in the number and categories of stocks assessed (especially in the Mediterranean) and due to the large variations in trends across stocks. As a result, the choice of indicators and their interpretation is being discussed, expanded and adjusted over time, as duly documented in the suite of STECF plenary reports and in the JRC EG technical reports. STECF is aware that minor differences in the indicators can occur compared to previous years. However STECF always use the latest assessment and best science available at the time of the report.

STECF notes that only 25 stocks have an actual $MSYB_{trigger}$ estimate out of 70 stocks analytical assessed by ICES. This result in an uncertain year-to-year variable indicator, restricting considerably the possibilities to monitor the CFP. STECF therefore identifies the need to increase the numbers of stocks for which an actual $MSYB_{trigger}$ estimate is available.

Regarding the progress made in the achievement of F_{MSY} in line with the CFP, STECF notes that the latest results are generally in line with those reported in the 2017 & 2018 CFP monitoring and confirm a reduction in the overall exploitation rate for the NE Atlantic. On average the stock biomass is increasing and stock status is improving. Nevertheless, based on the set of assessed stocks included in the analyses, STECF notes that many stocks remain overfished and/or outside safe biological limits, and that progress achieved until 2017 seems too slow to ensure that all stocks will be rebuilt and managed according to F_{MSY} by 2020.

STECF also concludes that stocks from the Mediterranean & Black Seas remain in a very poor situation, although there is a slight improvement in terms of fishing pressure and stock biomass.

STECF continues to recognise the need to broaden the scope of the CFP monitoring to cover additional aspects not so far dealt with. In particular, there is a need to develop the CFP monitoring process to cover the Landing Obligation, wider ecosystem and socio-economic aspects in the analysis.

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EXPERT GROUP REPORT

REPORT TO THE STECF

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

Ispra, Italy, February-March 2019

1 INTRODUCTION

Article 50 of the EU Common Fisheries Policy (REGULATION (EU) No 1380/2013) states:

"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 fulfil its obligations to report to the European Parliament and the Council, each year, the European Commission requests the Scientific, Technical and Economic Committee for Fisheries (STECF) to compute a series of performance indicators and advise on the progress towards the provisions of Article 50.

In an attempt to make the process of computing each of the indicators consistent and transparent and to take account of issues identified and documented in previous CFP monitoring reports, a revised protocol was adopted by the STECF in 2018 (Annex I).

An ad hoc Expert Group comprising Experts from the European Commission's Joint Research Centre (JRC) was convened during February and March 2019 to compute the performance indicator values according to the agreed protocol (Annex I) and to report to the STECF plenary meeting scheduled for 25-29 March 2019.

1.1 Terms of Reference to the ad hoc Expert group

The Expert Group is requested to report on progress in achieving MSY objectives in line with CFP.

2 DATA AND METHODS

2.1 Data sources

The data sources used referred to the coastal waters of the EU in FAO areas 27 (Northeast Atlantic and adjacent Seas) and 37 (Mediterranean and Black Seas). The Mediterranean included GSAs 1, 5, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, 25 and 29. The NE Atlantic included the ICES subareas "III", "IV" (excluding Norwegian waters of division IVa), "VI", "VII", "VIII", "IX" and "X".

2.1.1 Stock assessment information

For the Mediterranean region (FAO area 37), the information were extracted from the STECF Mediterranean Expert Working Group repositories (https://stecf.jrc.ec.europa.eu/reports/medbs) and from the GFCM stock assessment forms (http://www.fao.org/gfcm/data/safs/en).

For the NE Atlantic (FAO area 27), the information was downloaded from the ICES website (http://standardgraphs.ices.dk) on the 14th February 2019, comprising the most recent published assessments, carried out up to and including 2018. The dataset was updated with the North Sea Saithe stock assessment revised in March 2019. A thorough process of data quality checks and corrections was performed to ensure the information downloaded was in agreement with the summary sheets published online (online annex I, https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring).

The table reporting the URLs for the report or advice summary sheet for each stock is available at (online annex II, https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring).

2.1.2 Management units information

For the NE Atlantic, management units are defined by TACs, annual fishing opportunities for a species or group of species in a Fishing Management Zone (FMZ). The information regarding TACs in 2016 was downloaded from the FIDES (http://fides3.fish.cec.eu.int/) reporting system. Subsequently, such information was cleaned and processed, to identify the FMZ of relevance to this work, as well as the ICES rectangles they span to (Gibin, 2017; Scott et. al, 2017a; Scott et.al 2017b).

2.2 Methods

The methods applied and the definition of the sampling frames followed the protocol (Jardim et.al, 2015) agreed by STECF (2016) and updated following the discussion in STECF (2018a). The updated protocol is presented in Annex I and the R code used to carry out the analysis in Annex II.

2.3 Points to note

- Stocks assessed with biomass dynamics models do not provide a value for F_{PA}, although they may provide a B_{PA} proxy (0.5 B_{MSY}). Consequently, such stocks cannot be used to compute safe biological limits (SBL; sections 3.2.3, 3.2.4).

- The Generalized Linear Mixed Model (GLMM) uses a shortened time series, starting in 2003, instead of the full time-series of available data. This has the advantage of balancing the dataset by removing those years with only a low number of assessment estimates. It has the disadvantage of excluding data that could improve model fit.

- Indicators of trends computed with the GLMM show the average progress of the process they represent, including its uncertainty in terms of 50% and 95% confidence intervals. In the former case corresponding to the range between the 25% and 75% percentiles, and for the latter between the 2.5% and 97.5% percentiles.
- The GLMM fit within the bootstrap procedure does not converge for all resamples. Worst case is the biomass trends model fit with approximately 25% of non-convergence. Failed resamples were excluded when computating model-based indicators.

2.4 Differences from the 2018 CFP monitoring report

In 2018 STECF held an EWG to discuss the extension of the monitoring exercise (STECF, 2018b). Based on the findings of EWG1815 STECF recommended the following indicators to be added to the core analysis (STECF, 2018a):

- Number of stocks where F>FMSY OR SSB<BMSY
- Number of stocks where F<=FMSY AND SSB>=BMSY
- Time trend of F/FMSY for stocks outside the EU waters in FAO 27
- Trend in SSB or biomass index for stocks of data category 3

STECF also recommended to replace the recruitment indicator used until 2018 with the “Time trend in average decadal recruitment” indicator.

The above mentioned indicators were included in the current exercise for the NEA.

3 NORTHEAST ATLANTIC AND ADJACENT SEAS (FAO REGION 27)

3.1 Number of stock assessments available to compute CFP performance indicators

The number of stock assessments with estimates of F/F_{MSY} for the years 2003-2017 for FAO Region 27 are given in Figure 5 and by ecoregion in Table 3.

The time-series of data available for each year and stock (data categories 1 and 2) is shown in Figure 6. For stocks without estimates in 2017 the estimates of F and SSB were assumed to be the same as 2016. Consequently, the number of stocks included to compute the indicator values for 2017 was 70.

The stocks, including data category 3 (72 stocks), used to compute each indicator are shown in Table 4.

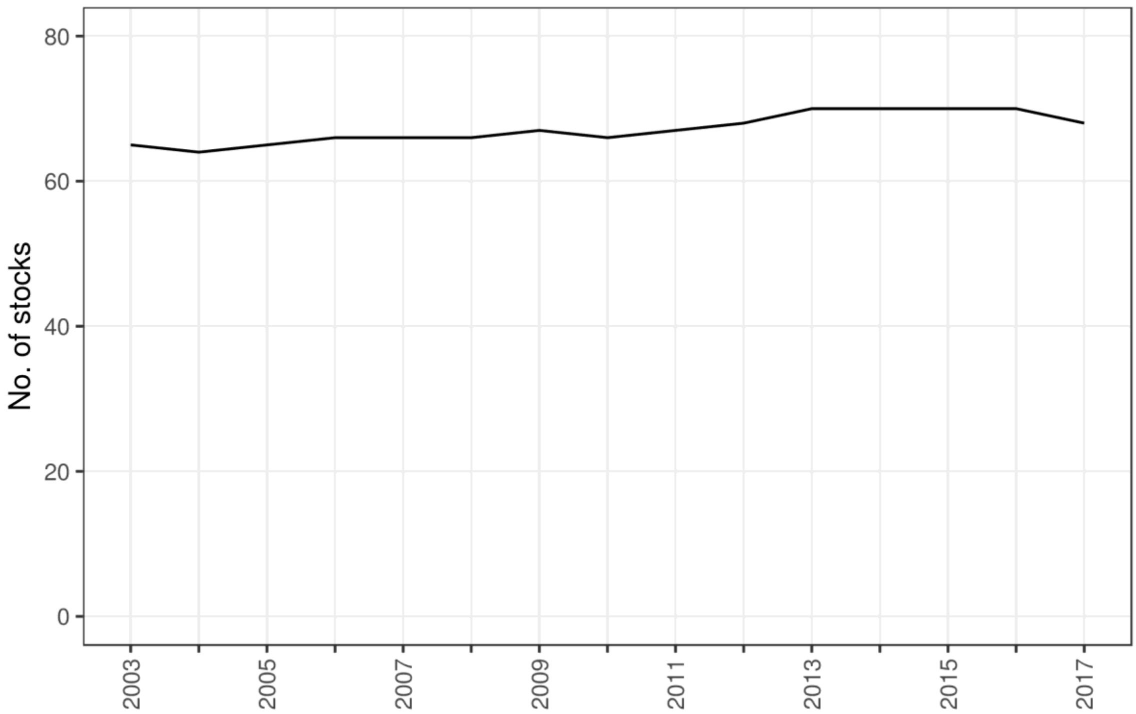

Figure 5. Number of stocks in the NE Atlantic for which estimates of F/F_{MSY} are available by year.

Table 3. Number of stocks in the ICES area for which estimates of F/F_{MSY} are available by ecoregion and year

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	65	64	65	66	66	66	67	66	67	68	70	70	70	70	68
Baltic Sea	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
BoBiscay & Iberia	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Celtic Seas	21	20	21	22	22	22	23	22	23	24	26	26	26	26	24
Greater North Sea	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Northeast Atlantic	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Figure 6. Time series of stock assessment results in the NE Atlantic for which estimates of F/F_{MSY} are available by year. Blank records indicate no estimate available for stock and year.

Compared to last year's report, two stocks have been added, while three have been dropped from the analysis relevant to Category 1 and 2 stocks.

The stocks added are:

- nep.fu.2021. This Category 1 stock has been added because this was the first instance when five years of data were available (the threshold for inclusion in the analysis).
- mon.27.78abd. This stock has been upgraded from Category 3 to Category 1.

The stocks dropped are:

- ank.27.8c9a. This stock has been downgraded from Category 1 to Category 3
- rng.27.5b6712b. This stock has been downgraded from Category 1 to Category 5.
- nep.fu.3-4. This Category 1 stock has been reported as having inconsistent abundance and harvest rate estimates across its time series, due to changes in the surveyed area.

Four Category 1 stocks were not included in the analysis due to not having TACs: bss.27.4bc7ad-h, bss.27.8ab, her.27.1-24a514a and pil.27.8c9a. In last year's report, these stocks were used for the calculation of the 'biomass data category 1-3' indicator, which has now been dropped.

For all stocks managed with a $B_{escapement}$ strategy, except Bay of Biscay anchovy (ane.27.8) and Norway pout in the North Sea, Skagerrak and Kattegat (nop.27.3a4), $MSYB_{escapement}$ was set by ICES at B_{PA} instead of B_{MSY}. Norway pout in the North Sea, Skagerrak and Kattegat (nop.27.3a4) uses a probabilistic method to set the catches: $C_{y+1}=C|(P[SSB<B_{lim}]=0.05)$. For this stock, the lower (0.025%) boundary of the SSB confidence interval was compared to B_{lim}. Bay of Biscay anchovy (ane.27.8) uses a HCR with Biomass triggers. ICES does not report reference points other than B_{lim}. The HCR's upper biomass trigger was used as $MSYB_{escapement}$.

There are 38 stocks for which MSYBtrigger was set at Bpa levels. Of these 2 stocks (hom.27.2a4a5b6a7a-ce-k8, pra.27.3a4a) have explicitly estimated both reference points, all the others used ICES's default procedure and as such MSYBtrigger was set to unknown as discussed by STECF (2018b).

As in last year's report (STECF, 2018c) the stock of pan-barn was not included in the indicator F/F_{MSY} for stocks outside EU waters of FAO region 27, due to its large impact in the indicator values.

For the stock nep.fu.13 the status of the stock is derived comparing the combined Firth of Clyde and Sound of Jura harvest rate with the Firth of Clyde harvest rate MSY, in agreement with the ICES procedures.

To keep consistency with previous reports and ICES definitions, widely distributed stocks are referred to as "Northeast Atlantic" in the figures and tables of this section.

Table 4. Indicators computed for each stocks.

FishStock	Year	above/below Fmsy	in/out SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$	F/Fmsy trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
ane.27.8	2017	X				X	X	
ane.27.9a	2017							X
anf.27.3a46	2017							X
ank.27.78abd	2016							X
ank.27.8c9a	2017							X
aru.27.5b6a	2016							X
aru.27.6b7-1012	2016							X
bli.27.5b67	2017	X	X		X	X	X	
bll.27.22-32	2016							X
bll.27.3a47de	2016							X
boc.27.6-8	2017							X
bsf.27.nea	2016							X
cod.27.21	2017							X
cod.27.22-24	2017	X	X		X	X	X	
cod.27.24-32	2017							X
cod.27.47d20	2017	X	X		X	X	X	
cod.27.6a	2016	X	X		X	X	X	
cod.27.7a	2017	X	X		X	X	X	
cod.27.7e-k	2017	X	X		X	X	X	
dab.27.22-32	2016							X
dab.27.3a4	2016							X
dgs.27.nea	2017	X		X		X	X	
fle.27.2223	2016							X
fle.27.2425	2016							X
fle.27.2628	2016							X
fle.27.2729-32	2016							X
fle.27.3a4	2017							X
gfb.27.nea	2017							X
gug.27.3a47d	2017							X
had.27.46a20	2017	X	X		X	X	X	
had.27.6b	2017	X	X		X	X	X	
had.27.7a	2017	X	X	X	X	X	X	
had.27.7b-k	2017	X	X		X	X	X	
her.27.20-24	2017	X	X		X	X	X	
her.27.25-2932	2017	X	X		X	X	X	
her.27.28	2017	X	X	X	X	X	X	
her.27.3031	2017	X		X	X	X	X	
her.27.3a47d	2017	X	X	X	X	X	X	
her.27.6a7bc	2017	X	X		X	X	X	

FishStock	Year	above/below Fmsy	in/out SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$	F/Fmsy trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
her.27.irls	2017	X	X	X	X	X	X	
her.27.nirs	2017	X	X		X	X	X	
hke.27.3a46-8abd	2017	X	X		X	X	X	
hke.27.8c9a	2017	X	X		X	X	X	
hom.27.2a4a5b6a7a-ce-k8	2017	X	X	X	X	X	X	
hom.27.9a	2017	X	X		X	X	X	
ldb.27.8c9a	2017	X	X		X	X	X	
lem.27.3a47d	2017							X
lez.27.4a6a	2017	X		X	X			
lez.27.6b	2017							X
lin.27.3a4a6-91214	2016							X
lin.27.5b	2016							X
mac.27.nea	2017	X	X		X	X	X	
meg.27.7b-k8abd	2017	X	X		X	X	X	
meg.27.8c9a	2017	X	X		X	X	X	
mon.27.78abd	2017	X	X		X	X	X	
mon.27.8c9a	2017	X	X	X	X	X	X	
mur.27.3a47d	2016							X
nep.fu.11	2017	X		X				
nep.fu.12	2017	X		X				
nep.fu.13	2017	X		X				
nep.fu.14	2017	X		X				
nep.fu.15	2017	X		X				
nep.fu.16	2017	X						
nep.fu.17	2017	X		X				
nep.fu.19	2017	X		X				
nep.fu.2021	2017	X						
nep.fu.22	2017	X		X				
nep.fu.25	2015							X
nep.fu.2627	2015							X
nep.fu.2829	2016							X
nep.fu.31	2015							X
nep.fu.6	2017	X		X				
nep.fu.7	2017	X		X				
nep.fu.8	2017	X		X				
nep.fu.9	2017	X		X				
nop.27.3a4	2017	X				X	X	
pil.27.8abd	2017							X
ple.27.21-23	2017	X	X		X	X	X	
ple.27.24-32	2017							X
ple.27.420	2017	X	X	X	X	X	X	

FishStock	Year	above/below Fmsy	in/out SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$	F/Fmsy trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
ple.27.7a	2017	X	X	X	X	X	X	
ple.27.7d	2017	X	X		X	X	X	
ple.27.7e	2017							X
ple.27.7fg	2017							X
ple.27.7h-k	2017							X
pok.27.3a46	2017	X	X		X	X	X	
pra.27.3a4a	2017	X	X	X	X	X	X	
raj.27.1012	2016							X
reb.2127.dp	2016							X
rjc.27.3a47d	2016							X
rjc.27.6	2017							X
rjc.27.7afg	2017							X
rjc.27.8	2017							X
rjc.27.9a	2017							X
rje.27.7fg	2017							X
rjh.27.9a	2017							X
rjm.27.3a47d	2016							X
rjm.27.67bj	2017							X
rjm.27.7ae-h	2017							X
rjm.27.8	2017							X
rjm.27.9a	2017							X
rjn.27.3a4	2016							X
rjn.27.678abd	2017							X
rjn.27.8c	2017							X
rjn.27.9a	2017							X
rju.27.7de	2017							X
san.sa.1r	2017	X				X	X	
san.sa.2r	2017	X				X	X	
san.sa.3r	2017	X				X	X	
san.sa.4	2017	X				X	X	
sbr.27.10	2017							X
sbr.27.9	2017							X
sdv.27.nea	2016							X
sho.27.67	2016							X
sho.27.89a	2016							X
sol.27.20-24	2017	X	X		X	X	X	
sol.27.4	2017	X	X		X	X	X	
sol.27.7a	2017	X	X		X	X	X	
sol.27.7d	2017	X	X		X	X	X	
sol.27.7e	2017	X	X	X	X	X	X	
sol.27.7fg	2017	X	X		X	X	X	

FishStock	Year	above/below Fmsy	in/out SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$	F/Fmsy trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
sol.27.7h-k	2017							X
sol.27.8ab	2017	X	X		X	X	X	
spr.27.22-32	2017	X	X		X	X	X	
spr.27.3a	2017							X
spr.27.4	2017	X				X	X	
spr.27.7de	2017							X
syc.27.3a47d	2016							X
syc.27.67a-ce-j	2016							X
syc.27.8abd	2016							X
syc.27.8c9a	2016							X
syt.27.67	2016							X
tur.27.22-32	2017							X
tur.27.3a	2017							X
tur.27.4	2016							X
usk.27.3a45b6a7-912b	2016							X
whb.27.1-91214	2017	X	X		X	X	X	
whg.27.47d	2017	X	X		X	X	X	
whg.27.6a	2017	X	X		X	X	X	
whg.27.7a	2016	X	X		X	X	X	
whg.27.7b-ce-k	2017	X	X		X	X	X	
wit.27.3a47d	2016							X
Total		**70**	**46**	**25**	**48**	**55**	**55**	**72**

3.2 Indicators of management performance

The first set of indicators (Figure 7 to Figure 18 and Table 5 to Table 10) compute the number with relation to specific thresholds. The presentation of these indicators is made in pairs, whit one indicator showing the number of stocks above/outside the relevant thresholds, followed by another showing the number of stocks below/inside. The second set of indicators (Figure 19 to Figure 26 and Table 11 to Table 18) depict time trends of important variables and is computed using a statistical model. Most indicators have a global and a regional depiction.

3.2.1 Number of stocks by year where fishing mortality exceeded F_{MSY}

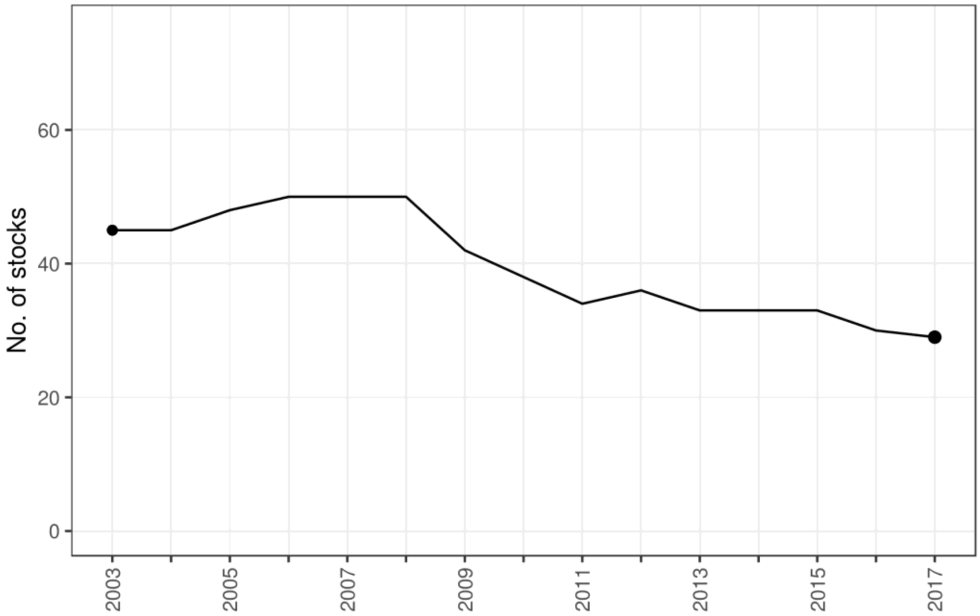

Figure 7. Number of stocks by year for which fishing mortality (F) exceeded F_{MSY}.

Figure 8. Number of stocks by ecoregion for which fishing mortality (F) exceeded F_{MSY}.

