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Scientific, Technical and Economic Committee for Fisheries (STECF) - Evaluation of the fishing effort and catch regime for demersal fisheries in the western Mediterranean Sea – PART IX (STECF-22-11)

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Joint Research Centre

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EWG-22-11 report:

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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 is the ninth of a suite of STECF EWG reports dedicated to the evaluation of the implementation of the Western Mediterranean Sea Multi-Annual management Plan (hereafter, MAP), following EWG reports 18-09, 18-13, 19-01, 19-14, 20-13, 21-01, 21-13, 22-01.

The group was requested to implement mixed fisheries bio-economic models to run a number of scenarios up to 2030 with varying parameters, to evaluate a fishing effort reductions for trawlers, longliners and netters in association to vessel number reductions for trawlers, increase in mesh size for trawlers, existing closure areas and catch limits for deep water shrimps (ARA and ARS) through five scenarios and draft a mixed fisheries advice.

For all mixed fisheries models applied during the EWG (TOR 3), the data from the DCF official data calls and from the western Mediterranean stock assessments, were updated using data from EWG 22-09 (Western Mediterranean stock assessments) and EWG 22-10 (FDI datacall). The same set of updated data were also used to answer TOR 1 and TOR 2.

The exploration of effort data time series (TOR 1) highlighted that in GSA7 the French OTB fleet >18m showed a decrease in fishing days counteracted by an increase of the corresponding fleet segments of French OTT which could be potentially due to a shift in gear use, although experts did not suggest specific causes that would drive this shift.

The comparison of fishing days for trawlers (OTB, OTM, OTT, PTB, PTM and TBB as per EU regulation 2019/2236) declared in the FDI official datacall and reported in the 2020 and 2021 regulations were reported this year as well. Discrepancies were found also between 2021 data and the 2021 regulation (as per 2020) with the values reported in the regulation being always higher (for all countries but not for all fleet segments) than the values declared in the FDI datacall. Results suggest that effort is decreasing faster than the regulation for most fleet segments and that the reference period 2015-2017 might not be representative anymore of the effort dynamics of the last few years. For Spain and Italy reductions by 2021 are suggested to be higher than the expected reduction by 2022, while this does not happen for France.

From the data quality checks very minor issues were highlighted and there was no reporting in the DTMT of these issues. EWG 22-11 would like to ask for clarifications to MSs concerning the association of gear type with the upper level of aggregation fishing technique as it was observed that odd matching were found which could undermine the calculation of fishing days in the comparisons with the yearly regulations. Specifically the gear OTB was often found under the PGP fishing technique and experts present at the EWG were not able to explain this match.

The estimated F by gear and GSA (TOR2) allowed updating the analysis of the linear relationship between F and E. As in previous years a linear relationship consistent across GSAs and stocks was not found. The HKE, MUT and ARA stocks showed a linear relationship with OTB in some cases. For HKE 1567 the relationship did not hold once observed by GSA (although this could be a modelling artefact from the assessment model) or in EMU 2. MUT showed a linear relationship in GSA 6 and 7 with OTB and OTT (but results for GSA 7 should be taken with caution as there is a very strong variation in F for a lower variation of effort). ARA in EMU 1 by GSA (and on the overall stock 6-7) showed a linear relationship with OTB. No relationship was found for gears as LLS, GTR (except for MUT in 9) or GNS, neither for the stocks of DPS or ARS. EWG 22-11 suggests that running the analysis at metier level

would give more meaningful results, although it should be noted that the metier is a very unstable resolution of fisheries, therefore difficult to define as data sources.

To the methodological section of models (Section 5) two subsections were added, one on the models behavior during mid and long term projections and one on the relationship between biomass increase and economic gain. All models at the moment are suggested to be used for mid-term projections but not for long-term projections as the population dynamics are led either by stock recruitment relationships (BEMTOOL), which are not robust at the moment due to the nature of the data or led by recruitment stochasticity (IAM, ISIS-Fish and SMART), based on a random resampling of the time series but not accounting for potential environmental effects.

This year for EMU 1 new analytical assessments were available to EWG 22-11 such as ARA 5, DPS 1 and DPS 5-6-7. In EMU 2, instead, 2 stocks were lost as it was not possible to have an updated analytical assessment due to data issues for MUT 10 and ARA 8-9-10-11. As ARA is one of the stocks with a catch limit defined by the EU Regulation 2022/110, the limitations due to the lack of assessment for this species when running the models in EWG 22-11, should be noted. Based on the final draft report from EWG 22-09, stock assessment of Western Mediterranean, which will be presented to STECF in November 2022, but has not yet been endorsed by STECF, the EWG observed that in 2020, 94% and, in 2021, 79% of the stocks were not at MSY. In 2022, the EWG shows that 73% of the stocks are not at MSY and 53% remain severely overfished. Some of the stocks could be already responding positively to the MAP measures, although the MAP has been implemented only since 2020 and the data available are only up to 2021. 9 out of 14 assessed stocks have decreasing fishing mortality, however, there are 4 stocks still behind transition to MSY of which two have declining biomass and increasing fishing mortality. Some stocks need particular attention for their low biomass level. EWG 22-09 identified as below the biomass reference point (Blim): Hake in GSAs 1-5-6-7, Hake in GSAs 8-9-10-11 and Blue and red shrimp in GSAs 1-2. In addition, five stocks are also below Bpa. Despite progress towards MSY, high levels of overfishing remains in particular for hake and deep-water shrimps.

Models results (Section 6) showed that for EMU 1 (result only from IAM) none of the proposed scenarios (5 scenarios + status quo) achieved the objective of reaching F_{MSY} by 2025. Red mullet in GSA 6 (MUT6) never reaches its Fmsy range during the simulation period (2022-2030) under any scenario, and hake in GSA 1-5-6-7 (HKE1567) is still above Fmsy in 2025. The other stock that is slightly behind the objectives is red mullet in GSA 1 (MUT1) with all scenarios. However, the other stocks (ARA12, ARA5, ARA67, NEP6, MUT7, DPS1 and DPS567) reach their F_{MSY} range in 2025 with scenarios A to D. Only with the status quo scenario (scenario F) the F_{MSY} range is not reached in 2025 for some of those stocks. Globally, all scenarios foresee some important negative economic impact for French and Spanish trawlers in the short and medium term with a decrease in their Gross Value Added. Even with scenario F (i.e. status quo), French trawler GVA is negative from 2022. This is due to the fuel price used in the simulation in 2022 and beyond from AER 2022 projections, where prices increased a lot compared to their initial values.

Due to time constraints, it was not possible to have results from the ISIS-Fish model for EMU 1.

For EMU 2 the setting of a maximum catch limit on ARA and ARS allows to approach F_{MSY} for ARS, but not for HKE, even when in combination with other measures such as reduction of fishing days and number of vessels and change in selectivity. For ARS 8-9-10-11, NEP 9 and MUT 9 all scenarios implemented allow to reach F_{MSY} in 2025 except for the status quo scenario (F). ARS, ARA and NEP stocks would benefit of all the scenarios, due to the re-allocation of the effort from the deep-water metier (OTB_DWS and OTB_DES) to the demersal (OTB_DES). This reallocation produces an increase in the fishing pressure on demersal fishing grounds, contributing to partly reduce the underutilization of red mullet in GSA 10, red mullet in GSA 9 and Norway lobster in GSA 9, but also increasing the F of hake. The total revenues and gross value added for the overall fleet are predicted to slightly increase with respect to the lowest values of the time series reached in 2020-2021. For scenarios A, B and D total revenues across all fleets will decrease compared to the SQ scenario (F), remaining above the recent values. A similar pattern is observed for gross value added.

Simulations on fuel price increase of 120% (of the average fuel price in 2022) in 2023 onwards in EMU 1 showed an exacerbation on the GVA of fleet segments that already suffered from the management implementation. It should be highlighted that already with the "fuel option 1" (with fuel price in 2022 and onwards from AER projections), the economic performances are already negative, especially for French fleets, as the fuel price has strongly increased compared to 2021. Estimations of GVA in 2022, when effort reductions are still quite limited, are already negative suggesting that the negative GVAs are mainly due to the 2022 fuel price peak.

In EMU 2 as well the main effect is to observe a lower GVA; specifically, the difference between the best performing scenario, that is B, and the status quo (F) is smaller. Here as well, the increase in fuel costs impacts more importantly on the GVA, compared to the decrease in fixed costs imposed by the effort limitations.

For the application of the bio-economic models for the assessment of the development regarding the implementation of the West Med MAP it was decided to follow the methodology of the AER and, therefore, subsidies are not included in the calculations for income.

The financial situation which the bio-economic models present for the year 2022 and beyond depend a lot on the assumptions regarding the development of fuel prices but include no mitigation measures for the fishing companies (like de minimis payments to cover parts of the increase in fuel costs 2022). Therefore, the modelling results show a lower level of gross value added compared to the real situation of the fishing companies.

EWG 22-11 suggests that from an economic standpoint, it would make sense to conduct a detailed impact assessment (IA) for the further implementation of the West Med MAP. With such an assessment it would be possible to calculate possible scenarios (including possible mitigation and adaptation measures) regarding the implementation of effort reduction and the possible economic performance of the fishing fleets. The EU MSs affected by the management plan could then discuss possible mitigation and adaptation measures for the fishing sector. As such an IA is not requested by the West Med MAP it would have not follow the usual procedure within DG Mare and can be limited to assessments within the STECF context.

EWG 22-11 concludes that the EWG chair and the STECF bureau should discuss with DG MARE how far such an impact assessment would be possible for the next EWG meeting in March 2023.

Concerning economic indicators (Section 7), EWG 22-11 suggests that all the different bio-economic modules should report the same economic indicators and specific reference points should be defined in order to evaluate the economic results of the different simulated scenarios in a consistent way. The selected economic indicators should be harmonized with the ones applied by STECF for the assessment of the economic performance of the fleet (AER) and the "balance" indicators. Also, in the STECF report 18-15 (STECF 2018) indicators are proposed which could be possibly applied. Additionally EWG 22-11 highlights that there are no indicators on sociological characteristics in the bio-economic models so far. Some of the models give "social" indicators, but in general these are closely related to the economic ones (gross value added, crew share, employment) and they do not actually produce detailed results on the social impact of fisheries policies.

Additional sections (Section 7) were added to review available information on technological creep in the western Mediterranean in the last ten years, but no information seems to be available now to account for this parameter within the models.

A new section was dedicated to the development of a standardized ad hoc datacall for VMS and logbook data for MSs involved in the West Med MAP. The aim is to ease communication with MSs on the submission of these data and obtain a standardized format for all MSs that would fasten the work of experts in future EWGs.

Due to time constraints, the two spatial modeling groups (SMART and ISIS-Fish) could not fulfill the scenarios requested in the TORs. The parameterization of such models is complex and time consuming, therefore to be able to respond to all TORs EWG 22-11 suggested that it would be very helpful to have scenarios at list a month before the beginning of the working group as it was done for EWG 22-01.

Finally, in order to ease the work of EWGs concerned with the evaluation of effort and catch limit regime in the Western Mediterranean, catch at age matrices, F at age matrices and LFDs by GSA and gear for HKE and MUT stocks should be prepared in advance of the EWGs. This work could be held either during the western Mediterranean stock assessment EWG (to be evaluated with the chair of the EWG) or by a short ad hoc contract.

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) –Evaluation of fishing effort and catch regime for demersal fisheries in the western Mediterranean Sea - part IX (STECF-22-11)

Background provided by the Commission

EWG 22-11 was requested to address the following Terms of References:

In the objective of reaching MSY by January 2025 at the latest for all Western Mediterranean demersal target stocks, EWG 22-11 is requested to:

TOR 1. Based on the work of the FDI EWG in September 2022, compile and provide complete sets of annual data on fishing effort from 2015 to 2021. This should be described in terms of fishing days, days at sea, GT*days, fishing hours and nominal effort by Member State, GSA, vessel lengths[1] (4 fleet segments: < 12m, 12m to 18m, 18m to 24m and > 24m) and, where possible, by fishing gear.

TOR 2. Update the F-E analyses for Effort Management Units 1 and 2 with the most recent socio-economic and biological data and the most recent stock assessments' results. Given the fuel-related situation in 2022, collect qualitative information on the situation and estimate if possible the consequences of fuel price increase in 2022, if possible for the different types of vessel sizes and fishing gears, with the most updated available data and expert knowledge.

TOR 3. Develop mixed-fisheries effort and catch management scenarios for all demersal fishing gear (e.g. bottom trawls, nets, longlines) in EMU1 and EMU2. All scenarios should account for the management measures adopted in 2020, 2021 and 2022. The scenarios aim at evaluating the best possible transition path towards MSY for all demersal stocks by January 2025.

Examples of plausible management scenarios are provided in Table 1 in Annex as well as the references to the legal texts adopted for the implementation of EU-level and national management measures in 2020, 2021 and 2022.

TOR 4. Based on the advice structure developed in 2021 (EWG 21-13) and Table 2 in Annex, provide a synoptic overview of: (i) the source of data and methods and; (ii) the management advice, including technical and conservation measures combined to a range of fishing effort and catch reductions that secure the achievement of MSY by January 2025 accounting for the socio-economic impact using the latest work done by STECF and JRC for the Annual Economic Report. In order to assess these impacts, it will be necessary to decouple the effect of the management options from the macroeconomic conditions (e.g., reduced prices due to COVID and increases in fuel prices in 2022 due to the conflict in Ukraine).

[1] See ToR 6.5 in STECF PLEN 21-03 pages 120-121 and Annex pages 155-167.

TOR 5. Discuss future steps in preparation of EWG 23-xx (likely in March 2023) that would investigate the impact of additional management measures in order to achieve MSY by January 2025 at the latest for the six main demersal species in the western Mediterranean Sea. Given the fuel-related situation in 2022, include in this discussion aspects related to changes in fleet capacity and activity.

TOR 6. To ensure that all unresolved data transmission issues encountered prior to and during the EWG meeting are reported on line via the Data Transmission Monitoring Tool (DTMT) available at https://datacollection.jrc.ec.europa.eu/web/dcf/dtmt. Guidance on precisely what should be inserted in the DTMT, log-on credentials and access rights will be provided separately by the STECF Secretariat focal point for the EWG.

Annexes

References to legal texts:

- Annex 1 of 2020[2], Annex 3 of 2021[3] and Annex 3 of 2022[4] Fishing Opportunities[5]

- French Ministerial Decree for closures in adopted in 2020 (JORF 0299, text n°85);

- Spanish Ministerial Decree for closures in adopted in 2020 (ORDEN-APA-423-2020 and OM 1212-20) and 2021 (ORDEN-APA-1341-21);

Italian Ministerial Decree for closures in adopted in 2020 (DECR.DIR.Zonechiusura_prot_9045689).

Table 1_Management scenarios

For each scenario, the models have to be run with the management measures adopted at EU and national level in 2020, 2021 and 2022, which from 2022 onwards include both effort and catch management measures. Namely, for trawlers: 10% reduction of effort applied in 2020, 7,5% reduction of effort applied in Spain and France in 2021 (resp. 10% reduction in Italy in 2021) and 6% reduction of effort applied in all 3 Member States in 2022, except for French and Spanish vessels active in GSA 7 in France where the reduction is of 4% due to the compensation mechanism.

As in previous EWGs, the percentages of reduction of trawlers, netters and longliners effort given in the scenarios are calculated in reference to the baseline period 2015-2017. Scenarios have to be run till 2030 in order to estimate the short and mid-term impact of the management measures from an environmental as well as socio-economic perspective.

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2 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_10485_2020_INIT&qid=1655826077148&from=EN
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1485&qid=1655826077148&from=EN

3 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0090&qid=1655826077148&from=EN

4 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R0110&qid=1655826077148&from=EN

Given the current uncertainty on fuel prices and its impact on the socio-economic results of EWG 22-11 modelling exercise, each scenario should be run with 2 fuel options: 1) fuel price in 2023 onwards = average price of fuel in 2022 and 2) fuel price in 2023 onwards = 120% of the average price of fuel in 2022.

Please note that, in Table 1, the scenarios in grey should be given priority in case time constraints do not allow addressing all proposed scenarios.

Regarding the effort reduction for longliners and netters in scenario E, it is suggested to update the table at page 64 of the STECF EWG 21-01 report in order to choose proportional reduction for each gear.

Management measures from 2025 to 2030 should be continued as per the end of the 2023-2024 period for each scenario until MSY is achieved (see scenario A as example).

* In all scenarios, to account for closure areas the catchability is adjusted to reflect the closure areas adopted in French (Dec 2019), Italian (Aug 2020) and Spanish (May 2020 & Dec 2021) national legislations, see list above.

** All reductions apply to the baseline (which corresponds to the average value of FDI fishing effort by fleet between 2015 and 2017).

*** Regarding trawler number reduction, scenario D should use the following:

France: -5 trawlers (per year) in 2023, 2024 and 2025

Italy: -125 trawlers to be distributed between 2023 and 2027

Spain: no vessel reduction

Scenario	Trawler effort reduction**	Longliner effort reduction**	Netter effort reduction**	Combined catch limits for ARA and ARS	Spatio-temporal closures*	Selectivity measures	Reduction in trawler number
A (-5%)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% 2025: MSY level	Same as in 2020-2021	∅	2023: -5% 2024: -5%
B (-7,5%)	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	Same as in 2020-2021	2023: 50% of all 3 MS fleet with more selective gear (45mm square mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of all 3 MS fleet with more selective gear	2023: -5% 2024: -5%
C (-10%)	2023: -10% 2024: -6,5%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	Same as in 2020-2021	∅	2023: -5% 2024: -5%
D (MS-specific)	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Catch limits transition path to MSY calculated by EWG 22-09	Same as in 2020-2021	2023: 50% of Spanish fleet with more selective gear (45mm square	*** (see above)

						mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of Spanish fleet with more selective gear	
E (All-in)	2023: -16,5% 2024: ∅	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	Catch limits transition path to MSY calculated by EWG 22-09	2023: permanent closure areas	∅	***
F (Status quo)	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	Same as in 2020-2021	∅	∅

Request to the STECF

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

STECF comments

The Expert Working Group (EWG) met online from 26th of September to 30th of September 2022. The meeting was attended by 17 experts, including five STECF members and one JRC expert. Two DG MARE representatives and one observer also participated in the EWG.

EWG 22-11 was a follow-up to EWG 22-01 (March 2022), EWG 21-13 (September 2021), EWG 21-01 (March 2021), EWG 20-13 (October 2020), EWG 19-14 (October 2019), EWG 19-01 (March 2019), EWG 18-13 (October 2018) and EWG 18-09 (June 2018).

STECF observes that all the ToRs have been addressed, noting that, similar to previous years, the order of sections in the report does not follow the order of ToRs exactly. In the EWG report, they are grouped into data-related ToRs and model-related ToRs. STECF comments follow this order.

Effort data (ToR 1)

STECF observes that EWG 22-11 used the data officially provided through the 2022 FDI data call as the main source of data for the analyses.

STECF observes that some discrepancies were identified between the FDI data and the yearly Regulations that could undermine the calculation of fishing days. Specifically, the EWG found that fishing days for trawlers were recorded by all Member States both as DTS (Demersal trawlers and/or demersal seiners) and PGP (Vessels using polyvalent passive gears only). The EWG was not able to explain this mismatch. STECF observes that the assignment method for fishing gears/fishing techniques used by Member States needs to be clarified and standardised for future meetings to avoid these discrepancies.

STECF observes that the EWG reported this year on the comparison of fishing days for trawlers (i.e., OTB, OTM, OTT, PTB, PTM and TBB as per Regulation (EU) 2019/2236), between the FDI official data call and those reported in the 2020 and 2021 Regulations. As in 2020, discrepancies were found between the 2021 data and the 2021 Regulation. The values reported in the Regulation for fishing days of trawlers were consistently higher (for all countries but not for all fleet segments) than the values declared in the FDI data call. The results suggest that overall effort is decreasing faster than indicated by the Regulation, although there are some exceptions to it at fleet segment level. Further, STECF notes that there are indications that the reference period 2015-2017 might not be representative anymore of the effort dynamics of the last few years. For Spain and Italy, reductions for 2022 based on 2021 data are suggested to be higher than the expected reduction compared to the 2015-2017 baseline. This is not the case for France in EMU 1.

STECF observes that the exploration of the effort data time series highlighted that, in GSA 7, the French single boat bottom trawler (OTB) fleet >18m showed decreased fishing days. This was counteracted by an increase in fishing days for the corresponding fleet segment of French twin bottom otter trawler (OTT) fleet. STECF observes that according to the EWG report, this is potentially due to a shift in gear use.

STECF observes that a new section in the EWG report was dedicated to the development of a standardized ad hoc data call for VMS and logbook data for Member States involved in the West Med MAP. The aim of this data call is to ease communication with Member States on the submission of these data and develop a standardised format for all Member States that would speed up the work carried out by future EWGs.

From the data quality checks carried out, STECF notes that the EWG report highlighted very minor issues. These related mainly to the checking of fishing days by gear, GSA and country. Aside from one outlier relating to data from Corsica for GSA 8 in one year, all other main data were found to be correct. One inconsistency was observed relating to fishing days (FD) registered for bottom trawl data for France in GSA 8, while there were three other errors relating to days at sea (SD) in the bottom trawl data for France in GSA 8 and longline data for France in GSA 7. These need to be clarified with the relevant Member States.

Fishing effort-fishing mortality relationships (ToR 2)

STECF observes that the provision of estimated fishing mortality (F) by gear and GSA allowed the analysis of the linear relationship between fishing mortality and fishing effort to be updated. However, STECF notes that, as in previous EWGs, there was no linear relationship consistent across GSAs and stocks. Specifically:

- For hake, red mullet and blue and red shrimp a linear relationship with single boat bottom trawls (OTB) was observed in several cases.
- For hake in GSAs 1,5,6 and 7, this relationship was not consistent by GSA (although this could be a modelling artefact from the assessment model). This was also the case for EMU 2.
- Red mullet showed a linear relationship in GSA 6 and 7 with single boat bottom otter trawls (OTB) and twin bottom otter trawls (OTT), noting that the results for GSA 7 should be taken with caution as there is a very strong variation in F for a lower variation of effort.
- Blue and red shrimp in EMU 1 by GSA (and on the overall stock 6-7) showed a linear relationship with OTB gear.
- No relationship was found for longlines (LLS), trammel nets (GTR) except for red mullet in GSA 9 nor for bottom-set gillnets (GNS) or rose shrimp or red shrimp with these gears.

Models (ToR 3)

STECF observes that for all mixed fisheries models applied during the EWG (ToR 3), the data from the DCF official data calls and from the western Mediterranean stock assessments, were updated using data from EWG 22-09 (Western Mediterranean stock assessments) and EWG 22-10 (FDI data call).

STECF notes that the EWG added two subsections to the methodological section (Section 5) in this year's EWG report. One section dealt with the model's behavior during mid- (up to 2030) and long-term (up to 2040) projections and a second section dealing with the relationship between biomass increase and economic gain. STECF suggests that all models be used for mid-term projections as long-term projections have high uncertainties. The reasons are that the population dynamics are led either by stock recruitment relationships (BEMTOOL), which are currently not robust due to the limited time series, or led by recruitment stochasticity (IAM, ISIS-Fish and SMART), based on a random resampling of the time series without taking account of potential environmental effects.

STECF notes that an additional section (Section 7) was added compared to this year's report to review available information on technological creep in the western Mediterranean over the last ten years. However, no sufficient information seems to be available currently to account for this parameter within the available models.

Scenarios including new management measures

STECF notes that EWG 22-11 was requested to implement mixed fishery bio-economic models and to run several scenarios up to 2030 with varying parameters. These model runs provided an evaluation of fishing effort reductions for trawlers, longliners and netters under the following scenarios:

- A reduction in the number of trawlers.
- An increase in mesh size used by trawlers.

- The impacts of existing closure areas.
- Introducing catch limits for deep water shrimps (ARA and ARS).

STECF observes that due to time constraints, the two spatial modeling groups (SMART and ISIS-Fish) could not fulfill all the scenarios requested in the ToRs as the parameterization of such models is complex and time consuming. The EWG only received these scenarios one week before the meeting and this did not allow parameterization of the models prior to the meeting. STECF suggests for future EWGs that the scenarios are provided at least a month in advance of the EWG as was previously the case for EWG 22-01.

Availability of analytical assessments for EMU 1 and EMU 2

STECF observes that this year for EMU 1, new analytical assessments were available to EWG 22-11 for blue and red shrimp in GSA 5, rose shrimp in GSA 1 and GSA's 5-6-7. Conversely, for EMU 2, it was not possible to provide updated analytical assessments for two stocks – red mullet in GSA 10 and blue and red shrimp in GSAs 8-9-10-11 due to data issues. As blue and red shrimp is one of the stocks with a catch limit defined in Regulation (EU) 2022/110, STECF notes the limitations due to the lack of assessment for this species when running the models in EWG 22-11.

Simulation Results for EMU 1 (GSAs 1-5-6-7)

STECF observes that the modelling results (Section 6) showed that for EMU 1 (results only from IAM), none of the proposed scenarios (5 scenarios + status quo) achieve the objective of reaching F_{MSY} by 2025. Red mullet in GSA 6 (MUT6) was found to never reach its F_{MSY} range over the entire simulation period (2022-2030) under any scenario. Hake in GSA 1-5-6-7 (HKE1567) was found to be above F_{MSY} up to 2025. STECF notes red mullet in GSA 1 (MUT1) will also not be at F_{MSY} by 2025 with all scenarios. However, the other stocks (ARA12, ARA5, ARA67, NEP6, MUT7, DPS1 and DPS567) reach their respective F_{MSY} range in 2025 with scenarios A to D. Only with the status quo scenario (scenario F) do these stocks fail to reach the F_{MSY} range by 2025.

STECF notes that the projections from the TAC scenarios are still preliminary for the IAM simulations and based on broad assumptions, given the difficulty to anticipate and model the effects of introducing a TAC for the relevant stocks. Nevertheless, the TAC scenarios show a strong positive response for several species with increasing stock sizes.

STECF observes that all scenarios project important negative economic impacts for French and Spanish trawlers in the short and medium term with a decrease in their GVA (Gross Value Added). Even with scenario F (i.e., status quo), the GVA for French trawlers is negative after 2022. This is due to the significant increase in fuel price in 2022 compared to baseline fuel price values used in the simulations carried out in the AER 2022.

STECF notes that the fuel price simulations using an increase of 120% (of the average fuel price in 2022) in 2023 onwards in EMU 1 show a marked increase on the impact on GVA of fleet segments that have already been most impacted by the implementation of the MAP. It should be highlighted that already with the "fuel option 1" (with fuel price in 2022 and onwards from AER projections), the economic performances are negative, especially for the French fleets, as the fuel price has increased significantly compared to 2021. Estimations of GVA in 2022, when effort reductions are still quite limited, are already negative suggesting that the negative GVAs are mainly due to the 2022 fuel price spike.

Simulation results for EMU 2 (GSAs 8-9-10-11)

STECF observes that for EMU 2, the setting of maximum catch limits for blue and red shrimp allows reaching F_{MSY}, but not for hake, even in combination with other measures such as a reduction in fishing days and the number of vessels as well as changes in selectivity.

STECF notes that for blue and red shimp in GSAs 8-9-10-11, *Nephrops* and red mullet in GSA 9, all scenarios except for the status quo scenario(F), indicate reaching F_{MSY} in 2025.

These stocks benefit under all scenarios, due to the re-allocation of fishing effort from the deep-water metiers (OTB_DWS and OTB_MDD) to the demersal bottom trawl metier (OTB_DES). This reallocation produces an increase in the fishing pressure on demersal fishing grounds, contributing to a partial reduction in the underutilization of red mullet in GSA 10, red mullet in GSA 9 and Norway lobster in GSA 9, but an increase in fishing mortality for hake.

STECF notes that the total revenues and GVA for the overall fleet are predicted to slightly increase with respect to the lowest values of the time series in 2020-2021. For scenarios A, B and D total revenues will decrease across all fleets compared to the SQ scenario (F), remaining above the recent values. A similar pattern is observed for GVA.

STECF notes that in EMU 2, as for EMU 1, the main effect of setting maximum catch limits for red and blue shrimp is a lower GVA. The difference between the best performing scenario (scenario B), and the status quo (F) is smaller as is the case for EMU 1. EMU 2 and EMU 1 indicate the increase in fuel costs impacts more significantly on GVA, than the decrease in fixed costs imposed by the effort limitations.

Influence of economic indicators on model results

STECF observes that in applying the bio-economic models for the assessment of the implementation of the West Med MAP, it was decided to follow the methodology of the AER and, therefore, subsidies were not included in the calculation of income. The main reason is that most of the subsidies in the EU are tax exemptions, which influence the level of fuel costs. STECF is aware that since 2020, most governments have provided direct financial support in the COVID crisis, and countries including France, Spain and Italy have also provided additional support in 2022 to mitigate against the raise of fuel costs due to the conflict in Ukraine. Member States are requested to deliver data on subsidies via the DCF but so far that data is not available. STECF notes that the EWG decided not to include those support payments to allow distinguishing between the impacts of the MAP from external economic shocks.

STECF observes that the financial situation simulated by the bio-economic models for the years 2022 and beyond depends a lot on the assumptions regarding the development of fuel prices. However, they do not include any mitigation measures or Government supports for fishing companies (e.g., de minimis payments to cover parts of the increase in fuel costs 2022). Therefore, the modelling results likely show a lower level of GVA compared to the situation being experienced currently by fishing companies.

STECF notes that EWG 22-11 suggested that from an economic standpoint, it would make sense to conduct an impact assessment (IA) for the further implementation of the West Med MAP. An IA would provide a longer-term perspective and, by applying different scenarios, provide Member States and the industry with information on the potential economic impacts of possible adaptation and mitigation measures. With the improved models available it should be possible to run a diverse set of scenarios. STECF suggests that the practicality of carrying out such an IA and the scope, content and data needed could be discussed at STECF PLEN 22-03.

To ensure consistency, STECF observes that it would be helpful if further development effort was put into the different bio-economic models to ensure they report the same economic indicators and specific reference points. This would facilitate the evaluation of the economic results produced from the different simulated scenarios. The selected feasibility of harmonizing the economic indicators with the ones applied by STECF for the assessment of the economic performance of the fleet (AER) and the "balance-capacity" indicators should be considered.

Additionally, STECF notes EWG report 18-15 (STECF, 2018) proposed indicators (such as Net Profit Margin or Net Value Added per FTE) which could be possibly applied. EWG 22-11 highlighted that there are no indicators of sociological characteristics in the bio-economic models to date. Some of the models give "social" indicators, but in general these are closely related to the economic ones (gross value added, crew share, employment) and they do not actually produce detailed results on the social impact of Regulations such as the West Med MAP.

STECF conclusions

STECF concludes that the discrepancies already highlighted in previous years between the effort levels reported in the FDI and fishing effort ceilings given in the annual Regulation are still not fully resolved. STECF emphasises that these discrepancies should be clarified with the Member States and considered in future regulations setting effort ceilings.

STECF concludes that the effort and fleet structure has significantly changed in recent years in the Western Mediterranean. This has led to the 2015-2017 baseline being potentially too old to serve as the reference for future effort ceilings, as effort seems to be decreasing faster than reported in the relevant effort ceiling regulation. STECF should discuss with DGMARE how to proceed with this during PLEN 22-03 in discussing the ToRs for the 2023 EWG.

STECF concludes that clarification should be sought from Member States on the association of gear type with the upper level of aggregation "fishing technique". This would allow a better understanding of whether discrepancies found are errors in the data or are due to the data sampling procedure being followed by Member States.

STECF concludes that, to provide a longer-term perspective of the potential economic impacts of possible adaptation and mitigation measures for Member States and the industry, the utility of STECF carrying out a limited impact assessment of the West MAP should be discussed at PLEN 22-03.

STECF concludes it would be helpful if the same economic indicators and specific reference points were used to allow evaluation of the economic results of the different simulated scenarios in a more consistent way across models. DG MARE could include this request for improved harmonization in next year's EWG TORs. STECF could discuss this during the winter plenary meeting 2022 to identify the best candidate indicators and follow up with the EWG 22-11 modelers to assess the feasibility and work plan for achieving this.

STECF concludes that a standardized ad hoc data call for VMS and logbook data for Member States involved in the West Med MAP should be developed. This could be completed during next year's preparatory EWG. STECF could subsequently discuss this during PLEN 23-01 as to whether this should be an ad hoc data call or part of one of the existing official data calls.

STECF concludes that DG MARE should provide the list of scenarios at least a month before the beginning of the working group as it was done for EWG 22-01. This would allow the modelers to update the models and provide the results before the end of the EWG.

STECF concludes that to ease the work of EWGs concerned with the evaluation of effort and catch limit regime in the Western Mediterranean, catch at age matrices, F at age matrices and LFDs by GSA and gear for hake and red mullet stocks could be prepared in advance of the EWGs. This work could be completed during the western Mediterranean stock assessment EWG (to be discussed with the chair of the EWG) or, alternatively, if feasible, through a short ad hoc contract.

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

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REPORT TO THE STECF

EXPERT WORKING GROUP ON Evaluation of the fishing effort and catch regime for demersal fisheries in the western Mediterranean Sea – part IX (EWG-22-11)

Virtual meeting, 26-30 September 2022

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

1 INTRODUCTION

This report is the ninth of a suite of STECF EWG reports dedicated to the evaluation of fishing effort regime (now also catch limit regime) in the Western Mediterranean Sea.

The first EWG in June 2018 (STECF 18-09) addressed a number of issues related to managing fisheries with fishing effort regimes. Building on a review of previous experiences worldwide, the report highlighted the main and well known concern that catchability estimates (relationship between fishing effort and fishing mortality) are imprecise and vary systematically since fishers will tend to increase their efficiency in order to maintain their historical catch and revenue levels in spite of effort reduction[6]. This was corroborated by quantitative analyses of differences in catch efficiency between fishing trips using trip-based data from Italy and Spain, differences that are only little explained by features such as vessel size or fishing area. Also, a study was presented monitoring continuous increase in gear size (width, opening, twin trawl etc) in the Mediterranean, highlighting a potential for further increase in fishing efficiency that may counteract the expected effect of effort reduction. Finally, a comparison of the completeness and consistency of the various datasets on catch and effort by fleet segments available at the JRC was performed, highlighting a number of gaps.

The second EWG in October 2018 (STECF 18-14) built further on these results. The relationship between fishing effort and fishing mortality, aggregated at the level of fleet segment and year, was analysed for a number of the MAP stocks using the available time series of stock assessment. This relationship was shown to be never linear, and in most cases it cannot even be detected in the time series. This means that a reduction of fishing effort will not translate by a similar reduction of fishing mortality at least in the first years of implementation. Secondly, the trips analyses were extended to new data from France, showing similar results as for Italy and Spain. Finally, a first review of existing bioeconomic mixed fisheries models in the Western Med was conducted. Considering that many models were potentially available but that none of them was directly operational for the purpose of the MAP, a 2 years road map was agreed to improve the availability and use of such models.

Accordingly, the third EWG in March 2019 (STECF 19-01) focused uniquely on updating and improving mixed-fisheries models. Several models of various complexity were presented and tested for the two regions (EMU1 & and EMU2). Good progresses were achieved but the most important issue left was the need to develop a single combined model for EMU1 including data from both Spain and France together, instead of the existing models by GSA. In addition, the EWG listed numerous other issues and future questions regarding data and models' dimensions (e.g. stock definition, inclusion of other species than the MAP species etc).

The fourth EWG in October 2019 (STECF 19-14) was the continuation of this work, progressing further on these issues in order to have models and datasets fully operational for providing mixed-fisheries advice on the MAP. In particular, a first version of a combined IAM model for EMU1 was presented, including both Spanish and French fleets but including only hake data. Two models were run in parallel for EMU 2 (BEMTOOL and SMART), providing different insights on future development. During the EWG 19-14, specific focus was also given to how to simulate closed areas in the bioeconomic models to evaluate their potential impact in the medium-term.

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[6] http://www.fao.org/gfcm/fishforum2018/presentations/en/, Theme 1 session 2

The fifth EWG in October 2020 (STECF 20-13) was largely an update of STECF 19-14 regarding models and scenarios (see ToRs). The models were updated with the most recent assessment data (from STECF EWG 20-09) and FDI effort data (from STECF 20-10) and extended to cover some of the gaps previously identified (mainly for EMU 1), and a number of scenarios were run. Additional issues were though considered. In 2020, the West Med MAP has been implemented since January 1st, through Regulation (EU) 2019/1022, with fishing opportunities in terms of maximum allowable fishing effort in fishing days fixed for 2020 in Council Regulation (EU) 2019/2236. The EWG compared the reference levels used for fishing effort quotas and discussed the implications of the sometimes large discrepancies observed between scientific and policy data.

The sixth EWG in March 2021 (STECF EWG 21-01) explored the datasets on the trawl fleets exploiting demersal stocks to estimate the conversion factors between fleet segments to ensure that effort swaps will not lead to an undesirable increase in fishing mortality. The EWG highlighted the need to have data at fishing trip (VMS data) level when estimating conversion factors. The impact of recreational fishery on the stocks covered by the Western Mediterranean Multi-Annual Plan was found to be negligible. The EWG also assessed the proposals for additional closure areas for 2021 received from Spain, but had no time nor data to propose alternative closure areas for EMU 1 and 2.

The seventh EWG held the last week of September 2021 was partially an update of STECF 20-13 and partially an update of STECF 21-01. The models were updated with the most recent assessment data (from STECF EWG 21-11) and FDI effort data (from STECF 21-12) and extended (compared to last year) to run scenarios accounting for alternative selectivity and introduction of TACs. The EWG updated the F-E relationships and estimated conversion factors at metier and stock level. In 2021, the second year of the West Med MAP has been implemented since January 1st, through Regulation (EU) 2021/90, setting fishing opportunities in terms of maximum allowable fishing effort in fishing days for 2021. This year as well the EWG compared the reference levels used for fishing effort quotas and found large discrepancies between scientific and policy data, the implications were discussed during the EWG.

The eighth EWG held the first week of March 2022 was a technical exercise to improve the mixed-fisheries modelling frameworks to in preparation of future EWGs. The EWG focused on the evaluation of two specific management measures considered in the western Mediterranean management plan: maximum catch limits (MCLs) and closure areas. In order to evaluate these measures in isolation from others considered in the western Mediterranean management plan, effort reductions applied in 2022 following Regulation (EU) 2022/110 were not considered during EWG 22-01. MCLs on ARA and ARS (following Regulation (EU) 2022/110) and on HKE and existing closure areas were evaluated. EWG 22-01 evaluated the possibility of defining additional closure areas with the available data and highlighted numerous limitations in the process.

This ninth EWG held the last week of September 2022 was partially an update of STECF 21-13. The models were updated with the most recent assessment data (from STECF EWG 22-09) and FDI effort data (from STECF 22-10) and extended (compared to last year) to run scenarios accounting for effort reductions of trawlers, longliners and netters at the same time. Additionally vessel number reduction was considered as well. No additional closure areas from the existing ones were considered and MCLs were accounted only for ARA and ARS stocks. An increase in selectivity was accounted for as well. All management scenarios were run twice under two different economic regimes during projections: the first with fuel price fixed as the average price estimated for 2022, the second one with fuel price increased by 120% from 2023 onwards. The EWG updated the F-E relationships and estimated F by GSA and by gear for all stocks. In 2022, the third year of the West Med MAP has been implemented since January 1st, through Regulation (EU) 2022/110, setting fishing opportunities in terms of maximum allowable fishing effort in fishing days and in terms of the maximum catch limits (MCLs) for 2022. This year as well the EWG compared the reference levels used for fishing effort quotas and found large discrepancies between scientific and policy data, the implications were discussed during the EWG.

1.1 Terms of Reference for EWG-22-11

EWG 22-11 was requested to address the following Terms of References:

In the objective of reaching MSY by January 2025 at the latest for all Western Mediterranean demersal target stocks, EWG 22-11 is requested to:

TOR 1. Based on the work of the FDI EWG in September 2022, compile and provide complete sets of annual data on fishing effort from 2015 to 2021. This should be described in terms of fishing days, days at sea, GT*days, fishing hours and nominal effort by Member State, GSA, vessel lengths[7] (4 fleet segments: < 12m, 12m to 18m, 18m to 24m and > 24m) and, where possible, by fishing gear.

TOR 2. Update the F-E analyses for Effort Management Units 1 and 2 with the most recent socio-economic and biological data and the most recent stock assessments' results. Given the fuel-related situation in 2022, collect qualitative information on the situation and estimate if possible the consequences of fuel price increase in 2022, if possible for the different types of vessel sizes and fishing gears, with the most updated available data and expert knowledge.

TOR 3. Develop mixed-fisheries effort and catch management scenarios for all demersal fishing gear (e.g. bottom trawls, nets, longlines) in EMU1 and EMU2. All scenarios should account for the management measures adopted in 2020, 2021 and 2022. The scenarios aim at evaluating the best possible transition path towards MSY for all demersal stocks by January 2025.

Examples of plausible management scenarios are provided in Table 1 in Annex as well as the references to the legal texts adopted for the implementation of EU-level and national management measures in 2020, 2021 and 2022.

TOR 4. Based on the advice structure developed in 2021 (EWG 21-13) and Table 2 in Annex, provide a synoptic overview of: (i) the source of data and methods and; (ii) the management advice, including technical and conservation measures combined to a range of fishing effort and catch reductions that secure the achievement of MSY by January 2025 accounting for the socio-economic impact using the latest work done by STECF and JRC for the Annual Economic Report. In order to assess these impacts, it will be necessary to decouple the effect of the management options from the macroeconomic conditions (e.g., reduced prices due to COVID and increases in fuel prices in 2022 due to the conflict in Ukraine).

TOR 5. Discuss future steps in preparation of EWG 23-xx (likely in March 2023) that would investigate the impact of additional management measures in order to achieve

[7] See ToR 6.5 in STECF PLEN 21-03 pages 120-121 and Annex pages 155-167.

MSY by January 2025 at the latest for the six main demersal species in the western Mediterranean Sea. Given the fuel-related situation in 2022, include in this discussion aspects related to changes in fleet capacity and activity.

TOR 6. To ensure that all unresolved data transmission issues encountered prior to and during the EWG meeting are reported on line via the Data Transmission Monitoring Tool (DTMT) available at https://datacollection.jrc.ec.europa.eu/web/dcf/dtmt. Guidance on precisely what should be inserted in the DTMT, log-on credentials and access rights will be provided separately by the STECF Secretariat focal point for the EWG.

Annexes

References to legal texts:

- Annex 1 of 2020[8], Annex 3 of 2021[9] and Annex 3 of 2022[10] Fishing Opportunities[11]
- French Ministerial Decree for closures in adopted in 2020 (JORF 0299, text n°85);
- Spanish Ministerial Decree for closures in adopted in 2020 (ORDEN-APA-423-2020 and OM 1212-20) and 2021 (ORDEN-APA-1341-21);

Italian Ministerial Decree for closures in adopted in 2020 (DECR.DIR.Zonechiusura_prot_9045689).

Table 1_Management scenarios

For each scenario, the models have to be run with the management measures adopted at EU and national level in 2020, 2021 and 2022, which from 2022 onwards include both effort and catch management measures. Namely, for trawlers: 10% reduction of effort applied in 2020, 7,5% reduction of effort applied in Spain and France in 2021 (resp. 10% reduction in Italy in 2021) and 6% reduction of effort applied in all 3 Member States in 2022, except for French and Spanish vessels active in GSA 7 in France where the reduction is of 4% due to the compensation mechanism.

As in previous EWGs, the percentages of reduction of trawlers, netters and longliners effort given in the scenarios are calculated in reference to the baseline period 2015-2017. Scenarios have to be run till 2030 in order to estimate the short and mid-term impact of the management measures from an environmental as well as socio-economic perspective.

Given the current uncertainty on fuel prices and its impact on the socio-economic results of EWG 22-11 modelling exercise, each scenario should be run with 2 fuel options: 1) fuel

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[8] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_10485_2020_INIT&qid=1655826077148&from=EN
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1485&qid=1655826077148&from=EN

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0090&qid=1655826077148&from=EN

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R0110&qid=1655826077148&from=EN

price in 2023 onwards = average price of fuel in 2022 and 2) fuel price in 2023 onwards = 120% of the average price of fuel in 2022.

Please note that, in Table 1, the scenarios in grey should be given priority in case time constraints do not allow addressing all proposed scenarios.

Regarding the effort reduction for longliners and netters in scenario E, it is suggested to update the table at page 64 of the STECF EWG 21-01 report in order to choose proportional reduction for each gear.

Management measures from 2025 to 2030 should be continued as per the end of the 2023-2024 period for each scenario until MSY is achieved (see scenario A as example).

* In all scenarios, to account for closure areas the catchability is adjusted to reflect the closure areas adopted in French (Dec 2019), Italian (Aug 2020) and Spanish (May 2020 & Dec 2021) national legislations, see list above.

** All reductions apply to the baseline (which corresponds to the average value of FDI fishing effort by fleet between 2015 and 2017).

*** Regarding trawler number reduction, scenario D should use the following:

France: -5 trawlers (per year) in 2023, 2024 and 2025

Italy: -125 trawlers to be distributed between 2023 and 2027

Spain: no vessel reduction

Scenario	Trawler effort reduction**	Longliner effort reduction**	Netter effort reduction**	Combined catch limits for ARA and ARS	Spatio-temporal closures*	Selectivity measures	Reduction in trawler number
A (-5%)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% 2025: MSY level	Same as in 2020-2021	∅	2023: -5% 2024: -5%
B (-7,5%)	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	Same as in 2020-2021	2023: 50% of all 3 MS fleet with more selective gear (45mm square mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of all 3 MS fleet with more selective gear	2023: -5% 2024: -5%
C (-10%)	2023: -10% 2024: -6,5%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	Same as in 2020-2021	∅	2023: -5% 2024: -5%
D (MS-specific)	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Catch limits transition path to MSY calculated by EWG 22-09	Same as in 2020-2021	2023: 50% of Spanish fleet with more selective gear (45mm square	*** (see above)

						mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of Spanish fleet with more selective gear	
E (All-in)	2023: -16,5% 2024: ∅	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	Catch limits transition path to MSY calculated by EWG 22-09	2023: permanent closure areas	∅	***
F (Status quo)	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	Same as in 2020-2021	∅	∅

1.2 Main findings

KEY FINDINGS FOR EMU1 (GSAs 1 2 5 6 7)

In EMU 1, several stocks are currently strongly overexploited, including Hake (HKE) in GSAs 1-5-6-7, red mullet (MUT) in GSA 1 and in GSA 6, and blue and red shrimp (ARA) in GSAs 1-2, GSA 5 and in GSAs 6-7. The scenarios investigated with the IAM model simulated a range of reductions of fishing effort of trawlers, longliners and netters, as well as reductions in number of vessels for the trawl fleet segments, implementation of maximum catch limits (MCL) on blue and red shrimps and improvement in selectivity. Although all scenarios predict globally an increase in the biomasses of the exploited stocks, no scenario foresees exploitation levels in line with the objectives of the plan, i.e. all stock at Fmsy in 2025. The stocks of hake in GSA1567, red mullet in GSA1 and red mullet in GSA6 do not reach this objective in 2025, whatever the scenario considered. However, the three stocks of ARA (ARA12, ARA5 and ARA67) do reach Fmsy in 2025, which is not surprising given the definition of the scenarios where Spanish trawler fishing efforts are adjusted to reach Fmsy of the ARA in 2025 and after. The stock of ARA5 is the most binding.

The implementation of important effort reduction combined with improvement in selectivity (scenarios B and D) predicts that the objective of being at or below Fmsy for each stock is reached in 2030, except for red mullet in GSA 6 (Fig. 1.2.1). For this stock, even in 2030, Fmsy is not reached whatever the scenario considered (to note that however, its SSB is above the estimation of Bmsy value from the stock assessment group EWG 22-09).

Globally, all scenarios foresee some important negative economic impact for French and Spanish trawlers in the short and medium term with a decrease in their Gross Value Added. The average gross value added per vessel is negative for most scenarios for the French trawlers, while it is positive for most of the Spanish vessels. It is important to note, that even with scenario F (i.e. status quo), French trawler GVA is negative from 2022. This is due to the fuel price used in the simulation in 2022 and beyond from AER 2022 projections, where prices increased a lot compared to their initial values.

Since MCL on blue and red shrimps is applied in all scenarios except the scenario status quo F (i.e. in scenarios A, B, C and D), the fleet segments using deep water trawling, i.e. the Spanish trawlers above 18 meters, are the most economically affected among Spanish vessels. The economic impact is greater after 2025, when fishing effort is adjusted to reach Fmsy for the three ARA stocks.

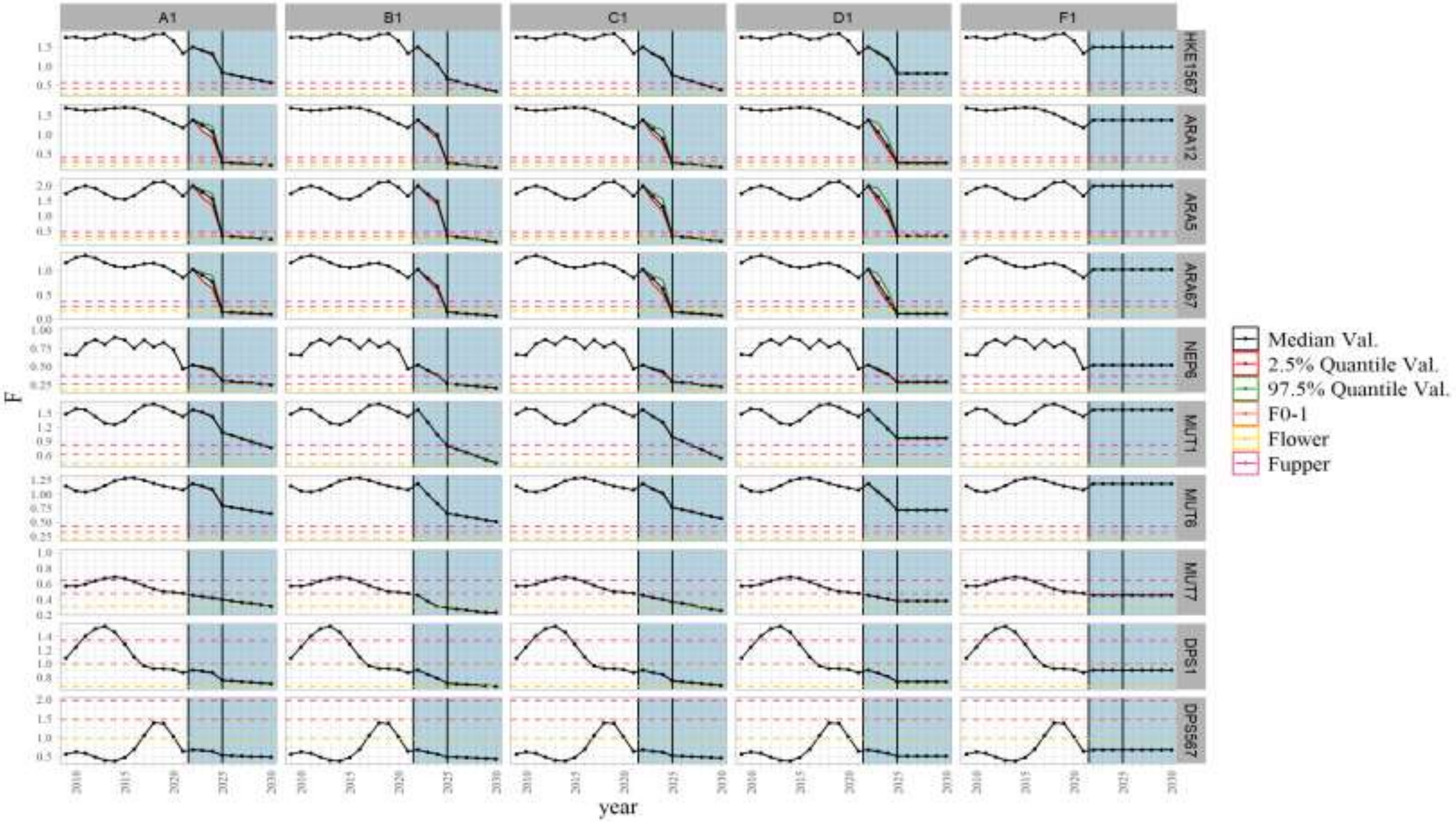


Figure 1.2.1. EMU 1 (IAM model). Predicted Fishing mortalities by modelled stock (in row) under alternative scenarios (in column). The stocks are as follow (from top to bottom): hake GSAs1-5-6-7 (HKE1567), blue and red shrimp GSAs1-2 (ARA12), blue and red shrimp GSA5 (ARA5), blue and red shrimp GSAs6-7 (ARA67), Norway lobster GSA6 (NEP6), red mullet GSA1 (MUT1), red mullet GSA6 (MUT6), red mullet GSA7 (MUT7), deep-water rose shrimp GSA1 (DPS1), and deep-water rose shrimp GSAs5-6-7 (DPS567). Historical values of Fbar are given in the white areas and simulated values in the blue area. Estimated F 0-1, Flower and Fupper from EWG 22-09 stock assessments are represented. Simulations run until 2030 and vertical black lines indicate the year 2025.

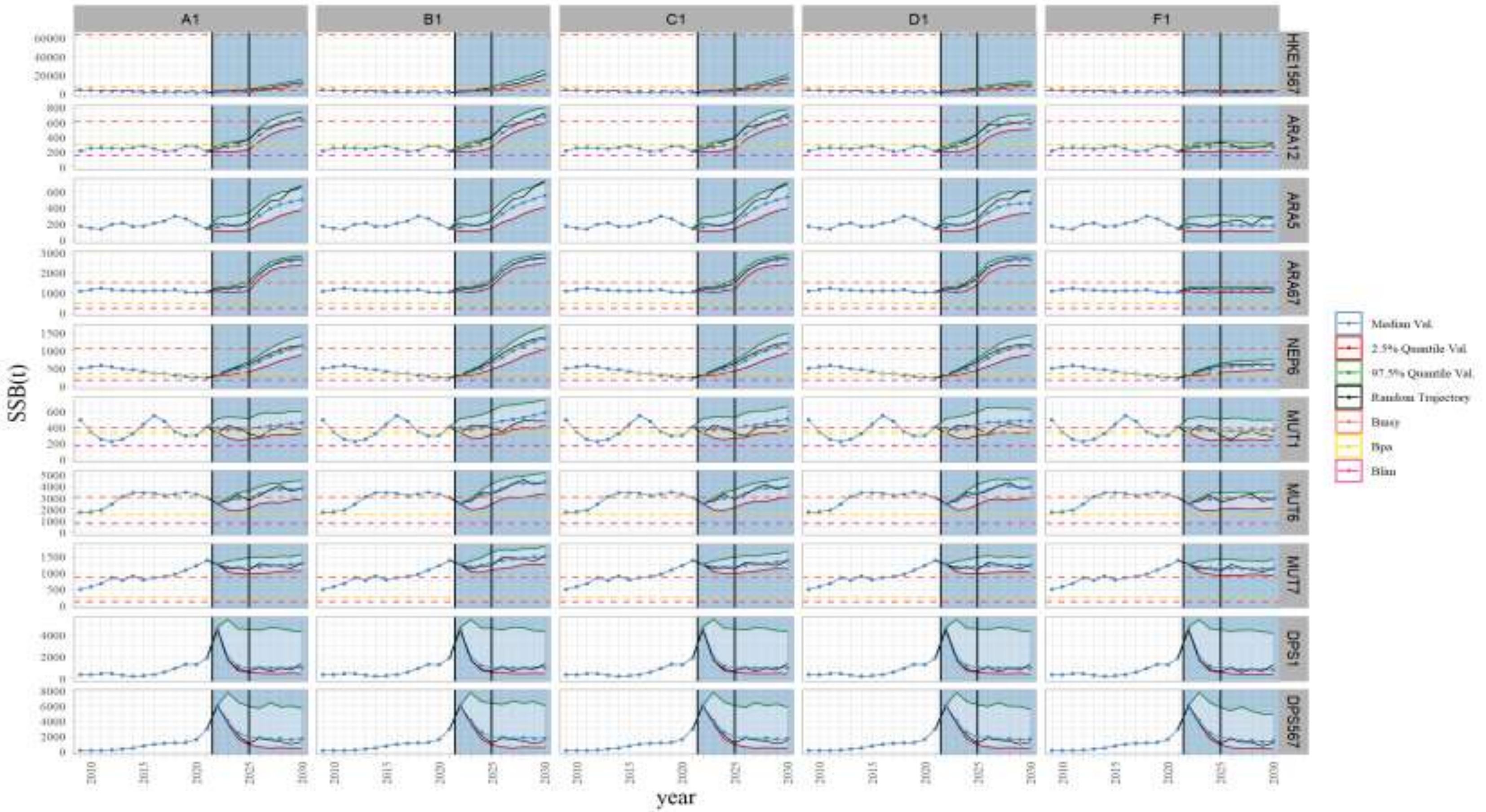


Figure 1.2.2. EMU 1 (IAM model). Predicted Spawning Stock Biomasses by modelled stock (in row) under alternative scenarios (in column). Historical values of SSB are given in the white areas and simulated values in the blue area. Simulations run until 2030 and vertical black lines indicate the year 2025. The stocks are as follow (from top to bottom): hake GSAs1-5-6-7 (HKE1567), blue and red shrimp GSAs1-2 (ARA12), blue and red shrimp GSA5 (ARA5), blue and red shrimp GSAs6-7 (ARA67), Norway lobster GSA6 (NEP6), red mullet GSA1 (MUT1), red mullet GSA6 (MUT6), red mullet GSA7 (MUT7), deep-water rose shrimp GSA1 (DPS1), and deep-water rose shrimp GSAs5-6-7 (DPS567). Estimated Bmsy, Bpa and Blim from EWG 22-09 stock assessments are represented.

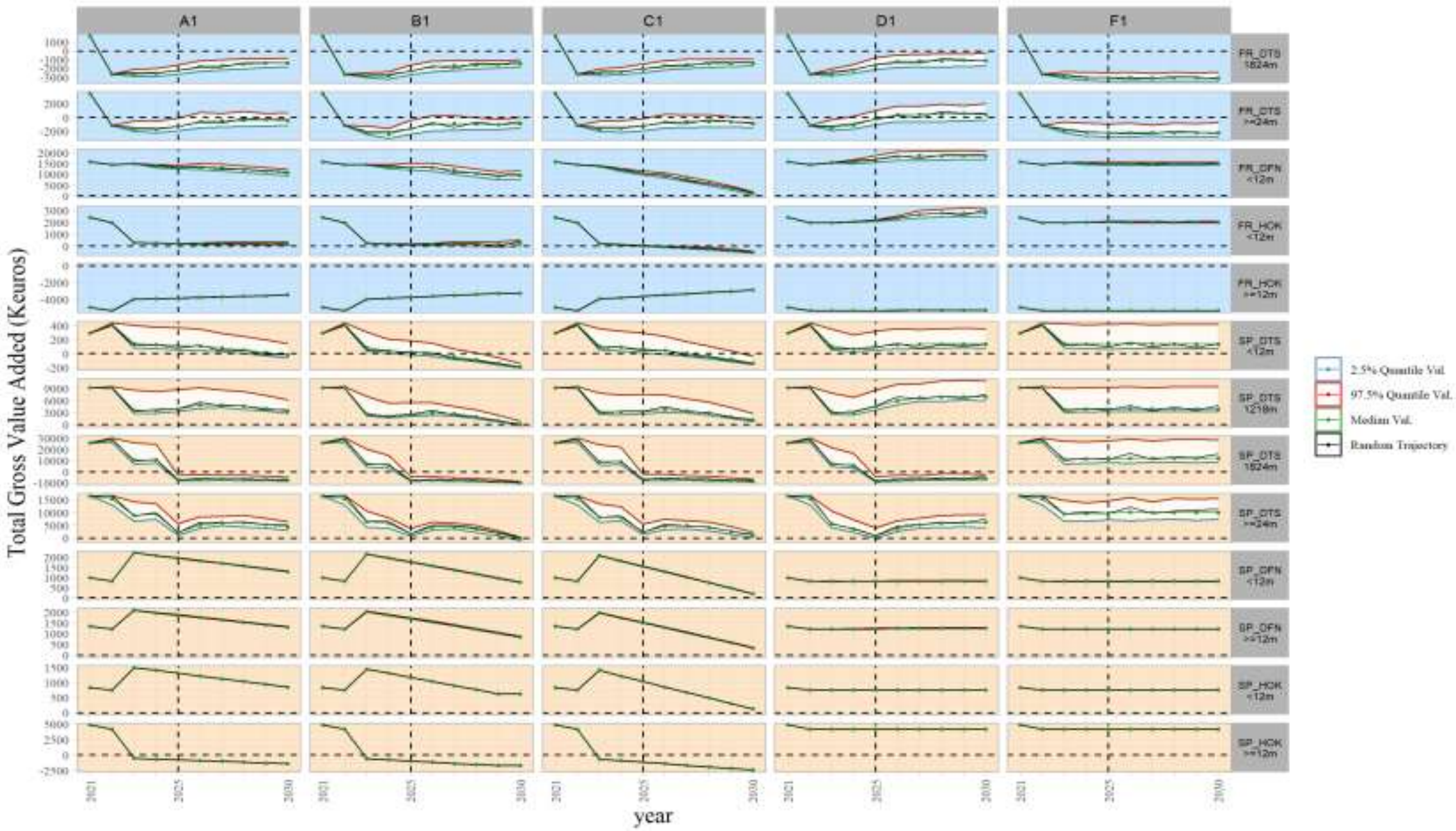


Figure 1.2.3. EMU 1 (IAM model). Evolution of the total Gross Value Added (GVA, i.e. proxy for the profit, in K euros) by fleet segment for each alternative scenario from 2021 to 2030. Vertical dotted black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m

KEY FINDINGS FOR EMU 2 (GSAs 8 9 10 11)

The most overexploited stocks in EMU 2 are hake (HKE 8-9-10-11) and giant red shrimp (ARS 8-9-10-11), for which a constant catch may lead to a further decrease of biomass, especially for ARS. The setting of a maximum catch limit foreseen in the EU Regulation 2022/110 would allow to approach F_{MSY} for ARS, but not for HKE, even when in combination with other measures such as reduction of fishing days and number of vessels and change in selectivity. For ARS 8-9-10-11, NEP 9 and MUT 9 at least one of the scenarios implemented allow to reach F_{MSY} in 2025. NEP 9, that is the third stock most overexploited after ARS and HKE, would see significantly reduced its fishing mortality below the F_{MSY} with all scenarios, except for scenario F (SQ). ARS, ARA and NEP stocks would benefit of all the scenarios, due to the re-allocation of the effort from the deep-water metier (OTB_DWS and OTB_DES) to the demersal (OTB_DES). This reallocation produces an increase in the fishing pressure on demersal fishing grounds, contributing to partly reduce the underutilization of red mullet in GSA 10, red mullet in GSA 9 and Norway lobster in GSA 9, but also increasing the F of hake.

The total revenues and gross value added for the overall fleet are predicted to slightly increase with respect to the lowest values of the time series reached in 2020-2021. For scenarios A, B and D total revenues across all fleets will decrease compared to the SQ scenario (F), remaining above the recent values. A similar pattern is observed for gross value added.

Scenario B, implementing effort reduction (in fishing days and number of vessels) in combination with the improvement in selectivity, shows a higher level of total revenues with respect to A and D. This is also true in terms of GVA, indicating that the increase in total revenues of scenario B compensates the higher operating costs of scenario D.

The total revenues are driven by the revenues of the target stocks. The change in revenues of target stocks and GVA is different among the fleet segments: in 2025 for several fleet segments (e.g. GSA11_DTS_VL0612, GSA10_DTS_VL2440, GSA9_DTS_VL2440 and GSA9_DTS_VL1824) the change of scenario B compared to SQ is lower than scenario A and D, while for others (e. g. GSA11_DTS_VL2440) scenario A is the lowest compared to SQ. For PGP fleet segments, scenario B is the best performing in terms of GVA and revenues (after SQ), highlighting that these segment benefit from the additional technical measures applied to trawlers.

Assuming a further increase in fuel price of 20% from 2023, shows a lower GVA for all scenarios simulated; in particular, scenarios A, B and D show, in the hypothesis of fuel increase of 20%, a decrease in the short term that was not present in the scenarios assuming the fuel price as in 2022. Also in the hypothesis of fuel price increase, the best performing scenario in terms of GVA is the status quo, followed by scenario B, D and finally A, highlighting also in this case the benefit of a combination of measures, including the improvement in selectivity, as the scenario that would allow to obtain a GVA more similar to the SQ in the medium term.

It is important to note that the scenarios here presented do not consider the adaptation of the catch limit to the status of the stock (e.g. F_{MSY}, SSB) that is expected to change during the application of management measures. This aspect needs to be further explored and refined to possibly accommodate the adaptive setting of catch limit year by year in the projections.

It should be noticed also that the simulations here presented are based on an assessment with reference year 2020 for red mullet in GSA 10; moreover, despite ARA is a stock with a catch limit, an analytical assessment was not available; thus the stock was replicated on the basis of MEDITS data (recruitment index and total mortality).

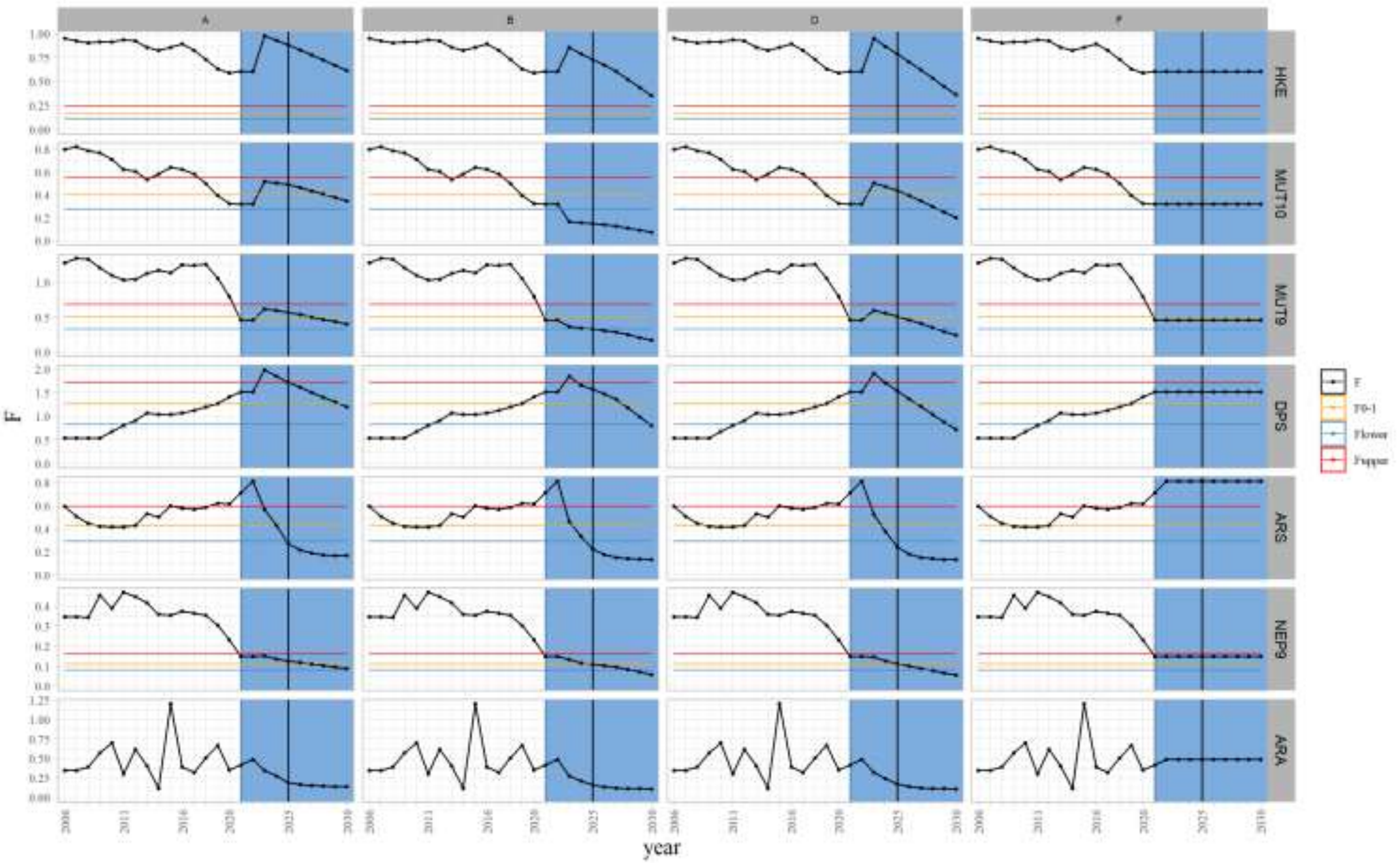


Figure 1.2.4. EMU 2 (BEMTOOL model). Predicted Fishing mortalities by modelled stock (in row) under the MAP scenario of effort reduction (in column). The stocks are as follow (from top to bottom): Hake GSAs8-9-10-11 (HKE), red mullet GSA10(MUT10), red mullet GSA9 (MUT9),deep-water rose shrimp GDSs9-10-11 (DPS), Giant red shrimp GSAs9-10-11(ARS), Norway lobster GSA9 (NEP9) and blue and red shrimp GSAs9-10-11 (ARA). Historical values of Fbar are given in the white areas and simulated values in the blue area. Estimated F 0-1, Flower and Fupper from EWG 20-09 stock assessments are represented, in orange, blue and red horizontal lines, respectively.

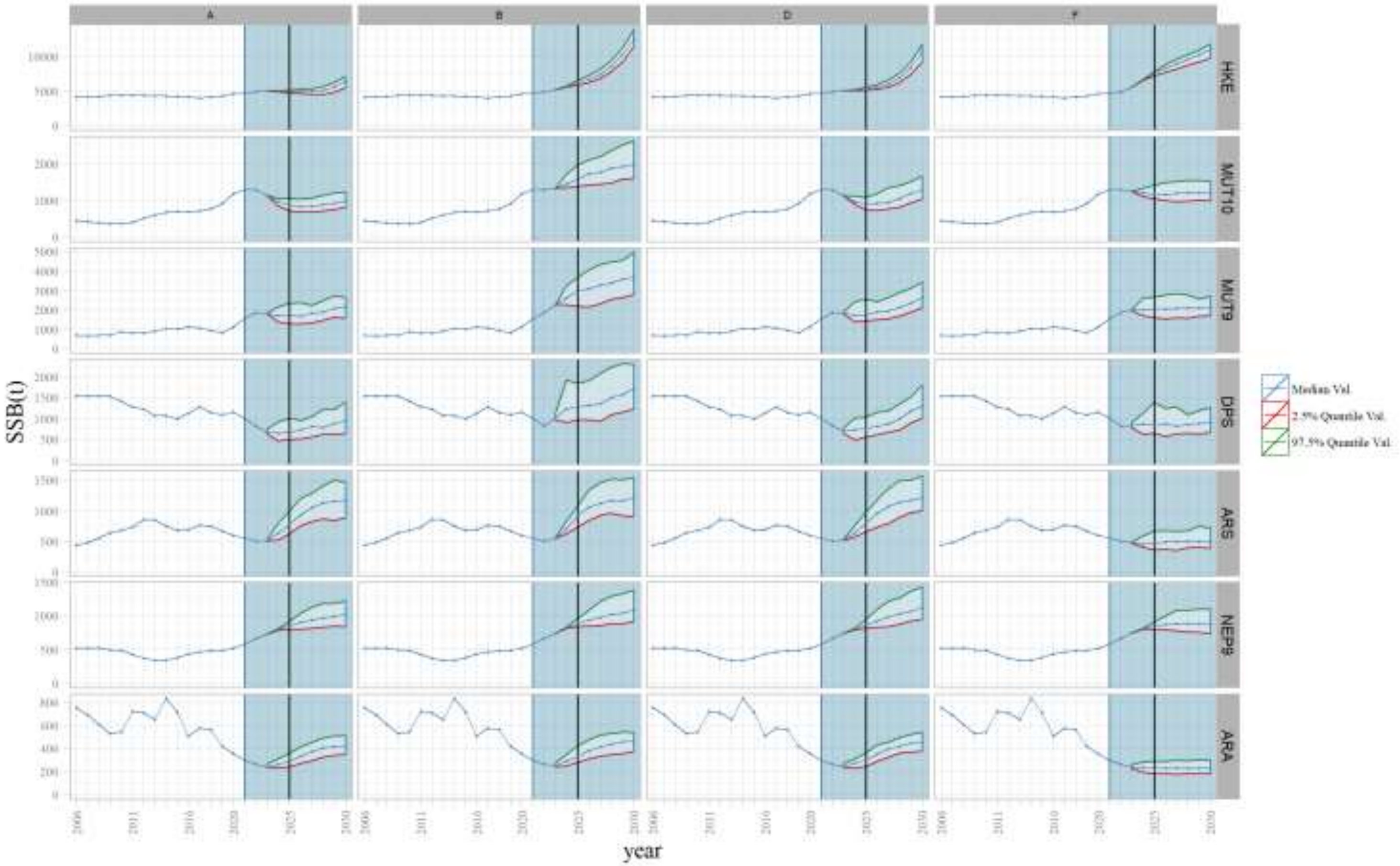


Figure 1.2.5 EMU 2 (BEMTOOL model). Predicted Spawning Stock Biomasses (in row) under the MAP scenario of effort reduction (in column). The stocks are as follow (from top to bottom): Hake GSAs8-9-10-11 (HKE), red mullet GSA10 (MUT10), red mullet GSA9 (MUT9), deep-water rose shrimp GSAs9-10-11 (DPS), Giant red shrimp GSAs9-10-11 (ARS), Norway lobster GSA9 (NEP9) and blue and red shrimp GSAs9-10-11 (ARA). Historical values of SSB are given in the white areas and simulated values in the blue area. Historical values of SSBs are given in the white areas and simulated values in the blue area. Simulations run until 2030 and vertical black lines indicate the year 2025.

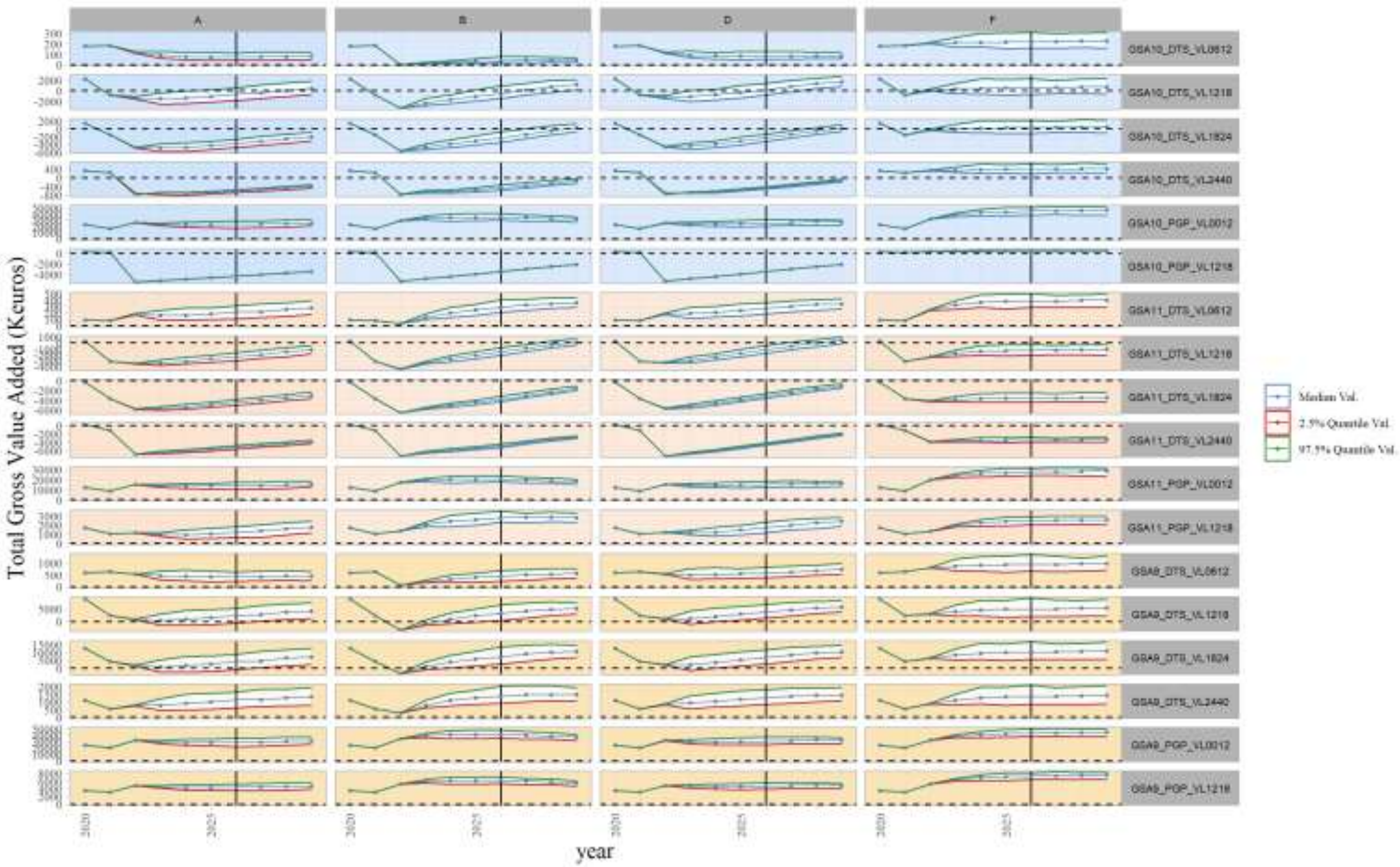


Figure 1.2.6. Evolution of the total Gross Value Added (GVA, i.e. proxy for the profit, in K euros) by fleet segment for each alternative scenario from 2021 to 2030 in the hypothesis of price equal to 2022. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row.

