Scientific, Technical and Economic Committee for Fisheries (STECF) -
Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-18-01)

Edited by Ernesto Jardim, Paris Vasilakopoulos, Alessandro Mannini, Iago Mosqueira and John Casey
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Contact information
Name: STECF secretariat
Address: Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra VA, Italy
E-mail: stecf-secretariat@jrc.ec.europa.eu
Tel.: +39 0332 789343

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Abstract

Authors:

**STECF advice:**

**Ad hoc Expert group report:**
E. Jardim, P. Vasilakopoulos, A. Mannini, I. Mosqueira, J. Casey
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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

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

STECF observations

STECF notes that to address the above Terms of Reference a JRC Expert Group (EG) was convened to compile available assessment outputs and conduct the extensive analysis. The EG output was presented in a comprehensive report accompanied by several detailed annexes providing: 1) CFP monitoring protocols as agreed by STECF (STECF, 2017); 2a) R code for computing NE Atlantic indicators; 2b) R code for computing Mediterranean indicators and 3) ICES data quality issues corrected prior to the analysis. The report and Annexes are available at https://stecf.jrc.ec.europa.eu/plen18_01

STECF notes that the report is clear and well laid out, transparently describing the analysis undertaken, cataloguing changes made in approach since the previous report (2017) and including URL links to the various reports and stock advice sheets underpinning the analysis. STECF commends the effort employed in updating nomenclature following various changes to the ICES database and the careful attention paid to ensuring the correct figures were used.

The most significant changes in the 2018 approach were:

i) A revision of the Mediterranean sampling frame used for the analysis

ii) Where data were unavailable for the most recent year, the data from the previous year was rolled forward

iii) MSY\textsubscript{B\text{ trigger}} was used as a proxy for lower bound of B\text{MSY}

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

The EG report then sets out results of the analysis for the ICES area of the NE Atlantic and Mediterranean & Black Sea separately in Sections 3 and 4 (respectively). Based on these results STECF provides an overview of what is currently known regarding the achievement of the MSY objectives, drawing together the results from the different sea areas to provide a comparative picture. The overview focuses on a limited number of ‘core’ indicators earlier agreed by STECF (2017). The EG report contains results for a number of ‘experimental’ indicators which STECF notes are still at the development stage. It is expected that these will be further developed as part of another STECF EWG (EWG 18-15) to be held later in 2018 (see conclusions). In this report, “ICES Area” refers to all stocks in the FAO Area 27 in the Northeast Atlantic assessed by ICES, while the denomination “NE Atlantic stocks” refers more specifically to the stocks distributed widely, including outside EU Waters.
Trends towards the MSY objectives in the ICES area and Mediterranean & Black Seas

The overview below describes the trends observed in the ICES area and the Mediterranean for the periods 2003 to 2016 and 2003 to 2015 respectively and applies to the stocks included in the reference list of stocks for these areas. The stocks are primarily those with a full analytical assessment (ICES Category 1).

Stock status in the ICES area

The indicators provided by the JRC EG show that stocks status has significantly improved (Figure 1) but also that many stocks are still overexploited in the ICES area, and that the rate of progress has slowed in the last few years. In the ICES area, among the 65 to 71 stocks which are fully assessed, the proportion of overexploited stocks (i.e. F>F\textsubscript{MSY}, blue line) decreased from more than 70% to close to 40%, over the last ten years and seems to have stabilised in the last three years. The proportion of stocks outside the safe biological limits (F>F\textsubscript{pa} or B<B\textsubscript{pa}, orange line), computed for the 46 stocks for which both reference points are available, follows the same decreasing trend, from 65% in 2003 to around 30% in 2016.

![Figure 1. Trends in stocks status, 2003-2016. Three indicators are presented: Blue line: the proportion of overexploited stocks (F>F\textsubscript{MSY}) within the sampling frame (65 to 71 stocks fully assessed in the ICES area, depending on year); Orange line: the proportion of stocks outside safe biological limits (F>F\textsubscript{pa} or B<B\textsubscript{pa}) (46 stocks); Red line: F>F\textsubscript{MSY} or SSB<MSY\textsubscript{Btrigger}. It is important to note, however, that some stocks now managed according to F\textsubscript{MSY} may still be outside safe biological limits, or conversely some stocks inside safe biological limits may still be overfished. The red line illustrates changes in the proportion of stocks where F>F\textsubscript{MSY} or SSB<MSY\textsubscript{Btrigger}. Here the improvement in status has been slower with the indicator remaining above 75% of stocks until 2007 before declining. The decline then appears to have stopped in 2013 and began to slowly increase again to about 60% of stocks in 2016 where F>F\textsubscript{MSY} or SSB<MSY\textsubscript{Btrigger}. STECF notes that the number or proportion of stocks above/below B\textsubscript{MSY} is still unknown, because an estimate of B\textsubscript{MSY} is only provided by ICES for very few stocks. STECF observes that the recent slope of the indicators suggests that progress until 2016 has been too slow to allow all stocks to be maintained or restored to at least the precautionary B\textsubscript{pa}, and managed according to F\textsubscript{MSY} by 2020.](image-url)
Stock Status in the Mediterranean & Black Sea

In the Mediterranean & Black Sea, the variable number of stocks contributing information in the early part of the time series renders the calculation of a robust indicator difficult and potentially misleading. STECF suggests the possibility of investigating this in the future for a shorter time period (e.g. from 2008 to 2015 when the stock numbers appear to be more stable). For the present STECF has utilised the summary Table 5.1 in the EG report to compute the F status for 2015 (last year in Mediterranean stock assessments). Out of 47 stocks, only around 13% (6 stocks) are not overfished, the majority are overfished.

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

As agreed by STECF (2017) the Expert Group computed the trends in fishing pressure using a robust statistical model (Generalised Linear Mixed Effects Model, GLMM) accounting for the variability of trends across stocks and including the computation of a confidence interval around the median. A large confidence interval means that different stocks have different trends. Because this is a model-based indicator, and because the number of stocks is slightly different from last year, small differences in the resulting outcomes compared to last year’s report should not be over interpreted.

This indicator can be used for regional comparison between the ICES area and Mediterranean & Black Seas. In the ICES area, the model-based indicator of the fishing pressure ($F/F_{MSY}$) shows an overall downward trend over the period 2003-2015 (Figure 2). In the early 2000s, the median fishing mortality was more than 1.5 times larger than $F_{MSY}$, but this has reduced and has now stabilised around 1.0. Reaching $F_{MSY}$ for most stocks in the analysis would require the upper bound of the confidence interval in figure 3.1 in the EWG report to be around 1. STECF also notes that this indicator of fishing pressure has not decreased since 2011.

The same model-based indicator was computed by the EG for an additional set of 9 stocks located in the NE Atlantic, but outside EU waters. This indicator seems to confirm the positive overall trend observed in EU waters, with the median value of the $F/F_{MSY}$ indicator closely tracking that produced for EU waters. STECF notes that the indicator for NE Atlantic stocks outside EU waters is based on comparatively few stocks and thus should be considered with care.

![Figure 2. Trends in the fishing pressure. Three model based indicators $F/F_{MSY}$ are presented (all referring to the median value of the model): one for 48 EU stocks with appropriate information in the ICES area (red line); one for an additional set of 9 stocks also located in the NE Atlantic but outside EU waters (green line); one for an additional set of 9 stocks also located in the NE Atlantic but outside EU waters (black line).](image-url)
outside EU waters (green line), and one for the 47 assessed stocks from the Mediterranean and Black Sea region (black line).

In contrast, the indicator computed for stocks from the Mediterranean Sea and Black Sea has remained at a very high level during the whole 2003-2015 period, with no decreasing trend. The value of $F/F_{MSY}$ varies around 2.3 indicating that the stocks are being exploited on average at rates well above the $F_{MSY}$ CFP objective.

**Trends in Biomass**

The model-based indicator of the trend in biomass shows improvement in the ICES area, but not in the Mediterranean and Black Sea (Figure 3). In the ICES area the biomass has been generally increasing since 2006, and was in 2016 on average around 39% higher than in 2003. This represents a slight change from the reporting in 2016 reflecting the fact that the modelled trend incorporates new information. In the Mediterranean & Black Sea the uncertainty associated with this indicator (see Figure 4.4 in the EWG report) makes it difficult to conclude anything about trend and the situation is essentially unchanged since the start of the series in 2003.

An improving trend is also observed for data poor stocks (Figure 3.23 in the EWG report), according to the indicator computed by the EG for 61 ICES Category 3 stocks. However, in view of the fact that this indicator is still regarded as experimental, care in interpretation is required.

*Figure 3.* Trends in the indicators of stock biomass (median values of the model-based estimates relative to 2003). Two indicators are presented: one for the ICES area (54 stocks considered, blue line); one for the Mediterranean region (47 stocks, black line). The EG noticed that a large uncertainty is associated to these estimates, coming from the fact that the biomass estimates are quite variable from one year to the next.

**Trends per Ecoregion**

For the ICES area, the EG provides some information and figures broken down by Ecoregion. The main trends are summarised here.
The fishing pressure has decreased and the status of stocks has improved in all ICES Ecoregions. In 2016, the proportion of overexploited stocks ranged between to 29 - 50% across the different Ecoregions, while the modelled estimate of the $F/F_{MSY}$ ratio for 2016 was between 0.89 and 1.18.

Some variations between Ecoregions in modelled trends can be seen. According to the latest indicator trends presented in the EG report, the fishing pressure decreased consistently over the whole period and the stock status improved most markedly in the Celtic Sea. Here the fishing mortality was at a very high level at the beginning of the time series ($F/F_{MSY}$>1.9) and decreased significantly to below 1.0. In the remaining areas, marked declines are also evident in the first part of the time series but the rate of decline of the indicator falls around 2010 and the indicator tends to level out. In the Bay of Biscay and Iberian Ecoregion, and stocks present throughout the wider Northeast Atlantic the indicator has fluctuated in the most recent years.

**Coverage of the scientific advice**

**Coverage of biological stocks by the CFP monitoring**

As stated previously (STECF PLEN 16-03), the analyses of the progress in achieving MSY objectives in the ICES area should consider all stocks with advice provided by ICES, on the condition of being distributed in EU waters, at least partially. Based on the ICES database accessed for the analysis, ICES provides a scientific advice for 257 biological stocks included in EU waters (at least in part). Of these, 159 stocks are data-poor, without an estimate of MSY reference points (ICES category 3 and above). Details of the numbers of ICES assessments by Category and by area are shown in Table 1.

**Table 1.** Numbers of stocks assessed by ICES for different stock categories in different areas. Note that not all of these stocks are managed by TACs and so the numbers are higher than those used in the CFP monitoring analysis.

<table>
<thead>
<tr>
<th>ICES Stock Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic Ocean</td>
<td>10</td>
<td>1</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>Azores</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>8</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>B &amp; Biscay &amp; Iberia</td>
<td>11</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>Celtic Seas</td>
<td>30</td>
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<td>19</td>
<td>1</td>
<td>13</td>
<td>11</td>
<td>74</td>
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<tr>
<td>Faeroes</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Greater North Sea</td>
<td>19</td>
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<td>14</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>48</td>
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<tr>
<td>Greenland Sea</td>
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<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
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<td>Iceland Sea</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Northeast Atlantic</td>
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<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16</td>
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<td>3</td>
<td>87</td>
<td>8</td>
<td>33</td>
<td>31</td>
<td>257</td>
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The present CFP monitoring analysis is focused on stocks with a TAC and for which estimates of fishing mortality, biomass and biological reference points are available. As detailed in the EGs technical reports, not all indicators can be calculated for all stocks in all years, and the EG was able to compute indicators for 46 to 71 stocks of category 1 depending on indicators and years. 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.

STECF notes however that the EG computed some additional indicators of trends in abundance index for 61 data poor stocks of category 3. These indicators are still considered experimental by
the EG and are not presented in the current STECF overview. Once this indicator becomes part of the ‘core’ list, the total number of stocks included in the CFP analysis will be up to 50% of the stocks assessed by ICES (i.e., 71 Category 1-2 plus 61 Category 3). STECF notes also that MSY reference points are expected to be computed by ICES for an increasing number of data-poor stocks over the coming years, which will increase the coverage of the CFP monitoring.

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

Coverage of TAC regulation by scientific advice

According to the EG report, STECF notes that 156 TACs (combination of species and fishing management zones) were in place in 2016 in the EU waters of the NE Atlantic.

