Food and Agriculture Organization of the United Nations

General Fisheries Commission for the Mediterranean
Commission générale des pêches pour la Méditerranée

Working Group on the Black Sea (WGBS)

Seventh meeting of the Subregional Group on Stock Assessment in the Black Sea (SGSABS)[1]

Online, 12–16 July 2021

Report

EXECUTIVE SUMMARY

The seventh meeting of the Subregional Group on Stock Assessment in the Black Sea (SGSABS) was held online from 12 to 16 July 2021. The key objectives of the meeting were to: i) review the status of the main fish stocks in the Black Sea; ii) review the existing data and assessment methods for the main stocks in the area; and iii) review input data and attempt analytical assessments for turbot (*Scophthalmus maximus*), red mullet (*Mullus barbatus*), whiting (*Merlangius merlangus*), horse mackerel (*Trachurus mediterraneus ponticus*), piked dogfish (*Squalus acanthias*), European sprat (*Sprattus sprattus*) and rapa whelk (*Rapana venosa*); and iv) provide advice on stock status and research priorities to improve knowledge on the status of the stocks. Six assessments were validated. Advice was provided on the status of seven stocks in the Black Sea: Black Sea turbot (*Scophthalmus maximus*), European sprat (*Sprattus sprattus*), horse mackerel (*Trachurus mediterraneus ponticus*), picked dogfish (*Squalus acanthias*), whiting (*Merlangius merlangus*), red mullet (*Mullus barbatus*) and rapa whelk (*Rapana venosa*). Of these, qualitative precautionary advice was given for horse mackerel, piked dogfish, whiting and rapa whelk, as the assessments were considered indicative of trends; more comprehensive quantitative advice was provided for red mullet and sprat. The advice for turbot was updated based on the decisions made in the 2019 benchmark, providing semi-quantitative advice, pending re-estimation of reference points. Black Sea anchovy (*Engraulis encrasicolus ponticus*) was assessed separately in a benchmark session held on 5–9 July 2021.

OPENING SESSION

1. The seventh meeting of the Subregional Group on Stock Assessment in the Black Sea (SGSABS) was held online from 12 to 16 July 2021. The meeting was attended by 41 fisheries experts from five Black Sea riparian States (Georgia, Bulgaria, Romania, Turkey and Ukraine), as well as by representatives of the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) Secretariat and the BlackSea4Fish project, the Directorate-General for Maritime Affairs and Fisheries of the European Commission (DG-MARE) and six invited experts. The full list of participants is provided in Appendix 2.

2. In order to support the Black Sea experts in analysing data and to provide assistance to the participants in analysing data and running the stock assessment models during the meeting, the GFCM Secretariat invited Ms Isabella Bitetto (Stock Assessment Scientist of COISPA Tecnologia & Ricerca [COISPA]), Mr Niels Hintzen (Stock Assessment Scientist, Wageningen Marine Research), Mr Matteo Murenu (Stock Assessment Scientist, University of Cagliari), Ms Cecilia Pinto (Stock Assessment Scientist, University of Genova), Ms Maria Teresa Spedicato (Assessment and Survey Specialist, COISPA) and Mr Walter ZUPA (Survey Specialist, COISPA) to participate in the meeting as independent external experts.

3. Ms Elisabetta Betulla Morello, Fisheries Resources Officer at the GFCM, presented the proposed annotated agenda for the meeting, noting that a data preparation meeting had been carried out under the hat of

[1] This meeting was supported by the European Union under grant agreement SI2.795396

the BlackSea4Fish project on 31 May–4 June 2021. The 2021 SGSABS agenda was adopted without changes (Appendix 1). In the absence of a current Chair, the SGSABS agreed on Ms Morello acting as Chair of this session and agreed on electing a new Chair during the meeting.

4. Ms Morello opened the meeting recalling the outcomes of the sixth meeting of the SGSABS (Constanta, December 2018) and associated benchmark sessions (Black Sea turbot: Burgas, July 2019 and Trabzon, October 2019), when advice was provided on the status of eight stocks in the Black Sea: turbot (*Scophthalmus maximus*), European anchovy, Black Sea subspecies (*Engraulis encrasicolus ponticus*), whiting (*Merlangius merlangus*) and horse mackerel (*Trachurus mediterraneus ponticus*) were assessed as in overexploitation; piked dogfish (*Squalus acanthias*) was assessed as depleted whereas the stocks of European sprat (*Sprattus sprattus*) and red mullet (*Mullus barbatus*) were considered uncertain. Rapa whelk (*Rapana venosa*) was considered as being fished close to maximum sustainable yield (MSY). She continued by summarising the recommendations of the sixth SGSABS towards the improvement of the quality of advice, as well as the work plan emerging from it.

5. Ms Morello continued by presenting the recap on relevant conclusions and decisions from the eighth Working Group for the Black Sea (WGBS) (Romania, December 2018) and the forty-third session of the Commission (Greece, November 2019), including the request for the revision of the framework for the provision of advice and COVID-19 pandemic related consequences on the WGSA work plan. In this respect she outlined the terms of reference for the revision of the framework for the provision of advice (Appendix 4/i) proposed by the Mediterranean GFCM Working Groups on Stock Assessment (WGSAs) as well as the outcomes of the Expert meeting on Stock Assessment Methodology held online on 3–4 February 2021.

6. Ms Morello introduced the STock Assessment Results (STAR) framework: a new tool developed by the Secretariat to organize GFCM stock assessment results, and streamline and automate the information flow from stock assessments to scientific advice, thus strengthening quality assurance and data dissemination. She underlined that the central part of the framework would be the STAR database, scheduled to be launched in 2021, which would serve as a foundation to provide a variety of quality-controlled data products related to the management of fisheries in the Mediterranean and Black Sea. The core STAR files would be made available regularly on the GFCM website once validated by the WGBS.

DATA PREPARATION

7. Mr Hüseyin Özbilgin, coordinator of the Black Sea4Fish project, provided a summary of the work done in preparation for this meeting under the hat of the BlackSea4Fish project. In particular, a data preparation meeting was organised from 31 May–4 June 2021, preceded by efforts carried out throughout 2020 to identify data gaps and data needs.

8. Presentations summarizing the existing data for each species and country followed. These presentations are available on the GFCM SharePoint (SGSABS/2021/Presentations) . Available data were also submitted in the form of standardized Excel input files which are available to the SGSABS, by country and species, on the GFCM SharePoint (SGSABS/2021/Input data and Scripts).

9. Following the presentations, the stock coordinators, interacting with the experts from each county as well as supporting external experts, collated all available data for each species to produce the input data for the assessments to be carried out at the Black Sea level. Input data are stored on the GFCM SharePoint and are available through the Stock Assessment Forms (SAFs) for each stock assessed.

ASSESSMENT OF THE STATUS OF BLACK SEA STOCKS

10. Analytical stock assessments were attempted for all Black Sea priority species except for piked dogfish (for issues related to the availability of input data) and Black Sea anchovy (for which a benchmark session took place on 5–9 July 2021). The SGSABS agreed to provide the following outputs for each validated assessment:

- SAF
- summary sheet
- STAR excel sheet
- input data and scripts of final models.

SUMMARY OF ACCEPTED STOCK ASSESSMENTS BY SPECIES

11. The following is a summary of the accepted stock assessments divided by species. Progressive numbers refer to the table of advice provided in Appendix 3.

N: 1

Stock: Turbot, *Scophthalmus maximus*

GSA: 29

Author(s): GFCM/BlackSea4Fish/Turbot Group

Fishery:

The turbot stock is shared among all riparian countries, and during the assessment, it was assumed that the Black Sea Turbot stock was a single unit in the entire Black Sea. The stock is accessible for fishing throughout most of the year (Prodanov *et al*., 1997) although catches reach their peak in the spring and autumn periods depending on each Black Sea riparian country (in March–April and October–November for Bulgaria and Romania; May–June for Ukraine, March–April, and September–October for Turkey [STECF, 2011]). Gillnet is the main fishing gear for catching turbot; however, it is also caught by beam trawls, long lines, and purse seine as bycatch. In 2019, the total allowable catch (TAC) for turbot was determined to be 857 tonnes. Although the fishing mortality (F) has been significantly decreasing in the two years since this decision was made, the estimated volume of illegal, unreported, unregulated (IUU) fishing is still considerably high.

Data and parameters:

All the information provided in the 2019 benchmark by the Black Sea riparian countries in addition to the data from 2019 and 2020 has been used to assess the Black Sea Turbot. During the 2021 data preparation meeting, no data were provided from Georgia for 2019–2020 and the Russian Federation only provided landing data. However, considering the availability of the catch-at-age data from the Russian Federation landings and the proximity of the Russian Federation to Ukraine, it was decided to use the Ukrainian age-length key (ALK) to be consistent with past assessments.

Assessment method:

Similar to the last benchmark (2019), state-space assessment model (SAM) (Fisheries Library in R [FLR]) was used to assess the Black Sea turbot in 2021 with the reference year of 2020. For the short-term forecast, EQsim (MSY framework) was used. The group decided that the reference point will be re-estimated after the agreed work-plan's implementation.

Model performance:

Model residuals did not show any trends. Overall diagnostics are acceptable, and although the retrospectives of fishing mortality showed a separate structure over the years, their overall trends are in the same direction. Therefore, it can be said that the retrospective analysis is consistent enough to accept the model results.

Results:

Spawning stock biomass (SSB) and the recruitment showed an increasing pattern in recent years. Since 2018, F has been significantly decreasing, yet it is still currently higher than the reference point.

$F_{current}$ ($F_{bar\ 4\text{-}8}$ in 2020)	0.28
F_{MSY}	0.16–0.26
$F_{current}/F_{MSY}$	1.75–1.07
Current SSB (tonnes)	6 397
Blim (tonnes)	1 763–3 535
Bpa (tonnes)	2 489 4 949

Diagnosis of stock status:

