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Scientific, Technical and Economic Committee for Fisheries (STECF) - Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-21-01)

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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-21-01)

The report of the ad hoc Expert Group on monitoring the performance of the Common Fisheries Policy was reviewed by the STECF at its 66th plenary meeting held virtually from 22-26 March 2021.

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 required.

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, 2c) R code for computing all European waters indicators, 3) URL links of the reports and stock advice sheets underpinning the analysis, 4) ICES data quality issues corrected prior to the analysis, 5) stability tests ran for Mediterranean and Black Sea indicators, non-EU stocks indicator, data category 3 indicator and decadal recruitment indicator, 6) Sensitivity analysis on the Mediterranean and Black sea indicators. The report and Annexes are available at https://stecf.jrc.ec.europa.eu/plen21_01

STECF notes that the report is clear and well laid out, transparently describing the analysis undertaken and cataloguing the changes made in the approach since the previous report (STECF 20-01 ad hoc).

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 objective, drawing together the results from the different sea areas to provide a comparative picture. In this report, “Northeast Atlantic” refers to stocks in FAO Area 27 inside and outside EU waters[1], and “Mediterranean & Black Seas” refers to stocks in FAO Area 37[2].

For the NE Atlantic (FAO area 27), the information was downloaded from the ICES website comprising the most recent published assessments carried out up to and including 2020. For the Mediterranean & Black Seas (FAO area 37), the information was extracted from the STECF Mediterranean Expert Working Groups repositories comprising the most recently published assessments carried out up to 2020, and from the GFCM stock assessment forms comprising the most recently published assessments carried out up to 2019.

The analysis for the “Mediterranean and Black Seas” represents only a limited number of stocks and small proportion of total EU landings across all species and areas. In addition, there was a reduction of the number of stocks used in the analyses compared to 2020. Only one stock from the Black Sea was available (from 7 in 2020), while the number of Mediterranean Sea stocks available was reduced from 47 to 35. This reduction in the number of stocks is due to several stock assessments not being carried out by STECF anymore at the request of DG MARE, and which were not taken over by GFCM. This was the case in the Black Sea. At the same time, the different calendar for the provision of advice under the GFCM framework means that the latest stock assessments become publically available only later in the year, and the 2020 GFCM stock assessments were therefore unavailable for the present analysis.

Finally, as the last assessment carried out in 2020 refers to 2019 data, the stocks which would now be in the UK waters exclusively are still included in this EU analysis.

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 Sea for the periods 2003 to 2019 and 2003 to 2018 respectively. It applies to the stocks included in the reference list of stocks for these areas.

Stock status in the NE Atlantic

The indicators provided by the JRC EG show that in the NE Atlantic (both EU and non-EU waters) stock status has significantly improved since 2003 (Figure 1) but also that many stocks are still overexploited. Among the stocks which are fully assessed (Table 3, EG report), the proportion of overexploited stocks (i.e. $F>F_{MSY}$, blue line) has decreased from around 75% to close to 40% over the last ten years. However, in 2019, the proportion of overexploited stocks has increased slightly. The proportion of stocks outside safe biological limits ($F>F_{pa}$ or $B<B_{pa}$, orange line), computed for the 42 stocks for which both reference points are available, follows the same decreasing trend, from 75% in 2003 to around 30% in 2018, but has increased again substantially in 2019.

[1] The stocks that are included in the NE Atlantic analysis are those stocks in ICES category 1, 2 and 3 for which assessments are available and that were managed through a TAC at EU level in 2017 (based on DG MARE TAC/quotas database). Stocks in EU waters include stocks in/or partially in ICES areas 3, 4, 6, 7, 8 and 9, but excluding Norwegian coastal stocks in area 4 (see list of stocks in section 5; Scott et al., 2017a).

[2] The combinations of Species/GSA that are included in the Mediterranean & Black Seas analysis are those based on a ranking system approach for which the species having a rank in the first ten positions either in total live weight or total economic values between 2012 and 2014 were chosen (see Mannini et al., 2017).

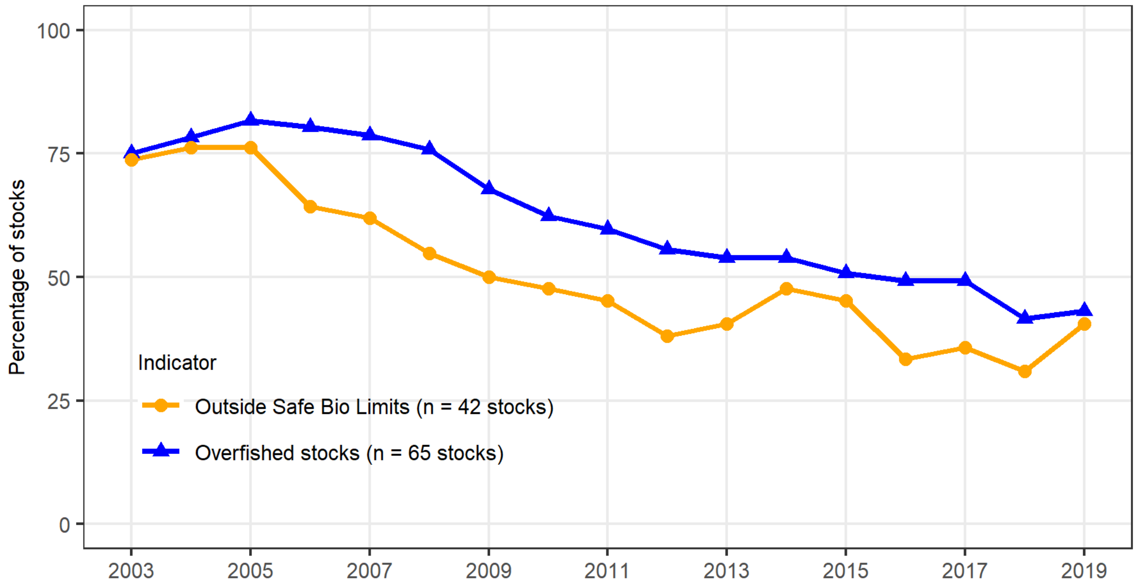

Figure 1. Trends in stock status in the NE Atlantic (both EU and non-EU waters) 2003-2019. Two indicators are presented: blue line: the proportion of overexploited stocks ($F>F_{MSY}$) within the sampling frame (out of a total of 65 stocks) and orange line: the proportion of stocks outside safe biological limits SBL ($F>F_{pa}$ or $B<B_{pa}$) (out of a total of 42 stocks).

STECF had previously commented on another indicator (see section 3.2.5 of EG report) showing the number of stocks where $F>F_{MSY}$ or $SSB<MSYB_{trigger}$ (used as a proxy of $SSB<B_{MSY}$ since by definition $MSYB_{trigger}$[3] is set at or below B_{MSY} and B_{MSY} is not available for the majority of stocks). This indicator is however available for 27 stocks only. The low number of stocks used makes the results unstable from year to year, hence it is not reported in Figure 1 and the trends need to be interpreted with care.

It is important to note, however, that in 2019, 4 stocks that are exploited below F_{MSY} are still outside safe biological limits (i.e. in this case, $B<B_{pa}$), while 8 stocks inside safe biological limits are still exploited above F_{MSY}, (i.e. $B>B_{pa}$ but $F_{MSY}<F<F_{pa}$) and 23 have an unknown status with regards to safe biological limits (Table 1). This means that for the last known year, among the 42 stocks considered only 40% are simultaneously not overfished and inside safe biological limits.

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 2019 in the NE Atlantic.

	Below F_{MSY}	Above F_{MSY}
Inside SBL	17	8
Outside SBL	4	13
Unknown	16	7

STECF continues to observe that the recent slope of the proportion of overexploited stocks (Figure 1) suggests that progress until 2019 has been too slow to allow all populations of fish to be managed at or below F_{MSY} no later than 2020.

[3] MSY Btrigger is considered the lower bound of spawning–stock biomass fluctuation for long-lived species when fished at F_{MSY} and is used in ICES advice rule to trigger a cautious response.

Stock Status in the Mediterranean & Black Seas

As explained above, in the Mediterranean & Black Seas, the number of stock assessments data publicly available vary year to year. In addition, not all stock assessments extend back to the early part of the time series. This renders the calculation of a robust indicator difficult and potentially misleading. According to the summary Table 5.1 in the EG report, out of 35 stocks, 6 (17%) were not overfished in 2018, the other 29 were 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 show different trends in F/F_{MSY} over time.

In the NE Atlantic EU waters, the model-based indicator of the fishing pressure (F/F_{MSY}) shows an overall downward trend over the period 2003-2019 (Figure 2). In the early 2000s, the median indicator of fishing mortality was more than 1.7 times larger than F_{MSY}, but this has reduced and since 2011 stabilised below 1.2, getting close to 1 in 2019. Note that the line being around 1 means that only around half of the stocks are fished below Fmsy. STECF notes that the objective of all stocks being exploited at or below Fmsy will be achieved when the upper bound of the confidence interval of the indicator in figure 19 in the EG report is below 1.

The same model-based indicator was computed by the EG for an additional set of 12 stocks located in the NE Atlantic, but outside EU waters. This indicator follows the same overall decreasing trend in overexploitation levels observed in EU waters until 2014. Since then, however, the indicator has shown an increasing number of stocks being exploited above F_{MSY}, especially since 2017 where the indicator has increased to almost twice F_{MSY}. STECF acknowledges that the indicator for NE Atlantic stocks outside EU waters is based on comparatively few stocks, and uncertainty around the actual value of the estimate (confidence interval) is high (see figure 21 in the EG report). This makes the results unstable from year to year, and should be interpreted with care. Nevertheless, the increasing trend in fishing mortality in recent years has been observed in most stocks analysed, and is particularly severe for one stock (figure 22, EG report); This trend was also already observed in the previous CFP monitoring report.

The indicator computed for stocks from the Mediterranean & Black Seas has remained at a very high level during the whole 2003-2018 period. After the observed peak between 2011-2013 where F/F_{MSY} has reached its highest historical level, there has been a somewhat decreasing trend in the fishing pressure. Nevertheless, the value of F/F_{MSY} has still been around 2.1 in recent years indicating that the stocks are being exploited on average at rates well above the F_{MSY} objective contained in the CFP.

The F/F_{MSY} model-based indicator was also estimated considering all stocks in EU waters, (i.e. both the in NE Atlantic EU waters *and* in the Mediterranean & Black Seas together (79 stocks), due to the international requirements on the EU to report on all stocks fished in EU Waters. However, the indicator (displayed in section 5 EG report) appeared somehow counterintuitive and difficult to interpret: instead of following a pattern in between NEA and Med-Black Sea realities as may have been intuitively expected, it rather follows closely the pattern shown by stocks in the NE Atlantic. This is due to the significant variability in trends observed in Mediterranean and Black Seas stocks, compared to the more consistent trends observed across the NEA stocks, which influence more strongly the modelled indicator. The result is that the overall F/F_{MSY} indicator for all EU waters shows a low and decreasing trend over time, which is not representative of the reality of the Mediterranean and Black Seas and may be mis-interpreted. For this reason, STECF decided not to present the results in Figure 2.

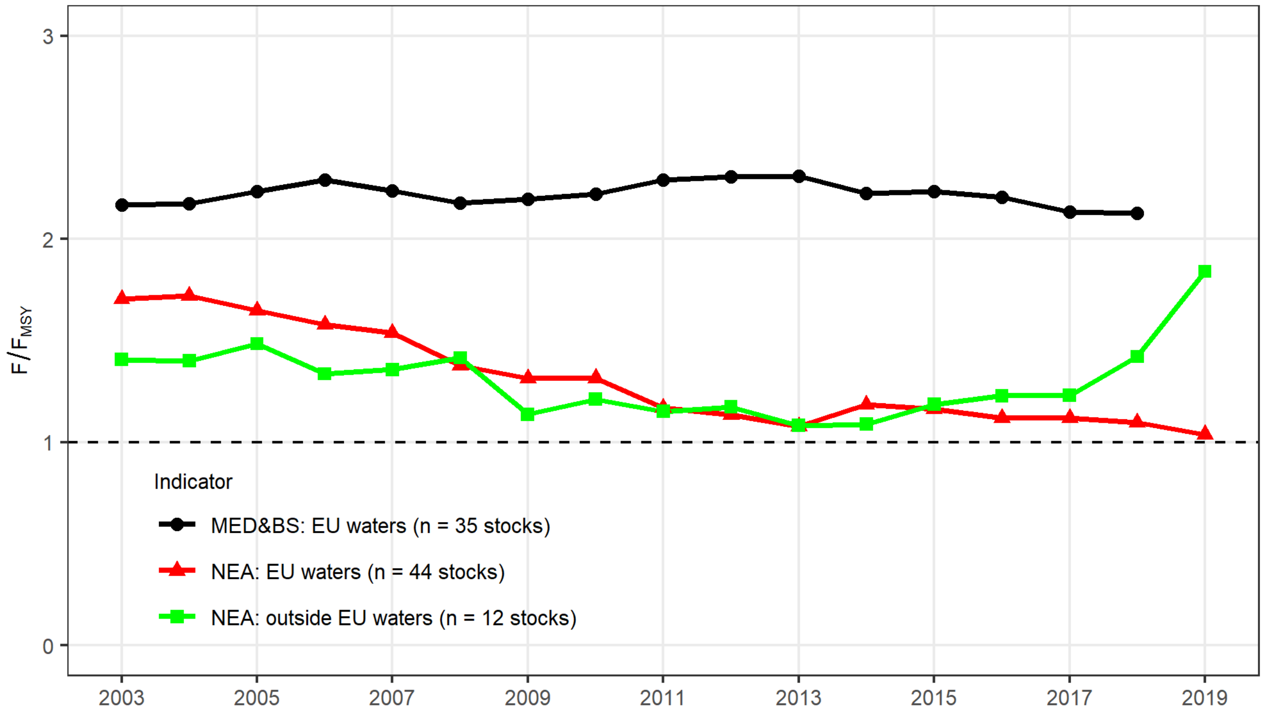

Figure 2. Trends in fishing pressure 2003-2019. Three model-based indicators F/F_{MSY} are presented (all referring to the median value of the model): one for 44 stocks with appropriate information in the NE Atlantic EU waters (red line); one for an additional set of 12 stocks also located in the NE Atlantic but outside EU waters (green line), and one for the 35 stocks from the Mediterranean Sea & Black Seas (black line).

Finally, STECF notes that trends observed this year may slightly differ from previous STECF reports. Beyond the issue of the varying number of stocks from year to year, these differences are largely imputable to the annual update of stock assessment results themselves: it happens that some stocks, assessed as overfished one year, are re-assessed as not-overfished the following year (or vice-versa), with the addition of a new year of data (the inherent so-called "retrospective pattern" of stock assessment). To illustrate this, the EG has produced a new set of graphs this year, displaying the changes of historical perceptions over time (Section 7, EG report). They show a systematic underestimation of F/F_{MSY} in NEA Atlantic EU waters, (i.e. that in every reporting year the model estimates F/F_{MSY} being close to 1 for the final data year, but in following reporting years that value for the same given data year is re-estimated to be above 1). Therefore, small differences in the resulting outcomes compared to last year's report should not be over-interpreted. In the Mediterranean and Black Seas there is no systematic under- or over-estimation observed in the historical pattern.

Trends in Biomass

The model-based indicator of the trend in biomass shows improvement in the NE Atlantic (EU waters only), particularly for data limited stocks (ICES category 3 stocks), but not necessarily in the Mediterranean & Black Seas (Figure 3). In the NE Atlantic the biomass has been generally increasing since 2007, and was in 2019 on average around 35% higher than in 2003. In the Mediterranean & Black Seas, biomass increased at the beginning of the time series, but declined after 2006. Since 2015 there has been an increase in biomass. STECF notes there is large uncertainty around this indicator (see figure 32 in the EG report).

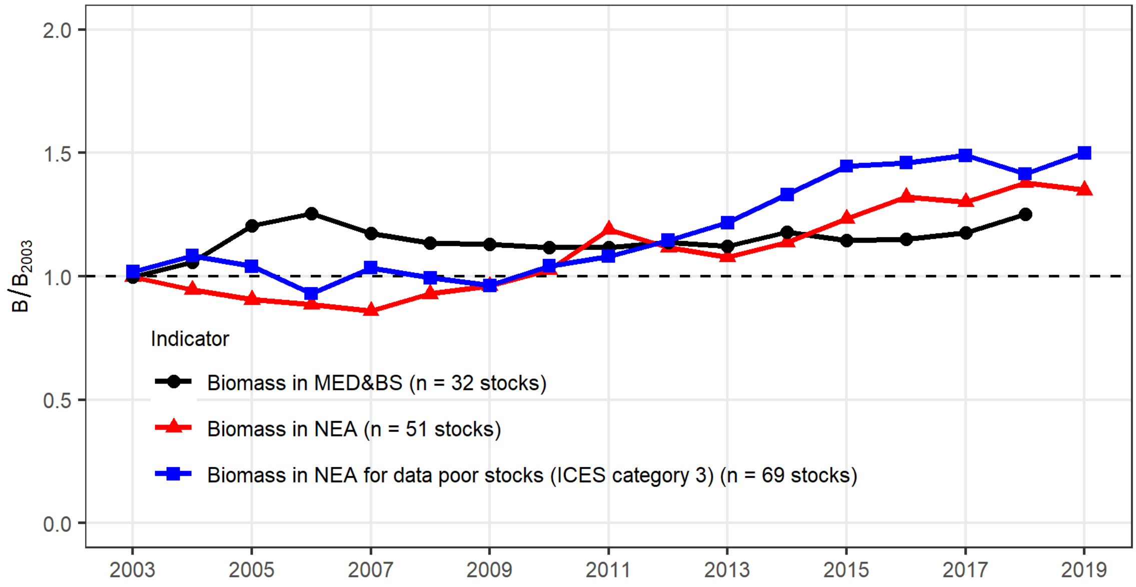

Figure 3. Trends in the indicators of stock biomass (median values of the model-based estimates relative to 2003). Three indicators are presented: one for the NE Atlantic EU waters (51 stocks considered, red line); one for the Mediterranean & Black Seas (32 stocks, black line); and one for data limited stocks (ICES category 3, 69 stocks, blue line).

Trends in Recruitment

The average decadal recruitment indicator shows a decreasing trend until 2012 and an inversion afterwards, which may reflect an increase in stocks' production. However, the characteristics of the indicator, a decadal ratio, only expresses the overall long-term trends over a twenty years window, and does not reflect year to year variability. For example, the 2019's decadal recruitment for a single stock is the ratio between the average recruitment from 2010 to 2019 over the average recruitment from 2000 to 2009 (check the protocol in Annex 1 of the EG report for more details; Figure 4).

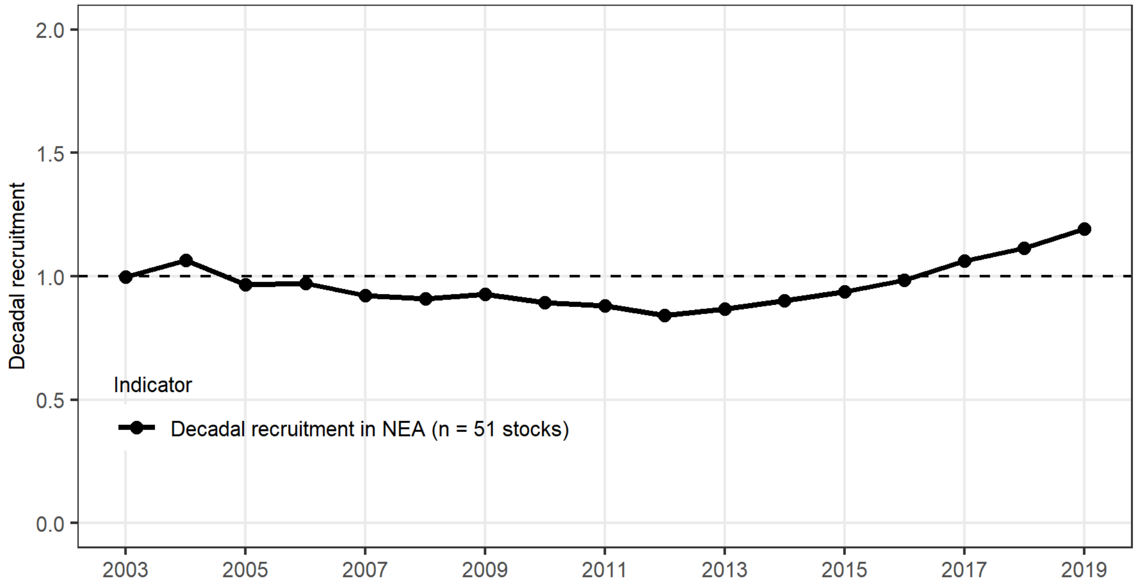

Figure 4. Trend in decadal recruitment scaled to 2003 in the NE Atlantic area (based on 51 stocks).

Trends per Ecoregion

The EG provides some information and figures broken down by Ecoregion for EU waters in NE Atlantic and the Mediterranean & Black Sea. STECF notes however, the large uncertainty associated with these indicators, particularly in the Mediterranean & Black Sea. This makes the results unstable from year to year and thus should be interpreted with care. .

In EU waters the overall fishing pressure across ICES Ecoregions has decreased and the status of stocks has improved compared to the start of the time series. Nevertheless, in two out of five regions the decreasing trend in exploitation has been reversed (North Sea) or stalled (Baltic Sea) in recent years. In 2019, the proportion of overexploited stocks ranged between to 13% - 71% across the different ICES Ecoregions, while the modelled estimate of the F/F_{MSY} ratio for 2019 was between 0.9 and 1.21, suggesting great regional differences in progresses. In the Iberia area a considerable increase in biomass has been observed, as well as in the widely distributed stocks.

Coverage of the scientific advice

Coverage of biological stocks by the CFP monitoring

The analyses of the progress in achieving the MSY objective 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 provided scientific advice for 256 biological stocks included in EU waters (at least in part). Of these, 159 stocks (62%) are data limited, without an estimate of MSY reference points (ICES category 3 and above, Table 2).

Table 2. Total number of stocks assessed by ICES for different stock categories in different areas. Note that not all of these stocks are considered of EU relevance (STECF 15-04) 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	8	0	4	0	0	0	12

Azores	0	0	2	0	1	0	3
Baltic Sea	8	0	8	1	1	0	18
BoBiscay & Iberia	12	0	20	0	9	5	46
Celtic Seas	25	0	16	2	13	10	66
Greater North Sea	22	0	18	4	7	3	54
Iceland, Greenland and Faroes	14	1	9	0	1	1	26
Widely	7	0	8	0	4	12	31
Total	96	1	85	7	36	31	256

The present CFP monitoring analysis for the NE Atlantic is focused on stocks with a TAC in 2017 and for which estimates of fishing mortality, biomass and biological reference points are available. As detailed in the EG's technical reports, not all indicators can be calculated for all stocks in all years, and the EG was able to compute indicators for 42 to 65 stocks of category 1 depending on indicators, years and areas, and 69 stocks of category 3 (Table 4, EG report). 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 and Black Seas region, stocks status and trends are only assessed for a limited number of stocks. The EG selected 247 combinations of Species/GSA in the sampling frame (Mannini et al., 2017), of which 64 combinations (26%) have been covered by 35 available stock assessments in 2019.

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 2019 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 "covered" by a stock assessment when at least one of its divisions match the spatial distribution of a stock for which reference points have been estimated from an ICES full assessment. Based on this indicator, 53% of the 156 TACs are covered, at least partially, by stock assessments that provide estimates of F_{MSY} (or a proxy), 48% by stock assessments that have B_{pa}, with only 19% covered by stock assessments that provide estimates or proxies of B_{MSY}.

Additionally, STECF notes that, using this index, some TACs can be considered as "covered" even if they relate no assessment for some parts of the considered management area, or 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 many TACs are still not covered by scientific advice based on F_{MSY} reference values.

Ongoing developments

STECF notes that work will continue in 2021 to allow the coverage of the CFP monitoring report to be expanded and the protocol to be reinforced, (section 8, EG report).

STECF acknowledges that monitoring the performance of the CFP requires significant effort to provide a comprehensive picture. The process presents several methodological challenges due to the annual variability in the number and categories of stocks assessed (especially in the Mediterranean and Black Sea) and due to the large variation in trends across stocks. As a result, the choice of indicators and their interpretation is regularly discussed by STECF, expanded and adjusted over time when necessary.

STECF is aware that a stable methodology and set of indicators provide an easier and increasing understanding by stakeholders of the CFP monitoring analysis over time. However, STECF also has to take into account annual changes in assessment methodologies, data and models, and to balance this with expectations for consistency.

STECF recognises the need to broaden the scope of the CFP monitoring to cover additional aspects not currently dealt with. In particular, indicators covering the landing obligation, wider ecosystem and socio-economic aspects in the analysis would be a useful expansion. This was initiated in 2018, but still needs further development in the relevant STECF EWGs to be made fully operational and routinely included in the CFP monitoring.

STECF conclusions

Regarding the progress made in the achievement of F_{MSY} in line with the CFP, STECF notes that the latest results confirm a reduction in the overall exploitation rate and increases in biomass for the NE Atlantic over the long time period. However, when considering stocks in the Baltic Sea, North Sea and outside EU waters, this has recently stabilised (Baltic Sea) or has even been reversed. Furthermore, STECF notes that many stocks remain overfished and/or outside safe biological limits, and that progress achieved until 2019 is obviously too slow to ensure that all stocks are fished at or below F_{MSY} in 2020.

STECF also concludes that stocks from the Mediterranean & Black Sea remain in a very poor situation, although there has been slight improvement in terms of fishing pressure and stock biomass. STECF raises concerns about the decreasing number of stock assessments being performed and available in these regions.

STECF notes that only few stocks have estimates or even proxies of B_{MSY} available. This restricts considerably the ability to monitor the performance of the CFP. STECF therefore identifies the need to increase the numbers of stocks for which a B_{MSY} estimate is available.

STECF recognises the need to broaden the scope of the monitoring to cover additional aspects of the CFP not currently dealt with.