STECF underlines that in many cases, the boundaries of the TAC management areas are not aligned with the biological limits of stocks used in ICES assessments. The EG therefore computed an indicator of advice coverage, where a TAC is considered to be “covered” by a stock assessment when at least one of its divisions matched the spatial distribution of a stock for which reference points have been estimated from an ICES full assessment. Based on this indicator, 56% among the 156 TACs are covered, at least partially, by stock assessments that provide estimates of $F_{MSY}$ (or a proxy) and 43% by stock assessments that have $B_{pa}$ (or a proxy).

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

General principles for future analysis

Based on the latest process of analysis and overview, STECF advises that the CFP monitoring process should continue with the following principles:

- The three indicators of stock status are useful and should be regularly computed in the coming years (expressed in stock numbers in the detailed report and in proportion in the synthesis).
- As soon as a representative number of $B_{MSY}$ estimates become available from ICES assessments, the proportion (and number) of stocks below or above this reference point should become part of the ‘core’ indicator set, together with an indicator of trends in the $B/B_{MSY}$ ratio.
- Regarding trends in fishing mortality and biomass, all indicators should be computed in a consistent way. STECF considers that the model-based indicators should continue to be used as the standard method for every time series (including indicators per Ecoregion and indicators for NE Atlantic stocks outside EU waters). These model-based indicators are preferable to arithmetic mean estimates, which although easy to communicate, are generally sensitive to outliers.
- To maintain ease of visual comparison, indicators of biomass trends should continue to be rescaled to the value of the starting year.
• As far as possible, according to data availability, the same indicators should be computed in the ICES area and in the Mediterranean region.

Ongoing development

STECF notes that the EG Report again includes sections providing preliminary outputs from a number of experimental indicators. STECF considers that these require further development to fully understand their performance and stability before adoption as 'core' indicators. STECF draws attention to an STECF EWG planned for later in the year (STECF 18-15) which is dedicated to the development of CFP monitoring and suggests that further progress on the experimental indicators relating to fish stocks could be made. During this meeting STECF encourages exploration of indicators for other aggregations such as stock categories (eg pelagic fish versus demersal fish).

STECF conclusions

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

Regarding the progress made in the achievement of FMSY in line with the CFP, STECF notes that the latest results are generally in line with those reported in the 2017 CFP monitoring and confirm a reduction in the overall exploitation rate for the ICES area. On average the stock biomass is increasing and stock status is improving. Nevertheless, based on the set of assessed stocks included in the analyses, STECF notes that many stocks remain overfished and/or outside safe biological limits, and that progress achieved until 2016 seems too slow to ensure that all stocks will be rebuilt and managed according to FMSY by 2020.

STECF also concludes that stocks from the Mediterranean Sea and Black sea remain in a very poor situation, with no change apparent in terms of fishing pressure or stock biomass.

STECF concludes that further progress has been made on the development of additional indicators relating to fish stocks which would benefit from some additional testing before being adopted as core indicators. STECF also recognises the need to broaden the scope of the CFP monitoring to cover additional aspects not so far dealt with. In particular, there is a need to develop the CFP monitoring process to cover wider ecosystem and socio-economic aspects in the analysis. STECF notes that the scheduled STECF EWG on CFP monitoring later in the year (STECF 18-15) will provide an opportunity to progress these requirements.

Contact details of STECF members

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Tel.</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abella, J. Alvaro</td>
<td>Independent consultant</td>
<td>0039-3384989821</td>
<td><a href="mailto:aabellafisheries@gmail.com">aabellafisheries@gmail.com</a></td>
</tr>
<tr>
<td>Andersen, Jesper Levring</td>
<td>Department of Food and Resource Economics (IFRO)</td>
<td>Tel.dir.: +45 35 33 68 92</td>
<td><a href="mailto:jla@ifro.ku.dk">jla@ifro.ku.dk</a></td>
</tr>
<tr>
<td>Arrizabalaga, Haritz</td>
<td>AZTI / Unidad de Investigación Marina, Herrera</td>
<td>Tel.: +34667174477</td>
<td><a href="mailto:harri@azti.es">harri@azti.es</a></td>
</tr>
<tr>
<td>Bailey, Nicholas</td>
<td>Independent consultant</td>
<td></td>
<td><a href="mailto:nickbailey2013@btinternet.com">nickbailey2013@btinternet.com</a></td>
</tr>
<tr>
<td>Bertignac, Michel</td>
<td>Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France</td>
<td>tel : +33 (0)2 98 22 45 25 - fax : +33 (0)2 98 22 46 53</td>
<td><a href="mailto:michel.bertignac@ifremer.fr">michel.bertignac@ifremer.fr</a></td>
</tr>
<tr>
<td>Borges, Lisa</td>
<td>FishFix, Brussels, Belgium</td>
<td></td>
<td><a href="mailto:info@fishfix.eu">info@fishfix.eu</a></td>
</tr>
<tr>
<td>Cardinale, Massimilian</td>
<td>Föreningsgatan 45, 330 Lysekil, Sweden</td>
<td>Tel: +46 523 18750</td>
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<td>Catchpole, Thomas</td>
<td>CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT</td>
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<td><a href="mailto:thomas.catchpole@cefas.co.uk">thomas.catchpole@cefas.co.uk</a></td>
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<td>Curtis, Hazel</td>
<td>Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K.</td>
<td>Tel: +44 (0)131 524 8664 Fax: +44 (0)131 558 1442</td>
<td><a href="mailto:Hazel.curtis@seafish.co.uk">Hazel.curtis@seafish.co.uk</a></td>
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<tr>
<td>Daskalov, Georgi</td>
<td>Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences</td>
<td>Tel.: +359 52 646892</td>
<td><a href="mailto:Georgi.daskalov@gmail.com">Georgi.daskalov@gmail.com</a></td>
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<td>Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany</td>
<td>Tel.: 040 38905-185</td>
<td><a href="mailto:ralf.doering@thuenen.de">ralf.doering@thuenen.de</a></td>
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<td>Gascuel, Didier</td>
<td>AGROCAMPUS OUEST 65 Route de Saint Brieuc, CS 84215, F-35042 RENNES Cedex France</td>
<td>Tel:+33(0)2.23.48.55.34</td>
<td><a href="mailto:Didier.Gascuel@agrocampus-ouest.fr">Didier.Gascuel@agrocampus-ouest.fr</a></td>
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<td>Knittweis, Leyla</td>
<td>Department of Biology University of Malta Msida, MSD 2080 Malta</td>
<td>Tel:</td>
<td><a href="mailto:Leyla.knittweis@um.edu.mt">Leyla.knittweis@um.edu.mt</a></td>
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<tr>
<td>Malvarosa, Loretta</td>
<td>NISEA, Fishery and Aquaculture Research, Via Irno, 11, 84135 Salerno, Italy</td>
<td>+39 089795775</td>
<td><a href="mailto:malvarosa@nisea.eu">malvarosa@nisea.eu</a></td>
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<tr>
<td>Martin, Paloma</td>
<td>CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49 08003 Barcelona Spain</td>
<td>Tel: 4.93.2309500</td>
<td><a href="mailto:paloma@icm.csic.es">paloma@icm.csic.es</a></td>
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<td>Motova, Arina</td>
<td>Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K</td>
<td>Tel: +44 131 524 8662</td>
<td><a href="mailto:arina.motova@seafish.co.uk">arina.motova@seafish.co.uk</a></td>
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<td>Murua, Hilario</td>
<td>AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain</td>
<td>Tel: 0034 667174433</td>
<td><a href="mailto:hmmurua@azti.es">hmmurua@azti.es</a></td>
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<td>Nord, Jenny</td>
<td>The Swedish Agency of Marine and Water Management (SwAM)</td>
<td>Tel. 0046 76 140 140 3</td>
<td><a href="mailto:Jenny.nord@havochvatten.se">Jenny.nord@havochvatten.se</a></td>
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<td>Tel: +34 667174368</td>
<td><a href="mailto:rprellezo@azti.es">rprellezo@azti.es</a></td>
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<td>Raid, Tiit</td>
<td>Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia</td>
<td>Tel.: +372 58339340</td>
<td><a href="mailto:Tiit.raid@gmail.com">Tiit.raid@gmail.com</a></td>
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<td>Sabatella, Evelina Carmen</td>
<td>NISEA, Fishery and Aquaculture Research, Via Irno, 11, 84135 Salerno, Italy</td>
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<td>Italian National Research Council (CNR), Institute of Marine Sciences (ISMAR), Largo Fiera della Pesca, 1 60125 Ancona - Italy</td>
<td>Tel: +39 071 2078841 Fax: +39 071 55313 Mob.: +39 3283070446</td>
<td><a href="mailto:a.sala@ismar.cnr.it">a.sala@ismar.cnr.it</a></td>
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<td>Scarchella, Giuseppe</td>
<td>1) Italian National Research Council (CNR), Institute of Marine Sciences (ISMAR) - Fisheries Section, Largo Fiera della Pesca, 1 60125 Ancona - Italy 2) AP Marine Environmental Consultancy Ltd, 2, ACROPOLEOS ST. AGLANIIA, P.O.BOX 26728 1647 Nicosia, Cyprus</td>
<td>Tel: +39 071 2078846 Fax: +39 071 55313 Tel.: +357 99664694</td>
<td><a href="mailto:g.berlinda@marpol.it">g.berlinda@marpol.it</a> <a href="mailto:gscarcella@apmarine.com.cy">gscarcella@apmarine.com.cy</a></td>
</tr>
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<td>Soldo, Alen</td>
<td>Department of Marine Studies, University of Split, Livanska 5, 21000 Split, Croatia</td>
<td>Tel.: +385914433906</td>
<td><a href="mailto:soldo@unist.hr">soldo@unist.hr</a></td>
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<td>Institute of Marine Biological Resources and Inland Waters (IMBRiW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gouves, P.O. Box 2214, Heraklion 71003, Crete, Greece</td>
<td>Tel.: +30 2810 337832 Fax: +30 6936566764</td>
<td><a href="mailto:somarak@hcmr.gr">somarak@hcmr.gr</a></td>
</tr>
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<td>Stransky, Christoph</td>
<td>Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany</td>
<td>Tel. +49 40 38905-228 Fax: +49 40 38905-263</td>
<td><a href="mailto:christoph.stransky@thuenen.de">christoph.stransky@thuenen.de</a></td>
</tr>
<tr>
<td>Ulrich, Clara (chair)</td>
<td>Technical University of Denmark, National Institute of Aquatic Resources, (DTU Aqua), Charlottenlund Slot, JægersborgAllé 1, 2920 Charlottenlund, Denmark</td>
<td></td>
<td><a href="mailto:clu@aqua.dtu.dk">clu@aqua.dtu.dk</a></td>
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<td>van Hoof, Luc</td>
<td>IMARES, Haringkade 1, IJmuiden, The Netherlands</td>
<td>Tel.: +31 61061991</td>
<td><a href="mailto:Luc.vanhoof@wur.nl">Luc.vanhoof@wur.nl</a></td>
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<td>Vanhee, Willy</td>
<td>Independent consultant</td>
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<td><a href="mailto:wvanhee@telenet.be">wvanhee@telenet.be</a></td>
</tr>
<tr>
<td>Vrgoc, Nedo</td>
<td>Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia</td>
<td>Tel.: +385 21408002</td>
<td><a href="mailto:vrgoc@izor.hr">vrgoc@izor.hr</a></td>
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REPORT TO THE STECF

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

Ispra, Italy, March-April 2018

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 2017 (Annex I).

An ad hoc Expert Group comprising Experts from the European Commission’s Joint Research Centre (JRC) was convened during March and April 2018 to compute the performance indicator values according to the agreed protocol (Annex I) and to report to the STECF plenary meeting scheduled for 09-13 April 2018.

1.1 Terms of Reference to the ad hoc Expert group

The Expert group is requested to report on progress in achieving MSY objectives in line with CFP.
2 DATA AND METHODS

2.1 Data sources

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

2.1.1 Stock assessment information

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

For the NE Atlantic (FAO area 27), the information was downloaded from the ICES website (http://standardgraphs.ices.dk) on the 19th March 2018, comprising the most recent published assessments, carried out up to and including 2017. 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 (Annex III).

Table 6.1 shows the URLs for the report or advice summary sheet for each stock.

2.1.2 Management units information

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

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 (2017a). 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 ($0.5 \times B_{MSY}$). Consequently, such stocks cannot be used to compute the indicators relating to safe biological limits (SBL).
- 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, but it has the disadvantage of excluding data that could improve model fit.
- 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-27.3a.4), $MSY_{B_{escapement}}$ 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: $C_{y+1}=C_{y}P[SSB<B_{lim}]=0.05$. For this stock, the lower (0.025%) boundary of the SSB confidence interval was compared to $B_{lim}$. 

