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Scientific, Technical and Economic Committee for Fisheries (STECF) - Monitoring of the performance of the Common Fisheries Policy (STECF-Adhoc-22-01)

Edited by Michaël Gras, Alessandro Mannini, Christoph Konrad, Sven Kupschus, Henning Winker and Paris Vasilakopoulos

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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: jrc-stecf-secretariat@ec.europa.eu
Tel.: +39 0332 789343

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Abstract

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

Authors:

STECF advice:
Abella, J. Alvaro; Bastardie, Francois; Borges, Lisa; Casey, John; Damalas, Dimitrios; Daskalov, Georgi; Döring, Ralf; Gascuel, Didier; Grati, Fabio; Ibaibarriaga, Leire; Jung, Armelle; Knittweis, Leyla; Ligas, Alessandro; Martin, Paloma; Motova, Arina; Moutopoulos, Dimitrios; Nord, Jenny; Prellezo, Raúl; O'Neill, Barry; Raid, Tiit; Rihan, Dominic; Sampedro, Paz; Somarakis, Stylianos; Stransky, Christoph; Ulrich, Clara; Uriarte, Andres; Valentinsson, Daniel; van Hoof, Luc; Vanhee, Willy; Villasante, Sebastian; Vrgoc, Nedo

Ad hoc expert group EWG-Adhoc-22-01 report:
Michaël Gras, Alessandro Mannini, Christoph Konrad, Sven Kupschus, Henning Winker and Paris Vasilakopoulos

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) - MONITORING OF THE PERFORMANCE OF THE COMMON FISHERIES POLICY (STECF-ADHOC-22-01)

1.1 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."

1.2 Request to the STECF

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

1.3 STECF observations

To address the above Terms of Reference, STECF expert group (STECF-Adhoc-22-01) was convened between January and March 2022 to compile available assessment outputs and conduct the extensive analysis required.

The expert group presented a comprehensive report accompanied by several detailed annexes providing: 1) CFP monitoring protocols as agreed by STECF (STECF, 2018a); 2) R code for computing NE Atlantic indicators; 3) R code for computing Mediterranean & Black Seas indicators. Electronic annexes include 1) URL links to electronic annexes referring to the reports and stock advice sheets underpinning the analysis, 2) ICES data quality issues corrected prior to the analysis, and 3) R code for computing all European waters indicators. The report and electronic annexes are available at https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring .

STECF notes that the report is clear and well laid out, comprehensively describing the analysis undertaken and cataloguing the changes made in the approach since the previous report (STECF-Adhoc-21-01).

The Ad-hoc 22-01 report then sets out results of the analyses separately for the Northeast Atlantic (NE Atlantic), the Mediterranean & Black Seas (Sections 3 and 4). Based on the above results, progress towards achieving MSY objectives are summarised below. In this report, "Northeast Atlantic" refers to stocks in FAO Area 27 inside and outside EU waters[1], and "Mediterranean & Black Seas" refers to stocks in FAO Area 37[2].

At the request of EUROSTAT, an overview for all European waters is also presented (Section 5 of the STECF-Adhoc-22-01 report).

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

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

For the NE Atlantic (FAO area 27), the most recent published assessments carried out up to (and including) 2021 incorporating data up to 2020 were downloaded from the ICES website on 27 January 2022. For the Mediterranean & Black Seas (FAO area 37), the information was extracted from the STECF Mediterranean Expert Working Group repositories comprising the most recently published assessments carried out up to 2021 with data up to 2020, and from the GFCM stock assessment forms comprising the most recently published assessments carried out up to 2020 with data up to 2019.

The analysis for the "Mediterranean and Black Seas" is performed on a limited number of stocks and a small proportion of total EU landings across all species and areas. The information is available for 34 stocks in the Mediterranean Sea, and only for one stock in the Black Sea. For many of these stocks though, the shorter time series of assessments (comparatively to the NE Atlantic) means that biomass reference points with regards to safe biological limits are still missing, and that F0.1 is commonly used as a proxy for $F_{MSY.}$ In addition, the different calendar for the provision of advice under the GFCM framework means that the latest stock assessments only become publicly available later in the year. Therefore, the 2021 GFCM stock assessments were unavailable for the present analysis.

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

The overview below describes the trends in fishing pressure observed in the NE Atlantic and the Mediterranean & Black Sea for the periods 2003 to 2020 and 2003 to 2019, respectively. It applies to the stocks with an analytical assessment (=ICES "categories 1 and 2" stocks) with associated reference points included in the reference list (sampling frame) of stocks for these areas.

Overview of stock status

Northeast Atlantic

The indicators provided in the STECF-Adhoc-22-01 report show that in the NE Atlantic (both EU and non-EU waters), stock status has significantly improved since 2003 (Figure A) but that many stocks are still overexploited: among the stocks which are fully assessed (Table 3, in the STECF-Adhoc-22-01 report), the proportion of overexploited stocks (i.e. $F>F_{MSY}$, blue line) has decreased from around 70% (2003-2008) to 28% in 2020. The proportion of stocks outside safe biological limits ($F>F_{pa}$ or $B<B_{pa}$, orange line, Table 5 in the STECF-Adhoc-22-01 report), computed for the 45 stocks for which both reference points are available, follows a similar decreasing trend, from above 80% (82% in 2003) to around 40% since 2016 (38% in 2020).

STECF observes that the proportion of overexploited stocks has decreased from more than 40% in 2019 to 28% in 2020, but STECF is not in the position to assess whether this change only reflects a yearly event, possibly linked to Covid-19 having induced a temporary decrease in the fishing pressure, or whether this represents a more long term trend of improvement.

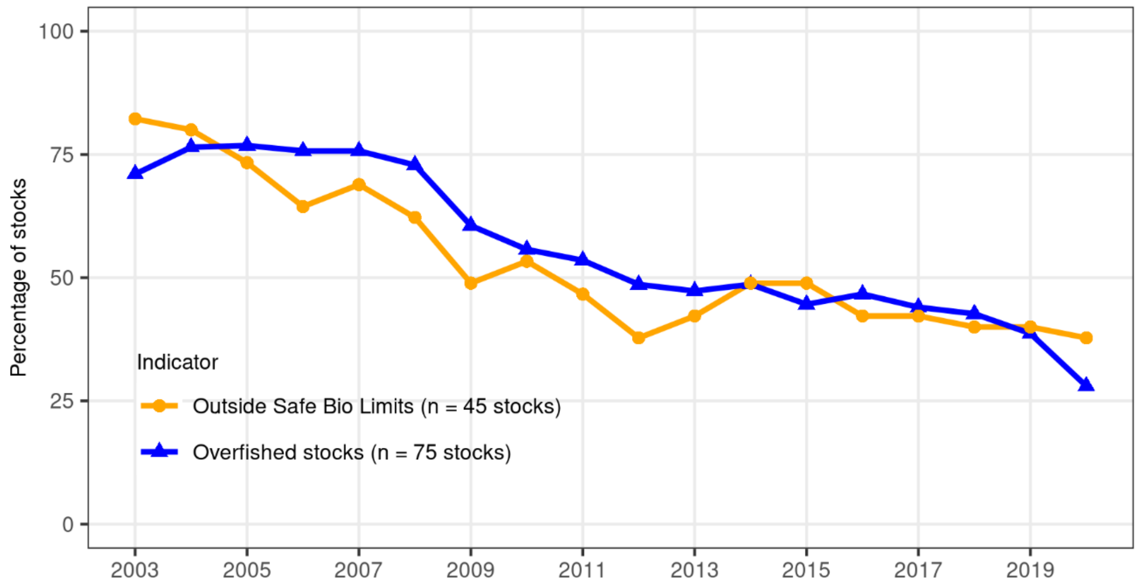

Figure A Trends in stock status in the NE Atlantic (both EU and non-EU waters) 2003-2020. Two calculated proportions are presented: blue line: the proportion of overexploited stocks ($F>F_{MSY}$) (out of a total of 75 stocks) and yellow line: the proportion of stocks outside safe biological limits SBL ($F>F_{pa}$ or $B<B_{pa}$) (out of a total of 45 stocks).

Combining these two calculated proportions (Table A), STECF notes that in 2020, 5 stocks that are exploited below F_{MSY} are still outside safe biological limits, and 5 stocks inside safe biological limits are still exploited above F_{MSY}. In addition, 30 have an unknown status with regards to safe biological limits. This means that for the last known year, of the 75 stocks considered, 31% (23 stocks) are known to be neither overexploited nor inside safe biological limits, suggesting that the Art. 2.2 objective of the CFP has not been met.

Table A Number of stocks overfished (F>FMSY), or not overfished (F≤FMSY), and inside (F≤Fpa and B≥Bpa) and outside (F>Fpa or B<Bpa) safe biological limits (SBL) in 2020 in the NE Atlantic.

	Below F_{MSY}	**Above F_{MSY}**
Inside SBL	23	5
Outside SBL	5	12
Unknown	26	4

Mediterranean & Black Seas

For the Mediterranean & Black Seas, the number of stocks assessed and for which data is available, varies from year to year. In addition, assessment results for some stocks do not extend back to the early part of the time-series. As a result, calculated proportions may be misleading and the trends over time are not presented in the report for this region. According to the summary Table 26 in the STECF-Adhoc-22-01 report, out of 34 stocks, 5 (14%) were not overfished in 2019, the other 29 were overfished. Proportions concerning safe biological limits cannot be calculated as biomass reference points are missing for most stocks.

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

As agreed by STECF (2018a) the Ad-hoc 22-01 report computed the trends in fishing pressure using a statistical model (Generalised Linear Mixed Effects Model, GLMM) accounting for the variability of trends across stocks and including the computation of a confidence interval around the median. A large confidence interval means that different stocks show different trends in F/F_{MSY} over time.

The model-based results for the NE Atlantic (inside and outside EU waters), Mediterranean and Black Seas and for all EU waters are displayed in Figures 15, 17, 26 and 32 of the STECF-Adhoc-22-01 report. For illustration, trends in the median values for F/F_{MSY} over time for inside and outside EU waters in the NE Atlantic and for the Mediterranean and Black Sea are summarised in Figure B below.

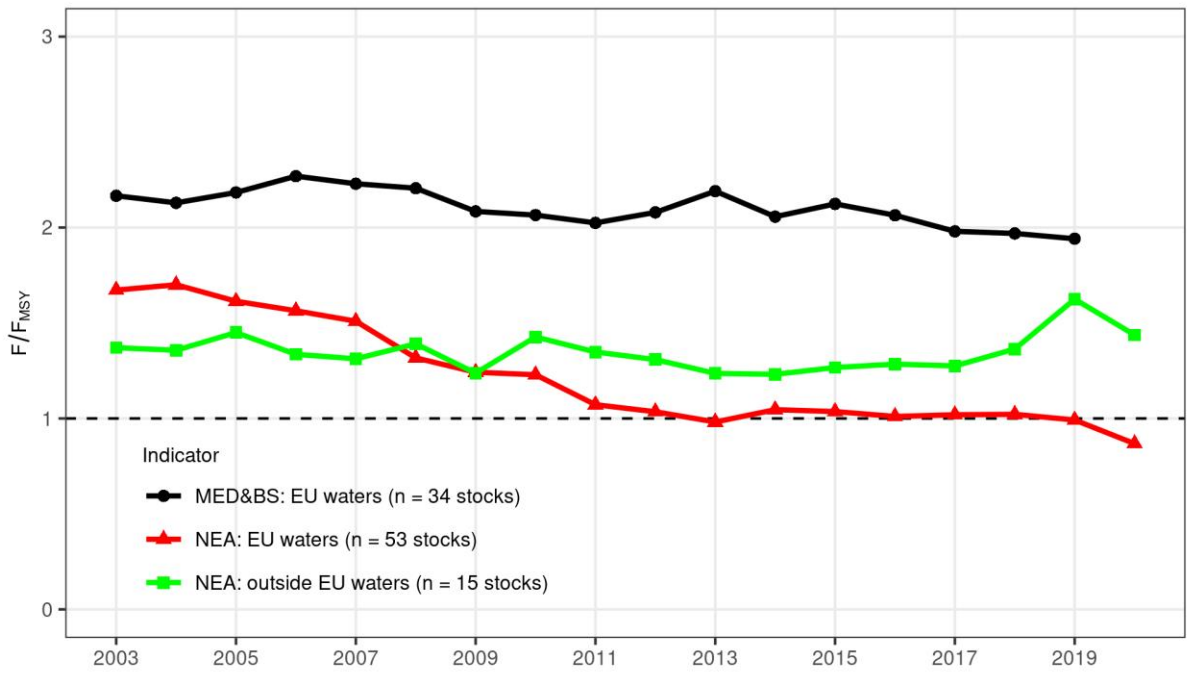

Figure B Trends in fishing pressure 2003-2020. Three model-based indicators F/FMSY are presented (all referring to the median value of the model): one for 53 stocks with appropriate information in the NE Atlantic EU waters (red line); one for an additional set of 15 stocks also located in the NE Atlantic but outside EU waters (green line), and one for the 34 stocks from the Mediterranean Sea & Black Seas (black line).

Northeast Atlantic

In the NE Atlantic EU waters, the model-based indicator of fishing pressure ($F/F_{MSY,}$ based on 52 stocks with appropriate information – Figure 15 in the STECF-Adhoc-22-01 report) shows a gradual downward trend over the period 2003-2020. In the early 2000s, the median of this indicator of fishing mortality was about 1.7 times larger than F_{MSY}, but this has reduced and stabilised close to 1 (F_{MSY}) over the period 2013-2019, noting that the line being around 1 means that only around half of the stocks are fished below F_{MSY}. In 2020 for the first time, the value has fallen below 1 (0.87).

The same model-based indicator was computed by the STECF-Adhoc-22-01 expert group for an additional set of 15 stocks located in the NE Atlantic, but outside EU waters (Figure 17 in the STECF-Adhoc-22-01 report). This median indicator has always remained above 1 (ranging 1.2-1.6) since 2003, with no increasing or decreasing trend.

STECF notes that the somewhat differing perceptions compared to last year may arise because the indicator for NE Atlantic stocks outside EU waters is based on comparatively few stocks (12 in the STECF Ad hoc 21-01 and 15 in the 22-01 reports respectively), and uncertainty around the actual value of the median estimates (confidence interval) is high (see Figure 17 in the STECF Ad hoc 22-01 report). Hence, the median estimates are likely to be unstable from one year to the next and should be interpreted with caution.

Mediterranean and Black Seas

The indicator for fishing pressure computed for stocks from the Mediterranean & Black Seas (34 stocks) has remained at a high level during the whole 2003-2019 period (Figure 26 in the STECF Ad hoc 22-01 report). While there appears to be a slight downward trend in the median value for F/F_{MSY} since 2013, it remains close to 2 x F_{MSY} (Figure 6.8.2), which is not in line with the objective of the CFP.

EU Waters

At the request of EUROSTAT, the F/F_{MSY} model-based indicator was also fitted using all stocks in EU waters as input data, (i.e. both the in NE Atlantic EU waters and in the Mediterranean & Black Seas together (86 stocks), to report on all stocks fished in EU Waters. However, the trend in indicator values (Figure 32 in the STECF-Adhoc-22-01 report) appears to be largely driven by F/F_{MSY} estimates for stocks in the NE Atlantic. This is likely due to the significant variability in trends observed in Mediterranean and Black Seas stocks, compared to the more consistent trends observed across the NE Atlantic stocks. The result is that the overall F/F_{MSY} indicator for all EU waters shows a low and decreasing trend over time, which masks the situation in the Mediterranean and Black Seas. For this reason, STECF decided not to present the trend for EU waters as a whole in Figure B as it is misleading.

Trends in Biomass

The model-based results for the NE Atlantic (EU waters), the Mediterranean and Black Seas and for data-limited stocks in the NE Atlantic (=ICES "category 3" stocks) are displayed respectively in Figures 19, 28 and 21 of the STECF Ad hoc 22-01 report. For illustration, trends in the median values for biomass over time are summarised in Figure 6.8.3 below. STECF notes there is large uncertainty around this indicator (see Figure 32 in the STECF-Adhoc-22-01 report).

The model-based indicators for the trend in biomass (Figures 19 and 28 of the STECF-Adhoc-22-01 report) show a general increase over time since 2007 in the NE Atlantic (EU waters only) both for assessed stocks and for data limited stocks for which only a relative biomass index is available from scientific survey data (Figure C). In 2020, biomass was on average around 35% (for assessed stocks) and 50% (for data limited stocks) higher than in 2003. In the Mediterranean & Black Seas, the median biomass was higher at the beginning of the time-series, but declined and remained stable from 2006–2015, after which it shows a gradual increase.

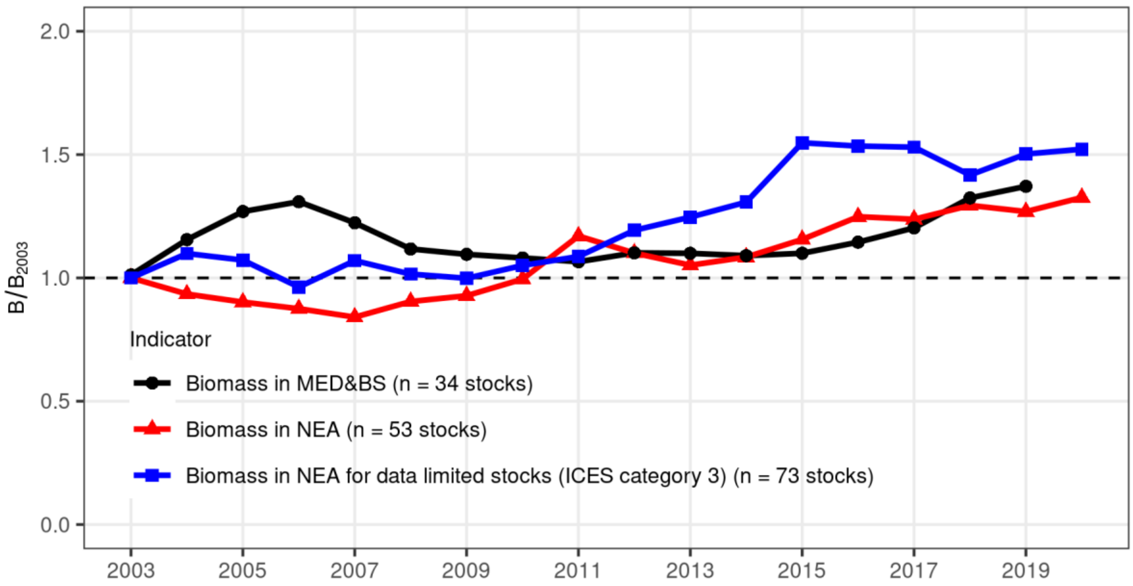

Figure C Trends in the indicators of stock biomass (median values of the model-based estimates relative to 2003). Three indicators are presented: one for the NE Atlantic EU waters (53 stocks considered, red line); one for the Mediterranean & Black Seas (34 stocks, black line); and one for data limited stocks (ICES category 3, 73 stocks, blue line).

As a general comment, STECF notes that the trends observed in this year's STECF-Adhoc-22-01 report may slightly differ from previous STECF reports. Beyond the issue of the varying number of stocks from year to year, such differences may also be partially attributable to the results from updates of the stock assessment. For example, there are instances that some stocks, assessed as overfished one year, are re-assessed as fished at or below Fmsy the following year (or vice-versa), due to the addition of an additional year of data (the inherent so-called "retrospective pattern" of stock assessment results). To illustrate this, changes of historical perceptions over time are given in Section 7 of the STECF-Adhoc-22-01 report. They show that the model systematically underestimates the median value for F/F_{MSY} compared to the subsequent year, and, conversely, overestimates the median value for B/B_{2003}, (Figures 34 and 35 in the STECF-Adhoc-22-01 report). Therefore, small differences in the resulting outcomes compared to last year's report should not be over-interpreted. In the Mediterranean and Black Seas, there appears to be no systematic under- or over-estimation observed in the historical pattern (Figures 36 and 37 in the STECF-Adhoc-22-01 report).

Trends in Recruitment

The model – based results for the trend in decadal recruitment are given in Figure 22 in the STECF-Adhoc-22-01 report. This indicator aims to identify long-term trends in spite of large year-to-year variability of recruitment for all stocks, and is calculated over a twenty-year moving average: For example, the 2019's decadal recruitment for a single stock is the ratio between the average recruitment from 2010 to 2019 over the average recruitment from 2000 to 2009 (check the protocol in Annex 1 of the STECF-Adhoc-22-01 report for more details; Figure 4 in the STECF-Adhoc-22-01 report). Median values model output is displayed in Figure D below.

The average decadal recruitment indicator shows a decreasing trend until 2012 and an inversion afterwards, which may reflect some improvement in the reproductive capacity of the stocks.

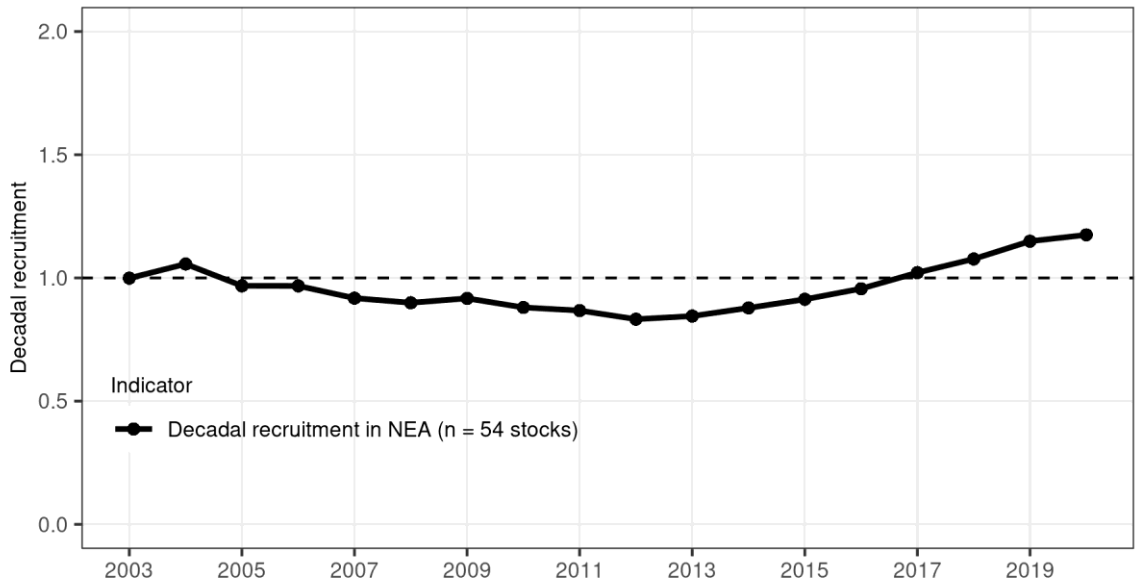

Figure D Trend in median values for decadal recruitment scaled to 2003 in the NE Atlantic area (based on 54 stocks).

Trends per Ecoregion

The STECF-Adhoc-22-01 report provides indicator trends by Ecoregion for EU waters in the NE Atlantic and the Mediterranean & Black Sea. STECF notes, however, that the number of stocks contributing to each ecoregion is generally rather small (<10 stocks per region) meaning that the indicator values may be imprecise. Consequently, the observed trends need to be interpreted with caution.

In EU waters, the overall fishing pressure in all ICES Ecoregions has decreased and the status of stocks has improved compared to the start of the time-series (Figures 4, 6 and 16 in the STECF-Adhoc-22-01 report). In 2020, the proportion of overexploited stocks ranged between 7% - 50% across the different ICES Ecoregions, while the modelled estimate of the F/F_{MSY} ratio for 2020 was between 0.5 and 1.14 with only the estimate for the Baltic Sea above 1.0. While the results for each region may be imprecise, for the stocks analysed, the trends give a clear signal that fishing pressure in each region has reduced over the time-series.

Coverage of the scientific advice

Coverage of biological stocks by the CFP monitoring

The analyses of the progress in achieving the MSY objective in the NE Atlantic should include all stocks with advice provided by ICES that are at least partially inside EU waters. According to the ICES database accessed for the analysis, ICES provided scientific advice for 262 biological stocks included in EU waters (at least in part). Of these, 153 stocks (58%) are data limited (ICES category 3 and above, Table B).

Table B Total number of stocks assessed by ICES for different stock categories in different areas. Note that not all of these stocks are considered of EU relevance (STECF 15-04) and as such, numbers are higher than those used in the CFP monitoring analysis.

	ICES Stock Category						Total
	1	2	3	4	5	6	
Arctic Ocean	9	0	3	0	0	0	12
Azores	0	0	2	0	1	0	3
Baltic Sea	9	0	8	1	1	0	19
BoBiscay & Iberia	12	4	17	0	9	5	47
Celtic Seas	23	0	18	4	8	3	56
Greater North Sea	17	1	6	0	1	1	26
Iceland, Greenland and Faroes	0	0	1	0	0	0	1
Widely	7	0	8	0	4	12	31
Total	103	6	79	7	36	31	262

The present CFP monitoring analysis for the NE Atlantic is focused on stocks with a TAC in 2017 and for which estimates of fishing mortality, biomass and biological reference points are available. As detailed in the STECF Ad hoc 22-01 report, not all indicators can be calculated for all stocks in all years. The expert group was able to compute indicators for 45 to 75 stocks of categories 1 and 2 depending on indicators, years and areas, and 73 stocks of category 3 (Table 4 in the STECF-Adhoc-22-01 report). These stocks represent the vast majority of catches, but a large number of biological stocks present in EU waters are still not included in the CFP monitoring analysis.

In the Mediterranean and Black Seas region, stocks status and trends are only assessed for a limited number of stocks. The expert group selected 243 combinations of Species/GSA in the sampling frame (Mannini et al., 2017[3]), of which 62 combinations (26%) have been covered by 34 available stock assessments in 2019. The difference between the number of combinations (62) and the number of stock assessments (34) stems from the fact that some stocks are assessed over multiple GSAs.

Coverage of TAC regulation by scientific advice

STECF notes that 156 TACs (combination of species and fishing management zones) in the EU waters of the NE Atlantic are derived using the agreed sampling frame (Gibin, 2017[4]; Scott et al 2017a[5], Scott et al 2017b[6]). 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 EWG therefore computed an indicator of advice coverage, where a TAC is "covered" by a stock assessment when at least one of its divisions match the spatial distribution of a stock for which reference points have been estimated from an ICES full assessment. Based on this indicator, 56% of the 156 TACs are covered, at least partially, by stock assessments that provide estimates of F_{MSY} (or a proxy), 51% by stock assessments that have B_{pa}, with only 22% covered by stock assessments that provide estimates or proxies of B_{MSY}.

[3] Mannini, A., Osio G.C., Jardim E., Mosqueira I., Scott F., Vasilakopoulos P., Casey J., 2017 - Technical report on: Sampling Frames for Mediterranean and Black Sea CFP Monitoring indicators Publications Office of the European Union, Luxembourg; EUR 28568; doi:10.2760/31047.

[4] Gibin M., 2017 - Integrating Fishing Management Zones, FAO and ICES statistical areas by data fusion, JRC Technical Report, JRC105881.

[5] Scott, F., Gibin, M. and Jardim, E., 2017a - Generating the CFP indicators sampling frame for FAO area 27 (Northeast Atlantic). JRC Technical Report, JRC106114, doi:10.2760/689063.

[6] Scott, F., Gibin, M., Vasilakopoulos, P. and Jardim, E. 2017b. Matching the sampling frame for FAO area 27 (Northeast Atlantic) with ICES assessments. JRC Technical Report, JRC106115, doi:10.2760/818883.

Additionally, STECF notes that, using this index, some TACs can be considered as "covered" if they relate to: (i) part of a given management area, (ii) several assessments contributing to a single TAC (e.g. *Nephrops* functional units in the North Sea) or (iii) scientific advice covering a different (but partially common) area (e.g. whiting in the Bay of Biscay). Thus, such an approach overestimates the spatial coverage of advice (i.e. the proportion of TACs based on a single and aligned assessment). This means that many TACs are still not covered by scientific advice based on F_{MSY} reference values.

Ongoing developments

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

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

STECF notes that work is planned in 2022 to revise the protocol, including a proposal to provide a more robust indicator for trends in biomass (See Section ToR 7.7 of this PLEN 22-01 report).
STECF also recognises the need to broaden the scope of the CFP monitoring to address those CFP objectives that are not currently dealt with. In particular, indicators covering the landing obligation, wider ecosystem and socio-economic aspects in the analysis would be a useful expansion. A process to develop such indicators was initiated in 2018 but needs further development to be made fully operational and routinely included in the CFP monitoring.

1.4 STECF conclusions

Regarding the progress made in the achievement of F_{MSY} in line with the CFP, STECF concludes that the latest results indicate a reduction in the overall exploitation rate and an increase in biomass of stocks in the NE Atlantic over the period 2003-2020. Nevertheless, many stocks remain overfished and/or outside safe biological limits and the objective of the CFP to ensure that all stocks are fished at or below F_{MSY} in 2020 has not been achieved.

STECF also concludes that the situation with regard to stocks in the Mediterranean and Black Sea remains challenging, with annual fishing mortality estimates around twice of F_{MSY} for the entire time-series (2003-2019). There are indications that fishing pressure has slightly decreased since 2013 to just below that average level in 2019, while biomass indicates the onset of a slight improvement since 2015 after a period of showing no trend between 2007 and 2015. Furthermore, there remains a need to increase the number of stocks that are assessed in the Mediterranean and Black Seas, to increase the representativeness of the indicator values.

STECF notes that many stocks still lack definition of some key reference points in relation to safe biological limits, F_{MSY} or B_{MSY}. STECF considers this issue to be a priority, and supports ongoing work in ICES, GFCM and STECF EWGs to improve this situation. Progresses will be incorporated in this CFP monitoring as they become available.
STECF recognises the need to revise and update the protocol that has been followed for this monitoring report since 2018, and to broaden its scope to consider possible additional CFP objectives not currently dealt with. Suggestions for this have been discussed in ToR 7.7 of this PLEN 22-01 report.