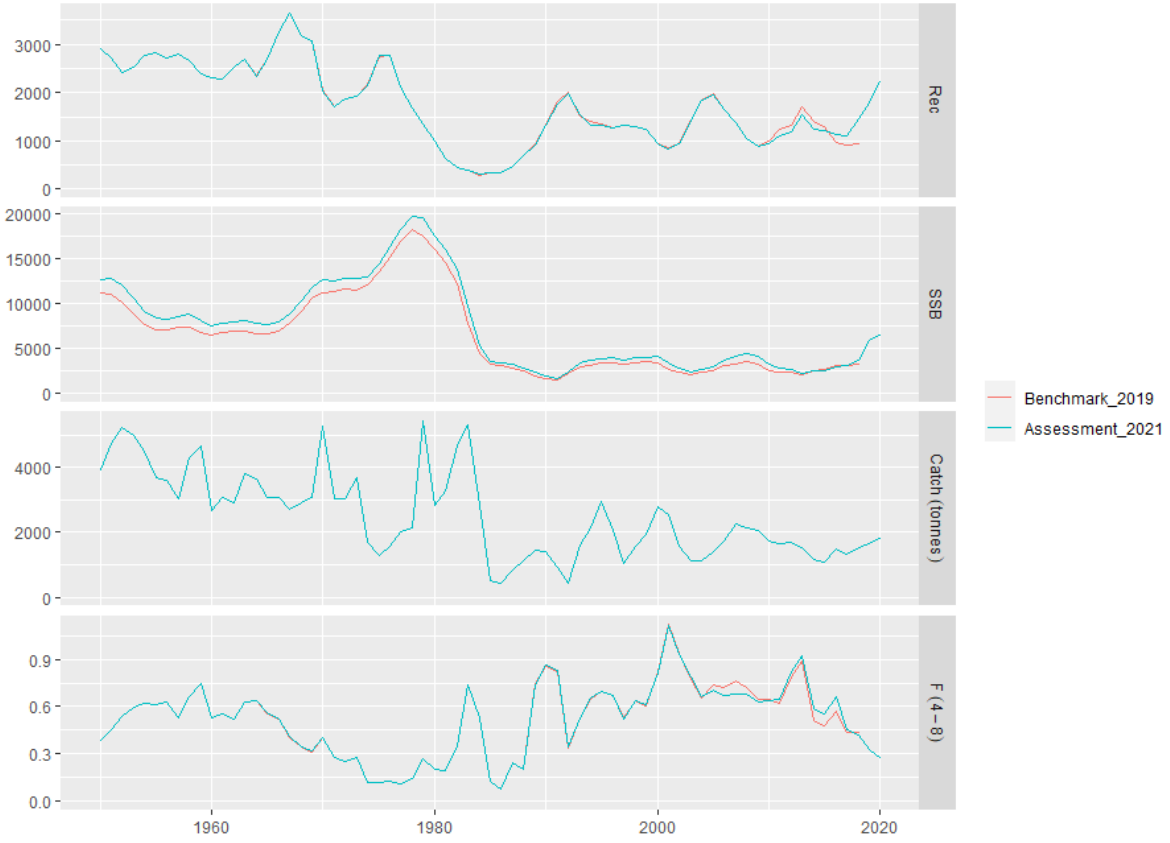
Stock trajectory is following the increasing evolution seen in past years and F is following the decreasing evolution seen in past years. F/FMSY is higher than 1 (1.75–1.07) while biomass shows a positive trend (B/Bpa ranges between 2.6–1.3). Reference points will be re-estimated according to an agreed upon roadmap.

Advice and recommendation:

Reduce Fcurrent towards FMSY.

As in the benchamark, the advice was to reduce fishing mortality. After re-estimating the reference points, the final advice will be given.

Comparison plot between 2019 benchmark and 2021 assessment results:



N: 2

Stock: Piked dogfish, *Squalus acanthias*

GSA: 29

Author(s): Cecilia Pinto, George Tiganov, Feriha Tserkova

Fishery:

In the Black Sea, the largest catches of piked dogfish occur along the coasts of Turkey, although this fish is not a target species of fisheries and is instead yielded as bycatch in trawl and purse seine operations mainly in the wintering period. During the period from 1989–1995, the volume of annual catches of piked dogfish from Turkish waters was 1 055–4 558 tonnes. In subsequent years, the volume decreased by a factor of two and did not exceed 2 400 tonnes due in part to the fact that piked dogfish has recently lost its commercial importance. In the waters of Ukraine, most piked dogfish are harvested in the spring and autumn months by target fishing using gillnets with 100 mm mesh-size, long-lines, and as bycatch of sprat trawl fisheries. As in Turkish waters, the maximum annual catch of picked dogfish from the last 20 years was observed during the period from 1989–1995, reaching 1 200–1 300 tonnes. After 1994 the volume of catches from Ukrainian waters fell to between 20 tonnes and 200 tonnes. Elsewhere in the Black Sea, piked dogfish is harvested mainly as bycatch and annual catches are usually lower than those from Ukraine. For example, from 1989–2005, the maximum annual catches of picked dogfish were: Bulgaria – 126 tonnes in 2001, Georgia – 550 tonnes in 1998, Romania – 52 tonnes in 1992, and the Russian Federation – 183 tonnes in 1990. It should be noted that in the waters of Bulgaria, the highest catches were observed in the early 2000s. In Romania dogfish is caught mainly as bycatch of the sprat trawl fishery and catches have decreased substantially because of decreasing trawling efforts. In Turkey piked dogfish lost its commercial importance in recent years. In recent years the importance of piked dogfish catches from Bulgaria and the Russian Federation have increased with the two countries representing more than 96 percent of total Black Sea catches. Overall, the decrease of dogfish landings from the last 20 years may be due to overfishing.

Data and parameters:

Significant problems were encountered in the preparation of the input data for the piked dogfish assessment with issues related to the creation of catch-at-age matrices. This prevented any models from being run during the meeting itself. Nevertheless, it triggered an in-depth reflection on the information available for this species and the improvements needed to ensure future advice for this stock. Identified issues included i) understanding of biological parameters (e.g. growth), especially for Bulgaria, ii) harmonization of data collection for biological data, with particular importance expressed on obtaining information on the smaller individuals, iii) optimization of surveys, iv) harmonization of ageing through a workshop, and v) quantification of bycatch. The Group agreed to draft a roadmap (Appendix 5/iv) to present to the WGBS including suggestions for the improvement of input data and a plan for the performance of the assessment using different modelling approaches (statistical catch-at-age and biomass models). Nevertheless, work continued after the meeting to compile a final and complete data set including all data required to run stock assessments.

Assessment method:

Owing to the serious shortcomings related to data preparation, no assessment models were run during the meeting. Following work done after the meeting, some preliminary assessment runs were performed using assessment for all (a4a) and surplus production model in continuous time (SPiCT) whose very preliminary results are summarized in the stock assessment form, with the aim of informing future assessment work. Advice was not based on the results of these assessments, but was provided on a precautionary basis, based on past advice.

Diagnosis of stock status:

In the absence of an assessment, precautionary advice was provided based on previous advice and new information. Previous assessments showed that $F_{current}$ was estimated as being 9.6 times higher than the calculated F_{unique} assumed in 2017 (F_{unique} from ICES 2014).

Advice and recommendation:

Fishing mortality should be reduced by more than 90 percent and a recovery plan established.

N: 3

Stock: European sprat, *Sprattus sprattus*

GSA: 29

Author(s): G Daskalov, Salih İlhan

Fishery:

Sprat represents a unit stock shared among the Black Sea countries. Its key role is determined by its importance from both a commercial and ecological point of view as sprat is one of the most important stocks in terms of landing and income in GSA 29. The sprat fishery takes place in the Black Sea (GFCM fishing sub-area 37.4 [division 37.4.2] and GSA 29) all year round with mid-water trawls, pair trawls and stationary gears. The sprat total landings in 2020 amounted to 48 688 tonnes.

Data and parameters:

Catch and weight-at-age, natural mortality, and 3 age structured fish abundance indices were used. Total catch-at-age data were compiled by summing catch-at-age matrices from Bulgaria, Romania, the Russian Federation, Turkey and Ukraine.

Assessment method

Available data of total landings, catches at age, weights and maturities at age are considered appropriate for assessing the stock using the SAM in FLR environment in the form of the package "FLSAM". The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects.

Model performance

The SAM model was fitted using catch-at-age data and three selected tuning indices: Turkish catch per unit effort (CPUE), Bulgarian CPUE and Russian Federation CPUE.

The checks and additional binding of the parameters was performed by the order of the major effects on the model fit namely:

1) observation variances of all data sources;
2) catchabilities of the surveys;
3) correlation structure of the F random walks;
4) correlation within surveys;
5) F random walk variances;
6) free up F states.

Important effects have been noticed on releasing and subsequently applying new bindings on the observation variances and catchabilities of the surveys. Another major effect was seen in the assumption of correlated age classes of the Turkish and Bulgarian CPUE indices and by applying the one that was obtained, the final best model was achieved.

Model residuals and retrospective analysis did not show any trends, patterns or violations. The estimates of the coefficients fitted by the selected model and corresponding standard error and were deemed consistent.

Results:

The trajectories of abundance and fishing mortality indicate that the sprat stock has recovered from the depression in the 1990s due to good recruitment in the 1999–2000 period and the biomass and catches have gradually increased over the 1990s and during the 2000s, though subject to a cyclic pattern. In 2012–2013 catches dropped more than three times, and SSB is estimated at the level of about 140 000 tonnes. After 2013 catches and biomass started rising again, reflecting the positive influence of strong year-classes from 2012–2015, however the high catches in 2015–2016 brought the exploitation above the reference level which was followed by a gradual depression in SSB and a decrease in catches. In recent years the exploitation rate has been kept below the reference level due to average stock status and average catches.

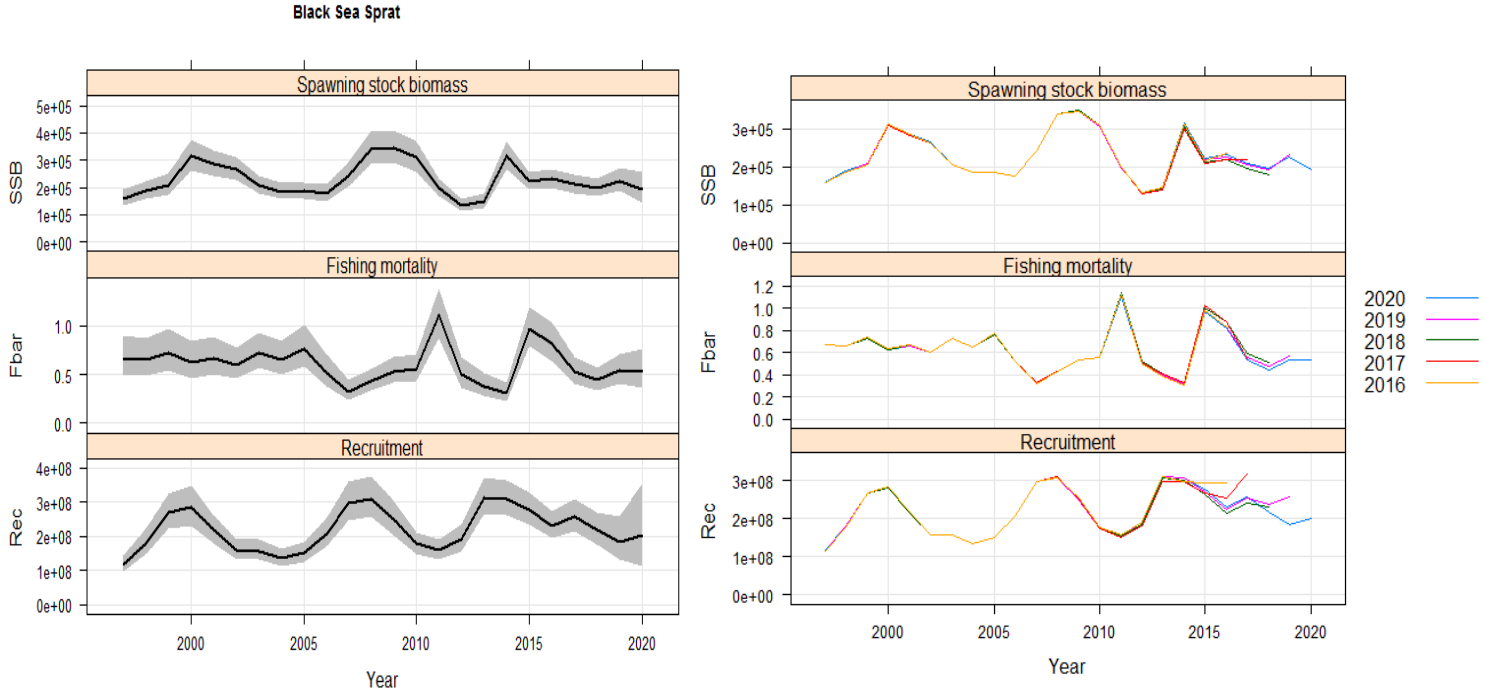
$E_{current}$ (from Fbar 1-3 in 2020, M=0.95)	0.36
E_{msy}	0.4
$E_{current}/E_{msy}$	0.9
Current SSB 2020 (tons)	190 865
33rd percentile biomass (tonnes)	190 865
66th percentile biomass (tonnes)	231 306

Diagnosis of stock status:

The current exploitation rate (E = 0.36, which corresponds to an F = 0.53) is smaller than E_{MSY} (0.40, which corresponds to an F = 0.64), indicating that sprat in GSA 29 is being fished below E_{MSY}. Therefore stock status is cautiously defined as sustainably exploited subject to additional assessment after completion of the benchmark process in July 2022.