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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 $MSY_{B\text{escapement}}$.

ICES is in the process of shifting $MSY_{B\text{trigger}}$ settings to levels which increase the probability of keeping $F$ at $F_{MSY}$, making it a good proxy for $B_{MSY}$. Nevertheless, there are still 40 out of 69 stocks relevant for this exercise, with $MSY_{B\text{trigger}}$ set at $B_{PA}$.

The GLMM fit within the bootstrap procedure does not converge for all resamples, up to 20% of the fits fail, with the exception of the trend in SSB or biomass index for stocks of data category 1-3 (relative to 2003) which had 223 over 500 resamples failing. Failed resamples were excluded when computing model-based indicators.

The 2017 ICES update of eco regions’ definition removed the category ‘widely distributed’ stocks. For compatibility with previous versions of this report, the stocks previously included in the category ‘widely distributed’ were kept, and renamed ‘Northeast Atlantic’.

### 2.4 Differences from the 2017 CFP monitoring report (STECF 17-04)

#### 2.4.1 Northeast Atlantic

- Stocks with less than five years of data were not included in the analysis.
- The CFP requirements indicator was updated, replacing $B_{PA}$ by $MSY_{B\text{trigger}}$, making it more in line with the CFP regulation and renamed to avoid misleading the readers, to ‘Stocks with $F$ above/below $F_{MSY}$ or SSB below/above $MSY_{B\text{trigger}}’.
- Stocks without stock assessment estimates for 2015 and/or 2016 were assigned values equivalent to 2014 and/or 2015 estimates respectively.
- The Northern shrimp stock (pra.27.1-2) was removed from the computation of the indicator $F/F_{MSY}$ outside the EU coastal waters, because the indicator values were heavily influenced by the outlier behaviour of this stock (STECF, 2017a).

#### 2.4.2 Mediterranean and Black Sea

- A new reference list of stocks was adopted in accordance with the revised protocol adopted by STECF (2017a). The previous reference list (Mannini et al., 2017) was complemented with stock assessment results for selected additional species established by the STECF (2017a).
- Stocks with less than five years of data were not included in the analysis.
- Stocks without stock assessment estimates for 2015 and/or 2016 were assigned values equivalent to 2014 and/or 2015 estimates respectively.

Because of the changes in data and protocol, the annual indicator values and associate time-series trends for the Mediterranean and Black seas presented in the current report, cannot be directly compared to those presented in previous CFP monitoring reports.
3 Northeast Atlantic and adjacent Seas (FAO region 27)

3.1 Number of stock assessments to compute CFP performance indicators

The number of stock assessments with estimates of $F/F_{\text{MSY}}$ for the years 2003-2016 for FAO Region 27 are given in Figure 3.1 and by ecoregion in Table 3.1.

The time-series of data available for each year and stock (data categories 1 and 2) is shown in Figure 3.2. For stocks without estimates in 2016 the estimates of $F$ and SSB were assumed to be the same as 2015. Consequently, the number of stocks included to compute the indicator values for 2016 was 71.

The stocks, including data category 3, used to compute each indicator are shown in Table 3.2.

Figure 3.1 Number of stocks in the ICES area for which estimates of $F/F_{\text{MSY}}$ are available by year.

Figure 3.2 Time-series of available data, per stock and per year, for each data category (1 and 2).

Table 3.1 Number of stocks in the ICES area for which estimates of $F/F_{\text{MSY}}$ are available by ecoregion and year

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Figure 3.2 Time series of stock assessment results in the ICES area for which estimates of $F/F_{MSY}$ are available by year. Blank records indicate no estimate available for stock and year.
Compared to the dataset used for the 2017 analyses (STECF, 2017b), the analyses presented in this report include the results from assessments for the following additional stocks of categories 01 and 02:

- had-iris (had.27.7a), ple-iris (ple.27.7a), whg-iris (whg.27.7a) and san-ns4 (san.sa.4), which were upgraded from category 03 in 2016 to category 01 in 2017.
- her.27.30.31 which appeared in 2017 for the first time, as a result of merging stocks her-30 and her-31.

Meanwhile, there were some stocks included in the 2017 analyses (STECF 2017b) which were excluded from the present analyses:

- her-30 which has now been merged with her-31 into her.27.30.31.
- nep-2021 (nep.fu.2021) and nep-2324 (nep.fu.2324) due to having less than five years of data available.

ICES revised the eco-region classification of the stocks. For consistency with the 2017 report (STECF, 2017b), the widely distributed stocks were kept the same as last year and the stocks of had.27.46a20, pok.27.3a46 and sol.27.7e were kept in the Greater North Sea eco-region.

In total, 71 stocks of categories 01 and 02 were included in the present analysis.
Table 3.2 Indicators computed for each stocks.

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3.2 Indicators of management performance

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

Figure 3.3 Number of stocks by year for which fishing mortality ($F$) exceeded $F_{MSY}$.

Figure 3.4 Number of stocks by year and ecoregion for which fishing mortality ($F$) exceeded $F_{MSY}$.

Table 3.3 Number of stocks by year and ecoregion for which fishing mortality ($F$) exceeded $F_{MSY}$.

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3.2.2 Number of stocks by year for which fishing mortality was equal to, or less than $F_{\text{MSY}}$

Figure 3.5 Number of stocks by year for which fishing mortality (F) did not exceed $F_{\text{MSY}}$.

Figure 3.6 Number of stocks by year and ecoregion for which fishing mortality (F) did not exceed $F_{\text{MSY}}$.

Table 3.4 Number of stocks by year and ecoregion for which fishing mortality (F) did not exceed $F_{\text{MSY}}$.

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3.2.3 Number of stocks outside safe biological limits

Figure 3.7 Number of stocks outside safe biological limits by year.

Figure 3.8 Number of stocks outside safe biological limits by ecoregion and year.

Table 3.5 Number of stocks outside safe biological limits by ecoregion and year.

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</table>
3.2.4 **Number of stocks inside safe biological limits**

![Figure 3.9 Number of stocks inside safe biological limits by year.](image)

![Figure 3.10 Number of stocks inside safe biological limits by ecoregion and year.](image)

**Table 3.6 Number of stocks inside safe biological limits by ecoregion and year.**

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</table>
3.2.5 Trend in $F/F_{MSY}$

Indicators of trends 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.

Trends in $F/F_{MSY}$ by ecoregion and year are given in Figure 3.11 and the associated percentiles are given in Table 3.7. Figure 3.11 shows the indicator value in 2016 close to 1, which means that over all stocks, on average, the exploitation levels are close to $F_{MSY}$. Nevertheless, there are still about 40% of the stocks which are being exploited above $F_{MSY}$ (see sections 3.2.1 and 3.2.2).

![Figure 3.11 Trend in F/FMSY. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.](image)

**Table 3.7 Percentiles for F/FMSY by year.**

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<td>1.32</td>
<td>1.28</td>
<td>1.17</td>
<td>1.06</td>
<td>1.00</td>
<td>0.90</td>
<td>0.89</td>
<td>0.82</td>
<td>0.89</td>
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<td>1.53</td>
<td>1.48</td>
<td>1.45</td>
<td>1.42</td>
<td>1.27</td>
<td>1.17</td>
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<td>1.00</td>
<td>0.99</td>
<td>0.92</td>
<td>1.02</td>
<td>0.98</td>
<td>0.93</td>
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<tr>
<td>50%</td>
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<td>1.61</td>
<td>1.55</td>
<td>1.52</td>
<td>1.48</td>
<td>1.34</td>
<td>1.23</td>
<td>1.17</td>
<td>1.05</td>
<td>1.04</td>
<td>0.97</td>
<td>1.07</td>
<td>1.03</td>
<td>0.98</td>
</tr>
<tr>
<td>75%</td>
<td>1.71</td>
<td>1.69</td>
<td>1.63</td>
<td>1.58</td>
<td>1.55</td>
<td>1.41</td>
<td>1.30</td>
<td>1.23</td>
<td>1.10</td>
<td>1.09</td>
<td>1.01</td>
<td>1.13</td>
<td>1.08</td>
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<tr>
<td>97.5%</td>
<td>1.87</td>
<td>1.85</td>
<td>1.77</td>
<td>1.70</td>
<td>1.68</td>
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</table>
Trends in $F/F_{MSY}$ by ecoregion are given in Figure 3.13 and Table 3.8. The regional analysis was carried out using the same model applied to regional datasets. Due to the small number of stocks in each ecoregion it was not possible to compute confidence intervals.

Figure 3.12 Trend in $F/F_{MSY}$ by ecoregion.

Table 3.8. Trend in $F/F_{MSY}$ by ecoregion and year

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<td>1.05</td>
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<td>1.21</td>
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<td>1.52</td>
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<td>1.10</td>
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<td>0.97</td>
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3.2.6 Trend in SSB (relative to 2003)

Indicators of trends 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.

Figure 3.13 and Table 3.9 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.

![Graph showing trend in SSB relative to 2003. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.]

Figure 3.13 Trend in SSB relative to 2003. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 3.9 Percentiles for SSB by year relative to 2003.

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<th>50%</th>
<th>75%</th>
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</table>
Trends in SSB by ecoregion and year are given in Figure 3.14 and Table 3.10. The regional analysis was carried out using the same model applied to regional datasets. Due to the small number of stocks in each ecoregion it wasn’t possible to compute confidence intervals.

![Figure 3.14 Trend in SSB by ecoregion relative to 2003.](image)

Table 3.10 SSB relative to 2003 by ecoregion.

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3.3 Experimental indicators

STECF (2017a) required a list of experimental indicators to be computed, similar to the 2017 exercise (STECF, 2017b). The estimates obtained for these indicators are not stable and should be considered with care.
3.3.1 Number of stocks with $F$ above $F_{msy}$ or SSB below MSYB_trigger

Figure 3.15 Number of stocks with $F$ above $F_{msy}$ or SSB below MSYB_trigger, by year.

Figure 3.16 Number of stocks with $F$ above $F_{msy}$ or SSB below MSYB_trigger, by ecoregion and year.

Table 3.11 Number of stocks with $F$ above $F_{msy}$ or SSB below MSYB_trigger by ecoregion and year.

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3.3.2 Number of stocks with $F$ below or equal to $F_{\text{msy}}$ and SSB above or equal to $\text{MSYB}_{\text{trigger}}$.

Figure 3.17 Number of stocks with $F$ below or equal to $F_{\text{msy}}$ and SSB above or equal to $\text{MSYB}_{\text{trigger}}$.

Figure 3.18 Number of stocks with $F$ below or equal to $F_{\text{msy}}$ and SSB above or equal to $\text{MSYB}_{\text{trigger}}$ by ecoregion and year.

Table 3.12 Number of stocks with $F$ below or equal to $F_{\text{msy}}$ and SSB above or equal to $\text{MSYB}_{\text{trigger}}$ by ecoregion and year.

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</table>
3.3.3 Trend in $F/F_{MSY}$ for stocks outside the EU coastal waters

Indicators of trends 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.

This indicator was based on 9 stocks. The Northern shrimp stock (pra.27.1-2) was removed from the computation of the indicator $F/F_{MSY}$ outside the EU coastal waters, because the indicator values were heavily influenced by the outlier behaviour of this stock (STECF, 2017a).

Figure 3.19 Trend in $F/F_{MSY}$ for stocks outside the EU coastal waters. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 3.13 Percentiles for $F/F_{MSY}$ for stocks outside the EU coastal waters by year.

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<td>1.14</td>
<td>1.05</td>
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<td>0.98</td>
<td>0.94</td>
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<td>0.98</td>
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<tr>
<td>50%</td>
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<td>1.52</td>
<td>1.62</td>
<td>1.47</td>
<td>1.41</td>
<td>1.40</td>
<td>1.19</td>
<td>1.25</td>
<td>1.15</td>
<td>1.17</td>
<td>1.06</td>
<td>1.03</td>
<td>1.07</td>
<td>1.06</td>
</tr>
<tr>
<td>75%</td>
<td>1.67</td>
<td>1.66</td>
<td>1.73</td>
<td>1.58</td>
<td>1.50</td>
<td>1.49</td>
<td>1.32</td>
<td>1.40</td>
<td>1.26</td>
<td>1.27</td>
<td>1.15</td>
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<td>1.17</td>
<td>1.14</td>
</tr>
<tr>
<td>97.5%</td>
<td>1.89</td>
<td>1.98</td>
<td>2.02</td>
<td>1.87</td>
<td>1.72</td>
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<td>1.37</td>
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3.3.4 Trend in SSB/B_{pa}

Indicators of trends 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 last between the 2.5% and 97.5% percentiles.