1.5 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

Name	Affiliation[1]	Email
Abella, J. Alvaro	Independent consultant	aabellafisheries@gmail.com
Bastardie, Francois	Technical University of Denmark, National Institute of Aquatic Resources (DTU-AQUA), Kemitorvet, 2800 Kgs. Lyngby, Denmark	fba@aqua.dtu.dk
Borges, Lisa	FishFix, Lisbon, Portugal	info@fishfix.eu
Casey, John	Independent consultant	blindlemoncasey@gmail.com
Damalas, Dimitrios	Hellenic Centre for Marine Research, Institute of Marine Biological Resources & Inland Waters, 576 Vouliagmenis Avenue, Argyroupolis, 16452, Athens, Greece	shark@hcmr.gr
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Georgi.m.daskalov@gmail.com
Döring, Ralf (vice-chair)	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Economic analyses Herwigstrasse 31, D-27572 Bremerhaven, Germany	ralf.doering@thuenen.de
Gascuel, Didier	AGROCAMPUS OUEST, 65 Route de Saint Brieuc, CS 84215, F-35042 RENNES Cedex, France	Didier.Gascuel@agrocampus-ouest.fr
Grati, Fabio	National Research Council (CNR) – Institute for Biological Resources and Marine Biotechnologies (IRBIM), L.go Fiera della Pesca, 2, 60125, Ancona, Italy	fabio.grati@cnr.it
Ibaibarriaga, Leire	AZTI. Marine Research Unit. Txatxarramendi Ugartea z/g. E-48395 Sukarrieta, Bizkaia. Spain.	libaibarriaga@azti.es
Jung, Armelle	DRDH, Techopôle Brest-Iroise, BLP 15 rue Dumont d'Urville, Plouzane, France	armelle.jung@desrequinsetdeshommes.org

Name	Affiliation[1]	Email
Knittweis, Leyla	Department of Biology, University of Malta, Msida, MSD 2080, Malta	Leyla.knittweis@um.edu.mt
Ligas, Alessandro	CIBM Consorzio per il Centro Interuniversitario di Biologia Marina ed Ecologia Applicata "G. Bacci", Viale N. Sauro 4, 57128 Livorno, Italy	ligas@cibm.it; ale.ligas76@gmail.com
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49, 08003 Barcelona, Spain	paloma@icm.csic.es
Motova, Arina	Sea Fish Industry Authority, 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HS, U.K	arina.motova@seafish.co.uk
Moutopoulos, Dimitrios	Department of Animal Production, Fisheries & Aquaculture, University of Patras, Rio-Patras, 26400, Greece	dmoutopo@teimes.gr
Nord, Jenny	The Swedish Agency for Marine and Water Management (SwAM)	Jenny.nord@havochvatten.se
Prellezo, Raúl	AZTI -Unidad de Investigación Marina, Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	rprellezo@azti.es
O'Neill, Barry	DTU Aqua, Willemoesvej 2, 9850 Hirtshals, Denmark	barone@aqua.dtu.dk
Raid, Tiit	Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia	Tiit.raid@gmail.com
Rihan, Dominic (vice-chair)	BIM, Ireland	rihan@bim.ie
Sampedro, Paz	Spanish Institute of Oceanography, Center of A Coruña, Paseo Alcalde Francisco Vázquez, 10, 15001 A Coruña, Spain	paz.sampedro@ieo.es
Somarakis, Stylianos	Institute of Marine Biological Resources and Inland Waters (IMBRIW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gournes, P.O. Box 2214, Heraklion 71003, Crete, Greece	somarak@hcmr. gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Herwigstrasse 31, D-27572 Bremerhaven, Germany	christoph.stransky@thuenen.de
Ulrich, Clara (chair)	IFREMER, France	Clara.Ulrich@ifremer.fr

Name	Affiliation[1]	Email
Uriarte, Andres	AZTI. Gestión pesquera sostenible. Sustainable fisheries management. Arrantza kudeaketa jasangarria, Herrera Kaia - Portualdea z/g. E-20110 Pasaia – GIPUZKOA (Spain)	auriarte@azti.es
Valentinsson, Daniel	Swedish University of Agricultural Sciences (SLU), Department of Aquatic Resources, Turistgatan 5, SE-45330, Lysekil, Sweden	daniel.valentinsson@slu.se
van Hoof, Luc	Wageningen Marine Research Haringkade 1, Ijmuiden, The Netherlands	Luc.vanhoof@wur.nl
Vanhee, Willy	Independent consultant	wvanhee@telenet.be
Villasante, Sebastian	University of Santiago de Compostela, Santiago de Compostela, A Coruña, Spain, Department of Applied Economics	sebastian.villasante@usc.es
Vrgoc, Nedo	Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia	vrgoc@izor.hr

REPORT TO THE STECF

Report of the ad hoc Expert Group on monitoring the performance of the Common Fisheries Policy (EWG-Adhoc-22-01)

Virtual meeting, January-March 2022

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 provision of article 50.

In an attempt to make the process of computing each of the indicators consistent and transparent and to take account of issues identified and documented in previous CFP monitoring reports, a revised protocol was adopted by the STECF in 2019 (Annex I).

An ad hoc Expert Group comprising experts from the European Commission's Joint Research Centre (JRC) was convened from January to March 2022 to compute the performance indicator values according to the agreed protocol (Annex I) and to report to the STECF plenary meeting scheduled for 21-25 March 2022.

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 are referring to coastal waters of the EU in FAO areas 27 (North East Atlantic and adjacent seas) and 37 (Mediterranean and Black Seas). The Mediterranean included FAO Geographical SubAreas (GSA) 1, 5, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, and 29. The NE Atlantic included the ICES subareas "III", "IV" (excluding Norwegian waters of division IVa), "VI", "VII", "VIII", "IX", and "X".

2.1.1 Stock assessment information

From mid-March 2020, the Covid-19 outbreak prevented the ICES Expert Working Groups to meet physically. The "Spring 2020" approach (https://www.ices.dk/news-and-events/news-archive/news/Pages/spring2020approach.aspx) was not applied in 2021 and advice sheets were back to their original format. The CFP monitoring report 2021 (STECF, 2021a) was the only report based primarily on abbreviated advice sheets. In this report, category 1 and 2 stocks bli.27.5b67, cod.27.6a and dgs.27.nea were given an abbreviated advice covering 2021 and 2022.

For the NE Atlantic (FAO area 27), the information was downloaded from the ICES website (https://standardgraphs.ices.dk) on 27 January 2022, comprising the most recent published assessments carried out up to and including 2021. Thorough data quality checks and corrections were carried out to ensure the information downloaded was in agreement with the summary sheets published online (online annex I and II, https://stecf.jrc.ec.europa.eu/reports/cfp-monitoring).

For the Mediterranean region (FAO area 37), the information was extracted from the STECF Mediterranean Expert Working Group repositories (https://stecf.jrc.ec.europa.eu/reports/medbs) comprising the most recent published assessments carried out up to 2021 and from the GFCM stock assessment forms (https://www.fao.org/gfcm/data/safs) comprising the most recent published assessments carried out up to 2020.

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

Stocks ank.27.8c9a, lez.27.4a6a, lez.27.6b, nep.fu.25, nep.fu.2627, nep.fu31 were assessed in the framework of category 1 or 2 using Bayesian biomass dynamic models. These models provide estimates of B/B_{MSY} that were used to assess their status against CFP criteria (CFP, i.e. $F<F_{MSY}$ and $B>B_{MSY}$). Since B_{PA} is defined as a fraction of B_{MSY} or not at all, and B_{MSY} is not reported as an absolute value, these stocks are not taken into account by the SBL indicator.

2.1.2 Management units information

For the NE Atlantic, management units are defined by Total Allowable Catches (TAC). Annual fishing opportunities for a species or a group of species in a Fishing Management Zone (FMZ). The information regarding the TACs in 2016 was downloaded from the FIDES reporting system. Subsequently, this information was cleaned and processed to identify the FMZ of relevance to this work, as well as the ICES rectangles they span to (Gibin, 2017; Scott et al., 2017a; Scott et al., 2017b). This work was done once in 2017 and has not been updated since then.

2.2 Methods

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

2.3 Points to note

- Stocks assessed with biomass dynamic models do not provide a value for F_{PA}, although they may provide a B_{PA} proxy ($0.5 \cdot B_{MSY}$). Consequently, such stocks cannot be used to compute safe biological limits (SBL; Sections 3.2.3 and 3.2.4).
- The Generalised Linear Mixed effects Model (GLMM) uses a shortened time series, starting in 2003, instead of the full time series of available data. This has the advantage of balancing the dataset by removing those years with only a low number of assessment estimates. It has the disadvantage of excluding data.
- Indicators of trends computed with the GLMM show the average progress of the process they represent, including its uncertainty in terms of 50% and 95% confidence intervals. In the former case corresponding to the range between 25% and 75% percentiles, and for the latter between 2.5% and 97.5% percentiles.
- The GLMM fit within the bootstrap procedure does not converge for all resamples. Worst case is the biomass trends model fit with approximately 1% non-convergence. Failed resamples were excluded when deriving model-based indicators.
- The biomass indicator for stocks assessed with data-limited methods (ICES stocks category 3) includes both abundance indices and biomass indices, with a variety of measurement units.

2.4 Differences from the 2021 CFP Monitoring Report

2.4.1 Northeast Atlantic and adjacent seas

The methods used in the analysis for this report were the same used for the 2021 report (STECF, 2021a).

As in last year's report (STECF, 2021a), an extra section was added to report results for two indicators of fisheries state for all European waters (Joining FAO area 27 and FAO area 37): one indicator of F/F_{MSY} and one for B/B_{2003}.

In 2021 the stock nep.fu.13 was excluded from the analysed dataset as the final advice for 2021 was published on 23 March 2021 (ICES 2020). In this year's report, the stock has been included in the analysis.

Compared to last year's report, with relation to ICES category 1 & 2 stocks,
3 stocks were renamed

- bzq.27.2425 (renamed from bwq.27.2425)
- bzq.27.2628 (renamed from bwq.27.2628)
- lin.27.346-91214 (renamed from lin.27.3a4a6-91214)

3 stocks outside EU waters were added to the category 1/2

- aru.27.5a14 (upgraded from cat 3 to cat 1)
- aru.27.5b6a (upgraded from cat 3 to cat 1)
- lin.27.5b (upgraded from cat 3 to cat 1)

10 stocks were added/upgraded into category 1/2

- ank.27.8c9a (upgraded from cat 3 to cat 2)
- her.27.3031 (upgraded from cat 5 to cat 1)
- lez.27.6b (upgraded from cat 3 to cat 2)
- nep.fu.13 (assessment occurred before cut off)
- nep.fu.2324 (included for the first time as it has now a 5-year F/F_{MSY} time series)
- nep.fu.25 (upgraded from cat 3 to cat 2)
- nep.fu.2627 (upgraded from cat 3 to cat 2)
- nep.fu.31 (upgraded from cat 3 to cat 2)
- sol.27.7d (upgraded from cat 3 to cat 1)
- whg.27.6a (upgraded from cat 5 to cat 1)

1 stock cod.27.1-2coast was split into 2

- cod.27.1-2coastN
- cod.27.2coastS

4 stocks were upgraded into category 3

- gur.27.3-8 (upgraded from cat 6 to cat 3)
- pil.27.7 (upgrade from cat 5 to cat 3)
- sol.27.8c9a (upgrade from cat 5 to cat 3)
- whg.27.3a (upgrade from cat 5 to cat 3)

1 stock was dropped in 2021:

- mur.27.7-10

2.4.2 Mediterranean and Black Seas

Due to the reduced numbers of stock assessments available for 2020 the indicators are plotted up to 2019 only and 2020's value is represented as stand-alone in Figure 24.
With relation to last year's report (STECF, 2021a) the following stocks were not included in the current analysis:

- Sardines in the Strait of Sicily (pil_16) and in the Aegean Sea (pil_22), Anchovy in the Aegean Sea (ane_22) and Norway lobster in the Balearic Islands (nep_5) were dropped from this year's analysis as the latest assessment was done in 2018, therefore it fell outside the year range used to estimate the indicators (2019-2021).
- Sardine in the Adriatic Sea (pil_17_18) has been dropped because no final agreement has been reached during the most recent GFCM benchmark and it has no accepted reference points (https://www.fao.org/gfcm/technical-meetings/detail/en/c/1395453/).

4 new stocks were added

- Hake in the Aegean Sea (hke_22)
- Deep-water rose shrimp in the Northern Spain (dps_06)
- Sardines in the Alboran Sea (pil_01) and in the Northern Spain (pil_06)

3 NORTHEAST ATLANTIC AND ADJACENT SEAS (FAO REGION 27)

3.1 Number of stock assessments available to compute CFP performance indicators

The number of stock assessments with estimates of F/F_{MSY} for the years 2003-2020 for FAO region 27 are given in Figure 1. The global values as well as the breakdown by Ecoregion are provided in Table 1.

The detailed time series for each category 1 and 2 stocks is presented in Figure 2. Three stocks (cod.27.6a, dgs.27.nea and bli.27.5b67) were given a 2-year advice in 2020. As a result no estimates of F/F_{MSY} were available for these in 2020.The number of stocks for which an F/F_{MSY} was estimated was 75 for the year 2019 and 72 for the year 2020.

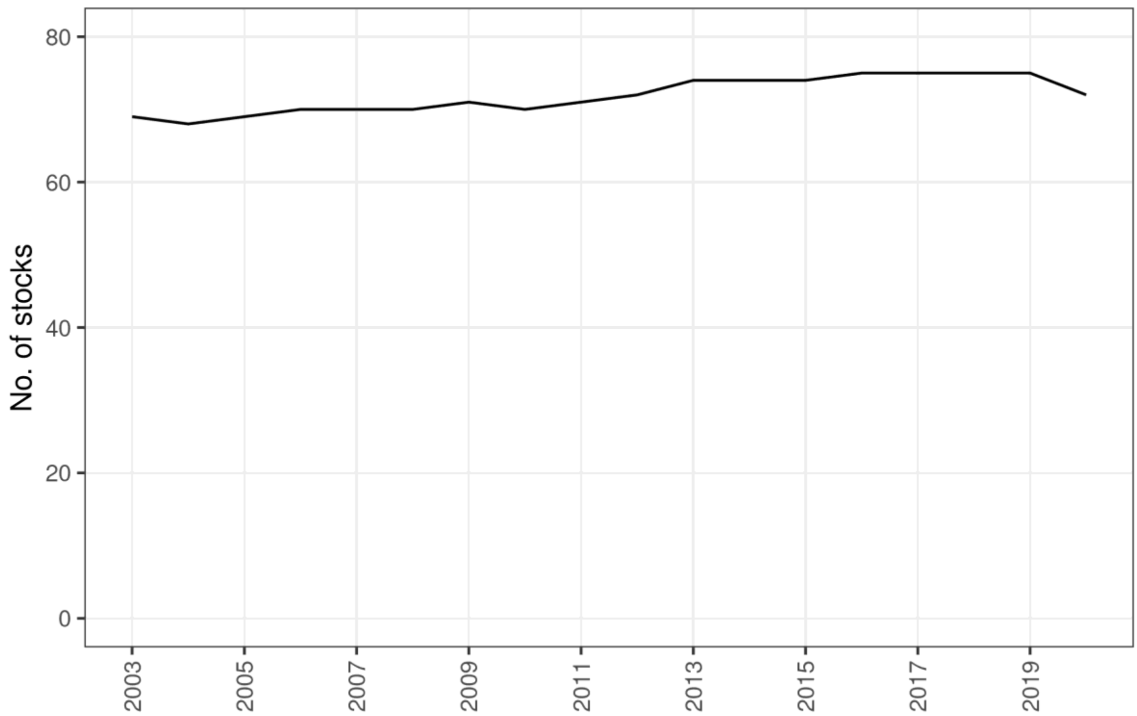

Figure 1: Number of stocks in the NE Atlantic for which estimates of F/F_{MSY} are available by year (NEAI0)

Table 1: Number of stocks in the ICES area for which estimates of F/F_{MSY} are available by ecoregion and year (NEAI0)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	69	68	69	70	70	70	71	70	71
Baltic Sea	8	8	8	8	8	8	8	8	8
BoBiscay & Iberia	12	12	12	12	12	12	12	12	12
Celtic Seas	21	20	21	22	22	22	23	22	23
Greater North Sea	22	22	22	22	22	22	22	22	22
Widely	6	6	6	6	6	6	6	6	6

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	72	74	74	74	75	75	75	75	72
Baltic Sea	8	8	8	8	8	8	8	8	8
BoBiscay & Iberia	12	12	12	12	13	13	13	13	13
Celtic Seas	24	26	26	26	26	26	26	26	25

Greater North Sea	22	22	22	22	22	22	22	22	22
Widely	6	6	6	6	6	6	6	6	4


Baltic Sea
cod.27.22-24
her.27.20-24
her.27.25-2932
her.27.28
her.27.3031
ple.27.21-23
sol.27.20-24
spr.27.22-32
BoBiscay & Iberia
ane.27.8
ank.27.8c9a
hom.27.9a
ldb.27.8c9a
meg.27.7b-k8abd
meg.27.8c9a
mon.27.78abd
mon.27.8c9a
nep.fu.2324
nep.fu.25
nep.fu.2627
nep.fu.31
sol.27.8ab
Celtic Seas
cod.27.6a
cod.27.7e-k
had.27.6b
had.27.7a
had.27.7b-k
her.27.irls
her.27.nirs
lez.27.4a6a
lez.27.6b
nep.fu.11
nep.fu.12
nep.fu.13
nep.fu.14
nep.fu.15
nep.fu.16
nep.fu.17
nep.fu.19
nep.fu.2021
nep.fu.22
ple.27.7a
sol.27.7a
sol.27.7e
sol.27.7fg
whg.27.6a
whg.27.7a
whg.27.7b-ce-k
Greater North Sea
cod.27.47d20
had.27.46a20
her.27.3a47d
nep.fu.6
nep.fu.7
nep.fu.8
nep.fu.9
nop.27.3a4
ple.27.420
ple.27.7d
pok.27.3a46
pra.27.3a4a
san.sa.1r
san.sa.2r
san.sa.3r
san.sa.4
sol.27.4
sol.27.7d
spr.27.3a4
tur.27.4
whg.27.47d
wit.27.3a47d
Widely
bli.27.5b67
dgs.27.nea
hke.27.3a46-8abd
hom.27.2a4a5b6a7a-ce-k8
mac.27.nea
whb.27.1-91214
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year

Figure 2: Time series of stock assessment results in the NE Atlantic for which estimates of F/F_{MSY} are available by year. Blank records indicate that no estimate was available for the stock in that year.

The number of stocks in category 1 and 2 for which an F/F_{MSY} estimate was available increased by 6 or 8 depending on the year. The number of stocks increased from 2003 (69) to 2019 (75) (Figure 1 and Table 1) with a subsequent decrease in 2020 due to the biannual advice stock (see section 2).

As in last year's report (STECF, 2021a), cod.27.24-32 was not included in the analysis. Although it has been upgraded from cat 3 to cat 1 in 2020 (ICES 2021b), the absence of fishing pressure reference points prevented its inclusion in the analysed dataset according to the protocol.

Six category 1 stocks were not included because they are not in the agreed sampling frame (Gibin, 2017; Scott et al., 2017a; Scott et al., 2017b; see section 2.1.2):

- bss.27.4bc7ad-h
- bss.27.8ab
- cod.27.24-32
- nep.fu.3-4
- pil.27.8abd
- pil.27.8c9a

The stock nep.fu.3-4 has been dropped from the analysed dataset due to having only 4 years of F/F_{MSY} estimates (the protocol requires 5 years).

There are 7 stocks managed with a $B_{escapment}$ strategy (ane.27.8, nop.27.3a4, san.sa.1r, san.sa.2r, san.sa.3r, san.sa.4, spr.27.3a4). For 5 of these stocks, ICES set $MSYB_{escapment}$ at B_{PA} and not at B_{MSY}. For the other two stocks, different rules were applied. For the first one, ane.27.8, a harvest control rule (HCR) with 2 biomass trigger points is used. For this stock, ICES reports only B_{lim} and the 2 trigger points as SSBmgt reference points. For the second one, nop.27.3a4, a probabilistic method is used to set the catches such as $C_{y+1} = C|(P[SSB<Blim]=0.05)$.

As in last year's and previous reports (STECF, 2021a; STECF, 2020), the stock pra.27.1-2 was not included in the indicator F/F_{MSY} for stocks outside EU waters of FAO region 27, due to its large impact on the indicator values.

Out of the 64 stocks with MSY reference points, 39 stocks have $MSYB_{trigger}$ set at B_{PA} levels. Three of these stocks have explicitly estimated both reference points (hom.27.9a, pra.27.3a4a and sol.27.7e), all the others used ICES's default procedure. For the latter cases $MSYB_{trigger}$ was set to unknown as discussed by STECF (2018b).

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

Table 2: Indicators computed for each stock

Stock Name	Year	Above / Below F_{MSY}	In/Out SBL	$F \leq F_{MSY}$& $B \geq B_{MSY}$	F/F_{MSY} trends	Biomass trends	Decadal recruitment trends	Biomass data category 3 trends
ane.27.8	2020	X				X	X	
ane.27.9a	2020							X
anf.27.3a46	2019							X
ank.27.78abd	2020							X
ank.27.8c9a	2020	X		X	X			X
aru.27.6b7-1012	2020							X
bli.27.5b67	2019	X	X		X	X	X	
bll.27.22-32	2019							X
bll.27.3a47de	2020							X
boc.27.6-8	2020							X
bsf.27.nea	2019							X
bwp.27.2729-32	2020							X
bzq.27.2425	2020							X
bzq.27.2628	2020							X
cod.27.21	2020							X
cod.27.22-24	2020	X	X		X	X	X	
cod.27.47d20	2020	X	X		X	X	X	
cod.27.6a	2019	X	X		X	X	X	
cod.27.7a	2020							X
cod.27.7e-k	2020	X	X		X	X	X	
dab.27.22-32	2019							X
dab.27.3a4	2018							X
dgs.27.nea	2019	X		X		X	X	
fle.27.2223	2018							X
fle.27.3a4	2020							X
gfb.27.nea	2019							X
gug.27.3a47d	2020							X

gur.27.3-8	2020							X
had.27.46a20	2020	X	X		X	X	X	
had.27.6b	2020	X	X		X	X	X	
had.27.7a	2020	X	X	X	X	X	X	
had.27.7b-k	2020	X	X		X	X	X	
her.27.20-24	2020	X	X		X	X	X	
her.27.25-2932	2020	X	X		X	X	X	
her.27.28	2020	X	X	X	X	X	X	
her.27.3031	2020	X	X		X	X	X	
her.27.3a47d	2020	X	X	X	X	X	X	
her.27.6a7bc	2020							X
her.27.irls	2020	X	X		X	X	X	
her.27.nirs	2020	X	X		X	X	X	
hke.27.3a46-8abd	2020	X	X		X	X	X	
hke.27.8c9a	2020							X
hom.27.2a4a5b6a7a-ce-k8	2020	X	X		X	X	X	
hom.27.3a4bc7d	2019							X
hom.27.9a	2020	X		X	X	X	X	
ldb.27.8c9a	2020	X	X		X	X	X	
lem.27.3a47d	2020							X
lez.27.4a6a	2020	X		X	X			
lez.27.6b	2020	X		X	X			X
lin.27.346-91214	2020							X
mac.27.nea	2020	X	X		X	X	X	
meg.27.7b-k8abd	2020	X	X		X	X	X	
meg.27.8c9a	2020	X	X		X	X	X	
mon.27.78abd	2020	X	X		X	X	X	
mon.27.8c9a	2020	X	X	X	X	X	X	
nep.fu.11	2020	X		X				
nep.fu.12	2020	X		X				

nep.fu.13	2020	X		X				
nep.fu.14	2020	X		X				
nep.fu.15	2020	X		X				
nep.fu.16	2020	X						
nep.fu.17	2020	X		X				
nep.fu.19	2020	X		X				
nep.fu.2021	2020	X		X				
nep.fu.22	2020	X		X				
nep.fu.2324	2020	X						
nep.fu.25	2020	X		X	X			X
nep.fu.2627	2020	X		X	X			X
nep.fu.2829	2020							X
nep.fu.30	2019							X
nep.fu.31	2020	X		X	X			X
nep.fu.6	2020	X		X				
nep.fu.7	2020	X		X				
nep.fu.8	2020	X		X				
nep.fu.9	2020	X		X				
nop.27.3a4	2020	X				X	X	
ple.27.21-23	2020	X	X		X	X	X	
ple.27.24-32	2020							X
ple.27.420	2020	X	X	X	X	X	X	
ple.27.7a	2020	X	X	X	X	X	X	
ple.27.7d	2020	X	X		X	X	X	
ple.27.7e	2020							X
ple.27.7fg	2020							X
ple.27.7h-k	2020							X
pok.27.3a46	2020	X	X		X	X	X	
pra.27.3a4a	2020	X	X	X	X	X	X	
raj.27.1012	2019							X

rjc.27.3a47d	2020						X
rjc.27.6	2019						X
rjc.27.7afg	2019						X
rjc.27.8	2019						X
rjc.27.9a	2019						X
rje.27.7fg	2019						X
rjh.27.4c7d	2019						X
rjh.27.9a	2019						X
rjm.27.3a47d	2020						X
rjm.27.67bj	2019						X
rjm.27.7ae-h	2019						X
rjm.27.8	2019						X
rjn.27.3a4	2020						X
rjn.27.678abd	2019						X
rjn.27.8c	2019						X
rjn.27.9a	2019						X
rjr.27.23a4	2018						X
rju.27.7de	2019						X
rng.27.3a	2019						X
san.sa.1r	2020	X			X	X	
san.sa.2r	2020	X			X	X	
san.sa.3r	2020	X			X	X	
san.sa.4	2020	X			X	X	
sbr.27.10	2019						X
sbr.27.9	2019						X
sdv.27.nea	2020						X
sho.27.67	2020						X
sho.27.89a	2020						X
sol.27.20-24	2020	X	X	X	X	X	
sol.27.4	2020	X	X	X	X	X	

sol.27.7a	2020	X	X		X	X	X	
sol.27.7d	2020	X	X		X	X	X	
sol.27.7e	2020	X	X	X	X	X	X	
sol.27.7fg	2020	X	X		X	X	X	
sol.27.8ab	2020	X	X		X	X	X	
sol.27.8c9a	2020							X
spr.27.22-32	2020	X	X		X	X	X	
spr.27.3a4	2020	X				X	X	
spr.27.7de	2020							X
syc.27.3a47d	2020							X
syc.27.67a-ce-j	2020							X
syc.27.8abd	2020							X
syc.27.8c9a	2020							X
syt.27.67	2019							X
tur.27.22-32	2020							X
tur.27.3a	2020							X
tur.27.4	2020	X	X	X	X	X	X	
usk.27.3a45b6a7-912b	2020							X
whb.27.1-91214	2020	X	X		X	X	X	
whg.27.3a	2019							X
whg.27.47d	2020	X	X		X	X	X	
whg.27.6a	2020	X	X		X	X	X	
whg.27.7a	2020	X	X		X	X	X	
whg.27.7b-ce-k	2020	X	X		X	X	X	
wit.27.3a47d	2020	X	X		X	X	X	
Total		**75**	**45**	**30**	**52**	**54**	**54**	**73**

3.2 Indicators of management performance

The first set of indicators (Figure 3 to Figure 14 and Table 8) represent the number of stocks with relation to specific thresholds. The presentation of these indicators is made in pairs, with one indicator showing the number of stocks above/outside the relevant thresholds, followed by another showing the number of stocks below/inside.
The second set of indicators (Figure 15 to
Figure 23 and Table 9 to Table 16) depicts time trends of indicators computed using a statistical model. Most indicators have a global and a regional depiction (indicators 1-8 and indicator 10).

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

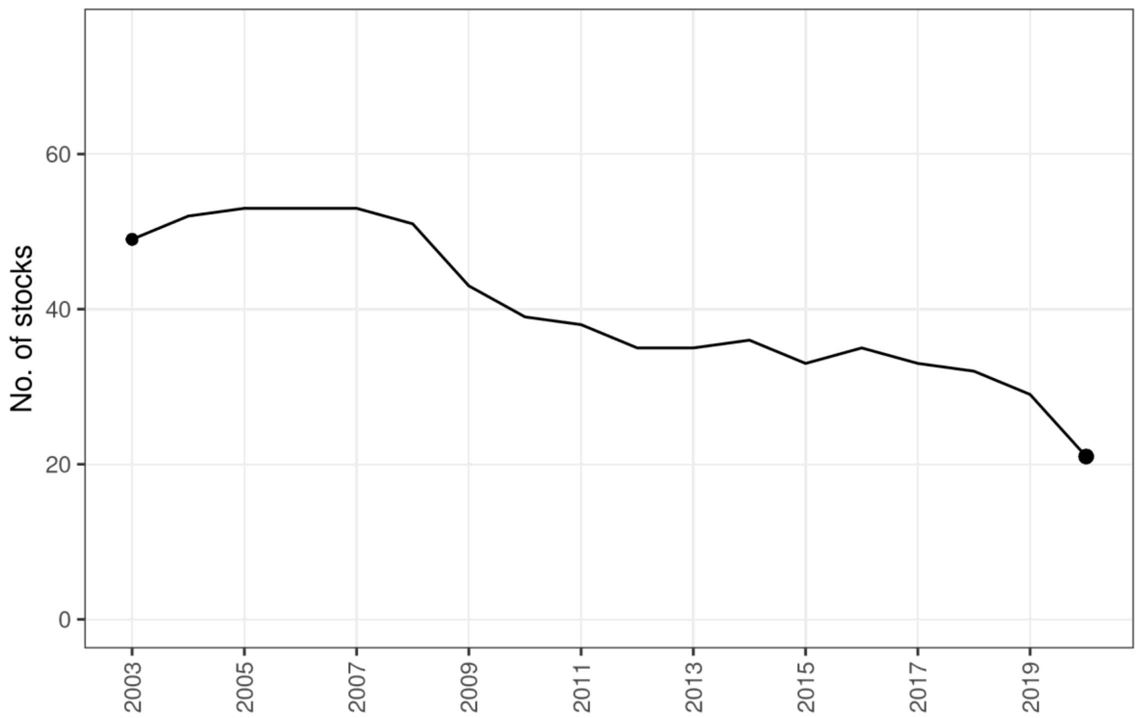

Figure 3: Number of stocks by year for which fishing mortality (F) exceeded F_{MSY} (NEAI1a).

