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Reports of the Scientific, Technical and Economic Committee for Fisheries (STECF) - Multiannual plan for demersal fisheries in the Western Mediterranean (STECF-16-21)

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Abstract

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

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Multiannual plan for demersal fisheries in the Western Mediterranean (STECF-16-21)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS, 24-28 OCTOBER 2016

1.1 Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meetings, evaluate the findings and make any appropriate comments and recommendations.

1.2 Background

The Expert Working Group 16-02 (EWG 16-02) convened in September 2016 in Varese (Italy), with the objective of setting the scientific grounds for the assessment of the biological, economic and social effects of a range of possible measures applicable in the context of a multiannual plan (MAP) for the European fisheries exploiting demersal stocks in the Western Mediterranean Sea. The report reflects the work by ten experts, and one observer. The EWG 16-02 was asked to respond to five different terms of reference:

TOR 1. STECF-EWG 16-02 is requested to assess the likely biological and socio-economic benefits of implementing different management options. For each scenario, STECF-EWG 16-02 is requested to run the appropriate forecast models in order to describe the likely situation of the fisheries up to 2035 and using the indicators given below:

Fisheries indicators: catch, fishing mortality relative to FMSY (F/FMSY);

Biological indicators: abundance (SSB and total biomass), recruitment, and mean individual size;

Socio-economic indicators: GVA, salary and employment.

The list of stocks subject to this analysis is also available in table 1.

TOR 2. Discuss pros and cons of the geographical scope of the plan, taking into account the distribution of the stocks, fleet dynamics and the economic link between areas.

TOR 3. Among the stocks listed in Annex I, provide an opinion on the stocks that can be considered as driving demersal fisheries in the Western Mediterranean Sea. The group should take account of the outcomes of STECF EWG 15-14 and EWG 16-04.

TOR 4. STECF-15-09 noted that, although in the long term catches are expected to recover, as a result of the increase in biomass, in the short term the benefits of rebuilding will not be immediate. Having said this, estimate the likely time required to find fishing fleets with the potential to get a positive economic performance.

TOR 5. Describe the quality of the data and the impact on the analysis. The methodology, assumptions, uncertainties and references should be also thoroughly detailed. The use of schemes is advisable.

1.3 STECF observations

STECF observes that TORs 2, 3 and 5 were completely addressed, while TOR 1 and TOR 4 were partially addressed.

For TOR 1, STECF notes that the different management options requested in the TORs were tested using a set of scenarios, which reflected the management options and the natural uncertainty, within a management strategy evaluation (MSE) context. Nevertheless, STECF also notes that socio-economic indicators (GVA and wages) were not computed due to inconsistencies in the economic data from the different datasets available to EWG, and also because a mixed-fisheries multi-species bioeconomic model does not currently exist for this region. For the same reason TOR 4 was also not fully addressed.

Regarding the results obtained by the EWG, STECF notes the following:

Regarding ToR 1, STECF underlines the result obtained by the EWG that the status quo scenario (to keep fishing mortality at the most recent level estimated from the observed period), is the worst option from those tested in terms of number of stocks recovering to SSB levels above BPA. This option is unlikely to allow the stocks to recover to levels that are capable of delivering Maximum Sustainable Yield (MSY).

STECF notes that according to the results obtained by the EWG, in 2025 around 75% of the stocks studied are expected to have SSB levels above BPA with a probability of 95%, if option 1 or 2 (fishing at FMSY or within FMSY ranges, respectively) is implemented.

STECF acknowledges that the simulations comparing output-based management (TAC) with input-based management (effort limits) are based on a number of simplifying assumptions that cannot capture the full complexity of the governance process regarding management decisions, implementation and control. The simulations showed that a TAC-based management is less precise for reaching the fishing mortality target due to the uncertainties in the stock assessments. On the other hand an effort-based management is sensitive to the problem of hyperstability1. STECF notes that the EWG has tested two different solutions to address this issue. STECF concludes that the approach taken is promising, but results are still preliminary and no robust conclusions regarding an effective effort management can yet be taken from these two approaches.

STECF considers that the effect of the measures designed to protect the juvenile fraction are stock/fishery dependant and are significant only for the fisheries inducing large fishing mortalities on juvenile stocks. These measures can only be considered as an additional measure, but do not replace the need to reduce the overall fishing mortality of the stocks.

STECF notes the EWG observation that some of the values obtained for FMSY were very low and others very high. Reference points should be revised and updated when needed. Such revision could also be used to estimate biomass reference points, which currently do not exist.

STECF notes the conclusion of the EWG that in the context of mixed fisheries and species interactions and considering the assessment uncertainty, some stocks' fishing mortalities

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[1] Non-linear relationship between fishing effort and fishing mortality. Due to fisherman ability to keep high catch rates albeit stock biomass decreases, the relationship between effort and fishing mortality becomes non-linear, with fishing mortality responding slowly to fishing effort restrictions.

may exceed the FMSY range upper boundary even when management is implemented at FMSY.

STECF notes that some fleets have been assessed by the EWG to be moderately/highly dependent on the stocks considered, and are also large employers on the region. A monitoring of social conditions in these fleet segments upon implementation of the MAP may provide valuable knowledge on the actual extent of the social impact of the MAP.

STECF observes that the implementation of biomass safeguards at the level of BPA, with a recovery period of 5 or 10 years, will delay the time to achieve FMSY, because the recovery period is longer than the period required to reach the fishing mortality target in 2020 (3 years). Some options to circumvent this issue might be considered.

Regarding TOR 2, STECF agrees with the conclusion from the EWG that having MAPs with a wider scope will limit both the number of stocks that will have to be split across regulations and the potential inconsistencies that may arise from having to make several regulations coherent. Also, having MAPs that focus on more homogenous regions may encourage buy-in by Member States and regional/local bodies and establish a more homogeneous playing field for all the fleets covered. Finally, with regards to this TOR 2, STECF reiterates its previous conclusions from STECF-15-02 that the implementation of MAPs by one, two or more regulations still remains largely a policy decision more than a scientific issue.

Regarding TOR 3, STECF agrees with all the conclusions obtained from the EWG-16-02. Most of the stocks included in the MAP can be considered as driving the fishery, with a few exceptions. *Aristomorpha foliacea* in GSAs 7, 9 and 11; and *Lophius* spp in GSAs 10 and 11 are driving the fishery but are not included in the ToRs, while on the other hand the *Parapenaeus longirostris* in GSAs 5 and 6 were included in the ToRs but are not driving the fishery.

Regarding TOR 4, STECF concludes that the TOR was not fully addressed due to data limitations and the lack of a fully operational model to deal with it. The term "economic recovery" defined in this TOR requires further operationalization based on economic indicators (i.e., profits, wages,…). STECF concludes also that the only indicator provided to address this TOR, Value per Unit of Fishing Mortality, provides only limited information on the economic effects of the different scenarios, given that the costs related to effort are not considered in its calculation.

STECF also notes that a number of stock assessments data were not available to the EWG, either because they could not be obtained from GFCM in time for the EWG or because they come from stock assessment models not easily compatible with the format of the evaluation model used by the EWG.

Regarding TOR 5, STECF notes that the EWG found consistencies and discrepancies between the catches in the stock assessments and the landings data from the AER database (Table 4.1.1) These inconsistencies could not be solved during the meeting and prevented the EWG to carry out a mixed-fisheries analysis as well as to compute the economic indicator GVA requested in the ToR.

1.4 STECF conclusions

STECF endorses the outcomes of the work performed by the EWG.

STECF considers that the observed data discrepancies should be further explored.

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

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REPORT TO THE STECF

EXPERT WORKING GROUP ON
Multiannual plan for demersal fisheries in the Western Mediterranean
(EWG-16-02)

Varese, Italy, 5-9 September 2016

2 EXECUTIVE SUMMARY

According to the Common Fisheries Policy (Regulation (EU) No 1380/2013), the objective of sustainable exploitation of marine biological resources is more effectively achieved through a multiannual approach to fisheries management, and hence multi-annual plans reflecting the specificities of different fisheries shall be adopted as a priority. STECF was requested to provide the scientific grounds for the assessment of the biological, economic and social effects of a range of possible measures applicable in the context of a multiannual plan for the European fisheries exploiting demersal stocks in the Western Mediterranean Sea (GSAs 1, 5, 6, 7, 8, 9, 10, 11). The Expert Working Group on Multi-annual Plans for the Northwest Mediterranean (EWG16-02) met in Varese, Italy, from the 5th to the 9th of September 2016, with the following terms of reference (edited for shortness, full version in report):

1. STECF-EWG 16-02 is requested to assess the likely biological and socio-economic benefits of implementing a set of management options (below) for [a group of] demersal stocks caught by bottom trawl nets, longlines, bottom-set nets (including trammel nets and gillnets) and traps in the Northwest Mediterranean. Details provided by DGMARE (see report).
2. Discuss pros and cons of the geographical scope of the plan, taking into account the distribution of the stocks, fleet dynamics and the economic link between areas.
3. Among the stocks listed, provide an opinion on the stocks that can be considered as driving demersal fisheries in the Western Mediterranean Sea.
4. Estimate the likely time required [for] fishing fleets [achieve] a positive economic performance.
5. Describe the quality of the data and the impact on the analysis. The methodology, assumptions, uncertainties and references should be also thoroughly detailed.

The management options designed by DGMARE were (edited for shortness, full version in report):

Baseline. Status quo option or no policy change at EU level, i.e. the current national management plans, in combination with all other existing rules of the new CFP, would continue to apply.

Option 1. Amending the existing national management plans, to integrate the objectives and tools of the CFP, such as MSY objectives, quantifiable targets and time-frames, biomass safeguards, specifications of the technical measures and the inclusion of provisions for the implementation of the landing obligation. This option would also include the commitments declared by the Member States in various high-level meetings to further reduce 20% fishing capacity by means of permanent and/or temporal cessations would be applied to the French, Italian and Spanish fishing fleets targeting demersal stocks in the Western Mediterranean Sea.

Option 2. Establishing a multiannual plan, which creates a single, integrated management framework, which includes conservation objectives such as MSY, quantifiable targets (including ranges) and time-frames; the setting-up of safeguards, specifications of the technical measures; and the inclusion of provisions for implementing regionalisation and the landing obligation. Three sub-options in achieving Fmsy should be tested: capacity and effort limitations, technical measures and catch-limitations.

The management options were tested using a set of scenarios, which reflected the management options and the natural uncertainty, within a management strategies evaluation (MSE) context, which were used to compute the fisheries and biological indicators defined in the ToRs. The analysis was carried out using methods developed by the JRC's a4a Initiative.

The socio-economic indicators GVA and salary were not possible to compute due to data limitations. For employment the EWG followed a similar approach to previous EWG, which combined employment levels with fleet dependency as a way to highlight potential social problems. The indicator required by ToR 4 was not possible to compute due to data limitations. In alternative an indicator based on the value per unit of fishing mortality was computed, which allowed some insights into the potential recovery of the economic performance of the fleets. Finally, a description of the data gaps found and inconsistencies across datasets, in the context of the methods used by the EWG is presented.

The sources of data available were: STECF Mediterranean stock assessments, Mediterranean biological data call 2016 and the annual economic report data call. These datasets have different levels of aggregation, which makes them largely incompatible. Modelling procedures may align the data so that it can be used for more in depth analysis, as long as some points of contact exist, for example consistent landings by stock and fleets. Nevertheless, the gaps in the data and inconsistencies on stocks landings/catches across datasets limited the EWG analysis prevented a mixed fisheries bio-economic analysis.

The baseline scenario does not improve the number of stocks recovered during the projection period, being the worst performing scenario in this metric. Option 1 and option 2 with effort management showed the best performance, with approximately 75% of the stocks recovered in 2025, while option 2 with TAC management is around 50%. This results is due to the larger uncertainty of TAC scenarios. The probability of achieving the fishing mortality target, as with the previous indicator, shows that the baseline performance is quite poor. Option 1 showed the best results in median but has a large uncertainty associated, while option 2 performs better than the baseline but still shows low probability of achieving the targets. The comparison between option 1 and option 2 results must be contextualized. Option 2 was designed to introduce flexibility in the management process, so that mixed fisheries effects can be better dealt with. However, the current analysis does not account for such effects; it’s a set of single species simulations, which ends up not taking full advantage of the Fmsy ranges. When computing this indicator option 1 naturally performs better because the target of the simulation is Fmsy. While option 2 uses the envelop approach (STECF, 2015), where two simulations are combined, one targeting the upper limit of the Fmsy ranges and the other the lower limit.

Comparing a TAC management system (output control) with an Effort management system (input control), for the stocks and regions included in the MAP proposal, showed that:

- TACs settings rely more on stock assessment than Effort management, which may be a problem considering the instability of the stock assessments due to short time series and data limitations.
- On the other hand an output control system is not affected by hyperstability, which can be the largest effect preventing management success in an Effort system.

In the case of Effort management, hyperstability, the mechanism by which the fleet keeps high fishing mortality while effort decreases, will impair the plan's ability to reach the fishing mortality target. In such case the effects of hyperstability can be mitigated by developing an effort correction method to cope with hyperstability. Two options were presented and tested. For real application requires further work.

The implementation of biomass safeguards at the level of Bpa, with a recovery period of 5 or 10 years, will delay the time target to achieve Fmsy, because the recovery period is longer than the period to reach the target in 2020 (3 years). Precedence during the transitional period should be taken by largest decrease in F.

Fishing at MSY will decrease catches in the short run (2020) and increase afterwards (2025). Biomass will increase, although in most cases to levels outside the historical ranges. At these levels of SSB the S/R fits may not hold. Fishing at MSY will increase the mean length of the stocks.

Changes in selection pattern due to (i) technical measures, (ii) the implementation of the landing obligation or (iii) differentiated effort management by fleet, will change the reference points.

The effects of technical measures designed to protect the juvenile fraction of the stocks, in biomass recovery and future catches is limited. Although in some stocks it can be more important, in particular it may stabilize the effect of other measures by letting the young individuals grow larger and avoiding the fishery from being dependent on recruitment and their inherent variability. These technical measures will have a larger impact on stocks which have fisheries deploying larger Fs on 0-year olds.

Simultaneously trying to manage several stocks at single species FMSY levels is likely to fail and create inconsistencies between targets for different stocks. Due to large uncertainty in the stock assessment, which propagates into reference points.

The current reference points are based on F0.1. In some cases the values obtained for Fmsy are very low and others very high. Considering that these references will be written in the regulation the EWG suggests that a thorough revision should be carried out, and the references updated when needed. Such revision could also be used to estimate biomass reference points, which currently don't exist.

In the area of influence of the MAP there are some fleets which are moderately dependent on the stocks considered, and simultaneously are large employers on the region. Such cases may require monitoring of social conditions to understand the extent of the impact of the MAP.

Regarding the spatial scope of the MAP, the EWG considered that a wider scope will limit both the number of stocks that will have to be split across regulations and the potential inconsistencies that may arise from having to make several regulations coherent. On the other hand, having MAPs that focus on more homogenous regions, like western Mediterranean may encourage buy-in by Member States and regional/local bodies and establish a more homogeneous playing field. Nevertheless, the implementation of MAPs remains largely a policy decision. As long as the objectives are followed and the biomass safeguards applied, the outcomes of MAPs designed under the current framework should not be impaired by their scope.

The EWG identified a set of species which, following the criteria of EWG 15 04, are driving the fisheries but are not included in the ToRs, namely *Aristomorpha foliacea* in GSAs 7, 9 and 11; and *Lophius* spp in GSAs 10 and 11. The *Parapenaeus longirostris* in GSAs 5 and 6, on the other hand are included in the ToRs but are not driving the fishery under the same criteria.

Regarding the data quality, inconsistencies between the 3 databases available to the group, stock assessments, Mediterranean DCF data call and the Annual Economic Report data call, prevented the EWG to carry out a mixed-fisheries analysis as well as compute the economic indicator GVA requested in the ToRs. A number of stock assessments were not available to the group due to (i) being carried out with VIT, which can’t be used to condition operating models, and (ii) not being provided by GFCM. Employment data at Mediterranean level limits the regional analysis. For example, the Italian information refers to both the Northwestern and Northeastern Mediterranean.

3 INTRODUCTION

The EWG-16-02 was held in Varese, Italy, from the 5th to the 9th of September 2016. The meeting was attended by 10 experts, 1 observer and partially by 1 DGMARE officer.

3.1 Background

According to the Common Fisheries Policy (Regulation (EU) No 1380/2013)[2], the objective of sustainable exploitation of marine biological resources is more effectively

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[2] Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009

achieved through a multiannual approach to fisheries management, and hence multiannual plans reflecting the specificities of different fisheries shall be adopted as a priority.

Multiannual plans should, where possible, cover multiple stocks where those stocks are jointly exploited. The multiannual plans should establish the framework for the sustainable exploitation of stocks and marine ecosystems concerned, defining clear time-frames and safeguard mechanisms for unforeseen developments. Multiannual plans should also be governed by clearly defined management objectives in order to contribute to the sustainable exploitation of the stocks and to the protection of the marine ecosystems concerned. Those plans should be adopted in consultation with Advisory Councils, operators in the fishing industry, scientists and other stakeholders having an interest in fisheries. Prior to including measures in a multiannual plan, account shall be taken of their likely environmental, economic and social impact.

The purpose of this request is to obtain the scientific grounds for the assessment of the biological, economic and social effects of a range of possible measures applicable in the context of a multiannual plan for the European fisheries exploiting demersal stocks in the Western Mediterranean Sea.

Additional information on this initiative is available at the website of the European Commission[3]. Furthermore, a public consultation is currently open until 16 September 2016[4].

3.2 Terms of Reference for EWG-16-02

TOR 1. STECF-EWG 16-02 is requested to assess the likely biological and socio-economic benefits of implementing the management options described in section 3.2.1.

For each scenario, STECF-EWG 16-02 is requested to run the appropriate forecast models in order to describe the likely situation of the fisheries up to 2035 and using the indicators given below:

- Fisheries indicators: catch, fishing mortality relative to Fmsy (F/Fmsy);
- Biological indicators: abundance (SSB and total biomass), recruitment, and mean individual size;
- Socio-economic indicators: GVA, salary and employment.

The list of stocks subject to this analysis is also available in table 1.

TOR 2. Discuss pros and cons of the geographical scope of the plan, taking into account the distribution of the stocks, fleet dynamics and the economic link between areas.

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and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC; OJ L354 of 28.12.2013, p.22.

[3] Inception Impact Assessment - Proposals for Regulations of the European Parliament and of the Council establishing multi-annual plans for the management of demersal fisheries in western EU waters (available here).

[4] https://ec.europa.eu/eusurvey/runner/MAP-Western-Mediterranean.

TOR 3. Among the stocks listed in Annex I, provide an opinion on the stocks that can be considered as driving demersal fisheries in the Western Mediterranean Sea. The group should take account of the outcomes of STECF EWG 15-14 and EWG 16-04.

TOR 4. STECF-15-09 noted that, although in the long term catches are expected to recover, as a result of the increase in biomass, in the short term the benefits of rebuilding will not be immediate. Having said this, estimate the likely time required to find fishing fleets with the potential to get a positive economic performance.

TOR 5. Describe the quality of the data and the impact on the analysis. The methodology, assumptions, uncertainties and references should be also thoroughly detailed. The use of schemes is advisable.

3.2.1 Annex to the ToR

Scope

1) **Geographical scope**:

- FAO area 37.1 (equivalent to GSAs 1, 5, 6, 7, 8, 9, 10, 11)

2) **Fishing fleets**:

- Bottom trawl nets, longlines, and bottom-set nets (including trammel nets and gillnets) and traps operating in FAO 37.1.

Management Options

Baseline

The first option is the status quo option or no policy change at EU level, i.e. the current national management plans, in combination with all other existing rules of the new CFP, would continue to apply.

The fisheries exploiting demersal stocks in the Western Mediterranean Sea would continue to be managed through the national management plans adopted by France, Italy and Spain under the "Mediterranean Regulation". The geographical scope confined to the territorial waters of the Member States and the partial coverage of the fishing gears will remain unchanged[5].

The landing obligation for demersal species would be compulsory as from 1 January 2017 for the species that define demersal fisheries. Under this option, discard plans would be adopted for 3 years, but then there would not be a legal framework for the implementation of the landing obligation.

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[5] According to article 19 of the "Mediterranean Regulation", national management plans shall be adopted by Member States for an exhaustive list of gears operating in their territorial waters. However, some of the relevant fishing activities targeting demersal stocks in the Western Mediterranean area are located beyond Member States' territorial waters and they are carried-out by fishing gears which shall not be subject to national management plans, such as longliners, gillnets, trammel nets and traps.

To sum-up, **the scenario under the baseline would be**:

1. Current fishing mortality (i.e. average of the last 3 years) would remain constant;
2. Even though under this option the landing obligation would apply, we assume that the amount of discards of the species in Annex III of the MEDREG is unlikely to have impact.

OPTION 1. Amending the existing management framework

Under this option the current management tools, namely the national management plans, would be reviewed in order to integrate the objectives of the revised CFP "Basic Regulation".

The main aspects to be considered in their revision would be: the development and introduction of amendments to the current scope (in terms of fish stocks, fisheries and area covered); the introduction of new conservation objectives such as MSY, quantifiable targets and time-frames; the setting-up of safeguards; specifications of the technical measures; and the inclusion of provisions for the implementation of the landing obligation.

Under this option, it would be included the actions planned by the Member States, through their Operational Programmes for the period 2014-2020, to ensure a sustainable balance between fishing capacity and available fishing opportunities. This option would also include the commitments declared by the Member States in various high-level meetings to further reduce fishing mortality. For this purpose, we have assumed that a reduction of 20% fishing capacity by means of permanent and/or temporal cessations would be applied to the French, Italian and Spanish fishing fleets targeting demersal stocks in the Western Mediterranean Sea.

To sum-up, **the scenario under Option 1 would be**:

1. Fishing mortality would be reduced for the fishing gears subject to a national management plan. However, fishing mortality would remain constant for those fishing gears not subject to national management plans (i.e. long lines, trammel nets and gill nets);
2. The target would be Fmsy;
3. We assume a 20% fishing capacity reduction in accordance with the IT, FR and ES Operational Programmes + additional measures adopted at national level;
4. As for the baseline, we assume that the amount of discards of the species in Annex III of the MEDREG is unlikely to have impact.

OPTION 2. Establishing a multiannual plan

This option aims at ensuring that EU fishing fleets targeting demersal stocks in the Western Mediterranean Sea are regulated by a single, integrated management framework.

According to the STECF, the majority of the demersal stocks evaluated in the Western Mediterranean Sea show a worrying level of exploitation rate and would benefit from the implementation of a multiannual plan that would align current exploitation levels with the objectives of the CFP. The multiannual would also contain all aforementioned elements: the introduction of conservation objectives such as MSY, quantifiable targets (including ranges) and time-frames; the setting-up of safeguards, specifications of the technical measures; and the inclusion of provisions for implementing regionalisation and the landing obligation.

In addition, the multiannual plan would allow through regionalisation the introduction of specific technical measures for those fishing gears having a major impact on the most over-exploited stocks (e.g. technical measures aimed at decreasing catches of juvenile hakes). Additionally, the multiannual plan would introduce alternative conservation measures to ensure that the objectives set in the CFP are also respected for by-catch species.

Within this option there are a number of choices to be made: (i) the geographical scope; (ii) the species driving the fisheries for which precise MSY-related target ranges would be set; (iii) the time horizon for achieving Fmsy; and (iv) the management regimes.

The choice of the management regime presents three sub-options in which achieving Fmsy can be done through:

a) Capacity and effort limitations
b) Technical measures
c) Catch-limitations

To sum-up, **the scenario under Option 2 would be**:

1. Fishing mortality would be reduced for all fishing gears concerned by the exploitation of the target stocks;
2. The targets would be the lower and upper bounds of Fmsy;
3. We assume a 20% fishing capacity reduction in accordance with the IT, FR and ES Operational Programmes + additional measures adopted at national level (the same as Option 1);
4. As for the baseline, we assume that the amount of discards of the species in Annex III of the MEDREG is unlikely to have impact.
5. The three sub-options would pursue achieving Fmsy by limiting access to fisheries through: (a) Capacity and effort; (b) Technical measures and (c) TAC and quota

Table 3.1 - List of stocks for analysis.

Priority	GSA	3A_code	Scientific name	Ref year	Fcurr	FMSY	Fcurr/FMSY	Report	Year of advice
1	1_7	HKE	*Merluccius merluccius*	2014	1.40	0.39	3.59	STECF 15_18	2015
1	9_11	HKE	*Merluccius merluccius*	2014	1.10	0.20	5.50	STECF 15_18	2015
2	1	ARA	*Aristeus antennatus*	2014	1.40	0.41	3.41	STECF 15_18	2015
2	1	ANK	*Lophius budegassa*	2013	0.25	0.16	1.56	STECF15_06	2014
1	1	MUT	*Mullus barbatus*	2013	1.31	0.27	4.85	STECF15_06	2014
1	1	DPS	*Parapenaeus longirostris*	2012	0.43	0.26	1.65	STECF13_22	2013
2	5	ARA	*Aristeus antennatus*	2013	0.42	0.24	1.75	SAC 17	2014
2	5	ANK	*Lophius budegassa*	2013	0.84	0.08	10.50	STECF15_06	2014
1	5	MUT	*Mullus barbatus*	2012	0.93	0.14	6.64	STECF14_08	2013
1	5	DPS	*Parapenaeus longirostris*	2012	0.77	0.62	1.24	STECF13_22	2013
2	6	ARA	*Aristeus antennatus*	2014	0.75	0.36	2.08	STECF 15_18	2015
2	6	ANK	*Lophius budegassa*	2013	0.91	0.14	6.50	STECF15_06	2014
1	6	MUT	*Mullus barbatus*	2013	1.47	0.45	3.27	STECF14_17	2014
1	6	DPS	*Parapenaeus longirostris*	2012	1.40	0.27	5.19	STECF13_22	2013
2	7	ANK	*Lophius budegassa*	2011	0.97	0.29	3.34	STECF12_19	2012
1	7	MUT	*Mullus barbatus*	2013	0.45	0.14	3.21	STECF14_17	2014
2	9	ARS	*Aristaeomorpha foliacea*	2014	0.13	0.51	0.25	STECF 15_18	2015
1	9	MUT	*Mullus barbatus*	2013	0.70	0.60	1.17	STECF14_17	2014
1	9	DPS	*Parapenaeus longirostris*	2013	0.69	0.71	0.97	STECF15_06	2014
1	10	ARS	*Aristaeomorpha foliacea*	2014	0.91	0.65	1.40	STECF 15_18	2015
1	10	MUT	*Mullus barbatus*	2013	0.50	0.50	1.00	SAC 17	2014
1	10	DPS	*Parapenaeus longirostris*	2013	1.60	0.92	1.70	SAC 17	2014
1	11	ARS	*Aristaeomorpha foliacea*	2014	0.50	0.31	1.61	STECF 15_18	2015
1	11	MUT	*Mullus barbatus*	2012	1.07	0.11	9.73	STECF14_08	2013

Table 3.2 - Average landing ratios (data 2013-2014, in %) for certain demersal fisheries in the Western Mediterranean Sea. The fisheries have been identified by area, Member State, target species and fishing gear.

FISHERIES	HKE	MUX	MNZ	WHB	ARA	DPS	NEP	ARS	BOG	BRF	BSS	CTC	GFB	JOD	OCC	OCM	PAX	RPG	RSE	SBG	SKA	SOL	SQC	SRG	TGS
GSA1-ESP-DEMF-LLS	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**91%**	**5%**	0%	0%	0%	0%	0%	0%	0%
GSA1-ESP-DEMSP-GNS	**76%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**13%**	0%	0%	0%	0%	0%	0%	0%	0%	**11%**	0%
GSA1-ESP-DEMSP-GTR	**23%**	**14%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**9%**	0%	0%	**45%**	0%	**9%**	0%	0%	0%	0%	0%	0%	0%	0%
GSA1-ESP-DEMSP-OTB	**16%**	**16%**	0%	**10%**	0%	**10%**	0%	0%	0%	0%	0%	0%	0%	0%	**33%**	0%	**15%**	0%	0%	0%	0%	0%	0%	0%	0%
GSA1-ESP-MDDWSP-OTB	**5%**	**17%**	**4%**	0%	**18%**	**20%**	0%	0%	0%	**17%**	0%	0%	**20%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA2-ESP-DEMSP-OTB	0%	0%	**32%**	0%	0%	0%	0%	0%	0%	**9%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**59%**	0%	0%
GSA2-ESP-MDDWSP-OTB	0%	0%	**50%**	0%	**37%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**13%**	0%	0%
GSA5-ESP-DEMF-LLS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	0%	0%
GSA5-ESP-DEMSP-GNS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**25%**	0%	**75%**	0%	0%	0%	0%
GSA5-ESP-DEMSP-GTR	0%	**24%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**46%**	0%	0%	0%	0%	0%	0%	**30%**	0%	0%	0%	0%	0%	0%
GSA5-ESP-DEMSP-OTB	**7%**	7%	**20%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**43%**	**6%**	0%	0%	0%	0%	0%	0%	0%	**11%**	0%	0%
GSA5-ESP-MDDWSP-OTB	0%	**27%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**20%**	0%	0%	0%	0%	0%	0%	0%	**53%**	0%	0%
GSA6-ESP-DEMF-LLS	**22%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**43%**	0%	0%	0%	0%	0%	0%	**35%**	0%
GSA6-ESP-DEMSP-GNS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**10%**	0%	0%	0%	0%	0%	**17%**	0%	0%	**56%**	0%	0%	0%	**16%**	0%
GSA6-ESP-DEMSP-GTR	0%	**33%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**30%**	0%	0%	0%	0%	**12%**	0%	0%	**15%**	0%	**10%**	0%	0%	0%
GSA6-ESP-DEMSP-OTB	**27%**	**19%**	**13%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**9%**	**13%**	**13%**	0%	0%	**7%**	0%	0%	0%	0%	0%
GSA6-ESP-MDDWSP-OTB	**11%**	0%	**54%**	**35%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA7-ESP-DEMF-LLS	0%	0%	0%	0%	0%	0%	0%	0%	0%	**80%**	0%	0%	0%	0%	0%	0%	**20%**	0%	0%	0%	0%	0%	0%	0%	0%
GSA7-ESP-DEMSP-GNS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**16%**	0%	0%	**44%**	0%	0%	0%	**40%**	0%
GSA7-ESP-DEMSP-GTR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**52%**	0%	0%	**44%**	0%	4%	0%	0%	0%
GSA7-ESP-DEMSP-OTB	**9%**	**25%**	**21%**	**15%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**20%**	0%	0%	0%	0%	0%	0%	10%	0%	0%
GSA7-ESP-MDDWSP-OTB	**45%**	0%	**38%**	0%	**17%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA7-FRA-DEMSP-GNS	**30%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**70%**	0%	0%	0%	0%	0%
GSA7-FRA-DEMSP-GTR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**13%**	0%	0%	0%	0%	**42%**	0%	**46%**	0%	0%	0%
GSA7-FRA-DEMSP-LLS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**51%**	0%	0%	0%	0%	0%	0%	0%	0%	**49%**	0%	0%	0%	0%	0%
GSA7-FRA-DEMSP-OTB	**15%**	0%	**44%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**41%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA8-FRA-CEP-GTR	0%	**33%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**21%**	0%	0%	0%	0%	0%	0%	**46%**	0%	0%	0%	0%	0%	0%
GSA8-FRA-DEMF-GTR	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**24%**	0%	0%	0%	0%	0%	0%	**19%**	0%	0%	**19%**	0%	**30%**	0%
GSA8-FRA-DEMF-LLS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**36%**	**42%**	0%	0%	0%	0%	0%	**23%**	0%
GSA8-FRA-DEMF-OTB	**5%**	**21%**	0%	0%	0%	0%	0%	0%	**40%**	0%	0%	0%	0%	9%	0%	0%	**9%**	0%	0%	0%	0%	0%	**15%**	0%	0%
GSA8-FRA-DEMSP-GTR	0%	**17%**	**49%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**21%**	0%	0%	0%	0%	**14%**	0%	0%	0%	0%	0%	0%
GSA8-FRA-DEMSP-OTB	**45%**	**45%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**10%**	0%	0%
GSA9-ITA-DEMSP-GNS	**79%**	**15%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**6%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA9-ITA-DEMSP-GTR	0%	**47%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**35%**	0%	0%	**17%**	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
GSA9-ITA-DEMSP-OTB	**34%**	**24%**	0%	0%	0%	**2%**	**10%**	0%	0%	0%	0%	**1%**	0%	0%	0%	**20%**	0%	0%	0%	0%	0%	0%	1%	0%	**8%**
GSA9-ITA-MDDWSP-OTB	1%	0%	0%	0%	**22%**	**33%**	**35%**	1%	0%	0%	0%	0%	0%	0%	0%	**8%**	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA10-ITA-DEMF-LLS	**100%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA10-ITA-DEMSP-GNS	**58%**	**14%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**5%**	0%	0%	**9%**	0%	0%	0%	0%	0%	0%	**14%**	0%	0%	0%
GSA10-ITA-DEMSP-GTR	**54%**	**25%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**22%**	0%	0%	0%
GSA10-ITA-DEMSP-OTB	2%	**43%**	0%	0%	0%	**25%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**28%**
GSA10-ITA-MDDWSP-OTB	0%	**27%**	0%	0%	0%	4%	0%	**69%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA10-ITA-UNK-OTB	**11%**	0%	0%	0%	0%	**21%**	0%	33%	0%	0%	0%	**11%**	0%	0%	9%	**8%**	**7%**	0%	0%	0%	0%	0%	0%	0%	0%
GSA11-ITA-UNK-GNS	0%	**12%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**88%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA11-ITA-UNK-GTR	0%	**77%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	**23%**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GSA11-ITA-UNK-LLS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**26%**	0%	0%	0%	0%	0%	0%	**74%**	0%
GSA11-ITA-UNK-OTB	**12%**	**31%**	0%	0%	**12%**	0%	0%	**17%**	0%	0%	0%	0%	0%	0%	0%	**10%**	0%	0%	0%	0%	0%	0%	**18%**	0%	0%
AVERAGE	**15%**	**13%**	7%	1%	2%	3%	1%	3%	1%	2%	1%	7%	0%	2%	5%	2%	8%	3%	3%	7%	2%	2%	4%	5%	1%

3.3 Economic analysis of management options

STECF-EWG 16-02 was requested to assess the socio-economic effects of implementing the management options, by computing a set of socio-economic indicators like GVA, salary and employment.

The following text describes the methodology the EWG tried to use to carry out an economic analysis of the policy options, although, due to data limitations, it was not possible to implement (see section 9.2).

Nevertheless, the EWG considered it was important to report on this subject so that future analysis can build on this attempt. Note that this methodology doesn't deliver a bio-economic model. It's a sophisticated transformation of the ecological and fisheries indicators into socio-economic indicators, without considering the feedback mechanisms between the two parts.

The methodology is described in Figure 3.1. As an example, 3 fleets are assumed to exploit demersal resources in the case study area, where stock assessment data is assumed to be available for 3 of the main demersal stocks. Fleets are groups of homogeneous vessels for which economic, transversal and fishing mortality data are available (or can be estimated) for a number of years. In the DCF there are two concepts of fishing fleets, the 'economic' concept, which relates fleets with economic performance, in particular relates effort with costs, and the 'biological' which relates fleets with fishing power, relating effort with fishing mortality. These two concepts need reconciliation to be used in a context like the one described here (see Annex 07 for a methodology to reconcile both information).

As the management system in the Mediterranean is mainly based on effort restrictions, management measures are assumed to modify activity (limitations on average days at sea or other measure of time per vessel) and/or capacity (number of vessels or other measure of capacity, like GT or KW). Specific management measures can be directed to each fleet segment involved in the fisheries under analysis.

A measure of nominal fishing effort by fleet segment is obtained by multiplying the corresponding values of the two management variables. When the two management variables are average days at sea per vessel and number of vessels, nominal effort is the total number of days at sea by fleet segment.

As reported in the TORs, the objective of the management plan is expressed in terms of a target for the fishing mortality of one or more stocks, that target being the fishing mortality at MSY. Fishing mortality cannot be directly modified by managers but through changes in the fishing activity and capacity of the fleet. To this end, a functional relationship between fishing mortality and effort variables is needed.

In Figure 3.1 , fishing mortality by stock (F.j, where j is index for stock) is split into partial fishing mortality by stock and fleet segment (Fij, where i is index for fleet segment). In optimal conditions, the partial fishing mortalities would be computed using the age structure of the catches of each fleet, to take into account differences between fleet's selectivity. A relationship between partial fishing mortality by stock and fleet segment and nominal fishing effort by fleet segment is assumed.

Given the assumptions described above, a change in fishing mortality (F.j) for the stock j can be translated into changes in partial fishing mortality for the same stock and for each fleet segment (Fij), and consequently into changes in nominal fishing effort Ei for each fleet segment. At the same time, the variations in nominal fishing effort Ei will be translated into variations in the partial fishing mortality for the other two stocks. As expected in mixed fisheries, changing the fishing mortality for a stock would produce changes in the fishing mortality also for the other stocks exploited in the same fishery.

Allocating changes in fishing mortality for the stock j, F.j, across the different fleet segments, Fij, is a management decision, as well as splitting the changes in fishing effort between activity and capacity. Although the first is usually taken at the government level, while the later remains within the business level. As reported above, nominal fishing effort can be expressed as the product of average days at sea per vessel (dd) and the number of vessels (N). Different combinations of activity and capacity would produce different effects on socio-economic indicators.

As described in Figure 3.1 , changes in activity would affect variable costs; while changes in capacity would affect the number of employees, the fixed costs, and the variable costs, as a reduction in the fleet produces also a reduction in the total days at sea. A description of the trade-offs between activity and capacity changes and their different effects on economic indicators are reported in section 5.5.2.

Once partial fishing mortalities are estimated for all combinations of stocks and fleet segments, these can be used together with other inputs (biomass, selectivity parameters, growth parameters, etc.) to estimate the levels of catches by stock and fleet segment. Catches can be converted in landings by using proportional coefficients estimated on time series data, and landings can be used to estimate revenues by stock and fleet segment. Revenues can be calculated by multiplying landings by price. To this end, a price dynamic model can be used. More details on this issue are reported in Annex 06.