![Figure 3.20 Trend in SSB/Bpa. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.](image)

Table 3.14 Percentiles for SSB/Bpa by year.

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<td>0.98</td>
<td>0.95</td>
<td>0.92</td>
<td>0.96</td>
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<td>0.88</td>
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<td>0.81</td>
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<td>0.89</td>
<td>0.95</td>
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<tr>
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<td>0.94</td>
<td>0.90</td>
<td>0.87</td>
<td>0.87</td>
<td>0.93</td>
<td>0.95</td>
<td>1.02</td>
<td>1.20</td>
<td>1.15</td>
<td>1.12</td>
<td>1.17</td>
<td>1.27</td>
<td>1.40</td>
</tr>
<tr>
<td>75%</td>
<td>1.07</td>
<td>1.00</td>
<td>0.96</td>
<td>0.92</td>
<td>0.92</td>
<td>0.99</td>
<td>1.01</td>
<td>1.08</td>
<td>1.30</td>
<td>1.22</td>
<td>1.19</td>
<td>1.25</td>
<td>1.36</td>
<td>1.51</td>
</tr>
<tr>
<td>97.5%</td>
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<td>1.10</td>
<td>1.09</td>
<td>1.05</td>
<td>1.05</td>
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<td>1.43</td>
<td>1.54</td>
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3.3.5 Trend in recruitment (relative to 2003)

Indicators of trends 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.

![Graph showing trend in recruitment relative to 2003](image)

**Figure 3.21 Trend in R/R2003.** Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

**Table 3.15 Percentiles for R/R2003 by year.**

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<td>25%</td>
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<td>0.75</td>
<td>0.76</td>
<td>0.83</td>
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<td>0.70</td>
<td>0.99</td>
<td>0.80</td>
<td>0.76</td>
<td>0.73</td>
<td>0.82</td>
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<tr>
<td>50%</td>
<td>1.00</td>
<td>0.94</td>
<td>0.96</td>
<td>1.06</td>
<td>0.90</td>
<td>0.89</td>
<td>1.30</td>
<td>1.01</td>
<td>0.96</td>
<td>0.94</td>
<td>1.06</td>
<td>1.27</td>
<td>1.11</td>
<td>1.26</td>
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<tr>
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<td>1.19</td>
<td>1.23</td>
<td>1.32</td>
<td>1.12</td>
<td>1.12</td>
<td>1.71</td>
<td>1.25</td>
<td>1.20</td>
<td>1.22</td>
<td>1.34</td>
<td>1.62</td>
<td>1.41</td>
<td>1.64</td>
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<tr>
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<td>1.88</td>
<td>1.98</td>
<td>1.69</td>
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<td>1.80</td>
<td>2.00</td>
<td>2.66</td>
<td>2.12</td>
<td>2.67</td>
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</table>
3.3.6  **Trend in SSB or biomass index for stocks of data category 1-3 (relative to 2003)**

Indicators of trends 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.

Note that the bootstrap procedure failed in 223 over 500 iterations, which is a sign of the poor fit of the model to the dataset. It also explains the value of 0.96 in 2003 (Table 3.16), which derives from the skewed distribution obtained for this indicator.

![Figure 3.22 Trend in SSB relative to 2003 for category 1-3 stocks. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.](image)

**Table 3.16** Percentiles for SSB relative to 2003 by year for category 1-3 stocks.

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<tr>
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<td>0.73</td>
<td>0.72</td>
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<td>0.82</td>
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<td>0.83</td>
<td>0.91</td>
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<td>0.94</td>
<td>0.99</td>
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<td>0.93</td>
<td>0.91</td>
<td>0.95</td>
<td>0.99</td>
<td>1.03</td>
<td>1.01</td>
<td>1.08</td>
<td>1.19</td>
<td>1.25</td>
<td>1.22</td>
<td>1.28</td>
<td>1.48</td>
<td>1.54</td>
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<tr>
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<td>1.23</td>
<td>1.23</td>
<td>1.26</td>
<td>1.29</td>
<td>1.37</td>
<td>1.34</td>
<td>1.43</td>
<td>1.60</td>
<td>1.65</td>
<td>1.61</td>
<td>1.69</td>
<td>1.93</td>
<td>2.06</td>
</tr>
<tr>
<td>97.5%</td>
<td>2.12</td>
<td>2.00</td>
<td>1.95</td>
<td>1.96</td>
<td>2.01</td>
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<td>2.47</td>
<td>2.72</td>
<td>3.06</td>
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</table>
3.3.7 Trend in SSB or biomass index for stocks of data category 3 (relative to 2003)

Indicators of trends 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.

Figure 3.23 Trend in SSB relative to 2003 for category 3 stocks. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 3.17 Percentiles for SSB relative to 2003 by year for category 3 stocks.

<table>
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<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>97.5%</th>
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<td>0.82</td>
<td>1.01</td>
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<td>0.84</td>
<td>1.02</td>
<td>1.19</td>
<td>1.74</td>
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<tr>
<td>2005</td>
<td>0.63</td>
<td>0.84</td>
<td>1.03</td>
<td>1.18</td>
<td>1.74</td>
</tr>
<tr>
<td>2006</td>
<td>0.66</td>
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<td>1.10</td>
<td>1.29</td>
<td>1.92</td>
</tr>
<tr>
<td>2007</td>
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<td>1.18</td>
<td>1.37</td>
<td>2.03</td>
</tr>
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<td>2008</td>
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<td>1.04</td>
<td>1.27</td>
<td>1.50</td>
<td>2.13</td>
</tr>
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<td>2009</td>
<td>0.71</td>
<td>0.99</td>
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<td>1.40</td>
<td>2.01</td>
</tr>
<tr>
<td>2010</td>
<td>0.67</td>
<td>1.04</td>
<td>1.25</td>
<td>1.47</td>
<td>2.09</td>
</tr>
<tr>
<td>2011</td>
<td>0.71</td>
<td>1.09</td>
<td>1.29</td>
<td>1.52</td>
<td>2.18</td>
</tr>
<tr>
<td>2012</td>
<td>0.90</td>
<td>1.24</td>
<td>1.47</td>
<td>1.74</td>
<td>2.57</td>
</tr>
<tr>
<td>2013</td>
<td>0.89</td>
<td>1.23</td>
<td>1.47</td>
<td>1.72</td>
<td>2.52</td>
</tr>
<tr>
<td>2014</td>
<td>0.93</td>
<td>1.29</td>
<td>1.55</td>
<td>1.82</td>
<td>2.64</td>
</tr>
<tr>
<td>2015</td>
<td>1.08</td>
<td>1.29</td>
<td>1.55</td>
<td>1.82</td>
<td>3.12</td>
</tr>
<tr>
<td>2016</td>
<td>1.11</td>
<td>1.53</td>
<td>1.85</td>
<td>2.21</td>
<td>3.22</td>
</tr>
</tbody>
</table>
3.4 Indicators of advice coverage

The indicator of advice coverage computes the number of stocks for which the reference points, $F_{\text{MSY}}$, $F_{\text{PA}}$, $MSY_{\text{trigger}}$ and $B_{\text{PA}}$ are available and the number of associated TACs. 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 3.18 Coverage of TACs by scientific advice (ICES categories 1+2).

<table>
<thead>
<tr>
<th></th>
<th>No of stocks</th>
<th>No of TACs</th>
<th>No of TACs based on stock assessments</th>
<th>Fraction of TACs based on stock assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{\text{MSY}}$</td>
<td>71</td>
<td>156</td>
<td>87</td>
<td>0.56</td>
</tr>
<tr>
<td>$MSY_{\text{trigger}}$</td>
<td>69</td>
<td>156</td>
<td>86</td>
<td>0.55</td>
</tr>
<tr>
<td>$F_{\text{PA}}$</td>
<td>46</td>
<td>156</td>
<td>72</td>
<td>0.46</td>
</tr>
<tr>
<td>$B_{\text{PA}}$</td>
<td>55</td>
<td>156</td>
<td>79</td>
<td>0.51</td>
</tr>
</tbody>
</table>
There was a strong increasing trend in the number of stocks assessed for years 2003-2009, from 22 up to 47; the number of stock assessments kept stable until 2014 and decreased to 39 in 2015 and 21 in 2016 (Figure 4.1 and Figure 4.2).

This situation renders the interpretation of the deterministic indicators misleading. With such differences in the number of stocks assessed each year, the trends in the indicators are confounded with the number of stocks available for their computation. Consequently, only the model-based indicators are shown.

Nevertheless, the indicator values presented (Figure 4.3 and Figure 4.4) 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 4.1 indicates by year, the number of stocks in the Mediterranean and Black Seas for which estimates of \( F/F_{MSY} \) are available. The major reduction in 2016 is due to:

- the STECF EWG part I carried out analytical assessments for only 8 out of 11 stocks (STECF 2017c).
- the STECF EWG part II carried out analytical assessment for 5 out of 19 stocks (STECF, 2018).
- GFCM assessments performed in 2017 in WGSASP and WGSADM have not yet been reviewed and approved by the GFCM Scientific Advisory Committee. Consequently, they were not included in the present analysis.

Table 4.1 shows the stocks added to the current exercise.

Since there are no results for 2016 for any of the GFCM stock assessments and the indicator values for 2016 are based on the results of only 21 stock assessments, such values are not comparable with those for earlier years of the time-series. Hence in Figure 4.1, the 2016 value is represented as stand-alone, and the indicators are plotted up to 2015 only.

![Figure 4.1 Number of stock assessments in the Mediterranean and Black Sea by year. The totals include stocks in the following GSAs only: 1, 5-7, 9, 10-19, 22-23, 25 and 29.](image)
Figure 4.2 Time-series of stock assessments available from both STECF and GFCM for computation of model based CFP monitoring indicators for Mediterranean and Black Seas. The red line indicates that only stock assessment results up to and including 2015 have been used to compute the indicator values.
### Table 4.1 Stocks added to the current exercise with relation to previous report.

<table>
<thead>
<tr>
<th>EcoRegion</th>
<th>Year</th>
<th>Stock</th>
<th>Description</th>
<th>Updated</th>
<th>New</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black sea</td>
<td>2014</td>
<td>ane_29</td>
<td>European anchovy in GSA 29</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2014</td>
<td>dgs_29</td>
<td>Picked dogfish in GSA 29</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2014</td>
<td>hmm_29</td>
<td>Mediterranean horse mackerel in GSA 29</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2016</td>
<td>rpw_29</td>
<td>Rapana whelk in GSA 29</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2014</td>
<td>tur_29</td>
<td>Turbot in GSA 29</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2014</td>
<td>spr_29</td>
<td>Sprattus sprattus in GSA 29</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Black sea</td>
<td>2016</td>
<td>whg_29</td>
<td>Whiting in GSA 29</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2015</td>
<td>ane_17_18</td>
<td>European anchovy in GSA 17, 18</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2015</td>
<td>nep_17_18</td>
<td>Nephrops in GSA 17, 18</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2015</td>
<td>pil_17_18</td>
<td>European pilchard(=Sardine) in GSA 17, 18</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>ars_18_19</td>
<td>Giant red shrimp in GSA 18, 19</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>dps_17_18</td>
<td>Deep-water rose shrimp in GSA 17, 18</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>hke_17_18</td>
<td>European hake in GSA 17, 18</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>hke_19</td>
<td>European hake in GSA 19</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>mts_17_18</td>
<td>Spottail mantis squillid in GSA 17, 18</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>mut_17_18</td>
<td>Red mullet in GSA 17, 18</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>sol_17</td>
<td>Common sole in GSA 17</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2015</td>
<td>mut_15_16</td>
<td>Red mullet in GSA 15,16</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2016</td>
<td>mut_19</td>
<td>Red mullet in GSA 19</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>hke_12_13_14_15_16</td>
<td>Merluccius merlucius in GSA 12, 13, 14, 15, 16</td>
<td>2015</td>
<td>N</td>
<td>GFCM</td>
</tr>
<tr>
<td>Central Med.</td>
<td>2014</td>
<td>dps_12_13_14_15_16</td>
<td>Parapenaeus longirostris in GSA 12, 13, 14, 15, 16</td>
<td>2015</td>
<td>N</td>
<td>GFCM</td>
</tr>
<tr>
<td>Eastern Med.</td>
<td>2016</td>
<td>ane_22_23</td>
<td>European anchovy in GSA 22, 23</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Eastern Med.</td>
<td>2016</td>
<td>pil_22_23</td>
<td>European pilchard(=Sardine) in GSA 22, 23</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2016</td>
<td>ane_09_10_11</td>
<td>European anchovy in GSA 09, 10, 11</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>ane_6</td>
<td>Anchovy in GSA 6</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>dps_1</td>
<td>Deep-water rose shrimp in GSA 1</td>
<td>2015</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>mut_7</td>
<td>Red mullet in GSA 7</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>dps_09_10_11</td>
<td>Deep-water rose shrimp in GSA 09, 10, 11</td>
<td>2015</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>mur_9</td>
<td>Surmullet in GSA 9</td>
<td>2015</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>ara_9</td>
<td>Blue and red shrimp in GSA 9</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
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<td>Giant red shrimp in GSA 9</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>nep_9</td>
<td>Norway lobster in GSA 9</td>
<td>2015</td>
<td>N</td>
<td>STECF</td>
</tr>
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<td>Western Med.</td>
<td>2015</td>
<td>nep_6</td>
<td>Norway lobster in GSA 6</td>
<td>2015</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
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<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
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<td>ara_1</td>
<td>Blue and red shrimp in GSA 1</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>mur_5</td>
<td>Striped red mullet in GSA 5</td>
<td>2015</td>
<td>Y</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2015</td>
<td>pil_6</td>
<td>European pilchard(=Sardine) in GSA 6</td>
<td>2016</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2014</td>
<td>ara_6</td>
<td>Blue and red shrimp in GSA 6</td>
<td>2015</td>
<td>N</td>
<td>GFCM</td>
</tr>
<tr>
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<td>2014</td>
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<td>Giant red shrimp in GSA 10</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2014</td>
<td>ars_11</td>
<td>Giant red shrimp in GSA 11</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2014</td>
<td>hke_01_05_06_07</td>
<td>European hake in GSA 01, 05, 06, 07</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2014</td>
<td>hke_09_10_11</td>
<td>European hake in GSA 09, 10, 11</td>
<td>2014</td>
<td>N</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2016</td>
<td>hom_09_10_11</td>
<td>Atlantic horse mackerel in GSA 09, 10, 11</td>
<td>2016</td>
<td>Y</td>
<td>STECF</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2013</td>
<td>mut_6</td>
<td>Red mullet in GSA 6</td>
<td>2015</td>
<td>N</td>
<td>GFCM</td>
</tr>
<tr>
<td>Western Med.</td>
<td>2013</td>
<td>ara_5</td>
<td>Aristeus antennatus in GSA 5</td>
<td>2015</td>
<td>N</td>
<td>GFCM</td>
</tr>
</tbody>
</table>
4.1 Indicators of management performance