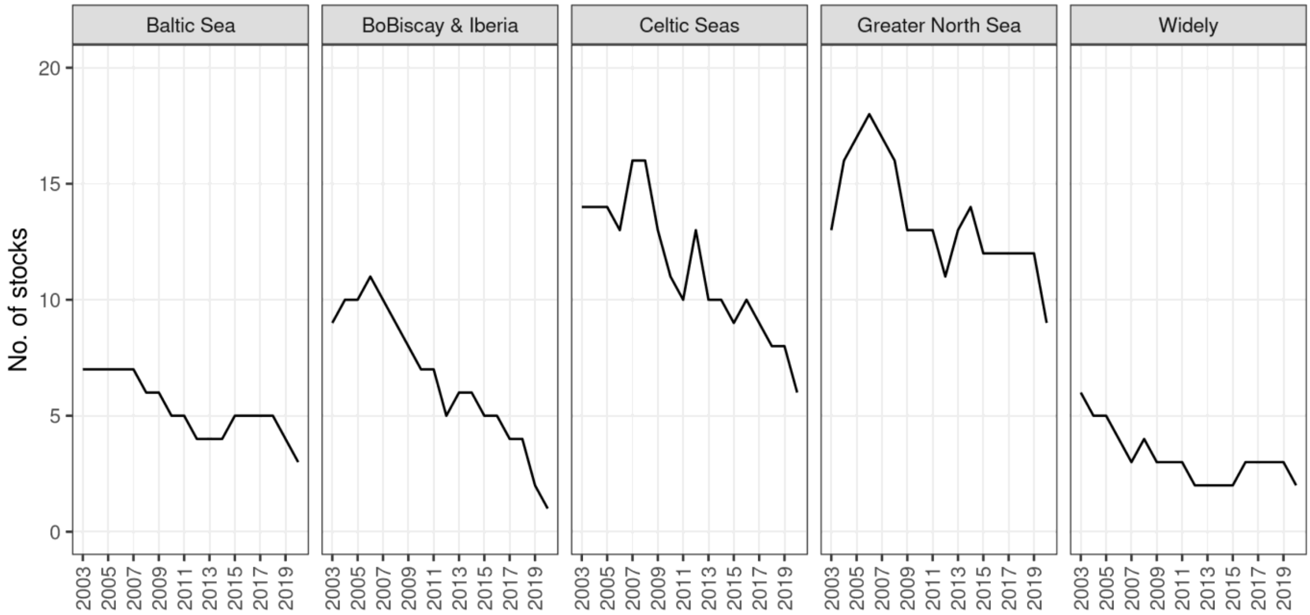

Figure 4: Number of stocks by ecoregion for which fishing mortality (F) exceeded F_{MSY} (NEA1b)

Table 3: Number of stocks by ecoregion for which fishing mortality (F) exceeded F_{MSY} (NEAI1)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	49	52	53	53	53	51	43	39	38
Baltic Sea	7	7	7	7	7	6	6	5	5
BoBiscay & Iberia	9	10	10	11	10	9	8	7	7
Celtic Seas	14	14	14	13	16	16	13	11	10
Greater North Sea	13	16	17	18	17	16	13	13	13
Widely	6	5	5	4	3	4	3	3	3

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	35	35	36	33	35	33	32	29	21
Baltic Sea	4	4	4	5	5	5	5	4	3
BoBiscay & Iberia	5	6	6	5	5	4	4	2	1
Celtic Seas	13	10	10	9	10	9	8	8	6
Greater North Sea	11	13	14	12	12	12	12	12	9
Widely	2	2	2	2	3	3	3	3	2

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

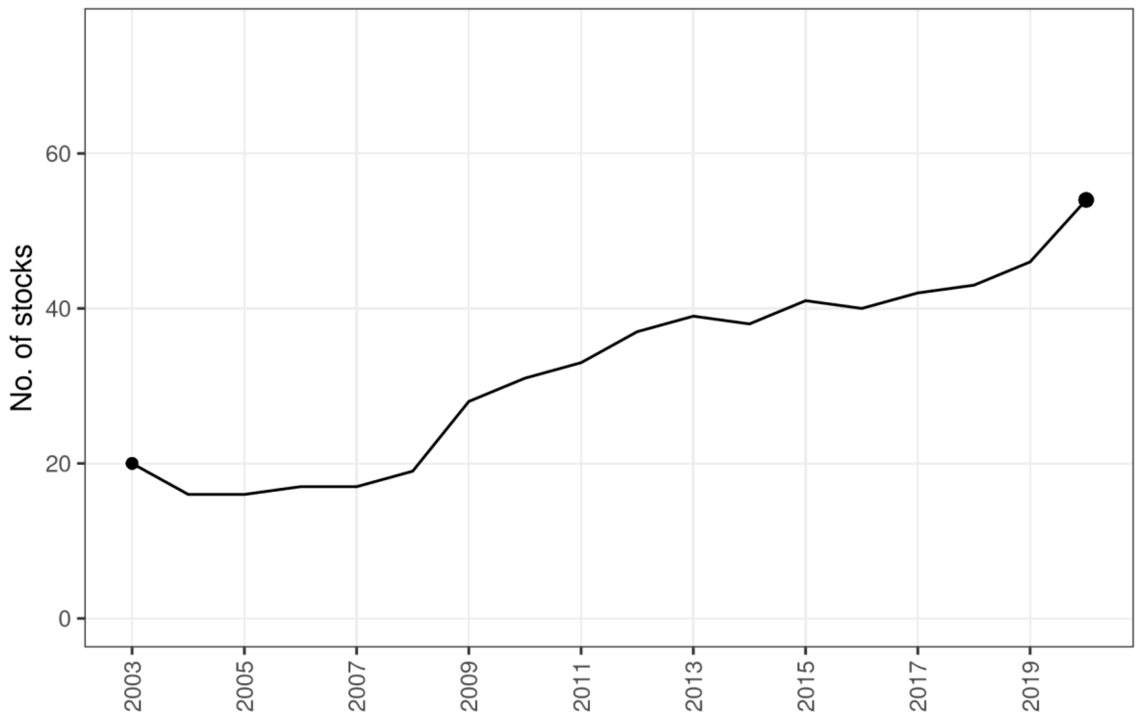

Figure 5: Number of stocks by year for which fishing mortality (F) did not exceed F_{MSY} (NEAI2a)

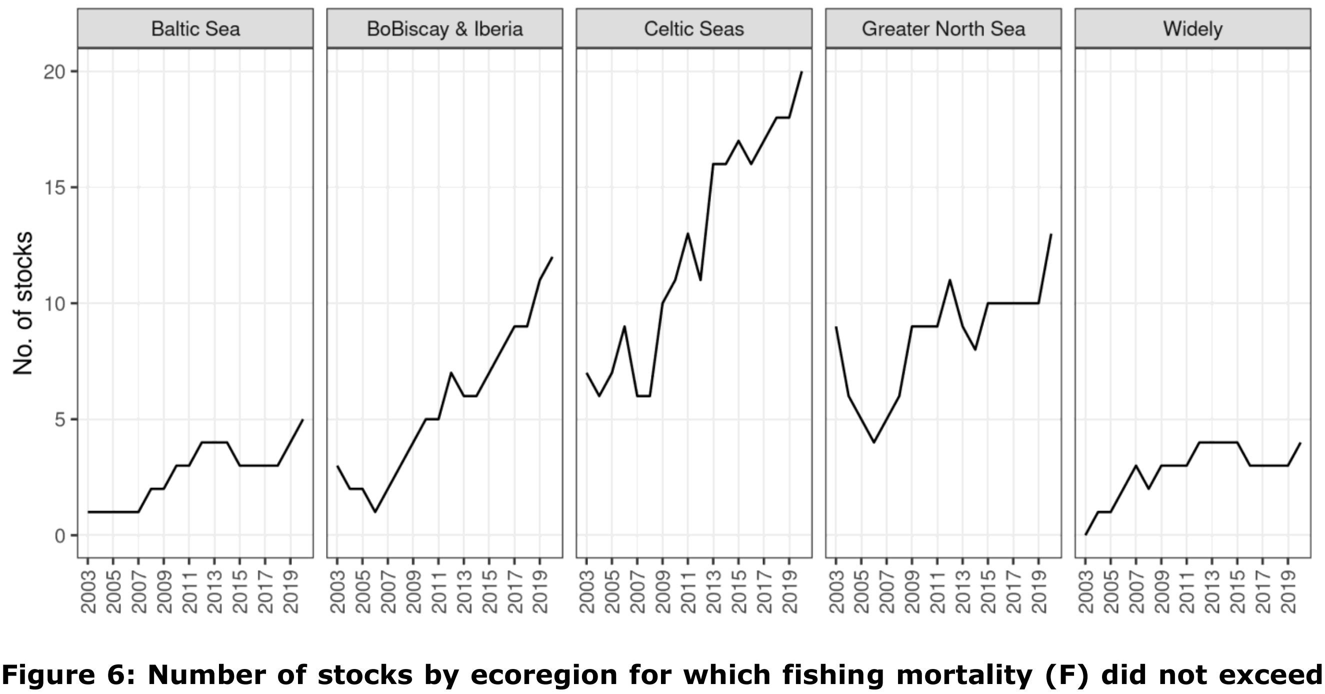

Figure 6: Number of stocks by ecoregion for which fishing mortality (F) did not exceed F_{MSY} (NEAI2b)

Table 4: Number of stocks by ecoregion for which fishing mortality (F) did not exceed F_{MSY} (NEAI2)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	20	16	16	17	17	19	28	31	33
Baltic Sea	1	1	1	1	1	2	2	3	3
BoBiscay & Iberia	3	2	2	1	2	3	4	5	5
Celtic Seas	7	6	7	9	6	6	10	11	13
Greater North Sea	9	6	5	4	5	6	9	9	9
Widely	0	1	1	2	3	2	3	3	3

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	37	39	38	41	40	42	43	46	54
Baltic Sea	4	4	4	3	3	3	3	4	5
BoBiscay & Iberia	7	6	6	7	8	9	9	11	12
Celtic Seas	11	16	16	17	16	17	18	18	20
Greater North Sea	11	9	8	10	10	10	10	10	13
Widely	4	4	4	4	3	3	3	3	4

3.2.3 Number of stocks outside safe biological limits

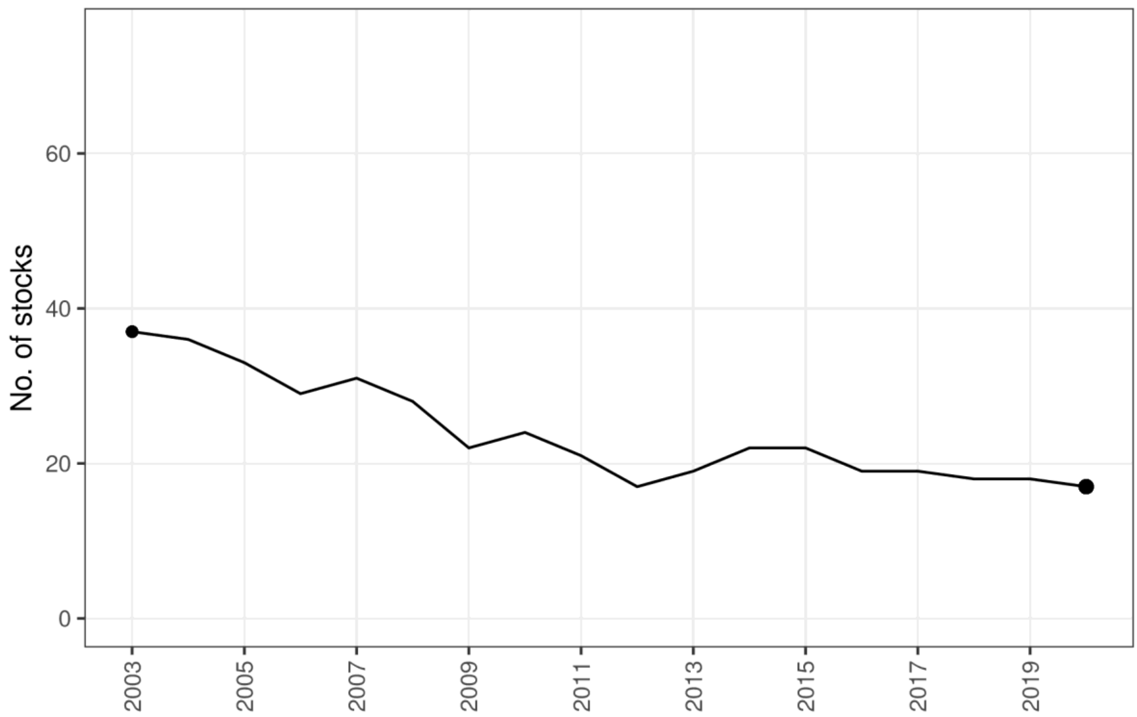

Figure 7: Number of stocks outside safe biological limits by year (NEAI3a)

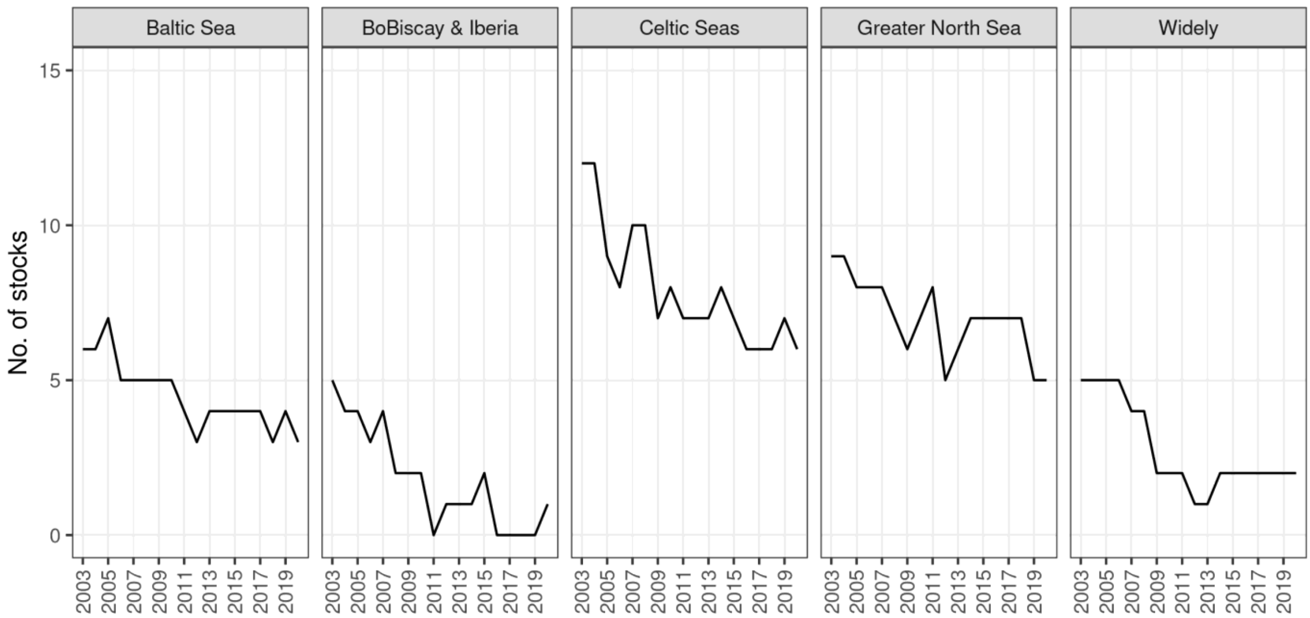

Figure 8: Number of stocks outside safe biological limits by ecoregion (NEAI3b)

Table 5: Number of stocks outside safe biological limits by ecoregion (NEAI3)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	37	36	33	29	31	28	22	24	21
Baltic Sea	6	6	7	5	5	5	5	5	4
BoBiscay & Iberia	5	4	4	3	4	2	2	2	0
Celtic Seas	12	12	9	8	10	10	7	8	7
Greater North Sea	9	9	8	8	8	7	6	7	8
Widely	5	5	5	5	4	4	2	2	2

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	17	19	22	22	19	19	18	18	17
Baltic Sea	3	4	4	4	4	4	3	4	3
BoBiscay & Iberia	1	1	1	2	0	0	0	0	1
Celtic Seas	7	7	8	7	6	6	6	7	6
Greater North Sea	5	6	7	7	7	7	7	5	5
Widely	1	1	2	2	2	2	2	2	2

3.2.4 Number of stocks inside safe biological limits

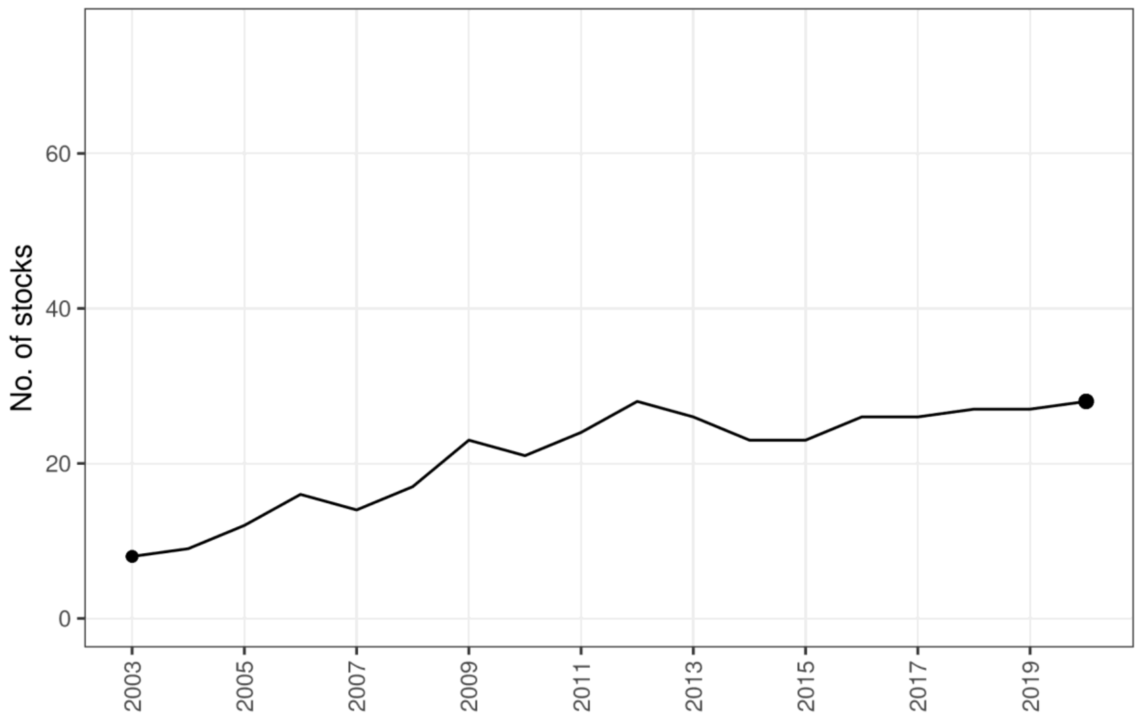

Figure 9:Number of stocks inside safe biological limits by year (NEAI4a)

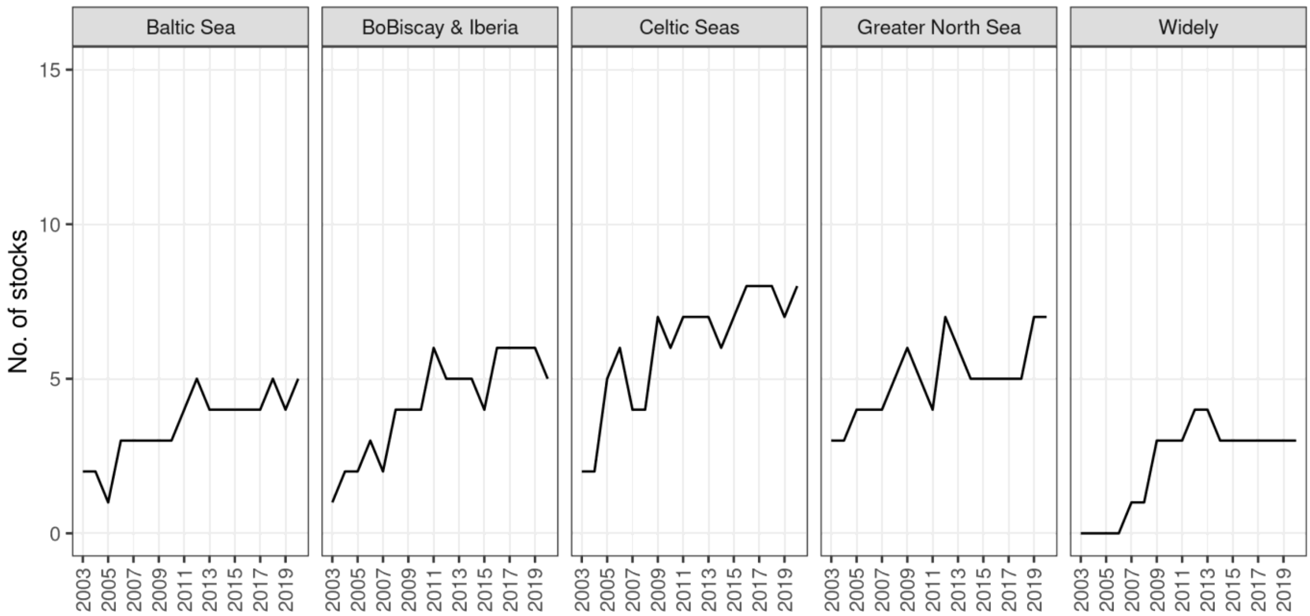

Figure 10: Number of stocks inside safe biological limits by ecoregion (NEAI4b)

Table 6: Number of stocks inside safe biological limits by ecoregion (NEAI4)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	8	9	12	16	14	17	23	21	24
Baltic Sea	2	2	1	3	3	3	3	3	4
BoBiscay & Iberia	1	2	2	3	2	4	4	4	6
Celtic Seas	2	2	5	6	4	4	7	6	7
Greater North Sea	3	3	4	4	4	5	6	5	4
Widely	0	0	0	0	1	1	3	3	3

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	28	26	23	23	26	26	27	27	28
Baltic Sea	5	4	4	4	4	4	5	4	5
BoBiscay & Iberia	5	5	5	4	6	6	6	6	5
Celtic Seas	7	7	6	7	8	8	8	7	8
Greater North Sea	7	6	5	5	5	5	5	7	7
Widely	4	4	3	3	3	3	3	3	3

3.2.5 *Number of stocks with F above F_{MSY} and SSB below B_{MSY}*

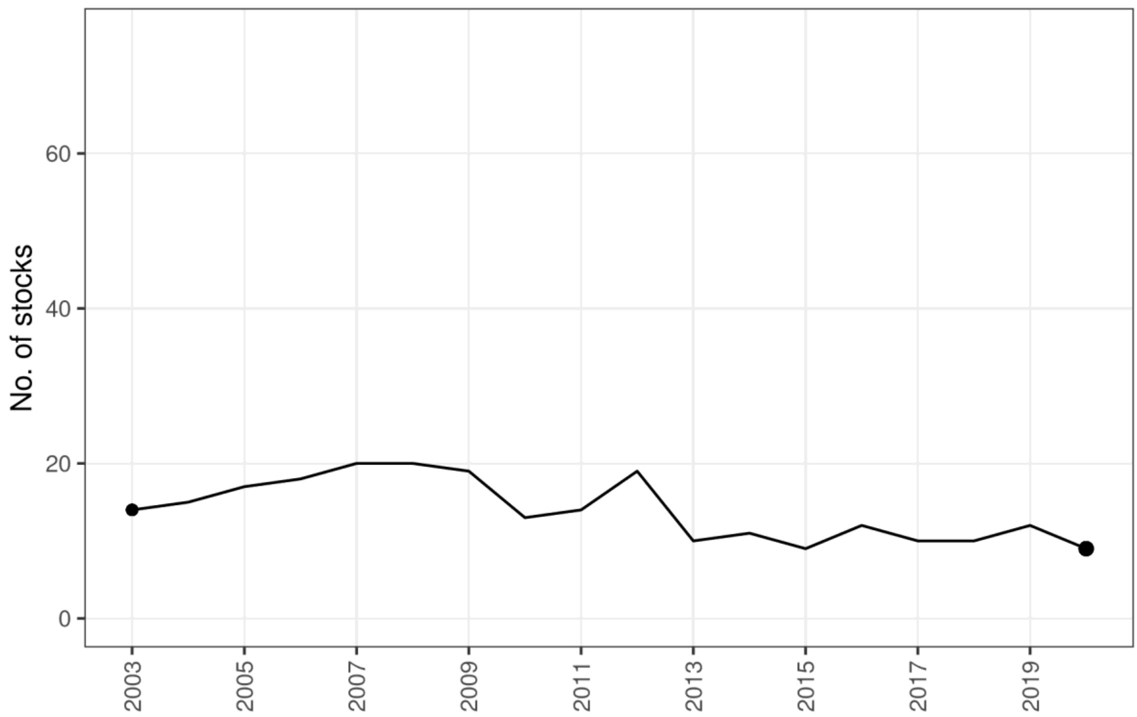

Figure 11: Number of stocks with F above F_{MSY} or SSB below B_{MSY} (NEAI5a)

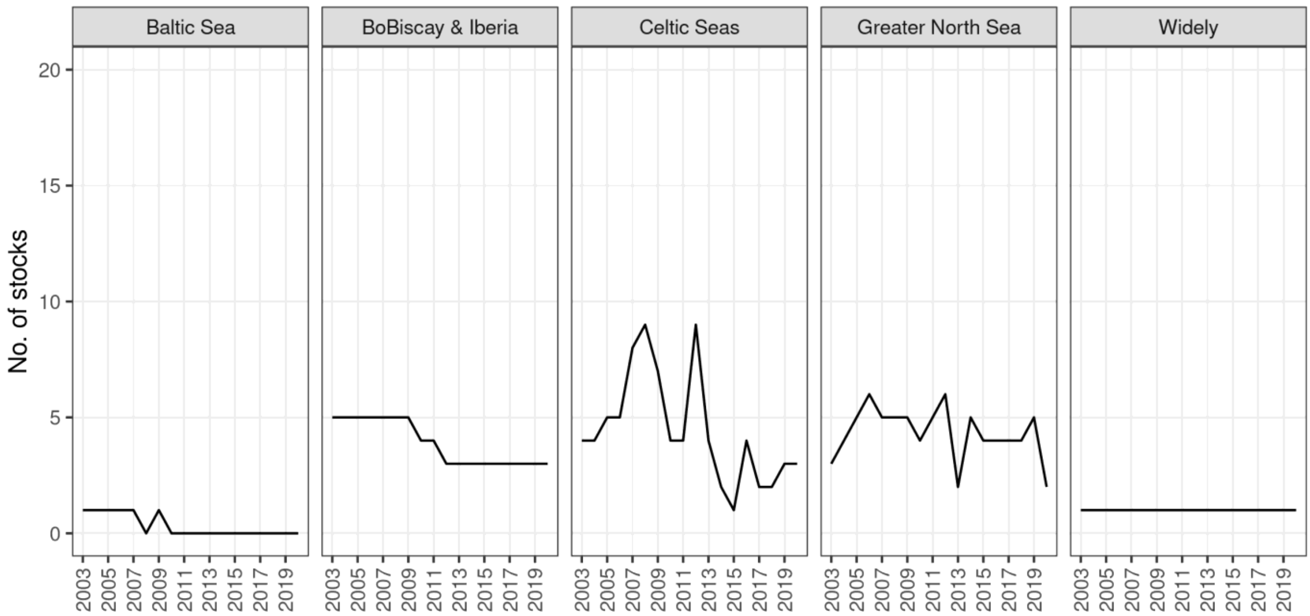

Figure 12: Number of stocks with F above F_{MSY} or SSB below B_{MSY} by ecoregion (NEAI5b)

Table 7: Number of stocks with F above F_{MSY} or SSB below B_{MSY} by ecoregion (NEAI5)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	14	15	17	18	20	20	19	13	14
Baltic Sea	1	1	1	1	1	0	1	0	0
BoBiscay & Iberia	5	5	5	5	5	5	5	4	4
Celtic Seas	4	4	5	5	8	9	7	4	4
Greater North Sea	3	4	5	6	5	5	5	4	5
Widely	1	1	1	1	1	1	1	1	1

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	19	10	11	9	12	10	10	12	9
Baltic Sea	0	0	0	0	0	0	0	0	0
BoBiscay & Iberia	3	3	3	3	3	3	3	3	3
Celtic Seas	9	4	2	1	4	2	2	3	3
Greater North Sea	6	2	5	4	4	4	4	5	2
Widely	1	1	1	1	1	1	1	1	1

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

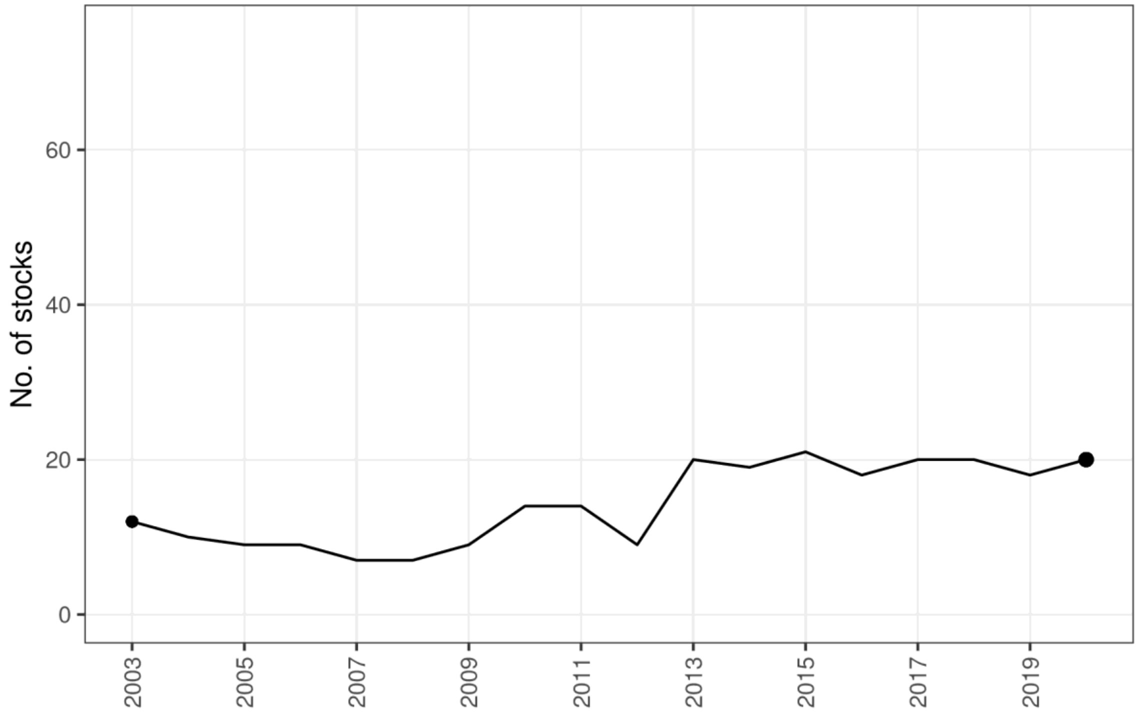

Figure 13: Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY} (NEAI6a)

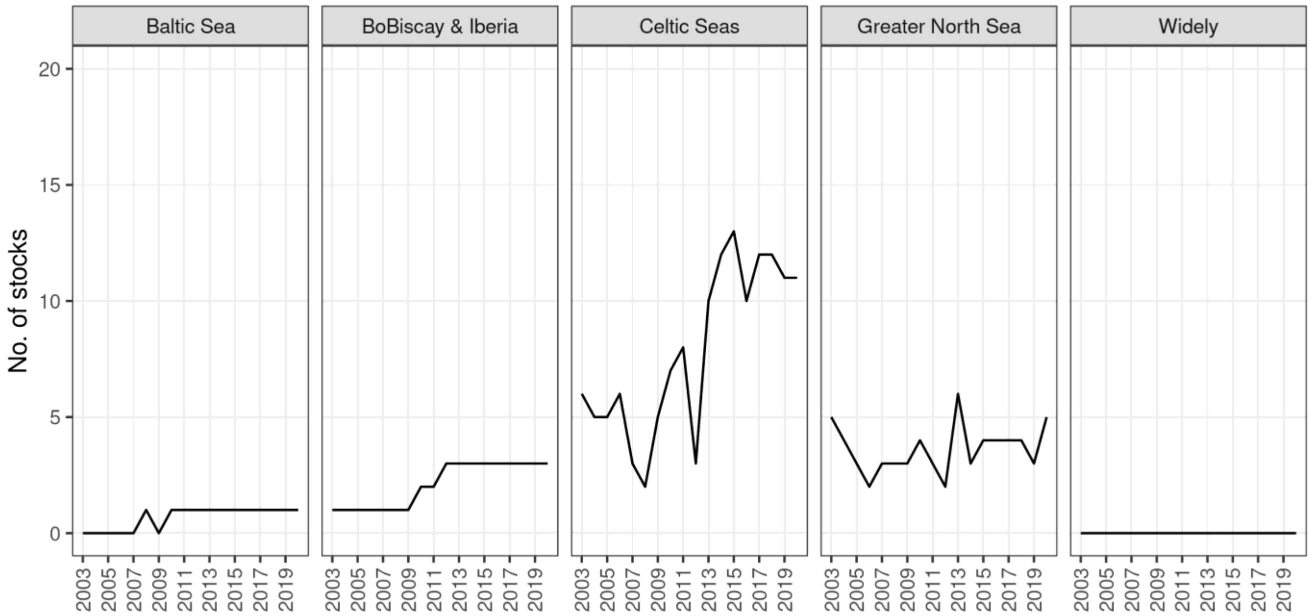

Figure 14: Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY} by ecoregion (NEAI6b)

Table 8: Number of stocks with F below or equal to F_{MSY} and SSB above or equal to B_{MSY} by ecoregion (NEAI6)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	12	10	9	9	7	7	9	14	14
Baltic Sea	0	0	0	0	0	1	0	1	1
BoBiscay & Iberia	1	1	1	1	1	1	1	2	2
Celtic Seas	6	5	5	6	3	2	5	7	8
Greater North Sea	5	4	3	2	3	3	3	4	3
Widely	0	0	0	0	0	0	0	0	0

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
All	9	20	19	21	18	20	20	18	20
Baltic Sea	1	1	1	1	1	1	1	1	1
BoBiscay & Iberia	3	3	3	3	3	3	3	3	3
Celtic Seas	3	10	12	13	10	12	12	11	11
Greater North Sea	2	6	3	4	4	4	4	3	5
Widely	0	0	0	0	0	0	0	0	0

3.2.7 Trend in F/F_{MSY}

The ratio F/F_{MSY} has decreased over the years 2003-2020 from 1.67 to 0.87 (Figure 15 and Table 9). In 2020, the 95% confidence interval bounds were 0.74-1.02.