Table 5. Number of stocks by ecoregion for which fishing mortality (F) exceeded F_{MSY}.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	45	45	48	50	50	50	42	38	34	36	33	33	33	30	29
Baltic Sea	7	6	6	6	6	6	6	5	5	5	4	3	6	5	7
BoBiscay & Iberia	7	7	8	8	8	8	7	6	6	6	7	7	6	6	3
Celtic Seas	13	12	13	14	16	16	14	12	9	12	8	8	8	9	9
Greater North Sea	13	16	17	19	17	17	13	12	11	12	12	13	11	8	8
Northeast Atlantic	5	4	4	3	3	3	2	3	3	1	2	2	2	2	2

3.2.2 Number of stocks by year where fishing mortality was equal to, or less than F_{MSY}

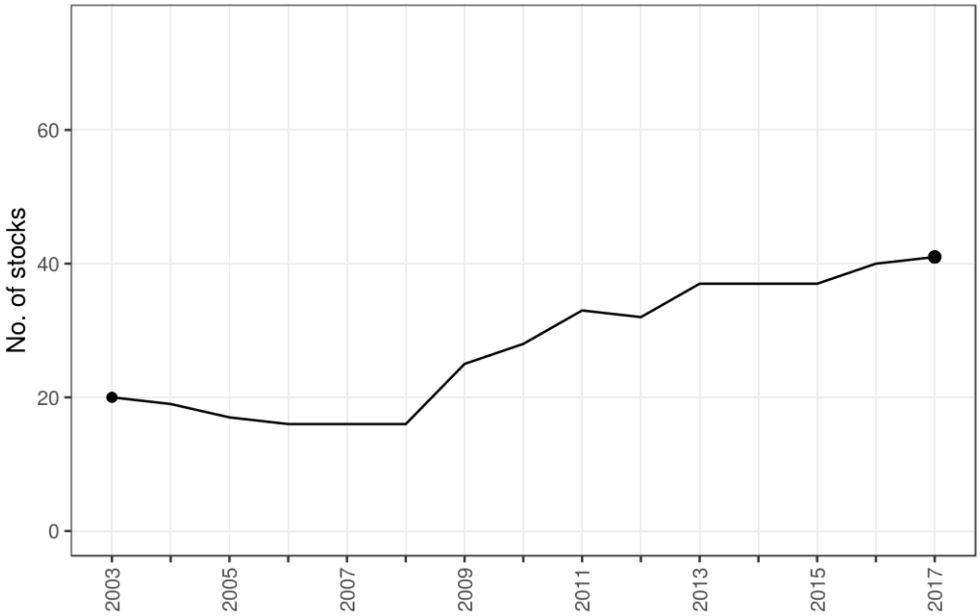

Figure 9. Number of stocks by year for which fishing mortality (F) did not exceed F_{MSY}.

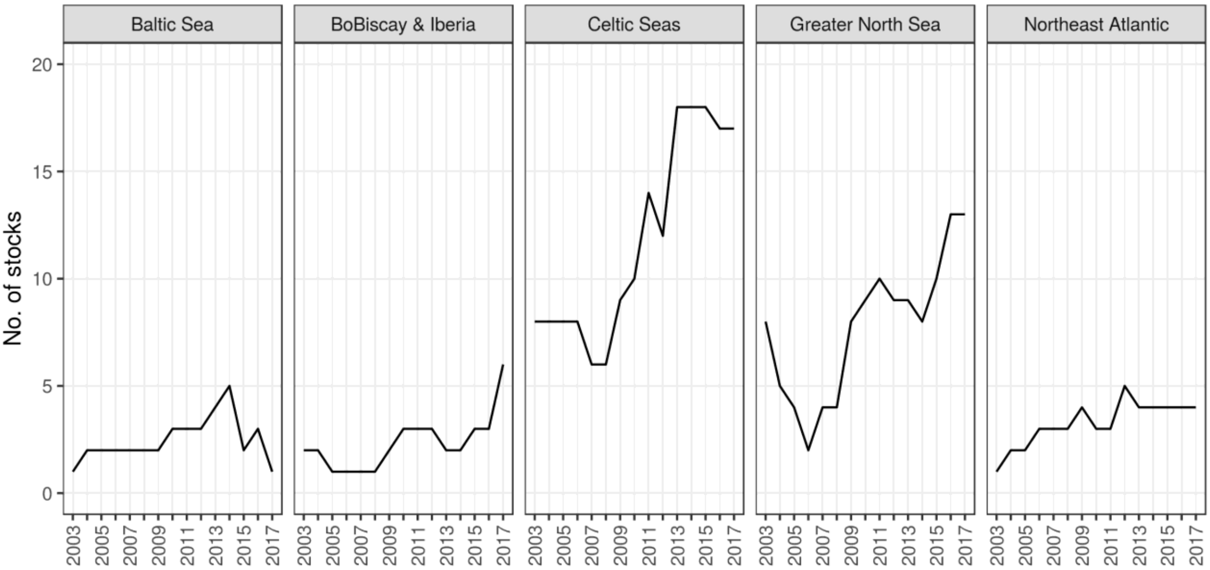

Figure 10. Number of stocks by ecoregion for which fishing mortality (F) did not exceed F_{MSY}.

Table 6. Number of stocks by ecoregion for which fishing mortality (F) did not exceed F_{MSY}.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	20	19	17	16	16	16	25	28	33	32	37	37	37	40	41
Baltic Sea	1	2	2	2	2	2	2	3	3	3	4	5	2	3	1
BoBiscay & Iberia	2	2	1	1	1	1	2	3	3	3	2	2	3	3	6
Celtic Seas	8	8	8	8	6	6	9	10	14	12	18	18	18	17	17
Greater North Sea	8	5	4	2	4	4	8	9	10	9	9	8	10	13	13
Northeast Atlantic	1	2	2	3	3	3	4	3	3	5	4	4	4	4	4

3.2.3 Number of stocks outside safe biological limits

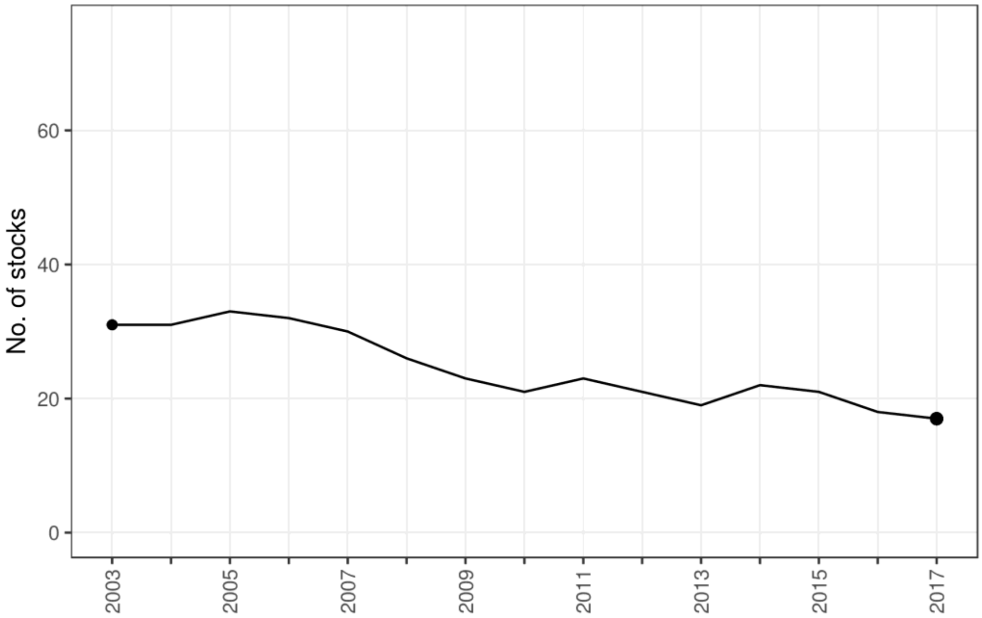

Figure 11. Number of stocks outside safe biological limits by year.

Figure 12. Number of stocks outside safe biological limits by ecoregion.

Table 7. Number of stocks outside safe biological limits by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	31	31	33	32	30	26	23	21	23	21	19	22	21	18	17
Baltic Sea	6	6	6	6	5	5	5	5	5	4	4	4	4	3	3
BoBiscay & Iberia	6	5	6	6	5	4	4	2	2	3	2	4	3	1	0
Celtic Seas	11	11	10	9	10	10	8	8	9	10	9	9	9	9	9
Greater North Sea	5	5	8	8	7	6	5	5	6	4	3	5	5	4	3
Northeast Atlantic	3	4	3	3	3	1	1	1	1	0	1	0	0	1	2

3.2.4 Number of stocks inside safe biological limits

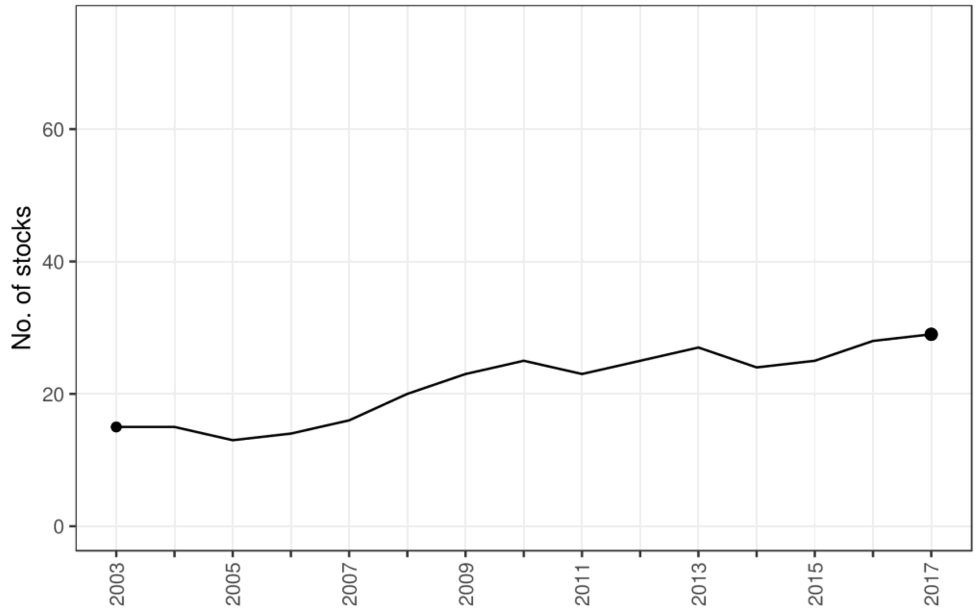

Figure 13. Number of stocks inside safe biological limits by year.

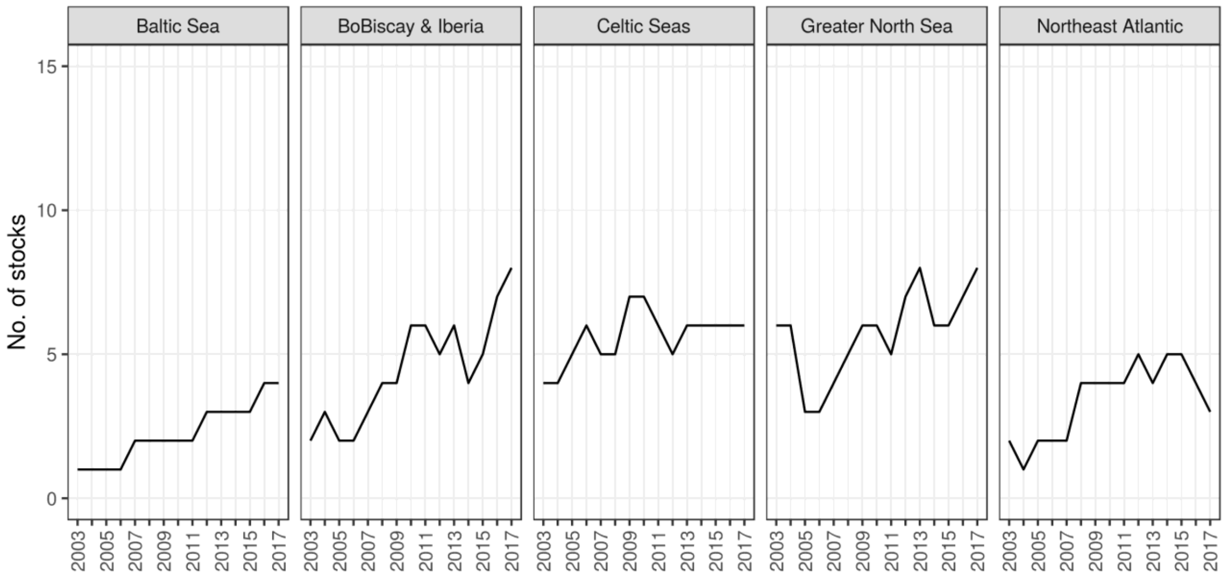

Figure 14. Number of stocks inside safe biological limits by ecoregion.

Table 8. Number of stocks inside safe biological limits by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	15	15	13	14	16	20	23	25	23	25	27	24	25	28	29
Baltic Sea	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4
BoBiscay & Iberia	2	3	2	2	3	4	4	6	6	5	6	4	5	7	8
Celtic Seas	4	4	5	6	5	5	7	7	6	5	6	6	6	6	6
Greater North Sea	6	6	3	3	4	5	6	6	5	7	8	6	6	7	8
Northeast Atlantic	2	1	2	2	2	4	4	4	4	5	4	5	5	4	3

3.2.5 *Number of stocks with F above Fmsy or SSB below B_{MSY}*

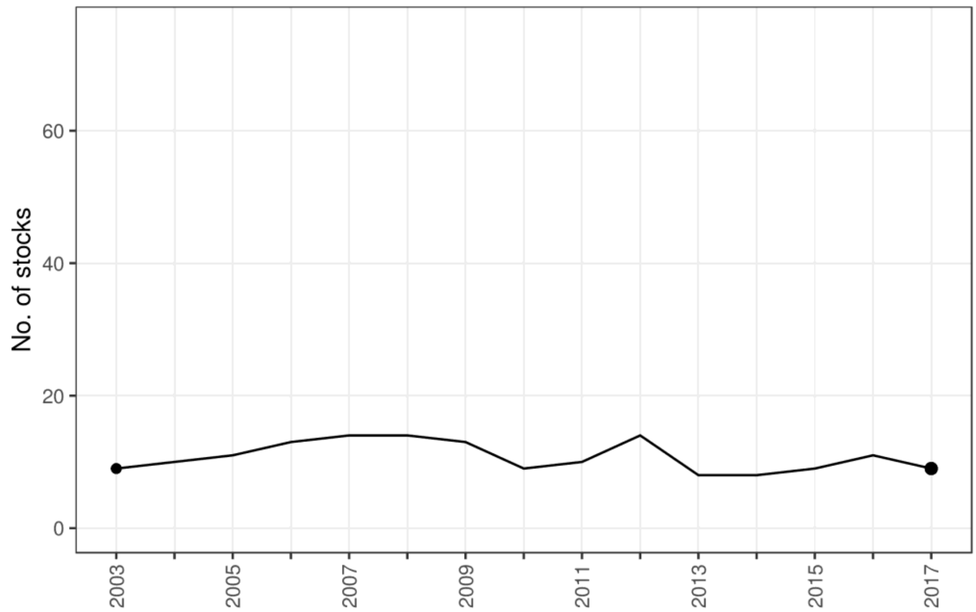

Figure 15. Number of stocks with F above Fmsy or SSB below B_{MSY} by year.

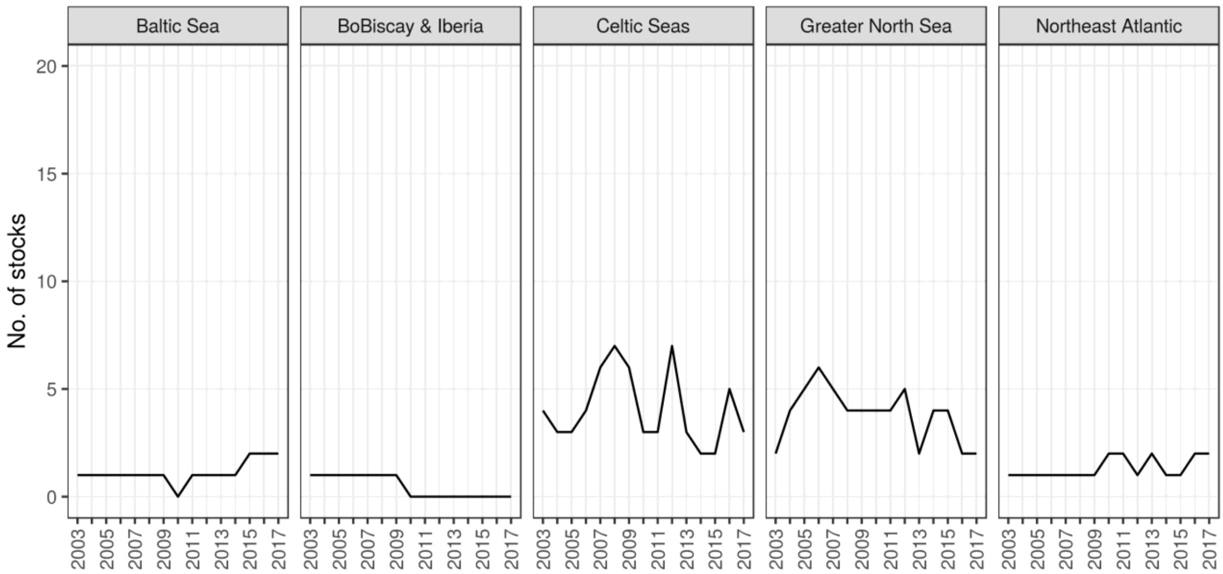

Figure 16. Number of stocks with F above F_{MSY} or SSB below B_{MSY} by ecoregion.

Table 9. Number of stocks with F above F_{MSY} or SSB below B_{MSY} by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	9	10	11	13	14	14	13	9	10	14	8	8	9	11	9
Baltic Sea	1	1	1	1	1	1	1	0	1	1	1	1	2	2	2
BoBiscay & Iberia	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Celtic Seas	4	3	3	4	6	7	6	3	3	7	3	2	2	5	3
Greater North Sea	2	4	5	6	5	4	4	4	4	5	2	4	4	2	2
Northeast Atlantic	1	1	1	1	1	1	1	2	2	1	2	1	1	2	2

3.2.6 Number of stocks with F below or equal to Fmsy and SSB above or equal to B_{MSY}

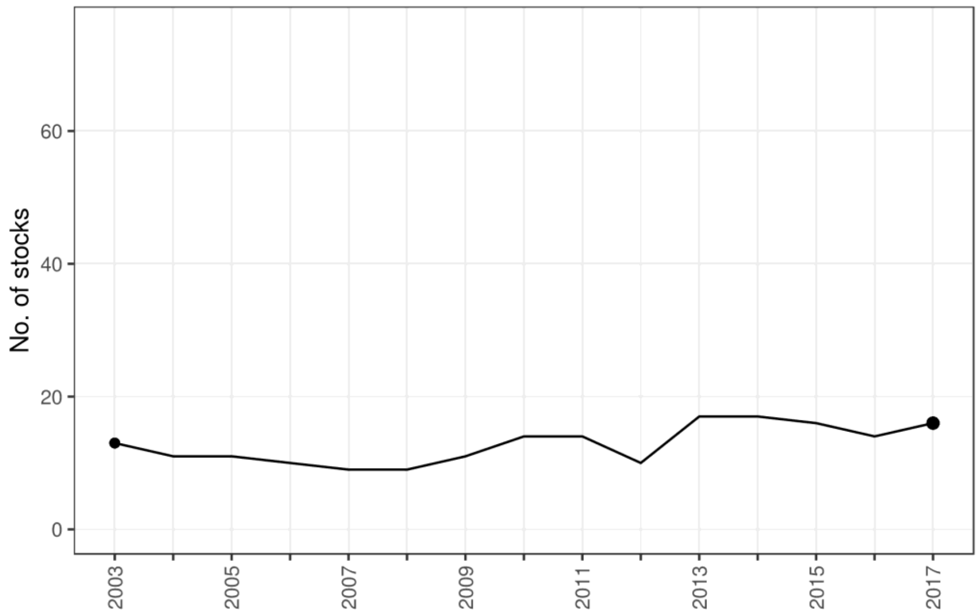

Figure 17. Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY}.

Figure 18. Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY} by ecoregion.

Table 10. Number of stocks with F below or equal to Fmsy and SSB above or equal to B_{MSY} by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ALL	13	11	11	10	9	9	11	14	14	10	17	17	16	14	16
Baltic Sea	1	1	1	1	1	1	1	2	1	1	1	1	0	0	0
BoBiscay & Iberia	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Celtic Seas	5	5	6	6	4	3	5	7	8	4	9	10	10	7	9
Greater North Sea	6	4	3	2	3	4	4	4	4	3	6	4	4	6	6
Northeast Atlantic	1	1	1	1	1	1	1	0	0	1	0	1	1	0	0

3.2.7 Trend in F/F_{MSY}

The trend in F/F_{MSY} is given in Figure 19 and associated percentiles in Table 11. Figure 19 shows the indicator values in 2016 and 2017 close to 1, which means that over all stocks, on average, the exploitation levels are close to F_{MSY}.

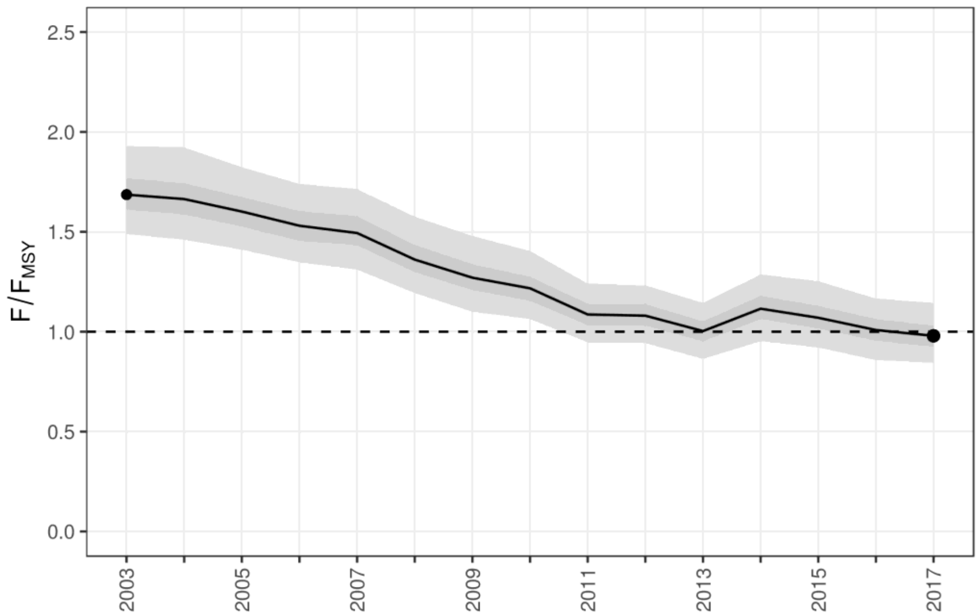

Figure 19. Trend in F/F_{MSY} (based in 48 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 11. Percentiles for F/F_{MSY} by year.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.5%	1.49	1.46	1.41	1.35	1.31	1.19	1.10	1.06	0.95	0.94	0.86	0.95	0.92	0.86	0.84
25%	1.61	1.59	1.53	1.46	1.43	1.30	1.21	1.16	1.03	1.03	0.95	1.06	1.02	0.96	0.93
50%	1.69	1.66	1.60	1.53	1.49	1.36	1.27	1.22	1.09	1.08	1.00	1.12	1.07	1.01	0.98
75%	1.77	1.74	1.67	1.60	1.58	1.43	1.34	1.27	1.14	1.14	1.05	1.18	1.13	1.06	1.03
97.5%	1.93	1.92	1.82	1.74	1.71	1.58	1.48	1.40	1.24	1.23	1.14	1.29	1.25	1.17	1.14

Trends in F/F_{MSY} by ecoregion are given in Figure 20 and Table 12. The regional analysis was carried out using the same model applied to regional datasets. Due to the small number of stocks in each ecoregion (ranging from 5 for the Northeast Atlantic to 16 for the Celtic Sea) it was not possible to compute confidence intervals.