4.1.1 Trend in F/FMSY

Indicators of trends 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.

![Figure 4.3 Trend in F/FMSY. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.](image)

Table 4.2 Percentiles for F/FMSY by year.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50%</td>
<td>1.73</td>
<td>1.82</td>
<td>1.87</td>
<td>1.94</td>
<td>1.80</td>
<td>1.85</td>
<td>1.87</td>
<td>1.88</td>
<td>2.11</td>
<td>1.94</td>
<td>1.95</td>
<td>1.81</td>
<td>1.88</td>
</tr>
<tr>
<td>25%</td>
<td>2.00</td>
<td>2.07</td>
<td>2.16</td>
<td>2.22</td>
<td>2.06</td>
<td>2.08</td>
<td>2.10</td>
<td>2.14</td>
<td>2.35</td>
<td>2.13</td>
<td>2.03</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>2.17</td>
<td>2.23</td>
<td>2.34</td>
<td>2.37</td>
<td>2.19</td>
<td>2.19</td>
<td>2.22</td>
<td>2.28</td>
<td>2.49</td>
<td>2.27</td>
<td>2.15</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td>2.36</td>
<td>2.37</td>
<td>2.52</td>
<td>2.52</td>
<td>2.32</td>
<td>2.33</td>
<td>2.36</td>
<td>2.64</td>
<td>2.42</td>
<td>2.38</td>
<td>2.30</td>
<td>2.40</td>
<td></td>
</tr>
<tr>
<td>97.50%</td>
<td>2.72</td>
<td>2.67</td>
<td>2.86</td>
<td>2.81</td>
<td>2.57</td>
<td>2.59</td>
<td>2.59</td>
<td>2.92</td>
<td>2.68</td>
<td>2.63</td>
<td>2.59</td>
<td>2.72</td>
<td></td>
</tr>
</tbody>
</table>

The model used is a mixed linear model, described in the protocol (Annex I). Values for 2016 were removed from the model fit. Bootstrapped quantiles of F/FMSY are displayed (Figure 4.3 and Table 4.1). The 50% quantile (black line), which is equivalent to the median, shows a median level slightly varying around of $F/F_{MSY} \approx 2.3$ for the full time series. In the Mediterranean and Black Seas assessments, a more conservative proxy for $F_{MSY}$, such as $F_{0.1}$, is commonly used resulting in a higher ratio for $F/F_{MSY}$. The lower quantile is above $F/F_{MSY} = 1$, indicating that the stocks are exploited well above the CFP management objectives. There is no trend, to indicate any improvement in exploitation since the implementation of the 2003 reform of the CFP.
4.1.2 Trend in SSB (relative to 2003)

Indicators of trends 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.

![Figure 4.4 Trend in SSB relative to 2003. Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.](image)

Table 4.3 Percentiles for SSB by year relative to 2003.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50%</td>
<td>0.58</td>
<td>0.53</td>
<td>0.55</td>
<td>0.63</td>
<td>0.57</td>
<td>0.54</td>
<td>0.57</td>
<td>0.58</td>
<td>0.57</td>
<td>0.53</td>
<td>0.53</td>
<td>0.57</td>
<td>0.58</td>
</tr>
<tr>
<td>25%</td>
<td>0.84</td>
<td>0.79</td>
<td>0.79</td>
<td>0.91</td>
<td>0.85</td>
<td>0.77</td>
<td>0.82</td>
<td>0.82</td>
<td>0.79</td>
<td>0.75</td>
<td>0.75</td>
<td>0.80</td>
<td>0.81</td>
</tr>
<tr>
<td>50%</td>
<td>1.01</td>
<td>0.95</td>
<td>0.94</td>
<td>1.07</td>
<td>1.00</td>
<td>0.91</td>
<td>0.96</td>
<td>0.97</td>
<td>0.93</td>
<td>0.87</td>
<td>0.89</td>
<td>0.96</td>
<td>0.97</td>
</tr>
<tr>
<td>75%</td>
<td>1.18</td>
<td>1.10</td>
<td>1.12</td>
<td>1.25</td>
<td>1.15</td>
<td>1.08</td>
<td>1.14</td>
<td>1.12</td>
<td>1.08</td>
<td>1.02</td>
<td>1.03</td>
<td>1.10</td>
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<td>1.66</td>
<td>1.66</td>
<td>1.87</td>
<td>1.76</td>
<td>1.58</td>
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<td>1.44</td>
<td>1.52</td>
<td>1.67</td>
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</table>

The 50% quantile (black line), has varied around $B/B_{2003} \approx 0.95$ (only in 2006 was the ratio above 1.0). However, the quantiles are large, representing a high level of uncertainty.
4.2 Indicators of advice coverage

In the Mediterranean and the Black Seas a total of 241 stocks were considered for the current exercise, of which 72 have stock assessments carried out between 2015-2017. The advice coverage for the Mediterranean and the Black Sea is 0.30.
### Status across all stocks in 2016

Table 5.1 Stock status for all stocks in the analysis. Columns refer to ecoregion, last year for which the estimated was obtained, stock code and description, value of $F/F_{MSY}$ ratio ($F_{ind}$), if $F$ is lower than $F_{MSY}$ ($F$ status), if the stock is inside safe biological limits (SBL), and if the stock is inside the CFP requirements (CFP). Stocks managed under escapement strategies do not have an estimate of $F/F_{MSY}$. Symbol ‘o’ stands for ‘YES’, an empty cell stands for ‘NO’ and ‘-’ unknown due to missing information.

<table>
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<tr>
<th>Region</th>
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<th>Year</th>
<th>Stock</th>
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<th>$F_{ind}$</th>
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<td>Roundnose grenadier ( Coryphaenoides rupestris) in subareas 6-7, and in Divisions 5.b and 12.b (Celtic Seas and the English Channel, Faroes grounds, and western Hatton Bank)</td>
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## Reports by Stock

Table 6.1 - URL links to the source reports by stock.

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### CONTACT DETAILS OF AD HOC EXPERT GROUP PARTICIPANTS

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<th>Name</th>
<th>Address</th>
<th>Telephone no.</th>
<th>Email</th>
</tr>
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<tr>
<td></td>
<td>J. Casey</td>
<td>European Commission, Joint Research Center, Unit D.02 Water and Marine Resources, Via Enrico fermi 2749, 21027 Ispra (VA), Italy</td>
<td>+39 0332 783936</td>
<td><a href="mailto:john.casey@ec.europa.eu">john.casey@ec.europa.eu</a></td>
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<tr>
<td></td>
<td>E. Jardim</td>
<td>European Commission, Joint Research Center, Unit D.02 Water and Marine Resources, Via Enrico fermi 2749, 21027 Ispra (VA), Italy</td>
<td>+39 0332 785311</td>
<td><a href="mailto:ernesto.jardim@ec.europa.eu">ernesto.jardim@ec.europa.eu</a></td>
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<tr>
<td></td>
<td>A. Mannini</td>
<td>European Commission, Joint Research Center, Unit D.02 Water and Marine Resources, Via Enrico fermi 2749, 21027 Ispra (VA), Italy</td>
<td>+39 0332 785784</td>
<td><a href="mailto:alessandro.mannini@ec.europa.eu">alessandro.mannini@ec.europa.eu</a></td>
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<td>I. Mosqueira</td>
<td>European Commission, Joint Research Center, Unit D.02 Water and Marine Resources, Via Enrico fermi 2749, 21027 Ispra (VA), Italy</td>
<td>+39 0332 785413</td>
<td><a href="mailto:iago.mosqueira@ec.europa.eu">iago.mosqueira@ec.europa.eu</a></td>
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<td>P. Vasilakopoulos</td>
<td>European Commission, Joint Research Center, Unit D.02 Water and Marine Resources, Via Enrico fermi 2749, 21027 Ispra (VA), Italy</td>
<td>+39 0332 785714</td>
<td><a href="mailto:paris.vasilakopoulos@ec.europa.eu">paris.vasilakopoulos@ec.europa.eu</a></td>
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Data and code are available in https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring.
Protocol for the Monitoring of the Common Fisheries Policy
Version 3.0

April 24, 2018

Ernesto Jardim\textsuperscript{1} (ernesto.jardim@ec.europa.eu)
Iago Mosqueira\textsuperscript{1} (iago.mosqueira@ec.europa.eu)
Paris Vasilakopoulos\textsuperscript{1} (paris.vasilakopoulos@ec.europa.eu)
Alessandro Mannini\textsuperscript{1} (alessandro.mannini@ec.europa.eu)
John Casey\textsuperscript{1} (john.casey@ec.europa.eu)

\textsuperscript{1}European Commission, DG Joint Research Centre, Directorate D — Sustainable Resources, Unit D.02 Water and Marine Resources, Via E. Fermi 2749, 21027 Ispra VA, Italy.
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1 Introduction

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

The 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 where fleets operate under the flag of any EU member state. However, due to limitations on data and the mitigated responsibility of the EU on management decisions on waters outside the EU EEZ (Exclusive Economic Zone), the analysis will 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

- $f$ represents fishing mortality;
- $b$ represents 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;
• $F_{\text{MSY}}$ represents fishing mortality that produces catches at the level of MSY in an equilibrium situation, or a proxy;

• $F_{\text{PA}}$ is the precautionary reference point for fishing mortality;

• $B_{\text{MSY}}$ is the biomass expected to produce MSY when fished at $F_{\text{MSY}}$ in an equilibrium situation, but also any other relevant proxy considered by the scientific advice body;

• $B_{\text{PA}}$ is the precautionary reference point for spawning stock biomass;

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

• operations:
  - $\lor$ stands for or in Boolean logic;
  - $\land$ stands for and in Boolean logic;

• model parameters:
  - $u$ is a random effect;
  - $y$ is a fixed effect on 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 $F_{\text{MSY}}$ and/or $B$ over $B_{\text{MSY}}$, 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 Seas (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 (Pampusaus longirostris)
  - 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 expanded up to the last 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:

1. exploitation levels
   by comparing fishing mortality $F$ with the target level $F_{MSY}$;

2. conservation status
   by comparing fishing mortality $F$ and spawning stock biomass $SSB$ with the precautionary levels of fishing mortality and biomass, $F_{PA}$ and $B_{PA}$, respectively;

To be discussed and agreed with the Med members.
3. biomass levels

by comparing spawning stock biomass SSB with the target level $B_{MSY}$.