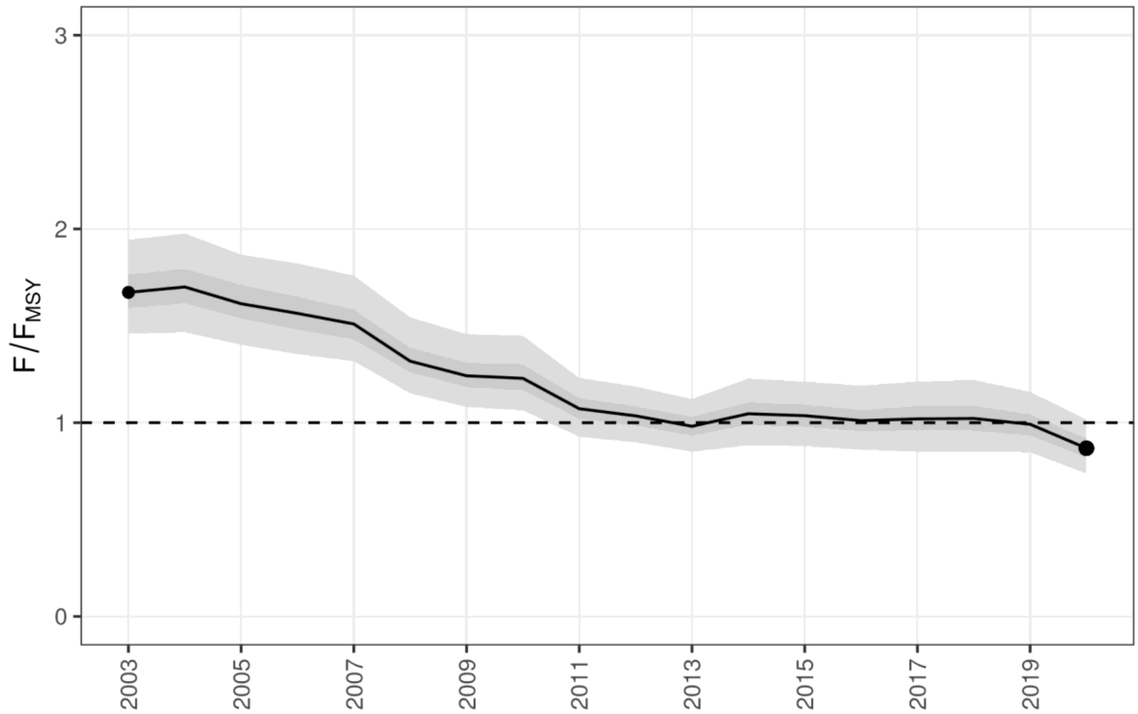

Figure 15: Trend in F/F_{MSY} (based on 52 stocks). Dark grey area shows the 50% confidence interval whereas the light grey shows the 95% confidence interval (NEAI7a)

Table 9: Percentiles for F/F_{MSY} by year (NEAI7a)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	1.46	1.47	1.40	1.35	1.32	1.15	1.08	1.06	0.93
25%	1.59	1.62	1.54	1.48	1.43	1.26	1.19	1.17	1.02
50%	1.67	1.70	1.61	1.56	1.51	1.32	1.24	1.23	1.07
75%	1.76	1.79	1.71	1.65	1.58	1.39	1.31	1.30	1.12
97.5%	1.94	1.98	1.87	1.82	1.76	1.54	1.46	1.45	1.23

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	0.90	0.85	0.88	0.88	0.86	0.85	0.85	0.85	0.74
25%	0.99	0.94	0.99	0.98	0.96	0.96	0.96	0.94	0.82
50%	1.04	0.98	1.05	1.04	1.01	1.02	1.02	0.99	0.87
75%	1.08	1.03	1.10	1.09	1.06	1.08	1.09	1.04	0.92
97.5%	1.19	1.12	1.23	1.21	1.19	1.21	1.22	1.16	1.02

For every ecoregion the indicator F/F_{MSY} decreased from 2003 to 2020 (Figure 16 and Table 10). In the Baltic Sea and in the Greater North Sea, the ratio remains above 1 whereas it is below 1 for the other three ecoregions. Although the same model was used for the global and the regional analyses, the small number of stocks in each ecoregion prevented the use of the bootstrap method to estimate the associated confidence intervals.

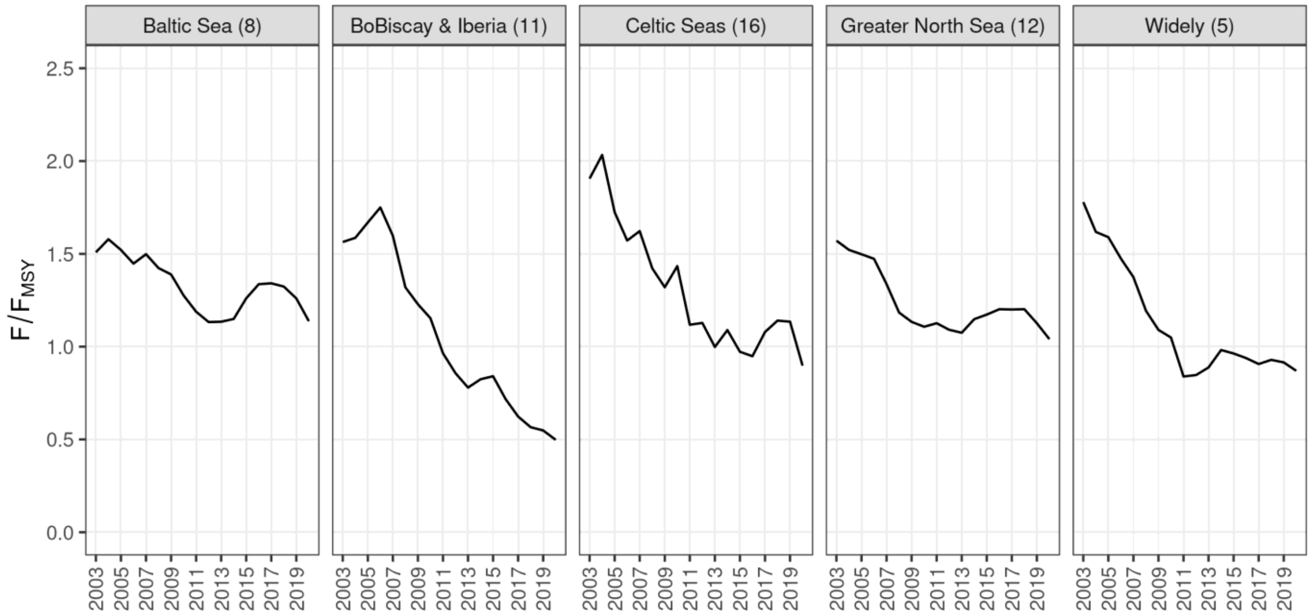

Figure 16: Trend in F/F_{MSY} by ecoregion. The number of stocks in each ecoregion are shown between parentheses (NEAI7b)

Table 10: Trend in F/F_{MSY} by ecoregion (NEAI7b)

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
Baltic Sea	1.51	1.58	1.52	1.45	1.50	1.42	1.39	1.28	1.19
BoBiscay & Iberia	1.56	1.59	1.67	1.75	1.60	1.32	1.23	1.15	0.96
Celtic Seas	1.91	2.03	1.72	1.57	1.62	1.42	1.32	1.43	1.12
Greater North Sea	1.57	1.52	1.50	1.47	1.34	1.18	1.13	1.11	1.13
Widely	1.78	1.62	1.59	1.47	1.37	1.19	1.09	1.05	0.84

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
Baltic Sea	1.13	1.13	1.15	1.26	1.34	1.34	1.32	1.26	1.14
BoBiscay & Iberia	0.86	0.78	0.82	0.84	0.72	0.62	0.57	0.55	0.50
Celtic Seas	1.13	1.00	1.09	0.97	0.95	1.08	1.14	1.13	0.90
Greater North Sea	1.09	1.07	1.15	1.17	1.20	1.20	1.20	1.13	1.04
Widely	0.85	0.89	0.98	0.96	0.94	0.91	0.93	0.92	0.87

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

The model used in section 3.2.7 was also used with data derived from stocks assessed by ICES and spanning across areas that fall primarily outside EU waters in FAO region 27 (Figure 17, Figure 18 and Table 11). The analysis was based on 15 stocks. As a result of that reduced number of stocks, the indicator was unstable and imprecise. Throughout the time series, the ratio F/F_{MSY} did not exhibit increasing or decreasing trend and was mostly significantly higher than 1 (Figure 17 and Table 11). An increase of the indicator was observed from 2014 to 2019. In 2020, a decrease is noted to reach 1.44 after peaking at 1.62 the year before. A sharp increase is observed on stock reg.28.1-2 towards the end of the time series (Figure 18).

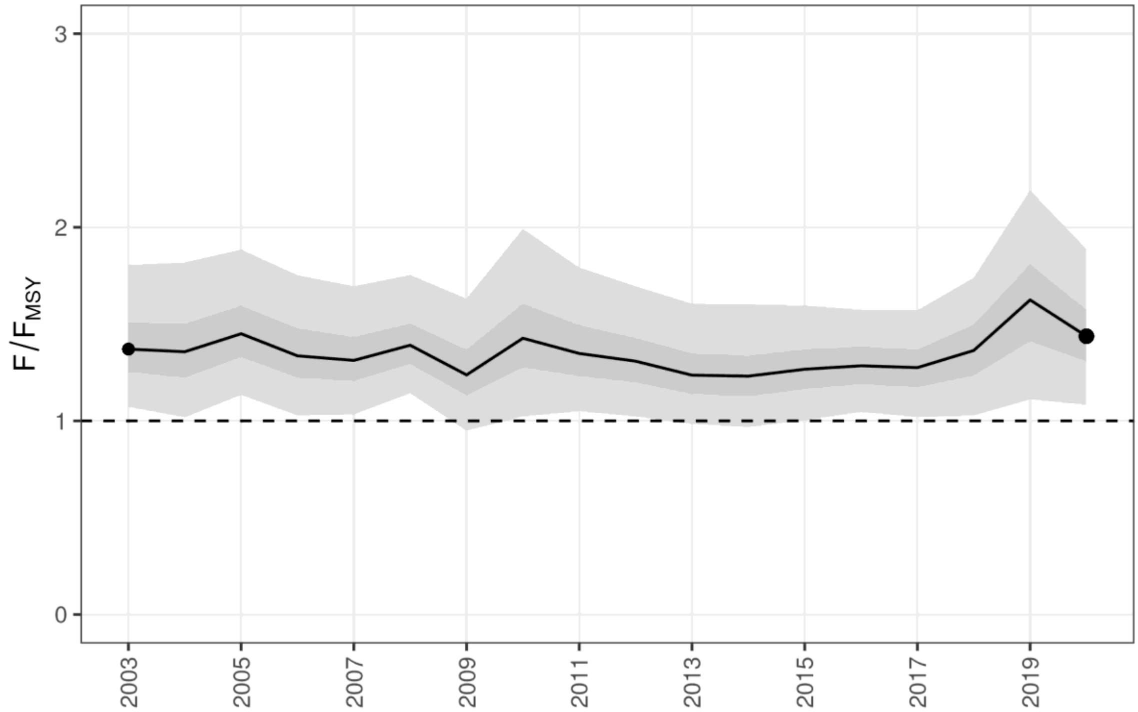

Figure 17: Trend in F/F_{MSY} for stocks outside EU waters (based on 15 stocks). Dark grey zone shows the 50% confidence interval whereas the light grey zone shows the 95% confidence interval (NEAI7out)

Table 11: Percentiles for F/F_{MSY} for stocks outside EU waters (NEAI7out)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	1.07	1.02	1.13	1.03	1.03	1.14	0.95	1.02	1.05
25%	1.25	1.22	1.33	1.22	1.21	1.30	1.13	1.28	1.23
50%	1.37	1.36	1.45	1.34	1.31	1.39	1.24	1.43	1.35
75%	1.51	1.50	1.59	1.48	1.43	1.50	1.37	1.60	1.49
97.5%	1.81	1.82	1.89	1.75	1.70	1.75	1.63	1.99	1.79

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	1.02	0.98	0.97	1.00	1.05	1.02	1.03	1.11	1.08
25%	1.20	1.14	1.13	1.17	1.19	1.18	1.24	1.41	1.31
50%	1.31	1.24	1.23	1.27	1.28	1.28	1.36	1.62	1.44
75%	1.43	1.35	1.34	1.37	1.38	1.37	1.50	1.81	1.57
97.5%	1.70	1.61	1.60	1.60	1.57	1.57	1.74	2.19	1.89

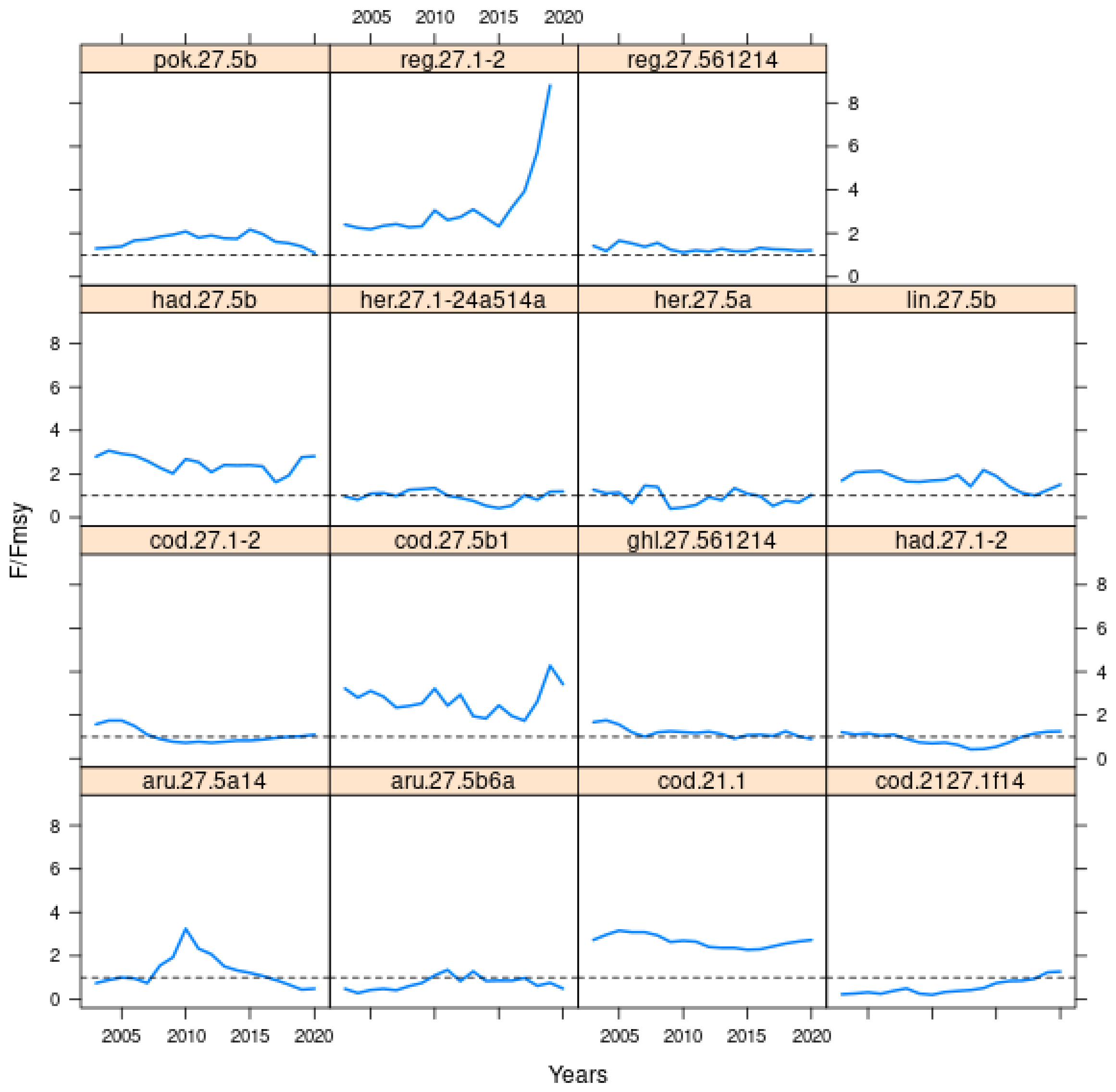

Figure 18: Trend of single stocks from outside EU waters. The dashed is set at 1 (i.e. where F=F$_{MSY}$)

3.2.9 Trend in SSB (relative to SSB in 2003)

The ratio B/B_{2003} was not significantly higher than 1 in 2020 (Figure 19 and Table 12). At the start of the time series, it decreased until 2007 when it reached 0.84. It then increased until 2020 and reached 1.33. Some convergence issues were encountered. The issue originated from the inclusion of cod.27.6a as no convergence issues occurred when that stock was excluded from the analysis. The stock was then excluded from the input dataset.

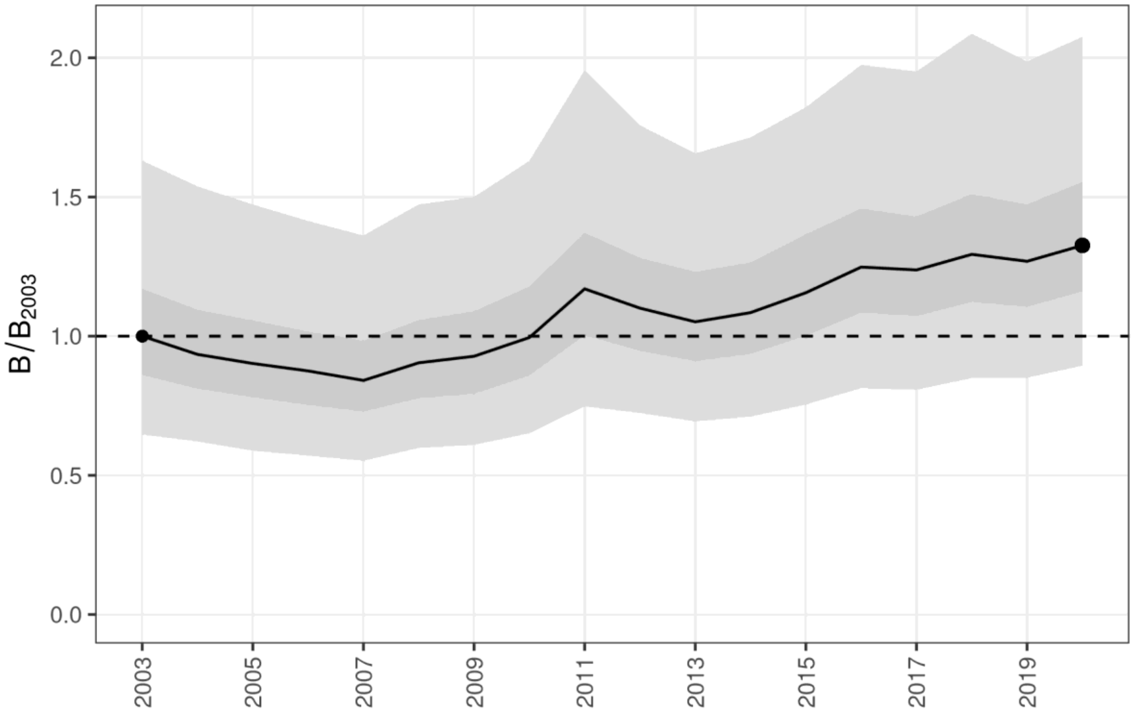

Figure 19: Trend in SSB relative to 2003 (based on 53 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval (NEAI8)

Table 12: Percentiles for SSB relative to 2003

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	0.65	0.62	0.59	0.57	0.55	0.60	0.61	0.65	0.75
25%	0.86	0.81	0.78	0.75	0.73	0.78	0.79	0.86	1.00
50%	1.00	0.93	0.90	0.88	0.84	0.90	0.93	1.00	1.17
75%	1.17	1.09	1.06	1.02	0.98	1.06	1.09	1.18	1.37
97.5%	1.63	1.54	1.47	1.41	1.36	1.47	1.50	1.63	1.96

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
2.5%	0.72	0.69	0.71	0.75	0.81	0.81	0.85	0.85	0.89
25%	0.95	0.91	0.94	1.00	1.09	1.07	1.12	1.11	1.16
50%	1.10	1.05	1.08	1.16	1.25	1.24	1.29	1.27	1.33
75%	1.28	1.23	1.26	1.37	1.46	1.43	1.51	1.47	1.55
97.5%	1.76	1.66	1.71	1.82	1.97	1.95	2.09	1.99	2.08

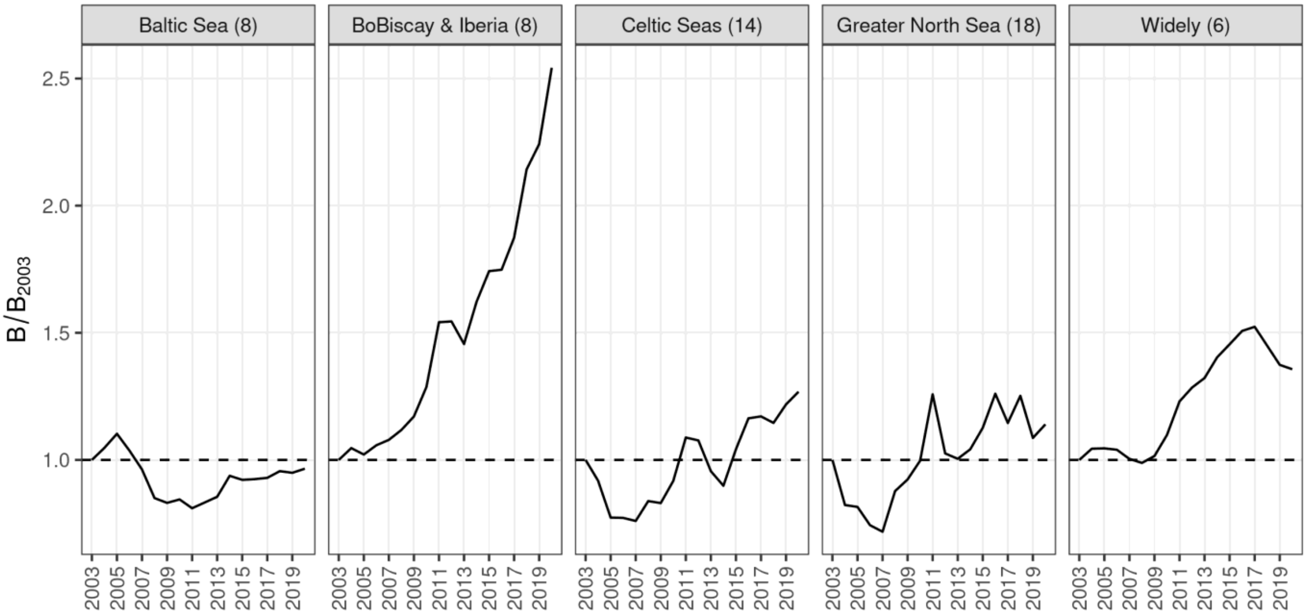

Figure 20: Trend in SSB by ecoregion relative to 2003. The number of stocks in each ecoregion are shown between parentheses (NEAI8b)

Table 13: SSB relative 2003 by ecoregion

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
Baltic Sea	1.00	1.05	1.10	1.04	0.96	0.85	0.83	0.84	0.81
BoBiscay & Iberia	1.00	1.05	1.02	1.06	1.08	1.12	1.17	1.29	1.54
Celtic Seas	1.00	0.92	0.77	0.77	0.76	0.84	0.83	0.92	1.09
Greater North Sea	1.00	0.82	0.82	0.74	0.72	0.88	0.92	1.00	1.26
Widely	1.00	1.04	1.05	1.04	1.00	0.99	1.02	1.10	1.23

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
Baltic Sea	0.83	0.85	0.94	0.92	0.92	0.93	0.96	0.95	0.97
BoBiscay & Iberia	1.54	1.46	1.62	1.74	1.75	1.87	2.14	2.24	2.54
Celtic Seas	1.08	0.96	0.90	1.04	1.16	1.17	1.15	1.22	1.27
Greater North Sea	1.03	1.00	1.04	1.13	1.26	1.15	1.25	1.09	1.14
Widely	1.28	1.32	1.40	1.45	1.51	1.52	1.45	1.37	1.36

3.2.10 Trend in biomass relative to biomass in 2003 for data-limited stocks

The biomass for category 3 stocks inside EU waters have increased since 2003 and reached 1.52 (Figure 21 and Table 14). The lower bound of the confidence interval remained below 1.

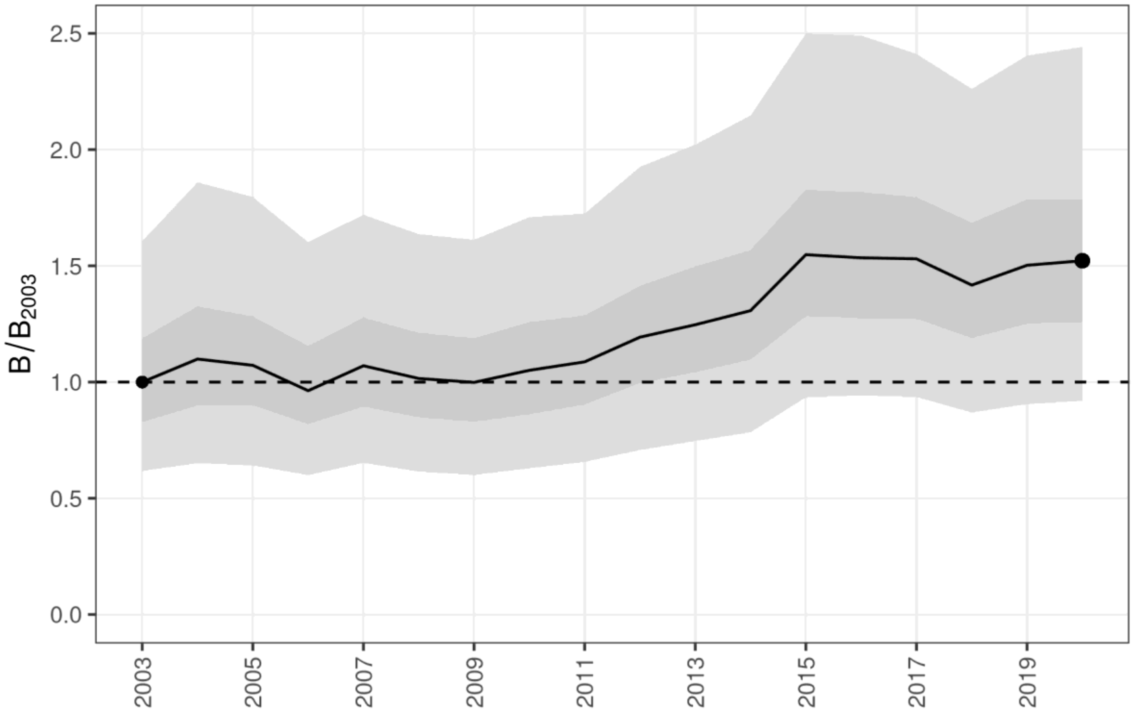

Figure 21: Trend in biomass or abundance indices relative to 2003 for data-limited stocks (ICES category 3; based on 73 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval (NEAI8b).

Table 14: Percentiles for biomass or abundance indices relative to 2003 for ICES category 3 stocks.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	0.62	0.65	0.64	0.60	0.65	0.61	0.60	0.63	0.66
25%	0.83	0.90	0.90	0.82	0.90	0.85	0.83	0.86	0.90
50%	1.00	1.10	1.07	0.96	1.07	1.02	1.00	1.05	1.09
75%	1.19	1.32	1.28	1.15	1.28	1.21	1.19	1.26	1.29
97.5%	1.61	1.86	1.80	1.60	1.72	1.64	1.61	1.71	1.72

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
2.5%	0.71	0.75	0.78	0.93	0.94	0.94	0.87	0.91	0.92
25%	1.00	1.04	1.10	1.28	1.28	1.27	1.19	1.25	1.26
50%	1.19	1.25	1.31	1.55	1.53	1.53	1.42	1.50	1.52
75%	1.41	1.50	1.57	1.83	1.82	1.79	1.68	1.78	1.78
97.5%	1.93	2.02	2.15	2.50	2.49	2.41	2.26	2.41	2.44

3.2.11 Trend in recruitment relatively to recruitment 2003

On average, the estimated decadal recruitment for category 1 and 2 stocks has followed a decreasing trend from 2003 to 2012 to reach a minimum of 0.83 (Figure 22 and Table 15). It should be noted that several category 1 or 2 stocks were omitted due to them being assessed using biomass dynamic models. Over the years 2012-2020, this indicator increased to reach 1.18 at the end of the time series. It is noted that the lower bound of the confidence interval is above 1. This trend might reflect an increase in stock production, although the characteristic of the indicator, a decadal ratio, makes it difficult to interpret. For example, the 2020 value for one stock is the result of the ratio between the average recruitment 2011-2020 on one hand and the average recruitment 2001-2010 on the other hand. Yearly decadal recruitment ratios for each stock constitute the dataset used as input data to fit the model. Predictions of the model are scaled to 2003 (see the protocol in Annex 1 for further details).