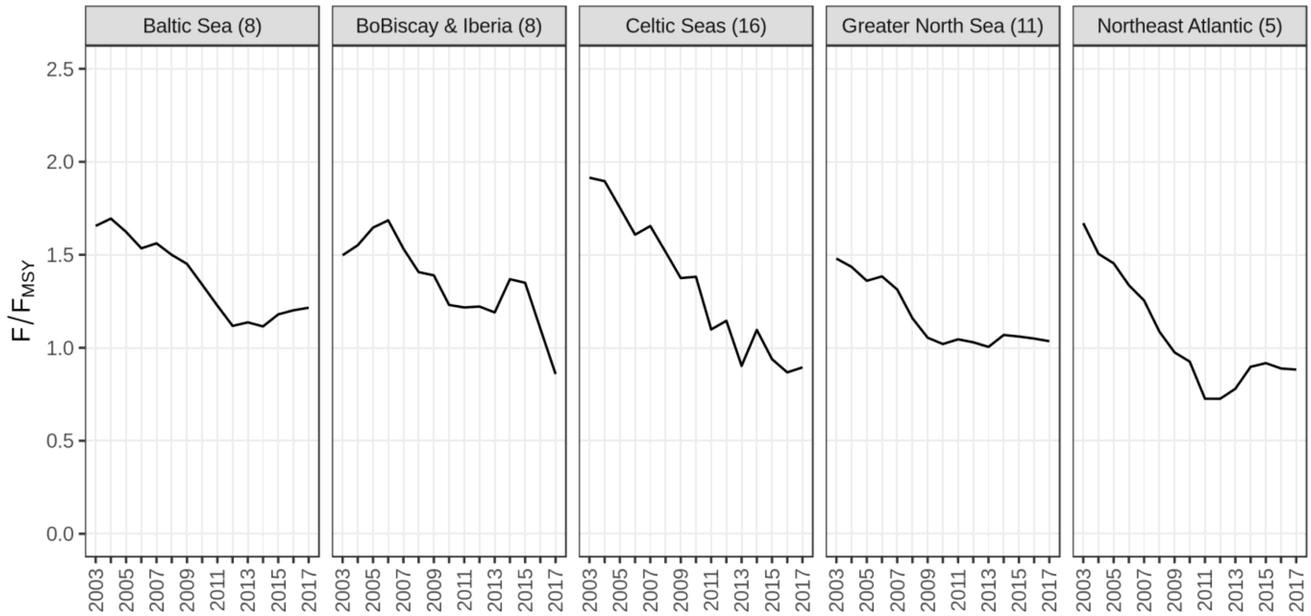

Figure 20. Trend in F/F_{MSY} by ecoregion. The number of stocks in each ecoregion are shown between parenthesis.

Table 12. Trend in F/F_{MSY} by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Baltic Sea	1.66	1.69	1.62	1.53	1.56	1.50	1.45	1.34	1.23	1.12	1.14	1.11	1.18	1.20	1.22
BoBiscay & Iberia	1.50	1.55	1.65	1.69	1.53	1.41	1.39	1.23	1.22	1.22	1.19	1.37	1.35	1.10	0.86
Celtic Seas	1.91	1.90	1.75	1.61	1.65	1.52	1.37	1.38	1.10	1.15	0.90	1.10	0.94	0.87	0.89
Greater North Sea	1.48	1.44	1.36	1.38	1.31	1.16	1.05	1.02	1.05	1.03	1.00	1.07	1.06	1.05	1.04
Northeast Atlantic	1.67	1.51	1.45	1.34	1.25	1.09	0.98	0.93	0.73	0.73	0.78	0.90	0.92	0.89	0.88

3.2.8 Trend in F/F_{MSY} for stocks outside EU waters

For comparison purposes the same model used in section 3.2.7 was applied to stocks assessed by ICES which spam over areas mostly outside EU waters in FAO region 27 (Figure 21 and Table 13). The reduced number of stocks available renders the indicator unstable and not very precise, hence the large confidence intervals.

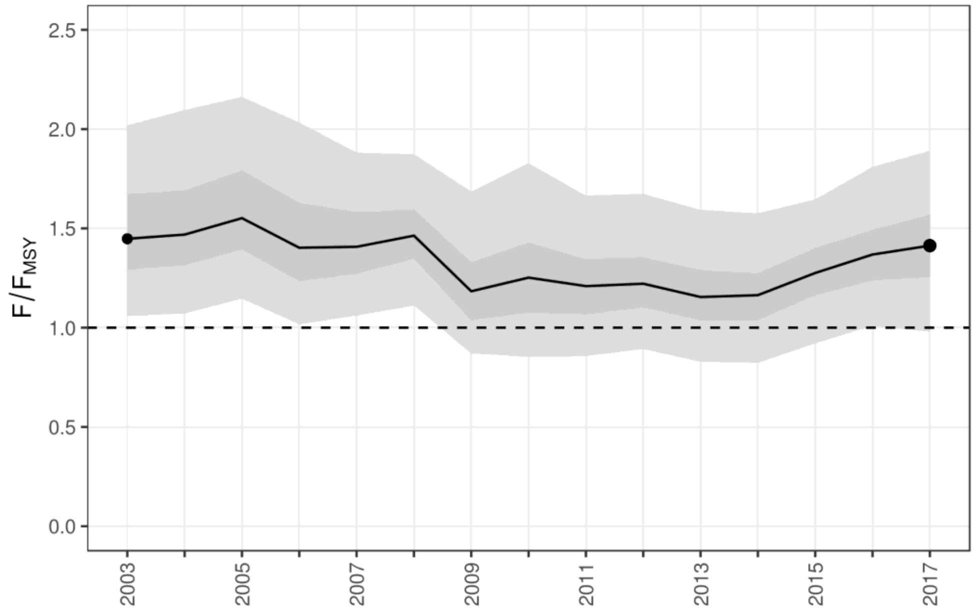

Figure 21. Trend in F/F_{MSY} for stocks outside EU waters (based in 11 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 13. Percentiles for F/F_{MSY} for stocks outside EU waters.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.5%	1.06	1.07	1.15	1.02	1.06	1.11	0.87	0.85	0.86	0.89	0.83	0.82	0.92	1.01	0.98
25%	1.29	1.32	1.39	1.24	1.27	1.35	1.04	1.08	1.07	1.10	1.04	1.04	1.16	1.24	1.26
50%	1.45	1.47	1.55	1.40	1.41	1.46	1.18	1.25	1.21	1.22	1.15	1.16	1.28	1.37	1.41
75%	1.67	1.69	1.79	1.63	1.58	1.59	1.33	1.43	1.34	1.35	1.29	1.27	1.40	1.49	1.57
97.5%	2.02	2.10	2.16	2.03	1.88	1.87	1.69	1.83	1.66	1.67	1.59	1.58	1.65	1.81	1.89

3.2.9 Trend in SSB (relative to 2003)

Figure 22 and Table 14 present the evolution of SSB over the period of the study, scaled to the initial (2003) value for presentation purposes. Over the time series SSB shows a generally increasing pattern, continuing the path estimated in previous years.

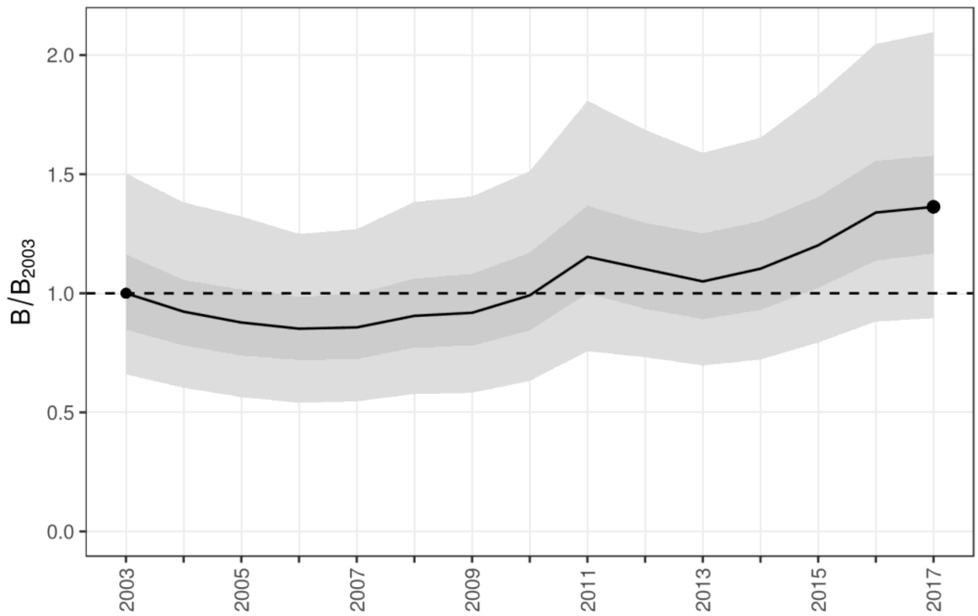

Figure 22. Trend in SSB relative to 2003 (based in 55 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 14. Percentiles for SSB relative to 2003.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.5%	0.66	0.60	0.56	0.54	0.55	0.58	0.58	0.63	0.76	0.73	0.70	0.72	0.79	0.88	0.89
25%	0.85	0.78	0.74	0.72	0.72	0.77	0.78	0.85	1.00	0.94	0.89	0.93	1.02	1.14	1.17
50%	1.00	0.92	0.88	0.85	0.86	0.91	0.92	0.99	1.15	1.10	1.05	1.10	1.20	1.34	1.36
75%	1.16	1.06	1.01	0.99	1.00	1.06	1.08	1.17	1.37	1.29	1.25	1.30	1.40	1.55	1.58
97.5%	1.50	1.38	1.32	1.25	1.27	1.38	1.41	1.51	1.81	1.69	1.59	1.65	1.83	2.05	2.10

Trends in SSB by ecoregion are given in Figure 23 and Table 15. The regional analysis was carried out using the same model applied to regional datasets. Due to the small number of stocks in each ecoregion (ranging between 6 in the Northeast Atlantic to 17 in the Greater North Sea) it wasn't possible to compute confidence intervals.

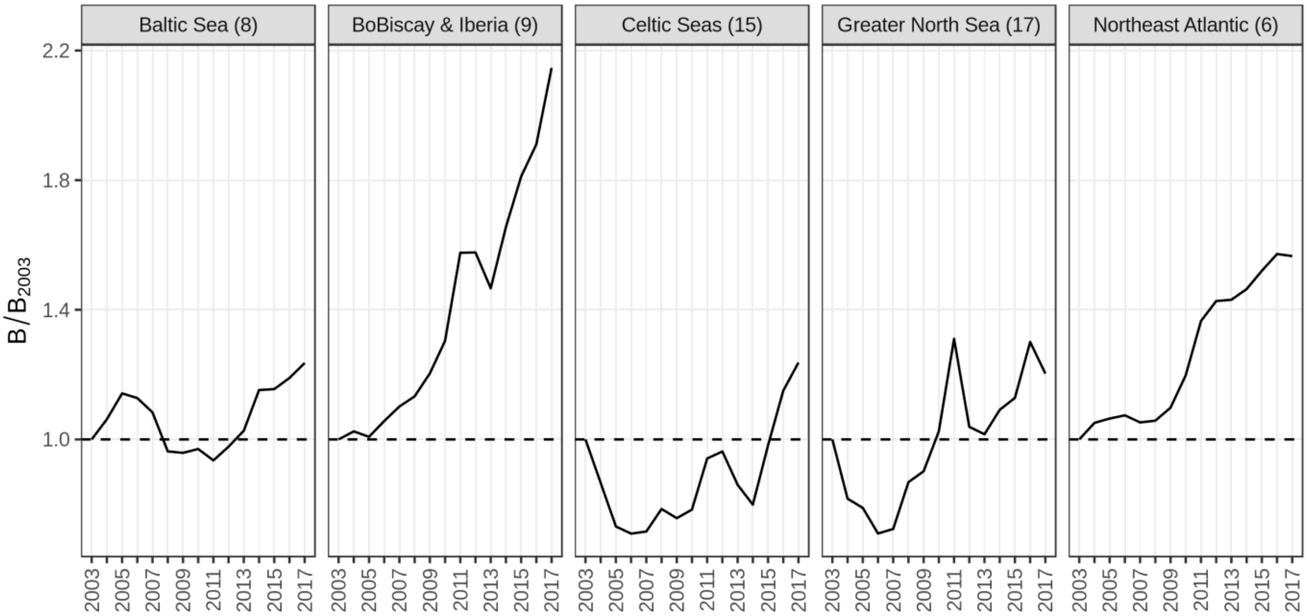

Figure 23. Trend in SSB by ecoregion relative to 2003. The number of stocks in each ecoregion are shown between parenthesis.

Table 15. SSB relative to 2003 by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Baltic Sea	1.00	1.06	1.14	1.13	1.08	0.96	0.96	0.97	0.94	0.98	1.03	1.15	1.16	1.19	1.24
BoBiscay & Iberia	1.00	1.02	1.01	1.06	1.10	1.13	1.20	1.30	1.58	1.58	1.47	1.66	1.81	1.91	2.15
Celtic Seas	1.00	0.87	0.73	0.71	0.72	0.79	0.76	0.78	0.94	0.96	0.86	0.80	0.98	1.15	1.24
Greater North Sea	1.00	0.82	0.79	0.71	0.72	0.87	0.90	1.03	1.31	1.04	1.02	1.09	1.13	1.30	1.20
Northeast Atlantic	1.00	1.05	1.06	1.07	1.05	1.06	1.10	1.20	1.37	1.43	1.43	1.46	1.52	1.57	1.57

3.2.10 Trend in biomass data limited stocks (relative to 2003)

Figure 24 and Table 16 present the trend of biomass or abundance indices for category 3 stocks, scaled to the initial (2003) value for presentation purposes. The indicator presents a positive trend over time, which potentially reflects an increase in the biomass of these stocks.

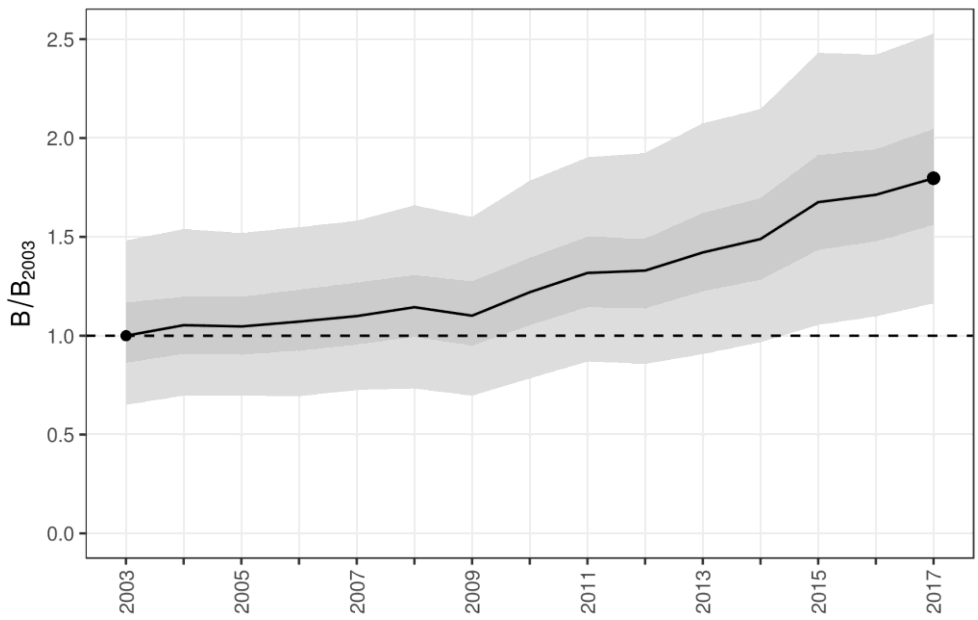

Figure 24. Trend in biomass or abundance indices relative to 2003 for data limited stocks (ICES category 3) (based in 72 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 16. Percentiles for biomass or abundance indices relative to 2003 for data limited stocks (ICES category 3).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.5%	0.65	0.70	0.70	0.69	0.72	0.73	0.70	0.78	0.87	0.86	0.91	0.97	1.05	1.10	1.16
25%	0.86	0.91	0.91	0.93	0.96	1.00	0.95	1.05	1.15	1.14	1.23	1.28	1.43	1.48	1.56
50%	1.00	1.05	1.05	1.07	1.10	1.14	1.10	1.22	1.32	1.33	1.42	1.49	1.68	1.71	1.80
75%	1.17	1.20	1.20	1.23	1.27	1.31	1.27	1.39	1.50	1.49	1.62	1.70	1.91	1.94	2.04
97.5%	1.48	1.54	1.52	1.55	1.58	1.66	1.60	1.78	1.90	1.92	2.07	2.15	2.43	2.42	2.53

3.2.11 Trend in recruitment (relative to 2003)

Figure 25 and Table 17 present the trend of recruitment over the period of the study, scaled to the initial (2003) value for presentation purposes. Over the time series recruitment shows a decreasing trend until 2012 and an inversion afterwards, which may reflect an increase in stock's production, although the characteristics of the indicator, a decadal ratio, makes it difficult to clearly interpret these results. For example the 2017's decadal recruitment for a single stock is the ratio between the average recruitment from 2008 to 2017 over the average recruitment from 1998 to 2007. Yearly decadal recruitment ratios for each stock constitute the dataset used to fit the model, of which predictions are afterwards scaled to 2003 (check the protocol in Annex 1 for more details).

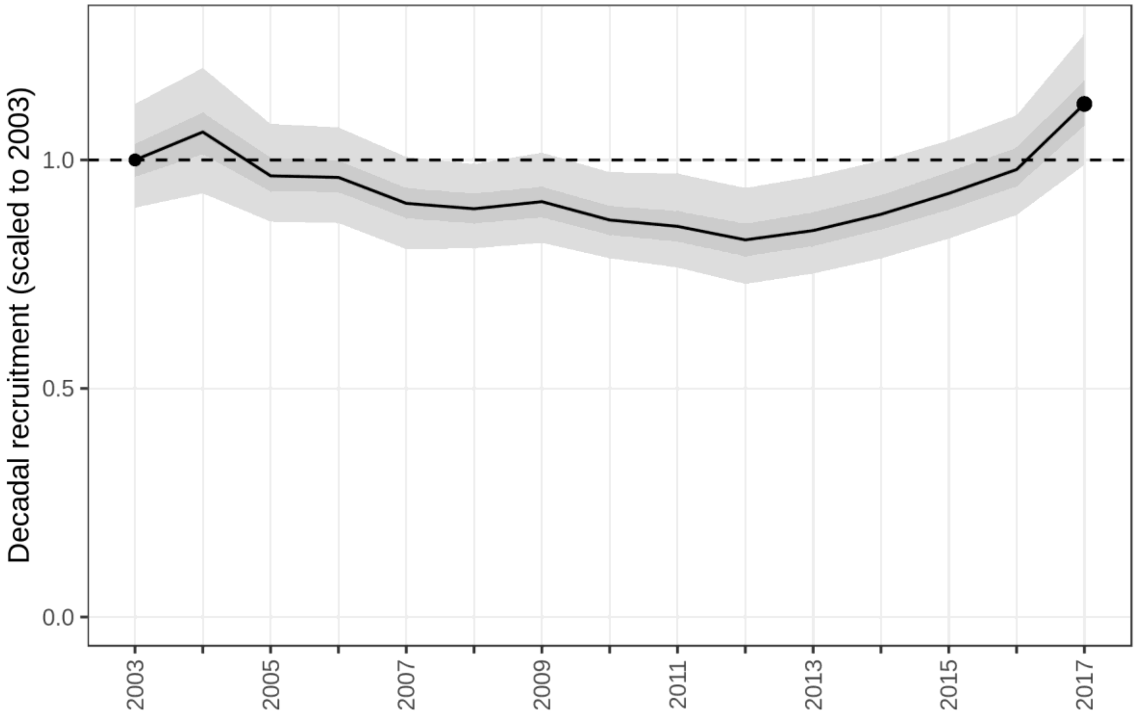

Figure 25. Trend in decadal recruitment scaled to 2003 (based in 55 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 17. Percentiles for decadal recruitment scaled to 2003.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.5%	0.90	0.93	0.86	0.86	0.80	0.81	0.82	0.78	0.76	0.73	0.75	0.78	0.83	0.88	0.99
25%	0.96	1.01	0.93	0.93	0.87	0.86	0.88	0.84	0.82	0.79	0.81	0.85	0.89	0.94	1.08
50%	1.00	1.06	0.97	0.96	0.91	0.89	0.91	0.87	0.85	0.83	0.85	0.88	0.93	0.98	1.12
75%	1.03	1.10	1.00	1.00	0.94	0.93	0.94	0.90	0.89	0.86	0.89	0.92	0.97	1.03	1.17
97.5%	1.12	1.20	1.08	1.07	1.01	0.99	1.02	0.97	0.97	0.94	0.96	1.00	1.04	1.10	1.28

Trends in decadal recruitment ratios by ecoregion and year are given in Figure 26 and Table 18. The regional analysis was carried out using the same model applied to regional datasets. Due to the small number of stocks in each ecoregion (ranging from 6 in the Northeast Atlantic to 17 in the Greater North Sea) it wasn't possible to compute confidence intervals.