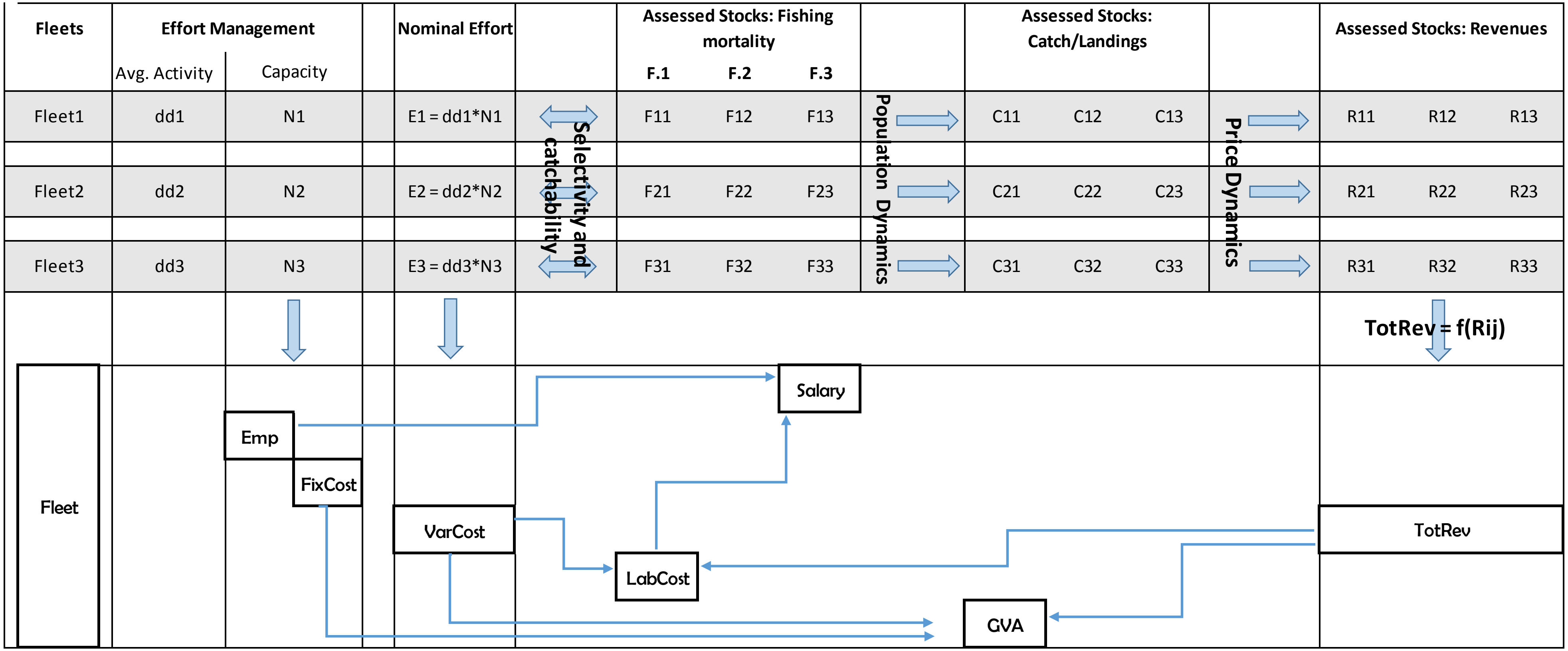
As reported above, changes in fishing activity and capacity would affect number of employees, fixed costs and variable costs. Another important variable useful to estimate socio-economic indicators is total revenues. Revenues by stock and fleet segment are not sufficient to calculate total revenues because of the great number of stocks exploited in demersal fisheries and the limited number of stocks assessed and included in the model for simulation. The revenues by fleet segment obtained by adding the values of the three stocks would represent just a fraction of the total revenues of the fleet segment.

The estimation of total revenues in bio-economic modelling for the demersal fisheries in the Mediterranean is a known problem. Some modelling solutions suggested in models like MEFISTO (Annex 11) and BEMTOOL (Annex 01) consist in using functional relationships between total revenues and revenues from assessed stocks. When the fraction of total revenues represented by the revenues from assessed stocks is quite stable over time, the remaining part of revenues (and landings) for each fleet segment can be estimated by a linear relationship. Other solutions consist in estimating the landings of non-assessed stocks as a linear or non-linear function of the landings of assessed stocks and multiplying by an average price for that group of species calculated on time series data.

Given the values for total revenues and variable costs, it is possible to estimate labour costs. This variable for Mediterranean fisheries is generally calculated by applying a crew share (which is generally around 50%) to the difference between total revenues and variable costs. The use of this approach is supported by the prevalence of the share contract among the working contracts adopted for the fishing sector in the Mediterranean countries.

An important indicator from a social point of view is the level of salaries in the sector. This can be calculated by dividing the labour cost by the number of employees. Both variables are available in the model structure.

The economic performance of the fleet segment can be measured through the gross value added. This indicator is given by the difference between total revenues and the sum of variable and fixed costs.



Legend:
dd: average days at sea or other measure of time
N: number of vessels or other capacity variable
E: nominal fishing effort
F: fishing mortality;
C: catch or landings
R: revenues
Emp: Number of employees
FixCost: fixed costs
VarCost: variable costs
LabCost: labour costs
Salary: Labour costs per employee
TotRev: Total revenues per fleet
GVA: Gross Value Added

Figure 3.1 - A mixed fisheries socio-economic model structure

4 DATA AND METHODS

4.1 Addressing the ToR

The EWG used several sources of data (section 4.2) to put together the necessary modeling methods to gain insights about the fisheries and test the management options required.

4.1.1 ToR 1

The management options were tested using a set of scenarios, which reflected the management options and the natural uncertainty, within a management strategies evaluation (MSE) context. The analysis was based on the MSE used in previous EWGs (STECF 2015b) and the a4a stock assessment model, both developed by the JRC's a4a Initiative (https://fishreg.jrc.ec.europa.eu/web/a4a, Jardim *et.al*, 2015, Millar *et.al*, 2015, Scott *et.al*, 2016), using the FLR framework (Kell *et.al*, 2007). The MSE results were used to compute the fisheries and biological indicators defined in the ToRs.

The socio-economic indicators GVA and salary were not possible to compute due to data limitations (see section 9.2). The EWG explored the use of a methodology similar to the one described in section 3.3 but after exploring the links between economic information and stock assessment results (see section 9.2) it concluded the inconsistencies were too high to carry on with that approach. Nevertheless, a discussion about the potential impacts of management options in GVA and salaries is presented in section 5.5.2.

With regards to employment the EWG followed a similar approach to previous EWG (STECF, 2015a,b,c), which combined employment levels with fleet dependency as a way to highlight potential social problems.

4.1.2 ToR 2

This ToR used previous advice given by STECF (STECF 2015d,e) adjusted to the Northwestern Mediterranean.

4.1.3 ToR 3

The results obtained by STECF EWG 15-14 and EWG 16-04 were analysed in light of the current ToRs, namely the list of stocks to be included in the MAP.

4.1.4 ToR 4

The indicator required by the ToRs was not possible to compute due to data limitations (see section 9.2). In alternative an indicator based on the value per unit of fishing mortality was computed, which allowed some insights into the potential recovery of the economic performance of the fleets.

4.1.5 ToR 5

A description of the data gaps found and inconsistencies across datasets, in the context of the methods used by the EWG is presented.

4.2 Data sources

The data available to carry out the analysis were:

- STECF Mediterranean stock assessments[6]: stock assessment results and input data;
- Mediterranean biological 2016 data call[7]: landings and catches in weight and numbers;

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[6] JRC database version 26/07/2016

- Annual economic report data call[8]: transversal variables (effort, capacity and landings in weight and value) and economic variables.

It's important to note that these datasets have different levels of aggregation, which makes them largely incompatible. Table 4.1 shows the differences among datasets.

Table 4.1 - Aggregation level of the datasets used by the EWG.

Aggregation level	Stock assessments	Mediterranean datacall	AER datacall (transversal variables)	AER datacall (economic variables)
Stock	X	X		
Species		X	X	
Fleet segment (biological)		X	X	
Fleet segment (economic)			X	X
GSA	X	X		
Member state		X	X	X
Mediterranean			X	X

Modelling procedures may align the data so that it can be used for more in depth analysis, as long as some points of contact exist, for example consistent landings by stock and fleets (see method used in Annex 07). Nevertheless, the gaps in the data and inconsistencies on stocks landings/catches across datasets limited the EWG analysis (see section 9 for more details).

4.3 Scenarios

The simulation study, using Management Strategies Evaluation (MSE), used a set of scenarios that represent the management options set by DGMARE in the ToRs. These constitute the set of alternative management systems under discussion. The EWG named these scenarios as "management scenarios".

A second set of scenarios were developed to represent the uncertainty in the system. The uncertainty in the stocks behaviour, embedded in the stock-recruitment relationship, and the uncertainty on the fleets' behaviour, included in the "hyperstability" mechanism. These scenarios were named "operating model scenarios".

Additionally, it was also tested the effect of implementation error, although due to lack of information to parametrize this effect only variance in the implementation was considered, not bias.

All together management options accounted for 59 scenarios, operating model for 4 and implementation error for 2, adding up to 472 scenarios for each stock, to a total of ~9000

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[7] https://datacollection.jrc.ec.europa.eu/c/document_library/get_file?uuid=8ae93bce-1cbc-4e3f-a505-938f8bd34046&groupId=10213

[8] https://datacollection.jrc.ec.europa.eu/c/document_library/get_file?uuid=7bf799bd-797e-4c71-8ec3-b86f7d3c9b07&groupId=10213.

scenarios. These were obviously impractical to run and analyse, and were trimmed down based on initial runs and how well some of the effects were understood. For example, having different time frames to recover a stock was not necessary.

4.3.1 Management scenarios

TOR 1 describes three management options to be evaluated: *Baseline*, *Amendment* and *Plan*. The *Plan* option includes three sub-options representing different management regimes: Capacity and effort limitations, technical measures and catch limitations. As technical measures cannot operate as a standalone regime, it is treated as an additional option for the effort and catch limitations regimes. Furthermore the biomass safeguard mechanism was included for the options *Amendment* and *Plan*.

For the *Plan* option a "envelope" approach was used. Such approach considers the potential consequences of fishing at the extremes (upper and lower) of the FMSY ranges, to simulate both high and low exploitation cases, and thereby inform managers on the range of potential outcomes of alternative tactical management decisions, without giving advice about the 'best' way to get to the target. Note that in this approach each scenario has two management options that lead to two simulations:

- Fupp - exploiting the stock at the upper boundary of the FMSY ranges,
- Flow - exploiting the stock at the lower boundary of the FMSY ranges

For more details about the envelope approach see STECF (2015a).

From these management options, 19 management simulation scenarios were derived to cover the sub-options of the three options (Table 4.2). The management scenarios are based on either effort management (*Baseline*, *Amendment* and *Plan*) or TAC management (*Plan* only). *Technical measures* is considered to be a sub-option of the *Plan* scenarios rather than a distinct management type.

Table 4.2 - Management scenarios

Option	Type	Target	Technical Measures	Biomass safeguard
1. Baseline	Effort	FSQ	FALSE	FALSE
2. Amendment	Effort	Fmsy	FALSE	FALSE TRUE
3. Plan	Effort	Flow	FALSE	FALSE TRUE
	Effort	Flow	TRUE	FALSE TRUE
	Effort	Fupp	FALSE	FALSE TRUE
	Effort	Fupp	TRUE	FALSE TRUE
	TAC	Flow	FALSE	FALSE TRUE
	TAC	Flow	TRUE	FALSE TRUE
	TAC	Fupp	FALSE	FALSE TRUE
	TAC	Fupp	TRUE	FALSE TRUE

In addition to the scenarios described above, two scenarios were added, which deal with the potential hyperstability of the fleets involved (Table 4.3). By hyperstability it was understood as the capacity of the fleet to avoid decreasing F proportionally to effort, which would allow the CPUE to be stable while the effort decreases. The options tested represent alternative ways of dealing with hyperstability, and try to show that it is possible to deal with process in a management context. They don't represent solid management alternative proposals. These options were applied only to effort regimes.

Finally, two more scenarios were added to test the effect of having a stock assessment model informing the decision making process. These scenarios were dropped later due to the large number of scenarios being tested, 700+. The scenario where a stock assessment model is used was kept.

Table 4.3 - Additional management scenarios

Effort correction	Stock assessment
None	TRUE
	FALSE
Intermediate year correction.	TRUE
	FALSE
Implementation correction.	TRUE
	FALSE

4.3.2 Operating model scenarios

The operating model uncertainty was based on the productivity of the stock and the capacity of the fleet to keep high yield with decreasing effort, hyperstability, which only apply when effort management is in operation, it does not apply for the TAC management type. Table 4.4 summarizes these scenarios.

Table 4.4 - Operating model scenarios

Operating model	Hyperstability	Stock recruitment
GM	FALSE	Geometric mean
GM & Hyp	TRUE	Geometric mean
BH	FALSE	Beverton & Holt
BH & Hyp	TRUE	Beverton & Holt

4.4 MSE

Management Strategies Evaluation (MSE; Butterworth et al., 1997, Cooke, 1999, Butterworth and Punt, 1999,Kell et al., 2005 and Punt and Donovan, 2007) were used to test the management options required in the ToRs. The analysis was carried out using methods developed by the JRC's a4a Initiative. A detailed description of the methodology is presented in Annex 03, including the conditioning of operating models, except recruitment deviates, which are described in Annex 08. Two stock-recruitment models were fitted, a Beverton & olt and a geometric mean, both with lognormal residuals. One set of residuals with independent draws and another with a 1 year lag correlation level of 0.8.

4.4.1 Reference points

Annex 03 and Annex 09 explain how the reference points were derived. For reference Table 4.5 presents the results obtained and used by the EWG.

Table 4.5 - Reference points for the stocks considered in this study. Fmsy and Blim is taken from stock assessment EWGs. Flow and Fupp refer to the lower and upper boundaries of the Fmsy ranges. Bpa refers to the precautionary biomass level.

Stock	Fmsy	Flow	Fupp	blim (t)	Bpa (t)
ANK 05	0.08	0.06	0.12	8.2	16.0
ANK 06	0.14	0.10	0.20	388.5	761.4
ARA 01	0.41	0.27	0.56	224.4	439.9
ARA 06	0.36	0.24	0.49	1018.2	1995.6
ARS 09	0.51	0.34	0.70	78.9	154.6
ARS 10	0.65	0.43	0.88	654.5	1282.7
ARS 11	0.31	0.21	0.43	25.5	50.0
DPS 01	0.26	0.17	0.36	79.8	156.3
DPS 05	0.62	0.41	0.84	2.4	4.8
DPS 06	0.27	0.18	0.37	113.4	222.3
DPS 09	0.71	0.47	0.97	403.0	789.9
HKE 01050607	0.39	0.26	0.53	5100.0	9995.8
HKE 091011	0.20	0.14	0.28	2215.6	4342.6
MUT 01	0.27	0.18	0.37	191.1	374.6
MUT 05	0.14	0.10	0.20	25.0	49.0
MUT 06	0.45	0.30	0.62	559.7	1097.0
MUT 07	0.14	0.10	0.20	409.8	803.3
MUT 09	0.60	0.40	0.82	1919.6	3762.3
MUT 11	0.11	0.08	0.16	94.4	185.0

4.4.2 Mid term options

The stock assessments used were not all carried out in the same year. As such the most current year in the assessments was not the same. Additionally, the ToR specifically required to project 2017, taking into account the 2016 agreement of reducing the trawl fleet’s capacity in 20%.

To accommodate the above features, the EWG projected the stocks status up to 2016 in status quo, where fishing mortality was the average of the three previous years, followed by a projection of 2017 including a 20% decrease in the trawl fleets partial fishing mortality. The EWG computed the average catches of trawl and non-trawl fleets in the last 3 years (Table 9.2), and used these percentages to simulate the 20% reduction. A better approach would have been to compute partial fishing mortalities using the catch-at-age information, which would take into account the selection pattern of the fleets. This approach would have been more adequate since the selectivity of the trawl fleets and the non-trawl fleets can be very distinct. Nevertheless, the data inconsistencies between the stock assessment catches and the catches reported through the Mediterranean data call did not allow the approach to be applied (see section 9.1).

5 ToR 1

5.1 Main management elements

In this section we use the results from hake in GSAs 1, 5, 6 and 7 to explore the multitude of management and operating model combinations. 736 scenarios were run.

5.1.1 Effort management scenarios

Here we investigate the behaviour of the effort management scenarios, used in all three management options: *Baseline*, *Amendment* and *Plan*.

Initially, we do not consider the impact of effort correction, hyperstability, technical measures, implementation error, biomass recovery or stock assessment. This can be considered to be the ideal case with perfect knowledge and implementation. The Plan scenario has two $Fmsy$ scenarios ($Fupp$ and $Flow$). Only the geometric mean stock recruitment relationship (SRR) is considered here for clarity. The uncertainty is a result of the stock recruitment residuals.

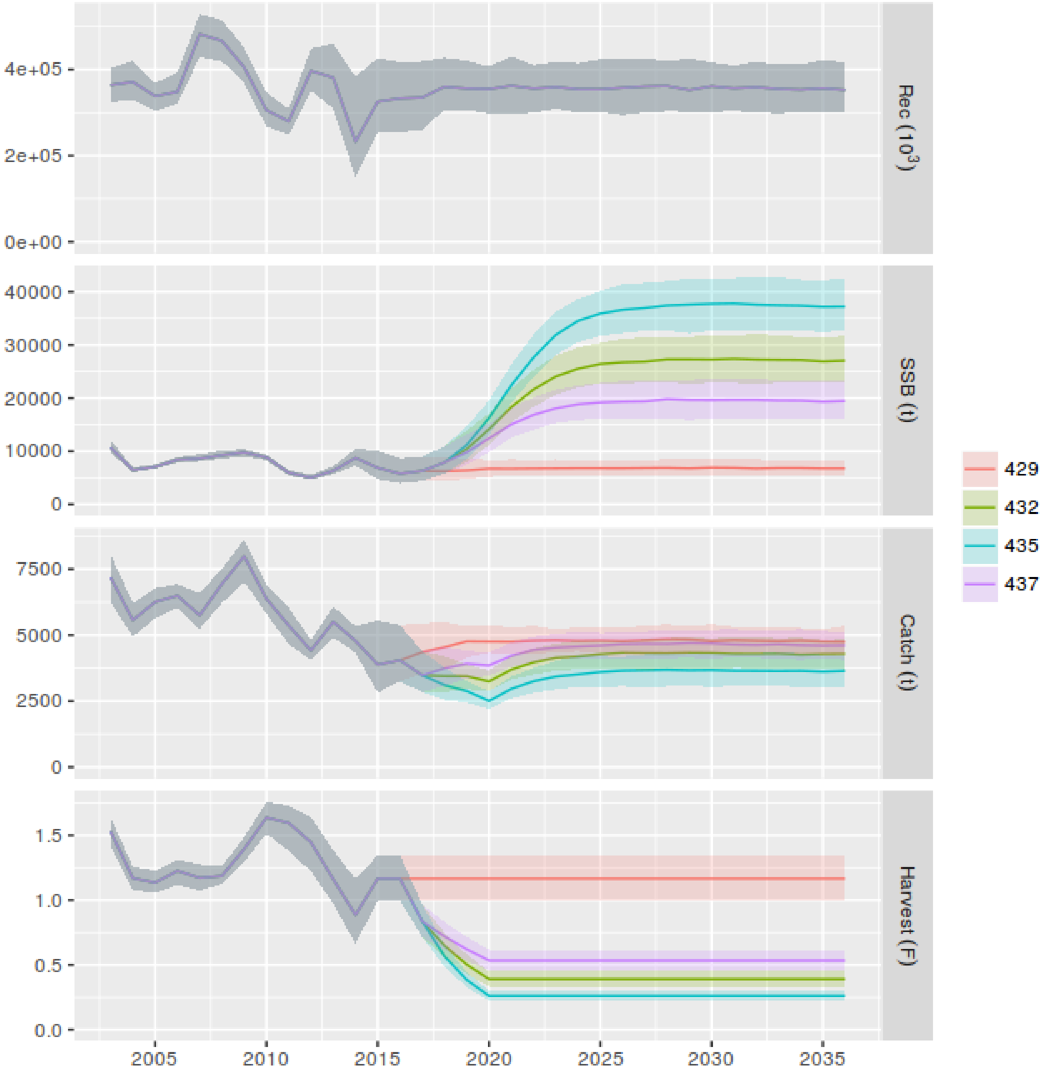


Figure 5.1. The effort management options: baseline (429), amendment (432) and plan (435 and 437). Recruitment, SSB, Catch and fishing mortality (Harvest) trajectories for hake in combined on hake in GSAs 1, 5, 6 and 7.

The Baseline scenario (429) maintains the F at the current level (the mean of F in 2014 to 2016). The Amendment (432) and Plan (435 and 437) scenarios each show a drop in F in 2017 as a result of the 20% cut in capacity. They then reach the target F ($Fmsy, Fupp$ and $Flow$)) in 2020 by decreasing F by the same proportion in each year.

5.1.2 Hyperstability

A key issue in effort management is hyperstability (a non-linear relationship between fishing effort and F). With hyperstability, a decrease in fishing effort does not result in a similar proportional decrease in F. If a linear relationship between fishing effort and F is assumed and hyperstability exists, the realized F will be higher than expected.

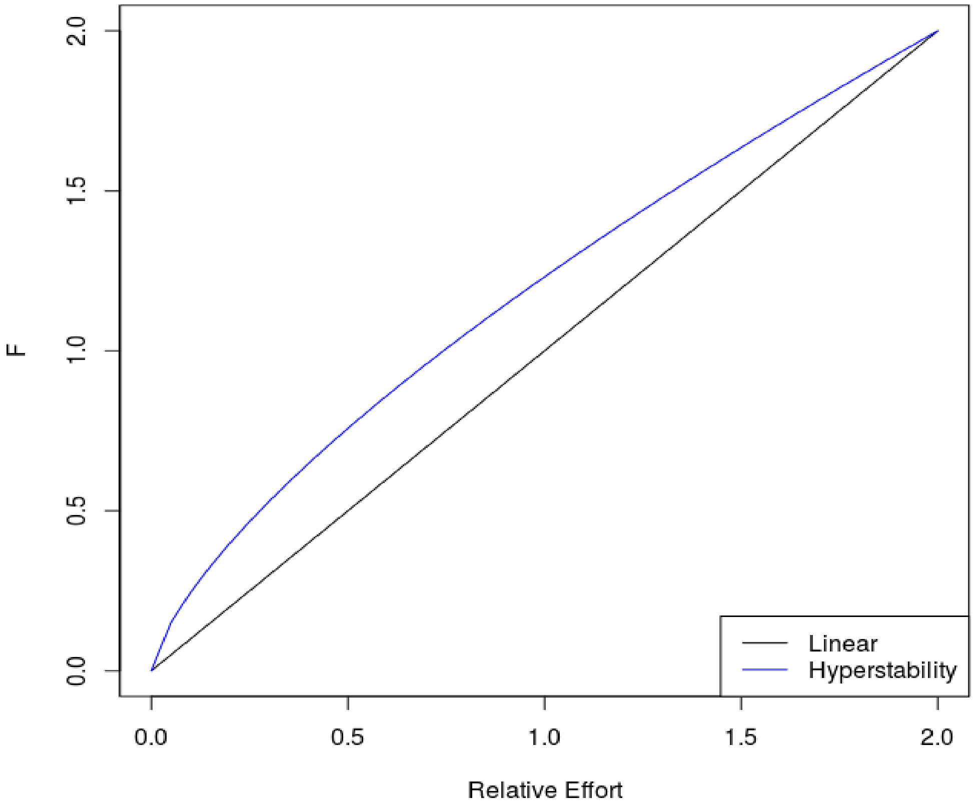


Figure 5.2 - Hyperstability in the effort and F relationship.

Relative effort and F relationships for the linear and hyperstability cases

We use the Amendment (Option 2) management scenario to illustrate the impact of hyperstability. Two scenarios are shown, one with and one without hyperstability. Again, all simulation options (stock assessment, implementation error etc.) are turned off.

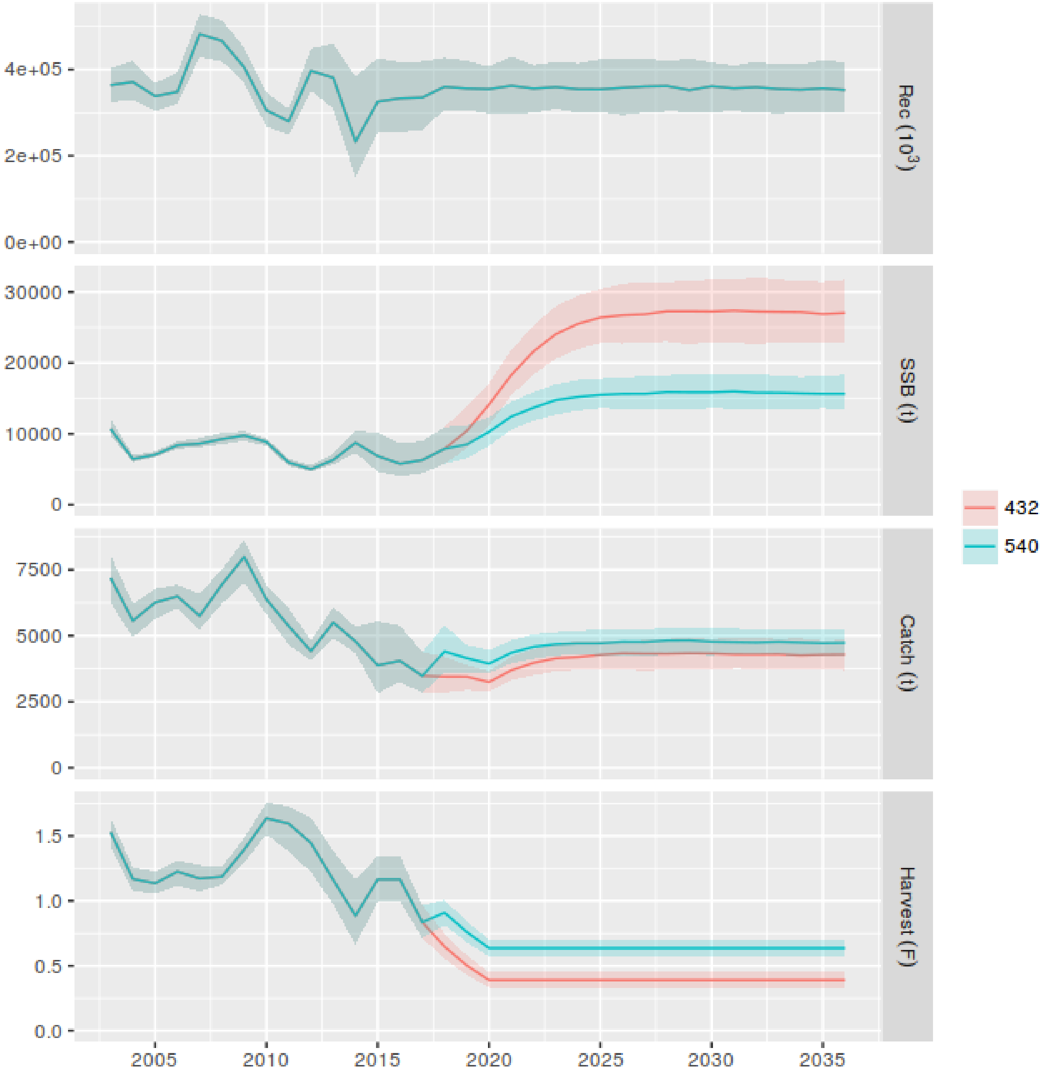


Figure 5.3. Impact of hyperstability. Two effort scenarios are shown: with hyperstability (540) and without (432) on hake in GSAs 1, 5, 6 and 7.

The scenario without hyperstability (432) performs as expected with the realised F following a path to FMSY by 2020. When hyperstability exists (540), the realised F is consistently higher than the target F. The fishing effort is being decreased but the resulting decrease in F is proportionally smaller.

5.1.3 Hyperstability correction

It is possible for managers to attempt to correct for the effect of hyperstability by anticipating its likely impact and adjusting the effort accordingly to achieve the desired F. Here two methods have been implemented: *implementation correction* and *intermediate year correction*. Both methods use the perception of the stock, possibly generated from a stock assessment, to adjust the projected effort in an attempt to get the target F.

The *implementation correction* method is based on the median difference between the target and the perception of what happened. The *intermediate year correction* method uses the perceived F in the previous year to update the target F in the following year.

The performance of the correction methods can be seen when hyperstability is introduced. Four scenarios are shown, including both correction methods when hyperstability is present and no correction with and without hyperstability. For the effort correction scenarios, the perceived stock is not based on a stock assessment and assumes perfect knowledge.

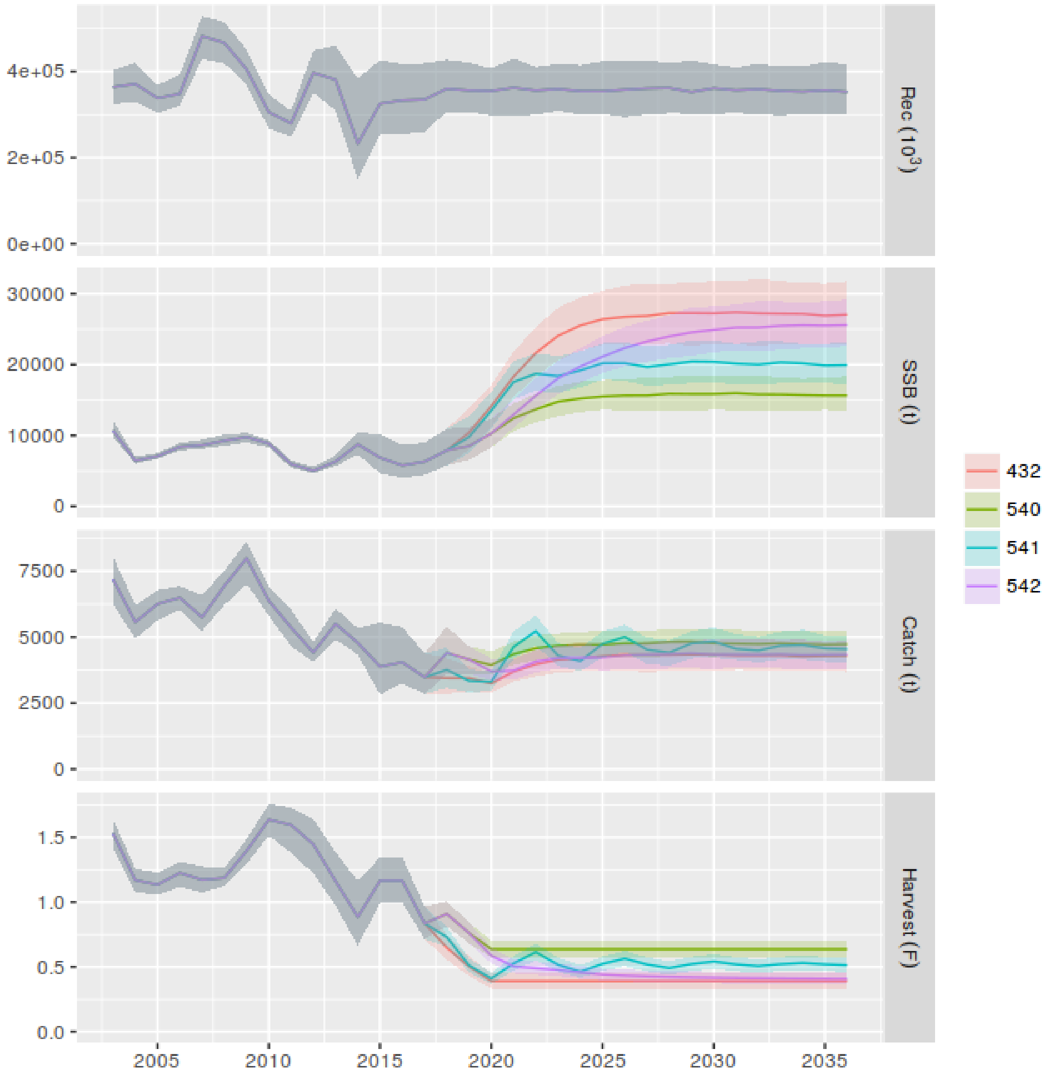
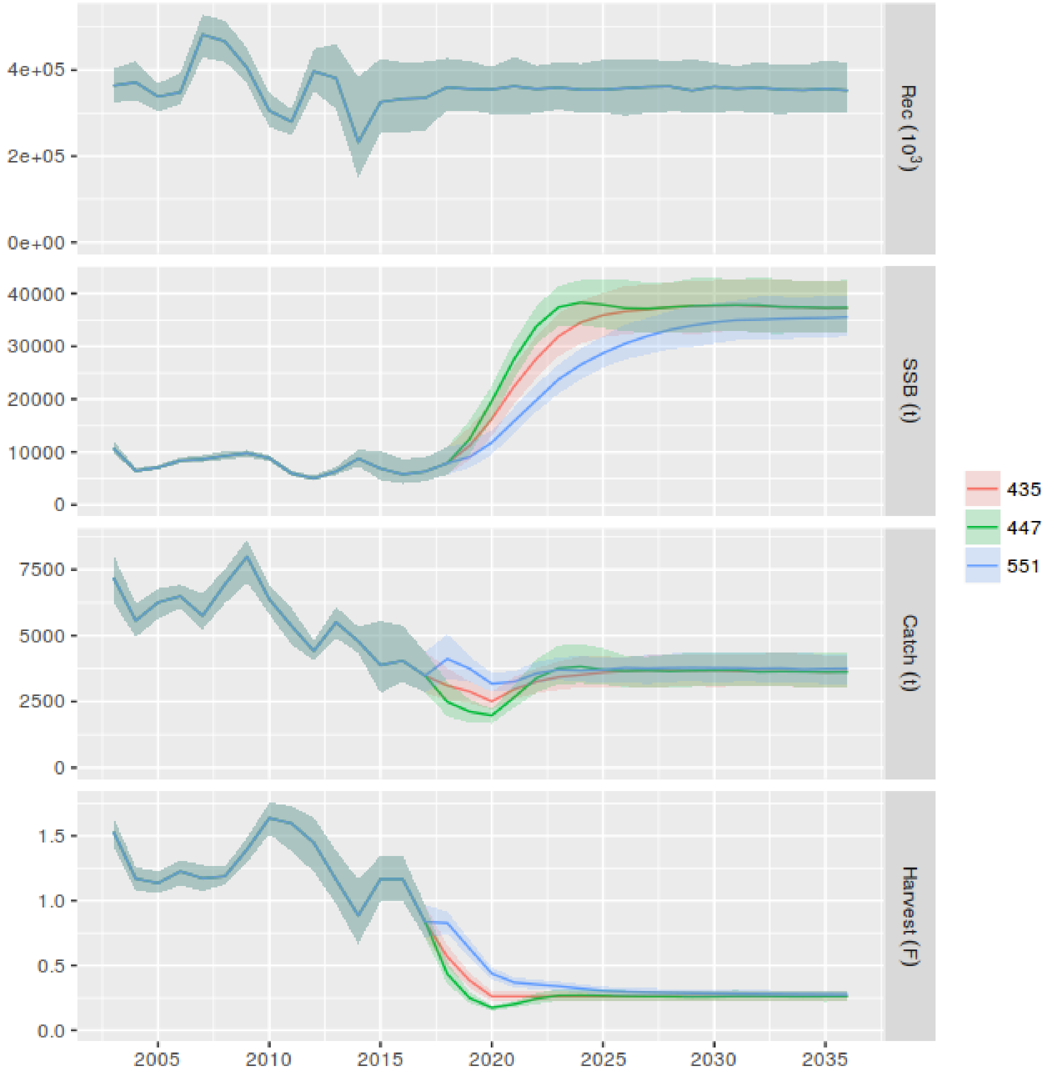


Figure 5.4. Hyperstability correction. Implementation correction (542), intermediate year correction (541), no correction (540) and no hyperstability(432) on hake in GSAs 1, 5, 6 and 7.

When hyperstability is present and there is no correction (540), the realised F is greater than the target F (as we saw in the previous example). With the *implementation correction* (542), the realised F slowly approaches the target F as the correcting method updates itself. The *intermediate year correction* is less stable and tends to oscillate around an F level that is above the target F but is still closer to the target F than when hyperstability is present but not corrected for. The scenario without hyperstability is also included for comparison (432).

5.1.4 TAC management

Here we compare the performance of the TAC management regime to that of effort management. Two effort management scenarios are shown, one without hyperstability and one with hyperstability and the implementation correction method. The TAC management type option only operates in the Plan scenario and is unaffected by the presence of hyperstability. The TAC management regime is part of the Plan management option which has two possible $Fmsy$ targets.



Here we only show the $Flow$ target. All other simulation options are switched off.

Figure 5.5. TAC implementation. TAC scenario (447), effort correction (551) and no hyperstability (435) on hake in GSAs 1, 5, 6 and 7.

All three scenarios eventually reach the $Flow$ target but their trajectories are different.

The TAC management scenario (447) approaches the target F faster than the corrected effort scenario (551) and the effort scenario without hyperstability (435). This results in lower catches in the initial years of the simulation. However, the TAC scenarios slightly overshoots the target. This pattern is a result of the lag inherent in a TAC system. Setting the TAC in the following year requires a short term forecast of 2 years to be made, starting from the previous year (the last data year). This forecast requires assumptions about the intermediate year to be made. The difference between the assumptions and the reality creates this discrepancy.

5.1.5 *Technical measures*

The technical measures option only applies to the Plan scenario. In the simulations the selection pattern is adjusted to reflect the technical measures. The selectivity on the first age was decreased and increased on the other ages.

Here we compare the effort scenario without hyperstability, with and without technical measures.