2 TIME SERIES OF FISHING EFFORT AND COMPARISON OF THE FISHING STATISTICS AVAILABLE TO SCIENTISTS AND THE EFFORT REFERENCE LEVELS AGREED IN THE EU REGULATIONS (TOR 1)

2.1 Comparison between FDI data and effort reference levels in EU regulation 2019/2236, 2021/90 and 2022/110

The complete set of graphs for days at sea, fishing days, fishing hours, gt*fishing days, kw*fishing days by country, GSA, fleet segment and gear can be found in Annex I.

Table 2.1.1 – Time series of fishing effort expressed in fishing days, days at sea, nominal effort in kw*fishing days (in thousands), nominal effort in GT*fishing days (in thousands), and hours at sea (in thousands) by Country, EMU, GSA and main gear. Data obtained from the DCF FDI datacall.

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	GND	fishdays	0	0	2	0	0	0	0
ESP	1	1	GNS	fishdays	4769	3805	2524	1282	1222	1758	1192
ESP	1	1	GTR	fishdays	8314	8999	8547	9954	10956	10006	9553
ESP	1	1	LLS	fishdays	2525	1529	969	710	611	574	700
ESP	1	1	OTB	fishdays	20559	20528	22026	20425	22006	18718	13984
ESP	1	1	other	fishdays	26604	22778	24751	27255	28650	26728	26577
ESP	1	1	OTT	fishdays	0	0	1	0	0	0	0
ESP	1	5	GNS	fishdays	3288	3208	2588	860	1088	1125	1746
ESP	1	5	GTR	fishdays	9948	9877	10150	11466	11734	10194	15589
ESP	1	5	LLS	fishdays	1913	1886	1638	2066	5022	6016	654
ESP	1	5	OTB	fishdays	11965	10490	10162	8715	8202	7306	6439
ESP	1	5	other	fishdays	4476	4397	4254	5162	5077	4437	3593
ESP	1	5	OTT	fishdays	1	1	0	0	0	0	0
ESP	1	6	GND	fishdays	10	0	0	0	0	0	0
ESP	1	6	GNS	fishdays	17782	15952	17827	9544	9665	9557	3406
ESP	1	6	GTR	fishdays	38276	41155	35621	33687	38794	38043	39511
ESP	1	6	LLS	fishdays	7489	9309	7174	9741	8228	6357	6095
ESP	1	6	OTB	fishdays	79416	79063	77802	76467	75860	69201	51514

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	6	other	fishdays	32823	36084	38813	36228	41020	32025	33332
ESP	1	6	OTT	fishdays	1	0	0	0	0	0	1
ESP	1	6	TBB	fishdays	0	0	0	0	0	0	1
ESP	1	7	GNS	fishdays	0	0	0	1	0	0	0
ESP	1	7	GTR	fishdays	0	0	0	3	0	17	48
ESP	1	7	LLS	fishdays	258	84	95	136	36	149	108
ESP	1	7	OTB	fishdays	2816	2557	2648	1391	650	1809	1145
ESP	1	7	other	fishdays	25	141	60	39	48	88	106
FRA	1	7	GND	fishdays	177	62	128	260	188	161	142
FRA	1	7	GNS	fishdays	29331	28112	30066	26373	22988	20251	24131
FRA	1	7	GTR	fishdays	33551	35411	38981	34696	31827	31183	35276
FRA	1	7	LLS	fishdays	5552	5257	5711	4964	5867	4851	6612
FRA	1	7	OTB	fishdays	11144	10004	8304	7623	7446	6170	6208
FRA	1	7	other	fishdays	50160	53810	52341	52216	42099	36268	44352
FRA	1	7	OTT	fishdays	593	1597	3121	3316	3917	4462	4324
FRA	1	7	TBB	fishdays	517	280	245	219	170	44	55
FRA	2	8	GNS	fishdays	2383	1733	1543	1193	1048	893	1111
FRA	2	8	GTR	fishdays	13774	13817	12437	11069	11165	9702	11217
FRA	2	8	LLS	fishdays	1140	1842	1842	1151	971	983	1956
FRA	2	8	OTB	fishdays	866	923	693	589	464	478	599
FRA	2	8	other	fishdays	3129	3517	2876	2868	2452	1893	2204
ITA	2	9	GND	fishdays	0	0	10	0	1	5	0
ITA	2	9	GNS	fishdays	44857	37949	41566	35704	23843	18159	30427
ITA	2	9	GTR	fishdays	88784	76977	59937	63720	54869	35678	45644
ITA	2	9	LLS	fishdays	2335	1858	3325	4529	3732	4041	8394

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ITA	2	9	OTB	fishdays	52936	51301	47459	44251	42227	33550	36566
ITA	2	9	other	fishdays	16613	19352	25049	32462	18349	19010	25596
ITA	2	9	TBB	fishdays	0	0	0	194	519	532	694
ITA	2	10	GND	fishdays	136	926	1491	5977	5874	5590	3125
ITA	2	10	GNS	fishdays	51263	63272	54570	43648	40359	28893	55197
ITA	2	10	GTR	fishdays	109730	105557	104857	132442	104994	57407	103071
ITA	2	10	LLS	fishdays	32416	32541	25541	20448	15458	20554	34641
ITA	2	10	OTB	fishdays	30756	35619	36293	33487	29526	23665	22630
ITA	2	10	other	fishdays	90064	108946	73214	68245	63212	45368	39280
ITA	2	10	TBB	fishdays	0	0	0	0	8	0	0
ITA	2	11	GND	fishdays	0	0	0	0	0	6	0
ITA	2	11	GNS	fishdays	19569	28187	16053	33984	29836	27161	24268
ITA	2	11	GTR	fishdays	62659	57113	57299	41208	30630	31645	53486
ITA	2	11	LLS	fishdays	5419	3989	6467	2421	3381	5668	8274
ITA	2	11	OTB	fishdays	15277	16925	16286	21240	18878	13677	14228
ITA	2	11	other	fishdays	46672	50078	44295	48050	46710	48001	55417
ITA	2	11	TBB	fishdays	0	0	0	0	2	0	0

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	GND	seadays	0	0	2	0	0	0	0
ESP	1	1	GNS	seadays	4772	3808	2525	1233	1206	1701	1148
ESP	1	1	GTR	seadays	8328	9008	8569	9718	10705	9798	9312
ESP	1	1	LLS	seadays	2542	1556	984	695	556	543	635
ESP	1	1	OTB	seadays	24549	24345	26838	20461	22206	18887	13984

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	other	seadays	28043	24028	26008	27417	28901	26881	25896
ESP	1	1	OTT	seadays	0	0	1	0	0	0	0
ESP	1	5	GNS	seadays	3288	3218	2619	854	1058	1087	1737
ESP	1	5	GTR	seadays	9958	9877	10160	11391	11371	10048	15419
ESP	1	5	LLS	seadays	1973	1920	1654	2045	4718	5862	615
ESP	1	5	OTB	seadays	13310	12225	12761	8623	8222	7312	6370
ESP	1	5	other	seadays	5531	5464	5515	5627	5392	4806	3806
ESP	1	5	OTT	seadays	1	1	0	0	0	0	0
ESP	1	6	GND	seadays	10	0	0	0	0	0	0
ESP	1	6	GNS	seadays	17911	16076	17980	8685	8832	8553	3052
ESP	1	6	GTR	seadays	38436	41341	35857	32657	37386	36029	38006
ESP	1	6	LLS	seadays	7740	9500	7287	9462	8057	6251	5756
ESP	1	6	OTB	seadays	95454	102458	103495	76565	75942	69257	51476
ESP	1	6	other	seadays	35015	38161	41265	36106	40250	31391	31269
ESP	1	6	OTT	seadays	1	0	0	0	0	0	1
ESP	1	6	TBB	seadays	0	0	0	0	0	0	1
ESP	1	7	GNS	seadays	0	0	0	1	0	0	0
ESP	1	7	GTR	seadays	0	0	0	2	0	17	48
ESP	1	7	LLS	seadays	321	173	172	121	41	156	87
ESP	1	7	OTB	seadays	3716	3539	3881	1391	650	1811	1131
ESP	1	7	other	seadays	34	281	95	48	56	89	114
FRA	1	7	GND	seadays	177	62	128	260	188	161	142
FRA	1	7	GNS	seadays	29346	28130	30063	26389	22982	20253	24131
FRA	1	7	GTR	seadays	33555	35427	38981	34697	31827	31185	35276
FRA	1	7	LLS	seadays	5663	5454	5799	4964	5868	4851	6612
FRA	1	7	OTB	seadays	11422	10263	8500	7817	7601	6317	6477

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
FRA	1	7	other	seadays	50202	53826	52344	52275	42090	36203	44328
FRA	1	7	OTT	seadays	600	1604	3388	3454	4135	4752	4686
FRA	1	7	TBB	seadays	517	280	245	219	170	45	55
FRA	2	8	GNS	seadays	2383	1733	1543	1193	1048	893	1111
FRA	2	8	GTR	seadays	13774	13817	12437	11069	11165	9702	11217
FRA	2	8	LLS	seadays	1140	1842	1842	1151	971	983	1956
FRA	2	8	OTB	seadays	866	923	693	589	464	478	599
FRA	2	8	other	seadays	3129	3517	2876	2868	2452	1893	2204
ITA	2	9	GND	seadays	0	0	9	0	1	5	0
ITA	2	9	GNS	seadays	43630	37026	41019	34219	24794	17085	30272
ITA	2	9	GTR	seadays	86418	74174	59024	62728	58467	33696	44707
ITA	2	9	LLS	seadays	2269	1768	3288	4381	3784	3937	8356
ITA	2	9	OTB	seadays	52900	51257	47457	44296	43476	33552	36566
ITA	2	9	other	seadays	16173	18431	24815	32028	18900	18337	25362
ITA	2	9	TBB	seadays	0	0	0	195	530	532	694
ITA	2	10	GND	seadays	131	818	1465	5424	5170	5237	3042
ITA	2	10	GNS	seadays	49189	58865	53789	40737	40951	26413	55003
ITA	2	10	GTR	seadays	106350	99466	103390	129714	103279	53052	102871
ITA	2	10	LLS	seadays	28118	29336	25351	18912	15808	19581	34459
ITA	2	10	OTB	seadays	30709	35479	36271	33570	30410	23657	22621
ITA	2	10	other	seadays	77746	91606	72612	65634	63162	42573	39174
ITA	2	10	TBB	seadays	0	0	0	0	9	0	0
ITA	2	11	GND	seadays	0	0	0	0	0	6	0
ITA	2	11	GNS	seadays	19003	25768	15862	31629	27578	24055	23784
ITA	2	11	GTR	seadays	58899	51698	56620	38286	28334	28176	51543
ITA	2	11	LLS	seadays	5049	3364	6402	2280	3130	5043	8010

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ITA	2	11	OTB	seadays	15278	16926	16285	21190	19505	13678	14228
ITA	2	11	other	seadays	44525	45623	43797	44718	43466	42791	54102
ITA	2	11	TBB	seadays	0	0	0	0	2	0	0

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	GND	kwfishdays	0	0	0	0	0	0	0
ESP	1	1	GNS	kwfishdays	119	96	63	42	42	50	35
ESP	1	1	GTR	kwfishdays	212	234	235	250	289	263	247
ESP	1	1	LLS	kwfishdays	85	62	38	29	32	28	31
ESP	1	1	OTB	kwfishdays	2655	2685	2839	2658	2851	2452	1785
ESP	1	1	other	kwfishdays	1684	1463	1674	1560	1827	1623	1703
ESP	1	1	OTT	kwfishdays	0	0	0	0	0	0	0
ESP	1	5	GNS	kwfishdays	122	118	108	32	53	51	78
ESP	1	5	GTR	kwfishdays	401	413	413	450	483	406	584
ESP	1	5	LLS	kwfishdays	80	79	75	95	223	242	38
ESP	1	5	OTB	kwfishdays	2421	2107	2011	1709	1609	1407	1300
ESP	1	5	other	kwfishdays	429	370	409	521	427	462	358
ESP	1	5	OTT	kwfishdays	0	0	0	0	0	0	0
ESP	1	6	GND	kwfishdays	1	0	0	0	0	0	0
ESP	1	6	GNS	kwfishdays	706	656	695	422	413	420	194
ESP	1	6	GTR	kwfishdays	1554	1740	1545	1460	1602	1527	1563
ESP	1	6	LLS	kwfishdays	367	512	387	425	425	329	279
ESP	1	6	OTB	kwfishdays	15501	15157	15016	14727	14647	13644	9681
ESP	1	6	other	kwfishdays	4755	5128	5083	4787	4618	3744	4098
ESP	1	6	OTT	kwfishdays	0	0	0	0	0	0	0

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	6	TBB	kwfishdays	0	0	0	0	0	0	0
ESP	1	7	GNS	kwfishdays	0	0	0	0	0	0	0
ESP	1	7	GTR	kwfishdays	0	0	0	0	0	1	4
ESP	1	7	LLS	kwfishdays	33	7	11	16	6	14	13
ESP	1	7	OTB	kwfishdays	1002	888	900	431	195	558	348
ESP	1	7	other	kwfishdays	4	17	7	5	5	8	8
FRA	1	7	GND	kwfishdays	18	6	13	25	8	6	5
FRA	1	7	GNS	kwfishdays	2422	2347	2604	2389	1971	1812	2164
FRA	1	7	GTR	kwfishdays	2539	2741	2984	2685	2345	2499	2905
FRA	1	7	LLS	kwfishdays	406	346	383	347	494	409	520
FRA	1	7	OTB	kwfishdays	3167	2859	2265	2016	1962	1619	1635
FRA	1	7	other	kwfishdays	3883	3954	4195	4339	3614	3359	4180
FRA	1	7	OTT	kwfishdays	186	503	981	1043	1220	1394	1351
FRA	1	7	TBB	kwfishdays	30	16	10	7	9	3	3
FRA	2	8	GNS	kwfishdays	250	198	158	124	106	99	103
FRA	2	8	GTR	kwfishdays	1471	1541	1375	1246	1192	1110	1275
FRA	2	8	LLS	kwfishdays	143	220	224	135	111	108	239
FRA	2	8	OTB	kwfishdays	179	208	173	150	117	115	156
FRA	2	8	other	kwfishdays	404	448	391	334	278	222	255
ITA	2	9	GND	kwfishdays	0	0	3	0	0	1	0
ITA	2	9	GNS	kwfishdays	1722	1585	2156	1609	1218	793	1237
ITA	2	9	GTR	kwfishdays	3787	3320	1679	1942	1931	1240	1732
ITA	2	9	LLS	kwfishdays	191	193	223	323	281	345	448
ITA	2	9	OTB	kwfishdays	11114	10658	8431	9433	9121	7483	7852
ITA	2	9	other	kwfishdays	2197	2191	2176	2634	2101	1751	2219
ITA	2	9	TBB	kwfishdays	0	0	0	31	115	92	94

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ITA	2	10	GND	kwfishdays	16	24	47	179	241	193	142
ITA	2	10	GNS	kwfishdays	1756	2269	2392	1266	1140	700	1478
ITA	2	10	GTR	kwfishdays	2275	2321	2897	2846	2695	1081	2452
ITA	2	10	LLS	kwfishdays	1776	1511	1369	885	678	797	1149
ITA	2	10	OTB	kwfishdays	5455	6288	5040	6087	5401	4182	3649
ITA	2	10	other	kwfishdays	6834	6738	4422	4596	4514	2762	2284
ITA	2	10	TBB	kwfishdays	0	0	0	0	1	0	0
ITA	2	11	GND	kwfishdays	0	0	0	0	0	1	0
ITA	2	11	GNS	kwfishdays	448	1264	657	948	1112	833	746
ITA	2	11	GTR	kwfishdays	3137	2115	2419	1936	1415	1230	1671
ITA	2	11	LLS	kwfishdays	448	429	306	159	144	226	252
ITA	2	11	OTB	kwfishdays	3118	3200	2485	5150	4471	3565	3219
ITA	2	11	other	kwfishdays	2210	2426	1895	2071	2275	1919	2455
ITA	2	11	TBB	kwfishdays	0	0	0	0	1	0	0

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	GND	gtfishdays	0	0	0	0	0	0	0
ESP	1	1	GNS	gtfishdays	13	10	7	4	5	5	4
ESP	1	1	GTR	gtfishdays	22	25	26	28	34	30	28
ESP	1	1	LLS	gtfishdays	11	8	5	4	4	4	5
ESP	1	1	OTB	gtfishdays	1125	1096	1159	1071	1146	996	704
ESP	1	1	other	gtfishdays	358	317	369	323	392	343	369
ESP	1	1	OTT	gtfishdays	0	0	0	0	0	0	0
ESP	1	5	GNS	gtfishdays	8	8	7	2	3	3	5
ESP	1	5	GTR	gtfishdays	27	28	29	32	34	28	42

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	5	LLS	gtfishdays	7	6	6	8	18	18	4
ESP	1	5	OTB	gtfishdays	773	680	664	573	535	472	428
ESP	1	5	other	gtfishdays	159	135	157	199	142	168	125
ESP	1	5	OTT	gtfishdays	0	0	0	0	0	0	0
ESP	1	6	GND	gtfishdays	0	0	0	0	0	0	0
ESP	1	6	GNS	gtfishdays	79	69	75	49	46	49	26
ESP	1	6	GTR	gtfishdays	179	206	183	174	185	171	176
ESP	1	6	LLS	gtfishdays	41	67	45	45	49	38	30
ESP	1	6	OTB	gtfishdays	4809	4715	4673	4568	4520	4249	3003
ESP	1	6	other	gtfishdays	1029	1092	1095	1065	977	818	909
ESP	1	6	OTT	gtfishdays	0	0	0	0	0	0	0
ESP	1	6	TBB	gtfishdays	0	0	0	0	0	0	0
ESP	1	7	GNS	gtfishdays	0	0	0	0	0	0	0
ESP	1	7	GTR	gtfishdays	0	0	0	0	0	0	0
ESP	1	7	LLS	gtfishdays	6	2	2	3	1	2	1
ESP	1	7	OTB	gtfishdays	273	245	251	126	59	163	98
ESP	1	7	other	gtfishdays	1	4	2	1	1	1	1
FRA	1	7	GND	gtfishdays	1	0	1	1	0	0	0
FRA	1	7	GNS	gtfishdays	97	91	91	82	67	61	68
FRA	1	7	GTR	gtfishdays	102	105	110	96	82	82	92
FRA	1	7	LLS	gtfishdays	16	14	15	14	17	15	19
FRA	1	7	OTB	gtfishdays	945	827	632	566	547	438	438
FRA	1	7	other	gtfishdays	193	183	192	200	156	147	161
FRA	1	7	OTT	gtfishdays	70	202	362	388	449	509	498
FRA	1	7	TBB	gtfishdays	2	1	1	0	1	0	0
FRA	2	8	GNS	gtfishdays	8	6	4	3	3	3	3

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
FRA	2	8	GTR	gtfishdays	52	52	47	41	42	36	41
FRA	2	8	LLS	gtfishdays	5	8	7	5	4	4	9
FRA	2	8	OTB	gtfishdays	36	40	40	41	33	31	37
FRA	2	8	other	gtfishdays	13	15	14	10	9	8	8
ITA	2	9	GND	gtfishdays	0	0	0	0	0	0	0
ITA	2	9	GNS	gtfishdays	112	94	121	100	91	57	78
ITA	2	9	GTR	gtfishdays	211	184	116	123	131	72	103
ITA	2	9	LLS	gtfishdays	8	10	14	21	24	21	31
ITA	2	9	OTB	gtfishdays	1883	1822	1481	1672	1600	1357	1401
ITA	2	9	other	gtfishdays	245	230	247	289	287	223	289
ITA	2	9	TBB	gtfishdays	0	0	0	4	25	12	13
ITA	2	10	GND	gtfishdays	1	4	4	14	18	15	11
ITA	2	10	GNS	gtfishdays	133	165	166	98	85	54	110
ITA	2	10	GTR	gtfishdays	172	183	195	218	204	88	188
ITA	2	10	LLS	gtfishdays	127	117	101	75	55	65	87
ITA	2	10	OTB	gtfishdays	951	1130	812	1162	981	750	620
ITA	2	10	other	gtfishdays	1048	967	501	560	560	379	281
ITA	2	10	TBB	gtfishdays	0	0	0	0	0	0	0
ITA	2	11	GND	gtfishdays	0	0	0	0	0	0	0
ITA	2	11	GNS	gtfishdays	35	74	45	64	76	52	51
ITA	2	11	GTR	gtfishdays	197	143	166	131	112	85	116
ITA	2	11	LLS	gtfishdays	22	24	23	12	12	16	19
ITA	2	11	OTB	gtfishdays	765	837	514	1221	1009	823	725
ITA	2	11	other	gtfishdays	168	177	155	188	234	161	244
ITA	2	11	TBB	gtfishdays	0	0	0	0	0	0	0

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ESP	1	1	GND	hrsea	0	0	0	0	0	0	0
ESP	1	1	GNS	hrsea	4	3	2	27	24	38	26
ESP	1	1	GTR	hrsea	9	13	13	209	226	215	207
ESP	1	1	LLS	hrsea	10	10	6	12	8	9	12
ESP	1	1	OTB	hrsea	395	379	426	248	271	231	170
ESP	1	1	other	hrsea	169	152	168	473	478	484	450
ESP	1	1	OTT	hrsea	0	0	0	0	0	0	0
ESP	1	5	GNS	hrsea	0	2	1	20	24	25	41
ESP	1	5	GTR	hrsea	5	11	7	264	261	235	365
ESP	1	5	LLS	hrsea	5	4	4	46	105	136	12
ESP	1	5	OTB	hrsea	214	206	222	104	100	89	77
ESP	1	5	other	hrsea	69	69	79	118	112	96	73
ESP	1	5	OTT	hrsea	0	0	0	0	0	0	0
ESP	1	6	GND	hrsea	0	0	0	0	0	0	0
ESP	1	6	GNS	hrsea	39	42	41	143	161	159	39
ESP	1	6	GTR	hrsea	95	135	111	600	715	721	771
ESP	1	6	LLS	hrsea	35	58	44	177	132	110	113
ESP	1	6	OTB	hrsea	1527	1728	1737	853	835	763	568
ESP	1	6	other	hrsea	322	349	351	490	585	483	466
ESP	1	6	OTT	hrsea	0	0	0	0	0	0	0
ESP	1	6	TBB	hrsea	0	0	0	0	0	0	0
ESP	1	7	GNS	hrsea	0	0	0	0	0	0	0
ESP	1	7	GTR	hrsea	0	0	0	0	0	0	0
ESP	1	7	LLS	hrsea	7	4	3	2	1	2	1
ESP	1	7	OTB	hrsea	69	67	74	18	8	23	14
ESP	1	7	other	hrsea	1	6	2	1	1	1	1

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
FRA	1	7	GND	hrsea	0	0	0	0	0	0	0
FRA	1	7	GNS	hrsea	3	3	2	3	1	1	0
FRA	1	7	GTR	hrsea	2	3	1	1	0	1	0
FRA	1	7	LLS	hrsea	3	5	4	0	0	0	0
FRA	1	7	OTB	hrsea	131	120	95	83	79	64	68
FRA	1	7	other	hrsea	11	8	9	12	10	13	13
FRA	1	7	OTT	hrsea	8	22	47	46	55	62	65
FRA	1	7	TBB	hrsea	0	0	0	0	0	0	0
FRA	2	8	GNS	hrsea	0	0	0	0	0	0	0
FRA	2	8	GTR	hrsea	0	0	0	0	0	0	0
FRA	2	8	LLS	hrsea	0	0	0	0	0	0	0
FRA	2	8	OTB	hrsea	0	0	0	0	0	0	0
FRA	2	8	other	hrsea	0	0	0	0	0	0	0
ITA	2	9	GND	hrsea	0	0	0	0	0	0	0
ITA	2	9	GNS	hrsea	334	300	284	293	194	146	258
ITA	2	9	GTR	hrsea	581	824	653	604	444	369	437
ITA	2	9	LLS	hrsea	14	17	28	38	27	32	76
ITA	2	9	OTB	hrsea	529	658	676	621	429	414	744
ITA	2	9	other	hrsea	124	171	252	330	153	174	302
ITA	2	9	TBB	hrsea	0	0	0	2	6	6	10
ITA	2	10	GND	hrsea	1	9	15	59	48	48	33
ITA	2	10	GNS	hrsea	502	619	513	423	298	253	523
ITA	2	10	GTR	hrsea	1100	1051	1001	942	792	490	934
ITA	2	10	LLS	hrsea	284	287	264	211	114	185	330
ITA	2	10	OTB	hrsea	360	347	494	482	286	284	429
ITA	2	10	other	hrsea	831	922	741	738	482	416	430

Country	EMU	GSA	gear	effort	2015	2016	2017	2018	2019	2020	2021
ITA	2	10	TBB	hrsea	0	0	0	0	0	0	0
ITA	2	11	GND	hrsea	0	0	0	0	0	0	0
ITA	2	11	GNS	hrsea	166	233	133	239	262	204	194
ITA	2	11	GTR	hrsea	562	475	485	301	278	261	462
ITA	2	11	LLS	hrsea	48	35	54	19	25	47	75
ITA	2	11	OTB	hrsea	179	222	246	328	194	181	265
ITA	2	11	other	hrsea	414	418	374	356	393	410	486
ITA	2	11	TBB	hrsea	0	0	0	0	0	0	0

2.2 Trends in effort expressed in fishing days

The complete set of graphs for days at sea, fishing days, fishing hours, gt*fishing days, kw*fishing days by country, GSA, fleet segment and gear can be found in Annex I.

EWG 22-11 agreed on presenting the trends of effort expressed in fishing days for Spain, France and Italy in the period 2015-2021 for the following gears: bottom otter trawl (OTB), set longlines (LLS), set gillnet (GNS) and trammel nets (GTR). For France, also the multi-rig otter trawl (OTT) was presented.

In GSA7, EWG 22-11 noted a gradual decrease in fishing effort for the French OTB fleet >18m (Fig. 2.2.2), while an opposite trend was observed for the corresponding fleet segments of French OTT (Fig. 2.2.7). This could be possibly due to a shift in gear.

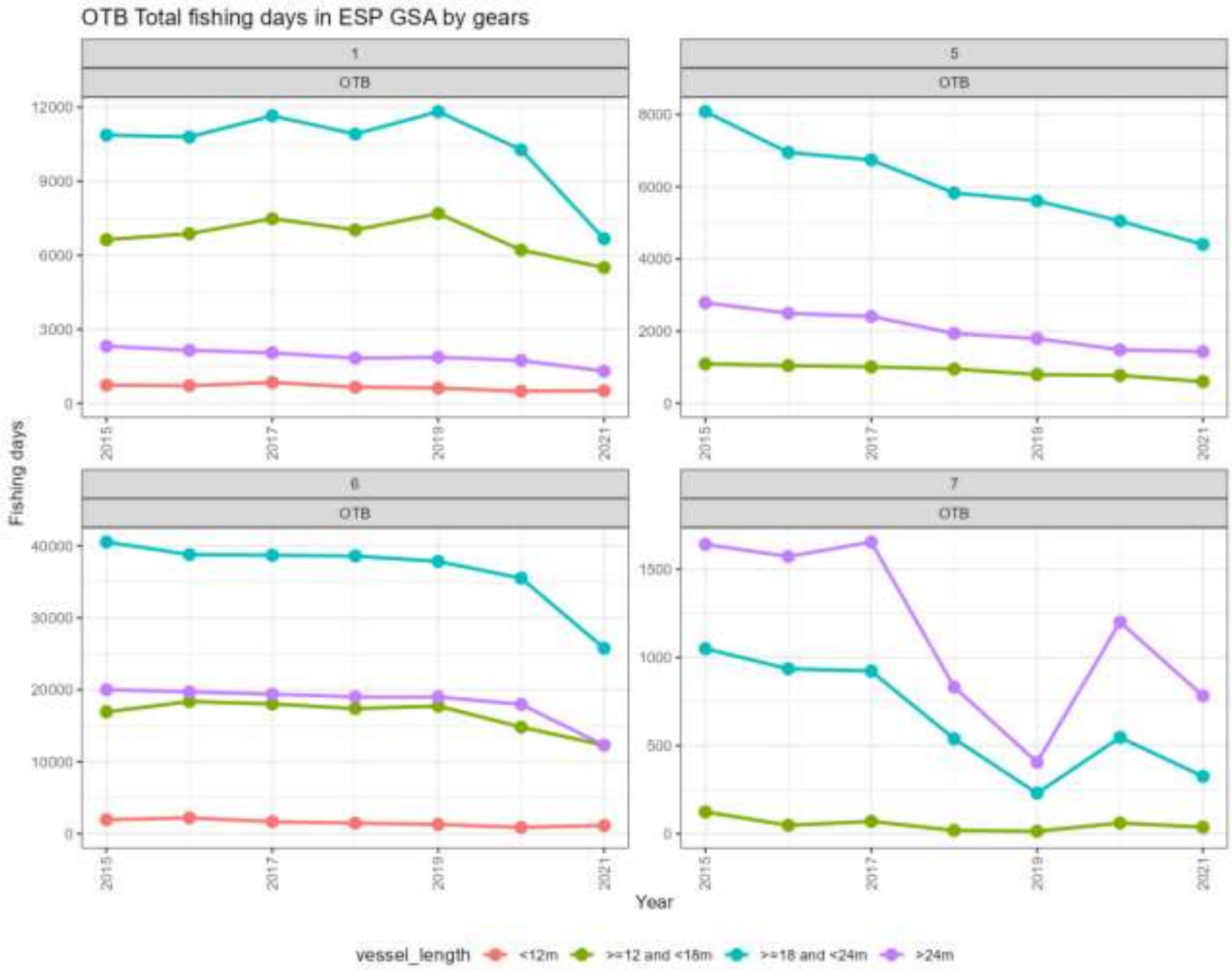


Figure 2.2.1 – Spain: time series of OTB fishing effort expressed in fishing days by fleet segment and GSA.

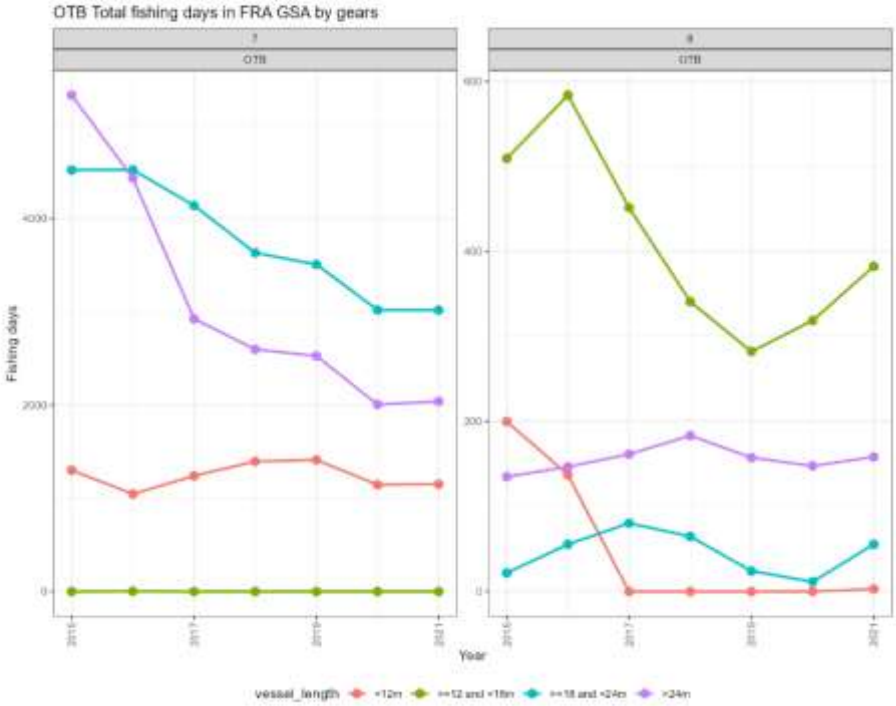


Figure 2.2.2– France: time series of OTB fishing effort expressed in fishing days by fleet segment and GSA.

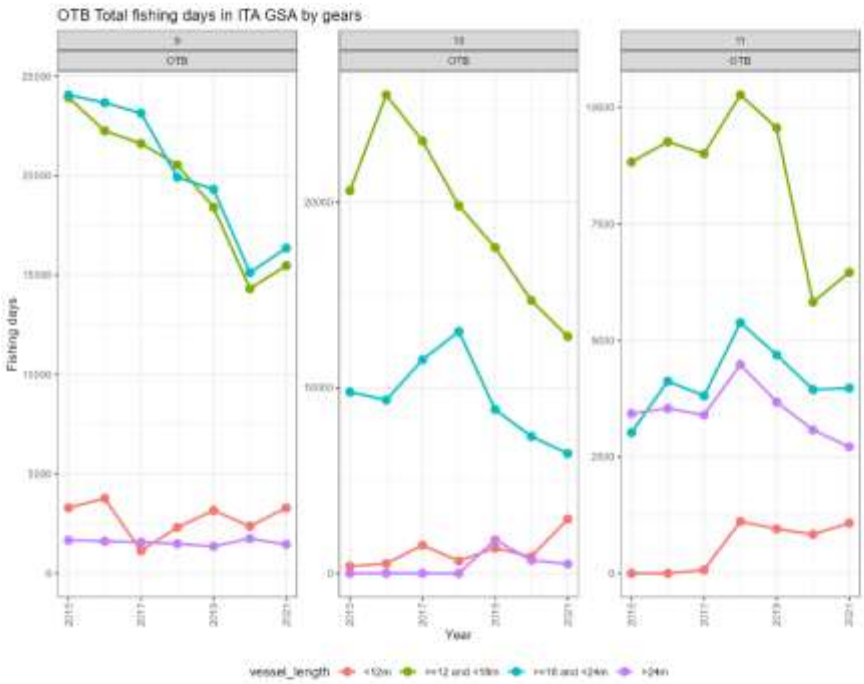


Figure 2.2.3– Italy: time series of OTB fishing effort expressed in fishing days by fleet segment and GSA.

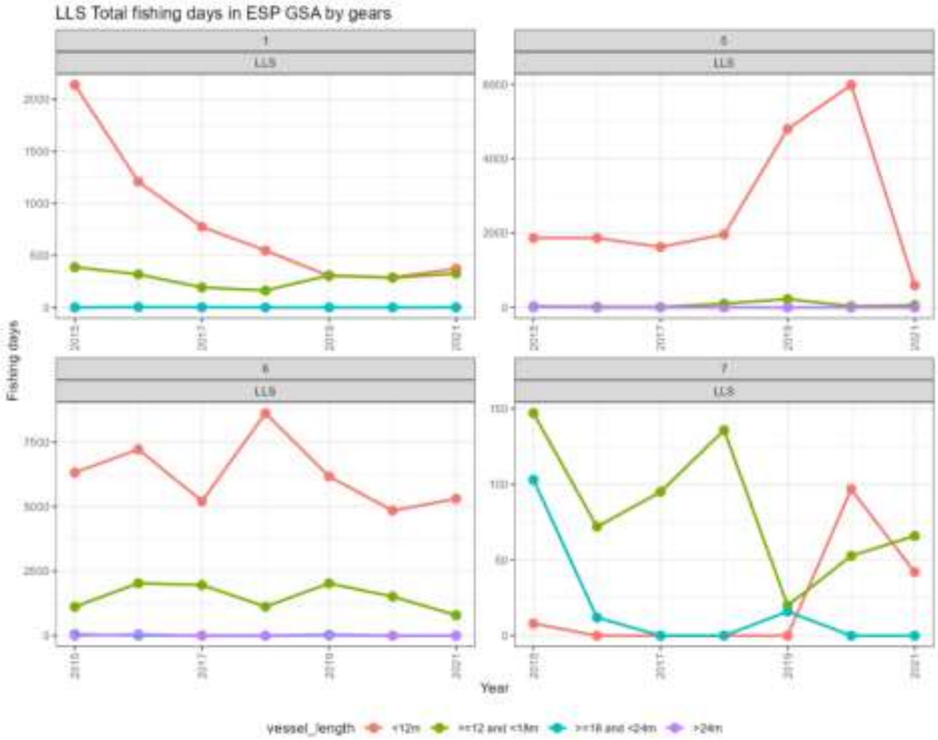


Figure 2.2.4– Spain: time series of LLS fishing effort expressed in fishing days by fleet segment and GSA.

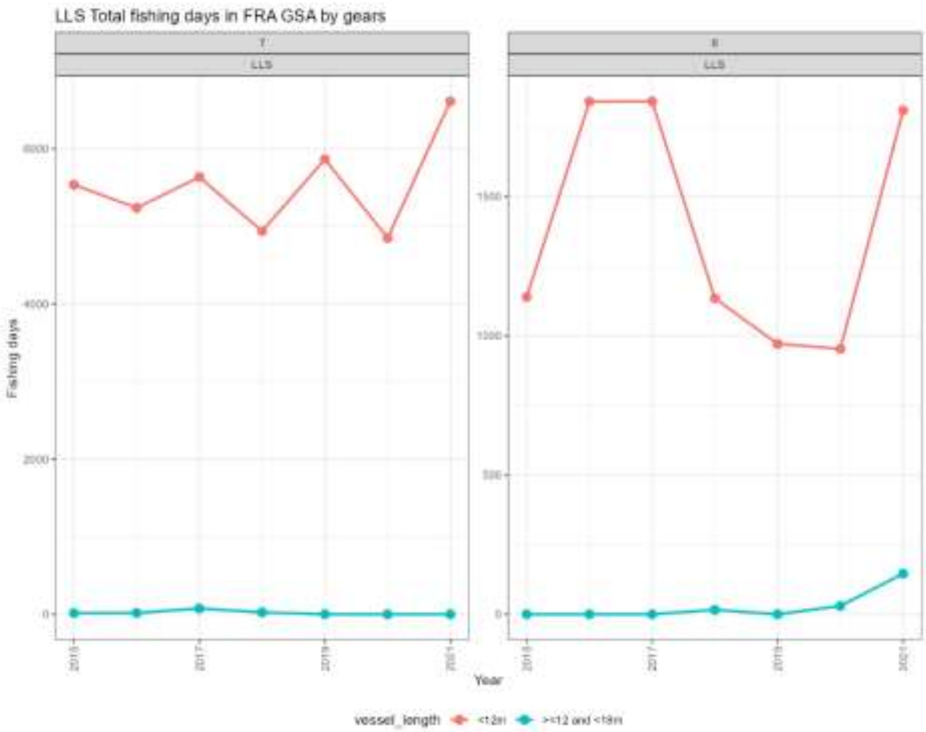


Figure 2.2.5– France: time series of LLS fishing effort expressed in fishing days by fleet segment and GSA.

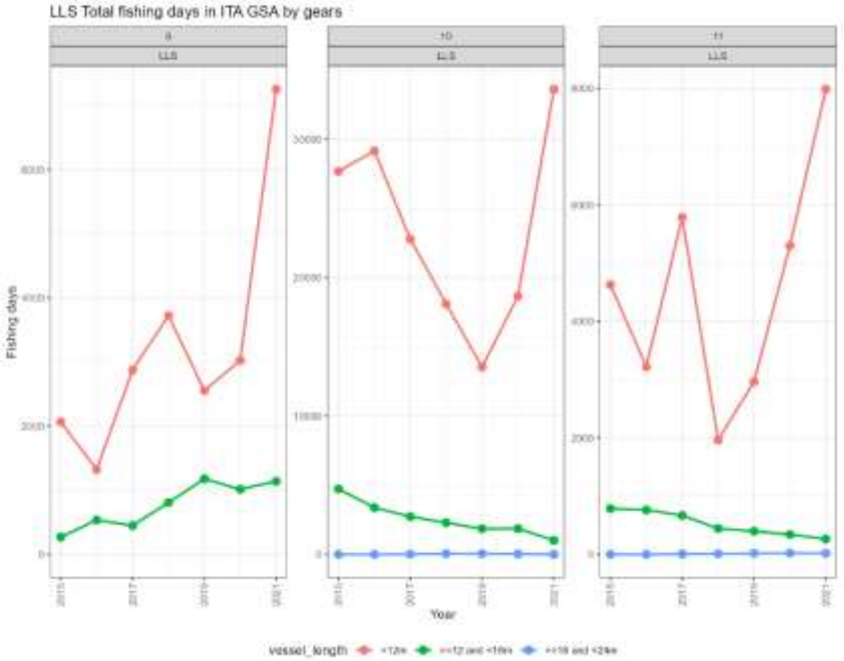


Figure 2.2.6– Italy: time series of LLS fishing effort expressed in fishing days by fleet segment and GSA.

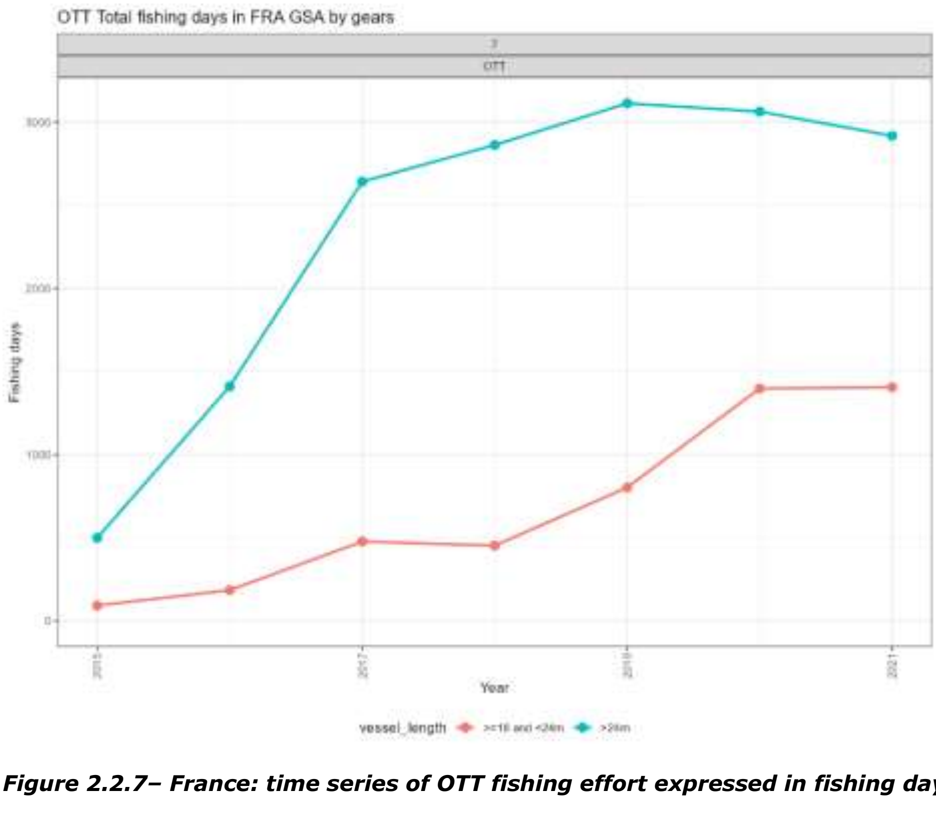


Figure 2.2.7– France: time series of OTT fishing effort expressed in fishing days by fleet segment and GSA.

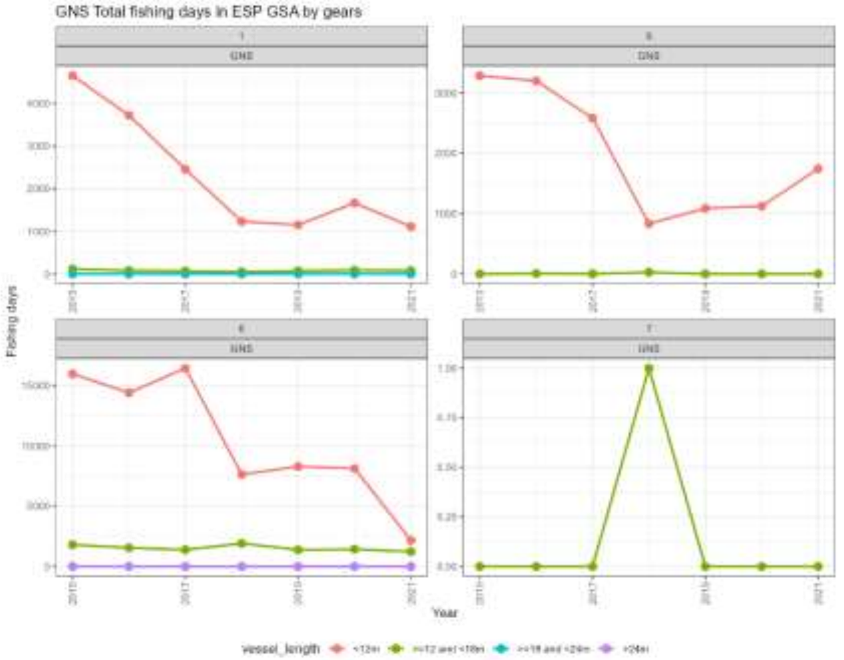


Figure 2.2.8 – Spain: time series of GNS fishing effort expressed in fishing days by fleet segment and GSA.

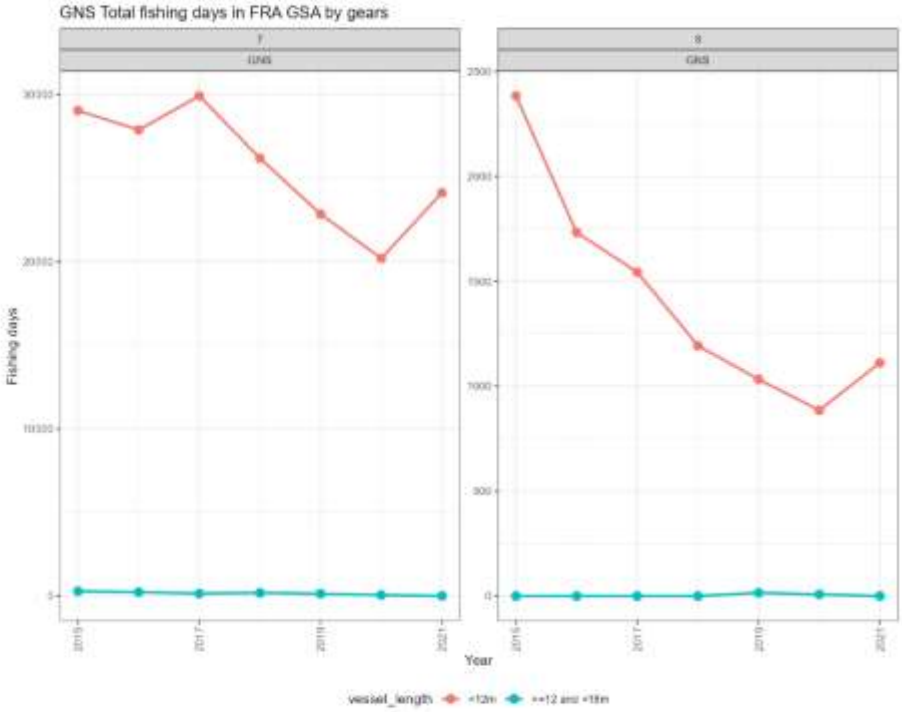


Figure 2.2.9 – France: time series of GNS fishing effort expressed in fishing days by fleet segment and GSA.

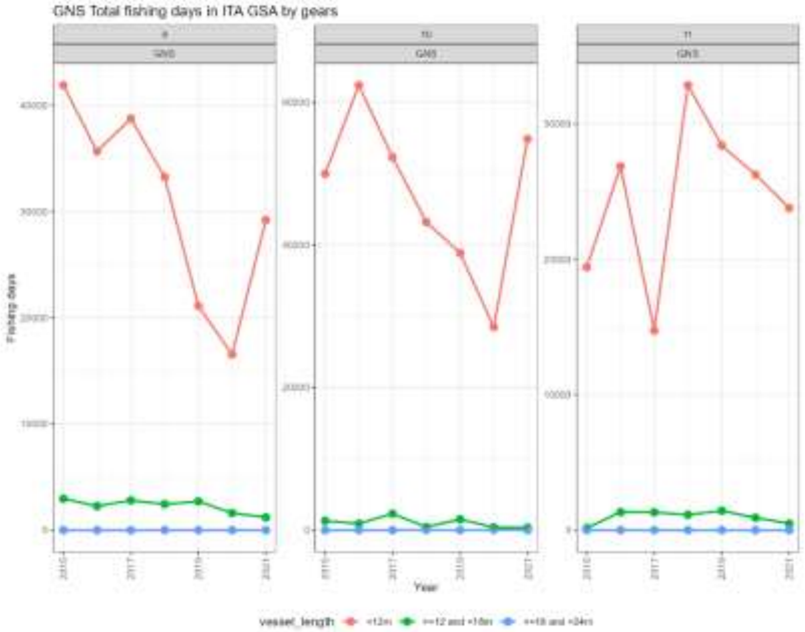


Figure 2.2.10 – Italy: time series of GNS fishing effort expressed in fishing days by fleet segment and GSA.

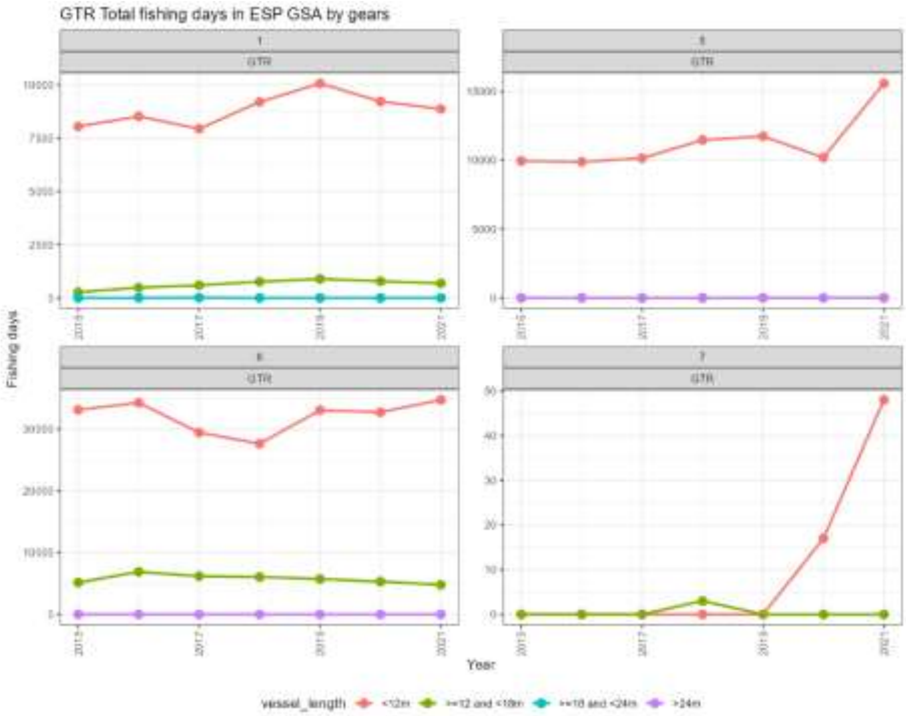


Figure 2.2.11 – Spain: time series of GTR fishing effort expressed in fishing days by fleet segment and GSA.

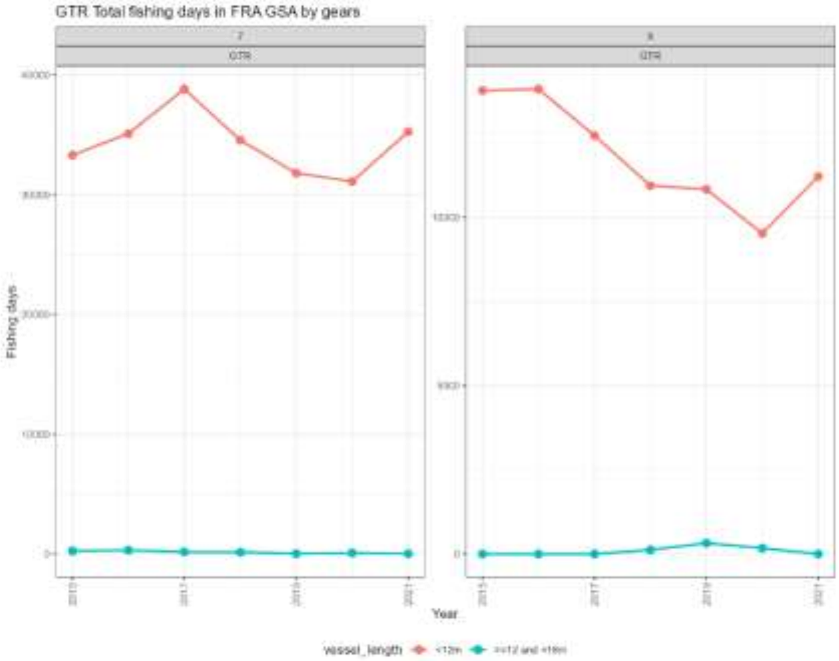


Figure 2.2.12 – France: time series of GTR fishing effort expressed in fishing days by fleet segment and GSA.

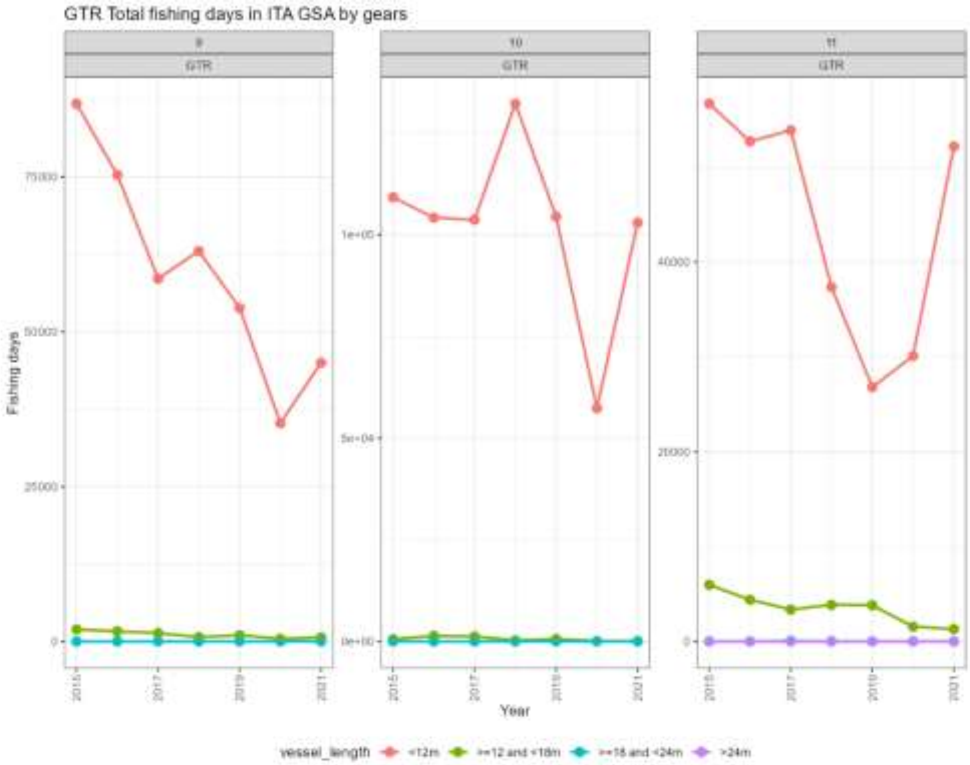


Figure 2.2.13 – Italy: time series of GTR fishing effort expressed in fishing days by fleet segment and GSA.

2.3 Comparison between FDI data and effort reference levels in EU regulation 2019/2236, 2021/90 and 2022/110

Compared to STECF 21-13 report a new prediction of fishing days for 2022 was added in the comparison tables to take into account the 2021 FDI and the baseline. A table for France in EMU2 was added.

2.3.1 Details for EMU 1

The fishing effort (in fishing days) from the FDI database and the fishing effort from the regulation were put in comparison as last year to verify if the effort reported in the FDI database is consistent with values dictated by the regulation. Only the FDI fishing effort from GSAs 1, 2, 5, 6 and 7 of trawl gears were taken into account. For the French and Spanish data, the trawl gears correspond to OTB, OTM, OTT, PTB, PTM and TBB as per EU regulation 2019/2236.

The 2020 and 2021 fishing opportunities were compared with the 2020 and 2021 values of fishing effort (in fishing days) from the FDI database. Being the regulation in 2022 based on a reduction of 21.5% for France and 23.5% for Spain from the 2015-2017 baseline, the FDI baseline (i.e. E 2015-2017) minus 21.5% or 23.5% of its value was compared with the values from the 2022 regulation (Table 2.3.1 and 2.3.2). The percentage of change between the regulation and the FDI fishing effort was calculated as the difference between the regulation effort and the FDI effort divided by the regulation multiplied by 100. Finally, two different predictions for the FDI effort in 2022 was calculated. One multiplying 2021 FDI data by 4% in the case of France and 6% for Spain, and the other calculation applying the total reduction to the baseline.

For French trawlers, the overall fishing effort from the regulation is higher than that estimated via the FDI database. If we were to apply an effort reduction of 21.5% based on the baseline (i.e. the average fishing effort for 2015-2017), the fishing days from the 2022 regulation would be 12.68% higher than the fishing effort values obtained for French trawlers after the reduction (Table 2.3.1). Also the 2021 regulation resulted to be higher by 2.09 % than the fishing days declared in the FDI dataset for 2021.

For Spanish trawlers as well, the overall fishing effort from the regulation is higher than that estimated via the FDI database. If we were to apply an effort reduction of 23.5% based on the baseline (i.e. the average fishing effort for 2015-2017), the fishing days from the 2022 regulation would be 37.85% higher than the fishing effort values obtained for Spanish trawlers after the reduction (Table 2.3.2). Also the 2021 regulation resulted to be higher by 27.13% than the fishing days declared in the FDI dataset for 2021.

Across fleet segments, the fishing effort from the regulation is greater, for most segments, than that estimated through the FDI database. For France data all regulations (2019/2236, 2021/90 and 2022/110) have higher values than those obtained from the FDI dataset for all the fleet segments in the coastal metier except in 2021 for the fleet segments >18 and <24 m.

Regarding Spanish trawlers, if we compare 76.5% of the average fishing effort of 2015-2017 and the one from the 2022/110 regulation, the regulation is higher for all fleet segments of the deep water and coastal metiers.

Table 2.33.1. Comparison of fishing effort (in fishing days) of French trawlers in GSAs 1,2,5,6 and 7 from the FDI database and the fishing effort from Regulation 2019/2236, Regulation 2021/90 and 2022/110 Regulation for EMU1. Percentage of change between effort from the FDI database and the 2022 regulation is calculated as follow: ((ERegulation2022- 78,5%E2015-2017)/ERegulation2022) *100

Stock group	**Fleet segment**	**FDI baseline: average of 2015-2017 fishing effort** $E_{2015-2017}$	**FDI Fishing effort in 2020**	**2020 Regulation**	**FDI Fishing effort in 2021**	**2021 Regulation**	**78.5 % of the FDI baseline** **0.785*** $E_{2015-2017}$	**2022 regulation**	**% of change between the 2020 regulation and 2020 FDI effort**	**% of change between the 2021 regulation and 2021 FDI effort**	**% of change between the 2022 regulation and 78.5% of the FDI baseline**	**% of change between the FDI 2021 and FDI baseline**	**Prediction 1 for 2022 (-4% FDI 2021)**	**Prediction 2 for 2022 (-21.5% Baseline)**
Red mullet in GSAs 1, 5, 6 and 7; Hake in GSAs 1-5-6-7; Deep-water rose shrimp in GSAs 1, 5 and 6; Norway lobster in GSAs 5 and 6	≥ 18 m and < 24 m	4666	4450	5144	4497	4715	3663	4372	13.49%	4.63%	16.22%	-3.76%	4197	3663
	≥ 24 m	6115	5382	6258	5208	5737	4800	5320	14.00%	9.22%	9.77%	-17.41%	5107	4800
TOTAL FISHING EFFORT OF FRENCH TRAWLS		**10781**	**9832**	**11402**	**9705**	**9912**	**8463**	**9692**	**13.77%**	**7.15%**	**12.68%**	**-11.09%**	**9304**	**8463**

Table 2.33.2. Comparison of fishing effort (in fishing days) of Spanish trawlers in GSAs 1,2,5,6 and 7 from the FDI database and the fishing effort from Regulation 2019/2236, Regulation 2021/90 and 2022/110 Regulation for EMU1. Percentage of change between effort from the FDI database and the 2022 regulation is calculated as follow: ((ERegulation2022- 76,5%E2015-2017)/ERegulation2022) *100

Stock group	**Fleet segment**	**FDI baseline: average of 2015-2017 fishing effort** $E_{2015-2017}$	**FDI Fishing effort in 2020**	**2020 Regulation**	**FDI Fishing effort in 2021**	**2021 Regulation**	**76.5 % of the FDI baseline** **0.765*** $E_{2015-2017}$	**2022 regulation**	**% of change between the 2020 regulation and 2020 FDI effort**	**% of change between the 2021 regulation and 2021 FDI effort**	**% of change between the 2022 regulation and 76.5% of the FDI baseline**	**% of change between the FDI 2021 and FDI baseline**	**Prediction 1 for 2022 (-6% FDI 2021)**	**Prediction 2 for 2022 (-23.5% Baseline)**
Red mullet in GSAs 1, 5, 6, 7; Hake in GSAs 1, 5, 6, 7; Deep-water rose shrimp in GSAs 1, 5, 6; Norway lobster in GSAs 5 and 6.	< 12 m	2708	1376	2260	1655	2072	2072	1921	39.12%	20.15%	-7.84%	-63.67%	1555	2072
	≥ 12 m and < 18 m	25123	21244	24284	17616	22260	19219	20641	12.52%	20.86%	6.89%	-42.61%	16559	19219
	≥ 18 m and < 24 m	51342	45587	45563	30059	41766	39277	38728	1.49%	28.03%	-1.42%	-70.80%	28256	39277
	≥ 24 m	19334	16826	16047	9256	14710	14790	13640	-3.61%	37.07%	-8.43%	-108.87%	8701	14790
Blue and red shrimps in GSA 1,5,6,7	< 12 m	2	0	0	0	0	2	0	-	-	-	-	0	0
	≥ 12 m and < 18 m	785	630	1139	857	1044	601	968	44.69%	17.96%	37.96%	8.35%	805	601
	≥ 18 m and < 24 m	7965	6169	10822	7705	10574	6093	9805	43.00%	27.13%	37.85%	-3.38%	7243	6093
	≥ 24 m	6911	5713	9066	6917	8488	5287	7871	36.98%	18.51%	32.83%	0.08%	6502	5287
TOTAL FISHING EFFORT OF SPANISH TRAWLS		**114170**	**97545**	**109181**	**74065**	**100914**	**87340**	**93574**	**11.39%**	**26.61%**	**6.66%**	**-54.15%**	**69621**	**87340**

2.3.2 *Details for EMU 2*

We compared the fishing effort (in fishing days) from the FDI database and the fishing effort from the regulation. Only the FDI fishing effort from GSAs 9-10-11 of trawl gears was considered for the Italian data, and FDI fishing effort from GSA 8 for French data. For both countries, the trawl gears correspond to OTB, OTM, TBB and PTM, as listed in the 2019/2236 Regulation.

We compared the 2021 regulation values with the 2021 values of fishing effort (in fishing days) from the FDI database and the 2020 FDI data and 2020 regulation. The regulation in 2022 is based on a reduction of 26% for Italy, and 21.5% for France, of the average effort from 2015-2017 of trawl gears, we calculated the FDI baseline (i.e. E(2015-2017)) and compared 74% in the case of Italy and 78.5 for France, of those values with the values from the 2021 regulation (table 2.3.3). The percentage of change between the regulation and the FDI fishing effort is calculated as the difference between the regulation effort and the FDI effort divided by the regulation multiplied by 100. Finally, two different predictions for the FDI effort in 2022 was calculated. One multiplying 2021 FDI data by 4% in the case of France and 6% for Italy, and the other calculation applying the total reduction to the baseline.

For Italian trawlers, the fishing effort from the regulation is higher than that estimated via the FDI database. If we were to apply an effort reduction of 26% based on the FDI (i.e. the average fishing effort for 2015-2017), the 2022 regulation would be 0.22% lower than the actual fishing effort reduction applied for Italian trawlers (table 2.3.3). Also the 2021 Regulation resulted in being higher by 11.76% than the data for 2021 reported in the official FDI datacall.

For French trawlers, the fishing effort from the regulation is higher than that estimated via the FDI database. If we were to apply an effort reduction of 23.5% based on the FDI (i.e. the average fishing effort for 2015-2017), the 2022 regulation would be 34.50% higher than the actual fishing effort reduction applied for Italian trawlers (table 2.3.3). Also the 2021 Regulation resulted in being higher by 55.07% than the data for 2021 reported in the official FDI datacall.

Table 2.33.2 Comparison of fishing effort (in fishing days) of Italian trawlers from the FDI database and the fishing effort from Regulation 2019/2236 Regulation 2021/90 and 2022/110 Regulation for EMU2. Percentage of change between effort from the FDI database and the regulation is calculated as follow: $((E_{Regulation} - 74\%E_{2015-2017})/E_{Regulation}) *100$

Stock group	Fleet segment	FDI baseline: average of 2015-2017 fishing effort $E_{2015-2017}$	FDI Fishing effort in 2020	2020 Regulation	FDI Fishing effort in 2021	2021 Regulation	74 % of the FDI baseline 0.74* $E_{2015-2017}$	2022 regulation	% of change between the 2020 regulation and 2020 FDI effort	% of change between the 2021 regulation and 2021 FDI effort	% of change between the 2022 regulation and 74% of the FDI baseline	% of change between the FDI 2021 and FDI baseline	Prediction 1 for 2022 (-6% FDI 2021)	Prediction 2 for 2022 (-26% Baseline)
Red mullet in GSAs 9, 10 and 11; Hake in GSAs 9-10-11; Deep-water rose shrimp in GSAs 9-10-11; Norway lobster in GSAs 9 and 10.	< 12 m	3374	4157	3081	7500	2824	2497	2534	-34.92%	-165.58%	1.47%	55.01%	7050	2497
	≥ 12 m and < 18 m	52679	30910	46350	33418	42487	38983	38110	33.31%	21.35%	-2.29%	-57.64%	31413	38983
	≥ 18 m and < 24 m	35031	23435	31170	26476	28572	25923	25629	24.82%	7.34%	-1.15%	-32.31%	24887	25923
	≥ 24 m	4680	4267	4160	4670	3813	3463	3421	-2.57%	-22.48%	-1.22%	-0.21%	4390	3463
Giant red shrimp in GSAs 9, 10 and 11.	< 12 m	567	129	510	101	467	420	419	74.71%	78.37%	-0.14%	-461.39%	95	420
	≥ 12 m and < 18 m	3345	3977	3760	1290	3447	2475	3091	-5.77%	62.58%	19.92%	-159.30%	1213	2475
	≥ 18 m and < 24 m	2838	3648	3028	1099	2776	2100	2489	-20.48%	60.41%	15.64%	-158.20%	1033	2100

	≥ 24 m	450	1459	405	233	371	333	333	-260.25%	37.20%	0.08%	-92.97%	219	333
TOTAL FISHING EFFORT OF ITALIAN TRAWLS		**102964**	**71982**	**92464**	**74787**	**84757**	**76193**	**76026**	**22.15%**	**11.76%**	**-0.22%**	**-37.68%**	**70300**	**78767**

Table 2.33.4 Comparison of fishing effort (in fishing days) of French trawlers from the FDI database and the fishing effort from Regulation 2019/2236 Regulation 2021/90 and 2022/110 Regulation for EMU2. Percentage of change between effort from the FDI database and the regulation is calculated as follow: $((E_{Regulation} - 74\% E_{2015\text{-}2017})/E_{Regulation})*100$

Stock group	Fleet segment	FDI baseline: average of 2015-2017 fishing effort $E_{2015\text{-}2017}$	FDI Fishing effort in 2020	2020 Regulation	FDI Fishing effort in 2021	2021 Regulation	78.5 % of the FDI baseline 0.785* $E_{2015\text{-}2017}$	2022 regulation	% of change between the 2020 regulation and 2020 FDI effort	% of change between the 2021 regulation and 2021 FDI effort	% of change between the 2022 regulation and 78.5% of the FDI baseline	% of change between the FDI 2021 and FDI baseline	Prediction 1 for 2022 (-4% FDI 2021)	Prediction 2 for 2022 (-21.5% Baseline)
Red mullet in GSAs 8, 9, 10 and 11; Hake in GSAs 8, 9, 10 and 11; Deep-water rose shrimp in GSAs 9, 10 and 11; Norway lobster in GSAs 9 and 10.	< 12 m	169	0	208	3	191	132	117	100.00%	98.47%	-13.13%	-5667.29%	112	132
	≥ 12 m and < 18 m	516	319	833	383	764	405	709	61.74%	49.93%	42.91%	-34.79%	681	405
	≥ 18 m and < 24 m	53	12	208	56	191	41	117	94.47%	70.94%	64.75%	5.33%	112	41
	≥ 24 m	148	152	208	160	191	116	117	26.83%	16.32%	0.88%	7.56%	112	116
TOTAL FISHING EFFORT OF FRENCH TRAWLS		**884**	**482**	**1457**	**601**	**1337**	**694**	**1060**	**66.89%**	**55.07%**	**34.50%**	**-47.23%**	**565**	**677**

2.4 Data quality checks

2.4.1 Total landings in weight data calls comparison

Time series of landings data were analyzed at stock level (GSA and species) and countries. In the analysis the main MAP species have been considered: ARA, ARS, DPS, HKE, MUT and NEP.

In the following table are reported time series available according to the two 2022 Data Calls: Fishery Dependent Information (FDI) and Mediterranean and Black Sea call (MBS) used in carrying out the comparison.

Table 2.4.1.1 – Time series available in the EU two official Data Calls

Data Calls	Time series
MBS	2002-2021
FDI	2013-2021

2.4.1.1 Total landings in weight data calls comparison: Italy data

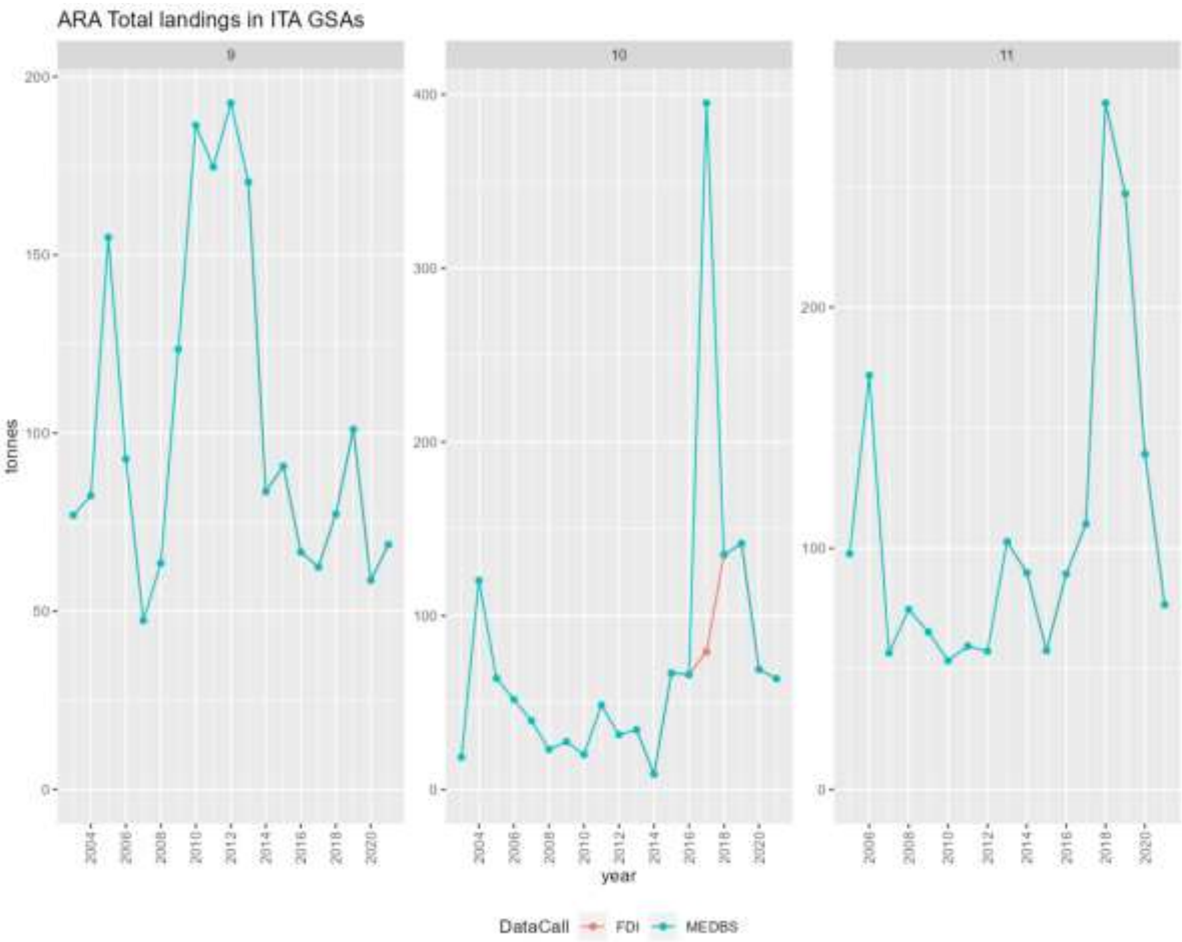


Figure 2.4.1.1.1 – ARA. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

Blue and red shrimp total landings comparison between FDI and MBS showed a very good matching in values in GSA9 (Ligurian and Northern Tyrrhenian Seas) and GSA11 (Sardinian waters). A poor match was observed in GSA10 (Southern Tyrrhenian Sea) in 2017 for which a very high value has been reported in the MEDBS data.

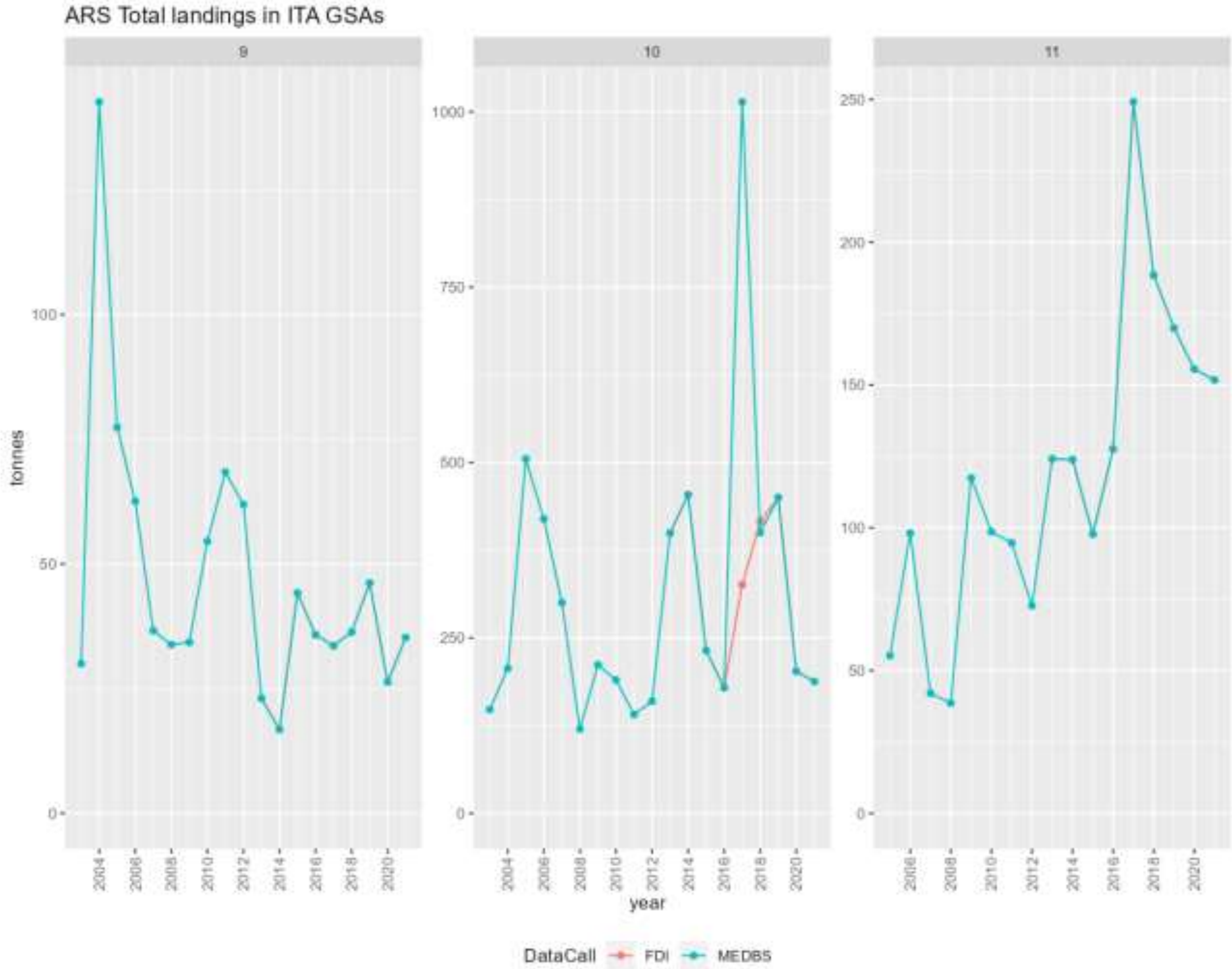


Figure 2.4.1.1.2 – ARS. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

As in the case of the Blue and red shrimp also in the Giant red shrimp total landings comparison between FDI and MBS showed a very good matching in values in GSA9 (Ligurian and Northern Tyrrhenian Seas) and GSA11 (Sardinian waters). A poor match was observed in GSA10 (Southern Tyrrhenian Sea) in 2017 for which a very high value has been reported in the MEDBS data.