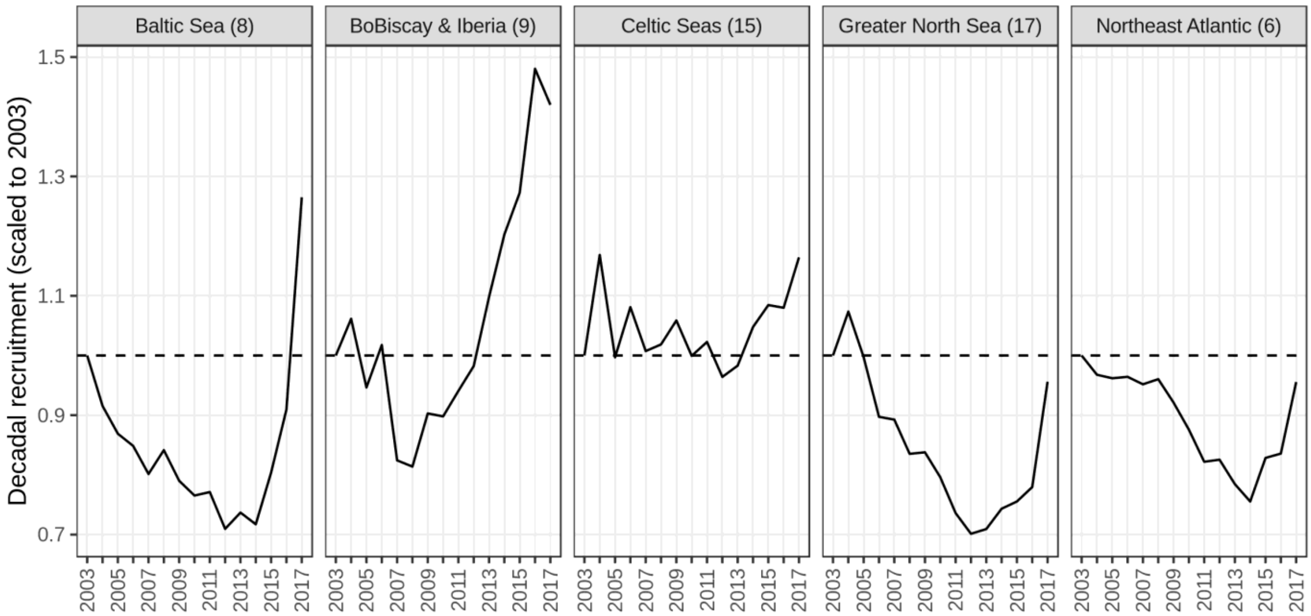

Figure 26. Trend in decadal recruitment scaled to 2003 by ecoregion. The number of stocks in each ecoregion are shown between parenthesis.

Table 18. Decadal recruitment scaled to 2003 by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Baltic Sea	1.00	0.92	0.87	0.85	0.80	0.84	0.79	0.77	0.77	0.71	0.74	0.72	0.80	0.91	1.27
BoBiscay & Iberia	1.00	1.06	0.95	1.02	0.82	0.81	0.90	0.90	0.94	0.98	1.10	1.20	1.27	1.48	1.42
Celtic Seas	1.00	1.17	1.00	1.08	1.01	1.02	1.06	1.00	1.02	0.96	0.98	1.05	1.08	1.08	1.16
Greater North Sea	1.00	1.07	1.00	0.90	0.89	0.84	0.84	0.80	0.74	0.70	0.71	0.74	0.76	0.78	0.96
Northeast Atlantic	1.00	0.97	0.96	0.96	0.95	0.96	0.92	0.88	0.82	0.83	0.78	0.76	0.83	0.84	0.96

3.3 Indicators of advice coverage

The indicator of advice coverage computes the number of stocks for which the reference points, F_{MSY}, F_{PA}, $MSYB_{trigger}$ and B_{PA} are available and the number of associated TACs (Table 19). Note that provided part of a given TAC management area overlaps with part of a stock assessment area, the setting of the TAC is considered as being based on the relevant stock assessment. Consequently, the advice coverage indicator is biased upwards if compared with the full spatial coverage of TAC areas by stock assessments.

Table 19. Coverage of TACs by scientific advice (ICES categories 1+2).

	No of stocks	No of TACs	No of TACs based on stock assessments	Fraction of TACs based on stock assessments
Fmsy	70	156	86	0.55
MSYBtrigger	32	156	31	0.20
Fpa	47	156	74	0.47
Bpa	53	156	78	0.50

4 MEDITERRANEAN AND BLACK SEA (FAO REGION 37)

During the period 2003-2009 the number of stocks assessments available increased from 21 up to 47. The number of stock assessments was stable until 2015 and decreased to 40 in 2016 (Figure 27 and Figure 28).

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. Consequently, only the model-based indicators for trends in F/FMSY and SSB are shown.

Nevertheless, the indicator values presented (Figure 29 to Figure 32, and Table 21 to Table 24) are not very robust due to the large changes in the number of stocks available to fit the model, and therefore the results should be interpreted with caution.

Figure 27 indicates by year the number of stocks in the Mediterranean and Black Seas for which estimates of F/F_{MSY} are available. The number of stock assessments available in 2017, 18, is due to:

- STECF EWG part I carried out analytical assessments for 13 out of 18 stocks (STECF 2018d).
- STECF EWG part II carried out analytical assessments for 6 out of 7 stocks (STECF, 2018e).
- STECF EWG on Black Sea stock assessment did not take place in 2018.
- GFCM assessments performed during 2018 in WGSASP and WGSADM were not published by the time this report was written, pending review and approval by GFCM’s Scientific Advisory Committee.

Table 20 shows the stocks added to the current exercise.

Due to the reduced numbers of stock assessments available for 2017 the indicators are plotted up to 2016 only and 2017’s value is represented as stand-alone in Figure 27.

With relation to last year's report (STECF, 2018c) the following stocks were not included in the current analysis:

- Rapana whelk (RPW_GSA29): the stock status evaluation was done using a catch only model (CMSY).

- Common cuttlefish (CTC_GSA17_18): the stock status evaluation was done using a catch only model (CMSY).

- Whiting (WHG_GSA29): reference point (namely F corresponding to E=0.4) is from STECF report EWG 15-16 (https://stecf.jrc.ec.europa.eu/documents/43805/1208033/STECF+15-16+-+Black+Sea+assessments.pdf/76f2f13e-8afa-4fb1-96df-7e29520c7ea5)

- Mediterranean Horse Mackerel (HMM_GSA29): reference point (namely F corresponding to E=0.4) is from STECF report EWG 15-16 (https://stecf.jrc.ec.europa.eu/documents/43805/1208033/STECF+15-16+-+Black+Sea+assessments.pdf/76f2f13e-8afa-4fb1-96df-7e29520c7ea5)

- Giant red shrimp in GSA 18-19 (ARS_18_19) was dropped in this year analysis as the latest assessment was done in 2014, therefore it fell outside the range used to estimate the indicators.

- Giant red shrimp assessments in GSA 9, 10 , 11 (ARS_9, ARS_10, ARS_11) from 2017 were dropped as a joint assessment (ARS_9_10_11) was available from the 2018 stock assessment.

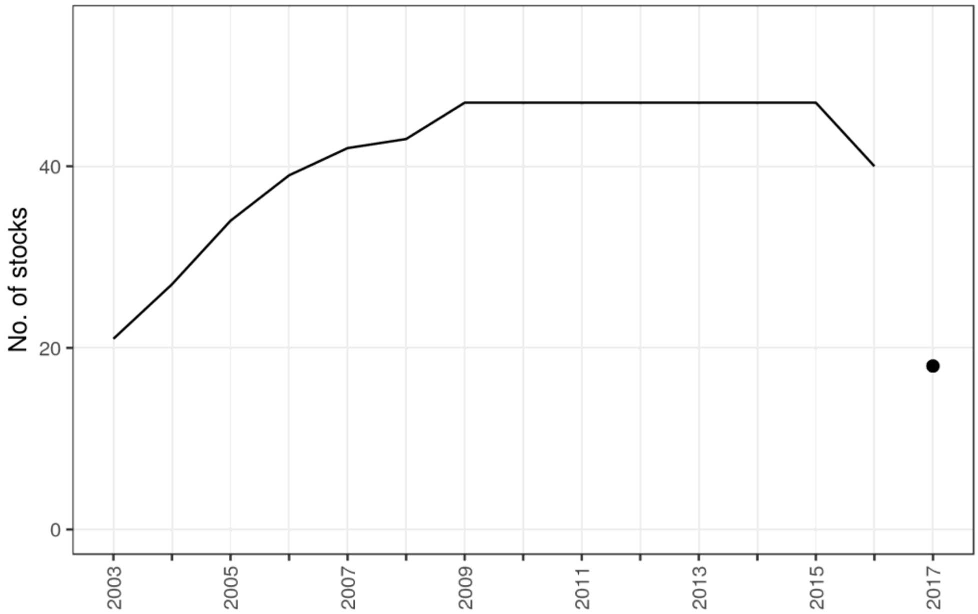

Figure 27. Number of stock assessments available in the Mediterranean and Black Sea. The totals include stocks in GSAs 1, 5-7, 9, 10-19, 22-23, 25 and 29.

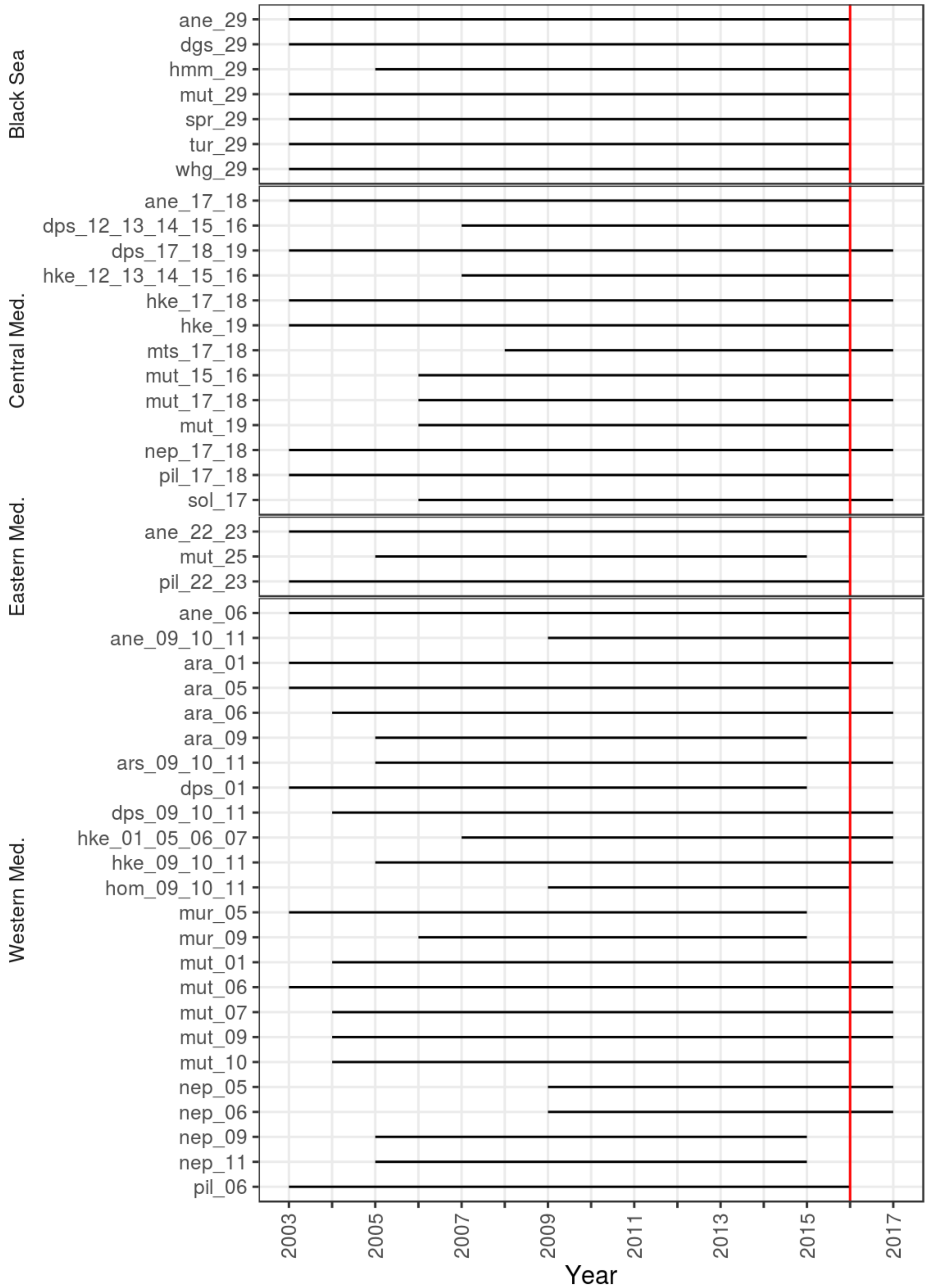

Figure 28. Time-series of stock assessments available from both STECF and GFCM for computation of model based CFP monitoring indicators for Mediterranean and Black Seas. The red line indicates that only stock assessment results up to and including 2016 were used to compute the indicator values.

Table 20. Stocks used in the current exercise.

EcoRegion	Year	Stock	Description	Updated	New stock	Source
Black sea	2016	ane_29	European anchovy in GSA 29	2016		STECF
Black sea	2016	dgs_29	Picked dogfish in GSA 29	2016		STECF
Black sea	2016	mut_29	Red mullet in GSA 29	2016		STECF
Black sea	2016	hmm_29	Mediterranean Horse Mackerel in GSA 29	2016		STECF
Black Sea	2016	whg_29	Whiting in GSA 29	2016		STECF
Black sea	2016	tur_29	Turbot in GSA 29	2016		STECF
Black sea	2016	spr_29	Sprattus sprattus in GSA 29	2016		STECF
Central Med.	2016	ane_17_18	European anchovy in GSA 17, 18	2016		GFCM
Central Med.	2016	nep_17_18	Nephrops in GSA 17, 18	2017		STECF
Central Med.	2016	pil_17_18	European pilchard(=Sardine) in GSA 17, 18	2016		GFCM
Central Med.	2016	dps_17_18_19	Deep-water rose shrimp in GSA 17, 18, 19	2017		STECF
Central Med.	2016	hke_17_18	European hake in GSA 17, 18	2017		STECF
Central Med.	2016	hke_19	European hake in GSA 19	2016		STECF
Central Med.	2016	mts_17_18	Spottail mantis squillid in GSA 17, 18	2017		STECF
Central Med.	2014	mut_17_18	Red mullet in GSA 17, 18	2017		STECF
Central Med.	2016	sol_17	Common sole in GSA 17	2017		STECF
Central Med.	2015	mut_15_16	Red mullet in GSA 15,16	2016		GFCM
Central Med.	2016	mut_19	Red mullet in GSA 19	2016		STECF
Central Med.	2015	hke_12_13_14_15_16	Merluccius merluccius in GSA 12, 13, 14, 15, 16	2016		GFCM
Central Med.	2015	dps_12_13_14_15_16	Parapenaeus longirostris in GSA 12, 13, 14, 15, 16	2016		GFCM
Eastern Med.	2016	ane_22_23	European anchovy in GSA 22, 23	2016		STECF
Eastern Med.	2015	mut_25	Mullus barbatus in GSA 25	2015		GFCM
Eastern Med.	2016	pil_22_23	European pilchard(=Sardine) in GSA 22, 23	2016		STECF
Western Med.	2016	ane_09_10_11	European anchovy in GSA 9, 10, 11	2016		STECF
Western Med.	2016	ane_06	Anchovy in GSA 6	2016		STECF
Western Med.	2015	dps_01	Deep-water rose shrimp in GSA 1	2015		STECF
Western Med.	2015	mut_07	Red mullet in GSA 7	2017		STECF
Western Med.	2015	dps_09_10_11	Deep-water rose shrimp in GSA 9, 10, 11	2017		STECF
Western Med.	2015	mur_09	Striped red mullet in GSA 9	2015		STECF
Western Med.	2015	ara_09	Blue and red shrimp in GSA 9	2015		GFCM
Western Med.	2017	ars_09_10_11	Giant red shrimp in GSA 9, 10, 11	2017	Y	STECF
Western Med.	2015	nep_09	Norway lobster in GSA 9	2015		STECF
Western Med.	2017	nep_05	Norway lobster in GSA 5	2017	Y	STECF
Western Med.	2015	nep_06	Norway lobster in GSA 6	2017		STECF
Western Med.	2015	nep_11	Norway lobster in GSA 11	2015		STECF

EcoRegion	Year	Stock	Description	Updated	New stock	Source
Western Med.	2015	ara_01	Blue and red shrimp in GSA 1	2017		STECF
Western Med.	2015	mur_05	Striped red mullet in GSA 5	2015		GFCM
Western Med.	2016	pil_06	European pilchard(=Sardine) in GSA 6	2016		STECF
Western Med.	2015	ara_06	Blue and red shrimp in GSA 6	2017		STECF
Western Med.	2014	hke_01_05_06_07	European hake in GSA 1, 5, 6, 7	2017		STECF
Western Med.	2014	hke_09_10_11	European hake in GSA 9, 10, 11	2017		STECF
Western Med.	2016	hom_09_10_11	Atlantic horse mackerel in GSA 9, 10, 11	2016		STECF
Western Med.	2017	mut_01	Red mullet in GSA 1	2017	Y	STECF
Western Med.	2015	mut_06	Red mullet in GSA 6	2017		STECF
Western Med.	2017	mut_09	Red mullet in GSA 9	2017	Y	STECF
Western Med.	2016	mut_10	Red mullet in GSA 10	2016	Y	STECF
Western Med.	2015	ara_05	Aristeus antennatus in GSA 5	2016		GFCM

4.1 Indicators of management performance

4.1.1 Trend in F/F_{MSY}

The model used is a mixed linear model, described in the protocol (Annex I). Values for 2017 were removed from the model fit. Bootstrapped quantiles of F/F_{MSY} are displayed in Figure 29 and Table 21. The 50% quantile (black line, equivalent to the median) shows an overall level varying around 2.4 for the whole time series, indicating that the stocks are exploited well above the CFP management objectives. In the Mediterranean and Black Seas assessments, a more conservative proxy for F_{MSY}, $F_{0.1}$, is commonly used resulting in a higher F/F_{MSY} ratio. There is a decreasing trend since 2011, from 2.7 to 2.2, which indicates a small improvement in exploitation. Nevertheless, the instability in the dataset used may have an impact in the results. In 2018 there were 47 stocks of which 14 were new, this year there are 47 stocks again although 5 are new and 5 are dropped.

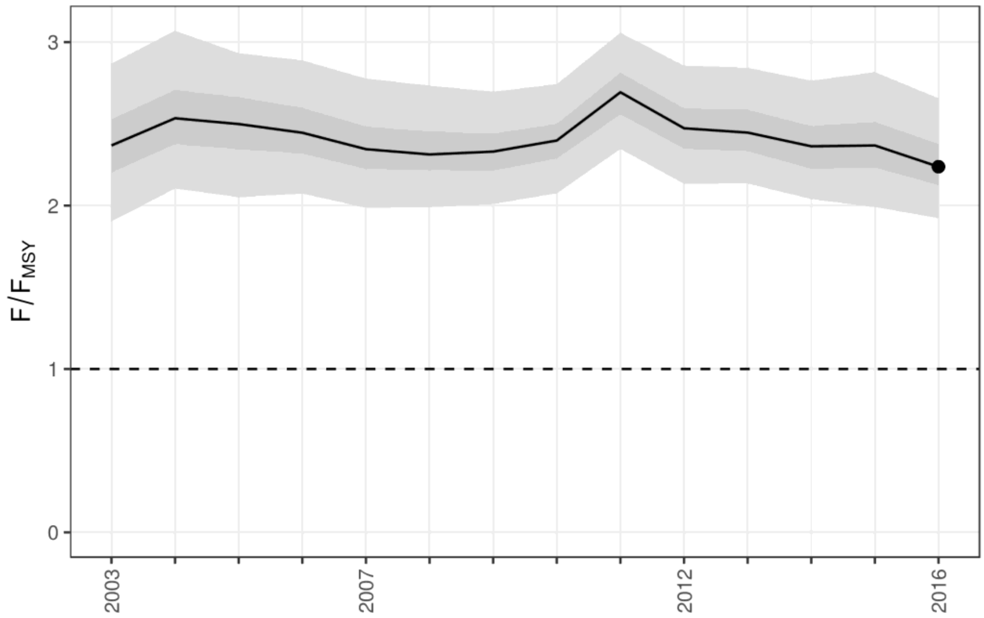

Figure 29. Trend in F/F_{MSY} (based in 47 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 21. Percentiles for F/FMSY.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2.5%	1.90	2.10	2.05	2.07	1.99	1.99	2.01	2.07	2.35	2.13	2.14	2.04	1.99	1.92
25%	2.20	2.38	2.35	2.32	2.23	2.22	2.22	2.29	2.56	2.35	2.33	2.23	2.23	2.13
50%	2.37	2.53	2.50	2.45	2.34	2.31	2.33	2.40	2.69	2.47	2.45	2.36	2.37	2.24
75%	2.53	2.71	2.66	2.60	2.48	2.45	2.44	2.50	2.81	2.59	2.58	2.48	2.51	2.38
97.5%	2.87	3.07	2.93	2.89	2.78	2.73	2.70	2.74	3.06	2.86	2.84	2.76	2.82	2.66

Dividing the trend by ecoregion it is highlighted that the analysis is driven by the Western med and the Central med ecoregions, where the number of stocks available is 24 and 13 respectively (Figure 30 and Table 22).