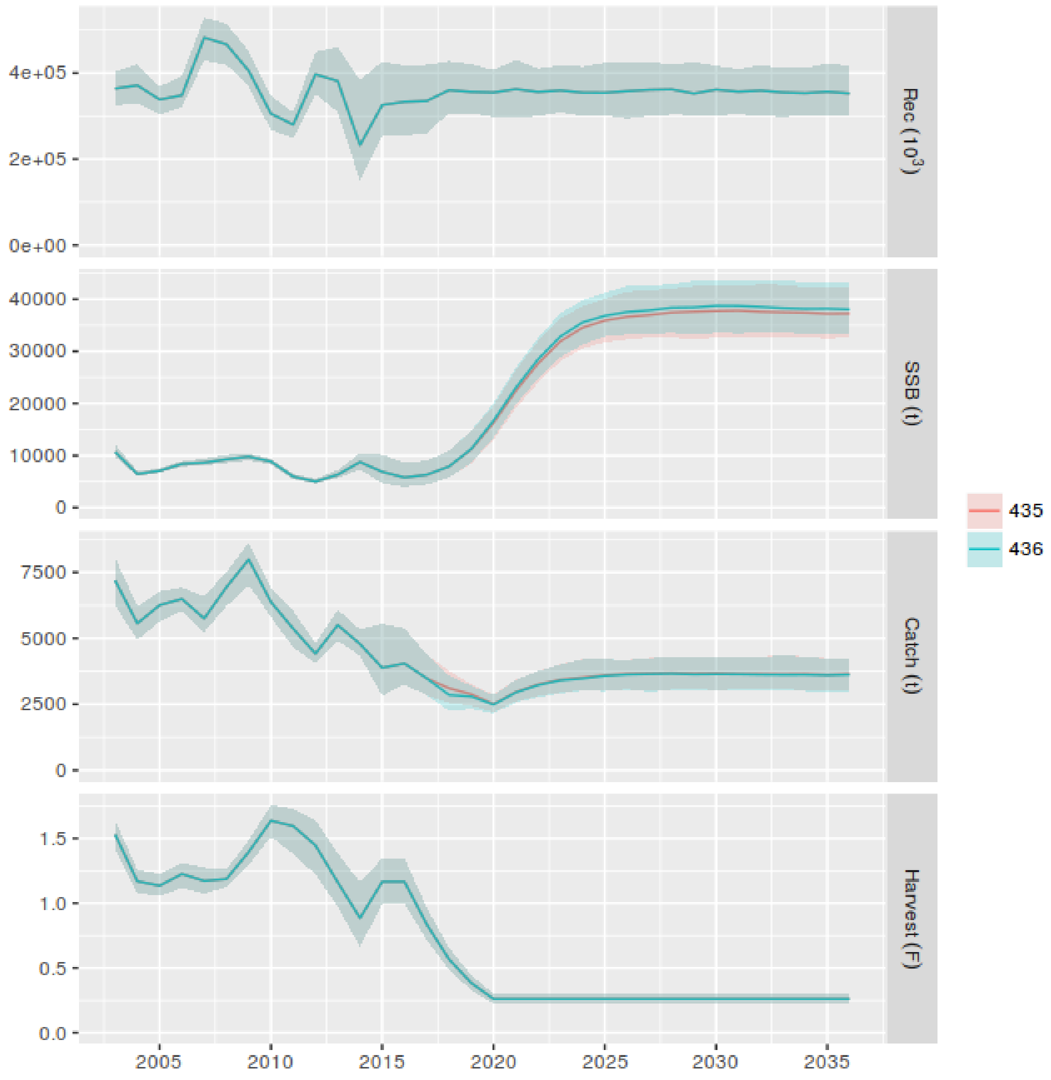


Figure 5.6. Impact of technical measures. With technical measures (436) and without technical measures (435) on hake in GSAs 1, 5, 6 and 7.

The only difference between the scenarios show here are the presence (436) or absence (435) of technical measures. The difference in the realized F and catches is very small. This is because for this stock the F on the first age is a very small proportion of the total mortality, Z (natural mortality, m, is high). When the technical measures are implemented the F on the first age is reduced but Z is largely unaffected. This means that the dynamics are essentially unchanged. However, the impact of technical measures on other stocks may be bigger, depending on the selection pattern and the resulting F-at-age.

In these simulations the $Fmsy$ reference point was not updated when technical measures are implemented, even though the shift in the selection pattern will result in different reference points. However, considering that the reference points will be written in the regulation our approach assumes that changing those references will not be immediate.

5.1.6 Stock assessment

Both the effort correction and TAC scenarios use the perceived stock to hit the target F. In the examples so far, no stock assessment has been performed as part of the management procedure and the perceived stock has been the same as the true stock (perfect knowledge was assumed). Here we show how having imperfect knowledge of the true state of the stock affects the performance of the scenarios.

Four scenarios are show, two that use TAC management and two that use effort management with hyperstability and effort correction. A stock assessment is either used to generate the perceived stock, or perfect knowledge is assumed.

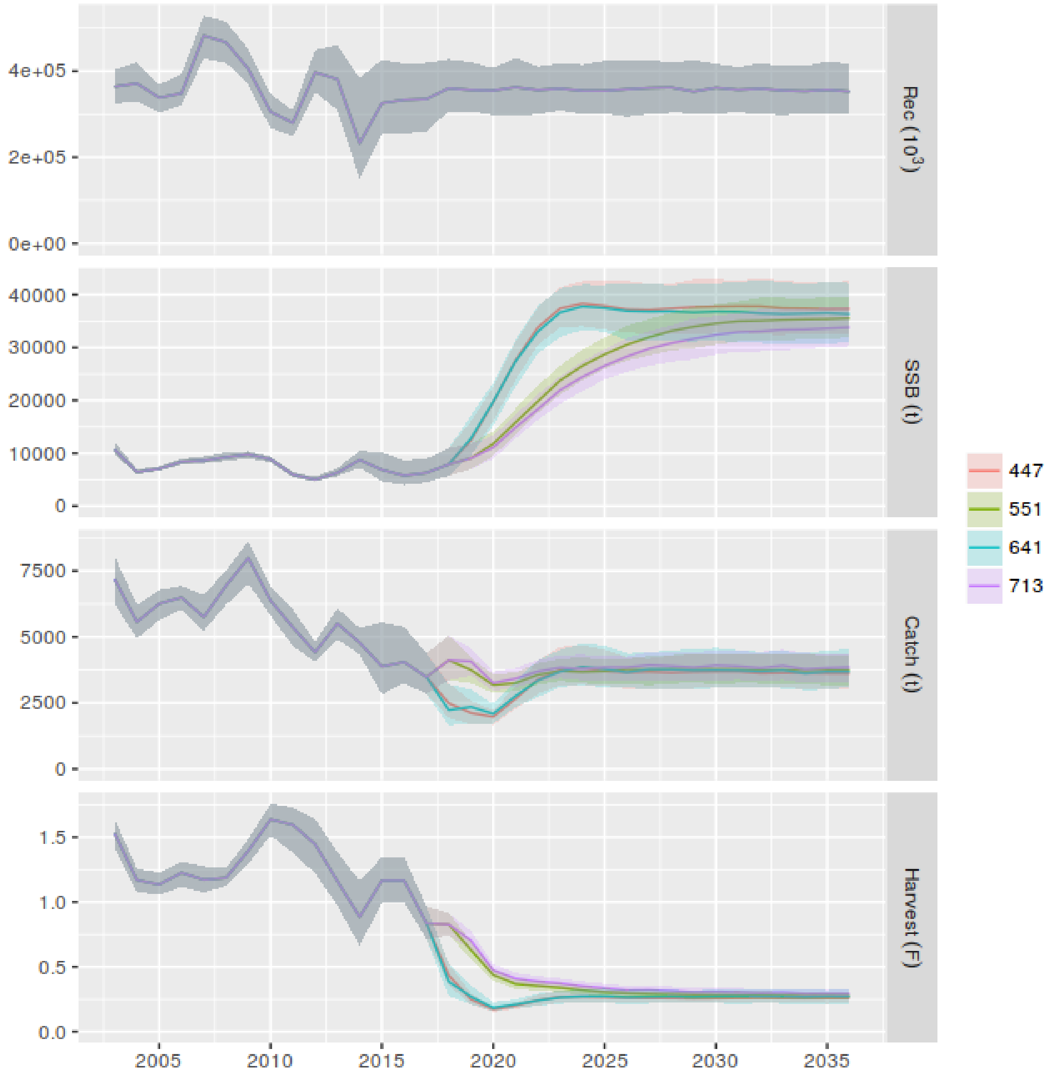


Figure 5.7. Using a stock assessment to generate the perceived stock. Effort management with a stock assessment (713) and without (551). TAC management with a stock assessment (641) and without (447) on hake in GSAs 1, 5, 6 and 7.

Using the stock assessment causes the uncertainty to increase for both the effort (551 without the assessment and 713 with the assessment) and TAC scenarios (447 without the assessment and 641 with the assessment), in particular on the most recent years estimates of fishing mortality, which have a large impact on our perception of the stock status and, as such, on the decisions made.

In the real world some kind of stock assessment has to be run as we cannot know the true state of the stock. However, using a stock assessment can cause large instabilities, particularly when the required decrease in F is very large and the time frame to achieve it very short.

5.1.7 Implementation error

Implementation error is the difference between the target set by management and what is actually implemented by the fishing fleet. There is no bias in the implementation error and lognormal noise is used.

Here we look at the *Plan* management option with effort management, hyperstability and effort correction.

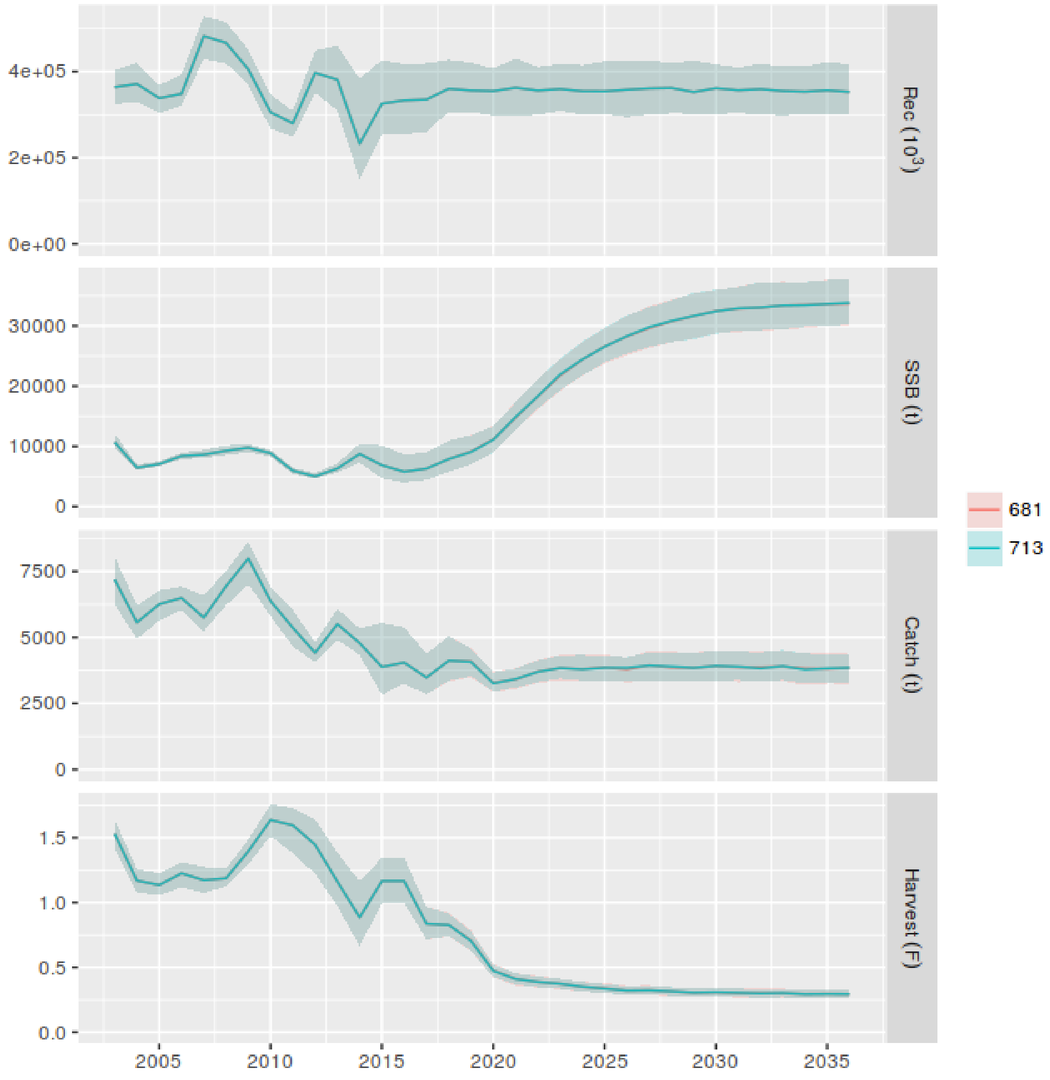


Figure 5.8. Impact of implementation error (681) and without implementation error (713) on hake in GSAs 1, 5, 6 and 7.

The difference between having implementation error (681) and not (713) is small. The uncertainty that these stock assessments show is already very large (due to residuals on the stock recruitment relationship and the interactions of the effort correction) and the implementation error was set to a small value (5% CV). However, there’s no information to parametrize the implementation model and the chosen CV seemed reasonable.

5.1.8 Biomass safeguard recovery timeframe

When the biomass drops below the safeguard limit (Bpa), a recovery plan may be implemented. This aims to decrease F to a safe level over period of 5 or 10 years. The current implementation assumes that the recovery F takes precedence over the management F. This may actually result in a higher F being set as the recovery F takes place over 5 or 10 years instead of the 3 years to reach $Fmsy$ in 2020.

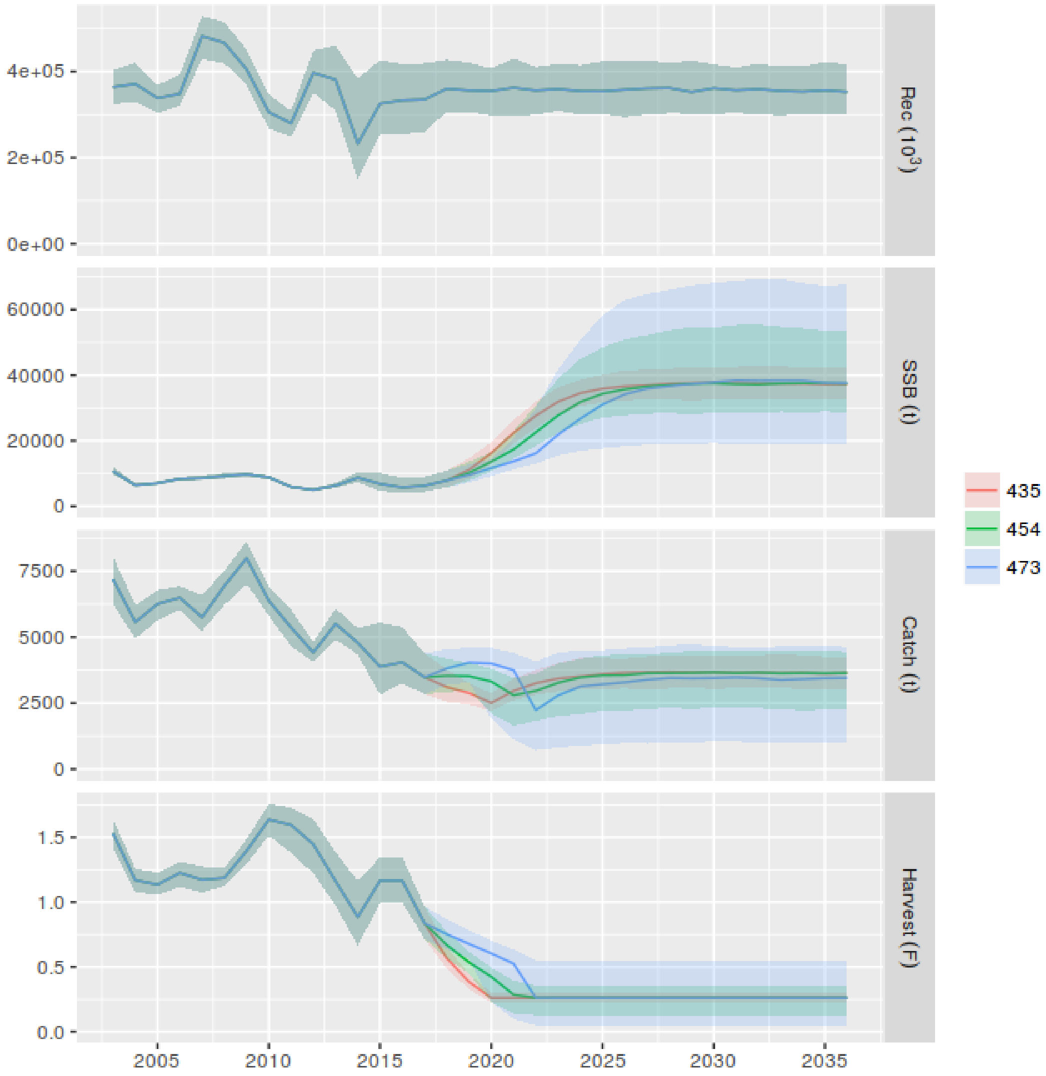


Figure 5.9. Biomass safeguard recovery plan of 5 years (454), 10 years (473) and without a plan (435) on hake in GSAs 1, 5, 6 and 7.

With no biomass recovery plan (435) the F decrease is faster than a 5 year recovery (454) which is faster than a 10 year recovery (473). The recovery Fs take precedence over the management Fs. The recovery plan also increases the uncertainty in the simulated results.

An alternative to the recovery F taking precedence is still to implement the recovery safeguard but take the minimum of the management and recovery Fs.

5.1.9 SRR

Two stock recruitment relationships are available for the simulations: a fitted Beverton-Holt relationship, estimated from the perceived SSB and recruitment, and a geometric mean based on the perceived recruitment time series. The Beverton-Holt strongly depends on having a reasonable SRR fit. This is unlikely given the short data series and will be very dependent on the stock.

Here we show the differences between using the two SRRs for the effort correction and TAC management regimes.

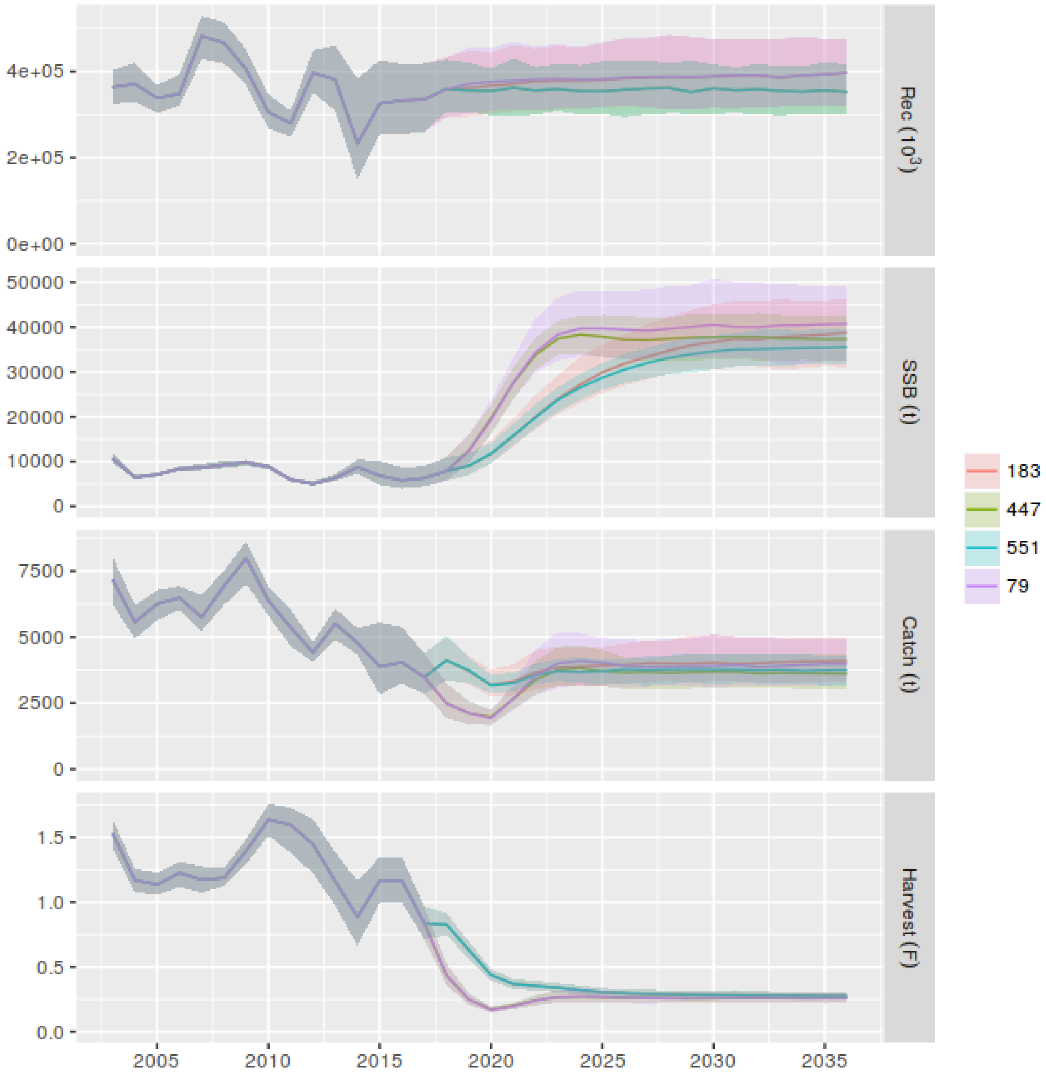


Figure 5.10. Impact of the two stock-recruitment relationships: Beverton-Holt with TAC management (79) and effort management (183). Geometric mean with TAC management (447) and effort management (551) on hake in GSAs 1, 5, 6 and 7.

5.2 (MSE) Management Strategies Evaluation Results

The large number of scenarios and stocks simulated made the analysis of individual scenarios extremely difficult. The summaries of the scenarios are included in Annex 04 (plots), Annex 05 (data) and Annex 10 (tables).

After performing a visual screening of the scenarios it was decided to drop some which showed odd results, namely:

- Giant and red shrimp in GSA 11. The dynamics were not well defined and this stock was dropped from the analysis.
- TAC management scenarios of blackbellied anglerfish in GSA 05, blue and red shrimps in GSA 01, deep water pink shrimp in GSA 06, red mullet in GSA 05 and red mullet in GSA 11. The TAC HCR is dependent on high quality stock assessments to perform the short term forecast needed to establish fishing opportunities for the year after. The scenarios dropped from the analysis had stock assessment results which were not very stable and resulted in strong cycles in the forecast.
- Beverton and Holt stock-recruitment relationship in deep water pink shrimp in GSA 05 and red mullet in GSA 07. The fits were generating an odd pattern in recruitment, which were having a large impact on the outcomes of the simulations.

5.2.1 Overall indicators

Two overall indicators were built. The evolution of the percentage of stocks recovered, where recovery was understood as the moment a stock shows less than 5% probability of its SSB being below Bpa. The probability of a management scenario reaching the F target. Where a scenario is considered to have reached the target, when fishing mortality is within a range of 20% around the target value, Fmsy.

These indicators combine a lot of data and the information they convene should be interpreted with care.

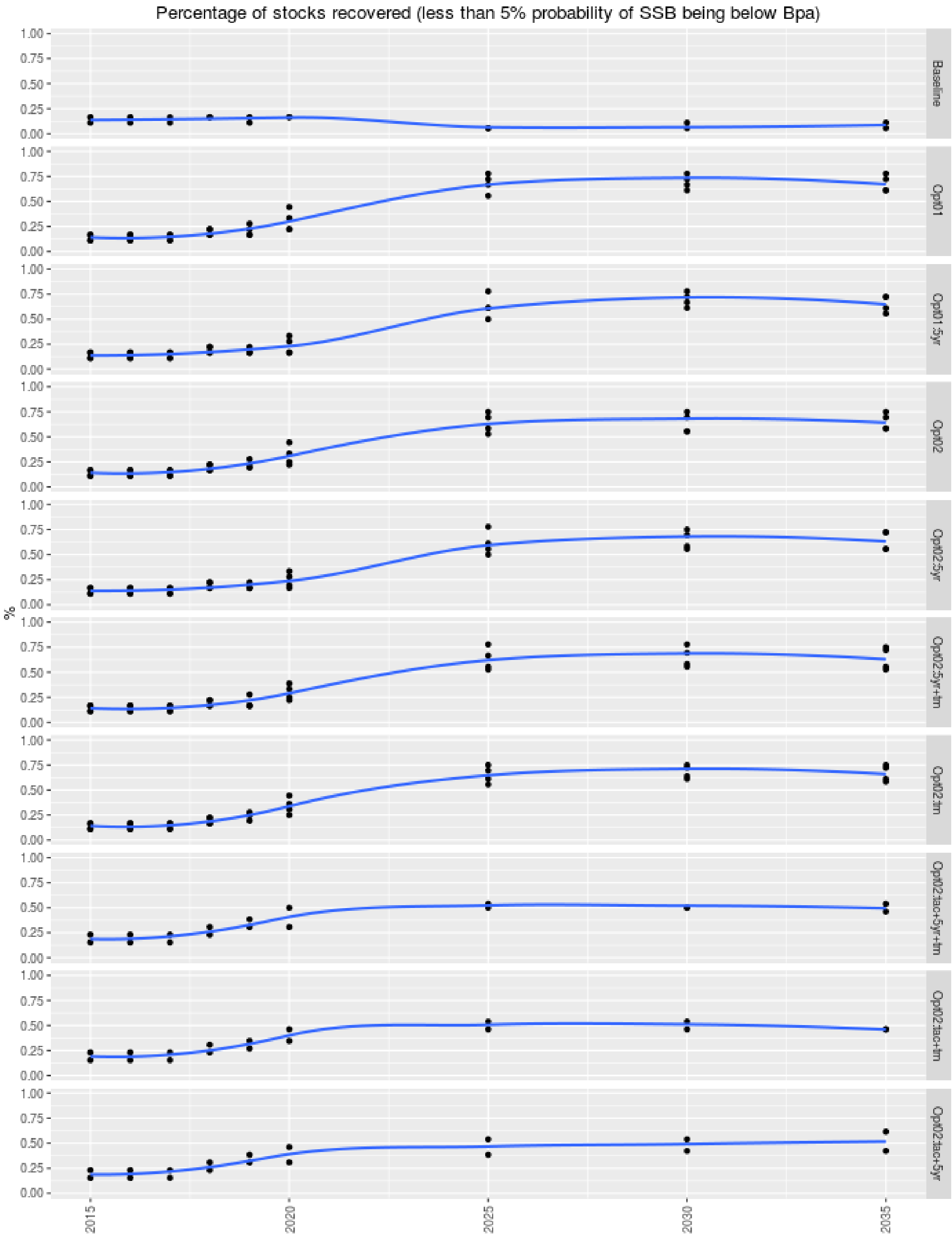


Figure 5.11 - Percentage of stocks recovered to SSB levels above Bpa and with low probability (<5%) of falling below that threshold.

Figure 5.11 shows that the Baseline scenario does not improve the number of stocks recovered during the projection period, being the worst performing scenario in this metric. Option 1 and option 2 with effort management showed the best performance, with approximately 75% of the stocks recovered in 2025, while option 2 with TAC management is around 50%. This results is due to the larger uncertainty of TAC scenarios (see Annex 04 for more details).

These results merge all the operating model options and, as such, reflect the uncertainty in the behavior of the fleets (hyperstability) and stocks (stock-recruitments). That’s why not all stocks recover, because if some of the operating model options occur, the management options considered may not be enough to drive the stock’s biomass as much as expected.

Figure 5.12 shows the probability of achieving the fishing mortality target. As with the previous indicator the Baseline performance is quite poor. Option 1 showed the best results in median but has a large uncertainty associated, while option 2 performs better than the baseline but still shows low probability of achieving the targets.

The comparison between option 1 and option 2 results must be contextualized. Option 2 was designed to introduce flexibility in the management process, so that mixed fisheries effects can be better dealt with. However, the current analysis does not account for such effects, it’s a set of single species simulations, which ends up not taking full advantage of the Fmsy ranges. When computing this indicator option 1 naturally performs better because the target of the simulation is Fmsy. While option 2 uses the envelop approach (STECF, 2015a), where two simulations are combined, one targeting the upper limit of the Fmsy ranges and the other the lower limit.

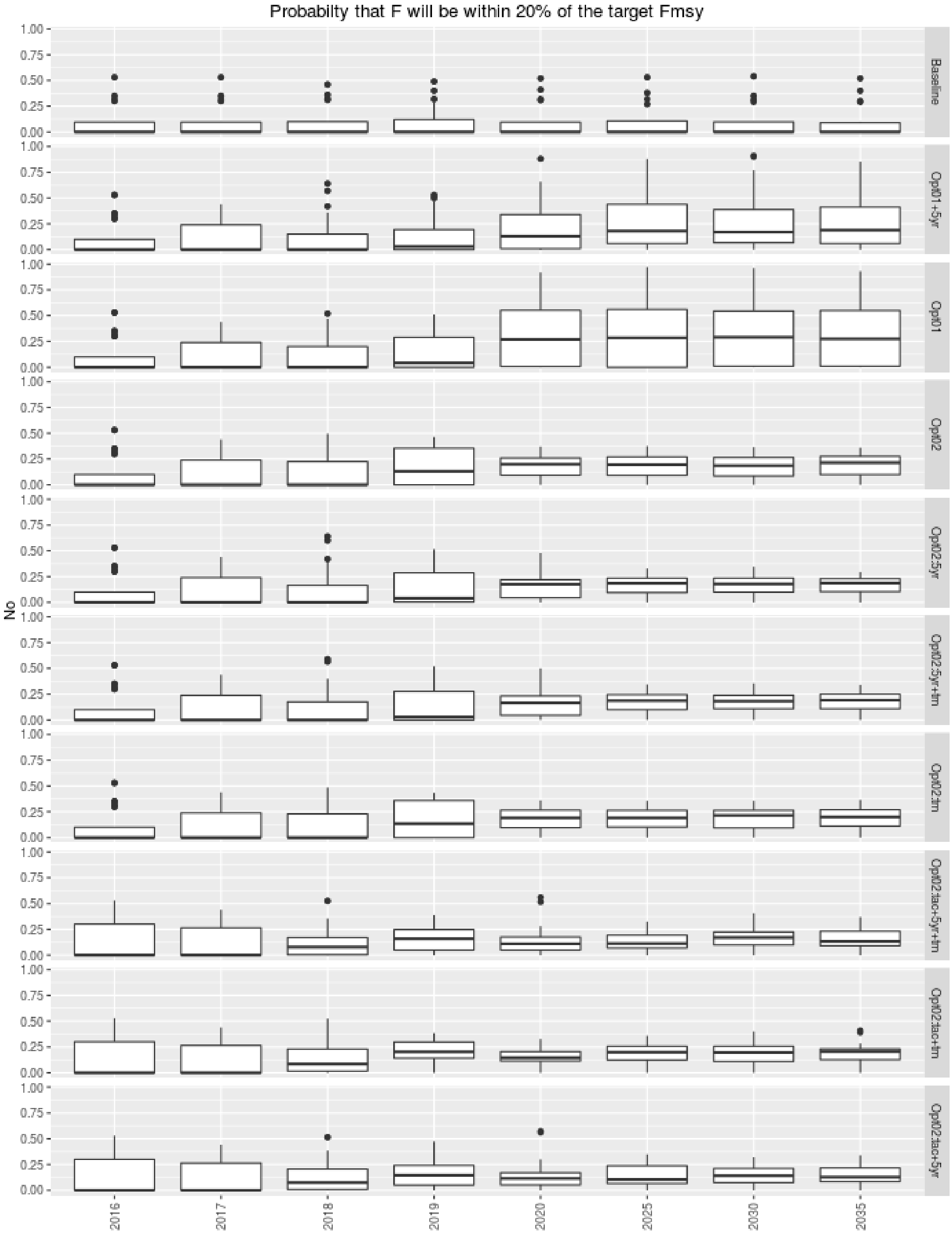


Figure 5.12 - Probability of reaching the target. Fishing mortality within 20% limits of Fmsy.

5.2.2 Indicators by stock

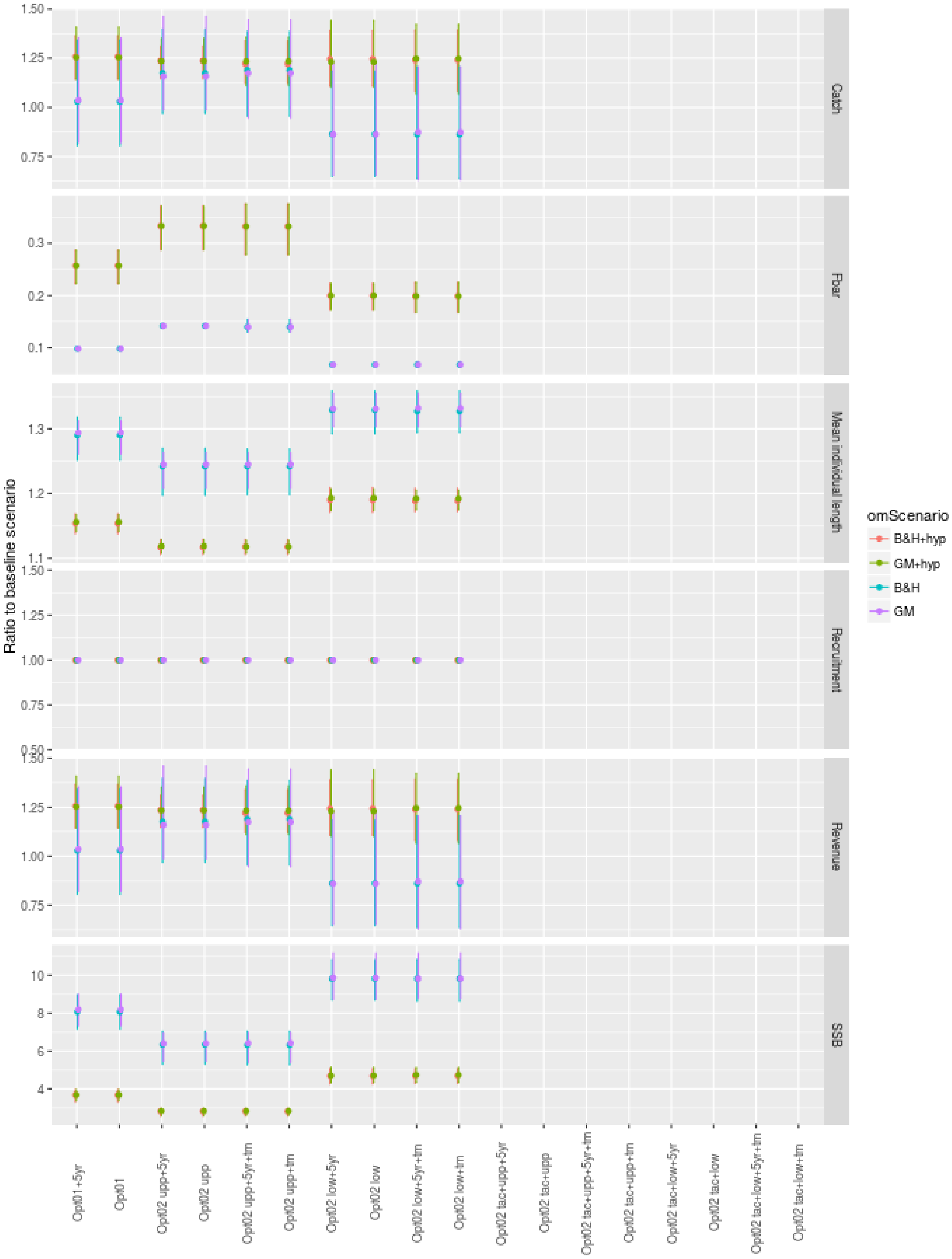


Figure 5.13 - Blackbellied angler (*Lophius budegassa, ANK*) in GSA 05. Summary of MSE results in 2025, shown as the ratio between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for Blackbellied angler (*Lophius budegassa, ANK*)in GSA 05 are stored in Annex 04, page 4-61. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. With hyperstability, the catches were largely unaffected by the management option. Without hyperstability, the Option 2 Flow management scenarios resulted in lower catch than Fupp with the Option 1 Fmsy results in between. The revenue showed the same pattern as the catches. The biomass recovery option and the technical measures option did not affect the performance. The performance of the two SRRs was similar. The presence of hyperstability generally increased catches, F, revenue, but decreased SSB and mean individual length. The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios. With hyperstability, the Flow catches and revenue were below the Baseline performance.

The TAC management scenarios are not included as these scenarios were very sensitive to the stock assessment inside the MSE loop.

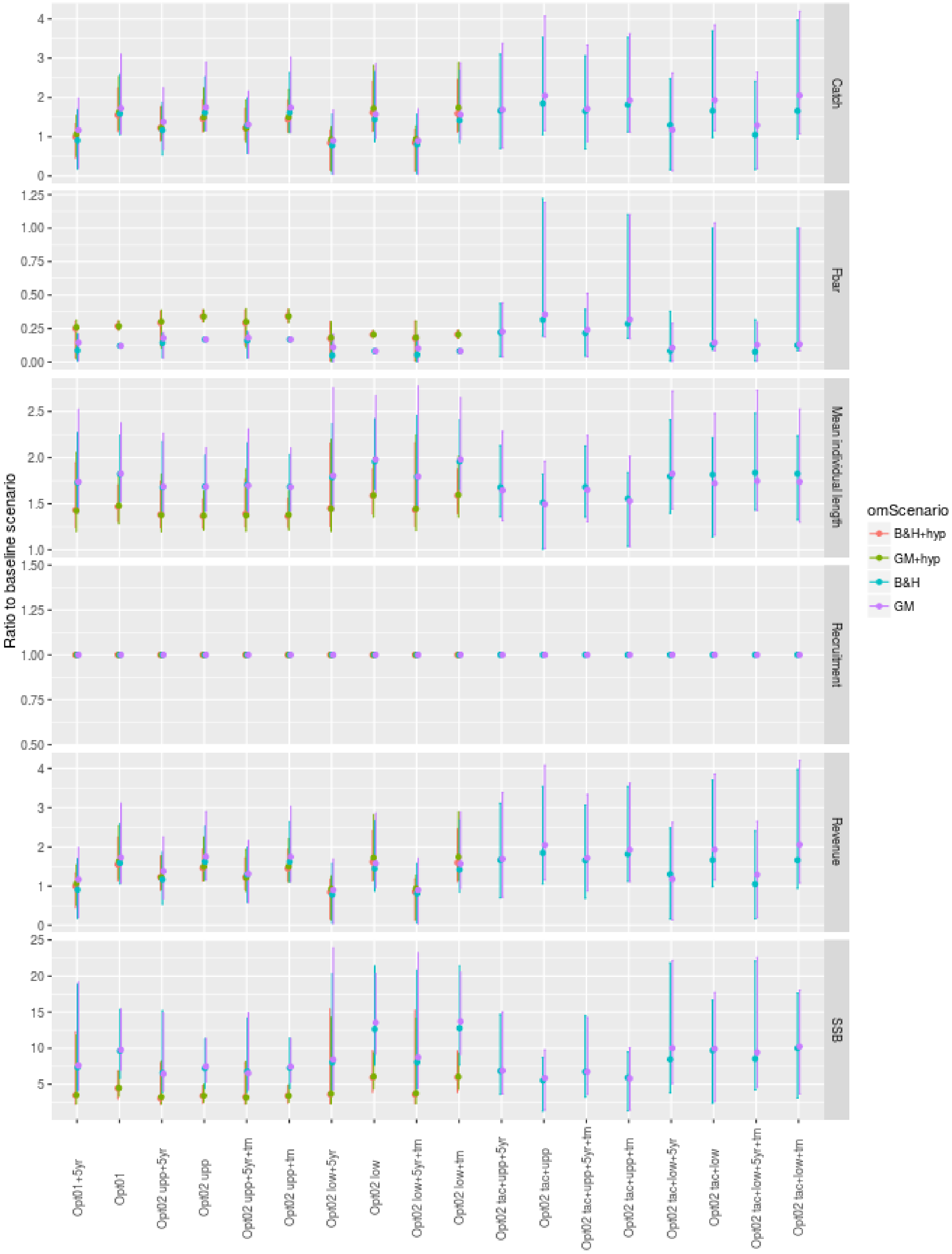


Figure 5.14 - Blackbellied angler (*Lophius budegassa, ANK*) in GSA 06. Summary of MSE results in 2025, shown as the ratio between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for Blackbellied angler (*Lophius budegassa, ANK*) in GSA 06 are stored in Annex 04, page 62-119. Across the effort management scenarios, the Option 2 Flow management scenarios generally resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The catch and revenue were affected by the presence of the biomass recovery option which generally resulted in lower catches and revenues. The performance of the two SRRs was similar.