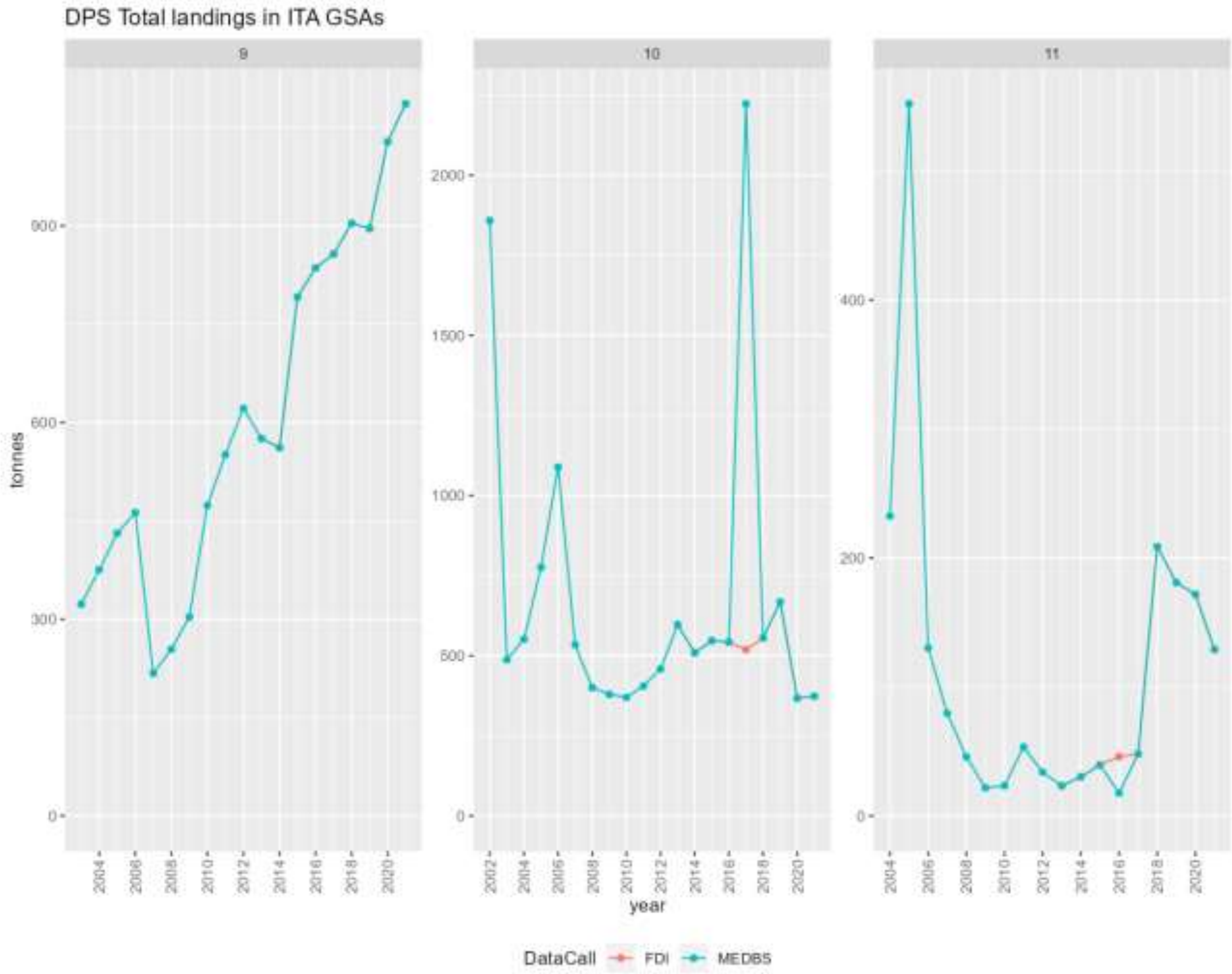


Figure 2.4.1.1.3 – DPS. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

Deep-water rose shrimp total landings comparison between FDI and MBS showed a very good match for values in GSA9 (Ligurian and Northern Tyrrhenian Seas). A poor match was observed in GSA10 (Southern Tyrrhenian Sea) in 2017 for which a very high value has been reported in the MEDBS data and in GSA11 (Sardinian waters) for which FDI data are higher.

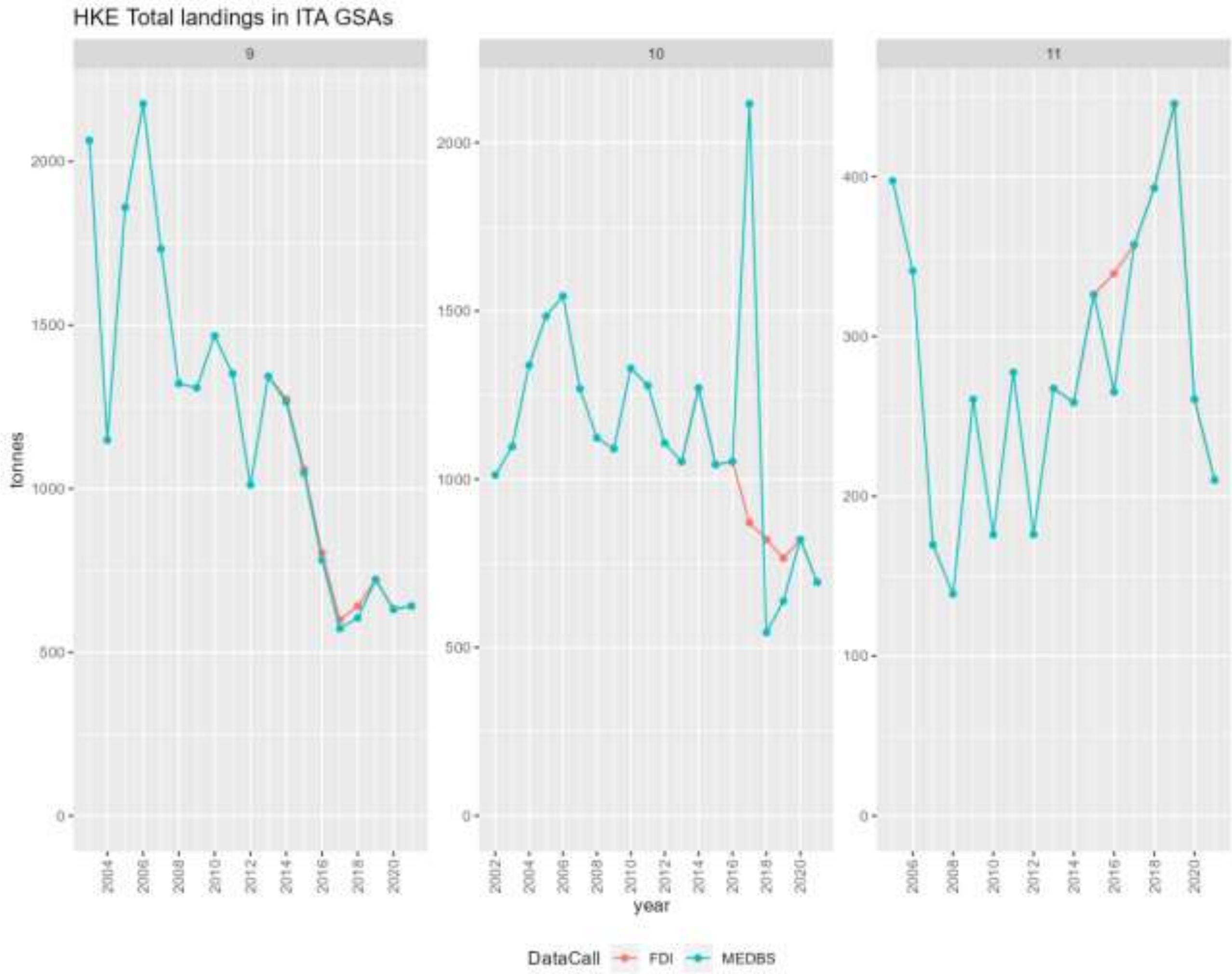


Figure 2.4.1.1.4 – HKE. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

European hake total landings comparison between FDI and MBS showed a very good matching in values in GSA9 (Ligurian and Northern Tyrrhenian Seas) even if some discrepancies have been detected from 2014 up to 2018, a poor match in GSA10 (Southern Tyrrhenian Sea) in 2017, 2018 and 2019 (in particular in 2017 when a very high value has been reported in the MEDBS data), and, finally, in GSA11 for 2016 data.

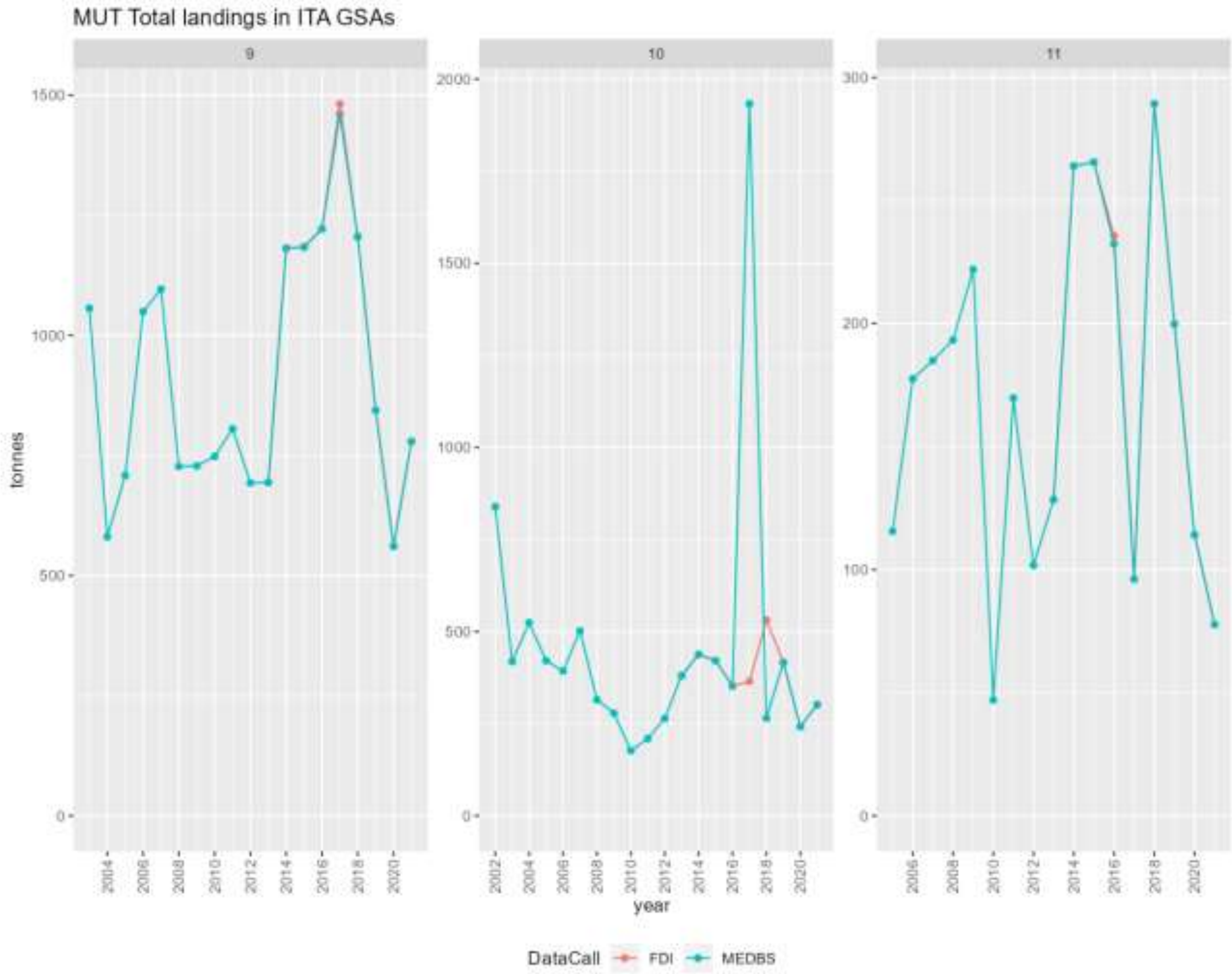


Figure 2.4.1.1.5 – MUT. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

Red mullet total landings comparison between FDI and MBS showed a very good matching in values in GSA9 (Ligurian and Northern Tyrrhenian Seas) and GSA11 (Sardinian waters) even if slightest discrepancies have been detected in 2016 in both GSA. Again, a poor match in GSA10 (Southern Tyrrhenian Sea) has been observed in 2017 and also in 2018 (in particular in 2017 when a very high value has been reported in the MEDBS data).

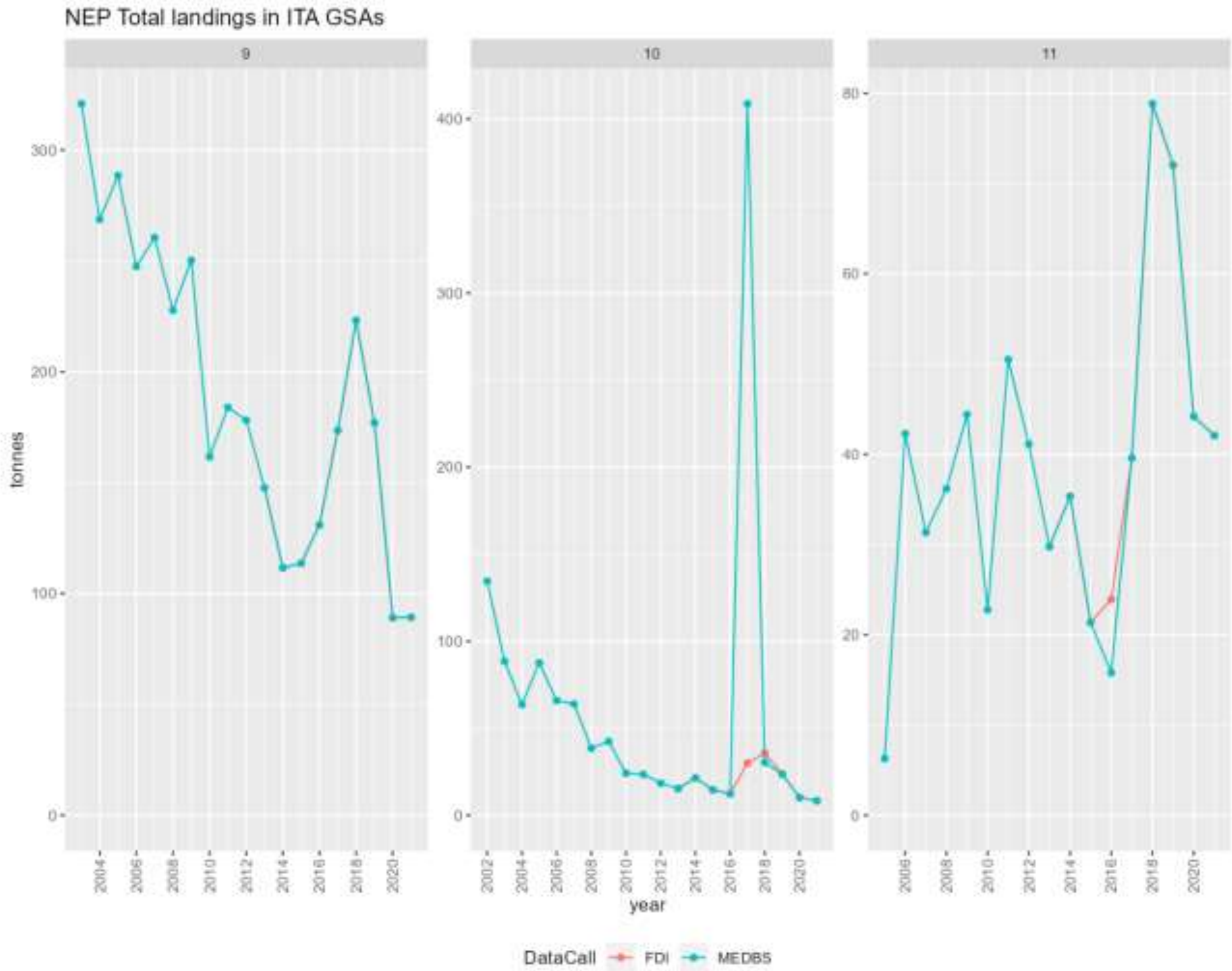


Figure 2.4.1.1.6 – NEP. Total landings comparison between MBS and FDI Data Calla for Italian GSAs

Norway lobster total landings comparison between FDI and MBS showed a very good matching in values in GSA9 (Ligurian and Northern Tyrrhenian Seas). In GSA11 (Sardinian waters) and GSA10 ((Southern Tyrrhenian Sea) discrepancies have been detected in 2017 in GSA 10 (when a very high value has been reported in the MEDBS data) and in 2016 in GSA11.

2.4.1.2 Total landings in weight data calls comparison: France data

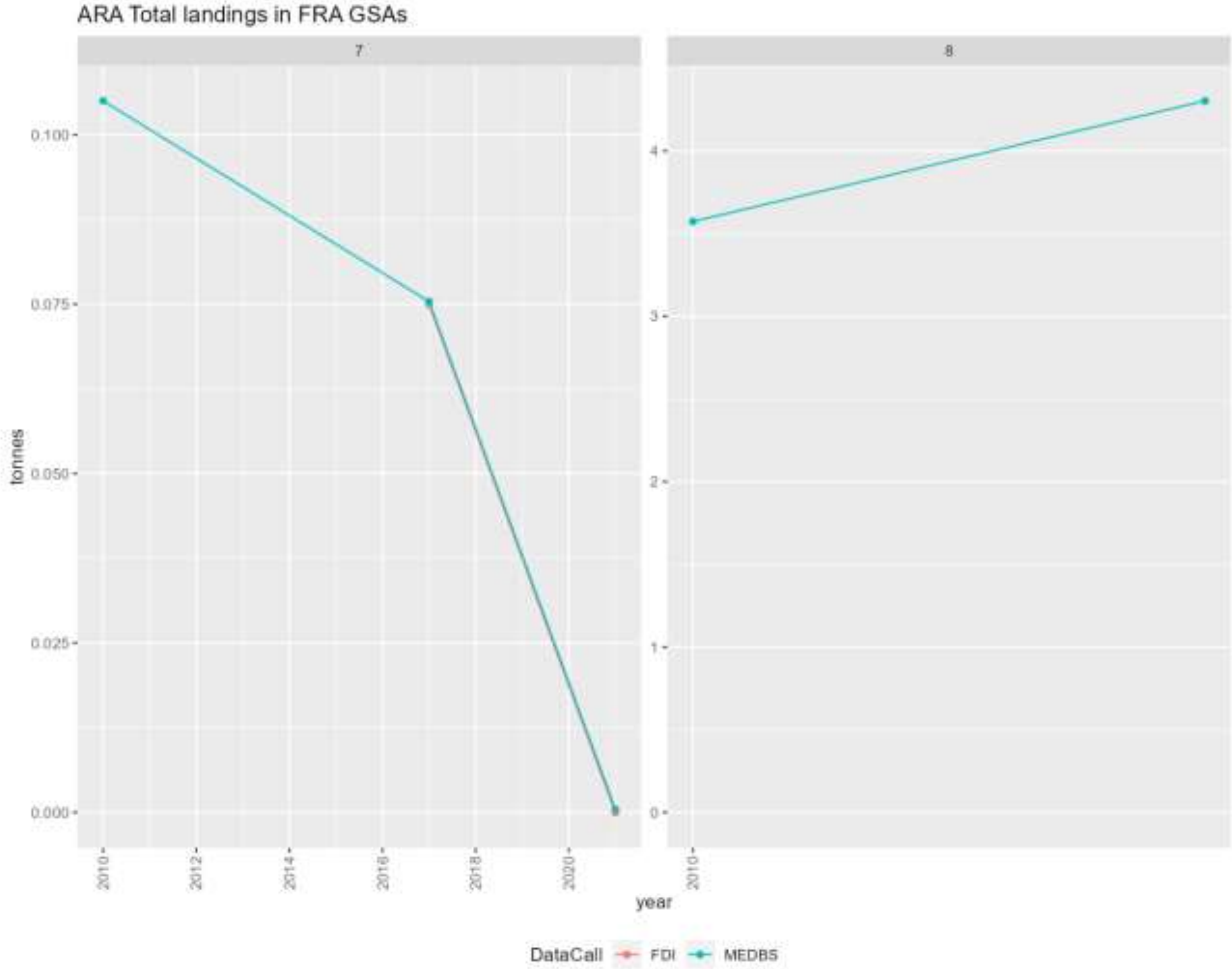


Figure 2.4.1.2.1 – ARA. Total landings comparison between MBS and FDI Data Calla for French GSAs

Blue and red shrimp total landings comparison between FDI and MBS showed a very good matching in values in both French GSAs (GSA7 Gulf of lion and GSA8 Corsica Island). It is important underlying, considering the introduction in the MAP of red shrimps catch limits, that this species is basically not landed in GSA7 and only some tons (about 4t) are reported only in two years in GSA8.

In both data calls time series have been never reported landings data for the Gian red shrimp (ARS) in both GSAs.

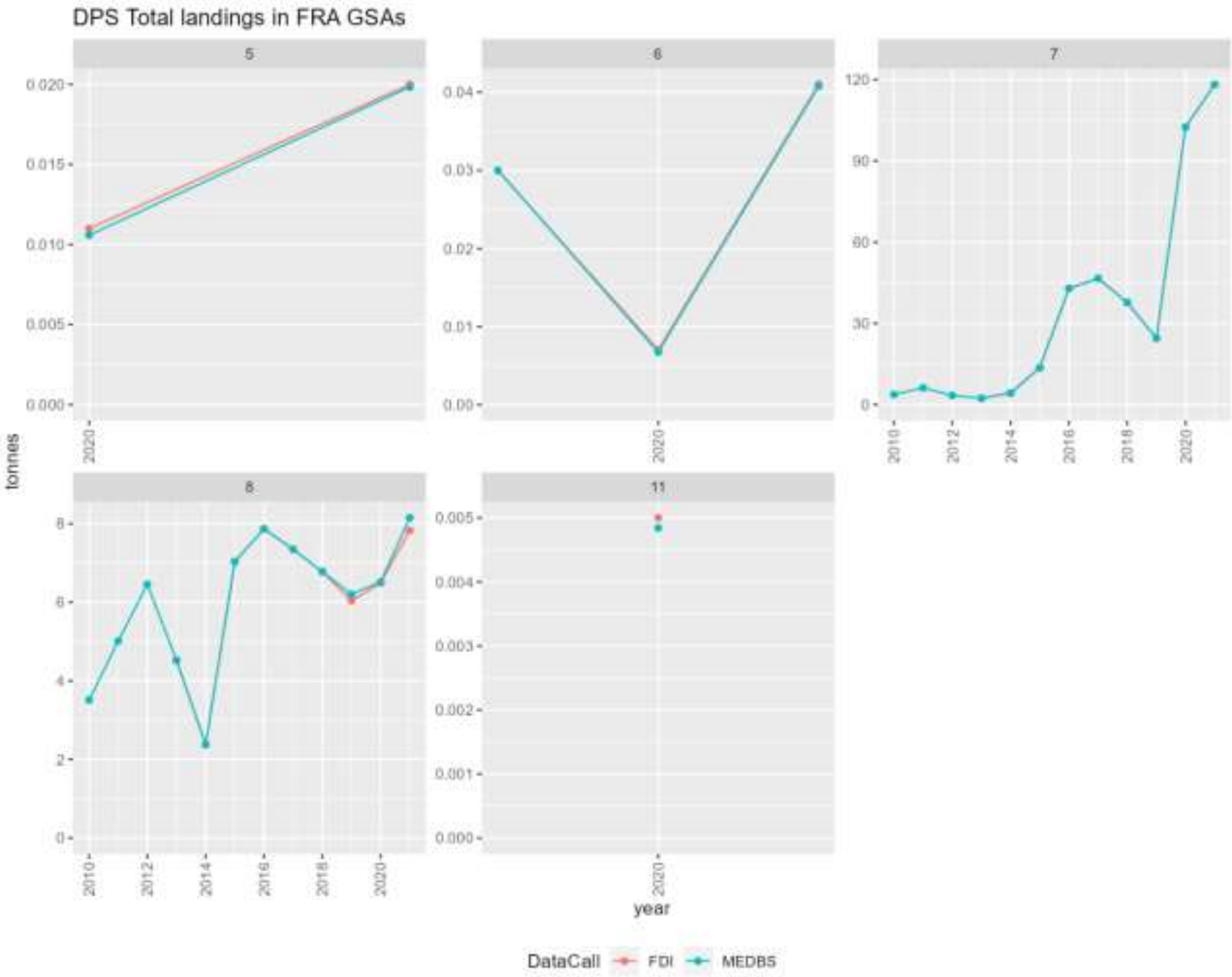


Figure 2.4.1.2.2 – DPS. Total landings comparison between MBS and FDI Data Calla for French GSAs

Deep-water rose shrimp total landings comparison between FDI and MBS showed a very good matching in values in all French GSAs. It is interesting notice that data come also from other two Spanish GSAs (GSA5 Balearic Islands and GSA6 Northern Spain) and one Italian GSA (GSA11 Sardinian waters). Slightest discrepancies have been observed for GSA5, GSA6 and GSA11 (actually not common French fishing areas).

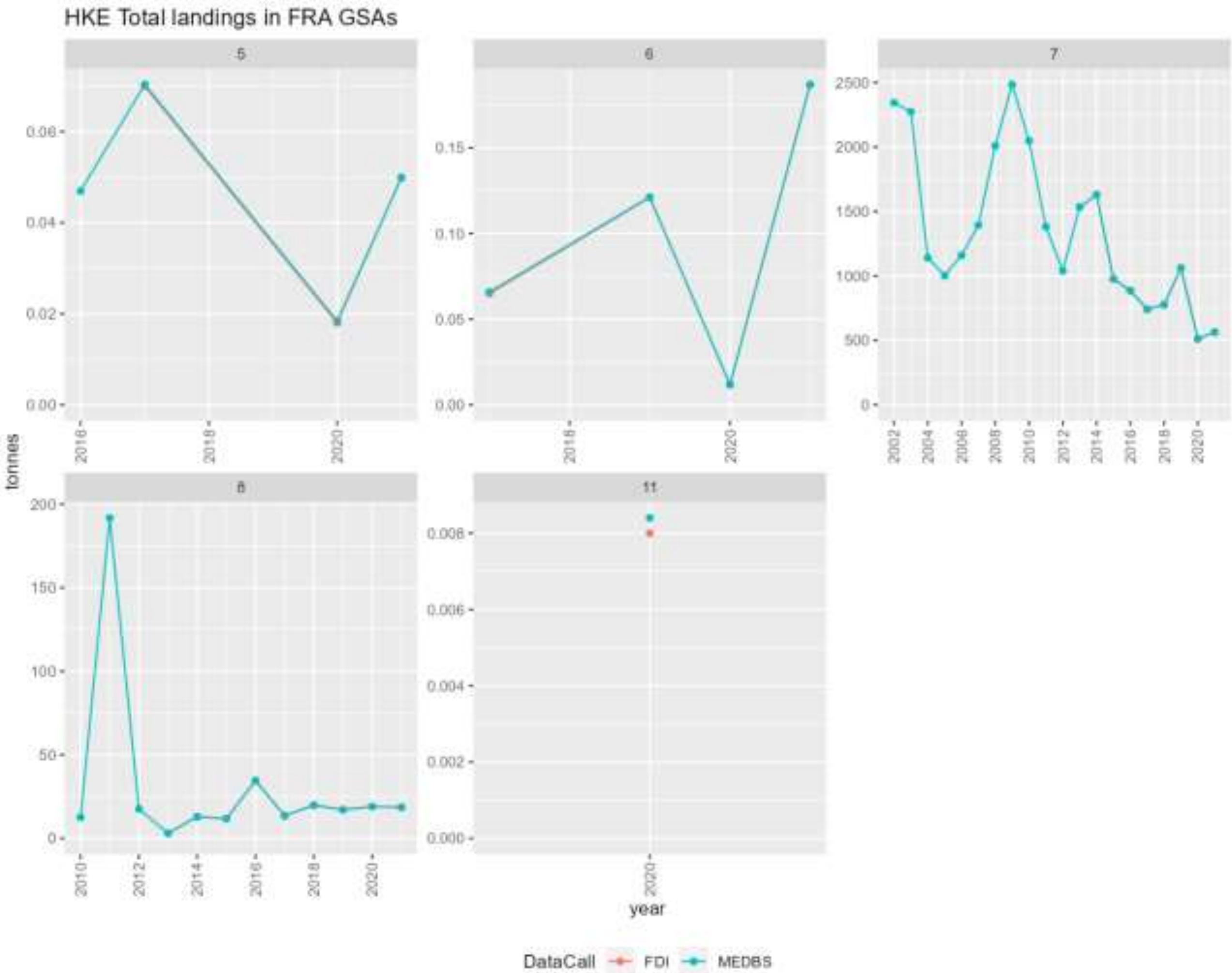


Figure 2.4.1.2.3 – HKE. Total landings comparison between MBS and FDI Data Calla for French GSAs

European hake total landings comparison between FDI and MBS showed a very good matching in values in all French GSAs. It is interesting notice that data come also from other two Spanish GSAs (GSA5 Balearic Islands and GSA6 Northern Spain) and one Italian GSA (GSA11 Sardinian waters). Slightest discrepancies have been observed in GSA11 data.

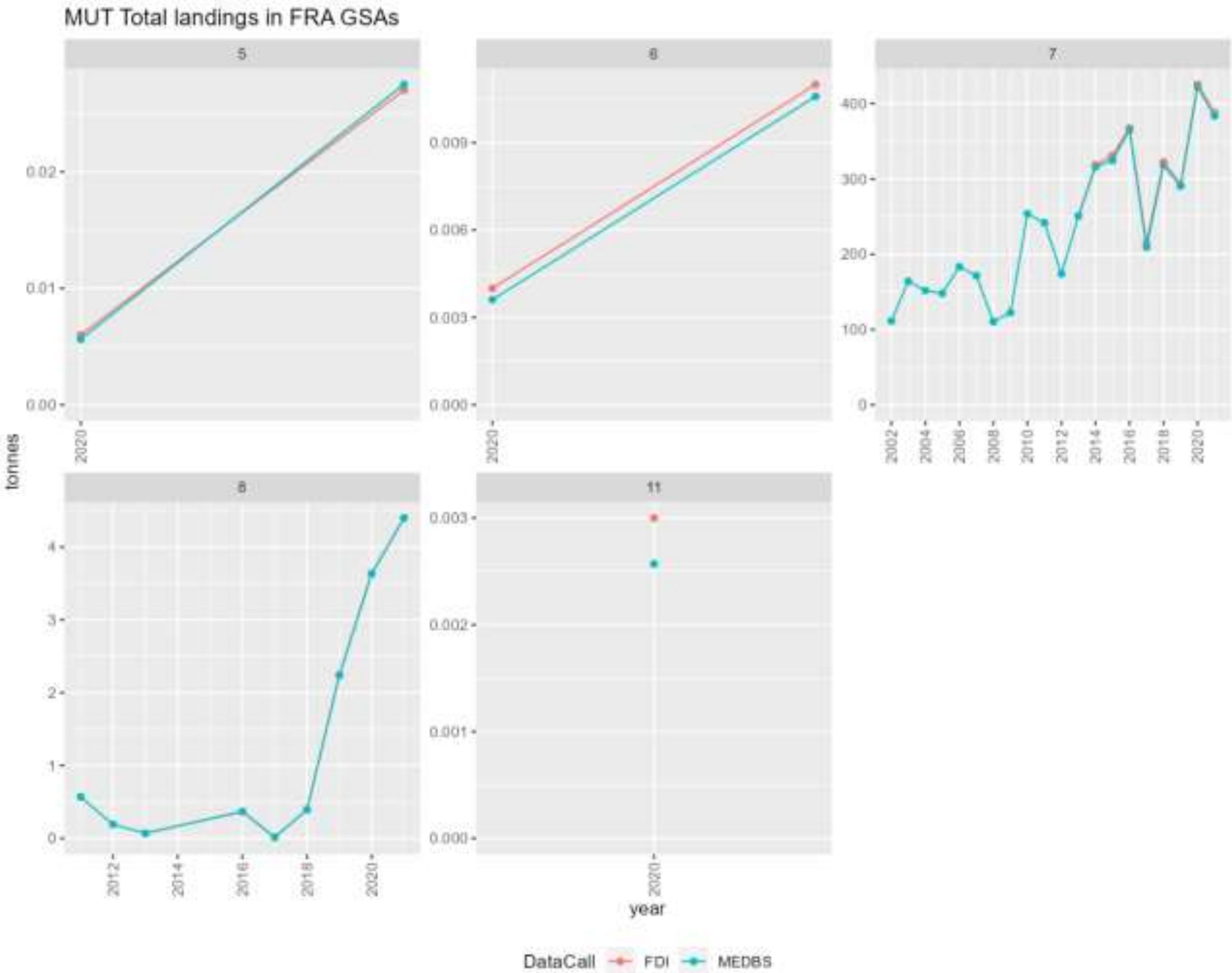


Figure 2.4.1.2.4 – MUT. Total landings comparison between MBS and FDI Data Calla for French GSAs

Red mullet total landings comparison between FDI and MBS showed a very good matching in values in all French GSAs. It is interesting notice that data come also from other two Spanish GSAs (GSA5 Balearic Islands and GSA6 Northern Spain) and one Italian GSA (GSA11 Sardinian waters). Slightest discrepancies have been observed in GSA5, GSA6 and GSA11 data.

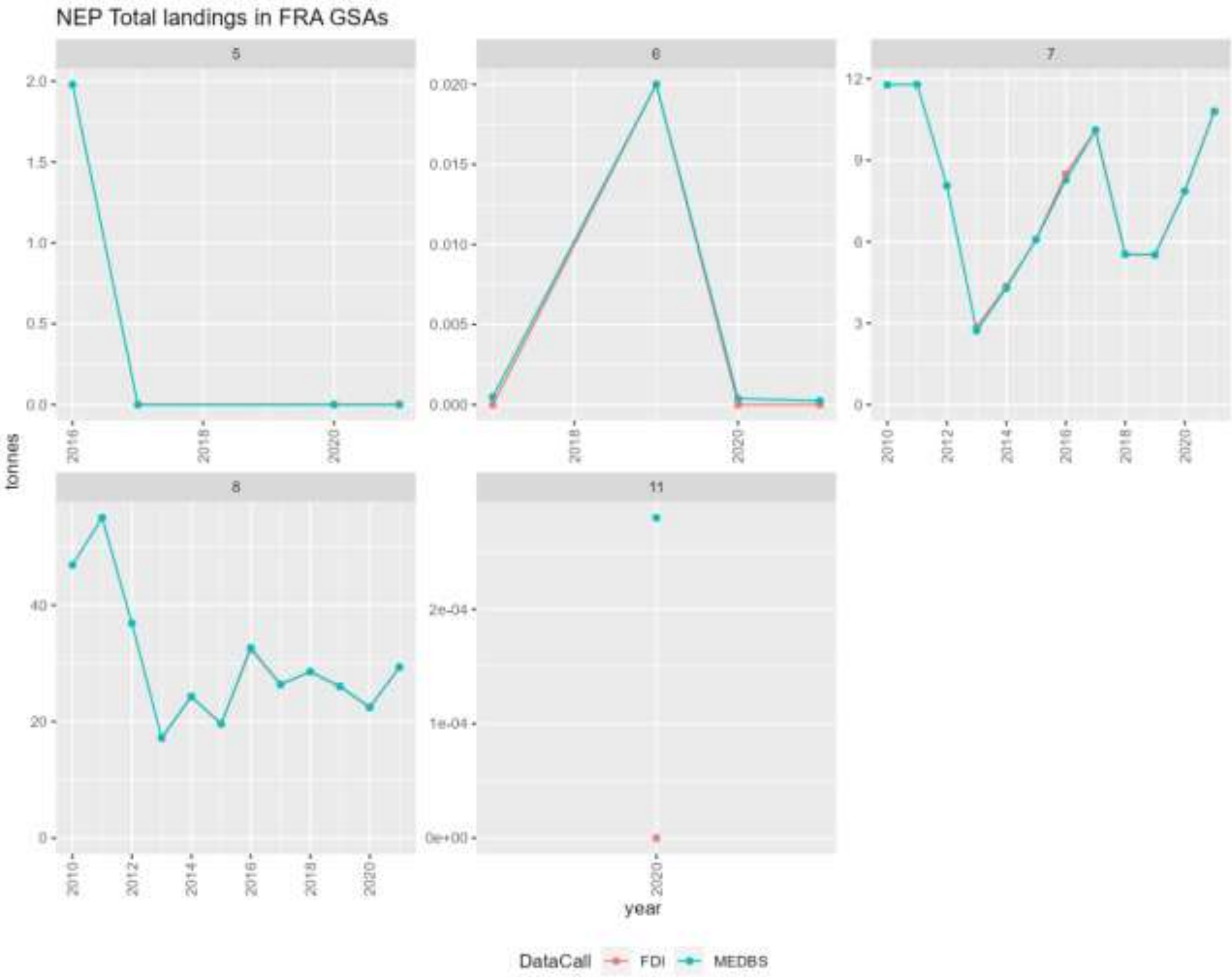


Figure 2.4.1.2.5 – NEP. Total landings comparison between MBS and FDI Data Calla for French GSAs

Norway lobster total landings comparison between FDI and MBS showed a very good matching in values in all French GSAs. It is interesting notice that data come also from other two Spanish GSAs (GSA5 Balearic Islands and GSA6 Northern Spain) and one Italian GSA (GSA11 Sardinian waters). Slightest discrepancies have been observed in GSA6 and GSA11 data.

2.4.1.3 Total landings in weight data calls comparison: Spain data

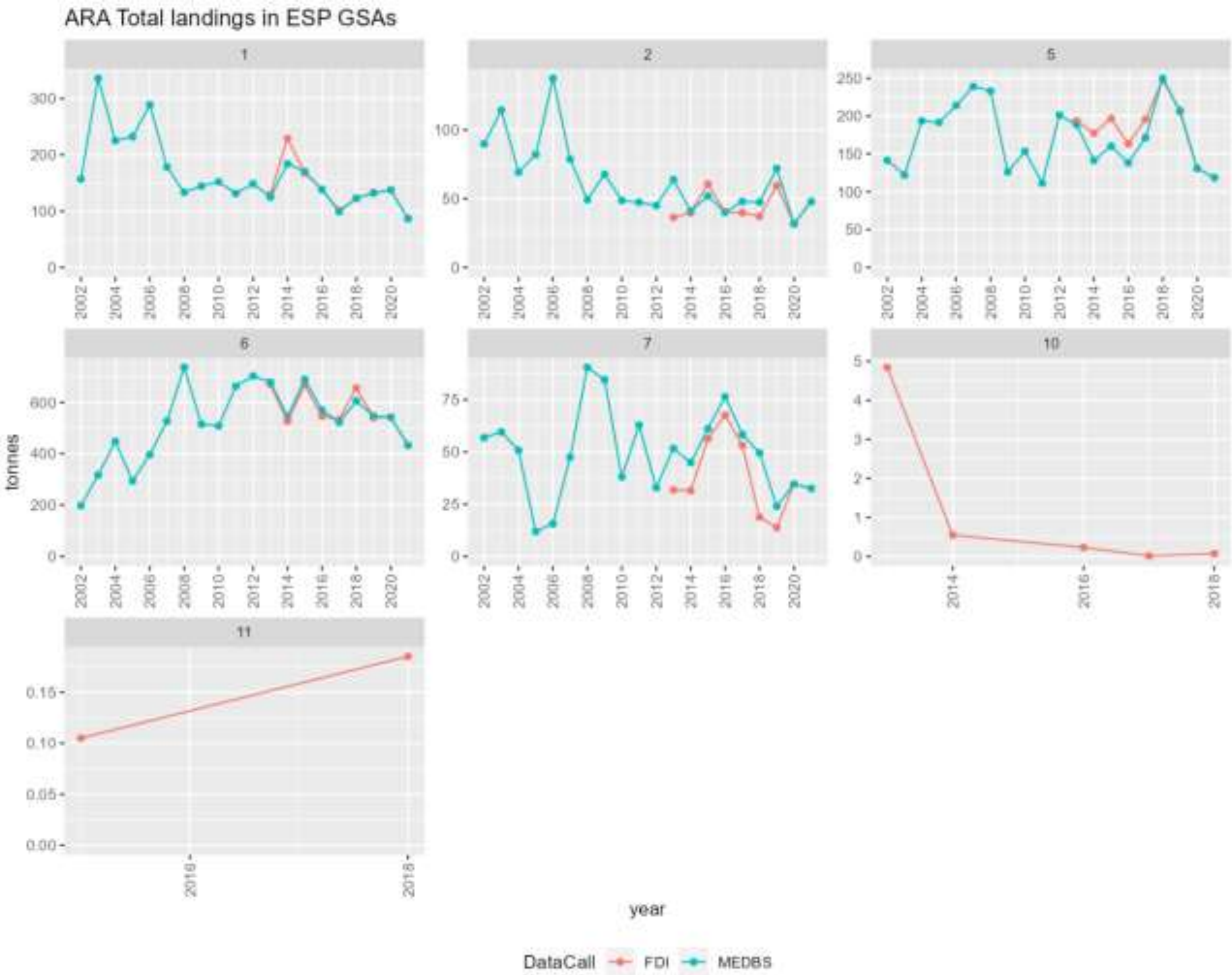


Figure 2.4.1.3.1 – ARA. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

Blue and red shrimp total landings comparison between FDI and MBS didn’t show a very good matching in values in all Spanish GSAs (GSA1 Southern Spain, GSA2 Alboran Islands, GSA5 Balearic Islands, GSA6 Norther Spain and GSA7 Gulf of Lion). Some landings data have been reported also from other two Italian GSAs (GSA10 and GSA11). Below are listed the main inconsistencies observed for this species:

GSA1: data in 2014 differ from the two data calls
GSA2: data in 2013, 2015, 2017,2018 and 2018 differ from the two data calls
GSA5: data in 2013, 2014, 2015, 2016 and 2017 differ from the two data calls
GSA6: data from 2013 up to 2019 differ from the two data calls
GSA7: data from 2013 up to 2019 differ from the two data calls
GSA10: data reported only in FDI data call
GSA11: data reported only in FDI data call

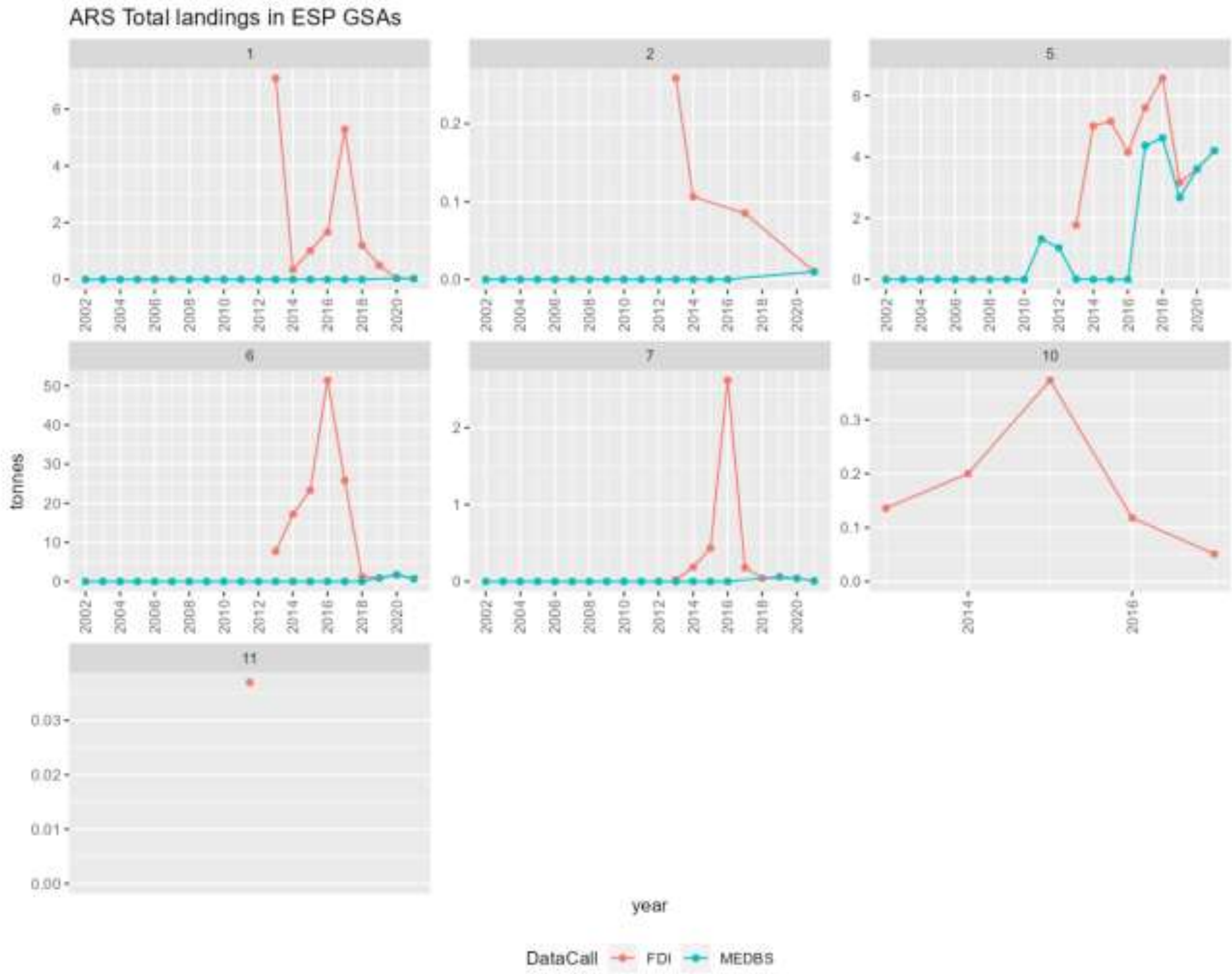


Figure 2.4.1.3.2 – ARS. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

Giant red shrimp total landings comparison between FDI and MBS didn't show a very good matching in values in all Spanish GSAs (GSA1 Southern Spain, GSA2 Alboran Islands, GSA5 Balearic Islands, GSA6 Norther Spain and GSA7 Gulf of Lion). Some landings data have been reported also from other two Italian GSAs (GSA10 and GSA11). Only in the last 2-3 years consistency seems improved. Although is well know that this species is not so abundant in Spanish areas (even if in GSA6 Northern Spain landings have been registered from 2013 up to 2017 with a peak of more than 50t in 2016) for which could be more difficult collected data properly, it is still important to remark how the consistency of landings data reported in the two data calls is very bad.

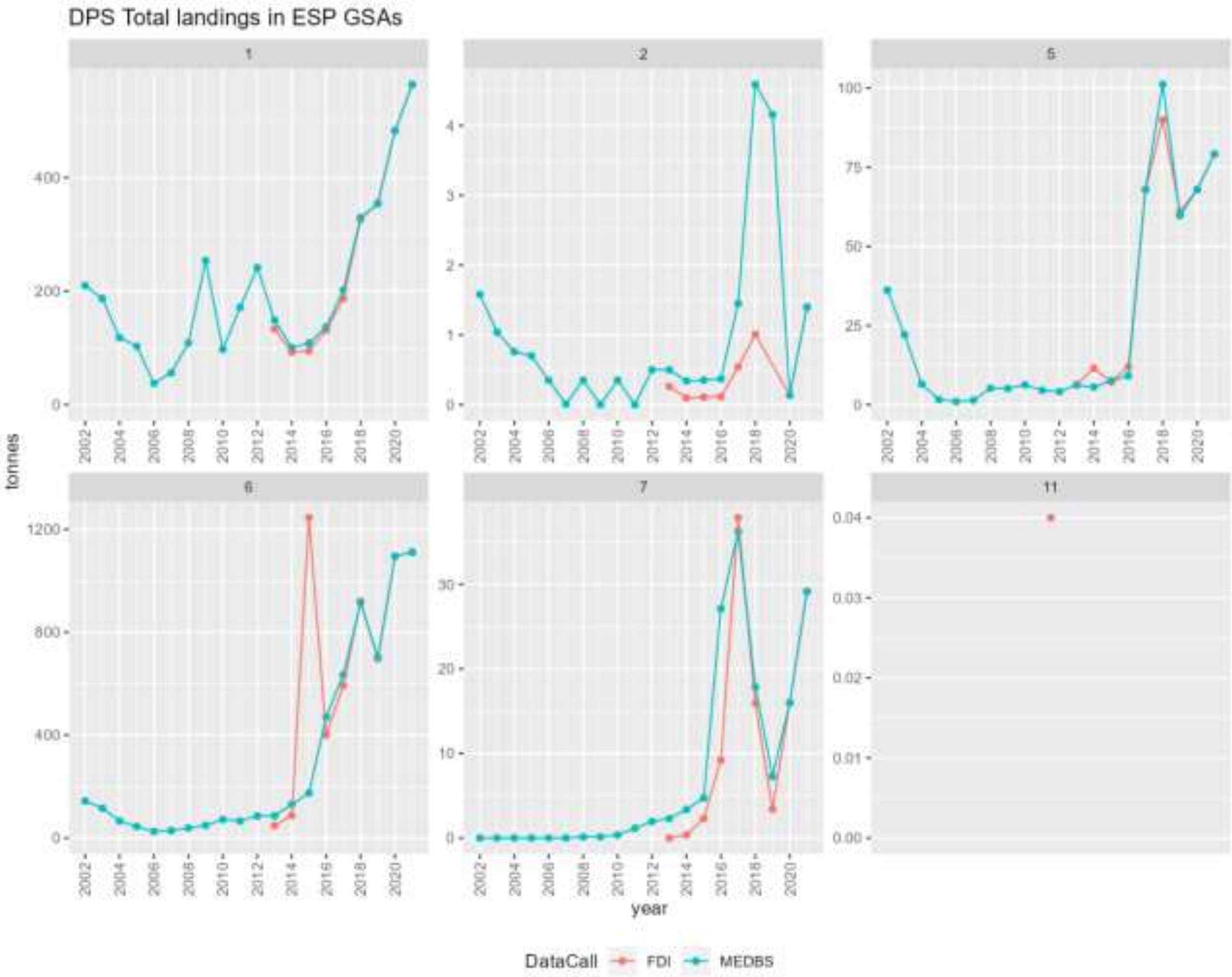


Figure 2.4.1.3.3 – DPS. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

Deep-water rose shrimp total landings comparison between FDI and MBS didn't show a very good matching in values in all Spanish GSAs except for GSAs 1 and 5 (Southern Spain and Balearic Islands). Some landings data have been reported also from Italian GSA11 (Sardinian waters). Only in the last 2-3 years the consistency seems improved. A very high value has been reported in 2015 in GSA6.

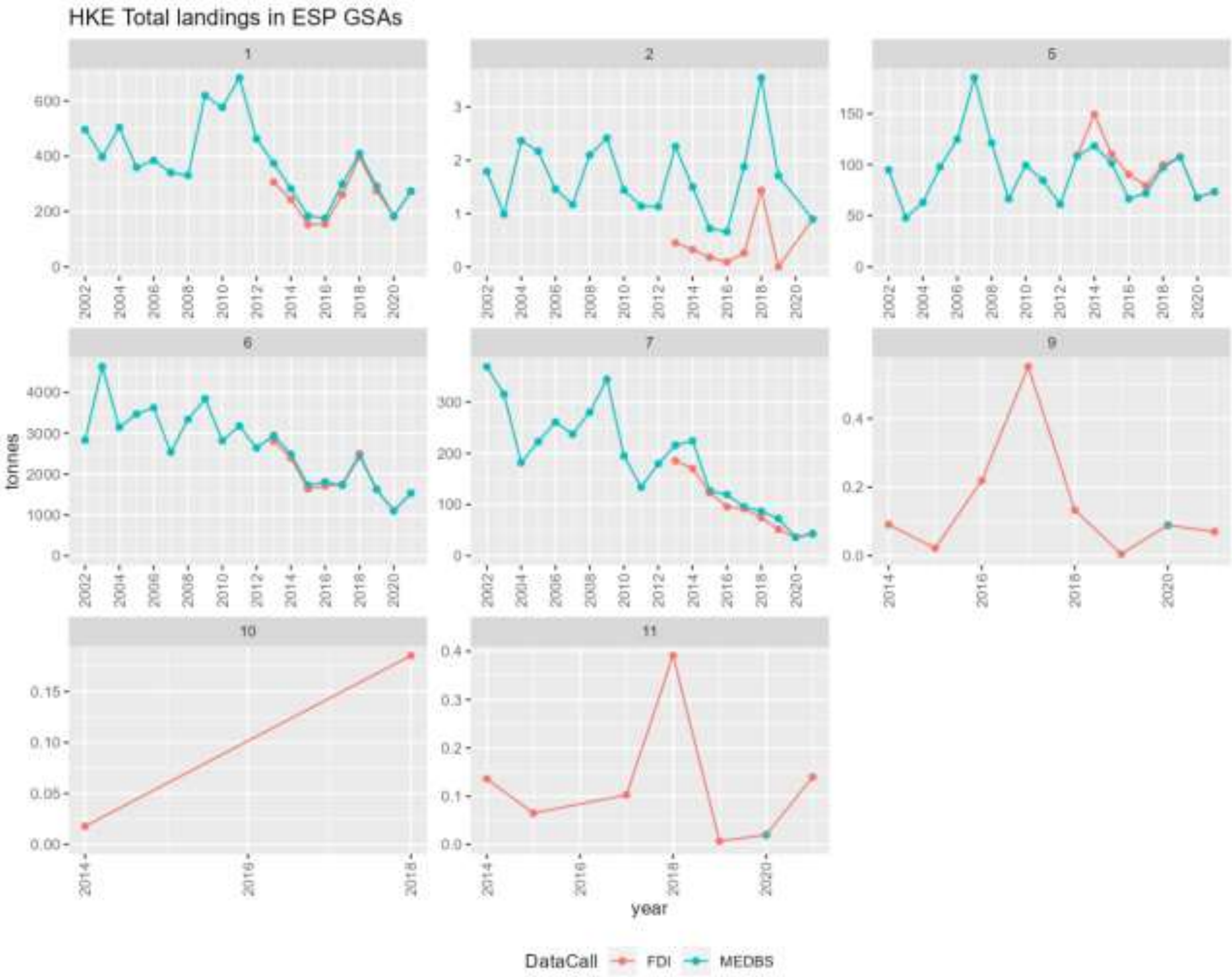


Figure 2.4.1.3.4 – HKE. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

European hake total landings comparison between FDI and MBS didn’t show a very good matching in values in GSA2 (Alboran Islands) and partially in GSA5 (Balearic Islands) and GSA7 (Gulf of Lion). Some landings data have been reported also from Italian GSAs 10 (Southern Tyrrhenian Sea) and 11 (Sardinian waters). In the last years the consistency seems improved. Consistency seems good in GSA1 (Southern Spain) and GSA6 (Northern Spain).

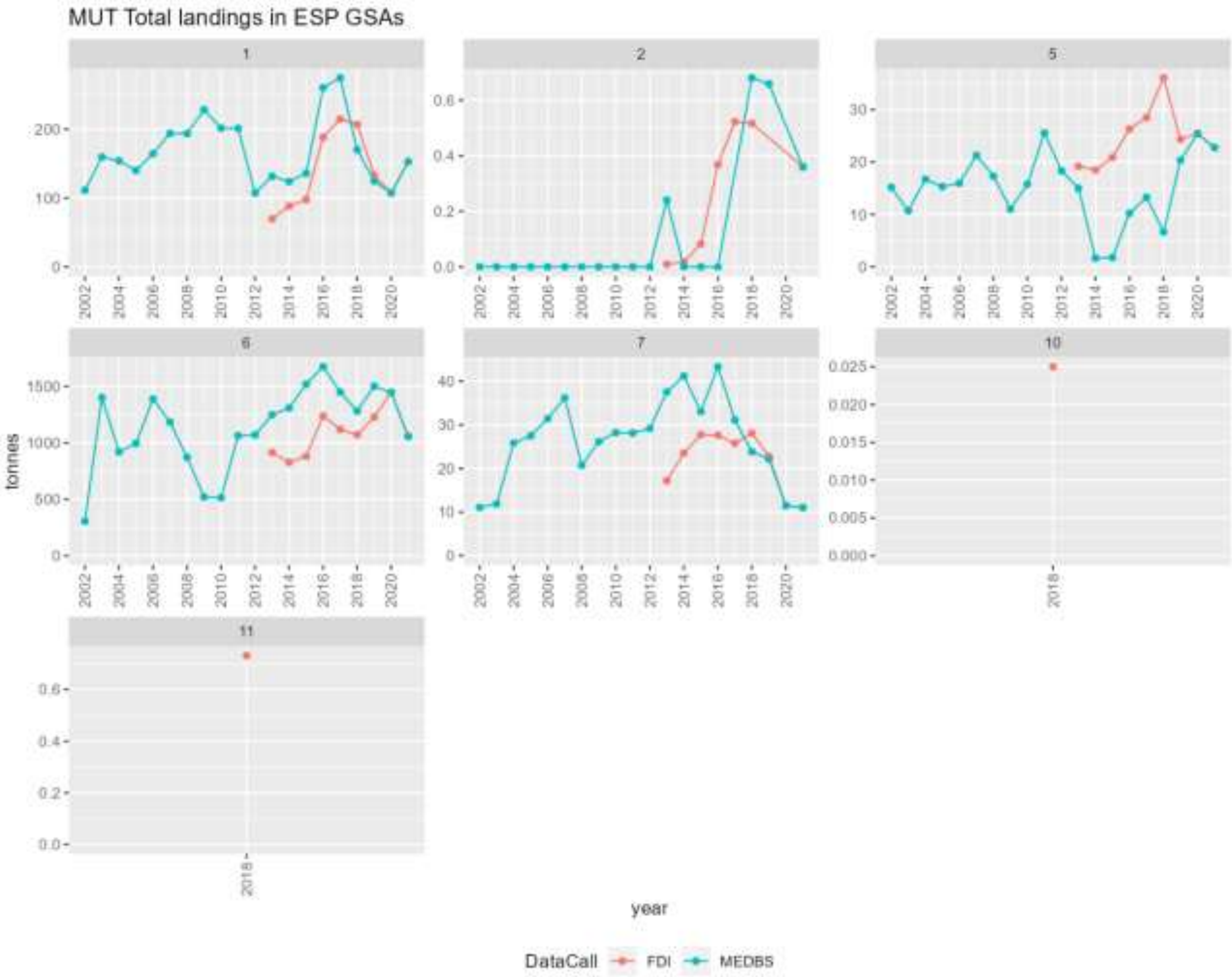


Figure 2.4.1.3.5 – MUT. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

Red mullet total landings comparison between FDI and MBS didn't show a very good matching in values in all Spanish GSAs (GSA1 Southern Spain, GSA2 Alboran Islands, GSA5 Balearic Islands, GSA6 Norther Spain and GSA7 Gulf of Lion). Some landings data have been reported also from other two Italian GSAs (GSA10 and GSA11). Only in the last 2-3 years consistency seems improved.

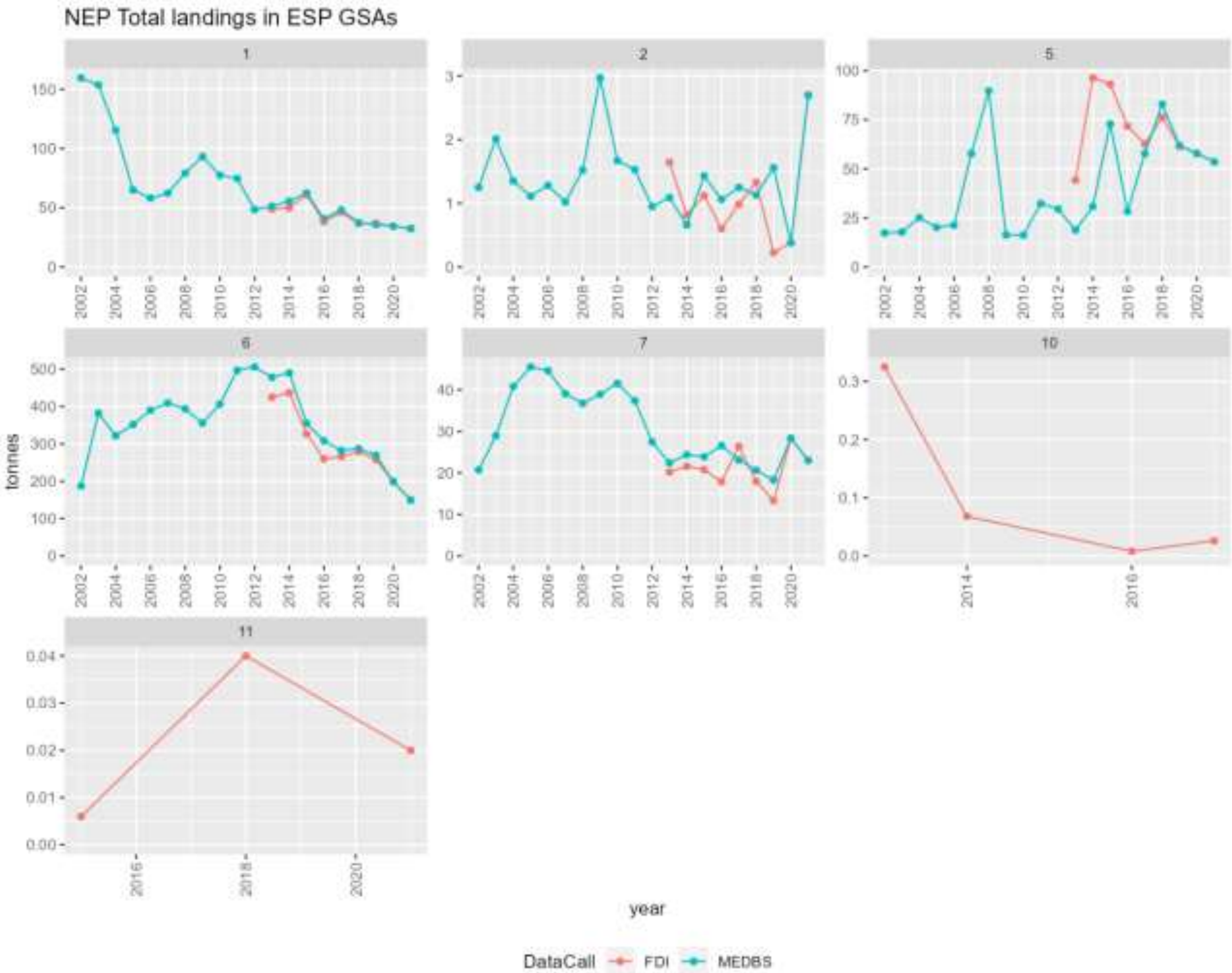


Figure 2.4.1.3.6 – NEP. Total landings comparison between MBS and FDI Data Calla for Spanish GSAs

Norway lobster total landings comparison between FDI and MBS didn't show a very good matching in values in GSA2 (Alboran Islands), in GSA5 (Balearic Islands) and GSA7 (Gulf of Lion). Some landings data have been reported also from Italian GSAs 10 (Southern Tyrrhenian Sea) and 11 (Sardinian waters). In the last years the consistency seems improved. Consistency is quite acceptable in GSA1 (Southern Spain) and GSA6 (Northern Spain).

2.4.1.4 Conclusions

Total landings in weight provided through the two EU Data Calls for which these data are mandatory have been compared at country, GSA and species level by year.

Results are quite different on a country basis.

Italian data showed a good consistency, almost perfect in GSA9 but still showing some discrepancies in GSA10 and GSA11 in 2017 and 2016 respectively. In particular, the highest landings values reported through the MEDBS datacall in GSA10 for year 2017 deserves a deep check.

France data resulted very consistent between the two data calls. Some records for two Spanish GSAs (GSA5 and GSA6) and for Italian GSA11 have been systematically reported. EWG 22-11 agreed that France needs to check if, even if concerning low landings values, these data are allocated to the right GSA. It is remarkable that for giant red shrimp (ARS) no landings have been reported while for the blue and red shrimp (ARA) very spared values have been provided along the years. It is not clear for the EWG 22-11 if these two species are basically not a target of the fishery activities in the areas or instead the very low or zero landings recorded are due to a DCF sample design not so appropriate for these two species.

Spain evaluation resulted the worst of the three countries. Indeed, many inconsistencies have been spotted. Moreover, some records for two Italian GSAs (GSA10 and GSA11) have been systematically reported. EWG 22-11 agreed that Spain needs to check if, even if concerning low landings values, these data are allocated to the right GSA and, as general suggest as a deep cross check between the procedures in providing data for the two data calls is needed. Finally, as in the case of France for both red shrimps species it is not clear if the spare landings reported for giant red shrimp are due to the fact that this species is basically not a target of the fishery activities in the areas or, rather due to a DCF sample design not so appropriate in collecting data for this species.

The complete set of data, R scripts and plots can be found in Annex II.

2.4.2 Fishing days and days at sea quarter activity for the main gears

The DCF Fisheries Dependent Information (FDI) data call provides effort at disaggregated level. Even though Member States are responsible for providing checked and validated data, some errors in the datasets can be expected.

In particular, the EWG 22-11 checked the consistency between some effort measures regarding days at sea and fishing days reported in the FDI Table G. In detail, Table G reports data on the following variables: *totseadays, totfishdays, totkwdaysatsea, totgtdaysatsea, totkwfishdays, totgtfishdays, hrsea, kwhrsea, gthrsea* and *totves*.

The check consisted in verifying that the average number of days at sea per vessel (*totseadys/totves*) by quarter and the average number of fishing days per vessel (*totfishdays/totves*) by quarter were not higher than the maximum number of days in a quarter. Two reference levels were defined: the total number of days in each quarter, approximated to 90 days for all quarters, and the same threshold minus the number of Saturdays and Sundays in the quarter, approximated to 64 days for all quarters. A value higher than the first threshold level can be considered as an error, while a value higher than the second one could be a potential error. Although the checks have been carried out for all the country/gsa/gear/quarter/Vessel Length combinations available in the dataset, the EWG 22-11 agreed in adding in the section report only the figures (2.4.2.1.1-2.4.2.3.10) concerning the main gears (OTB, OTT, GTR, GNS and LLS). All the plots, resulting csv files and R scripts used in running the analysis have been attached as electronic annex to this report (Annex III).