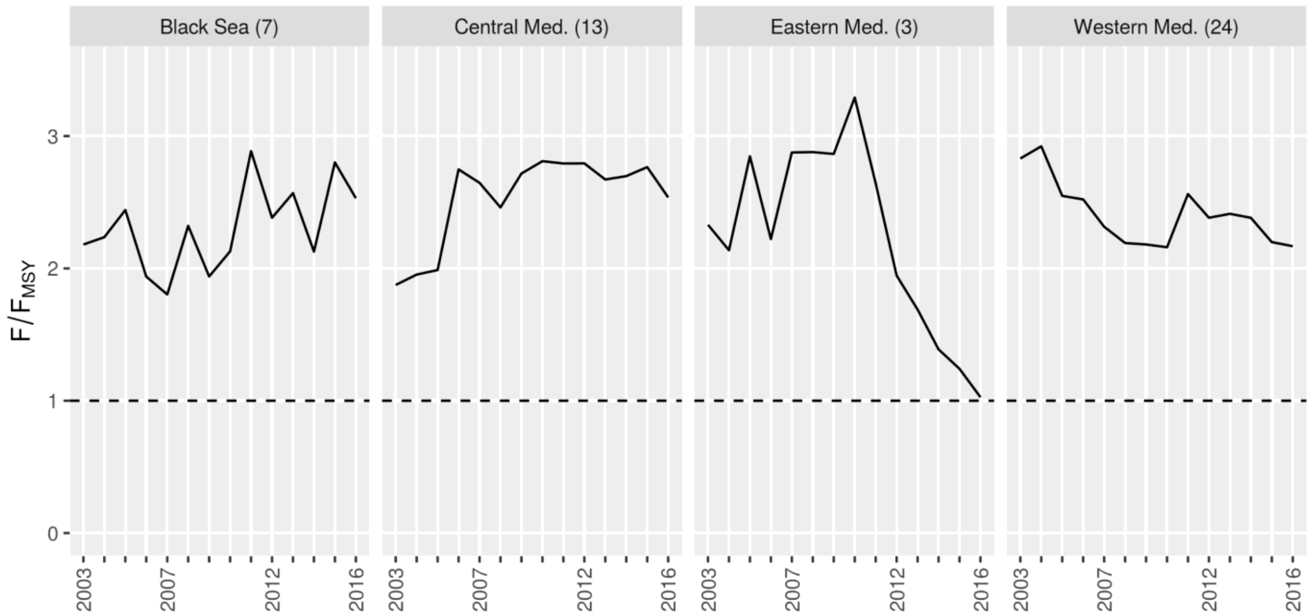

Figure 30. Trend in F/F_{MSY} by region. The number of stocks in each ecoregion are shown between parenthesis.

Table 22. F/FMSY by ecoregion**.**

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Black Sea	2.18	2.24	2.44	1.94	1.80	2.32	1.94	2.13	2.89	2.38	2.57	2.13	2.80	2.53
Cent. Med.	1.87	1.95	1.99	2.75	2.65	2.46	2.72	2.81	2.79	2.79	2.67	2.70	2.77	2.54
East Med.	2.33	2.14	2.85	2.22	2.88	2.88	2.87	3.29	2.64	1.95	1.69	1.39	1.24	1.03
West Med.	2.83	2.92	2.55	2.52	2.31	2.19	2.18	2.16	2.56	2.38	2.41	2.38	2.20	2.17

4.1.2 Trend in SSB (relative to 2003)

The 50% quantile (black line), has varied around 1 (Figure 31 and Table 23). There is an increasing trend since 2012, although it may reflect changes in the dataset available, as previously indicated. Quantiles are very large, representing a high level of uncertainty. The trends estimated by ecoregion (Figure 32 and Table 24) show the high variability between ecoregions not only in trends but mainly in the number of stocks by ecoregion as reported in the previous indicator.

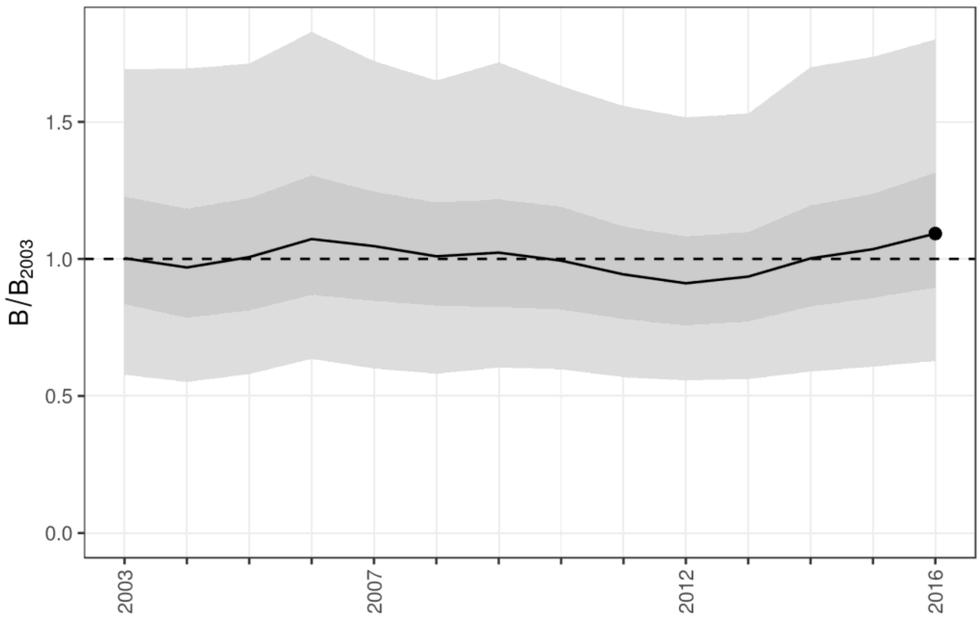

Figure 31. Trend in SSB relative to 2003 (based in 45 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 23. Percentiles for SSB relative to 2003**.**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2.50%	0.58	0.55	0.58	0.64	0.60	0.58	0.60	0.60	0.57	0.56	0.56	0.59	0.61	0.63
25%	0.84	0.79	0.81	0.87	0.85	0.83	0.83	0.82	0.78	0.76	0.77	0.83	0.86	0.90
50%	1.00	0.97	1.01	1.07	1.05	1.01	1.02	0.99	0.94	0.91	0.94	1.00	1.04	1.09
75%	1.23	1.18	1.22	1.30	1.24	1.21	1.22	1.19	1.12	1.08	1.10	1.19	1.24	1.31
97.50%	1.69	1.69	1.71	1.83	1.72	1.65	1.72	1.63	1.56	1.52	1.53	1.70	1.74	1.80

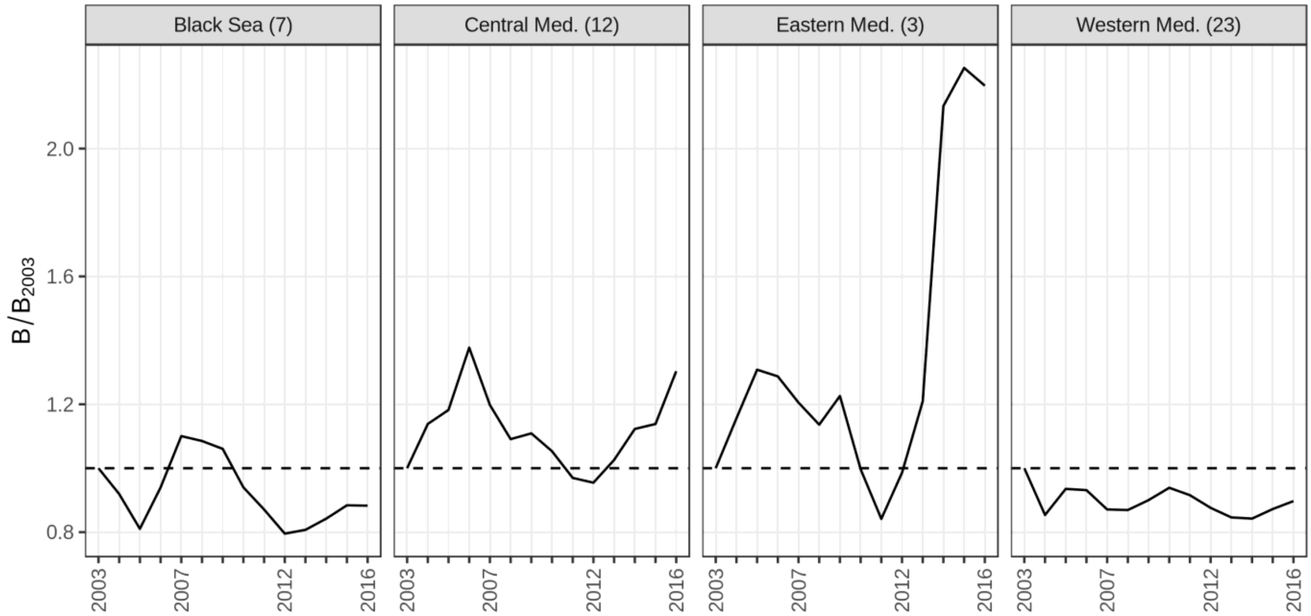

Figure 32 Trend in SSB relative to 2003 by ecoregion. The number of stocks in each ecoregion are shown between parenthesis.

Table 24. SSB relative to 2003 by ecoregion**.**

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Black Sea	1	0.92	0.81	0.94	1.10	1.09	1.06	0.94	0.87	0.80	0.81	0.84	0.88	0.88
Cent.Med.	1	1.14	1.18	1.38	1.20	1.09	1.11	1.05	0.97	0.95	1.03	1.12	1.14	1.30
East Med.	1	1.16	1.31	1.29	1.21	1.14	1.23	1.00	0.84	0.99	1.21	2.13	2.25	2.20
West Med.	1	0.85	0.94	0.93	0.87	0.87	0.90	0.94	0.92	0.88	0.85	0.84	0.87	0.90

4.2 Indicators of advice coverage

In the Mediterranean and the Black Seas a total of 249 stocks were considered for the current exercise, of which 73 have stock assessments carried out between 2016 and 2018. The advice coverage for the Mediterranean and the Black Sea is 0.29.

5 STATUS ACROSS ALL STOCKS IN 2017

Table 25. Stock status for all stocks in the analysis. Columns refer to ecoregion, last year for which the estimated was obtained, stock code and description, value of F/F_{MSY} ratio (F ind), if F is lower than F_{MSY} (F status), if the stock is inside safe biological limits (SBL), and if the stock has F above F_{MSY} or SSB below B_{MSY} ($F\sim F_{MSY}$ v $SSB\sim B_{MSY}$). Stocks managed under escapement strategies dot not have an estimate of F/F_{MSY}. Symbol 'o' stands for 'YES', an empty cell stands for 'NO' and '-' unknown due to missing information**.**

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F\sim F_{MSY}$ V $B\sim B_{MSY}$
FAO27	Baltic Sea	2017	cod.27.22-24	Cod (Gadus morhua) in subdivisions 22-24. western Baltic stock (western Baltic Sea)	2.31			-
FAO27	Baltic Sea	2017	her.27.20-24	Herring (Clupea harengus) in subdivisions 20-24. spring spawners (Skagerrak. Kattegat. and western Baltic)	1.07			-
FAO27	Baltic Sea	2017	her.27.25-2932	Herring (Clupea harengus) in subdivisions 25-29 and 32. excluding the Gulf of Riga (central Baltic Sea)	1.25		o	-
FAO27	Baltic Sea	2017	her.27.28	Herring (Clupea harengus) in Subdivision 28.1 (Gulf of Riga)	1.00		o	
FAO27	Baltic Sea	2017	her.27.3031	Herring (Clupea harengus) in subdivisions 30 and 31 (Gulf of Bothnia)	1.19		-	
FAO27	Baltic Sea	2017	ple.27.21-23	Plaice (Pleuronectes platessa) in subdivisions 21-23 (Kattegat. Belt Seas. and the Sound)	0.69	o	o	-
FAO27	Baltic Sea	2017	sol.27.20-24	Sole (Solea solea) in subdivisions 20-24 (Skagerrak and Kattegat. western Baltic Sea)	1.21			-
FAO27	Baltic Sea	2017	spr.27.22-32	Sprat (Sprattus sprattus) in subdivisions 22-32 (Baltic Sea)	1.07		o	-
FAO27	BoBiscay & Iberia	2017	ane.27.8	Anchovy (Engraulis encrasicolus) in Subarea 8 (Bay of Biscay)	-	o	-	-
FAO27	BoBiscay & Iberia	2017	hke.27.8c9a	Hake (Merluccius merluccius) in divisions 8.c and 9.a. Southern stock (Cantabrian Sea and Atlantic Iberian waters)	1.76		o	-
FAO27	BoBiscay & Iberia	2017	hom.27.9a	Horse mackerel (Trachurus trachurus) in Division 9.a (Atlantic Iberian waters)	0.40	o	o	-
FAO27	BoBiscay & Iberia	2017	ldb.27.8c9a	Four-spot megrim (Lepidorhombus boscii) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East)	0.92	o	o	-
FAO27	BoBiscay & Iberia	2017	meg.27.7b-k8abd	Megrim (Lepidorhombus whiffiagonis) in divisions 7.b-k. 8.a-b. and 8.d (west and southwest of Ireland. Bay of Biscay)	1.15		o	-
FAO27	BoBiscay & Iberia	2017	meg.27.8c9a	Megrim (Lepidorhombus whiffiagonis) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.85	o	o	-
FAO27	BoBiscay & Iberia	2017	mon.27.78abd	White anglerfish (Lophius piscatorius) in Subarea 7 and divisions 8.a-b and 8.d (Celtic Seas. Bay of Biscay)	1.00		o	-

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$
FAO27	BoBiscay & Iberia	2017	mon.27.8c9a	White anglerfish (Lophius piscatorius) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.53	o	o	o
FAO27	BoBiscay & Iberia	2017	sol.27.8ab	Sole (Solea solea) in divisions 8.a-b (northern and central Bay of Biscay)	0.91	o	o	-
FAO27	Celtic Seas	2016	cod.27.6a	Cod (Gadus morhua) in Division 6.a (West of Scotland)	5.65			-
FAO27	Celtic Seas	2017	cod.27.7a	Cod (Gadus morhua) in Division 7.a (Irish Sea)	0.09	o		-
FAO27	Celtic Seas	2017	cod.27.7e-k	Cod (Gadus morhua) in divisions 7.e-k (eastern English Channel and southern Celtic Seas)	1.73			-
FAO27	Celtic Seas	2017	had.27.6b	Haddock (Melanogrammus aeglefinus) in Division 6.b (Rockall)	0.78	o	o	-
FAO27	Celtic Seas	2017	had.27.7a	Haddock (Melanogrammus aeglefinus) in Division 7.a (Irish Sea)	0.48	o	o	o
FAO27	Celtic Seas	2017	had.27.7b-k	Haddock (Melanogrammus aeglefinus) in divisions 7.b-k (southern Celtic Seas and English Channel)	1.64		o	-
FAO27	Celtic Seas	2017	her.27.6a7bc	Herring (Clupea harengus) in divisions 6.a and 7.b-c (West of Scotland. West of Ireland)	0.38	o		-
FAO27	Celtic Seas	2017	her.27.irls	Herring (Clupea harengus) in divisions 7.a South of 52Â°30â€™N. 7.g-h. and 7.j-k (Irish Sea. Celtic Sea. and southwest of Ireland)	1.58			
FAO27	Celtic Seas	2017	her.27.nirs	Herring (Clupea harengus) in Division 7.a North of 52Â°30â€™N (Irish Sea)	0.56	o	o	-
FAO27	Celtic Seas	2017	lez.27.4a6a	Megrim (Lepidorhombus spp.) in divisions 4.a and 6.a (northern North Sea. West of Scotland)	0.33	o	-	o
FAO27	Celtic Seas	2017	nep.fu.11	Norway lobster (Nephrops norvegicus) in Division 6.a. Functional Unit 11 (West of Scotland. North Minch)	0.86	o	-	o
FAO27	Celtic Seas	2017	nep.fu.12	Norway lobster (Nephrops norvegicus) in Division 6.a. Functional Unit 12 (West of Scotland. South Minch)	0.85	o	-	o
FAO27	Celtic Seas	2017	nep.fu.13	Norway lobster (Nephrops norvegicus) in Division 6.a. Functional Unit 13 (West of Scotland. the Firth of Clyde and Sound of Jura)	1.16		-	
FAO27	Celtic Seas	2017	nep.fu.14	Norway lobster (Nephrops norvegicus) in Division 7.a. Functional Unit 14 (Irish Sea. East)	0.26	o	-	o
FAO27	Celtic Seas	2017	nep.fu.15	Norway lobster (Nephrops norvegicus) in Division 7.a. Functional Unit 15 (Irish Sea. West)	0.58	o	-	o
FAO27	Celtic Seas	2017	nep.fu.16	Norway lobster (Nephrops norvegicus) in divisions 7.b-c and 7.j-k. Functional Unit 16 (west and southwest of Ireland. Porcupine Bank)	1.61		-	-
FAO27	Celtic Seas	2017	nep.fu.17	Norway lobster (Nephrops norvegicus) in Division 7.b. Functional Unit 17 (west of Ireland. Aran grounds)	0.47	o	-	
FAO27	Celtic Seas	2017	nep.fu.19	Norway lobster (Nephrops norvegicus) in divisions 7.a. 7.g. and 7.j. Functional Unit 19 (Irish Sea. Celtic Sea. eastern part of southwest of Ireland)	0.47	o	-	o
FAO27	Celtic Seas	2017	nep.fu.2021	Norway lobster (Nephrops norvegicus) in divisions 7.g and 7.h. Functional Units 20 and 21 (Celtic Sea)	0.28	o	-	-

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$
FAO27	Celtic Seas	2017	nep.fu.22	Norway lobster (Nephrops norvegicus) in divisions 7.g and 7.f. Functional Unit 22 (Celtic Sea. Bristol Channel)	0.95	o	-	o
FAO27	Celtic Seas	2017	ple.27.7a	Plaice (Pleuronectes platessa) in Division 7.a (Irish Sea)	0.39	o	o	o
FAO27	Celtic Seas	2017	sol.27.7a	Sole (Solea solea) in Division 7.a (Irish Sea)	0.09	o		-
FAO27	Celtic Seas	2017	sol.27.7fg	Sole (Solea solea) in divisions 7.f and 7.g (Bristol Channel. Celtic Sea)	1.46			-
FAO27	Celtic Seas	2017	whg.27.6a	Whiting (Merlangius merlangus) in Division 6.a (West of Scotland)	0.23	o		-
FAO27	Celtic Seas	2016	whg.27.7a	Whiting (Merlangius merlangus) in Division 7.a (Irish Sea)	2.59			-
FAO27	Celtic Seas	2017	whg.27.7b-ce-k	Whiting (Merlangius merlangus) in divisions 7.b-c and 7.e-k (southern Celtic Seas and eastern English Channel)	1.04		o	-
FAO27	Greater North Sea	2017	cod.27.47d20	Cod (Gadus morhua) in Subarea 4. Division 7.d. and Subdivision 20 (North Sea. eastern English Channel. Skagerrak)	1.42			-
FAO27	Greater North Sea	2017	had.27.46a20	Haddock (Melanogrammus aeglefinus) in Subarea 4. Division 6.a. and Subdivision 20 (North Sea. West of Scotland. Skagerrak)	1.30		o	-
FAO27	Greater North Sea	2017	her.27.3a47d	Herring (Clupea harengus) in Subarea 4 and divisions 3.a and 7.d. autumn spawners (North Sea. Skagerrak and Kattegat. eastern English Channel)	0.81	o	o	o
FAO27	Greater North Sea	2017	nep.fu.6	Norway lobster (Nephrops norvegicus) in Division 4.b. Functional Unit 6 (central North Sea. Farn Deeps)	0.96	o	-	o
FAO27	Greater North Sea	2017	nep.fu.7	Norway lobster (Nephrops norvegicus) in Division 4.a. Functional Unit 7 (northern North Sea. Fladen Ground)	0.41	o	-	o
FAO27	Greater North Sea	2017	nep.fu.8	Norway lobster (Nephrops norvegicus) in Division 4.b. Functional Unit 8 (central North Sea. Firth of Forth)	1.21		-	
FAO27	Greater North Sea	2017	nep.fu.9	Norway lobster (Nephrops norvegicus) in Division 4.b. Functional Unit 9 (central North Sea. Moray Firth)	0.89	o	-	o
FAO27	Greater North Sea	2017	nop.27.3a4	Norway pout (Trisopterus esmarkii) in Subarea 4 and Division 3.a (North Sea. Skagerrak and Kattegat)	-		-	-
FAO27	Greater North Sea	2017	ple.27.420	Plaice (Pleuronectes platessa) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	0.95	o	o	o
FAO27	Greater North Sea	2017	ple.27.7d	Plaice (Pleuronectes platessa) in Division 7.d (eastern English Channel)	0.80	o	o	-
FAO27	Greater North Sea	2017	pok.27.3a46	Saithe (Pollachius virens) in subareas 4. 6 and Division 3.a (North Sea. Rockall and West of Scotland. Skagerrak and Kattegat)	0.90	o	o	-
FAO27	Greater North Sea	2017	pra.27.3a4a	Northern shrimp (Pandalus borealis) in divisions 3.a and 4.a East (Skagerrak and Kattegat and northern North Sea in the Norwegian Deep)	1.19			
FAO27	Greater North Sea	2017	san.sa.1r	Sandeel (Ammodytes spp.) in divisions 4.b and 4.c. Sandeel Area 1r (central and southern North Sea. Dogger Bank)	-	o	-	-
FAO27	Greater North Sea	2017	san.sa.2r	Sandeel (Ammodytes spp.) in divisions 4.b and 4.c. and Subdivision 20. Sandeel Area 2r (Skagerrak. central and southern North Sea)	-		-	-