The TAC management scenarios showed a similar pattern to the effort management results. However, their results were more uncertain, particularly when the biomass recovery was operating, but generally had higher catches and revenues.

The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios.

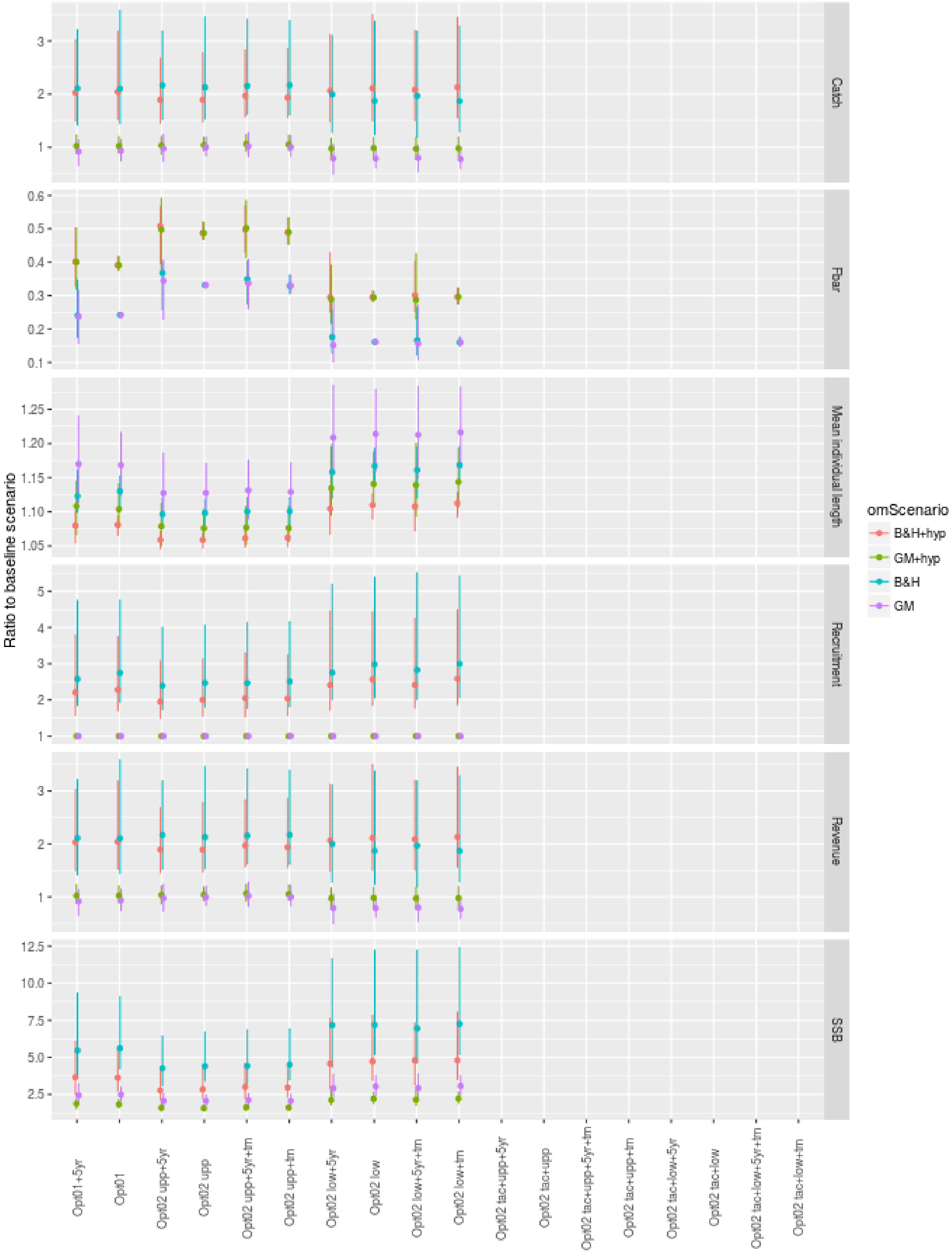


Figure 5.15 - Blue and red shrimp (*Aristeus antennatus*, ARA) in GSA 01. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for blue and red shrimps in GSA 01 are stored in Annex 04, page 120-177. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenues and catches were less affected by the management option and more affected by the choice of SRR in the operating model with the Beverton-Holt SRR resulting in higher catches and revenues than the geometric mean SRR. The biomass recovery option increased the uncertainty in the results. The technical measures option did not affect the performance of any of the scenarios.

The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios.

The TAC management scenarios are not included as these scenarios were very sensitive to the stock assessment inside the MSE loop.

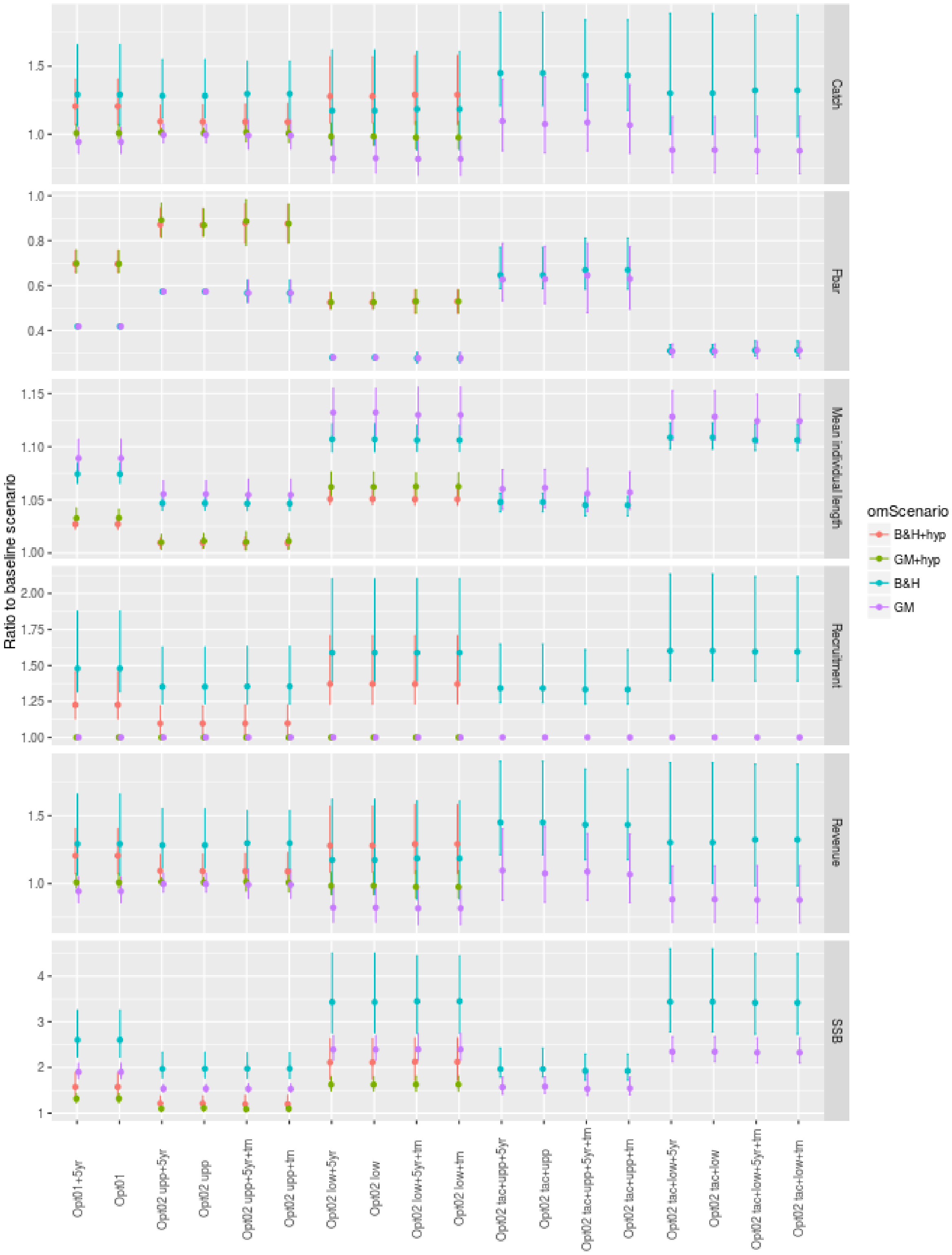


Figure 5.16 - Blue and red shrimp (*Aristeus antennatus*, ARA) in GSA 06. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for blue and red shrimp (*Aristeus antennatus*, ARA) in GSA 06 are stored in Annex 04, page 178-235. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenues and catches were less affected by the management option and more affected by the choice of SRR in the operating model with the Beverton-Holt SRR resulting in higher catches and revenues than the geometric mean SRR. The biomass recovery option and the technical measures option did not affect the performance of any of the scenarios.

The TAC management results showed a similar pattern to the effort management results. They were affected by the choice of SRR with the Beverton-Holt model resulting in higher catches, revenue and SSB. The Flow scenario gave lower F, catch and revenue but higher SSB and mean individual length.

The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios. With hyperstability, the Flow catches and revenue were below the Baseline performance.

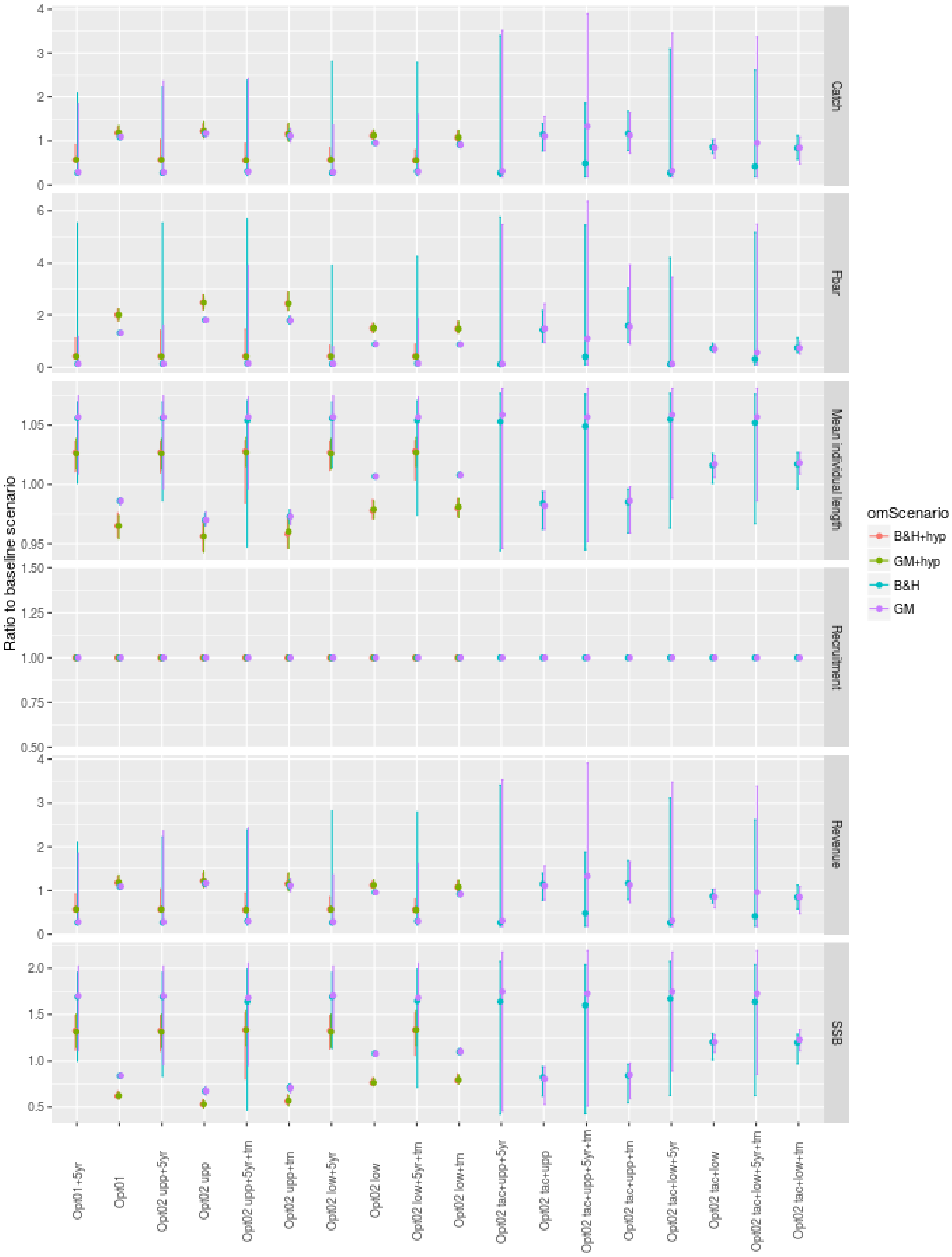


Figure 5.17 - Giant red shrimp (*Aristeomorpha foliacea, ARS*) in GSA 09. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for Giant red shrimp (*Aristeomorpha foliacea, ARS*) in GSA 09 are stored in Annex 04, page 236-293. Across the effort management scenarios the results were affected by the biomass recovery option which generally resulted in lower catches, F and revenues and higher mean individual lengths and SSB. The uncertainty was also higher. Without the biomass recovery, the Option 2 Flow management scenarios generally resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB.

The TAC management scenarios gave a similar pattern of results to the Option 2 effort management scenarios, with the biomass recovery having a strong impact.

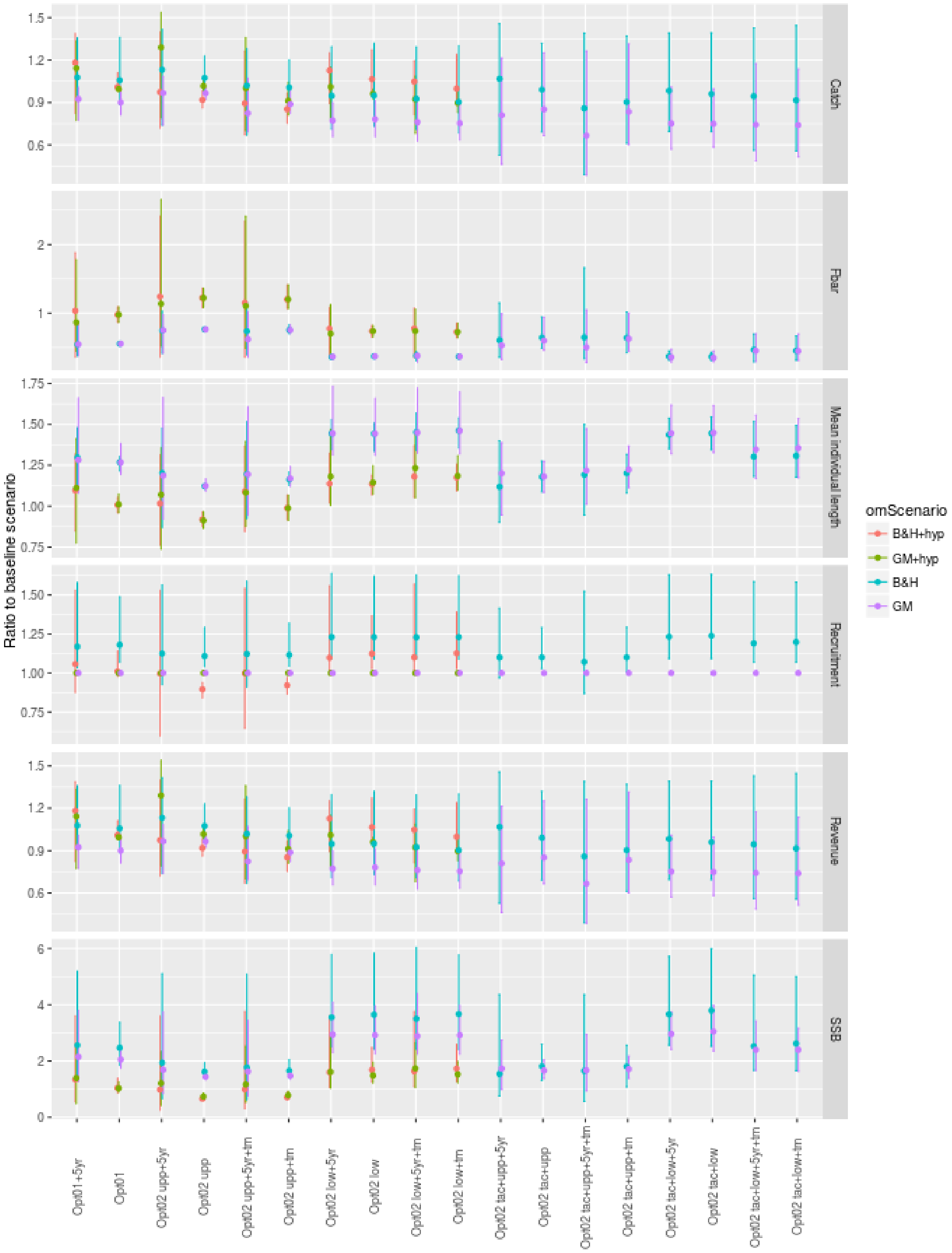


Figure 5.18 - Giant red shrimp (*Aristeomorpha foliacea, ARS*) in GSA 11. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for Giant red shrimp (*Aristeomorpha foliacea, ARS*) in GSA 11 are stored in Annex 04, page 352-409. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenues and catches were less affected by the management option and more affected by the choice of SRR in the operating model with the Beverton-Holt SRR resulting in higher catches and revenues than the geometric mean SRR. With the biomass recovery option the uncertainty was much higher with the Fupp scenario. The technical measures option had a limited impact on the results.

The TAC management results showed a similar pattern to the effort management results. They were affected by the choice of SRR with the Beverton-Holt model resulting in higher catches, revenue and SSB. The Flower scenario gave lower F, catch and revenue but higher SSB and mean individual length.

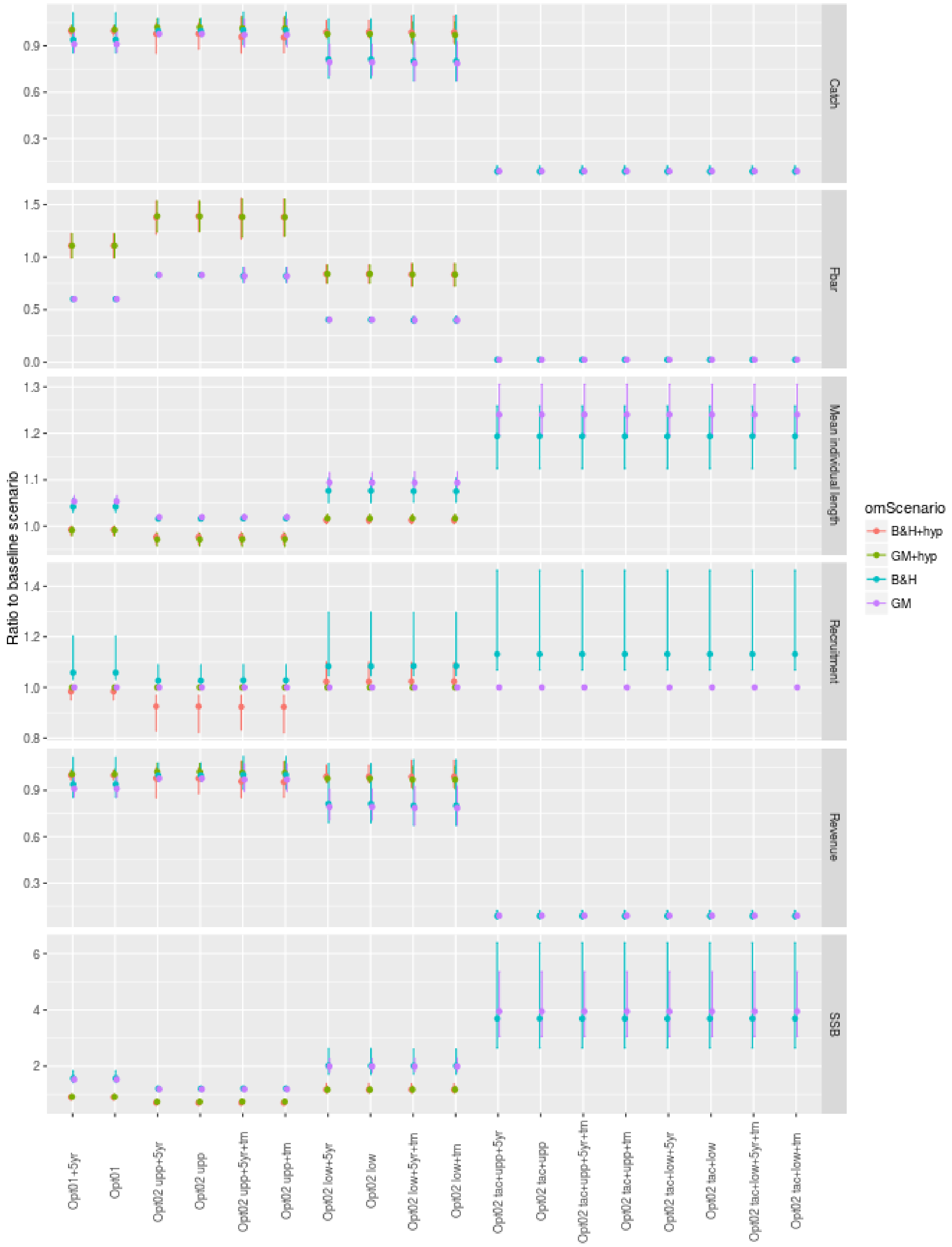


Figure 5.19 – Deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 01. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 01 are stored in Annex 04, page 410-467. Across the effort management scenarios, the Option 2

Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. With hyperstability, the catches were largely unaffected by the management option. Without hyperstability, the Option 2 Flow management scenarios resulted in lower F and lower catch but higher mean individual lengths and SSB than the Fupp scenarios with the Option 1 Fmsy results in between. The revenue showed the same pattern as the catches. The biomass recovery option and the technical measures option did not affect the performance. The performance of the two SRRs was similar.

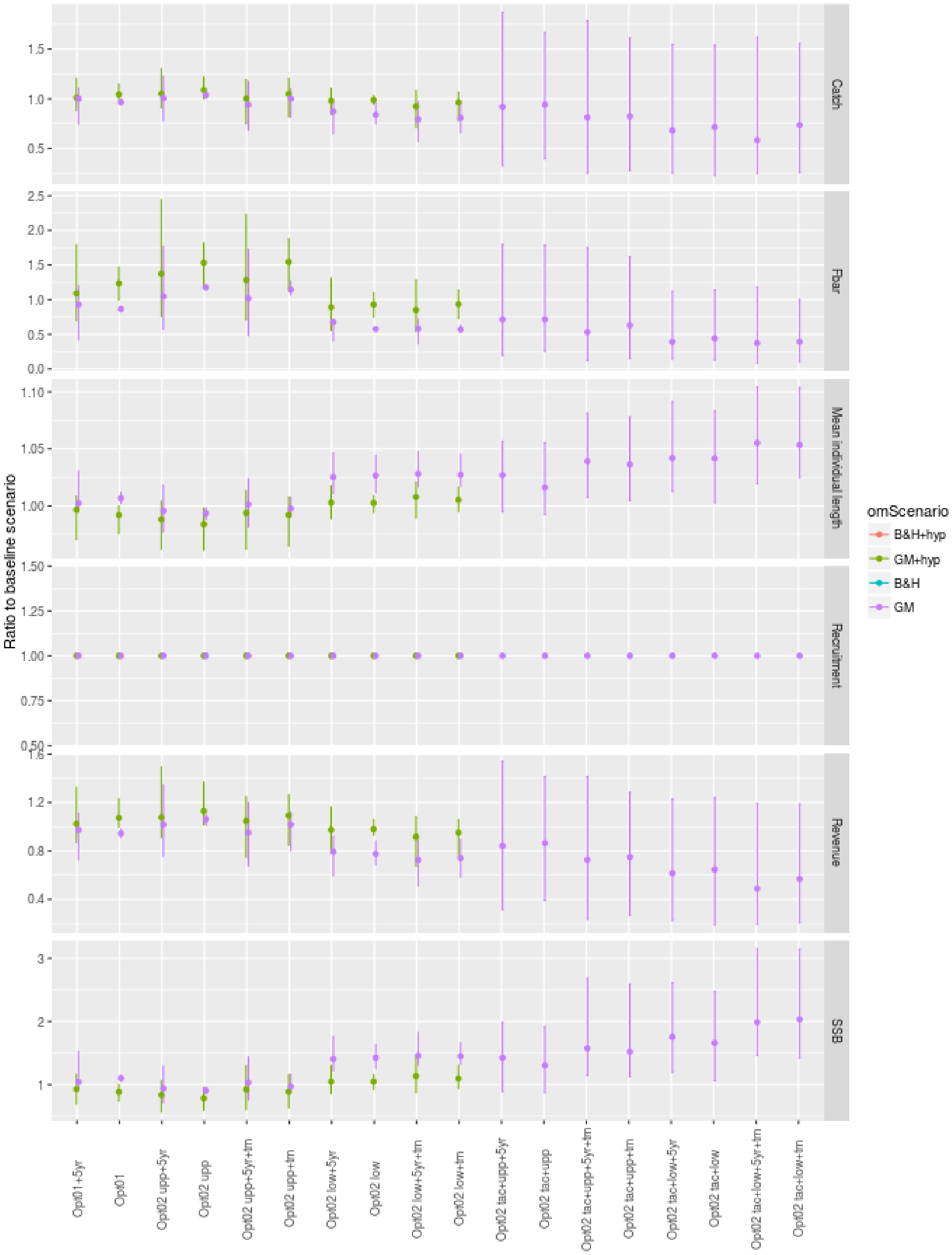


Figure 5.20 - Deep water pink shrimp (*Parapenaeus longirostris*, DPS) in GSA 05. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 05 are stored in Annex 04, page 468-525. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F and catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between the two. Within a management option, the presence of hyperstability resulted in higher F and catch and lower mean individual length and SSB. The revenue showed the same pattern as the catches. The biomass recovery option and the technical measures option had only limited impacts on the performance, with uncertainty increasing under biomass recovery.

The TAC management scenarios showed a generally similar pattern to the effort management scenarios, but with lower F, catch and revenue and higher SSB and mean individual length. Uncertainty was higher than the effort management scenarios.

The SSB and mean individual length was generally higher than the Baseline for all scenarios.

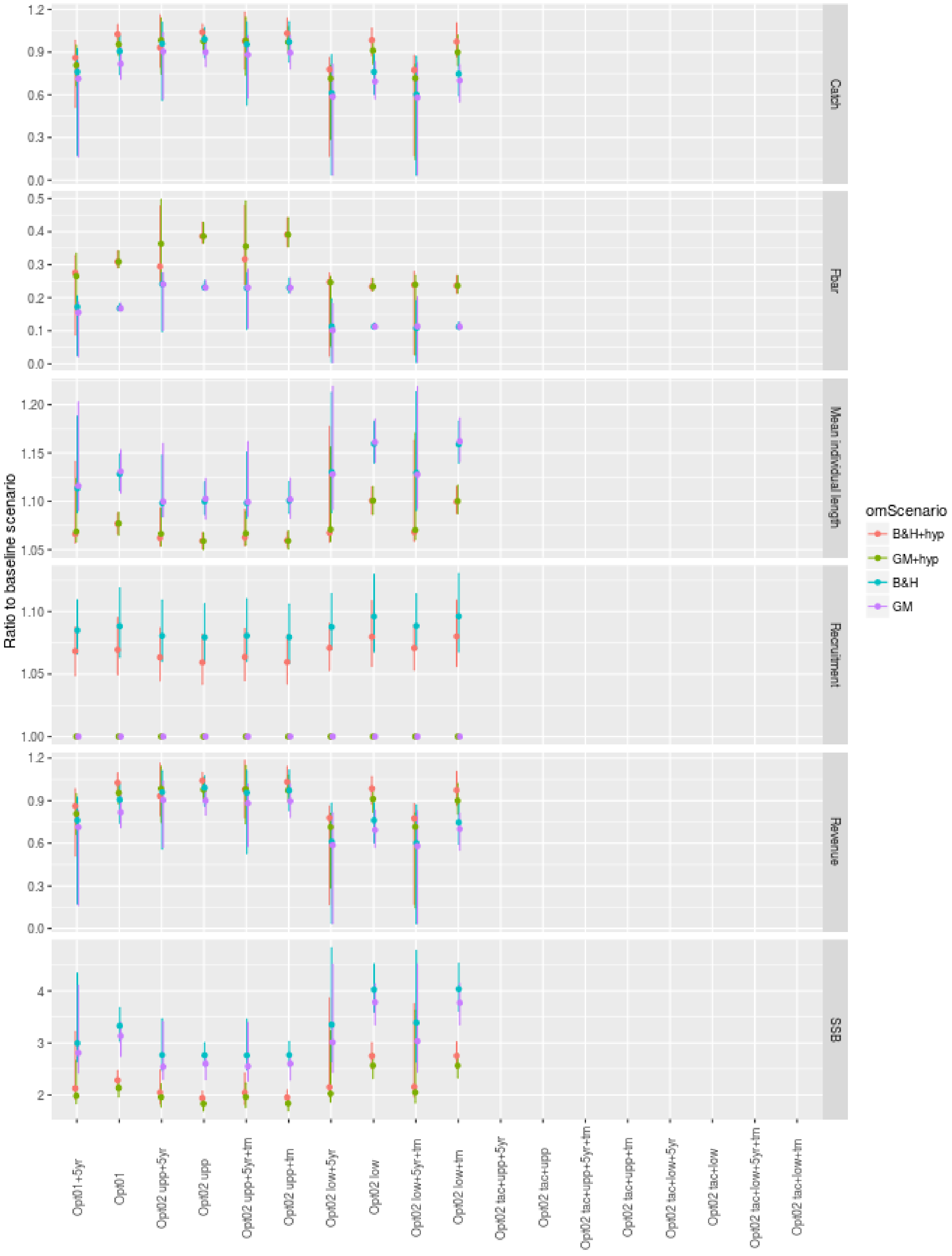


Figure 5.21 - Deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 06. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 06 are stored in Annex 04, page 526-583. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, lower catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenue showed the same pattern as the catches. The technical measures option had only a limited impact on the performance. The biomass recovery option increased uncertainty for all scenarios and resulted in lower catches, revenue, SSB and mean individual length, particularly for the Flow option. The SSB and mean individual length was generally higher than the Baseline for all scenarios. F and catches were lower than the Baseline for all scenarios. The performance of the two SRRs was similar.

The TAC management scenarios were not included due to the sensitivity of the results on the stock assessment within the MSE.

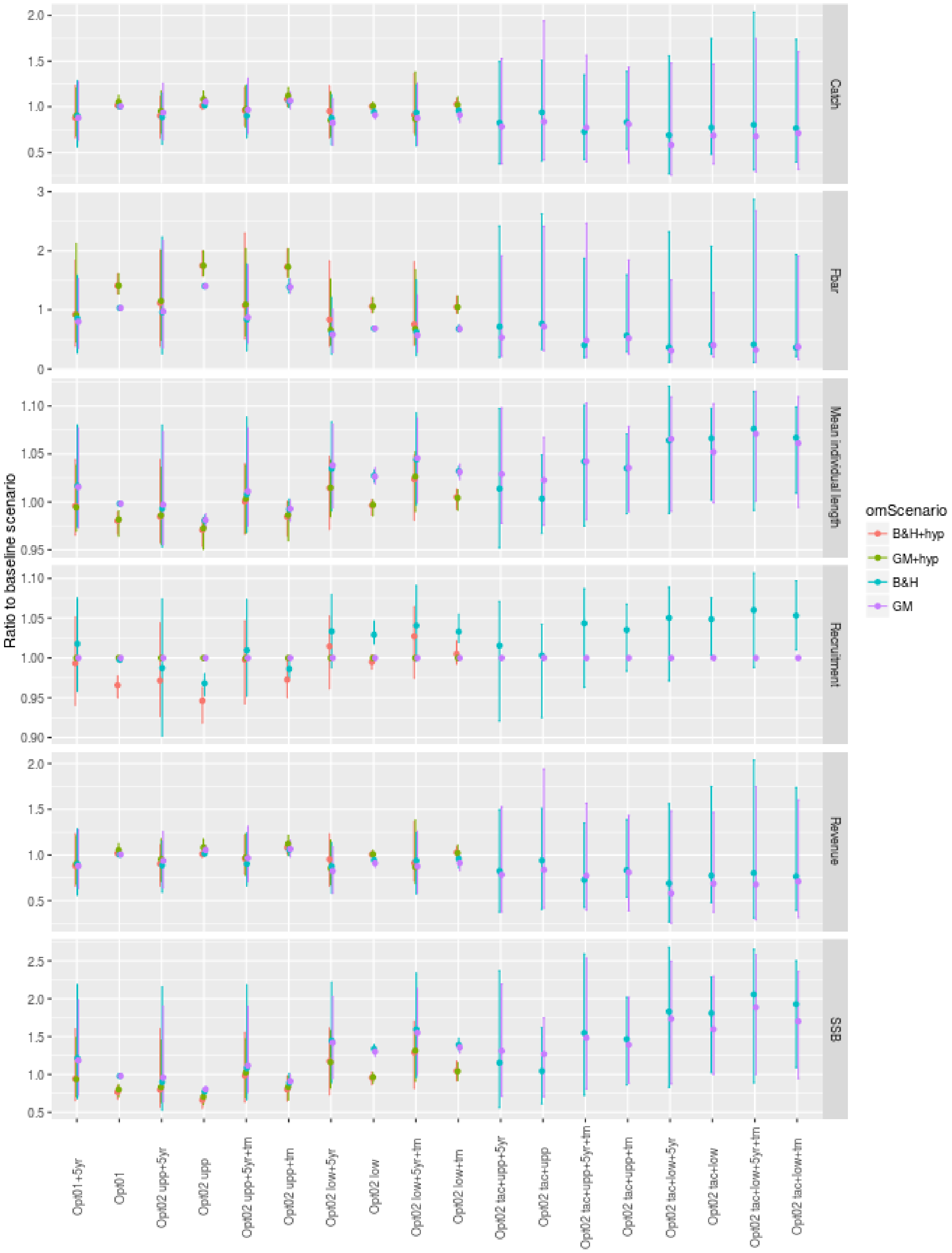


Figure 5.22 - Deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 09. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for deep water pink shrimp (*Parapenaeus longirostris,* DPS) in GSA 09 are stored in Annex 04, page 584-641. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, lower catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenue showed the same pattern as the catches. The technical measures option had only a limited impact on the performance. The biomass recovery option increased uncertainty for all scenarios and resulted in lower F for the Fupp option. For the effort scenarios, F was generally higher than the Baseline. The performance of the two SRRs was similar.

The TAC management scenarios showed a generally similar pattern to the effort management scenarios, but with lower F, catch and revenue and higher SSB and mean individual length. Uncertainty was higher than the effort management scenarios.