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[1] - Information on STECF members' affiliations is displayed for information only. In any case, Members of the STECF shall act independently. In the context of the STECF work, the committee members do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members 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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EXPERT GROUP REPORT

REPORT TO THE STECF

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

Virtual meeting, January-March 2021

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

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 2019 (Annex I).

An ad hoc Expert Group comprising Experts from the European Commission's Joint Research Centre (JRC) was convened from January to March 2021 to compute the performance indicator values according to the agreed protocol (Annex I) and to report to the STECF plenary meeting scheduled for 22-26 March 2021.

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

From mid-March 2020, the Covid-19 outbreak prevented the ICES working groups to meet physically. As a response to these exceptional circumstances, ICES came up with the so called "Spring 2020 approach". The ICES Advisory COMmittee (ACOM), in agreement with clients proposed to publish an abbreviated version of the advice on fishing opportunities with less narrative but still providing the key results and analyses. A more detailed description of this new protocol is available on the ICES website (https://www.ices.dk/news-and-events/news-archive/news/Pages/spring2020approach.aspx)

For the NE Atlantic (FAO area 27), the information was downloaded from the ICES website (http://standardgraphs.ices.dk) on the 21st January 2021, comprising the most recent published assessments, carried out up to and including 2020. 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).

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) comprising the most recent published assessments carried out up to 2020 and from the GFCM stock assessment forms (http://www.fao.org/gfcm/data/safs/en) comprising the most recent published assessments carried out up to 2019.

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 reporting system. Subsequently, this 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). This work was done once in 2017 and not updated since as there were no changes over time.

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 (2018). 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 1% of non-convergence. Failed resamples were excluded when computating model-based indicators.
- The biomass indicator for stocks assessed with data limited methods (ICES stocks category 3) include also abundance indices, not only biomass indices. This is not fully clear in the protocol.

2.4 Differences from the 2020 CFP monitoring report

The methods used in the analysis for this report were the same used for the 2020's report (STECF, 2020a). During the preparation of ICES data, the assignment of Ecoregions to stocks was revised: a list of Ecoregions by stock assigned by ICES was used as reference to reassign Ecoregions when needed. Additionally, the Ecoregion called "Northeast Atlantic" in previous reportsis now identified as 'Widely', in accordance to the ICES naming convention.

An extra section was added reporting results for two indicators of fisheries' state for all European waters: an indicator of F/F_{msy} and one for B/B_{2003} for all European waters (joining FAO area 27 and FAO area 37).

The nep.fu.13 stock was removed from the analysis as on the 11th of March ICES did not have finalized the review of the assessment and the results reported in the SAG database were defined not correct.

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 2003-2019 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 2019 the estimates of F and SSB were assumed to be the same as 2018. Consequently, the number of stocks included to compute the indicator values for 2019 was 64.

The stocks used to compute each indicator are shown in Table 4, including data category 3 (69 stocks).

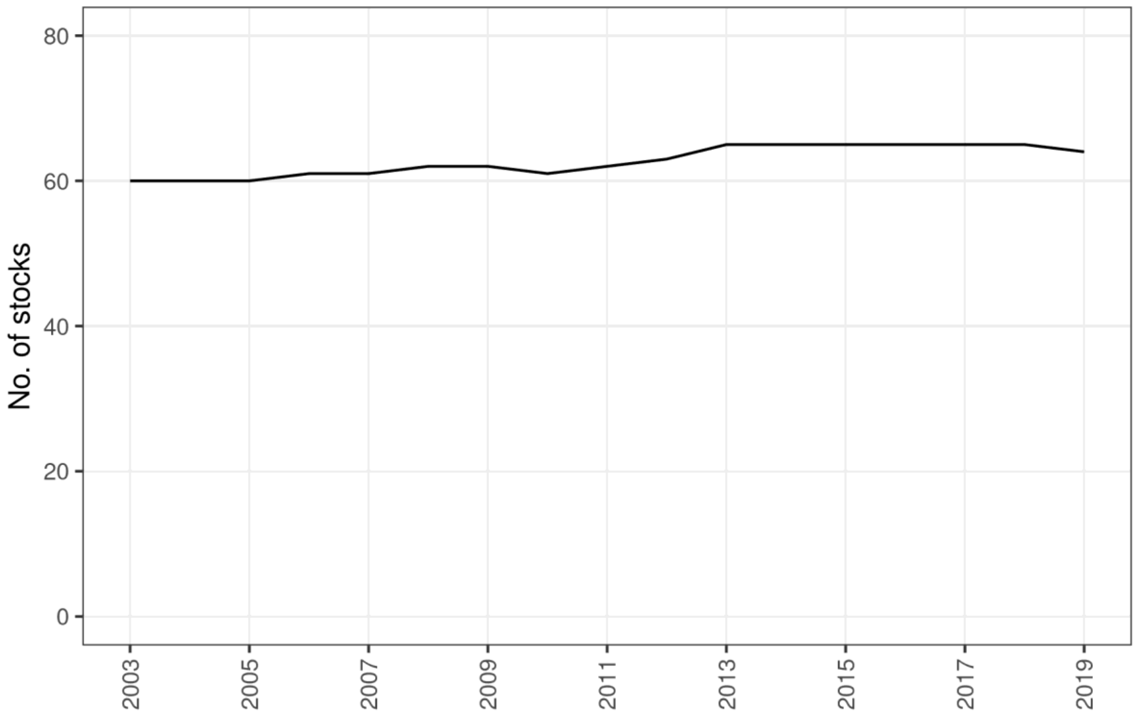

Figure 5. Number of stocks in the NE Atlantic for which estimates of F/F_{MSY} are available by year.

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
ALL	60	60	60	61	61	62	62	61	62
Baltic Sea	7	7	7	7	7	7	7	7	7
BoBiscay & Iberia	8	8	8	8	8	8	8	8	8
Celtic Seas	18	18	18	19	19	20	20	19	20
Greater North Sea	21	21	21	21	21	21	21	21	21
Widely	6	6	6	6	6	6	6	6	6
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	63	65	65	65	65	65	65	64	
Baltic Sea	7	7	7	7	7	7	7	7	
BoBiscay & Iberia	8	8	8	8	8	8	8	8	
Celtic Seas	21	23	23	23	23	23	23	22	
Greater North Sea	21	21	21	21	21	21	21	21	
Widely	6	6	6	6	6	6	6	6	

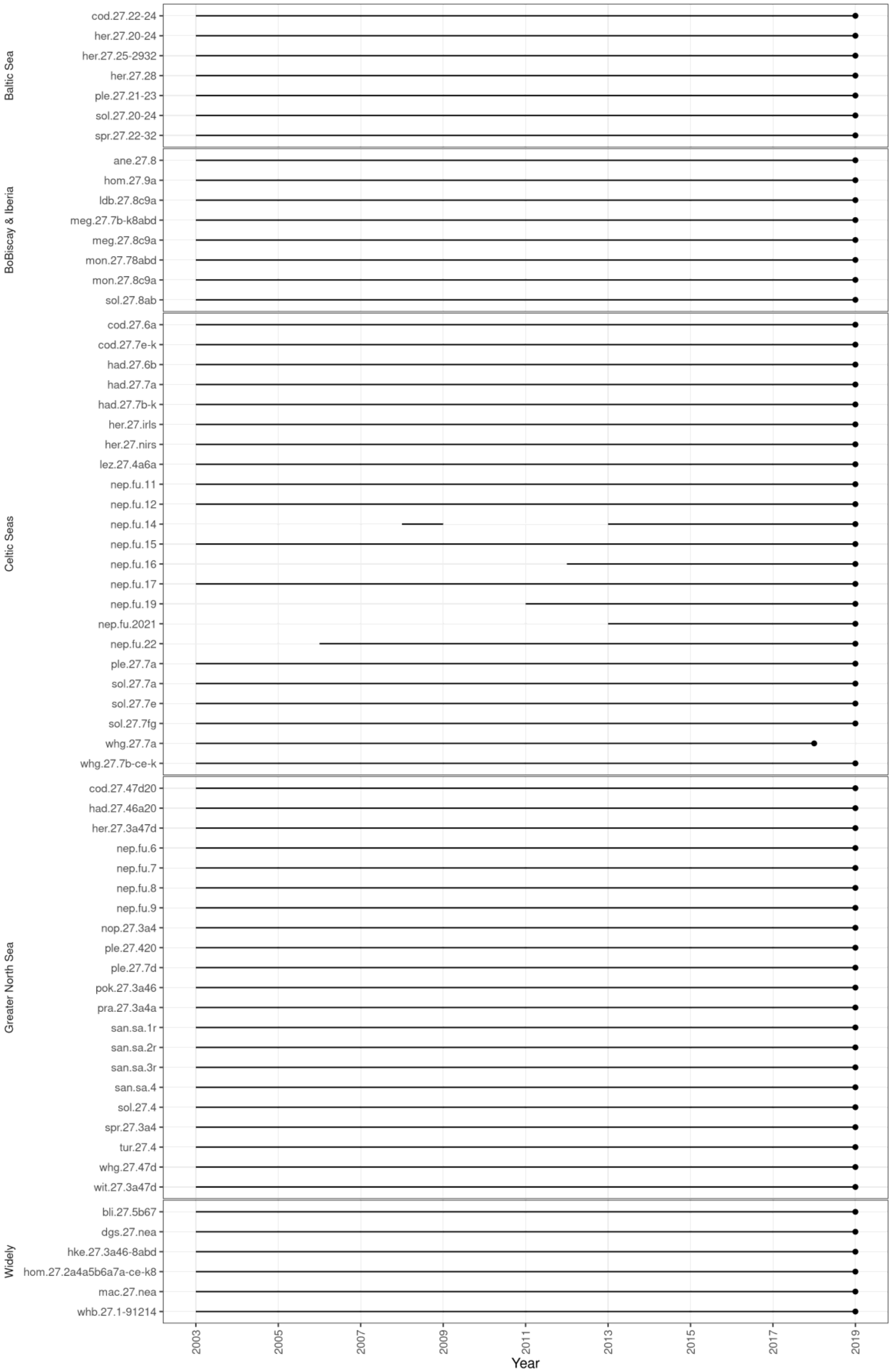

Figure 6. Time series of stock assessment results in the NE Atlantic for which estimates of F/F_{MSY} are available by year. Blank records indicate no estimate available for stock and year.

Compared to last year's report, with relation to Category 1 & 2 stocks, no stocks were added, two stocks have been dropped.

The stocks dropped are:

- hke.27.8c9a, whg.27.6a: these stocks have been downgraded from Category 1 to Category 3.

As in last year's report (STECF, 2020a) cod.27.24-32 was not included in the analysis, despite having been upgraded from Category 3 to Category 1 in 2020, due to the absence of reference points for F.

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.

As in last year's report (STECF, 2020a), the stock of nep.fu.3-4 has been dropped as having inconsistent abundance and harvest rate estimates across its time series, due to changes in the surveyed area.

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 which 3 have explicitly estimated both reference points (hom.27.9a, pra.27.3a4a and sol.27.7e), all the others used ICES's default procedure. For the latter cases MSYBtrigger was set to unknown as discussed by STECF (2018b).

As in last year's report (STECF, 2020a) 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 on the indicator values.

Under normal circumstances, 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. This year, being the results of the stock still under review by ICES, the stock is dropped from the current analysis.

To keep consistency with the new ICES definition, widely distributed stocks are referred to as "Widely" in the figures and tables of this section, and not "Northeast Atlantic" anymore as in previous reports.

Table 4. Indicators computed for each stock.

FishStock	Year	above/below F_{MSY}	in/out SBL	$F \leq F_{MSY}$ & $B \geq B_{MSY}$	F/F_{MSY} trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
ane.27.8	2019	x				x	x	
ane.27.9a	2019							x
anf.27.3a46	2019							x
ank.27.78abd	2019							x
ank.27.8c9a	2019							x
aru.27.6b7-1012	2018							x
bli.27.5b67	2019	x	x	x	x	x	x	
bll.27.22-32	2019							x
bll.27.3a47de	2019							x
bsf.27.nea	2019							x
bwp.27.2729-32	2019							x
bwq.27.2425	2019							x
bwq.27.2628	2019							x
cod.27.21	2019							x
cod.27.22-24	2019	x	x		x	x	x	
cod.27.47d20	2019	x	x		x	x	x	
cod.27.6a	2019	x	x		x	x	x	
cod.27.7a	2019							x
cod.27.7e-k	2019	x	x		x	x	x	
dab.27.22-32	2019							x
dab.27.3a4	2018							x
dgs.27.nea	2019	x		x		x	x	
fle.27.2223	2018							x
fle.27.3a4	2019							x
gfb.27.nea	2019							x
gug.27.3a47d	2019							x
had.27.46a20	2019	x	x		x	x	x	
had.27.6b	2019	x	x		x	x	x	
had.27.7a	2019	x	x	x	x	x	x	
had.27.7b-k	2019	x	x		x	x	x	
her.27.20-24	2019	x	x		x	x	x	
her.27.25-2932	2019	x	x		x	x	x	
her.27.28	2019	x	x	x	x	x	x	
her.27.3a47d	2019	x	x	x	x	x	x	
her.27.6a7bc	2019							x
her.27.irls	2019	x	x		x	x	x	
her.27.nirs	2019	x	x		x	x	x	
hke.27.3a46-8abd	2019	x	x		x	x	x	

hom.27.2a4a5b6a7a-ce-k8	2019	x	x		x	x	x	
hom.27.3a4bc7d	2018							x
hom.27.9a	2019	x		x	x	x	x	
ldb.27.8c9a	2019	x	x		x	x	x	
lem.27.3a47d	2019							x
lez.27.4a6a	2019	x		x	x			
lez.27.6b	2019							x
lin.27.3a4a6-91214	2018							x
mac.27.nea	2019	x	x		x	x	x	
meg.27.7b-k8abd	2019	x	x		x	x	x	
meg.27.8c9a	2019	x	x		x	x	x	
mon.27.78abd	2019	x	x		x	x	x	
mon.27.8c9a	2019	x	x	x	x	x	x	
mur.27.3a47d	2018							x
nep.fu.11	2019	x		x				
nep.fu.12	2019	x		x				
nep.fu.14	2019	x		x				
nep.fu.15	2019	x		x				
nep.fu.16	2019	x						
nep.fu.17	2019	x		x				
nep.fu.19	2019	x		x				
nep.fu.2021	2019	x						
nep.fu.22	2019	x		x				
nep.fu.25	2016							x
nep.fu.2627	2018							x
nep.fu.2829	2018							x
nep.fu.30	2019							x
nep.fu.31	2016							x
nep.fu.6	2019	x		x				
nep.fu.7	2019	x		x				
nep.fu.8	2019	x		x				
nep.fu.9	2019	x		x				
nop.27.3a4	2019	x				x	x	
ple.27.21-23	2019	x	x		x	x	x	
ple.27.24-32	2019							x
ple.27.420	2019	x	x	x	x	x	x	
ple.27.7a	2019	x	x	x	x	x	x	
ple.27.7d	2019	x	x		x	x	x	
ple.27.7e	2019							x
ple.27.7fg	2019							x
ple.27.7h-k	2019							x
pok.27.3a46	2019	x	x		x	x	x	
pra.27.3a4a	2019	x	x	x	x	x	x	
raj.27.1012	2018							x

rjc.27.3a47d	2018							x
rjc.27.6	2019							x
rjc.27.7afg	2019							x
rjc.27.8	2019							x
rjc.27.9a	2019							x
rje.27.7fg	2019							x
rjh.27.4c7d	2018							x
rjh.27.9a	2019							x
rjm.27.3a47d	2018							x
rjm.27.67bj	2019							x
rjm.27.7ae-h	2019							x
rjm.27.8	2019							x
rjn.27.3a4	2018							x
rjn.27.678abd	2019							x
rjn.27.8c	2019							x
rjn.27.9a	2019							x
rjr.27.23a4	2018							x
rju.27.7de	2019							x
rng.27.3a	2019							x
san.sa.1r	2019	x				x	x	
san.sa.2r	2019	x				x	x	
san.sa.3r	2019	x				x	x	
san.sa.4	2019	x				x	x	
sbr.27.10	2019							x
sbr.27.9	2019							x
sdv.27.nea	2018							x
sho.27.67	2018							x
sho.27.89a	2018							x
sol.27.20-24	2019	x	x		x	x	x	
sol.27.4	2019	x	x		x	x	x	
sol.27.7a	2019	x	x		x	x	x	
sol.27.7d	2019							x
sol.27.7e	2019	x	x	x	x	x	x	
sol.27.7fg	2019	x	x		x	x	x	
sol.27.8ab	2019	x	x		x	x	x	
spr.27.22-32	2019	x	x		x	x	x	
spr.27.3a4	2019	x				x	x	
spr.27.7de	2019							x
syc.27.3a47d	2018							x
syc.27.67a-ce-j	2018							x
syc.27.8abd	2018							x
syc.27.8c9a	2018							x
syt.27.67	2018							x
tur.27.22-32	2017							x

tur.27.3a	2019							x
tur.27.4	2019	x	x	x	x	x	x	
usk.27.3a45b6a7-912b	2018							x
whb.27.1-91214	2019	x	x		x	x	x	
whg.27.47d	2019	x	x		x	x	x	
whg.27.7a	2018	x	x		x	x	x	
whg.27.7b-ce-k	2019	x	x		x	x	x	
wit.27.3a47d	2019	x	x		x	x	x	
Total		**65**	**42**	**23**	**44**	**51**	**51**	**69**

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, with 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 2725 and Table 11 to Table 18) depicts time trends of important variables. These indicators are 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}

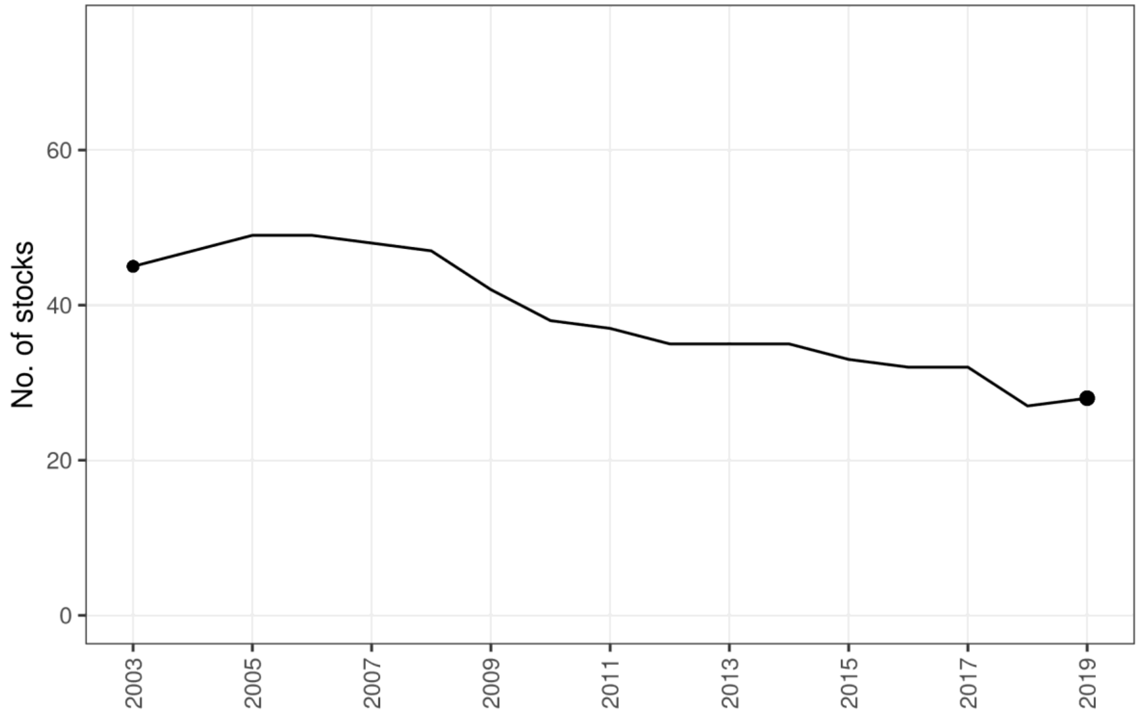

Figure 7. Number of stocks by year for which fishing mortality (F) exceeded F_{MSY}.

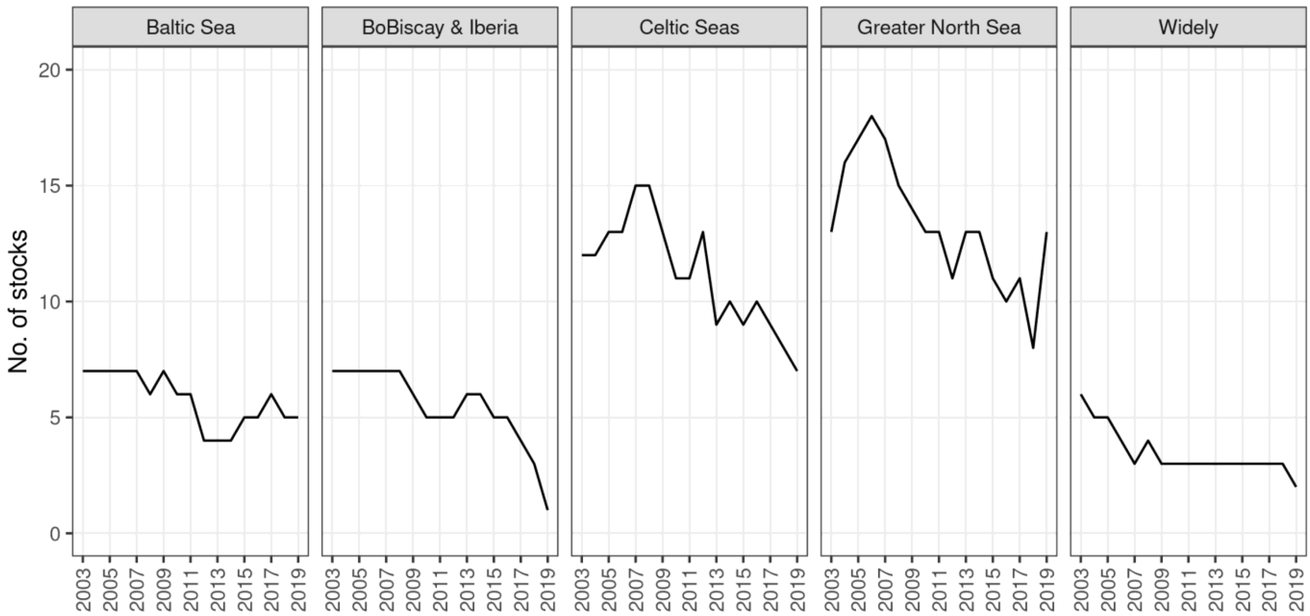

Figure 8. Number of stocks by ecoregion for which fishing mortality (F) exceeded F_{MSY}.

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
ALL	45	47	49	49	49	47	43	38	38
Baltic Sea	7	7	7	7	7	6	7	6	6
BoBiscay & Iberia	7	7	7	7	7	7	6	5	5
Celtic Seas	12	12	13	13	15	15	13	11	11
Greater North Sea	13	16	17	18	17	15	14	13	13
Widely	6	5	5	4	3	4	3	3	3
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	36	35	36	33	33	33	27	28	
Baltic Sea	4	4	4	5	5	6	5	5	
BoBiscay & Iberia	5	6	6	5	5	4	3	1	
Celtic Seas	13	9	10	9	10	9	8	7	
Greater North Sea	11	13	13	11	10	11	8	13	
Widely	3	3	3	3	3	3	3	2	

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

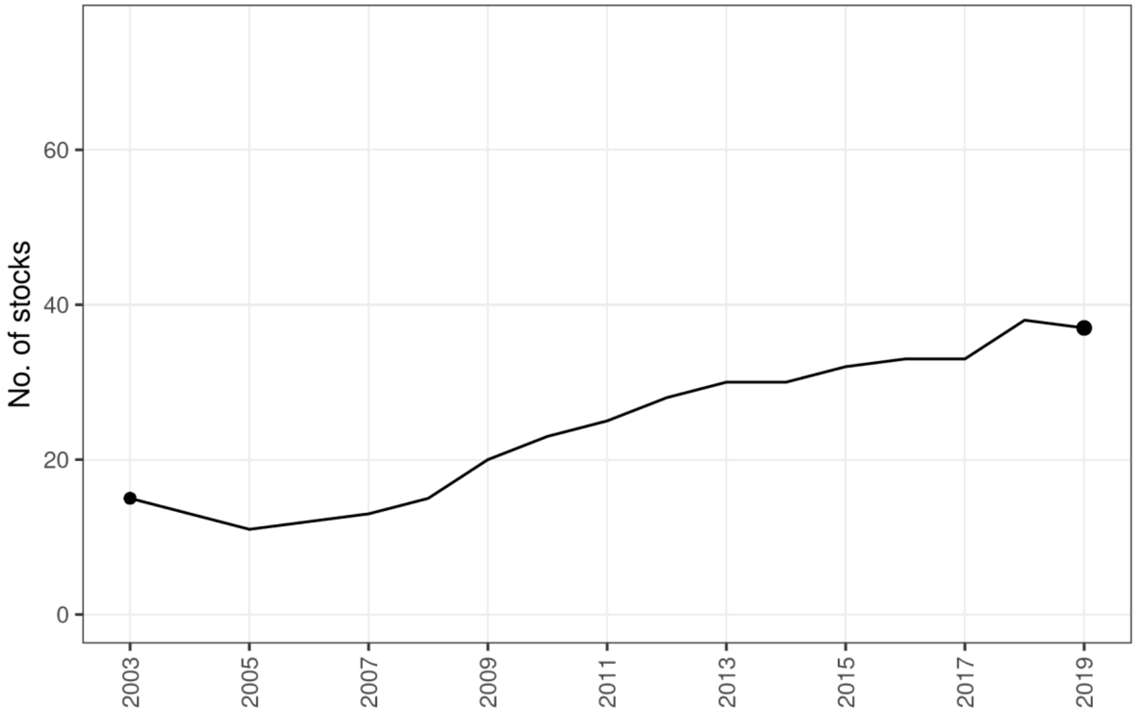

Figure 9. Number of stocks by year for which fishing mortality (F) did not exceed F_{MSY}.