2.4.2.1 Italy

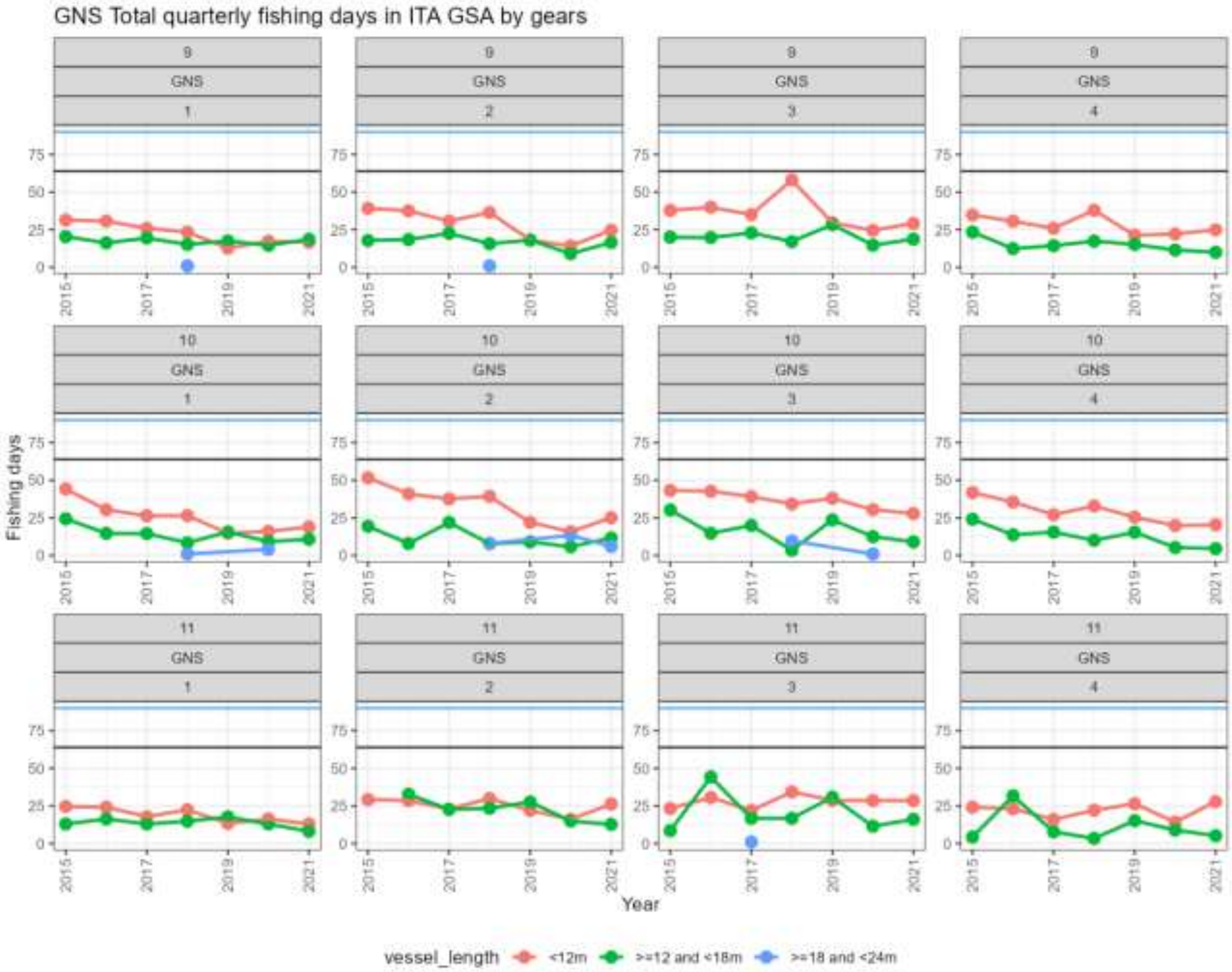


Figure 2.4.2.1.1 – Quarterly activity in fishing days of the gill-netters (GNS) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

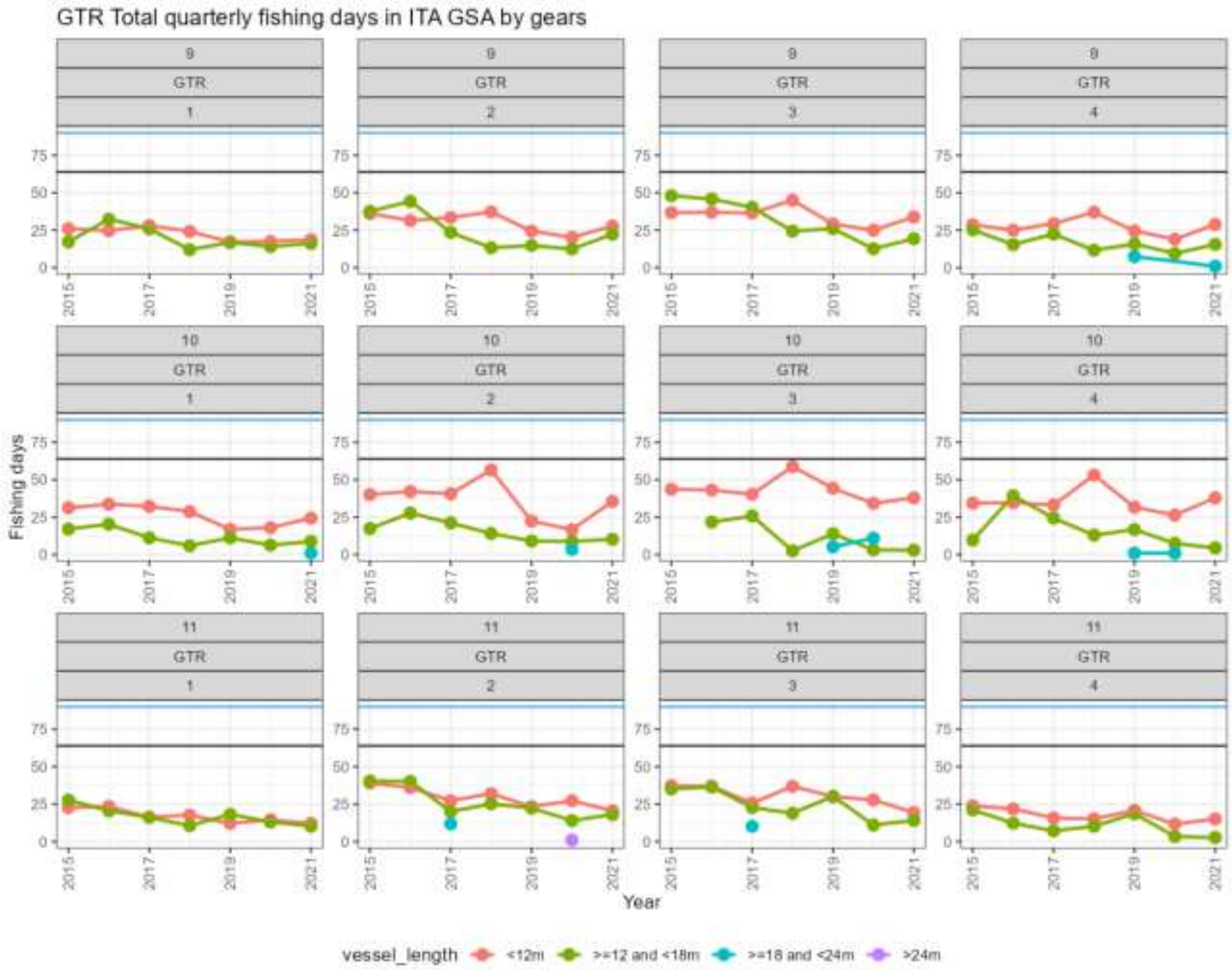


Figure 2.4.2.1.2 – Quarterly activity in fishing days of the trammel-netters (GTR) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

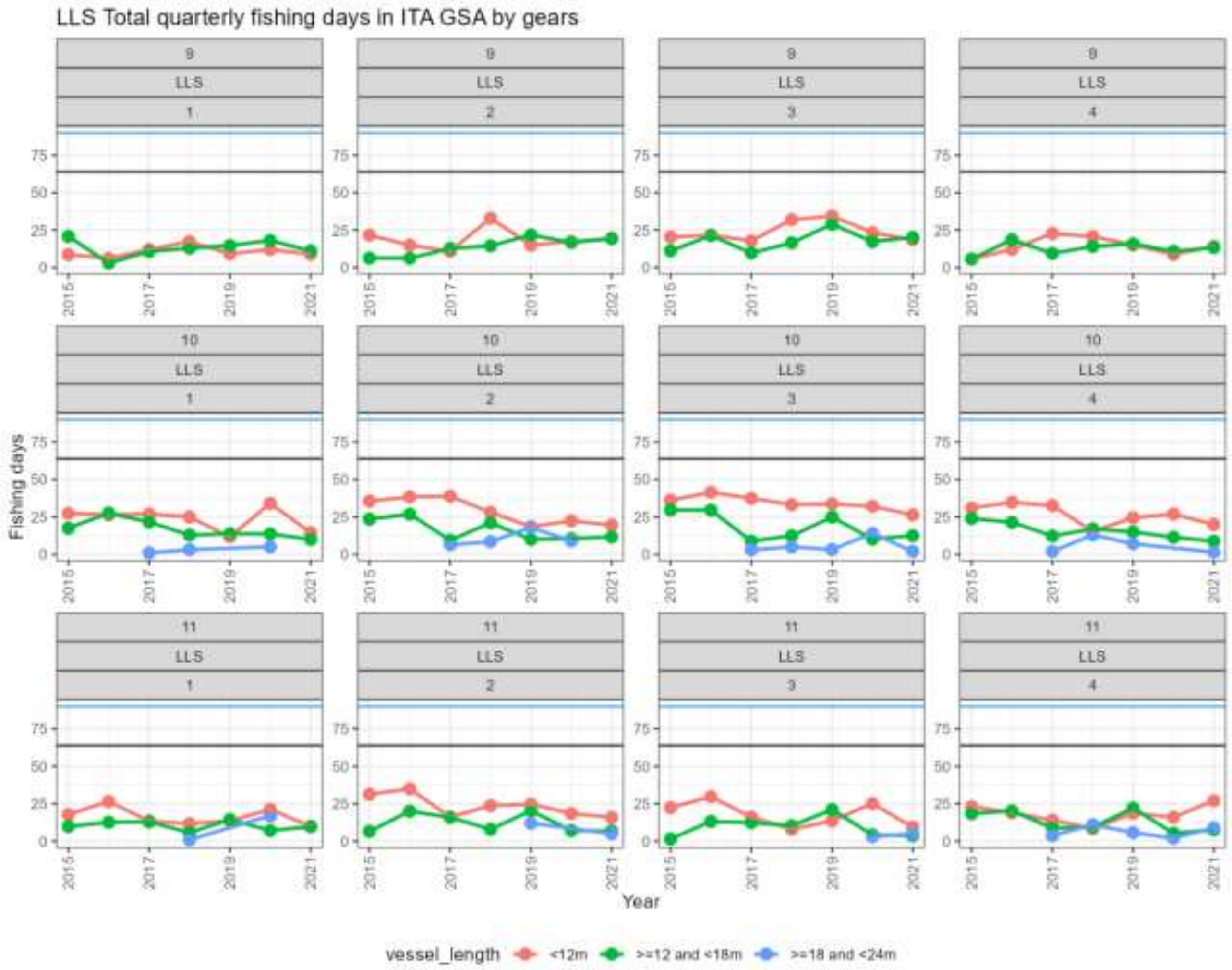


Figure 2.4.2.1.3 – Quarterly activity in fishing days of the set long liners (LLS) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

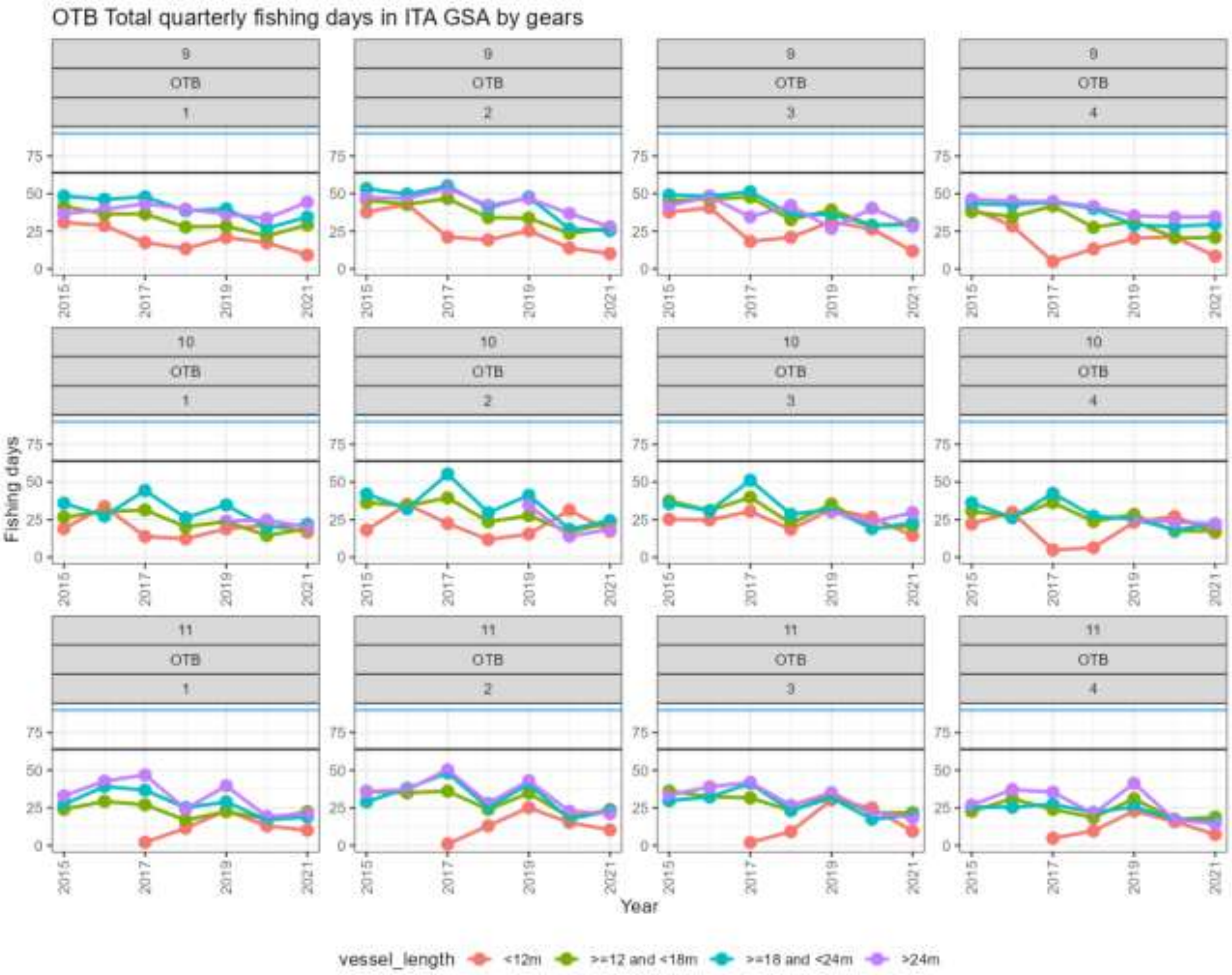


Figure 2.4.2.1.4 – Quarterly activity in fishing days of the bottom otter trawlers (OTB) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

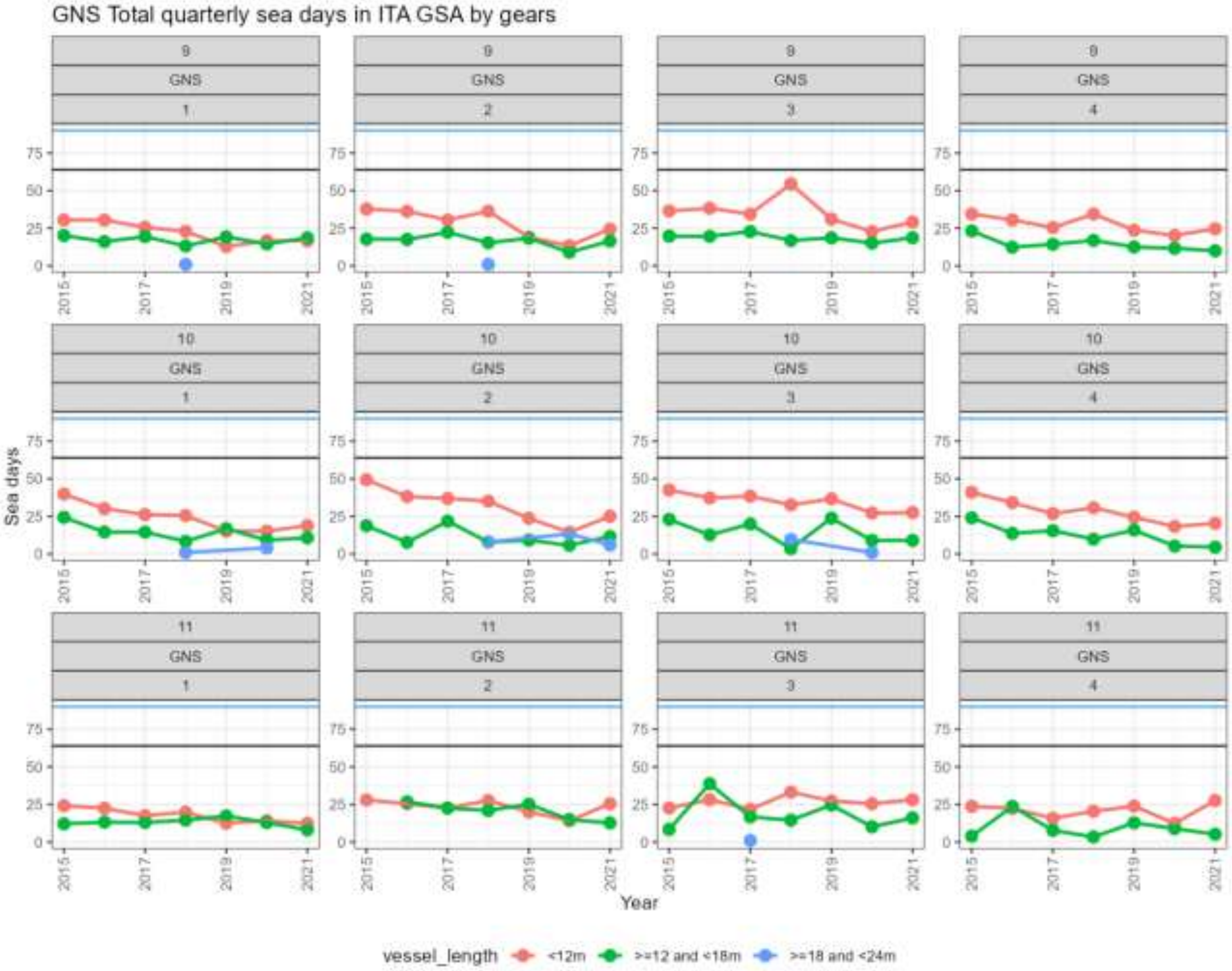


Figure 2.4.2.1.5 – Quarterly activity in days at sea of the gill-netters (GNS) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

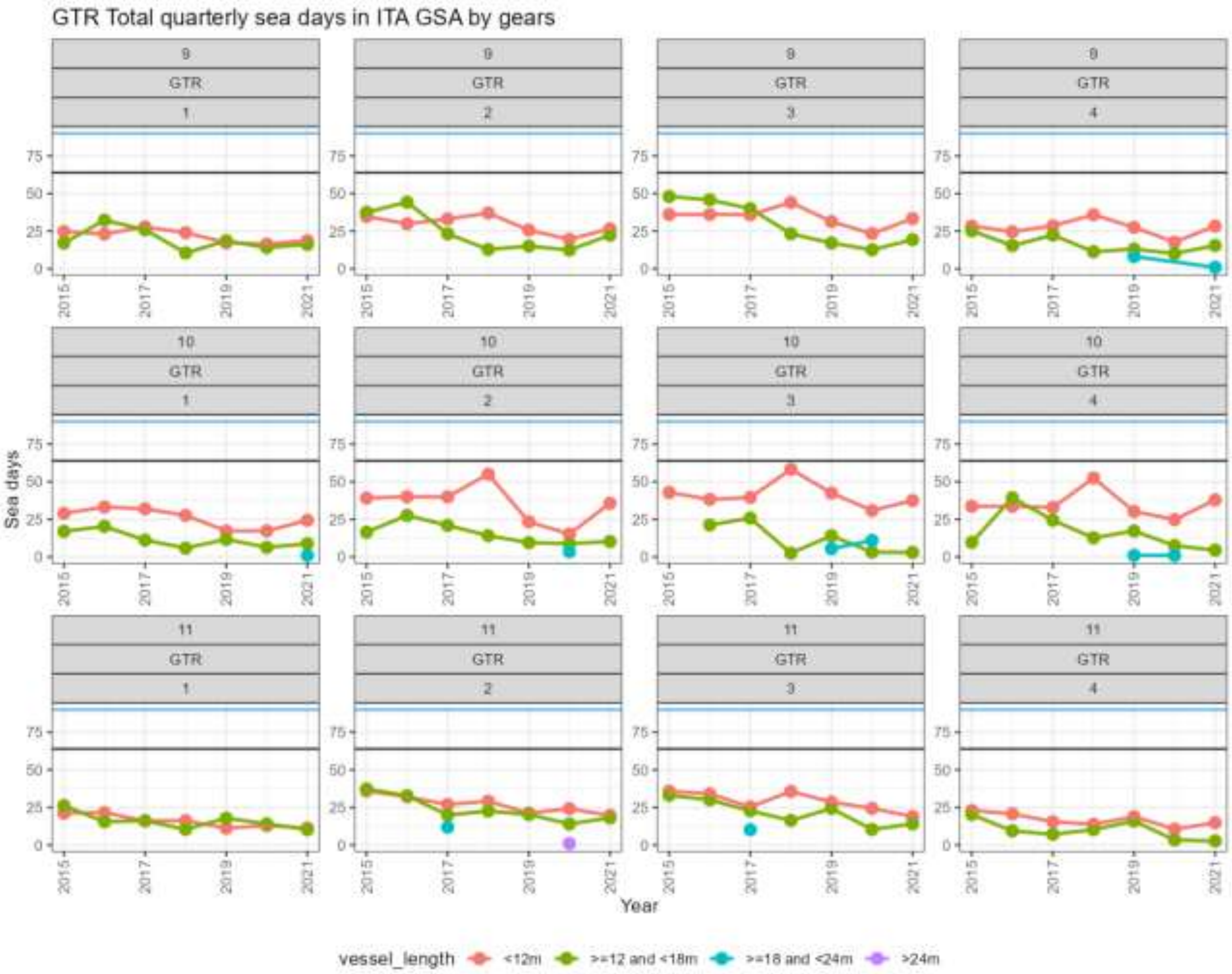


Figure 2.4.2.1.6 – Quarterly activity in days at sea of the trammel-netters (GNS) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

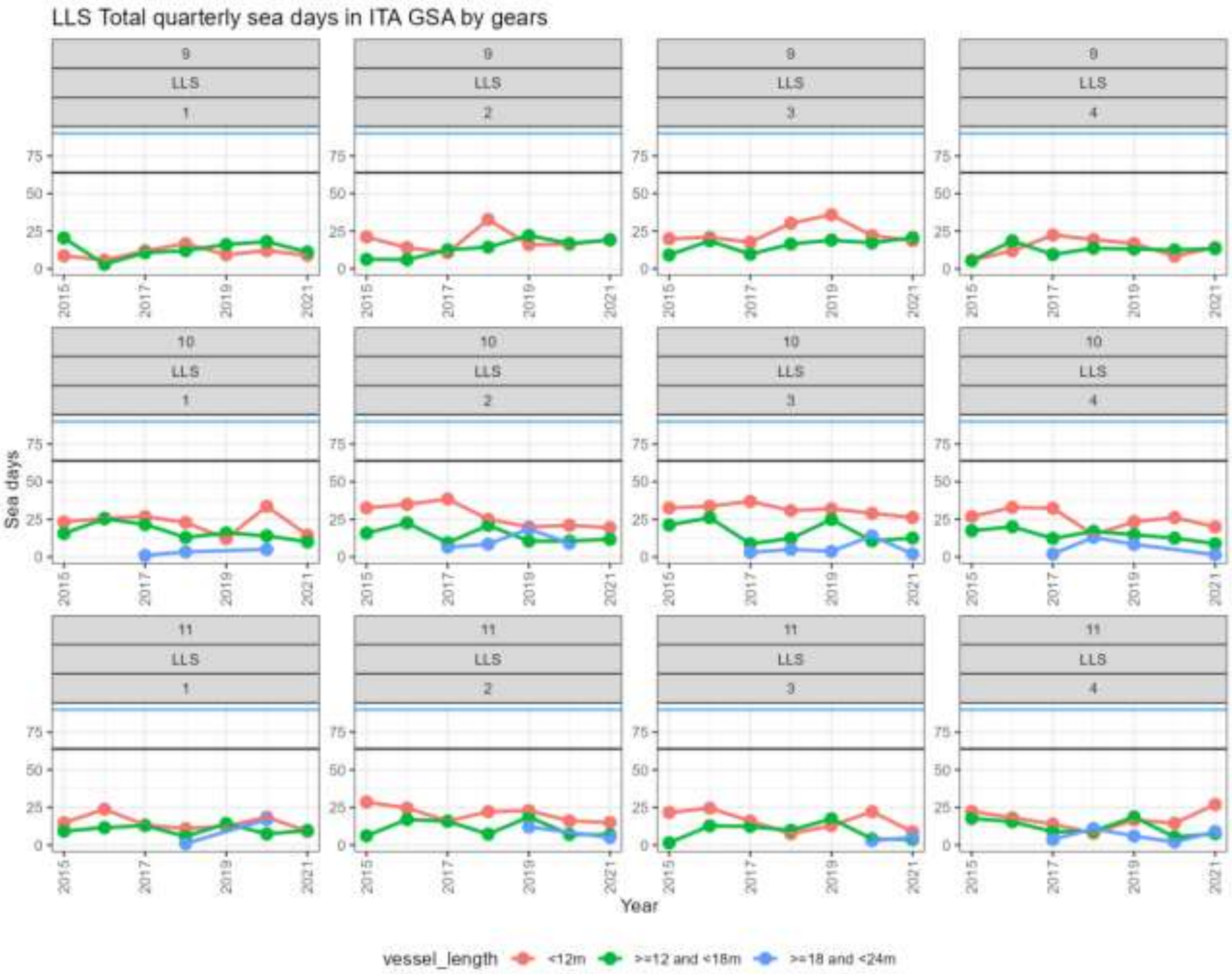


Figure 2.4.2.1.7 – Quarterly activity in days at sea of the set long liners (LLS) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

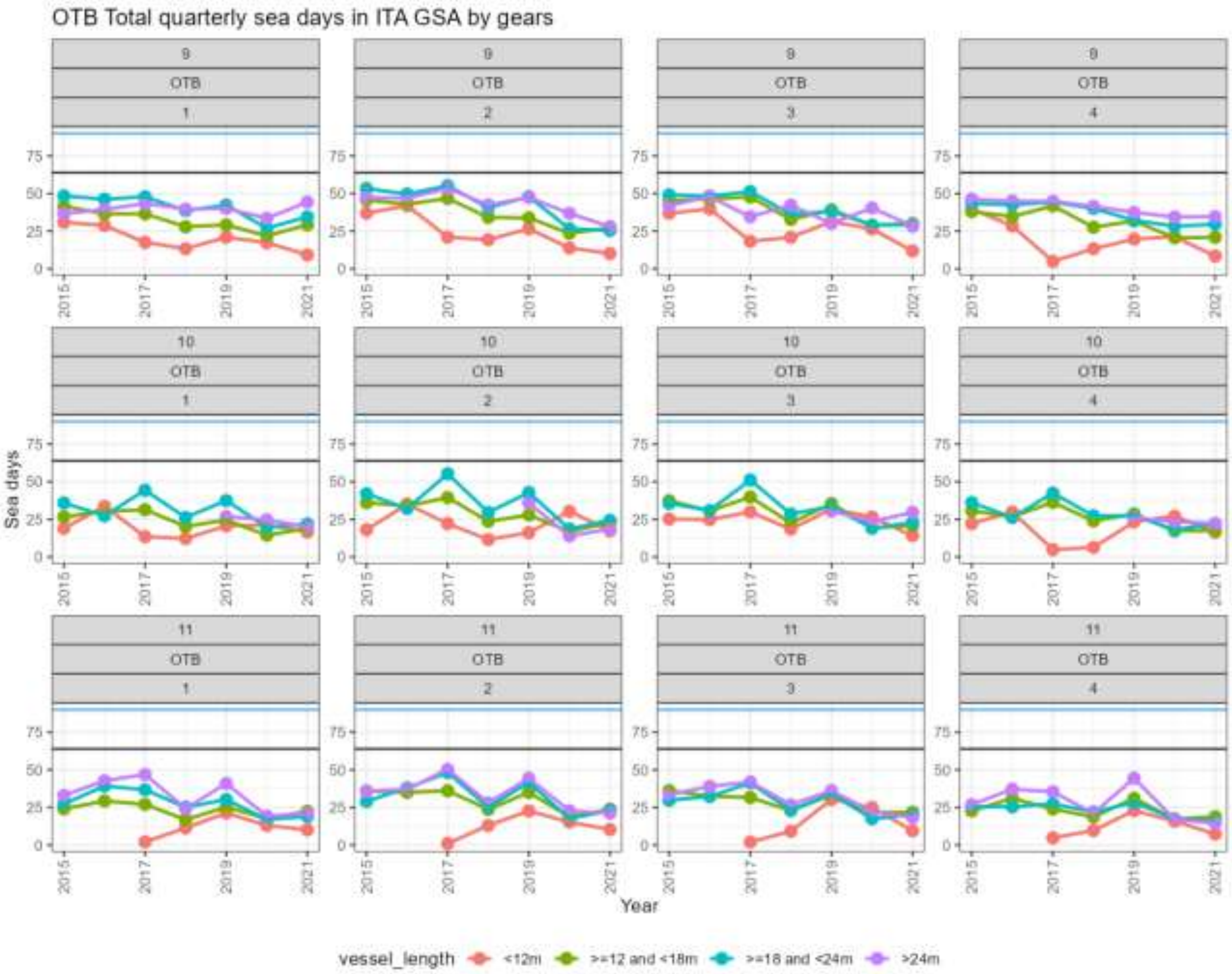


Figure 2.4.2.1.8 – Quarterly activity in days at sea of the bottom otter trawlers (OTB) in Italian GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

2.4.2.2 France

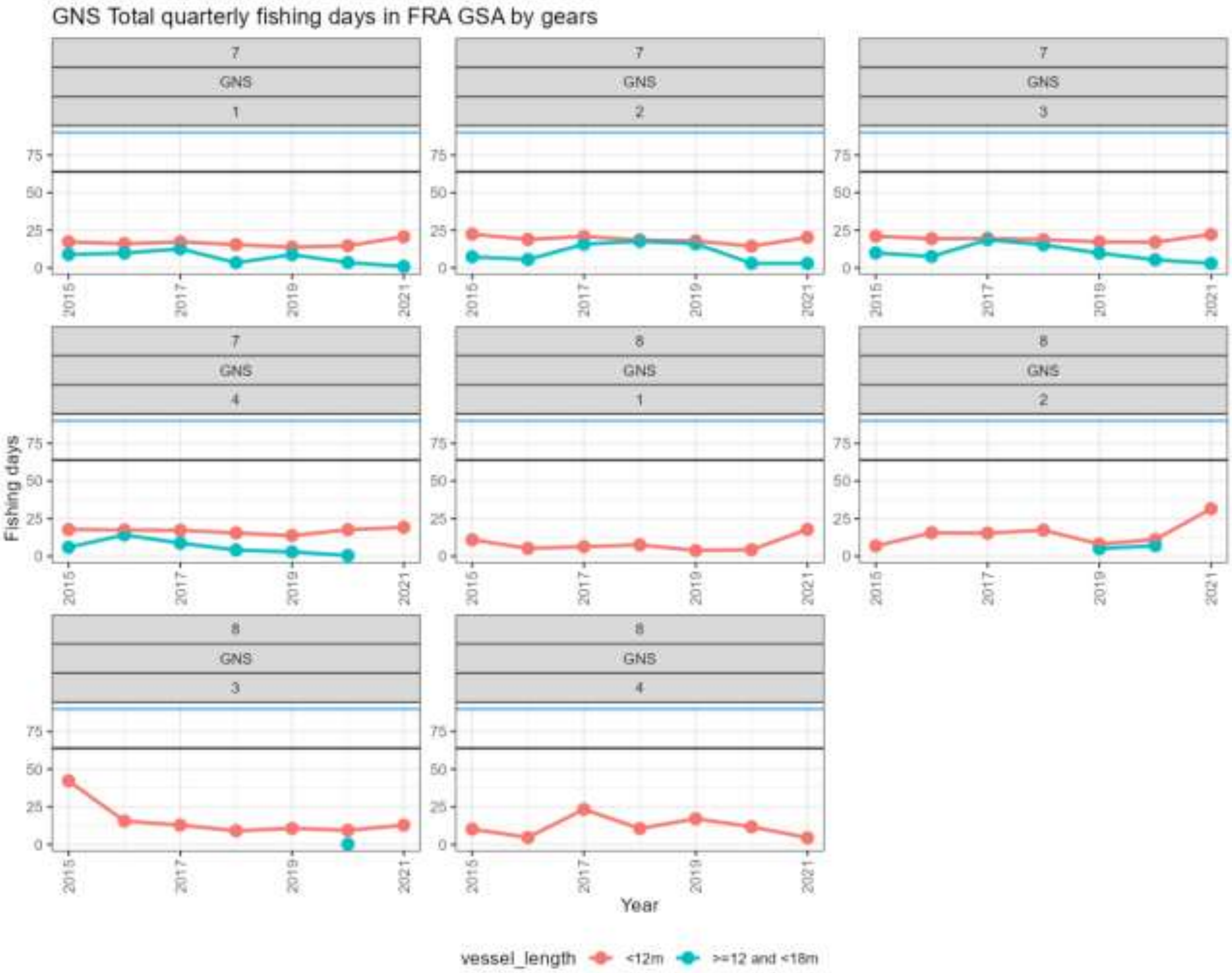


Figure 2.4.2.2.1 – Quarterly activity in fishing days of the gill-netters (GNS) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

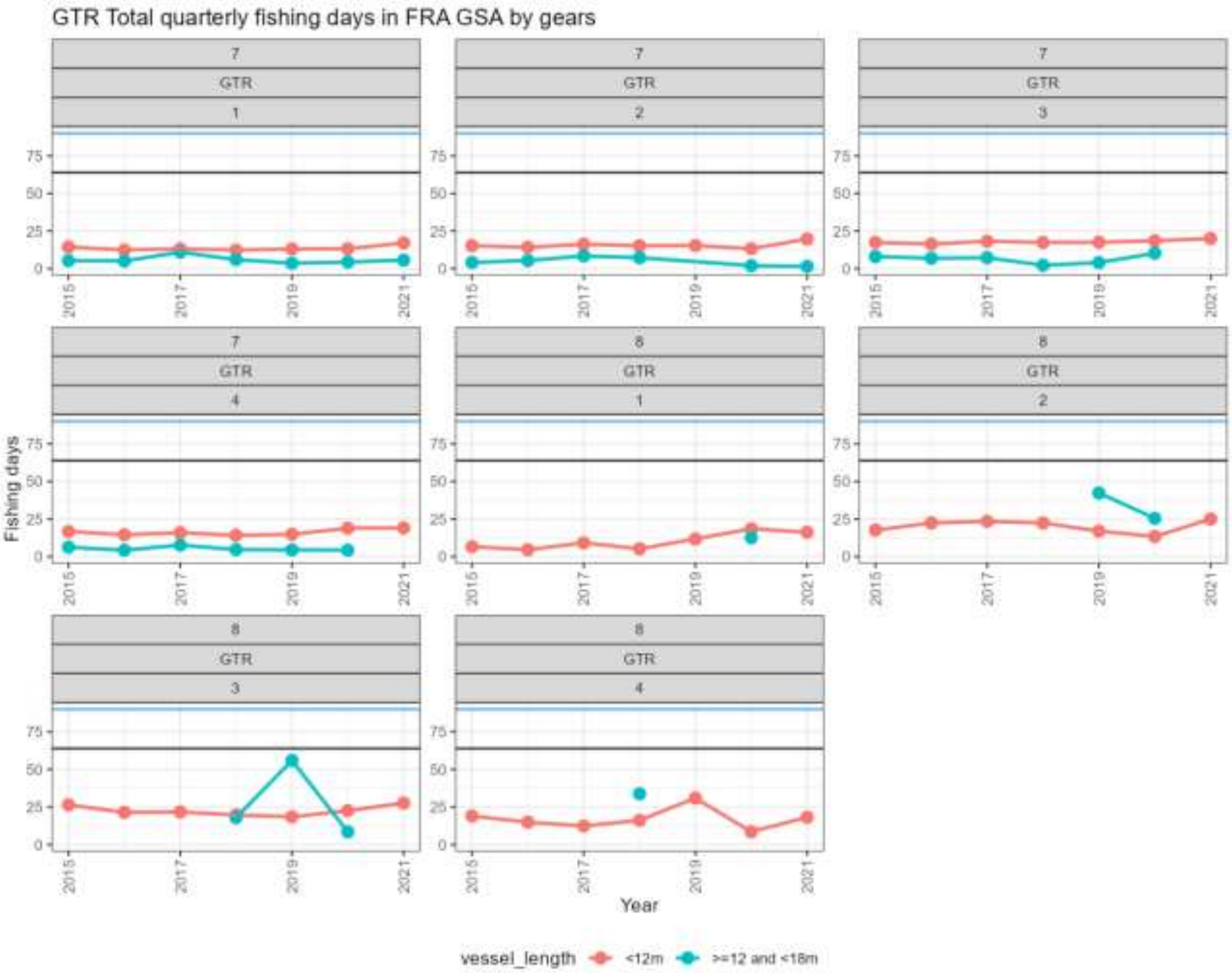


Figure 2.4.2.2.2 – Quarterly activity in fishing days of the trammel-netters (GTR) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

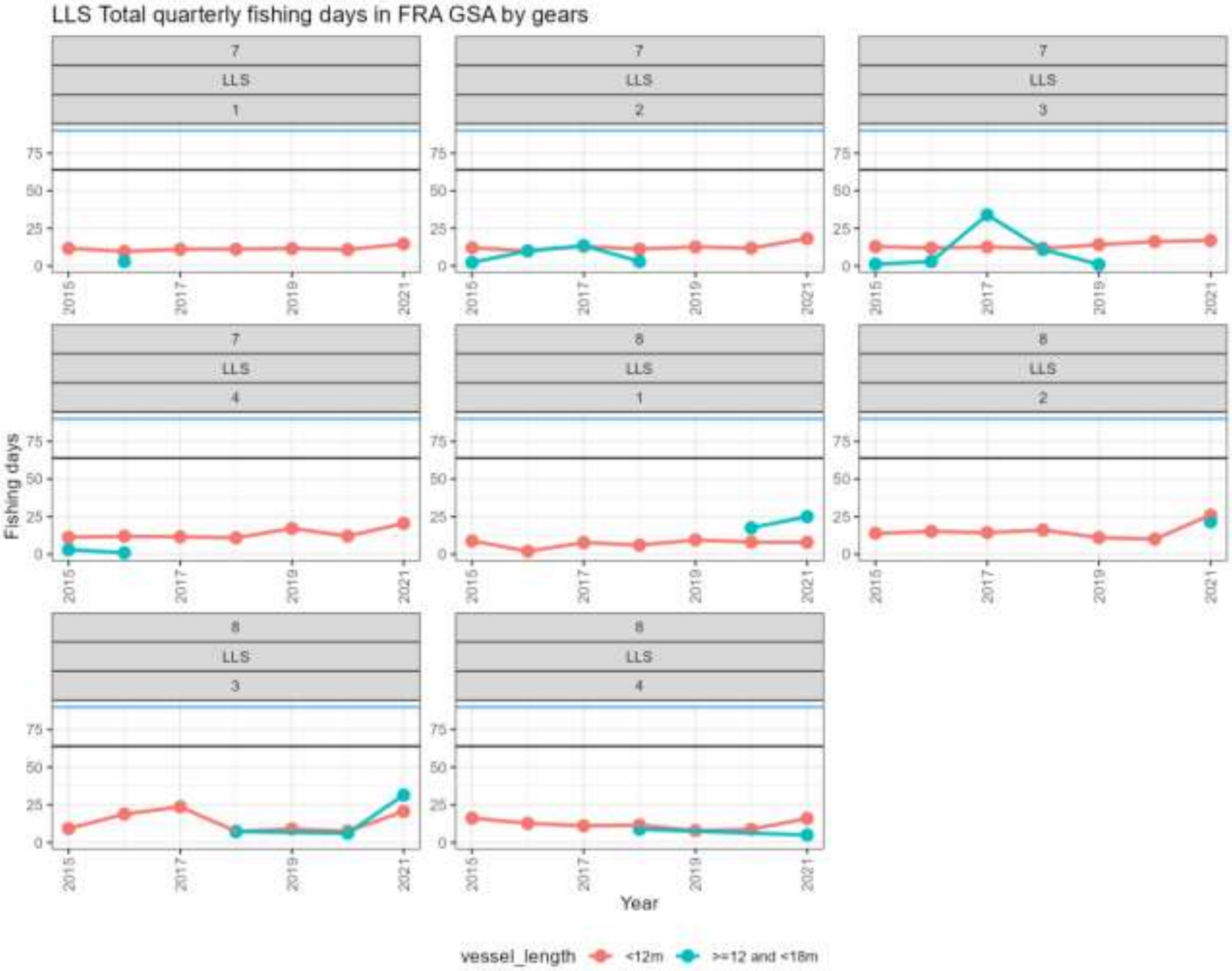


Figure 2.4.2.2.3 – Quarterly activity in fishing days of the set long liners (LLS) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

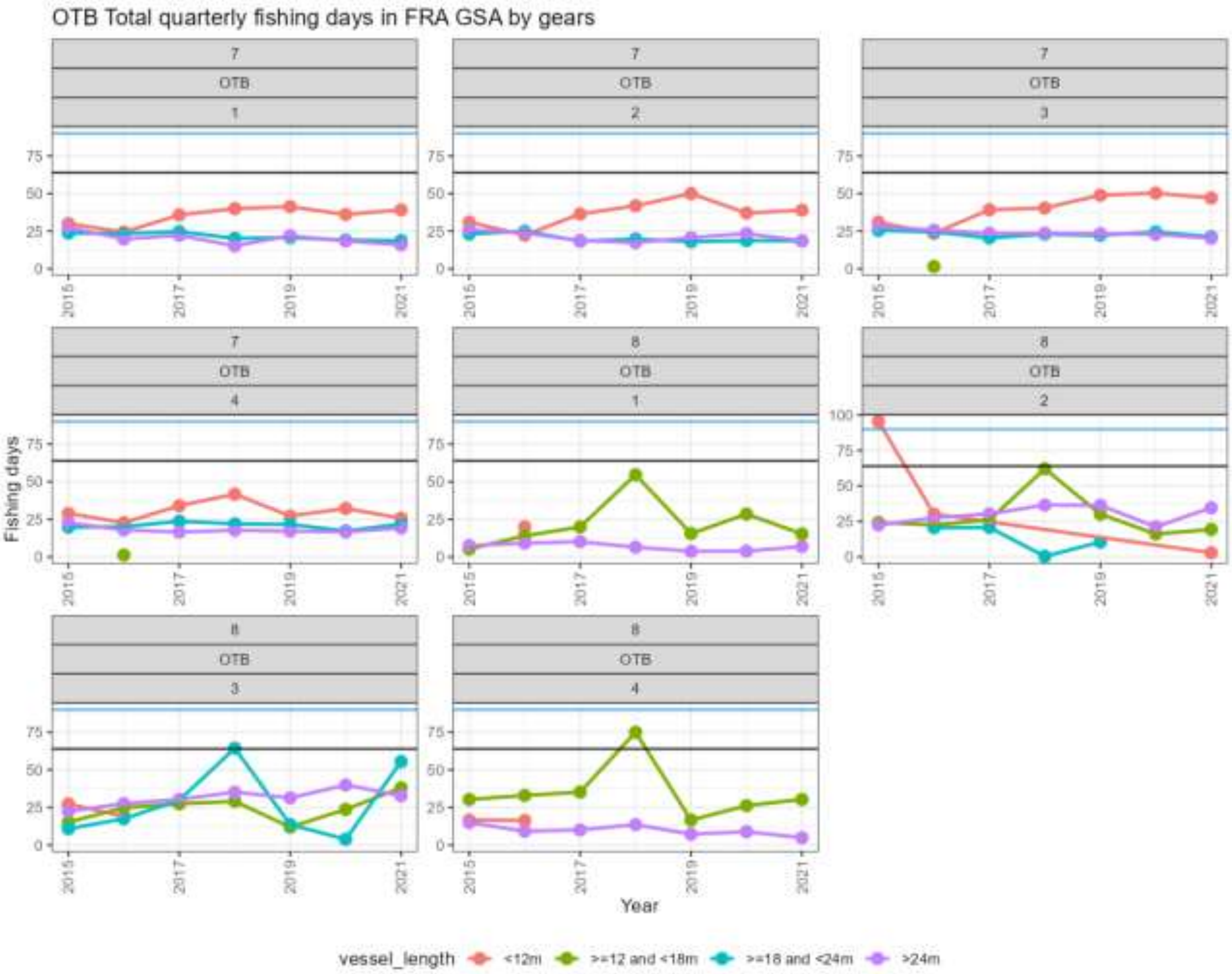


Figure 2.4.2.2.4 – Quarterly activity in fishing days of the bottom otter trawlers (OTB) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

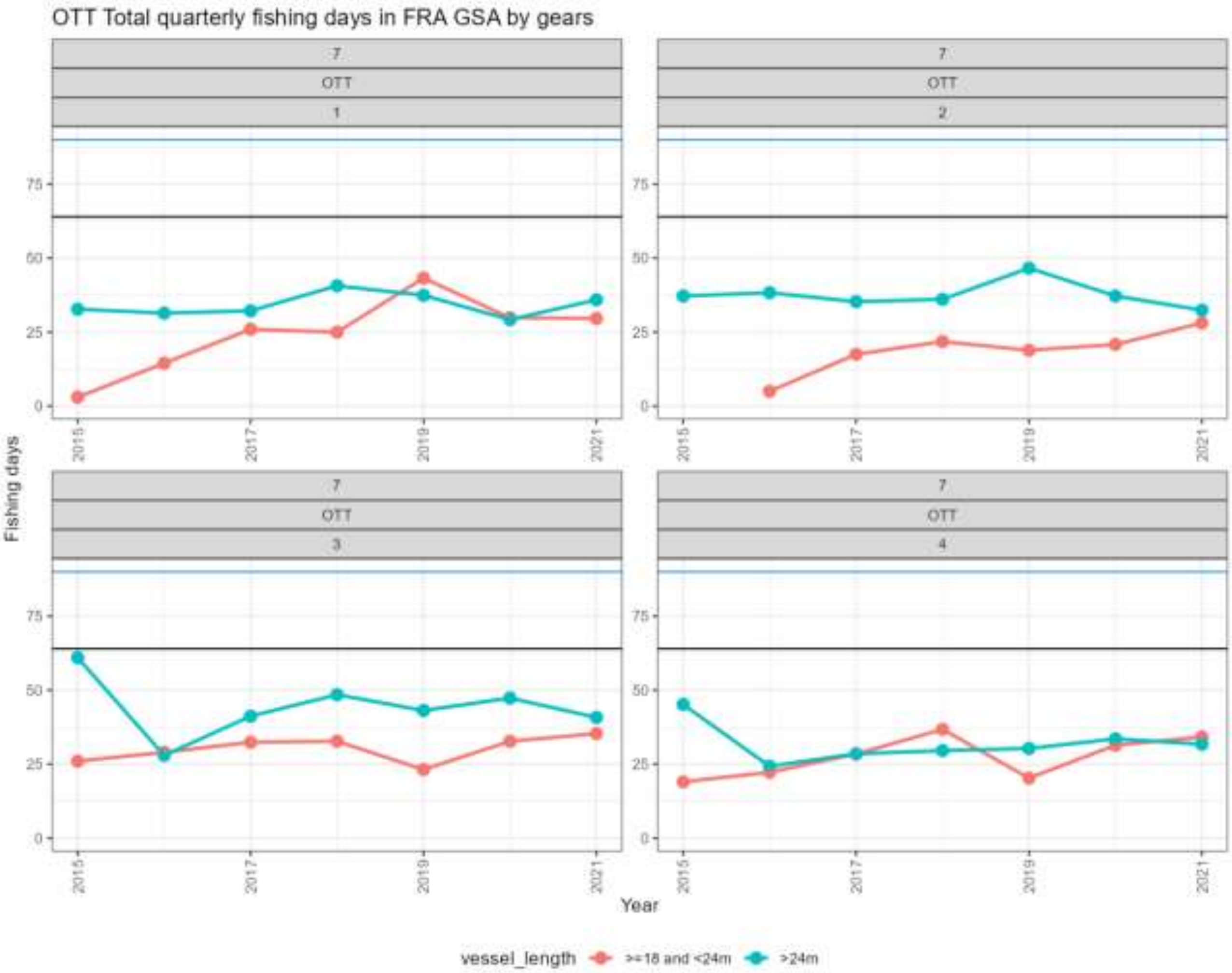


Figure 2.4.2.2.5 – Quarterly activity in fishing days of the twin otter trawlers (OTT) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

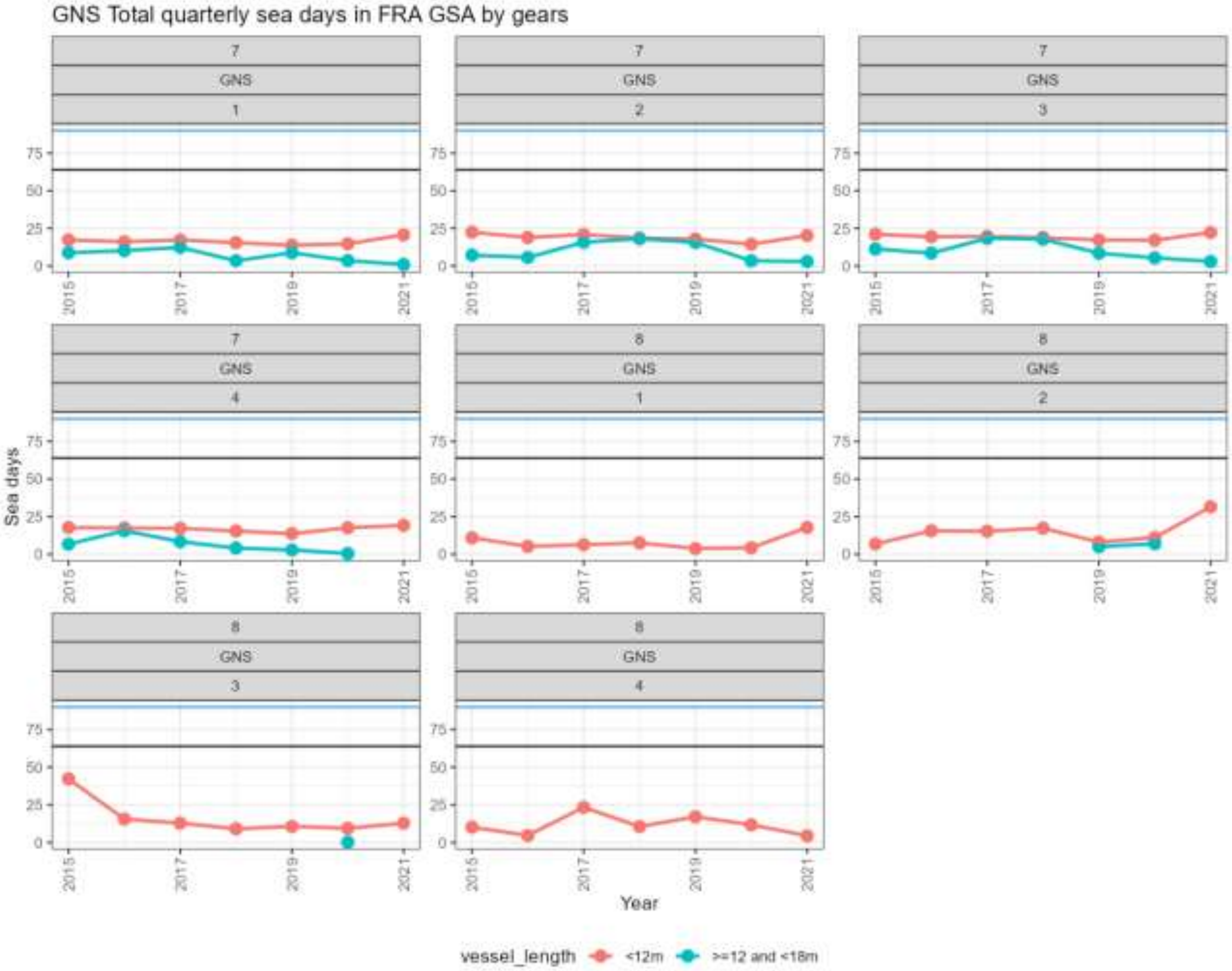


Figure 2.4.2.2.6 – Quarterly activity in days at sea of the gill-netters (GNS) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

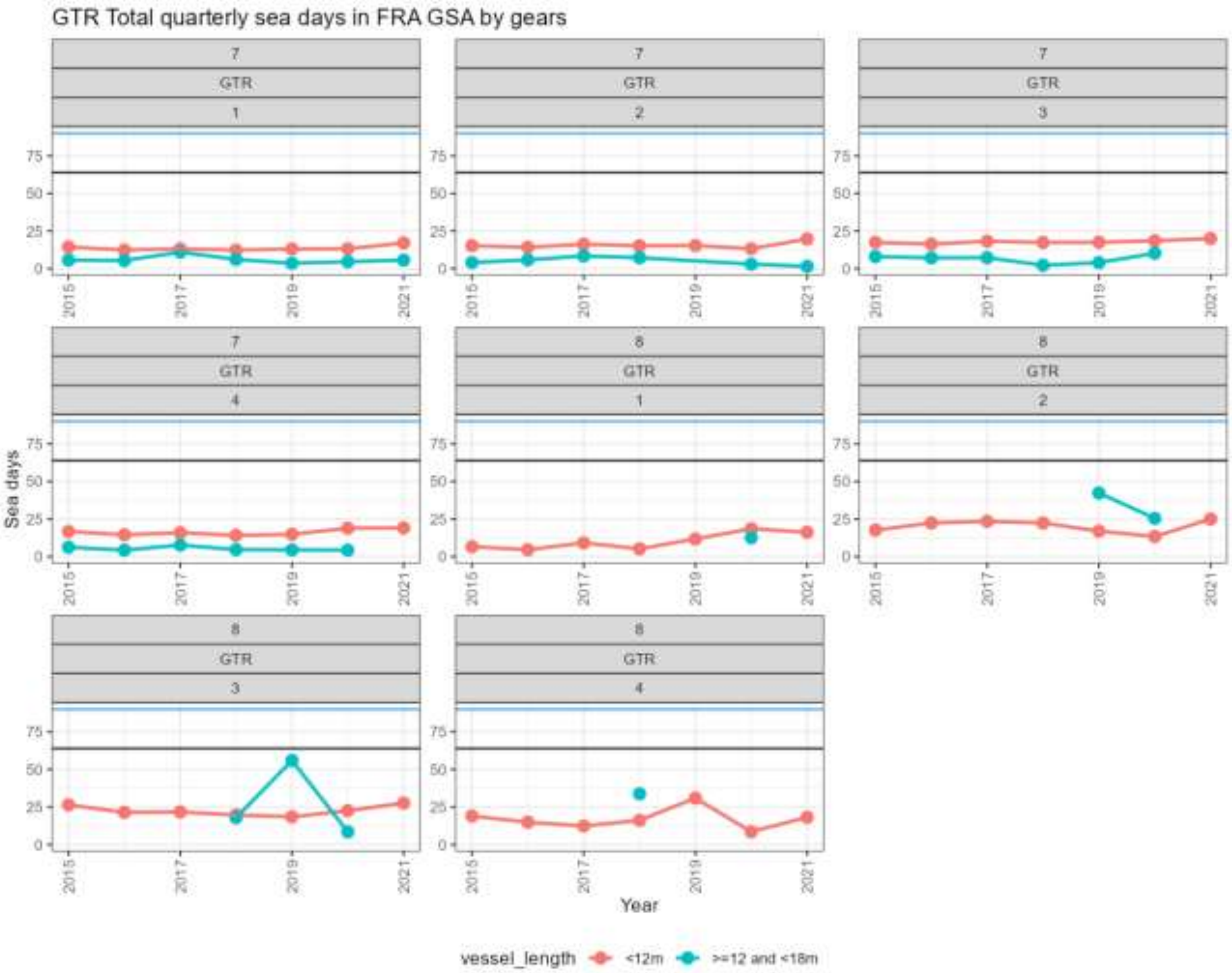


Figure 2.4.2.2.7 – Quarterly activity in days at sea of the trammel-netters (GNS) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

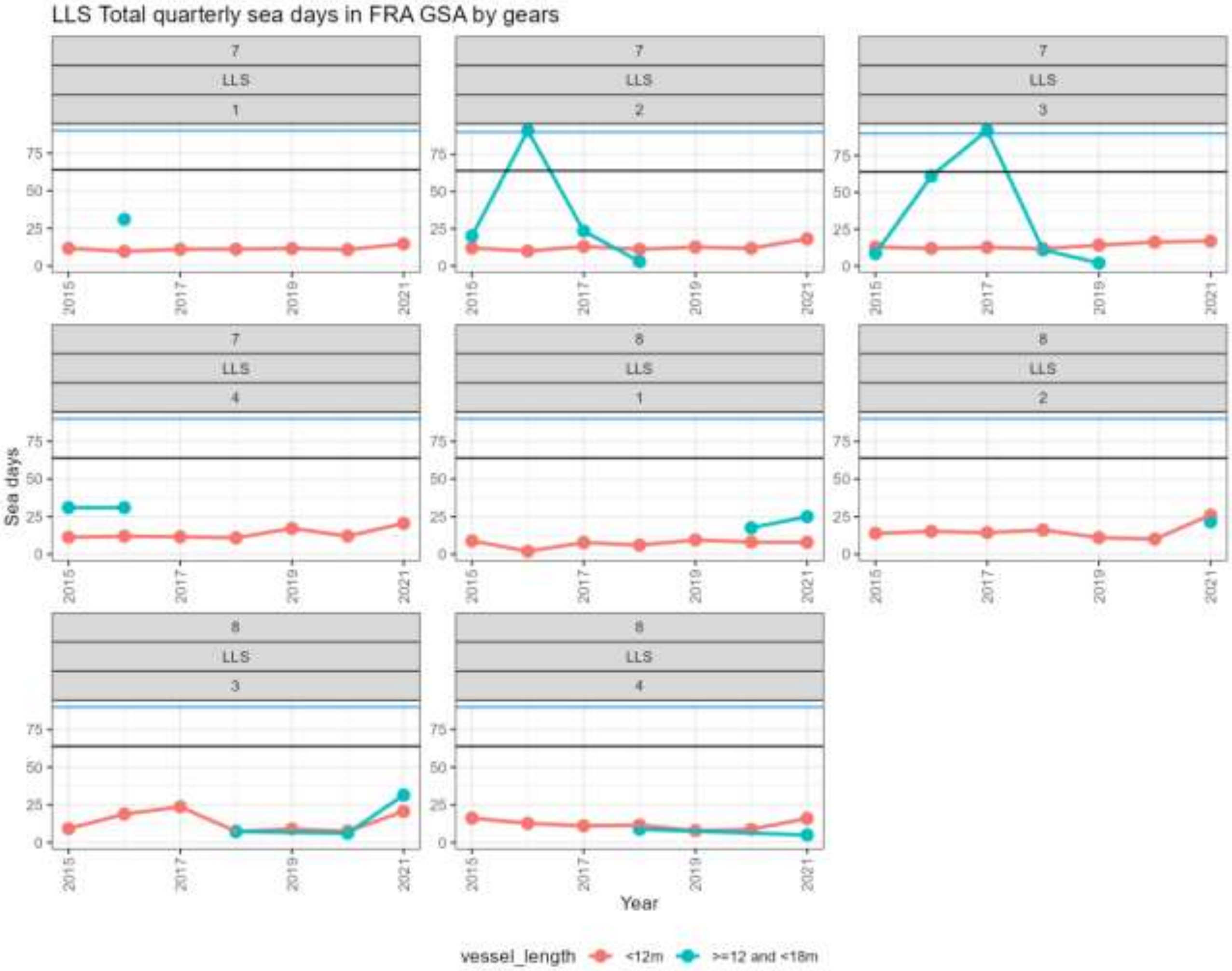


Figure 2.4.2.2.8 – Quarterly activity in days at sea of the set long liners (LLS) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

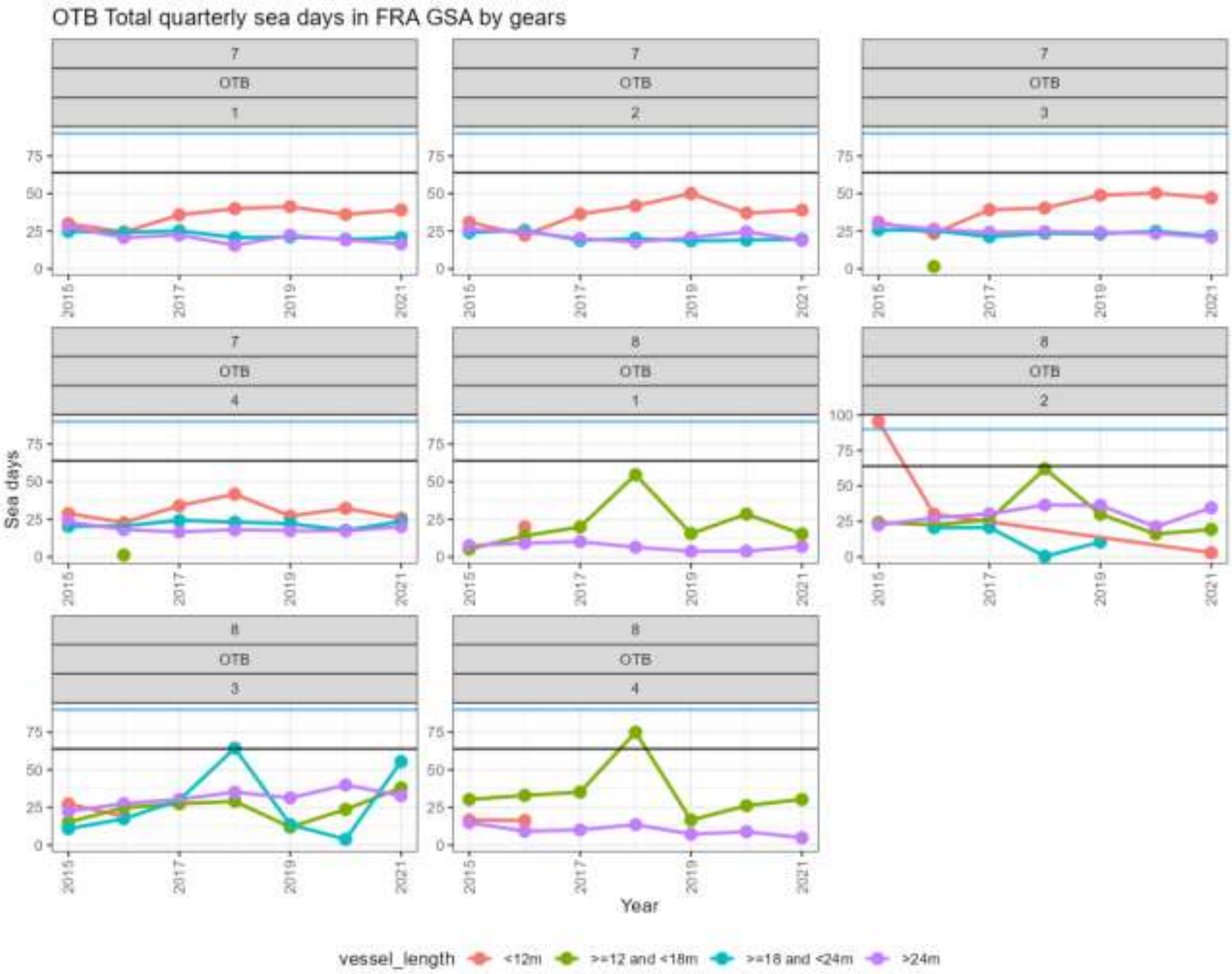


Figure 2.4.2.2.9 – Quarterly activity in days at sea of the bottom otter trawlers (OTB) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

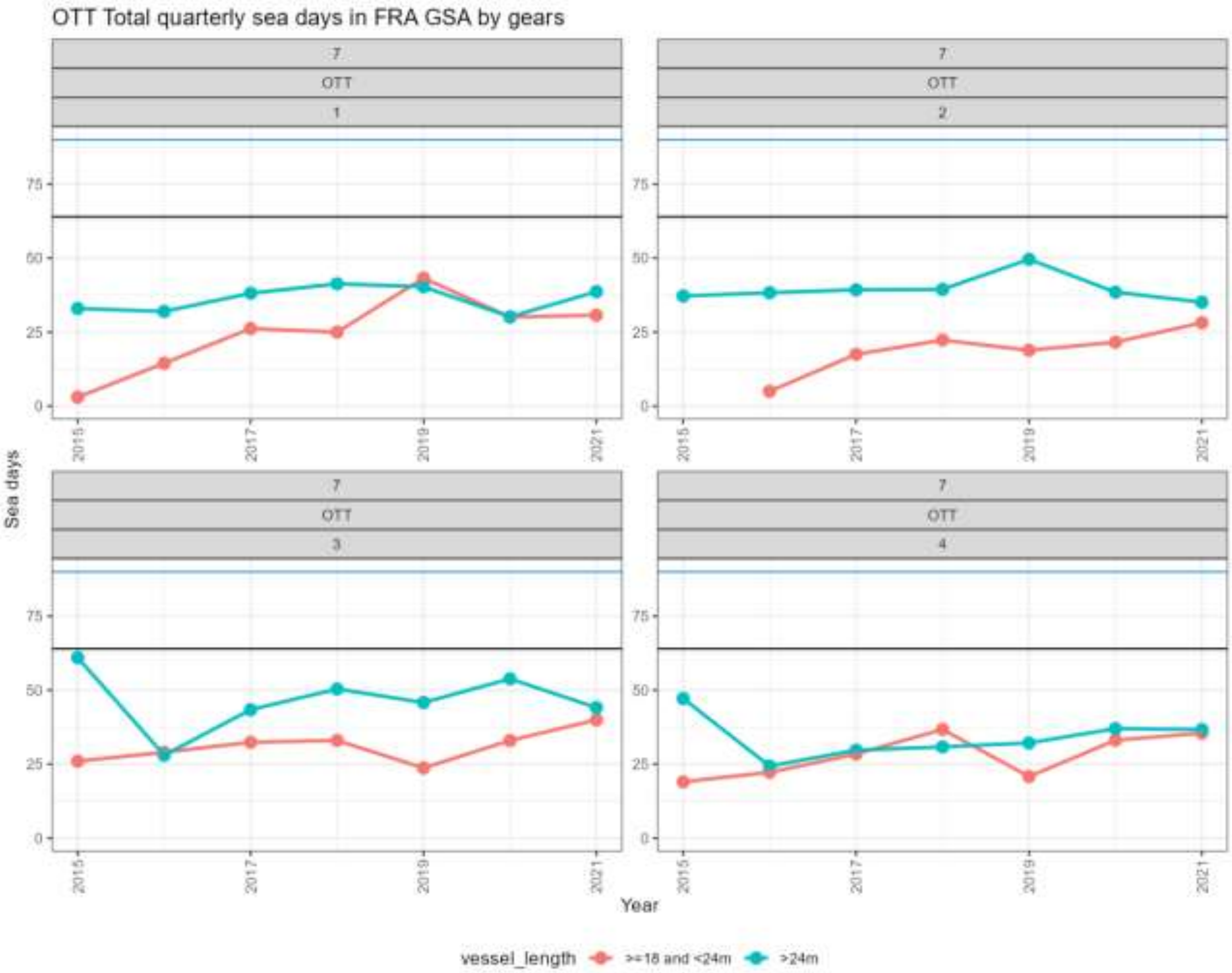


Figure 2.4.2.2.10 – Quarterly activity in days at sea of the twin otter trawlers (OTT) in French GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

2.4.2.3 Spain

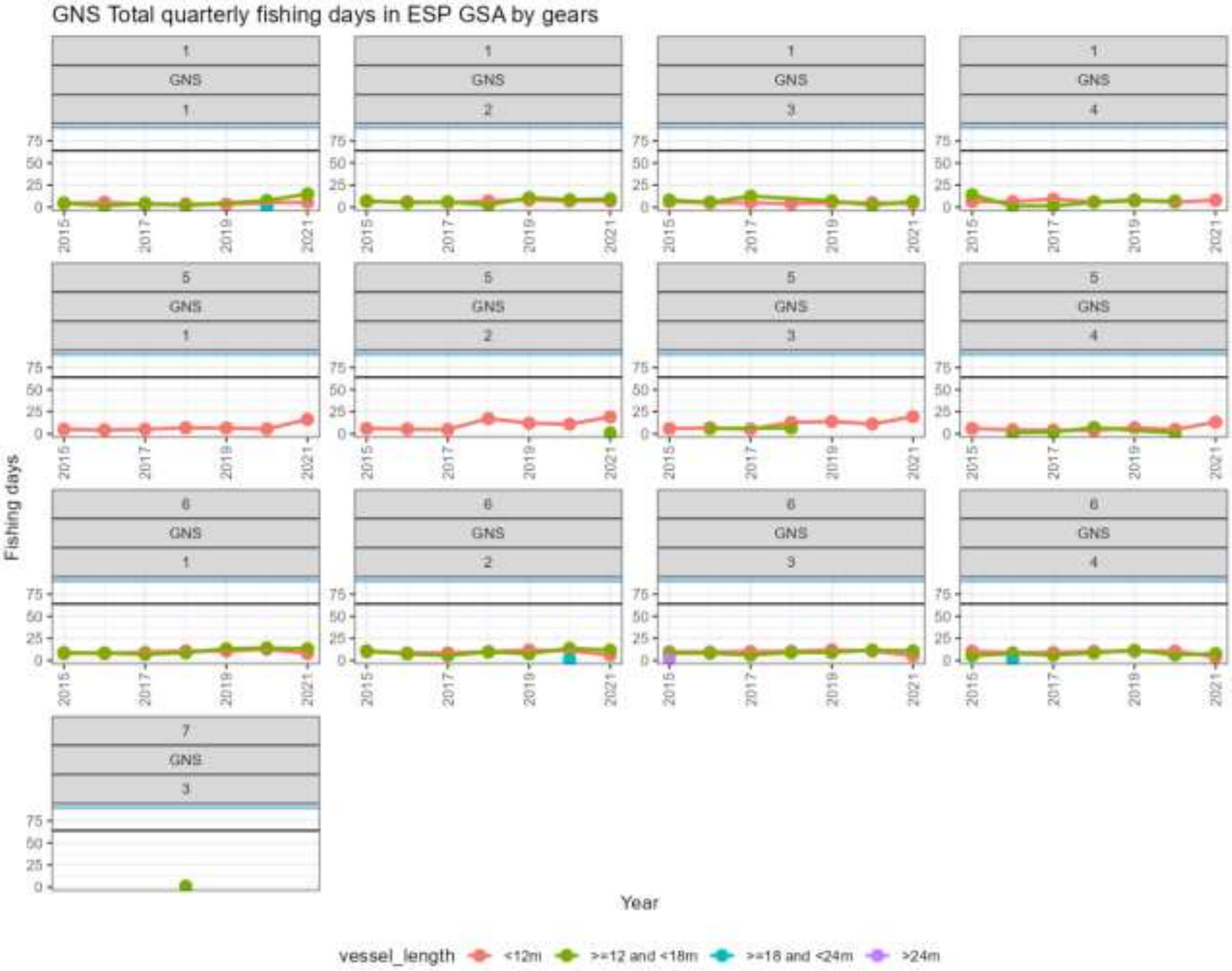


Figure 2.4.2.3.1 – Quarterly activity in fishing days of the gill-netters (GNS) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

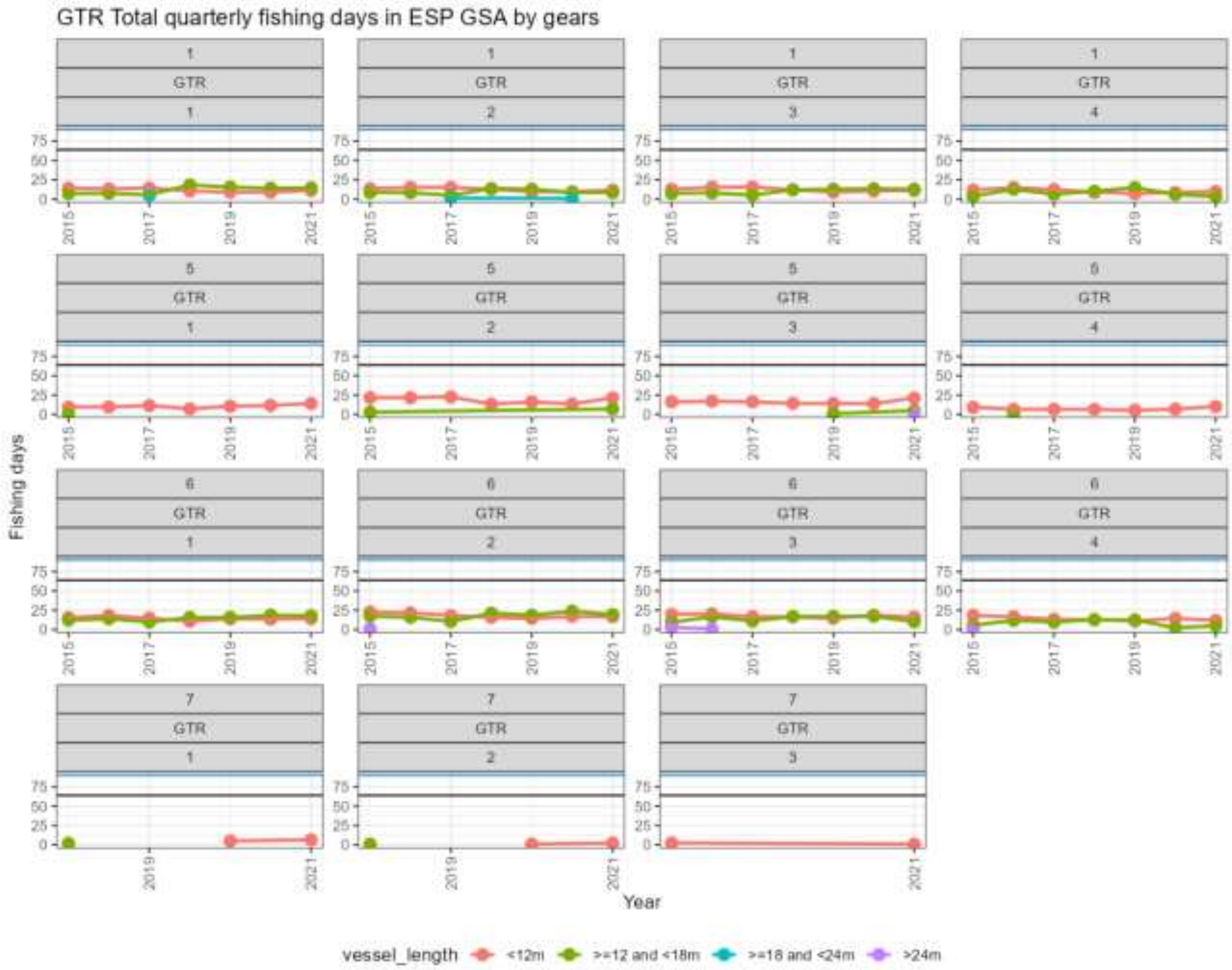


Figure 2.4.2.3.2 – Quarterly activity in fishing days of the trammel-netters (GTR) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

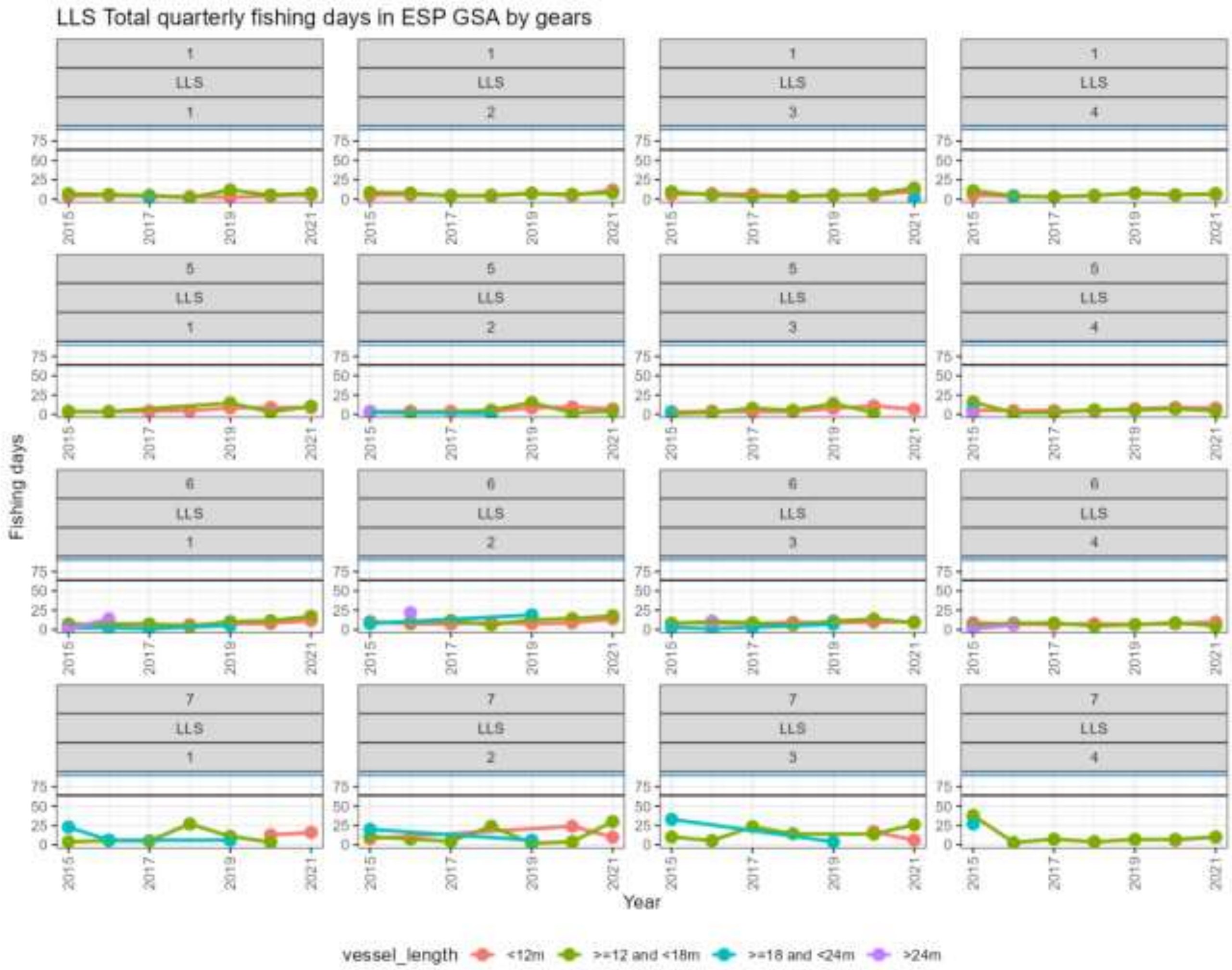


Figure 2.4.2.3.3 – Quarterly activity in fishing days of the set long liners (LLS) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

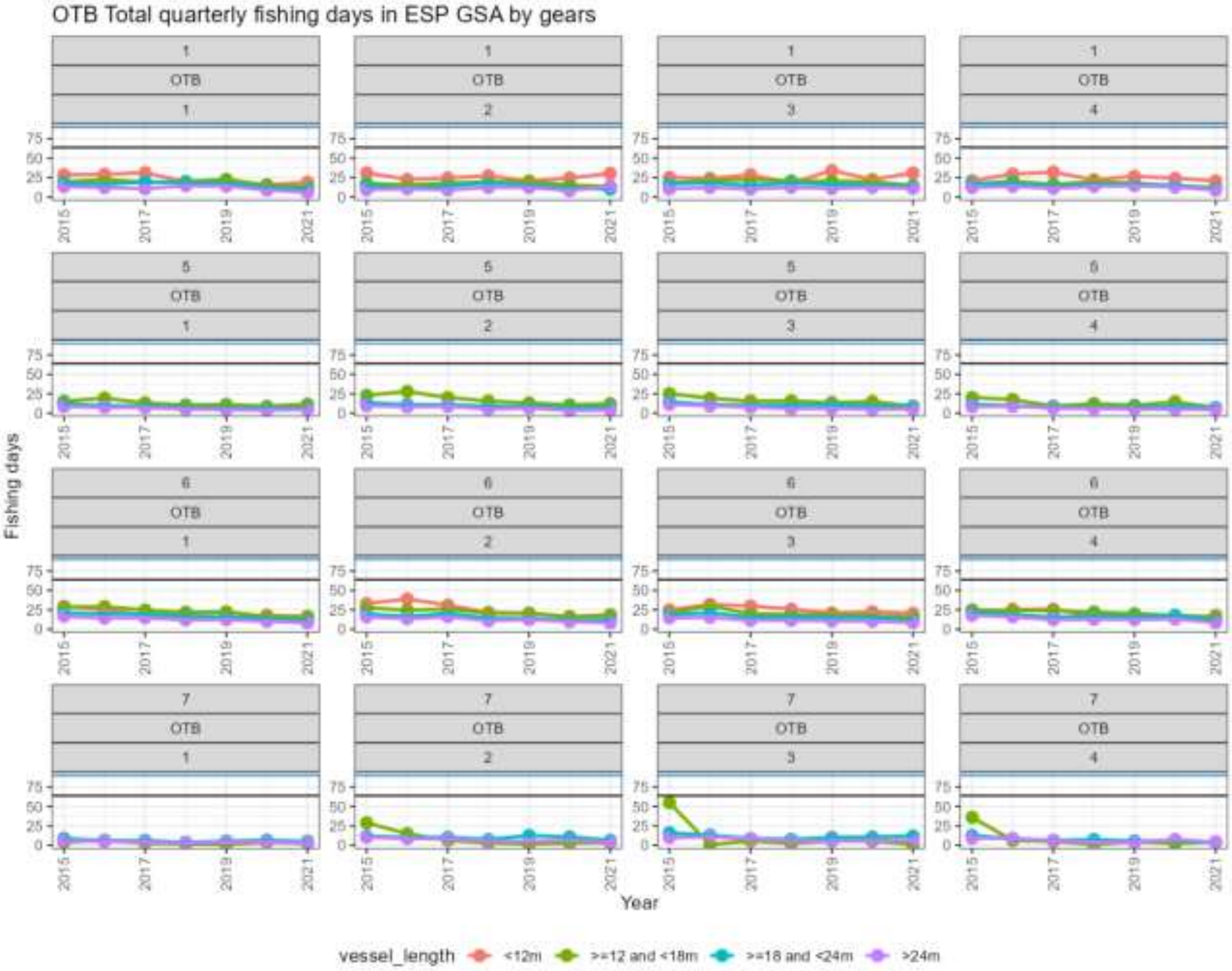


Figure 2.4.2.3.4 – Quarterly activity in fishing days of the bottom otter trawlers (OTB) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

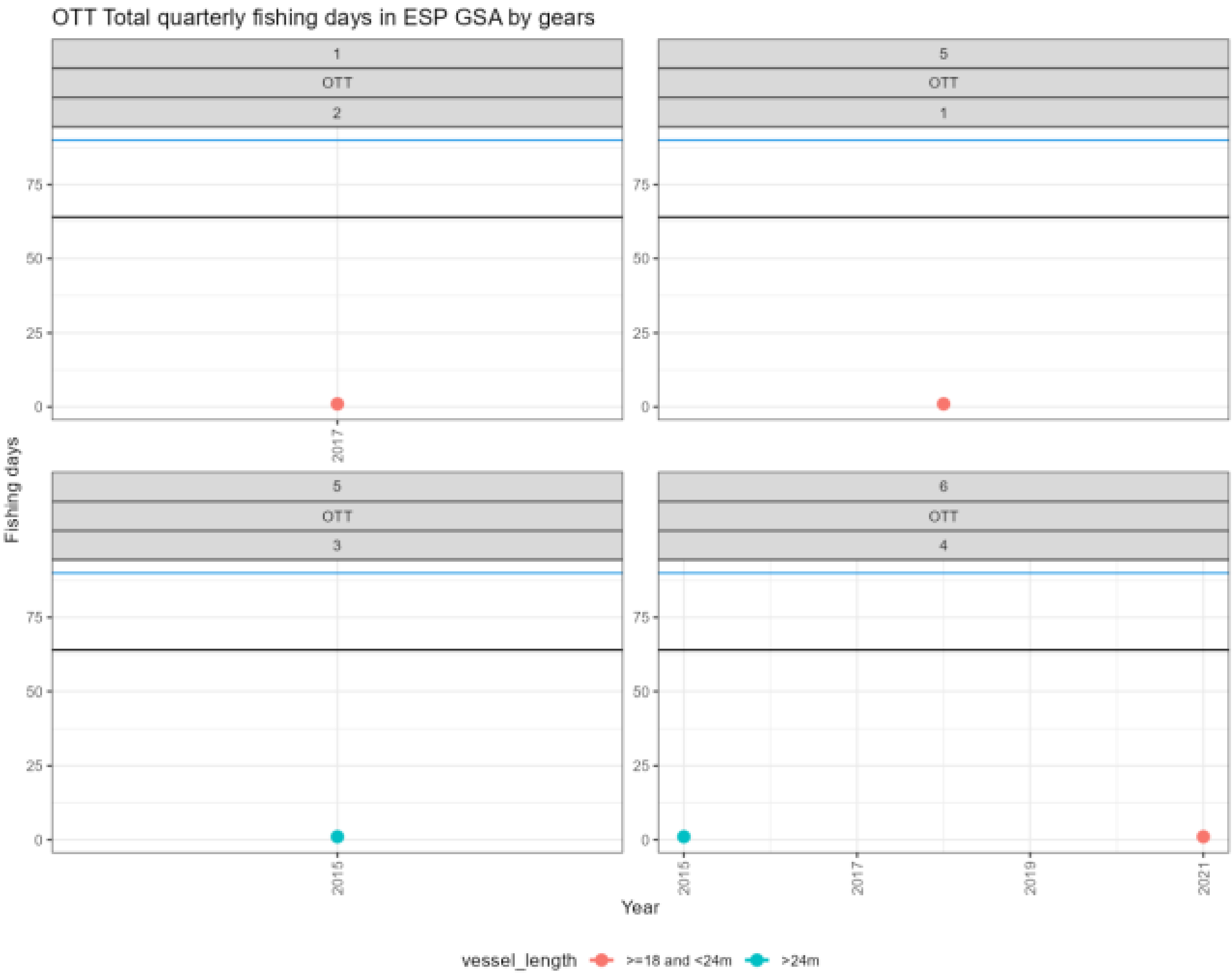


Figure 2.4.2.3.5 – Quarterly activity in fishing days of the twin otter trawlers (OTT) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