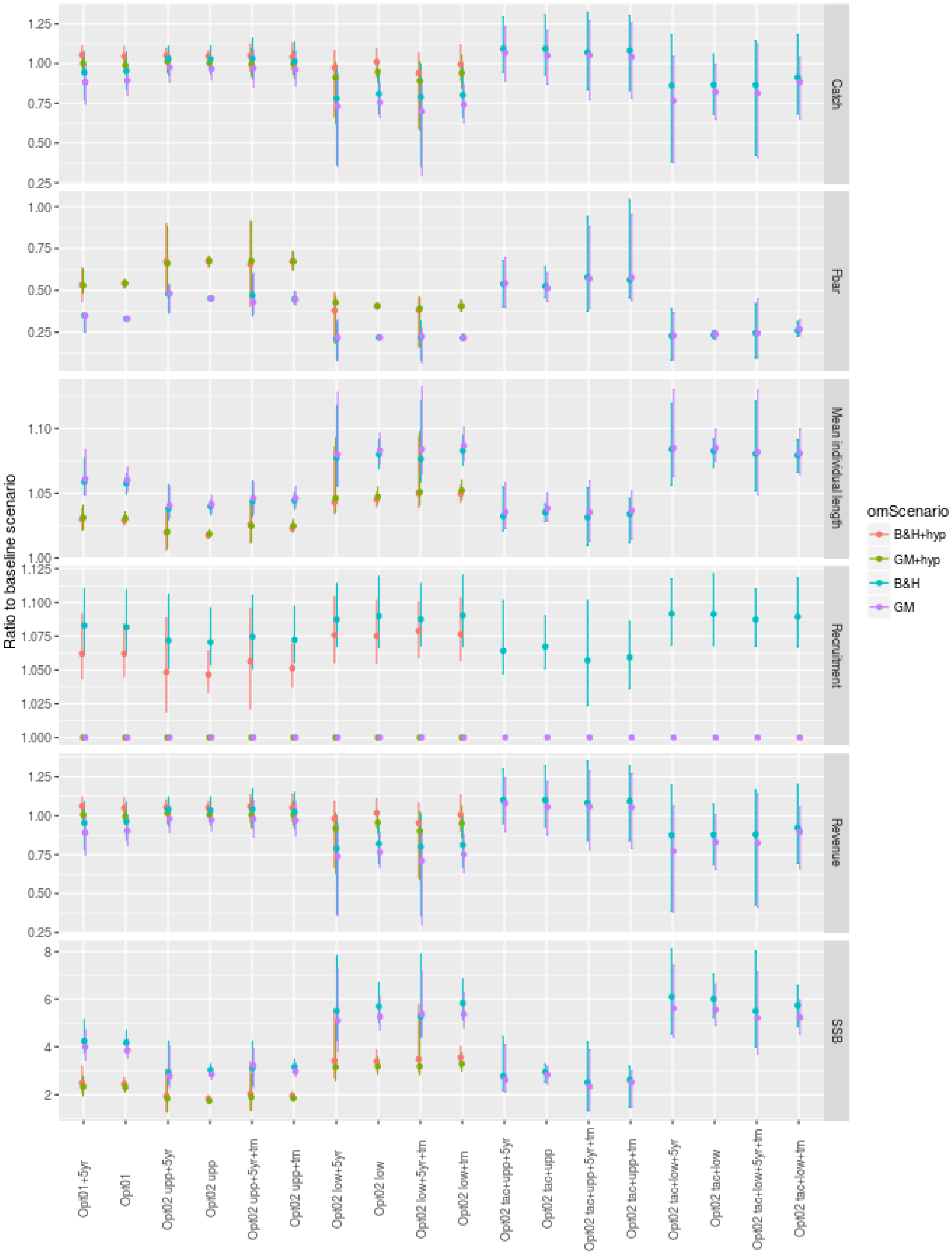


Figure 5.23 - European hake (*Merluccius merluccius,* HAKE) in GSAs 01, 05, 06 and 07. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for European hake (*Merluccius merluccius,* HAKE) in GSAs 01, 05, 06 and 07 are stored in Annex 04, page 642-700. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. With hyperstability, the catches were largely unaffected by the management option. Without hyperstability, the Option 2 Flow management scenarios resulted in lower catch than the Fupp scenarios with the Option 1 Fmsy results in between. The revenue showed the same pattern as the catches. The technical measures option did not affect the results. The biomass recovery option increased the uncertainty. The performance of the two SRRs was similar. The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios. The TAC management scenarios showed a similar pattern to the effort management scenarios.

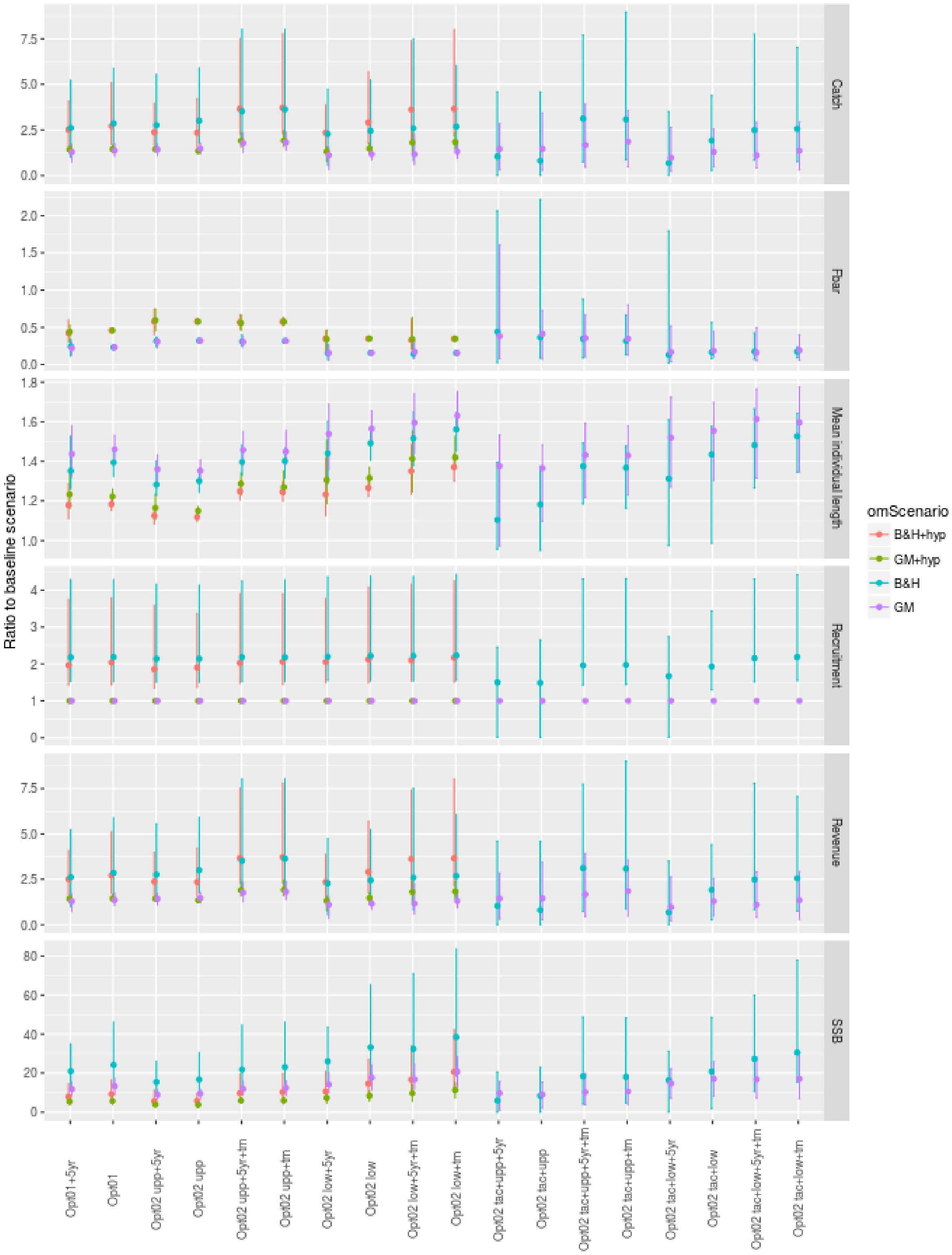


Figure 5.24 – European hake (*Merluccius merluccius, HAKE*) in GSAs 09, 10 and 11. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for European hake (*Merluccius merluccius,* HAKE) in GSAs 09, 10 and 11 are stored in Annex 04, page 701-758. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, lower catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The biomass recovery option did not affect the performance. The technical measures option resulted in slightly higher catches, SSB and mean individual length. The revenue followed a similar pattern to the catch. The performance of the two SRRs was similar with the Beverton-Holt SRR offering slightly higher catches.

The TAC management scenarios followed a similar pattern to the effort management scenarios but with increased uncertainty, particularly under the technical measures option.

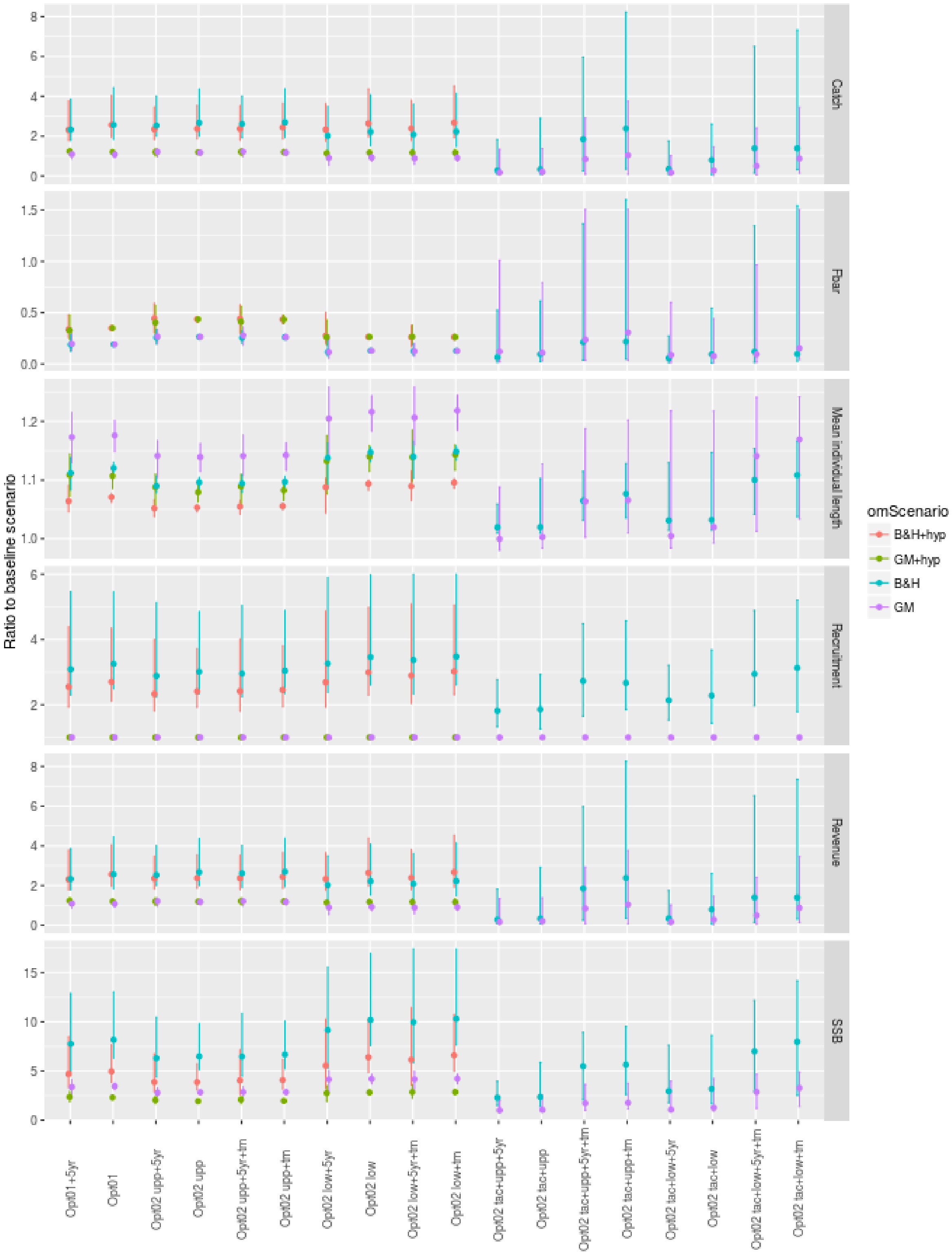


Figure 5.25 – Red mullet (*Mullus barbatus,* MUT) in GSAs 01. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 01 are stored in Annex 04, page 759-816. Across the effort management scenarios, the Option 2 Flow management

scenarios resulted in lower F, lower catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The biomass recovery option increased uncertainty in F. The technical measures option did not affect the result. The revenue followed a similar pattern to the catch. The geometric mean SRR gave higher mean individual length but the Beverton-Holt SRR gave higher SSB.

The TAC management scenarios followed a similar pattern to the effort management scenarios but with increased uncertainty. The F, catch, revenue, SSB and mean individual length were generally lower than the effort scenarios.

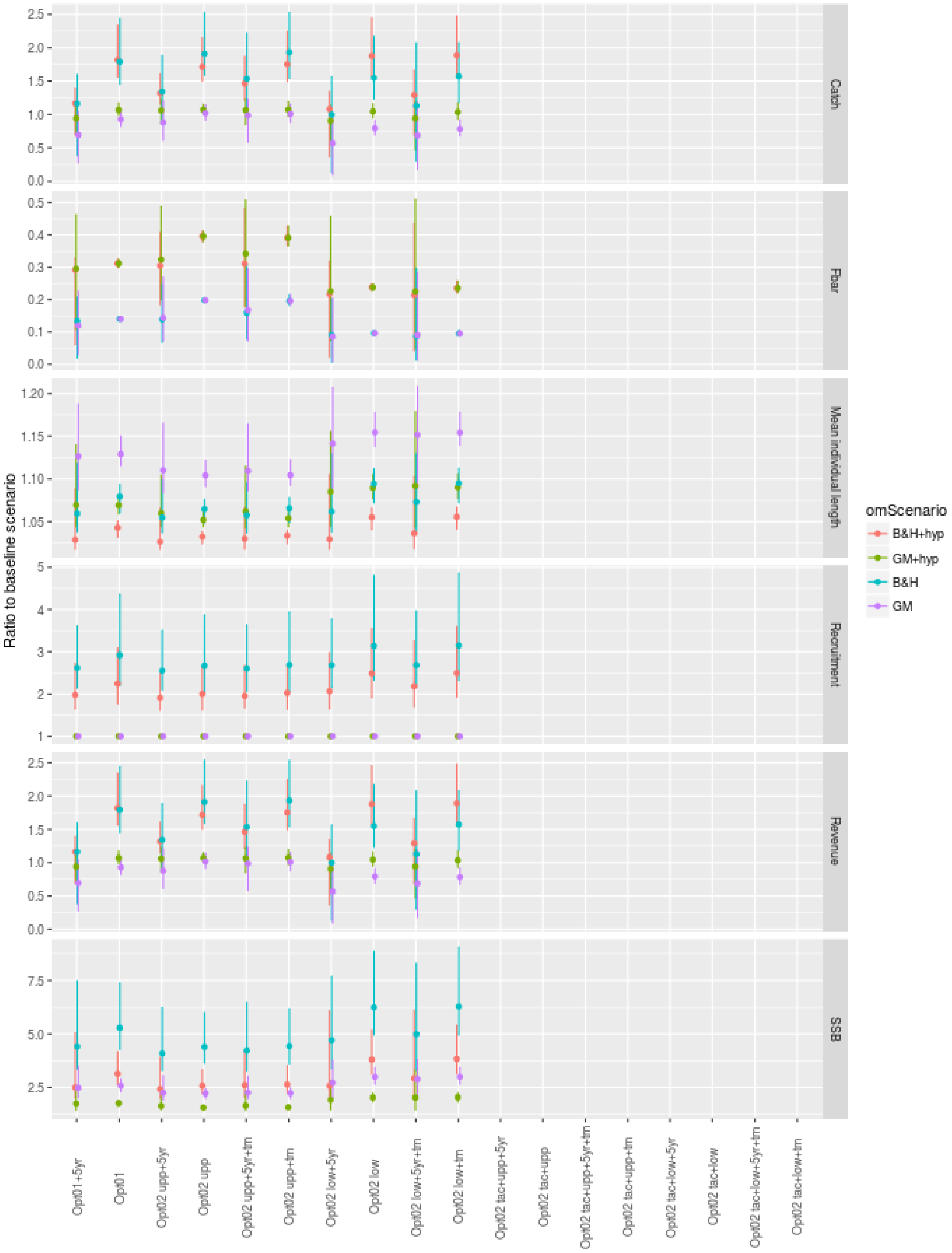


Figure 5.26 - Red mullet (*Mullus barbatus,* MUT) in GSAs 05. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 05 are stored in Annex 04, page 817-874. Across the effort management scenarios, the Option 2 Flow management

scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. The Fmsy level had only a limited impact on the catches. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The technical measures option had only a limited impact on the performance. The biomass recovery option increased uncertainty for all scenarios and resulted in lower catches and SSB, particularly for the Flow option. The revenue showed the same pattern as the catches. The SSB and mean individual length was generally higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios. The Beverton-Holt SRR resulted in higher catches but lower SSB.

The TAC management scenarios were not included due to the sensitivity of the results on the stock assessment within the MSE.

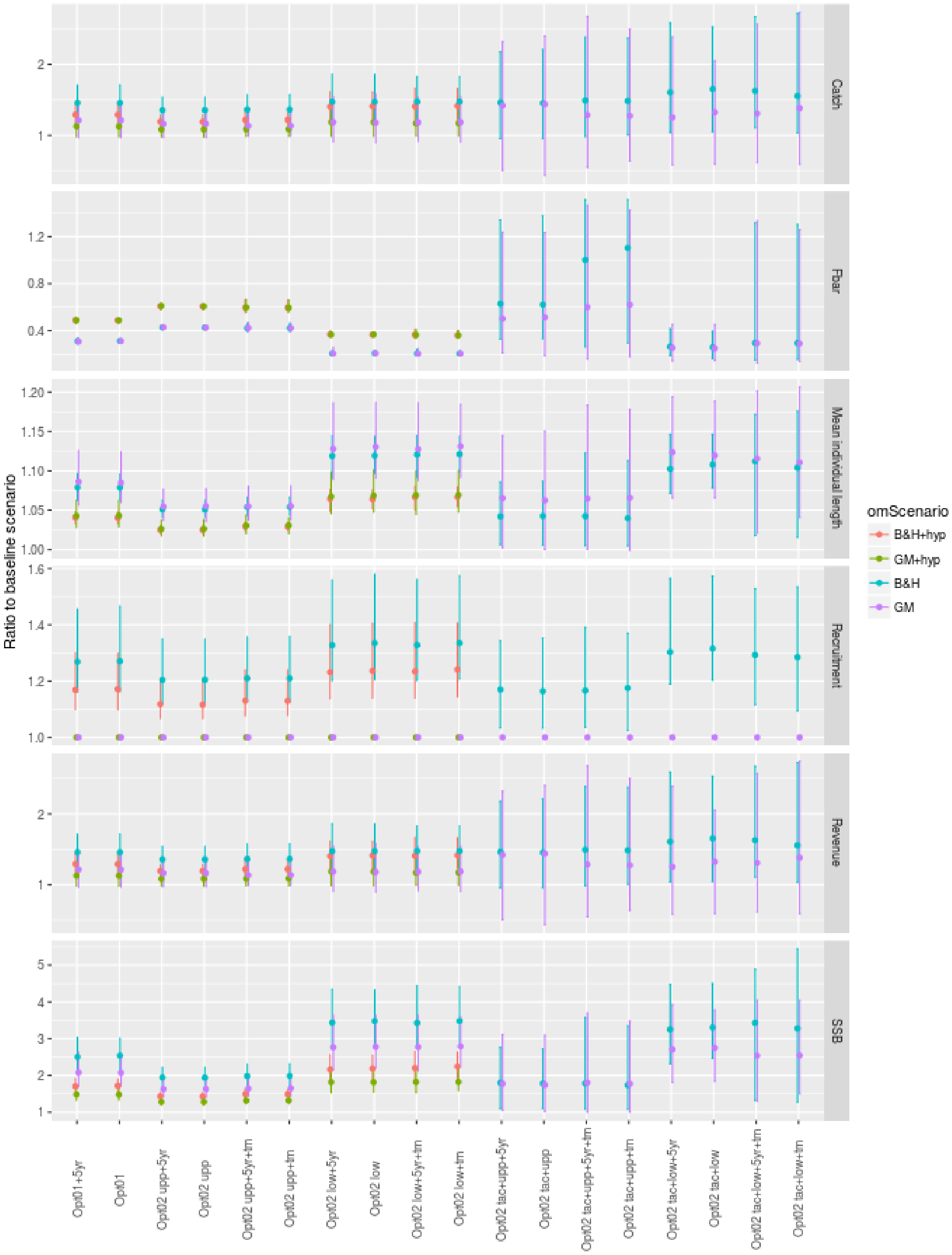


Figure 5.27 - Red mullet (*Mullus barbatus,* MUT) in GSAs 06. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 06 are stored in Annex 04, page 875-932. Across the effort management scenarios, the Option 2 Flow management

scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenues and catches were less affected by the management option and more affected by the choice of SRR in the operating model with the Beverton-Holt SRR resulting in higher catches and revenues than the geometric mean SRR. The biomass recovery option and the technical measures option did not affect the performance of any of the scenarios.

The TAC management results showed a similar pattern to the effort management results but had higher uncertainty.

The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios.

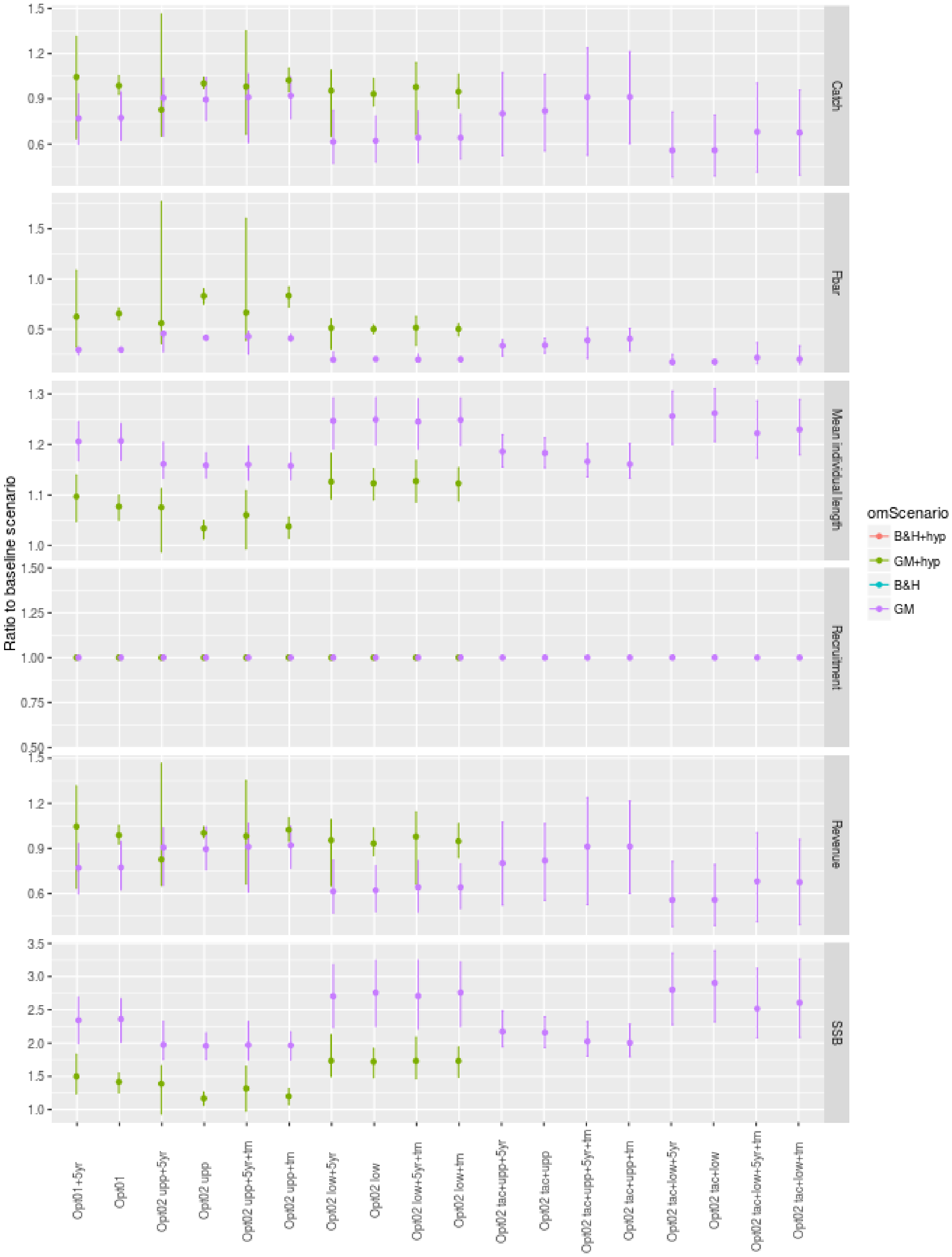


Figure 5.28 - Red mullet (*Mullus barbatus,* MUT) in GSAs 07. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 07 are stored in Annex 04, page 933-990. Across the effort management scenarios, the Option 2 Flow management

scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. With hyperstability, the catches were largely unaffected by the management option. Without hyperstability, the Option 2 Flow management scenarios resulted in lower catch than the Fupp scenarios with the Option 1 Fmsy results in between. The revenue showed the same pattern as the catches. The biomass recovery option increased uncertainty. The technical measures option did not affect the performance.

The TAC management scenarios show a similar pattern of results to the effort management scenarios. Uncertainty is higher than in the effort scenarios, but there is no impact of the biomass recovery.

The SSB and mean individual lengths were higher than the Baseline for all scenarios. F, catches and revenue were lower than the Baseline for all scenarios.

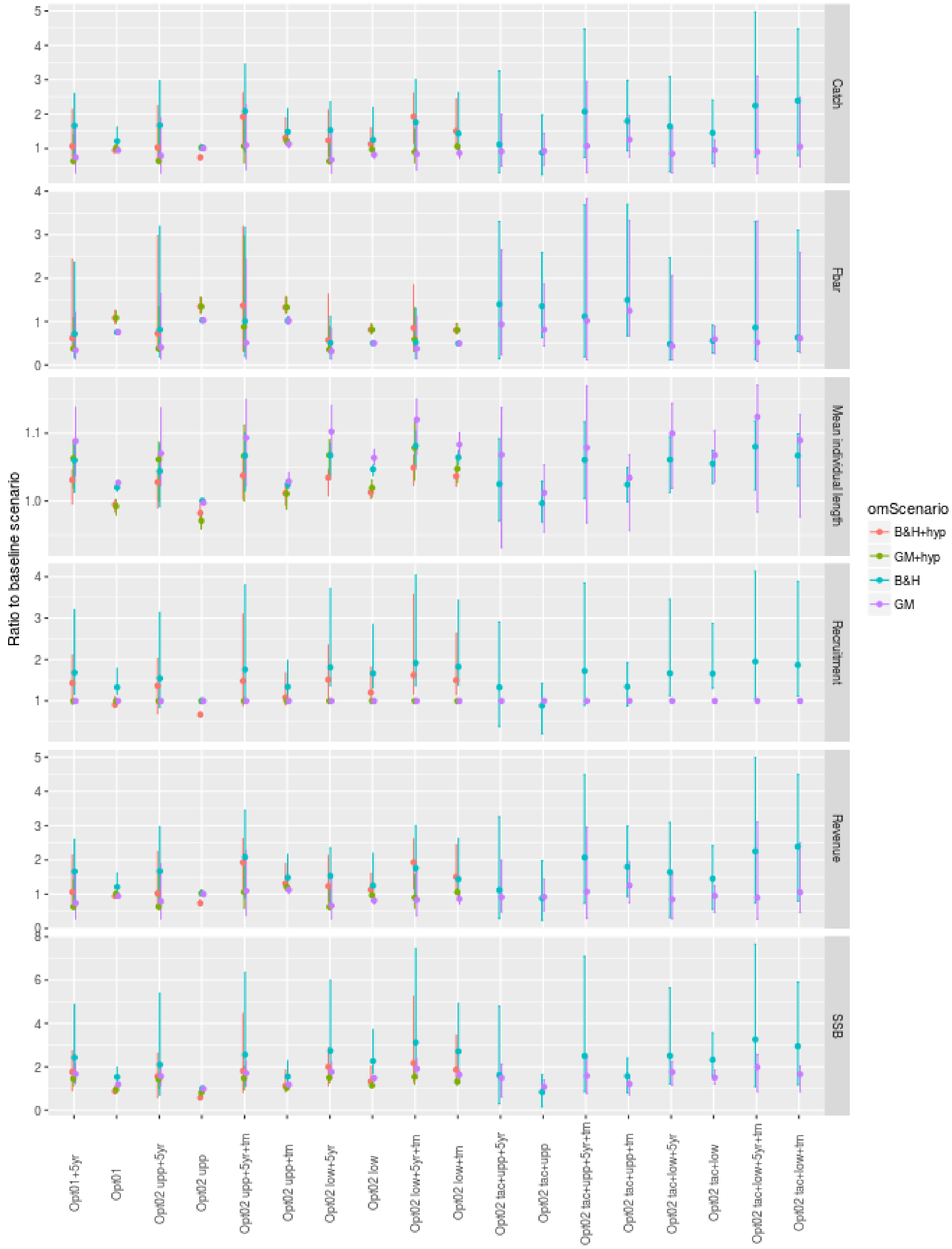


Figure 5.29 - red mullet (*Mullus barbatus,* MUT) in GSAs 09. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 09 are stored in Annex 04, page 991-1048. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and lower mean individual length and SSB. The revenues and catches were less affected by the management option and more affected by the choice of SRR in the operating model with the Beverton-Holt SRR resulting in higher catches and revenues than the geometric mean SRR. The biomass recovery option increased the uncertainty. With the Fupp scenario, the uncertainty was much smaller without the biomass recovery option. The technical measures option had a limited impact on the results.

The TAC management results followed a similar pattern to the effort management results but with higher uncertainty. The results were also affected by the choice of SRR with the Beverton-Holt model resulting in higher catches, revenue and SSB. The Flower scenario gave lower F, catch and revenue but higher SSB and mean individual length.

Mean individual lengths and SSB were generally above the Baseline scenario for all scenarios.

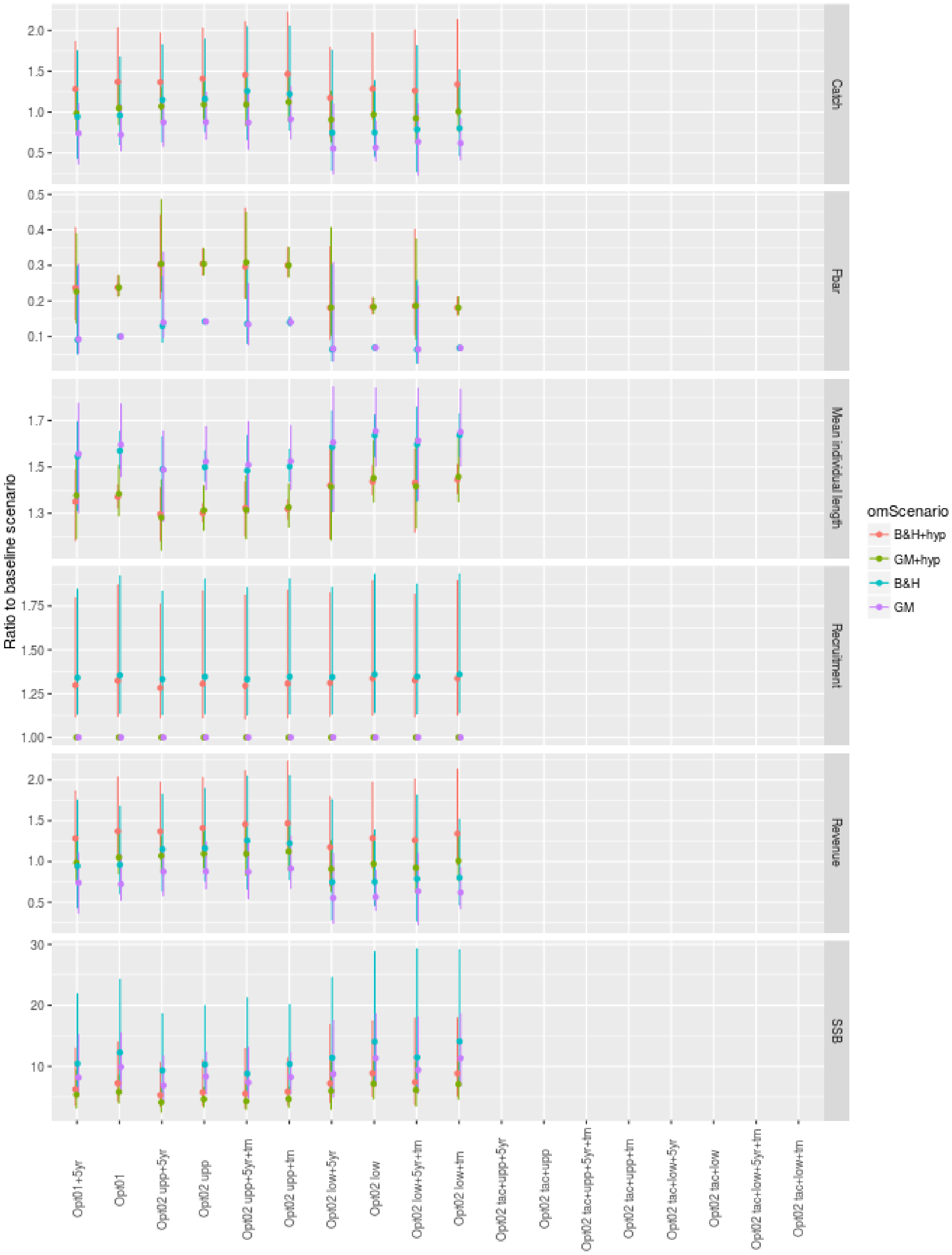


Figure 5.30 - red mullet (*Mullus barbatus,* MUT) in GSAs 11. Summary of MSE results in 2025, shown as the ration between each scenario and the Baseline. Indicators are presented by row, management scenarios in xx-axis, and colours distinguish operating model scenarios. Legend: B&H – Beverton & Holt, GM – geometric mean, hyp – hyperstability, 5yr – 5 years recovery period, upp – upper boundary of Fmsy range, low - lower boundary of Fmsy range, tm – technical measures, tac – TAC management.

The time series with scenarios for red mullet (*Mullus barbatus,* MUT) in GSAs 11 are stored in Annex 04, page 1049-1106. Across the effort management scenarios, the Option 2 Flow management scenarios resulted in lower F, lower catch, higher mean individual lengths and higher SSB than the Fupp scenarios with the Option 1 Fmsy results in between. Within a management option, the presence of hyperstability resulted in higher F and catch and lower mean individual length and SSB. The revenue showed the same pattern as the catches. The biomass recovery option increased the uncertainty of F. The technical measures option did not affect the performance. The SSB and mean individual lengths were higher than the Baseline for all scenarios. F was lower than the Baseline for all scenarios. With hyperstability, the Flow catches and revenue were below the Baseline performance.

The TAC management scenarios are not included as these scenarios were very sensitive to the stock assessment inside the MSE loop.

5.3 Reference points

The basis of stock assessments used in EWG 16-02 is from the body of STECF stock assessments performed in the last 4-5 years and the corresponding reference points. The main reference point adopted in the STECF EWG MED working groups for demersal fish has been a mortality reference point (F) derived by Yield per Recruit (Y/R) analysis. Since often Fmsy and Fmax are undefined in the Y/R curve, F0.1, is used as a proxy for Fmsy. F0.1 is defined as the fishing mortality rate at which the slope of the yield per recruit curve, as a function of fishing mortality, is 10% of its value at the origin.

To derive the Fmsy ranges, where F0.1 is used instead of Fmsy, a linear regression model was fitted to the Fmsy ranges derived from EQSIM (ICES, 2015) in the Atlantic and it is used to predict F0.1 ranges. The Fupp derived from this prediction have then been tested with an MSE procedure to test their robustness.

Figure 5.31 displays Fmsy by stock, grouped by individual species panels for the stocks in the NW MAP. The line in the panel represents the mean of the species within GSA.

The point of exploring the reference points is that these will be the management target in the NW MED MAP and will be hard coded in the management plan.

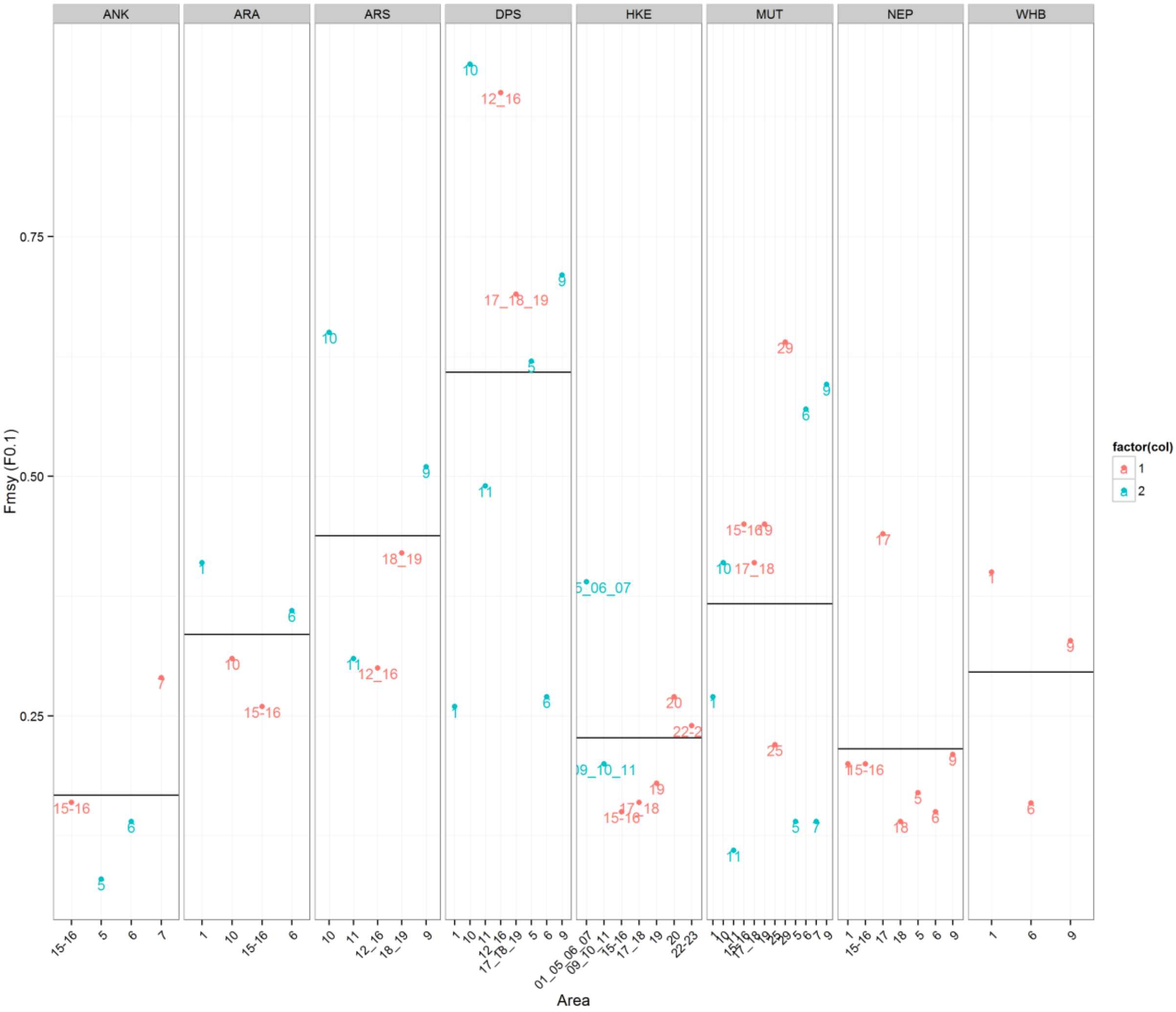


Figure 5.32- Fmsy (F0.1) reference points from STECF stock assessments, in blue stocks under the NW MED MAP, in red stocks from other Mediterranean GSAs. The numbers correspond to the GSA or combination of GSAs.