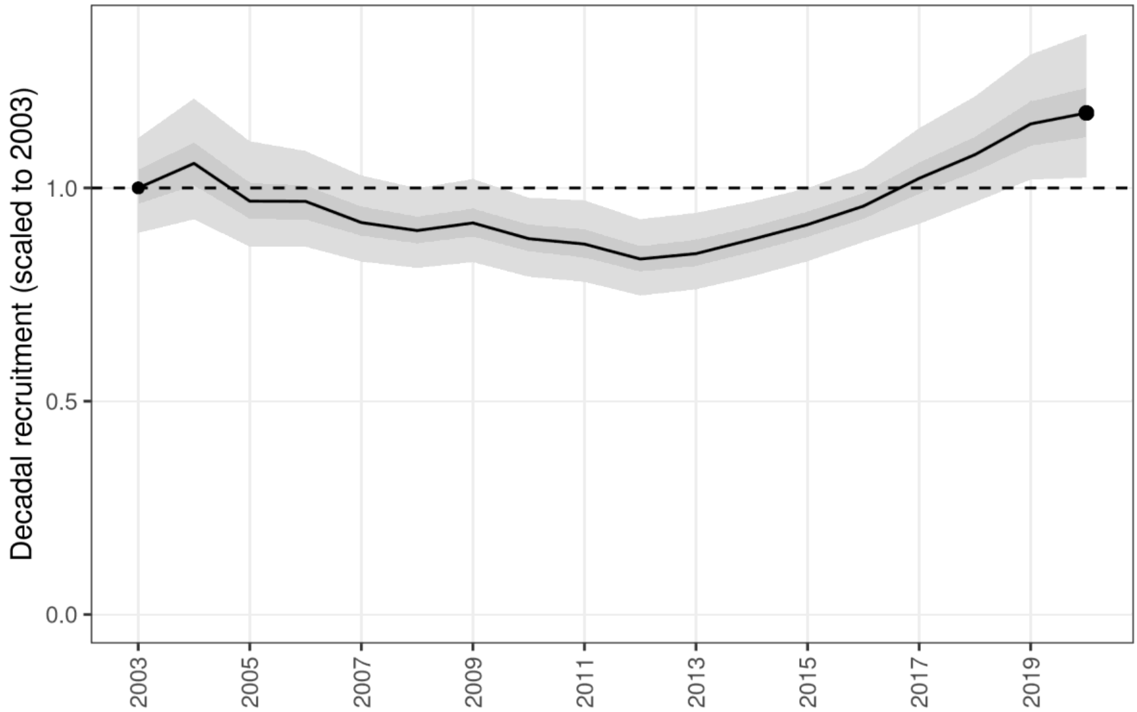

Figure 22: Trend in decadal recruitment scaled to 2003 (based on 54 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval (NEAI10).

Table 15: Percentiles for decadal recruitment scaled to 2003

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	0.89	0.93	0.86	0.86	0.83	0.81	0.83	0.79	0.78
25%	0.96	1.01	0.93	0.93	0.89	0.87	0.89	0.85	0.84
50%	1.00	1.06	0.97	0.97	0.92	0.90	0.92	0.88	0.87
75%	1.04	1.11	1.01	1.01	0.96	0.93	0.95	0.91	0.90
97.5%	1.12	1.21	1.11	1.09	1.03	1.00	1.02	0.98	0.97

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	0.75	0.76	0.79	0.83	0.87	0.92	0.97	1.02	1.02
25%	0.80	0.82	0.85	0.89	0.93	0.99	1.04	1.10	1.12
50%	0.83	0.85	0.88	0.91	0.96	1.02	1.08	1.15	1.18
75%	0.86	0.88	0.91	0.94	0.99	1.06	1.12	1.20	1.23
97.5%	0.93	0.94	0.97	1.00	1.05	1.14	1.21	1.31	1.36

The trend in decadal recruitment exhibited contrasting trends according to the regions (

Figure 23 and Table 16). This might be due to the method used to derive this indicator. Stocks from the Baltic Sea and Widely distributed exhibited an overall downward trend in decadal recruitment whereas stocks from the other ecoregions showed an increasing trend.

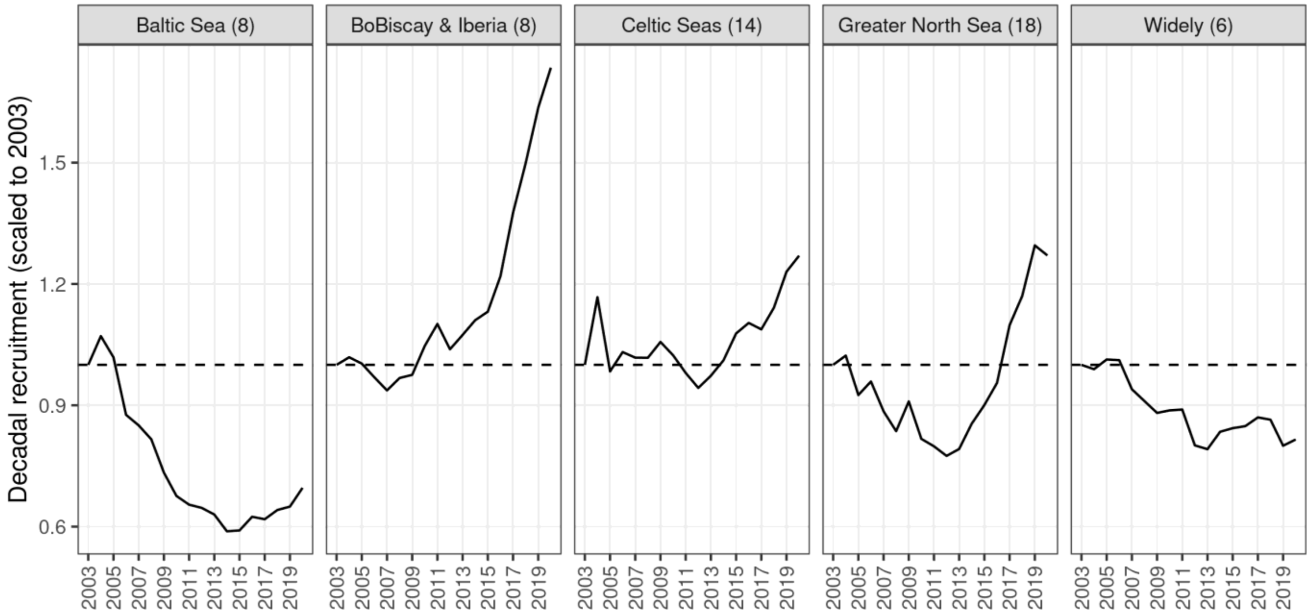

Figure 23: Trend in decadal recruitment scaled to 2003 by ecoregion. The number of stocks in each ecoregion are shown between parentheses (NEAI10b).

Table 16: Decadal recruitment scaled to 2003 by ecoregion

Ecoregion	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Baltic Sea	1.00	1.07	1.02	0.88	0.85	0.82	0.73	0.68	0.65
BoBiscay & Iberia	1.00	1.02	1.00	0.97	0.94	0.97	0.98	1.05	1.10
Celtic Seas	1.00	1.17	0.98	1.03	1.02	1.02	1.06	1.02	0.98
Greater North Sea	1.00	1.02	0.93	0.96	0.89	0.84	0.91	0.82	0.80
Widely	1.00	0.99	1.01	1.01	0.94	0.91	0.88	0.89	0.89

Ecoregion	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Baltic Sea	0.65	0.63	0.59	0.59	0.62	0.62	0.64	0.65	0.70
BoBiscay & Iberia	1.04	1.07	1.11	1.13	1.22	1.38	1.50	1.64	1.73
Celtic Seas	0.94	0.97	1.01	1.08	1.10	1.09	1.14	1.23	1.27
Greater North Sea	0.77	0.79	0.85	0.90	0.96	1.10	1.17	1.30	1.27
Widely	0.80	0.79	0.83	0.84	0.85	0.87	0.86	0.80	0.82

3.3 Indicators of advice coverage

The indicator of advice coverage provides the number of stocks for which the reference points F_{MSY}, F_{PA}, $MSYB_{trigger}$ and B_{PA} are available (Table 17). It also provides the number of TACs that are set by the European Commission. This figure is the same as last year, i.e. 156. The number of stocks having reference points have increased for all the reference point types compared to last year's report. The number of TACs for which a category 1 or 2 assessment was performed have also increased.

Table 17: Coverage of TACs by scientific advice (ICES category 1+2)

	No of stocks	No of TACs	No of TACs based on Stock Assessment	Fraction of TACs based on Stock Assessments
F_{MSY}	75	156	88	0.56
$MSYB_{trigger}$	37	156	34	0.22
F_{PA}	46	156	72	0.46
B_{PA}	57	156	80	0.51

4 MEDITERRANEAN AND BLACK SEA (FAO REGION 37)

During the period 2003-2009 the number of stocks assessments available increased from 20 up to 34. The number of stock assessments has been stable until 2019 decreasing to 21 in 2020 (Figure 24 and Figure 25 and Table 18).

The instability in the number of the stocks makes the interpretation of the deterministic indicators misleading. With such differences in the number of stocks assessed each year, the trends in the indicators are confounded with the number of stocks available for their computation. Consequently, only the model-based indicators for trends in F/F_{MSY} and SSB are shown.

Nevertheless, the indicator values presented (Figure 26 to Figure 29, and Table 19 to Table 22) 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 24 indicates by year the number of stocks in the Mediterranean and Black Seas for which estimates of F/F_{MSY} are available. The number of stock assessments available in 2020, 21, is due to the following reasons:

- STECF EWG part I carried out fully analytical assessments for 14 out of 19 stocks (STECF 2021b).
- STECF EWG part II carried out fully analytical assessments for 6 out of 9 stocks (Common Cuttlefish assessed using a CMSY model has not been included in the list) (STECF, 2021c).
- STECF EWG on Black Sea stock assessment is no longer carried out under the STECF umbrella since 2018. GFCM Black Sea Working Group provided final advice on the basis of fully analytical assessment only for three stocks (Turbot, European Sprat and Red mullet) (WGBS, 2021). However, both European sprat and Red mullet advices were based on the exploitation rate (E=F/Z) rather than in term of fishing level over reference point, hence the results for these assessments have not been taken in account.
- GFCM assessments performed during the WGSASP and WGSAD were not published by the time this report was written because the 2021 sessions will take place in early 2022.

For Norway lobster in the Adriatic Sea (nep_17_18) only the F/F_{MSY} indicator was computed, as this stock was assessed using a production model that did not estimate SSB values.

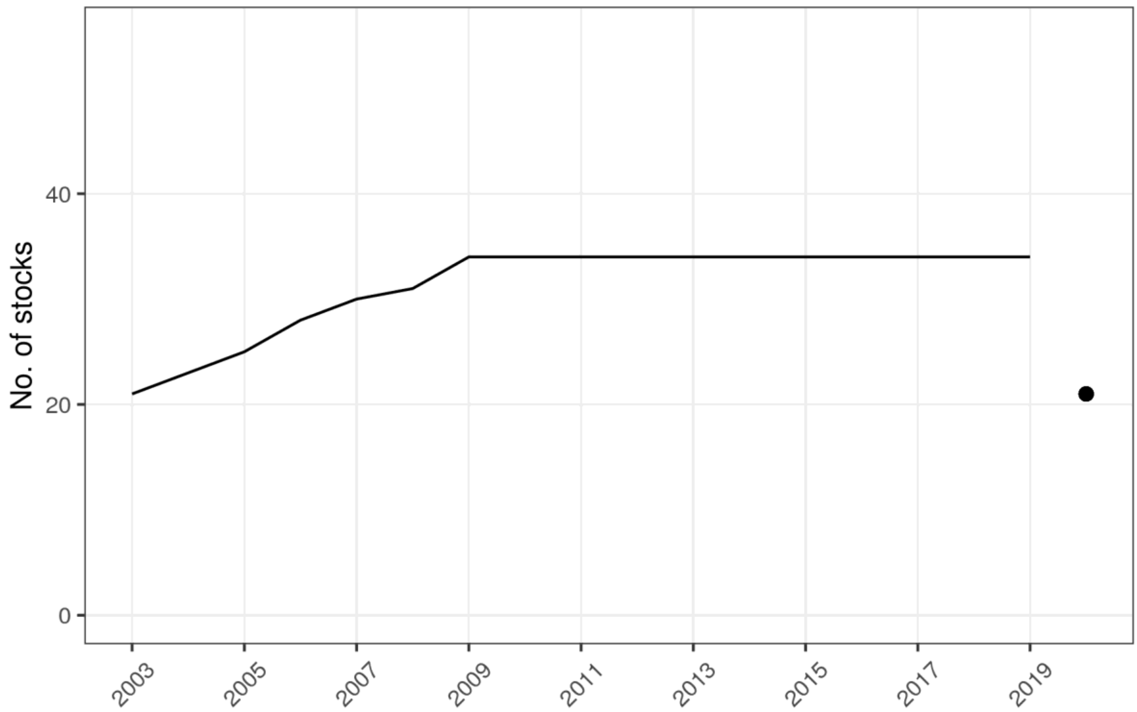

Figure 24: Number of stock assessments available in the Mediterranean and Black Sea. The totals include stocks in GSAs 1, 5-20, 22 and 29.

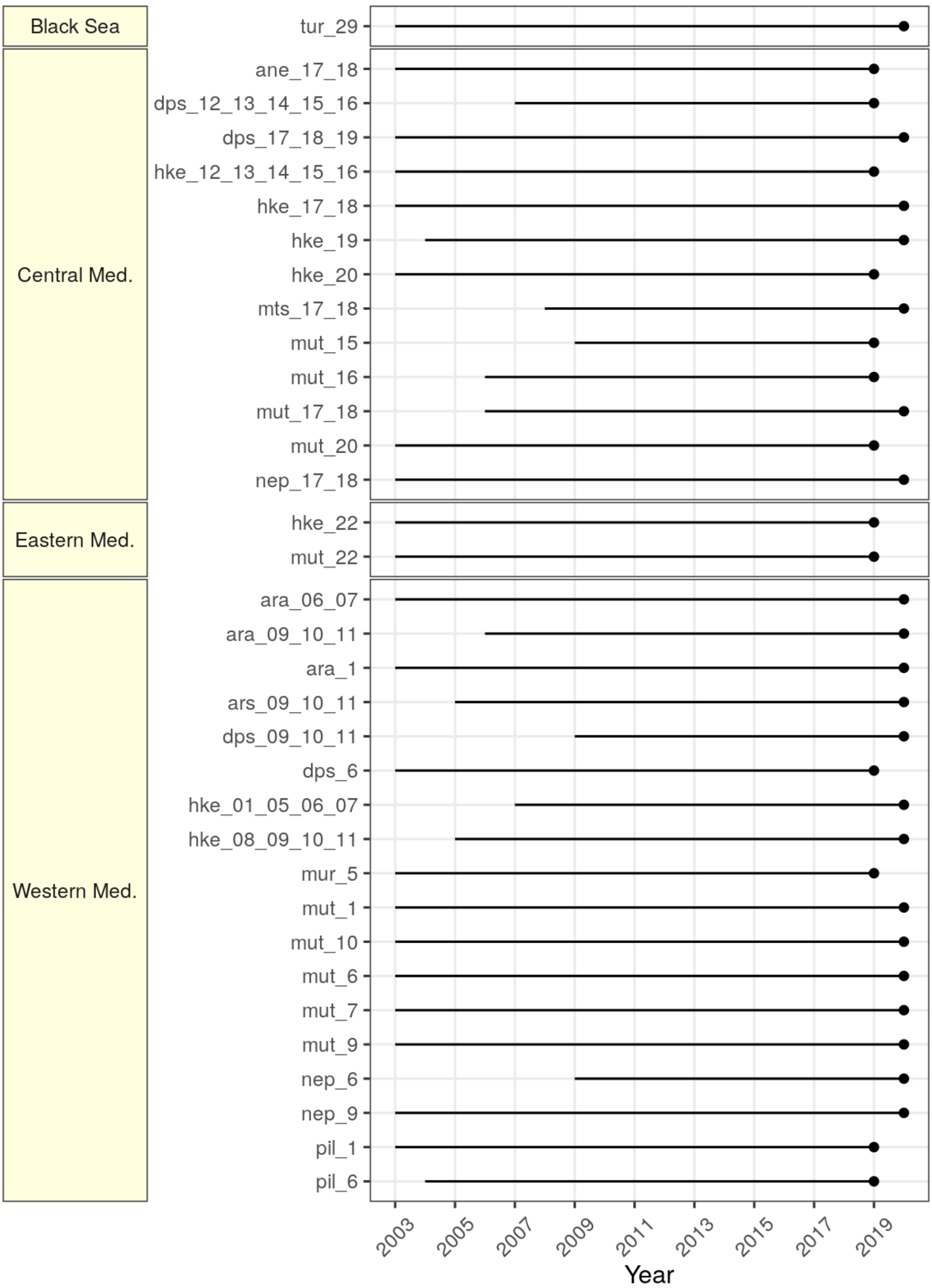

Figure 25: Time-series of stock assessments available from both STECF and GFCM for computation of model based CFP monitoring indicators for the Mediterranean and Black Seas.

Table 18: Stocks used in the current exercise.

EcoRegion	Year	Stock	Description	Updated	New stock	Source
Black Sea	2020	tur_29	Turbot in GSA 29	2021	N	GFCM
Central Med.	2019	ane_17_18	European anchovy in GSA 17_18	2020	N	GFCM
Central Med.	2019	dps_12_13_14_15_16	Deep-water rose shrimp in GSA 12_13_14_15_16	2020	N	GFCM
Central Med.	2020	dps_17_18_19	Deep-water rose shrimp in GSA 17_18_19	2021	N	STECF
Central Med.	2019	hke_12_13_14_15_16	European hake in GSA 12_13_14_15_16	2020	N	GFCM
Central Med.	2020	hke_17_18	European hake in GSA 17_18	2021	N	STECF
Central Med.	2020	hke_19	European hake in GSA 19	2021	N	STECF
Central Med.	2019	hke_20	European hake in GSA 20	2020	N	GFCM
Central Med.	2020	mts_17_18	Spottail mantis shrimp in GSA 17_18	2021	N	STECF
Central Med.	2019	mut_15	Red mullet in GSA 15	2020	N	GFCM
Central Med.	2019	mut_16	Red mullet in GSA 16	2020	N	GFCM
Central Med.	2020	mut_17_18	Red mullet in GSA 17_18	2021	N	STECF
Central Med.	2019	mut_20	Red mullet in GSA 20	2020	N	GFCM
Central Med.	2020	nep_17_18	Norway lobster in GSA 17_18	2021	N	STECF
Central Med.	2019	hke_22	European hake in GSA 22	2020	Y	GFCM
Eastern Med.	2019	mut_22	Red mullet in GSA 22	2020	N	STECF
Western Med.	2020	ara_01	Blue and red shrimp in GSA 01	2021	N	STECF
Western Med.	2020	ara_06_07	Blue and red shrimp in GSA 06_07	2021	N	STECF
Western Med.	2020	ara_09_10_11	Blue and red shrimp in GSA 09_10_11	2021	N	STECF
Western Med.	2020	ars_09_10_11	Giant red shrimp in GSA 09_10_11	2021	N	STECF
Western Med.	2019	dps_06	Deep-water rose shrimp in GSA 09_10_11	2020	Y	GFCM
Western Med.	2020	dps_09_10_11	Deep-water rose shrimp in GSA 09_10_11	2021	N	STECF
Western Med.	2020	hke_01_05_06_07	European hake in GSA 01_05_06_07	2021	N	STECF
Western Med.	2020	hke_08_09_10_11	European hake in GSA 08_09_10_11	2021	N	STECF
Western Med.	2019	mur_05	Surmullet in GSA 05	2020	N	STECF

Western Med.	2020	mut_01	Red mullet in GSA 01	2021	N	STECF
Western Med.	2020	mut_06	Red mullet in GSA 06	2021	N	STECF
Western Med.	2020	mut_07	Red mullet in GSA 07	2021	N	STECF
Western Med.	2020	mut_09	Red mullet in GSA 09	2021	N	STECF
Western Med.	2020	mut_10	Red mullet in GSA 10	2021	N	STECF
Western Med.	2020	nep_06	Norway lobster in GSA 06	2021	N	STECF
Western Med.	2020	nep_09	Norway lobster in GSA 09	2021	N	STECF
Western Med.	2019	pil_01	Sardine in GSA 01	2020	Y	GFCM
Western Med.	2019	pil_06	Sardine in GSA 06	2020	Y	GFCM

4.1 Indicators of management performance

4.1.1 Trend in F/F_{MSY}

To compute this indicator a similar model to those in the North East Atlantic was used, namely a mixed linear model, described in the protocol (Annex I). Values for 2020 were removed from the model fit. Bootstrapped quantiles of F/F_{MSY} are displayed in Figure 26 and Table 19. The 50% quantile (black line, equivalent to the median) shows an overall level varying around 2.10 for the whole time series, indicating that the stocks are exploited well above the CFP management objectives. In the Mediterranean and Black Seas assessments, a more conservative proxy for F_{MSY}, $F_{0.1}$, is commonly used resulting in a higher F/F_{MSY} ratio. There is a slightly decreasing trend since 2015, from 2.12 to 1.94, which indicates a small improvement in exploitation. Nevertheless, the instability in the dataset used may have an impact on the results.

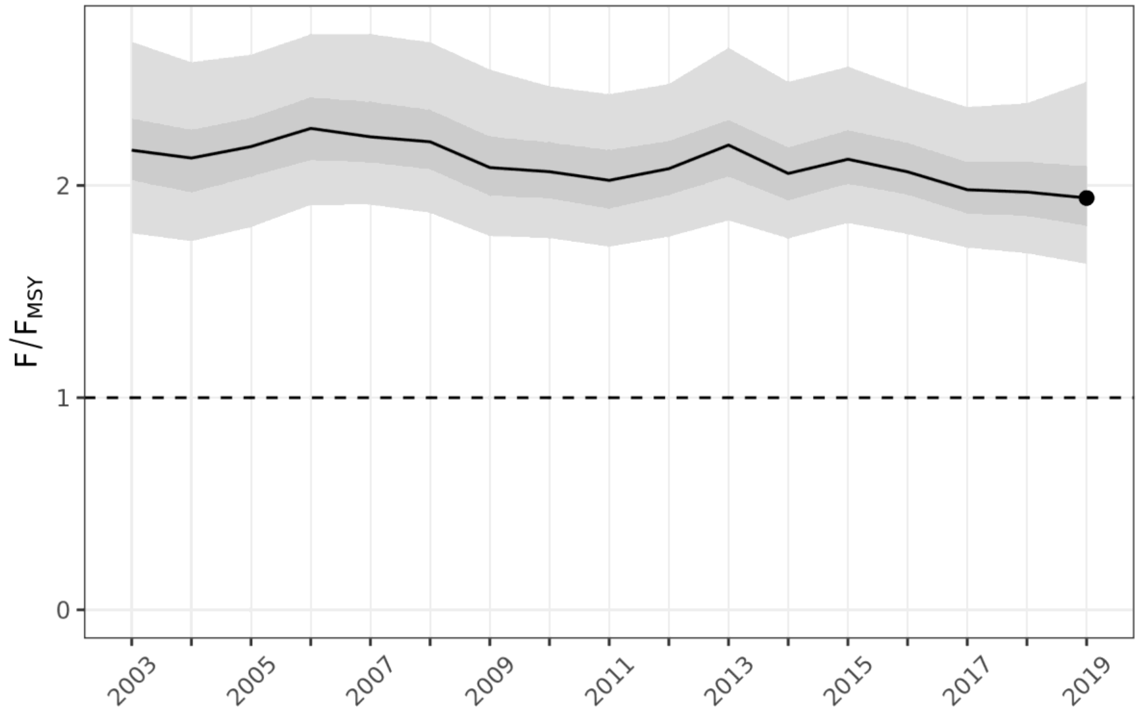

Figure 26: Trend in F/F_{MSY} (based on 34 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 19: Percentiles for F/F_{MSY}.

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	1.77	1.74	1.80	1.91	1.91	1.87	1.76	1.75	1.71
25%	2.03	1.97	2.04	2.12	2.11	2.08	1.95	1.94	1.89
50%	2.17	2.13	2.18	2.27	2.23	2.21	2.08	2.07	2.02
75%	2.31	2.26	2.32	2.41	2.39	2.36	2.23	2.20	2.17
97.5%	2.68	2.58	2.62	2.71	2.71	2.68	2.55	2.47	2.43

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	1.76	1.83	1.75	1.82	1.77	1.71	1.68	1.63	-
25%	1.96	2.04	1.93	2.01	1.96	1.87	1.86	1.81	-
50%	2.08	2.19	2.06	2.12	2.06	1.98	1.97	1.94	-
75%	2.21	2.31	2.18	2.26	2.20	2.11	2.11	2.09	-
97.5%	2.48	2.65	2.49	2.56	2.46	2.37	2.39	2.49	-

Trends by ecoregion are presented in Figure 27 and Table 20. Due to the reduced number of stocks available for the Eastern Mediterranean (2) and the Black Sea (1), the indicator is not shown.

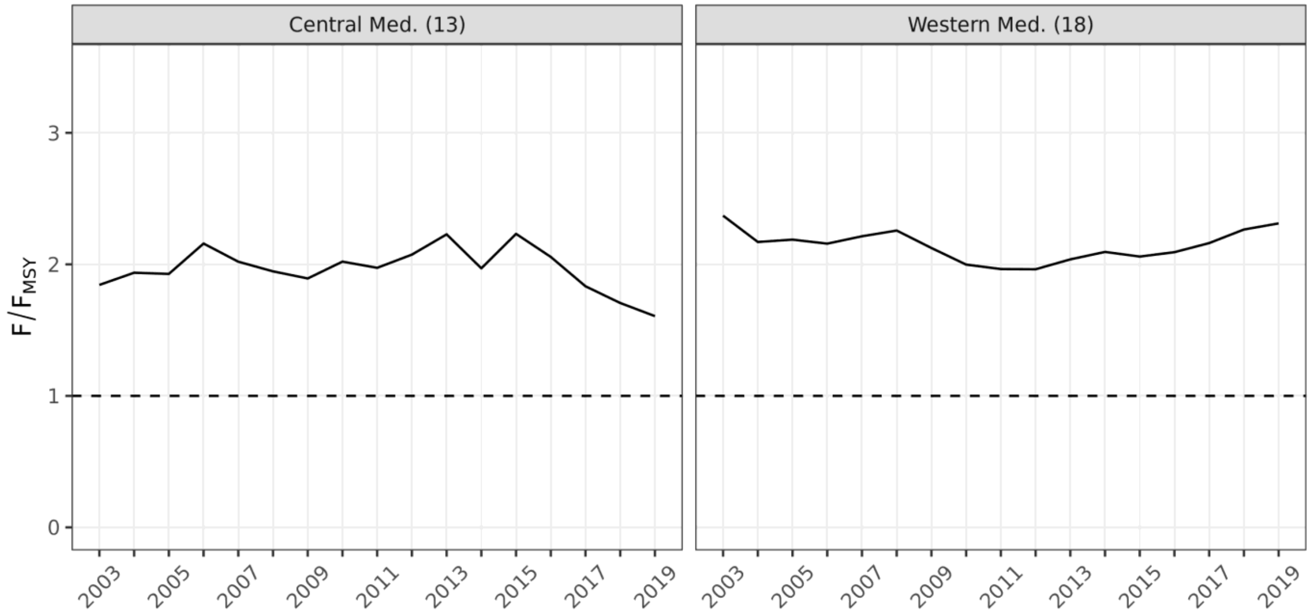

Figure 27: Trend in F/F_{MSY} by region. The number of stocks in each ecoregion are shown between parenthesis.

Table 20: F/F_{MSY} by ecoregion

Ecoregion	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Central Med	1.84	1.94	1.93	2.16	2.02	1.95	1.89	2.02	1.97
Western Med	2.37	2.17	2.19	2.16	2.21	2.26	2.12	2.00	1.96

Ecoregion	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Central Med	2.07	2.23	1.97	2.23	2.06	1.83	1.71	1.61	-
Western Med	1.96	2.04	2.09	2.06	2.09	2.16	2.27	2.31	-

4.1.2 Trend in SSB (relative to 2003)

This indicator was computed with a similar model to those in the North East Atlantic, namely a mixed linear model, described in the protocol (Annex I). The 50% quantile (black line), shows a bump at the beginning then a quite stable level which is increasing from 2014 (Figure 28 and Table 21). Quantiles are very large, representing a high level of uncertainty. The trends estimated by Ecoregion (Figure 29 and Table 22) show the high variability between ecoregions with a constant decrease in the Central Mediterranean from 2006 until 2014 inverting in the last years, while in the Western Mediterranean there is a clear increasing trend since 2008.

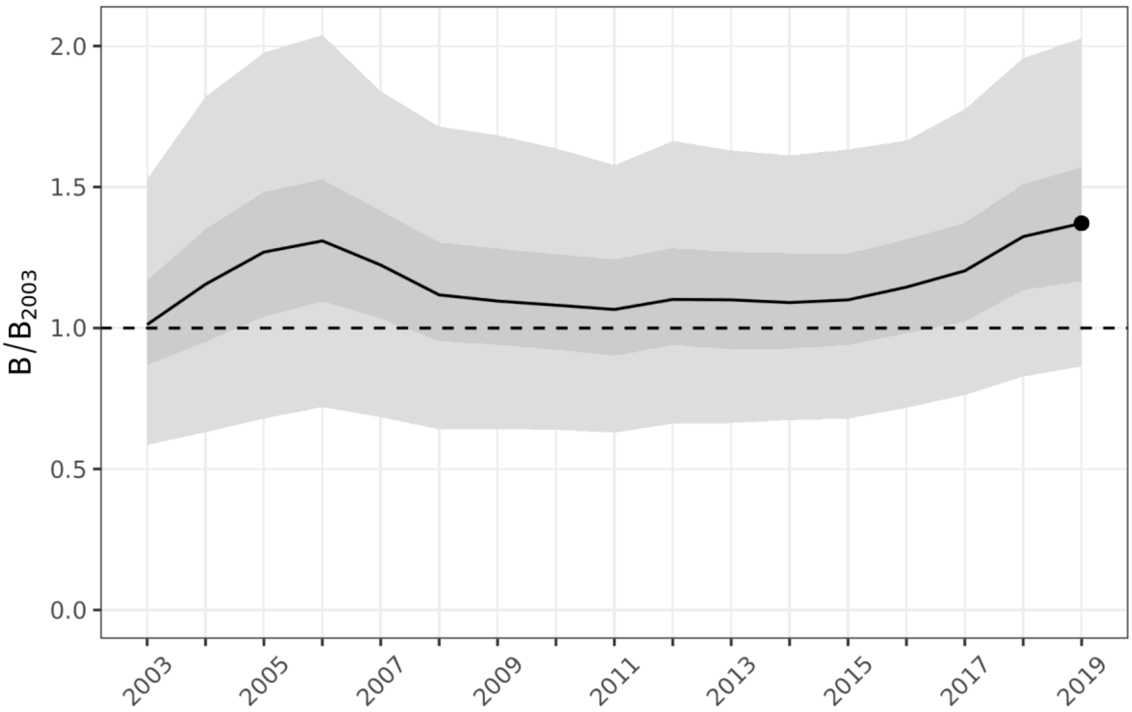

Figure 28: Trend in SSB relative to 2003 (based on 34 stocks). Dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 21: Percentiles for SSB relative to 2003.