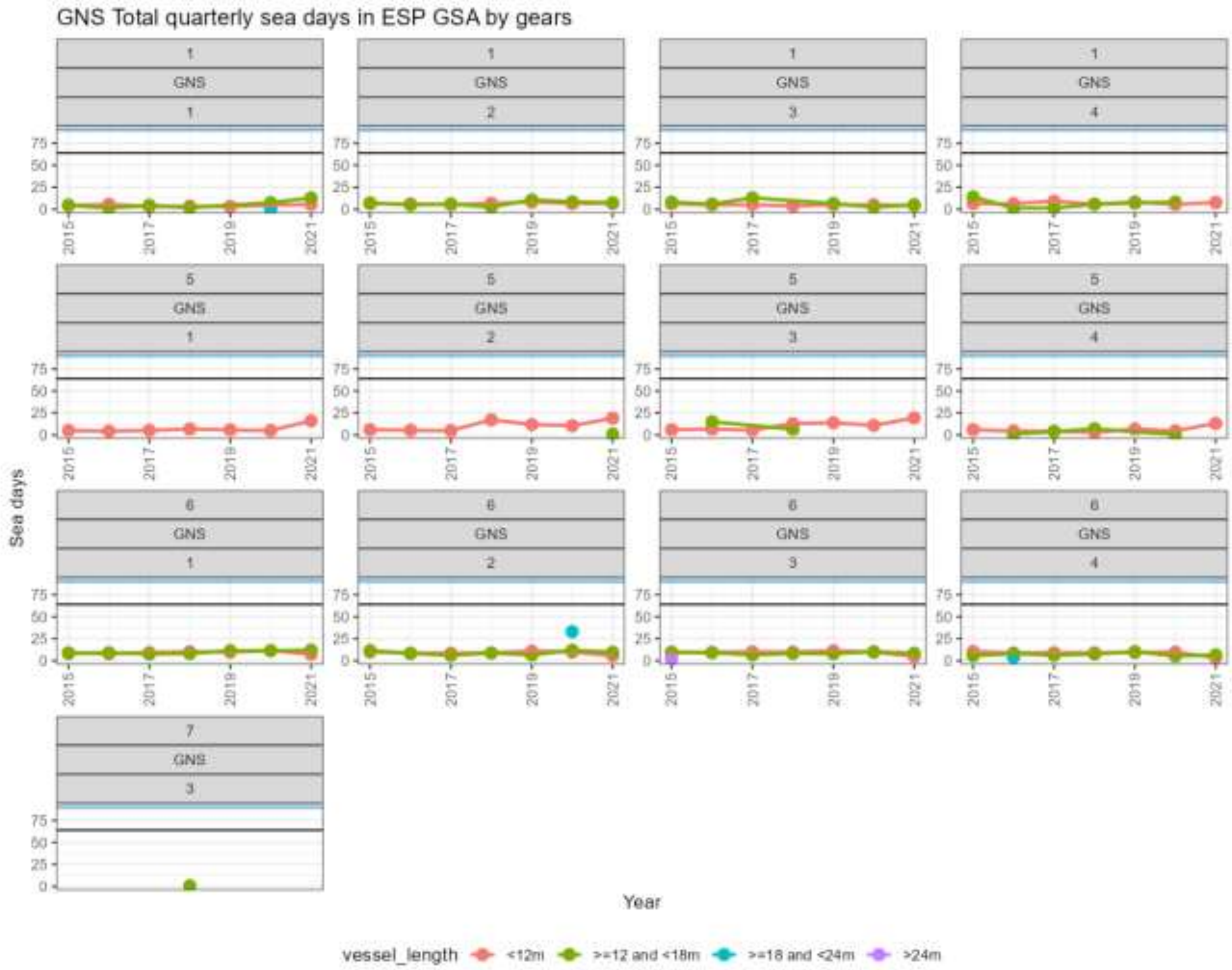


Figure 2.4.2.3.6 – Quarterly activity in days at sea of the gill-netters (GNS) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

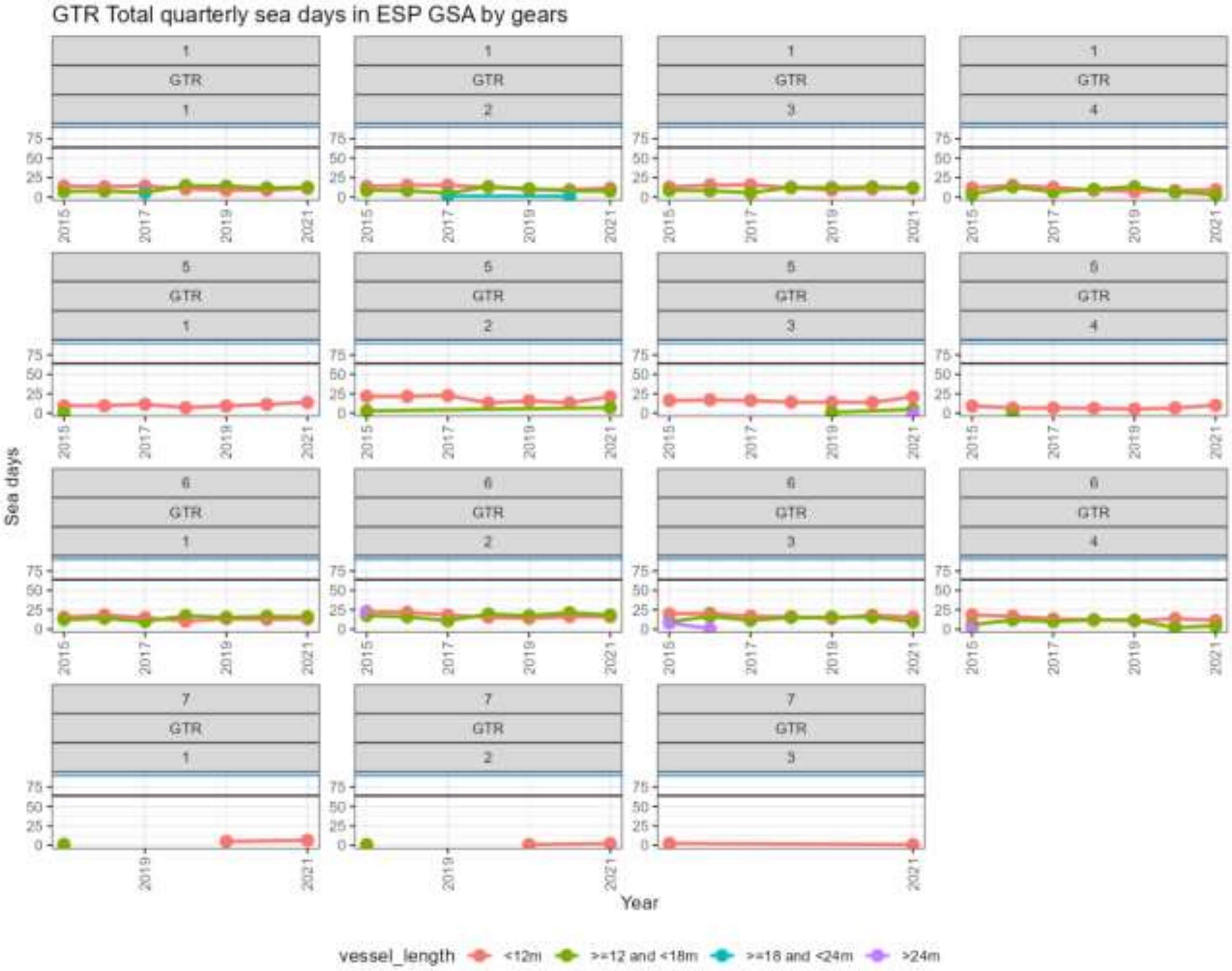


Figure 2.4.2.3.7 – Quarterly activity in days at sea of the trammel-netters (GNS) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

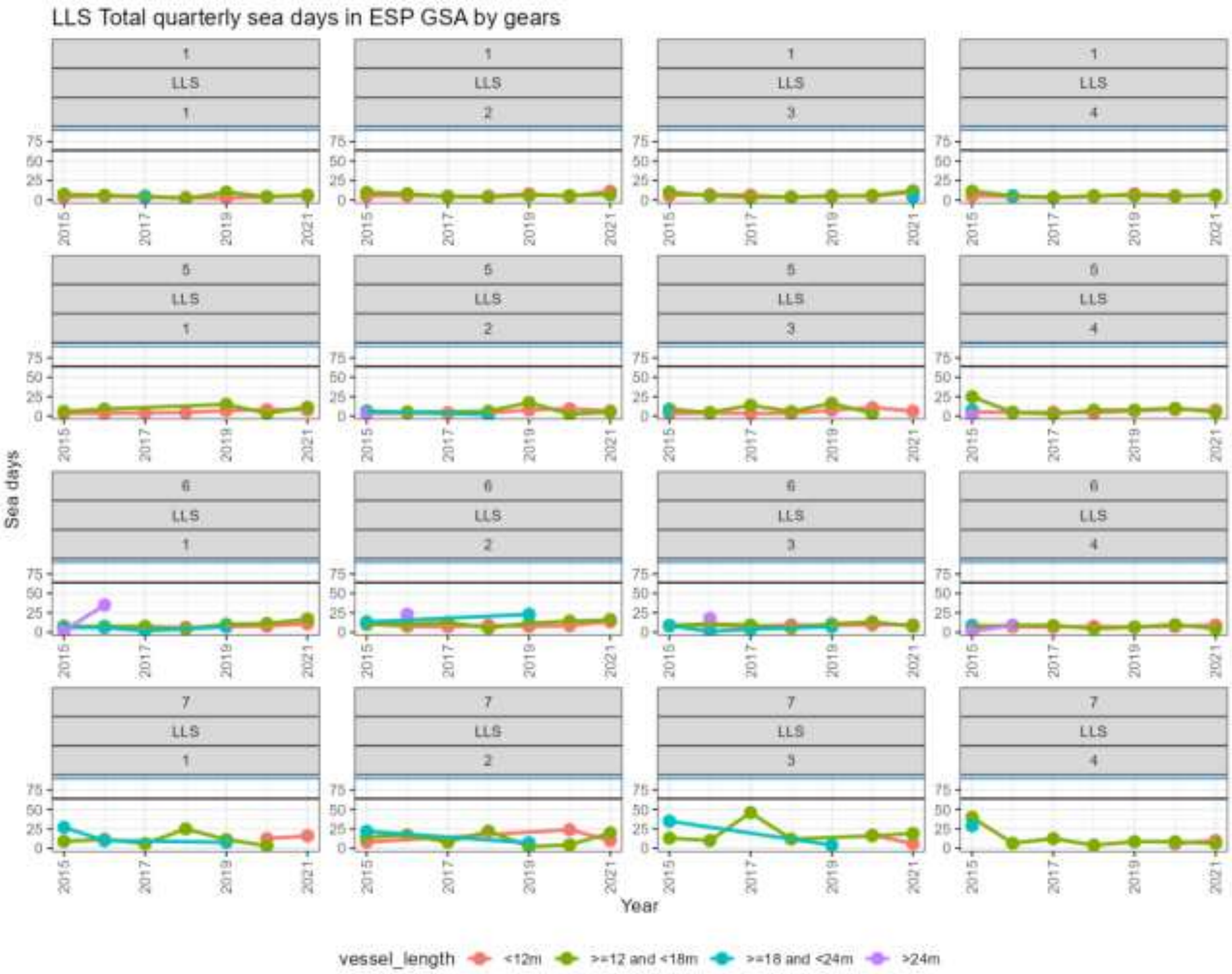


Figure 2.4.2.3.8 – Quarterly activity in days at sea of the set long liners (LLS) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

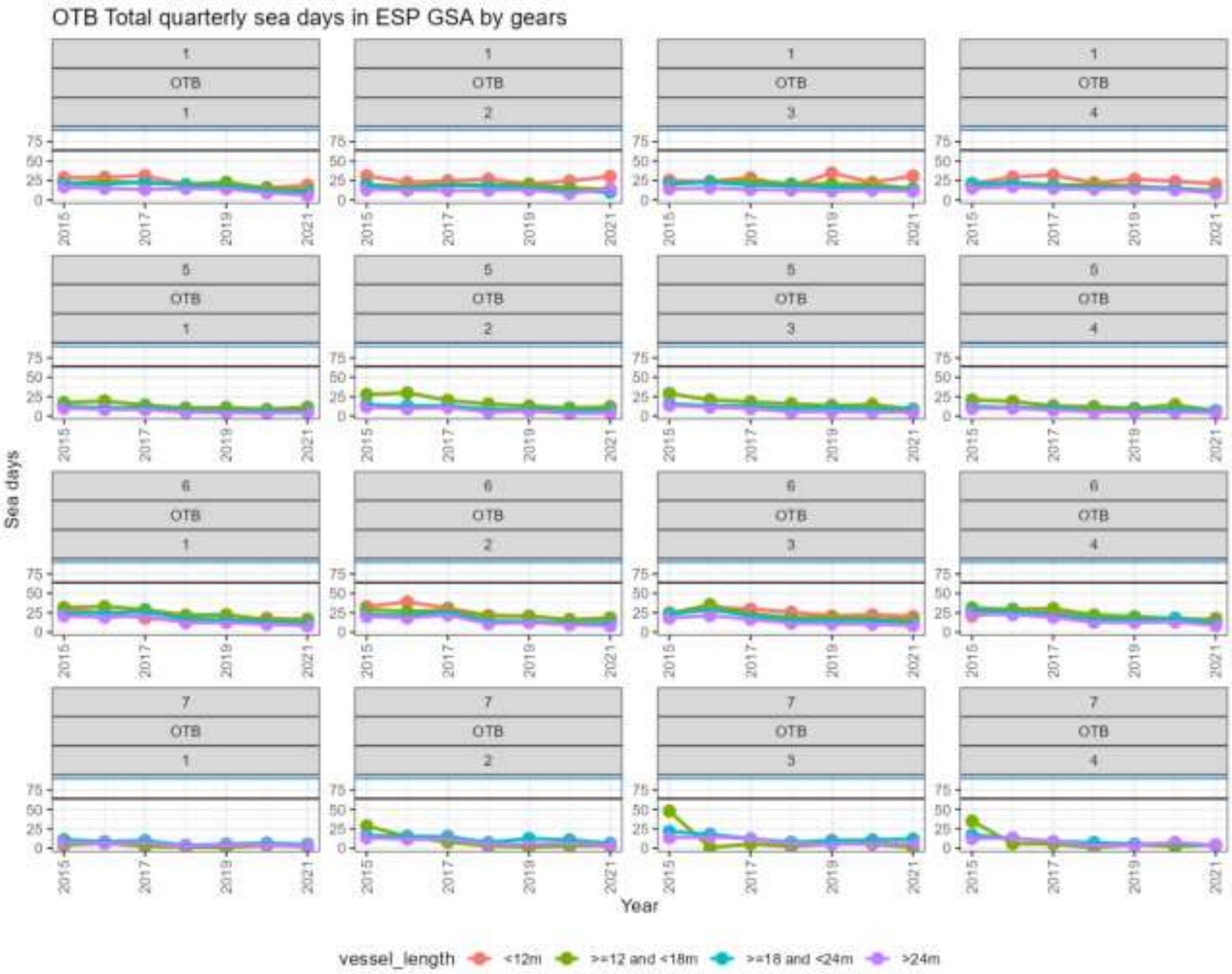


Figure 2.4.2.3.9 – Quarterly activity in days at sea of the bottom otter trawlers (OTB) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

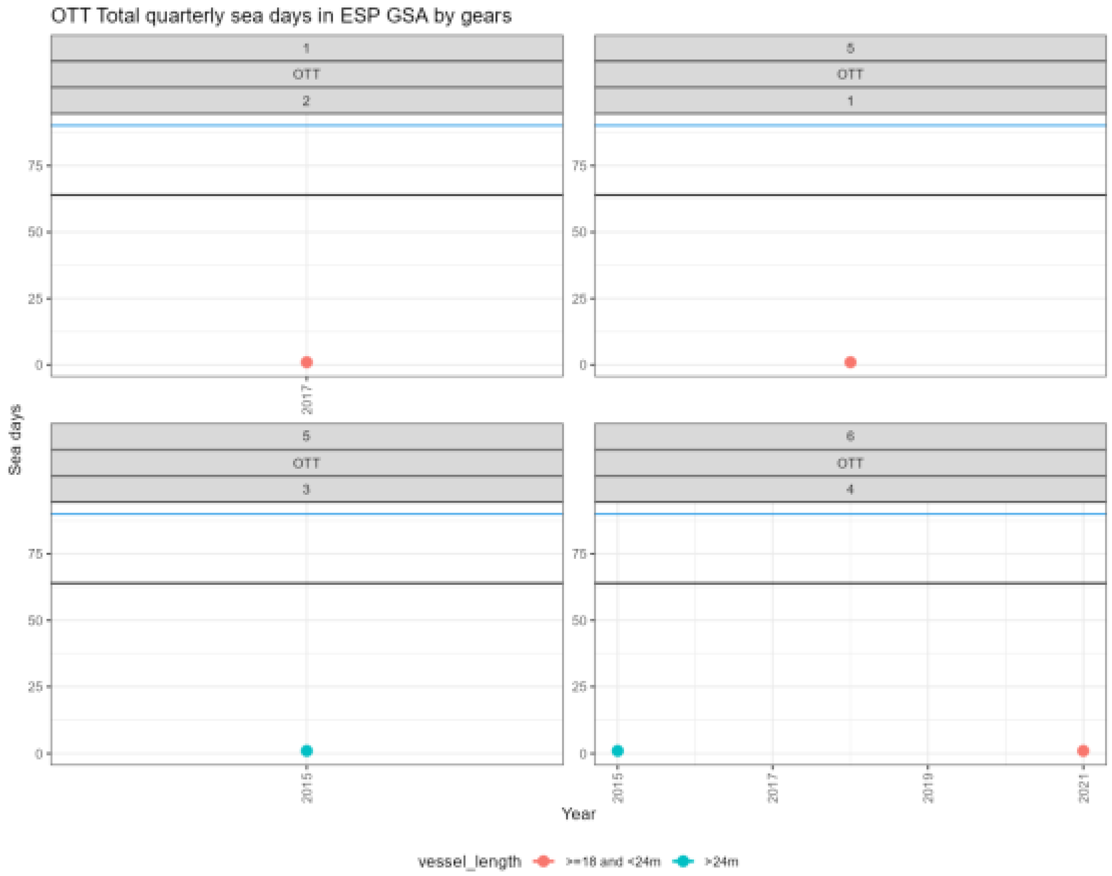


Figure 2.4.2.3.10 – Quarterly activity in days at sea of the twin otter trawlers (OTT) in Spanish GSAs. Black line corresponds to the 64 days threshold while the blue one to the 90 days threshold.

2.4.2.4 Conclusions

The check highlighted a total of 1 and 3 errors in the average number of fishing days and days at sea respectively (Table 2.4.2.4.1). In these cases, the values of average fishing days and average seadays are higher than the 90 days threshold. The error on fishing days (FD) have been registered in France GSA8 OTB data while the 3 errors on days at sea (SD) have been registered in France GSA8 OTB and in France GSA7 LLS.

Table 2.4.2.4.1 Number of cases where the ratio between total fishing days and the total number of vessel active in a given quarter exceed the 90 days threshold.

EMU	GSA	Country	Gear	Vessel length	Year	Quarter	FD or SD
2	8	FRA	OTB	<12m	2015	2	FD
2	8	FRA	OTB	<12m	2015	2	SD
1	7	FRA	LLS	>=12m and <18m	2016	2	SD
1	7	FRA	LLS	>=12m and <18m	2017	3	SD

The check highlighted a total of 3 errors in the average number of fishing days and days at sea respectively (Table 2.4.2.4.2). In these cases, the values of average fishing days and average seadays are higher than the 64 days threshold. The possible errors both on fishing days (FD) and days at sea (SD) have been registered in France GSA8 OTB.

Table 2.4.2.4.2 Number of cases where the ratio between total fishing days and the total number of vessel active in a given quarter exceed the 64 days threshold.

EMU	GSA	Country	Gear	Vessel length	Year	Quarter	FD or SD
2	8	FRA	OTB	>=12m and <18m	2018	4	FD
2	8	FRA	OTB	>=12m and <18m	2018	2	FD
2	8	FRA	OTB	>=18m and <24m	2018	3	FD
2	8	FRA	OTB	>=12m and <18m	2018	4	SD
2	8	FRA	OTB	>=12m and <18m	2018	2	SD
2	8	FRA	OTB	>=18m and <24m	2018	3	SD

2.4.3 Cross check matching between fishing technique and gear type in effort data

EWG 22-11 has been requested to prepare tables in which the comparison between FDI data and effort reference levels in EU regulation 2019/2236, 2021/90 and 2022/110 is showed. In preparing this table the EWG 22-11 experts agreed in using as key variable the gear type. In particular, five main gears base on trawling net have been selected: OTB, OTT OTM PTB and TBB (see section 2.3). During the data extractions has been noticed that in same records these trawlers gears have been associated not only to the expected DTS fishing technique but also with other ones (Table 2.4.3.1-3).

Table 2.4.3.1 Spain total fishing days by year/gear (upper light-orange rows) and GSA/fishing technique (left light red column) combinations. In green total by GSA.

ITALY	**2015**		**2016**	**2017**		**2018**			**2019**			**2020**			**2021**		
	OTB	**OTM**	**OTB**	**OTB**	**OTM**	**OTB**	**OTM**	**TBB**	**OTB**	**OTM**	**TBB**	**OTB**	**OTM**	**TBB**	**OTB**	**OTM**	**TBB**
GSA10	**30756**	**3790**	**35619**	**36293**	**457**	**33487**	**365**		**29526**	**535**	**8**	**23665**	**222**		**22630**	**353**	
DTS	28506	3790	33192	34572	457	32315	358		29159	535	8	23265	222		20895	353	
HOK	606		385	142		210			206			312			103		
PGP	1046		1319	1565		719	7		77			38			1602		
PMP	598		725														
PS				14		243			84			50			30		
GSA11	**15277**		**16925**	**16286**		**21240**			**18878**	**49**	**2**	**13677**			**14228**	**1**	
DTS	15277		16925	16176		19082			18435	47	2	13569			14031	1	
PGP				110		2153			443	2		106			197		
PS						4						2					
GSA9	**52936**		**51301**	**47459**	**658**	**44251**	**422**	**194**	**42227**	**497**	**519**	**33550**	**315**	**532**	**36566**	**315**	**694**
DTS	51166		49114	47297	658	43069	410	189	41540	497	394	33422	315	532	36458	313	336
PGP	1771		2187	142		1106	12		684		3	128			67		
PS				19		76		5	3		2				41		
TBB											120					2	358

Table 2.4.3.2 France total fishing days by year/gear (upper light-orange rows) and GSA/fishing technique (left light red column) combinations. In green total by GSA.

FRANCE	2015				2016				2017				2018				2019				2020				2021			
	OTB	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**	**OTB**	**OTM**	**OTT**	**TBB**
GSA11.1																							**6**					
DTS																							6					
GSA11.2																							**3**					
DTS																							3					
GSA5									**14**		**11**												**17**				**41**	
DTS									14		11												17				41	
GSA6									**19**		**8**							**3**	**2**				**15**				**33**	
DTS									19		8							3	2				15				33	
GSA7	**11144**	**397**	**593**	**517**	**10004**	**360**	**1597**	**280**	**8304**	**352**	**3121**	**245**	**7623**	**411**	**3316**	**219**	**7446**	**300**	**3917**	**170**	**6170**	**316**	**4462**	**44**	**6208**	**249**	**4324**	**55**
DFN				52				40				82				58												
DTS	9786	233	593		8922	314	1597		7004	223	3121		6199	287	3316		5978	160	3917		4997	157	4459		4995	152	4303	
FPO																								1				
MGO	1177			465	1045			216	1240			109	1395			103	1411			170	1145			44	1150			55
MGP	124																											
PGP																									1			
PMP								24				54				58												
TM	57	163			37	45			60	129			29	124			57	140			28	159	3		62	98	21	
GSA8	**866**	**2**			**923**				**693**				**589**	**1**			**464**				**478**	**5**			**599**	**2**		
DTS	866	2			923				693				589	1			464				478	5			596	2		

MGO							3

Table 2.4.3.3 Spain total fishing days by year/gear (upper light-orange rows) and GSA/fishing technique (left light red column) combinations. In green total by GSA.

SPAIN	2015				2016				2017				2018				2019					2020					2021			
	OTB	OTM	OTT	TBB	OTB	OTM	OTT	TBB	OTB	OTM	OTT	TBB	OTB	OTM	OTT	TBB	OTB	OTM	OTT	PTB	TBB	OTB	OTM	OTT	PTB	TBB	OTB	OTM	OTT	TBB
GSA1	**20559**				**20528**				**22026**		**1**		**20425**				**22006**			**4**		**18718**					**13984**			
DFN					1				3																					
DTS	20442				20355				21839		1		20259				22004			4		18718					13984			
HOK					3																									
PMP	116				169				184				166				1													
PS	1																1													
GSA10	**6**				**6**				**2**				**2**				**1**													
DTS	6				6				2				2				1													
GSA11.1																	**1**										**1**			
DTS																	1										1			
GSA11.2	**1**								**1**				**5**																	
DTS	1												5																	
HOK									1																					
GSA2	**879**				**787**				**803**				**610**				**652**					**493**			**3**		**966**			
DTS	879				787				802				610				652					493			3		966			
PMP									1																					
GSA5	**11965**		**1**		**10490**		**1**		**10162**				**8715**				**8202**	**3**				**7306**					**6439**	**1**		
DTS	11965		1		10440		1		10131				8709				8202	3				7306					6439	1		
HOK													6																	
PMP					50				31																					
GSA6	**79416**		**1**		**79063**				**77802**				**76467**	**2**			**75860**	**16**				**69201**	**14**				**51514**	**14**	**1**	**1**
DFN	1				9				1								14					0								
DRB									1																					
DTS	79278		1		77826				76936				76440	2			75842	16				69201	14				51500	14		1

HOK	1		206	24			
PMP	1	1078	501	3	4		14
PS	135	150	157				1
GSA7	**2816**	**2557**	**2648**	**1391**	**650**	**1809**	**1145**
DTS	2816	2557	2641	1391	650	1809	1145
HOK			7				
GSA9			**3**				
HOK			3				

The following table (figure 2.4.3.4) listed the acronyms codifications.

Table 2.4.3.4 Fishing technique and gear acronyms code

CODE	DEFINITION
FISHING TECHNIQUE	
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*
PGP	*Vessels using polyvalent passive gears only*
PMP	*Vessels using active and passive gears*
PS	*Purse seiners*
TBB	*Beam trawlers*
GEAR TYPE	
OTB	*Bottom otter trawl*
OTT	*Midwater otter trawl*
OTM	*Otter twin trawl*
PTB	*Bottom pair trawl*
TBB	*Beam trawl*

According to the definition of the fishing technique it is unlikely that for example OTB gear can be associated with PGP fishing technique (as happen for example in Italy). The number of trawlers fishing days associated with fishing techniques which seem not related to these fishing activities led the EWG 22-11 in considering as primary key in the computation of the total fishing days gear type rather than fishing technique. However, EWG 22-11 could appreciated if MS clarify how gear type activities have been associated with fishing technique activities (on main quarterly activities, on year basis, etc).

Unclear level of aggregation could lead to quite high change in the number of fishing days computed by fleet segment, in particular, in the smallest vessel length class (<12m). Table 2.4.3.5 show as the number of days computed in Italian GSAs by the two smallest fleet segment belong to mixed fishery (not deep water red shrimp) could be affected whether all the fishing technique associated to the five trawlers categories are included or if just DTS and TBB are used in the computation.

Table 2.4.3.5 Comparison of total fishing days of the five trawlers categories (OTB, OTT, OTM, PTB and TBB) computed by the two smaller fleet segments for the 3 Italian GSAs (9,10 and 11) when all the fishing techniques associated to these trawlers are taken in consideration or when only the expected DTS and TBB are filtered. Percentage of variation is showed

ITALY **Total fishing days**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
All fishing technique associated to OTB, OTT, OTM, PTB and TBB included							
VL <12m	3672	4292	2157	4102	5368	4157	7500
VL >=12 and <18m	54005	52173	51859	45996	39910	30892	33418
VL >= 18 and <24m	33710	35134	36230	33185	29103	23226	25905
VL >=24m	4805	4476	4758	4480	4581	4267	4670
Only DTS and TBB associated to OTB, OTT, OTM, PTB and TBB included							
VL <12m	1902	2105	1030	1666	4393	3992	5849
VL >=12 and <18m	51861	49745	51592	43913	39495	30740	33299
VL >= 18 and <24m	33710	35134	36230	33185	29103	23226	25905
VL >=24m	4805	4476	4758	4480	4581	4267	4670
Percentage of variation %							
VL <12m	48.20	50.96	52.25	59.39	18.16	3.97	22.01
VL >=12 and <18m	3.97	4.65	0.51	4.53	1.04	0.49	0.36
VL >= 18 and <24m	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VL >=24m	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2.4.1 Conclusions

The EWG 22-11 agreed that in computing total fishing days by MS/fleet segment/trawlers/target fishery data have been to filter from the FDI effort data (Table G) on gear type base having all the fishing techniques associated to these gears included. At the same the EWG 22-11 agreed in asking for clarification MS in which way the data by gear are associated to the upper-level fishing techniques resulting sometimes in quite unclear matching (e.g. OTB with PGP).

2.4.2 Comparison of effort Spanish data provided in the last two years FDI data calls

The effort Spanish data provided in EWG 22-11 differs from the one last year (EWG21-13) for the years 2015, 2016 and 2017, the ones of the baseline (Figure 2.4.4.1). Concretely the main differences for the coastal fleet (Figure 2.4.4.2) were for the VL2440 segment with a reduction of fishing days of 30%. For the deep fleet (Figure 2.4.4.3), the main differences were for the VL1218 and VL 1824, with an increase in fishing days of 50% in both cases. Due to these differences, this EWG's baseline changed compared to last year.

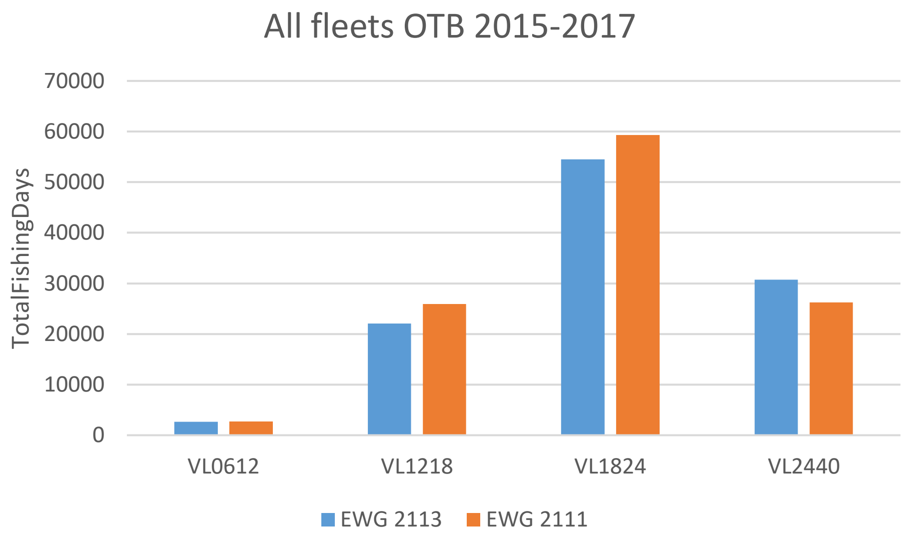


Figure 2.4.4.1. Total fishing days reported in EWG21-13 and EWG22-11 for all OTB fleets for the years 2015, 2016 and 2017.

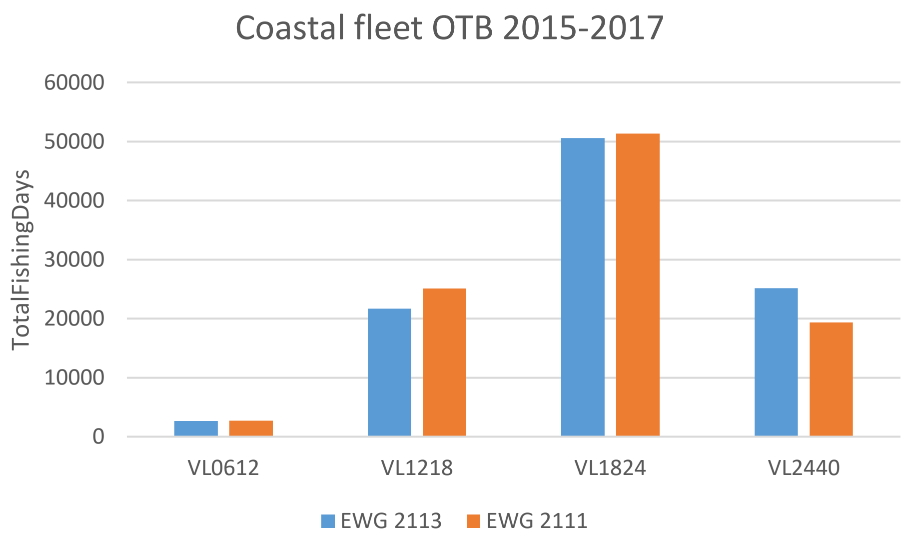


Figure 2.4.4.2. Total fishing days reported in EWG21-13 and EWG22-11 for the coastal OTB fleet for the years 2015, 2016 and 2017.

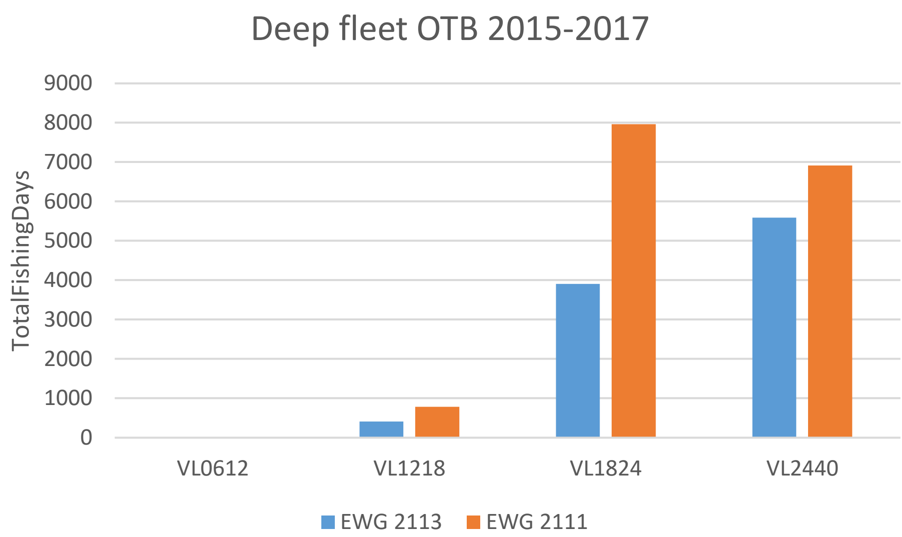


Figure 2.4.4.3. Total fishing days reported in EWG21-13 and EWG22-11 for the deep OTB fleet for the years 2015, 2016 and 2017.

3 ANALYSIS OF THE RELATIONSHIP BETWEEN FISHING EFFORT AND FISHING MORTALITY USING THE MOST RECENT DATA SETS AND STOCK ASSESSMENTS (TOR 2) AND ESTIMATION OF FISHING MORTALITY BY GEAR

3.1 Relationship between fishing mortality and fishing effort

3.1.1 Input data

The EWG 22-11 is requested to analyse the F-E relationship in the two EMUs (Effort Management Units): EMU1 for GSAs 1 to 7 and EMU2 for GSAs 8 to 11 (3.1.1).

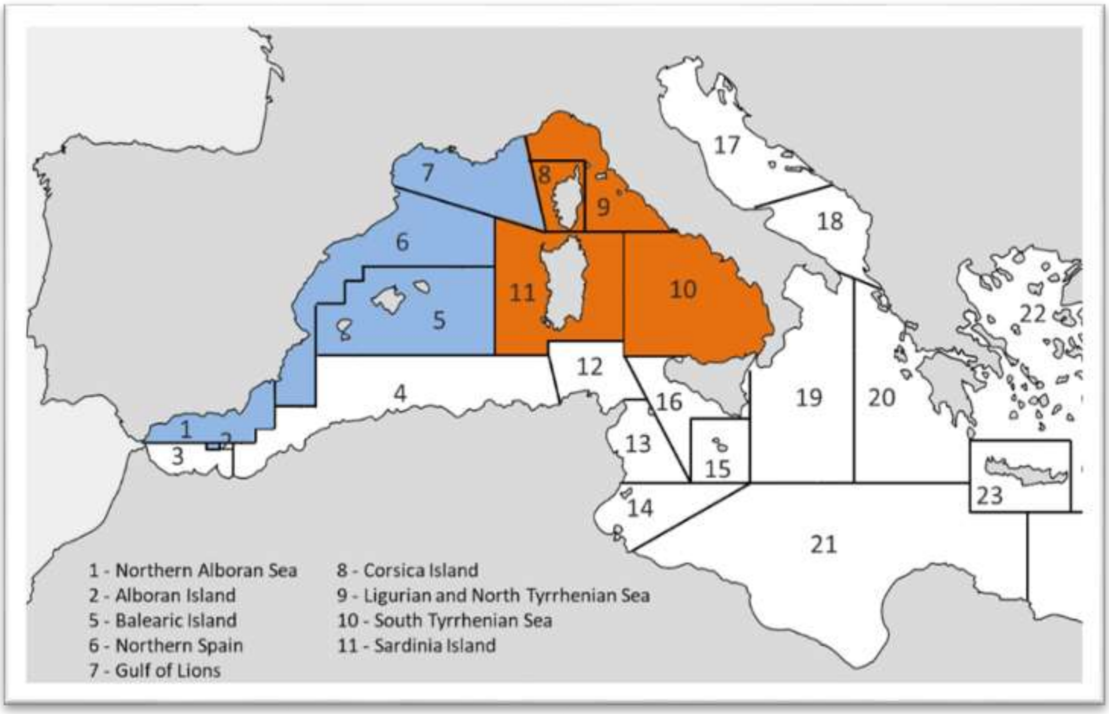


Figure 3.1.1. Mediterranean fishing management units ("GSAs") under the WMMAP for demersal fisheries. The west GSAs are grouped as Effort Management Unit 1 (EMU1) for management purposes and highlighted in blue, while the east GSAs are designated EMU2, in red.

To respond to ToR 2, EWG 22-11 based the analysis on the most recent stock assessments' results from EWG 22-09 "Western Mediterranean stock assessments". The report EWG receive the summary results and the vectors of fishing mortality estimated during EWG 22-09 for all the species listed in 3.1.1 (species as category 1 stocks included in the WMMAP), at the GSA level or EMU level (Table 3.1.2).

Table 3.1.1. Species covered by the WMMAP for demersal fisheries.

Common name	**Scientific name**	**FAO 3-alpha code**
Hake	*Merluccius merluccius*	HKE
Red mullet	*Mullus barbatus*	MUT
Deep-water rose shrimp	*Parapenaeus longirostris*	DPS
Norway lobster	*Nephrops norvegicus*	NEP

Giant red shrimp (only EMU2)	*Aristaeomorpha foliacea*	ARS
Blue and red shrimp	*Aristeus antennatus*	ARA

The analysis was also performed considering the main gears targeting the species listed in table 15 to evaluate how much gears other than bottom otter trawls, such as gillnets and longlines contribute to demersal stocks fishing mortality.

Table 3.1.2. Contribution of trawling fleets and fleets using other gears to the catches of the main target stocks in the Western Mediterranean, based on fisheries production data made available by JRC to this EWG.

EMU	Stock (species and area)	% trawl(1)	Other gear	Fbar range
EMU1	HKE 1_5_6_7	85%	nets (GTR or GNS): 14% bottom longline (LLS): 1%	1-3
EMU1	MUT 1	85%	nets (GTR or GNS): 9.6%	1-3
EMU1	MUT 6	93%	nets (GTR or GNS): 6.7%	1-3
EMU1	MUT 7	96%	GTR or GNS 6%	1-3
EMU1	DPS 1	100%		1-2
EMU1	DPS 5_6_7	100%		1-2
EMU1	NEP 6	100%		3-6
EMU1	ARA 1_2	100%		1-2
EMU1	ARA 6_7	100%		1-2
EMU2	HKE 8_9_10_11	58%	nets (GTR or GNS): 32%	1-3
EMU2	MUT 9	96%	nets (GTR or GNS): 4%	1-3
EMU2	DPS 9_10_11	100%		1-2
EMU2	NEP 9	100%		2-6
EMU2	ARA 9_10_11	100%		1-3
EMU2	ARS 9_10_11	100%		1-3

Note: (1) “trawl” is exclusively OTB in GSAs 1, 5 and 6, but combines OTB, OTM and OTT in GSA 7 (France).

3.1.2 Methods

For each stock considered, a vector of partial *F* was computed for each fishing gear accounting for more than 1% of the catches in weight. To this end, the catch at length in numbers per fishing gear made available by the JRC as files landings.csv and discards.csv was converted to catch at age in numbers ("slicing") using routine *l2a* of FLR package *FLa4a* and the relative contribution to *F* was computed according to the formula:

$$F_{a,g}^{y} = F_{a}^{y} \frac{C_{a,g}^{y}}{\sum_{j}^{G} C_{a,j}^{y}}$$

where F_a^y is the vector of fishing mortality at age *a* for each year *y*, $C_{a,g}^y$ is the reconstructed catch-at-age in numbers *a* for year *y* and each area *x* fishing gear *g* combination (*G* is the total number of area *x* fishing gear combinations). The F_a^y vector was obtained from the *R* objects in electronic Appendix I of EWG 22-11.

After the slicing procedure, the SOP correction factors were applied to catch numbers at age by GSA and gear and then the partial *F* computed.

For hake and deep-water rose shrimp in EMU2 (GSAs 8,9,10,11), and red mullet in EMU2 (GSA 9) the age slicing routine was applied by sex accordingly with the data procedure preparation adopted during the assessments of EWG 22-09.

Regarding the time-span of the reconstructed catch-at-age series ($C_{a,g}^y$) it is important to note that the length frequency data for fishing gear other than OTB was consistently available only from 2010 in the Spanish GSAs and 2011 in the French GSA, despite the existence of information on total catches since 2002 in some cases. In the Italian GSAs total catches and landings at length information are available since 2002 (2012 in GSA 8), while discard at length are consistently available since 2009. Hence, the partial *F* vectors were calculated since 2013.

The results presented and discussed in the following sections refer to the most recent year in the assessment (2021), although the relative importance of the various fishing gears have remained stable over time in the last years.

For each stock, the relationship between the effort (days at sea) and the fishing mortality is analyzed throughout a bivariate analysis that measures the strength of association between two variables and the direction of the relationship. Explicitly, Pearson correlation's method is applied by gear for the whole EMU and for each GSA which contribute to the total. All the analysis are plotted by distributing the points in a cloud of values and over imposing the lines which hypothesize a linear relationship between fishing effort and fishing mortality. In the figures the solid line represents the linear regression on the observed values, while the dashed line represents the linear regression forced to pass from the origin according to the reasonable assumption that F is nihil when no fishing effort is exerted on the stock. The correlation coefficients are also plotted within each graph.

It is worth of note that for the purposes of the analysis the DWS assemblage was excluded from the total effort for red mullet in each EMU and GSA, while for ARA and ARS only the efforts belonging to CRU, DWS, DES, MDD and NK assemblages where conversely considered as explained later.

3.1.3 *Results*

3.1.3.1 Catch proportions

The relative importance of OTB and other gear in the landings and discards by EMU and species and by EMU, gsa and species are shown below in Figure, Figure and Figure respectively.

From the 6 species listed as category 1 species, only European hake and the two red mullets have catches from fishing gears other than trawl (Figure). That is, all reported catches for Norway lobster, deep-water rose shrimp, giant red shrimp and blue and red shrimp come exclusively from Otter Bottom Trawl (OTB), with the exception of GSA 7 in which a fraction of these catches comes also from otter trawl twin-rig (OTT).

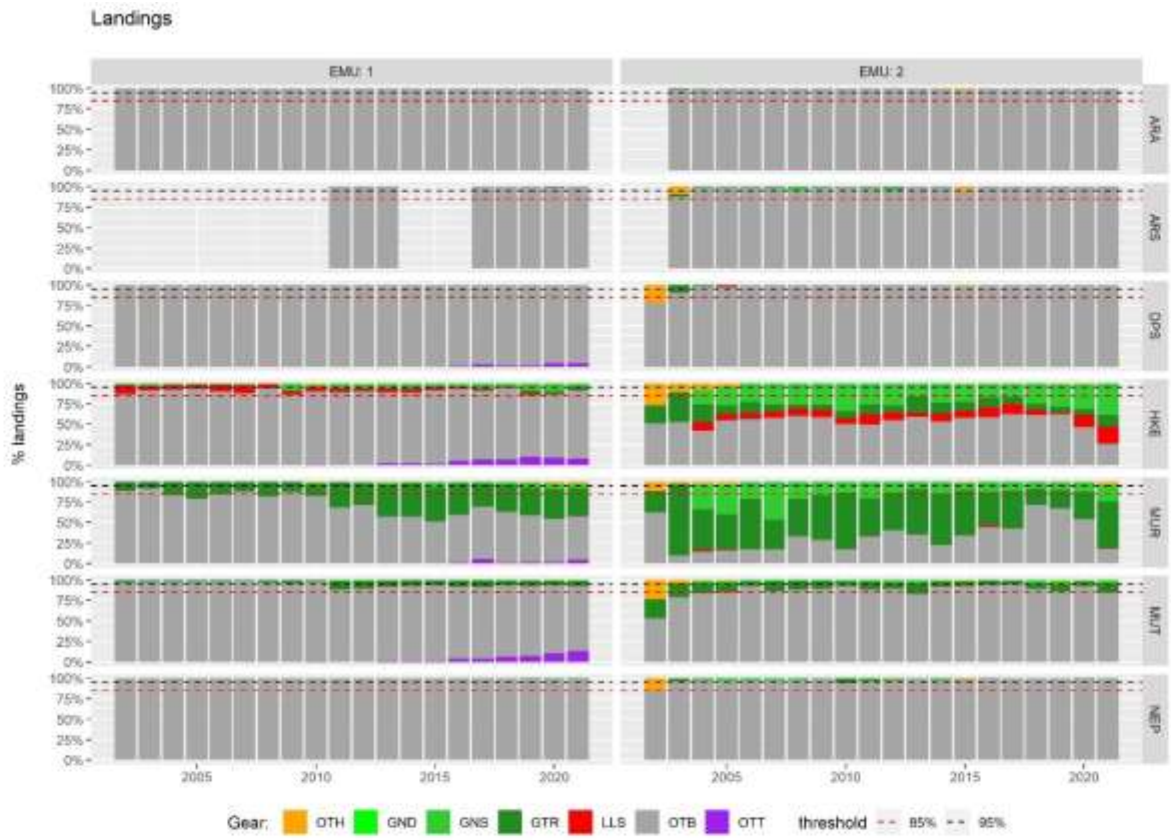


Figure 3.1.2. Proportion of landings by main fishing gear and EMU. Dotted lines indicate 85% and 95% contributions.

In particular in EMU1 the relative contribution to the demersal catches of fishing gears by GSA shows that the largest share of landings of hake, red mullet and deep-water rose shrimp are produced by OTB with the exception of GSA 7 where landings for OTT are relevant for France and landings of the Spanish for LLS are reducing considerably over time, producing <10% of the total landings in recent years. In GSA 1, 5 and 6 the relative importance of gears other than OTB is low, typically <10% both for hake and red mullet (Figure). In GSA7 according to the catch at length data for hake the selection pattern of OTB and OTT is different.

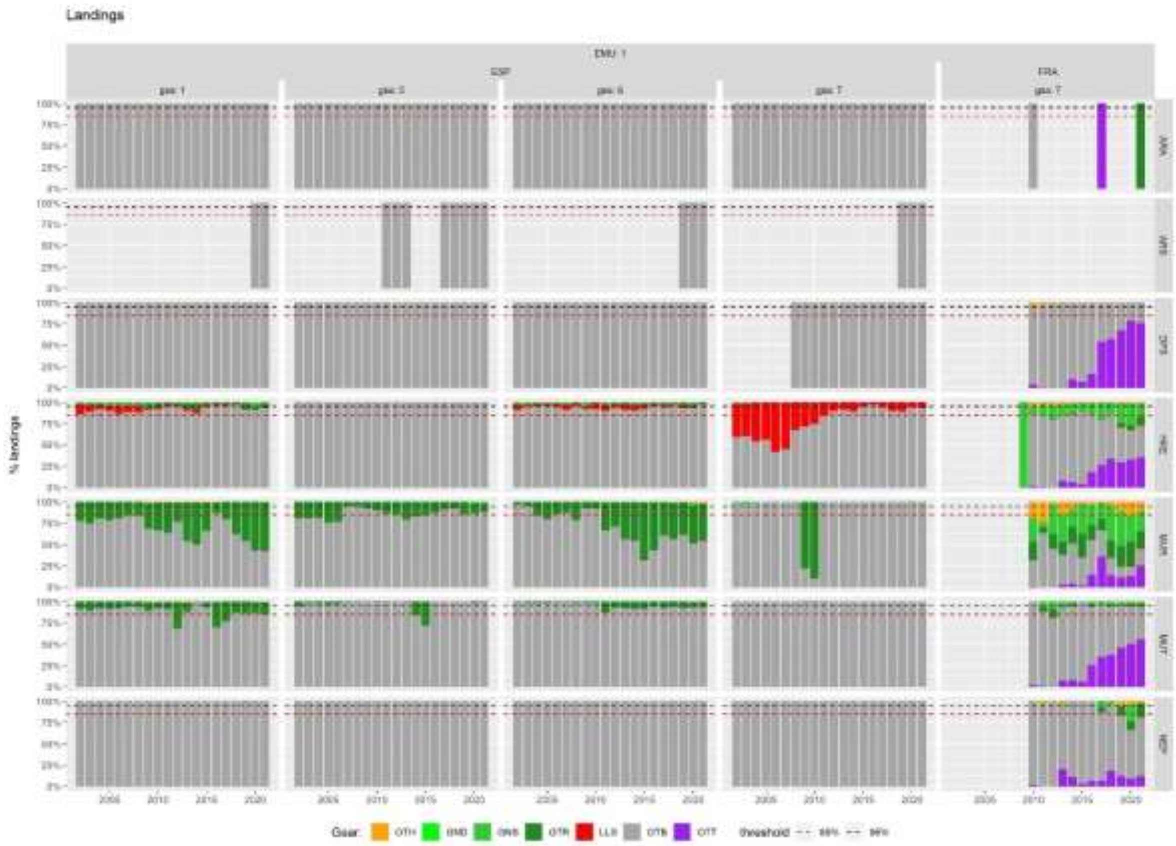


Figure 3.1.3. Proportion of landings by gear in each GSA by year for EMU1. Dotted lines indicate 85% and 95% contributions.

In EMU2, the contribution of other fishing gear than OTB to the total landings of hake and red mullet is high, particularly in GSA 9 and GSA 10 (Figure).

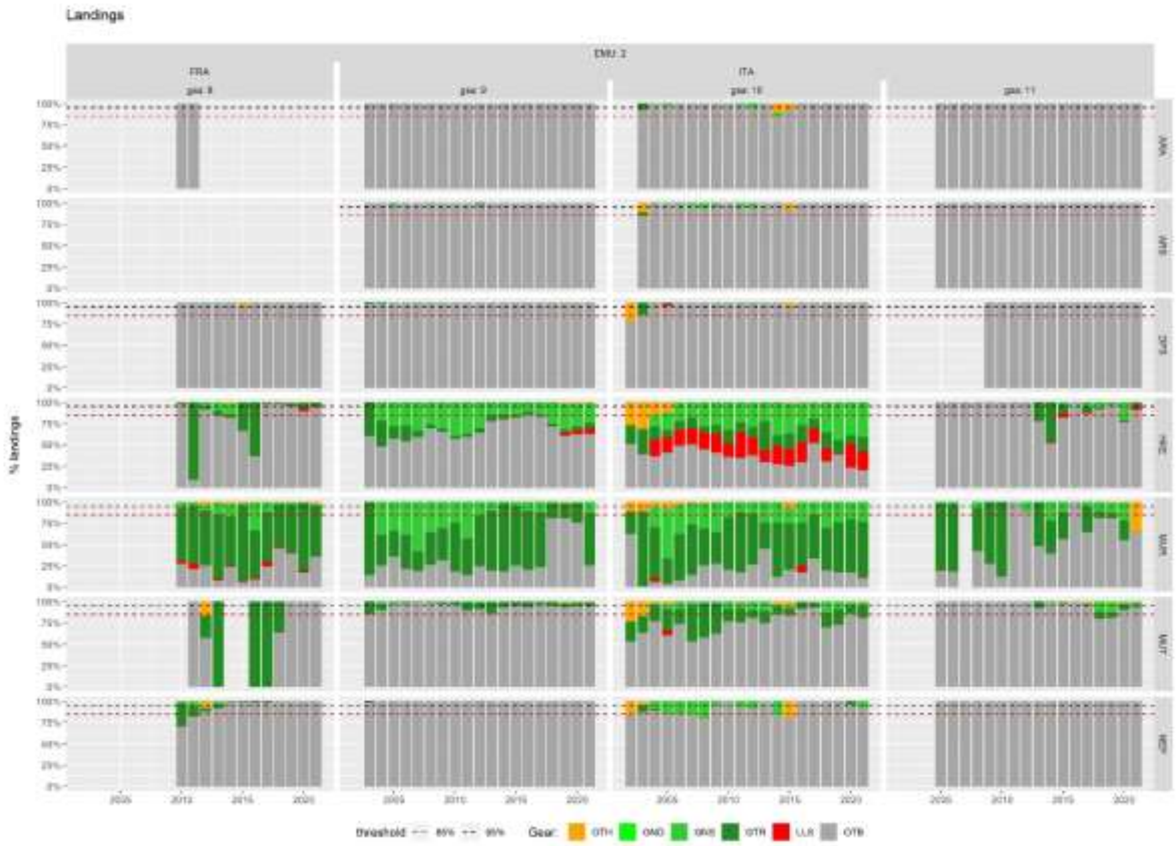


Figure 3.1.4. Proportion of landings by gear in each GSA by year for EMU2. Dotted lines indicate 85% and 95% contributions.

As regards the discards, the available information shows that, except for gsa 7, they come mostly from trawlers for both HKE and MUT (Figure), although the quantities reported are low, typically <5% of catches.

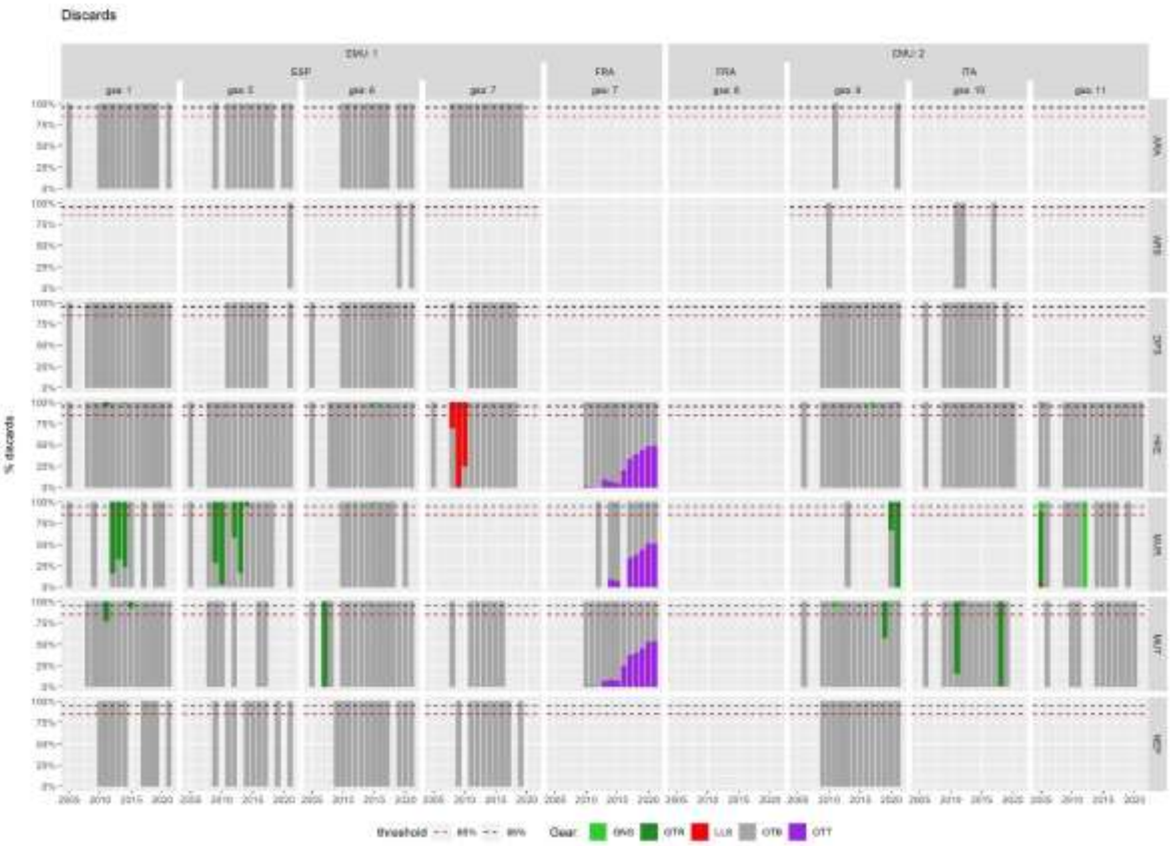


Figure 3.1.5. Proportion of discards by gear in each EMU and GSA by year. Dotted lines indicate 85% and 95% contributions.

3.1.3.2 Target assemblages

To properly link and find the relationship between the effort (days at sea) and the fishing mortality a check of target assemblages from FDI dataset matching with the landings by gear for the selected GSAs and species was done. The results shown in the table below highlight that effort is related to a maximum of 12 assemblages (Table). Taking in to account the biology and depth distribution of the species EWG 22-01 found that for the purposes of the analysis the DWS assemblage should be excluded from the total effort for red mullet, while for ARA and ARS only the efforts belonging to the assemblages CRU, DWS, DES, MDD and NK should be conversely considered.

Table 3.1.3 Target assemblages related to the areas and species object of the analysis (code match)

Code match	Code	Target assemblage description
	ANA	Anadromous
CAT	CAT	Catadromous
CEP	CEP	Cephalopods
CRU	CRU	Crustaceans
DEF	DEF	Demersal fish
	DES	Demersal species (Benthic species)
DWS	DWS	Deep-water species
FIF	FIF	Finfish
	FWS	Freshwater species

	GLE	Glass eel
LPF	LPF	Large pelagic fish
	MCD	Mixed crustaceans and demersal fish
	MCF	Mixed cephalopods and demersal fish
MDD	MDD	Mixed demersal and deep water species
	MIS	Miscellany
MOL	MOL	Molluscs
	MPD	Mixed pelagic and demersal fish
SLP	SLP	Small and large pelagic fish
SPF	SPF	Small pelagic fish
NK	NK	not known

3.1.3.3 HKE EMU1-GSAs 1,5,6,7

The relationship between the effort (days at sea) and the fishing mortality by gear is reported for HKE in EMU1 in Figure 3.1.1. In the graph the points are distributed in a cloud of values and the lines hypothesize a linear relationship between fishing effort and fishing mortality. The solid line represents the linear regression on the observed values. The dashed line represents the linear regression forced to pass from the origin according to the reasonable assumption that F is nihil when no fishing effort is exerted on the stock. The correlation coefficients are also plotted.

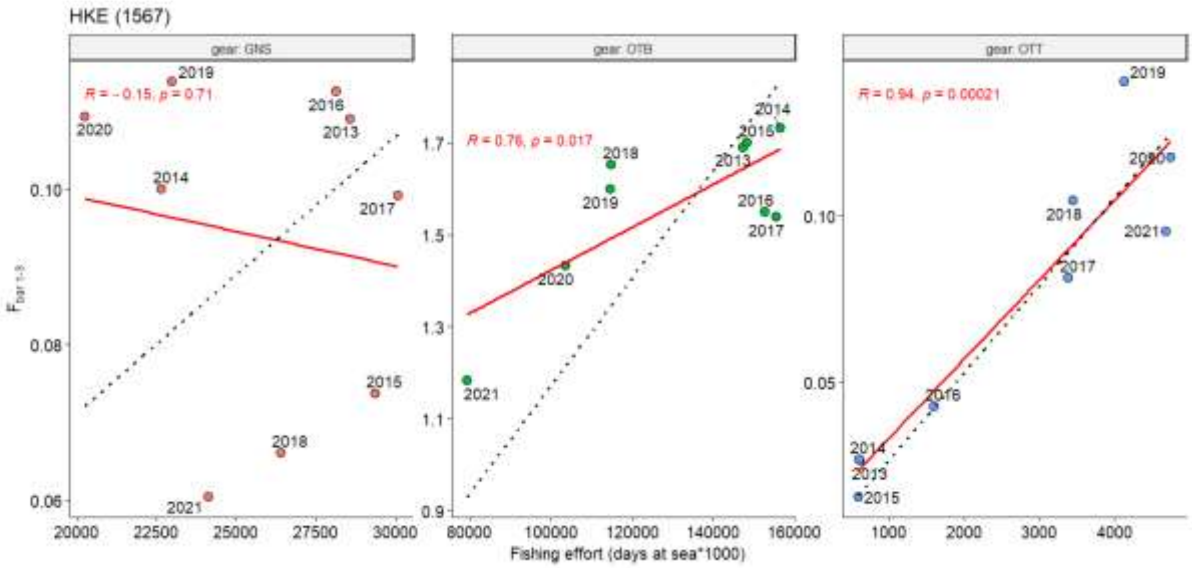


Figure 3.1.1 – Relationship between total effort and Fbar (1-3) for HKE by gears in EMU 1 (GSA 1, 5, 6 and 7 combined). Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

The relationship between the effort (days at sea) and the fishing mortality for HKE in each GSA of EMU1 for OTB is reported in Figure 3.1..

The analysis shown in Figure 3.1.1 highlights a positive linear relationship between fishing mortality and the fishing effort for both trawl gears (OTB and OTT) while the relationship is neither meaningful nor explanatory for the passive gear (GNS).

By performing the analysis for each GSA which belongs to the whole EMU, in most of the GSA the values are distributed in a cloud that does not allow to highlight any clear relationship between fishing mortality and the fishing effort. Only in GSA 6 for OTB and in GSA 7 for OTT the relationship is significantly stronger and much clear (Figure 3.1. and **Error! Reference source not found.**).

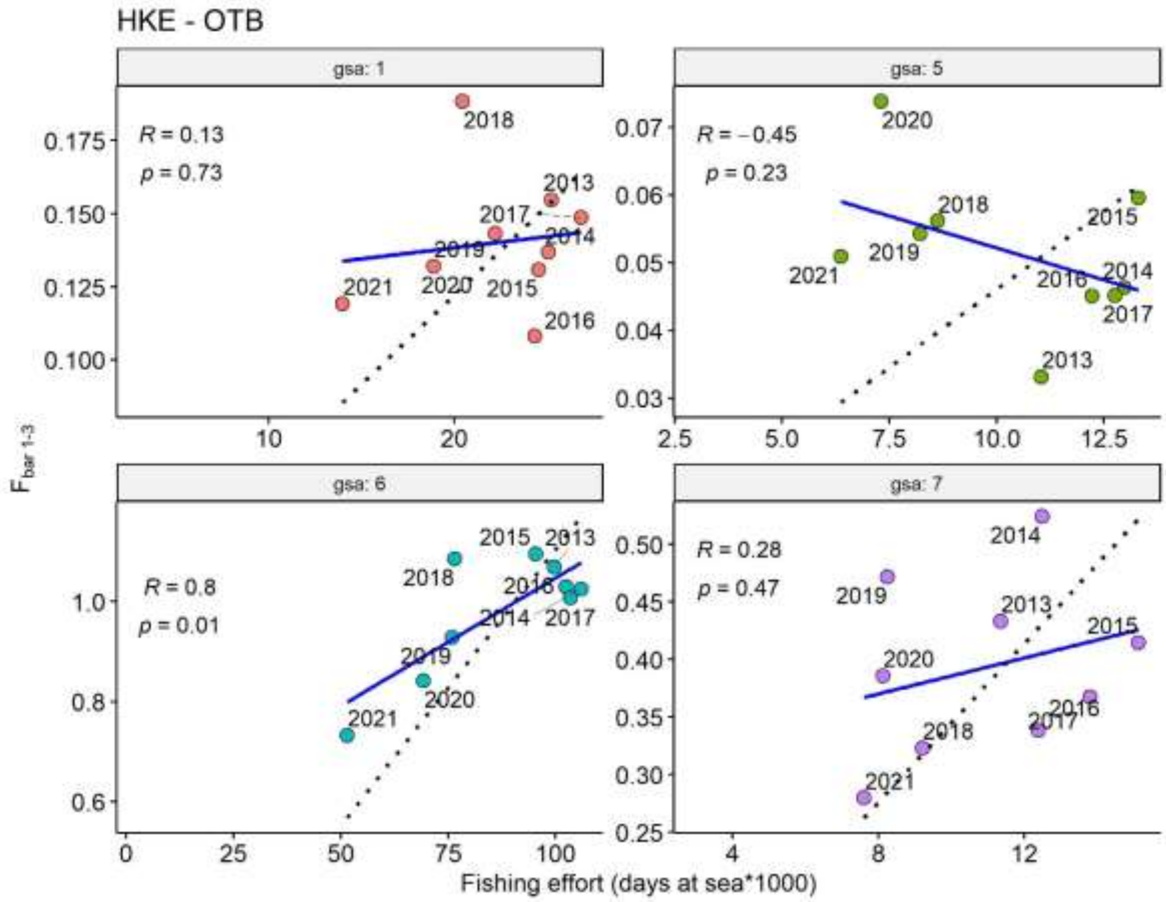


Figure 3.1.7 – Relationship between nominal effort and Fbar(1-3) for hake in GSAs 1, 5, 6 and 7. Blue line: linear regression for each GSA. Black dashed line: linear regression forced through the origin for each GSA.

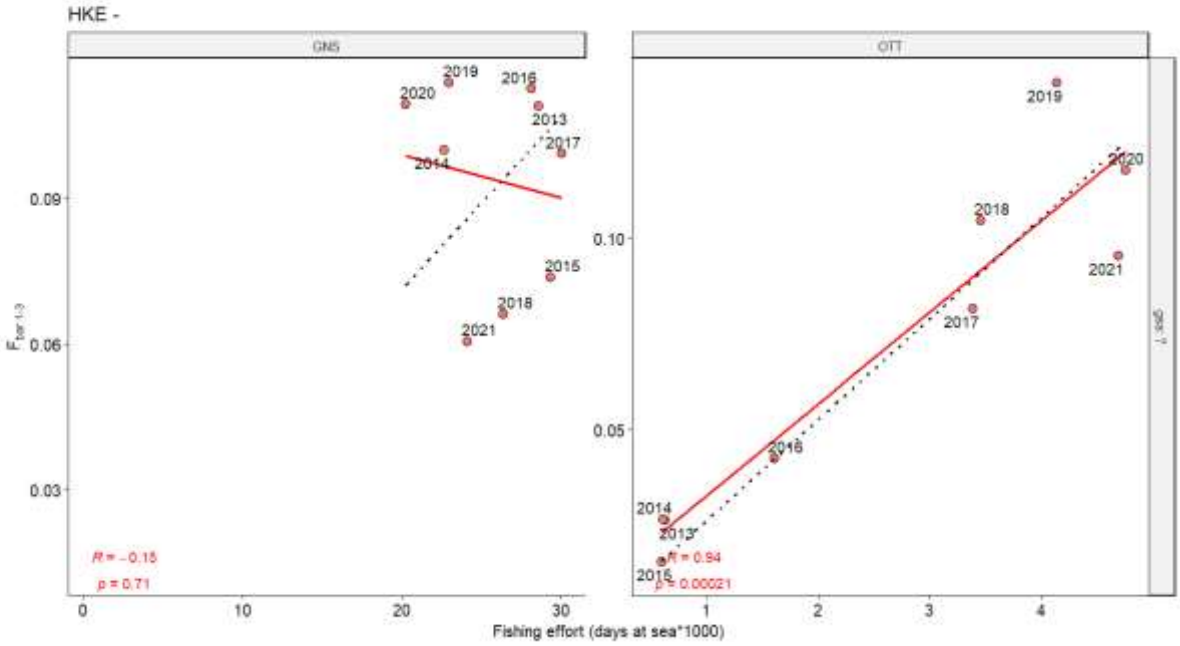


Figure 3.1.8 – Relationship between total effort and Fbar (1-3) for HKE by other gears than OTB (OTT and GNS) in GSA 7. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.4 MUT EMU1-GSA1

The relationship between the effort and the fishing mortality for red mullet in GSA 1 of EMU1 is reported for all gears in Figure 3.1.2. The points are distributed in a cloud of values that does not allow to highlight any clear relationship between fishing mortality and the fishing effort.

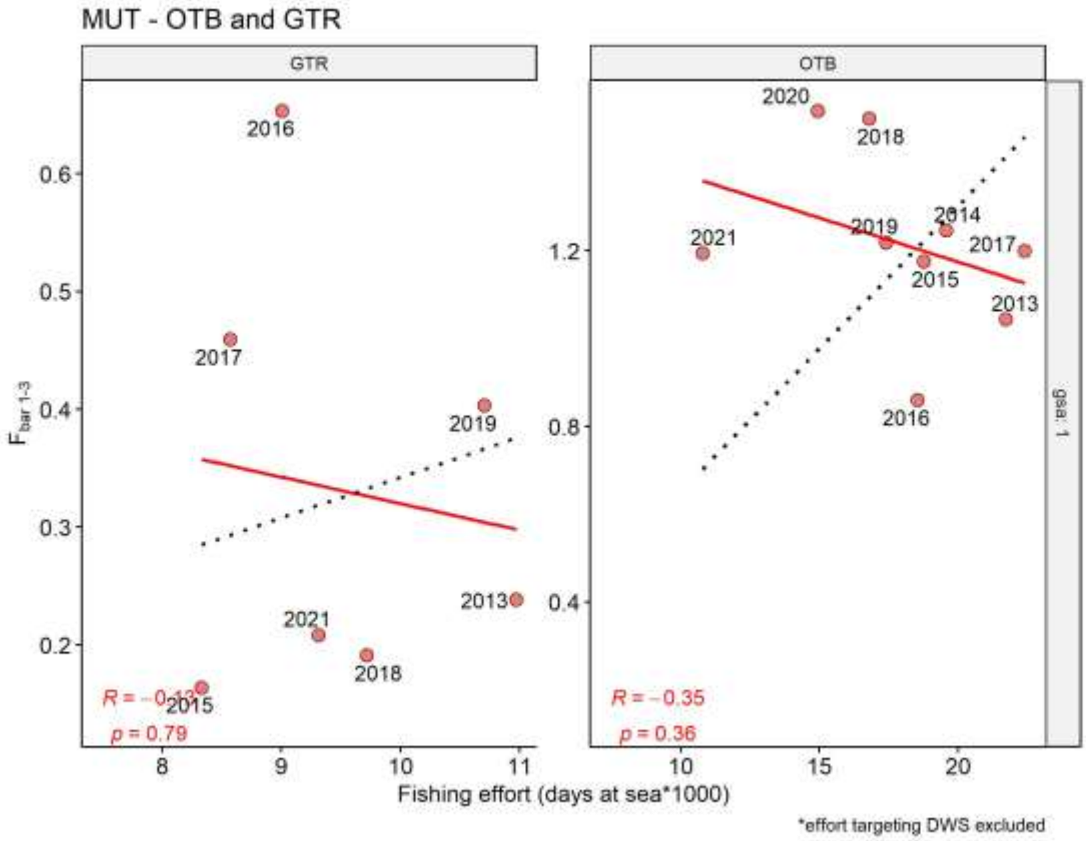


Figure 3.1.2 – Relationship between total effort and Fbar (1-3) for MUT in the management unit 1, GSA 1, by gear. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.5 MUT EMU1-GSA6

The relationship between the effort and the fishing mortality for red mullet in GSA 6 of EMU1 is reported for all gears in Figure 3.1.3. The points are distributed in a cloud of values that highlight a clear and significant relationship between fishing mortality and the fishing effort only for OTB.

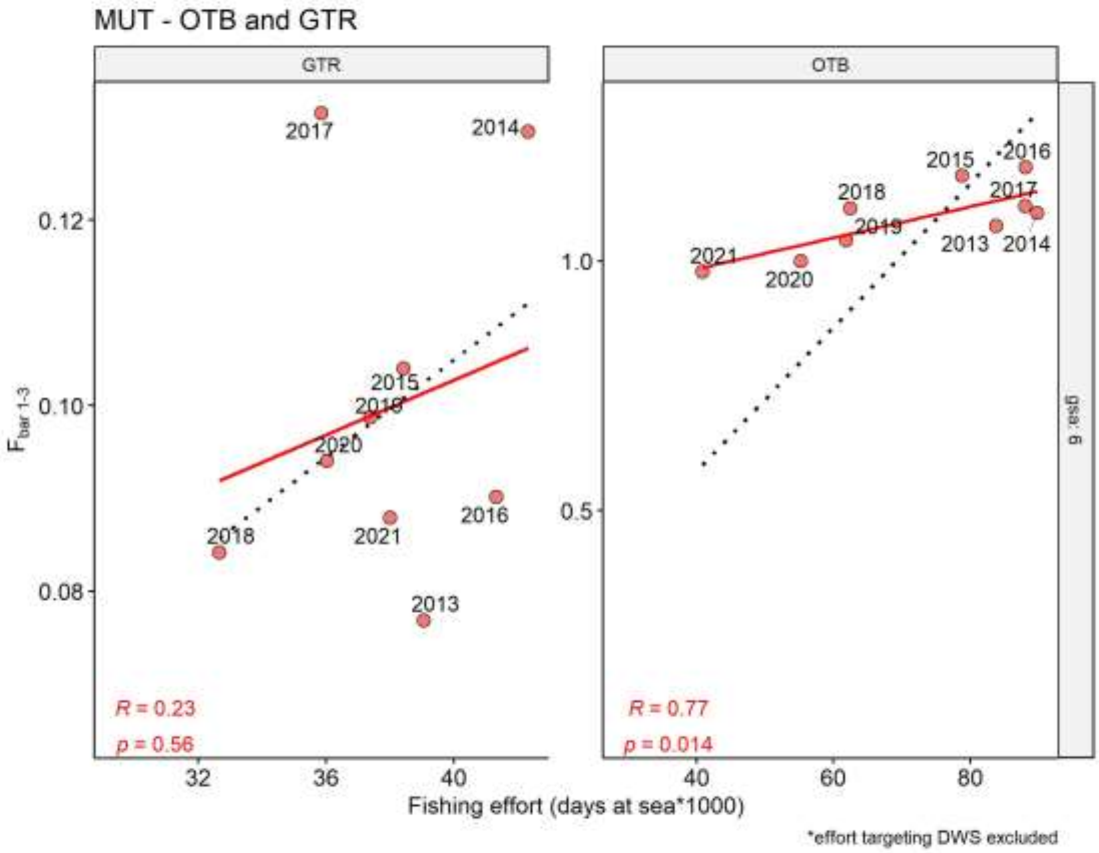


Figure 3.1.3 – Relationship between total effort and Fbar (1-3) for MUT in the management unit 1, GSA 6, by gear. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.6 MUT EMU1-GSA7

The relationship between the effort and the fishing mortality for red mullet in GSA 7 of EMU1 is reported for all gears in in Figure 3.1.4. A clear and significant relationship between fishing mortality and the fishing effort is only highlighted for trawls (OTB and OTT).