By exploring the plots some potential discrepancies emerge:

- The range of F0.1 values for DPS (deep water pink shrimp) is very large. Some values (GSA 1 and 6) are extremely low to the point of falling in the range of the mean of HKE (Mediterranean hake), which is unexpected for a productive shrimp.
- Between adjacent areas there are large differences in F0.1 (DPS 6 and 5, MUT 9 and 11, MUT 10 and 11 (MUT = red mullet)), this is biologically unlikely and probably some of these species belong to the same stock.
- An error in reference point was found in GSA 11 and derived from incorrect reporting in the STECF EWG report.

There could be different reasons driving the differences in F reference points. Some of the variability in Fmsy derives from natural mortality vectors (M) and the Von Bertalanffy growth parameters chosen for the stock.

For example the large difference in F0.1 for deep water pink shrimp (DPS) in GSA 1-5-6 can be explained with different growth parameters, as extracted from the report (STECF 2013).

Table 5.1 Biological parameters used in Y/R analysis to derive Fref. M is natural mortality at age.

species	area	Linf	K	t0	M(A0)	M(A1)	M(A2)	M(A3)	M(A4)	M(A5)	M(A6)	M method	F0.1
DPS	SA 1	45	0.39	0.10	1.25	0.82	0.39	0.28	0.22			PRODBIOM	0.26
DPS	SA 5	44	0.67	-0.21	1.22	0.55	0.44	0.39				PRODBIOM	0.62
DPS	SA 6	45	0.39	9.10	1.25	0.82	0.39	0.28	0.24	0.22	0.21	PRODBIOM	0.27

The EWG suggests an in depth exploration of the current methods for deriving F reference points to identify non harmonized practices and test the robustness of the current set of Fmsy before they are finally fixed in the regulation.

As a way forward the EWG suggests to:

- Harmonize the choices of VB parameters and M since some of the large difference may be the direct consequence on how these two are defined.
- In some cases F0.1 can be very low, explore taking Fmax when the Y/R curve is well defined.
- Explore alternative methods to compute Fmsy and Fmsy ranges using simulations.

5.4 Consistency across F targets

The states-space model described in Annex 02 was used to test the consistency of the Fmsy ranges in a context of mixed fisheries and species interactions. The model includes technical interactions between fleets and recruitment correlation across stocks. The model comes close to a multi-species equilibrium model, although taking a completely different approach. The fleet interactions are based on linear relationships between Fs and Ns. While the species interactions are based on the time series correlation across stocks' recruitment estimates.

Figure 5.33 shows the results of the analysis for each stock and for the two stock recruitment relationships tested. There are three important patterns emerging from this analysis:

- The simulations' quantiles are within the Fmsy ranges (ARA01, ARA06, DPS09, HKE1-7, MUT01, MUT06 and MUT09). For these stocks the Fmsy ranges seem to be aligned with the dynamics and uncertainty of the stocks and fisheries.
- The simulations' quantiles are outside the Fmsy ranges but the medians are inside (ARS09, ARS11, DPS01, DPS05, DPS10, HKE9-11, MUT07, MUT11 and MUT05). These stocks' assessment uncertainty creates a situation of higher risk of being off the Fmsy ranges.
- Both the quantiles and the medians are outside the Fmsy ranges (ANK05, ANK06 and DPS06). For these stocks the uncertainty about the dynamics are very high and the Fmsy ranges do not seem to be aligned with it, which reflects a high risk of missing the target and having these stocks limiting the fishery.

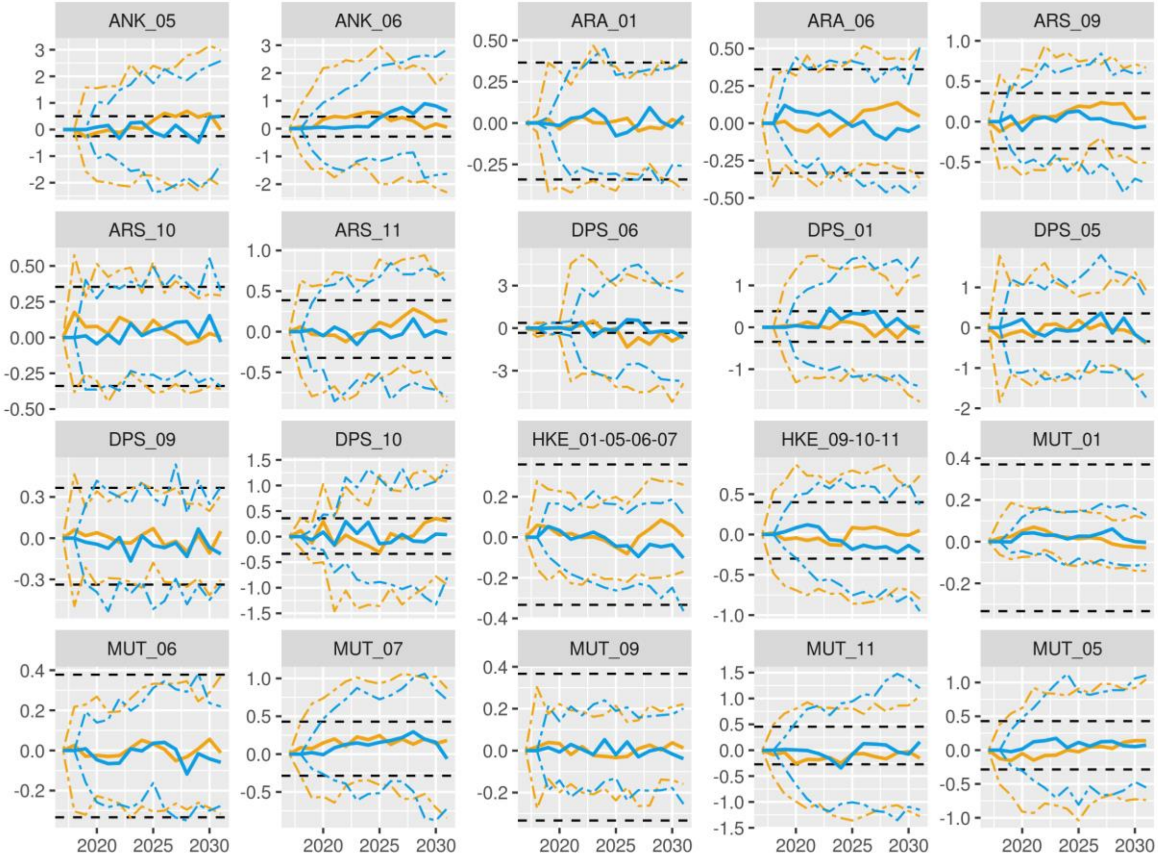


Figure 5.33 - Consistency of Fmsy targets with relation to assessment uncertainty, taking into account fleet interactions and species correlation in recruitment.

5.5 Economic analysis of management options

5.5.1 Economic performance of the EU fishing fleet in the Mediterranean

This section uses the data and analyses done at the 2016 Annual Economic Report (AER) (STECF, 2016a). The EU fleet fishing in the Mediterranean & Black Sea consisted of 34 438 active vessels. The small scale fleet (SSF) covered 27 051 vessels, or 79% of the regional fleet. Greece comprised the largest fleet in number (13 600 vessels, 41% of the total).

Total employment in 2014 was estimated at 93 256 jobs, corresponding to 74 858 FTEs. In terms of FTEs, Greece (41 438), Italy (20 694) and Spain (7 116) were the leading countries, together accounting for 93% of the total FTEs by the EU Mediterranean & Black Sea fleet.

The Mediterranean & Black Sea fleet spent more than an estimated 4 million days at sea in 2014 (including Greece). The Greek fleet accounted for 47% of the total number of days, followed by Italy (35%) and Spain (7%). The SSF accounted for 63% of the days at sea.

5.5.1.1 Landings

The weight and value of landings generated by the regional fleet in 2014 amounted to approximately 408 717 tonnes and €1.48 billion, respectively. In terms of landed weight, Italy (176 778 tonnes), Croatia (79 408 tonnes) and Spain (77 063 tonnes) were the leading countries, together accounting for 82% of the total weight of landings by the EU Mediterranean & Black Sea fleet.

In 2014 large-scale vessels generated by far the highest landed weight with 88% of the total estimated landed weight. Large-scale fleet generated around 77% of the value landed. Although over 63% of the effort was deployed by the small-scale fleet, these vessels landed only 12% of weight and 23% of the value in the region. This fleet segment is more important from a social point of view as it represents almost 61% of the FTE employment in the Mediterranean & Black Sea fleet (including Greece).

The main species for the EU Mediterranean fleet in 2014, in terms of weight was European pilchard (=sardine) (105 292 tonnes), followed by European anchovy (70 790 tonnes), European hake (16 003 tonnes) and then striped Venus (14 152 tonnes). Around 84% of European pilchards are mainly landed in the Adriatic Sea by Croatian (59%) and Italian (25%) fleets. While, the most landed species in value was European anchovy (€127 million) followed by European hake (€114 million).

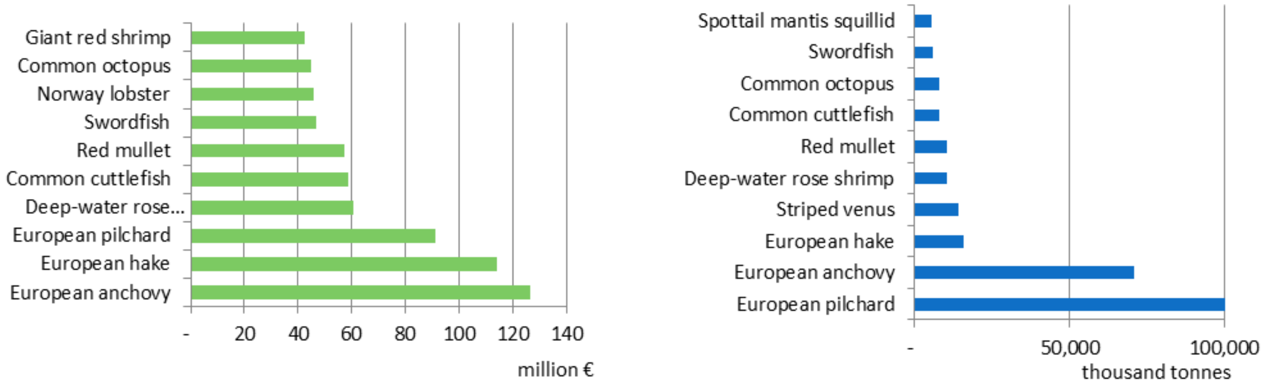


Figure 5.34 - List of the top 10 species in terms of weight and value landed for MS fleets operating in the Mediterranean & Black Sea, 2014. Source: 2016 AER (STECF, 2016a)

5.5.1.2 Economic performance

According to the 2016 AER, revenue and GVA have been decreasing since 2011; however, figures for 2014 show some improvement. The Italian fleet is the main contributor to trends in the region. Table 5.3 contain a summary of the economic performance of the Mediterranean & Black Sea fleet by Member State in 2014; while, Table 5.4 contains a summary of the economic performance of the Mediterranean & Black Sea by main type of fishing activity.

Excluding Greece, revenue (income from landings and other income) generated by the Mediterranean & Black Sea fleet in 2014 was an estimated €1.357 billion, 61% of which was generated by the Italian fleet (€824 million). In terms of economic performance, the amount of Gross Value Added (GVA), generated by EU Mediterranean & Black Sea fleet was €748 million. Italy (€461 million), Spain (€189 million), France (€49 million) and Croatia (€37 million) were the leading countries regarding GVA in 2014.

Gross profit was estimated at €286 million. The Italian fleet generated the largest gross profit in 2014 amounting to €226 million, followed by Spain (€37 million), Croatia (€14 million) and France (€8 million), together accounting for 97% of Gross profit. Net profit amounted to €42 million in 2014. Italy (€57 million), Spain (€13 million), Slovenia (€1 million), and Romania (€135 thousand) reported net profits in 2014. Five EU Mediterranean & Black Sea countries (excluding Greece) reported a loss (negative net profits) in 2014.

Among operating costs, the two major fishing expenses were crew and energy costs, accounting for €459 and €331 million, respectively. In terms of crew costs, Italy (€235 million), Spain (€150 million) and France (€40 million) were the leading countries, together accounting for 93% of the total crew costs. Regarding energy costs, Italy (€222 million), Spain (€66 million) and Croatia (€19 million) were the leading countries, together accounting for 93% of the total energy cost.

5.5.1.3 EU demersal fisheries in the Western Mediterranean Sea

The EU demersal fisheries in the Western Mediterranean Sea consider the EU fleets from Spain, France and Italy. According to the 2016 AER (STECF, 2016a), the fleet potentially targeting demersal fisheries covered by the MAP for the Western Mediterranean included around 9 000 vessels in 2014, with a combined gross tonnage of 56 331 GT and engine power of 473 615 kW. Days at sea amounted to 932 798, with an average of 103 days per vessel. In 2014 the estimated employment in the demersal fisheries has been equal to 14 119 jobs, corresponding to 10 717 FTEs.

According to the current AER, demersal trawlers represent 17% of the total fleet operating in the area (West Med), long-liners 2%, gillnets 9%, trammel nets and traps 59% and there is another 14% represented by polyvalent vessels. About 61% of the vessels are Italian, 25% are Spanish and 14% are French vessels. Demersal trawlers (around 1 500) are almost Italian and Spanish, more or less equally distributed. As far as long-liners (around 200 vessels), more than a half are Spanish (51%), followed by the French (37%) and Italian (12%). As far as gillnets, according to the 2016 AER, they are predominant in the French fleet (around 634 vessels) while vessels equipped with passive gears are predominant in Italy (more than 4 700 vessels).

Demersal fisheries are very important for the Western Mediterranean fleets: the production of French, Italian and Spanish vessels equipped with demersal trawlers, long-liners, gillnets, trammel nets and traps fishing in the waters covered by the MAP represents, approximately, 31% and 53% of the overall production in the area, in volume and value terms, respectively.

Currently the main species caught by demersal fisheries in the Western Mediterranean are: hake, red mullet, blue whiting, monkfishes, deep-water rose shrimp, giant red shrimp, blue and red shrimp and Norway lobster. In 2014, the volume of landings of European hake, red mullet and deep water rose shrimp, the species which define the Western Mediterranean demersal fisheries for the MAP, amounted to 10 000 tonnes and about €69 million (around 25% of the overall demersal production). The first species, both in volume and value (64%) is hake, followed by red mullet (25% in volume and 21% in value). Deep water rose shrimp represents 11% in volume terms and 14% in value terms, having the higher average price (8.65 €/kg). According to 2014 data on landings, the great bulk of deep water rose shrimp (94%) is caught by Italian trawlers. Hake is principally targeted by Italian vessels: 23% trawlers and 19% passive gears; another 29% of hake landings are to be attributed to Spanish trawlers and a 21% to French trawlers. As far as red mullet, it is targeted only by Italian (74%) and Spanish vessels (26%).

While the average price of the red mullet landed by Italian and Spanish vessels is almost the same (on average 5.92 €/kg), the prices of hake and deep water rose shrimp show a high variability between countries. In 2014, an average price of 16.15 €/kg in Spain and around 8.00 €/kg in France and Italy is registered for deep water rose shrimp. For hake the higher price (8.45 €/kg) is registered for the Italian vessels, to be attributed to the high share of production belonging to passive gears (about a half), whose landings are generally characterized by a higher quality and a higher commercial value. Hake landed by Spanish vessels was sold at an average price of 6.68 €/kg while hake landings from French vessels show the lowest average price (4.50 €/kg).

5.5.1.4 EU demersal trawlers and seiners in the Western Mediterranean Sea

According to section 9.2.2, demersal trawlers and seiners (DTS) are the main fleet in terms of demersal species catches in the Western Mediterranean Sea. According to the 2016 AER data, there are almost 6000 EU demersal trawlers and seiners in the Western Mediterranean Sea. These vessels employ almost 10 700 people.

The EU demersal fleet in the Western Mediterranean generated almost €26 million in profits and €180 million in GVA.

Table 5.2 - Main economic indicators for the EU fishing fleets in Western Mediterranean

		Profits	GVA	Employment	Vessels number
DTS	France	-1.8	6.8	216	126
	Italy	20.9	108.9	7556	4528
	Spain	6.9	64.2	2917	1334
	Total	25.9	179.9	10689	5988
Other fleets Western Med	France	9.9	38.4	1518	2332
	Italy	53.4	200.0	19376	18583
	Spain	13.1	107.6	5967	3569
	Total	76.3	346.0	26861	24484

At fleet segment level, the Italian demersal trawls and seines 12-18m segment generated the most revenue from the Mediterranean & Black Sea region in 2014 (€162 million), followed by the Italian polyvalent passive gear 06-12m segment (€159 million) and Italian demersal trawls and seines 18-24m segment (€156 million). The same fleet segments also generated the highest GVA and gross profit in 2014 (Table 5.5).

Table 5.5 provides results for the top 35 MS fleet segments (out of 126 active fleet segment recorded, Greek fleet is excluded) in terms of value of landings operating in the region in 2014. These fleets represented 72% of the population, covering 84% of the effort deployed (1.8 million days) and generating 91% of the revenue (€1.2 billion), 91% of the GVA (€667 million) and 94.5% of the gross profit (€264 million).

Table 5.3 - Structure and economic performance estimates by MS fleets operating in the Mediterranean & Black Sea region, 2014

		Estimated no. of vessels	% of total no. of vessels	Estimated employed	Estimated FTE	Days at sea	as a % of total DAS	Fishing days	as a % of total fishing days	Live weight of landings	as a % of total landed weight	Value of landings	as a % of total landed value	Revenue	Labour costs	Energy costs	Gross Value Added	GVA to revenue	Gross profit	Gross profit margin	Net profit	Net profit margin	Average GVA	GVA per FTE
		(#)	(%)	(person)	(#)	(day)	(%)	(day)	(%)	(tonnes)	(%)	(K €)	(%)	(K €)	(K €)	(K €)	(K €)	(%)	(K €)	(%)	(K €)	(%)	(K €)	(K €)
Mediterranean Sea and Black Sea	BGR	1,110	100%	1,517	532	21,265	100%	21,265	100%	7,897	100%	4,334	100%	5,488	2,736	1,508	2,687	49.0	-48	-0.9	-1,543	-28.1	2.4	5.0
	CYP	849	99%	1,192	702	65,078	99%	65,078	99%	1,237	94%	6,819	91%	6,812	668	1,927	937	13.8	269	4.0	-5,090	-74.7	1.1	1.3
	ESP	2,456	20%	8,689	7,116	294,435	30%	294,435	30%	77,063	8%	249,400	12%	334,044	149,799	66,119	189,481	56.7	37,025	11.2	13,203	4.0	77.1	26.6
	FRA	1,229	19%	1,745	991	61,611	13%	60,796	14%	13,837	3%	56,142	5%	93,945	40,479	16,844	48,696	44.5	8,217	1.9	-7,371	-10.2	26.9	33.5
	HRV	2,716	100%	4,842	2,151	241,236	100%	206,059	100%	79,408	100%	60,841	100%	76,479	22,785	19,194	36,596	47.9	13,811	18.1	-10,934	-14.3	13.5	17.0
	ITA	11,555	100%	26,932	20,694	1,432,584	100%	1,530,390	100%	176,778	100%	813,320	100%	824,161	234,964	221,711	460,958	55.9	225,994	27.4	57,391	7.0	39.9	22.3
	MLT	709	100%	1,418	1,115	31,293	100%	28,586	100%	2,401	100%	10,453	100%	11,670	6,103	2,702	5,251	45.0	-852	-7.3	-4,651	-39.9	7.4	4.7
	ROU	123	100%	330	38	2,774	100%	2,735	100%	2,200	100%	2,458	100%	2,458	1,041	554	1,485	60.4	445	18.1	135	5.5	12.1	39.2
	SVN	91	100%	126	80	8,595	100%	8,595	100%	254	100%	1,277	100%	2,741	918	232	2,261	82.5	1,343	49.0	1,012	36.9	24.8	28.2
	GRC	13,600	100%	46,465	41,438	1,920,719	100%	-		47,642	100%	278,651	100%					-44.8		-144.1		-169.2		

* Incomplete and questionable data for Greece. All monetary values have been adjusted for inflation; constant prices (2015). Data source: AER 2016.

Table 5.4 - Structure and economic performance estimates* by main gear type for MS fleets operating in the Mediterranean & Black Sea region, 2014

	Total number of vessels	Estimated % of vessels by gear type	Total employed	FTE	Days at sea	as a % of DAS by gear type	Fishing days	as a % of FD by gear type	Live weight of landings	as a % of landed weight by gear type	Value of landings	as a % of landed value by gear type	Revenue	Labour costs	Energy costs	Gross Value Added	GVA to revenue	Gross profit	Gross profit margin	Net profit	Net profit margin	Average GVA	GVA per FTE
	(#)	(%)	(person)	(#)	(day)	(%)	(day)	(%)	(tonnes)	(%)	(K €)	(%)	(K €)	(K €)	(K €)	(K €)	(%)	(K €)	(%)	(K €)	(%)	(K €)	(K €)
Pelagic	883	32.2%	6,508	4,936	110,355	48%	104,811	51%	186,563	7%	234,472	12%	238,813	91,849	34,577	153,094	64.1	61,245	25.7	22,485	9.4	173	31.0
Demersal	4,323	37.4%	13,659	11,741	550,180	39%	539,855	40%	112,015	7%	597,707	17%	686,489	182,358	244,022	307,948	44.9	125,589	18.3	221	0.0	71	26.2
Other	15,615	38.9%	26,471	16,726	1,498,337	47%	1,573,274	49%	62,497	10%	372,866	23%	411,800	176,022	51,574	271,216	65.9	92,537	22.7	19,445	4.8	17	16.2

* Excludes Greek data. All monetary values have been adjusted for inflation; constant prices (2015). Data source: AER 2016.

Table 5.5 - Structure and economic performance estimates for the top 35 MS fleets operating in the Mediterranean & Black Sea region, 2014

	Estimated no. of vessels	% of total no. of vessels	Estimated employed	Estimated FTE	Days at sea	as a % of total DAS	Fishing days	as a % of total fishing days	Live weight of landings	as a % of total landed weight	Value of landings	as a % of total landed value	Revenue	Labour costs	Energy costs	Gross Value Added	GVA to revenue	Gross profit	Gross profit margin	Net profit	Net profit margin	Average GVA	GVA per FTE
	(#)	(%)	(person)	(#)	(day)	(%)	(day)	(%)	(tonnes)	(%)	(K €)	(%)	(K €)	(K €)	(K €)	(K €)	(%)	(K €)	(%)	(K €)	(%)	(K €)	(K €)
ITA A37 DTS1218	1,254	100%	3,460	3,211	170,652	100%	166,676	100%	23,758	100%	158,081	100%	161,592	36,582	55,532	80,654	49.9	44,073	27.3	24,432	15.1	64.3	25.1
ITA A37 PGP0612	5,297	100%	9,734	7,172	666,877	100%	744,446	100%	22,231	100%	158,633	100%	158,922	63,271	21,140	110,108	69.3	46,837	29.5	14,391	9.1	20.8	15.4
ITA A37 DTS1824	632	100%	2,560	2,423	100,577	100%	100,797	100%	25,754	100%	152,480	100%	156,127	31,197	64,081	67,612	43.3	36,415	23.3	201	0.1	107.0	27.9
ESP A37 DTS1824	338	99%	1,474	1,530	48,452	99%	48,452	99%	7,904	100%	41,352	99%	83,686	28,438	25,577	36,297	43.4	7,859	9.4	2,007	2.4	107.3	23.7
ITA A37 DTS2440	195	100%	1,172	1,142	32,990	100%	31,689	100%	9,076	100%	77,450	100%	78,927	17,218	34,422	31,124	39.4	13,906	17.6	- 13,248	- 16.8	159.4	27.3
ESP A37 DTS2440	157	100%	735	793	24,902	100%	24,902	100%	5,354	100%	35,081	100%	50,795	16,464	18,168	21,925	43.2	5,462	10.8	980	1.9	139.9	27.6
ESP A37 PS1824	93	99%	1,017	978	13,019	100%	13,019	100%	22,543	100%	41,885	100%	46,106	25,061	3,734	35,003	75.9	9,942	21.6	7,546	16.4	376.5	35.8
ITA A37 PGP0006	2,300	100%	3,340	2,180	262,501	100%	282,684	100%	5,794	100%	43,598	100%	43,598	16,837	4,278	31,332	71.9	14,495	33.3	10,041	23.0	13.6	14.4
ITA A37 DRB1218 °	706	100%	1,541	485	54,805	100%	54,385	100%	15,614	100%	39,679	100%	39,831	15,324	4,825	28,975	72.8	13,651	34.3	3,194	8.0	41.0	59.8
ESP A37 PMP0612	995	97%	1,690	1,142	107,679	99%	107,679	99%	6,028	99%	29,265	99%	32,026	22,106	2,290	23,673	73.9	1,567	4.9	- 1,217	- 3.8	23.8	20.7
ITA A37 PGP1218 °	369	100%	1,099	895	49,099	100%	53,920	100%	3,786	100%	29,020	100%	29,038	9,743	4,556	18,868	65.0	9,124	31.4	1,979	6.8	51.1	21.1
ESP A37 PS1218	93	99%	876	713	11,125	100%	11,125	100%	18,252	100%	30,569	100%	28,907	14,967	1,923	20,607	71.3	5,640	19.5	5,026	17.4	221.6	28.9
ESP A37 DTS1218	160	99%	648	733	23,980	100%	23,980	100%	3,203	100%	12,370	100%	28,526	11,300	8,036	13,539	47.5	2,239	7.9	1,224	4.3	84.6	18.5
ITA A37 TM2440	67	100%	496	489	9,794	100%	9,789	100%	21,603	100%	22,480	100%	23,020	4,743	9,196	9,304	40.4	4,561	19.8	- 1,218	- 5.3	138.9	19.0
FRA A37 DTS2440 °	33	27%	152	148	6,676	29%	6,545	32%	7,563	17%	21,653	19%	20,867	8,833	9,145	1,015	4.9	- 7,818	- 37.5	- 12,287	- 58.9	30.8	6.8
HRV A37 PS2440 °	70	100%	651	456	13,298	100%	11,289	100%	43,887	100%	18,810	100%	20,160	7,056	4,169	9,546	47.4	2,491	12.4	- 5,736	- 28.5	136.4	20.9
ITA A37 HOK1218 °	122	100%	464	383	16,692	100%	16,790	100%	2,738	100%	18,669	100%	18,669	6,064	2,471	11,549	61.9	5,485	29.4	3,102	16.6	94.3	30.2
ESP A37 PS2440 °	27	100%	316	177	2,838	100%	2,838	100%	5,906	100%	23,552	100%	17,606	8,250	987	11,418	64.9	3,168	18.0	1,103	6.3	422.9	64.6
FRA A37 DFN0612	509	100%	513	323	22,633	100%	22,503	100%	952	100%	6,837	100%	15,354	7,594	1,434	10,763	70.1	3,169	20.6	1,593	10.4	21.1	33.3
ITA A37 PS40XX	10	100%	150	27	98	100%	98	100%	1,319	100%	15,185	100%	15,185	3,874	288	13,887	91.5	10,013	65.9	6,379	42.0	1,388.7	513.6
ITA A37 PS1824	43	100%	433	290	4,882	100%	4,383	100%	6,348	100%	15,090	100%	15,090	4,773	2,036	9,650	64.0	4,877	32.3	2,548	16.9	225.8	33.3
ITA A37 PS1218	93	100%	638	435	12,326	100%	12,257	100%	4,769	100%	13,331	100%	13,342	5,199	1,985	8,905	66.7	3,705	27.8	1,620	12.1	95.9	20.5
ITA A37 PS2440	37	100%	364	338	3,688	100%	3,665	100%	6,868	100%	11,546	100%	11,654	3,544	2,008	7,516	64.5	3,972	34.1	2	0.0	204.4	22.2
ITA A37 TM1218 °	39	100%	167	167	6,218	100%	6,320	100%	9,709	100%	10,698	100%	10,884	3,568	1,635	7,653	70.3	4,085	37.5	3,606	33.1	196.2	45.8
HRV A37 PS1824	53	100%	404	311	9,876	100%	8,526	100%	21,416	100%	9,540	100%	10,527	3,241	1,845	5,694	54.1	2,453	23.3	- 665	- 6.3	107.4	18.3
ITA A37 TM1824	38	100%	199	172	5,636	100%	5,625	100%	10,707	100%	10,039	100%	10,518	2,400	2,584	4,858	46.2	2,458	23.4	527	5.0	127.8	28.3
FRA A37 DTS1824 °	30	100%	75	49	4,156	100%	4,111	100%	2,414	100%	9,256	100%	10,148	3,100	3,419	4,167	41.1	1,067	10.5	245	2.4	138.9	84.2
ESP A37 DFN0612	84	99%	249	171	12,604	100%	12,604	100%	725	100%	3,437	100%	9,767	8,262	917	6,527	66.8	- 1,735	- 17.8	- 2,117	- 21.7	77.7	38.1
HRV A37 DTS1218	200	100%	358	227	18,726	100%	16,847	100%	2,162	100%	6,801	100%	9,578	2,062	3,687	3,987	41.6	1,924	20.1	- 833	- 8.7	19.9	17.6
ITA A37 DTS0612	183	100%	364	241	17,792	100%	18,386	100%	1,495	100%	9,481	100%	9,555	3,162	2,244	5,355	56.0	2,193	23.0	860	9.0	29.3	22.3
ITA A37 TBB1824	29	100%	138	138	3,804	100%	3,804	100%	1,312	100%	8,656	100%	8,935	1,562	3,657	3,023	33.8	1,461	16.4	- 374	- 4.2	102.8	22.0
ITA A37 HOK1824 °	42	100%	258	217	6,035	100%	6,026	100%	907	100%	6,749	100%	6,749	2,430	1,042	4,167	61.8	1,738	25.7	- 1,324	- 19.6	99.2	19.2
HRV A37 DFN0612	692	100%	952	302	65,520	100%	51,250	100%	575	100%	3,394	100%	6,677	2,094	953	3,841	57.5	1,747	26.2	- 118	- 1.8	5.6	12.7
ESP A37 PGO1218 ᶜ	43	95%	217	153	3,594	99%	3,594	99%	1,146	99%	6,049	99%	6,272	2,340	649	3,133	50.0	793	12.7	438	7.0	73.2	20.4
ITA A37 TBB2440	17	100%	107	94	2,360	100%	2,329	100%	1,618	100%	5,724	100%	5,779	1,214	2,499	2,149	37.2	935	16.2	- 632	- 10.9	126.4	22.8

Excludes Greek data. All monetary values have been adjusted for inflation; constant prices (2015). Data source: AER 2016.

5.5.2 Impacts on the economic performance and salaries of different management measures

In general terms, in the Mediterranean, when aiming at achieving Fmsy there is the need to reduce fishing mortality (F). Reductions in fishing mortality can be achieved mainly by: (a) Effort (capacity and fishing time) reductions; (b) technical measures changes and (c) implementing TAC and quotas.

The use of these management options to regulate fisheries implies establishing limitations in the activity inputs or outputs. Therefore, all these measures have an impact on the economic performance of the fleets. But the impacts of these management measures will be diverse. Unfortunately, the model used in the working group to assess the likely biological and socio-economic benefits of implementing the management options is not able to estimate the economic and social performance of fleets and so it cannot properly estimate the effects of these management options.

Effort reductions can be implemented reducing the number of vessels participating in the fishery (capacity), the fishing time (e.g. fishing days), or a combination of both. Choosing whether reducing capacity or fishing time is a political decision, but it has some important trade-offs. Economically, it is preferred to reduce capacity because it will lead to lower overall fishing costs; however, it will also lead to a higher unemployment than if only fishing time is reduced. But even if higher employment levels can be maintained when fishing time is reduced, average salaries will tend to be lower, because of the extended use of shared remuneration systems in the fisheries, as we will see below. So, from a social point of view there is also a trade-off between choosing between capacity and fishing time reductions, and its preference may depend on the social and economic situation of the country (e.g. overall unemployment rate, average salary)[9].

The effects of technical measures changes and the establishment of TAC and quotas are more uncertain. Changes in the technical measures may have an impact on the variable fishing costs (e.g. due to operating a different gear, as well as buying the gear, or moving to new fishing areas in consequence of fisheries closures), but also on the revenues (e.g. change the composition of the catches). Similarly, the establishment of TAC and quotas (if there is compliance) can impact both the variable fishing costs and revenues because depending on the choke species, fishers will have to change fishing strategies to avoid unwanted catches.

The extended use of shared remuneration systems implies that salaries are related to the fleet’s economic performance. In Mediterranean fisheries, salaries are often determined as a function of the value of landings minus some operational costs (usually landing fees, fuel, ice, food, and bait costs). However, the share rate and the operating

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[9] In order to illustrate the impact that capacity and fishing time reductions have on costs and consequently on the economic performance of the fleets, we propose the following example. Let’s assume that a fishery is compounded of 100 vessels, with fixed costs of 10 per vessel, and variable costs of 1 per day per vessel. Initially, each vessel is fishing 200 days per year.

- Hence, if nothing changes, then total costs of the fleet would be 10*100 + 1*200*100 = 21000.
- If the 20% effort reduction is done (assuming a constant relation between capacity and effort) thought a 20% **capacity reduction** (number of vessels), then totals costs would be 10*80 + 1*200*80 = 16800.
- If the 20% effort reduction is done thought a 20% **fishing time reduction**, then totals costs would be 10*100 + 1*160*100 = 17000.

costs (or variable costs) that are deducted from the value of landings before sharing can vary between fishing fleets, fisheries, countries, and even vessels[10].

Because management measures have an impact on the fleet's economic performance, and salaries in fisheries are related to the fleet's economic performance, the different management measures will lead to different salary levels and consequently also to further different cost levels.

In front of a big shock (e.g. changes in management measures), the crew share rate in the shared remuneration system may change, as we will see below, and so on the two extreme cases we will have salaries behaving as pure shared remuneration system salaries or as fixed salaries depending on the stability of the crew share rate[11].

So, capacity reductions lead to higher profits (more pronounced when looking at the profits per vessel) than fishing time reductions. Moreover, when considering shared remuneration systems, fishers receive higher salaries in the capacity reduction option than in the fishing time reduction option, even if the total salary costs are similar. In addition, with shared remuneration systems, once the overall economic performance increases (e.g. from recovering of fish stocks), salaries increase allowing fishers to capture part of the fisheries rents. But even if profits increase, they increase less than predicted considering fixed salaries.

5.6 Employment

The information used for evaluating employment came from the data compiled for the 2015 Annual Economic Report (STECF, 2015f) regional analysis. Transversal data from

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[10] The trawl fisheries in the Spanish Mediterranean remunerate their crew with a share (often 50%) of the revenues minus operational costs, but crew also receive a small part of the landings (*morralla*, composed of low valued species) (Lleonart, et al., 1999 and 2003; Maynou et al., 2006);

In France, the most common crew remuneration system is based on a share of the revenue minus the operational costs, as modeled in Macher et al. (2008);

In Italy, the crew is also remunerated following a similar mechanism. However, in the artisanal fishery of Cilento (Italy), crew members receive about 50% of the revenues, and any fish that have not been sold because of damage or no commercial value (Colloca et al., 2003).

[11] We use the data from the previous example to illustrate the impact on salaries and we model salaries as fixed or shared remunerations. In addition, we assume total revenues to be 26000 and fixed salaries to be 10 per fisher (for a total of 3000, with 3 crew per vessel for 100 vessels initially):

- In the **initial case**, we have that revenues were 26000 fixed and variable costs amounted to 21000, with fixed salaries of 3000, it will lead to a profitability of 2000 (20 per vessel). When assuming a shared remuneration system, the salary is estimated as a share (often 50%) of revenues (26000) minus variable costs (20000), so also 3000 and the same profitability level (2000).
- In the 20% **capacity reduction** (number of vessels), we have 80 vessels, 800 fixed and 16000 variable costs. We need to estimate the revenues, by assuming that the CPUE slightly increases (about 10%) due to the reduction in total effort and potential recover of the stocks, then revenues could amount to 23000. Fixed salaries would be then 2400 (10*3*80), and profits would be 3800 (23000-800-16000-2400), 47.5 per vessel. On the other hand, shared salaries are estimated to be 3500 (50% of 23000-16000), being the salary per fisher 14.6 (3500/(3*80)) instead of the fixed 10. Profits would be 2700 (23000-800-16000-3500), 33.75 per vessel.
- In the 20% **fishing time reduction**, we have 100 vessels, 1000 fixed and 16000 variable costs. For the case of fixed salaries (assuming that the remuneration is fixed per time worked) then salary costs would also be 2400. While profits would be 3600 (23000-1000-16000-2400), equal to 36 per vessel. The shared salaries would amount to 3500 (50% of 23000-16000), while the salary per fisher would be 11.67 (3500/(3*100)). Profits would be 2500 (23000-1000-16000-3500), equal to 25 per vessel.

2012 to 2014 were chosen to provide information on dependency of fishing fleets to the selected stocks (see list of stocks provided in ToRs).

Initial discussions uncovered that for the purposes of the Northwest Mediterranean MAP it is useful to have an understanding of the numbers of fishers directly involved in the fisheries in question, as well as the economic dependency on the stocks under review.

As such, this analysis aims to identify potential high impacts in employment due to the implementation of the MAP. Although there are several factors that influence economic dependency and employment (see section 5.5.2), it can be assumed that a fleet which shows a high dependency on the stocks under management carries the potential to be more affected by effort reductions, which in the Mediterranean are quite large, than a fleet with low dependency. If additionally the fleets with high dependency are also the largest providers of employment, then a potential large impact on employment exists and the analysis flags these situations. Having identified potential problems allows, e.g. DGMARE and stakeholders to develop monitoring programs to survey the progress of employment conditions.