Advice and recommendations:

Temporary advice was provided (until completion of the benchmark process) to keep the exploitation rate below the precautionary level of E_{msy} = 0.4 and not increase the fishing effort.



N: 4

Stock: Horse Mackerel, *Trachurus mediterraneus*

GSA: 29

Author(s): Erdal Ustundag

Fishery:

Horse mackerel is a major commercial species for fishery on the waters of the Black Sea. Horse mackerel stocks in the Black Sea are usually caught by using active (bottom trawler, pelagic trawler and large purse seine) and passive (extension and longline) nets. Most of the horse mackerels caught in Turkish waters are caught by purse seine vessels. Assuming that the horse mackerel caught in the Black Sea is a single population, stock analysis was performed as unit stock.

Data and parameters:

There are long-year series in the landing data of the countries. However, since the length-frequency distribution (LFD) data are available since 2005, the period between 2005 and 2020 was included in the analysis. Data quality was checked before starting the extended survivors analysis (XSA); it was determined that commercial data and survey data were given together in the Turkish catch-at-age data between 2013 and 2016. Catch-at-age and weight-at-age data were recalculated by removing the survey data. In some years, catch-at-age and weight-at-age data were calculated by using Turkish age and weight combinations for some countries without data on the age distribution of landings.

In XSA, commercial CPUE and survey CPUE data were examined as a tuning index. However, the analysis was continued using only commercial CPUE because of better residual results. XSA was performed by taking age 5 plus and mortality rates as calculated according to Gislason 2020.

Assessment method:

Stock assessment analysis was performed with the XSA method using the FLR package in the R statistics program.

Model performance:

The values of the residuals are higher than excepted. However, overall diagnostics are acceptable and retrospective analysis is consistent.

Results:

While recruitment increased, spawning stock biomass showed a decreasing pattern starting from 2019. Fishing mortality has been decreasing from 2016, but is currently higher than the reference point.

$F_{current}$ ($F_{bar\ 1\text{-}3}$) (2020)	1.17854
$F_{0.1}$ (2020)	
$F_{current}/F_{0.1}$	
Current SSB (tonnes)	16 848
33rd percentile biomass (tonnes)	
66th percentile biomass (tonnes)	

Diagnosis of stock status:

In overexploitation.

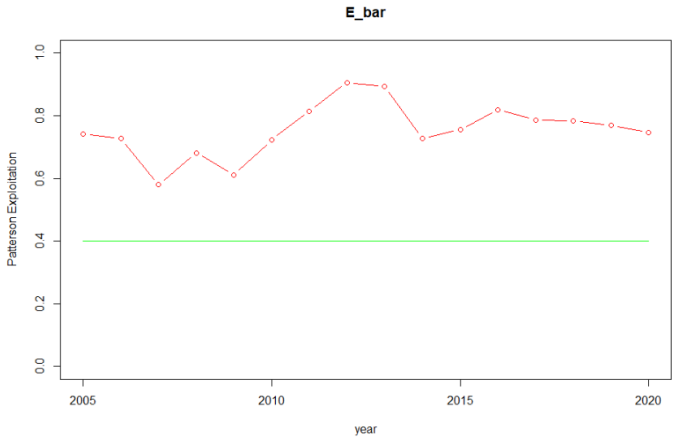
Advice and recommendation:

Although the stock appeared in a state of overexploitation in 2020, precautionary advice was given on the status of the stock owing to issues related to data quality, trends in residuals and retrospective patterns.

In order for the analysis results to be more reliable, it is important to review and check the countries' data and to work on improving the data quality such as by CPUE standardization and by increasing survey data. In

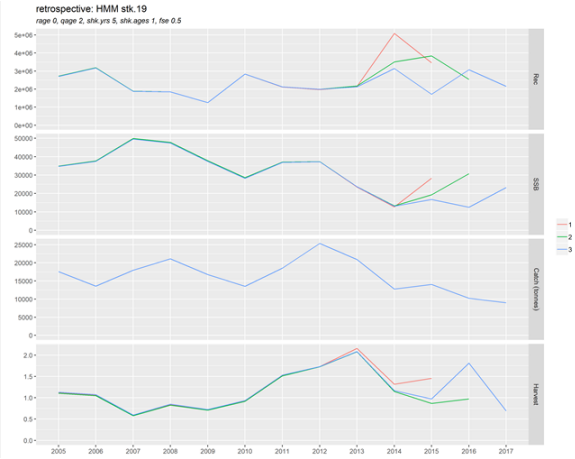
addition, providing catch-at-age and weight-at-age data for all countries will make the combined data used in the analysis more reliable.

The group recommends a progressive reduction of the fishing effort.

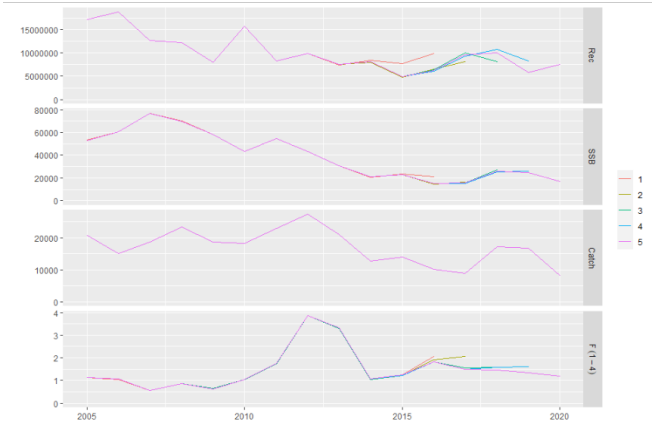


Comparative plot between last year and this year results.

2017



2021



N: 5

Stock: Red mullet, *Mullus barbatus*

GSA: 29

Author(s): Yoana Georgieva

Fishery:

In the vicinity of the Crimean and Caucasian coasts, two particular forms of red mullet are distinguished: "settled" and "migratory" ones. "Migratory" red mullet moves to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and returns to the coasts of the Crimea for wintering. Red mullet migrates along the coasts of Romania and Bulgaria to the Turkish waters of the Black Sea and the Sea of Marmara for wintering in September–November. The "migratory" form of red mullet is considered a different stock and is excluded from the Black Sea analysis. Consequently, the catches by the Russian Federation and Ukraine, which are dominated by the "migratory" form of red mullet, are excluded from the Black Sea stock assessment.

Red mullet is one of the most important fish species fished and consumed in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Gillnets are also allowed to fish red mullet all along Turkish coasts. Catches of red mullet in European Union waters are taken primarily by Bulgaria, with only small amounts landed by Romanian fishers.

Data and parameters:

The last (reference) year when red mullet stock was assessed was 2017. In 2020 (reference year) assessment, new information for landing, catch-at-age and weigh-at-age (2018–2020) by countries was provided.

Until 2017, one tuning index was used in the red mullet assessment. The data series were from Turkish commercial CPUE and covered the period 2009–2015. Since that period no updates of this file were done. In 2020, a new tuning index (2009–2020) was built based on Turkish commercial CPUE (numbers of boat, landings and working hour). For the period 2009–2013, it was not possible for the catch-at-age and weight-at-age composition of the Turkish commercial catches to be retrieved. Combined Black Sea catch-at-age and weight-at-age matrices were applied for the reconstruction of the Turkish tuning index by age groups (numbers per age). After 2014, Turkish catch-at-age and weight-at-age data were used.

New information of Turkish scientific demersal surveys (Turkey east and Turkey west) for spring and autumn were provided, but the data series had gaps in between. It was proposed to see if it is possible to reconstruct the missing years and compile a single Turkish survey set. After analysing the data it was concluded to be impossible to use all of the available information for the needs of the assessment. There were only one year where both, spring and autumn, surveys overlapped. Finally, it was decided to include only the Turkey east autumn survey (2016–2020) in the modelling.

Bulgaria provided data from scientific survey for spring and autumn (2016–2020). Years were missing from the autumn surveys and therefore only the spring surveys were eligible for use in the analyses. However, in 2019–2020, very small quantities of red mullet catch were registered in the surveys, and for some years the small age classes (0 and 1) were missing. Two variations for running the model were tested – with and without the Bulgarian tuning index and the variation with the Bulgarian tuning showed bigger residuals than the one with the Turkish tunings only. However, there were almost no differences in the final results of the assessment. The Group decided not to use Bulgarian tuning data in the analyses, but in the future the Group should recall that this information exists and note when these data sets are long enough to be used in the assessment.

In the previous assessments two natural mortality values for all of the age classes were used: NM = 0.44 (1990–2003) and 0.73 = 2004–2017. It was not clear from where these two values were obtained nor the reason behind this significant change. Later, it was determined that for the last assessment (reference year 2017) a new NM vector was calculated (based on the CnW method) and used. After a discussion regarding the biology of the species (the younger specimens are highly predated and are more vulnerable than the adults), it was decided not to further modify the NM vector and to use the same in this year's assessment.

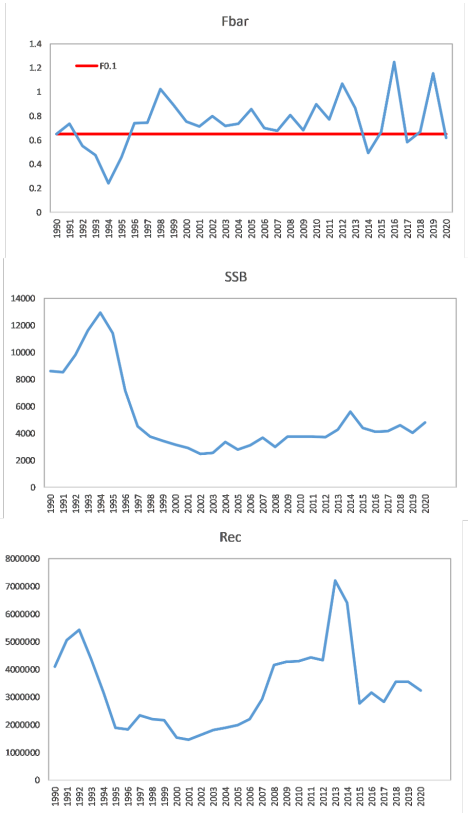
Assessment method: Statistical catch-at-age (XSA, FLR), FLBRP package for yield per recruit analysis.

Model performance: Model residuals did not show any specific trends. Overall diagnostics are acceptable, and retrospective analysis is consistent.