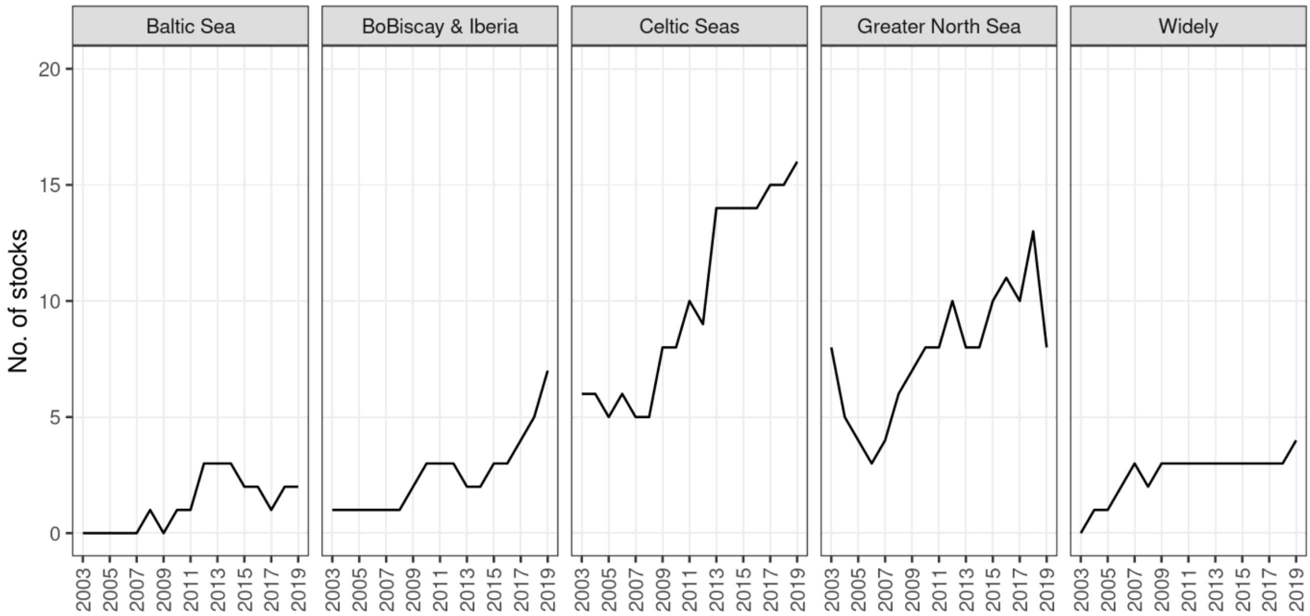

Figure 10. Number of stocks by ecoregion for which fishing mortality (F) did not exceed F_{MSY}.

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
ALL	15	13	11	12	13	15	20	23	25
Baltic Sea	0	0	0	0	0	1	0	1	1
BoBiscay & Iberia	1	1	1	1	1	1	2	3	3
Celtic Seas	6	6	5	6	5	5	8	8	10
Greater North Sea	8	5	4	3	4	6	7	8	8
Widely	0	1	1	2	3	2	3	3	3
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	28	30	30	32	33	33	38	37	
Baltic Sea	3	3	3	2	2	1	2	2	
BoBiscay & Iberia	3	2	2	3	3	4	5	7	
Celtic Seas	9	14	14	14	14	15	15	16	
Greater North Sea	10	8	8	10	11	10	13	8	
Widely	3	3	3	3	3	3	3	4	

3.2.3 Number of stocks outside safe biological limits

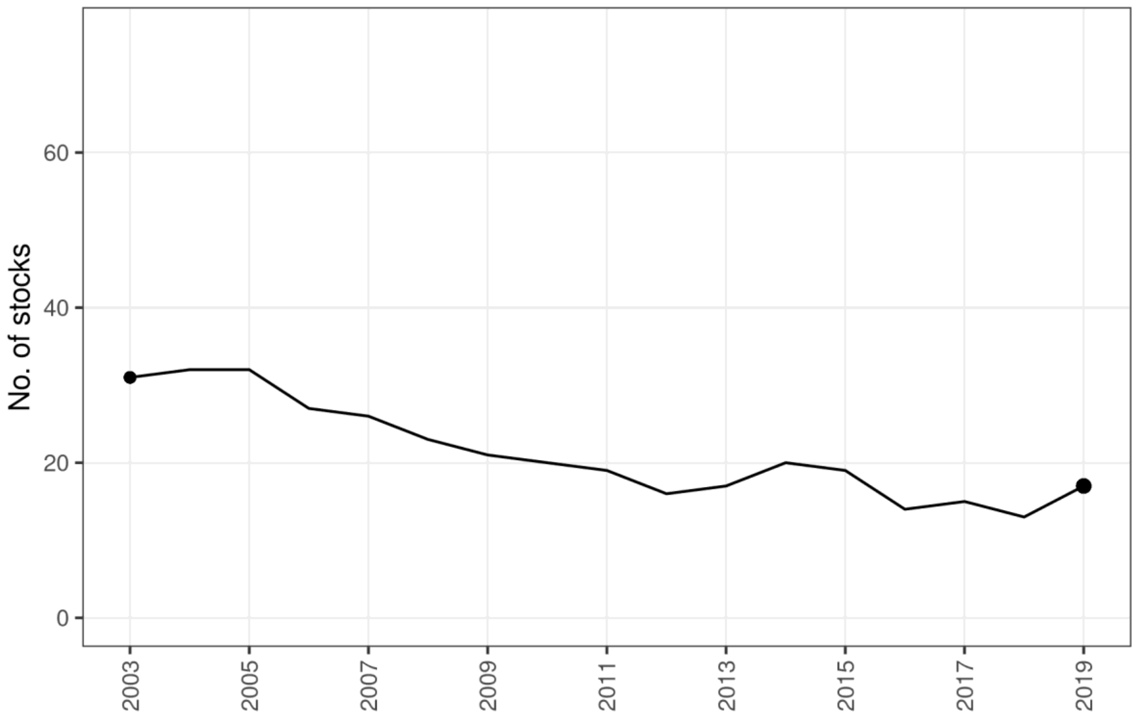

Figure 11. Number of stocks outside safe biological limits by year.

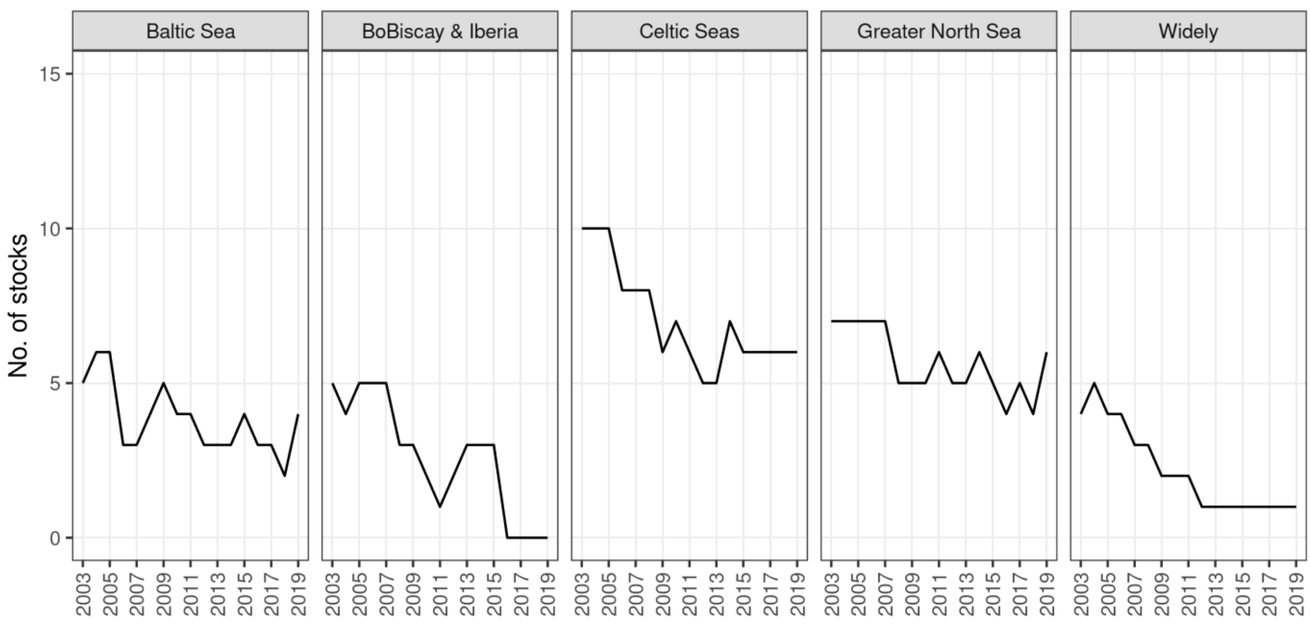

Figure 12. Number of stocks outside safe biological limits by ecoregion.

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

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011
ALL	31	32	32	27	26	23	21	20	19
Baltic Sea	5	6	6	3	3	4	5	4	4
BoBiscay & Iberia	5	4	5	5	5	3	3	2	1
Celtic Seas	10	10	10	8	8	8	6	7	6
Greater North Sea	7	7	7	7	7	5	5	5	6
Widely	4	5	4	4	3	3	2	2	2
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	16	17	20	19	14	15	13	17	
Baltic Sea	3	3	3	4	3	3	2	4	
BoBiscay & Iberia	2	3	3	3	0	0	0	0	
Celtic Seas	5	5	7	6	6	6	6	6	
Greater North Sea	5	5	6	5	4	5	4	6	
Widely	1	1	1	1	1	1	1	1	

3.2.4 Number of stocks inside safe biological limits

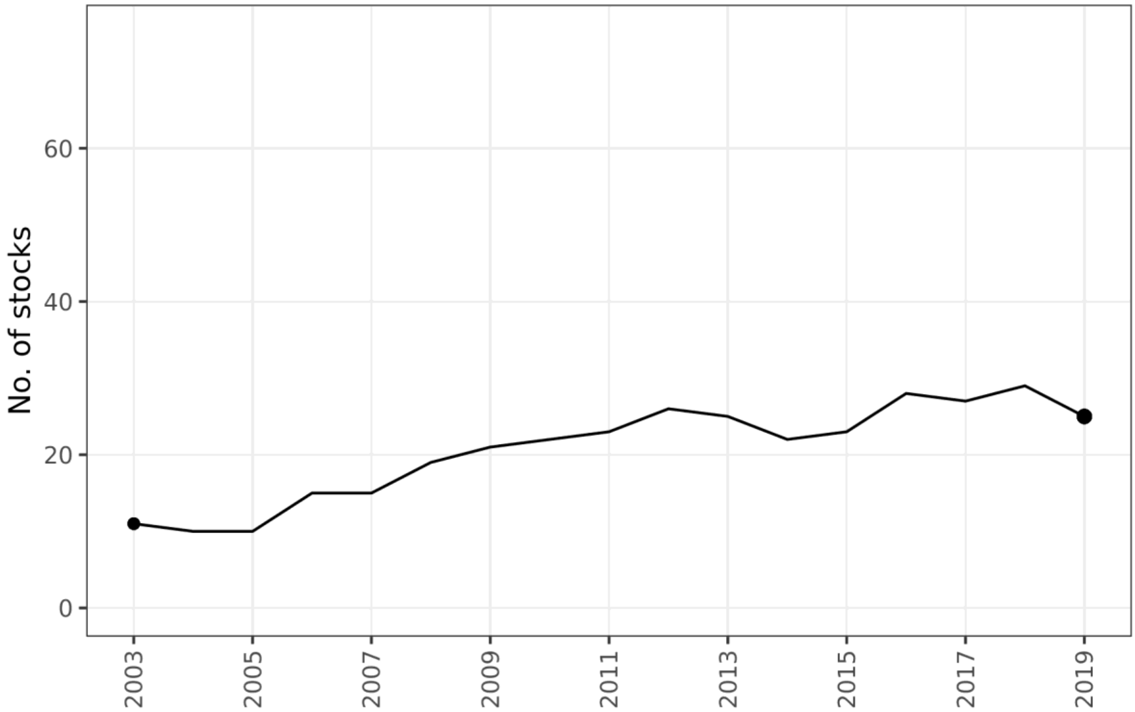

Figure 13. Number of stocks inside safe biological limits by year.

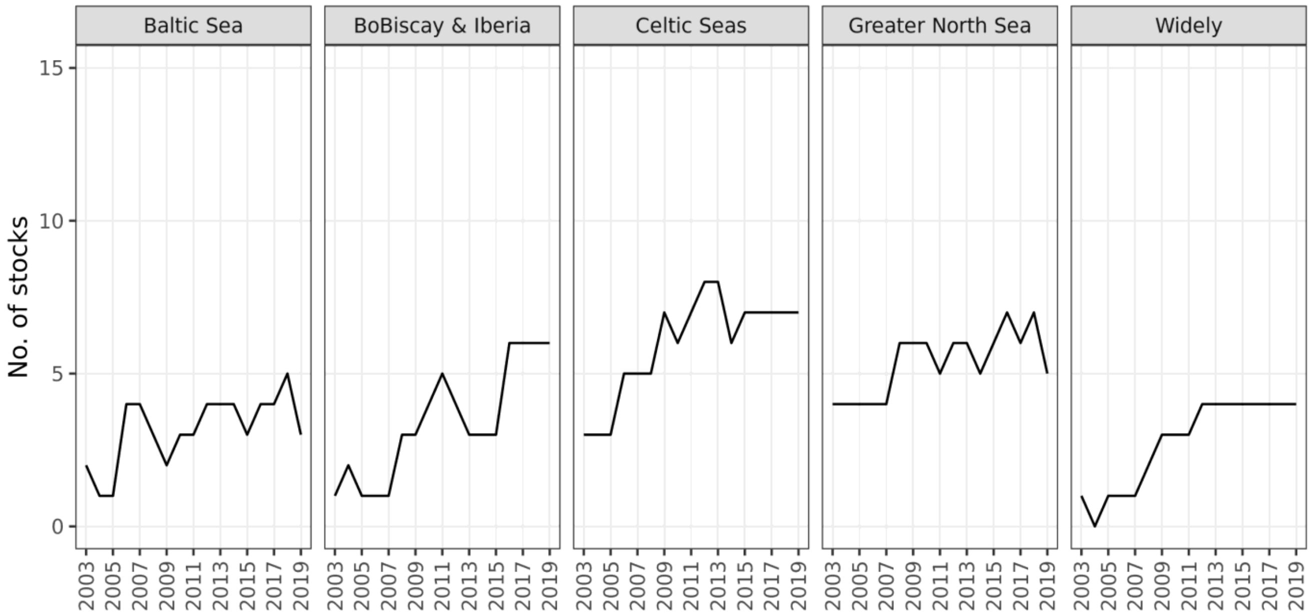

Figure 14. Number of stocks inside safe biological limits by ecoregion.

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

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011
ALL	11	10	10	15	15	19	21	22	23
Baltic Sea	2	1	1	4	4	3	2	3	3
BoBiscay & Iberia	1	2	1	1	1	3	3	4	5
Celtic Seas	3	3	3	5	5	5	7	6	7
Greater North Sea	4	4	4	4	4	6	6	6	5
Widely	1	0	1	1	1	2	3	3	3
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	26	25	22	23	28	27	29	25	
Baltic Sea	4	4	4	3	4	4	5	3	
BoBiscay & Iberia	4	3	3	3	6	6	6	6	
Celtic Seas	8	8	6	7	7	7	7	7	
Greater North Sea	6	6	5	6	7	6	7	5	
Widely	4	4	4	4	4	4	4	4	

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

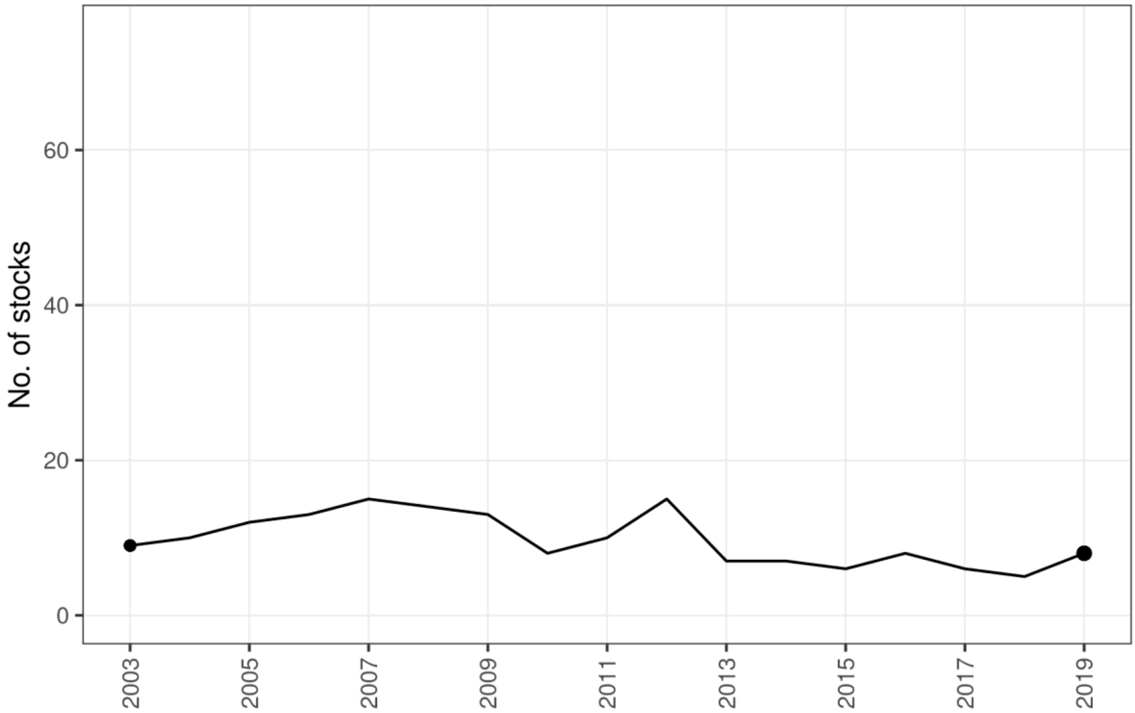

Figure 15. Number of stocks with F above Fmsy or SSB below B_{MSY} by year.

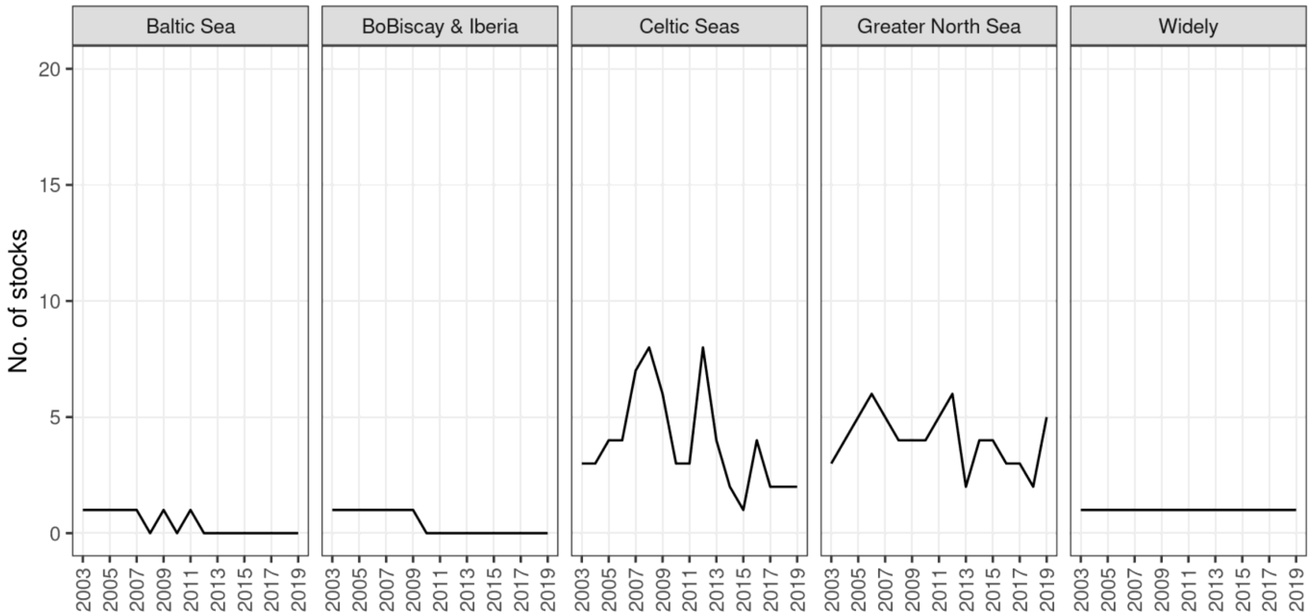

Figure 16. Number of stocks with F above F_{MSY} or SSB below B_{MSY} by ecoregion.

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
ALL	9	10	12	13	15	14	13	8	10
Baltic Sea	1	1	1	1	1	0	1	0	1
BoBiscay & Iberia	1	1	1	1	1	1	1	0	0
Celtic Seas	3	3	4	4	7	8	6	3	3
Greater North Sea	3	4	5	6	5	4	4	4	5
Widely	1	1	1	1	1	1	1	1	1
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	15	7	7	6	8	6	5	8	
Baltic Sea	0	0	0	0	0	0	0	0	
BoBiscay & Iberia	0	0	0	0	0	0	0	0	
Celtic Seas	8	4	2	1	4	2	2	2	
Greater North Sea	6	2	4	4	3	3	2	5	
Widely	1	1	1	1	1	1	1	1	

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

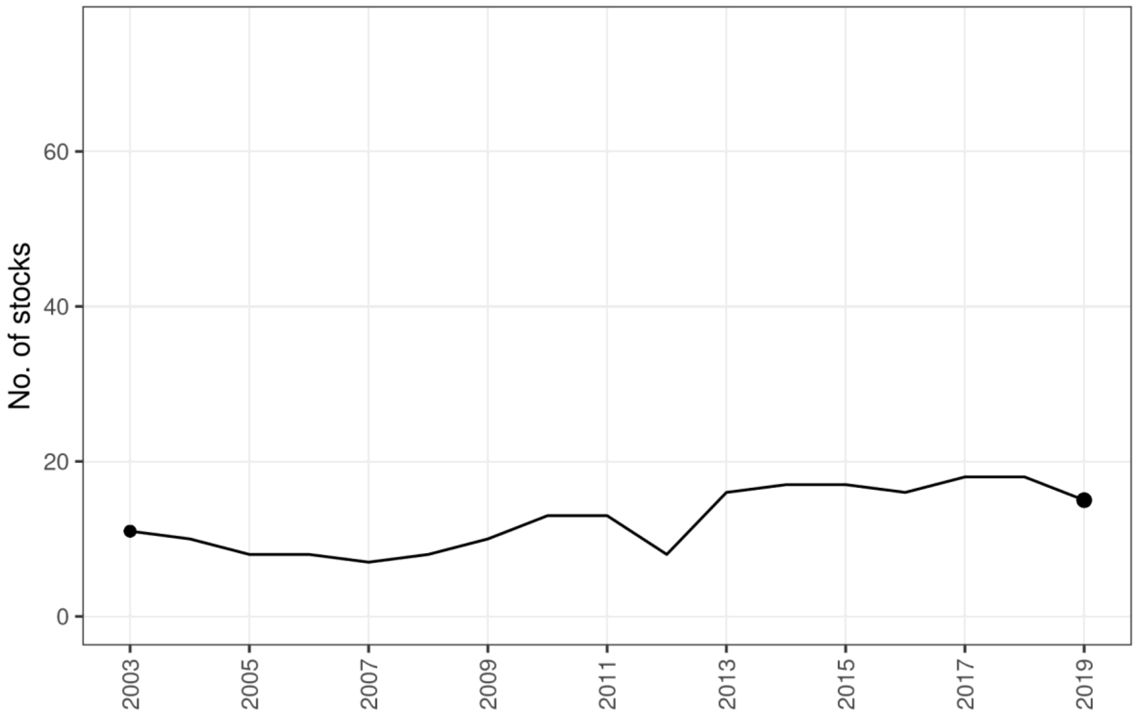

Figure 17. Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY}.

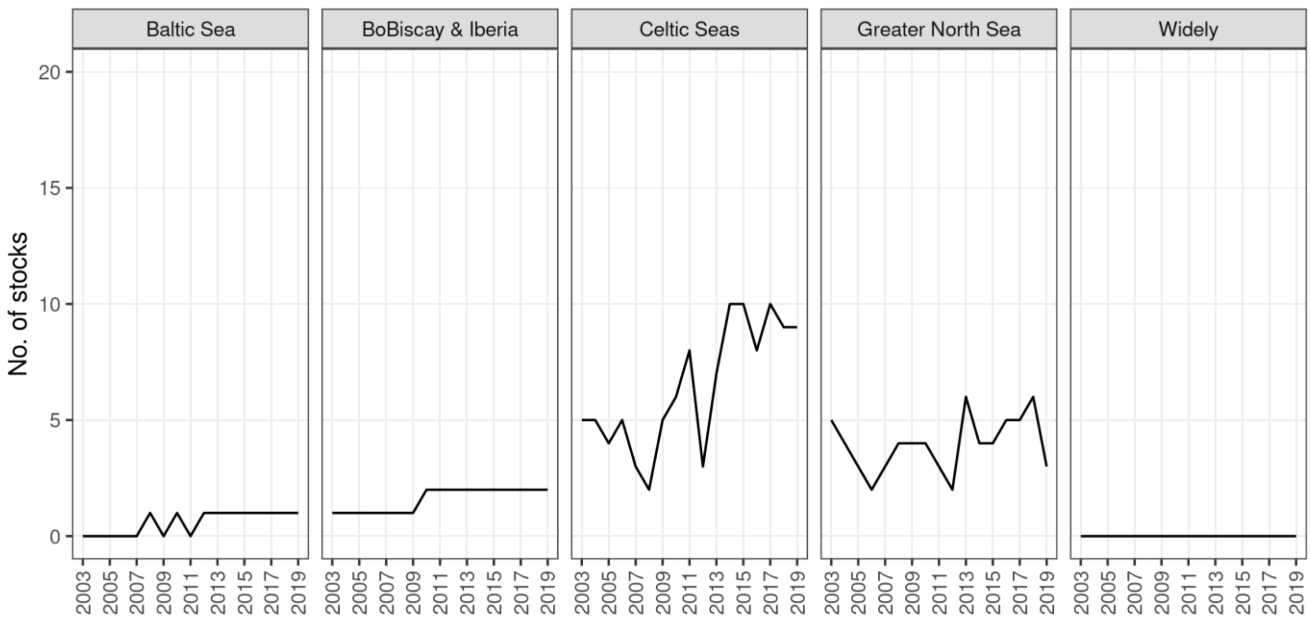

Figure 18. Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY} by ecoregion.