5.6.1 Steps taken

The first step involved taking relevant data from the AER regional analysis, for the fleets in question, including: employment (both total number employed and full time equivalent (FTE)) on national level, and landings (value and live weight on GSA level). Using these data, several indicators, such as economic dependency[12] to the fishing activity in the northwestern Mediterranean for 6 species [European hake, HKE (*Merluccius merluccius*), blue and red shrimp ARA (*Aristeus antennatus)*, black-bellied anglerfish ANK (*Lophius budegassa)*, red mullet MUT (*Mullus barbatus*), deep-water rose shrimp DPS (*Parapenaeus longirostris)*, and giant red shrimp ARS (*Aristaeomorpha foliacea)*] in GSAs 1, 5, 6, 7, 9, 10 and 11 were calculated.

The final evaluation included total employment for fleets dependent on European hake (*Merluccius merluccius*), blue and red shrimp (*Aristeus antennatus)*, black-bellied anglerfish (*Lophius budegassa)*, red mullet (*Mullus barbatus*), deep-water rose shrimp (*Parapenaeus longirostris)*, and giant red shrimp (*Aristaeomorpha foliacea*) with selection focused on the value of landings from these species compared with each fleet's overall Area 37 (GSAs 2 and 8 not included in ToRs) landings' values, in order to estimate fleet dependency on these stocks.

5.6.2 Employment

Available employment data were problematic given the nature of aggregation and scale. Employment and Full time equivalent (FTE) data could not be retrieved at the GSA level for the majority of GSAs, therefore national level data retrieved from DCF data compiled for the 2015 Annual Economic Report (STECF 2015f) were used for Spain in GSAs 1, 5, 6 and 7 and France (GSA 7).

For Italy, employment data for GSAs 9, 10, and 11 are problematic as the employment is aggregated at the national level, combining the data from all the fleets exploiting the

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[12] Dependency is calculated as the share of landings value coming from the region/species compared to the overall value of landings for the selected fleet segments.

different Italian GSAs, including those in the southern and eastern waters of Italy. To get around this, published employment data from the MARE/2014/27 (Spedicato, 2016) project were used for GSAs 9 and 11. No data were available for GSA 10.

Employment for fleet segments is presented below for those which meet the minimum threshold of 5% dependency on the selected stocks.

Table 5.6 - SPAIN GSAs 1, 5, 6, 7. Employment and FTE by fleet segment, ranked according to numbers employed. Data from 2012 to 2014 were averaged.

Fleet segments	Employment	FTE
ESP A37 DTS1824	1327	1256
ESP A37 DTS2440	699	585
ESP A37 DTS1218	546	490
ESP A37 HOK1218	283	145
ESP A37 DFN1218	274	100
ESP A37 DFN0612	207	140
ESP A37 HOK1824	187	170
ESP A37 HOK0612	166	95
ESP A37 DTS0612	50	42

A wide variety of different fleet segment operate within GSAs 1, 5, 6 and 7, including long lines (HOK 06-12m, 12-18; 18-24), trawls (DTS 06-12m, 12-18; 18-24; 24-40), and lift/gillnets (DFN 06-12, 12-18). Trawlers (DTS 12-40m) provide a significant share of employment with 68% found in these segments.

Table 5.7 - FRANCE GSA 7. Employment and FTE by fleet segment, ranked according to numbers employed. Data from 2012 to 2014 were averaged.

Fleet segments	Employment	FTE
FRA A37 DTS2440	138	100
FRA A37 DTS1824	83	62
FRA A37 DFN1218	36	15

The French fleets operating in GSA7 which met the minimum threshold of 5% include only three fleet segments: Trawlers (DTS 18-24 and 24-40) and liftnets/gillnets. Of these, 85% of employment is found in the DTS segment.

Table 5.8 - ITALY GSA 9. Employment and FTE by fleet segment, ranked according to numbers employed. Data from 2012 to 2014 were averaged. Source: Spedicato (2016) * Data available only at aggregated level for ITA A37 PGP0006 and ITA A37 PGP0

Fleet segments	Employment	FTE
ITA A37 PGP0012 *	1608	871
ITA A37 DTS1824	390	333
ITA A37 DTS1218	342	292
ITA A37 PGP1218	158	86
ITA A37 DTS0612	NA	NA

ITA A37 DTS2440	31	26

The fleet segments operating within GSA 9 are made of a variety of gear types, especially trawls and stationary gears such as gill nets and set nets. 72% of employment is found in the PGP00-12m segment while trawlers make up 19% of the total. It should be noted that employment numbers were not available for the DTS0612 segment, although it is expected it could have low employment, as this segment employs only 367 persons (224 FTE) at Italian national level.

Table 5.9 - ITALY GSA 11. Employment and FTE by fleet segment, ranked according to numbers employed. Data from 2012 to 2014 were averaged. Source: Spedicato (2016).

Fleet segments	Employment	FTE
ITA A37 DTS1218	142	121
ITA A37 DTS1824	122	104
ITA A37 DTS2440	84	72
ITA A37 DTS0612	NA	NA

Employment for the fleet segments which met the minimum 5% threshold in GSA 11 is found only in the trawling fleets (DTS 0612 to DTS2440). 75% of the employment is found in the middle range fleets (DTS 1218 and DTS1824). It should be noted that employment numbers were not available for the smallest boats in DTS0612, but the same considerations highlighted in GSA 9 on this fleet segment can apply also in GSA 11.

5.6.2.1 High employment fleets

Given the scale of the Western Mediterranean Sea, high employment fleets vary from GSA to GSA. Overall though, trawlers make up the highest employment segments. Among Spain's fleet segments in GSAs 1, 5, 6, and 7, trawlers make up the greatest employment with 68%. Of these trawlers, 73% of employment comes from middle range boats (DTS12-18, 18-24). For France, trawlers operating in GSA 7, 85% of employment is found in the DTS24-40 and DTS18-24 segments. While for GSA 9 in Italy, the PGP under-12, segment makes up 63% of employment. In GSA11, trawlers again make up the highest employment with almost 41% (DTS1218).

It should be noted that employment numbers were not available at GSA level for many of the smallest fleet segments, e.g., DTS0612 (GSA 9 and GSA 11). As mentioned before, the national figure reports 367 employees (224 FTE) in this fleet segment. However, this data cannot be used to provide an accurate figure of the employment in this segment at GSA level.

5.6.3 Dependency on the selected stocks

The fleets dependency upon landings of selected stocks in comparison to their overall value of landings vary significantly among gear type, boat length, and GSA, although in general the most impacted fleet segment is DTS. Fourteen fleets have landings values greater than 30% coming from the selected stocks.

The following tables present the fleet segments with the highest percentages of landings (Value and weight) of the selected stocks by GSA. Data from 2012 to 2014 were used and averaged to produce the summary tables. The percentage contribution of the selected stocks to the total landings weight and value of each fleet segment are shown. For red mullet (MUT) in GSAs 1, 5, 6 and 7, some misreporting in economic data was observed. Biological official data on MUR and MUT by GSA were used to split the MUX (*Mullus* spp.) economic data into each species. The MUT estimates where then added to the MUT economic data. Similarly, the coding MNZ is used for reporting landings of species belonging to the genus *Lophius*. As it was not possible to obtain accurate estimation of the proportion in the landings of *L. piscatorius* (MON) and *L. budegassa* (ANK), the three categories (MNZ, MON, and ANK) were pulled together and used to estimate the contribution of anglerfish to the different fleets.

Table 5.10 - GSA 1. Northern Alboran Sea. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 1. Data from 2012 to 2014 were averaged. A minimum threshold of 5% dependency was used. Selected stocks in GSA 1 are ANK, ARA, DPS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ESP A37 DTS2440	628	27.3	3755	65.3
ESP A37 DTS1824	2201	19.0	11131	49.2
ESP A37 DTS1218	964	16.5	4424	32.2
ESP A37 DTS0612	64	12.4	272	18.0

In GSA 1, four DTS fleet segments have landings (weight) and values greater than 12% and 18% respectively for the selected stocks (ANK, ARA, DPS, HKE, MUT). Three fleet segments are highly dependent upon the selected stocks with contribution in landings value greater than 30%. The fleet segment DTS2440 shows a very high dependency (65%) in terms of landings value. This is mainly due to blue and red shrimp (ARA) which is contributing for more than 40% to the landings value of this fleet segment.

Table 5.11 - GSA 5. Balearic Islands. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 5. Data from 2012 to 2014 were averaged. Selected stocks in GSA 5 are ANK, ARA, DPS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ESP A37 DTS2440	212	33.7	2036	69.31
ESP A37 DTS1824	1085	17.8	7601	43.86
ESP A37 DTS1218	231	10.3	1131	14.30

In the Balearic Islands (GSA 5), only DTS fleets show dependency higher than 5% on the selected stocks. As in the case of GSA 1, DTS 2440 fleet segment is highly dependent on the stocks both in terms of landings weight (34%) and value (69%) as the vessels included in this segment target the blue and red shrimp which is a very highly priced species.

Table 5.12 - GSA 6. Northern Spain. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 6. Data from 2012 to 2014 were averaged. A minimum threshold of 5% dependency was used. Selected stocks in GSA 6 are ANK, ARA, DPS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ESP A37 DTS2440	4929	35.6	29423	61.2
ESP A37 DTS1824	6695	24.7	33723	43.4
ESP A37 DTS1218	2780	12.5	10205	23.4
ESP A37 DTS0612	282	13.2	1008	22.5
ESP A37 HOK1218	423	9.8	2028	3.1
ESP A37 HOK0612	230	9.5	719	8.2
ESP A37 DFN1218	700	8.3	2705	12.8
ESP A37 DFN0612	770	6.3	2950	10.1

In GSA6, unlike the Balearic Islands (GSA5), fleets other than DTS, as well as DTS, are dependent with contribution higher than 5% on the selected stocks. However, the fleets highly dependent on the stock are again the largest segments of DTS (1824 and 2440). In particular, DTS2440 vessels who are targeting blue and red shrimp show the highest dependency, mainly due to the ARA which is contributing by 30% of the landings value of this fleet segment (7% in landings weight).

Table 5.13 - GSA 7. Gulf of Lions. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 7. Data from 2012 to 2014 were averaged. A minimum threshold of 5% dependency was used. Selected stocks in GSA 7 are ANK, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ESP A37 HOK1218	14	55.9	105	51.1
ESP A37 DTS1824	236	41.7	1305	42.5
ESP A37 DTS2440	284	27.1	2450	17.9
ESP A37 HOK1824	2	17.8	15	13.6
FRA A37 DTS1824	2446	17.4	9019	21.7
FRA A37 DTS2440	6899	16.0	18308	24.9
FRA A37 DFN1218	80	14.6	754	12.2
ESP A37 DTS1218	5	9.9	23	8.2

For GSA 7, eight fleet segments for the selected stocks (ANK, HKE, MUT) have landings (weight) and values greater than 10% and 8% respectively. Of these, two fleet segments are highly dependent upon the selected stocks with values around 50% (ESP HOK1218 and ESP DTS1824). French fleet segments of GSA 7, with the highest dependence in terms of landing value are DTS (FRA A37 DTS1824 and FRA A37 DTS2440, 22 and 25% respectively) and then French netters with 12% dependency.

Table 5.14 - GSA 9. Ligurian and North Tyrrhenian Sea. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 9. Data from 2012 to 2014 were averaged. A minimum threshold of 5% dependency was used. Selected stocks in GSA 9 are ARS, DPS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ITA A37 DTS2440	254	43.8	2727	43.2
ITA A37 DTS1824	4066	32.0	31894	30.5
ITA A37 DTS1218	2589	31.3	21885	27.8
ITA A37 PGP1218	633	23.0	4089	11.1
ITA A37 DTS0612	138	17.6	1436	13.9
ITA A37 PGP0612	2459	9.0	23727	9.5
ITA A37 PGP0006	630	4.5	5498	7.4

In GSA 9, three fleet segments (DTS2440, DTS1824, and DTS1218) show a high dependency on the selected stocks. Also the fleet segment PGP1218 shows some dependency on the selected stocks, especially in terms of landings live weight. This dependency is mainly driven by European hake that represents the target species of gill net fisheries that are carried out in the area.

Table 5.15 - GSA 10. South Tyrrhenian Sea. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 10. Data from 2012 to 2014 were averaged. A minimum threshold of 5% dependency was used. Selected stocks in GSA 10 are ARS, DPS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ITA A37 DTS1218	2104	33.9	14665	43.3
ITA A37 DTS1824	2546	29.8	19092	41.6
ITA A37 DTS0612	85	25.4	523	30.7
ITA A37 PGP0612	5681	11.9	36923	17.7
ITA A37 PGP0006	970	11.8	8346	13.5
ITA A37 PGP1218	833	10.5	5695	16.4

Also in GSA10, DTS fleet segments are those most dependent on the selected stocks, with values up to 43% in the case of landing value in DTS1218. Also fleet segments using polyvalent gears show some dependency on the selected stocks (up to 18% in landing value for PGP0612). As in GSA 9, the main target species of PGP vessels is European hake (using gill nets and longlines).

Table 5.16 - GSA 11. Sardinia. Landings live weight and value compared (percentage contribution to total landings and values) to overall landings and values of the most dependent fleet segments in GSA 11. A minimum threshold of 5% dependency was used. Data from 2012 to 2014 were averaged. Selected stocks in GSA 11 are ARS, HKE, MUT.

Fleet segments	Total landings (t)	% selected stocks	Total Value ('000 euros)	% selected stocks
ITA A37 DTS2440	687	29.9	6380	37.1
ITA A37 DTS1824	829	18.9	6027	22.5
ITA A37 DTS1218	704	16.6	4516	19.2
ITA A37 DTS0612	5	6.6	32	6.8

In GSA11, only DTS vessels show dependency on the selected stocks (European hake, red mullet, and giant red shrimp). The highest level of dependency is shown by largest vessels which are usually operating on the fishing grounds off the continental slope targeting giant red shrimp. Smallest vessels are less dependent on the selected stock as they are operating close to the coast targeting other species (striped red mullet, common octopus, etc.).

It is important when evaluating dependency with a view towards impact assessment to focus on fleet characteristics such as the location of the fleet and boat length (and profitability) as well as the percentage of selected stocks landings compared to overall landings. Fleet segment ESP A37 HOK1218 in GSA 7, for example, though landing only 14 tons of fish, receives more than 50% of their landings value from the selected stocks (mostly European hake). ESP A37 DTS2440 is also highly dependent with more than 60% of values coming from blue and red shrimp.

6 ToR 2

The MAP, as a strategic tool of the CFP, sets tactical objectives to achieve the CFP goals. The contents of the MAP, as defined in Artº 10.1, can be grouped into measures that relate to the stocks and measures that relate to the fleets.

The first set includes objectives regarding the exploitation of the stocks and risk-avoiding actions. The agreement between the Council, the Parliament and the Commission, translated those into Fmsy ranges, biomass safeguards and recovery periods for each stock.

The second set is related with the implementation of landing obligations (Artº 15) and should operate at a local level, adjusted to the fleet(s) dimension. These are technical measures and other measures to reduce unwanted catches.

In Mediterranean waters, the geographical scope of MAPs is at a regional level, based on individual GSAs assessments (1, 5, 6, 7, 8, 9, 10, and 11). Nevertheless, joined stock assessments of European hake were previously performed combining GSAs 1-7 and GSAs 9-11 (STECF, 2015g), based on EU-STOCKMED project conclusions. The results of those assessments showed good fit and more stable pattern than the assessments performed on single GSAs. Therefore, the exploration of the feasibility of carrying out combined assessment on other species, such as deep-water rose shrimp, Norway lobster, red mullet, European anchovy, etc., was suggested by STECF (2016b) taking into considerations the results of the STOCKMED Project (Fiorentino et al., 2015).

Moreover, a dedicated session was held by the Working Group on Stock Assessment of Demersal Species (WGSAD, GFCM, 2015) on stock boundaries based on available information (either qualitative or quantitative). Results of STOCKMED, where a multi-disciplinary set of information for identification of stock boundaries within a holistic framework (e.g. genetics, biological traits, oceanographic connectivity) in EU waters was collected and analyzed, were presented. Although participants agreed that the current delimitation of stock boundaries for many of the stocks assessed, mainly based on Geographical Subareas (GSAs) may not be adequate for some stocks, the WGSAD concluded that joining assessments of stocks inhabiting adjacent GSAs should be done only on the basis of species and stock specific scientific evidence, including evidence demonstrating that a joint assessment is more appropriate than separate GSAs assessments to obtain a realistic picture of the stock status (e.g. Strait of Sicily combined assessments), based on biological/ecological evidence as well as on fisheries information. The WGSAD recognized that the stock units identified in the STOCKMED project were to be considered as preliminary hypothesis which needed to be checked with further investigation (e.g. geography, marine habitats, fishing practices, economy). Also, it was highlighted the need to collect existing and new information especially in the case of eastern and southern Mediterranean GSAs to complement the information presented to better identify stock boundaries in the Mediterranean sea. Considering the Multiannual plan in the Western Mediterranean Sea, the concerned GSAs are 2, 3, 4 and 12, respectively Alboran Island, Southern Alboran Sea, Algeria, Northern Tunisia (Figure 6.1). Therefore, WGSAD was not in the position to adopt new stock boundaries for the stock assessments.

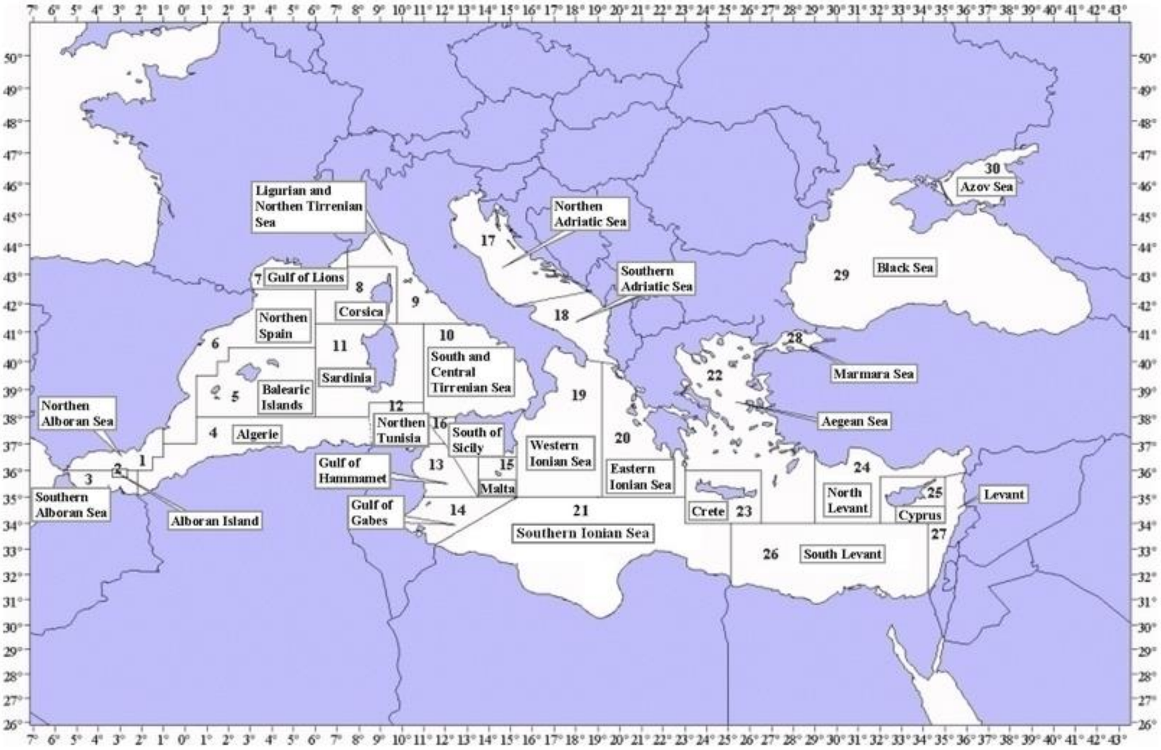

Figure 6.1 - Geographical location of GSAs

From the point of view of the stock measures, having MAPs with a wider scope would limit both the number of stocks that will have to be split across regulations and the potential inconsistencies that may arise from having to make several regulations coherent. Nevertheless, it still remains largely a policy decision if the implementation of MAPs is better regulated by one, two or more regulations. As long as the objectives are still followed and the biomass safeguards applied, the outcomes of MAPs designed under the current framework, should not be impaired by their scope.

When considering fleet measures, the spatial scope is largely dependent on the fleet composition and the technical characteristics of the vessels. In such cases, having MAPs that focus on more homogenous regions, like western Mediterranean may encourage buy-in by Member States and regional/local bodies and establish a more homogeneous playing field.

7 TOR 3

In order to assess whether the stocks listed in Annex I are driving demersal fisheries in the Western Mediterranean, the findings of EWG 15-14 (STECF, 2015h) were used. EWG 15-14 has identified the different demersal fisheries operating in the Mediterranean Sea at GSA level, as well as the species which drive each fishery, both in terms of economic value and in terms of landings. The criterion used by EWG 15-14 to assess whether a species is driving a fishery was the species' inclusion within the 75% of the cumulative percentage of value or landings. The findings of EWG 15-14 were summarised for the European Western Mediterranean GSAs (1, 2, 5, 6, 7, 8, 9, 10, 11) and for the species mentioned in the ToRs (*Merluccius merluccius*, *Mullus* spp., *Lophius* spp., *Aristeus antennatus*, *Parapenaeus longirostris*, *Aristaeomorpha foliacea*). *Mullus* spp. and *Lophius* spp. were used instead of *Mullus barbatus* and *Lophius budegassa* of Annex I, respectively, because they were treated as such by EWG 15-14. The number of fisheries where each Annex I stock appeared within the fishery's 75% cumulative percentage of value and/or landings was then counted, separately for fisheries using set gears and OTB fisheries (demersal trawlers) (Table 7.1).

The majority of the stocks included in the ToRs were found to drive demersal fisheries in the Western Mediterranean Sea (Table 7.1). However, some discrepancies between the ToRs and the findings of EWG 15-14 were also identified:

- *P. longirostris* in GSAs 5 and 6 does not fall within the 75% cumulative percentage of either value or landings of any fishery, despite being listed in Annex I.
- *A. antennatus* is included within the 75% cumulative percentage of both value and landings in two OTB fisheries in GSA 7 and in another two OTB fisheries in GSA 9. It is also included within the 75% cumulative percentage of value in an OTB fishery in GSA 11. However, these three stocks (*A. antennatus* in GSAs 7, 9 and 11) are not listed in Annex I.
- *Lophius* spp. is included within the 75% cumulative percentage of landings of an OTB fishery in GSA 10 and of a GTR fishery in GSA 11. However, these two stocks (*Lophius* spp. in GSAs 10 and 11) are not listed in Annex I.
- Stocks driving demersal fisheries in GSAs 2 and 8 have not been included in Annex I.

We believe that the stocks driving demersal fisheries in the Western Mediterranean which are currently absent from Annex I, as outlined above, should be also included in a future MSE.

Table 7.1 - Species that drive demersal fisheries in the Western Mediterranean Sea. Species examined are the ones mentioned in Annex I of the EWG 16-02 ToRs. Numbers in brackets indicate the total number of fisheries identified by EWG 15-14 per GSA. The rest of the numbers indicate the number of fisheries where each of the species appears within the 75% cumulative percentage of value or landings. Discrepancies between the stocks mentioned in ToRs and stocks that drive the fisheries are marked with asterisks. Set: Fisheries using set gears; OTB: Fisheries using demersal trawlers; Other: Fisheries using other towed gears; HKE: *Merluccius merluccius*; MUX: *Mullus* spp.; MNZ: *Lophius* spp.; ARA: *Aristeus antennatus*; DPS: *Parapenaeus longirostris*; ARS: *Aristaeomorpha foliacea*.

	GSA 1				GSA 2*		GSA 5				GSA 6				GSA 7 (FRA)						GSA 7 (ESP)			
	Value		Landings		Value	Landings	Value		Landings		Value		Landings		Value			Landings			Value		Landings	
	Set (4)	OTB (3)	Set (4)	OTB (3)	OTB (3)	OTB (3)	Set (2)	OTB (3)	Set (2)	OTB (3)	Set (4)	OTB (3)	Set (4)	OTB (3)	Set (6)	OTB (1)	Other (4)	Set (6)	OTB (1)	Other (4)	Set (3)	OTB (3)	Set (3)	OTB (3)
HKE	3	2	3	2		1		1		3	1	2	2	3	1	1		1	1		1	2	1	3
MUX	2	2	2	1			1	2	1	2	1	1	1	1								1		1
MNZ		2		2	2	2		1		1		2		2		1		1	1			2		2
ARA		2		2	2	2		2		2		2		2								2*		2*
DPS		2		1				0**		0**		0**		0**										
ARS																								

	GSA 8*				GSA 9				GSA 10				GSA 11				Total			
	Value		Landings		Value		Landings		Value		Landings		Value		Landings		Value		Landings	
	Set (6)	OTB (2)	Set (6)	OTB (2)	Set (2)	OTB (3)	Set (2)	OTB (3)	Set (3)	OTB (3)	Set (3)	OTB (3)	Set (1)	OTB (1)	Set (1)	OTB (1)	Set (31)	OTB (25)	Set (31)	OTB (25)
HKE		2		2	2	2	2	2	3	1	3	2		1		1	11 (**35%**)	14 (**56%**)	12 (**39%**)	20 (**80%**)
MUX	4	2	3	2	2	1	2	2	2	2	2	2	1	1	1	1	13 (**42%**)	12 (**48%**)	12 (**39%**)	12 (**48%**)
MNZ	1		1									1*			1*		1 (**3%**)	10	3 (**10%**)	11

									(**40%**)		(**44%**)
ARA		2*	2*			1*		0	13 (**52%**)	0	12 (**48%**)
DPS	1	2	2	2	3			0	6 (**24%**)	0	7 (**28%**)
ARS		1	1	2	2	1	1	0	4 (**16%**)	0	4 (**16%**)

* Not included in ToRs

** Included in ToRs, but not driving any demersal fisheries

8 ToR 4

The analysis of ToR 4 as required in the ToRs was not possible due to data limitations. On the other hand the definition of "economic recovery" is not fully operational once that the choice of keeping a high fishing activity concentrated on a smaller number of vessels, or keeping the current number of vessels with a reduced fishing activity will define the profits of the fleets.

In alternative the EWG developed an indicator that may show when the fleets will be recovering their yield, although this indicator does not reflect the absolute economic profit.

Figure 8.1 presents boxplots of the distribution of value per unit of fishing mortality (a proxy for Value Per Unit of Effort, VPUE), in relative terms to 2015 values. Each raw represents a management scenario, the xx axis represents time in years.

The baseline scenario shows the 2015's VPUE are not sustainable over time. If fishing mortality level is kept at F status quo the expected VPUE will be drop, about 50% of 2015's, forever. Figure 8.1 shows that all management options are better alternatives than kept the fishing mortality at F status quo levels: year by year VPUE indicators are always higher than at F status quo levels. Moreover, effort scenarios recover in 2020 the 2015's, while the TAC scenarios take longer, and in some cases never recover.

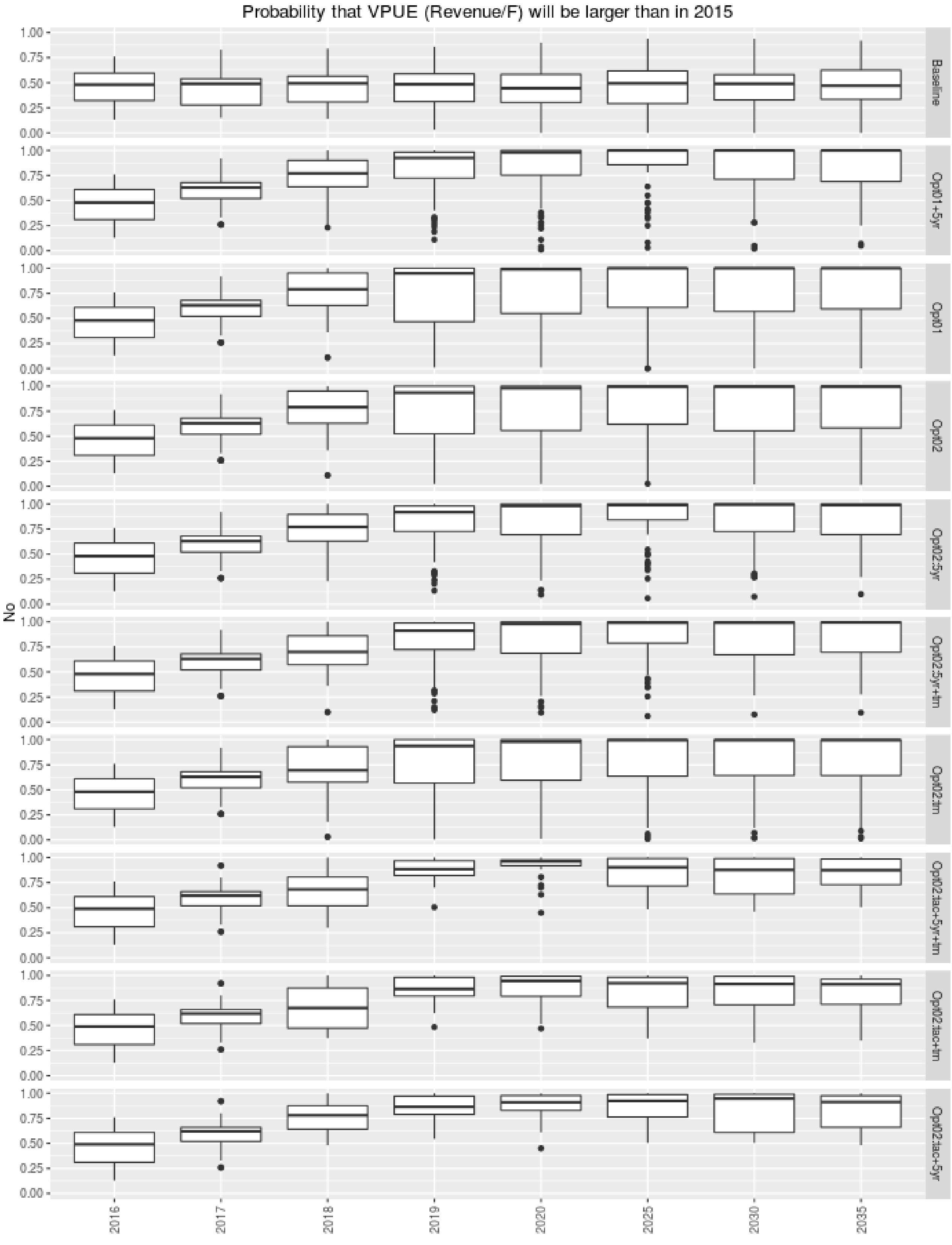

Figure 8.1 - Probability of value per unit of effort (here measured as revenue/fishing mortality) .

9 ToR 5

In the Mediterranean there is not a multi-species, multi-fleet bio-economic model parametrized for the GSAs defined in the ToR. As such the alternative analysis relied on building linkages across fleets and stocks, and transform catches, effort and capacity into revenues and costs, to evaluate the economic performance of each scenario, together with the ecological effects of the management options. Section 3.3 presents a better description of this approach.

To carry out such analysis it was necessary to (i) break down each stock's fishing mortality into partial fishing mortalities by fleet, (ii) estimate and predict the economic variables at the level of the relevant fleets catching these species, and (iii) link fishing mortality with economic costs.

The EWG explored these relations and concluded that the differences between the different data sources were too high and difficult to understand to be used for computing the indicators needed. These apply both to the mixed fisheries data included in the DCF Mediterranean datacall and the transversal data called under the AER analysis. In both cases the mismatch with the data used as a basis for assessment prevented the follow up analysis to be carried out.

In addition the EWG analysed the gear composition of the fleets catching the stocks in the ToR and the gear composition of the economic fleet segments. The stocks are mainly caught by trawl fleets and the trawl fleet segment in the economic data is well defined and stable over time. As such a immediate link between the economic variables and fishing mortality could be done, without having to model the costs at the level of the gear. Fixed gears do not show such consistency and would not allow such link.

The EWG used the results from two ad-hoc contracts, the data on transversal variables from the AER data call and the stock assessment results to compare the different data sources. A large discrepancy for some stocks would prevent the analysis. There was no time during the meeting to do sensitivity analysis on the impacts of such discrepancies, and the group considered the amount of work needed outside the possibilities of the group.

The next 3 sections will deal with these issues.

9.1 Mixed fisheries

In order to compute the fishing mortality at MSY if only the trawl fleets' effort is subject to management actions, as required in Option 1 of the ToRs, the EWG needed to use the catch-at-age by fleet to split the stocks' fishing mortality into fleet specific fishing mortality, also known as partial fishing mortality.

Before the meeting the JRC performed a comparison between the official STECF assessment catch-at-age matrices, used to fit the stock assessment models, and the catch-at-age matrices reported through the Mediterranean data call, which were computed by an ad hoc contract.

The comparison resulted in several mismatches, both in the total number of individuals, and in the pattern of catch by age (see Table 9.1, Figure 9.1 and Figure 9.2). The percentage ratio of the differences, in total numbers by year, is reported in Table 9.1.

For many stocks and year, the percentage was very high, sometimes with highest number derived from the official assessment and sometimes from the Mediterranean data call without a clear pattern among years.

Moreover, the pattern in catch by age class was sometimes different between the two sources (Figure 9.2 as example).

These differences could be due to several reasons:

- The DCF Mediterranean biological data database updating for some stocks over following data calls.
- Discards abundance by age class, in years in which it was not mandatory e.g. pre 2009, was estimated during the assessment EWG and used to fill in gaps in discards. This effectively increased, for some stocks, the numbers at age, in particular for first age class.
- In some cases, different age slicing approaches have been used to convert abundance at length in abundance at age and could have determined differences in the abundance pattern by age class.
- Different data sources (non official DCF data) used during EWGs (e.g. own expert dataset).
- Errors in saving final STECF assessments stock objects.

To overcome these discrepancies in total numbers at age, it was agreed to consider the catch proportion in weight by gear as a proxy of partial fishing mortality values by fleet.

Since, currently, National Management plans are implemented only for trawl nets, the proportion was computed between two gear categories: TRAWLERS and OTHER GEARS (i.e., gillnet, trammelnet, longline, etc.)

Excluding Mediterranean hake in GSAs 9-11, trawlers caught more than 80% of the total catch in weight.

Table 9.1 - Percentage of difference in catch in numbers by year and stock between official assessment and the Mediterranean data call.

Year	STOCK HKE 1_7	HKE 9_11	ARA 1	ANK 1	MUT 1	DPS 1	ARA 5	ANK 5	MUT 5	DPS 5	ARA 6	ANK 6	MUT 6	DPS 6	ANK 7	MUT 7	ARS 9	MUT 9	DPS 9	ARS 10	MUT 10	DPS 10	ARS 11	MUT 11
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA	NA	NA	-5.92	-50.96	0.00	NA	-28.33	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	62.05	NA	0.00	NA	0.00	0.00	NA	11.14	-16.53	-5.94	0.00	NA	-26.05	0.00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	30.91	NA	0.00	NA	0.00	0.00	NA	-0.91	-18.10	11.52	0.00	0.00	-24.72	0.00	NA	0.00	NA	NA	NA	NA	NA	NA	NA	NA
2005	-61.14	NA	0.00	NA	0.00	0.00	NA	4.87	-20.53	14.39	0.00	0.00	-24.55	0.00	NA	0.02	NA	NA	NA	NA	NA	NA	NA	0.00
2006	-30.32	-16.53	0.00	NA	0.00	0.00	NA	4.86	-75.77	-26.68	0.00	0.00	-25.80	0.00	NA	0.02	0.00	-162.54	-1034.80	1.24	NA	NA	40.66	0.00
2007	-17.65	-155.56	0.00	NA	0.00	0.00	NA	-12.09	2.57	-67.38	0.00	0.00	-24.40	0.00	NA	0.00	0.00	-182.45	-45.35	2.42	NA	NA	40.68	0.00
2008	-20.64	-205.75	0.00	NA	0.00	0.00	NA	6.14	NA	-22.94	0.00	0.00	-24.02	0.00	NA	-0.01	-38.70	-22.59	-37.45	-14.37	NA	NA	6.21	0.00
2009	-0.46	-7.79	0.00	NA	5.96	0.00	NA	-104.29	-43.29	11.91	0.00	-8.05	-27.96	0.00	NA	0.02	0.00	-16.23	-3.57	35.34	NA	NA	15.12	0.00
2010	-36.97	-16.19	0.00	NA	0.36	0.00	NA	-72.85	-6.41	12.45	0.00	-5.33	-5.79	0.00	NA	0.01	-39.67	-6.77	-0.38	52.69	NA	NA	31.26	0.00
201	-	-	0.0	NA	4.4	0.0	NA	-	-	11.6	0.0	-	-	0.0	NA	4.0	-	1.73	-2.19	75.8	NA	NA	7.0	0.0

1	4.62	14.90	0		2	0		87.93	15.16	2	0	1.79	43.97	0		0	34.69			0			4	0
2012	-10.86	-2.06	0.00	NA	12.43	0.00	NA	20.90	-5.24	-7.45	0.00	-1.74	-28.66	0.00	NA	0.01	-18.33	-1.43	-5.41	NA	NA	NA	21.53	0.00
2013	32.18	-2.41	0.00	NA	1.55	0.00	NA	12.39	NA	NA	0.00	-1.45	-28.30	NA	NA	7.24	0.00	-18.05	-12.25	NA	NA	NA	37.72	NA
2014	-1.86	-7.00	0.00	NA	NA	0.00	NA	NA	NA	NA	0.00	NA	NA	NA	NA	NA	-3.79	NA	NA	1.24	NA	NA	19.20	NA
MEAN	**-4.95**	**-47.58**	**0.00**	**NA**	**2.25**	**0.00**	**NA**	**-19.80**	**-20.44**	**-10.86**	**0.00**	**-1.84**	**-26.05**	**0.00**	**NA**	**1.13**	**-15.02**	**-51.04**	**-142.68**	**22.05**	**NA**	**NA**	**24.38**	**0.00**

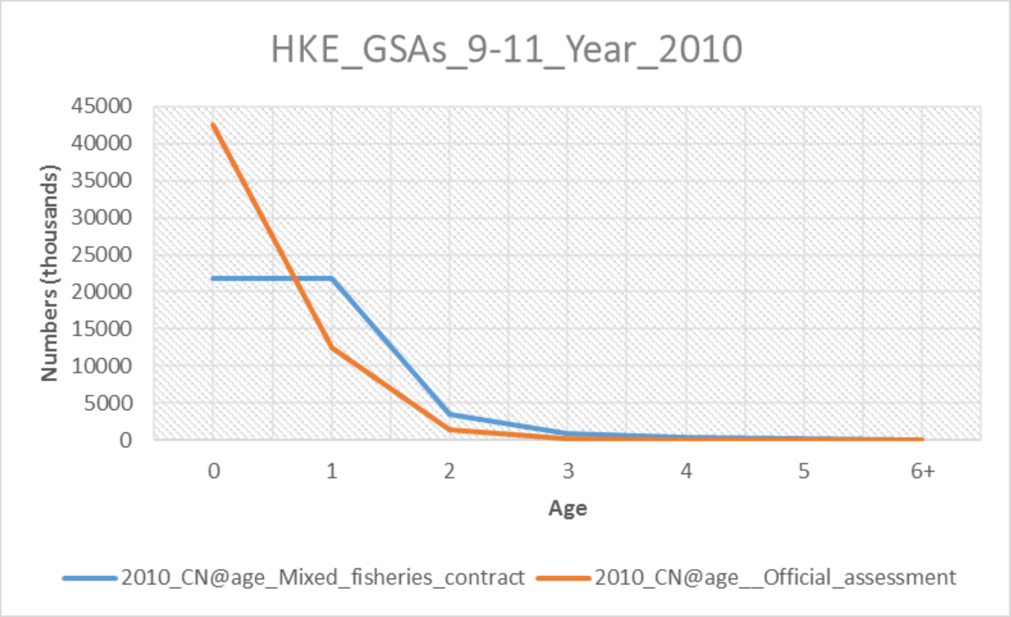

Figure 9.1- Total catch at age derived from sum of catch numbers at age of Hake in GSA 9-11 in 2010, according to official stock assessments (orange line) and the Mediterranean data call (blue line).