Results:

$F_{current}$ ($F_{bar\ 1\text{-}4}$ in 2018-2020)	0.81
$F_{0.1}$ (2018-2020)	0.65
$F_{current}/F_{0.1}$	1.3
Current SSB (tonnes)	4 479.6
33rd percentile biomass (tonnes)	
66th percentile biomass (tonnes)	

Plot showing the results:



Diagnosis of stock status:

In overexploitation

Advice and recommendation:

Quantitative advice was produced and it was recommended to reduce $F_{current}$ towards $F_{0.1}$.

N: 6

Stock: Whiting, *Merlangius merlangus*

GSA: 29

Fishery:

In the Black Sea, the whiting is one of the most abundant species among the demersal fishes. It does not undertake distant migrations, spawning mainly in the cold season within the whole habitat area. The whiting produces pelagic juveniles, which inhabit the upper 10 m water layer for about a year and the adult whiting is cold-living, preferring temperatures of 6–10°C. Whiting is one of the most widely caught and consumed fish species in the Black Sea region. It is mostly caught as a target fish species by bottom trawls in Turkey and gillnets are permitted to fish for whiting along the Turkish coasts. Bulgarian and Romanian fishers are the primary catchers of whiting in European Union seas.

Data and parameters:

The 2018 assessment was an update of the 2017 assessment carried out using an extra year of data. The complete absence of age 0 individuals in the 2017 catches, along with very poor internal and external consistency of all data-at-age (catches and surveys alike), prevented any of the models from converging. Uncertainties at the level of discards remained so these crucial data were not included. The SGSABS agreed on providing precautionary advice for this species based on the advice formulated in 2017 (reduce fishing mortality). Future work should consider using length data to derive ages through slicing exercises while working on improving information on discards and ageing. In 2020, a new tuning index (2009–2020) was created based on the Turkish commercial CPUE (number of boats and hours of operation). Survey data from Turkey, Bulgaria and Romania were also used as tuning index however, some survey data were not used due to missing years. Spring and fall data from Turkish scientific demersal surveys (Turkey east and Turkey west) were provided, but the data series had gaps in between. The SGSABS explored if the lost years could be reconstructed and a single Turkish survey set formed, but finally, only the Turkey east autumn survey (2017–2020) was chosen to be utilized in the modelling. Bulgaria provided data from scientific survey for spring and autumn (2016–2020), but there were missing years in the autumn surveys and therefore only spring survey data were considered usable for the analyses. Romania provided data from scientific survey for spring and autumn (2012–2020) and they were all used all used in the assessment. However, in the end a number of issues were encountered which prevented the models from converging: i) the absence of age 0 in 2017 data, ii) the lack of internal consistency in the surveys, iii) the lack of contrast in the data, iv) inconsistency between surveys, v) difficulty in ageing for this species. It was determined that the future use of length data should be considered and an exercise of exploring how age data are derived should be carried out.

Assessment method:

XSA (FLR)

Model performance:

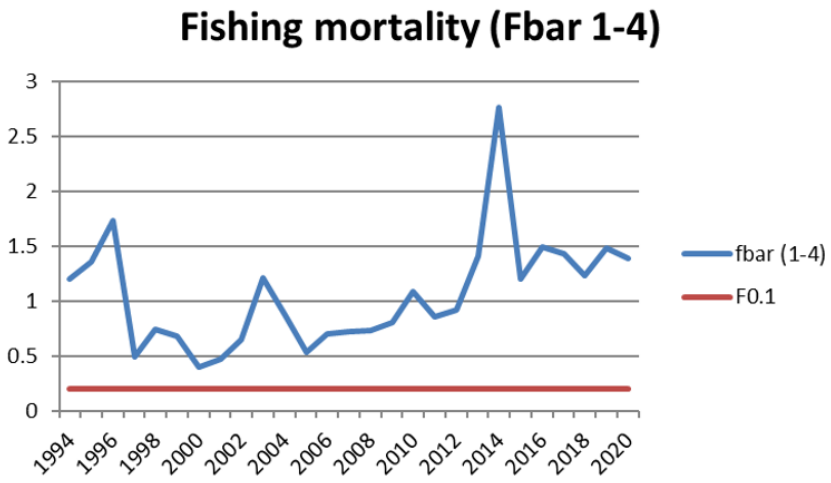
The complete absence of age 0 individuals in the 2017 catches, along with very poor internal and external consistency of all data-at-age (catches and surveys alike), prevented any of the models from converging. Final model residuals did not show any specific trends. Overall diagnostics are acceptable, and retrospective analysis is consistent.

Results:

$F_{current}$ ($F_{bar\ 1\text{-}4}$ in 2018–2020)	
$F_{0.1}$ (2018–2020)	0.2
$F_{current}/F_{0.1}$	6.85
Current SSB (tonnes)	
33rd percentile biomass (tonnes)	
66th percentile biomass (tonnes)	

Plot showing the results:

Fcurrent (2018-2020)=1.37
F0.1= 0.2
Fcurr/F0.1=6.85



Diagnosis of stock status:

In overexploitation based on qualitative advice.

Advice and recommendation:

Reduce fishing mortality on a precautionary basis.

The 2018 assessment was an update of the 2017 assessment carried out using an extra year of data. Owing to issues related to input data, the SGSABS agreed to provide precautionary advice for this species based on the advice formulated in 2017 (reduce fishing mortality). Future work should consider using length data to derive ages through slicing exercises while working on improving information on discards and ageing.

N: 7

Stock: Rapa whelk, *Rapana venosa*

GSA: 29

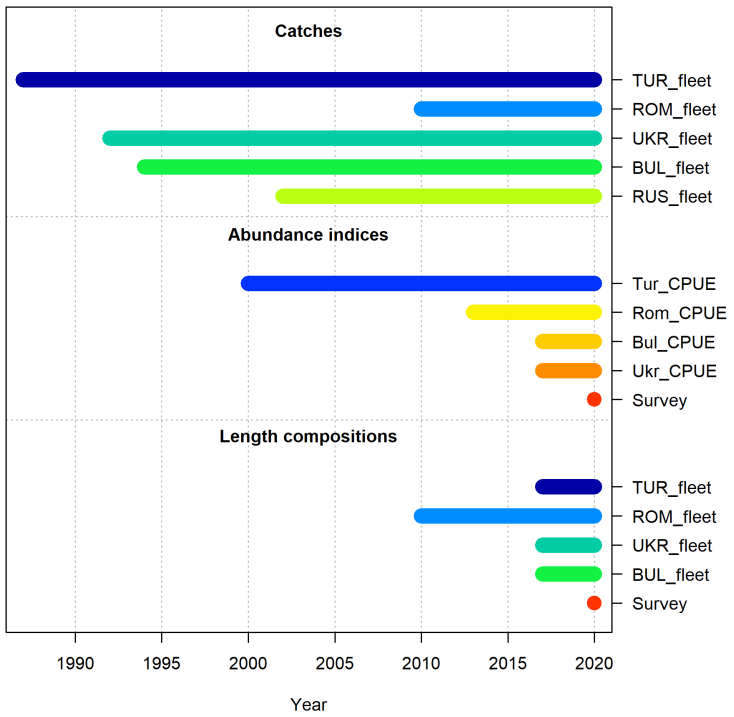
Fishery:

Before 1988, landings of rapa whelk from all Black Sea countries had been at a quite low. In the Union of Soviet Socialist Republics (USSR) at that time it was only collected by divers who gathered small amounts for souvenirs mostly in the Crimean and Caucasian areas. Rapana catches began increasing after Black Sea countries began exporting to Asia and following the depletion of commercial fish in the Black Sea. However, it wasn't until much later that intensive stock exploitation was started in the northern part of the Black Sea. Russian Federation and Georgian landings remain negligible and often equal zero and in other Black Sea countries the export of rapa was reduced in 2020 due to restrictions caused by the COVID-19 pandemic.

Rapa whelk landings in the Black Sea come predominantly from beam trawls and dredge; a small amount is reported from divers.

Data and parameters:

This assessment was carried out using the final data set compiled during 'Data preparation meeting: Black Sea priority species' in 2021.



The von Bertalanffy growth parameters were obtained by combining length-at-age data sets provided by Turkey and Ukraine. The length-weight relationship parameters were calculated as an average of values from Turkish, Ukrainian and Bulgarian landing data over four recent years. The lengths at first maturity (Lm50) were similar in both researched Turkish and Ukrainian areas. The natural mortality vector was obtained by scaling over 3–8 age classes with the ProdBioM approach modified by COISPA based on t_{max} = 15 and the von Bertalanffy growth parameters.

The Turkish CPUE series was calculated as landings divided by vessel numbers and while this is the longest series, it is not standardized by vessel type or day/hour efforts. The Ukrainian CPUE is catch per hour with a dredge. Romania and Bulgaria both have four CPUE series with beam trawls by different vessel types. The BCrumb tool was applied to combine four time series of CPUE into an overall harmonized time series for both Romania and Bulgaria.

In autumn 2020, all Black Sea countries conducted rapana surveys in their national areas and the combined LFD was included for model tuning.

Assessment method:

The framework Stock Synthesis (SS3) was applied for the assessment. Catch-at-age and weight-at-age data were generated internally from the growth (von Bertalanffy and length-weight) parameters using the LFDs by the fleets.

Model performance:

The LFDs for the fishery fleets aggregated across time were reconstructed quite well by the model. The Pearson residuals for the fleets were quite low (mostly between -2 and 2) and without patterns. For observed and expected CPUE indices, the fitting presents some inconsistency, particularly the peaks of the Turkish series which are poorly described by the model.

The retrospective analysis was applied up to three years back with pre-fixed parameters of the Beverton-Holt stock-recruitment relationship (R_0 and steepness) to eliminate their variability due to a lack of data. To evaluate discrepancies, the Mohn's rho-index (the average relative bias of retrospective estimates) was applied. Its values were -0.16 for SSB, -0.23 for Rec and 0.16 for fishing mortality (Fbar) over the last three years. Thus, the model cannot be considered stable. Additionally, the lack of data over a long period makes robust retrospective analysis impossible and in this case detailed data are available only for the last four years.

Results:

The rapa whelk SSB has a fluctuated trend with peaks in 2002 and 2015 but increasing stock exploitation during recent years makes it generally trend downward. The SSB_{2021} accounted for to 67 000 tonnes with $SSB_{unfished}$ equal to 177 200 tonnes. The SSB_{2021} was interpreted as providing information on 1 January 2021, i.e. not for the year 2021, and $SSB_{unfished}$ was considered as a capacity value. The level of uncertainty was very high in the early period due to a lack of data and the uneven distribution of this non-indigenous species in the Black Sea. A forecast was made in the assumption that $F = F_{2020}$.