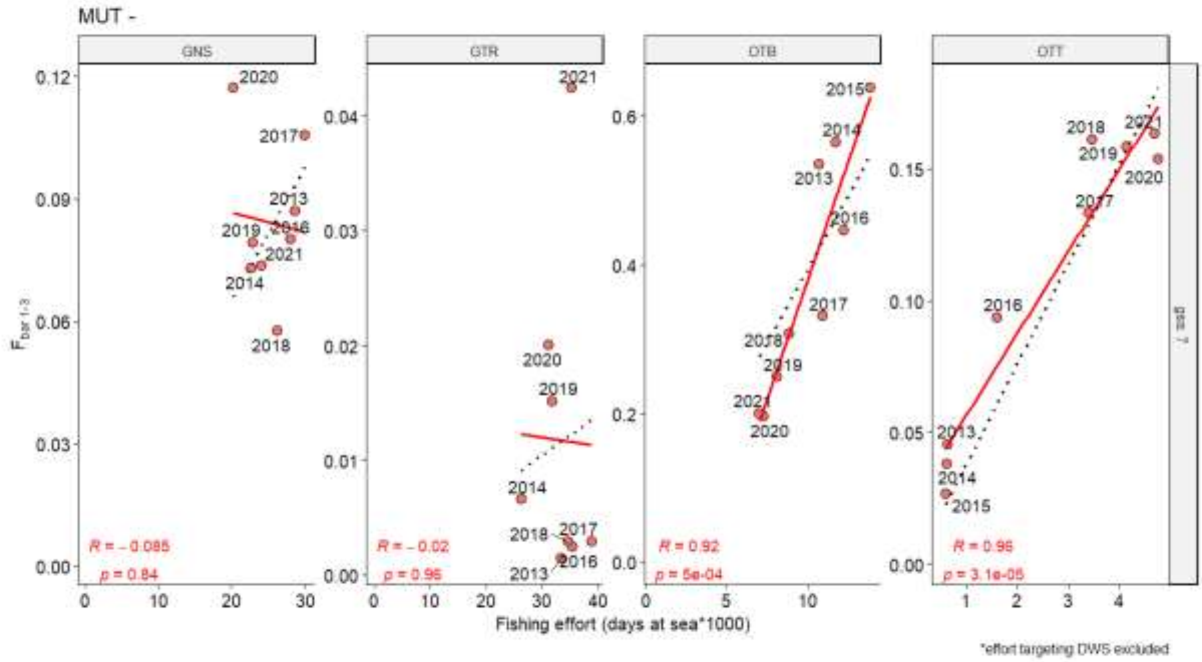


Figure 3.1.4 – Relationship between total effort and Fbar (1-3) for MUT in the management unit 1, GSA 7, by gear. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.7 ARA EMU1-GSAs 1 and 2

The relationship between the effort and the fishing mortality for ARA was analyzed only for OTB in GSA 1, since landings and effort information for GSA2 were not available. The analysis shows a significant relationship for GSA 1(**Error! Reference source not found.**).

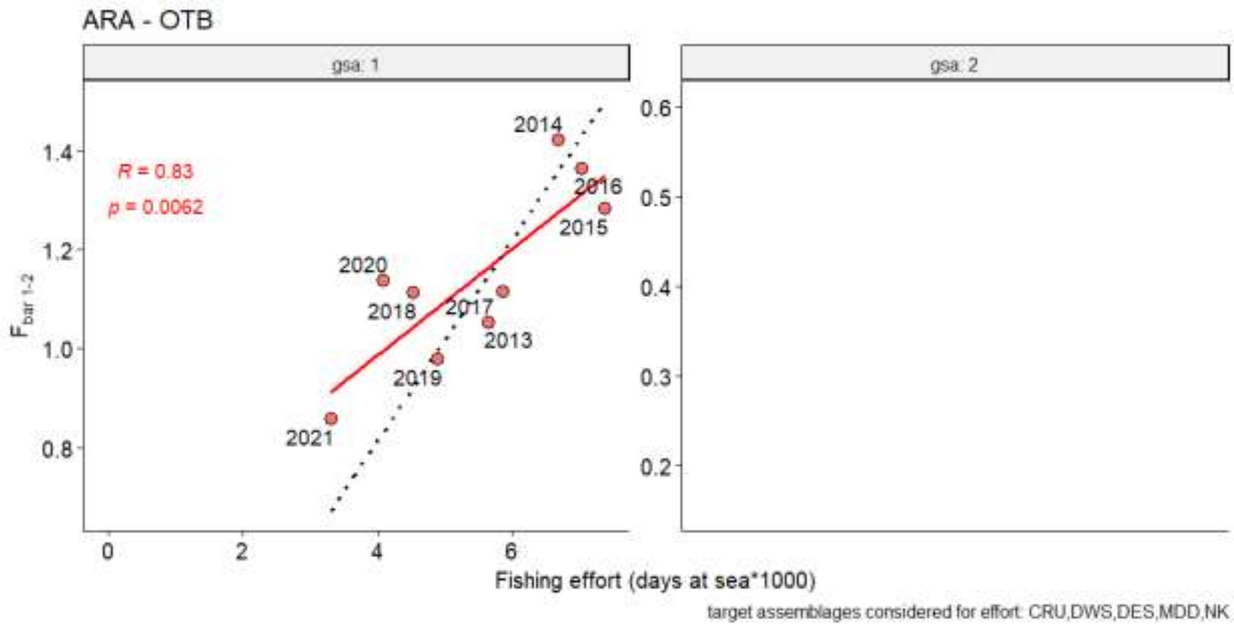


Figure 3.1.12 – Relationship between total effort and Fbar (1-2) for ARA by GSA (1 and 2 combined) for OTB in the management unit 1. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.8 ARA EMU1-GSAs 6 and 7

The relationship between the effort and the fishing mortality for Red and blue shrimp was analyzed for the main gear (OTB). A positive and significant relationship was found (Figure 3.1.5).

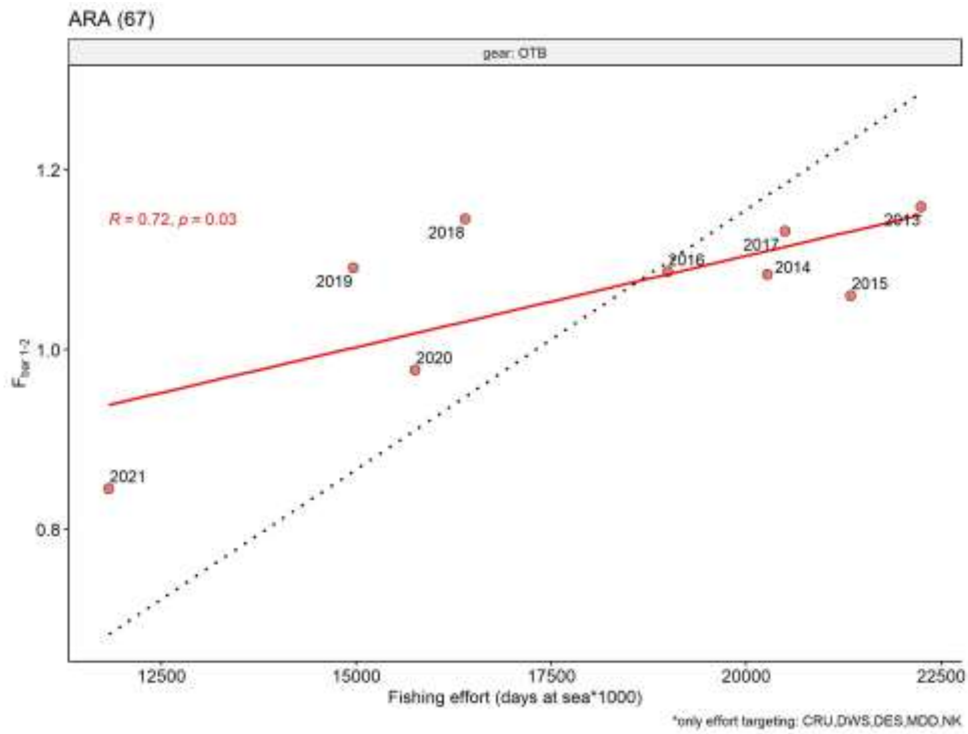


Figure 3.1.5 – Relationship between total effort and Fbar (1-2) for ARA in EMU 1 (GSAs 6 and 7 combined). Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

By exploring the contribution at GSA level, both GSA 6 and 7 showed a similar positive trend (Figure 3.1.6).

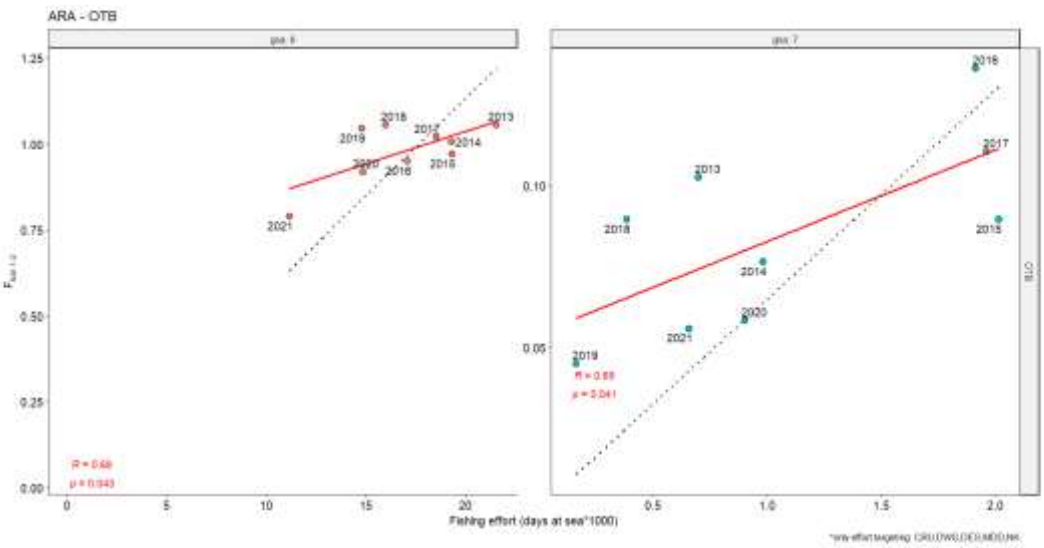


Figure 3.1.6 – Relationship between total effort and Fbar (1-2) for ARA by GSA (6 and 7) for OTB in the management unit 1. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.9 NEP EMU1-GSA 6

Nephrops in GSA 6 was excluded from the analysis as no final results were available for this stock at the time of the EWG.

3.1.3.10 DPS EMU1-GSA 1

For the Deep-water rose shrimp in unit EMU1, GSA 1 the relationship between the effort and the fishing mortality was analysed but the correlation found was not significant (Figure 3.1.7).

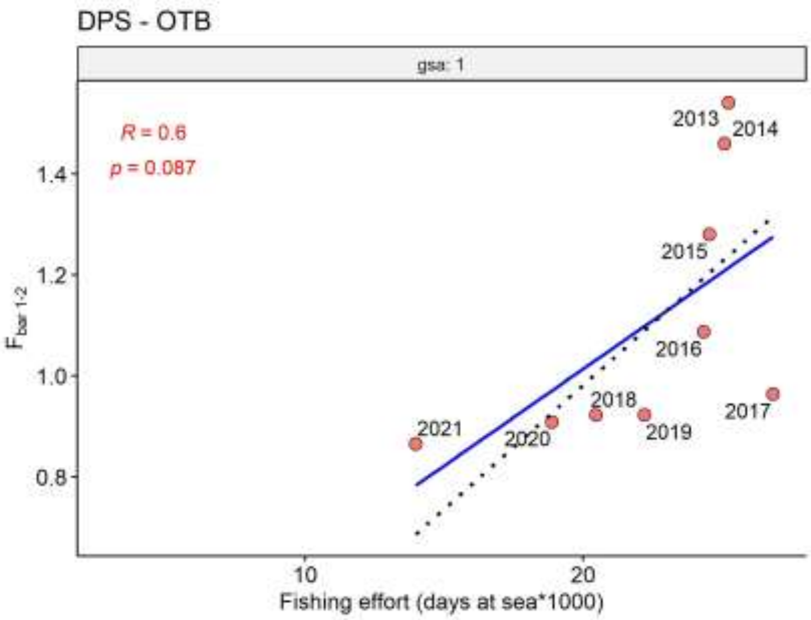


Figure 3.1.7 – Relationship between total effort and Fbar (1-2) for DPS by OTB in the GSA 1 of the management unit 1. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.11 DPS EMU1-GSAs 5,6,7

For the Deep-water rose shrimp in EMU1, GSAs 5, 6 and 7 the relationship between the effort and the fishing mortality was analysed. Both for the whole EMU (Figure 3.1.) and for all single GSAs (Figure 3.1.) the points are distributed in a cloud of values that does not highlight a positive correlation between the two variables.

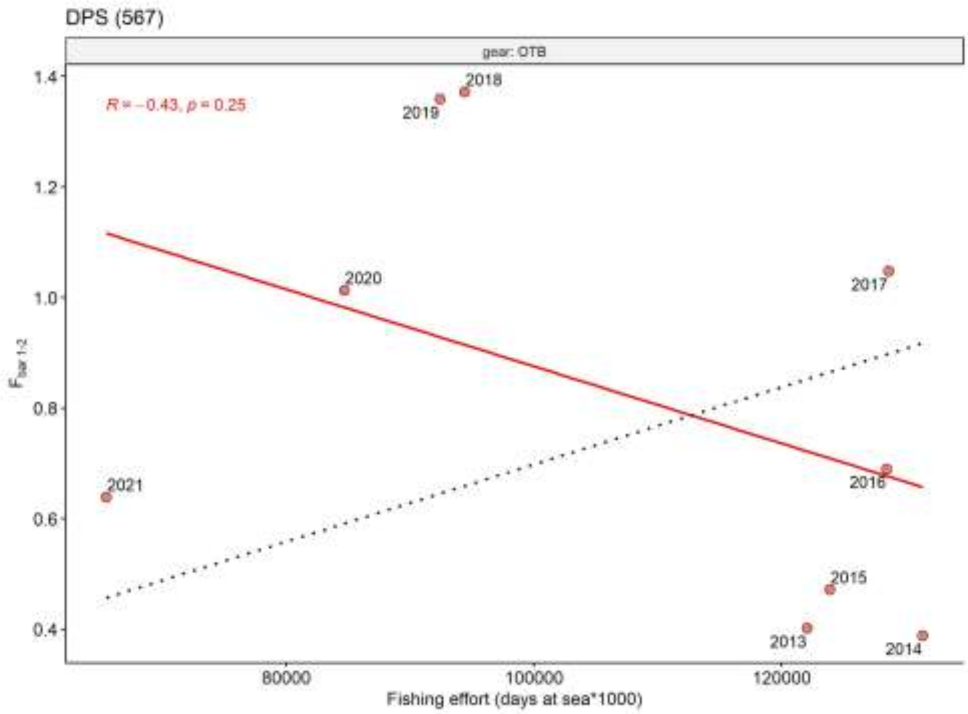


Figure 3.1.6 – Relationship between total effort and Fbar (1-2) for DPS (GSAs 5, 6 and 7 combined) for OTB in the management unit 1. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

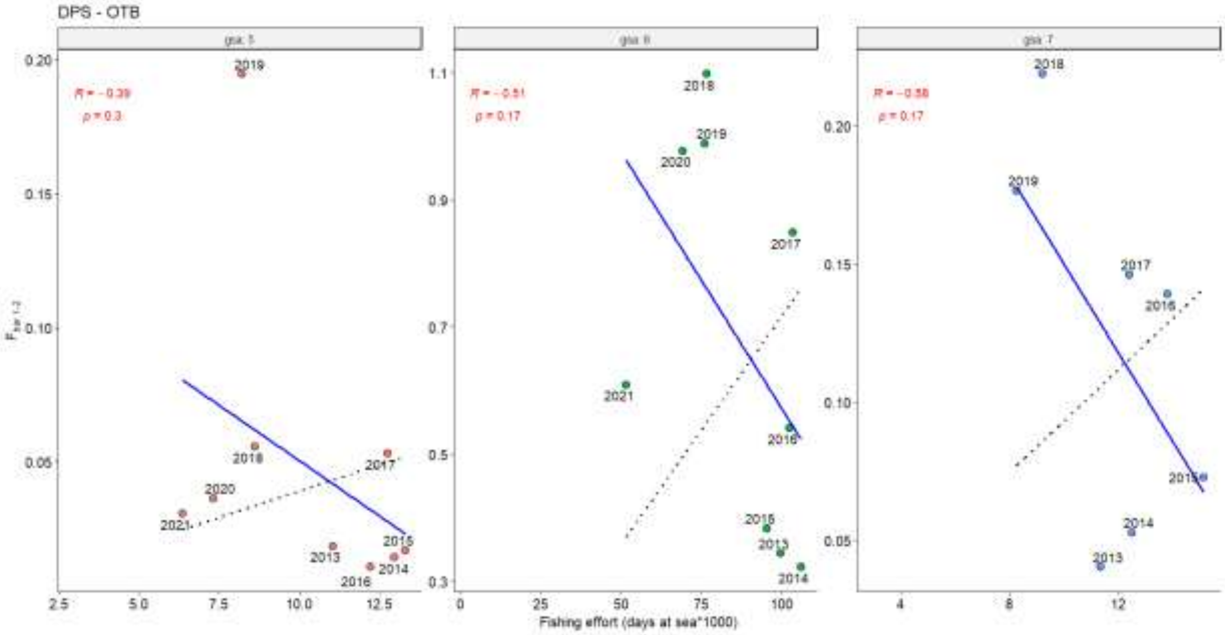


Figure 3.1.17 – Relationship between total effort and Fbar (1-2) for DPS by GSA (5, 6 and 7) for OTB in the management unit 1. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.12 HKE EMU2-GSAs 8,9,10,11

The correlation between total effort and fishing mortality for European hake in EMU2 (GSAs 8, 9, 10, 11) was analysed for all gears (Figure 3.1.). Although most of the gears showed a positive correlation none of them was significant.

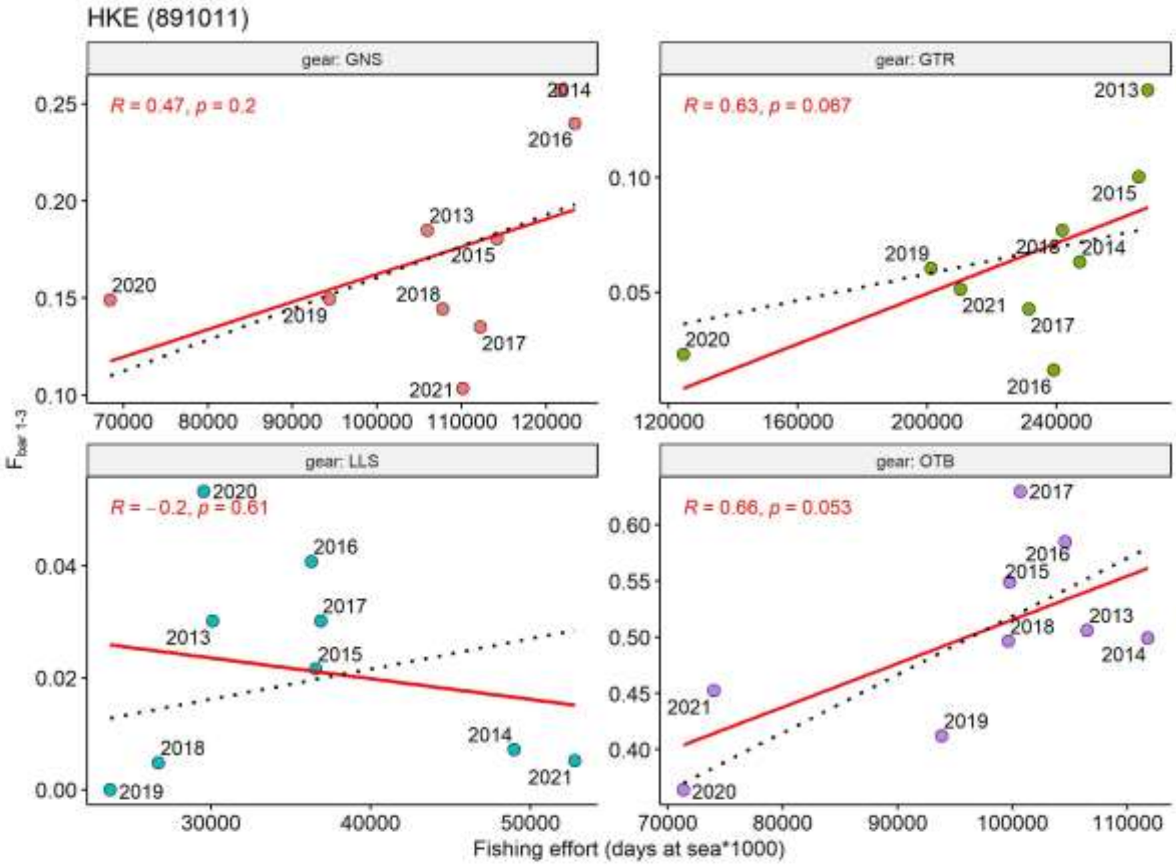


Figure 3.1.18 – Relationship between total effort and Fbar (1-3) for HKE by gears in EMU 2 (GSA 8, 9 10 and 11 combined). Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

By splitting the analysis at GSA level, a significant relationship was found only for OTB in GSA9 (Figure 3.1.), while for the other gears all the analysis does not find any relationship (Figure 3.1.).

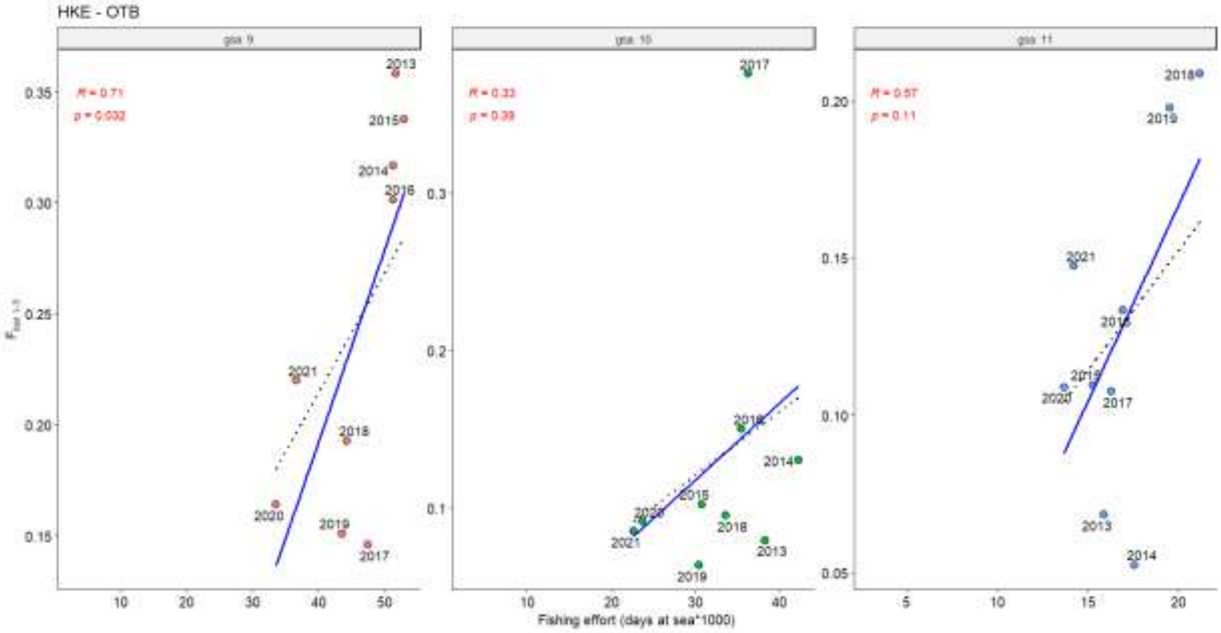


Figure 3.1.19 – Relationship between total effort and Fbar (1-3) for HKE-OTB by GSA (9, 10 and 11) in the management unit 2. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

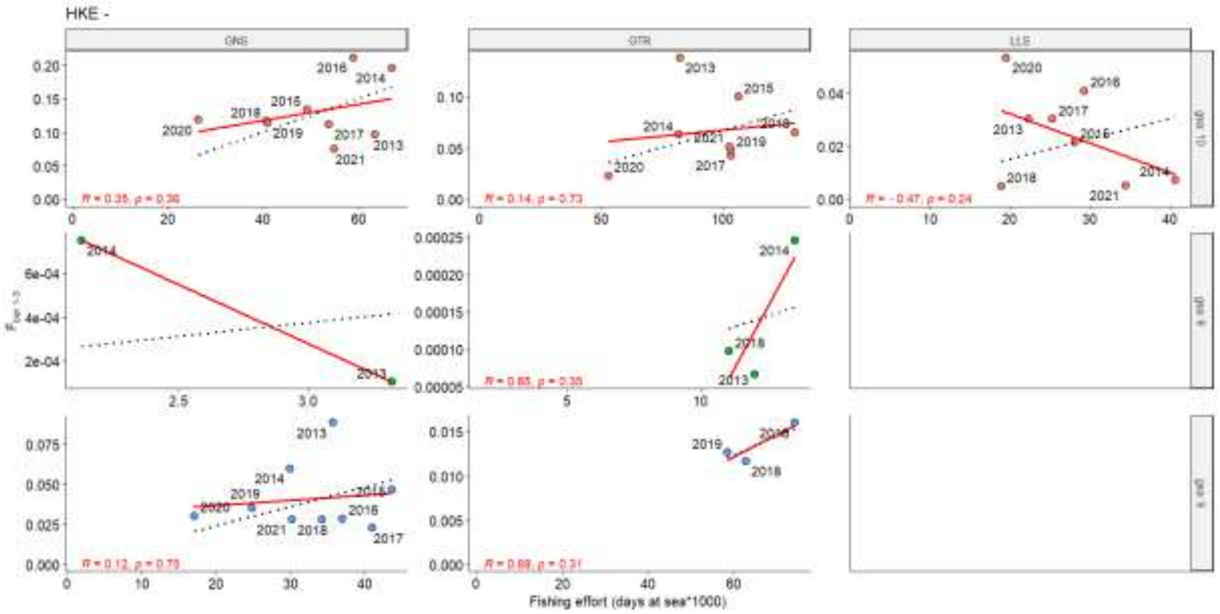


Figure 3.1.20 – Relationship between total effort and Fbar (1-3) for HKE by GSA (9, 10 and 11) and passive gears in the management unit 2. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.13 MUT EMU2-GSA9

The red mullet corresponding to the stock assessment unit in EMU2 GSA9 is shown in the following figures and table.

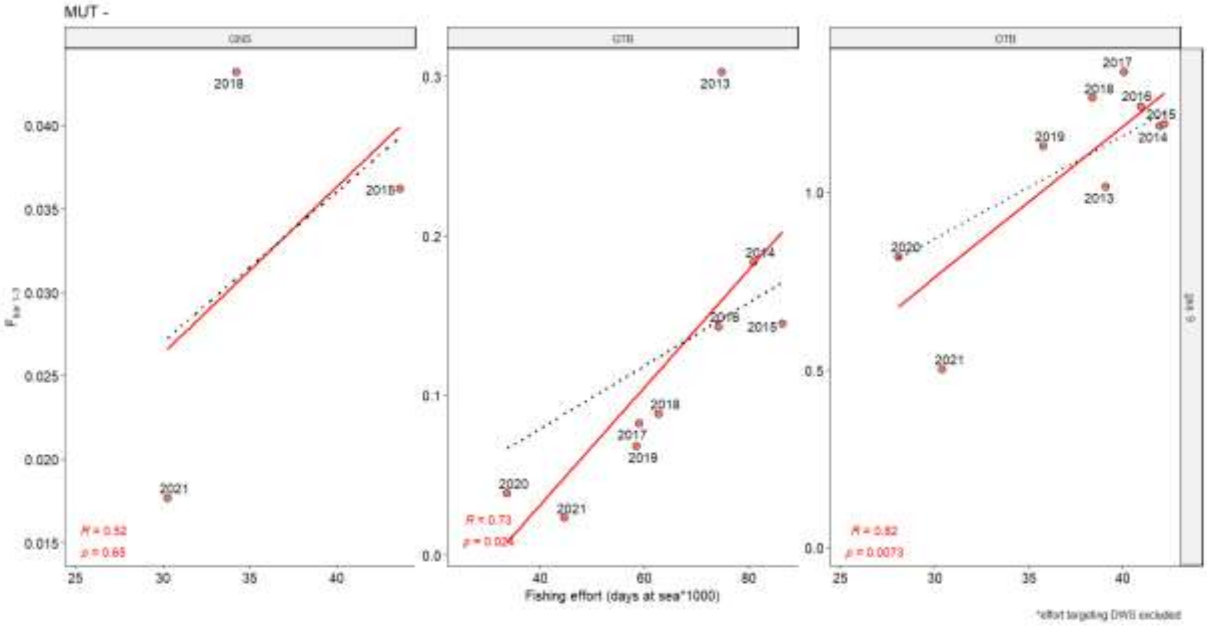


Figure 3.1.21 – Relationship between total effort and Fbar (1-3) for MUT by gear in GSA 9 of the management unit 2. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.14 DPS EMU2-GSAs 9, 10 and 11

The relationship between total effort and fishing mortality of deep-water rose shrimp in EMU2, GSAs 9, 10 and 11 is shown for OTB in the following figures.

At EMU level the points are distributed in a cloud of values that does not highlight a positive correlation between the two variables (Figure 3.1.).

On the contrary at GSA level (Figure 3.1.), a significant positive relationship between the two variables was detected only in GSA 9.

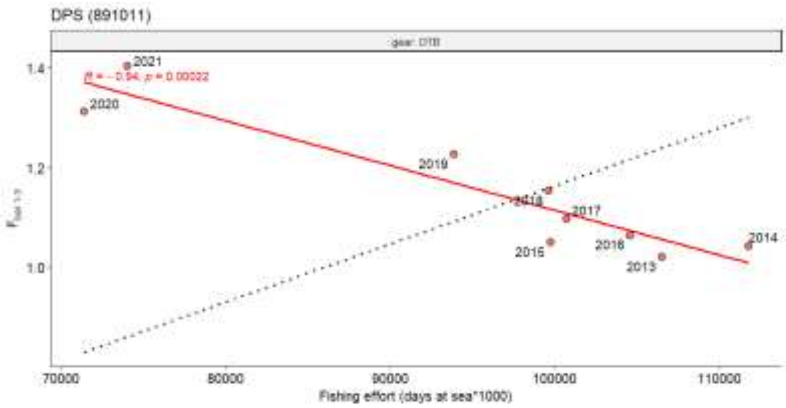


Figure 3.1.22 – Relationship between total effort and Fbar (1-3) for DPS by OTB in the management unit 2 (GSA 9, 10 and 11 combined). Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

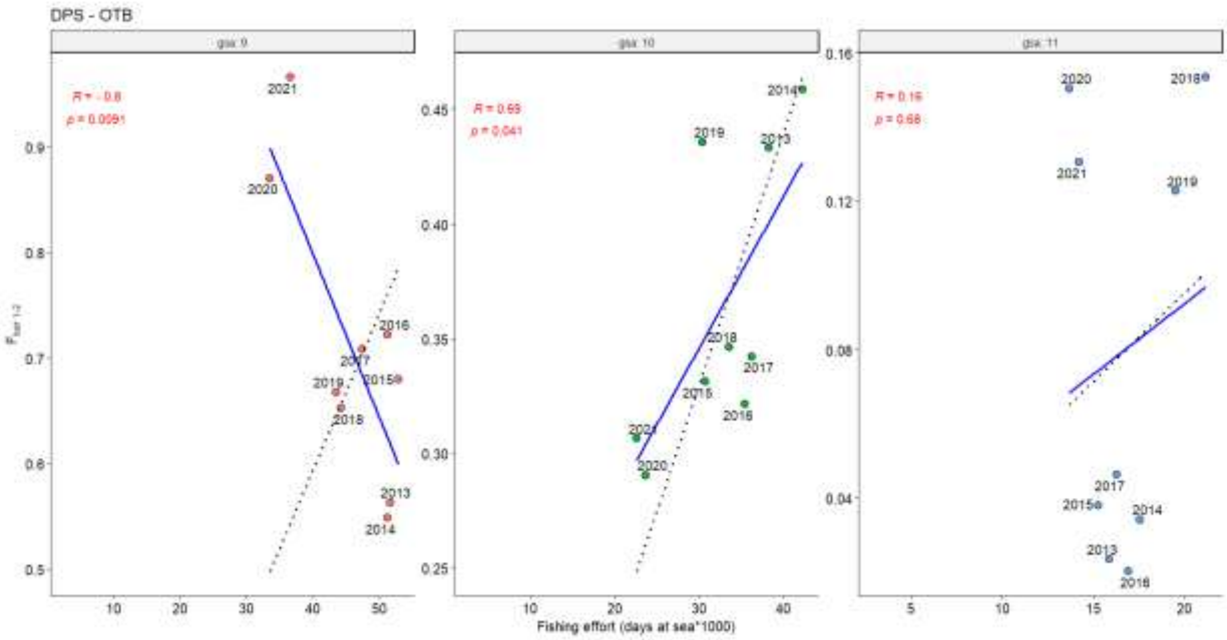


Figure 3.1.23 – Relationship between total effort and Fbar (1-3) for DPS-OTB by GSA (9, 10 and 11) in the management unit 2. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.1.3.15 ARS EMU2-GSAs 8, 9 and 10

The Red and blue shrimp relationship between total effort and fishing effort for ARS in EMU2 (GSAs 9,10 and 11) was explored for OTB. As shown in Figure 3.1. and Figure 3.1. there is no a correlation neither in the EMU nor in any of the single GSA.

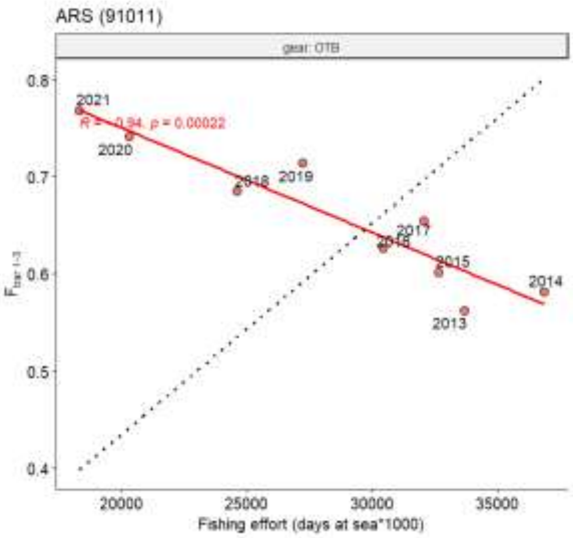


Figure 3.1.24 – Relationship between total effort and Fbar (1-3) for ARS by OTB in the management unit 2 (GSAs 9, 10 and 11 combined). Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

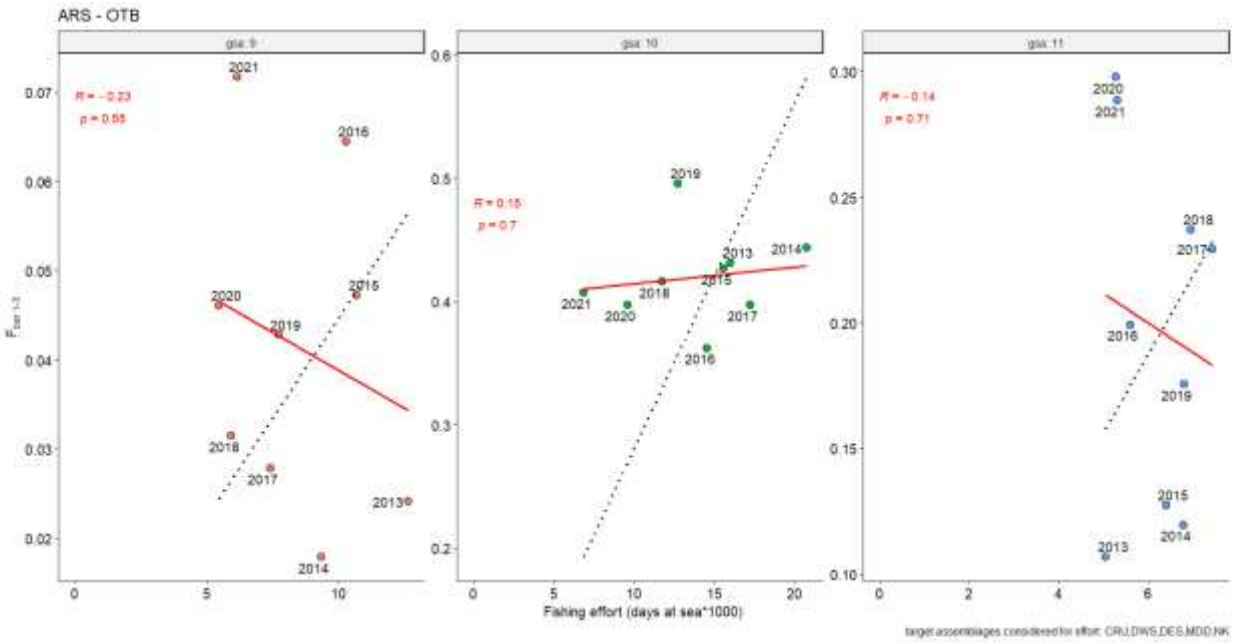


Figure 3.1.25 – Relationship between total effort and Fbar (1-3) for ARS-OTB by GSA (9, 10 and 11) in the management unit 2. Continuous line: linear regression on the observed points. Dashed line: linear regression forced through the origin.

3.2 Estimation of fishing mortality by gear

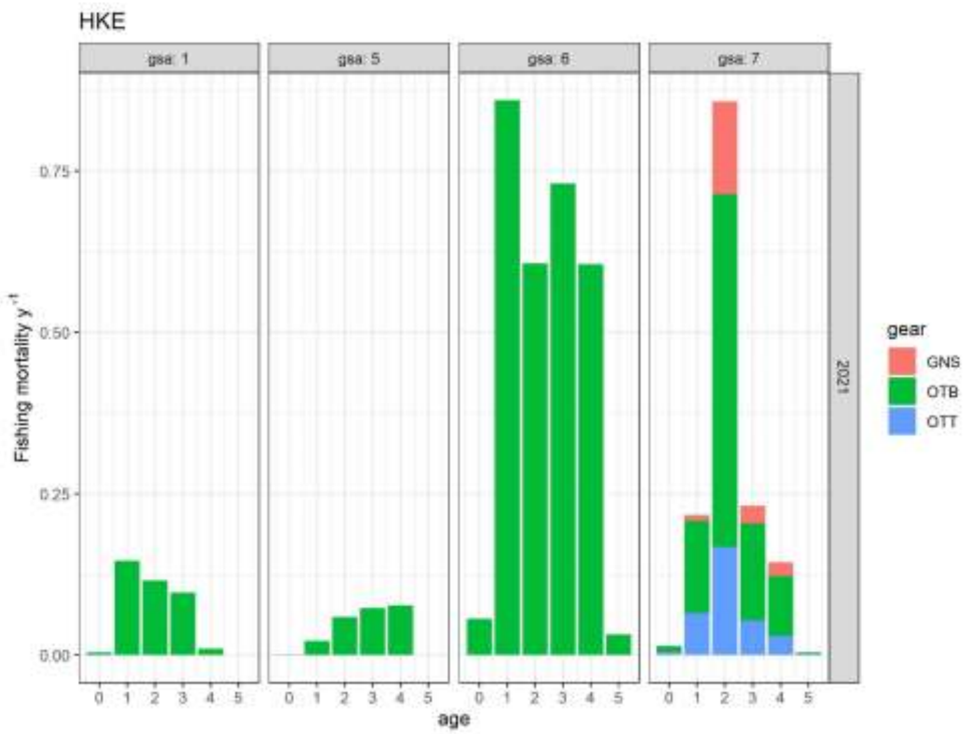
3.2.1 Methods

For the methodology see Section 3.1.2.

3.2.2 Results

3.2.2.1 Vector of partial F for HKE EMU1-GSAs 1,5,6,7

The vector of partial *F* by gears for hake corresponding to the stock assessment in unit EMU1 (GSAs 1, 5, 6 and 7) is shown in the following figure and, for the time series 2013-2021, in the table below.

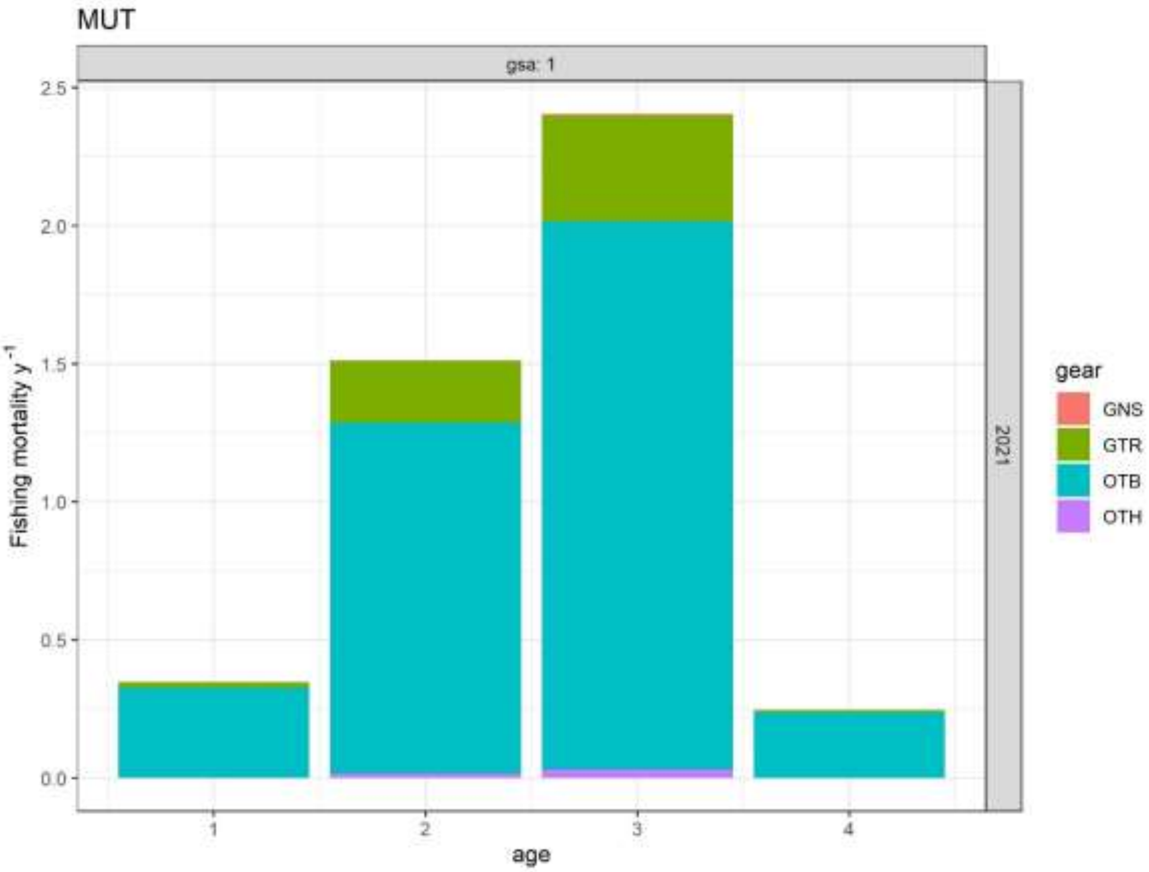


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	HKE.1567	HKE	1	OTB	0	0	0	1.00E-04	1.00E-04	0.0124	0.0074	0.0046	0.0034	0.0039
1	HKE.1567	HKE	1	OTB	1	0.079	0.0897	0.0852	0.0785	0.1583	0.1583	0.1614	0.128	0.1459
1	HKE.1567	HKE	1	OTB	2	0.1995	0.1373	0.1674	0.1573	0.1632	0.2224	0.1513	0.1381	0.1153
1	HKE.1567	HKE	1	OTB	3	0.1857	0.1835	0.1398	0.0887	0.1247	0.1846	0.1168	0.13	0.0963
1	HKE.1567	HKE	1	OTB	4	0.0689	0.0448	0.06	0.0116	0.026	0.0484	0.0034	0.0825	0.0094
1	HKE.1567	HKE	1	OTB	5	0.0019	0	0	0.0043	0	0	0	0	0
1	HKE.1567	HKE	5	OTB	0	7.00E-04	0.0011	2.00E-04	1.00E-04	1.00E-04	0.0035	0.0081	0.0022	4.00E-04
1	HKE.1567	HKE	5	OTB	1	0.052	0.0558	0.0604	0.0322	0.0301	0.0729	0.0889	0.105	0.0217
1	HKE.1567	HKE	5	OTB	2	0.0277	0.0382	0.0623	0.046	0.0514	0.0571	0.0489	0.0413	0.0587
1	HKE.1567	HKE	5	OTB	3	0.0196	0.045	0.0558	0.0571	0.0539	0.0384	0.0252	0.0751	0.0724
1	HKE.1567	HKE	5	OTB	4	0.0682	0.0313	0.0675	0.0568	0.0596	0.0179	0.0094	0	0.0765

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	HKE.1567	HKE	5	OTB	5	0.0017	0.0038	0	8.00E-04	0	0.0052	0	0.0201	0
1	HKE.1567	HKE	6	OTB	0	0.0646	0.0838	0.1084	0.0838	0.0824	0.0814	0.0533	0.0487	0.0562
1	HKE.1567	HKE	6	OTB	1	0.9463	0.8205	0.8426	0.8269	0.9651	1.1128	0.9357	0.9111	0.8595
1	HKE.1567	HKE	6	OTB	2	1.1685	1.2379	1.2734	1.1645	0.9328	1.1266	0.7438	0.8078	0.6067
1	HKE.1567	HKE	6	OTB	3	1.0904	1.0146	1.1667	1.0955	1.1224	1.0133	1.1054	0.8052	0.7303
1	HKE.1567	HKE	6	OTB	4	0.7602	0.4928	0.404	0.5615	0.6174	0.2912	0.2164	0.1283	0.6056
1	HKE.1567	HKE	6	OTB	5	0.0206	0.0371	0.0348	0.0147	0.0271	0.0152	0.0168	0.0061	0.0312
1	HKE.1567	HKE	7	GNS	0	0	0	0	0	0	0	0	0	0
1	HKE.1567	HKE	7	GNS	1	0.0126	0.0184	0.0159	0.0088	0.01	0.005	0.0611	0.0315	0.0096
1	HKE.1567	HKE	7	GNS	2	0.2371	0.1938	0.1696	0.2622	0.2875	0.1576	0.2474	0.2896	0.1444
1	HKE.1567	HKE	7	GNS	3	0.0773	0.0877	0.0357	0.0667	0	0.0356	0.0329	0.0069	0.0274
1	HKE.1567	HKE	7	GNS	4	0.1026	0.0077	0	0.0341	0	0.0199	0	0	0.0213
1	HKE.1567	HKE	7	GNS	5	0.0075	0	0	0	0	0	0	0	0
1	HKE.1567	HKE	7	OTB	0	0.0351	0.0696	0.0647	0.0507	0.0183	0.0228	0.0486	0.0425	0.0088
1	HKE.1567	HKE	7	OTB	1	0.5629	0.6984	0.6322	0.5495	0.3257	0.2484	0.3577	0.2679	0.1425
1	HKE.1567	HKE	7	OTB	2	0.5751	0.643	0.5022	0.43	0.5758	0.5198	0.8449	0.6166	0.5461
1	HKE.1567	HKE	7	OTB	3	0.1618	0.2311	0.1092	0.1228	0.1133	0.2005	0.2129	0.2724	0.15
1	HKE.1567	HKE	7	OTB	4	0.1587	0.0493	0.0851	0.1158	0.0375	0.0776	0.0687	0.1306	0.0925
1	HKE.1567	HKE	7	OTB	5	0.0156	0.0076	0.0117	0.022	0.0133	0.0197	0.0224	0.0121	0.0026
1	HKE.1567	HKE	7	OTT	0	0.0028	0.0045	0.0025	0.0084	0.0065	0.0093	0.0206	0.0179	0.0045
1	HKE.1567	HKE	7	OTT	1	0.0448	0.0459	0.0273	0.0899	0.1104	0.0977	0.1178	0.1006	0.0651
1	HKE.1567	HKE	7	OTT	2	0.0276	0.0263	0.0157	0.0284	0.0957	0.149	0.2324	0.1401	0.1675
1	HKE.1567	HKE	7	OTT	3	0.0071	0.0081	0.0036	0.0096	0.0386	0.0673	0.0716	0.1129	0.0537
1	HKE.1567	HKE	7	OTT	4	0.0048	0.0026	0.0042	0.0128	0.0126	0.023	0.0274	0.0557	0.0295
1	HKE.1567	HKE	7	OTT	5	6.00E-04	4.00E-04	5.00E-04	0.0031	0.0048	0.0077	0.0094	0.0053	0.0013

3.2.2.2 Vector of partial F for MUT EMU1-GSA1

The vector of partial *F* by gears for red mullet corresponding to the stock assessment in unit EMU1, GSA 1 is shown in the following figure and, for the time series 2013-2021, in the table below.

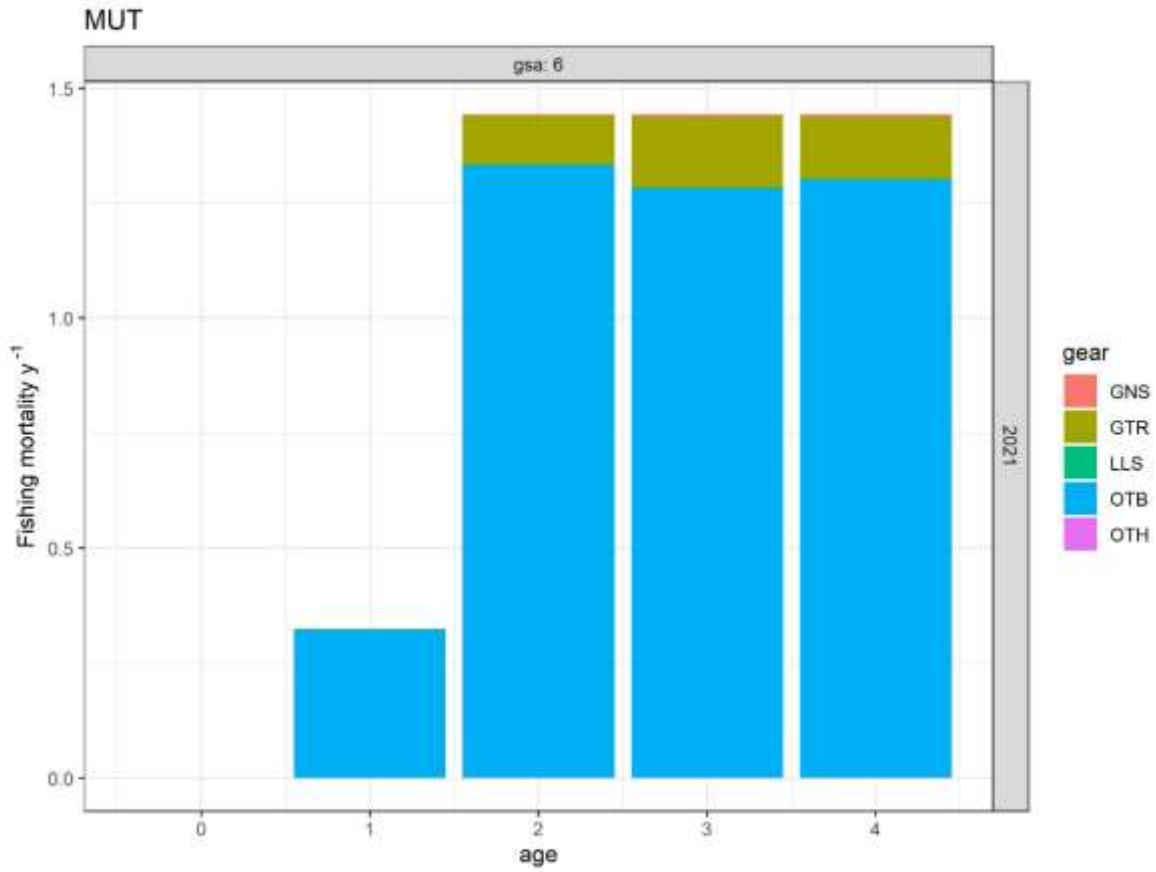


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.1	MUT	1	GNS	1	NA	NA	NA	NA	NA	NA	NA	NA	3.00E-04
1	MUT.1	MUT	1	GNS	2	NA	NA	NA	NA	NA	NA	NA	NA	0.0033
1	MUT.1	MUT	1	GNS	3	NA	NA	NA	NA	NA	NA	NA	NA	0.0066
1	MUT.1	MUT	1	GNS	4	NA	NA	NA	NA	NA	NA	NA	NA	1.00E-04
1	MUT.1	MUT	1	GTR	1	0	NA	0	0.0343	0.0461	0.0458	0.0079	NA	0.0195
1	MUT.1	MUT	1	GTR	2	0	NA	0.1036	0.3813	0.4339	0.2798	0.1284	NA	0.2231
1	MUT.1	MUT	1	GTR	3	0.7143	NA	0.3874	1.5438	0.8971	0.2474	1.073	NA	0.3818
1	MUT.1	MUT	1	GTR	4	0.1418	NA	0.0553	0.1119	0.0902	0.006	0.0249	NA	0.0097
1	MUT.1	MUT	1	OTB	1	0.3128	0.3041	0.3269	0.3349	0.3588	0.3669	0.3879	0.3706	0.3255
1	MUT.1	MUT	1	OTB	2	1.3637	1.3256	1.3218	1.2286	1.3314	1.5197	1.5971	1.6159	1.2699
1	MUT.1	MUT	1	OTB	3	1.4528	2.1067	1.8778	1.0145	1.9084	2.6123	1.669	2.5679	1.9849
1	MUT.1	MUT	1	OTB	4	0.0806	0.2163	0.1773	0.1507	0.1978	0.2876	0.2566	NA	0.2363
1	MUT.1	MUT	1	OTH	1	NA	NA	NA	NA	NA	NA	NA	NA	0.0016
1	MUT.1	MUT	1	OTH	2	NA	NA	NA	NA	NA	NA	NA	NA	0.0162

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.1	MUT	1	OTH	3	NA	NA	NA	NA	NA	NA	NA	NA	0.0303
1	MUT.1	MUT	1	OTH	4	NA	NA	NA	NA	NA	NA	NA	NA	6.00E-04

3.2.2.3 Vector of partial F for MUT EMU1-GSA6

The vector of partial *F* by gears for red mullet corresponding to the stock assessment in unit EMU1, GSA 6 is shown in the following figure and, for the time series 2013-2021, in the table below.

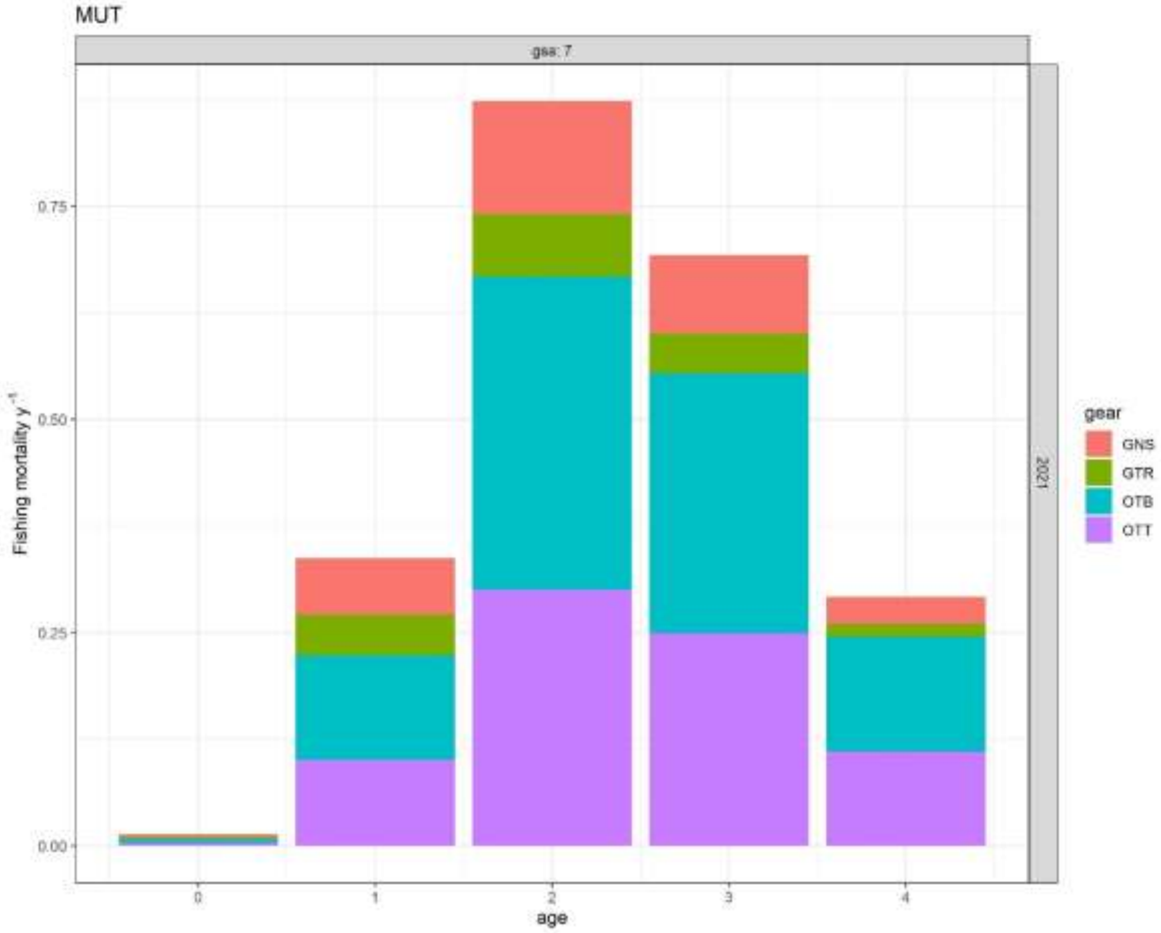


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.6	MUT	6	GNS	0	NA	NA	NA	NA	NA	NA	NA	NA	0
1	MUT.6	MUT	6	GNS	1	NA	NA	NA	NA	NA	NA	NA	0	1.00E-04
1	MUT.6	MUT	6	GNS	2	NA	NA	NA	NA	NA	NA	NA	0.0054	0.0024
1	MUT.6	MUT	6	GNS	3	NA	NA	NA	NA	NA	NA	NA	0.0109	0.0048
1	MUT.6	MUT	6	GNS	4	NA	NA	NA	NA	NA	NA	NA	0	0.0044
1	MUT.6	MUT	6	GTR	0	NA	NA	NA	0	0	0	NA	NA	0
1	MUT.6	MUT	6	GTR	1	0.0113	0.0058	0.0095	0.0037	0.0023	0.0049	0.0024	5.00E-04	0.0028
1	MUT.6	MUT	6	GTR	2	0.1543	0.1807	0.1953	0.1194	0.1343	0.1391	0.1518	0.0934	0.1062
1	MUT.6	MUT	6	GTR	3	0.0649	0.2021	0.1071	0.1473	0.258	0.1085	0.1419	0.1881	0.1547
1	MUT.6	MUT	6	GTR	4	0.0466	0.2302	0.2354	0.1833	0.366	0.0337	0.1918	0	0.1359

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.6	MUT	6	LLS	0	NA	NA	NA	NA	NA	NA	NA	NA	0
1	MUT.6	MUT	6	LLS	1	NA	NA	NA	NA	NA	NA	NA	NA	1.00E-04
1	MUT.6	MUT	6	LLS	2	NA	NA	NA	NA	NA	NA	NA	NA	0.0018
1	MUT.6	MUT	6	LLS	3	NA	NA	NA	NA	NA	NA	NA	NA	0.0023
1	MUT.6	MUT	6	LLS	4	NA	NA	NA	NA	NA	NA	NA	NA	0.0017
1	MUT.6	MUT	6	OTB	0	NA	NA	NA	1.00E-04	1.00E-04	1.00E-04	NA	NA	1.00E-04
1	MUT.6	MUT	6	OTB	1	0.3377	0.3671	0.3782	0.3849	0.3753	0.3568	0.3443	0.3344	0.3227
1	MUT.6	MUT	6	OTB	2	1.3921	1.4717	1.5229	1.6023	1.5391	1.4639	1.3847	1.3833	1.3316
1	MUT.6	MUT	6	OTB	3	1.4815	1.4503	1.6111	1.5744	1.4155	1.4945	1.3946	1.2807	1.2797
1	MUT.6	MUT	6	OTB	4	1.4998	1.4221	1.4828	1.5385	1.3075	1.5693	1.3447	1.4845	1.3002
1	MUT.6	MUT	6	OTH	0	NA	NA	NA	NA	NA	NA	NA	NA	0
1	MUT.6	MUT	6	OTH	1	NA	NA	NA	NA	NA	NA	NA	0	0
1	MUT.6	MUT	6	OTH	2	NA	NA	NA	NA	NA	NA	NA	0.0024	9.00E-04
1	MUT.6	MUT	6	OTH	3	NA	NA	NA	NA	NA	NA	NA	0.0048	0.0013
1	MUT.6	MUT	6	OTH	4	NA	NA	NA	NA	NA	NA	NA	0	6.00E-04

3.2.2.4 Vector of partial F for MUT EMU1-GSA7

The vector of partial *F* for red mullet corresponding to the stock assessment unit in EMU1 GSA 1 is shown in the following figure and, for the time series 2013-2021, in the table below.

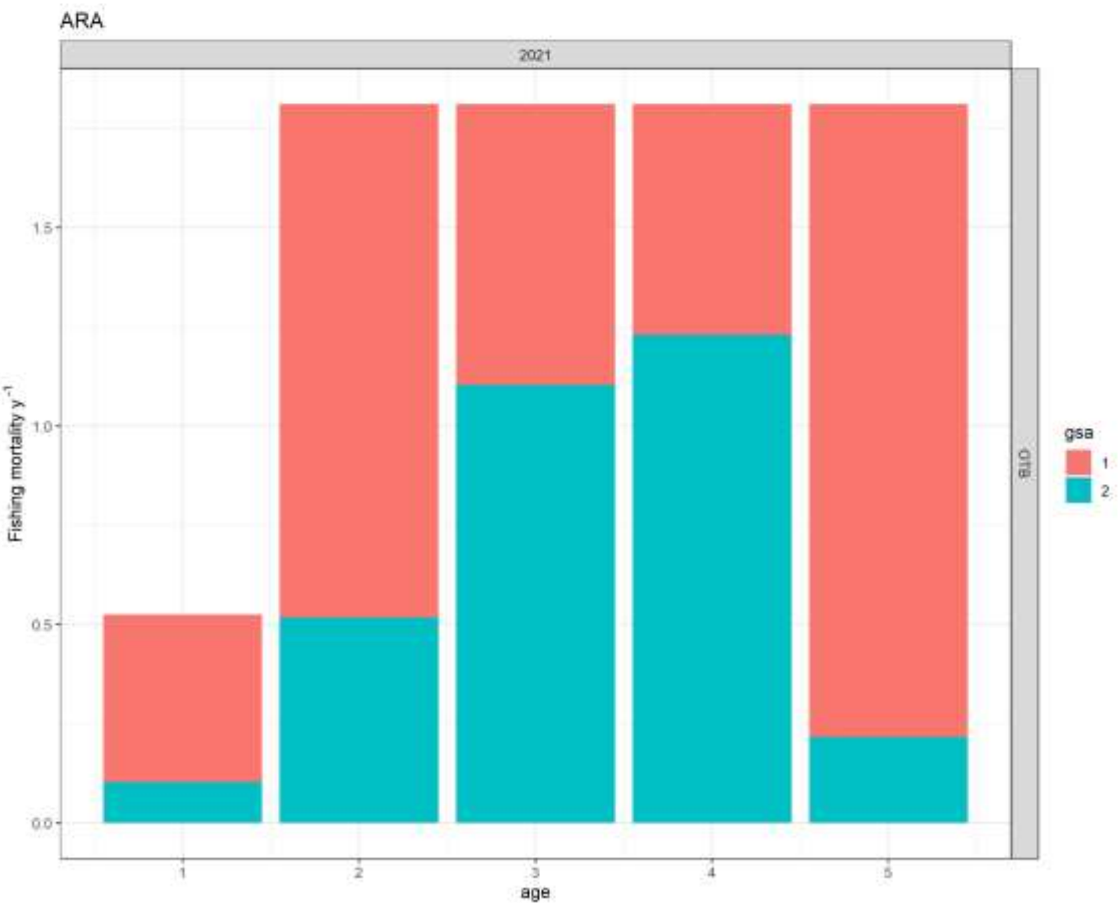


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.7	MUT	7	GNS	0	0	0	NA	0	0	1.00E-04	0	0	0.0033
1	MUT.7	MUT	7	GNS	1	0.0175	0.0249	NA	0.0133	0.0334	0.0198	0.0028	0.026	0.0661
1	MUT.7	MUT	7	GNS	2	0.147	0.1491	NA	0.1151	0.2417	0.1226	0.0975	0.2334	0.132
1	MUT.7	MUT	7	GNS	3	0.1831	0.1176	NA	0.1912	0.1469	0.0874	0.2167	0.2089	0.0924
1	MUT.7	MUT	7	GNS	4	0.0829	0.0413	NA	0.1398	0.034	0.0325	0.1514	0.0927	0.0315
1	MUT.7	MUT	7	GTR	0	0	0	NA	0	0	0	0	0	0.0025
1	MUT.7	MUT	7	GTR	1	3.00E-04	0.002	NA	4.00E-04	9.00E-04	0.001	5.00E-04	0.0045	0.0474
1	MUT.7	MUT	7	GTR	2	0.0025	0.013	NA	0.0036	0.0067	0.0062	0.0187	0.0403	0.0735
1	MUT.7	MUT	7	GTR	3	0.0031	0.0114	NA	0.006	0.0041	0.0045	0.0415	0.0354	0.0463
1	MUT.7	MUT	7	GTR	4	0.0014	0.0042	NA	0.0044	9.00E-04	0.0017	0.029	0.0137	0.0153
1	MUT.7	MUT	7	OTB	0	0.0172	0.0183	0.0179	0.0143	0.0114	0.0088	0.0088	0.0078	0.0044
1	MUT.7	MUT	7	OTB	1	0.4134	0.424	0.4454	0.3429	0.2532	0.2169	0.2101	0.1746	0.1227

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	MUT.7	MUT	7	OTB	2	0.9876	1.013	1.1618	0.8312	0.5549	0.5518	0.4863	0.3441	0.3672
1	MUT.7	MUT	7	OTB	3	0.7241	0.8053	0.9269	0.597	0.5027	0.4544	0.2901	0.2568	0.3047
1	MUT.7	MUT	7	OTB	4	0.3008	0.348	0.3924	0.2052	0.26	0.1928	0.0795	0.1055	0.1346
1	MUT.7	MUT	7	OTT	0	0.0019	0.0011	0.0011	0.0034	0.0049	0.0062	0.0055	0.006	0.0034
1	MUT.7	MUT	7	OTT	1	0.0397	0.0295	0.0223	0.0812	0.115	0.1349	0.1394	0.1373	0.1007
1	MUT.7	MUT	7	OTT	2	0.0823	0.069	0.0494	0.1838	0.2392	0.2843	0.3114	0.2688	0.3
1	MUT.7	MUT	7	OTT	3	0.0575	0.053	0.0344	0.1056	0.1737	0.2196	0.1769	0.2026	0.2492
1	MUT.7	MUT	7	OTT	4	0.0226	0.0225	0.0125	0.0296	0.0537	0.0956	0.0457	0.0846	0.1104

3.2.2.5 Vector of partial F for ARA EMU1-GSAs 1 and 2

The vector of partial *F* for Red and blue shrimp for OTB, corresponding to the stock assessment in unit EMU1, GSA 1 and 2 is shown in the following figure and, for the time series 2013-2021, in the table below.

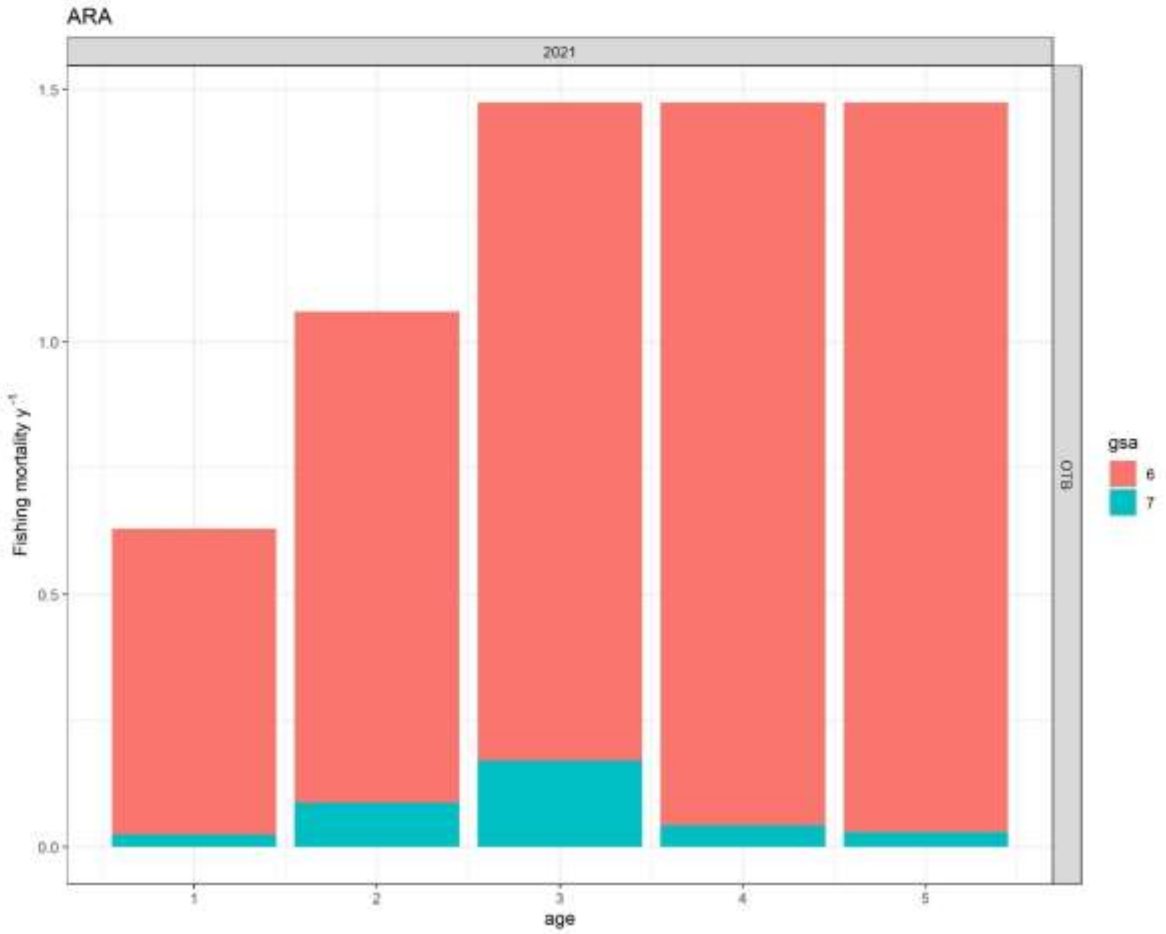


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	ARA.12	ARA	1	OTB	1	0.6429	0.7023	0.6714	0.7186	0.6042	0.6022	0.5647	0.5543	0.4224
1	ARA.12	ARA	1	OTB	2	1.4643	2.142	1.8939	2.0103	1.6277	1.6218	1.3918	1.722	1.2933

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	ARA.12	ARA	1	OTB	3	1.2516	1.5534	1.7806	1.4113	1.1589	1.1998	0.609	1.1076	0.7077
1	ARA.12	ARA	1	OTB	4	0.6256	1.4823	1.7741	1.1457	1.397	1.3265	0.1557	1.453	0.5812
1	ARA.12	ARA	1	OTB	5	2.3166	2.3592	2.3746	1.6373	2.3597	1.6745	1.5175	1.8691	1.5942
1	ARA.12	ARA	2	OTB	1	0.1032	0.056	0.0918	0.0355	0.1239	0.0845	0.0701	0.0248	0.1026
1	ARA.12	ARA	2	OTB	2	1.109	0.4735	0.7383	0.5907	0.8835	0.7465	0.7977	0.2752	0.5172
1	ARA.12	ARA	2	OTB	3	1.3217	1.0621	0.8516	1.1896	1.3523	1.1684	1.5805	0.8896	1.1028
1	ARA.12	ARA	2	OTB	4	1.9477	1.1332	0.8581	1.4552	1.1142	1.0418	2.0338	0.5442	1.2294
1	ARA.12	ARA	2	OTB	5	0.2567	0.2563	0.2577	0.9636	0.1515	0.6937	0.672	0.1282	0.2164

3.2.2.6 Vector of partial F for ARA EMU1-GSAs 6 and 7

The vector of partial *F* for Red and blue shrimp for OTB, corresponding to the stock assessment unit in EMU1 GSA 1 and 2 is shown in the following figure and, for the time series 2013-2021, in the table below.



EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	ARA.67	ARA	6	OTB	1	0.8389	0.7903	0.7642	0.7614	0.7977	0.8149	0.8018	0.6905	0.6065

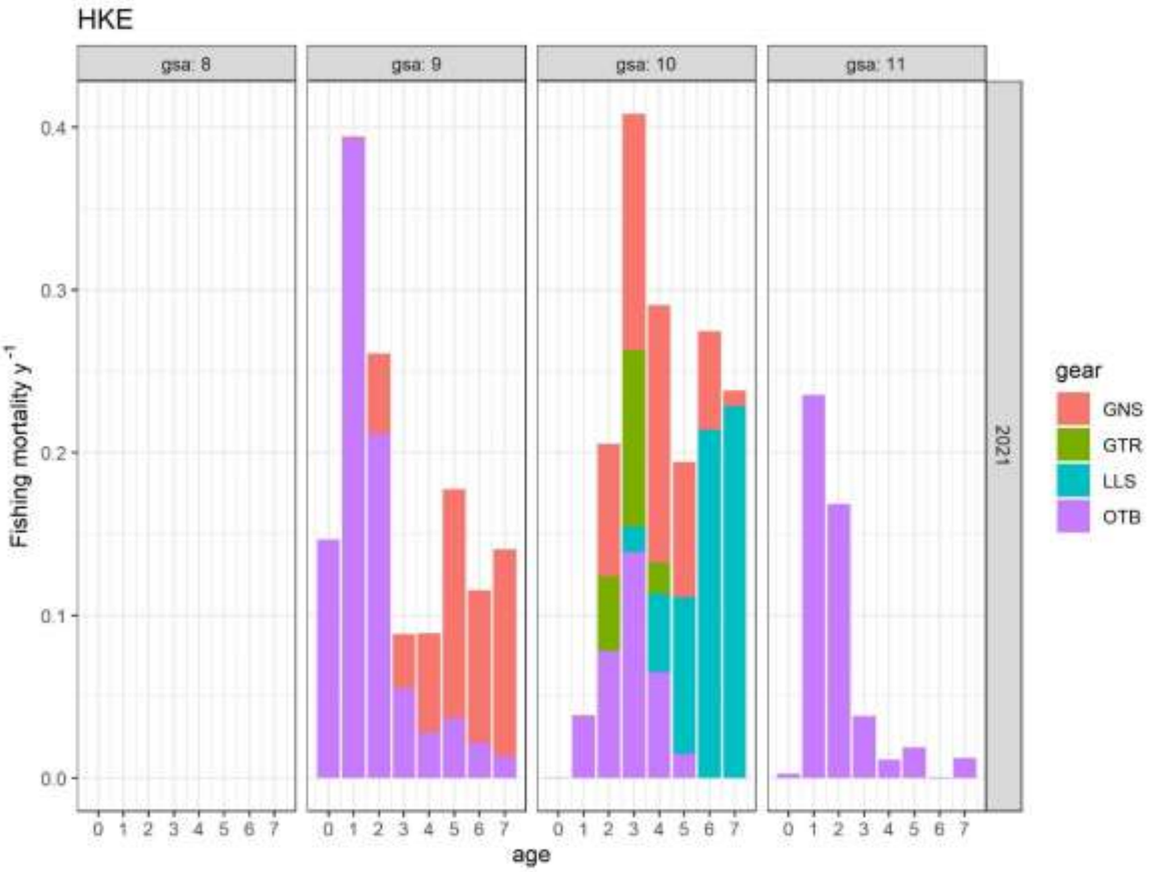
EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	ARA.67	ARA	6	OTB	2	1.274	1.2243	1.1763	1.1391	1.2448	1.2964	1.29	1.1471	0.9726
1	ARA.67	ARA	6	OTB	3	1.8206	1.5378	1.4701	1.5847	1.6622	1.7875	1.7498	1.6028	1.3028
1	ARA.67	ARA	6	OTB	4	2.008	1.7717	1.6264	1.722	1.7807	1.9031	1.8721	1.6729	1.4314
1	ARA.67	ARA	6	OTB	5	1.9426	1.8825	1.844	1.8927	1.9635	1.9834	1.8716	1.699	1.4449
1	ARA.67	ARA	7	OTB	1	0.0259	0.0183	0.0266	0.0492	0.0467	0.0396	0.0122	0.0386	0.0243
1	ARA.67	ARA	7	OTB	2	0.1792	0.1345	0.1526	0.2232	0.1743	0.1396	0.0778	0.0782	0.0874
1	ARA.67	ARA	7	OTB	3	0.2001	0.3515	0.3777	0.3095	0.3109	0.2091	0.152	0.1009	0.171
1	ARA.67	ARA	7	OTB	4	0.0126	0.1177	0.2213	0.1722	0.1924	0.0935	0.0296	0.0308	0.0424
1	ARA.67	ARA	7	OTB	5	0.0781	0.0068	0.0037	0.0015	0.0096	0.0131	0.0302	0.0047	0.029

3.2.2.7 Vector of partial F for NEP EMU1-GSA 6

No vector for the partial F for NEP 6 was estimated as there were uncertainties in the assessment at the time of the EWG.