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	0.59	0.63	0.68	0.72	0.68	0.64	0.64	0.64	0.63
25%	0.87	0.95	1.04	1.10	1.03	0.95	0.94	0.92	0.90
50%	1.01	1.16	1.27	1.31	1.22	1.12	1.10	1.08	1.07
75%	1.17	1.35	1.48	1.53	1.41	1.30	1.28	1.26	1.24
97.5%	1.53	1.82	1.98	2.04	1.84	1.71	1.68	1.64	1.58

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	0.66	0.66	0.67	0.68	0.72	0.76	0.83	0.86	-
25%	0.94	0.93	0.93	0.94	0.98	1.02	1.14	1.17	-
50%	1.10	1.10	1.09	1.10	1.14	1.20	1.32	1.37	-
75%	1.28	1.27	1.26	1.26	1.31	1.37	1.51	1.57	-
97.5%	1.66	1.63	1.61	1.63	1.66	1.78	1.96	2.03	-

Point estimates without confidence intervals by ecoregion are presented in Figure 29 and Table 22. Due to the number of stocks available for the Eastern Mediterranean (2) and the Black Sea (1), the B/B_{2003} indicator was not estimated.

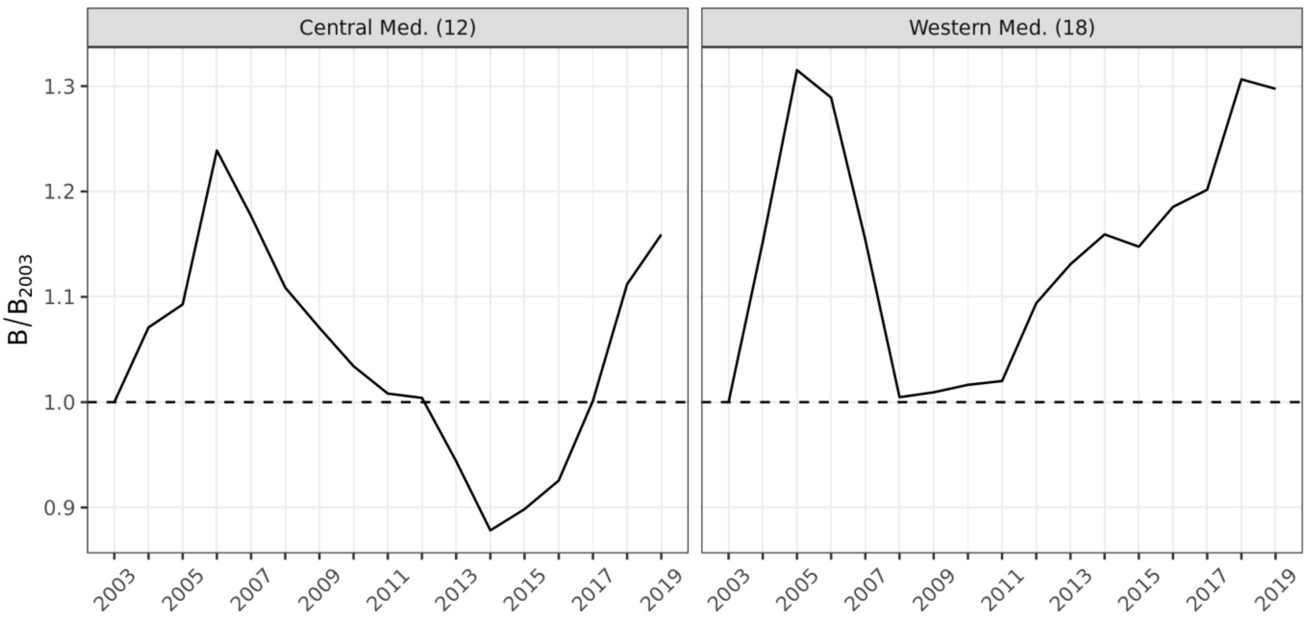

Figure 29: Trend in SSB relative to 2003 by ecoregion. The number of stocks in each ecoregion are shown in parenthesis.

Table 22: SSB relative to 2003 by ecoregion.

Ecoregion	2003	2004	2005	2006	2007	2008	2009	2010	2011
Central Med	1	1.07	1.09	1.24	1.18	1.11	1.07	1.03	1.01
Western Med	1	1.15	1.32	1.29	1.15	1.00	1.01	1.02	1.02

Ecoregion	2012	2013	2014	2015	2016	2017	2018	2019	2020
Central Med	1.00	0.94	0.88	0.90	0.93	1.00	1.11	1.16	-
Western Med	1.09	1.13	1.16	1.15	1.19	1.20	1.31	1.30	-

4.2 Indicators of advice coverage

In the Mediterranean and the Black Seas a total of 243 stocks were selected for the analysis; 230 stocks fell within the Mediterranean and Black Sea sampling frame and 13 stocks we analytically assessed but not in the sampling frame (see the protocol in Annex I and Mannini et al., 2017). Of these, 62 are covered by stock assessments carried out between 2019 and 2021. In some cases, multiple stocks were aggregated in a single multi-area stock assessment, in which case all stocks in the stock list are accounted for, hence why 34 stock assessments cover 62 stocks. The advice coverage for the Mediterranean and the Black Sea is 0.26. In Table 23, the 13 EU stocks not in the sample frame list are shown.

Table 23: Stocks assessed not in the sampling frame list

ARA_07	ARA_10	ARS_09	DPS_06	DPS_11
DPS_15	DPS_17	HKE_08	HKE_15	MUT_01
MUT_07	MUT_10	MUT_15		

5 EUROPEAN WATERS

STECF was requested in 2021 to provide two indicators of performance for the CFP at the European level (STECF, 2021a). The same model as in the individual areas was applied to the Northeast Atlantic and the Mediterranean and Black Seas combined to provide estimates of F/F_{MSY} and B/B_{2003} (Indicators 7 and 8 in the protocol). For the purpose of deriving this index, the Northeast Atlantic and Mediterranean and Black Seas datasets were pooled together and used as input data (Figure 30 and Figure 31). The time window was reduced by one year (2003-2019) in comparison to the Northeast Atlantic analysis as the Mediterranean and Black Sea data set stops in 2019. The trend in both indicators appeared to be strongly influenced by the Northeast Atlantic dataset. The influence was most likely due to the higher consistency of the trend in the Northeast Atlantic as well as the higher number of stocks included in the input dataset.

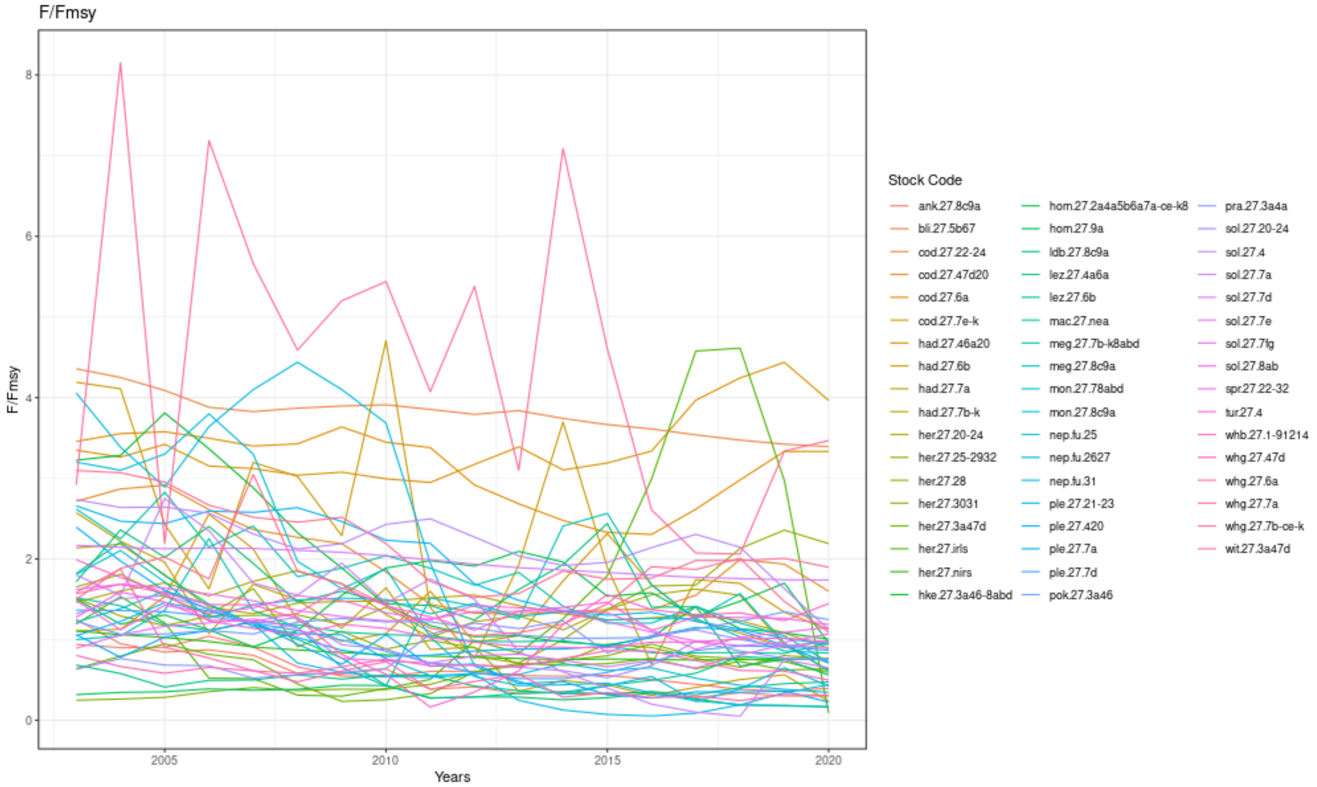

Figure 30: Summary of the trends of all stocks used to estimate the F/FMSY indicator for the Northeast Atlantic.

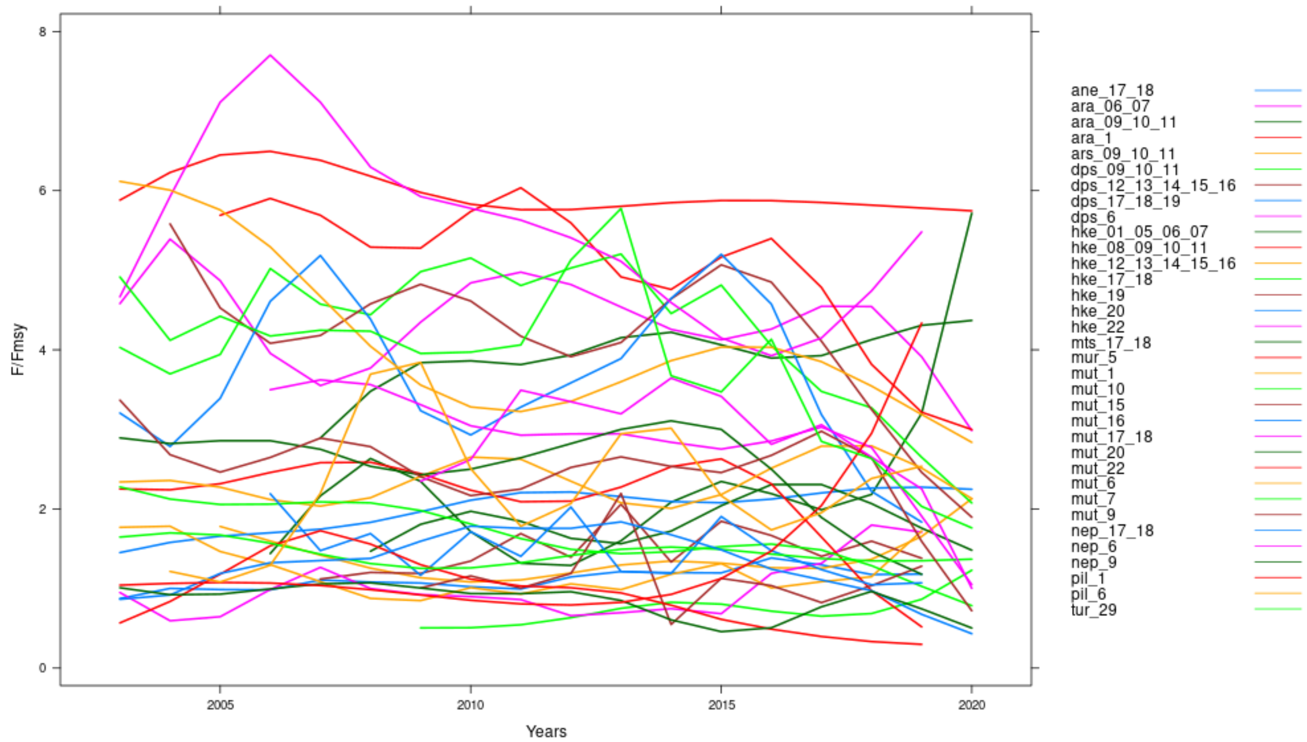

Figure 31: Summary of the trends of all stocks used to estimate the F/F_{MSY} indicator for the Mediterranean and Black Seas.

5.1 Indicators of management performance

Trends in F/F_{MSY} in EU Waters (FAO 27 and 37) exhibited a decreasing trend from 2003 to 2013 (Figure 32 and Table 24). From 2013, the indicator did not exhibit any increasing or decreasing trend and stabilized around 1.11. In last year's report, the confidence interval lower bound was above 1. In this year's report the lower bound was below 1.

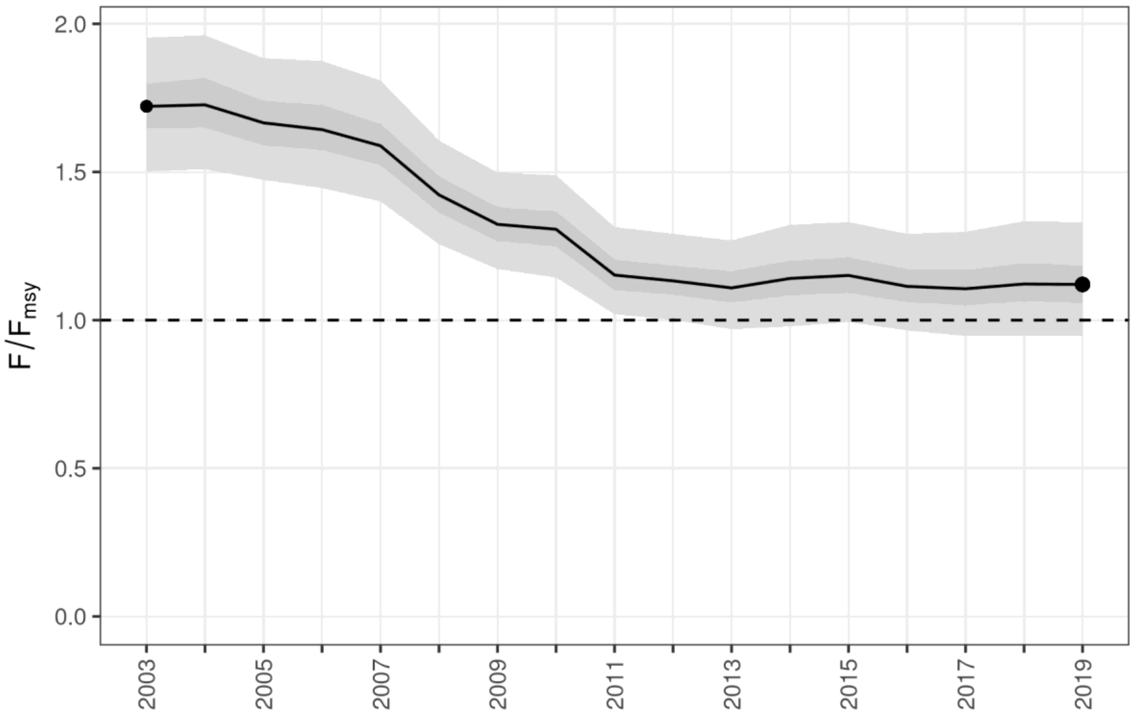

Figure 32: Trend in F/F_{MSY} (based on 86 stocks, 52 from the Northeast Atlantic and 34 from the Mediterranean and Black Sea). The dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval).

Table 24: Percentiles for F/F_{MSY} by year

	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.5%	1.50	1.51	1.47	1.45	1.40	1.26	1.17	1.14	1.02
25%	1.65	1.65	1.59	1.57	1.52	1.36	1.27	1.25	1.10
50%	1.72	1.73	1.67	1.64	1.59	1.42	1.32	1.31	1.15
75%	1.80	1.82	1.74	1.73	1.66	1.48	1.38	1.37	1.20
97.5%	1.95	1.96	1.88	1.87	1.81	1.61	1.50	1.49	1.31

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.5%	1.00	0.97	0.98	0.99	0.97	0.95	0.95	0.95	-
25%	1.09	1.06	1.08	1.09	1.06	1.05	1.06	1.06	-
50%	1.13	1.11	1.14	1.15	1.11	1.11	1.12	1.12	-
75%	1.18	1.16	1.20	1.21	1.17	1.17	1.19	1.18	-
97.5%	1.29	1.27	1.32	1.33	1.29	1.30	1.33	1.33	-

Trends in B/B_{2003} decreased over the years 2003-2007 to reach 0.90. Overall, the indicator of biomass increased over the years 2007-2019 reaching 1.27 and peaked at 1.30 in 2018 (Figure 33 and Table 12).

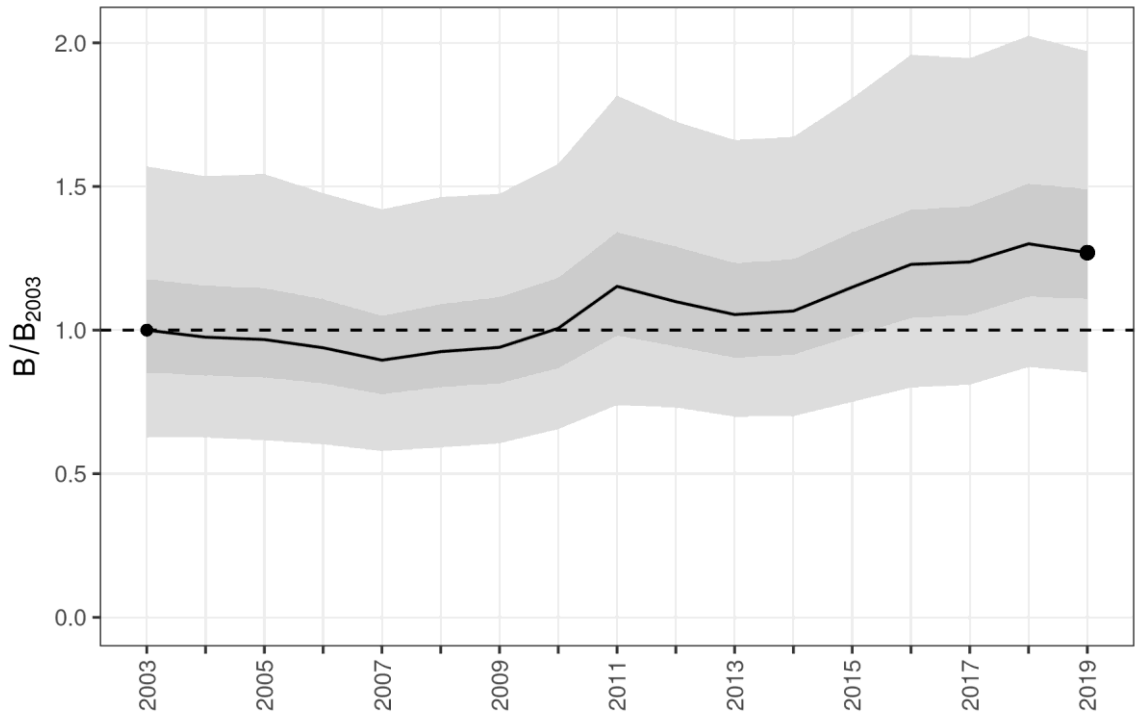

Figure 33: Trend in B/B_{2003} (based on 87 stocks; 53 for the Northeast Atlantic and 34 for the Mediterranean and Black Seas). The dark grey zone shows the 50% confidence interval; the light grey zone shows the 95% confidence interval.

Table 25: Percentiles of SSB relative to 2003

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2.5%	0.63	0.63	0.62	0.60	0.58	0.59	0.61	0.66	0.74
25%	0.85	0.84	0.84	0.82	0.78	0.80	0.82	0.87	0.98
50%	1.00	0.98	0.97	0.94	0.90	0.93	0.94	1.01	1.15
75%	1.18	1.15	1.14	1.11	1.05	1.09	1.11	1.18	1.34
97.5%	1.57	1.54	1.54	1.48	1.42	1.46	1.48	1.58	1.82

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
2.5%	0.73	0.70	0.70	0.75	0.80	0.81	0.87	0.85	-
25%	0.94	0.90	0.92	0.98	1.04	1.05	1.12	1.11	-
50%	1.10	1.05	1.07	1.15	1.23	1.24	1.30	1.27	-
75%	1.29	1.23	1.25	1.34	1.42	1.43	1.51	1.49	-
97.5%	1.73	1.66	1.67	1.81	1.96	1.95	2.02	1.97	-

6 Status across all stocks

Table 26: Stock status for all stocks in the analysis. Columns refer to ecoregion, last year for which the estimate was obtained, stock code and description, value of F/F_{MSY} ratio (F ind), if F is lower than F_{MSY} (F Status), if the stock is inside safe biological limits (SBL) (for both indicators F_{PA} and B_{PA}), and if the stock has F below F_{MSY} and SSB above B_{MSY} (F≤F_{MSY} & SSB≥B_{MSY}). Stocks managed under escapement strategies do not have an estimate of F/F_{MSY}, their F status is calculated as $MSYB_{escapement}$ over the stock size. Symbol 'Y' stands for 'Yes', 'N' stands for 'NO' and '-' stands for 'unknown' due to missing information.

Region	EcoRegion	Year	Stock	Description	F ind	F status	SBL	CFP
FAO27	Baltic Sea	2020	cod.27.22-24	Cod (*Gadus morhua*) in subdivisions 22-24. western Baltic stock (western Baltic Sea)	3.39	N	N	-
FAO27	Baltic Sea	2020	her.27.20-24	Herring (*Clupea harengus*) in subdivisions 20-24. spring spawners (Skagerrak. Kattegat. and western Baltic)	0.62	Y	N	-
FAO27	Baltic Sea	2020	her.27.25-2932	Herring (*Clupea harengus*) in subdivisions 25-29 and 32. excluding the Gulf of Riga (central Baltic Sea)	2.19	N	N	-
FAO27	Baltic Sea	2020	her.27.28	Herring (*Clupea harengus*) in Subdivision 28.1 (Gulf of Riga)	0.76	Y	Y	Y
FAO27	Baltic Sea	2020	her.27.3031	Herring (*Clupea harengus*) in subdivisions 30 and 31 (Gulf of Bothnia)	0.59	Y	Y	-
FAO27	Baltic Sea	2020	ple.27.21-23	Plaice (*Pleuronectes platessa*) in subdivisions 21-23 (Kattegat. Belt Seas. and the Sound)	0.94	Y	Y	-
FAO27	Baltic Sea	2020	sol.27.20-24	Sole (*Solea solea*) in subdivisions 20-24 (Skagerrak and Kattegat. western Baltic Sea)	0.75	Y	Y	-
FAO27	Baltic Sea	2020	spr.27.22-32	Sprat (*Sprattus sprattus*) in subdivisions 22-32 (Baltic Sea)	1.19	N	Y	-
FAO27	BoBiscay & Iberia	2020	ane.27.8	Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay)	NA	Y	-	-
FAO27	BoBiscay & Iberia	2020	ank.27.8c9a	Black-bellied anglerfish (*Lophius budegassa*) in divisions 8.c and 9.a (Cantabrian Sea. Atlantic Iberian waters)	0.39	Y	-	Y
FAO27	BoBiscay & Iberia	2020	hom.27.9a	Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters)	0.16	Y	-	Y
FAO27	BoBiscay & Iberia	2020	ldb.27.8c9a	Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East)	0.56	Y	Y	-
FAO27	BoBiscay & Iberia	2020	meg.27.7b-k8abd	Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b-k. 8.a-b. and 8.d (west and southwest of Ireland. Bay of Biscay)	0.72	Y	Y	-

FAO27	BoBiscay & Iberia	2020	meg.27.8c9a	Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.61	Y	Y	-
FAO27	BoBiscay & Iberia	2020	mon.27.78abd	White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a-b and 8.d (Celtic Seas. Bay of Biscay)	0.83	Y	Y	-
FAO27	BoBiscay & Iberia	2020	mon.27.8c9a	White anglerfish (*Lophius piscatorius*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	0.35	Y	Y	Y
FAO27	BoBiscay & Iberia	2020	nep.fu.2324	Norway lobster (*Nephrops norvegicus*) in divisions 8.a and 8.b. Functional Units 23-24 (northern and central Bay of Biscay)	0.64	Y	-	-
FAO27	BoBiscay & Iberia	2020	nep.fu.25	Norway lobster (*Nephrops norvegicus*) in Division 8.c. Functional Unit 25 (southern Bay of Biscay and northern Galicia)	0.17	Y	-	N
FAO27	BoBiscay & Iberia	2020	nep.fu.2627	Norway lobster (*Nephrops norvegicus*) in Division 9.a. Functional Units 26-27 (Atlantic Iberian waters East. western Galicia. and northern Portugal)	0.43	Y	-	N
FAO27	BoBiscay & Iberia	2020	nep.fu.31	Norway lobster (*Nephrops norvegicus*) in Division 8.c. Functional Unit 31 (southern Bay of Biscay and Cantabrian Sea)	0.44	Y	-	N
FAO27	BoBiscay & Iberia	2020	sol.27.8ab	Sole (*Solea solea*) in divisions 8.a-b (northern and central Bay of Biscay)	1.15	N	N	-
FAO27	Celtic Seas	2019	cod.27.6a	Cod (*Gadus morhua*) in Division 6.a (West of Scotland)	3.33	N	N	-
FAO27	Celtic Seas	2020	cod.27.7e-k	Cod (*Gadus morhua*) in divisions 7.e-k (eastern English Channel and southern Celtic Seas)	3.97	N	N	-
FAO27	Celtic Seas	2020	had.27.6b	Haddock (*Melanogrammus aeglefinus*) in Division 6.b (Rockall)	1.13	N	Y	-
FAO27	Celtic Seas	2020	had.27.7a	Haddock (*Melanogrammus aeglefinus*) in Division 7.a (Irish Sea)	0.23	Y	Y	Y
FAO27	Celtic Seas	2020	had.27.7b-k	Haddock (*Melanogrammus aeglefinus*) in divisions 7.b-k (southern Celtic Seas and English Channel)	0.89	Y	Y	-
FAO27	Celtic Seas	2020	her.27.irls	Herring (*Clupea harengus*) in divisions 7.a South of 52Â°30â€™N. 7.g-h. and 7.j-k (Irish Sea. Celtic Sea. and southwest of Ireland)	0.09	Y	N	-
FAO27	Celtic Seas	2020	her.27.nirs	Herring (*Clupea harengus*) in Division 7.a North of 52Â°30â€™N (Irish Sea)	0.76	Y	Y	-
FAO27	Celtic Seas	2020	lez.27.4a6a	Megrim (*Lepidorhombus spp.*) in divisions 4.a and 6.a (northern North Sea. West of Scotland)	0.47	Y	-	Y
FAO27	Celtic Seas	2020	lez.27.6b	Megrim (*Lepidorhombus spp.*) in Division 6.b (Rockall)	0.75	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.11	Norway lobster (*Nephrops norvegicus*) in Division 6.a. Functional	0.29	Y	-	Y

				Unit 11 (West of Scotland. North Minch)				
FAO27	Celtic Seas	2020	nep.fu.12	Norway lobster (*Nephrops norvegicus*) in Division 6.a. Functional Unit 12 (West of Scotland. South Minch)	0.26	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.13	Norway lobster (*Nephrops norvegicus*) in Division 6.a. Functional Unit 13 (West of Scotland. the Firth of Clyde and Sound of Jura)	0.62	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.14	Norway lobster (*Nephrops norvegicus*) in Division 7.a. Functional Unit 14 (Irish Sea. East)	0.23	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.15	Norway lobster (*Nephrops norvegicus*) in Division 7.a. Functional Unit 15 (Irish Sea. West)	0.58	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.16	Norway lobster (*Nephrops norvegicus*) in divisions 7.b-c and 7.j-k. Functional Unit 16 (west and southwest of Ireland. Porcupine Bank)	0.63	Y	-	-
FAO27	Celtic Seas	2020	nep.fu.17	Norway lobster (*Nephrops norvegicus*) in Division 7.b. Functional Unit 17 (west of Ireland. Aran grounds)	0.36	Y	-	N
FAO27	Celtic Seas	2020	nep.fu.19	Norway lobster (*Nephrops norvegicus*) in divisions 7.a. 7.g. and 7.j. Functional Unit 19 (Irish Sea. Celtic Sea. eastern part of southwest of Ireland)	0.58	Y	-	N
FAO27	Celtic Seas	2020	nep.fu.2021	Norway lobster (*Nephrops norvegicus*) in divisions 7.g and 7.h. Functional Units 20 and 21 (Celtic Sea)	0.26	Y	-	Y
FAO27	Celtic Seas	2020	nep.fu.22	Norway lobster (*Nephrops norvegicus*) in divisions 7.f and 7.g. Functional Unit 22 (Celtic Sea. Bristol Channel)	0.76	Y	-	N
FAO27	Celtic Seas	2020	ple.27.7a	Plaice (*Pleuronectes platessa*) in Division 7.a (Irish Sea)	0.22	Y	Y	Y
FAO27	Celtic Seas	2020	sol.27.7a	Sole (*Solea solea*) in Division 7.a (Irish Sea)	0.65	Y	N	-
FAO27	Celtic Seas	2020	sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	0.89	Y	Y	Y
FAO27	Celtic Seas	2020	sol.27.7fg	Sole (*Solea solea*) in divisions 7.f and 7.g (Bristol Channel. Celtic Sea)	1.07	N	Y	-
FAO27	Celtic Seas	2020	whg.27.6a	Whiting (*Merlangius merlangus*) in Division 6.a (West of Scotland)	0.31	Y	Y	-
FAO27	Celtic Seas	2020	whg.27.7a	Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)	3.47	N	N	-
FAO27	Celtic Seas	2020	whg.27.7b-ce-k	Whiting (*Merlangius merlangus*) in divisions 7.b-c and 7.e-k (southern Celtic Seas and eastern English Channel)	1.09	N	N	-
FAO27	Greater North Sea	2020	cod.27.47d20	Cod (*Gadus morhua*) in Subarea 4. Division 7.d. and Subdivision 20 (North Sea. eastern English Channel. Skagerrak)	1.60	N	N	-
FAO27	Greater North Sea	2020	had.27.46a20	Haddock (*Melanogrammus aeglefinus*) in Subarea 4. Division 6.a. and Subdivision 20 (North Sea. West of Scotland. Skagerrak)	0.98	Y	Y	-