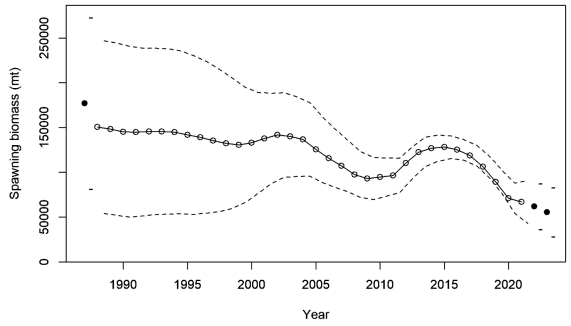
$F_{current}$ ($F_{bar\ 3\text{-}8}$ in 2020)	0.36
$F_{0.1}$	0.30
$F_{current}/F_{0.1}$	1.20
Current SSB (tonnes)	67 000
SSB unfished (tonnes)	177 200

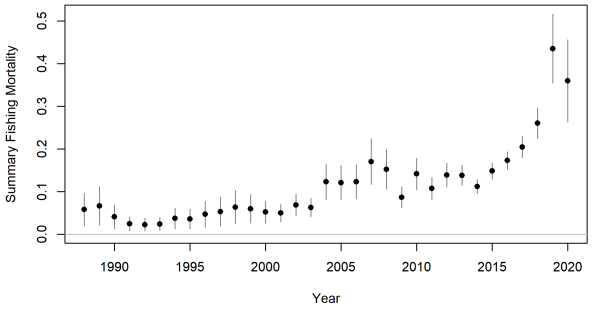
Diagnosis of stock status:

The stock was also assessed with a separable virtual population analysis (VPA) that gave very consistent results with SS3. In view of the consistent, deteriorating, signals, qualitative advice is provided based on the SS3 model. The Black Sea rapa whelk stock was considered in possible overexploitation.

Advice and recommendation:

Do not increase fishing mortality, on a precautionary basis.





GENERAL CONCLUSIONS, RECOMMENDATIONS AND SCIENTIFIC ADVICE

12. The SGSABS, in line with its terms of reference for 2021, based on scientific evidence and on the discussions held, agreed upon the following conclusions and provided the following advice:

General remarks

The SGSABS reviewed the terms of reference put forward by the Mediterranean WGSAs for the revision of the framework for the provision of advice, as requested by the forty-third session of the GFCM (Greece, November 2019). The SGSABS agreed with the proposed terms of reference, including the fact that such revision would have to entail consultation with scientists and managers/administrations and that the process would be linked to the GFCM 2030 Strategy for sustainable fisheries and aquaculture in the Mediterranean and the Black Sea (GFCM 2030 Strategy) discussion within the GFCM. The proposed terms of reference are included as Appendix 4/i.

The SGSABS agreed on using the new STAR Excel templates proposed by the GFCM Secretariat to contain detailed summaries of validated stock assessments including metadata, results and information required to produce the table of advice. The data submitted with STAR templates will be imported in a database and comprise the basis for future quality-controlled products. The STAR templates have been devised in such a manner as to allow for the streamlined automation of tasks (including the automated production of the table of advice and data analysis), reduce the risk of errors and promote transparency.

Input data

The SGSABS commended the important steps taken towards providing advice on the basis of year n-1 data for all species. In light of this, the Group agreed that the execution of the SGSABS in July each year was the appropriate way forward to ensure this condition be met in the future as well.

While acknowledging the peculiar situation provided by the COVID-19 pandemic, that resulted in important but fragmented data preparation efforts over the past 18 months, as well as the difficulties related to holding such meetings online, the SGSABS underlined the improvements in data for most species, as well as in the modelling approaches undertaken. The Group underlined the significant enhancement in the capabilities of the pool of Black Sea experts in terms of stock assessment and recommended that capacity building activities continue in the Black Sea. Nevertheless, the absence of data compilation efforts carried out in the context of other bodies still caused a gap in terms of data preparation. In analysing the outcomes of the 2021 meeting, the SGSABS underlined the central and critical function of data preparation in the provision of advice on the status of the stocks in the Black Sea. The Group reiterated its strong recommendation to foresee that detailed data preparation exercises (including preliminary testing of different models) precede all assessment work in the Black Sea, benchmarks in particular, and recognized the crucial role of the BlackSea4Fish in fostering this kind of work, according to the terms of reference provided in Appendix 4/ii.

The SGSABS noted with pleasure the updates on the advancing creation of a Black Sea subregional scientific database containing all data required to perform stock assessment and including the necessary data quality checks. The Group looked forward to its presentation and roll-out in autumn 2021.

The SGSABS acknowledged the work being done to expand the fishery-independent surveys covering the distribution of the main commercial species in the Black Sea in a comprehensive way and praised the establishment of a Black Sea standardized beam trawl survey for rapa whelk covering all of the Black Sea. Nevertheless, it strongly encouraged the work be continued.

Status of priority stocks

Advice was provided on the status of seven stocks in the Black Sea: Black Sea turbot (*Scophthalmus maximus*), European sprat (*Sprattus sprattus*), horse mackerel (*Trachurus mediterraneus ponticus*), picked dogfish (*Squalus acanthias*), whiting (*Merlangius merlangus*), red mullet (*Mullus barbatus*) and rapa whelk (*Rapana venosa*). Of these, qualitative precautionary advice was given for horse mackerel, piked dogfish, whiting and rapa whelk, as the assessments were considered indicative of trends; more comprehensive quantitative advice was provided for red mullet and sprat. The advice for turbot was updated based on the decisions taken in the 2019 benchmark, providing semi-quantitative advice, pending re-estimation of reference points. Advice on the status of the Black Sea anchovy stock was the outcome of a benchmark session carried out on 5–9 July 2021 that considered stock status uncertain pending finalization of the benchmark according to an agreed roadmap.

A synthesis of the advice and the recommendations provided by the SGSABS for each species is given below. A summary of the status and advice by stock is available in Appendix 3 of these conclusions and recommendations. A complete description of input data and analysis carried out can be found in the individual stock assessment forms, which will be made publicly available on the GFCM website after validation by the WGBS.

Black Sea anchovy: despite the important improvements in the input data and in the modelling approach adopted for this species, the benchmark was not concluded and contrasting signals in the data did not allow the status of the stock to be ascertained. Pending finalization of the benchmark, for which a roadmap was agreed, the status of the stock was considered uncertain and it was advised not to increase fishing effort on a precautionary basis. The conclusions of the Black Sea anchovy benchmark are still pending finalization and will be presented to the WGBS on 28–30 July 2021.

Turbot*:* the assessment of the turbot stock was updated according to all the input data, assumptions and model settings agreed in the benchmark session of 2019, with two extra years of data. The updated assessment confirmed the decreasing trend in F (F/FMSY was higher than 1 [1.75–1.07]) and the increasing trend in SSB (B/Bpa ranged between 2.6–1.3). The stock was considered to be in overexploitation with biomass above the range of reference points. The advice was to reduce fishing mortality on a precautionary basis. The SGSABS recalled the fact that the eighth session of the WGBS in 2019 had considered the reference points emerging from the benchmark assessment in need of revision and recommended to continue the work on reference points for turbot in the presence of all experts. This was reflected in Recommendation GFCM/43/2019/3 amending Recommendation GFCM/41/2017/4 on a multiannual management plan for turbot fisheries in the Black Sea (geographical subarea 29) that required the WGBS to provide scientific advice, including the necessary elements for setting biological reference points and for the revision of TAC and quotas, at its annual meeting in 2022. In light of this, the SGSABS agreed on a roadmap for the work to be done to estimate reference points towards the finalization of the benchmark in 2022, in advance of the WGBS meeting. This roadmap is included as Appendix 5/i of these conclusions and recommendations. The Group further agreed that more work was needed to improve the input data (notably the standardization of the existing demersal surveys and their expansion to all Black Sea countries) before the next benchmark.

Piked dogfish: significant problems were encountered in the preparation of the input data for the piked dogfish assessment with issues related to the creation of catch-at-age matrices. This prevented any models from being run. Nevertheless, it triggered an in-depth reflection on the information available for this species and the improvements needed to ensure future advice for this stock. Identified issues included i) understanding of biological parameters (e.g. growth), especially for Bulgaria, ii) harmonization of data collection for biological data, with particular importance expressed on obtaining information on the smaller individuals, iii) optimization of surveys, iv) harmonization of ageing through a workshop, and v) quantification of bycatch. The Group agreed to draft a roadmap (Appendix 5/iv) to present to the WGBS including suggestions for the improvement of input data and a plan for the performance of the assessment using different modelling approaches (statistical catch-at-age and biomass models). In the absence of an assessment, the SGSABS agreed to provide precautionary advice based on previous advice and new information. The population was thus still considered depleted and F should be reduced by more than 90 percent and a recovery plan should be established.

European sprat: based on the contrasting advice provided by the benchmark session in 2018 and pending its finalization, European sprat was assessed using a newly-configured SAM model with improved input data and additional tuning series from the Russian Federation. The same data set was used to run an XSA model according to the settings used to provide advice in 2018. Based on an extensive discussion on the assumptions made on natural mortality, the Group decided to revert to the old natural mortality estimates (1.28 for age 0 and 0.95 for all other ages) as they were determined based on survey data rather than estimated by empirical estimators based on growth parameters or other life history traits. This solution was also in line with the natural mortality used elsewhere for this species (e.g. in the Baltic Sea where it is estimated using a multispecies model). The Group evaluated the results of the two models and discussed their pros and contra (Appendix 6). The final decision, based on the diagnostics of the assessments (mainly retrospective and residuals) as well as on the pros and contra, was to adopt the SAM model to provide quantitative advice for sprat, which was found to be sustainably exploited and fishing effort should not be increased. The SGSABS agreed on a roadmap for the finalization of the benchmark which was suggested for July 2022 in a separate session from the SGSABS plenary. This roadmap is provided in Appendix 5/ii.

Horse mackerel: an appraisal and revision of the input data was performed and some issues related to the over-representation of age 0 in certain years (2013–2016) were solved resulting in newly calculated catch-at-age and weight-at-age matrices to be used in the assessment. A new natural mortality estimate was also adopted. The results of the final assessment revealed a resource in overexploitation with an exploitation rate nearly twice as high as Patterson's reference level of 0.4. The Group reiterated previously identified limitations related to the use of the nominal Turkish CPUE used to tune the XSA model as the only tuning index for the XSA of horse mackerel: i) the CPUE at age was derived using the catch-at-age of the fishery itself, and ii) the CPUE indices for small pelagic species often suffer from hyperstability owing to the schooling behaviour of this species. Based on this, and despite the significant improvements in the data and the model, the SGSABS agreed on providing qualitative precautionary advice pending the standardization of the nominal CPUE in advance of the next SGSABS in 2022. Horse mackerel was thus deemed in overexploitation and the advice was to reduce fishing mortality on a precautionary basis. The group agreed on a roadmap to improve input data, as detailed in Appendix 5/iii.

Red mullet: this assessment presented significant advances with respect to previous years, especially in terms of input data. In particular, the Turkish commercial CPUE was recalculated and the demersal survey for Turkey east in autumn was deemed to now have a long enough time series to be used in the model. Attempts were made to include a tuning index based on the Bulgarian mid-water trawl survey but it increased the noise and did not provide significantly different results. The improvement in data quality allowed quantitative advice to be provided, showing a stock in overexploitation (F/Fmsy = 1.3) for which F should be reduced. A plan was made to further improve the quality of input data, including: i) through the proposal for the establishment of a standardized genetic study to investigate the mixing of *Mullus barbatus* and *Mullus surmuletus* in the catches of all Black Sea countries, and ii) through a more in-depth analysis of survey data.