A group of indicators, hereafter referred to as model based, are computed 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\(^2\) and in an application to Mediterranean stocks\(^3\).

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

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

3.4 Number of stocks inside safe biological limits

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

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

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

where in FAO 27

$$B_{MSY} = MSY_{B_{trigger}}$$

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

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

where in FAO 27

$$B_{MSY} = MSY_{B_{trigger}}$$


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

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

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.

\[ I_t = \exp\left( y_{ts} - S^{-1} \sum_{s=1}^{S} y_{2003,s} \right) \]

\[ z_{jt} = \beta_0 + y_t + u_j \]

where

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

and

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

3.9 Trend in $B/B_{PA}$

\[ I_t = y_t \]

\[ z_{jt} = \beta_0 + y_t + u_j \]

where

\[ z_{jt} = \log E\left[ \frac{b_{jt}}{B_{PA}} \right] \]

and

\[ \frac{b_{jt}}{B_{PA}} \sim Gamma(\alpha, \beta) \]
3.10 Trend in recruitment

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.

\[ I_t = \exp(y_{ts} - S^{-1} \sum_{s=1}^{S} y_{2003,s}) \]

\[ z_{jt} = \beta_0 + y_t + u_j \]

where

\[ z_{jt} = \log E[r_{jt}] \]

and

\[ r_{jt} \sim Gamma(\alpha, \beta) \]

3.11 Trend in biomass

This indicator uses biomass trends extracted from SSB estimates for category 1 and 2 stocks, together with biomass indices published by ICES for stocks of category 3.

\[ I_t = y_t \]

\[ z_{jt} = \beta_0 + y_t + u_j \]

where

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

and

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

3.12 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

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

\[ \lambda = \begin{cases} 
1 & F_{MSY} \text{ exists} \\
0 & \text{otherwise} 
\end{cases} \]

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

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

\[ \lambda = \begin{cases} 
1 & B_{PA} \text{ exists} \\
0 & \text{otherwise} 
\end{cases} \]

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

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

\[ \lambda = \begin{cases} 
1 & B_{MSY} \text{ exists} \\
0 & \text{otherwise} 
\end{cases} \]

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.

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

\[ \lambda = \begin{cases} 
1 & \text{spatial overlap exists} \\
0 & \text{otherwise} 
\end{cases} \]

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

# Setup

# year when assessments were performed
assessmentYear <- 2017
# 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 <- (fnlYear-2):fnlYear
# vector of years for stock status projection
# 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
theme_set()

# load & pre-process

# NEA indicators
# EJ(20170302)

# extract the main ecoregion but keep the list
# widely distributed to keep coherent with previous years (taken from 2017's files)

# fix codes for stock size and fishing mortality
# f
isa$FishingPressureDescription %in% c("Fishing Pressure: F"), "FishingPressureDescription"] <- "F"
isa$FishingPressureDescription %in% c("Harvest Rate", "Harvest rate"),
"FishingPressureDescription" <- "HR"

# biomass
isa[isa$StockSizeDescription %in% c("TSB/Bmsy"), "StockSizeDescription" <- "B/Bmsy"

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

# reporting stk by data category
stBydc <- unique(subset(isa, Year %in% vpy), c("FishStock", "DataCategory", "EcoRegion")]

# A new column is added based on Max_Area so that it is comparable across the other data sets
rectangles$Area <- paste0("27.", toupper(as.character(rectangles$Max_Area)), sep="")

# check that each rectangle is unique and only appears once in the data
length(unique(rectangles$Rectangle)) == nrow(rectangles)

# sampling frame (TACs)
load("../data/ices/sframe.RData")

# fmz is the frame of all TACs
# For consistency
colnames(fmz)[colnames(fmz) == "area"] <- "Area"
colnames(fmz)[colnames(fmz) == "spp"] <- "Species"
colnames(fmz)[colnames(fmz) == "stock_id"] <- "TAC_id"

sframe <- subset(fmz, TAC_id %in% sframe_TAC)

# 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]
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"], "\s")
spp2Species <- toupper(unlist(lapply(spp, function(x) x[1])))

# split ICES area by -
areas <- strsplit(isa12[,"Areas"], ",")
names(areas) <- isa12[,"FishStock"]
areas <- melt(areas)
colnames(areas) <- c("Area", "FishStock")
isa12 <- merge(isa12, areas)
# keep relevant columns only
isa12 <- isa12[,c("FishStock", "Area", "Species", "SpeciesName", "SGName", "DataCategory", "EcoRegion")]
# remove ecoregions outside EU waters
isa12 <- subset(isa12, !is.na(c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")))
# remove her-noss which is widely distributed but mainly norway
isa12 <- subset(isa12, FishStock!="her.27.1-24a51a")

# fix species codes
# fix Baltic area codes
rectangles$Area <- "27.3.A.20", "Area"] <- "27.3.A"
rectangles$Area <- "27.3.A.21", "Area"] <- "27.3.A"
rectangles$Area <- "27.3.B.23", "Area"] <- "27.3.B"
rectangles$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
unique(isa12$Area)[!(unique(isa12$Area) %in% unique(rectangles$Area))]
# Areas in FMZ but missing in rectangles
unique(sframe$Area)[!(unique(sframe$Area) %in% unique(rectangles$Area))]

# fix area codes
# fix Baltic area codes

# Horse mackerel
isa12[isa12$Species == "HOM", "Species"] <- "JAX"
# ANK & MON - Anglerfish - species to genus
isa12[isa12$Species == "ANK", "Species"] <- "ANF"
isa12[isa12$Species == "MON", "Species"] <- "ANF"
# Megrim - species and genus to genus
isa12[isa12$Species == "MEG", "Species"] <- "LEZ"
isa12[isa12$Species == "LDB", "Species"] <- "LEZ"
# rays
isa12[isa12$Species == "RNG", "Species"] <- "RTX"

# missing species
sort(unique(isa12$Species)[!(unique(isa12$Species) %in% unique(sframe$Species))])

# 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(isa12r$FishStock)) == sort(unique(isa12r$FishStock)))
# Merge sampling frame with rectangles
sfr <- merge(sframe, rectangles[,c("Area", "Rectangle")], by="Area")

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

```r
# remove stocks with short time series
sts <- subset(isa, Year in dy & !is.na(FishingPressure))$FishStock
sts <- subset(sts, Year in dy & !is.na(sts))

# stocks to retain
stkToRetain <- unique(isa$FishStock)[1]
stkToRetain <- stkToRetain[is.na(stkToRetain) & !is.na(stkToRetain)]

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

# check what's available
table(isa, c("FishingPressureDescription", "StockSizeDescription"))

# process data for indicators

# fixing BMSYescapement not reported by ICES

# fixing Recruitments of 0

# Bref

# B escapement as Bref for relevant stocks

# Brefpa as Bref for relevant stocks (already in Bpa)
```
```r
# Fref
#----------------------------------------------------------
saeu$Fref <- saeu$FMSY # no Fref for B escapement
#----------------------------------------------------------
saeu$Fref[saeu$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[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$indF[saeu$MSYBescapement] <- saeu$Fref[saeu$MSYBescapement] / saeu$StockSize[saeu$MSYBescapement]
saeu <- transform(saeu, sfFind=!is.na(saeu$indF))

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

#----------------------------------------------------------
# final dataset
#----------------------------------------------------------
saeu <- subset(saeu, Year>=iniYear & Year <=fnlYear & AssessmentYear %in% vay & sfFind)

#----------------------------------------------------------
# project stock status up to last year in cases missing
#----------------------------------------------------------
saeu <- projectStkStatus(saeu, vpy)

#----------------------------------------------------------
# Indicators (design based)
#----------------------------------------------------------

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

png("figNEAI0a.png", 1800, 1200, res=300)
ggplot(subset(inStks, EcoRegion=="ALL"), aes(x=Year, y=N)) +
  geom_line() +
```
```r
ylab("No. of stocks") +
xlab("") +
ylim(c(0,75)) +
sc +
th
dev.off()

# time series
# NEEDS CHECK, YAXIS IS NOT REVERSED
png("figNEAI0b.png", 3000, 4500, res=300, bg = "transparent")
ggplot(df0, aes(Year, FishStock)) +
  geom_point(data=aggregate(df0Year, by=list(FishStock=df0$FishStock), max),
aes(x, FishStock))+
  geom_line(data=data.frame(Year=2009:2013, FishStock="nep.fu.14"), color="white") +
  geom_line(data=data.frame(Year=2007:2009, FishStock="nep.fu.13"), color="white") +
  geom_line(data=data.frame(Year=2003:2005, FishStock="nep.fu.13"), color="white") +
  geom_point(data=data.frame(Year=2003, FishStock="nep.fu.13"), size=0.3) +
ylab("Stock") +
xlab("Year") +
scale_y_discrete(name="", limits = rev(unique(df0$FishStock))) +
th
dev.off()

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

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

# plot
png("figNEAI1.png", 1800, 1200, res=300)
ggplot(subset(fInda, EcoRegion=="ALL"), aes(x=Year, y=N)) +
  geom_line() +
  expand_limits(y=0) +
  geom_point(aes(x=iniYear, y=N[1])) +
  geom_point(aes(x=fnlYear, y=N[1:2]), 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(fIndb, EcoRegion != "ALL"), aes(x=Year, y=N)) +
  geom_line() +
  facet_grid(~EcoRegion) +
ylab("No. of stocks") +
xlab("") +
sc +
ylim(0, 20) +

# table
write.csv(dcast(fIndb, 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
ggplot(subset(fIndb, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
  geom_line() +
  facet_grid(.~EcoRegion) +
  ylab("No. of stocks") +
  xlab("") +
  sc +
  ylim(0, 20) +
  th
dev.off()

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

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

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

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

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

# plot
ggplot(subset(fIndd, EcoRegion=='ALL'), aes(x=Year, y=N)) +
  geom_line() +
  expand_limits(y=0) +
  geom_point(aes(x=iniYear, y=N[1L])) +
  geom_point(aes(x=fnlYear, y=N[length(N)]), size=2) +
  ylab("No. of stocks") +
  xlab("") +
  ylim(c(0, 75)) +
  sc +
  th
dev.off()
geom_line() + facet_grid(.~EcoRegion) + ylab("No. of stocks") + xlab("") + sc + ylim(0, 15) + th
dev.off()

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

# (I5) Stocks outside CFP objectives

# 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(0, 75) + sc + th
dev.off()

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

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

# (I6) Stocks inside CFP objectives

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

# Indicators (model based)

# (I7) F/Fmsy model
idx < seq(saeu$FishingPressureDescriptionxlim["F", "F/Fmsy"])
saeu$sfI7 <- idx & .na(saeu$MSYBecapemage)
df0 <- saeu[saeu$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, "diagNA17.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifit.bs <- split(1:it, 1:it)
ifit <- function(i, ifit, x) it$it[i,]
ifitm <- do.call("rbind", ifit.bs)
ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)

# plot
plot(png("figNEAI7.png", 1000, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_line(aes(y=quantile(0.5, qtl), fill="gray", alpha=0.60)) +
  geom_line(aes(y=quantile(0.75, qtl), fill="gray", alpha=0.95)) +
  geom_ribbon(aes(ymin=quantile(0.25, qtl), ymax=quantile(0.75, qtl), fill="gray", alpha=0.60)) +
  geom_point(aes(x=Year, y=quantile(0.5, qtl)))

# table
write.csv(ifitq[-1], 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))

# fit model
ifitRegional <- lapply(split(df0, df0$EcoRegion), function(x){
  fit <- glmer(indF ~ Year + (1|FishStock), data = x, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  # no variance with bootstrap due to small number of stocks
})
```

ifit.pred <- predict(ifit, re.form~0, type="response", newdata=nd)

# output
list(ifit=ifit, ifit.pred=ifit.pred)

lst0 <- lapply(ifitRegional, "[[", "ifit.pred")

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

# plot

ggplot(fIndfr, aes(x=Year, y=N)) +
geom_line() +
facet_grid(.~EcoRegion) +
ylab(expression(F/F[MSY])) +
theme() +
ylim(0, 2.5) +
th
dev.off()

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

# (I70ut) F/Fmsy stocks outside EU

df0 <- subset(isa, (EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea", "her.27.1-24a514a") & FishStock!="pra.27.1-2" & Year>=in1Year & Year<=nf1Year & AssessmentYear %in% vay)

df0$Fref <- df0$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

fitout <- glmer(indF ~ Year + (1|FishStock), data = df0, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))

runDiagsME(fitout, "FishStock", df0, "diagNEAI7out.pdf", nc, nd)