3.2.2.8 Vector of partial F for HKE EMU2-GSAs 8,9,10,11

The vector of partial *F* by gears for European hake corresponding to the stock assessment in unit EMU2 (GSAs 8, 9, 10, 11) is shown for 2021 in the following figure, and for the time series 2013-2021 in the table below.



EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	HKE.891011	HKE	8	GNS	0	0	0	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	1	0	1.00E-04	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	2	0	0	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	3	3.00E-04	0.0022	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	4	1.00E-04	0.001	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	5	0	0	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	6	0.0013	0	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GNS	7	0	0	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	GTR	0	0	0	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	GTR	1	0	0	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	GTR	2	0	0	NA	NA	NA	2.00E-04	NA	NA	NA
2	HKE.891011	HKE	8	GTR	3	2.00E-04	7.00E-04	NA	NA	NA	1.00E-04	NA	NA	NA

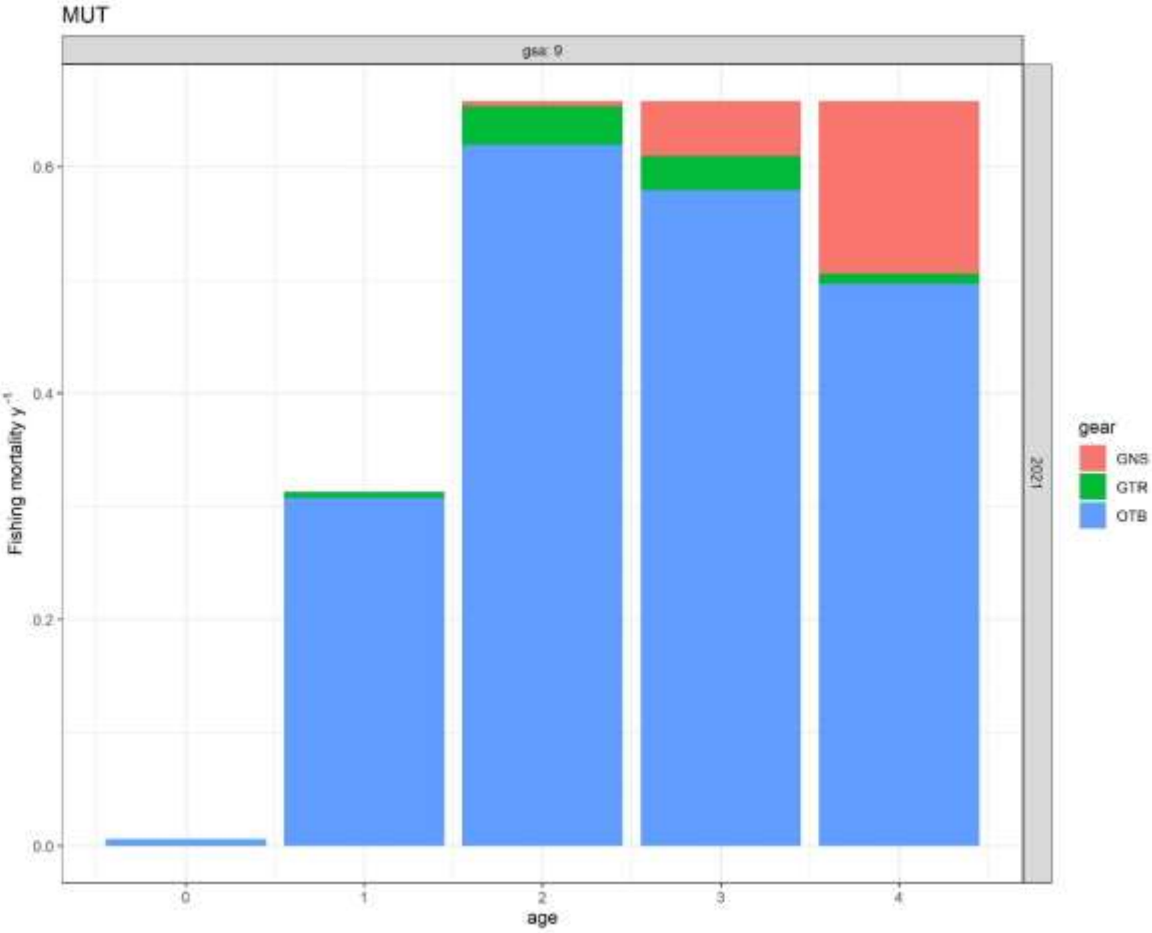
EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	HKE.891011	HKE	8	GTR	4	2.00E-04	3.00E-04	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	GTR	5	0	0	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	GTR	6	3.00E-04	0	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	GTR	7	0	0	NA	NA	NA	0	NA	NA	NA
2	HKE.891011	HKE	8	LLS	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	5	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	LLS	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	0	0.0018	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	1	0.0014	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	2	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	3	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	4	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	5	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	6	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	8	OTB	7	0	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	GNS	0	0	0	0	0	0	0	0	0	0
2	HKE.891011	HKE	9	GNS	1	0.0069	0.0043	5.00E-04	0.0016	2.00E-04	0.0012	5.00E-04	0.0013	9.00E-04
2	HKE.891011	HKE	9	GNS	2	0.1089	0.0611	0.0491	0.0384	0.0264	0.0285	0.0173	0.0356	0.0491
2	HKE.891011	HKE	9	GNS	3	0.1496	0.1143	0.0902	0.0453	0.0421	0.0541	0.0877	0.0536	0.0336
2	HKE.891011	HKE	9	GNS	4	0.0709	0.0415	0.0989	0.0611	0.0159	0.1652	0.146	0.096	0.0609
2	HKE.891011	HKE	9	GNS	5	0.0819	0.0515	0.0765	0.0754	0.03	0.1466	0.2596	0.1206	0.1405
2	HKE.891011	HKE	9	GNS	6	0.0786	0.104	0.0979	0.0874	0.0336	0.2333	0.2929	0.1367	0.0942
2	HKE.891011	HKE	9	GNS	7	0.0424	0.0481	0.0652	0.0602	0.0304	0.3306	0.3325	0.2901	0.1272
2	HKE.891011	HKE	9	GTR	0	NA	NA	NA	0	NA	0	0	NA	NA
2	HKE.891011	HKE	9	GTR	1	NA	NA	NA	9.00E-04	NA	2.00E-04	0.0037	NA	NA
2	HKE.891011	HKE	9	GTR	2	NA	NA	NA	0.0187	NA	0.0087	0.0182	NA	NA
2	HKE.891011	HKE	9	GTR	3	NA	NA	NA	0.0284	NA	0.0261	0.016	NA	NA
2	HKE.891011	HKE	9	GTR	4	NA	NA	NA	0.0308	NA	0.006	0.0013	NA	NA
2	HKE.891011	HKE	9	GTR	5	NA	NA	NA	0.0569	NA	0	0	NA	NA
2	HKE.891011	HKE	9	GTR	6	NA	NA	NA	4.00E-04	NA	4.00E-04	0	NA	NA
2	HKE.891011	HKE	9	GTR	7	NA	NA	NA	0.0029	NA	0	0	NA	NA
2	HKE.891011	HKE	9	LLS	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	HKE.891011	HKE	9	LLS	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	5	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	LLS	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	9	OTB	0	0.0677	0.1674	0.1347	0.138	0.0981	0.1475	0.0652	0.0919	0.1467
2	HKE.891011	HKE	9	OTB	1	0.5833	0.5638	0.5146	0.4434	0.2155	0.3379	0.2842	0.2915	0.3932
2	HKE.891011	HKE	9	OTB	2	0.2975	0.2431	0.3527	0.3032	0.1718	0.1601	0.1162	0.1594	0.2117
2	HKE.891011	HKE	9	OTB	3	0.1933	0.1434	0.145	0.1579	0.051	0.0799	0.0523	0.0415	0.0549
2	HKE.891011	HKE	9	OTB	4	0.085	0.2422	0.081	0.1102	0.0282	0.0969	0.032	0.0323	0.0281
2	HKE.891011	HKE	9	OTB	5	0.061	0.1519	0.0658	0.0612	0.0431	0.0912	0.0487	0.0349	0.0369
2	HKE.891011	HKE	9	OTB	6	0.1053	0.0489	0.0789	0.1004	0.039	0.1599	0.0785	0.0236	0.0212
2	HKE.891011	HKE	9	OTB	7	0.192	0.0332	0.0566	0.0819	0.0496	0.0801	0.0519	0.0192	0.0134
2	HKE.891011	HKE	10	LLS	6	0.2191	0.2952	0.125	0.2996	0.1959	0	NA	0.1762	0.2142
2	HKE.891011	HKE	10	LLS	7	0.2031	0.4456	0.2989	0.4031	0.3944	0	NA	0.0207	0.2286
2	HKE.891011	HKE	10	OTB	0	0.1218	0.0324	0.0602	0.0599	0.0906	7.00E-04	0.0845	0.0015	2.00E-04
2	HKE.891011	HKE	10	OTB	1	0.1948	0.2306	0.2169	0.2726	0.5156	0.0307	0.0808	0.0638	0.0377
2	HKE.891011	HKE	10	OTB	2	0.0314	0.1009	0.0725	0.1325	0.5158	0.1411	0.0778	0.0903	0.0782
2	HKE.891011	HKE	10	OTB	3	0.0114	0.0587	0.0164	0.0447	0.0957	0.1134	0.0312	0.1188	0.139
2	HKE.891011	HKE	10	OTB	4	0.0107	0.0593	0.0148	0.0264	0.0726	0.0687	0.004	0.0047	0.0651
2	HKE.891011	HKE	10	OTB	5	0.002	0	0.0073	0.003	0.17	0.066	0.0162	0	0.0149
2	HKE.891011	HKE	10	OTB	6	0.024	0.0247	0.0025	0.0417	0.0656	0.0674	0	0	0
2	HKE.891011	HKE	10	OTB	7	0.0011	0	0	7.00E-04	0.0093	0.0049	0.0012	0	0
2	HKE.891011	HKE	11	GNS	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	5	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GNS	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	3	NA	NA	NA	NA	NA	NA	NA	NA	NA

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	HKE.891011	HKE	11	GTR	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	5	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	GTR	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	5	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	6	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	LLS	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	HKE.891011	HKE	11	OTB	0	0.0188	0.0023	0.0132	0.0176	0.016	0.0272	0.0024	0.0016	0.0028
2	HKE.891011	HKE	11	OTB	1	0.0792	0.0667	0.1759	0.2263	0.1818	0.4126	0.2629	0.241	0.2356
2	HKE.891011	HKE	11	OTB	2	0.0437	0.0406	0.0598	0.0936	0.0868	0.1893	0.2217	0.0682	0.1683
2	HKE.891011	HKE	11	OTB	3	0.0821	0.0493	0.0931	0.0802	0.0543	0.0237	0.109	0.0177	0.0382
2	HKE.891011	HKE	11	OTB	4	0.0588	0.029	0.0572	0.0673	0.0158	0.006	0.0413	0.0194	0.0111
2	HKE.891011	HKE	11	OTB	5	0.0624	0.0135	0.0327	0.0857	0.0152	0.0057	0.009	0.0194	0.0189
2	HKE.891011	HKE	11	OTB	6	0.1037	0.0544	0.1055	0.0268	0.0163	0	0.0016	0.001	6.00E-04
2	HKE.891011	HKE	11	OTB	7	0.0987	3.00E-04	0.0321	0.0132	7.00E-04	0.0312	0.0038	0.0345	0.0121

3.2.2.9 Vector of partial F for MUT EMU2-GSA9

The vector of partial *F* for red mullet corresponding to the stock assessment unit in EMU2 GSA9 is shown in the following figures and table.

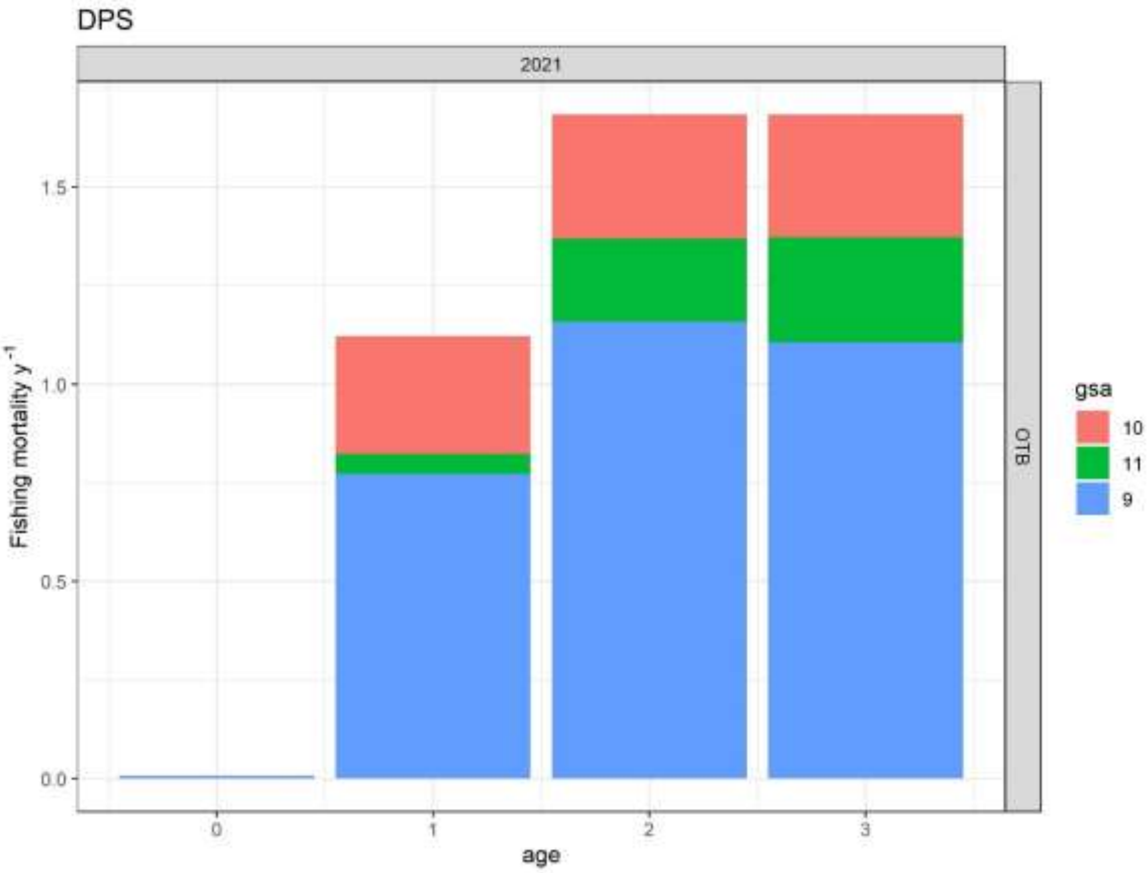


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	MUT.9	MUT	9	GNS	0	NA	NA	0	NA	NA	0	NA	NA	0
2	MUT.9	MUT	9	GNS	1	NA	NA	3.00E-04	NA	NA	2.00E-04	NA	NA	2.00E-04
2	MUT.9	MUT	9	GNS	2	NA	NA	0.0148	NA	NA	0.0128	NA	NA	0.0044
2	MUT.9	MUT	9	GNS	3	NA	NA	0.0935	NA	NA	0.1167	NA	NA	0.0484
2	MUT.9	MUT	9	GNS	4	NA	NA	0.1815	NA	NA	0.2123	NA	NA	0.1524
2	MUT.9	MUT	9	GTR	0	1.00E-04	0	0	0	0	0	0	0	0
2	MUT.9	MUT	9	GTR	1	0.0162	0.0072	0.0076	0.0152	0.0051	0.0091	0.0202	0.0056	0.0052
2	MUT.9	MUT	9	GTR	2	0.3333	0.1981	0.1678	0.1661	0.0838	0.1021	0.0874	0.0482	0.0341
2	MUT.9	MUT	9	GTR	3	0.5575	0.3453	0.2589	0.2471	0.1584	0.1543	0.0961	0.0622	0.0301
2	MUT.9	MUT	9	GTR	4	0.7002	0.2574	0.2321	0.1914	0.0996	0.0691	0.5069	0.0746	0.0087
2	MUT.9	MUT	9	OTB	0	0.0145	0.0152	0.0153	0.0154	0.0158	0.0155	0.0133	0.0095	0.006
2	MUT.9	MUT	9	OTB	1	0.7433	0.7817	0.7839	0.7828	0.8133	0.7959	0.6698	0.4878	0.3074
2	MUT.9	MUT	9	OTB	2	1.2645	1.4615	1.483	1.5127	1.6379	1.5789	1.3641	0.9897	0.6194

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	MUT.9	MUT	9	OTB	3	1.0403	1.3144	1.3132	1.4317	1.5633	1.4228	1.3554	0.9757	0.5795
2	MUT.9	MUT	9	OTB	4	0.8976	1.4022	1.2519	1.4873	1.6221	1.4124	0.9446	0.9633	0.4969

3.2.2.10 Vector of partial F for DPS EMU2-GSAs 9, 10 and 11

The vector of partial *F* for Deep-water rose shrimp for OTB corresponding to the stock assessment in unit EMU2, GSAs 9, 10 and 11 is shown in the following figures and table.

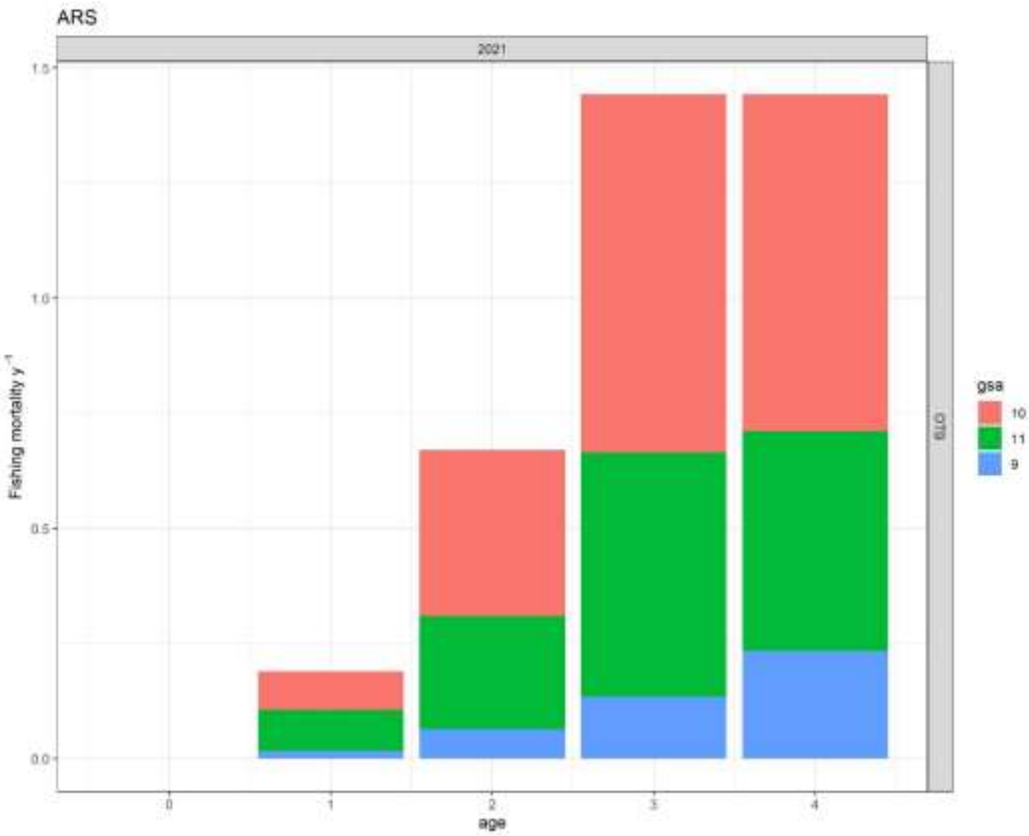


EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	DPS.891011	DPS	9	OTB	0	8.00E-04	0.0025	0.0028	0.0014	0.0025	0.0058	0.0063	0.0066	0.0068
2	DPS.891011	DPS	9	OTB	1	0.2244	0.3169	0.383	0.3772	0.4605	0.4786	0.6239	0.7674	0.7731
2	DPS.891011	DPS	9	OTB	2	0.9019	0.7801	0.9769	1.0668	0.9561	0.8267	0.7112	0.9729	1.1584
2	DPS.891011	DPS	9	OTB	3	1.1429	1.1004	1.1256	1.2252	1.1638	1.0596	0.9255	1.0028	1.1066
2	DPS.891011	DPS	10	OTB	0	0.0047	0.0031	0.0029	0.0043	0.0034	4.00E-04	3.00E-04	5.00E-04	8.00E-04
2	DPS.891011	DPS	10	OTB	1	0.5831	0.5069	0.4448	0.4691	0.3985	0.3414	0.2761	0.2049	0.299
2	DPS.891011	DPS	10	OTB	2	0.2834	0.4106	0.2182	0.1739	0.2861	0.3513	0.5955	0.376	0.314
2	DPS.891011	DPS	10	OTB	3	0.0419	0.0808	0.0513	0.0174	0.0889	0.0324	0.275	0.1414	0.3106
2	DPS.891011	DPS	11	OTB	0	0	0	0	0	0	1.00E-04	0	0	0
2	DPS.891011	DPS	11	OTB	1	0.0084	0.0093	0.0117	0.0046	0.0185	0.1019	0.0808	0.0764	0.0501

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	DPS.891011	DPS	11	OTB	2	0.0388	0.0591	0.0643	0.0358	0.0742	0.205	0.1647	0.2245	0.2111
2	DPS.891011	DPS	11	OTB	3	0.0393	0.0686	0.0826	0.034	0.0637	0.2909	0.2709	0.4292	0.2663

3.2.2.11 Vector of partial F for ARS EMU2-GSAs 8, 9 and 10

The vector of partial *F* for Red and blue shrimp for OTB, corresponding to the stock assessment in unit EMU1 GSA 1 and 2 is shown in the following figures and table.



EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	ARS.91011	ARS	9	OTB	0	0	0	0	0	0	0	0	0	0
2	ARS.91011	ARS	9	OTB	1	0.0028	0.0046	0.0034	0.0116	0.0014	0.0042	0.0087	0.0035	0.0172
2	ARS.91011	ARS	9	OTB	2	0.0121	0.0149	0.042	0.0511	0.0231	0.0227	0.0339	0.0185	0.0637
2	ARS.91011	ARS	9	OTB	3	0.0574	0.0341	0.0965	0.1308	0.0592	0.0674	0.0857	0.1164	0.1341
2	ARS.91011	ARS	9	OTB	4	0.092	0.0437	0.3068	0.2193	0.136	0.1526	0.1401	0.2068	0.234
2	ARS.91011	ARS	10	OTB	0	0	0	0	0	0	0	0	0	0
2	ARS.91011	ARS	10	OTB	1	0.1177	0.0967	0.1113	0.0931	0.135	0.0983	0.1082	0.0739	0.0842
2	ARS.91011	ARS	10	OTB	2	0.4194	0.3916	0.3797	0.3305	0.3691	0.4596	0.4266	0.323	0.3604
2	ARS.91011	ARS	10	OTB	3	0.7566	0.8416	0.7896	0.663	0.6871	0.6902	0.9516	0.7949	0.7774

EMU	stock	species	gsa	gear	age	2013	2014	2015	2016	2017	2018	2019	2020	2021
2	ARS.91011	ARS	10	OTB	4	0.6931	0.8748	0.5318	0.5235	0.55	0.9127	0.9243	0.8509	0.7314
2	ARS.91011	ARS	11	OTB	0	0	0	0	0	0	0	0	0	0
2	ARS.91011	ARS	11	OTB	1	0.0185	0.0424	0.0341	0.0502	0.0255	0.0668	0.0596	0.106	0.0885
2	ARS.91011	ARS	11	OTB	2	0.0593	0.1005	0.1036	0.1651	0.1792	0.1154	0.1629	0.3058	0.2461
2	ARS.91011	ARS	11	OTB	3	0.2423	0.2156	0.2442	0.3826	0.4834	0.5287	0.3042	0.4817	0.5308
2	ARS.91011	ARS	11	OTB	4	0.2711	0.1729	0.2917	0.4336	0.5437	0.221	0.2772	0.3353	0.4769

4 AVAILABILITY OF DATA ON FUEL PRICES, SUBSIDIES AND INFLATION RATES FOR THE PERIOD 2015-2022 (TOR 2)

4.1 Subsidies dedicated to the fishing industry in the EU context

4.1.1 Subsidies in fisheries

The European Union is often criticised for handing out high subsidies to the fishing sector (Sumaila et al. 2019). From an economic standpoint most subsidies are seen very critical as they lower the costs of fishing and allow fishing vessels to stay in business even in cases where revenues are too low to stay profitable. There are, however, also state aid payments which the objective to transform the fishing fleet and support the achievement of sustainable exploitation. Therefore, certain governmental payments are now classified as 'capacity-enhancing' subsidies while some others are classified as 'benefical'. Especially in the past, when subsidies were also provided for vessel constructions, subsidies were a main reason for overcapacity and overfishing in EU fisheries. Within the WTO long negotiations regarding fisheries subsidies resulted now in an agreement to reduce certain types of subsidies (WTO 2022). There is no requirement in the agreement for the EU to change the policies within the EU. However, there is a broader discussion about the contribution of the fishing sector to the green new deal. The proposals for a contribution of the fishing sector include also changes in the internal EU rules for the provision of state aid in the EU.

Current forms of state aid within the EU

For a description of the current situation regarding subsidies within the EU we distinguish between the longer-term measures and the measures which were introduced in the current time of crises (Covid pandemic and increase in fuel costs).

4.1.1.1 Longer-term measures

The MS provide generally two types of payments or exemptions for the fishing sector: tax exemptions and measures under the European Maritime and Fisheries Fund (EMFF) (European Maritime, Fisheries and Aquaculture Fund (EMFAF) from 2023 on). Tax exemptions are mainly but not solely for fuel as all fishers within the EU are exempted from all national fuel taxes. In some countries fishing companies are also exempted from other taxes or social security payments. The fuel tax exemptions were introduced as nearly all countries outside of the EU have no fuel taxes at all or lower levels as in the EU. In case such exemption would not be granted larger vessels would be able to buy fuel for much lower prices when fishing outside of EU waters compared to vessels which fish only inside EU waters. In the future due to the objective to decarbonize the fishing fleet, the EU may assist the sector to introduce different kinds of engines or at least to reduce the consumption of fossil fuels substantially which would lessen the necessity for tax exemptions. As mentioned above there may be also a measure to reduce the extent of the tax exemptions as a measure within the new green deal.

The national EMFF and EMFAF operational programs include possible measures to support specific projects of fishing companies (e.g. already fuel saving investments, change to a more selective fishing gear). The funding schemes provide funding up to a certain percentage of the project and not cover the full costs of e.g. an investment.

Some of the EMFF measures are classified as 'capacity-enhancing' subsidies, while others are classified as 'beneficial' helping the fishing companies to fish sustainably (Sumaila et al. 2019). A good example are payments for improving selectivity of the fishing gear. Those payments should not be classified as 'subsidies' as they are paid by governments with a clear goal to change the behaviour of the fishing vessels to achieve societal goals (like, for example, preservation of bottom habitats by using a different fishing gear).

4.1.1.2 Short-term measures due to the crises

From April 2020 on, new rules intended to mitigate the impact of the COVID-19 outbreak on the fishery were adopted. Several MS, including Spain, activated the crisis mechanism of the EMFF. The requirement was that the MS still had budget left for those measures. Other MS already activated the crisis mechanism of the new European Maritime, Fisheries and Aquaculture Fund (EMFAF) although their operational program are not yet adopted (the EU allowed that they go retroactive into force). A specific measure which was introduced in several MS were payments for temporary cessation of fishing activities. In many fisheries, especially small-scale fisheries, the markets for fresh fish collapsed and it was at least for some time not possible to sell fish directly to, for example, restaurants or via auctions (Doering et al. 2021, see also as an example from the North Sea Goti-Aralucea et al. 2021).

With the severe increase in fuel costs due to the war in Ukraine, governments introduced now also measures to cover (parts of) the increasing costs for fuel. France provides the fishing sector with 0,35 € per litre of fuel until the end of 2022 (FiskerForum 2022). In Spain, the government decided to use the general EU allowance to pay up to 35.000 € per company to cover increasing costs for fuel (EU Commission 2022a). In addition, the government directly support the companies until the end of 2022 by paying 0,20 € per litre of fuel to reduce the high fuel prices. In Italy eligible beneficiaries in agricultural, forestry, fishery and aquaculture sectors are entitled to receive up to 35,000 € per company in any of the following forms: (i) direct grants; (ii) tax or payment advantages; (iii) repayable advances; and (iv) reduction or exemption from the payment of social security and welfare contributions (EU Commission 2022b).

This maximum payment under the *de minimis* ceiling was later increased from 35.000 € to 75.000 € by the EU. The advantage of this EU allowance is that MS can simply use national finances up to this amount per company without a requirement to follow e.g. general state aid rules of the EU.

The objective of those payments is that fishing companies can go on fishing by covering parts of the increasing costs of those companies. It doesn’t make sense to go fishing when your costs are higher than your revenues. However, those payments go along with other state aid measures in the West Med like permanent cessation and longer-term schemes for decarbonisation.

4.1.2 Availability of data

The DCF definition for operational subsidies is “Direct payments which general government or the institutions of the European Union make to resident producers. (ESA D.3). Refers to direct payments/transfers related to the vessel activity, except for: fuel tax refunds, subsidies for permanent cessation of fishing activities and investment subsidies (fleet modernization).

MS are requested to provide data for this variable at the fleet segment level within the annual fleet economic data call. The AER 2020 data revealed a significant increase in operating subsidies for the Med DTS segments that are reported to be around 29 million € in 2020. The increase can be partially explained by the support provided to alleviate the sector due to the COVID-19 pandemic. However, due to the wide range of these measures, different approaches are used by Member States in their economic classification.

4.1.3 Application of subsidies in bio-economic models for the Western Med

As described the longer-term ‘subsidies’ within the EU are given mainly as tax exemptions or for specific projects or investments of the fishing companies. Therefore, they are not direct payments of the government to the fishing companies (not taking the COVID and fuel costs measures 2020-2022 here into account). Following from that the STECF has agreed for the presentation of the economic data in the Annual Economic Report on the EU fishing fleets (see e.g., STECF 2021), that subsidies are not considered in the calculation of the economic performance indicators. The economic data within the DCF include information on public payments for the fleet segments, but it is then not counted under income. In publications the fuel tax exemptions are classified as 'capacity-enhancing' but there is no direct money flow from the government to the companies – they have 'simply' lower costs for fuel.

For the application of the bio-economic models for the assessment of the development regarding the implementation of the WestMedMap it was decided to follow the methodology of the AER and, therefore, subsidies are not included in the calculations for income.

However, that decision has consequences. The financial situation which the bio-economic models present for the year 2022 and beyond depend a lot on the assumptions regarding the development of fuel prices but include no mitigation measures for the fishing companies (like de minimis payments to cover parts of the increase in fuel costs 2022). Therefore, the modelling results show a lower levels of gross value added (see Fig. 1.2.3 and Fig. 1.2.6) compared to the real situation of the fishing companies. This should be kept in mind when looking at the results of the modelling.

Nevertheless, the assumption to not count the subsidies allows normally to single out the impacts of the plan compared to other measures implemented by the governments. In this time of crises, the situation may be a bit more unclear as the increase in fuel costs assumed in the models are due to an external 'shock' instead of measures implemented by the EU or EU MS.

4.1.4 Rebuilding processes – experiences from other fisheries

The main concern regarding the WestMedMap may be that a severe reduction in fishing effort will force fishing vessels out of business. As mentioned above, since Spring 2020 the fishing sector saw two severe crises:

- the COVID pandemic with changes in value chains (especially a reduced demand from restaurants and catering services (Doering et al. 2021)) and lower revenues in many fisheries, and
- since February 2022 the heavy increase in fuel costs due to the war in the Ukraine.

The fishing sector receives or received governmental payments to cover increasing costs or the loss of revenues. However, this is a very specific situation as this are external shocks to the sector. The aim of those payments is also that it keeps fishing companies active to supply fish to the markets and not just finance inactivity with the vessels in the harbours.

There may be the impression that those payments in this time of crisis are not the main reason that fishing vessels are still active. The WestMedMap already reduced the activity of fishing vessels (lower effort of fleet segments) but the vessels are still active and the only reason for that is that they receive regularly high subsidies. However, for the Med DTS segments the AER 2020 data reveal that, even if overall gross profit decreased by almost 20% in comparison with 2019, only 3 of 21 segments were at a loss in terms of gross profit (STECF 2022) and this does not include direct government support (see the AER methodology). As explained above fishing vessels receive mainly tax exemptions which lower the cost for fishing but receive in 'normal' times no direct other support for their operations. There may be other reasons why fishing vessels are still in business. A company can survive short periods of time even with losses, the company may have reserves, or the vessel owner has alternative sources of income. In other cases, the vessel owner may borrow money from banks but there is also information that the fishing companies increase their indebtedness to wholesalers (this will be visible in a deteriorating of the financial position of the companies). There may be also the expectation that this is only a temporal situation and in a few years there will be again increasing catches.

In case of a rebuilding program, and the West Med MAP can be seen as (a) rebuilding plan(s) for the stocks in the Western Med, the fishing sector will have lower catches for at least several years (in the West Med MAP this is regulated via the allowed effort and in addition now by a TAC). The general expectation is that long-term gains from a recovery of the stocks will be higher than the short-term losses (Doering & Egelkraut 2008, Sumaila et al. 2012, OECD 2012). However, without the coverage of those short-term losses' parts of the fleets or even all vessels will not be profitable anymore. Some companies may survive a phase of low revenues and profits but usually several companies will have to file for bankruptcy and will have to leave the fishing sector. In some of the fisheries in the EU with long-term management plan governments introduced measures for adaptation and mitigation of the situation. STECF also analysed some of the rebuilding programs in previous years especially by conducting impact assessments. Those examples can provide information what measures where elaborated and possible effects of the implementation of certain measures.

4.1.4.1 North Sea flatfish plan

The flatfish management plan for the North Sea was adopted 2007 (Council Regulation (EC) No. 676/2007). In case of the flatfish plan, the impact assessment revealed that there will be several years of low catches before an increase in catches can be expected. The government of the Netherlands decided to implement a decommissioning scheme scrapping 15% of the vessels fishing for plaice and sole in the North Sea (STECF 2009, p. 121). This allowed the remaining vessels to receive higher shares of the remaining quota and more days at sea as the plan also regulated the allowed fishing effort.

4.1.4.2 North Sea cod

In 2008 the EU introduced a LTMP for the North Sea cod stock (Council regulation (EU) 1342/2008). The plan included Harvest Control Rules (HCR) regarding how, depending on the current level of fishing mortality, TAC and effort limits for the directed fisheries on cod should be implemented to reach the objectives of the plan (Fmsy of 0.4). Each year STECF proposed TAC and effort limits following the requirements of the plan (Art. 7 – 9 for TAC, Art. 11-13 for effort). A concern was the level of discards of cod as cod was basically a target or by-catch species in all demersal roundfish fisheries of the North Sea. Fleets with not more than 1.5% cod catch of the total catches of that group of vessels could be exempted, all others were also subject of the effort limitations. There was, therefore, an incentive to reduce the bycatch of cod. One example for an exemption was a Swedish Nephrop fishery were the vessels implemented a specific sorting grid in the net to allow cod to escape (a technical solution), other fleets changed fishing grounds to avoid cod bycatch. The UK introduced an incentive scheme to reduce bycatches of cod by granting more effort in case fishers switch fishing grounds to areas with less cod bycatch (Marine Scotland Science 2012).

STECF commented (STECF 2011, p. 31) that Art. 13 included a new approach in EU fisheries management: "Article 13 provides incentives for cod avoidance in the form of an increase in allowable effort if cod-avoidance measures are undertaken. The way in which cod avoidance may be achieved is left open to be decided by the Member States and the industry, e.g. through the use of highly selective gear, or spatiotemporal modifications of fishing activity. As such, Article 13 is an innovative instrument following the new paradigm."

The analysis of the economic data from the AER revealed that between 2007 and 2009 fleet capacity was reduced by 25% (STECF 2011, pp. 77-79). Smaller vessels gave up the fishery while larger vessels stayed in the fishery. STECF stated: "While costs and revenues are falling at an aggregate level, the data suggests that both are increasing at a vessel level, a view supported by the increase in per vessel effort levels. Overall, costs per unit of effort have declined and revenues per unit of effort have increased. This suggests, plausibly, that it has been the most cost-inefficient participants which have exited the fleet while relatively more efficient vessels have remained engaged and have, up to 2009, been able to increase their activity" (STECF 2011, p. 79). However, opposite to the North Sea flatfish plan, no direct decommissioning schemes were implemented by MS, but vessels owners could receive some governmental support via the general EU funding schemes.

It is not here to judge how successful the plan was but there was a substantial reduction in F (ICES 2022). But there was no real recovery of the stock.

4.1.4.3 Southern hake

In an impact assessment for Southern hake STECF discussed in 2011 how to achieve Fmsy in 2015 (STECF 2011). The main instrument in the management plan was a reduction of TAC for hake but STECF calculated that this is only possible with the adoption of additional technical measures. A clear link, however, between a change in mesh size and the effectiveness of the closed area was not possible. In the meantime, Southern hake is managed within a multi-species management plan and the stock recovered (EU 2019, ICES 2022b).

4.1.4.4 Northern hake

For the Northern hake stock also a long-term management plan was adopted and STECF has done an impact assessment in 2007 (STECF 2007). The management plan included besides the management via TAC also possible effort restrictions. At the time of the IA, it was unclear whether these measures needed to be implemented. STECF concluded that changes in effort level could mean also changes in distribution patterns of catches. Also, other measures were considered, like improvements in gear selectivity, to reduce the catch of hake in other fisheries.

4.1.4.5 General experiences regarding mitigation and adaptation measures

The four examples give an impression what measures were implemented, and, in some cases, also which measures were implemented to adapt to reduce fishing opportunities. The reduction of unwanted (by)catches of certain species was the main instrument (could also be combined with change of areas) as this allowed a reduction in F without a strong impact on fisheries with this stock as target species. Several countries introduced short-term instruments, like temporal cessation, to mitigate some of the impacts. In the German coastal fisheries on pelagic stocks in the Southern Baltic Sea vessels received payments for reduced effort. The justification was always that this reduction in fishing effort would improve the stock status. The problem can be that such a measure can reduce fishing effort but how far can it be used to reduce negative economic impacts over a longer time. Modelling results for several scenarios for the WestMedPlan show that negative or decreasing gross value added will be the situation at least until 2030. The stocks may increase but to reach Fmsy a substantial reduction of effort will have to be in place.

4.1.5 EWG 22-11 conclusions regarding subsidies

EWG 22-11 concludes, as experiences with other rebuilding plans show, that the success of the rebuilding plans are often based on mixture of measures, the improvement of enforcement of the restrictions, the reduction of fishing capacity and improvement in the incentive structure of measures. The acceptance of measures by the fishers is an important factor for the success of fisheries management measures.

From an economic standpoint it would make sense to conduct a detailed impact assessment for the further implementation of the WestMedMap. For that the usual routine for IAs within the EU Commission is not necessary as the MAP does not require this officially. It could stay a scientific assessment. Nevertheless, with such an assessment it would be possible to calculate possible scenarios regarding the implementation of effort reduction and the possible economic performance of the fishing fleets. The EU MS affected by the management plan could then discuss possible mitigation and adaptation measures for the fishing sector. The model results predict negative and mostly decreasing GVA for many fleet segments (see Fig. 1.2.3 and 1.2.6) under most of the scenarios. Therefore, there will be a necessary adjustment of the fleet to the lower catch possibilities.

EWG 22-11 concludes that the EWG chair and the STECF bureau should discuss with DG MARE how far such an impact assessment would be possible for the next EWG meeting in March 2023.

4.1.6 References

Döring, R., Edebohls, I., Pearce, J., Wakeford, R., Hintzen, N., Abreu, S., Alhaija, R. A., Aranda, M., Depeuter, S., Deetman, B., Frigioiu, I., Hammerlund, C., Hayes, D. R., Heyworth, S., Kovacs, M., Masinovic, I., Metz, S., Mol, A., Mytlewski, A., Ottolenghi, F., et al(2021) Study on the main effects of the COVID-19 pandemic on the EU fishing and aquaculture sectors : EASME/EMFF/2018/011 Lot 1 Specific Contract No.4 and EASME/EMFF/2018/011 Lot 2 Specific Contract No.5 ; Final Report. Luxembourg: Publications Office of the European Union, 52 p

Döring, R. and T. Egelkraut. 2008. Investing in Natural Capital as Management Strategy in Fisheries – The Case of the Baltic Sea Cod Fishery. Ecological Economics 64(3): 634-642.

EU Commission 2022. State aid: Commission approves €10 billion Spanish scheme to support companies in context of Russia's invasion of Ukraine. Retrieved 28.09.22 from https://ec.europa.eu/commission/presscorner/detail/da/ip_22_3390

EU Commission 2022. State aid: Commission approves €1.2 billion Italian scheme to support agricultural, forestry, fishery and aquaculture sectors in context of Russia's invasion of Ukraine. Retrieved 28.09.22 from https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3113

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union.

FiskerForum 2022. France extends fuel support measures for fishing. Retrieved 28.9.22 from: https://fiskerforum.com/france-extends-fuel-support-measures-for-fishing/

Goti-Aralucea, L., Berkenhagen, J., Sulanke, E., Döring, R. 2021. Efficiency vs resilience: The rise and fall of the German brown shrimp fishery in times of COVID 19. Mar Policy 133:104675

ICES 2022a. Cod (Gadus morhua) in Subarea 4, Division 7.d, and Subdivision 20 (North Sea, eastern English Channel, Skagerrak). Retrieved 30.09.22 from: https://ices-library.figshare.com/articles/report/Cod_Gadus_morhua_in_Subarea_4_Division_7_d_and_Subdivision_20_North_Sea_eastern_English_Channel_Skagerrak_/19447880?backTo=/collections/ICES_Advice_2022/5796935

ICES 2022b. Hake (Merluccius merluccius) in divisions 8.c and 9.a, Southern stock (Cantabrian Sea and Atlantic Iberian waters). Retrieved at 04.10.2022 from: https://ices-library.figshare.com/articles/report/Hake_Merluccius_merluccius_in_divisions_8_c_and_9_a_Southern_stock_Cantabrian_Sea_and_Atlantic_Iberian_waters_/19448018?backTo=/collections/ICES_Advice_2022/5796935

ICES 2022c. Hake (Merluccius merluccius) in subareas 4, 6, and 7, and in divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay). Retrieved at 04.10.2022 from: https://ices-library.figshare.com/articles/report/Hake_Merluccius_merluccius_in_subareas_4_6_and_7_and_in_divisions_3_a_8_a_b_and_8_d_Northern_stock_Greater_North_Sea_Celtic_Seas_and_the_northern_Bay_of_Biscay_/19448012?backTo=/collections/ICES_Advice_2022/5796935

Marine Scotland Science 2012. Data Provision and evaluation of measures employed in Scotland under the management plan for cod stocks Article 13 provision during 2012. Retrieved 30.09.22 from: https://stecf.jrc.ec.europa.eu/documents/43805/595773/Evaluation+Measures+employed+in+Scotland+under+Cod+Recovery+plan+Article+13+provision+during+2012.pdf

OECD 2012. Rebuilding Fisheries: The Way Forward. OECD Publishing. http://dx.doi.org/10.1787/978926417635-en

STECF 2007. Northern hake long-term management plan impact assessment (SGBRE-07-05). Luxembourg: Office for Official Publications of the European Communities

STECF 2009. Report of the STECF Study Group on the Evaluation of Fishery Multi-annual Plans (SGMOS 09-02). Publications Office of the European Union, Luxembourg.

STECF 2021 - The 2021 Annual Economic Report on the EU Fishing Fleet (STECF 21-08), EUR 28359 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-40959-5.

STECF 2022. The 2022 Annual Economic Report on the EU Fishing Fleet (STECF 22-06), Prellezo, R., Sabatella, E., Virtanen, J. and Guillen, J. editors, Publications Office of the European Union, Luxembourg.

Sumaila UR, Cheung W, Dyck A, Gueye K, Huang L, Lam V, et al. 2012. Benefits of Rebuilding Global Marine Fisheries Outweigh Costs. PLoS ONE 7(7): e40542

Sumaila, U. R., Skerritt, D., Schuhbauer, A., Ebrahim, N., Li, Y., Kim, H. S., Mallory, T. G., Lam, V. W. L., & D. Pauly. Updated estimates and analysis of global fisheries subsidies. Marine Policy 109: 103695

WTO 2022: Agreement on fisheries subsidies. Retrieved 27.09.22 from: https://www.wto.org/english/tratop_e/rulesneg_e/fish_e/fish_e.htm

4.2 Trends on average price for fish, average energy cost for the MED fishing fleets of Italy, Spain and France and inflation rates for concerned MS economy, from 2020-2020 and nowcast for 2021-2022 (for prices and energy costs)

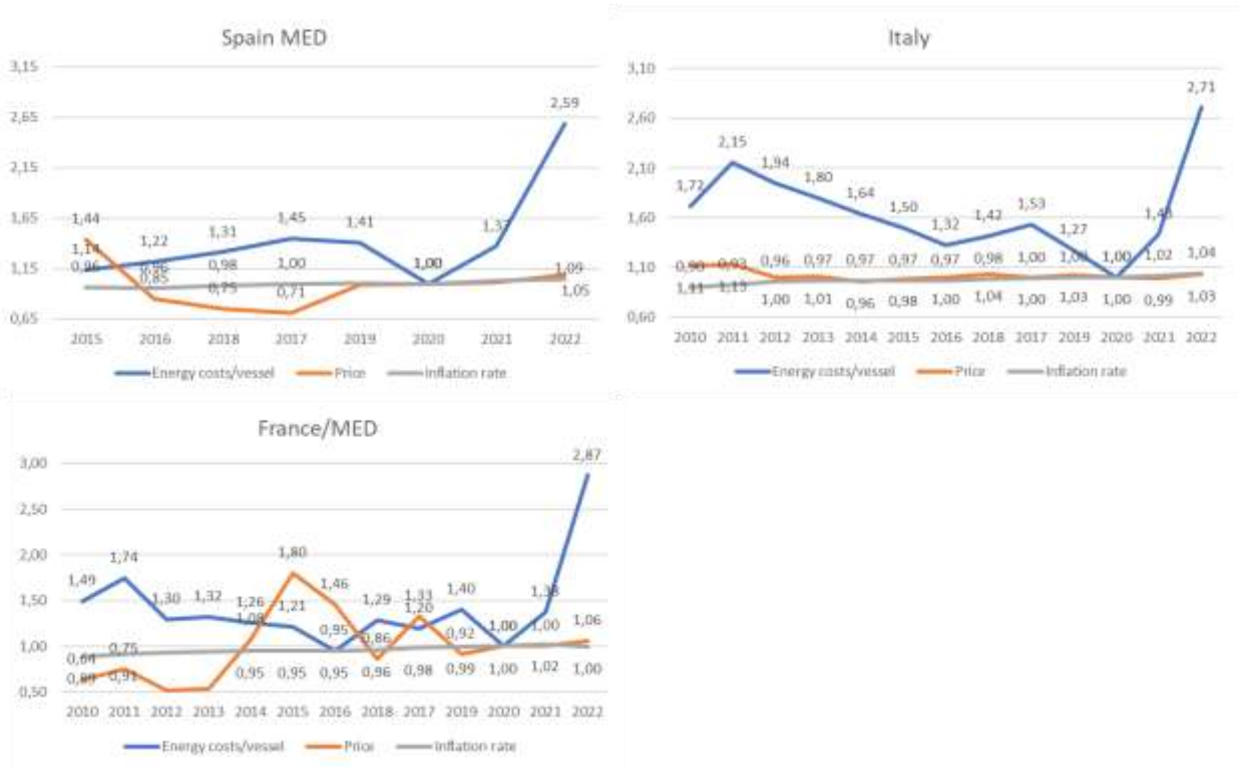


Figure 4.2.1 Data sources: Energy costs and fish prices: MS data submissions under the 2022 Fleet Economic data call (MARE/A3/AC(2022)). All monetary values have been adjusted for inflation; constant prices (2020). Inflation rates: EUROSTAT. Base 100=2020.

In general, the increase in inflation rates during the last 2 years raises concerns because the fleet is not always able to transfer the operating costs increase in the final prices for fish. In addition, if we consider that energy costs are a major item in the cost structure of the fishing fleet, it can be confirmed that the results of the WestMed fishing fleet will show an important deterioration of the economic performance.

Spain/MED: While prices in 2022 from 2020 have increased, in real terms, around 9%, fuel costs have increased by 259%. The increase of inflation rate in 2022 compared to 2020 is estimated around 5%.

Italy: prices in real trend have increased by 3% in 2022 from 2020, less than the estimated increase of inflation rate (4%, from 3% to 7%). Fuel costs increased by 270%.

France/MED: prices in real trend have increased more than inflation rates, but fuel costs have increased by 287%.

5 PROGRESS ON OPERATIONAL MIXED-FISHERIES MODELS (TOR 3)

5.1 IAM in EMU 1

5.1.1 Recall on the main issues and conclusions from EWG 22-01

In EMU1, the implementation of the IAM model for GSAs 1-5-6-7 carried out during the STECF meeting is still in development. During EWG 22-01, socio-economic indicators such as employment, gross profit and gross profit margin were not available. It was pointed out that to compute employment indicator, the relationship between Full-Time Equivalents (FTE) and fishing effort and the calculation of salary/crew costs needed to be discussed.

For Maximum Catch Limit (MCL) implementation scenarios, it was pointed out that it would be preferable for the fishing effort per fleet segment to be adjusted to reach an Fmsy, rather than a MCL value given as an input to the IAM model.

It was concluded that an adjustment of the fleet segmentation would allow the economic impacts of the alternative scenarios to be simulated on other fleet segments than trawlers, and some needed adjustments on the fleet segmentation was proposed in EWG 22-01.

In EWG 21-13, it was pointed out that scenarios involving changes in the number of vessels, rather than just changes in fishing effort, could be explored if included in the TORs.

5.1.2 Implementation progresses in EWG 22-11

IAM (Impact Assessment Model), a bioeconomic mixed fishery simulation model, was implemented in EMU1, following the experiences gained in EWG 19-14, EWG 20-13, EWG 21-13 and EWG 22-01. The IAM model is documented in the webpage: https://ifremer-iam.github.io/IAM/.

The data sources used for the French and Spanish update are the FDI data, the Annual Economic Report (AER) data, the landings and discards data from the Med and Black sea data call (MBSDC), and the outputs of the EWG 22-09 group on the Mediterranean Stock Assessment.

5.1.3 Stocks

The stocks taken into consideration in IAM-Med simulations are those for which analytic stock assessment results from EWG 22-09 were available:

- HKE1567: Hake (*Merluccius merluccius*) in GSAs 1-5-6-7,
- MUT1: Red mullet (*Mullus barbatus*) in GSA 1,
- MUT6: Red mullet (*Mullus barbatus*) in GSA 6,
- MUT7: Red mullet (*Mullus barbatus*) in GSA 7,
- NEP6: Norway Lobster (*Nephrops norvegicus*) in GSA 6,
- ARA12: Blue and red shrimp (*Aristeus antennatus*) in GSAs 1-2,
- ARA5: Blue and red shrimp (*Aristeus antennatus*) in GSA 5,
- ARA67: Blue and red shrimp (*Aristeus antennatus*) in GSAs 6-7,
- DPS1: Deep-water rose shrimp (*Parapenaeus longirostris*) in GSA 1,
- DPS567: Deep-water rose shrimp (*Parapenaeus longirostris*) in GSAs 5-6-7.

Stochastic recruitment has been explicitly considered for those stocks, as in EWG 21-13 and EWG 22-01. To build a random succession of recruitments for stocks to be applied on the 2022-2030 projection period, 9 years are randomly drawned with replacement from the available historical period (2009-2021). Each draw will determine for each projection year the annual recruitment combinations to be applied for each stock. **250 such trajectories** are simulated and used to build confidence intervals. Simulations run from 2021 to 2030.

Furthermore, catches of the following species from the management plan are simulated in the IAM model, however the dynamics of these species are not explicitly represented, due to lack of analytical or accepted stock assessments. They are referenced hereafter as "static species", and associated catches are simulated as a linear function of the simulated fishing effort, assuming a constant value of Landings Per Unit of Effort (LPUE). LPUE data are based on the 2021 values from FDI data.

- Red mullet (*Mullus barbatus*) in GSA 5,
- Norway lobster (*Nephrops norvegicus*) in GSA 1, 5 and 7.

The other « static species » considered in the model and that are not included in the management plan are: stripped red mullet (MUR), anchovy (ANE), sardine (PIL), Atlantic mackerel (MAC), monkfish (MNZ), common octopus (OCC), octopuses (OCT), Atlantic bluefin tuna (BFT), and « ZZZ » (which stands for all other remaining species caught per fleet).

Table 5.1.3.1. Summary of the stocks in the Western Mediterranean management plan and how they are integrated in the IAM model.

Stocks in management plan	**Dynamic or static in IAM**	**Comment**
blue and red shrimp (*Aristeus antennatus*) in GFCM subareas 1, 2, 5, 6 and 7	Dynamic: stocks ARA12 (GSAs 1-2), ARA5 (GSA 5), and ARA67 (GSAs 6-7)	The integration of the stock ARA5 as a dynamic species in the IAM model is new this year, as analytic stock assessment was available from EWG 22-09.
deep-water rose shrimp (*Parapenaeus longirostris*) in GFCM subareas 1, 5, 6 and 7	Dynamic: stocks DPS1 (GSA1), DPS567 (GSAs 5-6-7)	The integration of the stocks DPS1 and DPS567 as dynamic species in the IAM model is new this year, as analytic stock assessment were available from EWG 22-09.
European hake (*Merluccius merluccius*) in GFCM subareas 1-5-6-7	Dynamic: stock HKE1567 (GSAs 1-5-6-7)	
Norway lobster (*Nephrops norvegicus*) in GFCM subareas 5 and 6	Dynamic: stocks NEP6 (GSA6) Static: stock NEP5 (GSA 5)	No population dynamics available from the stock assessments for NEP5

red mullet (*Mullus barbatus*) in GFCM subareas 1, 5, 6 and 7	Dynamic: stocks MUT 1 (GSA 1), MUT 6 (GSA 6), and MUT 7 (GSA 7) Static: stock MUT 5 (GSA 5)	Stock assessment are not available for *Mullus barbatus* in GSA 5.

5.1.4 Fleets

The fleet typology used is based on the fleet segmentation of the Data Collection Framework (DCF). A fleet segment is the combination of a particular fishing technique category and a vessel length category. Spanish and French fleet segments were modified from the previous implementations (i.e. EWG 19-14, EWG 20-13, EWG 21-13, and EWG22-01), based on what was discussed during the EWG 22-01 group.

As it was pointed out during EWG 22-01, a redefinition of the fleet segments in the IAM model was needed. In the previous definition, the French "other" fleets were exclusively defined based on vessel size, regardless of other criterions, while the Spanish "other" fleets were only defined through the prism of the fishing technique, without consideration of vessel size. This leads to inconsistencies in the representation in the model of French and Spanish "other" fleets, especially for small-scale fishery. It also led to the inclusion of French fleet segments that are irrelevant to the plan (such as PS, PGP, FPO), and to the exclusion of Spanish fleet segments that might be relevant. Therefore, we redefined the categorisation for the "other" fleets, with four categories replicated for Spain and for France: vessels using hooks (HOK) above and below 12m, and netters (DFN) above and below 12m. In this segmentation, vessels using hooks are assimilated to longliners and netters to gillnetters by discriminating between two of the dominant gears - since all vessels are operating a number of different gears through the year.

As it was pointed out in EWG 22-01, the revision of the IAM fleet segments reveals a much better harmonization between French and Spanish "other" fleets while leaving out fleet segments that do not contribute to the mortality of nor economically depends on the species of the plan (see EWG 22-01 report).

The six French fleets explicitly modelled are thus French demersal trawlers 18-24m, French demersal trawlers >=24m, French netters <12m, French netters >=12m, French vessels using hooks <12m, and French vessels using hooks >=12m.

Regarding the Spanish fleets, eight Spanish fleet segments are considered: Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m, Spanish netters >=12m, Spanish vessels using hooks <12m, and Spanish vessels using hooks >=12m.

As in EWG 22-01, the IAM model has been adapted to **differentiate between coastal and deep-sea trawling**. This concerns the three Spanish fleet segments: Spanish trawlers 12-18m, Spanish trawlers 18-24m, and Spanish trawlers >24m where a distinction between fishing effort toward deep-sea trawling and coastal trawling has been made. The entry "Target-assemblage" in the FDI database has been used to parametrized the IAM model. The fishing efforts within the IAM fleet segments are also differentiated by gear (see Table 5.1.4.1 for more details).

Table 5.1.4.1 Modelled fleets in the IAM application in EMU1 and correspondence with FDI and AER fleets. "!= " means different. DFN stands for Drift and/or fixed netters, DTS for Demersal trawlers and/or demersal seiners, HOK for Vessels using hooks, and DWS for deep water species. For the gear types OTB stands for Bottom otter trawl, OTT for Multi-rig otter trawl, OTM for Midwater otter trawl, GNS for Set gillnet, GTN for Combined gillnets-trammel nets, GTR for Trammel net, LLS for Set longlines and LLD for Drifting longlines.

IAM Fleet segment names	**Names in the report figures**	**Fleet segments in AER**	**Fishing techniques in FDI**	**"Metier" or gear explicitly modelled**
French demersal trawlers 18-24m	FR_DTS 1824m	fs_name => FRA MBS DTS1824 NGI* cluster_name=> MBS DTS VL1824	fishing tech = DTS vessel_length = VL1824	OTB, OTT, OTM, "other" To note: no distinction between coastal and deep trawling, as no effort and catches for DWS target assemblage in FDI database
French demersal trawlers 24-40m	FR_DTS >=24m	fs_name => FRA MBS DTS2440 NGI* cluster_name=> MBS DTS VL2440	fishing tech = DTS vessel_length = VL2440	OTB, OTT, OTM To note: no distinction between coastal and deep trawling, as no effort and catches for DWS target assemblage in FDI database
French netters <12m	FR_DFN < 12m	fs_name => FRA MBS DFN0006 NGI and FRA MBS DFN0612 NGI	fishing tech = DFN vessel_length = VL0006 and VL0612,	GNS, GTR, GTN, "other"
French netters >= 12m	FR_DFN > 12m	fs_name => FRA MBS DFN1218 NGI* cluster_name=> MBS DFN VL1218	fishing tech = DFN vessel_length = VL1218, VL1824, and VL2440	GNS, "other"
French vessels using hooks < 12m	FR_HOK < 12 m	fs_name => FRA MBS HOK0006 NGI and FRA MBS HOK0612 NGI	fishing tech = HOK vessel_length = VL0006 and VL0612	LLS, LLD, "other"
French vessels using	FR_HOK > 12 m	*No data (the cost structure in the model is*	fishing tech = HOK vessel_length =	LLD, "other"

hooks >= 12m		*assumed equal to the "other" French vessels >=12m)*	VL1218, VL1824, and VL2440	
Spanish trawlers < 12m	SP_DTS < 12m	fs_name => ESP MBS DTS0612 NGI	country_code =ESP fishing tech = DTS vessel_length = VL0006, and VL0612 sub_region= GSA1, GSA5 , GSA6 and GSA7	OTB To note: no distinction between coastal and deep trawling, as no effort and catches for DWS target assemblage in FDI database
Spanish trawlers 12-18m	SP_DTS 1218m	fs_name => ESP MBS DTS1218 NGI	fishing tech = DTS vessel_length = VL1218 target_assemblage = DWS	OTB_DWS
			fishing tech = DTS vessel_length = VL1218 target_assemblage != DWS	OTB_other, other
Spanish trawlers 18-24m	SP_DTS 1824m	fs_name => ESP MBS DTS1824 NGI	fishing tech = DTS vessel_length = VL1824 target_assemblage = DWS	OTB_DWS
			fishing tech = DTS vessel_length = VL1824 target_assemblage != DWS	OTB_other, other
Spanish trawlers >=24m	SP_DTS >=24m	fs_name => ESP MBS DTS2440 NGI	fishing tech = DTS vessel_length = VL2440 target_assemblage = DWS	OTB_DWS
			fishing tech = DTS vessel_length = VL2440 target_assemblage != DWS	OTB_other, other

Spanish netters <12m	SP_DFN < 12m	fs_name => ESP MBS DFN0612 NGI	fishing tech = DFN vessel_length = VL0006 and VL0612	GNS, GTR, “other”
Spanish netters >=12m	SP_DFN > 12m	fs_name => ESP MBS DFN1218 NGI	fishing tech = DFN vessel_length = VL1218, VL1824, and VL2440	GNS, GTR, “other”
Spanish vessels using hooks < 12m	SP_HOK < 12 m	fs_name => ESP MBS HOK0612 NGI* cluster_name=> MBSHOKVL0612NGI	fishing tech = HOK vessel_length = VL0006 and VL0612	LLS, LLD, “other”
Spanish vessels using hooks >= 12m	SP_HOK > 12 m	fs_name => ESP MBS HOK1218 NGI*, ESP MBS HOK1218 LLD*, and ESP MBS HOK1824 LLD* cluster_name=> MBSHOKVL1218NGI, MBSHOKVL1218NGILLD, MBSHOKVL1824NGILLD	fishing tech = HOK vessel_length = VL1218, VL1824, and VL2440	LLS, LLD, “other”

On the basis of this segmentation, the FDI data (table A) have been used to represent the proportions of gears employed by each IAM fleet segment (Fig. 5.1.4.1). The fishing gear classification is the FAO classification, that can be consulted here: https://www.fao.org/cwp-on-fishery-statistics/handbook/capture-fisheries-statistics/fishing-gear-classification/en/. Figure 5.1.4.2 shows the proportion, in terms of landings in value, of the species of the plan per IAM fleet segment. We can thus deduct the economic dependency on the species of the plan for the different fleet segments in 2021. Figure 5.1.4.2 shows the proportion, in terms of 2021 landings in value, of the species of the plan for each IAM fleet segment. The economic dependence in 2021 on the species of the plan for the different fleet segments can thus be deduced.

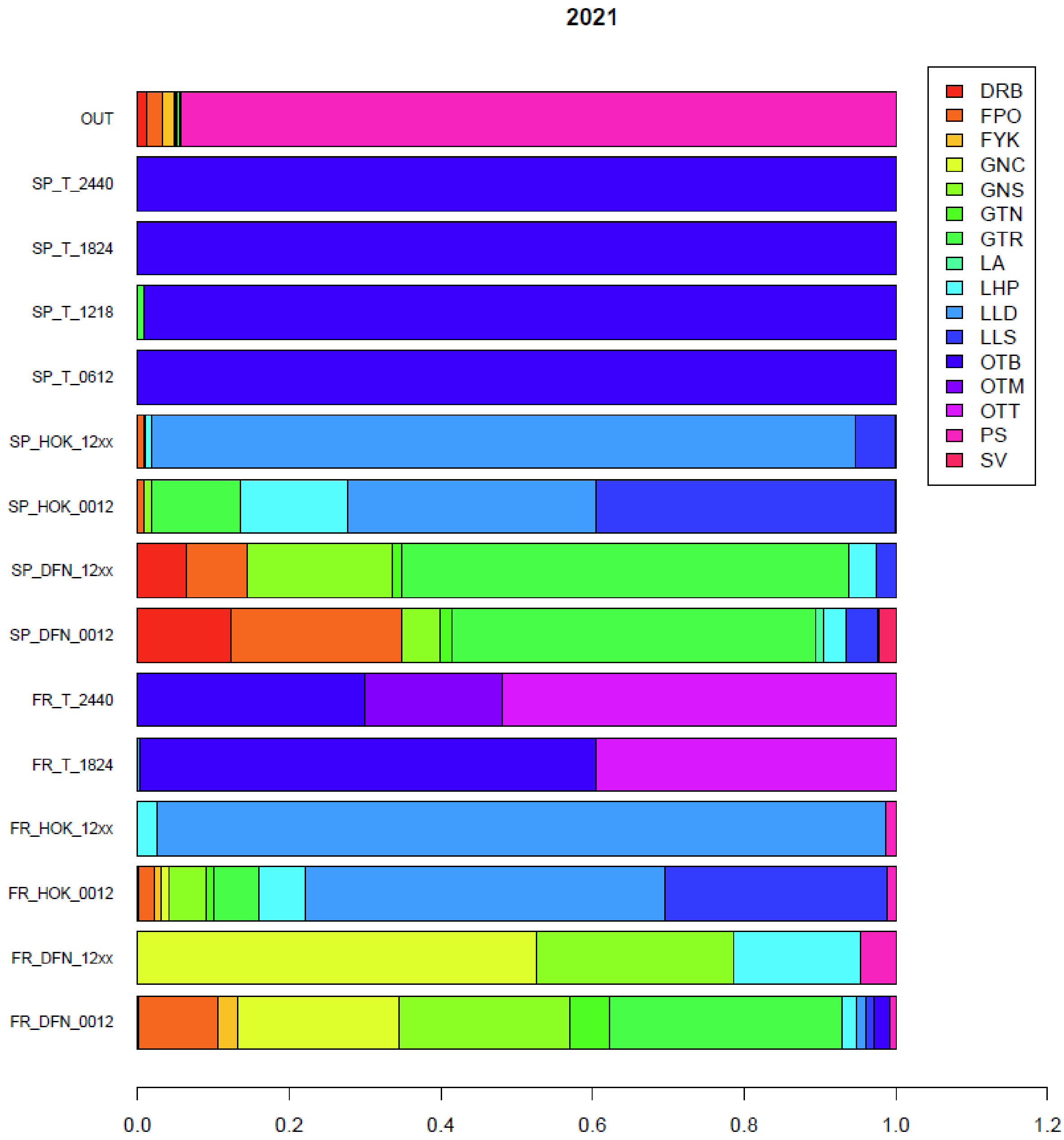


Figure 5.1.4.1. Proportion of gear usage (computed in terms of % of 2021 landings issued from each gear) among current IAM fleet segments (in row). The "OUT" segment cumulates all fleet segments left out. T is short for DTS and stands for demersal trawlers and/or demersal seiners, DFN for drift and/or fixed netters, and HOK for vessels using hooks. For the gear types, DRB stands for boat dredge, FPO for pots and traps, FYK for fyke nets, GNC for Encircling gillnets, GNS for Set gillnet, GTN for Combined gillnets-trammel nets, GTR for Trammel net, LA for Lampara nets, LHP for Hand and Pole lines, LLD for Drifting longlines, LLS for Set longlines, OTB for Bottom otter trawl, OTM for Midwater otter trawl, OTT for Multi-rig otter trawl, PS for Purse seine, SV for Beach and boat seine, and NK and NO for unknown gear. Roughly, red to orange colors corresponds to dredges and traps (DRB – FPO – FYK), yellow to green corresponds to various gillnets (GNC – GNS - GTN – GTR), green to lightblue corresponds to longlines (LA -LHP – LLD – LLS), darkblue corresponds to unknown gears (NK – NO), purple corresponds to trawls (OTB – OTM – OTT), and purple to red corresponds to seines (PS – SV).

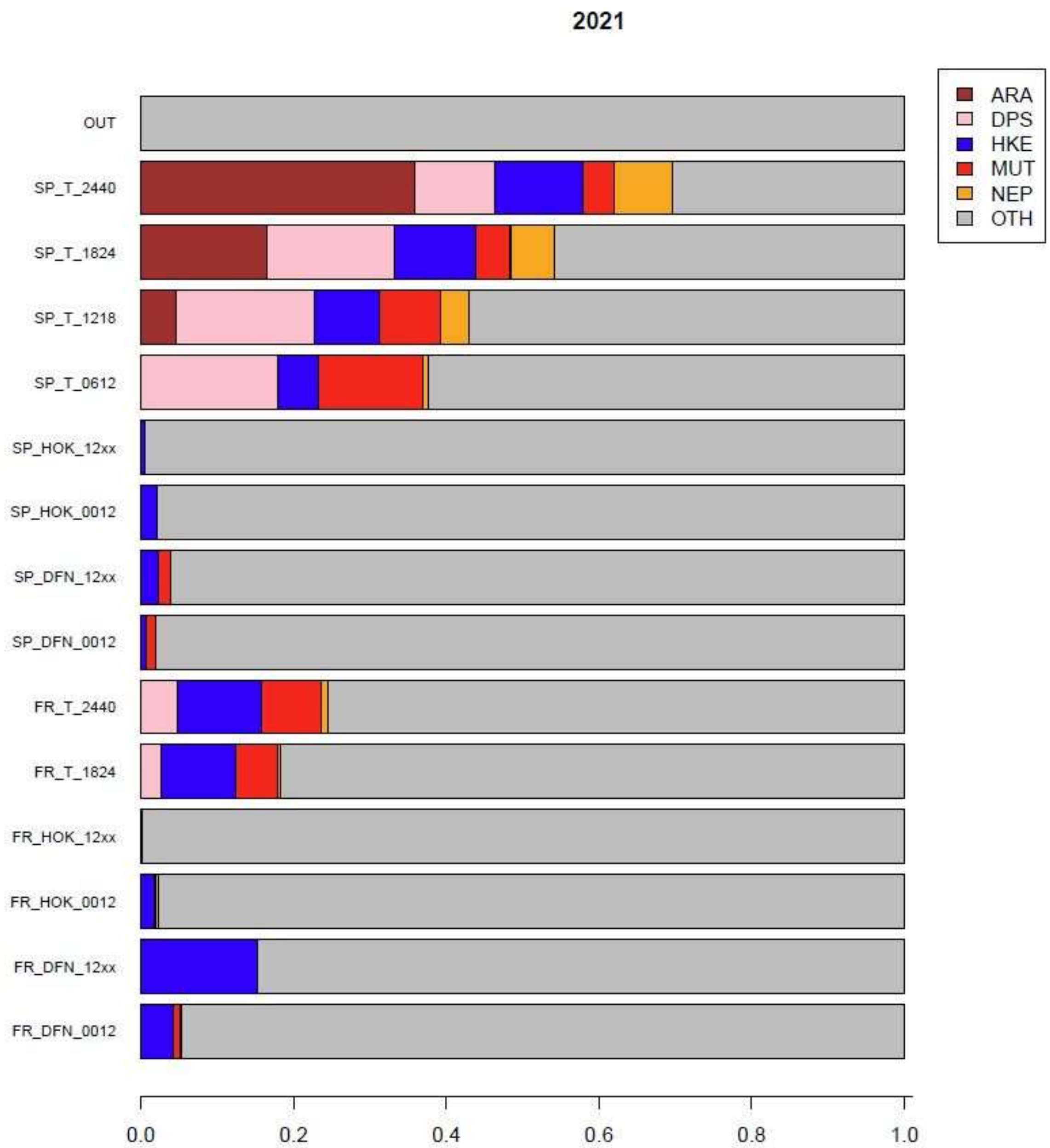


Figure 5.1.4.2. Proportion of species of the plan landed (landings in value) by IAM fleet segments (in row) based on 2021 FDI data. The "OUT" segment cumulates all fleet segments left out. T is short for DTS and stands for demersal trawlers and/or demersal seiners, DFN for drift and/or fixed netters, and HOK for vessels using hooks. The vessel length class 12xx means all vessels superior to 12 meters. Coloured space represents species targeted by the westmed management plan (ARA: *Aristeus antennatus*, DPS: *Parapeneus longirostris*, HKE*: Merluccis merluccius*, MUT*: Mullus barbatus*, NEP: *Nephrops norvegicus*), and grey areas (OTH) represents all other species cumulated.

5.1.5 Relationship between biomass increase and economic gains

Economic indicators are produced for the French and Spanish fleets. The latest year of available AER data (i.e. 2020) was used to parameterise the model. The economic indicators produced are revenue per fleet and gross value added (GVA) per fleet.

Revenues, or hereafter referred to as gross value of landings (GVL), is based on estimates of landings multiplied by market prices. As landings are a function of the biomasses of the stocks modelled, a change in these biomasses will therefore affect landings and therefore fleet revenues. It is important to note that in this version of IAM, landings of "static" species are based on LPUEs that are estimated to be constant throughout the simulation. This is an important assumption, as it means that the sources of revenue from species that are not explicitly modelled in IAM depend solely on fishing effort. This means that if fishing effort decreases, this source of income decreases in proportion to the decrease in fishing effort. The model therefore does not take into account a potential positive effect of a decrease in fishing effort on the non-modelled species. Therefore, in scenarios where fishing effort is reduced and non-modelled stocks would increase, revenues (or GVL) would be underestimated.

Catches and landings are calculated as in equations (5.1.5.1) and (5.1.5.2):

$$C_{s,a,f,t} = \frac{F_{s,a,f,t}}{Z_{s,a,t}} * N_{s,a,t} * (1 - e^{-Z_{s,a,t}}) \quad (5.1.5.1)$$

$$\text{with } Z_{s,a,t} = M_{s,a} + \sum_{f} F_{s,a,f,t}$$

$C_{s,a,f,t}$ stands for the catches in abundance at time t of stock s at age a by fleet f; $N_{s,a,t}$ is the abundance of stock s at age a at time t, $F_{s,a,f,t}$ is the fishing mortality of stock s at age a at time t coming from fleet f (related to fishing effort of fleet f at time t), and $M_{s,a}$ is the natural mortality of stock s at age a.

The landings (in weight) of stock s at age a by fleet f at time t ($L_{s,a,f,t}$) is calculated from the catches, such as:

$$L_{s,a,f,t} = C_{s,a,f,t} * w_{s,a} - d_{s,a,f,t} \quad (5.1.5.2)$$

with $w_{s,a}$ the weight at age a of an individual of stock s and $d_{s,a,f,t}$ the discards in weight of stock s at age a by fleet f at time t.

For more details, see the IAM documentation, available here: https://ifremer-iam.github.io/IAM/.

Revenue by fleet corresponds to landings multiplied by market prices, such as in equation (5.1.5.3):

$$GVL_{f,t} = \sum_{s}\sum_{c} L_{s,c,f,t}\, p_{s,c,f} + \sum_{ss} LPUE_{ss,f}\, p_{ss,f}\, E_{f,t} \quad (5.1.5.3)$$

With $GVL_{f,t}$ the gross value of landings (or revenue) of fleet f at time t, $L_{s,c,f,t}$ the landings (in weight) of modelled stock s for commercial category c by fleet f at time t, $p_{s,c,f}$ the market price of stock s for commercial category c for fleet f, $LPUE_{ss,f}$ the landing per unit of effort of static species ss for fleet f (i.e. non explicitly modelled species, static species include all species caught by the fleet f), $p_{ss,f}$ the average market price of species ss for fleet f, and $E_{f,t}$ the fishing effort of fleet f at year t.

Landings per commercial category are estimated from landings per age-classes and using the commercial categories/ages matrices described in the EWG 20-13 report.