FAO27	Greater North Sea	2020	her.27.3a47d	Herring (*Clupea harengus*) in Subarea 4 and divisions 3.a and 7.d. autumn spawners (North Sea. Skagerrak and Kattegat. eastern English Channel)	0.64	Y	Y	Y
FAO27	Greater North Sea	2020	nep.fu.6	Norway lobster (*Nephrops norvegicus*) in Division 4.b. Functional Unit 6 (central North Sea. Farn Deeps)	1.12	N	-	N
FAO27	Greater North Sea	2020	nep.fu.7	Norway lobster (*Nephrops norvegicus*) in Division 4.a. Functional Unit 7 (northern North Sea. Fladen Ground)	0.49	Y	-	Y
FAO27	Greater North Sea	2020	nep.fu.8	Norway lobster (*Nephrops norvegicus*) in Division 4.b. Functional Unit 8 (central North Sea. Firth of Forth)	0.37	Y	-	Y
FAO27	Greater North Sea	2020	nep.fu.9	Norway lobster (*Nephrops norvegicus*) in Division 4.a. Functional Unit 9 (central North Sea. Moray Firth)	0.63	Y	-	Y
FAO27	Greater North Sea	2020	nop.27.3a4	Norway pout (*Trisopterus esmarkii*) in Subarea 4 and Division 3.a (North Sea. Skagerrak and Kattegat)	NA	Y	-	-
FAO27	Greater North Sea	2020	ple.27.420	Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	0.71	Y	Y	Y
FAO27	Greater North Sea	2020	ple.27.7d	Plaice (*Pleuronectes platessa*) in Division 7.d (eastern English Channel)	0.87	Y	Y	-
FAO27	Greater North Sea	2020	pok.27.3a46	Saithe (*Pollachius virens*) in subareas 4. 6 and Division 3.a (North Sea. Rockall and West of Scotland. Skagerrak and Kattegat)	1.25	N	Y	-
FAO27	Greater North Sea	2020	pra.27.3a4a	Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East (Skagerrak and Kattegat and northern North Sea in the Norwegian Deep)	0.98	Y	N	N
FAO27	Greater North Sea	2020	san.sa.1r	Sandeel (*Ammodytes* spp.) in divisions 4.b and 4.c. Sandeel Area 1r (central and southern North Sea. Dogger Bank)	NA	N	-	-
FAO27	Greater North Sea	2020	san.sa.2r	Sandeel (*Ammodytes* spp.) in divisions 4.b and 4.c. and Subdivision 20. Sandeel Area 2r (Skagerrak. central and southern North Sea)	NA	N	-	-
FAO27	Greater North Sea	2020	san.sa.3r	Sandeel (*Ammodytes* spp.) in divisions 4.a and 4.b. and Subdivision 20. Sandeel Area 3r (Skagerrak. northern and central North Sea)	NA	Y	-	-
FAO27	Greater North Sea	2020	san.sa.4	Sandeel (*Ammodytes* spp.) in divisions 4.a and 4.b. Sandeel Area 4 (northern and central North Sea)	NA	N	-	-
FAO27	Greater North Sea	2020	sol.27.4	Sole (*Solea solea*) in Subarea 4 (North Sea)	1.12	N	N	-

FAO27	Greater North Sea	2020	sol.27.7d	Sole (*Solea solea*) in Division 7.d (eastern English Channel)	1.74	N	N	-
FAO27	Greater North Sea	2020	spr.27.3a4	Sprat (*Sprattus sprattus*) in Division 3.a and Subarea 4 (Skagerrak. Kattegat and North Sea)	NA	Y	-	-
FAO27	Greater North Sea	2020	tur.27.4	Turbot (*Scophthalmus maximus*) in Subarea 4 (North Sea)	0.97	Y	Y	Y
FAO27	Greater North Sea	2020	whg.27.47d	Whiting (*Merlangius merlangus*) in Subarea 4 and Division 7.d (North Sea and eastern English Channel)	0.50	Y	Y	-
FAO27	Greater North Sea	2020	wit.27.3a47d	Witch (*Glyptocephalus cynoglossus*) in Subarea 4 and divisions 3.a and 7.d (North Sea. Skagerrak and Kattegat. eastern English Channel)	1.90	N	N	-
FAO27	Widely	2019	bli.27.5b67	Blue ling (*Molva dypterygia*) in subareas 6-7 and Division 5.b (Celtic Seas and Faroes grounds)	0.30	Y	Y	-
FAO27	Widely	2019	dgs.27.nea	Spurdog (*Squalus acanthias*) in Subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	0.24	Y	-	N
FAO27	Widely	2020	hke.27.3a46-8abd	Hake (*Merluccius merluccius*) in subareas 4. 6. and 7. and divisions 3.a. 8.a-b. and 8.d. Northern stock (Greater North Sea. Celtic Seas. and the northern Bay of Biscay)	1.01	N	Y	-
FAO27	Widely	2020	hom.27.2a4a5b6a7a-ce-k8	Horse mackerel (*Trachurus trachurus*) in Subarea 8 and divisions 2.a. 4.a. 5.b. 6.a. 7.a-c.e-k (the Northeast Atlantic)	0.96	Y	N	-
FAO27	Widely	2020	mac.27.nea	Mackerel (*Scomber scombrus*) in subareas 1-8 and 14 and Division 9.a (the Northeast Atlantic and adjacent waters)	0.96	Y	Y	-
FAO27	Widely	2020	whb.27.1-91214	Blue whiting (*Micromesistius poutassou*) in subareas 1-9. 12. and 14 (Northeast Atlantic and adjacent waters)	1.45	N	N	-
FAO37	Black Sea	2019	tur_29	Turbot in GSA 29	2.03	N	-	-
FAO37	Central Med.	2019	ane_17_18	European anchovy in GSA 17, 18	1.18	N	-	-
FAO37	Central Med.	2019	dps_12_13_14_15_16	Deep-water rose shrimp in GSA 12, 13, 14, 15, 16	1.38	N	-	-
FAO37	Central Med.	2019	dps_17_18_19	Deep-water rose shrimp in GSA 17, 18, 19	2.27	N	-	-
FAO37	Central Med.	2019	hke_12_13_14_15_16	European hake in GSA 12, 13, 14, 15, 16	1.72	N	-	-

FAO37	Central Med.	2019	hke_17_18	European hake in GSA 17, 18	2.65	N	-	-
FAO37	Central Med.	2019	hke_19	European hake in GSA 19	2.46	N	-	-
FAO37	Central Med.	2019	hke_22	European hake in GSA 22	5.48	N	-	-
FAO37	Central Med.	2019	hke_20	European hake in GSA 20	1.84	N	-	-
FAO37	Central Med.	2019	mts_17_18	Spottail mantis squillid in GSA 17, 18	1.76	N	-	-
FAO37	Central Med.	2019	mut_15	Red mullet in GSA 15	1.28	N	-	-
FAO37	Central Med.	2019	mut_16	Red mullet in GSA 16	1.07	N	-	-
FAO37	Central Med.	2019	mut_17_18	Red mullet in GSA 17, 18	1.91	N	-	-
FAO37	Central Med.	2019	mut_20	Red mullet in GSA 20	1.18	N	-	-
FAO37	Central Med.	2019	nep_17_18	Norway lobster in GSA 17, 18	0.68	Y	-	-
FAO37	Eastern Med.	2019	mut_22	Red mullet in GSA 22	0.30	Y	-	-
FAO37	Western Med.	2019	ara_01	Blue and red shrimp in GSA 01	5.78	N	-	-
FAO37	Western Med.	2019	ara_06_07	Blue and red shrimp in GSA 06, 07	3.91	N	-	-
FAO37	Western Med.	2019	ara_09_10_11	Blue and red shrimp in GSA 09, 10, 11	3.20	N	-	-
FAO37	Western Med.	2019	ars_09_10_11	Giant red shrimp in GSA 09, 10, 11	1.65	N	-	-
FAO37	Western Med.	2019	dps_06	Deep-water rose shrimp in GSA 06	1.71	N	-	-

FAO37	Western Med.	2019	dps_09_10_11	Deep-water rose shrimp in GSA 09, 10, 11	0.86	Y	-	-
FAO37	Western Med.	2019	hke_01_05_06_07	European hake in GSA 01, 05, 06, 07	4.31	N	-	-
FAO37	Western Med.	2019	hke_08_09_10_11	European hake in GSA 08, 09, 10, 11	3.22	N	-	-
FAO37	Western Med.	2019	mur_05	Surmullet in GSA 05	0.52	Y	-	-
FAO37	Western Med.	2019	mut_01	Red mullet in GSA 01	2.51	N	-	-
FAO37	Western Med.	2019	mut_06	Red mullet in GSA 06	3.19	N	-	-
FAO37	Western Med.	2019	mut_07	Red mullet in GSA 07	1.35	N	-	-
FAO37	Western Med.	2019	mut_09	Red mullet in GSA 09	1.59	N	-	-
FAO37	Western Med.	2019	mut_10	Red mullet in GSA 10	1.03	N	-	-
FAO37	Western Med.	2019	nep_06	Norway lobster in GSA 06	2.25	N	-	-
FAO37	Western Med.	2019	nep_09	Norway lobster in GSA 09	0.74	Y	-	-
FAO37	Western Med.	2019	pil_01	European pilchard(=Sardine) in GSA 01	4.34	N	-	-
FAO37	Western Med.	2019	pil_06	European pilchard(=Sardine) in GSA 06	2.54	N	-	-

7 Historical trends

As the number of stocks under consideration changes every year due to the availability of stock assessments, historical retrospectives of both modelled indicators (F/F_{MSY} and B/B_{2003}) were carried out (Figure 34-Figure 37). The indicators were grouped by FAO region. The input data were the F and B indicators computed each year for the purpose of monitoring the CFP performance since 2017. The time horizon chosen was 5 years, this means up to 5 years of data were peeled off before estimating the indicators. Only the median was used to compare inter-annual behaviour.

In the Northeast Atlantic, the trajectories of both indicators F/F_{MSY} and B/B_{2003} were consistent over the years they were computed. The fishing pressure indicator decreased over the years 2003-2019. The biomass indicator increased over the same period. A change in the perception was observed with an upward revisions for F/F_{MSY} and a downward revision in B/B_{2003} over time. In other words, the fishing pressure levels were underestimated each year whereas the SSB estimates were overestimated (Figure 34 and Figure 35).

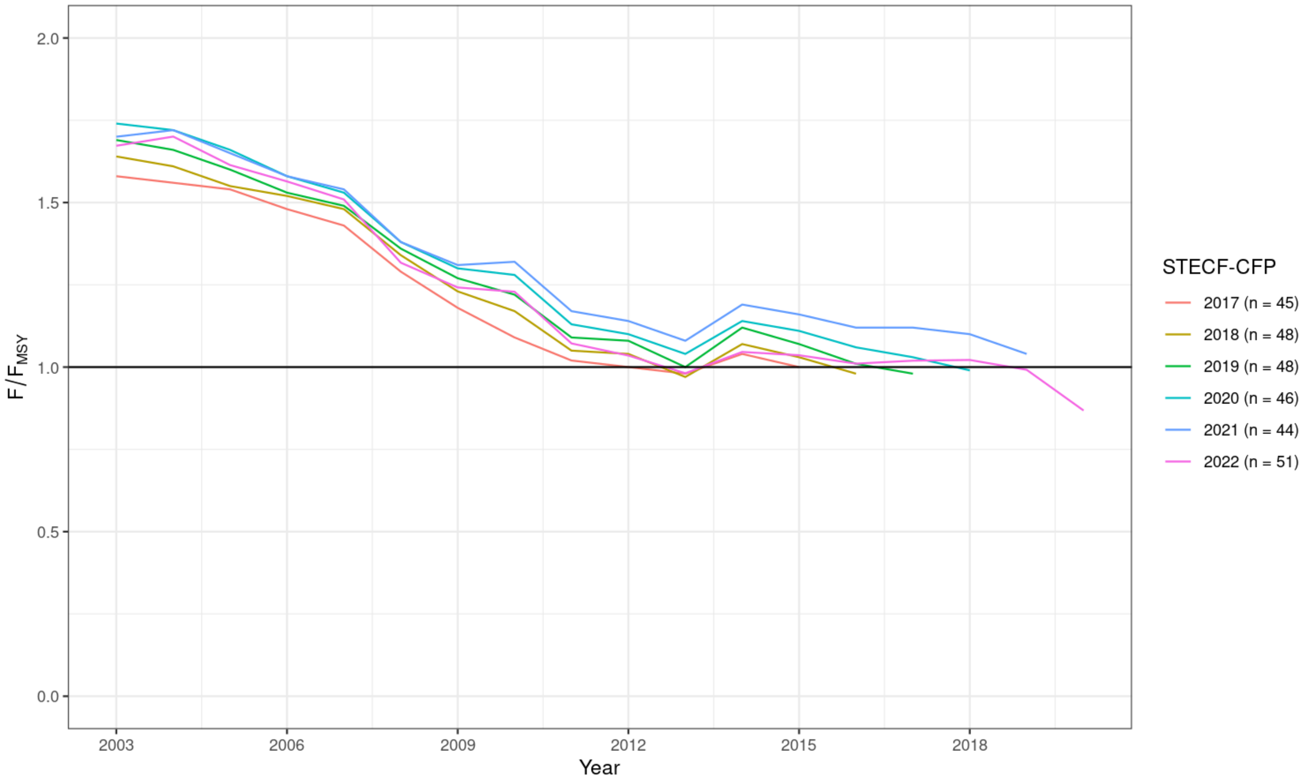

Figure 34: Historical retrospective reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the Northeast Atlantic Area

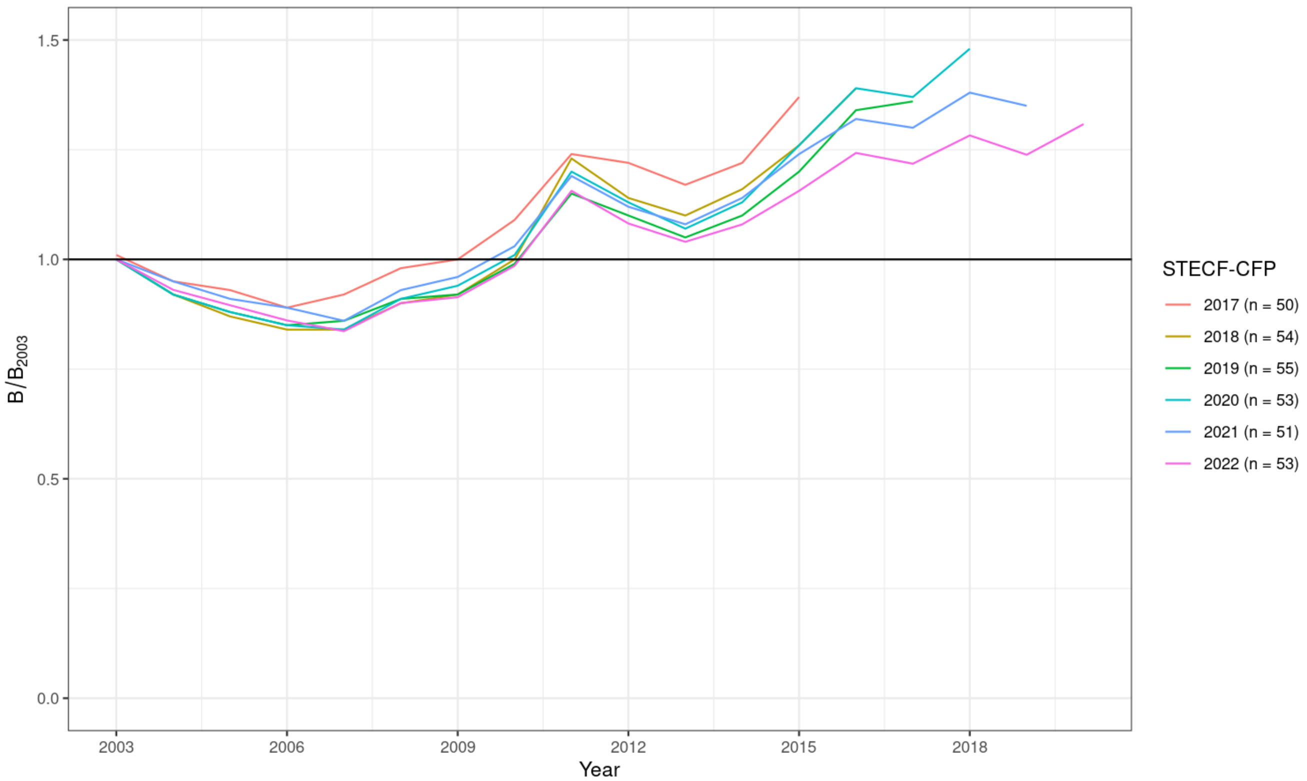

Figure 35: Historical retrospective reported in STECF CFP monitoring reports since 2017 for B/B_{2003} in the Northeast Atlantic area

In the Mediterranean and Black Sea, the different times series of F/F_{MSY} values are most of the time >2. The only values below that level are the last two F/F_{MSY} values of the most recent time series. The biomass indicator (B/B_{2003}) exhibited a pattern similar to the fishing mortality's. The first 3 time series were either close or below 1. Only the last two time series remained above 1 throughout the time series. This is consistent with a decrease of the fishing mortality (Figure 36 and Figure 37).

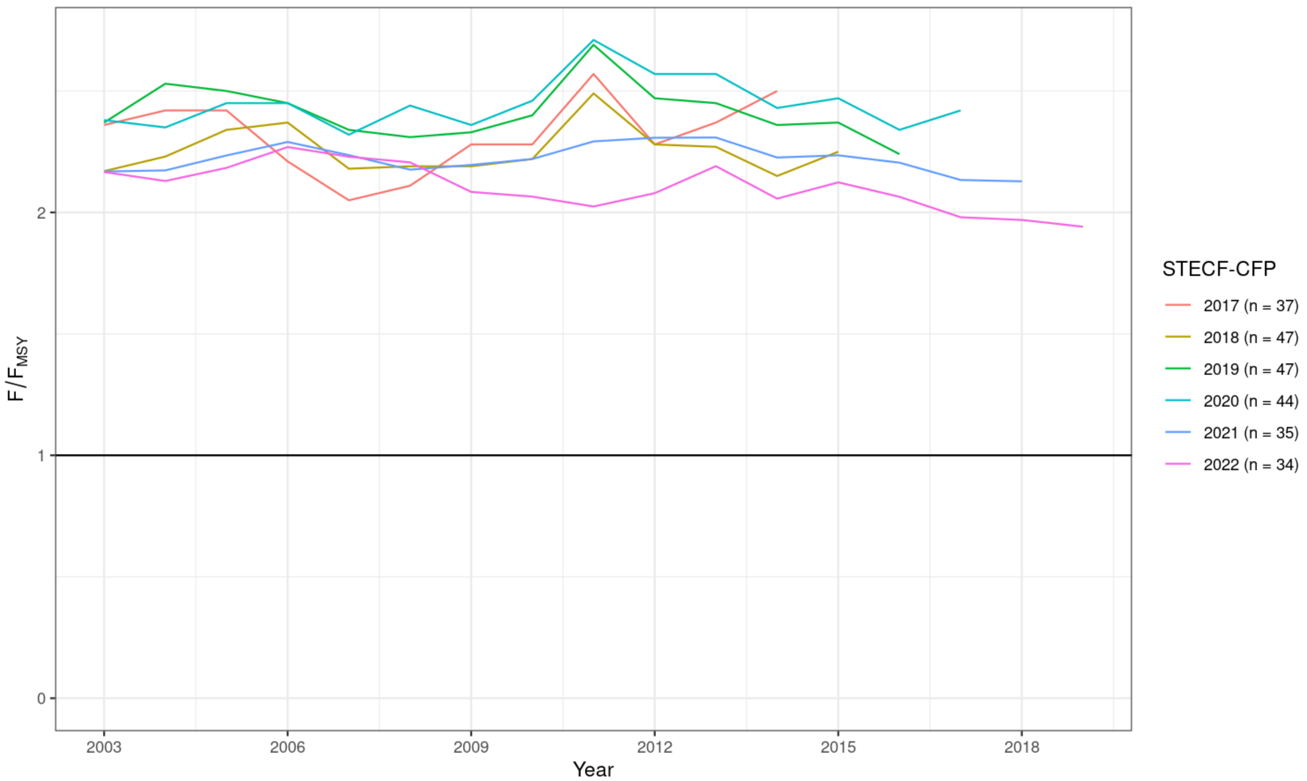

Figure 36: Historical retrospective reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the Mediterranean and Black Sea area

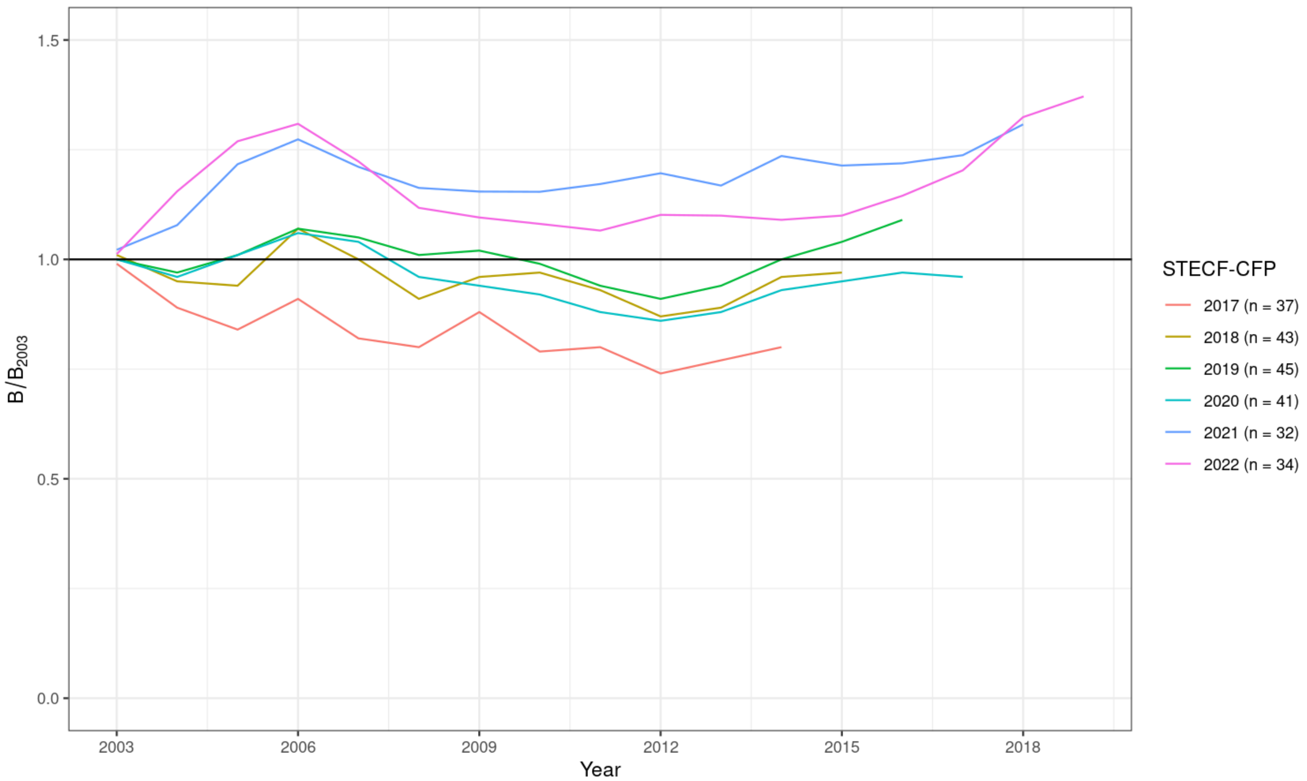

Figure 37: Historical retrospective reported in STECF CFP monitoring reports since 2017 for F/F_{MSY} in the Mediterranean and Black Sea area.

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9 CONTACT DETAILS OF AD HOC EXPERT WORKING GROUP EWG-ADHOC-22-01 PARTICIPANTS

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

JRC experts		
Name	**Affiliation[1]**	**Email**
Michaël Gras	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	michael.gras@ec.europa.eu
Alessandro Mannini	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	alessandro.mannini@ec.europa.eu
Christoph Konrad	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	christoph.konrad@ec.europa.eu
Sven Kupschus	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	sven.kupschus@ec.europa.eu
Henning Winker	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	henning.winker@ec.europa.eu
Paris Vasilakopoulos	European Commission, Joint Research Centre, Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra (VA), Italy	paris.vasilakopoulos@ec.europa.eu

10 List of Annexes

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

List of electronic annexes documents:

EWG-Adhoc-22-01 – Annex 1 – URL links to the source of the reports by stock

EWG-Adhoc-22-01 – Annex 2 – ICES data quality issues corrected prior to the analysis

EWG-Adhoc-22-01 – Annex 3 - R code for computing all European waters indicators

11 List of Background Documents

List of background documents:

EWG-Adhoc-22-01 – Doc 1 - Declarations of JRC experts (see also section 9 of this report – List of participants)

9 ANNEX 1 – NEA CODE

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

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

rm(list=ls())
gc()
#setwd("/home/pintoce/2021-cfpindicators/analysis")
setwd("~/gitlab/2022-cfpindicators/")
source("analysis/funs.R")