Whiting: the input data for this assessment were revised and improved and additional tuning indices were used (Turkish bottom trawl and Bulgarian mid water trawl surveys). This resulted in a significantly improved assessment with all the models that were run consistently revealing fishing mortality rates over six times higher than the target F. Nevertheless, the poor internal consistency of some of the data sets-at-age and the marked pattern in the residuals of most datasets prompted the SGSABS to agree on providing qualitative precautionary advice for this species based on the outcomes of the XSA run including all tuning indices. The stock was considered in overexploitation and the advice was to reduce F on a precautionary basis. An in-depth appraisal was made of the newly available data emerging from the discards monitoring programme and it was concluded that these data could not yet be used due to the issues related to the way in which biological samples of catches were collected. Future work should therefore delve into i) the biological sampling of catches in Turkey, possibly by month and by discriminating between catches collected onboard and catches derived from the market, towards the most appropriate application of discard rates-at-length, ii) an in-depth analysis of survey indices and iii) work towards the possibility of standardizing nominal CPUEs.

Rapa whelk: very significant improvements were noted in the assessment of this species. Two modelling approaches were used, the principal one being SS3, with the supporting outcomes of a simpler model, a separable VPA. The two modelling approaches gave very consistent results:

- increasing F in both models (Current F from SS3 is at Fmsy [F/Fmsy = 0.92] and above F0.1 [F/F0.1 = 1.02]);
- decreasing SSB in both models;
- decreasing recruitment in SS3;
- spawning potential ratio (SPR) index from SS3 is at MSY threshold (SPR/SPRmsy = 1.02) for recent years;
- all indices used, except for the Ukrainian CPUE, showed the same decreasing signal.

In light of the limitations (the Turkish CPUE was nominal and not well-fitted by the SS3 model) and strengths of the models performed and in view of the consistent, deteriorating, signals provided by both models and all available information, qualitative advice was provided for this stock based on the SS3 model. The Black Sea rapa whelk stock was deemed to be in possible overexploitation and fishing mortality should not be increased on a precautionary basis. Given the different situation of the fishery in the different countries of the Black Sea, SS3 is an adequate model as it is able to take into account all data separated by country. Future assessments will take advantage of more data, notably more points in the Black Sea rapa survey will shed light on the differential situation by country, in terms of catches and population at sea.

SGSABS WORKPLAN FOR 2021/2023

13. In order to continue working towards the improvement of advice on the status of Black Sea stocks, the SGSABS proposed the following activities for 2021/2023, to be further discussed and carried out with the support of the BlackSea4Fish project:

i. Continue to investigate the stock identification for the main commercial species, especially for red mullet, horse mackerel and piked dogfish.
ii. Improve the quality of data through an in-depth appraisal of available data, their quality and the identification of issues, biases and gaps, to be carried out within data preparation meetings organized in advance of the SGSABS and benchmark sessions. Work should include detailed descriptions of data collection schemes and raising methodologies (terms of reference are available in Appendix 4/ii).
iii. Finalize the roll-out of the creation of the Black Sea subregional scientific database.
iv. Execute the plan of action for the improvement of input data and the assessment of piked dogfish, including under the umbrella of the Black Sea4Fish project.
v. Perform a standardized analysis of red mullet mis-identification in catches across the whole of the Black Sea using genetics.
vi. Continue to compile information on rapa whelk abundance, distribution and length, and evaluate the possibility of providing age estimations, under the umbrella of the Black Sea4Fish project.
vii. Improve the estimation of bycatch of priority species, including estimates of discards and discards by age/length of red mullet, whiting and horse mackerel;
viii. Ensure the implementation of surveys at sea that provide fishery-independent indexes of abundance for the main commercial species, in particular regarding i) acoustic estimates for horse mackerel, and ii) the extension of the coverage of demersal trawl surveys, and provide improved indices for turbot and piked dogfish, as well as new indices for red mullet.
ix. In addition, the SGSABS proposed the organization of the following meetings:
    a. Data preparation meetings prior to the SGSABS session in 2022 and prior to all benchmark sessions according to the general terms of reference included in Appendix 4/ii.
    b. The SGSABS proposed that the 2021/2022 intersession should include the finalization of the benchmark assessments for anchovy, sprat and turbot followed by a benchmark for horse mackerel in 2022/2023 (Appendix 7).

ANY OTHER MATTER

14. A new chairperson was proposed for consideration of the WGBS, in the person of Mr Ali Cemal Gücü for the next two years (2022 and 2023).

DATE AND VENUE OF THE NEXT SESSION

15. The SGSABS proposed to hold the next session in July 2022.

ADOPTION OF THE REPORT

16. The conclusions and recommendations were adopted by the SGSABS on 16 July 2021. The report was adopted on 27 September 2021 after revisions and amendments made by electronic correspondence.

Appendix 1

Agenda

1. Opening session
2. Data preparation
3. Hands on session on the assessment of priority stocks and presentation of results
4. Formulation of conclusions, recommendations and management advice to be transmitted for the consideration by the WGBS and the Scientific Advisory Committee on Fisheries (SAC)
5. Closing session

Appendix 2

List of participants

Gizem AKKUS (Turkey)

Mohab BADRELDIN (Egypt)

Pinelopi BELEKOU (European Union)

Murat DAĞTEKIN (Turkey)

Georgi DASKALOV (Bulgaria)

Kostiantyn DEMIANENKO (Ukraine)

Adham ELEBRASHI (Egypt)

Ercan ERDEM (Turkey)

Madalina GALATCHI (Bulgaria)

Yaşar GENÇ (Turkey)

Yordan GOSPODINOV (BLSAC)

Erdinç GÜNEŞ (Turkey)

Bohdan HULAK (Ukraine)

Salih ILHAN (Turkey)

Tinatin JOGLIDZE (Georgia)

Ancuta KAZIMIROVICZ (Romania)

Yevhen LEONCHYK (Ukraine)

Irine LOMASHVILI (Georgia)

Guranda MAKHARADZE (Georgia)

Valodia MAXIMOV (Romania)

Mihaela MIREA (BLSAC)

Marina PANAYOTOVA (Bulgaria)

Ionut PETRESCU (Romania)

Elitsa PETROVA-PAVLOVA (Bulgaria)

Violin RAYKOV (Bulgaria)

Sergey SNIHIROV (Ukraine)

Constantin STROIE (Romania)

George TIGANOV (Romania)

Feriha TSERKOVA (Bulgaria)

Erdal USTUNDAG (Turkey)

Madona VARSHANIDZE (Georgia)

Maria YANKOVA (Bulgaria)

GFCM SECRETARIAT

Miguel BERNAL

Elisabetta Betulla MORELLO

Hüseyin ÖZBILGIN (BlackSea4Fish project coordinator)

Konstantin PETROV

Yoana GEORGIEVA (BlackSea4Fish project)

Mihail VATSOV

Rusi ATANASOV (BlackSea4Fish project)

Matteo STARNONI

INVITED EXPERTS

Isabella BITETTO (COISPA)

Niels HINTZEN (WMR)

Matteo MURENU (University of Cagliari)

Cecilia PINTO (University of Genova)

Maria Teresa SPEDICATO (COISPA)

Walter ZUPA (COISPA)

Appendix 3

Scientific advice on the status of the Black Sea (GSA 29) stocks assessed, including SGSABS comments

#	Species	Methods	Time series of catches used in the final model	$F_{current}$ *$E_{current}$	F_{unique} *E=0.4	F/F_{unique} *E/E=0.4	$B_{current}$	B_{MSY} *B_{pa} **B_{lim}	B/B_{MSY} *B/B_{pa} **B/B_{lim}	Stock status	Scientific advice	Comments (SGSABS)
1	Turbot (*Scophthalmus maximus*)	SAM	1950–2020	0.28			6 397 tonnes			In overexpl., biomass above the range of reference points	Reduce fishing mortality	Stock trajectory is following the increasing evolution seen in past years and F is following the decreasing evolution seen in past years. F/FMSY is higher than 1 [1.75–1.07] while biomass shows a positive trend (B/Bpa ranges between 2.6–1.3). Reference points will be re-estimated according to the agreed roadmap.

#	Species	Methods	Time series of catches used in the final model	$F_{current}$ *$E_{current}$	F_{unique} *E=0.4	F/F_{unique} *$E/E=0.4$	$B_{current}$	B_{MSY} *B_{pa} **B_{lim}	B/B_{MSY} *B/B_{pa} **B/B_{lim}	Stock status	Scientific advice	Comments (SGSABS)
2	Piked dogfish (*Squalus acanthias*)			-	-	-	-	-	-	Depleted	Implement a recovery plan	Precautionary advice was provided based on previous advice and new information. Previous assessments showed that F current was estimated as being 9.6 times higher than the calculated Funique assumed in 2017 (F_{unique} from ICES 2014). The population was thus still considered depleted and F should be reduced by more than 90 percent and a recovery plan established.
3	European Sprat (*Sprattus sprattus*)	SAM	1997–2020	Fcurr = 0.53 (0.37–0.76) *Ecurr = 0.36 (0.28–0.45)	*E=0.4	*Ecurr/E0.4 = 0.9 (0.7 – 1.13)	190 865 tonnes			Sustainable exploitation	Do not increase fishing mortality	The advice was based on a much improved SAM model including additional datasets compared to the benchmark session of 2018. Results of the XSA runs performed corroborated the results of the SAM. Quantitative advice was provided and the stock was considered in sustainable exploitation. A roadmap was agreed towards the finalization of the benchmark.
4	Horse mackerel (*Trachurus mediterraneus ponticus*)	XSA	2005–2020				-	-	-	In overexploitation	Reduce fishing mortality	Despite significant improvements in input data (notably catch-at-age 0), precautionary qualitative advice was given on the status of the stock, owing to issues related to the fact that nominal CPUE was used as a tuning index and slightly high residuals were evident in the older ages. The use of a nominal CPUE index (sliced into ages using a catch-at-age matrix from the catches themselves) from Turkey to tune the XSA model was challenged and an agreement was reached on performing its standardization before the next SGSABS in 2022. Further investigation of the acoustic survey data was deemed important, as was the need to collect as complete a dataset as possible from all Black Sea countries, including on discards.

#	Species	Methods	Time series of catches used in the final model	$F_{current}$ *$E_{current}$	F_{unique} *E=0.4	F/F_{unique} *$E/E=0.4$	$B_{current}$	B_{MSY} *B_{pa} **B_{lim}	B/B_{MSY} *B/B_{pa} **B/B_{lim}	Stock status	Scientific advice	Comments (SGSABS)
5	Red mullet (*Mullus barbatus*)	XSA	1990–2020	0.81	0.65	1.3	-	-	-	In overexploitation	Reduce fishing mortality	This assessment presented significant advances with respect to previous years, especially in terms of input data. In particular, the Turkish commercial CPUE was recalculated and the demersal survey for Turkey east in autumn was deemed to now have a long enough time series to be used in the model. Attempts were made to include a tuning index from the Bulgarian mid-water trawl survey but it increased the noise and did not provide significantly different results. The M vector used in 2018 SGSABS was used. The improvement in data quality allowed quantitative advice to be provided, showing a stock in overexploitation for which F should be reduced.
6	Whiting (*Merlangius merlangus*)	XSA	1994–2020	-	-	-	-	-	-	In overexploitation	Reduce fishing mortality	The input data for this assessment were revised and improved and additional tuning indices were used (Turkish bottom trawl and Bulgarian mid water trawl surveys). This resulted in a significantly improved assessments with all models run consistently revealing fishing mortality rates over six times higher than the target F. Nevertheless, the poor internal consistency of some of the datasets-at-age and the marked pattern in the residuals of most datasets prompted the SGSABS to agree on providing qualitative precautionary advice for this species based on the outcomes of the XSA run including all tuning indices. The stock was considered in overexploitation and the advice was to reduce F on a precautionary basis. Future work should concentrate on the inclusion of discards in the assessment, the

#	Species	Methods	Time series of catches used in the final model	$F_{current}$ *$E_{current}$	F_{unique} *E=0.4	F/F_{unique} *E/E=0.4	$B_{current}$	B_{MSY} *B_{pa} **B_{lim}	B/B_{MSY} *B/B_{pa} **B/B_{lim}	Stock status	Scientific advice	Comments (SGSABS)
												standardization of nominal CPUEs and an analysis of all survey data.
7	Rapa whelk (*Rapana venosa*)	*SS3 Separable VPA	1988–2020	-	-	-	-	-	-	In possible overexploitation	Fishing mortality should not be increased	The stock was assessed with SS3 and separable VPA; they gave very consistent results with increasing F (Current F from SS3 is at Fmsy [F/Fmsy = 0.92] and above F0.1 [F/F0.1 = 1.20]) and decreasing SSB and recruitment. In view of the consistent, deteriorating, signals, qualitative advice was provided based on the SS3 model. The Black Sea rapa whelk stock was considered in possible overexploitation and fishing mortality should not be increased on a precautionary basis.