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
ALL	11	10	8	8	7	8	10	13	13
Baltic Sea	0	0	0	0	0	1	0	1	0
BoBiscay & Iberia	1	1	1	1	1	1	1	2	2
Celtic Seas	5	5	4	5	3	2	5	6	8
Greater North Sea	5	4	3	2	3	4	4	4	3
Widely	0	0	0	0	0	0	0	0	0
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
ALL	8	16	17	17	16	18	18	15	
Baltic Sea	1	1	1	1	1	1	1	1	
BoBiscay & Iberia	2	2	2	2	2	2	2	2	
Celtic Seas	3	7	10	10	8	10	9	9	
Greater North Sea	2	6	4	4	5	5	6	3	
Widely	0	0	0	0	0	0	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 close to 1, which means that over all stocks, on average, the exploitation levels are close to F_{MSY}.

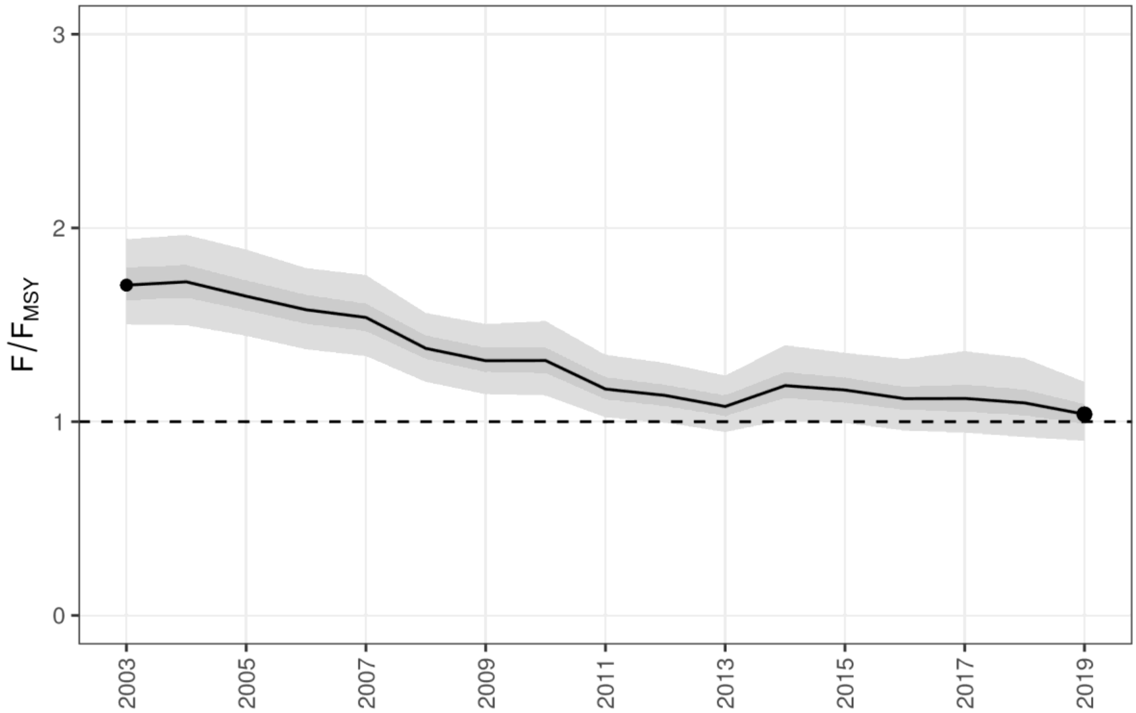

Figure 19. Trend in F/F_{MSY} (based on 44 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

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

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	1.50	1.50	1.44	1.37	1.34	1.21	1.14	1.13	1.02
25%	1.63	1.64	1.58	1.51	1.47	1.33	1.26	1.25	1.12
50%	1.70	1.72	1.65	1.58	1.54	1.38	1.31	1.32	1.17
75%	1.79	1.81	1.73	1.65	1.61	1.44	1.38	1.38	1.23
97.5%	1.94	1.96	1.89	1.79	1.76	1.56	1.50	1.52	1.35
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
2.5%	1.00	0.95	1.01	0.99	0.95	0.94	0.92	0.90	
25%	1.08	1.03	1.12	1.10	1.06	1.05	1.03	0.99	
50%	1.14	1.08	1.19	1.16	1.12	1.12	1.10	1.04	
75%	1.19	1.13	1.26	1.23	1.18	1.19	1.16	1.09	
97.5%	1.30	1.24	1.40	1.36	1.32	1.36	1.33	1.21	

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 Widely to 14 for the Celtic Seas) it was not possible to compute confidence intervals.

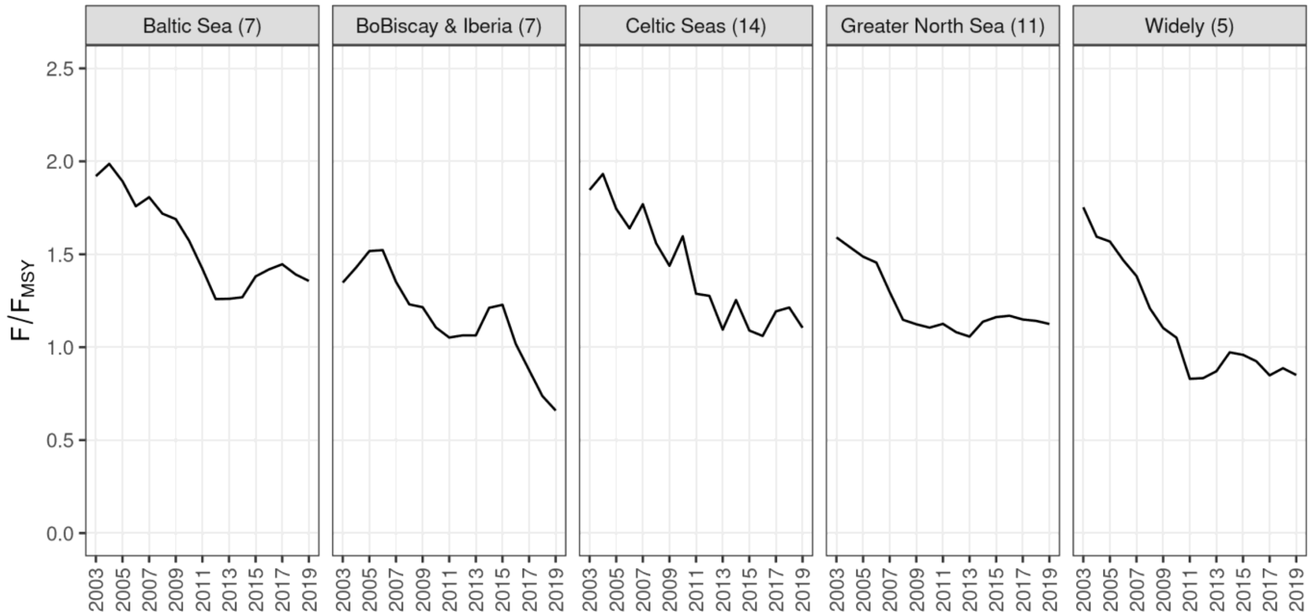

Figure 20. Trend in F/F_{MSY} by ecoregion. The number of stocks in each ecoregion are shown between parentheses.

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

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011
Baltic Sea	1.92	1.99	1.89	1.76	1.81	1.72	1.69	1.57	1.42
BoBiscay & Iberia	1.35	1.43	1.52	1.52	1.35	1.23	1.22	1.11	1.05
Celtic Seas	1.85	1.93	1.74	1.64	1.77	1.56	1.44	1.60	1.29
Greater North Sea	1.59	1.54	1.49	1.46	1.30	1.15	1.12	1.11	1.13
Widely	1.75	1.59	1.57	1.47	1.38	1.21	1.10	1.05	0.83
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Baltic Sea	1.26	1.26	1.27	1.38	1.42	1.45	1.39	1.36	
BoBiscay & Iberia	1.06	1.06	1.21	1.23	1.02	0.88	0.74	0.66	
Celtic Seas	1.28	1.09	1.25	1.09	1.06	1.19	1.21	1.10	
Greater North Sea	1.08	1.06	1.14	1.16	1.17	1.15	1.14	1.12	
Widely	0.83	0.87	0.97	0.96	0.92	0.85	0.89	0.85	

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 span 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. The last year shows a strong increase in fishing pressure which seems to be driven by a general increase of F/Fmsy across all stocks and a strong increase for reg.27.1-2 (Figure 22).

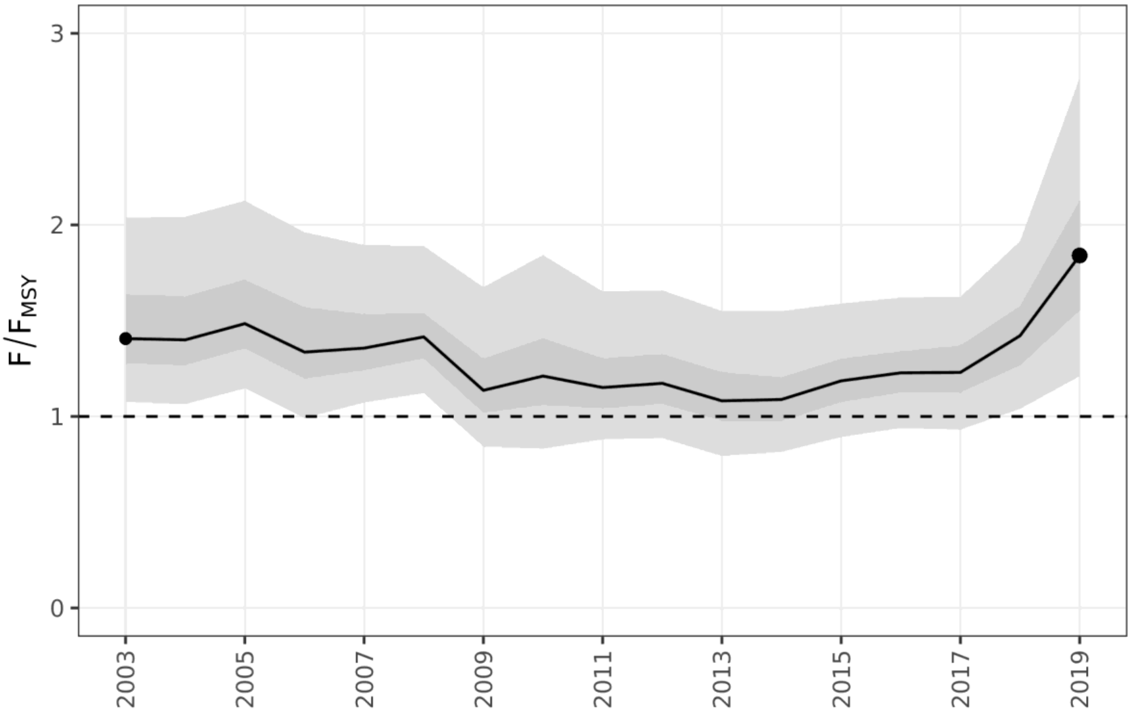

Figure 21. Trend in F/F_{MSY} for stocks outside EU waters (based on 12 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

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

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	1.08	1.06	1.15	0.99	1.07	1.12	0.84	0.83	0.88
25%	1.28	1.27	1.36	1.20	1.24	1.30	1.02	1.06	1.04
50%	1.41	1.40	1.48	1.34	1.36	1.42	1.14	1.21	1.15
75%	1.64	1.63	1.71	1.57	1.53	1.54	1.30	1.41	1.30
97.5%	2.04	2.04	2.13	1.96	1.90	1.89	1.68	1.84	1.65
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
2.5%	0.89	0.79	0.82	0.89	0.94	0.93	1.04	1.21	
25%	1.07	0.98	0.98	1.08	1.13	1.13	1.27	1.55	
50%	1.17	1.08	1.09	1.19	1.23	1.23	1.42	1.84	
75%	1.32	1.23	1.20	1.30	1.34	1.37	1.57	2.12	
97.5%	1.66	1.55	1.55	1.59	1.62	1.62	1.91	2.77	

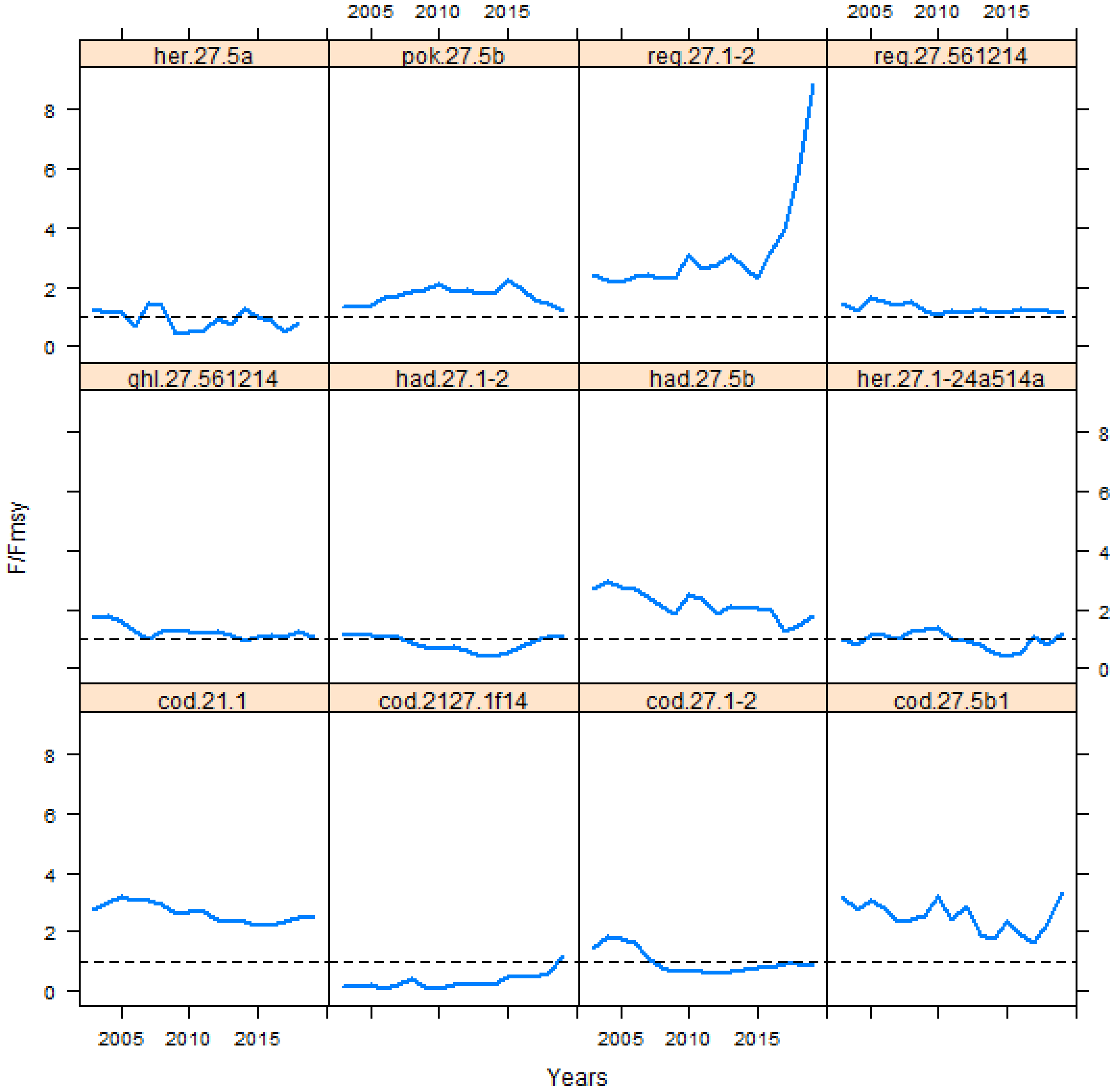

Figure 22. Trend of single stocks from outside EU waters. The dashed line corresponds to F/F_{MSY} equal to 1.

3.2.9 Trend in SSB (relative to 2003)

Figure 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.

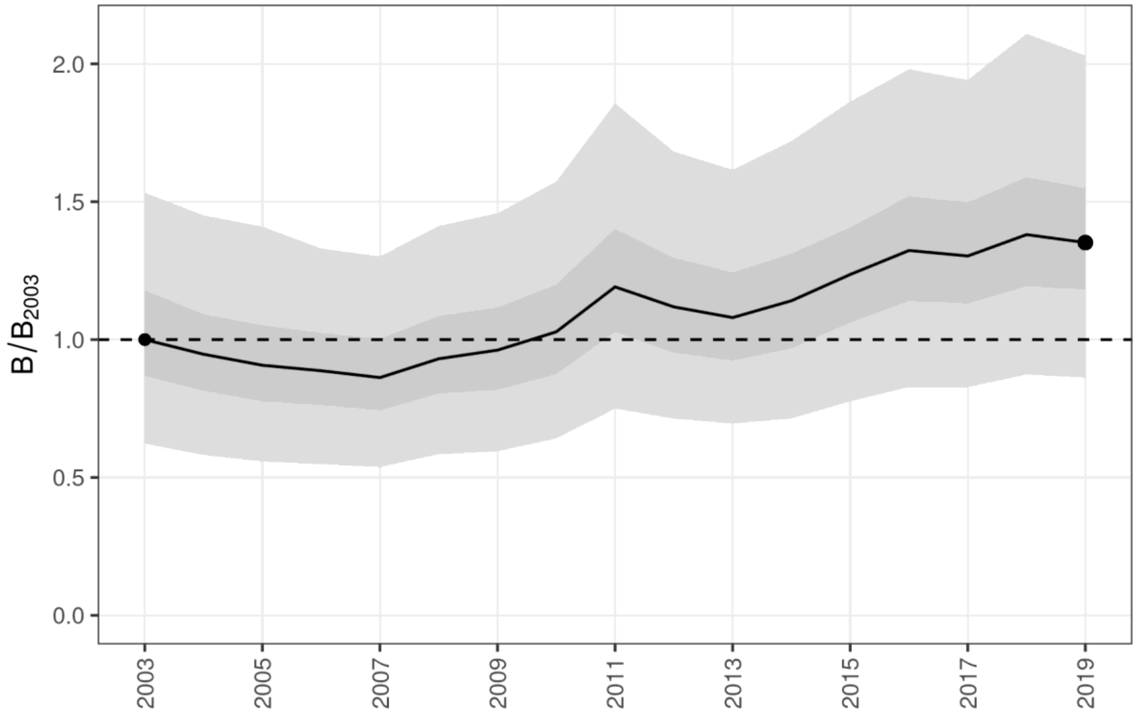

Figure 23. Trend in SSB relative to 2003 (based on 51 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 14. Percentiles for SSB relative to 2003.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	0.62	0.58	0.56	0.55	0.54	0.58	0.60	0.64	0.75
25%	0.87	0.82	0.78	0.76	0.74	0.81	0.82	0.88	1.03
50%	1.00	0.95	0.91	0.89	0.86	0.93	0.96	1.03	1.19
75%	1.18	1.09	1.05	1.02	1.00	1.08	1.12	1.20	1.40
97.5%	1.53	1.45	1.41	1.33	1.30	1.41	1.46	1.57	1.86

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
2.5%	0.71	0.70	0.71	0.78	0.83	0.83	0.87	0.86
25%	0.95	0.92	0.97	1.06	1.14	1.13	1.19	1.18
50%	1.12	1.08	1.14	1.24	1.32	1.30	1.38	1.35
75%	1.30	1.24	1.31	1.41	1.52	1.50	1.59	1.55
97.5%	1.68	1.62	1.72	1.86	1.98	1.94	2.11	2.03

Trends in SSB by ecoregion are given in Figure 2422 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 Widely to 17 in the Greater North Sea) it wasn't possible to compute confidence intervals.

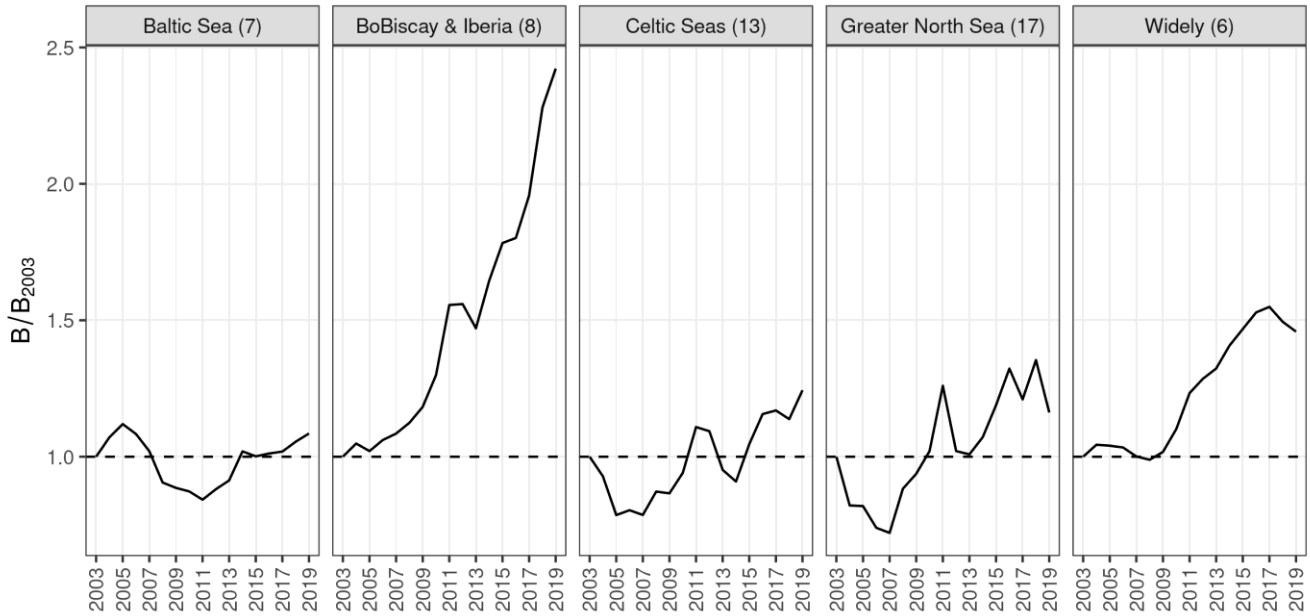

Figure 2422. Trend in SSB by ecoregion relative to 2003. The number of stocks in each ecoregion are shown between parentheses.

Table 15. SSB relative to 2003 by ecoregion.

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011
Baltic Sea	1	1.07	1.12	1.08	1.02	0.91	0.89	0.87	0.84
BoBiscay & Iberia	1	1.05	1.02	1.06	1.08	1.12	1.18	1.30	1.56
Celtic Seas	1	0.93	0.79	0.80	0.79	0.87	0.87	0.94	1.11
Greater North Sea	1	0.82	0.82	0.74	0.72	0.88	0.94	1.02	1.26
Widely	1	1.04	1.04	1.03	1.00	0.99	1.02	1.10	1.23
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Baltic Sea	0.88	0.91	1.02	1.00	1.01	1.02	1.05	1.09	
BoBiscay & Iberia	1.56	1.47	1.65	1.78	1.80	1.96	2.28	2.42	
Celtic Seas	1.09	0.95	0.91	1.05	1.16	1.17	1.14	1.24	
Greater North Sea	1.02	1.01	1.07	1.19	1.32	1.21	1.35	1.16	
Widely	1.29	1.32	1.41	1.47	1.53	1.55	1.49	1.46	

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

Figure 2523 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.