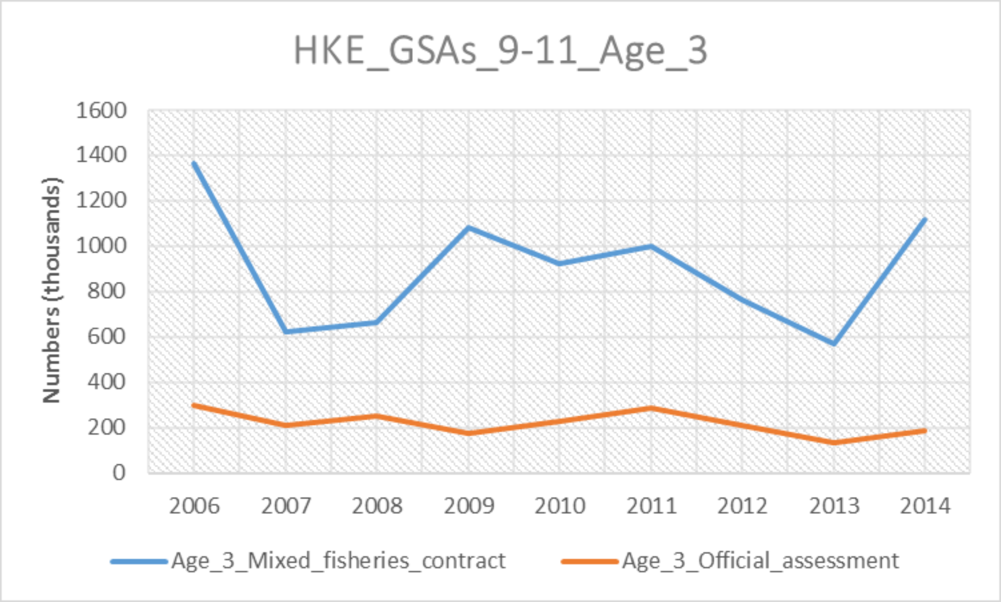

Figure 9.2 - Total catch at age derived from sum of catch numbers at age 3 of Hake in GSA 9-11 in the whole time series, according to official stock assessments (orange line) and the Mediterranean data call (blue line).

Table 9.2 - Catch proportion by gear (mean of the last three years) and matching between catch at age matrices between official assessment and Mediterranean data call.

Priority	GSA	3A_code	Scientific name	Ref year	Fcurr	FMSY	Fcurr/ FMSY	Report	Working group	Year of advice	% trawler catches (mean of the last 3 years)	% other gears (mean of the last 3 years)	CN@age Matrix macthing
1	1_7	HKE	*Merluccius merluccius*	2014	1.40	0.39	3.59	STECF 15_18	EWG 15_11	2015	89.63	10.37	NO
1	9_11	HKE	*Merluccius merluccius*	2014	1.10	0.20	5.50	STECF 15_18	EWG 15_11	2015	62.75	37.25	NO
2	1	ARA	*Aristeus antennatus*	2014	1.40	0.41	3.41	STECF 15_18	EWG 15_18	2015	100	0	YES
2	1	ANK	*Lophius budegassa*	2013	0.25	0.16	1.56	STECF 15_06	EWG 14_19	2014	96.30	3.70	YES
1	1	MUT	*Mullus barbatus*	2013	1.31	0.27	4.85	STECF 15_06	EWG 14_19	2014	93.17	6.83	NO*
1	1	DPS	*Parapenaeus longirostris*	2012	0.43	0.26	1.65	STECF 13_22	EWG 13_09	2013	100	0	YES
2	5	ARA	*Aristeus antennatus*	2013	0.42	0.24	1.75	SAC 17	GFCM WGSAD 2015	2014	100	0	NA
2	5	ANK	*Lophius budegassa*	2013	0.84	0.08	10.50	STECF 15_06	EWG 14_19	2014	100	0	YES
1	5	MUT	*Mullus barbatus*	2012	0.93	0.14	6.64	STECF 14_08	EWG 13_19	2013	84.87	15.13	NO
1	5	DPS	*Parapenaeus longirostris*	2012	0.77	0.62	1.24	STECF 13_22	EWG 13_09	2013	100	0	YES
2	6	ARA	*Aristeus antennatus*	2014	0.75	0.36	2.08	STECF 15_18	EWG 15_11	2015	100	0	YES
2	6	ANK	*Lophius budegassa*	2013	0.91	0.14	6.50	STECF 15_06	EWG 14_19	2014	97.53	2.47	NO*
1	6	MUT	*Mullus barbatus*	2013	1.47	0.45	3.27	STECF 14_17	EWG 14_09	2014	91.39	8.61	NO
1	6	DPS	*Parapenaeus longirostris*	2012	1.40	0.27	5.19	STECF 13_22	EWG 13_09	2013	100	0	YES
2	7	ANK	*Lophius budegassa*	2011	0.97	0.29	3.34	STECF 12_19	EWG 12_10	2012	94.43	5.57	NO

Priority	GSA	3A_code	Scientific name	Ref year	Fcurr	FMSY	Fcurr/ FMSY	Report	Working group	Year of advice	% trawler catches (mean of the last 3 years)	% other gears (mean of the last 3 years)	CN@age Matrix macthing
1	7	MUT	*Mullus barbatus*	2013	0.45	0.14	3.21	STECF 14_17	EWG 14_09	2014	92.78	7.22	YES
2	9	ARS	*Aristaeomorpha foliacea*	2014	0.13	0.51	0.25	STECF 15_18	EWG 15_11	2015	100	0	NO
1	9	MUT	*Mullus barbatus*	2013	0.70	0.60	1.17	STECF 14_17	EWG 14_09	2014	92.34	7.66	NO
1	9	DPS	*Parapenaeus longirostris*	2013	0.69	0.71	0.97	STECF 15_06	EWG 14_19	2014	100	0	NO
1	10	ARS	*Aristaeomorpha foliacea*	2014	0.91	0.65	1.40	STECF 15_18	EWG 15_11	2015	99.64	0.36	NO
1	10	MUT	*Mullus barbatus*	2013	0.50	0.50	1.00	SAC 17	NA	2014	81.87	18.13	NA
1	10	DPS	*Parapenaeus longirostris*	2013	1.60	0.92	1.70	SAC 17	NA	2014	99.98	0.02	NA
1	11	ARS	*Aristaeomorpha foliacea*	2014	0.50	0.31	1.61	STECF 15_18	EWG 15_11	2015	100	0	NO
1	11	MUT	*Mullus barbatus*	2012	1.07	0.11	9.73	STECF 14_08	EWG 13_19	2013	100	0	YES

*First part of the time series ok, the second one no.

9.2 Linking economics and ecology through transversal variables

To perform the economic evaluation of the policy options the methodology described in section **Error! Reference source not found.** was attempted. In order to match the data in economics ith the data in stock assessment, to link the costs and revenues to the stock productivity and fleet exploitation, it was required to have fleet segments that matched the two datasets and consistent landings and catches. An initial analysis was carried out to assess the data available, followed by a comparison of fleet data and finally comparing the landings by species and GSA in each dataset.

9.2.1 Data quality and missing data the AER dataset.

Four datasets were made available for this analysis: a dataset with economic data (economics dataset) including variables: totcrewwage (total crew wages), totunpaidlab (total unpaid labour), totenercost (total energy cost), totrepcost (total repair cost), totvarcost (total other variable cost), totnovarcost (total other non variable cost), totdepcost (total depreciation cost) and totrightscost (total fishing rigths cost); a dataset with capacity data (capacity dataset) including variables totves (total number of vessels), totgt (total gross tonnage), totkw (total engine power), avgloa (average vessel length) and avgage (average age of vessels); a dataset with effort data (effort dataset) including variables totfishdays (total fishing days), totseadays (total days at sea), maxseadays (maximum days at sea), totkwfishdays (total kw*fishing days), totgtfishdays (total gt*fishing days), totenercons (total energy consumption) and tottrips (total number of trips); and a dataset with landings (landings dataset) including variables totwghtlandg (total weight of landings) and totvallandg (total value of landings).

Specific shortcomings of the datasets were identified as following:

- Economics dataset:
    - France: totunpaidlab and totrightscosts were NA in 2008-2014. Totdepcost was also NA for 2009-2010 and most of 2008. Therefore, crew share, fixed costs and GVA could not be calculated for France in 2008-2014. There is the possibility that totunpaidlab is aggregated into totcrewwage, so totunpaidlab is 0 and totrightcost could be 0. But without knowing how the data was aggregated and coded it renders impossible to use the data.
- Effort dataset:
    - Spain: No effort data in 2008-2010, therefore variable costs by unit of effort could not be computed for Spain in these years.
    - France: No effort data in 2008-2012, therefore variable costs by unit of effort could not be computed for France in these years.
    - France: Sub-regions given as FAO areas (i.e. 37.1.1, 1.2, 1.3) instead of GSA in 2013. These were corrected to GSAs 6, 7 and 8 respectively, based on 2014 data.
- Landings dataset:
    - Spain: All gears were given as “not known” (NK) in 2008-2014. Therefore, no disaggregation at the gear level was possible for crew share, revenues and GVA for Spain.
    - Spain: Most sub_reg entries in 2008-2009 were “37.1.1” so they were omitted in the calculation of crew share, revenues and GVA as it was unclear if they referred to GSA 1, 5 or 6. A few more sub_reg entries were “37.1.3” and were also omitted for the same reason. The “37.1.2” entries were corrected as GSA 7.

   - France: No data in 2008-2009. France: All gears were given as “not known” (NK) in 2010. Therefore, no disaggregation at the gear level was possible for crew share, revenues and GVA for France in 2010.

9.2.2 Fleet segment stability and consistency with relevant metiers

Biological data are mainly focusing on fishing gears, while economic data are focusing on fleet segments (i.e. fishing techniques). EWG 16-02 analyzed the effort data of fleet segments and fishing gears in the database from the AER report 2016 to be able to make a link between fishing gears and fleet segments.

A focus is made on the DTS (demersal trawlers and/or demersal seiners) fleet segment, once that trawlers are responsible for >80% of the landings of the selected stocks for all the studied GSAs. Figure 9.3 displays values of landings by fishing gears for the DTS fleet segment across GSAs.

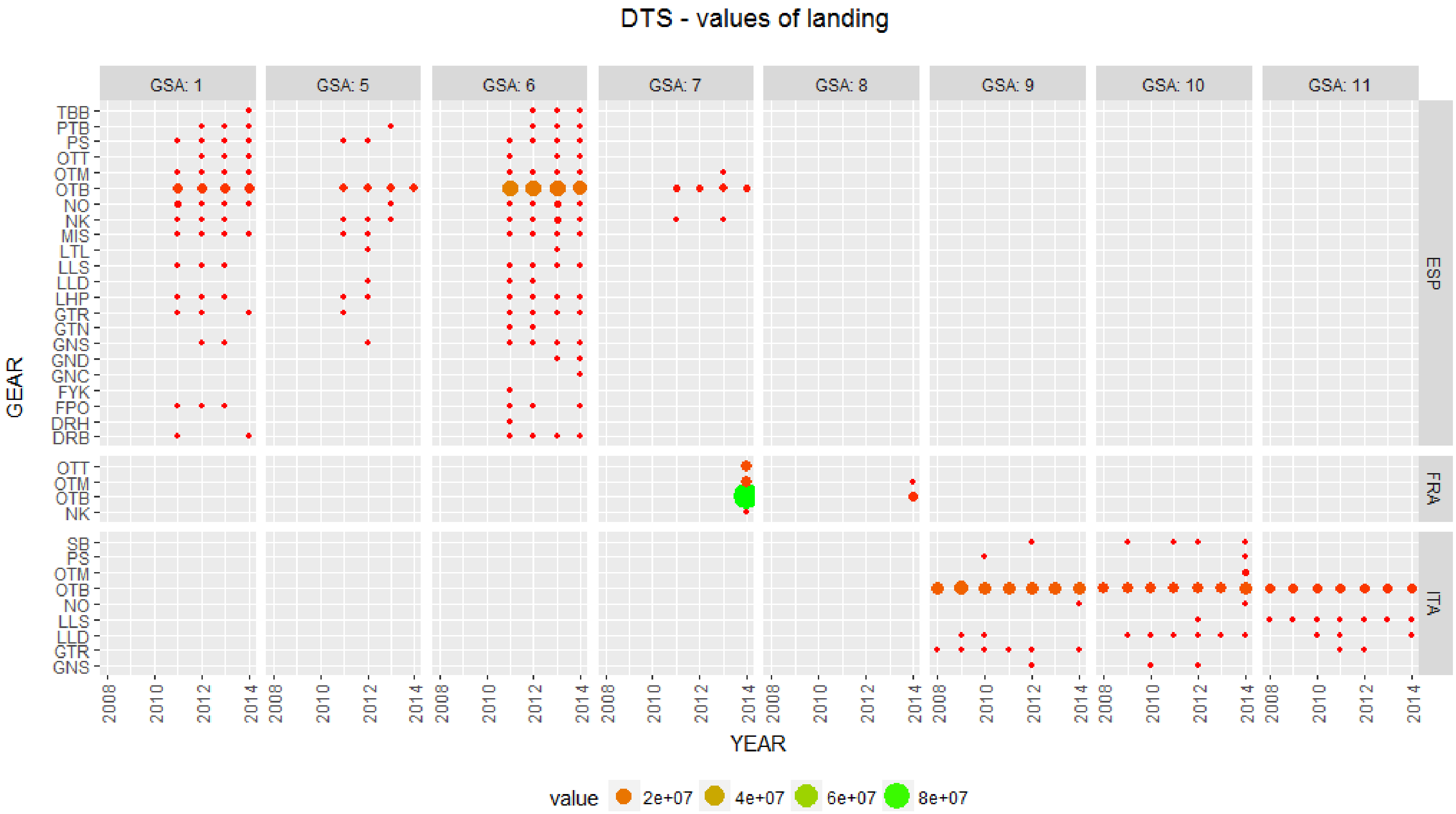

Figure 9.3 - Value of landings by gear for DTS fleet segments across GSAs.

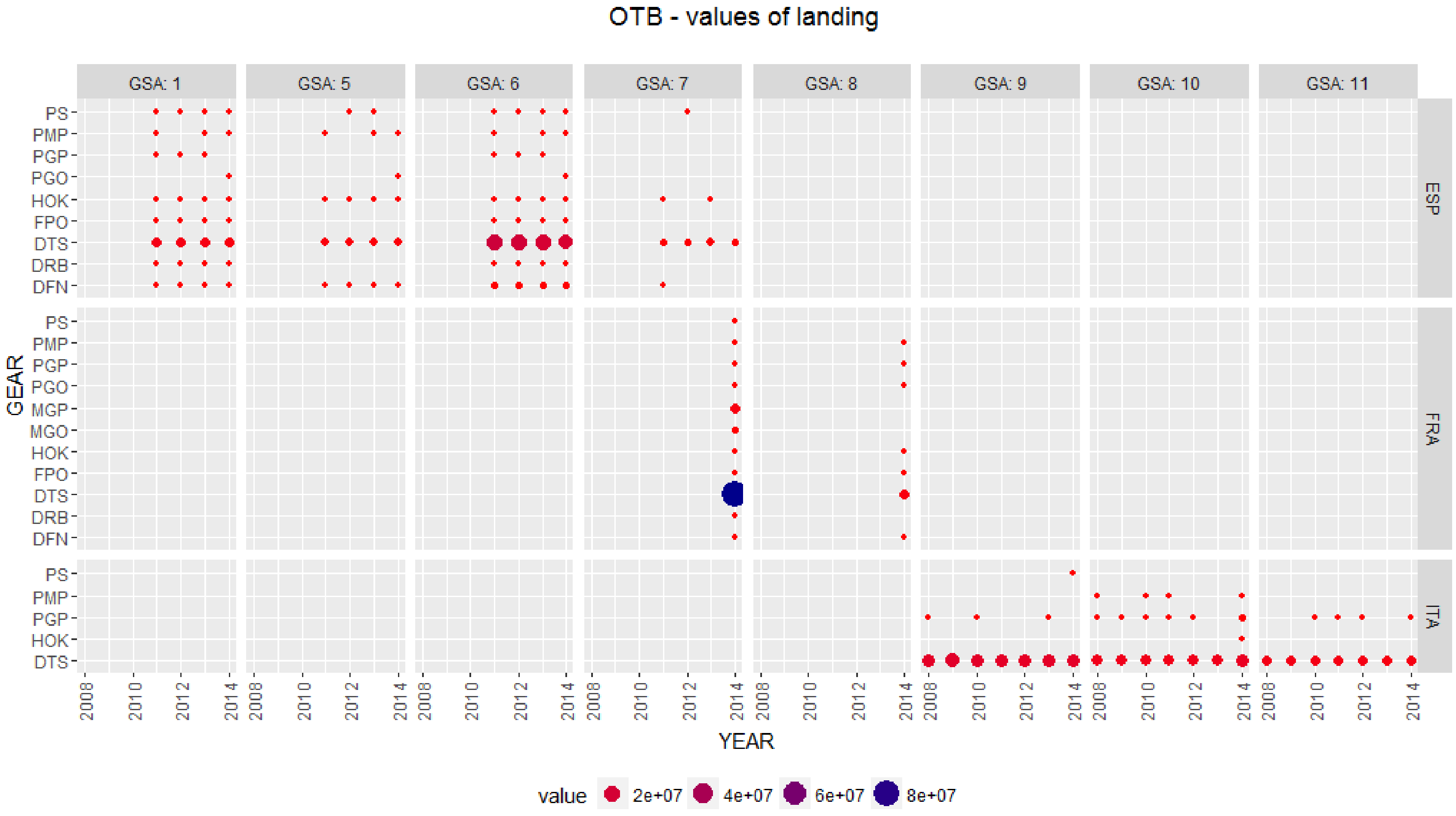

Figure 9.4 - shows the proportion (in terms of effort) of the different fleet segments and Figure 9.5 makes a focus on the GSA 7 and 8.

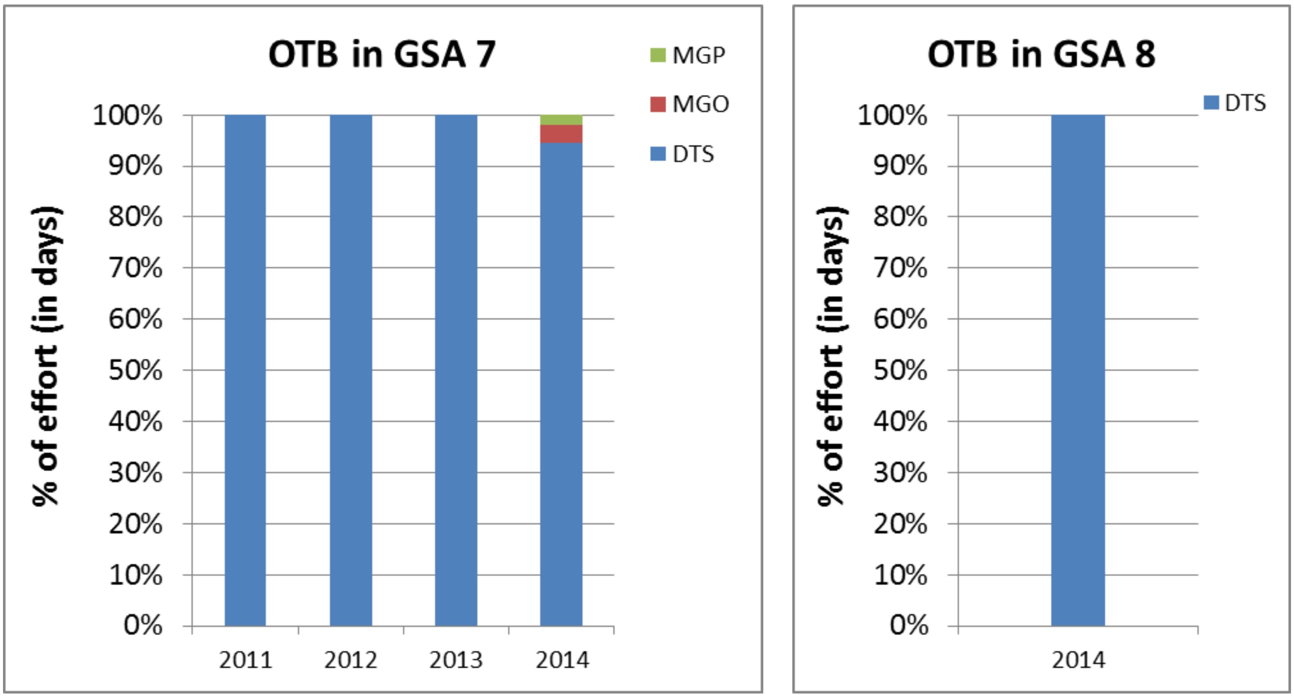

Figure 9.5 - Proportion of OTB effort between French fleet segments.

Results show that the DTS fleet segment uses mainly OTB in all the studied GSAs. Figure 9.3 and Figure 9.4 exhibit that OTB is mainly used by DTS. Therefore EWG 16-02 assumes that DTS fleet segment can be a proxy for estimating cost of OTB fishing gear.

To note that results for DTS fleet segments and OTB are an exception. This clear relation between DTS and OTB is indeed not observed for other fleet segments and fishing gears. Figure x4 illustrates the relationship between DFN (drifted and/or fixed netters) and fishing gears in GSA 7 and shows that DFN is using a mix of gears, with a dominance of GTR, GNS and LLS for GSA 7.

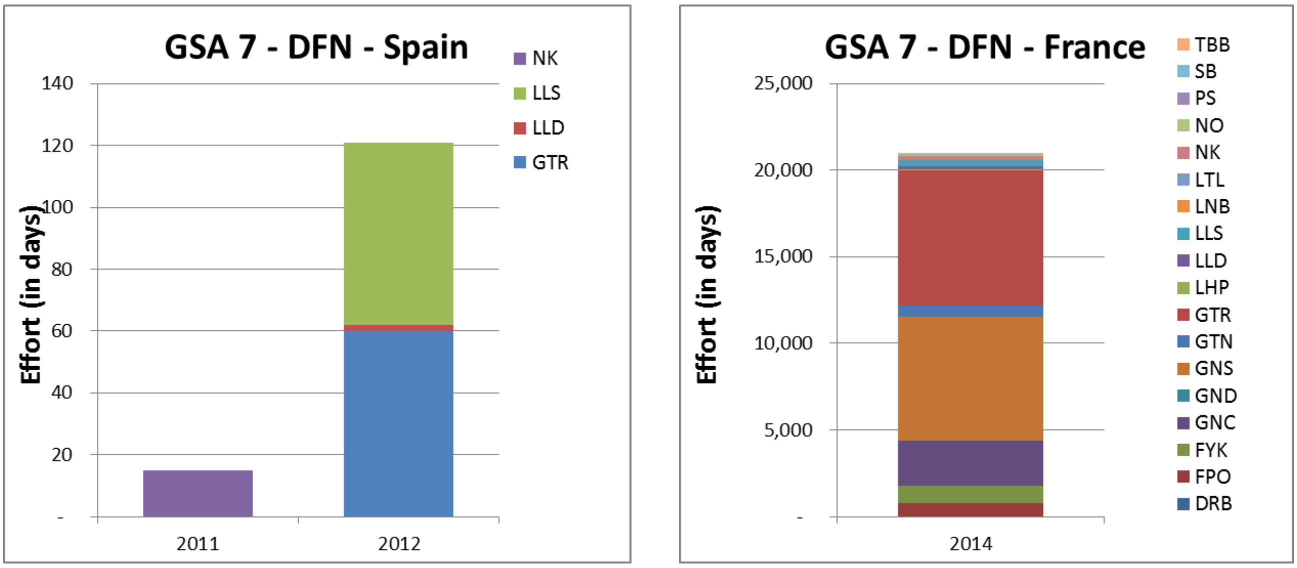

Figure 9.6 - Repartition of the effort of DFN fleet segment between fishing gears in GSA 7.

Analyses of landings data highlighted that fishing gears reported for the DTS fishing techniques in GSA 1, 5 and 6 were mainly NK, i.e. not known. Effort data shown that most of the gears used by

DTS fleet segments are OTB, therefore EWG 16-02 assumed that the fishing gears reported as NK in the DTS fishing segments (in landings data) were OTB.

9.2.3 Comparison of Catch and Landings

The EWG compared the AER landings with the total catch reported in the stock assessment used for the MSEs. The expectation is that total catch (landings + discards) from the assessments is always higher than the AER landings and that the trends are similar. A small degree of variation is acceptable, but not major discrepancies.

The species for which the comparison was performed are "HKE", "ARS", "ARA","ANK", "DPS", "MUT" in GSAs 1-11. In case of joint HKE assessments, the AER landings were aggregated at the same scale of the assessment ("01_05_06_07" and "09_10_11"). The time series are shorter on the AER landings, hence the comparison was possible only on the most recent and overlapping years.

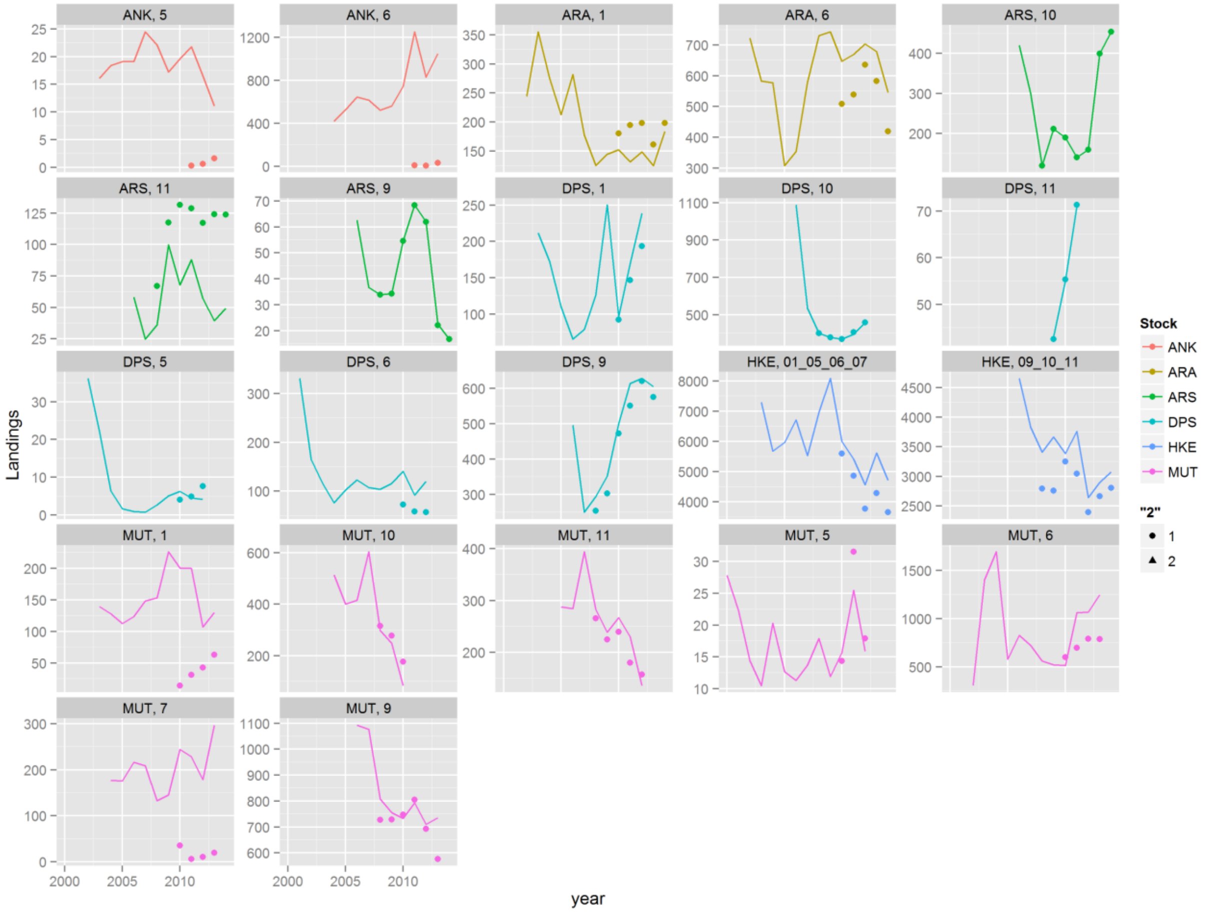

Figure 9.7 - Comparison of Landings from AER report (dots) and catch from STECF stock assessments (lines) by species and area.

Figure 9.7 shows the trends in landings and catches by stock from the AER report and catch from STECF stock assessments. For ARA 1 and ARS 11 the landings from AER are much higher than the catch from STECF assessments which is anomalous. ARS 9 and 10, DPS 1, 9, 10 and 11 match well. HKE stocks, accounting for an approximate 20% of discards that is not reported in the AER landings, are acceptable as well as MUT 11. For MUT there are strong discrepancies between data sources and these depend from reporting in the AER landings of a mixture of MUX, MUM, MUT and MUR which does not match how these species are reported in the biological data.

The EWG found consistencies and discrepancies between the catches in the stock assessments and the landings from the AER. Some discrepancies could be due to a comparison of data originating from different data calls, to experts in the STECF EWG reconstructing different time series of discards and landings or using national datasets and different species aggregations in the biological Med and BS data call and in the AER.

9.3 Stock assessments

Not all stock assessments were available to the EWG in order to run the MSE simulations. The three stocks assessed by GFCM were not made available, although an official request was done by DGMARE. Two stocks were assessed with a VIT model (anglerfish in GSAs 1 and 7), which does not estimate time series of fishing mortality and abundance by age, preventing the application of the MSE developed for this EWG.

10 CONCLUSIONS

10.1 ToR 1

Comparing a TAC management system (output control) with an Effort management system (input control), for the stocks and regions included in the MAP proposal, showed that:

- TACs settings relies more on stock assessment than Effort, which may be a problem considering the instability of the stock assessments, due to short time series and data limitations.
- On the other hand an output control system is not affected by hyperstability, which can be the largest effect preventing management success in an Effort system.

Considering the uncertainty in stock assessments and the limitations in the estimation of stock-recruitment, the EWG considers the simulations after 2025 to be very uncertain. As such the analysis performed up to 2035, as requested by the ToR, should be taken with care and not considered very reliable.

In the case of Effort management, hyperstability, the mechanism by which the fleet keeps high fishing mortality while effort decreases, will impair the plan's ability to reach the fishing mortality target. In such case the effects of hyperstability can be mitigated by developing an effort correction method to cope with hyperstability. Two options were presented and tested. For real application requires further work.

The implementation of biomass safeguards at the level of Bpa, with a recovery period of 5 or 10 years, will delay the time target to achieve Fmsy, because the recovery period is longer than the period to reach the target in 2020 (3 years). Precedence during the transitional period should be taken by largest decrease in F.

Fishing at MSY will decrease catches in the short run (2020) and increase afterwards (2025). Biomass will increase, although in most cases (identify) to levels outside the historical ranges. At these levels of SSB the S/R fits may not hold. Fishing at MSY will increase the mean length of the stocks.

Changes in selection pattern due to (i) technical measures, (ii) the implementation of the landing obligation or (iii) differentiated effort management by fleet, will change the reference points.

The effects of technical measures designed to protect the juvenile fraction of the stocks, in biomass recovery and future catches is limited. Although in some stocks it can be more important, in particular it may stabilize the effect of other measures by letting the young individuals grow larger and avoiding the fishery from being dependent on recruitment and their inherent variability. These technical measures will have a larger impact on stocks which have fisheries deploying larger Fs on 0-year olds.

In 2025 75% of the stocks studied are expected to have SSB levels above Bpa with a probability of 95%, if option 1 is implemented.

Simultaneously trying to manage several stocks at single species FMSY levels is likely to fail and create inconsistencies between targets for different stocks, due to large uncertainty in the stock assessment, which propagates into reference points.

The current reference points are based on F0.1. In some cases the values obtained for Fmsy are very low and others very high. Considering that these references will be written in the regulation the EWG suggests that a thorough revision should be carried out, and the references updated when needed. Such revision could also be used to estimate biomass reference points, which currently don't exist.

In the area of influence of the MAP there are some fleets which are moderately dependent on the stocks considered, and simultaneously are large employers on the region. Such cases may require monitoring of social conditions to understand the extent of the impact of the MAP.

10.2 ToR 2

Having MAPs with a wider scope will limit both the number of stocks that will have to be split across regulations and the potential inconsistencies that may arise from having to make several regulations coherent. Nevertheless, the GFCM-WGSAD recognized that the stock units identified in the STOCKMED project were to be considered as preliminary hypothesis which needed to be checked with further investigation (e.g. geography, marine habitats, fishing practices, economy). Also, it was highlighted the need to collect existing and new information especially in the case of eastern and southern Mediterranean GSAs to complement the information presented to better identify stock boundaries in the Mediterranean sea. Considering the Multiannual plan in the Western Mediterranean Sea, the concerned GSAs are 2, 3, 4 and 12, respectively Alboran Island, Southern Alboran Sea, Algeria, Northern Tunisia (Figure 6.1). Therefore, WGSAD was not in the position to adopt new stock boundaries for the stock assessments.

With regards to fleets, the spatial scope is largely dependent on the fleet composition and the technical characteristics of the vessels. In such cases, having MAPs that focus on more homogenous regions, like western Mediterranean may encourage buy-in by Member States and regional/local bodies and establish a more homogeneous playing field.

The implementation of MAPs by one, two or more regulations still remains largely a policy decision. As long as the objectives are still followed and the biomass safeguards applied, the outcomes of MAPs designed under the current framework, should not be impaired by their scope.

10.3 ToR 3

The EWG identified a set of species which, following the criteria of EWG 15 04, are driving the fisheries but are not included in the ToRs, namely *Aristomorpha foliacea* in GSAs 7, 9 and 11; and *Lophius* spp in GSAs 10 and 11.

The *Parapenaeus longirostris* in GSAs 5 and 6, on the other hand are included in the ToRs but are not driving the fishery under the same criteria.

10.4 ToR 4

It was not possible to compute the indicators requested in the ToRs. Nevertheless, a proxy indicator suggests that by 2020 there's a high probability that the fleets' value per unit of effort will be larger than the 2015 levels.

10.5 ToR 5

Inconsistencies between the 3 databases available to the group, stock assessments, Mediterranean DCF data call (insert reference) and the AER data call, prevented the EWG to carry out a mixed-fisheries analysis as well as compute the economic indicator GVA requested in the ToRs.

A number of stock assessments were not available to the group due to (i) being carried out with VIT, which can’t be used to condition operating models, and (ii) not being provided by GFCM.

Employment data at Mediterranean level limits the regional analysis. For example, the Italian information refers to both the Northwestern and Northeastern Mediterranean.

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12 ACRONYMNS

Fleet segments:

DFN: drift and/or fixed netters
DRB: dredgers
DTS: demersal trawlers and/or demersal seiners
FPO: vessels using pots and/or traps
HOK: vessels using hooks
MGO: vessel using other active gears
MGP: vessels using polyvalent active gears only
PG: vessels using passive gears only for vessels < 12m
PGO: vessels using other passive gears
PGP: vessels using polyvalent passive gears only
PMP: vessels using active and passive gears
PS: purse seiners
OTM: pelagic trawlers
TBB: beam trawlers

Fishing gears:

DRB: boat dredge
DRH: hand dredges
FPO: pots and traps
FYK: fyke nets
GNC: encircling gillnets
GND: driftnet
GNS: set gillnet
GTN: combined gillnets-trammel nets
GTR: trammel net
LHP: hand and pole lines
LLD: drifting longlines
LLS: set longlines
LTL: trolling lines
OTB: bottom otter trawl
OTM: midwater otter trawl
OTT: multi-rig otter trawl
PS: purse seine
PTB: bottom pair trawl
TBB: beam trawl
MIS: miscellaneous gear
NK: not known
NO: no gear

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

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14 LIST OF ANNEXES

Electronic annexes are published on the meeting's web site on:
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List of electronic annexes documents:

EWG-16-02 – Annex 1 – BEMTOOL
EWG-16-02 – Annex 2 – A Multi Species State Variable model
EWG-16-02 – Annex 3 – a4a Management Strategy Evaluation algorithm.
EWG-16-02 – Annex 4 – MSE results. Plots of stocks and scenarios for TOR 1
EWG-16-02 – Annex 5 – MSE results. Summary dataset for TOR 1
EWG-16-02 – Annex 6 – Price model
EWG-16-02 – Annex 7 – Report to support STECF EWG 16-02: Multiannual plan for demersal fisheries in the Western Mediterranean – Economic indicators
EWG-16-02 – Annex 8 – Scenarios for future recruitment of NW Mediterranean stocks
EWG-16-02 – Annex 9 – Western Med MAP Fmsy ranges
EWG-16-02 – Annex 10 – Supporting tables.
EWG-16-02 – Annex 11 – MEFISTO

15 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on:
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List of background documents:

EWG-16-02 – Doc 1 - Declarations of invited and JRC experts (see also section 12 of this report – List of participants)

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