Appendix 4/i

Proposed terms of reference for the revision of the framework for the provision of advice

The revision of the framework of advice will entail consultation with scientists and managers/administrations, including through meetings (a first one proposed by the first semester 2020). This process will be linked to the GFCM 2030 Strategy for sustainable fisheries and aquaculture in the Mediterranean and the Black Sea (GFCM 2030 Strategy) discussion within the GFCM.

The revision should take into account the peculiarities of stocks/fisheries assessed (e.g. pelagics vs. demersals), with particular focus on priority species, and the following proposed terms of reference are suggested:

1. Review existing practice (methods, measures taken – indicators and reference points) for advice and management within the GFCM.
2. Review frameworks for the provision of advice in other regional fisheries management organizations and advisory bodies, with particular attention to be paid to those bodies providing advice for many species.
3. Revise the calendar for the provision of advice.
4. Address the provision of advice for data limited situations and the formulation of precautionary advice, including:
   - framework for providing advice when direct methods and/or harvest rates are used as well as in data poor/limited situations, including precautionary catch or effort advice.
5. Specify procedures for the estimation of reference points in different data availability situations, including:
   - Review reference points in adopted GFCM decisions and discuss technical approaches in relation to their estimation.
   - Address biomass reference points (percentiles, trends and other) and guidelines on their use (especially with respect to short time series).
   - Address reference points for data limited and new situations (e.g. spawning potential ratio).
6. Formulate a procedure for the performance of forecasts.
   - Provide guidelines on how to translate outcomes of scientific assessments into catch or effort advice towards monitoring the fishery vs. the advice given.
7. Formulate a procedure for the performance of management strategy evaluations (MSE) when needed, including the investigation of a range of possible measures, including temporal/spatial measures and technical measures such as gear selectivity and exploitation patterns.
8. Review aspects related to the transmission of information on status of stocks, including:
   - how to report data issues in terms of their use and problems, with particular reference to differences with official data on catch and effort, as well as the use of surveys in the assessment;
   - how to report stock status (summary sheets); and
   - how to report the outcome of benchmarking process.
9. Review the format and content of the elements for management plans.

Appendix 4/ii

Terms of reference for the meeting on data preparation in the Black Sea

A data preparation meeting prior to the Subregional Group on Stock Assessment in the Black Sea (SGSABS) in 2022 will be held and it is foreseen to last six days, focusing on three main elements:

- In-depth analysis of available biological data for all priority commercial species. This will include two main tasks:
    - Collation of all information, prior to the meeting, available in the literature and from ongoing monitoring projects for:
        i. growth parameters;
        ii. maturity;
        iii. spawning and recruitment periods and areas;
        iv. natural mortality estimates and methods for the estimation of vectors by age (e.g. Prodbiom, Gislason, Chen & Watanabe and Pauly);
        v. length-weight relationships;
        vi. age information.

        Stock coordinators for each species should be assigned to coordinate the work by species.
    - Analysis of collated information by species and choice of best parameters for use in subsequent analyses.
- An in-depth analysis of tuning fleets:
    - Fishery dependent indices: the use of nominal catch per unit effort (CPUE) should be analysed in depth for small pelagic species (Black Sea anchovy, European sprat and horse mackerel), as well as for turbot and whiting, addressing three issues in particular:
        i. the standardization of nominal CPUE using auxiliary data available on the fishery in order account for changes in catchability owing to external sources. The use of environmental variables in the standardization should be investigated. Outcomes will also include a plan for future data collection towards improving the data available for standardization;
        ii. the use of catch-at-age from the fishery to slice the CPUE index into ages.
    - Fishery independent (e.g. trawl surveys):
        i. In-depth analysis of the seasonality of survey indices for turbot, piked dogfish and red mullet. This will involve a scrutiny of disaggregated data by season, including length frequency distributions;
        ii. Based on the results achieved in point (i), the use of standardization methods to allow for the combination of seasons should be investigated taking into account both the biology of the species in question and environmental variables
- The analysis of basic catch data, including an analysis of all available biological data e.g. length-frequency distributions and the parameters used to slice lengths into ages for commercial catch. This will also imply that all countries provide data, at least, on landings.

Appendix 5/i

Roadmap for the estimation of reference points for Black Sea turbot

In response to the requests of the eighth session of the Working Group on the Black Sea (WGBS) (2019) and in order to fulfil the requirements of Recommendation GFCM/43/2019/3 amending Recommendation GFCM/41/2017/4 on a multiannual management plan for turbot fisheries in the Black Sea (geographical subarea 29), the Subregional Group on Stock Assessment in the Black Sea (SGSABS) proposed a roadmap, with a timeline, for the estimation of reference points for Black Sea turbot to be carried out before the SGSABS meeting in July 2022.

The plan is to focus the work on continuing what was started during the 2019 benchmark and make use of eqsim (a stochastic equilibrium reference point software) to provide maximum sustainable yield (MSY) reference points based on the equilibrium distribution of stochastic projections, under a number of different assumptions.

The work will be carried out in a stepwise manner, building on previous efforts while also foreseeing a significant capacity-building component. The final result of the roadmap will be the estimation of reference points and the finalization of the Black Sea turbot benchmark.

Step 1

1.1 A detailed description of the work done to date on the estimation of reference points for Black Sea turbot, including information on how the process works, the assumptions made and a detailed description of the preliminary results will be compiled. This document will be circulated to all Black Sea experts for them to get acquainted with the work.

Deadline: October 2021

1.2 A workshop (maximum two days) will be organized to present the method and the outcomes and provide the opportunity to learn the basics of running eqsim on the context of Black Sea turbot.

Deadline: November 2021

Step 2

2.1 A session will be organized to investigate, discuss and decide all relevant assumptions that need to be made before running the final analyses

Deadline: January 2022

Step 3

3.1 The estimation of reference points will be completed according to the decisions taken in Step 2 and final estimates will be provided

Deadline: April 2022

Step 4

4.1 The update of the turbot assessment will be performed and the newly estimated reference point will be used to determine stock status and run short term forecasts towards providing the scientific basis for the possible revision of the total allowable catch (TAC) to be discussed at the WGBS in 2022 the WGBS in 2022 estimation of reference points will be completed according to the decisions taken in Step 2 and final estimates will be provided

Deadline: SGSABS in July 2022

Appendix 5/ii

Roadmap for the finalization of the benchmark assessment of European sprat in the Black Sea

Suggested date for final session of the benchmark: July 2022 back-to-back with the SGSABS plenary session, in the presence of an external reviewer

Data issues

Age reading

Work should advance on determining a protocol for age reading and interpretation of otoliths in different seasons and months, starting from efforts already made by the BlackSea4Fish project. To be done in a stepwise manner:

- online session to determine the main issues to be addressed: October/November 2021; and
- face-to-face meeting as soon as possible to work on otoliths, finalize a protocol and understand next steps

Standardization of CPUE indices

- Turkey before July 2022;
- Ukraine: to be facilitated by GFCM Secretariat and Black Sea4Fish project;
- Russia: to be facilitated by Black Sea4Fish project and Georgi Daskalov;
- Bulgaria: depending on funding.

Modelling issues

SAM

- Incorporate improved data and explore further options (e.g. plus group).
- Perform capacity-building and transfer knowledge on the current model.
- Organize a workshop on the use of SAM for assessing small pelagic species for the entire GFCM area of application.

Estimate reference points

- Participate in the work planned for the estimation of reference points for turbot.
- Estimate reference points for sprat.

Appendix 5/iii

Roadmap for the improvement of input data for the assessment of horse mackerel in the Black Sea

The SGSABS agreed on addressing the following aspects related to the input data of the horse mackerel assessment in advance of the 2022 meeting of the SGSABS:

- further data exploration and improvement of data quality for all countries;
- standardization of the Turkish nominal CPUE; and
- possible inclusion of information on discards within the assessment.

In order to fulfil the above objectives, all available data by country should be put on the table for analysis towards optimizing their use and increasing the quality of advice, with particular reference to:

- available data on length frequency distributions of catch and surveys;
- available data on surveys, in particular acoustic surveys that have been collected but not analysed yet as well as new ones;
- available data to standardize tuning indices (e.g. CPUE), e.g. georeferenced daily catches environmental data, VMS data, fishery and fleet data; and
- available data on discards.

Appendix 5/iv

Roadmap for the assessment of piked dogfish (*Squalus acanthias*) in the Black Sea (GSA 29)

Cecilia Pinto, George Tiganov, Feriha Tserkova, Madalina Galatchi, Vova Maximov

SUMMARY

1. Improvement of data:

- Understand biological parameters;
- Harmonize data collection for biological data, in particular collect length and sex information of all individuals caught, also those below the landing size as there seem to be a bias towards adult individuals within the data collection process;
- Optimize (in time and space) bottom trawl surveys to better describe the species;
- Organize a workshop on ageing techniques of piked dogfish in order to create training opportunities and increase knowledge exchange between countries;
- Quantify bycatch.

2. Modelling approaches to be trialled instead of XSA:

- More flexible catch-at-age models (e.g. a4a); and
- Production models (SPiCT and JABBA).

PROPOSAL

The only historical data available for piked dogfish in GSA 29 are total landings. The time series is available since 1989 for Romania, Bulgaria, Ukraine, Georgia, the Russian Federation and Turkey (Table 1). As shown in Figure 1, total landings were historically dominated by Turkey, with an average value of 1 726 tonnes for the period between 1991 and 2000. Ukraine and Georgia followed with average values of 226 tonnes, 90 tonnes while Russia, Romania and Bulgaria always reported lower landing with respectively average values of 24 tonnes, 11 tonnes and 39 tonnes for the same period between 1991 and 2000. After the year 2000 total landings showed a strong decrease in Turkey, Ukraine and Georgia down to values lower than 100 tonnes in 2010. Since 2015 all countries except Bulgaria have either stopped landing piked dogfish or land very low quantities which are by-caught by other fisheries. Bulgaria is the only country that still has a commercial fishery targeting piked dogfish. Information on discards for piked dogfish is not available across the whole time series for all countries.