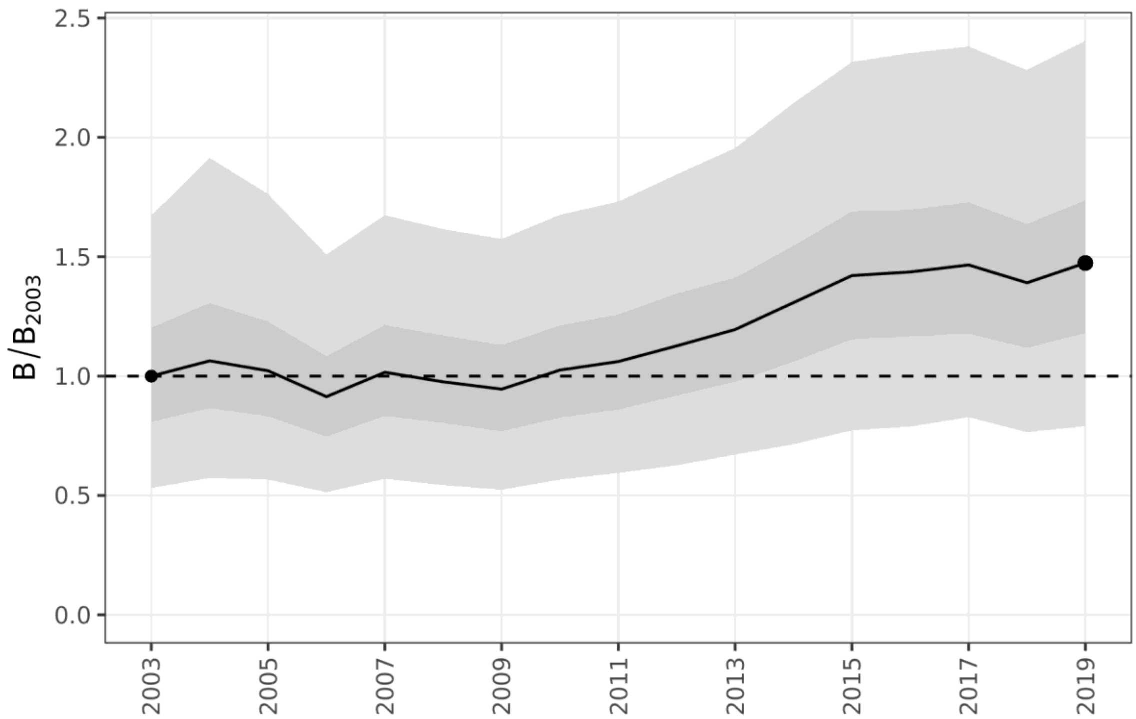

Figure 2523. Trend in biomass or abundance indices relative to 2003 for data limited stocks (ICES category 3) (based on 69 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

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**
2.5%	0.53	0.57	0.57	0.51	0.57	0.54	0.52	0.57	0.59
25%	0.81	0.87	0.83	0.75	0.83	0.81	0.77	0.83	0.86
50%	1.00	1.06	1.02	0.91	1.02	0.98	0.95	1.03	1.06
75%	1.20	1.31	1.23	1.08	1.21	1.17	1.13	1.21	1.26
97.5%	1.67	1.91	1.76	1.51	1.67	1.62	1.57	1.68	1.73
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
2.5%	0.63	0.67	0.71	0.77	0.79	0.83	0.76	0.79	
25%	0.92	0.98	1.06	1.16	1.17	1.18	1.12	1.18	
50%	1.13	1.20	1.31	1.42	1.44	1.47	1.39	1.47	
75%	1.34	1.41	1.54	1.69	1.70	1.73	1.64	1.74	
97.5%	1.85	1.96	2.14	2.32	2.35	2.38	2.28	2.41	

3.2.11 Trend in recruitment (relative to 2003)

Figure 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 2019's decadal recruitment for a single stock is the ratio between the average recruitment from 2010 to 2019 over the average recruitment from 2000 to 2009. 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).

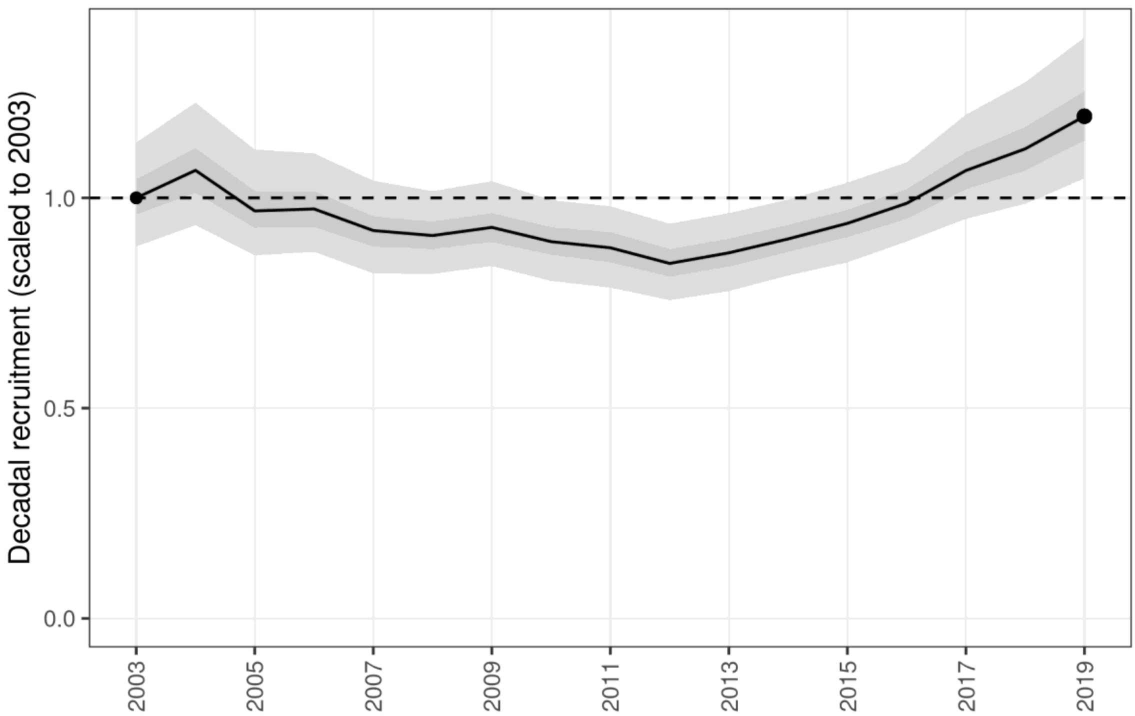

Figure 24. Trend in decadal recruitment scaled to 2003 (based on 51 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 17. Percentiles for decadal recruitment scaled to 2003.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	0.88	0.93	0.86	0.87	0.82	0.82	0.84	0.80	0.79
25%	0.96	1.01	0.93	0.93	0.88	0.88	0.90	0.86	0.85
50%	1.00	1.07	0.97	0.97	0.92	0.91	0.93	0.90	0.88
75%	1.04	1.12	1.02	1.02	0.96	0.94	0.96	0.93	0.92
97.5%	1.13	1.23	1.12	1.11	1.04	1.02	1.04	0.99	0.98
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
2.5%	0.76	0.78	0.82	0.85	0.90	0.95	0.99	1.05	
25%	0.81	0.84	0.87	0.91	0.95	1.02	1.07	1.14	

50%	0.84	0.87	0.90	0.94	0.99	1.07	1.12	1.19
75%	0.88	0.90	0.94	0.97	1.02	1.11	1.17	1.25
97.5%	0.94	0.96	1.00	1.04	1.08	1.20	1.27	1.38

Trends in decadal recruitment ratios by ecoregion and year are given in Figure 2725 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 Widely to 17 in the Greater North Sea) it was not possible to compute confidence intervals.

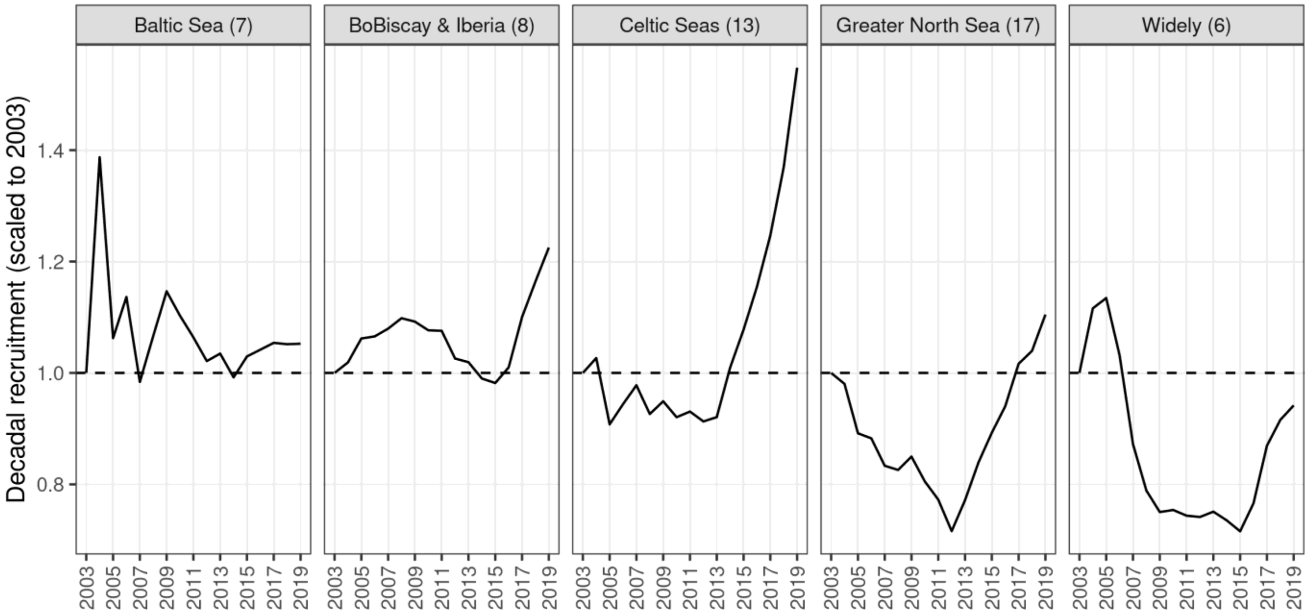

Figure 2725. Trend in decadal recruitment scaled to 2003 by ecoregion. The number of stocks in each ecoregion are shown between parentheses.

Table 18. Decadal recruitment scaled to 2003 by ecoregion.

EcoRegion	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Baltic Sea	1	1.39	1.06	1.14	0.98	1.07	1.15	1.10	1.06
BoBiscay & Iberia	1	1.02	1.06	1.07	1.08	1.10	1.09	1.08	1.08
Celtic Seas	1	1.03	0.91	0.94	0.98	0.93	0.95	0.92	0.93
Greater North Sea	1	0.98	0.89	0.88	0.83	0.83	0.85	0.80	0.77
Widely	1	1.12	1.13	1.03	0.87	0.79	0.75	0.75	0.74
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Baltic Sea	1.02	1.03	0.99	1.03	1.04	1.05	1.05	1.05	
BoBiscay & Iberia	1.03	1.02	0.99	0.98	1.01	1.10	1.16	1.23	
Celtic Seas	0.91	0.92	1.01	1.08	1.15	1.25	1.37	1.55	
Greater North Sea	0.72	0.77	0.84	0.89	0.94	1.02	1.04	1.10	
Widely	0.74	0.75	0.74	0.72	0.77	0.87	0.92	0.94	

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	65	156	82	0.53
MSYBtrigger	30	156	29	0.19
Fpa	43	156	69	0.44
Bpa	49	156	75	0.48

4 MEDITERRANEAN AND BLACK SEA (FAO REGION 37)

During the period 2003-2009 the number of stocks assessments available increased from 19 up to 35. The number of stock assessments has been stable until 2017 decreasing to 26 in 2018 and 23 in 2019 (Figure 27 and Figure 28).

The instability in the number of the stocks makes 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/F_{MSY} 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 2019, 23, is due to the following reasons:

- STECF EWG part I carried out analytical assessments for 15 out of 19 stocks (STECF 2020b).
- STECF EWG part II carried out analytical assessments for 7 out of 13 stocks (STECF, 2020c).
- STECF EWG on Black Sea stock assessment is no longer carried out under the STECF umbrella since 2018. GFCM Black Sea Working Group provided fully analytical assessment only for two stock (turbot and anchovy) (WGBS, 2019). However, anchovy advice was based on the exploitation rate rather than in term of fishing pressure (F) over reference point, therefore the results for this assessment has not been taken in account.
- Many GFCM assessments presented during 2018 and 2019 in WGSASP and WGSAD were not published by the time this report was written or they were outdated with respect to the STECF ones, while 2020 sessions will take place in early 2021.

Table 20 shows the stocks added to the current exercise.

Due to the reduced numbers of stock assessments available for 2019 the indicators are plotted up to 2018 only and 2019’s value is represented as stand-alone in 27.

With relation to last year's report (STECF, 2020a) the following stocks were not included in the current analysis:

- All the Black Sea (GSA 29) stocks excluding turbot, were removed because outdated (last year assessment is 2016). The stocks are: anchovy, picked dog fish, horse mackerel, red mullet, sprat and whiting.

- Common Sole in the Adriatic Sea was dropped (sol_17) as STECF EWG (STECF, 2020c) carried out sensitive analysis highlighting huge uncertainty in the growth rate and natural mortality vectors used in assessing this stock. It is likely that this stock will need a benchmark.

- The red mullet in the Ionian Sea (mut_19), anchovy and sardine in Northern Spain (ane_6 and pil_6), anchovy in Western Italian waters (ane_09_10_11), Atlantic horse mackerel in Western Italian waters (hom_09_10_11) and blue and red shrimp in the Balearic Islands (ara_5) were dropped from this year’s analysis as the latest assessment year was 2016.

Three stocks were replaced by a different spatial extent:

- Anchovy and sardine in the Aegean Sea (ane_22_23 and pil_22_23) were replaced by assessments for area 22 alone (ane_22 and pil_22).
- Hake in Western Italian waters (hke_09_10_11) was replaced by the assessment for areas 8, 9, 10 and 11 combined (hke_08_09_10_11).

Four new stocks were added:

- Hake and red mullet in the Eastern Ionian Sea (hke_20 and mut_20)
- Sardine in the Strait of Sicily (pil_16)
- Red mullet in the Aegean Sea (mut_22)

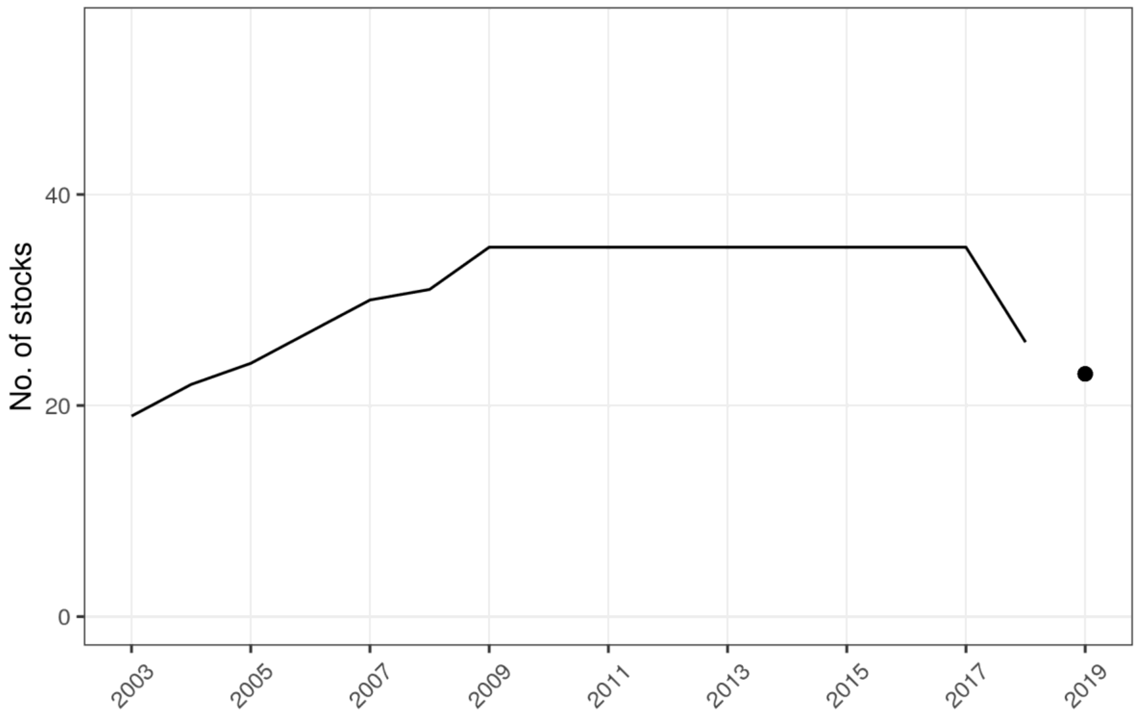

Figure 28. Number of stock assessments available in the Mediterranean and Black Sea. The totals include stocks in GSAs 1, 5-7, 9, 10-19, 22-23, 25 and 29.

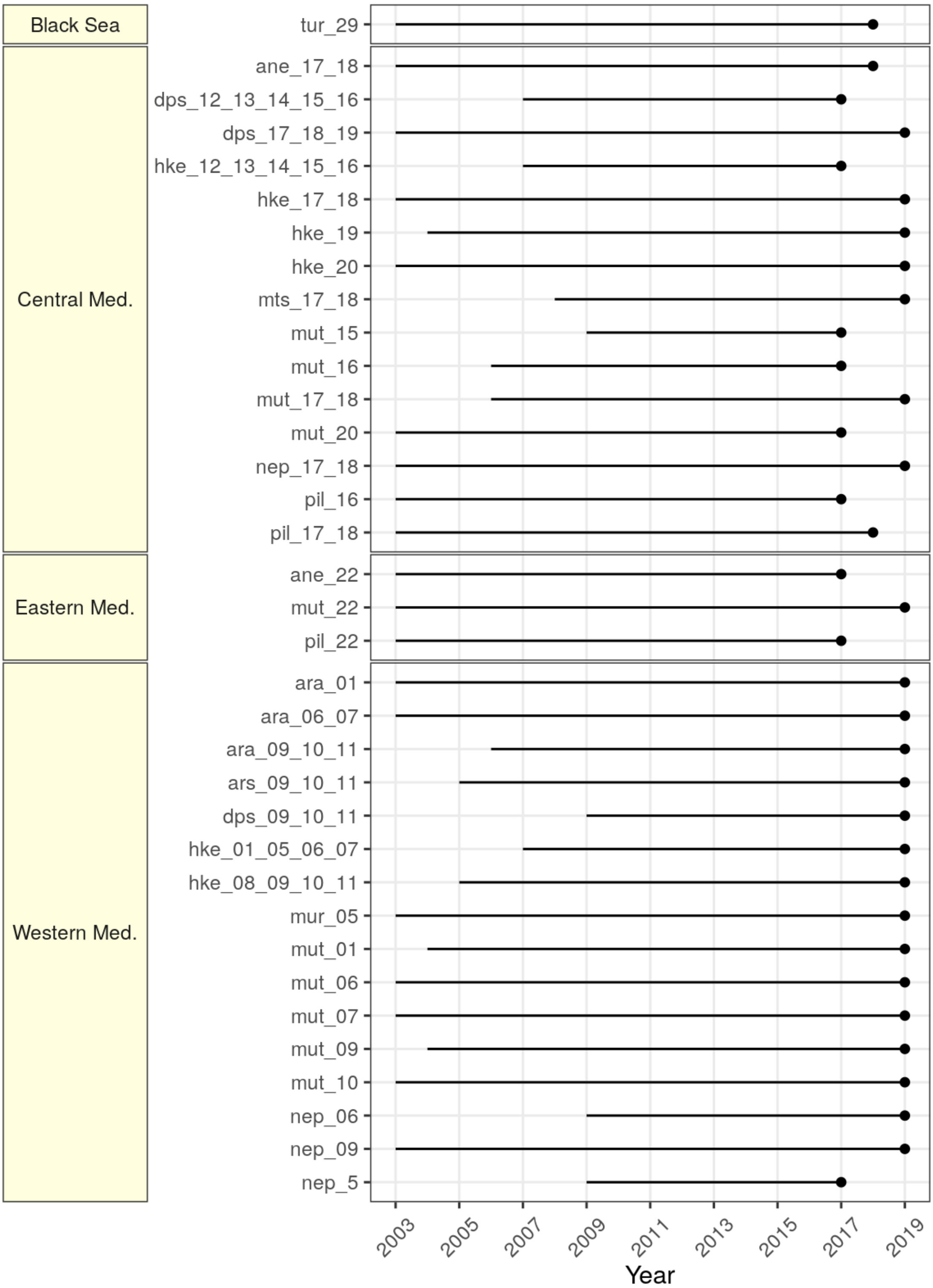

Figure 29. Time-series of stock assessments available from both STECF and GFCM for computation of model based CFP monitoring indicators for the Mediterranean and Black Seas.

Table 20. Stocks used in the current exercise.

EcoRegion	Year	Stock	Description	Updated	New_stock	Source
Black Sea	2018	tur_29	Turbot in GSA 29	2019	N	GFCM
Central Med.	2018	ane_17_18	European anchovy in GSA 17_18	2019	N	GFCM
Central Med.	2017	dps_12_13_14_15_16	Deep-water rose shrimp in GSA 12_13_14_15_16	2018	N	GFCM
Central Med.	2019	dps_17_18_19	Deep-water rose shrimp in GSA 17_18_19	2020	N	STECF
Central Med.	2017	hke_12_13_14_15_16	European hake in GSA 12_13_14_15_16	2018	N	GFCM
Central Med.	2019	hke_17_18	European hake in GSA 17_18	2020	N	STECF
Central Med.	2019	hke_19	European hake in GSA 19	2020	N	STECF
Central Med.	2019	hke_20	European hake in GSA 20	2020	Y	STECF
Central Med.	2019	mts_17_18	Spottail mantis shrimp in GSA 17_18	2020	N	STECF
Central Med.	2017	mut_15	Red mullet in GSA 15	2018	N	GFCM
Central Med.	2017	mut_16	Red mullet in GSA 16	2018	N	GFCM
Central Med.	2019	mut_17_18	Red mullet in GSA 17_18	2020	N	STECF
Central Med.	2017	mut_20	Red mullet in GSA 20	2018	Y	GFCM

Central Med.	2019	nep_17_18	Norway lobster in GSA 17_18	2020	N	STECF
Central Med.	2017	pil_16	European pilchard(=Sardine) in GSA 16	2018	Y	GFCM
Central Med.	2018	pil_17_18	European pilchard(=Sardine) in GSA 17_18	2019	N	GFCM
Eastern Med.	2017	ane_22	European anchovy in GSA 22	2018	Y	GFCM
Eastern Med.	2019	mut_22	Red mullet in GSA 22	2020	Y	STECF
Eastern Med.	2017	pil_22	European pilchard(=Sardine) in GSA 22	2018	Y	GFCM
Western Med.	2019	ara_01	Blue and red shrimp in GSA 01	2020	N	STECF
Western Med.	2019	ara_06_07	Blue and red shrimp in GSA 06_07	2020	N	STECF
Western Med.	2019	ara_09_10_11	Blue and red shrimp in GSA 09_10_11	2020	N	STECF
Western Med.	2019	ars_09_10_11	Giant red shrimp in GSA 09_10_11	2020	N	STECF
Western Med.	2019	dps_09_10_11	Deep-water rose shrimp in GSA 09_10_11	2020	N	STECF
Western Med.	2019	hke_01_05_06_07	European hake in GSA 01_05_06_07	2020	N	STECF
Western Med.	2019	hke_08_09_10_11	European hake in GSA	2020	Y	STECF

			08_09_10_11			
Western Med.	2019	mur_05	Surmullet in GSA 05	2020	N	STECF
Western Med.	2019	mut_01	Red mullet in GSA 01	2020	N	STECF
Western Med.	2019	mut_06	Red mullet in GSA 06	2020	N	STECF
Western Med.	2019	mut_07	Red mullet in GSA 07	2020	N	STECF
Western Med.	2019	mut_09	Red mullet in GSA 09	2020	N	STECF
Western Med.	2019	mut_10	Red mullet in GSA 10	2020	N	STECF
Western Med.	2019	nep_06	Norway lobster in GSA 06	2020	N	STECF
Western Med.	2019	nep_09	Norway lobster in GSA 09	2020	N	STECF
Western Med.	2017	nep_5	Norway lobster in GSA 5	2018	N	GFCM

4.1 Indicators of management performance

4.1.1 *Trend in F/F_{MSY}*

To compute this indicator a similar model to those in the North East Atlantic was used, namely a mixed linear model, described in the protocol (Annex I). Values for 2019 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 2.22 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 slightly decreasing trend since 2013, from 2.31 to 2.13, which indicates a small improvement in exploitation levels. Nevertheless, the instability in the dataset used may have an impact in the results (See Online Annex 04).

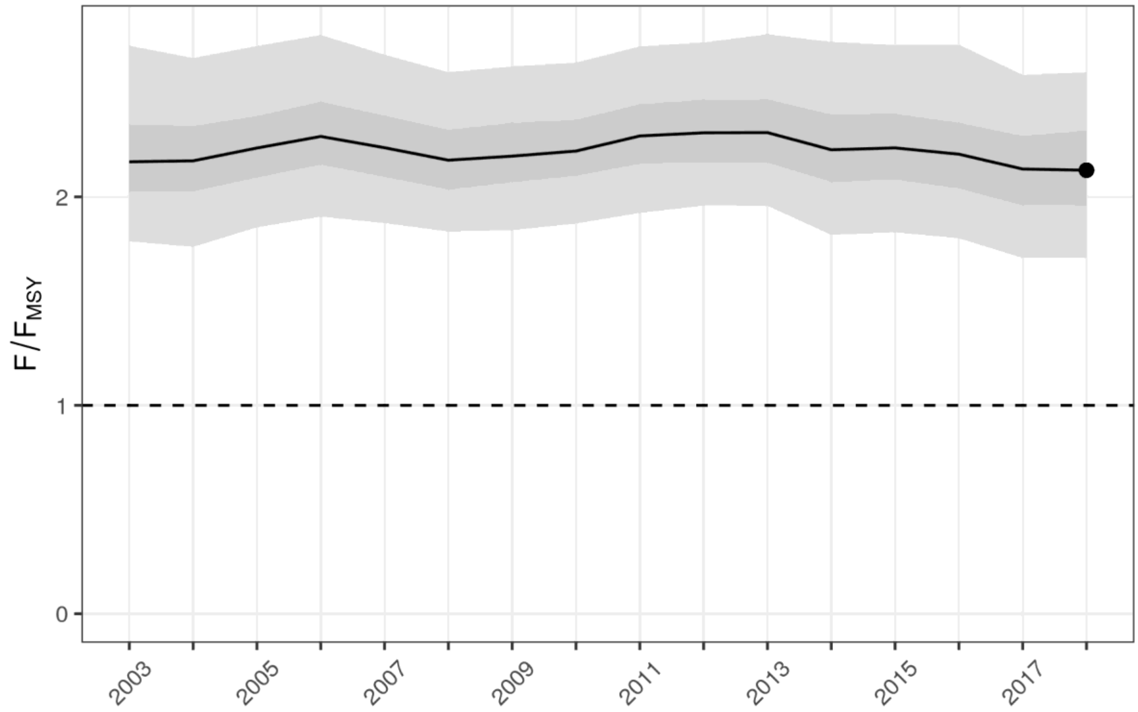

Figure 30. Trend in F/F_{MSY} (based on 35 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 21. Percentiles for F/FMSY.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.5%	1.79	1.76	1.85	1.90	1.87	1.83	1.84	1.87	1.92	1.96	1.96	1.82	1.83	1.80	1.71	1.71
25%	2.03	2.03	2.09	2.16	2.10	2.04	2.07	2.10	2.16	2.17	2.17	2.07	2.08	2.04	1.96	1.96
50%	2.17	2.17	2.23	2.29	2.24	2.18	2.20	2.22	2.29	2.31	2.31	2.23	2.24	2.20	2.13	2.13
75%	2.35	2.34	2.39	2.46	2.39	2.32	2.35	2.37	2.44	2.46	2.47	2.39	2.40	2.35	2.29	2.32
97.5%	2.73	2.67	2.72	2.78	2.68	2.60	2.63	2.64	2.72	2.74	2.78	2.74	2.73	2.73	2.59	2.60

Trends by ecoregion are presented in Figure and Table 22. Due to the small number of stocks available for the Eastern Mediterranean (3) and the Black Sea (1), the indicator is not shown.