# bootstrap

stk <- unique(df0$FishStock)

ifitout.bs <- split(i: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$sconv$LME4)>0) v0[] <- NA

v0

}, mc.cores=nc)

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

ifitq <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)

ifitm <- cbind(Year=as.numeric(yrs), as.data.frame(t(ifitm)))

# plot

png("figNEAI7out.png", 1800, 1200, res=300)

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) +
ylab(expression(F/F[MSY])) +
geom_hline(yintercept = 1, linetype=2) +
ylim(0, 2.5) +
geom_point

ifitb.bs
c
control=glmerControl

geom_ribbon

c
control=glmerControl

dev.

th

dev.off()

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

# (I8) SSB model

# (I8) SSB model regional

df0 <- saeu$sfI8,
df0$Year <- factor(df0$Year)

yrs <- levels(df0$Year)
df0$Year <- factor(df0$Year)

# fit

ifitb <- glmer(StockSize ~ Year + (1|FishStock), data = df0, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))

lapply(mclapply(ifitb, "FishStock", df0, "diagNEAI10.pdf", nc, nd)

# bootstrap

stk <- unique(df0$FishStock)

ifitb.bs <- mclapply(ifitb, function(x){
  stk <- sample(stk, replace=TRUE)
  df1 <- df0[0,]
  fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  v0 <- predict(fit, 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)-mean(log(ifitm[,1]), na.rm=TRUE))

ifitm <- apply(ifitm, 2, quantile, qtl, na.rm=TRUE)

ifitm <- cbind(as.data.frame(t(ifitm)), as.data.frame(t(ifitm)))

# plot

png("figNEAI9.png", 1000, 1200, res=300)
ggplot(ifitm, aes(x=Year)) +
  geom_ribbon(aes(ymin = `50`, ymax = `90`, fill="gray", alpha=.60) +
  geom_line(aes(y=`50`, fill="gray", alpha=.95) +
  geom_point(aes(x=Year[1], y=`50`[1]), size=2) +
  geom_hline(yintercept = `SSB`, linetype=2) +
  ylab(expression(B/B[2003])) ) +
  theme(legend.position = "none") +
  theme +
  dev.off()

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

# (I8) SSB model regional

# (I8) SSB model regional

df0 <- saeu$sfI8,
df0$Year <- factor(df0$Year)

yrs <- levels(df0$Year)
df0$Year <- factor(df0$Year)

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

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

# plot
png("FigNEAI8b.png", 2400, 1200, res=300)
ggplot(ifitbr, 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") +
835 sc +
840 dev.off()

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

# (I9) SSB/Bpa model
#--------------------------------------------------------------------
845 idx <- saeu$StockSizeDescription &! ("SSB", "TSB", "B/Bmsy")
saeu$sfI9 <- idx &! lis.na(saeu$indBpa)
df0 <- saeu[saeu$sfI9,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)

nd <- data.frame(Year=factor(yrs))

# fit
ifitb <- glmer(indBpa ~ Year + (1|FishStock), data = df0, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap")
runDiagsME(ifitb, FishStock", df0, "diagNEAI9.pdf", nc, nd)

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

ifitim <- do.call("rbind", ifitb.bs)
ifitq <- apply(ifitim, 2, quantile, qt=na.rm=TRUE)
ifitq <- cbind(YEAR=as.numeric(yrs), as.data.frame(t(ifitq)))

# plot
png("FigNEAI9.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(ymax = `50%`)) +
  expand_limits(y=0) +

880 theme(legend.position = "none") +
885 dev.off()

# table
## (I10) Recruitment model (same data as SSB trends)

```r
# (I10) Recruitment model (same data as SSB trends)

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

## # bootstrap

```r
stk <- unique(df0$FishStock)
ifitr.bs <- mclapply(ifitr.bs, function(x){
  stk <- sample(stk, replace=TRUE)
  df1 <- df0[0,]
  for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
  fit <- glmer(Recruitment ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  v0 <- predict(fit, re.form=-1, type="response", newdata=nd)
  if(length(fit@optinfo$conv$line4)>0) v0[] <- NA
  v0 } , mc.cores=nc)
```

## # plot

```r
tb0 <- t(ifitm)[-1,]
colnames(tb0) <- ifitm[,1]
write.csv(tb0, file="tabNEAI10.csv")
```

## # table

```r
tb0 <- t(ifitm)[-1,]
colnames(tb0) <- ifitm[,1]
write.csv(tb0, file="tabNEAI10.csv")
```

## (I11) SSB model for cat 1-3

```r
df0 <- subset(isa, 1((EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")) & DataCategory<9 & StockSize>=8 & Year>=iniYear & Year <= fnlYear & AssessmentYear %in% vay & StockSizeDescription %in% c("Biomass Index", "SSB", "TSB", "Relative BI (comb)", "B/Bmsy", "Relative SSB", "standardized CPUE", "Relative BI", "Biomass Index (comb)", "LPUE"))
```

## # remove stocks with short time series

```r
sts <- table(df0$FishStock, df0$Year)
sts <- rownames(sts)[apply(sts, 2, sum)<5]
df0 <- subset(df0, !(FishStock %in% sts))
```

## # project for stocks without 2015, 2016 estimates

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

```r
# (I11) SSB model for cat 1-3
```

```r
df0 <- subset(isa, 1((EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")) & DataCategory<9 & StockSize>=8 & Year>=iniYear & Year <= fnlYear & AssessmentYear %in% vay & StockSizeDescription %in% c("Biomass Index", "SSB", "TSB", "Relative BI (comb)", "B/Bmsy", "Relative SSB", "standardized CPUE", "Relative BI", "Biomass Index (comb)", "LPUE"))
```

## # remove stocks with short time series

```r
sts <- table(df0$FishStock, df0$Year)
sts <- rownames(sts)[apply(sts, 2, sum)<5]
df0 <- subset(df0, !(FishStock %in% sts))
```

## # project for stocks without 2015, 2016 estimates

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

## # bootstrap

```r
stk <- unique(df0$FishStock)
ifitr.bs <- mclapply(ifitr.bs, function(x){
  stk <- sample(stk, replace=TRUE)
  df1 <- df0[0,]
  for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
  fit <- glmer(Recruitment ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  v0 <- predict(fit, re.form=-1, type="response", newdata=nd)
  if(length(fit@optinfo$conv$line4)>0) v0[] <- NA
  v0 } , mc.cores=nc)
```

## # plot

```r
tb0 <- t(ifitm)[-1,]
colnames(tb0) <- ifitm[,1]
write.csv(tb0, file="tabNEAI10.csv")
```

## # table

```r
tb0 <- t(ifitm)[-1,]
colnames(tb0) <- ifitm[,1]
write.csv(tb0, file="tabNEAI10.csv")
```
df0 <- projectStkStatus(df0, vpy)

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

# fit
ifitb123 <- glmer(StockSize ~ Year + (1|FishStock), data = df0, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitb123, "FishStock", df0, "diagNEAI11.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitb123.bs <- split(1:it, 1:it)
ifitb123.bs <- mclapply(ifitb123.bs, function(x){
  stk <- sample(stk, replace=TRUE)
  df1 <- df0[0,]
  for(i in stk)
    df1 <- rbind(df1, subset(df0, FishStock==i))
  fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
  if(length(v0@optinfo$conv$1me4)>0) v0[] <- NA
})

ifitm <- do.call("rbind", ifitb123.bs)
ifitm <- cbind(Year=seq(975, 985), as.data.frame(t(ifitm)))

# plot
png("FigNEAI11.png", 1800, 1200, res=300)
ggplot(ifitm, aes(x=Year)) +
  geom_ribbon(aes(ymin = `99.5%`, 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_line(yintercept = 1, linetype=2) +
  ylab(expression(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +

sc +
  theme()
dev.off()

# table
tb0 <- t(ifitm)[-1,]
coinames(tb0) <- ifitm[,1]
write.csv(tb0, file="tabNEAI11.csv")

# (I12) SSB model for cat 3

df0 <- subset(data, !(EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", 
  "Iceland Sea")) & DataCategory==2 & StockSizeDescription & Year==iniYear & Year <=
  fnlYear & AssessmentYear %in% vay & StockSizeDescription %in% c("Biomass Index", 
  "SSB", "TSB", "Relative BI (comb)", "B/Bmsy", "Relative SSB", "standardized CPUE", 
  "Relative BI", "Biomass Index (comb)", "LPUE"))

# remove stocks with short time series
st0 <- table(df0$FishStock, df0$Year)
sts <- rownames(st0)[apply(sts, 1, sum)<5]
df0 <- subset(df0, !(FishStock %in% sts))

# id

st12 <- tapply(df0$Year, df0$FishStock, max)
st12 <- data.frame(FishStock=names(st12), Year=st12, variable="st12", value=TRUE)

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

# pre process for model
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))
```
# fit
ifitm <- glmer(StockSize ~ Year + (1|FishStock), data = df0, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
runDiagsME(ifitm, "FishStock", df0, "diagNEAI12.pdf", nc, nd)

# bootstrap
stk <- unique(df0$FishStock)
ifitm3 <- split(1:it, 1:it)
ifitm3 <- mclapply(ifitm3, function(x){
  stk <- sample(stk, replace=TRUE)
  fit <- glmer(StockSize ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
  v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
  if(length(fit@optinfo$convlme4)>0) v0[] <- NA
} }, mc.cores=mc)

ifitm <- do.call("rbind", ifitm3)
ifitm <- exp(log(ifitm)-mean(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(Year=x)) + geom_point() +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_line(aes(y=50%)) + expand_limits(y=0) +
ggplot(ifitq, aes(Year=x, y=50%)) +
  geom_point() + geom_point(aes(Year=x, y=50%)) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab("Recruitment trends") +
  theme(legend.position = "none") +
  scale_color_manual(name="Fish Stock") +
  dev.off()

# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
write.csv(tb0, file="tabNEAI12.csv")

# Stocks used in each indicator
#====================================================================================
df0 <- melt(saeu[, !is.na$projected.], c('FishStock', 'Year'), c('sfFind', 'sfSBL',
  'sfCFP', 'sfIF', 'sfIF', 'sfIF'))
df0 <- do.call("rbind", lapply(split(df0, df0$FishStock), function(x) subset(x,
  Year=max(x$Year))))
df0 <- rbind(df0, df0, df0)
levels(df0$variable) <- c('above/below Fmsy', 'in/out SBL', 'in/out CFP', 'F/Fmsy
trends', 'Biomass data category 1-3 trends', "Biomass data category 3 trends")
stkPerIndicator <- dcast(df0, FishStock+Year=variable, value.var='value')

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

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

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

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

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

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

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

# Set dropped stocks to NA in FishStock column
isa12sf$FindFishStock <- isa12sf$FishStock
isa12sf$FindFishStock[drop_stock_f] <- as.character(NA)
isa12sf$FindFishStock[drop_stock_b] <- 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)
})

covoutf <- 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)
})

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

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

covout <- 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(covout) <- c("F_indicator", "B_indicator", "Fpa_indicator", "Bpa_indicator")
write.csv(covout, "coverage.csv")

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

# Exporting and saving
write.csv(saeu, file="saeu.csv")
save.image("RData.nea")
library(reshape2)
library(ggplot2)
library(lme4)
library(influence.ME)
library(lattice)
library(parallel)
library(rgdal)
library(reshape2)
library(plyr)
source("funs.R")

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

# year when assessments were performed
assessmentYear <- 2017
# 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[c(2,3,5,6,8,9,11,12,13)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=dy, labels=as.character(vp))
th <- theme(axis.text.x = element_text(angle=90, vjust=0.5), panel.grid.minor =
  element_blank())

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

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

# assessments
gfcm <- read.csv("../data/med/GFCM_SA.csv")
gfcm$Meeting <- "GFCM"
gfcm$Fref <- gfcm$Fref_point
stecf <- read.csv("../data/med/STECF_CFP_2018.csv")
msa <- rbind(stecf, gfcm)
msa$Fref <- msa$Fref_point

# keep only one hake 1718 and sol17 assessment, must be adjusted
# based on plen decision
msa <- subset(msa, !key %in% c("SOL_17_EWG17_15", "HKE_17_18_EWG17_15") &
  Method="SS3")

# keep relevant columns only
  "asses_year", "Meeting", "Assessment_URL", "Species", "EcoRegion")]

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

# recode and compute indicators
msa$stk <- tolower(paste(msa$Stock, msa$Area, sep=" "))
msa$StockDescription <- paste(msa$Species, " in GSA", gsub("_", ", "", msa$Area))
msa$Fref <- as.numeric(msa$Fref)
msa$projected <- FALSE