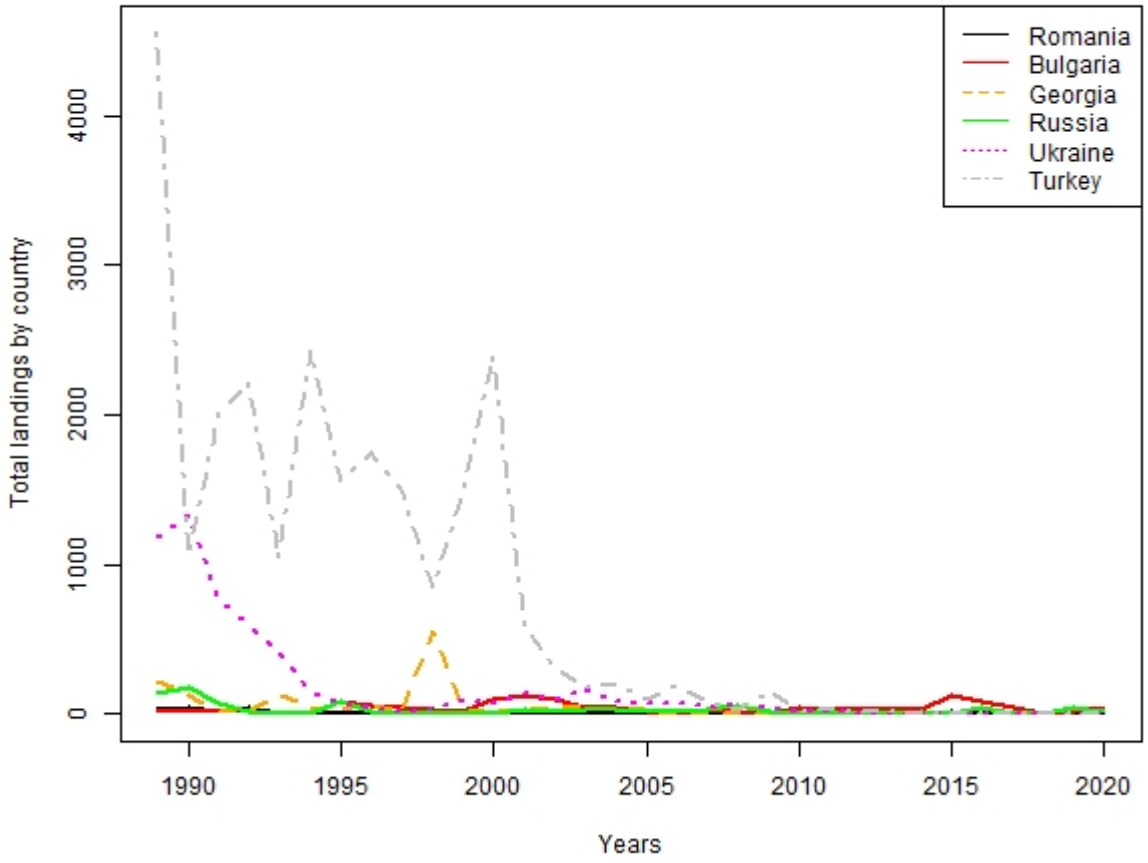


Figure 1. Total landings of piked dogfish reported by country in GSA 29 between 1989 and 2020

Table 1. Total landings of piked dogfish reported by country in GSA 29 between 1989 and 2020

YEAR	ROMANIA	BULGARIA	TURKEY	UKRAINE	GEORGIA	RUSSIA	TOTAL
1989	30	28	4558	1191	217	135	6159
1990	45	16	1059	1330	128	183	2761
1991	26	21	2017	775	18	67	2924
1992	52	15	2220	595	14	15	2911
1993	6	12	1055	409	131	5	1618
1994	2	12	2432	148	45	11	2650
1995	7	80	1562	67	31	90	1837
1996	5	64	1748	44	71	19	1951
1997	5	40	1510	20	1	9	1585
1998	5	28	855	38	550	6	1482
1999	5	25	1478	94	18	9	1629
2000	5	102	2390	71	21	12	2601
2001	5	126	576	134	27	27	895
2002	5	100	316	97	65	19	602
2003	5	51	184	172	40	29	481
2004	5	47	211	93	31	34	421
2005	5	15	102	75	35	19	251
2006	9	6	193	67	10	17	302
2007	17	24	91	45	2	32	211
2008	10	23	35	79	0.4	59	206
2009	4	9	159	47	1.5	14	235
2010	3	42	16	18	1.5	9	89
2011	4	38	27	22	1.5	4	96
2012	2	29	25	6	1.5	6	69
2013	9	31	25	7	1.5	4	77
2014	2	34	3	3	1.5	18	62
2015	13	133	0	4	NA	6	156

2016	3	83	0	5	NA	40	132
2017	2	50	0	2	NA	0	54
2018	0.5	10	0	0.8	NA	0	11
2019	0.6	17	0	0.95	NA	41	59
2020	0.9	48	0	0.278	NA	22	71

Landings data by age are available only for the most recent years and only for Bulgaria and Romania. Romania has the longest time series, with age readings starting in 2014, while Bulgaria started recording length measurement data only since 2017 (but with a gap year in 2018). Age readings of piked dogfish are done through the transversal section of the dorsal spines.

Abundance indices from the BTS spring and autumn surveys are also available only for Romania and Bulgaria. Romania has a time series starting in 2009 for total abundances while age readings start in 2014 as for landings data. Bulgaria has values for the total abundance index starting in 2006 although there are some gap years in 2008, 2012 and 2013. Length measurements are available since 2014.

Biomass indices from the BTS spring and autumn surveys are available for Romania starting in 2019 both for total biomass and age readings of survey data. Bulgaria has values for the total biomass index starting in 2006 although there are some gap years in 2008, 2012 and 2013 as for the abundance index. Length measurements are available since 2014.

Bulgaria has started age readings of piked dogfish through the dorsal spines only in 2020, therefore all available length data prior to 2020 are sliced to obtain age matrices, using Romanian age length keys.

Estimates of biological information such as growth parameters, mortality vector and maturity vector are reported in the Stock Assessment Form from 2018 (Radu, 2018), year of the latest assessment run. No new information on these parameters was presented this year during SGSABS (12–16 July 2021).

LIMITATIONS IN THE ASSESSMENT PROCESS DUE TO LIMITED DATA COLLECTION

In 2018 the stock was assessed through the extended survivor analysis (XSA) which is a model based on catch-at-age data and abundance at age indices. Such data are the main limitation in this stock considering that age structured data are available at the earliest from 2014, meaning that to run a model based on age structured data will always require to reconstruct a time series from 1989 to 2013. Reconstructing 25 years of age structured data based on historical landings, with only six years of age observations could introduce a high potential of bias in the stock assessment results and therefore in the evaluation of such a depleted species. Additionally information on the age structure of the stock are available, only from Romania and Bulgaria, therefore the underlying assumption within the reconstruction process, is that the species shows the same size distribution across the whole of the Black Sea and also that its availability to fishing gears does not change between gears. Unfortunately scientific information from literature or historical datasets is not available to verify such assumptions.

During SGSABS this year there was a discussion concerning the reliability of results obtained from a dataset which is reconstructed for more than 50 percent of its composition considering the potential high level of uncertainty that would be introduced in the process. Two suggestions were brought forward on what would be the best way to proceed in the assessment process, accounting for the uncertainty introduced by the data limitations and how to quantify its effect on models' outputs.

In order to be consistent with the age based model used in 2018 (XSA) and make its results comparable with the new modelling framework it was suggested to implement a statistical catch-at-age model that would allow to account for gaps in the time series, such as the a4a model within the FLR framework). Through the application of a4a the uncertainty around the model outputs would be quantified through a Markov chain Monte Carlo (MCMC) procedure previously described in the Black Sea Turbot Benchmark report (GFCM 2019).

In parallel with the statistical catch-at-age implementation it was suggested to run a biomass dynamic model which would still have a high level of uncertainty as the survey indices are available only for the last six years, but would reduce the uncertainty introduced by the reconstruction of age classes from 1989 up to 2013. The model frameworks suggested were SPICT (https://github.com/DTUAqua/spict) and JABBA (https://github.com/jabbamodel/JABBA).

ADVICE ON DATA COLLECTION

The group also brought forward a number of thoughts on the implementation of data collection for this species. There was a request from the experts of the different countries to work towards a harmonization of the data collection for this species across all countries in GSA 29. Length measurements are collected mainly at landings spots and often data from on-board observations seem to come only from survey data. There was a request to highlight the need for collecting the length and sex of all individuals that are caught, also those inferior to the landing size as there seem to be a bias towards adults' individuals within the data collection process. Specifically there was a request to identify a period to organize a workshop on ageing techniques of piked dogfish in order to create training opportunities and increase knowledge exchange between countries. BTS survey were also suggested to be not ideal to collect information on this species as they are implemented in the spring and in the autumn while the species seem to concentrate in the survey area mainly in the winter where picked dogfish feeds intensively. The spawning period can be distinguished in two periods, a spring peak (April–May) and a Summer-Autumn peak (August–September) (Serobaba *et al*., 1988).

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Appendix 6

Pros and contra of XSA and SAM models as well as lists of input data required, updated with considerations from the SGSABS in 2021 (red text refers to 2021 additions)

XSA	SAM
Pros	
▪ Simpler to use	▪ It accounts uncertainty ▪ Allows inclusion of time series with gaps (i.e. use of surveys) ▪ Forward methodology (more precise for recent year estimates) ▪ Allows performance of MSE – framework for MSE already in place ▪ More diagnostic tools (likelihood, AIC, uncertainty) ▪ Does not assume catches without error ▪ Web interface for immediate output view and sharing of results ▪ Can include aggregate biomass indices
Contra	
▪ XSA not suitable for short lived species ▪ Deterministic model, providing no uncertainty around estimates ▪ Applies a backward estimation, so recent years are the most uncertain and requires estimates to be averaged over the last three years which is nearly entirely the whole life span of the species ▪ Assumes catch without error ▪ Cannot deal with gaps in the time series ▪ Retrospective shows instability in the historical part of the time series ▪ Historical part of the time series shows a hugely productive stock in a period when it was recovering from a crash ▪ There is a recommendation from the 2019 WGBS to move away from XSA towards statistical catch-at-age models	▪ More complicated to use but important capacity-building efforts have been made – and can continue to be made – towards ensuring this problem is overcome
Data requirements	
▪ Catch-at-age with no gaps in the time series ▪ Tuning indices with no gaps in the time series ▪ Estimates of natural mortality ▪ Weight-at-age ▪ Maturity-at-age	▪ Catch-at-age ▪ Tuning indices ▪ Estimates of natural mortality ▪ Weight-at-age ▪ Maturity-at-age

Appendix 7

Proposed multiannual planning of benchmark sessions in the WGBS (benchmark sessions denoted in blue)

	Species	2021/2022	2022/2023	2023/2024
Small pelagic stocks	Black Sea anchovy	Work towards finalization of benchmark		
	European sprat	Finalization of benchmark (July 2022)		
	Horse mackerel		Preceded by data preparation	
Demersal stocks	Turbot	Estimation of reference points (April 2022)		
	Whiting			Preceded by data preparation
	Red mullet			
	Rapa whelk			
	Piked dogfish			