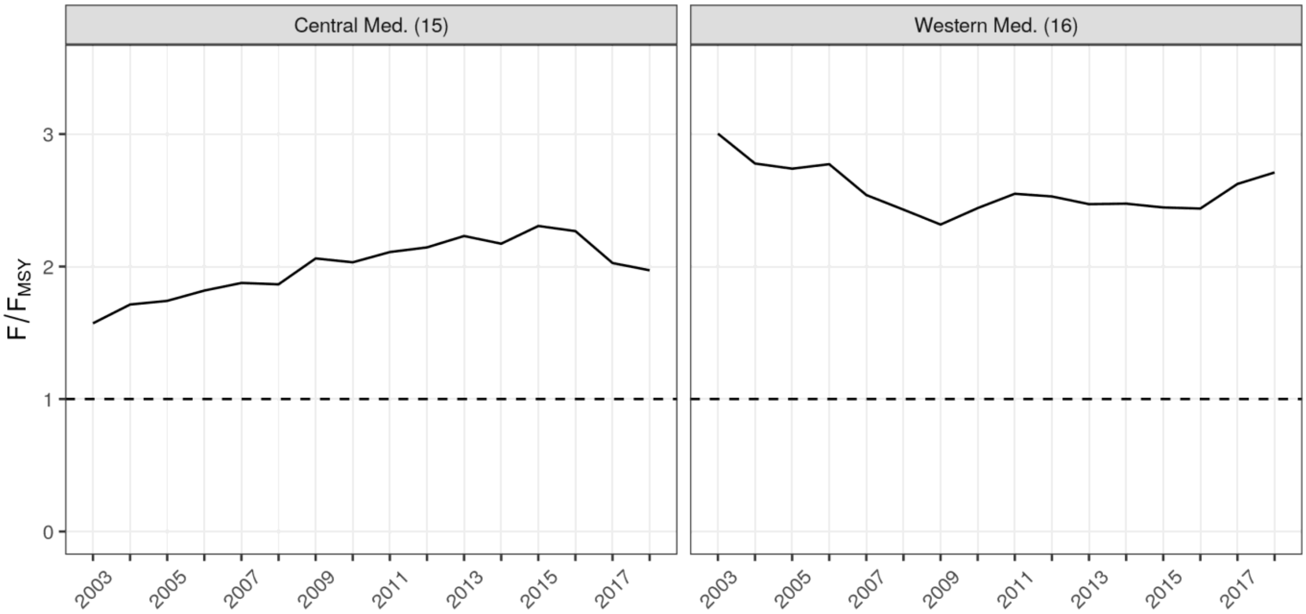

Figure 31. Trend in F/F_{MSY} by region. The number of stocks in each ecoregion are shown between parentheses.

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

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Central Med.	1.57	1.71	1.74	1.82	1.88	1.87	2.06	2.03	2.11	2.14	2.23	2.17	2.31	2.27	2.03	1.97
Western Med.	3.00	2.78	2.74	2.77	2.54	2.43	2.32	2.44	2.55	2.53	2.47	2.47	2.45	2.44	2.62	2.71

4.1.2 Trend in SSB (relative to 2003)

This indicator was computed with a similar model to those in the North East Atlantic, namely a mixed linear model, described in the protocol (Annex I). The 50% quantile (black line), increased in the first four years then showed no clear pattern in the trend having values varying around 1.15 (Figure 31 and Table 23). Quantiles are very large, representing a high level of uncertainty. The trends estimated by Ecoregion (Figure 32 and Table 2424) show the high variability between ecoregions with a constant decrease in the Central Mediterranean from 2006 until 2016 inverting in the last two years, while in the Western Mediterranean there is a clear increasing trend since 2008. As an increasing trend of SSB (Figure 31) corresponds to a stable trend of the exploitation rate indicator (Figure 29) a sensitivity analysis was run on the Mediterranean and Black Sea indicators. See Online Annex 04 for details.

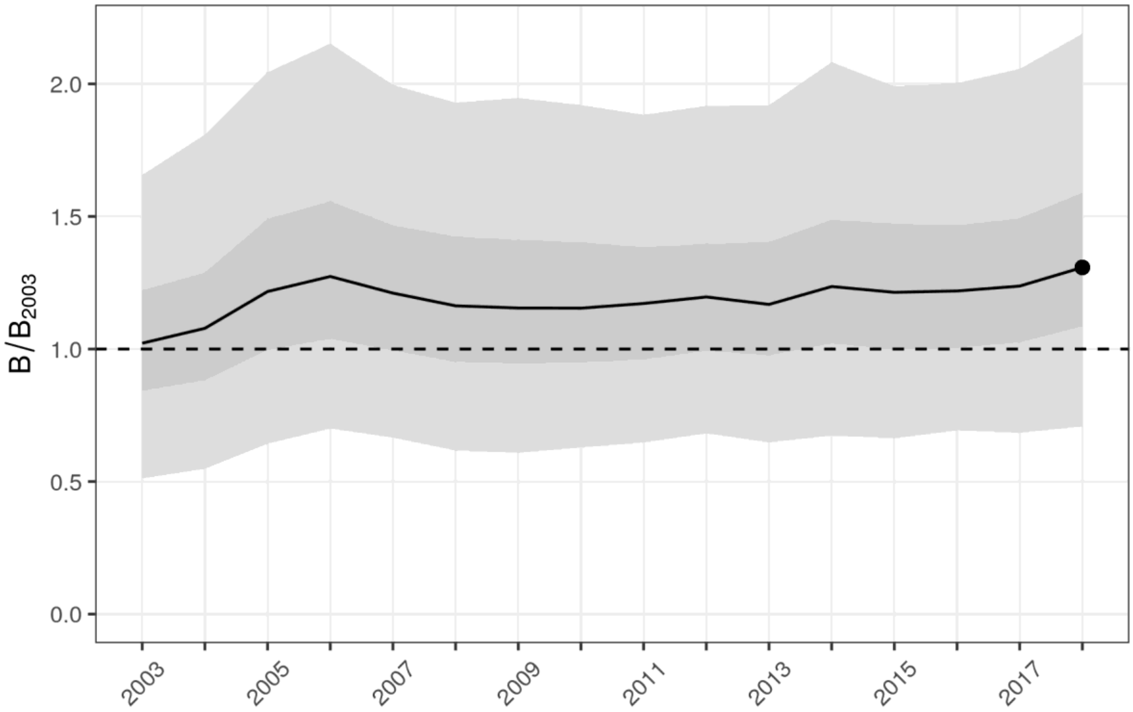

Figure 32. Trend in SSB relative to 2003 (based on 32 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

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

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.5%	0.51	0.55	0.64	0.70	0.67	0.62	0.61	0.63	0.65	0.68	0.65	0.67	0.66	0.69	0.68	0.71
25%	0.84	0.88	1.00	1.04	1.00	0.95	0.95	0.95	0.96	0.99	0.98	1.02	1.00	1.01	1.03	1.09
50%	1.02	1.08	1.22	1.27	1.21	1.16	1.15	1.15	1.17	1.20	1.17	1.24	1.21	1.22	1.24	1.31
75%	1.22	1.29	1.49	1.56	1.47	1.42	1.41	1.40	1.38	1.40	1.40	1.49	1.47	1.47	1.49	1.59
97.5%	1.66	1.81	2.04	2.15	2.00	1.93	1.95	1.92	1.88	1.92	1.92	2.08	1.99	2.00	2.06	2.19

Trends by ecoregion are presented in Figure 32 and Table 2424. Due to the reduced number of stocks available for the Eastern Mediterranean (3) and the Black Sea (1), the indicator is not shown.

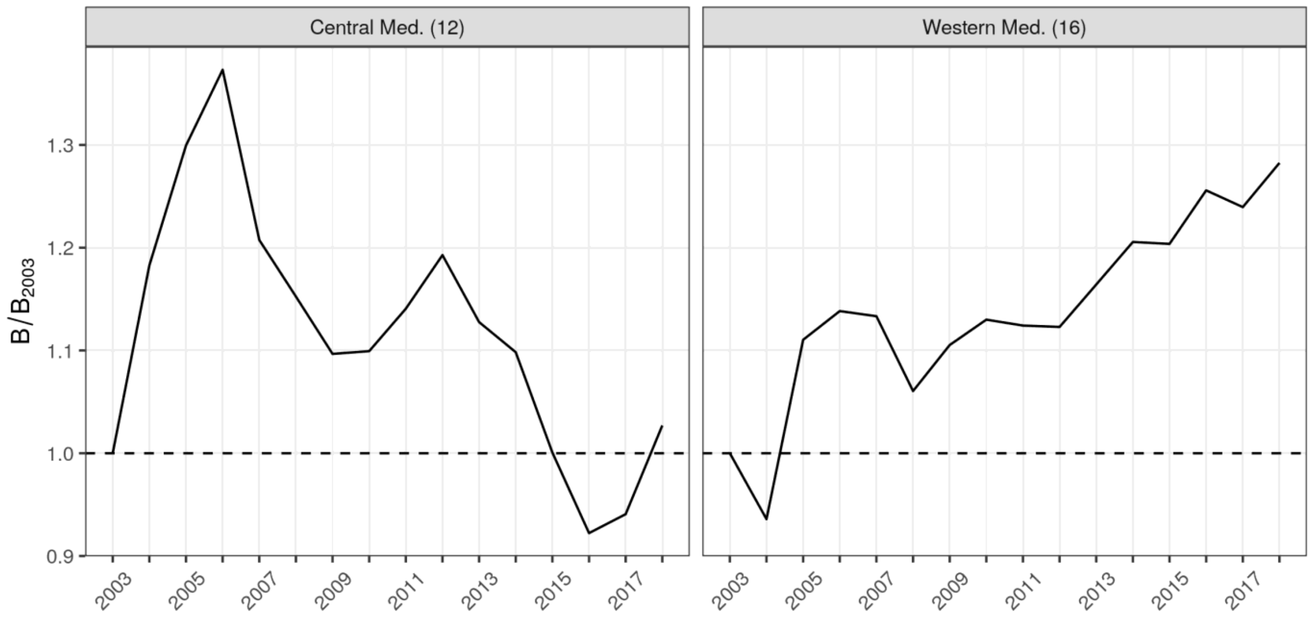

Figure 33 Trend in SSB relative to 2003 by ecoregion. The number of stocks in each ecoregion are shown between parentheses.

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

EcoRegion	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Central Med.	1	1.18	1.30	1.37	1.21	1.15	1.10	1.10	1.14	1.19	1.13	1.10	1.00	0.92	0.94	1.03
Western Med.	1	0.94	1.11	1.14	1.13	1.06	1.11	1.13	1.12	1.12	1.16	1.21	1.20	1.26	1.24	1.28

4.2 Indicators of advice coverage

In the Mediterranean and the Black Seas a total of 247 stocks were selected for the analysis (see the protocol in Annex 01). Of these, 64 are covered by stock assessments carried out between 2018 and 2020. In some cases more than one stock was aggregated in a single multi-area stock assessment, in which case all stocks in the stock list are accounted for, hence why 35 stock assessments cover 64 stocks. The advice coverage for the Mediterranean and the Black Sea is 0.26.

5 EUROPEAN WATERS (FAO REGION 27 AND REGION 37)

Indicators of management performance (trend of F/F_{MSY} and B/B_{2003}) for all European waters, including both FAO regions 27 and 37 were estimated following the same procedure as presented in the Protocol (Annex 01). The analysis was run only until 2018 to respect the time limit set to the Mediterranean and Black Sea time series. The trends for these two European waters' indicators are strongly biased towards the values of the F/F_{MSY} and B/B_{2003} obtained for the North East Atlantic (section *3.2.7* and *3.2.9*). The bias is most likely due to the higher consistency of trends among the ICES stock assessments used in the North East Atlantic analysis (Figure 34), compared to the trends of the stock assessments used in the Mediterranean and Black Sea analysis (Figure 35).

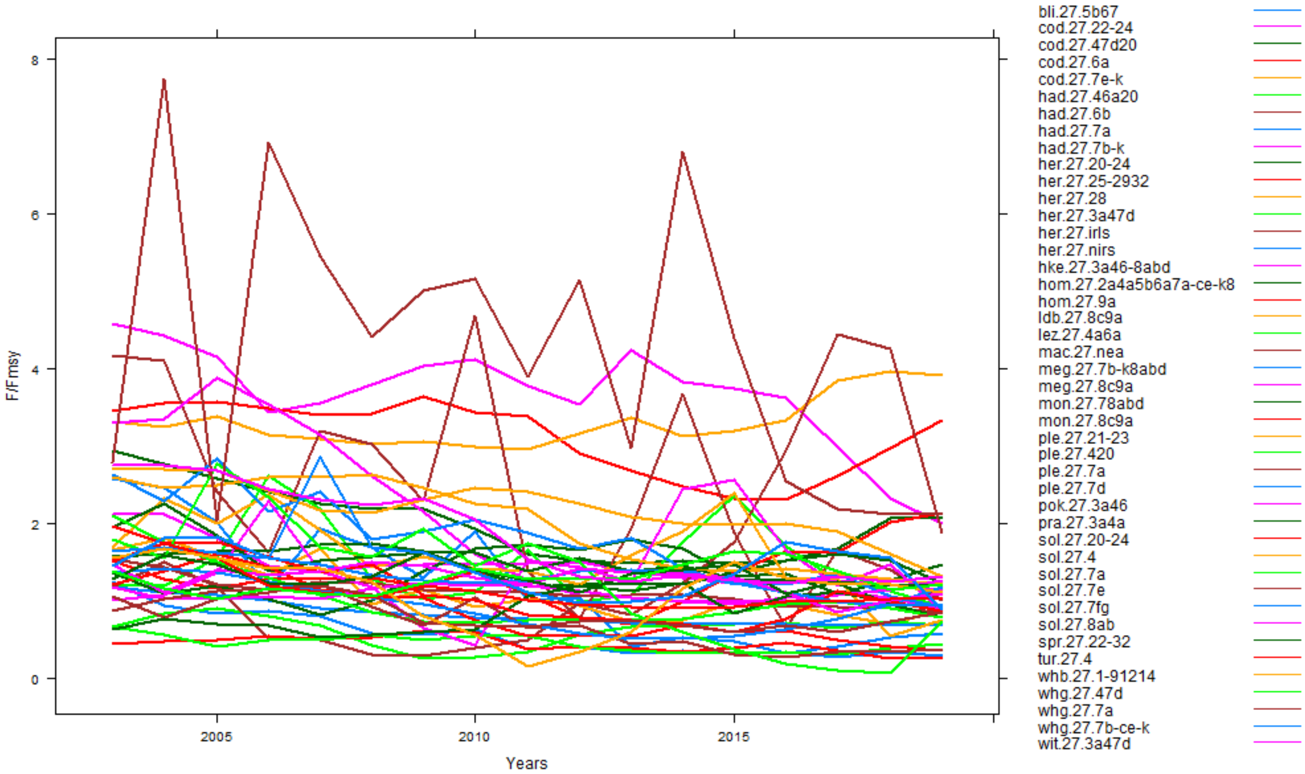

Figure 34. Summary of the trends of all stocks used to estimate the F/F_{MSY} indicator for the North East Atlantic

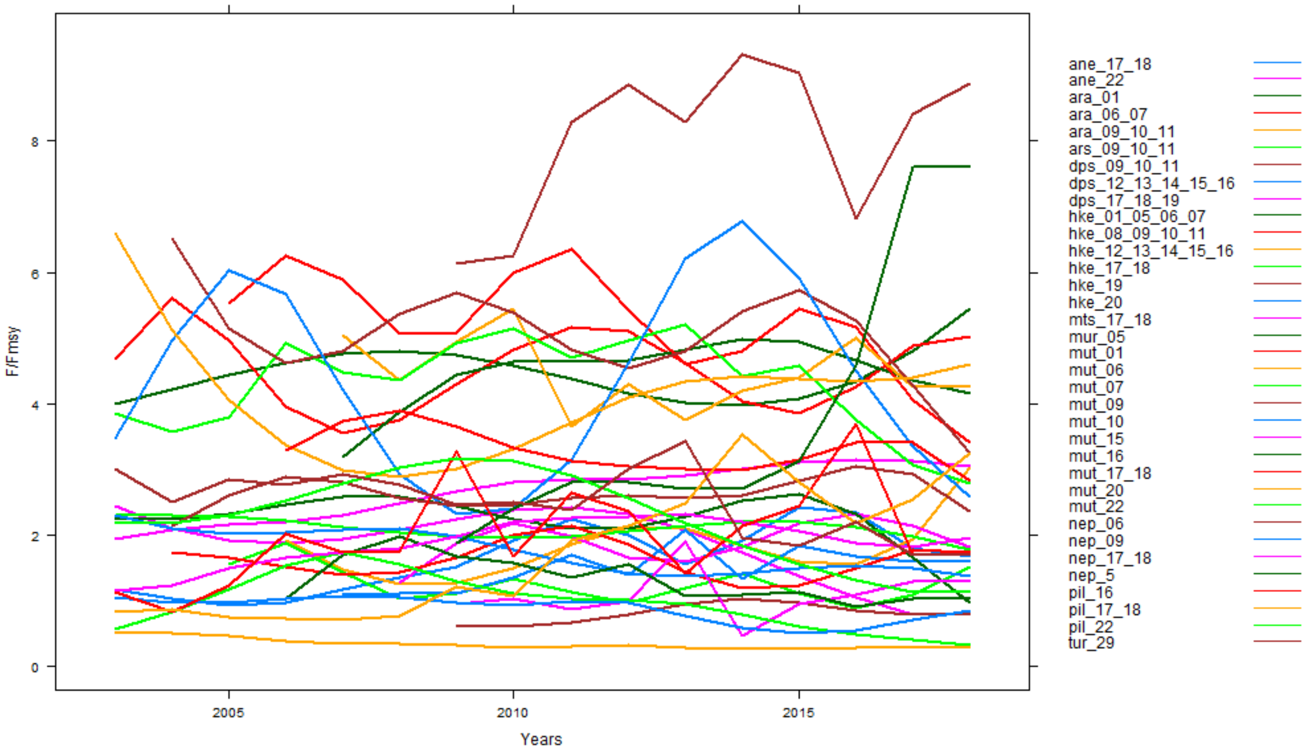

Figure 35. Summary of the trends of all stocks used to estimate the F/F_{MSY} indicator for the Mediterranean and Black Sea.

5.1 Indicators of management performance

The trend in F/F_{MSY} is given in Figure 33 and associated percentiles in Table 25. Figure 33 shows the indicator values are decreasing until 2013 and then stabilize around values of 1.2, meaning that on average the exploitation levels are over F_{MSY}.

5.1.1 *Trend in F/F_{MSY}*

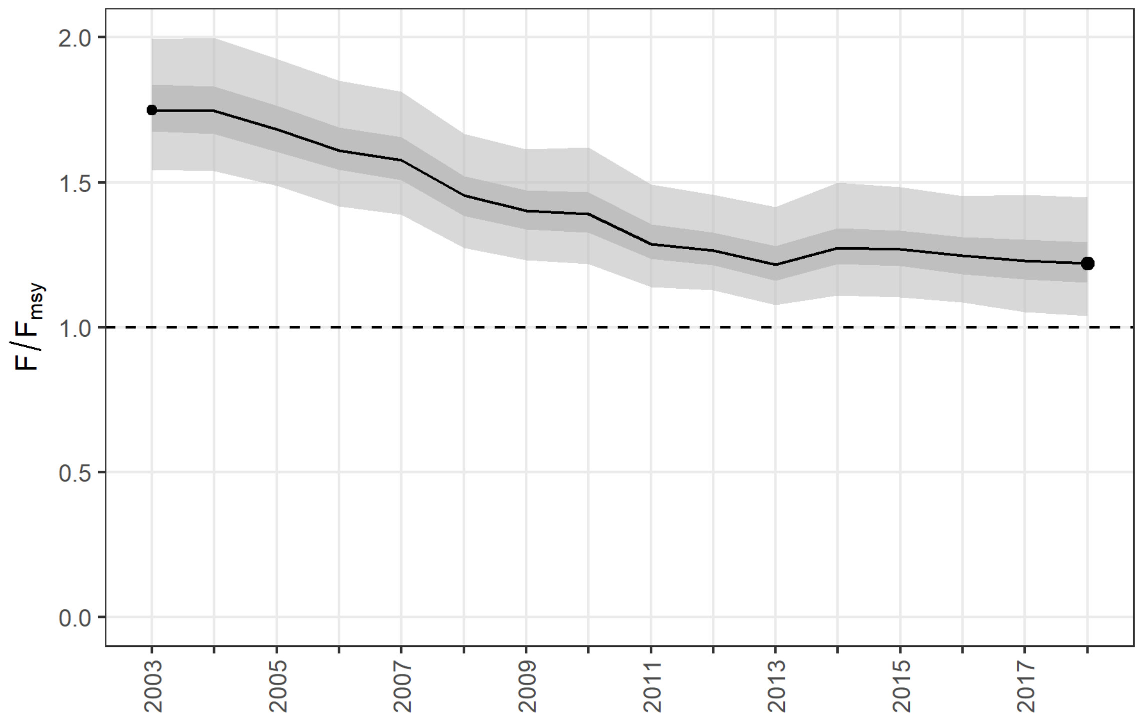

Figure 36 Trend in F/F_{MSY} (based on 79 stocks; 44 NE Atlantic and 35 Mediterranean ones). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 25. Percentiles for F/F_{MSY} by year.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.5%	1.54	1.54	1.49	1.42	1.39	1.27	1.23	1.22	1.14	1.13	1.08	1.11	1.10	1.09	1.05	1.04
25%	1.68	1.67	1.61	1.54	1.51	1.38	1.34	1.33	1.24	1.21	1.16	1.22	1.21	1.18	1.16	1.16
50%	1.75	1.75	1.68	1.61	1.58	1.45	1.40	1.39	1.29	1.26	1.22	1.27	1.27	1.25	1.23	1.22
75%	1.84	1.83	1.77	1.69	1.66	1.52	1.47	1.47	1.36	1.33	1.28	1.34	1.33	1.31	1.30	1.29
97.5%	1.99	2.00	1.93	1.85	1.81	1.67	1.61	1.62	1.49	1.46	1.41	1.50	1.48	1.45	1.46	1.45

5.1.2 *Trend in SSB (relative to 2003)*

Figure 34 and Table 26 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. As in the Mediterranean and Black Sea (area 37) indicators an increasing SSB trend corresponds to the exploitation level stabilizing around overexploitation values, hence a relevant sensitivity analysis was carried out (see Annex 04 for details).