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

# year when assessments were performed
assessmentYear <- 2021
# final data year with estimations from stock assessments
fnlYear <- assessmentYear - 1
# initial data year with estimations from stock assessments
iniYear <- 2003
# vector of years
dy <- iniYear:fnlYear
# vector of years for valid assessments
vay <- (assessmentYear-2):assessmentYear
# vector of years for stock status projection
vpy <- (fnlYear-2):fnlYear
# options for reading data
options(stringsAsFactors=FALSE)
# number of simulations for mle bootstrap
it <- 1000
# number of cores for mle bootstrap parallel
nc <- 11 #(11 on Michael's laptop and 150 on the SNES)
# quantiles to be computed
qtl <- c(0.025, 0.25, 0.50, 0.75, 0.975)
# to control the seed in mclapply
RNGkind("L'Ecuyer-CMRG")
set.seed(1234)
# to make plots consistent
vp <- dy
vp[c(2,3,5,6,8,9,11,12,14,15)] <- ""
theme_set(theme_bw())
sc <- scale_x_continuous(breaks=seq(iniYear, fnlYear, 2)) #, labels=as.character(vp)
```

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

# To save csv files, RData files and graphs turn the following to true
savecsv <- FALSE
savedata <- FALSE
savegraph <- FALSE


# Open a window to display graphs
if (savegraph==FALSE) x11()

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

#-----------------------------------------------------------------
# assessmentsnep.
#-----------------------------------------------------------------
isa <- rbind(read.csv("data/ices/corrected_data.csv", stringsAsFactors=FALSE)[,-c(31,32)],
         read.csv("data/ices/corrected_data_cat3.csv", stringsAsFactors=FALSE))

isa[isa$FishStock=="cod.27.7a","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="reb.27.14b","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="reb.27.5a14","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="bll.27.22-32","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="hom.27.3a4bc7d","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="tur.27.22-32","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="sbr.27.10","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="raj.27.1012","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="syt.27.67","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="tur.27.3a","StockSizeDescription"] <- "B/Bmsy"
isa[isa$FishStock=="whg.27.3a","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="spr.27.7de","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="rjh.27.4c7d","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="usk.27.3a45b6a7-912b","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="rjm.27.3a47d","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="rjn.27.3a4","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="syc.27.8c9a","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="sho.27.89a","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="syc.27.8abd","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="sho.27.67","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="rjc.27.3a47d","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="syc.27.3a47d","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="sdv.27.nea","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="syc.27.67a-ce-j","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="sol.27.8c9a","StockSizeDescription"] <- "Biomass index"
isa[isa$FishStock=="had.27.5a","StockSizeDescription"] <- "SSB"
isa[isa$FishStock=="bss.27.8ab","StockSizeDescription"] <- "SSB"
isa[isa$FishStock=="reb.2127.dp","StockSizeDescription"] <- "Relative SSB"
isa[isa$FishStock=="nep.fu.30","StockSizeDescription"] <- "Abundance index"
isa[isa$FishStock=="pil.27.8c9a","StockSizeDescription"] <- "SSB"
isa[isa$FishStock=="ghl.27.1-2","StockSizeDescription"] <- "TSB"



#isa <- read.csv("data/ices/Dataset_2021.csv", stringsAsFactors=FALSE)
```

```
#isa$FishingPressure <- as.numeric(isa$FishingPressure)
#isa$Recruitment <- as.numeric(isa$Recruitment)
# extract the main ecoregion but keep the list
##no list of ecoregion this year as correct ecoregion set after indication by David Miller
# er <- strsplit(isa[,"EcoRegion"], ",")
# isa$EcoRegionList <- isa$EcoRegion
# isa$EcoRegion <- unlist(lapply(er, function(x) x[1]))
# er <- strsplit(isa[,"EcoRegion"], " ")
# isa$EcoRegion <- unlist(lapply(er, function(x) paste(x[-length(x)], collapse=" ")))
#isa[isa$EcoRegion=="Bay of Biscay and the Iberian Coast", "EcoRegion"] <- "BoBiscay & Iberia"

# widely distributed to keep coherent with previous years (taken from 2017's files)
# >>> old codes don't exist anymore, updated to new ones

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

# this is not needed anymore as already correct for had nad pok and wrong for sol
# correcting Greater North Sea
#isa[isa$FishStock %in% c("had.27.46a20", "pok.27.3a46", "sol.27.7e"), "EcoRegion"] <-
"Greater North Sea"

# fix codes for stock size and fishing mortality if needed
isa[isa$FishingPressureDescription %in% c("Harvest Rate", "Harvest rate"),
"FishingPressureDescription"] #<- "HR"

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

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

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

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

load("data/ices/sframe.RData", verbose=T)
# 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)

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

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

# NOTE: should do these fixes to isa and after subset to isa12
colnames(isa12)[colnames(isa12) == "ICES.Areas..splited.with.character....."] <- "Areas"
# Drop duplicates
isa12 <- unique(isa12)
# Remove white space and any capital letters from assessment name
isa12[,"FishStock"] <- tolower(gsub("\\s", "", isa12[,"FishStock"]))
# Make a species column from the assessment name
spp <- strsplit(isa12[,"FishStock"], "\\.")
isa12$Species <- toupper(unlist(lapply(spp, function(x) x[1])))
# Split ICES area by ~
areas <- strsplit(isa12[,"Areas"], "~")
names(areas) <- isa12[,"FishStock"]
areas <- reshape2::melt(areas)
colnames(areas) <- c("Area","FishStock")
isa12 <- merge(isa12, areas)
# keep relevant columns only
isa12 <- isa12[,c("FishStock","Area", "Species", "SpeciesName", "SGName", "DataCategory", "EcoRegion")]
isa12[,"Area"] <- toupper(gsub("\\s", "", isa12[,"Area"]))
# remove ecoregions outside EU waters
#isa12 <- subset(isa12, !(EcoRegion %in% c("Arctic Ocean", "Greenland Sea", "Faroes", "Iceland Sea")))
isa12 <- subset(isa12, !(EcoRegion %in% c("Arctic Ocean", "Iceland, Greenland and Faroes")))
# drop if ecoregion is NA
isa12 <- subset(isa12, !is.na(EcoRegion))
# remove her-noss which is widely distributed but mainly norway; 2022: We keep it that way
isa12 <- subset(isa12, FishStock!="her.27.1-24a514a")

#List of stocks to check,
isa12[isa12$FishStock=="ank.27.8c9a",] # upgrade from cat 3 to cat 2 SPiCT; 1980-2021; relative ref points; B relative to Bmsy and F relative to Fmsy; No Recruitment estimate
isa12[isa12$FishStock=="aru.27.5a14",]  # considered outside EU
isa12[isa12$FishStock=="aru.27.5b6a",]  # considered outside EU
isa12[isa12$FishStock=="cod.27.1-2.coastn",] # considered outside EU
isa12[isa12$FishStock=="her.27.3031",] # Baltic upgrade from cat 5 to cat 1 SS3; 1963-2021; Ref Pts from management plan
isa12[isa12$FishStock=="lez.27.6b",] # upgrade from cat 3 to cat 2 SPiCT; relative ref points; B relative to Bmsy and F relative to Fmsy; No Recruitment estimate
```

```
isa12[isa12$FishStock=="lin.27.5b",] # considered outside EU
isa12[isa12$FishStock=="nep.fu.25",] # upgrade from cat 3 to cat 2 SPiCT ; relative ref points; B relative to Bmsy and F relative to Fmsy; No Recruitment estimate
isa12[isa12$FishStock=="nep.fu.2627",] # upgrade from cat 3 trend in CPUE to cat 2 SPiCT; 1975-2021; relative ref points; B relative to Bmsy and F relative to Fmsy; No Recruitment estimate
isa12[isa12$FishStock=="nep.fu.31",]  # upgrade from cat 3 trend in CPUE to cat 2 SPiCT; 1987-2021; relative ref points; B relative to Bmsy and F relative to Fmsy; No Recruitment estimate
isa12[isa12$FishStock=="sol.27.7d",] # upgrade from cat 3 XSA Cat 1 SAM assessment 1982-2021 Management plan in place
isa12[isa12$FishStock=="whg.27.6a",] # upgrade from cat 5 to cat 1 SAM assessment 1981-2021

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

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

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

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

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

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

#------------------------------------------------------------------
# fix species codes
#------------------------------------------------------------------
#check the species code
# Horse mackerel
# Checked in 2022 and HOM still exists
isa12[isa12$Species=="HOM","Species"] <- "JAX"
# ANK & MON - Anglerfish - species to genus
# Checked in 2022 and MON still exist. In 2022 ANK still exists (it was commented last year)
isa12[isa12$Species=="ANK","Species"] <- "ANF"
isa12[isa12$Species=="MON","Species"] <- "ANF"
# Megrim - species and genus to genus
# Checked in 2022 and MEG+LDB still exist
isa12[isa12$Species=="MEG","Species"] <- "LEZ"
isa12[isa12$Species=="LDB","Species"] <- "LEZ"
# species with combined TACs (NOTE THESE CAN INCREASE IN THE FUTURE)
```

```
# WIT there's a combined TAC with lemon sole: L/W/2AC4-C
# TUR there's a combined TAC with brill T/B/2AC4-C
# Both TUR and WIT were not cat 1 in 2017 assessments
isa12[isa12$Species=="WIT","Species"] <- "L/W"
isa12[isa12$Species=="TUR","Species"] <- "T/B"
# missing species
sort(unique(isa12$Species)[!(unique(isa12$Species) %in% unique(sframe$Species))])
#[1] "BSS" "PIL"
# PIL and BSS don't have TACs
#TUR and WIT are now codede as combined TACs stocks


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

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

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

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

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

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

# At this stage we kept 78 stocks out of 109

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

# remove stocks with short time series
sts <- subset(isa, Year %in% dy & !is.na(FishingPressure))$FishStock
# remove short time series (less than 5 years)
sts <- table(sts)
sts <- names(sts)[sts<5]  # No time series are shorter than 5 years
#"nep.fu.2324"
# remove also nep.fu.3-4, assessment area is not stable so doesn't have 5 years of comparable
data
#also removing nep.fu.13 as 2020 assessment is not finalized yet, information are available only
for the firth of Clyde, but a single estimate for Firth of Clyde and Sound of Jura was estimated in
the SAG so waiting for corrections from ICES: today 11/03/2021 we remove the stock until
further notice
# sts <- c(sts, "nep.fu.3-4", "nep.fu.13")
sts <- c(sts, "nep.fu.3-4")

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

#-----------------------------------------------------------------
# subset assessments
```

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

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

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

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

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

# NOP 34, MSYBescapement not available so Blim used as a reference
saeu[saeu$FishStock == "nop.27.3a4", c("StockSize", "MSYBescapement")] <-
saeu[saeu$FishStock == "nop.27.3a4", c("Low_StockSize", "Blim")]

# ANE BISC - need to add value from ss, using upper trigger from 2019 as proxy for
MSYBescapement
saeu[saeu$FishStock == "ane.27.8", "MSYBescapement"] <- 89000

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

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

#-------------------------------------------------------------------
# Bref
#-------------------------------------------------------------------
# check MSYBtrigger approx. Bpa, need some boundaries for rounding
stksBpaMSYBtrigger <- unique(saeu[saeu$MSYBtrigger/saeu$Bpa < 1.05 &
saeu$MSYBtrigger/saeu$Bpa > 0.95, c("FishStock", "Bpa", "MSYBtrigger")])
stksBpaMSYBtrigger <- stksBpaMSYBtrigger[order(stksBpaMSYBtrigger$FishStock),]
if (savecsv)  write.csv(stksBpaMSYBtrigger, file="results/stksBpaMSYBtrigger.csv")

# create field
saeu$Bref <- saeu$MSYBtrigger
# if MSYBtrigger is set at Bpa level set to NA, with the exception
# of a couple of stocks which were explicitly set that way by the AWG
saeu$Bref[saeu$MSYBtrigger==saeu$Bpa & !(saeu$FishStock %in% c("hom.27.9a",
"pra.27.3a4a", "sol.27.7e"))] <- NA
```

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

# Bpa
saeu$Brefpa <- saeu$Bpa
# some stocks don't have Bpa (it was set at MSYBtrigger level)
saeu$Brefpa[saeu$FishStock %in% c("hom.27.9a")] <- NA
# set 0 as NA
saeu$Brefpa[saeu$Brefpa==0] <- NA
# if relative Brefpa = 0.5
saeu[saeu$StockSizeDescription == "B/Bmsy", "Brefpa"] <- 0.5

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

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

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

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

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

#-------------------------------------------------------------------
# COMPUTE SBL | year + FishStock
#-------------------------------------------------------------------
saeu$SBL <- !(saeu$indFpa > 1 | saeu$indBpa < 1)
```

```
# if one is NA SBL can't be inferred
saeu$SBL[is.na(saeu$indFpa) | is.na(saeu$indBpa)] <- NA
# no SBL for B escapement
saeu$SBL[!is.na(saeu$MSYBescapement)] <- NA
saeu <- transform(saeu, sfSBL=!is.na(SBL))

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

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

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

saeu <- projectStkStatus(saeu, vpy)
if (savecsv) write.csv(saeu, "data/ices/saeu.csv", row.names=F)

#====================================================================
=========
# Indicators (design based)
#====================================================================
=========

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

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

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

# time series
# check stocks with non continuos time series
# plot needs to be fixed mannualy but should be possible to auto
```

```
stks_ncts <- tapply(df0$Year, df0$FishStock, function(x){
        !(max(x) - min(x) + 1 == length(x))
})
stks_ncts <- names(stks_ncts)[stks_ncts]

if (savegraph) png("results/figNEAI0b.png", 3000, 4500, res=300, bg = "transparent")
ggplot(df0, aes(Year, reorder(FishStock, desc(FishStock)))) +
        geom_line() +
        geom_point(data=aggregate(list(Year=df0$Year, EcoRegion=df0$EcoRegion),
           by=list(FishStock=df0$FishStock), max)) +
  # NEP missing years
        geom_line(data=data.frame(Year=2009:2013, FishStock="nep.fu.14",
   EcoRegion="Celtic Seas"), color="white") +
        geom_line(data=data.frame(Year=2007:2009, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), color="white") +
        geom_line(data=data.frame(Year=2003:2005, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), color="white") +
        geom_point(data=data.frame(Year=2003, FishStock="nep.fu.13",
    EcoRegion="Celtic Seas"), size=0.3) +
        ylab("") +
        xlab("Year") +
        sc +
        th +
        facet_grid(EcoRegion~., switch="y", space="free_y", scales="free_y") +
        theme(strip.placement="outside", strip.background.y=element_blank(),
   panel.spacing.y=unit(0.05, "lines"))
if (savegraph) dev.off()

if (savecsv)  write.csv(reshape2::dcast(inStks, EcoRegion~Year, value.var='N'),
file="results/tabNEAI0.csv", row.names=FALSE)

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

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

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

```
        th
if (savegraph) dev.off()

# table
if (savecsv)  write.csv(reshape2::dcast(fInda, EcoRegion~Year, value.var='N'),
file="results/tabNEAI1.csv", row.names=FALSE)

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

# plot
if (savegraph) png("results/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
if (savegraph) dev.off()

# plot
if (savegraph) png("results/figNEAI2b.png", 2400, 1200, res=300)
ggplot(subset(fIndb, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
        geom_line() +
        facet_grid(.~EcoRegion) +
        ylab("No. of stocks") +
        xlab("") +
        sc +
        ylim(0, 20) +
        th
if (savegraph) dev.off()

# table
if (savecsv)  write.csv(reshape2::dcast(fIndb, EcoRegion~Year, value.var='N'),
file="results/tabNEAI2.csv", row.names=FALSE)

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

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

```
if (savegraph) dev.off()

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

# table
if (savecsv)  write.csv(reshape2::dcast(fIndc, EcoRegion~Year, value.var='N'),
file="results/tabNEAI3.csv", row.names=FALSE)

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

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

# plot
if (savegraph) png("results/figNEAI4b.png", 2400, 1200, res=300)
ggplot(subset(fIndd, EcoRegion != 'ALL'), aes(x=Year, y=N)) +
	geom_line() +
	facet_grid(.~EcoRegion) +
	ylab("No. of stocks") +
	xlab("") +
	sc +
	ylim(0, 15) +
	th
if (savegraph) dev.off()

# table
if (savecsv)  write.csv(reshape2::dcast(fIndd, EcoRegion~Year, value.var='N'),
file="results/tabNEAI4.csv", row.names=FALSE)

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

## plot
```

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

# plot
if (savegraph) png("results/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
if (savegraph) dev.off()

# table
if (savecsv) write.csv(reshape2::dcast(fIndf, EcoRegion~Year, value.var='N'),
file="results/tabNEAI5.csv", row.names=FALSE)

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

# plot
if (savegraph) png("results/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
if (savegraph) dev.off()

# plot
if (savegraph) png("results/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
if (savegraph) dev.off()
```

```
# table
if (savecsv)  write.csv(reshape2::dcast(fIndfb, EcoRegion~Year, value.var='N'),
file="results/tabNEAI6.csv", row.names=FALSE)

if (savedata)  save.image("results/saeu.RData")
#==========================================================================
=========
# Indicators (model based)
#==========================================================================
=========

#-------------------------------------------------------------------
# (I7) F/Fmsy model
#-------------------------------------------------------------------
idx <- saeu$FishingPressureDescription %in% c("F", "F/Fmsy")
saeu$sfI7 <- idx & is.na(saeu$MSYBescapement)
df0 <- saeu[saeu$sfI7,]

# png("./FFmsyNEA_stock.png", 600, 600)
# xyplot(df0$indF~df0$Year|df0$FishStock, xlab = "Years", ylab = "F/Fmsy", lwd=2, type=c("l"),
scales=list(y=list(relation="free")))
# dev.off()

if (savegraph) png("results/FFmsyNEA_stock_single.png", 1000, 600)
#xyplot(df0$indF~df0$Year, group=df0$FishStock, xlab = "Years", ylab = "F/Fmsy", lwd=2,
type=c("l"), auto.key=list(space = "right", points = FALSE, lines = TRUE)) #columns=2,
ggplot(data=df0,
       aes(x=Year,
           y=indF)
) +
  geom_line(aes(color=FishStock)) +
  xlab("Years")+
  ylab("F/Fmsy")+
  theme(legend.position = "right") +
  labs(color = "Stock Code")+
  ggtitle("F/Fmsy")

if (savegraph) dev.off()


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, "results/diagNEAI7.pdf", nc, nd)

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

ifit.bs <- mclapply(ifit.bs, function(x){
        stk <- sample(stk, replace=TRUE)
        df1 <- df0[0,]
        for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
```

```
        fit <- glmer(indF ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

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

# plot
if (savegraph) png("results/figNEAI7.png", 1800, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) + expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(F/F[MSY])) +
  ylim(0, 3) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
if (savegraph) dev.off()

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

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

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

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

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

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

# table
if (savecsv)  write.csv(reshape2::dcast(fIndfr, EcoRegion~Year, value.var='N'),
file="results/tabNEAI7b.csv", row.names=FALSE)

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

if (savegraph) png("results/FFmsyOut_stock.png", 600, 600)
xyplot(df0$indF~df0$Year|df0$FishStock, xlab = "Years", ylab = "F/Fmsy", lwd=2, type=c("l")) +
latticeExtra::layer(panel.abline(h=1, lty = 2))#, scales=list(y=list(relation="free")
if (savegraph) dev.off()

# pdf("./FFmsyOut_stock_single.pdf", 12, 12)
# xyplot(df0$indF~df0$Year, group=df0$FishStock, xlab = "Years", ylab = "F/Fmsy", lwd=2,
type=c("l"), auto.key=list(space = "right", points = FALSE, lines = TRUE))
# dev.off()

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

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

# bootstrap
stk <- unique(df0$FishStock)
ifitout.bs <- split(1:it, 1:it)
ifitout.bs <- mclapply(ifitout.bs, function(x){
	stk <- sample(stk, replace=TRUE)
	df1 <- df0[0,]
	for(i in stk) df1 <- rbind(df1, subset(df0, FishStock==i))
```

```
        fit <- glmer(indF ~ Year + (1|FishStock), data = df1, family = Gamma("log"),
control=glmerControl(optimizer="nlminbwrap"))
        v0 <- predict(fit, re.form=~0, type="response", newdata=nd)
        if(length(fit@optinfo$conv$lme4)>0) v0[] <- NA
        v0
}, mc.cores=nc)

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

# plot
if (savegraph) png("results/figNEAI7out.png", 1800, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) + expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  ylab(expression(F/F[MSY])) +
  geom_hline(yintercept = 1, linetype=2) +
  ylim(0, 3) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
if (savegraph) dev.off()

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

#--------------------------------------------------------------------
# (I8) SSB model
#--------------------------------------------------------------------
saeu$sfI8 <- saeu$StockSizeDescription %in% c("SSB", "TSB")
#saeu[saeu$FishStock=="cod.27.6a" & saeu$Year==2020,"StockSize"] <- 4107.7
#saeu[saeu$FishStock=="dgs.27.nea" & saeu$Year==2020,"StockSize"] <- 70131.53
#saeu[saeu$FishStock=="bli.27.5b67" & saeu$Year==2020,"StockSize"] <- 94121.39

df0 <- saeu[saeu$sfI8,]
#df0 <- saeu[saeu$sfI8 & saeu$FishStock!="cod.27.6a",]
#

df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

# fit
ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa")) #"nlminbwrap" had to change optimizer to allow
convergence

#df0[df0$FishStock=="cod.27.6a" & df0$Year==2020,"StockSize"] <- 1200
#df0[df0$FishStock=="cod.27.6a" & df0$Year==2020,"StockSize"] <- 4107.667 #1200
#df0[df0$FishStock=="cod.27.6a" & df0$Year==2020,"StockSize"] <- 2213 # Advide forecast
#df0[df0$FishStock=="bli.27.5b67" & df0$Year==2020,"StockSize"] <- 94121.4
#df0[df0$FishStock=="dgs.27.nea" & df0$Year==2020,"StockSize"] <- 70131.53 #1200
```

```
#
#test <- df0[df0$FishStock=="cod.27.6a",c("StockSize","Year")]
#test <- df0[df0$FishStock=="bli.27.5b67",c("StockSize","Year")]
#test <- df0[df0$FishStock=="dgs.27.nea",c("StockSize","Year")]
#
#
#test$Year <- as.integer(test$Year)
#plot(StockSize ~ Year, data=test, ylim=c(0,max(test$StockSize)))
#
#
#ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0[!df0$FishStock %in%
c("cod.27.6a"),], family = Gamma("log"), control=glmerControl(optimizer="bobyqa"))
#ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0[!df0$FishStock %in%
c("cod.27.6a","bli.27.5b67","dgs.27.nea"),], family = Gamma("log"),
control=glmerControl(optimizer="bobyqa")) #"nlminbwrap" had to change optimizer to allow
convergence
##ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa")) #"nlminbwrap" had to change optimizer to allow
convergence
##ifitb <- glmer(StockSize ~ Year + (1|FishStock), data =  df0, family = Gamma("log"),
control=glmerControl(optimizer="Nelder_Mead")) #"nlminbwrap" had to change optimizer to
allow convergence
runDiagsME(ifitb, "FishStock", df0, "results/diagNEAI8.pdf", nc, nd)
runDiagsME(ifitb, "FishStock", df0, "results/diagNEAI8_no_cod.pdf", nc, nd)
runDiagsME(ifitb, "FishStock", df0, "results/diagNEAI8_3_avg.pdf", nc, nd)

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

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

# plot
if (savegraph) png("results/figNEAI8_no_cod.png", 1800, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) +
  expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +
```

```
  sc +
  th
if (savegraph) dev.off()

# table
tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
if (savecsv)  write.csv(tb0, file="results/tabNEAI8_no_cod.csv")

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

ifitbRegional <- lapply(split(df0, df0$EcoRegion), function(x){
        # fit model
        ifitb <- glmer(StockSize ~ Year + (1|FishStock), data = x, family = Gamma("log"),
control=glmerControl(optimizer="bobyqa"))   #nlminbwrap change optimizer for convergence
(still one convergence issue due to gradient at 0.007 (tol=0.002))
        # no variance with bootstrap due to small number of stocks
        ifitb.pred <- predict(ifitb, re.form=~0, type="response", newdata=nd)
        # output
        list(ifitb=ifitb, ifitb.pred=ifitb.pred/ifitb.pred[nd==iniYear])
})

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

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

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

# table
if (savecsv)  write.csv(reshape2::dcast(fIndbr, EcoRegion~Year, value.var='N'),
file="results/tabNEAI8b.csv", row.names=FALSE)

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

```
saeu0$sfI10 <- !is.na(saeu0$Recruitment)
df0 <- saeu0[saeu0$sfI10,]
# data for table about stocks and indicators
sfI10 <- subset(df0, Year>=iniYear & Year<=fnlYear)
sfI10 <- tapply(sfI10$Year, sfI10$FishStock, max)
sfI10 <- data.frame(FishStock=names(sfI10), Year=sfI10, variable="sfI10", value=TRUE)
# project and compute indicator
df0 <- projectStkStatus(df0, vpy)

for(i in (iniYear):fnlYear) df0 <- decadalR(df0, i)

df0 <- subset(df0, Year>=iniYear & Year<=fnlYear)
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))

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

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

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

#load("./RData_nea_newrec")
# plot
if (savegraph) png("results/figNEAI10.png", 1800, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) +
  expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  #ylab(expression(decadal_R/R[2003])) +
  ylab("Decadal recruitment (scaled to 2003)") +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
if (savegraph) dev.off()
```

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

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

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

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

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

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

# table
if (savecsv)  write.csv(reshape2::dcast(fIndrr, EcoRegion~Year, value.var='N'),
file="results/tabNEAI10b.csv", row.names=FALSE)

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

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

# remove stocks with short time series
sts <- table(df0$FishStock, df0$Year)
```

```
sts <- rownames(sts)[apply(sts, 1, sum)<5]
df0 <- subset(df0, !(FishStock %in% sts))

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

# project for stocks without last two years estimates
# NEED CHECK
df0 <- projectStkStatus(df0, vpy)

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

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

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

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

# plot
if (savegraph) png("results/figNEAI12.png", 1800, 1200, res=300)
ggplot(ifitq, aes(x=Year)) +
  geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
  geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
  geom_line(aes(y=`50%`)) +
  expand_limits(y=0) +
  geom_point(aes(x=Year[1], y=`50%`[1])) +
  geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
  geom_hline(yintercept = 1, linetype=2) +
  ylab(expression(B/B[2003])) +
  xlab("") +
  theme(legend.position = "none") +
  sc +
  th
if (savegraph) dev.off()

tb0 <- t(ifitq)[-1,]
colnames(tb0) <- ifitq[,1]
```

```
if (savecsv)  write.csv(tb0, file="results/tabNEAI12.csv")

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

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

if (savecsv)  write.csv(bootconv, file="results/bootconv.csv")

#============================================================
=========
# Stocks used in each indicator
#============================================================
=========
#sa1 <- as.data.table(saeu)
df0 <- reshape2::melt(saeu[!saeu$projected,], c('FishStock', 'Year'), c('sfFind', 'sfSBL', 'sfCFP',
'sfI7', 'sfI8'))
df0 <- do.call("rbind", lapply(split(df0, df0$FishStock), function(x) subset(x,
Year==max(x$Year))))
# fix year for I10 when assessment not from previous year
df1 <- sfI10
df1$Year <- subset(df0, FishStock %in% df1$FishStock & variable=="sfFind")$Year

# merge
df0 <- merge(df0, df1, all=TRUE)
df0 <- rbind(df0, sfI12)
levels(df0$variable) <- c('above/below Fmsy', 'in/out SBL', 'in/out CFP', 'F/Fmsy trends', 'Biomass
trends', 'Decadal recruitment trends', "Biomass data category 3 trends")
stkPerIndicator <- reshape2::dcast(df0, FishStock+Year~variable, value.var='value')

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

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

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

```
# All stocks with Fpa indicator - Same as stocks
fpaind_stocks <- subset(saeu, Year==fnlYear & !is.na(indFpa))$FishStock

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

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

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

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

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

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

# Set dropped stocks to NA in FishStock column
isa12sf$FindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$FindFishStock %in% drop_stock_f,"FindFishStock"] <- as.character(NA)
isa12sf$BindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$BindFishStock %in% drop_stock_b ,"BindFishStock"] <- as.character(NA)
isa12sf$FpaindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$FpaindFishStock %in% drop_stock_fpa,"FpaindFishStock"] <- as.character(NA)
isa12sf$BpaindFishStock <- isa12sf$FishStock
isa12sf[isa12sf$BpaindFishStock %in% drop_stock_bpa,"BpaindFishStock"] <- as.character(NA)

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

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

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

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

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

if (savecsv)  write.csv(coverage, "results/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
#==============================================================
=========

if (savecsv)  write.csv(saeu, file="results/saeu.csv")
if (savedata)  save.image("results/out_nea.RData")
```

10 ANNEX 2 – MED CODE

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

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

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


# year when assessments were performed

# assessmentYear <-as.numeric(substr(Sys.time(), start = 1, stop = 4))
assessmentYear <- 2021
# 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 <- 200
# quantiles to be computed
qtl <- c(0.025, 0.25, 0.50, 0.75, 0.975)
# to control de seed in mclapply
RNGkind("L'Ecuyer-CMRG")
set.seed(1234)
```

```
# to make plots consistent
vp <- dy
#vp[c(2,4,6,8,10,12,14,16)] <- ""
theme_set(theme_bw())

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

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


# load and pre-process ####
gfcm <- read.csv("../data/med/GFCM_CFP_2022.csv")
gfcm$Meeting <- "GFCM"

stecf <- read.csv("../data/med/STECF_CFP_2022.csv")

msa <- rbind(stecf, gfcm)
msa$Fref <- msa$Fref_point

# keep relevant columns only
msa <- msa[,c("Stock", "Area", "Year", "R", "SSB", "F", "Fref", "Blim", "Bref", "asses_year", "Meeting", "Assessment_URL", "Species", "EcoRegion")]

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

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


#------------------------------------------------------------
# recode and compute indicators
#------------------------------------------------------------
msa$stk <- tolower(paste(msa$Stock, msa$Area, sep="_"))
msa$StockDescription <- paste(msa$Species, "in GSA", gsub("_", ", ",  msa$Area))
msa$Fref <- as.numeric(msa$Fref)
msa <- transform(msa, indF = F/Fref)
msa <- transform(msa, sfFind=!is.na(indF), i1=indF>1, i2=indF<=1)
names(msa)
msa <- msa[!msa$Stock%in%"SOL",]
#------------------------------------------------------------
# subset
# (filtering through the sampling frame done during data harvesting)
#------------------------------------------------------------
```

```
sam <- msa[!is.na(msa$indF) & msa$Year >=iniYear & msa$Year <= fnlYear &
msa$asses_year %in% vay,]

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

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

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

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

# plot
png("figMedI0.png", 1800, 1200, res=300)
ggplot(subset(mnStks, Year!=fnlYear), aes(x=Year, y=N)) +
	geom_line() +
	ylab("No. of stocks") +
	xlab("") +
	ylim(c(0,55)) +
	sc +
	th +
   geom_point(aes(x=fnlYear, y=mnStks$N[length(mnStks$N)]), size=2)
dev.off()
```

```
png("figMedI0b.png", 1200, 1600, res=200)
df0 <- sam[!sam$projected,]
ggplot(df0, aes(Year,reorder(stk, desc(stk))))+
       geom_line() +
       geom_point(data=aggregate(list(Year=df0$Year, EcoRegion=df0$EcoRegion),
   by=list(stk=df0$stk), max)) +
       ylab("") +
  theme(axis.text.y = element_text(angle = 180, vjust = 0.5, hjust=1))+
       xlab("Year") +
       sc +
       th +
       facet_grid(EcoRegion~., switch="y", space="free_y", scales="free_y") +
theme(strip.text.y.left = element_text(angle=0))+
       theme(strip.placement="outside",
            #strip.background.y=element_blank(),
            strip.background =element_rect(fill="lightyellow"),
       panel.spacing.y=unit(0.05, "lines"))
dev.off()


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

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

vp <- iniYear:I(fnlYear-1)
vp[c(2,4,6,8,10,12,14,16)] <- ""
sc <- scale_x_continuous(breaks=iniYear:I(fnlYear-1), labels=as.character(vp))

#-------------------------------------------------------------------
# (I7) F/Fmsy model based indicator
#-------------------------------------------------------------------
df0 <- sam

pdf("./FFmsyMED_stock.pdf", 12, 12)
xyplot(df0$indF~df0$Year|df0$stk, xlab = "Years", ylab = "F/Fmsy", lwd=2, type=c("l"),
scales=list(y=list(relation="free")))
dev.off()

png("./FFmsyMED_stock_single.png", 1000, 600)
xyplot(df0$indF~df0$Year, group=df0$stk, xlab = "Years", ylab = "F/Fmsy", lwd=2,
type=c("l"), auto.key=list(space = "right", points = FALSE, lines = TRUE))
dev.off()


idx <- !is.na(sam$SSB)
df0 <- sam[idx,]
pdf("./SSBMED_stock.pdf", 12, 12)
xyplot(df0$SSB~df0$Year|df0$stk, xlab = "Years", ylab = "SSB", lwd=2, type=c("l"),
scales=list(y=list(relation="free")))
dev.off()
```

```
pdf("./SSBMED_stock_single.pdf", 12, 12)
xyplot(df0$SSB~df0$Year, group=df0$stk, xlab = "Years", ylab = "F/Fmsy", lwd=2,
type=c("l"), auto.key=list(space = "right", points = FALSE, lines = TRUE))
dev.off()


df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))
No <- length(unique(df0$stk))

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


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

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

# plot
png("figMedI7.png", 1800, 1200, res=300)
ggplot(mfitq, aes(x=Year)) +
	geom_ribbon(aes(ymin = `2.5%`, ymax = `97.5%`), fill="gray", alpha=0.60) +
	geom_ribbon(aes(ymin = `25%`, ymax = `75%`), fill="gray", alpha=0.95) +
	geom_line(aes(y=`50%`)) +
	expand_limits(y=0) +
	geom_point(aes(x=Year[length(Year)], y=`50%`[length(`50%`)]), size=2) +
	geom_hline(yintercept = 1, linetype=2) +
	ylab(expression(F/F[MSY])) +
	xlab("") +
	theme(legend.position = "none") +
	sc +
	th
dev.off()
```

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

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

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

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

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

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

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

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

```
#-----------------------------------------------------------------
# (I8) SSB indicator
#-----------------------------------------------------------------
# model
# pil_6 has a large impact in the indicator ...
idx <- !is.na(sam$SSB)
df0 <- sam[idx,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))
No <- length(unique(df0$stk))

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

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

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

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

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

#---------------------------------------------------------------
# (I8) SSB indicator regional
#---------------------------------------------------------------
idx <- !is.na(sam$SSB)
df0 <- sam[idx,]
df0$Year <- factor(df0$Year)
yrs <- levels(df0$Year)
nd <- data.frame(Year=factor(yrs))
# remove Eastern Med. where only 2 stocks are available
df0 <- df0[!df0$EcoRegion%in%toremove,]
# df0 <- df0[df0$EcoRegion!="Eastern Med.",]
# df0 <- df0[df0$EcoRegion!="Black Sea",]
mfitbRegional <- lapply(split(df0, df0$EcoRegion), function(x){
	# fit model
	mfitb <- glmer(SSB ~ factor(Year) + (1|stk), data =  x, family = Gamma("log"), 
control=glmerControl(optimizer="nlminbwrap"))
	# no variance with bootstrap due to small number of stocks
	mfitb.pred <- predict(mfitb, re.form=~0, type="response", newdata=nd)
	# output
	list(mfitb=mfitb, mfitb.pred=mfitb.pred/mfitb.pred[nd==iniYear])
})

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

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

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

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

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

save.image("med.RData")
```

12 ANNEX 3 - PROTOCOL

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STECF

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

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