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$
FAO27	Greater North Sea	2017	san.sa.3r	Sandeel (Ammodytes spp.) in divisions 4.a and 4.b. and Subdivision 20. Sandeel Area 3r (Skagerrak. northern and central North Sea)	-	o	-	-
FAO27	Greater North Sea	2017	san.sa.4	Sandeel (Ammodytes spp.) in divisions 4.a and 4.b. Sandeel Area 4 (northern and central North Sea)	-	o	-	-
FAO27	Greater North Sea	2017	sol.27.4	Sole (Solea solea) in Subarea 4 (North Sea)	1.09		o	-
FAO27	Greater North Sea	2017	sol.27.7d	Sole (Solea solea) in Division 7.d (eastern English Channel)	0.94	o		-
FAO27	Greater North Sea	2017	sol.27.7e	Sole (Solea solea) in Division 7.e (western English Channel)	0.74	o	o	o
FAO27	Greater North Sea	2017	spr.27.4	Sprat (Sprattus sprattus) in Subarea 4 (North Sea)	-	o	-	-
FAO27	Greater North Sea	2017	whg.27.47d	Whiting (Merlangius merlangus) in Subarea 4 and Division 7.d (North Sea and eastern English Channel)	1.27		o	-
FAO27	Northeast Atlantic	2017	bli.27.5b67	Blue ling (Molva dypterygia) in subareas 6-7 and Division 5.b (Celtic Seas. English Channel. and Faroes grounds)	0.25	o	o	-
FAO27	Northeast Atlantic	2017	dgs.27.nea	Spurdog (Squalus acanthias) in subareas 1-10. 12 and 14 (the Northeast Atlantic and adjacent waters)	0.29	o	-	
FAO27	Northeast Atlantic	2017	hke.27.3a46-8abd	Hake (Merluccius merluccius) in subareas 4. 6. and 7. and divisions 3.a. 8.a-b. and 8.d. Northern stock (Greater North Sea. Celtic Seas. and the northern Bay of Biscay)	0.89	o	o	-
FAO27	Northeast Atlantic	2017	hom.27.2a4a5b6a7a-ce-k8	Horse mackerel (Trachurus trachurus) in Subarea 8 and divisions 2.a. 4.a. 5.b. 6.a. 7.a-c.e-k (the Northeast Atlantic)	0.62	o		
FAO27	Northeast Atlantic	2017	mac.27.nea	Mackerel (Scomber scombrus) in subareas 1-8 and 14 and Division 9.a (the Northeast Atlantic and adjacent waters)	1.82			-
FAO27	Northeast Atlantic	2017	whb.27.1-91214	Blue whiting (Micromesistius poutassou) in subareas 1-9. 12. and 14 (Northeast Atlantic and adjacent waters)	1.47		o	-
FAO37	Black Sea	2016	ane_29	European anchovy in GSA 29	1.29		-	-
FAO37	Black Sea	2016	dgs_29	Piked dogfish in GSA 29	11.74		-	-
FAO37	Black Sea	2016	hmm_29	Horse mackerel in GSA 29	3.62		-	-
FAO37	Black Sea	2016	mut_29	Red mullet in GSA 29	1.48		-	-
FAO37	Black Sea	2016	spr_29	European sprat in GSA 29	0.85	o	-	-
FAO37	Black Sea	2016	tur_29	Turbot in GSA 29	3.74		-	-
FAO37	Black Sea	2016	whg_29	Whiting in GSA 29	1.85		-	-
FAO37	Central Med.	2016	ane_17_18	European anchovy in GSA 17, 18	2.23		-	-
FAO37	Central Med.	2016	dps_12_13_14_15_16	Deep_water rose shrimp in GSA 12, 13, 14, 15, 16	1.71		-	-

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$
FAO37	Central Med.	2016	dps_17_18_19	Deep-water rose shrimp in GSA 17, 18, 19	2.85		-	-
FAO37	Central Med.	2016	hke_12_13_14_15_16	European hake in GSA 12, 13, 14, 15, 16	3.05		-	-
FAO37	Central Med.	2016	hke_17_18	European hake in GSA 17, 18	4.00		-	-
FAO37	Central Med.	2016	hke_19	European hake in GSA 19	8.88		-	-
FAO37	Central Med.	2016	mts_17_18	Spottail mantis shrimp in GSA 17, 18	2.76		-	-
FAO37	Central Med.	2016	mut_15_16	Red mullet in GSA 15, 16	1.24		-	-
FAO37	Central Med.	2016	mut_17_18	Red mullet in GSA 17, 18	1.39		-	-
FAO37	Central Med.	2016	mut_19	Red mullet in GSA 19	1.56		-	-
FAO37	Central Med.	2016	nep_17_18	Norway lobster in GSA 17, 18	1.94		-	-
FAO37	Central Med.	2016	pil_17_18	Sardine in GSA 17, 18	2.77		-	-
FAO37	Central Med.	2016	sol_17	Common sole in GSA 17	1.96		-	-
FAO37	Eastern Med.	2016	ane_22_23	European anchovy in GSA 22, 23	0.99	o	-	-
FAO37	Eastern Med.	2015	mut_25	Red mullet in GSA 25	1.03		-	-
FAO37	Eastern Med.	2016	pil_22_23	Sardine in GSA 22, 23	1.06		-	-
FAO37	Western Med.	2016	ane_06	European anchovy in GSA 06	1.19		-	-
FAO37	Western Med.	2016	ane_09_10_11	European anchovy in GSA 09, 10, 11	1.53		-	-
FAO37	Western Med.	2016	ara_01	Blue and red shrimp in GSA 01	2.02		-	-
FAO37	Western Med.	2016	ara_05	Blue and red shrimp in GSA 05	1.48		-	-
FAO37	Western Med.	2016	ara_06	Blue and red shrimp in GSA 06	3.28		-	-
FAO37	Western Med.	2015	ara_09	Blue and red shrimp in GSA 09	0.84	o	-	-
FAO37	Western Med.	2016	ars_09_10_11	Giant red shrimp in GSA 09, 10, 11	1.07		-	-
FAO37	Western Med.	2015	dps_01	Deep-water rose shrimp in GSA 01	0.90	o	-	-
FAO37	Western Med.	2016	dps_09_10_11	Deep-water rose shrimp in GSA 09, 10, 11	2.05		-	-

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \sim F_{MSY}$ V $B \sim B_{MSY}$
FAO37	Western Med.	2016	hke_01_05_06_07	European Hake in GSA 01, 05, 06, 07	5.43		-	-
FAO37	Western Med.	2016	hke_09_10_11	European Hake in GSA 09, 10, 11	4.57		-	-
FAO37	Western Med.	2016	hom_09_10_11	Atlantic horse mackerel in GSA 09, 10, 11	2.43		-	-
FAO37	Western Med.	2015	mur_05	Striped red mullet in GSA 05	3.51		-	-
FAO37	Western Med.	2015	mur_09	Surmullet in GSA 09	0.95	o	-	-
FAO37	Western Med.	2016	mut_01	Red mullet in GSA 01	5.23		-	-
FAO37	Western Med.	2016	mut_06	Red mullet in GSA 06	5.50		-	-
FAO37	Western Med.	2016	mut_07	Red mullet in GSA 07	1.56		-	-
FAO37	Western Med.	2016	mut_09	Red mullet in GSA 09	2.28		-	-
FAO37	Western Med.	2016	mut_10	Red mullet in GSA 10	0.46	o	-	-
FAO37	Western Med.	2016	nep_05	Norway lobster in GSA 05	3.38		-	-
FAO37	Western Med.	2016	nep_06	Norway lobster in GSA 06	4.08		-	-
FAO37	Western Med.	2015	nep_09	Norway lobster in GSA 09	1.78		-	-
FAO37	Western Med.	2015	nep_11	Norway lobster in GSA 11	2.07		-	-
FAO37	Western Med.	2016	pil_06	Sardine in GSA 06	2.57		-	-

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7 CONTACT DETAILS OF EWG-ADHOC-19-01 PARTICIPANTS

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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8 List of Annexes

Electronic annexes are published on the meeting's web site on:
https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring

List of electronic annexes documents:

EWG - Adhoc - 19-01 – Annex 1 – URL links to the source reports by stock

EWG - Adhoc - 19-01 – Annex 2 – ICES data quality issues corrected prior to the analysis

9 Background Document

EWG-Adhoc-19-01 – Doc 1 -Declarations of JRC experts (see also section 7 of this report – List of participants)

10 ANNEX 1 – PROTOCOL

Protocol for the Monitoring of the Common Fisheries Policy
Version 4.0

January 31, 2019

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Contents

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

To make the process as consistent as possible, the following set of rules were developed to be used as a guiding protocol for computing the required indicators. The rules also contribute to the transparency of the process.

The protocol covers the three major elements in the process:

- Data issues: data sources, reference list of stocks, selection of stocks, etc;
- Indicators of management performance: description of the indicators, procedures for their computation and presentation format;
- Indicators of changes in advice coverage: description of the indicators, procedures for their computation and presentation format.

1.1 Scope

The monitoring of the CFP should cover all areas were 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 mainly focus on stocks within the EU EEZ in the FAO areas 27 (NEA: Northeast Atlantic and Adjacent Seas) and 37 (MED: Mediterranean and Black Sea).

The analysis will have two perspectives, at the global EU level and a regional overview where the indicators are computed for the following regions, if enough data is available:

- Baltic Sea (NEA)
- Greater North Sea (NEA)
- Celtic Sea (NEA)
- Bay of Biscay and Iberian Waters (NEA)
- Widely distributed stocks (NEA)
- Western Mediterranean (MED)
- Eastern Mediterranean (MED)
- Central Mediterranean (MED)
- Black Sea (MED)

1.2 Definitions

- f or F represent fishing mortality;
- b or B represent biomass, either as total stock biomass or spawning stock biomass (SSB);
- k represents a standardized biomass index, which is considered by experts to represent the evolution of biomass over time;
- r represents recruitment (young individuals entering the fishery) in number of individuals;

- F_{MSY} represents fishing mortality that produces catches at the level of MSY in an equilibrium situation, or a proxy;
- F_{PA} is the precautionary reference point for fishing mortality;
- B_{MSY} is the biomass expected to produce MSY when fished at F_{MSY} in an equilibrium situation, but also any other relevant proxy considered by the scientific advice body;
- B_{PA} is the precautionary reference point for spawning stock biomass;
- indices:
  - $j = 1 \ldots N$ indexes stocks, where N is the total number of stocks selected for the analysis;
  - $t = 1 \ldots T$ indexes years, where T is the number of years in the reported time series;
  - $m = 1 \ldots M$ indexes sampling units, where M is the total number of stocks in the reference list;
  - $s = 1 \ldots S$ indexes bootstrap simulations;
- operations:
  - $\vee$ stands for *or* in Boolean logic;
  - $\wedge$ stands for *and* in Boolean logic;
- model parameters:
  - u is a random effect in stock;
  - y is a fixed effect in year.

2 Data

2.1 Data sources

All indicators are computed using results from single species quantitative stock assessments. Time series of estimates of fishing mortality, spawning stock biomass, and the adopted biological reference points for each stock are to be provided by the International Council for the Exploration of the Sea (ICES), the General Fisheries Commission for the Mediterranean (GFCM) 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 and similar methods are not included. These models do not estimate time series of fishing mortality or spawning stock biomass.

Results from methods that directly estimate total abundance and/or harvest rate may be used for the computation of some indicators.

2.2 Reference list of stocks

The list of stocks to be used for computing indicators, hereafter termed the *reference list*, is used to stabilize the basis on which the indicators are computed. It assures that the relevant stocks are considered and constitutes the base for computing the scientific coverage of the advise. The reference list must include at least those stocks that are subject to direct management from the EU, as changes in their status can be linked more clearly to the implementation of the CFP.

Because of the differences in the nature and availability of data and information in different regions, region-specific reference lists were adopted for the EU waters:

- Northeast Atlantic (FAO area 27): The list of stocks comprises all stocks subject to management by Total Allowable Catch (TAC) limits.

- Mediterranean and Black Sea (FAO area 37): the list of stocks comprises all stocks of the species
  - anchovy (*Engraulis encrasicolus*)
  - blackbellied angler (*Lophius budegassa*)
  - blue and red shrimp (*Aristeus antennatus*)
  - giant red shrimp (*Aristaeomorpha foliacea*)
  - deep-water rose shrimp (*Parapenaeus longirostris*s)
  - hake (*Merluccius merluccius*)
  - striped red mullet (*Mullus surmuletus*)
  - red mullet (*Mullus barbatus*)
  - Norway lobster (*Nephrops norvegicus*)
  - sardine (*Sardina pilchardus*)
  - common sole (*Solea solea*)
  - sprat (*Sprattus sprattus*)
  - turbot (*Psetta maxima*)
  - blue whiting (*Micromesistius poutassou*)
  - whiting (*Merlangius merlangus*)

  plus the stocks ranked in the top ten in either landings or reported economic value over the 2012-2014 period.

2.3 Selection of stock assessments

- The stock assessments to be selected include all stock assessments carried out in the three years before the analysis, are listed in the reference list and have at least 5 years of estimates.
- Exploratory assessments or assessments not yet approved by the advisory bodies are not considered;
- When several stocks are merged in a single stock only the aggregated stock is considered, the reference list must be updated accordingly;
- When a stock is split in two (or more) stocks only the disaggregated stocks are considered, the reference list must be updated accordingly;
- If two assessments for the same stock exist the most recent one is kept.
- if two assessments in the same year for the same stock exist the one from the relevant RFMO is kept.

Selected stocks of which the stock assessment results don't cover the recent period of evaluation, the most recent estimates available will be kept constant and replicated up to the most recent year of the analysis.

3 Indicators of management performance

The indicators employed to monitor the performance of the CFP management regime reflect the evolution of exploitation status and conservation status.

The first group of indicators build a historical perspective by simply counting the number of stocks above/below a defined treshold in each year. A second group of indicators model a trend over time with a Generalized Linear Mixed Model (GLMM), using *stock* as a random effect, *year* as a fixed effect, and a Gamma distribution with a *log* link. The indicator is the model prediction of the *year* effect, and the indicator's uncertainty is computed with a block bootstrap procedure using *stock* as blocks. This model was tested in a simulation study[1] and in an application to Mediterranean stocks[2].

[1] Minto, C. 2015. Testing model based indicators for monitoring the CFP performance. Ad-hoc contract report, pp 14.

[2] Chato-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.

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

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

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

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

3.3 Number of stocks outside safe biological limits

$$I_t = \sum_{j=1}^{j=N} (f_{jt} > F_{PA} \vee b_{jt} < B_{PA})$$

3.4 Number of stocks inside safe biological limits

$$I_t = \sum_{j=1}^{j=N} (f_{jt} \leq F_{PA} \wedge b_{jt} \geq B_{PA})$$

3.5 Number of stocks where F is above F_{MSY} or SSB is below B_{MSY}

$$I_t = \sum_{j=1}^{j=N} (f_{jt} > F_{MSY} \vee b_{jt} < B_{MSY})$$

where in FAO 27

$$B_{MSY} = MSYB_{trigger}$$

3.6 Number of stocks where F is below or equal to F_{MSY} and SSB is above or equal to B_{MSY}

$$I_t = \sum_{j=1}^{j=N} (f_{jt} \leq F_{MSY} \wedge b_{jt} \geq B_{MSY})$$

where in FAO 27

$$B_{MSY} = MSYB_{trigger}$$

3.7 Trend in F/F_{MSY}

For these indicators stocks managed under escapement strategies and stocks for which fishing mortality was reported as a harvest rate are not included.

$$I_t = y_t$$

$$z_{jt} = \beta_0 + y_t + u_j$$

where

$$z_{jt} = \log E[\frac{f_{jt}}{F_{MSY}}]$$

and

$$\frac{f_{jt}}{F_{MSY}} \sim Gamma(\alpha, \beta)$$

3.8 Trend in SSB

For this indicator stocks for which biomass was reported as a relative value or total abundance are not included. This indicator is scaled to the 2003 estimate for presentational purposes.

$$I_t = median(\exp(\log y_{ts} - S^{-1} \sum_{s=1}^{s=S} \log y_{2003,s}))$$

$$z_{jt} = \beta_0 + y_t + u_j$$

where

$$z_{jt} = \log E[b_{jt}]$$

and

$$b_{jt} \sim Gamma(\alpha, \beta)$$

3.9 Trend in recruitment

The indicator is computed using the ratio between the average decadal recruitment of two following decades. For each year the previous decade and the decade before are used. The time window moves with years as such building the time series used for the indicator.

$$I_t = y_t$$

$$z_{jt} = \beta_0 + y_t + u_j$$

where

$$z_{jt} = \log E[d_{jt}]$$

and

$$d_{jt} = \frac{\sum_{t=1}^{t=-10} r_j t}{\sum_{t=-11}^{t=-20} r_j t}$$

and

$$d_{jt} \sim Gamma(\alpha, \beta)$$

3.10 Trend in biomass for data limited stocks

This indicator uses biomass indices computed from scientific surveys or CPUE (catch per unit of effort) considered by experts to represent the evolution of biomass in time. The data is build from the list of biomass indices published by ICES for data limited stocks category 3.

The indicator is calculated on a model-based form only,

$$I_t = y_t$$

$$z_{jt} = \beta_0 + y_t + u_j$$

where

$$z_{jt} = \log E[k_{jt}]$$

and

$$k_{jt} \sim Gamma(\alpha, \beta)$$

4 Indicators of changes in advice coverage

These indicators are computed for the last year of the analysis only.

4.1 Number of stocks for which estimates of F_{MSY} exist

$$I = \sum_{j=1}^{j=N} (x_j = \lambda)$$

$$\lambda = \begin{cases} x = 1 & F_{MSY}\, exists \\ x = 0 & otherwise \end{cases}$$

4.2 Number of stocks for which estimates of B_{PA} exist

$$I = \sum_{j=1}^{j=N} (x_j = \lambda)$$

$$\lambda = \begin{cases} x = 1 & B_{PA}\, exists \\ x = 0 & otherwise \end{cases}$$

4.3 Number of stocks for which estimates of B_{MSY} exist

$$I = \sum_{j=1}^{j=N} (x_j = \lambda)$$

$$\lambda = \begin{cases} x = 1 & B_{MSY}\, exists \\ x = 0 & otherwise \end{cases}$$

4.4 Fraction of TACs covered by stock assessments

This indicator considers that a sampling frame unit is covered by a stock assessment if there is at least a partial overlap between its spatial distribution and the spatial distribution of the stock.

$$I = M^{-1} \sum_{m=1}^{m=M} (x_m = \lambda)$$

$$\lambda = \begin{cases} x = 1 & spatial\, overlap\, exists \\ x = 0 & otherwise \end{cases}$$

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 part of this analysis must be published online once approved by the STECF plenary.

11 Annex 2a -NEAcode

```r
######################################################################
# EJ(20190319)
# NEA indicators
######################################################################

library(reshape2)
library(ggplot2)
library(lme4)
library(influence.ME)
library(lattice)
library(parallel)
library(rgdal)
library(reshape2)
library(plyr)
source("funs.R")

#=====================================================================
# Setup
#=====================================================================

# year when assessments were performed
assessmentYear <- 2018
# final data year with estimations from stock assessments
fnlYear <- assessmentYear - 1
# initial data year with estimations from stock assessments
iniYear <- 2003
# vector of years
dy <- iniYear:fnlYear
# vector of years for valid assessments
vay <- (assessmentYear-2):assessmentYear
# vector of years for stock status projection
vpy <- (fnlYear-2):fnlYear
# options for reading data
options(stringsAsFactors=FALSE)
# number of simulations for mle bootstrap
it <- 500
# number of cores for mle bootstrap parallel
nc <- 7
# quantiles to be computed
qtl <- c(0.025, 0.25, 0.50, 0.75, 0.975)
# to control de seed in mclapply
RNGkind("L'Ecuyer-CMRG")
set.seed(1234)
# to make plots consistent
vp <- dy
vp[c(2,4,6,8,10,12,14)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=dy, labels=as.character(vp))
th <- theme(axis.text.x  = element_text(angle=90, vjust=0.5), panel.grid.minor = element_blank())

#=====================================================================
# load & pre-process
#=====================================================================

#---------------------------------------------------------------------
# assessments
#---------------------------------------------------------------------
isa <- read.csv("../data/ices/Dataset_2019.csv", stringsAsFactors=FALSE)

isa$FishingPressure <- as.numeric(isa$FishingPressure)

# extract the main ecoregion but keep the list
er <- strsplit(isa[,"EcoRegion"], ",")
isa$EcoRegionList <- isa$EcoRegion
isa$EcoRegion <- unlist(lapply(er, function(x) x[1]))
er <- strsplit(isa[,"EcoRegion"], " ")
isa$EcoRegion <- unlist(lapply(er, function(x) paste(x[-length(x)], collapse=" ")))
```

```r
isa[isa$EcoRegion=="Bay of Biscay and the Iberian Coast", "EcoRegion"] <- "BoBiscay & Iberia"

# widely distributed to keep coherent with previous years (taken from 2017's files)
isa[isa$OldFishStock %in% c("arg-rest", "bli-5b67", "boc-nea", "bsf-nea", "dgs-nea", "gfb-comb", "her-noss", "hke-nrtn", "hom-west", "lin-oth", "mac-nea", "rng-5b67", "smn-dp", "trk-nea", "usk-oth", "whb-comb"), "EcoRegion"] <- "Northeast Atlantic"

# a couple of stocks that need fixing
# correcting Greater North Sea
isa[isa$FishStock %in% c("had.27.46a20", "pok.27.3a46", "sol.27.7e"), "EcoRegion"] <- "Greater North Sea"

# fix codes for stock size and fishing mortality
# f
#Line not needed for Cat < 3,  it was fixed
##the next three lines of code do something that is already done in the Data correction, please update them as I already suggested (Ceci)
isa[isa$FishingPressureDescription %in% c("Fishing Pressure: F"), "FishingPressureDescription"] <- "F"

#Line still needed, but will be fixed outside, delivery tbd (ask Ceci)
isa[isa$FishingPressureDescription %in% c("Harvest Rate", "Harvest rate"), "FishingPressureDescription"] <- "HR"

# biomass (will be changed, ask Ceci for delivery time)
isa[isa$StockSizeDescription %in% c("TSB/Bmsy"), "StockSizeDescription"] <- "B/Bmsy"

# order by year
isa <- isa[order(isa$Year),]

# reporting stk by data category
stBydc <- unique(subset(isa, Year %in% vpy)[,c("FishStock", "DataCategory", "EcoRegion")])
stBydc <- transform(stBydc, cat=as.integer(DataCategory))
write.csv(table(stBydc[,c("EcoRegion","cat")]), file="stBydc.csv")

#--------------------------------------------------------------------
# ICES rectangles data
#--------------------------------------------------------------------

rectangles <- readOGR("../data/ices_areas", layer="ICES_StatRec_map_Areas_Full_20170124")
rectangles <- rectangles@data[,c("Area_27", "AreasList", "ICESNAME")]
colnames(rectangles) <- c("Max_Area","Area_List", "Rectangle")
rectangles <- subset(rectangles, !is.na(Max_Area))
# A new column is added based on Max_Area so that it is comparable across the other data sets
rectangles$Area <- paste("27.",toupper(as.character(rectangles$Max_Area)),sep="")
# Check that each rectangle is unique and only appears once in the data
# i.e. each rectangle is uniquely assigned to one area
length(unique(rectangles$Rectangle)) == nrow(rectangles)

#--------------------------------------------------------------------
# sampling frame (TACs)
#--------------------------------------------------------------------

load("../data/ices/sframe.RData")
# fmz is the frame of all TACs
# For consistency
colnames(fmz)[colnames(fmz) == "area"] <- "Area"
colnames(fmz)[colnames(fmz) == "spp"] <- "Species"
colnames(fmz)[colnames(fmz) == "stock_id"] <- "TAC_id"
sframe <- subset(fmz, TAC_id %in% sframe_TAC)