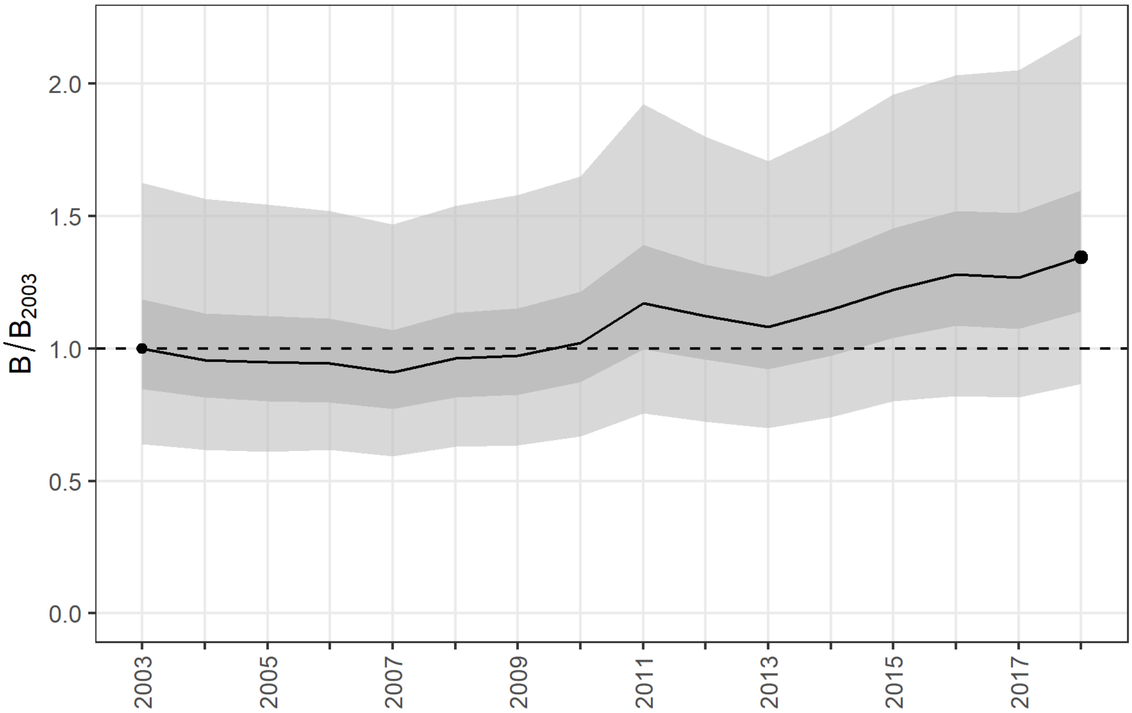

Figure 37 Trend in B/B_{2003} (based on 83 stocks; 51 NE Atlantic and 32 Mediterranean ones). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 26. Percentiles for SSB relative to 2003**.**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2.5%	0.64	0.62	0.61	0.62	0.59	0.63	0.63	0.67	0.75	0.72	0.70	0.74	0.80	0.82	0.81	0.87
25%	0.85	0.82	0.80	0.80	0.77	0.82	0.82	0.87	1.00	0.96	0.92	0.97	1.04	1.09	1.07	1.14
50%	1.00	0.96	0.95	0.94	0.91	0.96	0.97	1.02	1.17	1.12	1.08	1.15	1.22	1.28	1.27	1.34
75%	1.18	1.13	1.12	1.11	1.07	1.14	1.15	1.21	1.39	1.32	1.27	1.36	1.45	1.52	1.51	1.60
97.5%	1.63	1.56	1.54	1.52	1.47	1.54	1.58	1.65	1.92	1.80	1.71	1.82	1.96	2.03	2.05	2.19

6 STATUS ACROSS ALL STOCKS IN 2019

Table 27. Stock status for all stocks in the analysis. Columns refer to ecoregion, last year for which the estimate 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) (for both indicators Fpa and Bpa), and if the stock has F below F_{MSY} and SSB above B_{MSY} ($F \leq F_{MSY}$ & $SSB \geq B_{MSY}$). Stocks managed under escapement strategies dot not have an estimate of F/F_{MSY}, their F status is calculated as MSYBescapment over the Stock size. Symbol 'Y' stands for 'YES', 'N' stands for 'NO' and '-' stands for unknown due to missing information**.**

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	$F \leq F_{MSY}$ & $B \geq B_{MSY}$
FAO27	Baltic Sea	2019	cod.27.22-24	Cod (*Gadus morhua*) in subdivisions 22-24. western Baltic stock (western Baltic Sea)	2.01	N	N	-
FAO27	Baltic Sea	2019	her.27.20-24	Herring (*Clupea harengus*) in subdivisions 20-24. spring spawners (Skagerrak. Kattegat. and western Baltic)	1.23	N	N	-
FAO27	Baltic Sea	2019	her.27.25-2932	Herring (*Clupea harengus*) in subdivisions 25-29 and 32. excluding the Gulf of Riga (central Baltic Sea)	2.13	N	N	-
FAO27	Baltic Sea	2019	her.27.28	Herring (*Clupea harengus*) in Subdivision 28.1 (Gulf of Riga)	0.89	Y	Y	Y
FAO27	Baltic Sea	2019	ple.27.21-23	Plaice (*Pleuronectes platessa*) in subdivisions 21-23 (Kattegat. Belt Seas. and the Sound)	1.22	N	Y	-
FAO27	Baltic Sea	2019	sol.27.20-24	Sole (*Solea solea*) in subdivisions 20-24 (Skagerrak and Kattegat. western Baltic Sea)	0.88	Y	N	-
FAO27	Baltic Sea	2019	spr.27.22-32	Sprat (*Sprattus sprattus*) in subdivisions 22-32 (Baltic Sea)	1.22	N	Y	-
FAO27	BoBiscay & Iberia	2019	ane.27.8	Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay)	-	Y	-	-

FAO27	BoBiscay & Iberia	2019	hom.27.9a	Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters)	0.26	Y	-	Y
FAO27	BoBiscay & Iberia	2019	ldb.27.8c9a	Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East)	0.76	Y	Y	-
FAO27	BoBiscay & Iberia	2019	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)	0.93	Y	Y	-
FAO27	BoBiscay & Iberia	2019	meg.27.8c9a	Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.88	Y	Y	-
FAO27	BoBiscay & Iberia	2019	mon.27.78abd	White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a-b and 8.d (Celtic Seas. Bay of Biscay)	0.78	Y	Y	-
FAO27	BoBiscay & Iberia	2019	mon.27.8c9a	White anglerfish (*Lophius piscatorius*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.36	Y	Y	Y
FAO27	BoBiscay & Iberia	2019	sol.27.8ab	Sole (*Solea solea*) in divisions 8.a-b (northern and central Bay of Biscay)	1.10	N	Y	-
FAO27	Celtic Seas	2019	cod.27.6a	Cod (*Gadus morhua*) in Division 6.a (West of Scotland)	3.33	N	N	-
FAO27	Celtic Seas	2019	cod.27.7e-k	Cod (*Gadus morhua*) in divisions 7.e-k (eastern English Channel and southern Celtic Seas)	3.91	N	N	-
FAO27	Celtic Seas	2019	had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	1.01	N	Y	-
FAO27	Celtic Seas	2019	had.27.7a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)	0.59	Y	Y	Y
FAO27	Celtic Seas	2019	had.27.7b-k	Haddock (*Melanogrammus aeglefinus*) in divisions 7.b-k (southern Celtic Seas and English Channel)	1.15	N	Y	-
FAO27	Celtic Seas	2019	her.27.irls	Herring (*Clupea harengus*) in divisions 7.a South of 52°30'N. 7.g-h. and 7.j-k	1.89	N	N	-

				(Irish Sea. Celtic Sea. and southwest of Ireland)				
FAO27	Celtic Seas	2019	her.27.nirs	Herring (*Clupea harengus*) in Division 7.a North of 52°30’N (Irish Sea)	0.69	Y	Y	-
FAO27	Celtic Seas	2019	lez.27.4a6a	Megrim (*Lepidorhombus spp*.) in divisions 4.a and 6.a (northern North Sea. West of Scotland)	0.45	Y	-	Y
FAO27	Celtic Seas	2019	nep.fu.11	Norway lobster (*Nephrops norvegicus*) in Division 6.a. Functional Unit 11 (West of Scotland. North Minch)	0.66	Y	-	Y
FAO27	Celtic Seas	2019	nep.fu.12	Norway lobster (*Nephrops norvegicus*) in Division 6.a. Functional Unit 12 (West of Scotland. South Minch)	0.30	Y	-	Y
FAO27	Celtic Seas	2019	nep.fu.14	Norway lobster (*Nephrops norvegicus*) in Division 7.a. Functional Unit 14 (Irish Sea. East)	0.33	Y	-	Y
FAO27	Celtic Seas	2019	nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a. Functional Unit 15 (Irish Sea. West)	0.84	Y	-	Y
FAO27	Celtic Seas	2019	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)	0.67	Y	-	-
FAO27	Celtic Seas	2019	nep.fu.17	Norway lobster (*Nephrops norvegicus*) in Division 7.b. Functional Unit 17 (west of Ireland. Aran grounds)	0.22	Y	-	N
FAO27	Celtic Seas	2019	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)	0.35	Y	-	N
FAO27	Celtic Seas	2019	nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h. Functional Units 20 and 21 (Celtic Sea)	3.54	N	-	-
FAO27	Celtic Seas	2019	nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.f and 7.g. Functional Unit 22 (Celtic Sea. Bristol Channel)	0.66	Y	-	Y
FAO27	Celtic Seas	2019	ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	0.37	Y	Y	Y

FAO27	Celtic Seas	2019	sol.27.7a	Sole (*Solea solea*) in Division 7.a (Irish Sea)	0.74	Y	N	
FAO27	Celtic Seas	2019	sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	0.86	Y	Y	Y
FAO27	Celtic Seas	2019	sol.27.7fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel. Celtic Sea)	0.96	Y	Y	-
FAO27	Celtic Seas	2018	whg.27.7a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)	2.12	N	N	-
FAO27	Celtic Seas	2019	whg.27.7b-ce-k	Whiting (*Merlangius merlangus*) in divisions 7.b-c and 7.e-k (southern Celtic Seas and eastern English Channel)	0.89	Y	N	-
FAO27	Greater North Sea	2019	cod.27.47d20	Cod (*Gadus morhua*) in Subarea 4. Division 7.d. and Subdivision 20 (North Sea. eastern English Channel. Skagerrak)	2.06	N	N	-
FAO27	Greater North Sea	2019	had.27.46a20	Haddock (*Melanogrammus aeglefinus*) in Subarea 4. Division 6.a. and Subdivision 20 (North Sea. West of Scotland. Skagerrak)	0.93	Y	Y	-
FAO27	Greater North Sea	2019	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)	0.69	Y	Y	Y
FAO27	Greater North Sea	2019	nep.fu.6	Norway lobster (*Nephrops norvegicus*) in Division 4.b. Functional Unit 6 (central North Sea. Farn Deeps)	1.98	N	-	N
FAO27	Greater North Sea	2019	nep.fu.7	Norway lobster (*Nephrops norvegicus*) in Division 4.a. Functional Unit 7 (northern North Sea. Fladen Ground)	0.75	Y	-	Y
FAO27	Greater North Sea	2019	nep.fu.8	Norway lobster (*Nephrops norvegicus*) in Division 4.b. Functional Unit 8 (central North Sea. Firth of Forth)	1.12	N	-	N
FAO27	Greater North Sea	2019	nep.fu.9	Norway lobster (*Nephrops norvegicus*) in Division 4.a. Functional Unit 9 (central North Sea. Moray Firth)	1.25	N	-	N
FAO27	Greater North Sea	2019	nop.27.3a4	Norway pout (*Trisopterus esmarkii*) in Subarea 4 and Division 3.a (North Sea. Skagerrak and Kattegat)	NA	N	-	-

FAO27	Greater North Sea	2019	ple.27.420	Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	0.79	Y	Y	Y
FAO27	Greater North Sea	2019	ple.27.7d	Plaice (*Pleuronectes platessa*) in Division 7.d (eastern English Channel)	1.19	N	Y	-
FAO27	Greater North Sea	2019	pok.27.3a46	Saithe (*Pollachius virens*) in subareas 4. 6 and Division 3.a (North Sea. Rockall and West of Scotland. Skagerrak and Kattegat)	1.27	N	N	-
FAO27	Greater North Sea	2019	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)	0.88	Y	N	N
FAO27	Greater North Sea	2019	san.sa.1r	Sandeel (*Ammodytes* spp.) in divisions 4.b and 4.c. Sandeel Area 1r (central and southern North Sea. Dogger Bank)	NA	N	-	-
FAO27	Greater North Sea	2019	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)	NA	N	-	-
FAO27	Greater North Sea	2019	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)	NA	Y	-	-
FAO27	Greater North Sea	2019	san.sa.4	Sandeel (*Ammodytes* spp.) in divisions 4.a and 4.b. Sandeel Area 4 (northern and central North Sea)	NA	Y	-	-
FAO27	Greater North Sea	2019	sol.27.4	Sole (*Solea solea*) in Subarea 4 (North Sea)	1.31	N	N	-
FAO27	Greater North Sea	2019	spr.27.3a4	Sprat (*Sprattus sprattus*) in Division 3.a and Subarea 4 (Skagerrak. Kattegat and North Sea)	NA	Y	-	-
FAO27	Greater North Sea	2019	tur.27.4	Turbot (*Scophthalmus maximus*) in Subarea 4 (North Sea)	1.02	N	Y	N
FAO27	Greater	2019	whg.27.47d	Whiting (*Merlangius merlangus*) in Subarea 4 and Division 7.d (North Sea and	1.21	N	N	-

	North Sea			eastern English Channel)				
FAO27	Greater North Sea	2019	wit.27.3a47d	Witch (*Glyptocephalus cynoglossus*) in Subarea 4 and divisions 3.a and 7.d (North Sea. Skagerrak and Kattegat. eastern English Channel)	1.31	N	N	-
FAO27	Widely	2019	bli.27.5b67	Blue ling (*Molva dypterygia*) in subareas 6-7 and Division 5.b (Celtic Seas and Faroes grounds)	0.30	Y	Y	-
FAO27	Widely	2019	dgs.27.nea	Spurdog (*Squalus acanthias*) in subareas 1-10. 12 and 14 (the Northeast Atlantic and adjacent waters)	0.24	Y	-	N
FAO27	Widely	2019	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)	0.88	Y	Y	-
FAO27	Widely	2019	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)	1.47	N	N	-
FAO27	Widely	2019	mac.27.nea	Mackerel *(Scomber scombrus*) in subareas 1-8 and 14 and Division 9.a (the Northeast Atlantic and adjacent waters)	0.86	Y	Y	-
FAO27	Widely	2019	whb.27.1-91214	Blue whiting (*Micromesistius poutassou*) in subareas 1-9. 12. and 14 (Northeast Atlantic and adjacent waters)	1.11	N	Y	-
FAO37	Black Sea	2018	tur_29	Turbot in GSA 29	1.69	N	-	-
FAO37	Central Med.	2018	ane_17_18	European anchovy in GSA 17, 18	1.68	N	-	-
FAO37	Central Med.	2017	dps_12_13_14_15_16	Deep-water rose shrimp in GSA 12, 13, 14, 15, 16	1.59	N	-	-
FAO37	Central Med.	2018	dps_17_18_19	Deep-water rose shrimp in GSA 17, 18, 19	3.05	N	-	-

FAO37	Central Med.	2017	hke_12_13_14_15_16	European hake in GSA 12, 13, 14, 15, 16	4.25	N	-	-
FAO37	Central Med.	2018	hke_17_18	European hake in GSA 17, 18	2.79	N	-	-
FAO37	Central Med.	2018	hke_19	European hake in GSA 19	3.26	N	-	-
FAO37	Central Med.	2018	hke_20	European hake in GSA 20	2.58	N	-	-
FAO37	Central Med.	2018	mts_17_18	Spottail mantis shrimp in GSA 17, 18	1.82	N	-	-
FAO37	Central Med.	2017	mut_15	Red mullet in GSA 15	1.30	N	-	-
FAO37	Central Med.	2017	mut_16	Red mullet in GSA 16	1.03	N	-	-
FAO37	Central Med.	2018	mut_17_18	Red mullet in GSA 17, 18	2.83	N	-	-
FAO37	Central Med.	2017	mut_20	Red mullet in GSA 20	0.29	Y	-	Y
FAO37	Central Med.	2018	nep_17_18	Norway lobster in GSA 17, 18	1.96	N	-	N
FAO37	Central Med.	2017	pil_16	European pilchard(=Sardine) in GSA 16	1.70	N	-	-
FAO37	Central	2018	pil_17_18	European pilchard(=Sardine)	3.25	N	-	-

	Med.			in GSA 17, 18				
FAO37	Eastern Med.	2017	ane_22	European anchovy in GSA 22	0.78	Y	-	-
FAO37	Eastern Med.	2018	mut_22	Red mullet in GSA 22	0.33	Y	-	-
FAO37	Eastern Med.	2017	pil_22	European pilchard(=Sardine) in GSA 22	1.13	N	-	-
FAO37	Western Med.	2018	ara_01	Blue and red shrimp in GSA 01	5.44	N	-	-
FAO37	Western Med.	2018	ara_06_07	Blue and red shrimp in GSA 06, 07	5.03	N	-	-
FAO37	Western Med.	2018	ara_09_10_11	Blue and red shrimp in GSA 09, 10, 11	3.03	N	-	-
FAO37	Western Med.	2018	ars_09_10_11	Giant red shrimp in GSA 09, 10, 11	1.52	N	-	-
FAO37	Western Med.	2018	dps_09_10_11	Deep-water rose shrimp in GSA 09, 10, 11	0.82	Y	-	-
FAO37	Western Med.	2018	hke_01_05_06_07	European hake in GSA 01, 05, 06, 07	4.16	N	-	-
FAO37	Western Med.	2018	hke_08_09_10_11	European hake in GSA 08, 09, 10, 11	3.41	N	-	-
FAO37	Western Med.	2018	mur_05	Surmullet in GSA 05	0.97	Y	-	-

FAO37	Western Med.	2018	mut_01	Red mullet in GSA 01	1.74	N	-	-
FAO37	Western Med.	2018	mut_06	Red mullet in GSA 06	4.59	N	-	-
FAO37	Western Med.	2018	mut_07	Red mullet in GSA 07	1.78	N	-	-
FAO37	Western Med.	2018	mut_09	Red mullet in GSA 09	2.36	N	-	-
FAO37	Western Med.	2018	mut_10	Red mullet in GSA 10	1.37	N	-	-
FAO37	Western Med.	2018	nep_06	Norway lobster in GSA 06	8.87	N	-	-
FAO37	Western Med.	2018	nep_09	Norway lobster in GSA 09	0.84	Y	-	-
FAO37	Western Med.	2017	nep_05	Norway lobster in GSA 5	7.60	N	-	-

7 HISTORICAL TRENDS

Historical trends for the two main indicators, F/F_{MSY} and B/B_{2003}, starting from 2017 are plotted in figure 38 to 41. 2017 was chosen as a starting year for sake of comparison, as it was the first year that the indicators were modelled. The year's specific sample size available to run the analysis is reported in the figures' legend to show how sample variability or lack of it can influence consistency of trends and comparability across years.

North East Atlantic trends (Figure 38 and 39) show consistency across years, although in 2021 levels of F/F_{MSY} are increasing compared to previous years, as levels of B/B_{2003} are decreasing. Trends for the Mediterranean and Black sea area (Figure 40 and 41) show high variability and low consistency except for 2018, 2019 and 2020 that suffered the list of changes in sample size compared to other years.

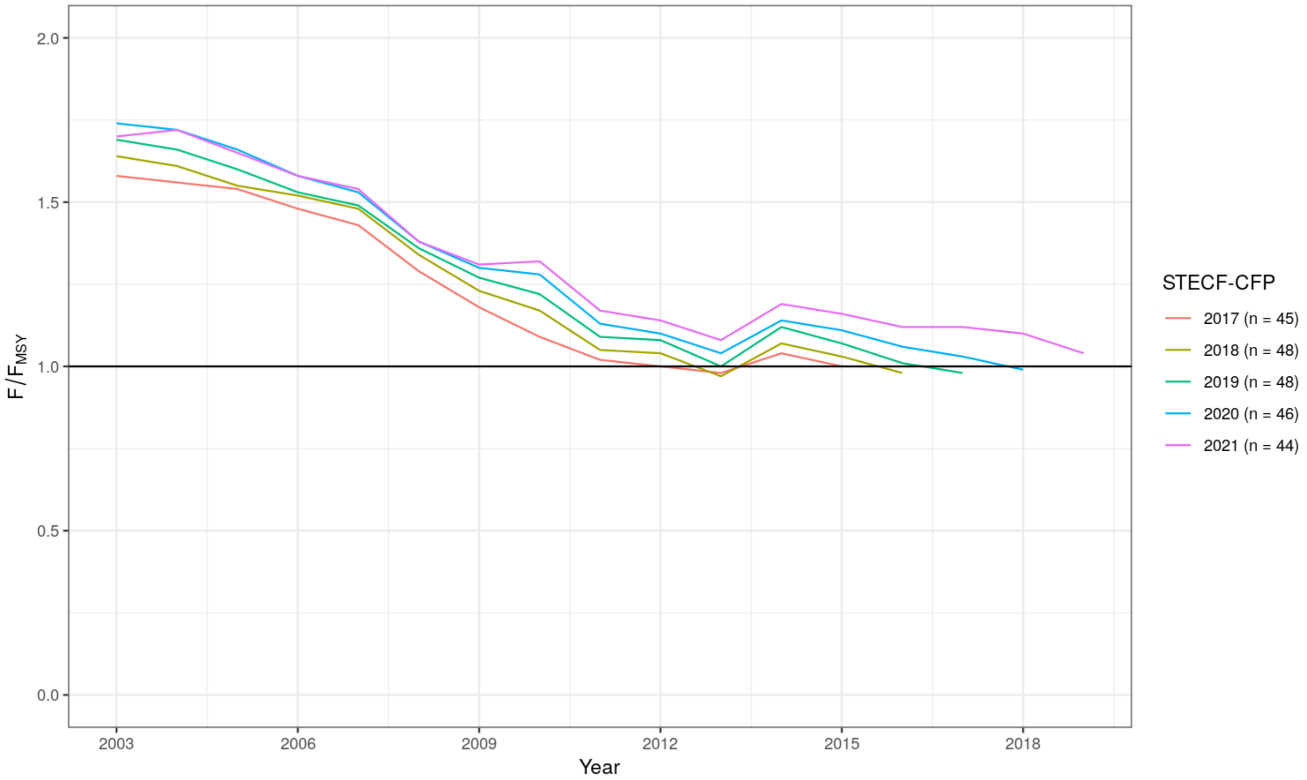

Figure 38 Historical trends reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the North East Atlantic area.

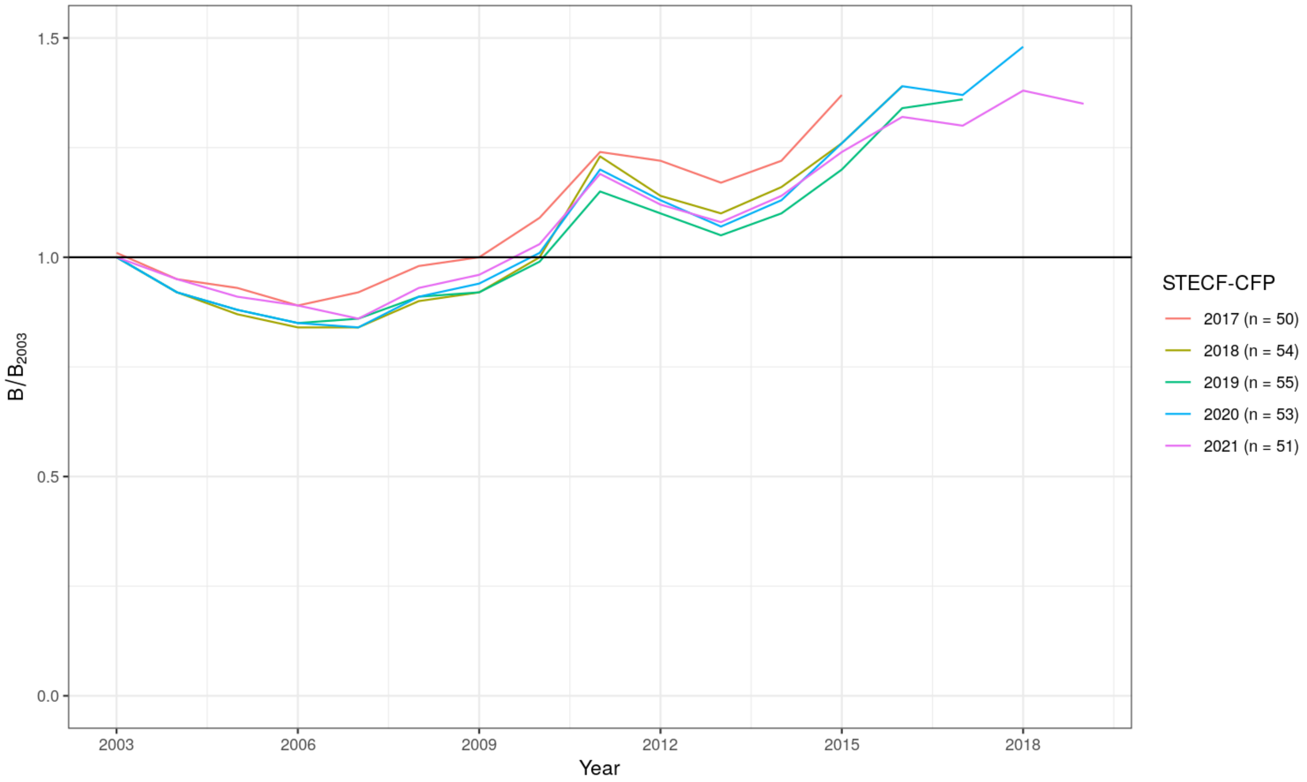

Figure 39 Historical trends reported in STECF CFP monitoring reports since 2017 for B/B_{2003} in the North East Atlantic area.

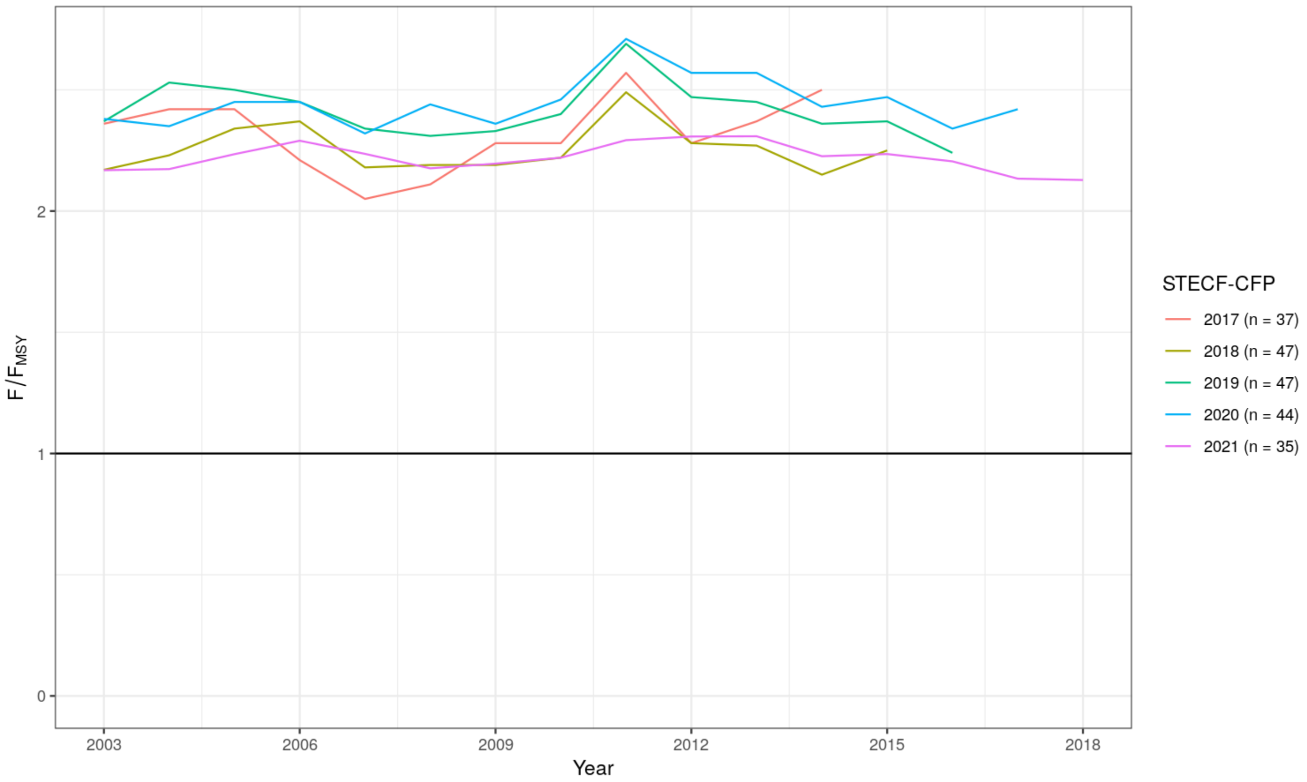

Figure 40 Historical trends reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the Mediterranean and Black Sea area.