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

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

# Number of stocks (remove projected years)
mmStks <- aggregate(stk~Year, df0, length)
names(mmStks) <- c("Year", "N")

# plot
png("figMedI0.png", 1800, 1200, res=300)
ggplot(subset(mmStks, Year!=fnlYear), aes(x=Year, y=N)) +
  geom_line() +
  ylab("No. of stocks") +
  xlab("") +
  ylim(c(0,50)) +
  sc +
  th +
  geom_point(aes(x=fnlYear, y=mmStks$N[length(mmStks$N)]), size=2)
dev.off()

png("figMedI0b.png", 1200, 1600, res=200)
ggplot(subset(sam, !sam$projected), aes(Year, stk)) +
  geom_line() +
  ylab("Stock") +
  xlab("Year") +
  sc +
  th +
  geom_vline(xintercept = fnlYear-1, col = "red")
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[seq(2,13,2)] <- ""
sc <- scale_x_continuous(breaks=iniYear:I(fnlYear-1), labels=as.character(vp))

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

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

# bootstrap
set.seed(1234)
stk <- unique(df0$stk)
mfit.bs <- mclapply(mfit.bs, function(x){
  stk <- unique(df0$stk)
  df0 <- sample(stk, replace=TRUE)
  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(v0)<0) v0[] <- NA
  v0
}, mc.cores=nc)
# remove failed iter
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)

# 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=0.80) +
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, y=0.5*length(Year)), y=`50%`, cex=0.6) +
geom_hline(yintercept = 1, linetype=2) +
ylab("response") +
xlab("") +
theme(legend.position = "none") +

dev.off()

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

#---------------------------------------------
# (I8) SSB indicator
#---------------------------------------------

# model
idx <- !is.na(sam$SSB)
df0 <- sam[idx,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

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

# bootstrap
set.seed(1234)
stk <- unique(df0$stk)
mfitb.bs <- split(1:it, 1:it)
mfitb.bs <- mclapply(mfitb.bs, function(x){
  stk <- sample(stk, replace = TRUE)
  df1 <- df0
  for(i in stk)
    df1 <- rbind(df1, subset(df0, stk==i))
  fit <- glmer(SSB ~ Year + (1|stk), data = df1, family = Gamma("log"),
               control = glmerControl(optimizer = "nlminbwrap"))
  v0 <- predict(fit, re.form = ~0, type = "response", newdata = nd)
  if(length(fit@optinfo$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)
mfitq <- apply(mfitm, 2, quantile, c(0.025, 0.25, 0.50, 0.75, 0.975), na.rm = TRUE)
mfitq <- cbind(Year = as.numeric(yrs), as.data.frame(t(mfitq)))

# plot
png("figMedI8.png", 1800, 1200, res = 300)
ggplot(mfitq, aes(x = Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill = "gray", alpha = 0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill = "gray", alpha = 0.95) +
  geom_line(aes(y = `50%`)) +
  expand_limits(y = 0) +
  geom_point(aes(x = Year[length(Year)], y = `50%`[length(`50%`)]), size = 2) +
  geom_hline(yintercept = 1, linetype = 2) +
  ylab(expression(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
dev.off()

tb0 <- t(mfitq)[-1,]
colnames(tb0) <- mfitq[,1]
write.csv(tb0, file = "tabMedI8.csv")
write.csv(sam, file = "sam.csv")
save.image("RData.med")
ANNEX III – QUALITY CONTROL OF ICES DATASET
ICES data quality issues corrected prior to the analysis

By: Paris Vasilakopoulos

4 April 2018

The stock assessment graphs (SAG) dataset found at http://standardgraphs.ices.dk/stockList.aspx was used to extract the ICES data needed for the CFP indicators analysis. Prior to the analysis, an extensive data quality check was carried out on the data relevant to the analysis. During this data quality check the following fields were checked and corrected:

- Stock size, fishing pressure and reference points of stocks cat. 1-3 (data moved from custom columns when needed).
- Stock size description, stock size units, fishing pressure description, fishing pressure units of stocks cat 1-2.
- Stock size description of stocks cat 3.

There are still issues to be corrected in the ICES SAG dataset which were not addressed here due to time limitations and because they were not very relevant to our analysis. For example, we noticed inconsistencies and errors in stock units, fishing pressure description and fishing pressure units of many cat 3 stocks.

Category 1-2 stocks

ane.27.8
Fishing Pressure Units corrected from “NA” to ‘Proportion’

ank.27.8c9a
Stock size description corrected to TSB/Bmsy
Stock size units corrected to ‘Relative to Bmsy’
Fishing Pressure Units corrected to ‘Relative to Fmsy’

ghl.27.1-2
Stock size description corrected to TSB
Fishing Pressure Units corrected from “NA” to ‘Proportion’

ghl.27.561214
Stock size units corrected to ‘Relative to Bmsy’
Fishing Pressure Units corrected to ‘Relative to Fmsy’

lin.27.5a
Fishing Pressure Units corrected from “NA” to ‘Proportion’
HRlim, HRmsy, HRpa moved from custom columns to their right place

usk.27.5a14
Fishing Pressure Units corrected from “NA” to ‘Proportion’
HRlim, HRmsy, HRpa moved from custom columns to their right place

lez.27.4a6a
Stock size units corrected to ‘Relative to Bmsy’
Fishing Pressure Units corrected to 'Relative to Fmsy’

pil.27.8abd
Stock size units corrected to ‘Relative to mean’
Fishing Pressure Units corrected to ‘Relative to mean’
rng.27.5b6712b
Stock size units corrected to ‘Relative to Bmsy’
Fishing Pressure Units corrected to ‘Relative to HRmsy’

bss.27.4bc7ad-h
Fishing Pressure Units corrected from blank to ‘Year-1’

had.27.46a20
Fishing Pressure Units corrected from blank to ‘Year-1’

sol.27.8ab
Fishing Pressure Description corrected to F
Fishing Pressure Units corrected from blank to ‘Year-1’

whg.27.47d
Fishing Pressure Units corrected from blank to ‘Year-1’

cap.27.1-2
Fishing Pressure Description corrected to NA
Fishing Pressure Units corrected to NA

cap.27.2a514
Fishing Pressure Description corrected to NA
Fishing Pressure Units corrected to NA

pok.27.5a
Stock size description corrected to SSB

pra.27.1-2
Stock size units corrected to ‘Relative to Bmsy’
Fishing Pressure Units corrected to ‘Relative to Fmsy’

pra.27.4a20
Stock size description corrected to SSB
Fishing Pressure Description corrected to F

reg.27.1-2
Stock size units corrected to ‘Relative to mean’
Fishing Pressure Units corrected to ‘Relative to mean’

dgs.27.nea
Stock size description corrected from ‘TSB’ to ‘TSB’
Fishing Pressure Description corrected to Harvest rate

hom.27.2a4a5b6a7a-ce-k8
ICES Areas splited with character field is blank. Corrected to 27.2.a.1 ~ 27.2.a.2 ~ 27.4.a ~ 27.5.b.1.a ~ 27.5.b.1.b ~ 27.5.b.2 ~ 27.6.a ~ 27.7.a ~ 27.7.b ~ 27.7.c.1 ~ 27.7.c.2 ~ 27.7.e ~ 27.7.f ~ 27.7.g ~ 27.7.h ~ 27.7.j.1 ~ 27.7.j.2 ~ 27.7.k.1 ~ 27.7.k.2 ~ 27.8.a ~ 27.8.b ~ 27.8.c ~ 27.8.d.1 ~ 27.8.d.2 ~ 27.8.e.1 ~ 27.8.e.2

nep.fu.11
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.12
Stock size description corrected to Abundance
Stock size units corrected to millions
nep.fu.13
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.14
Stock size description corrected to Abundance
Stock size units corrected to millions
Fishing Pressure Description corrected to Harvest rate

nep.fu.15
Stock size description corrected to Abundance
Stock size units corrected to billions
Fishing Pressure Units corrected to Percent

nep.fu.16
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.17
Stock size description corrected to Abundance
Stock size units corrected millions

nep.fu.19
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.2021
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.22
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.2324
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.3-4
Stock size description corrected to Abundance
Stock size units corrected to millions
Fishing Pressure Units corrected to Percent

nep.fu.6
Stock size description corrected to Abundance
Stock size units corrected to millions
Fishing Pressure Description corrected to Harvest rate

nep.fu.7
Stock size units corrected to billions
Fishing Pressure Description corrected to Harvest rate

nep.fu.8
Stock size description corrected to Abundance
Stock size units corrected to millions

nep.fu.9
Stock size description corrected to Abundance
Stock size units corrected to millions
Fishing Pressure Units corrected to Percent

cod.27.1-2
cod.27.22-24
cod.27.5a
cod.27.5b1
cod.27.6a
cod.27.7a
cod.27.7e-k
had.27.1-2
had.27.5a
had.27.5b
had.27.6b
had.27.7a
had.27.7b-k
her.27.20-24
her.27.25-2932
her.27.28
her.27.3031
her.27.3a47d
her.27.5a
her.27.6a7bc
her.27.irls
her.27.nirs
hke.27.3a46-8abd
hke.27.8c9a
hom.27.2a4a5b6a7a-ce-k
hom.27.9a
ldb.27.8c9a
mac.27.nea
meg.27.7b-k8abd
meg.27.8c9a
ple.27.21-23
ple.27.7a
ple.27.7d
pok.27.1-2
pok.27.3a46
pok.27.5a
pok.27.5b
pra.27.4a20
reb.27.1-2
reg.27.561214
san.sa.1r
san.sa.2r
san.sa.3r
san.sa.4
sol.27.20-24
sol.27.4
sol.27.7a
sol.27.7d
sol.27.7e
sol.27.7fg
spr.27.4
spr.27.22-32
whb.27.1-91214
whg.27.7a
whg.27.7b-ce-k
Fishing Pressure Units corrected from ‘per year’ to ‘Year-1’

**Category 3 stocks**

**sbr.27.10**
The old sbr-x stock should be updated to sbr.27.10 (according to [http://sd.ices.dk/services/odata4/StockListDWs4](http://sd.ices.dk/services/odata4/StockListDWs4)). Also, based on this [http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/Special_requests/EU_sbr-x_review.pdf](http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/Special_requests/EU_sbr-x_review.pdf) its DataCategory needs to be updated to 3 (rather than current 5.2), and the abundance index value and description in the SAG dataset moved from Custom1 and CustomName1 columns to StockSize and StockSizeDescription, respectively. Also, stock size description was corrected to Abundance Index

**bss.27.8ab**
Stock size moved from custom column
Stock size description corrected to LPUE
Stock size unit corrected to kg/day
Fishing pressure corrected to NA

**ele.2737.nea**
No info in designated columns, everything in custom columns
Stock size description corrected to ‘NA’

**wit.27.3a47d**
Stock Size moved from custom column (IBTS Q3-the optimal index according to advice sheet)
Stock size description corrected to Biomass index
Stock size unit corrected to kg/h

**ane.27.9a**
Stock size description corrected to Biomass Index (comb)

**rjr.27.23a4**
Stock size description corrected from ‘Relative AI (comb)’ to ‘Relative AI (comb)’

**rjn.27.9a**
Stock size description corrected from ‘Relative BI (comb)’ to ‘Relative BI (comb)’

**rjh.27.9a**
Stock size description corrected from ‘Relative BI’ to ‘Relative BI’

**rjc.27.8**
Stock size description corrected from ‘Relative BI (comb)’ to ‘Relative BI (comb)’

**rjc.27.9a**
Stock size description corrected from ‘Relative BI (comb)’ to ‘Relative BI (comb)’

**gfb.27.nea**
Stock size description corrected from ‘Relative BI (comb)’ to ‘Relative BI (comb)’

**cod.27.21**
Stock size description corrected to Relative SSB

**dab.27.3a4**
Stock size description corrected to Relative SSB

**fle.27.2223**
Stock size description corrected to Biomass Index
fle.27.2425
Stock size description corrected to Biomass Index

fle.27.2729-32
Stock size description corrected to Biomass Index
Stock size unit corrected to kg/fishing station

ple.27.24-32
Stock size description corrected to Relative SSB

sdv.27.nea
Stock size description corrected to Relative BI (comb)

spr.27.3a
Stock size description corrected to Abundance Index

spr.27.7de
Stock size description corrected to Relative BI

syc.27.67a-ce-j
Stock size description corrected to Relative BI (comb)
Stock size unit corrected to kg/hour

tur.27.4
Stock size description corrected to Relative SSB

bll.27.22-32
Stock size description corrected to Abundance Index
GETTING IN TOUCH WITH THE EU

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