```

```r
# Each ICES area should only appear once for each FMZ stock (to prevent the appearance of duplicate rectangles when merging with the ICES rectangle data later). We check this here:

unarea <- daply(sframe, .(TAC_id), function(x){
    return(length(unique(x$Area))==nrow(x))
})
all(unarea)

#==================================================================
# Stocks to retain
# matches sampling frame and ICES assessments through ICES rectangles
#==================================================================

#------------------------------------------------------------------
# subset assessments and ecoregions, add areas
#------------------------------------------------------------------

# remove 3+
cols <- c("FishStock","ICES.Areas..splited.with.character....." , "SpeciesName", "SGName", "DataCategory", "EcoRegion")
isa12 <- isa[isa$DataCategory<3, cols]

# NOTE: should do these fixes to isa and after subset to isa12
colnames(isa12)[colnames(isa12) == "ICES.Areas..splited.with.character....."] <- "Areas"
# Drop duplicates
isa12 <- unique(isa12)
# Remove white space and any capital letters from assessment name
isa12[,"FishStock"] <- tolower(gsub("\\s", "", isa12[,"FishStock"]))
# Make a species column from the assessment name
spp <- strsplit(isa12[,"FishStock"], "\\.")
isa12$Species <- toupper(unlist(lapply(spp, function(x) x[1])))
# Split ICES area by ~
areas <- strsplit(isa12[,"Areas"], "~")
names(areas) <- isa12[,"FishStock"]
areas <- melt(areas)
colnames(areas) <- c("Area","FishStock")
isa12 <- merge(isa12, areas)
# keep relevant columns only
isa12 <- isa12[,c("FishStock","Area", "Species", "SpeciesName", "SGName", "DataCategory", "EcoRegion")]
isa12[,"Area"] <- toupper(gsub("\\s", "", isa12[,"Area"]))
# remove ecoregions outside EU waters
isa12 <- subset(isa12, !(EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")))
# drop if ecoregion is NA
isa12 <- subset(isa12, !is.na(EcoRegion))
# remove her-noss which is widely distributed but mainly norway
isa12 <- subset(isa12, FishStock!="her.27.1-24a514a")

### stocks comparison with last year:
# nep.fu.3-4 - is still present at this point (should be thrown out later)

#------------------------------------------------------------------
# fix area codes
#------------------------------------------------------------------

# fix Baltic area codes
rectangles[rectangles$Area == "27.3.A.20","Area"] <- "27.3.A"
rectangles[rectangles$Area == "27.3.A.21","Area"] <- "27.3.A"
rectangles[rectangles$Area == "27.3.B.23","Area"] <- "27.3.B"
rectangles[rectangles$Area == "27.3.C.22","Area"] <- "27.3.C"

isa12[isa12$Area == "27.3.A.20","Area"] <- "27.3.A"
isa12[isa12$Area == "27.3.A.21","Area"] <- "27.3.A"
isa12[isa12$Area == "27.3.B.23","Area"] <- "27.3.B"
isa12[isa12$Area == "27.3.C.22","Area"] <- "27.3.C"
```

```
sframe[sframe$Area == "27.3.20","Area"] <- "27.3.A"
sframe[sframe$Area == "27.3.21","Area"] <- "27.3.A"
sframe[sframe$Area == "27.3.23","Area"] <- "27.3.B"
sframe[sframe$Area == "27.3.22","Area"] <- "27.3.C"

# Check: shouldn't have any 24.x.x areas
# Areas in ICES assessment but missing in rectangles
### rewrite
unique(isa12$Area)[!(unique(isa12$Area) %in% unique(rectangles$Area))]
#[1] "21.1" "21.2"

# Areas in FMZ but missing in rectangles
unique(sframe$Area)[!(unique(sframe$Area) %in% unique(rectangles$Area))]
#[1] "21.1.F"  "21.3.M"  "34.1.2"  "34.1.13" "34.1.11" "34.1.12" "34.2"

#--------------------------------------------------------------------
# fix species codes
#--------------------------------------------------------------------
#check the species code
# Horse mackerel
# Checked in 2019 and HOM still exists
isa12[isa12$Species=="HOM","Species"] <- "JAX"
# ANK & MON - Anglerfish - species to genus
# Checked in 2019 and ANK+MON still exist
isa12[isa12$Species=="ANK","Species"] <- "ANF"
isa12[isa12$Species=="MON","Species"] <- "ANF"
# Megrim - species and genus to genus
# Checked in 2019 and MEG+LDB still exist
isa12[isa12$Species=="MEG","Species"] <- "LEZ"
isa12[isa12$Species=="LDB","Species"] <- "LEZ"
# rays
# Checked in 2019 and RNG is no longer present
isa12[isa12$Species=="RNG","Species"] <- "RTX"
# species with combined TACs (NOTE THESE CAN INCREASE IN THE FUTURE)
# WIT there's a combined TAC with lemon sole: L/W/2AC4-C
# TUR there's a combined TAC with brill T/B/2AC4-C
# Both TUR and WIT were not cat 1 in 2017 assessments
isa12[isa12$Species=="WIT","Species"] <- "L/W"
isa12[isa12$Species=="TUR","Species"] <- "T/B"
# missing species
sort(unique(isa12$Species)[!(unique(isa12$Species) %in% unique(sframe$Species))])
#[1] "BSS" "PIL" "REB"
# REB is in areas outside EU waters 27.5, 27.12, 27.14
# PIL and BSS don't have TACs

#--------------------------------------------------------------------
# merge assessments,tacs/sf and rectangles
#--------------------------------------------------------------------

# merge assessments with rectangles
isa12r <- merge(isa12, rectangles[,c("Area","Rectangle")], by="Area")

# Do we have all the assessments?
all(sort(unique(isa12$FishStock)) == sort(unique(isa12r$FishStock)))

# Merge sampling frame with rectangles
sfr <- merge(sframe, rectangles[,c("Area","Rectangle")], by="Area")

# Do we have all the TACs?
all(sort(unique(sframe$TAC_id)) == sort(unique(sfr$TAC_id)))

# merge assessments with sampling frame
isa12sf <- merge(sfr, isa12r[,c("Species","Rectangle","FishStock","DataCategory")], by=c("Species","Rectangle"), all.x = TRUE)

#--------------------------------------------------------------------
# final stock list
```

```
#----------------------------------------------------------------------

# remove stocks with short time series
sts <- subset(isa, Year %in% dy & !is.na(FishingPressure))$FishStock
# remove short time series
sts <- table(sts)
sts <- names(sts)[sts<5]

# stocks to retain
stkToRetain <- unique(isa12sf$FishStock)[-1]
stkToRetain <- stkToRetain[!(stkToRetain %in% sts)]

#----------------------------------------------------------------------
# subset assessments
#----------------------------------------------------------------------
# filtering
saeu <- subset(isa, FishStock %in% stkToRetain)

# reporting
stkToDrop <- unique(isa[!(isa$FishStock %in% stkToRetain), c("FishStock", "EcoRegion", "DataCategory")])
write.csv(stkToDrop, file="stkToDropBySampFrame-nea.csv")
stkToRetain <- unique(isa[isa$FishStock %in% stkToRetain, c("FishStock", "EcoRegion", "DataCategory")])
write.csv(stkToRetain, file="stkToRetainBySampFrame-nea.csv")

# check what's available
table(saeu[,c("FishingPressureDescription","StockSizeDescription")])

#======================================================================
# process data for indicators
#======================================================================

#----------------------------------------------------------------------
# fixing BMSYescapment not reported by ICES
#----------------------------------------------------------------------
saeu$MSYBescapement <- NA

# NOP 34
saeu[saeu$FishStock == "nop.27.3a4", c("StockSize", "MSYBescapement")] <- saeu[saeu$FishStock == "nop.27.3a4", c("Low_StockSize", "Blim")]

# ANE BISC - need to add value from ss, using upper trigger as proxy for MSYBescapement
saeu[saeu$FishStock == "ane.27.8", "MSYBescapement"] <- 89000

# acording to the sumsheets SAN and SPR-NSEA use Bpa for MSYBescapement
saeu[saeu$FishStock %in% c("san.sa.1r","san.sa.2r","san.sa.3r","san.sa.4","spr.27.4"),"MSYBescapement"] <- saeu[saeu$FishStock %in% c("san.sa.1r","san.sa.2r","san.sa.3r","san.sa.4","spr.27.4"),"Bpa"]

#----------------------------------------------------------------------
# fixing Recruitments of 0
#----------------------------------------------------------------------
saeu[saeu$Recruitment==0 & !is.na(saeu$Recruitment),"Recruitment"] <- NA

#----------------------------------------------------------------------
# Bref
#----------------------------------------------------------------------
# check MSYBtrigger = Bpa
stksBpaMSYBtrigger <- unique(saeu[saeu$MSYBtrigger==saeu$Bpa, c("FishStock", "Bpa", "MSYBtrigger")])
stksBpaMSYBtrigger <- stksBpaMSYBtrigger[order(stksBpaMSYBtrigger$FishStock),]
write.csv(stksBpaMSYBtrigger, file="stksBpaMSYBtrigger.csv")

# create field
saeu$Bref <- saeu$MSYBtrigger
# if MSYBtrigger is set at Bpa level set to NA, with the exception
```

```
# of a couple of stocks which were explicitly set that way by the AWG
saeu$Bref[saeu$MSYBtrigger==saeu$Bpa & !(saeu$FishStock %in% c("her.27.3031", "hom.27.2a4a5b6a7a-ce-k8", "lez.27.4a6a", "pra.27.3a4a"))] <- NA

# B escapement as Bref for relevant stocks
saeu$Bref[!is.na(saeu$MSYBescapement)] <- saeu$MSYBescapement[!is.na(saeu$MSYBescapement)]
saeu$Bref <- as.numeric(saeu$Bref)
# set 0 as NA
saeu$Bref[saeu$Bref==0] <- NA
# if relative Bref = 1
saeu[saeu$StockSizeDescription == "B/Bmsy", "Bref"] <- 1

# Bpa
saeu$Brefpa <- saeu$Bpa
# some stocks don't have Bpa (it was set at MSYBtrigger level)
saeu$Brefpa[saeu$FishStock %in% c("her.27.3031")] <- NA
# set 0 as NA
saeu$Brefpa[saeu$Brefpa==0] <- NA
# if relative Brefpa = 0.5
saeu[saeu$StockSizeDescription == "B/Bmsy", "Brefpa"] <- 0.5

#-------------------------------------------------------------------
# Fref
#-------------------------------------------------------------------
saeu$Fref <- saeu$FMSY
# no Fref for B escapement
saeu$Fref[!is.na(saeu$MSYBescapement)] <- NA
saeu$Fref <- as.numeric(saeu$Fref)
# set 0 as NA
saeu$Fref[saeu$Fref==0] <- NA
# if relative Fmsy must be 1
saeu[saeu$FishingPressureDescription %in% c("F/Fmsy", "HR/HRmsy"), "Fref"] <- 1

saeu$Frefpa <- saeu$Fpa
# no Fref for B escapement
saeu$Frefpa[!is.na(saeu$MSYBescapement)] <- NA
saeu$Frefpa <- as.numeric(saeu$Frefpa)
# set 0 as NA
saeu$Frefpa[saeu$Frefpa==0] <- NA
# if relative Fparef must be NA
saeu[saeu$FishingPressureDescription %in% c("F/Fmsy", "HR/HRmsy"), "Frefpa"] <- NA

#-------------------------------------------------------------------
# COMPUTE F/Fref and B/Bref | year + stock
#-------------------------------------------------------------------
saeu <- transform(saeu,
        indF = FishingPressure/Fref,
        indB=StockSize/Bref,
        indBpa=StockSize/Brefpa,
        indFpa = FishingPressure/Frefpa)

# in case of escapement strategy MSY evaluated by SSB ~ Bref
saeu$indF[!is.na(saeu$MSYBescapement)] <-
        saeu$Bref[!is.na(saeu$MSYBescapement)]/saeu$StockSize[!is.na(saeu$MSYBescapement)]

saeu <- transform(saeu, sfFind=!is.na(indF))

#-------------------------------------------------------------------
# COMPUTE SBL | year + FishStock
#-------------------------------------------------------------------
saeu$SBL <- !(saeu$indFpa > 1 | saeu$indBpa < 1)
# if one is NA SBL can't be inferred
saeu$SBL[is.na(saeu$indFpa) | is.na(saeu$indBpa)] <- NA
# no SBL for B escapement
saeu$SBL[!is.na(saeu$MSYBescapement)] <- NA
```

```
saeu <- transform(saeu, sfSBL=!is.na(SBL))

#--------------------------------------------------------------------
# COMPUTE CFP objectives | year + FishStock
#--------------------------------------------------------------------
saeu$CFP <- !(saeu$indF > 1 | saeu$indB < 1)
# if one is NA CFP can't be inferred
saeu$CFP[is.na(saeu$indF) | is.na(saeu$indB)] <- NA
# no CFP for B escapement
saeu$CFP[!is.na(saeu$MSYBescapement)] <- NA
saeu <- transform(saeu, sfCFP=!is.na(CFP))

#--------------------------------------------------------------------
# final dataset
#--------------------------------------------------------------------
# remove WG projections
saeu <- subset(saeu, Year <= (AssessmentYear-1))
saeu0 <- saeu
saeu <- subset(saeu, Year>=iniYear & AssessmentYear %in% vay & sfFind)

#--------------------------------------------------------------------
# project stock status up to last year in cases missing
#--------------------------------------------------------------------

saeu <- projectStkStatus(saeu, vpy)

moo1 <- saeu[!saeu$projected, c("FishStock", "Year", "EcoRegion")]
moo2 <- table(moo1[,c("FishStock", "Year", "EcoRegion")])
moo2 <- dcast(data.frame(moo2), FishStock~Year, value.var = 'Freq' )
#====================================================================
# Indicators (design based)
#====================================================================

#--------------------------------------------------------------------
# Number of stocks (remove projected years)
#--------------------------------------------------------------------
df0 <- saeu[!saeu$projected,]
inStks <- getNoStks(df0, "FishStock", length)

## check for potential duplicates
mo1 <- df0[df0$EcoRegion == "Greater North Sea", c("EcoRegion", "FishStock", "Year")]
table(mo1[,c("FishStock", "Year")])

png("figNEAI0a.png", 1800, 1200, res=300)
ggplot(subset(inStks, EcoRegion=="ALL"), aes(x=Year, y=N)) +
        geom_line() +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,80)) +
        sc +
        th
dev.off()

# time series
png("figNEAI0b.png", 3000, 4500, res=300, bg = "transparent")
ggplot(df0, aes(Year, reorder(FishStock, desc(FishStock)))) +
        geom_line() +
  geom_point(data=aggregate(list(Year=df0$Year, EcoRegion=df0$EcoRegion),
    by=list(FishStock=df0$FishStock), max)) +
  # NEP missing years
        geom_line(data=data.frame(Year=2009:2013, FishStock="nep.fu.14",
    EcoRegion="Celtic Seas"), color="white") +
        geom_line(data=data.frame(Year=2007:2009, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), color="white") +
        geom_line(data=data.frame(Year=2003:2005, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), color="white") +
        geom_point(data=data.frame(Year=2003, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), size=0.3) +
```

```
        ylab("") +
        xlab("Year") +
        sc +
        th +
  facet_grid(EcoRegion~., switch="y", space="free_y", scales="free_y") +
  theme(strip.placement="outside", strip.background.y=element_blank(),
    panel.spacing.y=unit(0.05, "lines"))
dev.off()

write.csv(dcast(inStks, EcoRegion~Year, value.var='N'), file="tabNEAI0.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I1) Stocks F > Fmsy
#-------------------------------------------------------------------
fInda <- getNoStks(saeu, "indF", function(x) sum(x>1))

# plot
png("figNEAI1.png", 1800, 1200, res=300)
ggplot(subset(fInda, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
png("figNEAI1b.png", 2400, 1200, res=300)
ggplot(subset(fInda, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 20) +
        th
dev.off()

# table
write.csv(dcast(fInda, EcoRegion~Year, value.var='N'), file="tabNEAI1.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I2) Stocks F <= Fmsy
#-------------------------------------------------------------------
fIndb <- getNoStks(saeu, "indF", function(x) sum(x<=1))

# plot
png("figNEAI2.png", 1800, 1200, res=300)
ggplot(subset(fIndb, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
png("figNEAI2b.png", 2400, 1200, res=300)
ggplot(subset(fIndb, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
```

```
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 20) +
        th
dev.off()

# table
write.csv(dcast(fIndb, EcoRegion~Year, value.var='N'), file="tabNEAI2.csv",
row.names=FALSE)

#------------------------------------------------------------------
# (I3) Stocks outside SBL
#------------------------------------------------------------------
fIndc <- getNoStks(saeu, "SBL", function(x) sum(!x, na.rm=TRUE))

# plot
png("figNEAI3.png", 1800, 1200, res=300)
ggplot(subset(fIndc, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
png("figNEAI3b.png", 2400, 1200, res=300)
ggplot(subset(fIndc, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 15) +
        th
dev.off()

# table
write.csv(dcast(fIndc, EcoRegion~Year, value.var='N'), file="tabNEAI3.csv",
row.names=FALSE)

#------------------------------------------------------------------
# (I4) Stocks inside SBL
#------------------------------------------------------------------
fIndd <- getNoStks(saeu, "SBL", function(x) sum(x, na.rm=TRUE))

## plot
png("figNEAI4.png", 1800, 1200, res=300)
ggplot(subset(fIndd, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
png("figNEAI4b.png", 2400, 1200, res=300)
```

```
ggplot(subset(fIndd, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 15) +
        th
dev.off()

# table
write.csv(dcast(fIndd, EcoRegion~Year, value.var='N'), file="tabNEAI4.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I5) Stocks outside CFP objectives
#-------------------------------------------------------------------
fIndf <- getNoStks(saeu, "CFP", function(x) sum(!x, na.rm=TRUE))

## plot
png("figNEAI5.png", 1800, 1200, res=300)
ggplot(subset(fIndf, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
png("figNEAI5b.png", 2400, 1200, res=300)
ggplot(subset(fIndf, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 20) +
        th
dev.off()

# table
write.csv(dcast(fIndf, EcoRegion~Year, value.var='N'), file="tabNEAI5.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I6) Stocks inside CFP objectives
#-------------------------------------------------------------------
fIndfb <- getNoStks(saeu, "CFP", function(x) sum(x, na.rm=TRUE))

# plot
png("figNEAI6.png", 1800, 1200, res=300)
ggplot(subset(fIndfb, EcoRegion=='ALL'), aes(x=Year, y=N)) +
        geom_line() +
        expand_limits(y=0) +
        geom_point(aes(x=iniYear, y=N[1])) +
        geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,75)) +
        sc +
        th
dev.off()

# plot
```

```r
png("figNEAI6b.png", 2400, 1200, res=300)
ggplot(subset(fIndfb, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 20) +
        th
dev.off()

# table
write.csv(dcast(fIndfb, EcoRegion~Year, value.var='N'), file="tabNEAI6.csv", row.names=FALSE)

#====================================================================
# Indicators (model based)
#====================================================================

#--------------------------------------------------------------------
# (I7) F/Fmsy model
#--------------------------------------------------------------------
idx <- saeu$FishingPressureDescription %in% c("F", "F/Fmsy")
saeu$sfI7 <- idx & is.na(saeu$MSYBescapement)
df0 <- saeu[saeu$sfI7,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifit <- glmer(indF ~ Year + (1|FishStock), data = df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifit, "FishStock", df0, "diagNEAI7.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifit.bs <- split(1:it, 1:it)

ifit.bs <- mclapply(ifit.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
        fit <- glmer(indF ~ Year + (1|FishStock), data = df1, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

ifitm <- do.call("rbind", ifit.bs)
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("figNEAI7.png", 1800, 1200, res=300)
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])) +
  ylim(0, 2.5) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()
```

```
# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI7.csv")

#-------------------------------------------------------------------
# (I7b) F/Fmsy model regional
#-------------------------------------------------------------------
df0 <- saeu[saeu$sfI7,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

ifitRegional <- lapply(split(df0, df0$EcoRegion), function(x){
        # fit model
        ifit <- glmer(indF ~ Year + (1|FishStock), data = x, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        # no variance with bootstrap due to small number of stocks
        ifit.pred <- predict(ifit, re.form=~0, type="response", newdata=nd)
        # output
        list(ifit=ifit, ifit.pred=ifit.pred)
})

lst0 <- lapply(ifitRegional, "[[", "ifit.pred")
fIndfr <- data.frame(EcoRegion=rep(names(lst0), lapply(lst0, length)), N=unlist(lst0), Year=as.numeric(as.character(nd[,1])))

# plot
png("figNEAI7b.png", 2400, 1200, res=300)
ggplot(fIndfr, aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab(expression(F/F[MSY])) +
        xlab("") +
        sc +
        ylim(0, 2.5) +
        th
dev.off()

# table
write.csv(dcast(fIndfr, EcoRegion~Year, value.var='N'), file="tabNEAI7b.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I7out) F/Fmsy stocks outside EU
#-------------------------------------------------------------------
df0 <- subset(isa, (EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea") | FishStock=="her.27.1-24a514a") & FishStock!="pra.27.1-2" & Year>=iniYear & Year<=fnlYear & AssessmentYear %in% vay)
df0$Fref <- as.numeric(df0$FMSY)
df0 <- transform(df0, indF = FishingPressure/Fref, sfFind=!is.na(FishingPressure/Fref))
idx <- df0$FishingPressureDescription %in% c("F", "F/Fmsy") & df0$sfFind
df0 <- df0[idx,]

# check data series is complete
table(df0[,c("FishStock","Year")])

# create year variable for prediction
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifitout <- glmer(indF ~ Year + (1|FishStock), data = df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitout, "FishStock", df0, "diagNEAI7out.pdf", nc, nd)
```

```
# bootstrap
stk <- unique(df0$FishStock)
ifitout.bs <- split(1:it, 1:it)
ifitout.bs <- mclapply(ifitout.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
        fit <- glmer(indF ~ Year + (1|FishStock), data = df1, family =
Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

ifitm <- do.call("rbind", ifitout.bs)
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("figNEAI7out.png", 1800, 1200, res=300)
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) +
  ylab(expression(F/F[MSY])) +
  geom_hline(yintercept = 1, linetype=2) +
  ylim(0, 2.5) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI7out.csv")

#-------------------------------------------------------------------
# (I8) SSB model
#-------------------------------------------------------------------
saeu$sfI8 <- saeu$StockSizeDescription %in% c("SSB", "TSB")
df0 <- saeu[saeu$sfI8,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0, family =
Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitb, "FishStock", df0, "diagNEAI8.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitb.bs <- split(1:it, 1:it)
ifitb.bs <- mclapply(ifitb.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
        fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family =
Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

ifitm <- do.call("rbind", ifitb.bs)
```

```
ifitm <- exp(log(ifitm)-median(log(ifitm[,1]), na.rm=TRUE))
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("figNEAI8.png", 1800, 1200, res=300)
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(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI8.csv")

#----------------------------------------------------------------------
# (I8b) SSB model regional
#----------------------------------------------------------------------
df0 <- saeu[saeu$sfI8,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

ifitbRegional <- lapply(split(df0, df0$EcoRegion), function(x){
        # fit model
        ifitb <- glmer(StockSize ~ Year + (1|FishStock), data = x, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        # no variance with bootstrap due to small number of stocks
        ifitb.pred <- predict(ifitb, re.form=~0, type="response", newdata=nd)
        # output
        list(ifitb=ifitb, ifitb.pred=ifitb.pred/ifitb.pred[nd==iniYear])
})

lst0 <- lapply(ifitbRegional, "[[", "ifitb.pred")
fIndbr <- data.frame(EcoRegion=rep(names(lst0), lapply(lst0, length)), N=unlist(lst0), Year=as.numeric(as.character(nd[,1])))

# plot
png("figNEAI8b.png", 2400, 1200, res=300)
ggplot(fIndbr, aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        geom_hline(yintercept = 1, linetype=2) +
        ylab(expression(B/B[2003])) +
        xlab("") +
        theme(legend.position = "none") +
        sc +
        th
dev.off()

# table
write.csv(dcast(fIndbr, EcoRegion~Year, value.var='N'), file="tabNEAI8b.csv", row.names=FALSE)

#----------------------------------------------------------------------
# (I10) Recruitment model
#----------------------------------------------------------------------
saeu0$sfI10 <- !is.na(saeu0$Recruitment)
```

```
df0 <- saeu0[saeu0$sfI10,]
# data for table about stocks and inicators
sfI10 <- subset(df0, Year>=iniYear & Year<=fnlYear)
sfI10 <- tapply(sfI10$Year, sfI10$FishStock, max)
sfI10 <- data.frame(FishStock=names(sfI10), Year=sfI10, variable="sfI10", value=TRUE)
# project and compute indicator
df0 <- projectStkStatus(df0, vpy)
for(i in (iniYear):fnlYear) df0 <- decadalR(df0, i)
df0 <- subset(df0, Year>=iniYear & Year<=fnlYear)
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifitr <- glmer(decadalR ~ Year + (1|FishStock), data =  df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitr, "FishStock", df0, "diagNEAI10.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitr.bs <- split(1:it, 1:it)
ifitr.bs <- mclapply(ifitr.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
        fit <- glmer(decadalR ~ Year + (1|FishStock), data = df1, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

ifitm <- do.call("rbind", ifitr.bs)
ifitm <- exp(log(ifitm)-median(log(ifitm[,1]), na.rm=TRUE))
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("figNEAI10.png", 1800, 1200, res=300)
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(decadal_R/R[2003])) +
  ylab("Decadal recruitment (scaled to 2003)") +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI10.csv")

#---------------------------------------------------------------------
# (I10b) R model regional
#---------------------------------------------------------------------

ifitrRegional <- lapply(split(df0, df0$EcoRegion), function(x){
        # fit model
        ifitr <- glmer(decadalR ~ Year + (1|FishStock), data = x, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
```

```r
        # no variance with bootstrap due to small number of stocks
        ifitr.pred <- predict(ifitr, re.form=~0, type="response", newdata=nd)
        # output
        list(ifitr=ifitr, ifitr.pred=ifitr.pred/ifitr.pred[nd==iniYear])
})

lst0 <- lapply(ifitrRegional, "[[", "ifitr.pred")
fIndrr <- data.frame(EcoRegion=rep(names(lst0), lapply(lst0, length)), N=unlist(lst0), Year=as.numeric(as.character(nd[,1])))

# plot
png("figNEAI10b.png", 2400, 1200, res=300)
ggplot(fIndrr, aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        geom_hline(yintercept = 1, linetype=2) +
    ylab("Decadal recruitment (scaled to 2003)") +
        xlab("") +
        theme(legend.position = "none") +
        sc +
        th
dev.off()

# table
write.csv(dcast(fIndrr, EcoRegion~Year, value.var='N'), file="tabNEAI10b.csv", row.names=FALSE)

#-------------------------------------------------------------------
# (I12) SSB model for cat 3
#-------------------------------------------------------------------
df0 <- subset(isa, !(EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")) & DataCategory>2 & DataCategory<4 & StockSize>0 & Year>=iniYear & Year <= fnlYear & AssessmentYear %in% vay & StockSizeDescription %in% c("Biomass index", "Abundance index", "SSB", "TSB", "Relative BI (comb)", "B/Bmsy", "Relative SSB", "standardized CPUE", "Relative BI", "Biomass Index (comb)", "LPUE"))


#######
#remove stocks that are duplicates (boc.27.6-8 and nep.fu.2829)
# remove this: "Boarfish (Capros aper) in subareas 6-8 (Celtic Seas, English Channel, and Bay of Biscay) "
# or           "Boarfish (Capros aper) in subareas 6-8 (Celtic Seas, English Channel, and Bay of Biscay)"
# AND
#    "Norway lobster (Nephrops norvegicus) in Division 9.a, functional units 28-29 (Atlantic Iberian waters East and southwestern and southern Portugal)"
# or "Norway lobster (Nephrops norvegicus) in Division 9.a, Functional Units 28-29 (Atlantic Iberian waters East and southwestern and southern Portugal)"
#######

# dups <- c(
# "Boarfish (Capros aper) in subareas 6-8 (Celtic Seas, English Channel, and Bay of Biscay) ",
# "Greater silver smelt (Argentina silus) in Subareas 7-10 and 12, and Division 6.b (other areas)",
# "Norway lobster (Nephrops norvegicus) in Division 9.a, Functional units 26-27 (Atlantic Iberian waters East, western Galicia, and northern Portugal)",
# "Norway lobster (Nephrops norvegicus) in Division 9.a, Functional Units 28-29 (Atlantic Iberian waters East and southwestern and southern Portugal)",
# "Greater-spotted dogfish (Skyliorhinus stellaris) in subareas 6 and 7 (West of Scotland, southern Celtic Sea, and the English Channel)",
# "Tusk (Brosme brosme) in Subareas 4 and 7-9, and Divisions 3.a, 5.b, 6.a, and 12.b (Northeast Atlantic)"
#  )
#
# df0 <- df0[!df0$StockDescription %in% dups,]