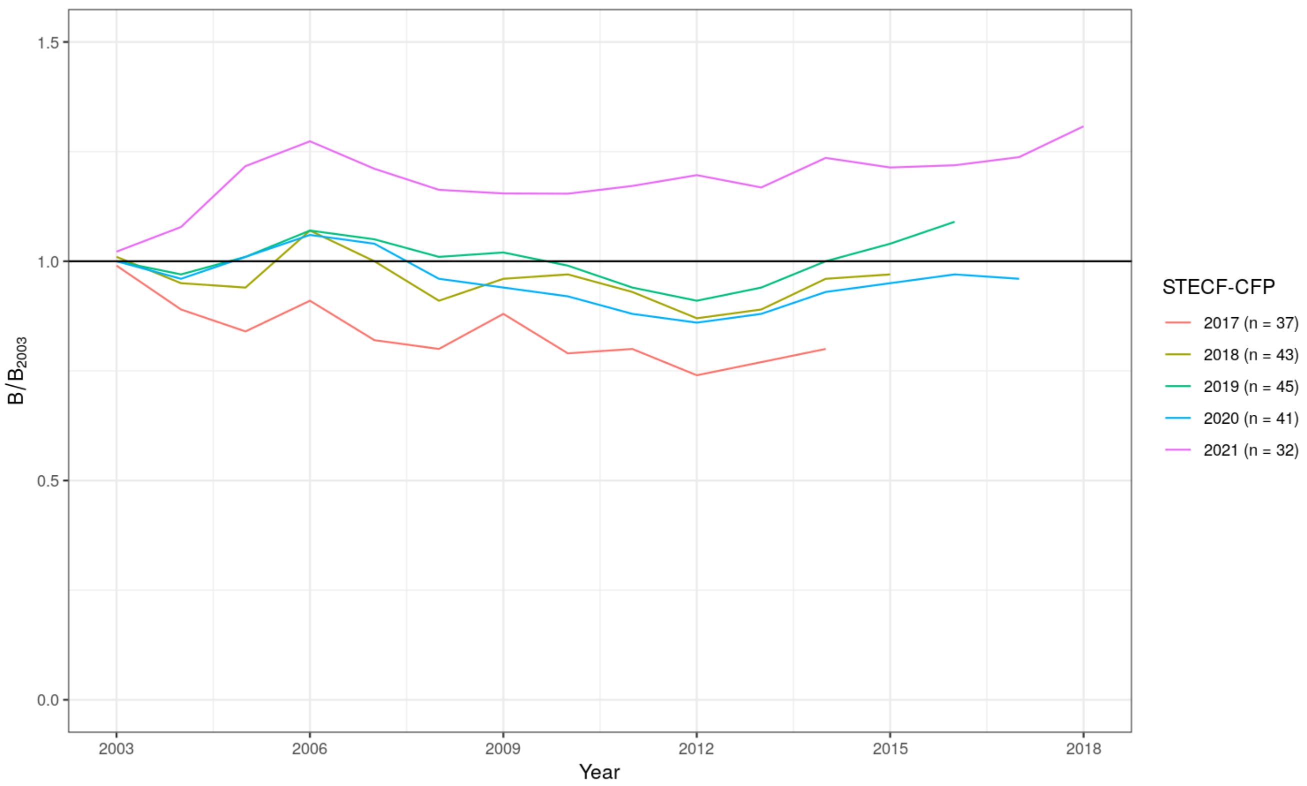

Figure 41 Historical trends reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the Mediterranean and Black Sea area.

8 ONGOING DEVELOPMENTS

Work will continue in 2021 to allow the CFP monitoring report to be improved and the protocol to be reinforced, including

- Review of the interpolation of missing points at the beginning and at the end of the time series
- Revise the model for trend analysis

NEA Atlantic:

- Review the data poor Category 3 indicator considering ICES work on MSY proxies for Category 3 stocks
- Review the alignment of the TACs and Ecoregions

Mediterranean and Black Seas:

- Set a minimum number of stocks to run the analysis at Ecoregion level
- Review the minimum number of years of the time series to include single stocks in the analysis (i.e., include at list 1 cohort)
- Establish a rule to define which year the analysis should be run to (final Year-1; final Year-2; final Year)

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10 CONTACT DETAILS OF EWG-ADHOC-21-01 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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11 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 - 21-01 – Annex 1 – URL links to the source reports by stock

EWG - Adhoc - 21-01 – Annex 2 – ICES data quality issues corrected prior to the analysis

EWG - Adhoc - 21-01 – Annex 3 – Indicator's stability tests

EWG – Adhoc - 21-01 – Annex 4 – Sensitivity analysis for FAO area 37 indicators

12 BACKGROUND DOCUMENT

EWG-Adhoc-21-01 – Doc 1 - Declarations of JRC experts (see also section 10 of this report – List of participants)

13 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:
  - $j = 1 \dots N$ indexes stocks, where N is the total number of stocks selected for the analysis;
  - $t = 1 \dots T$ indexes years, where T is the number of years in the reported time series;
  - $m = 1 \dots M$ indexes sampling units, where M is the total number of stocks in the reference list;
  - $s = 1 \dots S$ 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.

14 ANNEX 2A – NEA CODE

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

library(ggplot2)
library(lattice)
library(lme4)
library(influence.ME)
library(parallel)
library(rgdal)
library(plyr)
library(reshape2)

rm(list=ls())
setwd("./…")
source("./funs.R")

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

# year when assessments were performed
assessmentYear <- 2020
# 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 <- 1000
# number of cores for mle bootstrap parallel
nc <- 150
# 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(2,3,5,6,8,9,11,12,14,15)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=seq(iniYear, fnlYear, 2)) #, 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_2021.csv", stringsAsFactors=FALSE)
#isa$FishingPressure <- as.numeric(isa$FishingPressure)
#isa$Recruitment <- as.numeric(isa$Recruitment)
# extract the main ecoregion but keep the list
##no list of ecoregion this year as correct ecoregion set after indication by David Miller
# 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=" ")))
#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)
# >>> old codes don't exist anymore, updated to new ones

## following David Miller Table this change is wrong so avoiding it now
#isa[isa$FishStock %in% c("dgs.27.nea", "aru.27.6b7-1012", "bli.27.5b67", "hke.27.3a46-8abd",
"mac.27.nea", "whb.27.1-91214", "hom.27.2a4a5b6a7a-ce-k8", "reb.2127.dp", "lin.27.3a4a6-91214",
"usk.27.3a45b6a7-912b", "rng.27.5b6712b", "bsf.27.nea", "her.27.1-24a514a", "boc.27.6-8",
"sdv.27.nea", "gfb.27.nea"), "EcoRegion"] <- "Northeast Atlantic"

# this is not needed anymore as already correct for had nad pok and wrong for sol
# 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 if needed
isa[isa$FishingPressureDescription %in% c("Harvest Rate", "Harvest rate"),
"FishingPressureDescription"] #<- "HR"
```

```
# 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)
#TRUE
#-------------------------------------------------------------------
# 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)

# 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 <- reshape2::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")))
isa12 <- subset(isa12, !(EcoRegion %in% c("Arctic Ocean", "Iceland, Greenland and Faroes")))
# 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")

#-----------------------------------------------------------------
# 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))]
#NA

# 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 2021 and HOM still exists
isa12[isa12$Species=="HOM","Species"] <- "JAX"
# ANK & MON - Anglerfish - species to genus
# Checked in 2021 and MON still exist
#isa12[isa12$Species=="ANK","Species"] <- "ANF"
isa12[isa12$Species=="MON","Species"] <- "ANF"
# Megrim - species and genus to genus
# Checked in 2021 and MEG+LDB still exist
isa12[isa12$Species=="MEG","Species"] <- "LEZ"
isa12[isa12$Species=="LDB","Species"] <- "LEZ"
# 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"
# PIL and BSS don't have TACs
#TUR and WIT are now codede as combined TACs stocks


#------------------------------------------------------------------
# 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 (less than 5 years)
sts <- table(sts)
sts <- names(sts)[sts<5]
#"nep.fu.2324"
# remove also nep.fu.3-4, assessment area is not stable so doesn't have 5 years of comparable data
#also removing nep.fu.13 as 2020 assessment is not finalized yet, information are available only for the
firth of Clyde, but a single estimate for Firth of Clyde and Sound of Jura was estimated in the SAG so
waiting for corrections from ICES: today 11/03/2021 we remove the stock until further notice
```

```
sts <- c(sts, "nep.fu.3-4", "nep.fu.13")


# 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, MSYBescapement not available so Blim used as a reference
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 from 2019 as proxy for MSYBescapement
saeu[saeu$FishStock == "ane.27.8", "MSYBescapement"] <- 89000

# according to the sumsheets SAN and SPR-NSEA use Bpa for MSYBescapement
saeu[saeu$FishStock %in%
c("san.sa.1r","san.sa.2r","san.sa.3r","san.sa.4","spr.27.3a4"),"MSYBescapement"] <-
saeu[saeu$FishStock %in% c("san.sa.1r","san.sa.2r","san.sa.3r","san.sa.4","spr.27.3a4"),"Bpa"]
```

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

#--------------------------------------------------------------------
# Bref
#--------------------------------------------------------------------
# check MSYBtrigger approx. Bpa, need some boundaries for rounding
stksBpaMSYBtrigger <- unique(saeu[saeu$MSYBtrigger/saeu$Bpa < 1.05 & saeu$MSYBtrigger/saeu$Bpa
> 0.95, 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("hom.27.9a", "pra.27.3a4a",
"sol.27.7e"))] <- 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("hom.27.9a")] <- 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 <- saeu0 <- subset(saeu, Year <= fnlYear)
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
# check stocks with non continuos time series
# plot needs to be fixed mannualy but should be possible to auto
stks_ncts <- tapply(df0$Year, df0$FishStock, function(x){
	!(max(x) - min(x) + 1 == length(x))
})
stks_ncts <- names(stks_ncts)[stks_ncts]

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(reshape2::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(reshape2::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(reshape2::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(reshape2::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(reshape2::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(reshape2::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
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(reshape2::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, 3) +
  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)
})

# naming including No of stocks
No <- lapply(split(df0, df0$EcoRegion), function(x) length(unique(x$FishStock)))
names(ifitRegional) <- paste(names(No), " (", No, ")", sep="")

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(reshape2::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", "Iceland, Greenland and Faroes") |
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, 3) +
```

```
  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="bobyqa")) #"nlminbwrap" had to change optimizer to allow
convergence
runDiagsME(ifitb, "FishStock", df0, "diagNEAI8.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitb.bs <- split(1:it, 1:it)
ifitb.bs <- mclapply(ifitb.bs, function(x){
	stk <- sample(stk, replace=TRUE)
	df1 <- df0[0,]
	for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
	fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa")) #"nlminbwrap" had to change optimizer to allow
convergence
	v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
	if(length(fit@optinfo$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="bobyqa"))   #nlminbwrap change optimizer for convergence (still one
convergence issue due to gradient at 0.007 (tol=0.002))
	# 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])
})

# naming including No of stocks
```

```
No <- lapply(split(df0, df0$EcoRegion), function(x) length(unique(x$FishStock)))
names(ifitbRegional) <- paste(names(No), " (", No, ")", sep="")

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(reshape2::dcast(fIndbr, EcoRegion~Year, value.var='N'), file="tabNEAI8b.csv",
row.names=FALSE)

#------------------------------------------------------------------
# (I10) Recruitment model
#------------------------------------------------------------------
saeu0 <- saeu0[!saeu0$FishStock %in% "cod.27.24-32",] # excluded from the analysis due to the absence
of F reference points
#saeu0$Recruitment <- as.numeric(saeu0$Recruitment)

saeu0$sfI10 <- !is.na(saeu0$Recruitment)
df0 <- saeu0[saeu0$sfI10,]
# data for table about stocks and indicators
sfI10 <- subset(df0, Year>=iniYear & Year<=fnlYear)
sfI10 <- tapply(sfI10$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)))

#load("./RData_nea_newrec")
# 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"))
	# 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])
})

# naming including No of stocks
No <- lapply(split(df0, df0$EcoRegion), function(x) length(unique(x$FishStock)))
names(ifitrRegional) <- paste(names(No), " (", No, ")", sep="")

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(reshape2::dcast(fIndrr, EcoRegion~Year, value.var='N'), file="tabNEAI10b.csv",
row.names=FALSE)

#------------------------------------------------------------------
# (I12) SSB model for cat 3
# >>> Check which are in sampling frame
# >>> Add to report Abundance indices also used
#------------------------------------------------------------------

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

# 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 last two years 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="tabNEAI12.csv")

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

bootconv <- data.frame(
	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
#===================================================================
#sa1 <- as.data.table(saeu)
df0 <- reshape2::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$Year))))
# fix year for I10 when assessment not from previous year
df1 <- sfI10
df1$Year <- subset(df0, FishStock %in% df1$FishStock & variable=="sfFind")$Year

# merge
df0 <- merge(df0, df1, 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 <- reshape2::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("out_nea.RData")
```

15 ANNEX 2B - MED CODE

```
#################################################################
# AM(20201121)
# MED indicators
#################################################################

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 <- 2020
# 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 <- 6
# 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(2,4,6,8,10,12,14,16)] <- ""
```

```
theme_set(theme_bw())

sc <- scale_x_continuous(breaks=seq(iniYear,fnlYear,2), labels=as.character(seq(iniYear,fnlYear,2)))
th <- theme(axis.text.y  = element_text(angle=0, vjust=0.5), axis.text.x  = element_text(angle=45,
vjust=0.5),panel.grid.minor = element_blank())

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


# load and pre-process ####
gfcm <- read.csv("../data/med/GFCM_CFP_2021.csv")
gfcm$Meeting <- "GFCM"

stecf <- read.csv("../data/med/STECF_CFP_2021.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"

listEcoReg <-
setNames(as.data.frame(table(substring(unique(paste0(msa$Stock,msa$EcoRegion)),4))),c("EcoReg","Fr
eq"))
toremove <- as.character(listEcoReg[listEcoReg$Freq<4,]$EcoReg)


#------------------------------------------------------------------
# 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)
names(msa)
msa <- msa[!msa$Stock%in%"SOL",]
```

```
#-----------------------------------------------------------------
# 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)
df0 <- sam[!sam$projected,]
ggplot(df0, aes(Year,reorder(stk, desc(stk))))+
        geom_line() +
        geom_point(data=aggregate(list(Year=df0$Year, EcoRegion=df0$EcoRegion),
  by=list(stk=df0$stk), max)) +
        ylab("") +
 theme(axis.text.y = element_text(angle = 180, vjust = 0.5, hjust=1))+
        xlab("Year") +
        sc +
        th +
        facet_grid(EcoRegion~., switch="y", space="free_y", scales="free_y") +
theme(strip.text.y.left = element_text(angle=0))+
        theme(strip.placement="outside",
           #strip.background.y=element_blank(),
           strip.background =element_rect(fill="lightyellow"),
        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(2,4,6,8,10,12,14,16)] <- ""
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$Year)
nd <- data.frame(Year=factor(yrs))
No <- length(unique(df0$stk))

# 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")

#---------------------------------------------------------------
# (I7b) F/Fmsy model regional
#----------------------------------------------------------------
df0 <- sam
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# remove Eastern Med. where only 2 stocks are available
df0 <- df0[!df0$EcoRegion%in%toremove,]

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

# naming including No of stocks
No <- lapply(split(df0, df0$EcoRegion), function(x) length(unique(x$stk)))
names(mfitRegional) <- paste(names(No), " (", No, ")", sep="")

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

```
# plot
png("figMedI7b.png", 2400, 1200, res=300)
ggplot(fIndfr, aes(x=Year, y=N)) +
	geom_line() +
	facet_grid(.~EcoRegion) +
	geom_hline(yintercept = 1, linetype=2) +
	ylab(expression(F/F[MSY])) +
	xlab("") +
	sc +
	ylim(0, 3.5) +
	th
dev.off()

# table
write.csv(reshape2::dcast(fIndfr, EcoRegion~Year, value.var='N'), file="tabMedI7b.csv",
row.names=FALSE)

#------------------------------------------------------------------
# (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))
No <- length(unique(df0$stk))

# 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")

	#--------------------------------------------------------------
	# (I8) SSB indicator regional
	#--------------------------------------------------------------
	idx <- !is.na(sam$SSB)
	df0 <- sam[idx,]
	df0$Year <- factor(df0$Year)
	yrs <- levels(df0$Year)
	nd <- data.frame(Year=factor(yrs))
	# remove Eastern Med. where only 2 stocks are available
	df0 <- df0[!df0$EcoRegion%in%toremove,]
	# df0 <- df0[df0$EcoRegion!="Eastern Med.",]
	# df0 <- df0[df0$EcoRegion!="Black Sea",]
```

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

# naming including No of stocks
No <- lapply(split(df0, df0$EcoRegion), function(x) length(unique(x$stk)))
names(mfitbRegional) <- paste(names(No), " (", No, ")", sep="")

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

# plot
png("figMedI8b.png", 2400, 1200, res=300)
ggplot(bIndfr, aes(x=Year, y=N)) +
	geom_line() +
	facet_grid(.~EcoRegion) +
	geom_hline(yintercept = 1, linetype=2) +
	ylab(expression(B/B[2003])) +
	xlab("") +
	sc +
	th
dev.off()



# table
write.csv(reshape2::dcast(bIndfr, EcoRegion~Year, value.var='N'), file="tabMedI8b.csv", 
row.names=FALSE)

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

16 ANNEX 2C – SINGLE INDICATOR CODE

```
library(reshape2)
library(ggplot2)
library(lme4)
library(influence.ME)
library(lattice)
library(parallel)
library(rgdal)
library(reshape2)
library(plyr)
library(data.table)

#====================================================================
# Setup
#====================================================================
source("../funs.R")
# year when assessments were performed
assessmentYear <- 2019
# 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 <- 1000
# number of cores for mle bootstrap parallel
nc <- 150
# 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(2,4,6,8,10,12,14,16)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=(dy - 2002), labels=as.character(vp))
```

```
th <- theme(axis.text.x  = element_text(angle=90, vjust=0.5), panel.grid.minor = element_blank())
################# Setup finished

####################################
# loading and cleaning med data same as Ale's code except
# last small section. It is essentially producing the object
# sam and saves it as MED.csv - this can be directly read
###################################
###################################
# Mediterranean and Black Sea data
# load and pre-process
#####################################
# assessments
gfcm <- read.csv("../../data/med/GFCM_CFP_2021.csv")
gfcm$Meeting <- "GFCM"
stecf <- read.csv("../../data/med/STECF_CFP_2021.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"

listEcoReg <-
setNames(as.data.frame(table(substring(unique(paste0(msa$Stock,msa$EcoRegion)),4))),c("EcoReg","Fr
eq"))
toremove <- as.character(listEcoReg[listEcoReg$Freq<4,]$EcoReg)


#-----------------------------------------------------------------
# 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)
names(msa)
```

```
msa <- msa[!msa$Stock%in%"SOL",]
#----------------------------------------------------------------
# subset
# (filtering through the sampling frame done during data harvesting)
#----------------------------------------------------------------
sam <- msa[!is.na(msa$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)
}


#################### NEW SECTION

col_keep <- c(
  "indF",
  "Year",
  "stk",
  "EcoRegion",
  "SSB"
  )
```

```
MED_sa <- as.data.table(sam)
MED1 <- MED_sa[,..col_keep]
fwrite(MED1, file = "./MED.csv")

################################################################
################################################################
################################################################
#### NEA data is the saue.csv from the nea-report.R thus I did not
# write/use code to clean it
####

############## SSB model
med <- fread("MED.csv")

# loading only data that was used in SSB indicator (sfI8)
nea <- fread("../saeu.csv")[(sfI8)]
# adding area code - not used in the end
nea[, area := "nea"]
med[, area := "med"]

# cleaning NEA data and combining nea and med (this is indicator specific)
# could probably be done only once (see F indicator)- but this works
col_keep <- c(
  "FishingPressureDescription",
  "MSYBescapement",
  "Year",
  "indF",
  "FishStock",
  "EcoRegion",
  "FishingPressure",
  "StockSizeDescription",
  "StockSize",
  "Recruitment",
  "DataCategory",
  "AssessmentYear",
  "StockSizeUnits",
  "area"
)

nea <- nea[,..col_keep]
```

```
old1 <- names(nea)
new1 <- c(
  "FishingPressureDescription",
  "MSYBescapement",
  "Year",
  "indF",
  "stk",
  "EcoRegion",
  "FishingPressure",
  "StockSizeDescription",
  "SSB" ,
  "Recruitment",
  "DataCategory",
  "AssessmentYear",
  "StockSizeUnits",
  "area"
)
setnames(nea,old1, new1)
col_keep <- c(
  "Year",
  "stk",
  "EcoRegion",
  "SSB",
  "area"
  )


neaSSB <- nea[,..col_keep]
medSSB <- med[,..col_keep]
medSSB <- medSSB[!is.na(SSB)]
combSSB <- rbind(neaSSB,medSSB)
combSSB <- combSSB[Year < 2019]
combSSB[,year := factor(Year - 2003)]

# model fitted
#checking nested effect model but rejected based on AIC an BIC
fit <- glmer(SSB ~ year + (1|stk) , data =  combSSB, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa"))
#fit2 <- glmer(SSB ~ year + (1|stk/area), data =  combSSB, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa"))

#AIC(fit,fit2)

#BIC(fit,fit2)
```

```
#runDiagsMe does not work with data table - thus the conversion here
nd <- data.frame(year = sort(unique(combSSB$year)))
df <- as.data.frame(combSSB)
runDiagsME(fit, "stk", df, "diagNEAI8_SSB_stk.pdf", nc, nd)

# Bootstrap
df0 <- combSSB
yrs <- sort(unique(combSSB$year))
stk <- unique(df0$stk)
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, 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)

# creating quantiles and dividing estimates by median 2003
ifitm <- do.call("rbind", ifitout.bs)
ifitm <- exp(log(ifitm)-median(log(ifitm[,1]), na.rm=TRUE))
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
ifitqSSB_stk <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

# plotting results
png("boot_SSB_unique_stk.png",  1800, 1200, res=300)
ggplot(ifitqSSB_stk, 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(ifitqSSB_stk)[-1,]
colnames(tb0) <- seq(iniYear,fnlYear,1)
write.csv(tb0, file="./tab_SSB_single_percs.csv")

save.image("./ssb_combined.RData")
rm(list = ls())

##############################################################
source("../funs.R")
# year when assessments were performed
assessmentYear <- 2019
# 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 <- 1000
# number of cores for mle bootstrap parallel
nc <- 1
# 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(2,4,6,8,10,12,14,16)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=(dy - 2002), labels=as.character(vp))
th <- theme(axis.text.x  = element_text(angle=90, vjust=0.5), panel.grid.minor = element_blank())
##############################################################

med <- fread("MED.csv")
# loading only data used in F/Fmsy indicator
nea <- fread("../saeu.csv")[(sfI7)]
```

```
nea[, area := "nea"]
med[, area := "med"]

# cleaning NEA data and combining nea and med (this is indicator specific)
# could probably be done only once (see SSB indicator)- but this works

col_keep <- c(
  "FishingPressureDescription",
  "MSYBescapement",
  "Year",
  "indF",
  "FishStock",
  "EcoRegion",
  "FishingPressure",
  "StockSizeDescription",
  "StockSize",
  "Recruitment",
  "DataCategory",
  "AssessmentYear",
  "StockSizeUnits",
  "area"
)

nea <- nea[,..col_keep]


old1 <- names(nea)
new1 <- c(
  "FishingPressureDescription",
  "MSYBescapement",
  "Year",
  "indF",
  "stk",
  "EcoRegion",
  "FishingPressure",
  "StockSizeDescription",
  "SSB" ,
  "Recruitment",
  "DataCategory",
  "AssessmentYear",
  "StockSizeUnits",
  "area"
)
setnames(nea,old1, new1)
```

```
col_keep <- c(
  "Year",
  "stk",
  "EcoRegion",
  "indF",
  "area"
  )

nea <- nea[,..col_keep]
med <- med[,..col_keep]
combF <- rbind(nea,med)
combF <- combF[Year < 2019]
combF[,year := factor(Year - 2003)]



fit <- glmer(indF ~ year + (1|stk) , data =  combF, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa"))

#Run diagnostics
nd <- data.frame(year = sort(unique(combF$year)))
df <- as.data.frame(combF)
runDiagsME(fit, "stk", df, "diag_F_stk.pdf", nc, nd)

# Bootstrap
df0 <- combF
yrs <- sort(unique(combF$year))
stk <- unique(df0$stk)
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, stk==i))
  fit <- glmer(indF ~ year + (1|stk), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa"))
  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)
#ifitm <- exp(log(ifitm)-median(log(ifitm[,1]), na.rm=TRUE))
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)
```

```
ifitq_stk <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitq)))

#plot stuff
png("boot_F_unique_stk.png", 1800, 1200, res=300)
ggplot(ifitq_stk, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) +
  expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(F/F[msy])) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

# table
tb0 <- t(ifitq_stk)[-1,]
colnames(tb0) <- seq(iniYear, fnlYear, 1)
write.csv(tb0, file="./tab_singleFind_percs.csv")

load("./indF_comb.RData")

save.image("indF_comb.RData")
####################################
```

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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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