```

```
# remove stocks with short time series
sts <- table(df0$FishStock, df0$Year)
sts <- rownames(sts)[apply(sts, 1, sum)<5]
df0 <- subset(df0, !(FishStock %in% sts))

# id
sfI12 <- tapply(df0$Year, df0$FishStock, max)
sfI12 <- data.frame(FishStock=names(sfI12), Year=sfI12, variable="sfI12", value=TRUE)

# project for stocks without 2015, 2016 estimates
# NEED CHECK
df0 <- projectStkStatus(df0, vpy)

# pre process for model
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifitb3 <- glmer(StockSize ~ Year + (1|FishStock), data =  df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitb3, "FishStock", df0, "diagNEAI12.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitb3.bs <- split(1:it, 1:it)
ifitb3.bs <- mclapply(ifitb3.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
        fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

ifitm <- do.call("rbind", ifitb3.bs)
ifitm <- exp(log(ifitm)-median(log(ifitm[,1]), na.rm=TRUE))
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("figNEAI12.png", 1800, 1200, res=300)
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(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI11.csv")

#======================================================================
# Bootstrap convergence problems
#======================================================================

bootconv <- data.frame(
```

```r
        indicator=c('F/Fmsy trends', 'F/Fmsy trends out', 'Biomass trends', 'Decadal recruitment trends', "Biomass data category 3 trends"),
        convergence=c(sum(unlist(lapply(lapply(ifit.bs, is.na), sum))==0), sum(unlist(lapply(lapply(ifitout.bs, is.na), sum))==0), sum(unlist(lapply(lapply(ifitb.bs, is.na), sum))==0), sum(unlist(lapply(lapply(ifitr.bs, is.na), sum))==0), sum(unlist(lapply(lapply(ifitb3.bs, is.na), sum))==0))/it
)

write.csv(bootconv, file="bootconv.csv")

#====================================================================
# Stocks used in each indicator
#====================================================================

df0 <- melt(saeu[!saeu$projected,], c('FishStock', 'Year'), c('sfFind', 'sfSBL', 'sfCFP', 'sfI7', 'sfI8'))
df0 <- do.call("rbind", lapply(split(df0, df0$FishStock), function(x) subset(x, Year==max(x$Year))))
df0 <- merge(df0, sfI10, all=TRUE)
df0 <- rbind(df0, sfI12)
levels(df0$variable) <- c('above/below Fmsy', 'in/out SBL', 'in/out CFP', 'F/Fmsy trends', 'Biomass trends', 'Decadal recruitment trends', "Biomass data category 3 trends")
stkPerIndicator <- dcast(df0, FishStock+Year~variable, value.var='value')

# NOTE: this file must be fixed "by hand" to remove duplications
# created for the cat 1 stocks which were projected
# (no time to right code now ...)
write.csv(stkPerIndicator, file="stkPerIndicator.csv")

#====================================================================
# Coverage
#====================================================================

# All stocks of relevance
stocks <- subset(saeu, Year==fnlYear)$FishStock
# All stocks with B indicator
bind_stocks <- subset(saeu, Year==fnlYear & !is.na(indB))$FishStock
# All stocks with F indicator - Same as stocks
find_stocks <- subset(saeu, Year==fnlYear & !is.na(indF))$FishStock
# All stocks with Bpa indicator
bpaind_stocks <- subset(saeu, Year==fnlYear & !is.na(indBpa))$FishStock
# All stocks with Fpa indicator - Same as stocks
fpaind_stocks <- subset(saeu, Year==fnlYear & !is.na(indFpa))$FishStock

# Current list
all_stocks <- unique(isa12sf$FishStock)
# ignore NA
all_stocks <- all_stocks[!is.na(all_stocks)]

# Which stocks to drop from all stocks
drop_stock <- all_stocks[!(all_stocks %in% stocks)]

# Which stocks to drop as no f indicator
drop_stock_f <- all_stocks[!(all_stocks %in% find_stocks)]

# Which stocks to drop as no b indicator
drop_stock_b <- all_stocks[!(all_stocks %in% bind_stocks)]

# Which stocks to drop as no fpa indicator
drop_stock_fpa <- all_stocks[!(all_stocks %in% fpaind_stocks)]

# Which stocks to drop as no bpa indicator
drop_stock_bpa <- all_stocks[!(all_stocks %in% bpaind_stocks)]

# Set dropped stocks to NA in FishStock column
isa12sf$FindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$FindFishStock %in% drop_stock_f,"FindFishStock"] <-
```

```
as.character(NA)
isa12sf$BindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$BindFishStock %in% drop_stock_b ,"BindFishStock"] <- as.character(NA)
isa12sf$FpaindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$FpaindFishStock %in% drop_stock_fpa,"FpaindFishStock"] <- as.character(NA)
isa12sf$BpaindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$BpaindFishStock %in% drop_stock_bpa,"BpaindFishStock"] <- as.character(NA)

# Proportion of TACs that have at least one rectangle assessed by FindFishStock and BindFishStock
outf <- aggregate(isa12sf$FindFishStock, by=list(isa12sf$TAC_id), function(x) {
          no_rect_ass_find <- sum(!is.na(x))
          assessed_find <- no_rect_ass_find > 1
          return(assessed_find)
})

outb <- aggregate(isa12sf$BindFishStock, by=list(isa12sf$TAC_id), function(x) {
          no_rect_ass_bind <- sum(!is.na(x))
          assessed_bind <- no_rect_ass_bind > 1
          return(assessed_bind)
})

outfpa <- aggregate(isa12sf$FpaindFishStock, by=list(isa12sf$TAC_id), function(x) {
          no_rect_ass_find <- sum(!is.na(x))
          assessed_find <- no_rect_ass_find > 1
          return(assessed_find)
})

outbpa <- aggregate(isa12sf$BpaindFishStock, by=list(isa12sf$TAC_id), function(x) {
          no_rect_ass_bind <- sum(!is.na(x))
          assessed_bind <- no_rect_ass_bind > 1
          return(assessed_bind)
})

coverage <- data.frame(
        No_stocks = c(length(find_stocks), length(bind_stocks), length(fpaind_stocks), length(bpaind_stocks)),
        No_TACs = length(unique(isa12sf$TAC_id)),
        No_TACs_assessed = c(sum(outf$x), sum(outb$x), sum(outfpa$x), sum(outbpa$x)),
        Frac_TACs_assessed = c(mean(outf$x),mean(outb$x), mean(outfpa$x), mean(outbpa$x))
)
rownames(coverage) <- c("F_indicator", "B_indicator", "Fpa_indicator", "Bpa_indicator")

write.csv(coverage, "coverage.csv")

# number of stocks for which MSYBtrigger==Bpa
#df0 <- transform(saeu, bb=Bpa/MSYBtrigger==1)
#length(unique(subset(df0, bb==TRUE)$FishStock))

#===================================================================
# Exporting and saving
#===================================================================

write.csv(saeu, file="saeu.csv")
save.image("RData.nea")
```

12 ANNEX02B-MEDCODE

```r
######################################################################
# EJ(20190319)
# MED indicators
######################################################################

library(reshape2)
library(ggplot2)
library(lme4)
library(influence.ME)
library(lattice)
library(parallel)
library(rgdal)
library(reshape2)
library(plyr)
source("funs.R")

#=====================================================================
# Setup
#=====================================================================

# year when assessments were performed
assessmentYear <- 2018
# final year with estimations from stock assessments
fnlYear <- assessmentYear - 1
# initial year with estimations from stock assessments
iniYear <- 2003
# vector of years
dy <- iniYear:fnlYear
# vector of years for valid assessments
vay <- (assessmentYear-2):assessmentYear
# vector of years for stock status projection
vpy <- (fnlYear-2):fnlYear
# options for reading data
options(stringsAsFactors=FALSE)
# number of simulations for mle bootstrap
it <- 500
# number of cores for mle bootstrap parallel
nc <- 7
# quantiles to be computed
qtl <- c(0.025, 0.25, 0.50, 0.75, 0.975)
# to control de seed in mclapply
RNGkind("L'Ecuyer-CMRG")
set.seed(1234)
# to make plots consistent
vp <- dy
vp[c(2,4,6,8,10,12,14)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=dy, labels=as.character(vp))
th <- theme(axis.text.x  = element_text(angle=90, vjust=0.5),
panel.grid.minor = element_blank())

#=====================================================================
# load & pre-process
#=====================================================================

#---------------------------------------------------------------------
# load and pre-process
#---------------------------------------------------------------------

# assessments
gfcm <- read.csv("../data/med/GFCM_SA_2019.csv")
gfcm$Meeting <- "GFCM"
#gfcm$Fref <- gfcm$Fref_point
stecf <- read.csv("../data/med/STECF_CFP_2019.csv")
msa <- rbind(stecf, gfcm)
msa$Fref <- msa$Fref_point

# keep relevant columns only
msa <- msa[,c("Stock", "Area", "Year", "R", "SSB", "F", "Fref", "Blim",
```

```
"Bref", "asses_year", "Meeting", "Assessment_URL", "Species", "EcoRegion")]

# id assessment source
msa[msa$Meeting!="GFCM","Meeting"] <- "STECF"
names(msa)[names(msa)=="Meeting"] <- "source"

#--------------------------------------------------------------------
# recode and compute indicators
#--------------------------------------------------------------------
msa$stk <- tolower(paste(msa$Stock, msa$Area, sep="_"))
msa$StockDescription <- paste(msa$Species, "in GSA", gsub("_", ", ", msa$Area))
msa$Fref <- as.numeric(msa$Fref)
msa <- transform(msa, indF = F/Fref)
msa <- transform(msa, sfFind=!is.na(indF), i1=indF>1, i2=indF<=1)

#--------------------------------------------------------------------
# subset
# (filtering through the sampling frame done during data harvesting)
#--------------------------------------------------------------------
sam <- msa[!is.na(msa$indF) & msa$Year >=iniYear & msa$Year <= fnlYear & msa$asses_year %in% vay,]

#--------------------------------------------------------------------
# project stock status
# (check fnlYear < assessmentYear-1)
#--------------------------------------------------------------------
sam$projected <- FALSE

# use y-2 for stocks missing in y-1
sy2 <- sam[sam$Year==sort(vpy)[1], "stk"]
sy1 <- sam[sam$Year==sort(vpy)[2], "stk"]
v0 <- sy2[!(sy2 %in% sy1)]
if(length(v0)>0){
        df0 <- subset(sam, Year==sort(vpy)[1] & stk %in% v0)
        df0$Year <- sort(vpy)[2]
        df0$projected <- TRUE
        sam <- rbind(sam, df0)
}

# use y-1 for stocks missing in y
sy <- sam[sam$Year==sort(vpy)[3], "stk"]
v0 <- sy1[!(sy1 %in% sy)]
if(length(v0)>0){
        df0 <- subset(sam, Year==sort(vpy)[2] & stk %in% v0)
        df0$Year <- sort(vpy)[3]
        df0$projected <- TRUE
        sam <- rbind(sam, df0)
}

#====================================================================
# Indicators
#====================================================================
#--------------------------------------------------------------------
# Number of stocks (remove projected years)
#--------------------------------------------------------------------
df0 <- sam[!sam$projected,]
mnStks <- aggregate(stk~Year, df0, length)
names(mnStks) <- c("Year", "N")

# plot
png("figMedI0.png", 1800, 1200, res=300)
ggplot(subset(mnStks, Year!=fnlYear), aes(x=Year, y=N)) +
        geom_line() +
        ylab("No. of stocks") +
        xlab("") +
        ylim(c(0,55)) +
        sc +
        th +
```

```
    geom_point(aes(x=fnlYear, y=mnStks$N[length(mnStks$N)]), size=2)
dev.off()

png("figMedI0b.png", 1200, 1600, res=200)
ggplot(sam[!sam$projected,], aes(Year,reorder(stk, desc(stk))))+
        geom_line() +
        ylab("") +
        xlab("Year") +
        sc +
        th +
        geom_vline(xintercept = fnlYear-1, col = "red") +
  facet_grid(EcoRegion~., switch="y", space="free_y", scales="free_y") +
  theme(strip.placement="outside", strip.background.y=element_blank(),
    panel.spacing.y=unit(0.05, "lines"))
dev.off()

write.csv(dcast(df0, EcoRegion~Year, value.var='stk', margins=TRUE, fun.aggregate=length), file="tabMedI0.csv", row.names=FALSE)

#-------------------------------------------------------------------
#  drop final assessment year, redo scales for plotting
#-------------------------------------------------------------------
sam <- sam[sam$Year!=fnlYear,]

vp <- iniYear:I(fnlYear-1)
vp[c(2,3,4,6,7,8,9,11,12,13)] <- ""
sc <- scale_x_continuous(breaks=iniYear:I(fnlYear-1), labels=as.character(vp))

#-------------------------------------------------------------------
# (I7) F/Fmsy model based indicator
#-------------------------------------------------------------------
df0 <- sam
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# model
mfit <- glmer(indF ~ Year + (1|stk), data = df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(mfit, "stk", df0, "diagMedI7.pdf", nc, nd)

# bootstrap
set.seed(1234)
stk <- unique(df0$stk)
mfit.bs <- split(1:it, 1:it)
mfit.bs <- mclapply(mfit.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, stk==i))
        fit <- glmer(indF ~ Year + (1|stk), data = df1, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)
# remove failed iters
mfit.bs <- mfit.bs[unlist(lapply(mfit.bs, is.numeric))]

mfitm <- do.call("rbind", mfit.bs)
mfitq <- apply(mfitm, 2, quantile, c(0.025, 0.25, 0.50, 0.75, 0.975), na.rm=TRUE)
mfitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(mfitq)))

# plot
png("figMedI7.png", 1800, 1200, res=300)
ggplot(mfitq, 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[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 +
        th
dev.off()

# table
tb0 <- t(mfitq)[-1,]
colnames(tb0) <- mfitq[,1]
write.csv(tb0, file="tabMedI7.csv")

#-----------------------------------------------------------------
# (I8) SSB indicator
#-----------------------------------------------------------------
# model
# pil_6 has a large impact in the indicator ...
idx <- !is.na(sam$SSB)
df0 <- sam[idx,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# model
mfitb <- glmer(SSB ~ factor(Year) + (1|stk), data =  df0, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(mfitb, "stk", df0, "diagMedI8.pdf", nc, nd)

# bootstrap
set.seed(1234)
stk <- unique(df0$stk)
mfitb.bs <- split(1:it, 1:it)
mfitb.bs <- mclapply(mfitb.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, stk==i))
        fit <- glmer(SSB ~ Year + (1|stk), data = df1, family = Gamma("log"), control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)
# remove failed iters
mfitb.bs <- mfitb.bs[unlist(lapply(mfitb.bs, is.numeric))]

mfitm <- do.call("rbind", mfitb.bs)
mfitm <- exp(log(mfitm)-mean(log(mfitm[,1]), na.rm=TRUE))
mfitq <- apply(mfitm, 2, quantile, c(0.025, 0.25, 0.50, 0.75, 0.975), na.rm=TRUE)
mfitq <- cbind(Year=as.numeric(yrs), as.data.frame(t(mfitq)))

# plot
png("figMedI8.png", 1800, 1200, res=300)
ggplot(mfitq, 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[length(Year)], y=`50%`[length(`50%`)]), size=2) +
        geom_hline(yintercept = 1, linetype=2) +
```

```
        ylab(expression(B/B[2003])) +
        xlab("") +
        theme(legend.position = "none") +
        sc +
        th
dev.off()

tb0 <- t(mfitq)[-1,]
colnames(tb0) <- mfitq[,1]
write.csv(tb0, file="tabMedI8.csv")

write.csv(sam, file="sam.csv")
save.image("RData.med")
```

KJ-NA-29733-EN-N

STECF

The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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doi:10.2760/22641

ISBN 978-92-76-02913-7