Calculation of the gross value added (GVA) by fleet is described in equation (5.1.5.4):

$$GVA_{f,t} = GVL_{f,t} - \left(fuelv_f * fuelp_f + ovc_f\right)E_{f,t} - rep_f - Fixc_f \quad (5.1.5.4)$$

Where $fuelv_f$ is the fuel consumption (in litre) by unit of effort of fleet f, $\boldsymbol{fuelp_f}$ the **fuel price** per litre (in €/l) for fleet f, ovc_f the other variable costs per unit of effort (including landing costs, oil, bait, gear, food and ice costs), $E_{f,t}$ the fishing effort of fleet f at time t,

rep_f the reparations and maintenance costs and $Fixc_f$ the other annual fixed costs of fleet f (including costs related to equipment, insurance and management costs).

Fishing effort is expressed in fishing days.

5.1.6 Mid (2030) and long term (2040) projections

Uncertainty in recruitment of the different stocks modelled is taken into account during the simulation period (i.e. 2022-2030), see section 5.1.3 for more details on recruitment uncertainty. If the simulation were extended to 2040, the same methodology would be applied.

If we want to go further and simulate changes in certain stocks due to external factors (e.g. effects of climate change on recruitment), scenarios of likely changes in recruitment could be integrated into IAM. This would be possible if these scenarios were provided before the group. One way of providing these scenarios of changes in recruitment could be a matrix with projections of recruitment by stock and year for each year of the simulation period; or indications of potential changes in recruitment (i.e. probabilities of having poor recruitment increasing in the future, or vice versa for example).

In the medium-term projections currently available, if not specified in the management scenarios, with the exception of recruitment, all parameters are held constant. However, it is possible to change the LPUE of different stocks or species in the medium and/or long term projections. As with recruitment, we would need to have this information/assumptions before the group.

5.2 BEMTOOL in EMU 2

5.2.1 Recall on the main issues and conclusions from EWG 22-01

According to the conclusions of EWG 22-01, the implementation of BEMTOOL in EMU 2 can include scenarios focused on the issue of the potential increase of the fishing power associated to the technological creep. In addition, a module present in BEMTOOL and related to the reaction of the sector to a management measure, can be applied, taking into account the lower limit for changes in fishing activity and the possibility of disinvestment. A major missing element is the possibility to adapt the the catch limit according to the annual change in the stock status.

These three issues were not investigated during EWG 22-11 for time constraints.

The implementation of catch limits on more than one species, highlighted during EWG 22-01, has been investigated during EWG 22-11.

5.2.2 Implementation progresses in EWG 22-11

BEMTOOL bio-economic simulation model was implemented for EMU2, following the experiences gained in EWG 19-01, 19-14, 20-13, 21-13, and 22-01. DCF data (FDI and MED&BS Data Call on landings, discards, fishing effort, biological and economic parameters) and results from the assessments carried out during the EWG 22-09 were analysed, to allow the parameterization of BEMTOOL during EWG 22-11. The model included the seven stocks covered by the Multiannual Management Plan (MAP) in the EMU2 (GSAs 9-10-11).

Respect to the model implemented in EWG 22-09 red mullet in GSA 10 was not updated to 2021, due to the lack of an analytical stock assessment carried out by EWG 22-09. Moreover, for ARA9-10-11, for which an analytical stock assessment was not present from

EWG 22-09 as well, it was not possible to use the previous stock assessment. In this case, the MEDITS data were used to extract a recruitment index by year and a total mortality by year (from catch curve method), in order to reconstruct the stock in BEMTOOL through the calibration option.

During the EWG 22-11 the model used in EWG 22-01 was utilised, taking into account the different types of fishing activity exerted by each fleet segment at metier level. Assessed fishing mortality, spawning stock biomass and the observed catches were compared with the simulated ones where possible, as made also in the previous EWGs.

5.2.3 Mid (2030) and long term (2040) projections

For projections it was assumed until 2030 a geometric mean of the recruitment for all the stocks except hake for which a segmented regression was assumed (following EWG 22-09). Considering that a robust stock-recruitment relationship is lacking, it is preferable at the moment to carry out only mid-term projections. The uncertainty on recruitment is considered in all scenarios: the geometric mean is perturbed with a lognormal error for all the stcks except hake for which the uncertainty on the segmented regression is derived on the basis of assessment results through Eqsim and used in the model. The scenarios are defined modifying accordingly the effort (total days as vessels*average day per vessel) by fleet segment and, when required, the selectivity. The fishing days are modified until 2030, while the number of vessels are modified until 2024 for scenarios A and B, and until 2027 for scenario D and then remain the same until 2030. The catch limit for ARS and ARA is set until 2025 and set at the same level of 2025 until 2030. After 2030 catch limits are kept constant with no adjustment to variations in the biomass. The socio-economic coefficients are the same for all scenarios except for the scenarios assuming an increase in fuel price of 20%.

5.2.4 Relationship between biomass increase and economic gains

In BEMTOOL model the relationship between biomass increase and economic gain is governed by several equations. Firstly, by the Baranov catch equation, as reported in Lembo *et al.* (2009), is used to derive the numbers of individuals caught by age and by month of simulation. The fishing mortality by age, by fleet (as combination fleet segment-metier) is estimated according to the following equation:

$$F_f(a) = (Z_{inp} - mean(M)) * Sel_f(a) * f_{act,f} * p_f$$

where $f_{act,f}$ is the fishing coefficient of fleet *f*, $Sel_f(a)$ the selectivity of fleet *f* in the age class *a*, Z_{inp} the total mortality in input (e.g. from the stock assessment), *mean(M)* the average natural mortality on all the age classes and p_f the production coefficient estimated as the proportion of *F* due to fleet segment *f*.

When the biomass increases, for example due to the management measures in force, the catch is expected to increase in the medium term. The catch is estimated by fleet and split in landing and discard, through the following equation:

$$Dis_f(a) = \frac{1}{1 + e^{-\frac{\ln(9)}{DisR_f}*(DisL_{50\%,f} - a)}}$$

where DisL50%,f is the size at which the 50% of the population is discarded by the fleet f, DisRf is the difference between size at which 75% and 25% of the population is discarded by the fleet f and a is the age class.

The price by species and fleet is estimated according to a function characterized by an elasticity coefficient, allowing the price to change in a way inversely proportional to the change in landing:

$$p_{s,f,t} = p_{s,f,t-1}\left(1+\varepsilon_{s,f,landing}\frac{L_{s,f,t}-L_{s,f,t-1}}{L_{s,f,t-1}}\right)$$

where:

$p_{s,f,t}$ is the price of the species s, for the fleet segment f at time t; (€)

$L_{s,f,t}$ is the landings of the species s, for the fleet segment f at time t (Kg);

$\varepsilon_{s,f,landing}$ elasticity coefficient price-landings for species s and fleet segment f (€/kg).

Alternative options are available to model the fish price, for example to the mean size in the landing to take into account the quality of the product. To parameterize this price function the price by commercial category would be very useful to evaluate compensation mechanisms between landing and revenues.

The change in landings and revenues of the target stock is proportionally propagated to the landing and revenues of the other species fished by the fleet f:

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t} \qquad \textbf{(66)}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t} \qquad \textbf{(67)}$$

where:

$R_{f,t}$ are the total revenues (target species+ other species) of the fleet segment f at time t (€);

$R_{f,s,t}$ are the revenues of the target species s of the fleet segment f at time t (€);

rr_f is correction factor to pass from the revenues of target species to the total revenues of the fleet segment f.

Nevertheess, other options are implemented in BEMTOOL in order to allow relationship between landing (resp. revenues) of the other species and landing (resp. revenues) of target species different from proportional.

5.2.5 Stocks

The stocks taken into consideration in BEMTOOL simulations are, as in the EWG 22-01:

- European hake in GSAs 9, 10 and 11 (HKE);
- Red mullet in GSA9 (MUT9);
- Red mullet in GSA10 (MUT10) (last year assessment);
- Deep-water rose shrimp in GSAs 9, 10 and 11 (DPS);
- Giant red shrimp in GSAs 9, 10 and 11 (ARS);
- Norway lobster in GSA9 (NEP9);

- Blue and red shrimp GSA9, 10 and 11 (ARA) (MEDITS data used to reconstruct the stock in BEMTOOL, being missing a quantitative assessment).

For the 7 stocks the decisions made during the EWG 22-09 on recruitment to be used for the reference points estimation and for the short term forecast have been followed for the scenarios. In particular, for all the stocks, except hake, a geometric mean was used for the projections; for hake the segmented regression identified during the EWG 22-09 was used in the deterministic runs. For deriving the uncertainty around the segmented regression of hake t be used for the stochastic runs, the segmented regression was estimated in Eqsim, fixing the breakpoint at level identified in EWG 22-09 and using the same stock object. For the other stocks the geometric mean from EWG 22-09 was perturbed with a multiplicative lognormal error with mean 0 and sd 0.3, as in the previous meetings.

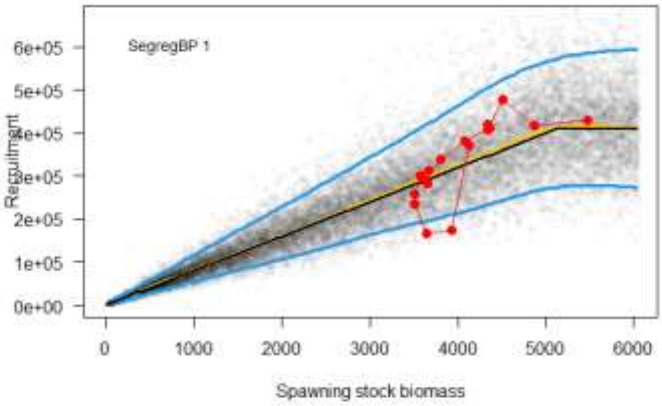


Figure 5.2.5.1 Segmented regression as estimated in Eqsim, using the stock object of EWG 22-09 and fixing the same breakpoint.

Table 5.2.5.1 reports the parameters of the stock-recruitment relationship for hake and the geometric mean used for the other stocks in the scenarios.

Table 5.2.5.1 Parameters of the stock recruitment relationship for hake and GM for the other stocks. The recruits are in thousands.

Area	**Species**	**Recruitment projections**	**a**	**b**	**Recruits in 2022**	**Comments**
8-9-10-11	Hake	HS	83.65	5130	429133.221	
9	Red Mullet	GM			279683	
10	Red Mullet				GM from last year	=151 186
8_9_10_11	Deep-water rose shrimp	GM			3146559	
9	Norway lobster	GM			37684	

8_9_10_11	Red and blue shrimp				GM from BEMTOOL (calibration)	=22 275
9_10_11	Giant red shrimp	GM			528634	

The relevant results of the assessment for the model parameterization, i.e. the current fishing mortality (F_{curr}) and the reference point ($F_{0.1}$) are reported in the Table 5.2.5.2.

The table also reports the upper and lower range of F_{MSY}, according to the formulas used in EWG 22-09:

$$F_{low} = 0.00296635 + 0.66021447 \times F_{0.1}$$

$$F_{upp} = 0.007801555 + 1.349401721 \times F_{0.1}$$

where $F_{0.1}$ is a proxy of F_{MSY}.

and the needed reduction to reach $F_{0.1}$ for each stock.

Considering the ratio between the current fishing mortality and the reference point ($F_{curr}/F_{0.1}$), the stocks more at risk are European hake (HKE; ratio=3.59), Giant red shrimp (ARS; ratio=1.5), and N. norvegicus in GSA 9 (NEP; ratio=1.55). Red mullet in GSA9 and Deep-water rose shrimp 9-10-11 are slightly overexploited (ratio 1.08 and 1.11 respectively).

5.2.5.2 Results of the assessments from EWG 22-09 relevant for BEMTOOL parameterization. The computation of the reduction by stock to reach F0.1 is also reported.

Stock	Fcurrent	F0.1	Change in F
Hake 8-9-10-11	0.61	0.17	-87%
Red mullet 9	0.54	0.50	-8%
Red mullet 10	NA	NA	NA
Deep-water rose shrimp9-10-11	1.40	1.26	-10%
Giant red shrimp 9-10-11	0.77	0.43	-44%
Nephrops 9	0.17	0.11	-34%
Blue and red shrimp 9-10-11	NA	NA	NA

The results of the stock assessment for the 7 considered stocks have been replicated in BEMTOOL, considering the effort by metier for each fleet segment. The comparison of F, SSB and Catch showed a good level of agreement between BEMTOOL and the stock assessment results, where present (Figure 5.2.5.2 and 5.2.5.3).

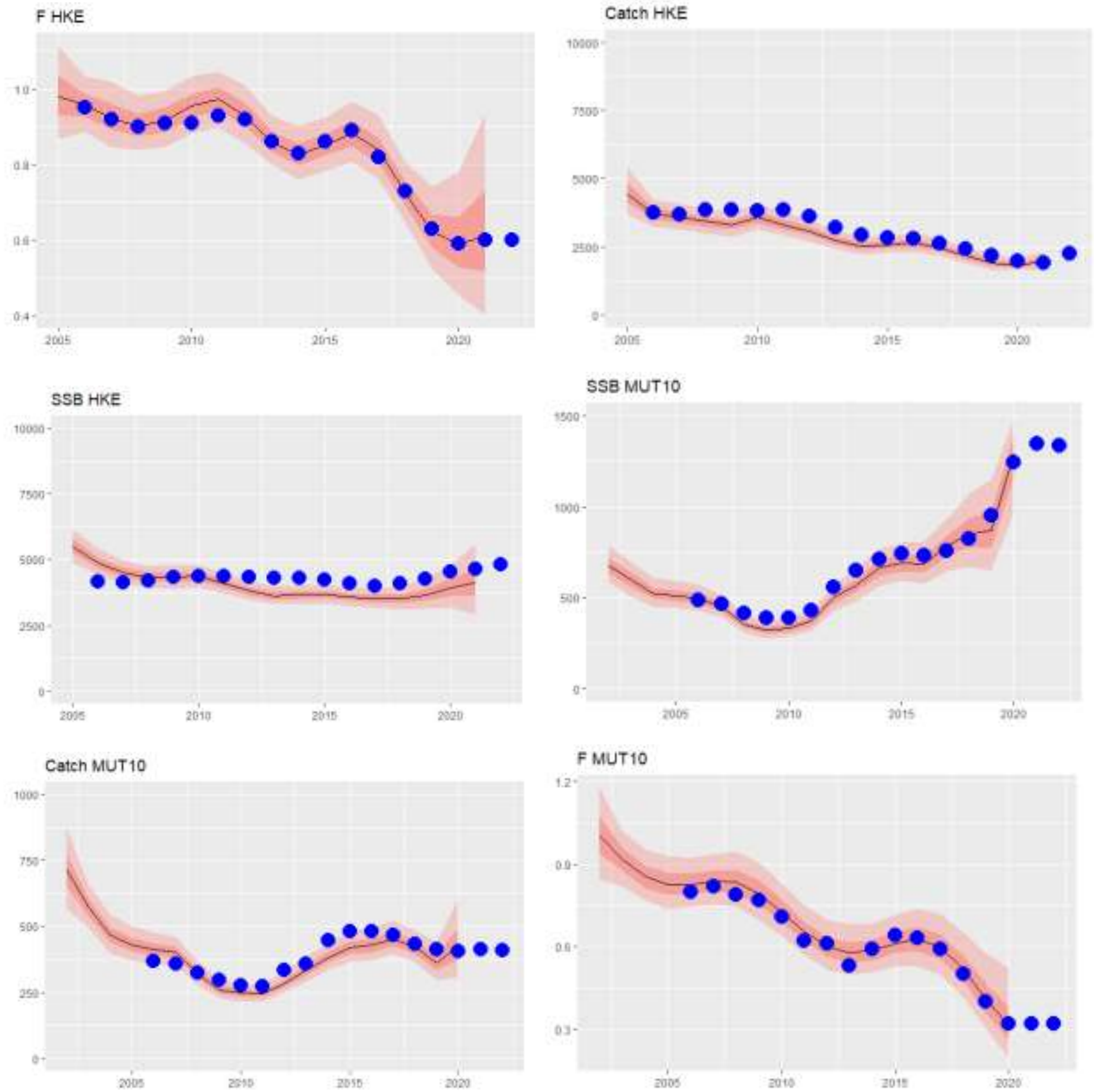


Figure 5.2.5.2 – Comparison between stock assessment results with 95% confidence interval (pink) and BEMTOOL estimates (blue dots) on F, SSB and Catch for HKE 8-9-10-11 and MUT10.

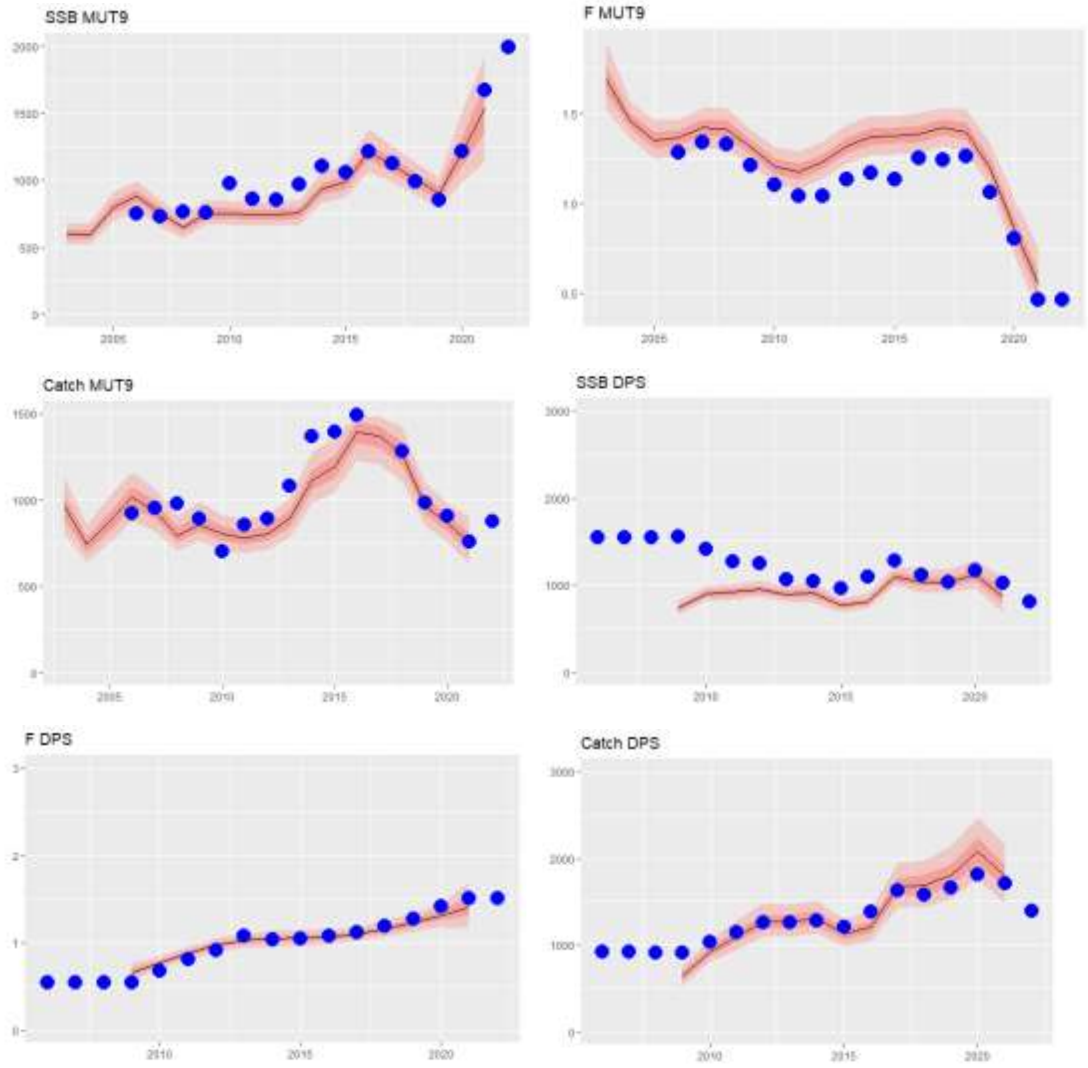


Figure 5.2.5.3 – Comparison between stock assessment results with 95% confidence interval (pink) and BEMTOOL estimates (blue dots) on F, SSB and Catch for MUT9, DPS 9-10-11.

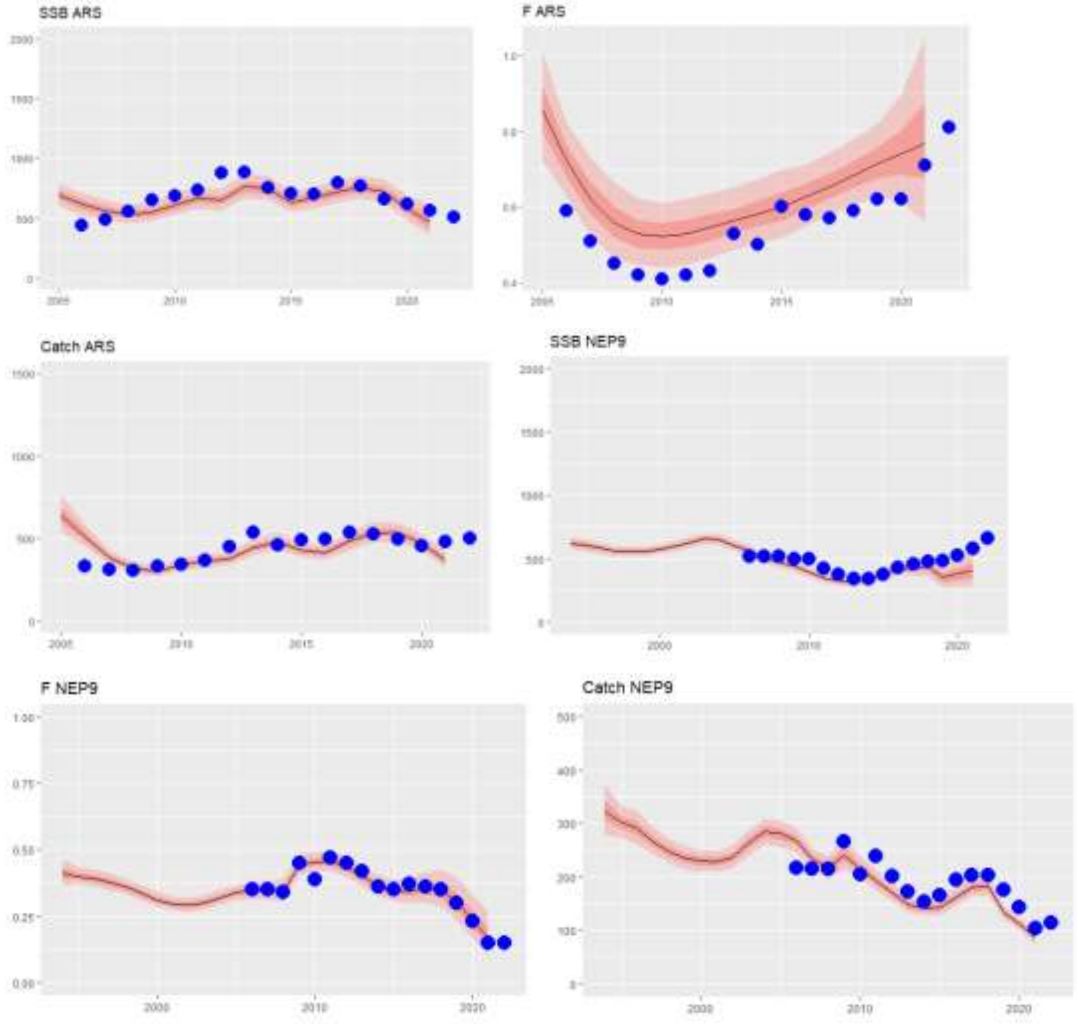


Figure 5.2.5.4 – Comparison between stock assessment results with 95% confidence interval (pink) and BEMTOOL estimates (blue dots) on F, SSB and Catch for ARS9-10-11 and NEP9.

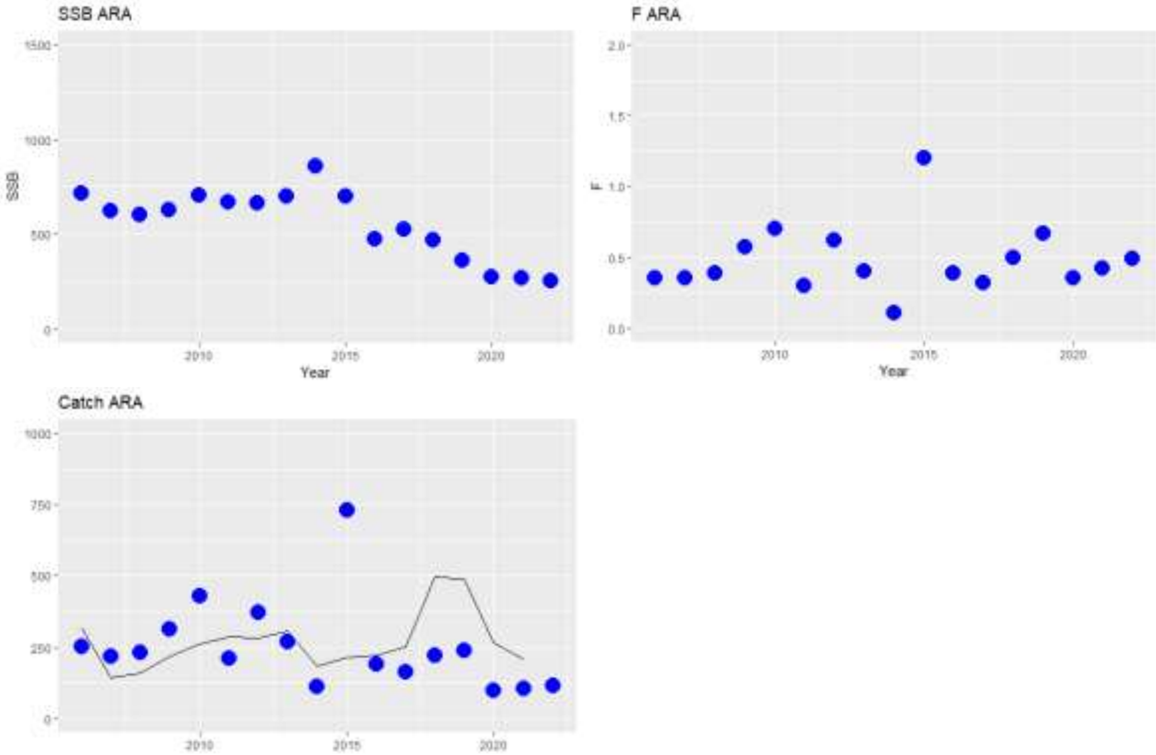


Figure 5.2.5.5– Comparison between observed landing (black line) and BEMTOOL estimates (blue dots) on for ARA 9-10-11. The F and SSB reconstructed by BEMTOOL are also reported.

5.2.6 Fleets

In the simulation and forecast scenarios 19 fleet segments have been analysed. Trawlers have been disaggregated by fishing activity at metier level (OTB_DEF, OTB_DWS and OTB_MDD) as shown in table 5.2.6.1. FDI data from 2014 to 2021 were used. STECF 18-07 EU Fleet Economic and Transversal data from 2008 to 2013 were used. All data include both active and passive demersal gears operated by fleet segments that rely on, and influence, some or all the stocks included in the MAP. Six fleets are allocated to GSA9 and to GSA11 and seven fleets to GSA10, overall 12 fleets are trawlers and 7 fleets use passive gears.

The fuel costs, the other variable costs and the labour costs have been disaggregated at metier level following the methodology to disaggregate economic variables by activity developed in SECFISH project (MARE/2016/22- SI2.768889, https://datacollection.jrc.ec.europa.eu/docs/regional-grants). This methodology allows to take into account the difference in the variable costs associated to the activity of each metier as well as the difference in the labour costs as depending on the revenues and, thus, indirectly by the metier. The SECFISH methodology is divided into two steps: the first based on the individual vessel costs, effort and revenues data, to derive the relationships between costs and transversal variables; the second step is represented by the disaggregation of the costs times series through the relationships (step 1) and the transversal variables. For this application, the relationships related to the Italian fleet within SECFISH project were used to derive the costs at metier level.

Fixed costs, maintenance costs and capital costs have been associated to the vessels and, thus, to the fleet segment (see Table 5.2.6.1).

Table 5.2.6.1–Combinations fleet segments-metier included in the BEMTOOL simulations and forecast scenarios by GSA, gear type, including demersal trawlers (DTS) and polyvalent passive gears (PGP), and vessel length (VL).

	GSA 9	GSA 10	GSA 11
DTS	GSA9_DTS_VL0612 DEF	GSA10_DTS_VL0612 DEF	GSA11_DTS_VL0612 DEF
	GSA9_DTS_VL1218 DEF	GSA10_DTS_VL1218 DEF	GSA11_DTS_VL1218 DEF
	GSA9_DTS_VL1218 DWS	GSA10_DTS_VL1218 DWS	GSA11_DTS_VL1218 DWS
	GSA9_DTS_VL1218 MDD	GSA10_DTS_VL1218 MDD	GSA11_DTS_VL1218 MDD
	GSA9_DTS_VL1824 DEF	GSA10_DTS_VL1824 DEF	GSA11_DTS_VL1824 DEF
	GSA9_DTS_VL1824 DWS	GSA10_DTS_VL1824 DWS	GSA11_DTS_VL1824 DWS
	GSA9_DTS_VL1824 MDD	GSA10_DTS_VL1824 MDD	GSA11_DTS_VL1824 MDD
	GSA9_DTS_VL2440 DEF	GSA10_DTS_VL2440 DEF	GSA11_DTS_VL2440 DEF
	GSA9_DTS_VL2440 MDD	GSA10_DTS_VL2440 DWS	GSA11_DTS_VL2440 DWS
		GSA10_DTS_VL2440 MDD	GSA11_DTS_VL2440 MDD
PGP	GSA9_PGP_VL0012	GSA10_PGP_VL0006	GSA11_PGP_VL0012
	GSA9_PGP_VL1218	GSA10_PGP_VL0612	GSA11_PGP_VL1218
		GSA10_PGP_VL1218	

5.3 ISIS-Fish in EMU 1

5.3.1 Recall on the main issues and conclusions from EWG 22-01

The ISIS-Fish model used in course of EWG 22-01 was implemented for Hake in the Gulf of Lion. It was used to simulate the scenarios of effort reduction, MCL and spatial closures adapted to the Gulf of Lion.

It was parameterised using 2015-2017 logbook and VMS data for the French trawler's activity, 2015-2017 logbooks and a rough spatialisation for French netters and 2015 data for the Spanish fleets provided by Spanish experts. The population spatial distribution was simplistic, assuming homogeneous density in two habitats delineated by depth limits.

Following EWG 22-11, it was decided to expand the model to EMU 1 to allow the evaluation of spatial closures along the Spanish coast, and to ease the population parameterisation based on the assessment model outputs. The population zones had to be revised based on the estimations provided by the ad-hoc contracts using the methodology of Alglave et al. 2022. The parameterisation of the fleets'activity had to be updated and expanded to EMU1 using FDI data for all segments and logbook-VMS data available for EWG 22-01.

5.3.1 Implementation progresses in EWG 22-11

The ISIS-Fish model has been recreated to cover GSAs 1, 5, 6, and 7. The new structure and parameters are described under section X. stocks and Y. Fleets respectively. The model could not be calibrated on time to run the scenarios during EWG22-11.

5.3.2 Stocks (Population dynamics)

The population dynamics model is similar to the assessment model with regard to population age structure and maturity assumption. It uses VBGF growth function from Mellon et al. 2008 and length-weight relationship (STECF 21-11). Recruitment is forced to assessment results for the hindcasted period then equal to 2019-2021 average in projection. It enters the fishery at age 0, progressively along the years as defined in previous work (Q1: 16%, Q2: 42%, Q3: 33%, Q4: 9%) (Leforestier et al. 2019).

Based on the estimations of population spatial distribution (EWG 22-01), population zones have been defined for juveniles (<29cm or December age 1) and adults and the variability of the density was assessed and characterised. Because estimates were not available over the same period for the Spanish and French zones (Spanish: first semester 2018-2020; French: all year 2015-2020), results were partly analysed separately for the two regions. The method relied on a clustering with continuity constraints of spatial cells applied simultaneously on all year x month maps. It resulted in a grouping of cells into five clusters (per stage) that share similar density and are close by. Cluster were relatively stable in time leading to the definition of five populations zones per stage with constant boundaries, each cell belonged to the cluster to which it was the most frequently assigned by the clustering (Fig. 5.3.2.1). The variations of fish biomass within each population zone were analysed to evidenced i) the share of population between French and Spanish coast, ii) the inter-annual variability of biomass per zone and iii) the seasonal variability of biomass per zone.

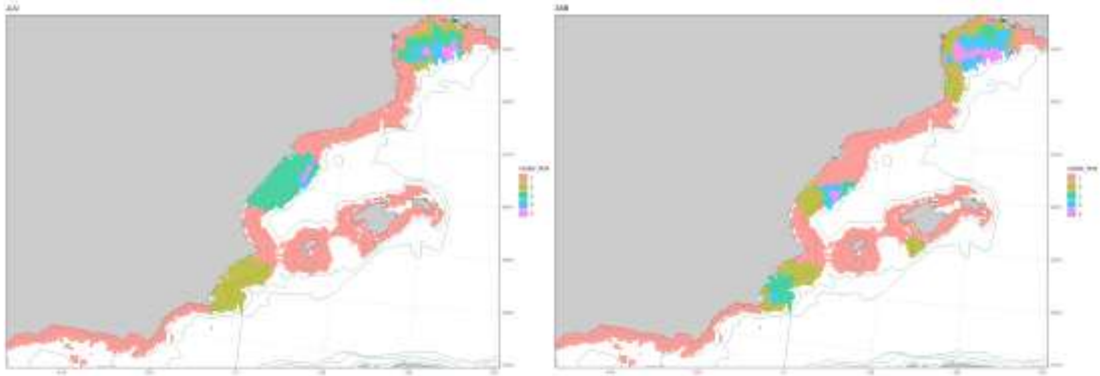


Figure 5.3.2.8: Population zones of juveniles (<29cm; left) and adults (right) estimated based on a clustering of the cells of the monthly maps according to their density and neighborhood.

The main conclusions were i) the share of juveniles and adults between French and Spanish coasts is stable in time and displays 60 to 75% of juveniles and 20 to 25% of adults in GSA7 (Fig 5.3.2.2). The discrepancy between the proportion of juveniles and adults between the two zones can be explained by either migrations between regions or different mortality rates. Because it is not possible to elucidate the true mechanism with the data at hand nor to estimate migration rates and because of technical limits due to available estimates, we decided to assume that the discrepancy resulted from different mortality rates as a first guess. Therefore we assume that fish recruit in one of the two regions and then stay within this region. This assumption could be verified or invalidated through model validation. Consequently, in the model, the recruitment is forced with the observed distribution of the juveniles; then fish of age 1 are forced to distribute according to estimations within their region of recruitment.

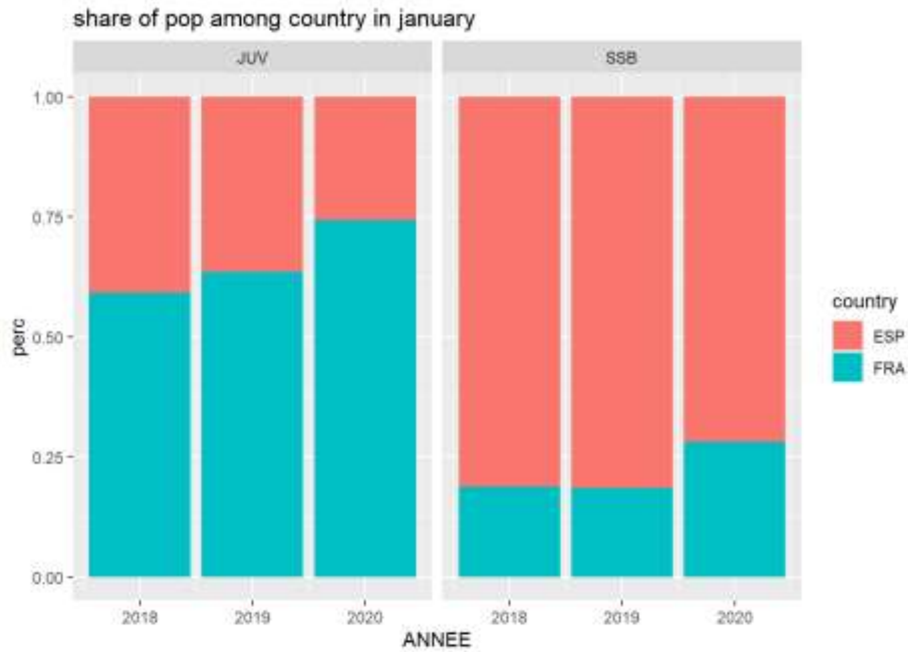


Figure 5.3.2.9: share of juveniles (<29cm) (left) and adults (right) in the French (GSA7) and Spanish areas (GSA 1-5-6) according to the estimates of biomass distribution (EWG 22-01)

Regarding the inter-annual ii) and seasonal iii) variability of biomass per zone within each region, it was found that inter-annual variability was high and larger than seasonal variability for all region and stages except for adults in the Gulf of Lion. Indeed, a consistent decrease of biomass in cluster 2 (coastal zones) and a simultaneous increase in clusters 4 and 5 (offshore zones) between April and September interpreted as a migration. Therefore the model assumes one unique migration in June and redistributes fish according to observation.

For all stages and regions, the distribution is updated with annual estimates in December.

5.3.3 Fleets

The parameterisation of fleet activity in ISIS-Fish required the use of several databases in addition to the FDI data. Indeed, the purpose of the model is to describe finely the spatial distribution of fishing effort to overlap with the distribution of fish populations. VMS-logbook data were available for French (2015-2020) and Spanish (2018-2020) trawlers, together with vessel information for French trawlers. Only FDI data were available for netters and longliners. Therefore, for these later fleets, we assumed one métier per GSA, and the zones were defined based on expert knowledge and few VMS data.

5.3.3.1 Preparatory work on Spanish trawlers' data

In order to match logbook-VMS data with FDI data for the Spanish trawlers, the main harbours and length of vessels recorded in VMS-logbook data have been identified with the help of Spanish experts. Based on expert knowledge, the 47 harbours identified along the Spanish coast were then grouped in 9 "super harbours", to be more manageable in ISIS-Fish, and to reflect main fishing grounds (Fig. 5.3.2.3, left). NB: The same procedure was applied to French harbours leading to 6 super harbours along the French coast (Fig. 5.3.2.3, right). The "effort group" (related to regulation) was acknowledge in the log-book data and allowed deriving vessel length-class. The number of vessels per length-class and super harbour was then computed.

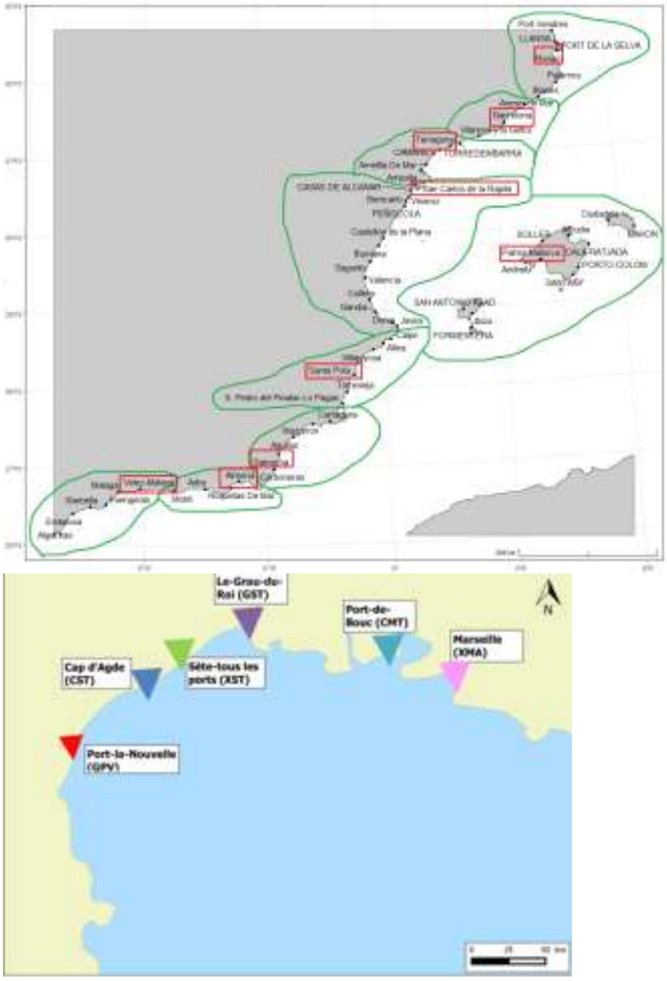


Figure 5.3.2.4: Groups of harbours identified from expert knowledge for Spanish fleets (left) and French fleets (right).

5.3.3.2 Identification of métiers and strategies for trawlers

For the French trawlers, efforts per métiers as identified by the Sacrois algorithm and reported in logbook were analysed. Five métiers were consistently practiced over the 2015-2020 period: OTB_MZZ, OTB_OCT, OTB_OTH, OTT, OTM (5.3.2_Annex4_data2022_explo_metier_sacrois.pdf).

For the Spanish trawlers, logbooks and expert knowledge allowed the identification of three métiers: OTB_DEF, OTB_DWS, OTB_MDD and two strategies (coastal and offshore) based on métiers practiced (DWS implies offshore, 5.3.2_Annex5_ESP_agg_fleet_strategy_metier.xlsx).

VMS data allowed the mapping of effort per year, month, métier, strategy, vessel length and super harbour (5.3.2_Annex6.1_ESP_carto_zone, 5.3.2_Annex7.1_FRA_carto_zone). The analysis (multi-table MFA, 5.3.2_Annex6.2_ESP_zone_metier_MFA, 5.3.2_Annex7.2_FRA_zone_metier_MFA) concluded in the absence of a clear seasonality in fishing grounds and on the similarity of metier zones between strategies. To simplify the implementation and account for the variability in effort distribution, two main fishing zones were defined per métier based on clustering with continuity constraints on effort maps aggregated per year for all strategies attached to a given harbor: the core zone (cluster 2) and the low-effort zone (cluster 1) (example Fig. 5.3.2.4, 5.3.2_Annex6.3_ESP_agg_zone_peche, 5.3.2_Annex7.3_FRA_agg_zone_peche).

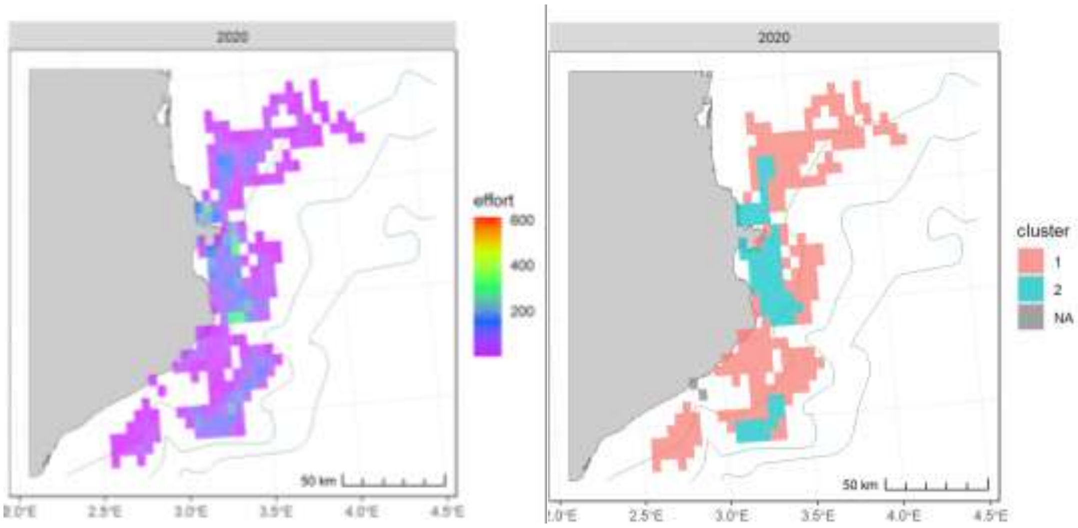


Figure 5.3.2.10: Example of maps of annual fishing effort for a given métier by vessels of a given super harbor (left) and implementation in ISIS-Fish (right) in the form of two métier zones (cluster 1 and 2). In the model, the level of effort differs between cluster 1 and 2 to reflect the concentration of effort in cluster 2 cells, but effort is homogeneously distributed within each cluster.

5.3.3.3 Match between FDI and logbook-VMS data for Trawlers

Effort, landings and vessel count used to parameterise the model were extracted from FDI tables A, G and J respectively, except for Spanish longliners, which vessel numbers was inferred from the number of active vessels using GNS reported in table G to avoid accounting for vessels using LLD. For trawlers, FDI could not inform values per month, strategy, metier and metier-zones. Therefore, logbooks were used to ventilate the effort per "FDI-fleet" (Fishing-tech x length-class x sub-region) at this level.

The correspondence between logbook trawler segments and FDI trawler "fleets" required a few assumptions related to spatial aspects (Table 5.3.2.3). It was thus considered that catches and effort reported in a given GSA were solely due to vessels with this GSA as principal sub-region. This simplifying assumptions is acceptable, according to fishing effort maps that evidence that vessels only marginally fish outside the GSA where they are attached.

Table 5.3.2.3 Correspondence between FDI columns and logbook column.

FDI	**Logbooks**
Country	Country
Length-class	Length-class
Fishing technic	Main Gear
Sub-region/Principal sub-region	Super harbour sub-region

Although not perfect, the match between reported values in both sources was satisfying (5.3.2_Annex8_fdi_vs_logbook).

5.3.3.4 Fishing mortality and Effort standardisation

In ISIS-Fish fishing mortality results for the computation of partial fishing mortalities per age-class, metier and fleet. The partial fishing mortalities $F_{age,métier,fleet}$ are computed as follow (Eq. 5.3.2.1):

$F_{age,métier,fleet} =$

$Acc_{age,season} \times Sel_{age,gear} \times Std_{gear} \times Tar_{métier} \times Efficiency_{fleet} \times Effort_{métier}$ (Eq.5.3.2.11)

Selectivity $(Sel_{age,gear})$ is a distinct process from accessibility and only represents the probability of a fish of a certain length or age to be retained by the gear. Based on the partial fishing mortalities computed by gear (EWG 21-01), we derived the presence/absence of certain age classes of hake in the catch of each gear and used it as a first guess (Table 1). An improved selectivity curve will be computed based on catches at length per gear made available during the EWG for a later version of the model.

Table 5.3.2.1. Selectivity per gear and age

<table>
<tr><th>Gear/Age</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4+</th></tr>
<tr><td>OTB/OTT</td><td colspan="5">1</td></tr>
<tr><td>GNS/GTR</td><td>0</td><td colspan="3">1</td><td>0</td></tr>
<tr><td>LLS</td><td colspan="2">0</td><td colspan="3">1</td></tr>
</table>

Effort is then possibly standardised to account for the differences in catchability of gears (Std_{gear}), métiers (target factor, $Tar_{métier}$) and fleets (efficiency) through three coefficients computed outside the model using glm analysis of CPUE data. Because métier definition in FDI and logbooks differed, only gear standardisation and fleet efficiency were estimated using FDI data aggregated by year, quarter, gear, and vessel length-class. The underlying assumption of neglecting the target factor was that the differences in CPUE between two métiers that use the same gear were solely due to differences in fish density on the respective fishing grounds or to seasonnality. We also assumed that, fleet efficiency only depended on vessel length-class regardless of the fishing technic. The generalised linear model used for the estimations is of the form (Eq.5.3.2.2):

Log(CPUE) ~ year + quarter + gear + length-class (Eq.5.3.2.2)

The year and quarter effect attempts to correct for the effect of the inter-annual and seasonal fluctuations of biomass or accessibility of fish that influence CPUE (Table 2).

Table 5.3.2.2: estimates of gear and length-class effect on CPUE.

var	term	estimate
year		0.77
quarter		0.914
vessel_length	VL0612	14.938
vessel_length	VL1218	58.546
vessel_length	VL1824	38.035
vessel_length	VL2440	72.971
gear	GNS_FRA	6.721
gear	LLS_ESP	1.928
gear	OTB_ESP	3.441
gear	OTB_FRA	12.781
gear	OTH_ESP	0.191
gear	OTH_FRA	0.49
gear	OTM_FRA	4.366
gear	OTT_FRA	13.234

$Acc_{age,season}$ is fish accessibility, a purely biological process independent from gear that depends on age and season. It is calibrated because impossible to measure. Calibration is in progress at the time of delivering the report.

5.3.4 Mid (2030) and long term (2040) projections

Once parameterized, ISIS-Fish combines spatially explicit fish and fleet dynamics at a monthly time step. Catches derive from the Baranov equation, in which fishing mortality depends on fish age, fleet and métier (gear, efficiency and zone). Fishing mortality is computed in each fish population zone where the spatial distribution of population abundance (dynamically predicted by the population submodel) and the spatial distribution of fishing effort monthly updated by the exploitation and management submodels overlap.

In projection, recruitment and migrations of hake are forced to past years average. Effort of each fleet is set as specified by the scenario in relation to the reference period (2015-2017) or maintained at 2018-2020 value. The model allows explicitly accounting for the spatial and seasonal distribution of fish and fishers in the evaluation of impact of closures. It simulates effort report outside the closed area under user-defined assumptions (by default report on the remaining métier zone). Impact on biomass is highly dependent on assumptions made regarding fish movements. In this case, we considered hake to be highly mobile but bonded to specific habitats. This results in the biomass being uniformly redistributed within each habitat at the beginning of each time step but the fish don't leave their habitat in-between migration times (December and possibly June). Selectivity measures are directly implemented by changing the selectivity curve. Quotas can either be forced annually (computed outside the model beforehand) or internally computed every year according to any fishing mortality target or harvest control rule. Landings are monthly counted against quotas and fishing behavior can be implemented so that when a quota is exhausted in course of the year, fishers either stop fishing, or report their effort on other métiers or continue fishing and discard. Currently a change in vessel number while maintaining a constant effort by fleet would have no effect on model results. Management measures can be combined. The economic module of ISIS-Fish is not as sophisticated as the IAM one and provides results only in terms of catches and gross revenues by fleet.

5.4 SMART in EMU 2

5.4.1 Recall on the main issues and conclusions from EWG 22-01

During the EWG 22-01, SMART was used also to simulate the potential effects of TAC-based management measures. This new (for SMART) situation was modelled as follows:

1. After the estimation of the LPUE by species/month, the sets of cells with LPUE > 0 for ARS and ARA were identified;
2. If (for instance) a TAC is set for ARA, the model starts estimating the new fishing effort from January and proceeds to the successive months until the TAC for ARA is reached. When it happens (e.g. in July), the model close the set of cells with LPUE > 0 for ARA and does not allow to allocate fishing effort in that set of cells until the end of the year;
3. In practice, this means that the TAC scenarios are modelled as FRA (Fishery-Restricted Areas) scenarios where the FRA corresponds to the fishing grounds of the species under TAC regulation;
4. Intuitively, this determines a situation in which, after the TAC was reached, the fleets are allowed to work only on fishing grounds where the species under TAC regulation is absent;
5. It is important to add that, during the first phase (point 2 of this list), the optimization function of SMART (which works on the spatial LPUE of the target species) is set to maximize revenues for the species under TAC regulation. Actually, until the TAC is reached, fishers engage a "gold rush" for the species under TAC regulation. This modelling approach has been defined considering that fishers are aware of the TAC.

During the EWG 22-11, the input data sets were updated to incorporate the historical time-series from 1 January 2012 to 31 December 2021. In particular, the data collected in the year 2021 was integrated concerning:

1. the monitoring of fishing effort activities, both for VMS spatial positions and for the collection of species and quantities landed;
2. indicators of the trend of the status of the resource by the scientific survey (MEDITS campaign 2021).

The R package "smartR" (D'andrea et al., 2020) was employed to configure the SMART model and suit it to the requirements of the EMU2 case study. The SMART model, as well as the workflow of the smartR package, can be summarized in the following logical steps:

1. Use landings and catch data, combined with VMS data, to estimate the spatial/temporal productivity of each cell, in terms of aggregated LPUE by species;
2. Use survey data to estimate the Length-Frequency Distribution (LFD) and the Age-Frequency Distribution (AFD), by species, for each cell/time;
3. Use VMS data to assess the fishing effort by vessel/cell/time;

4. Combine LPUE, LFD/AFD, and VMS data to model the landings by vessel/species/length class/time;
5. Estimate the cost by vessel/time associated with a given effort pattern and the related revenues, which are a function of the landings by vessel/species/length class/time;
6. Combine costs and revenues by vessel, at the yearly scale, to obtain the incomes, which are the proxy of the vessel performance. Incomes could be aggregated at the fleet level to estimate the overall performance;
7. Use estimated landings by species/age, together with survey data, to run MICE model for the selected case of study in order to obtain a biological evaluation of the fisheries.

This workflow allows using SMART to simulate the potential adaptation of fishers, in terms of fishing effort displacement in space and time, to different management measures including closed areas/effort regime/temporal closure. Given that a new fishing effort pattern corresponds to new catches and related revenues, cost and, ultimately, profits, SMART tries to forecast the biological and economic consequences of different management scenarios.

The key aspects resulting from the application of SMART are 1) the explicit reference to the spatial dimension and consequent geographical allocation of effort, landings, costs, and revenues; 2) individual-based optimization of the single vessels' patterns of fishing effort at a monthly time scale; 3) multiple species stock assessment with the MICE (Model of Intermediate Complexity of the Ecosystem) paradigm. A detailed description of an application of the method is available in Russo et al., 2019, and a detailed description of the smartR package is provided in D'Andrea et al., 2020.

In addition, the stock objects shared by the FTP of the EWG 22-11 were integrated and processed using a modified version of the Elman network described in Russo et al., 2014. Actually, the Elman network was feed with the time series of catches in number of individuals by age class, SSB by year, and abundance at sea in number of individuals by age class and trained by species in order to fit the historical time series. The, the trained Elman networks were used to predict the future trends of SSB and abundance at sea in number of individuals by age class using the new pattern of catch, as obtained after the estimation of fishing effort adaptation/displacement.

Finally, the potential effects of the management scenarios based on changes of the selectivity (as determined by technical modifications of gears) were investigated using the selectivity vectors (F by age/stocks) estimated using BEMTOOL.

5.4.2 Application of the SMART model to the West Med MAP

The spatial productivity (monthly LPUE as grams of catch per meter of LOA and hour of fishing) was estimated using landings and VMS data, according to the procedure of Russo et al., 2018 and Russo et al., 2019. At the same time, the economic parameters needed to model the relationships between 1) fishing effort and its related costs (crew salaries, fixed costs, etc.); 2) spatial fishing footprint and its related costs (i.e. fuel consumption); 3) yield and production costs (i.e. commercialization); 4) yield and revenues (using the prices at the market of the different species by size class) were collected and integrated into the model. Values of prices at the market by species and length class, together with the price of fuel, were partially retrieved by Russo et al. (2014b) and integrated using the public databases provided by the "Istituto di servizi per il mercato agricolo alimentare"

(ISMEA - http://www.ismea.it/flex/FixedPages/IT/WizardPescaMercati.php/L/IT) and by the Ministry of Economic Development (https://dgsaie.mise.gov.it/prezzi_carburanti_mensili.php).

5.4.3 Space and time scale

For this application of SMART to the case study of Western Mediterranean Effort Management Unit 2, the resolution of the square grid for the GSAs 9, 10, and 11 is the same as the EWG 19-14 with cells of 6 x 6 nm (Figure 4.1.2.1). The cells covering the area deeper than 800m depth were excluded to reduce the complexity and computational time required for the simulations.

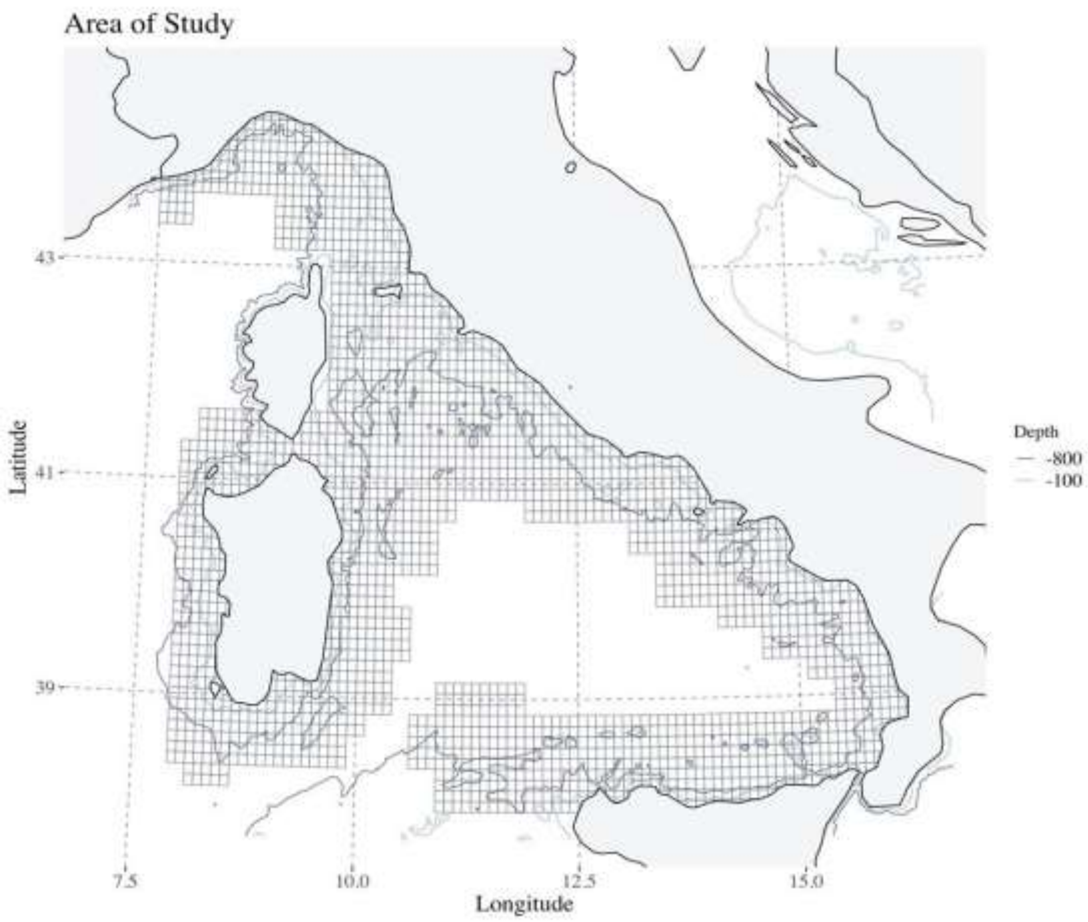


Figure 5.4.3.1 – Area of the Effort Management Unit 2 case study considered in the Western Mediterranean EWG 20 13. The square grid of 6 x 6 nm used for the definition of the SMART model for the Italian GSAs in the Tyrrhenian Sea (9 – 10 - 11).

5.4.4 Fleets

The fleet included in the analyses is composed of the Italian trawlers with LOA equal or larger than 15m, that is the portion of the fleet equipped with VMS. The native VMS pings were pre-processed using the VMSbase platform (Russo et al., 2014) and coupled, at the level of single vessels and at a monthly scale, with logbook, landings, and economic data (fuel consumption, etc.). Figure 4.1.2.2 depicts the average hours of fishing across the time series by cell.

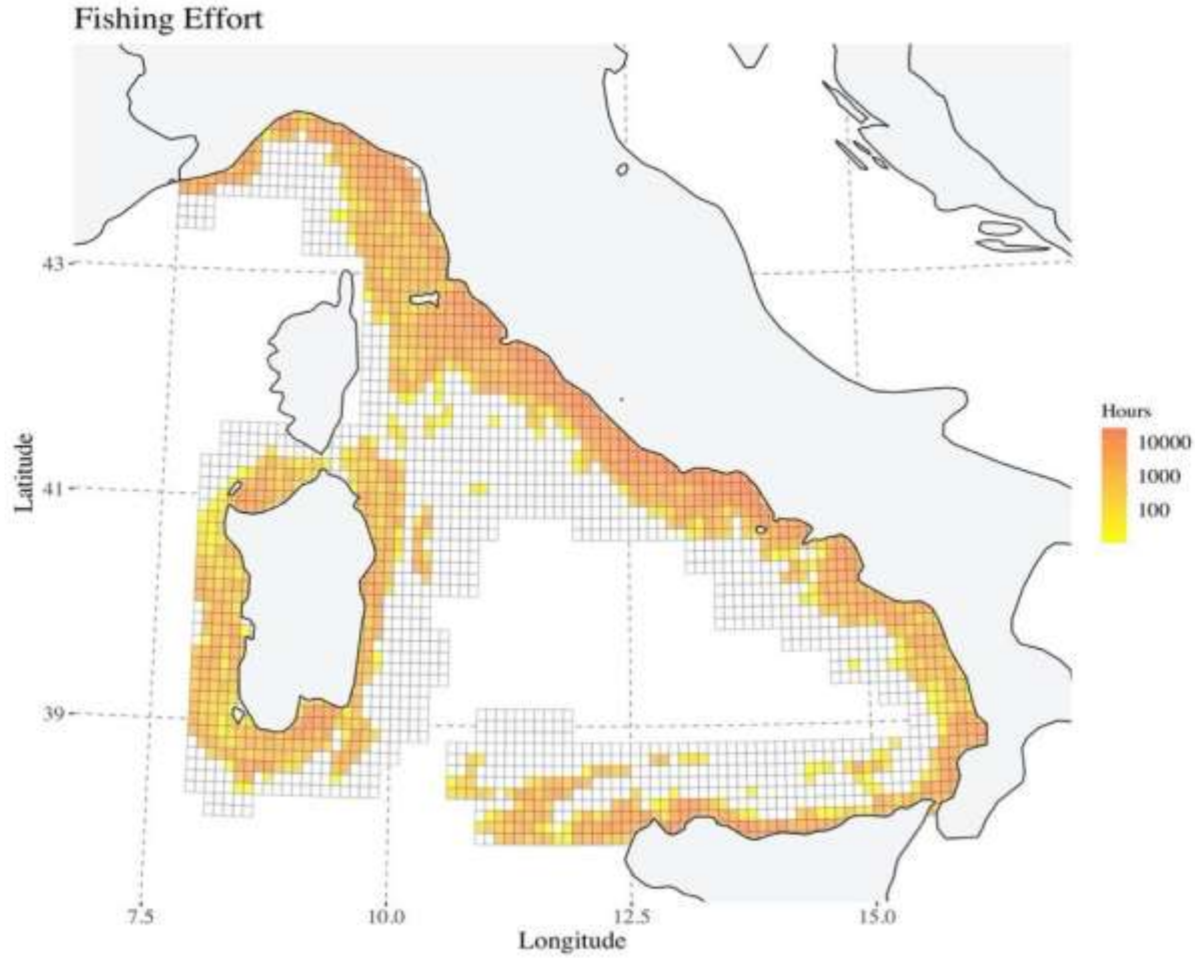


Figure 5.4.4.1 - Map of the average fishing hours (in logarithmic base 10 scale represented by a color scale from yellow – low to orange - high) for the 96 months' temporal series (years 2012- 2020).

5.4.5 Stocks

Five species corresponding to six stocks of the MAP were considered for this implementation of SMART. Namely:

- the Giant red shrimp (*Aristeomorpha foliacea* - ARS) in GSA 9, 10 and 11;
- the Deep-water rose shrimp (*Parapenaeus longirostris* – DPS) in GSA 9, 10 and 11;
- the Hake (*Merluccius merluccius* – HKE) in GSA 9, 10 and 11;
- the Norway loabster (*Nephrops norvegicus* - NEP) in GSA 9;
- the Red mullet (*Mullus barbatus* - MUT) in GSA 9;
- and the Red mullet (*Mullus barbatus* - MUT) in GSA 10.

The stock object for the blue and red shrimp (*Aristeus antennatus* – ARA) in GSA 9, 10 and 11 was not available.

The relationships between these stocks and the fleet of trawlers are described in Fig. 5.4.5.1.

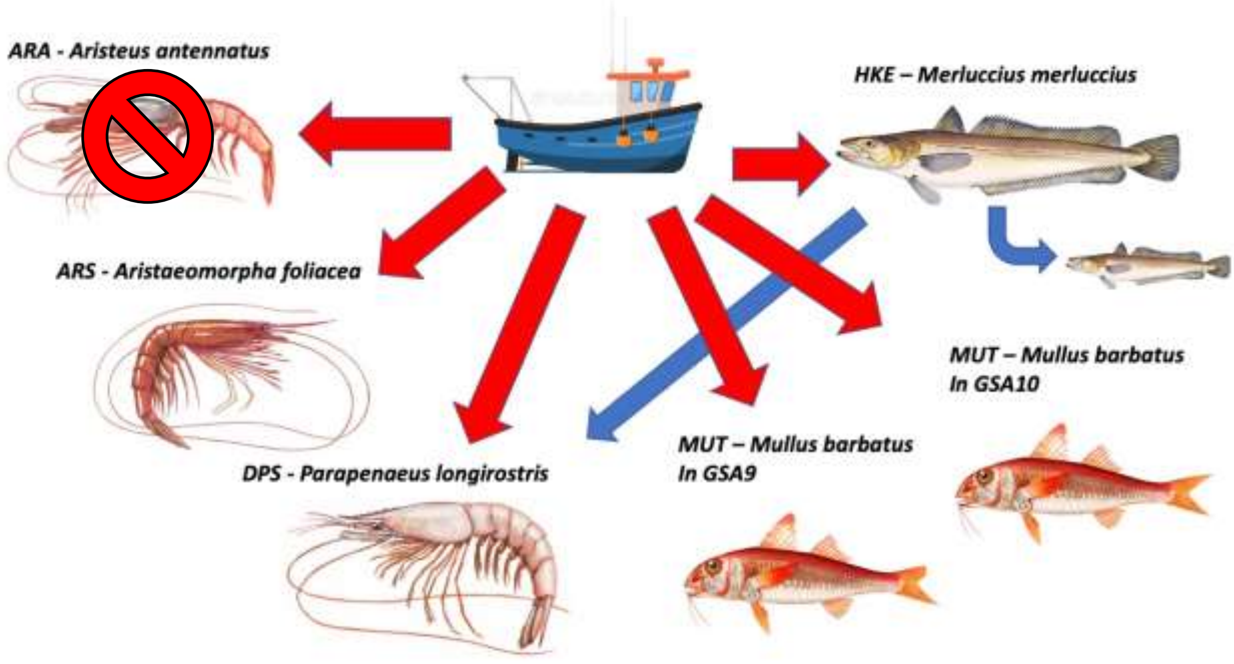


Figure 5.4.5.1 - Representation of the relationships between trawl fishing and the four stocks considered for the application of SMART in the EMU2, together with the main trophic relationships between stocks. Adult HKE is a predator of DPS and HKE juveniles. MUT and ARS were considered as stand-alone stocks with no trophic relationship with other investigated species.

5.4.6 *Model fitting*

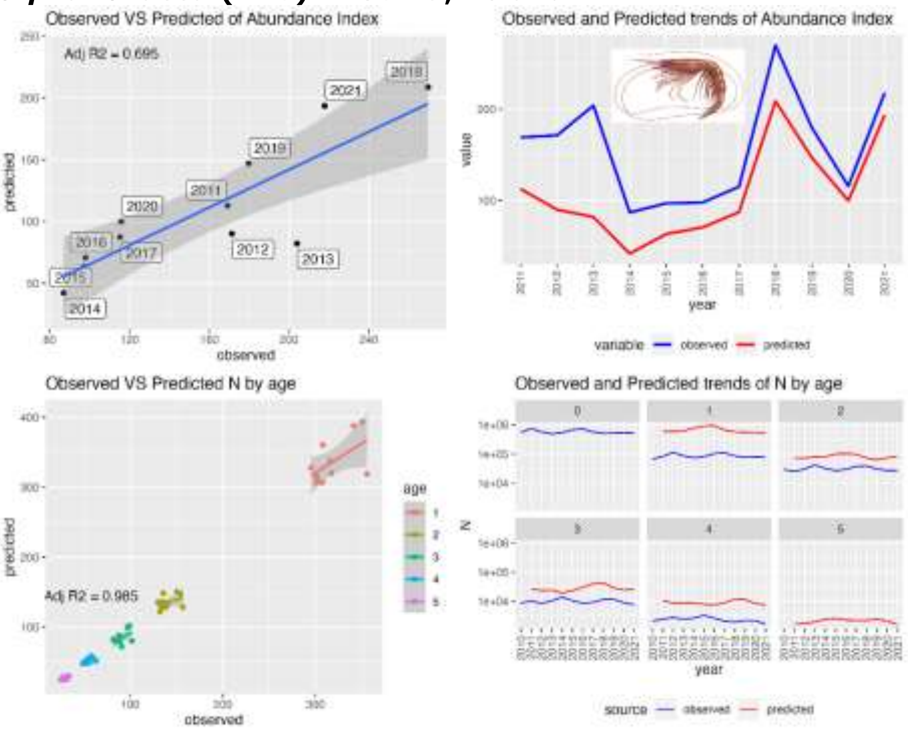
The trained Elman networks by stock were evaluated using basic statistics and summarized using a graphical approach. Namely:

- The observed (stock object data) and predicted (SMART) values of Abundance Index (Total number of individuals/km^2) were compared in a scatterplot and the adjusted R^2 was used to assess the goodness of the fit;
- The observed (stock object data) and predicted (SMART) values of Abundance Index (Total number of individuals/km^2) were also compared as a function of time (time series);
- The observed (stock object data) and predicted (SMART) values of Abundance Index (Number of individuals by age class/km^2) were compared in a scatterplot and the adjusted R^2 of a liner model including age as a factor was used to assess the goodness of the fit;
- The observed (stock object data) and predicted (SMART) values of Abundance Index (Number of individuals by age class/km^2) were also compared as a function of time (time series)

An overview of these patterns and indexes should allow to evaluate the reliability of the model and its ability to capture the dynamics of each stock.

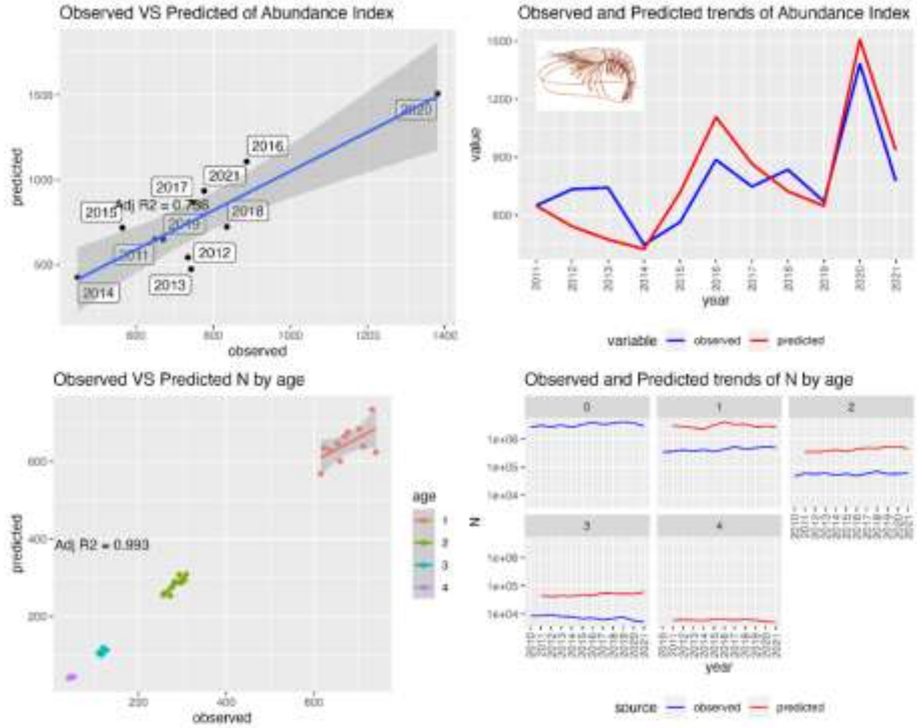
In the case of *Aristeomorpha foliacea* (ARS) in GSA 9, 10 and 11, the trained SMART model evidences a very good ability to capture the trends of abundance of this stock from 2014 to 2021, but performed worse on the first three years (2011-2013).

***Aristeomorpha foliacea* (ARS) in GSA 9, 10 and 11**



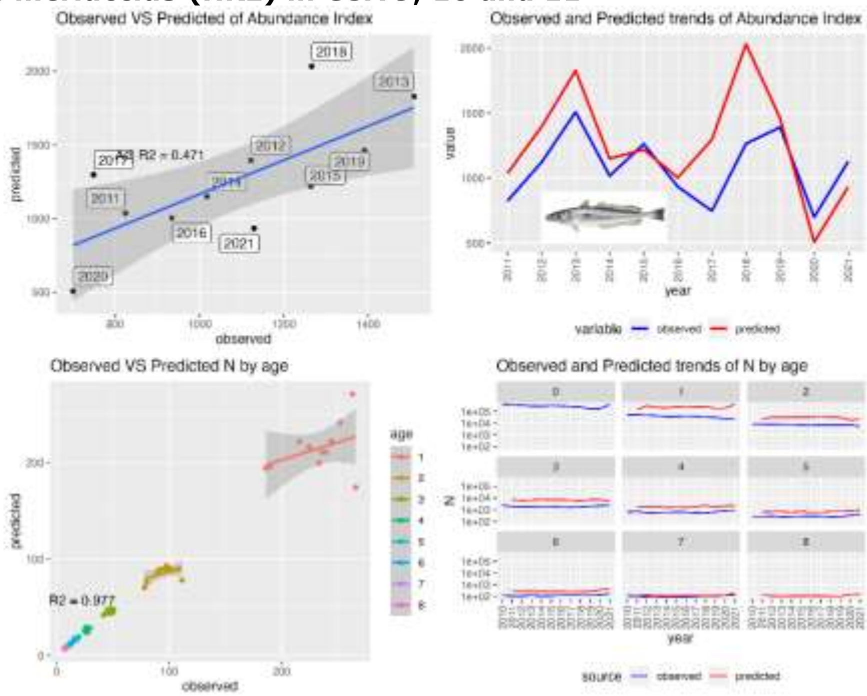
In the case of *Parapenaeus longirostris (DPS) in GSA 9, 10 and 11*, the trained SMART model evidences a very good ability to capture the trends of abundance of this stock, except for the first three years (2011-2013) where it performed worse.

***Parapenaeus longirostris (*DPS) in GSA 9, 10 and 11**



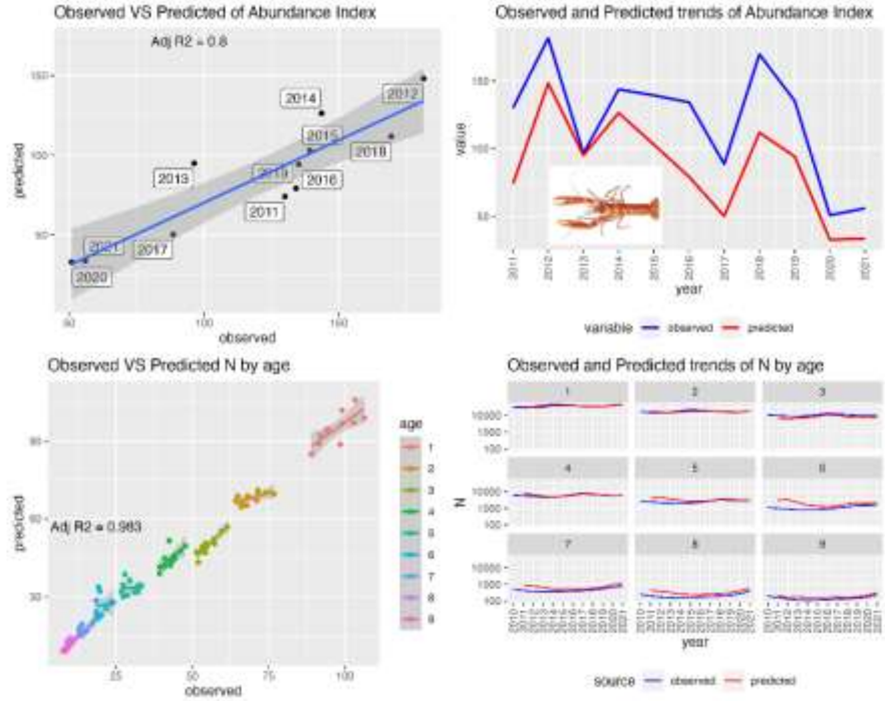
In the case of *Merluccius merluccius (HKE) in GSA 9, 10 and 11*, the trained SMART model evidences a good ability to capture the trends of abundance of these stocks in the first and the last parts of the periods considered, whereas it does not fit very well the data in the 2017-2018 period.

***Merluccius merluccius* (HKE) in GSA 9, 10 and 11**



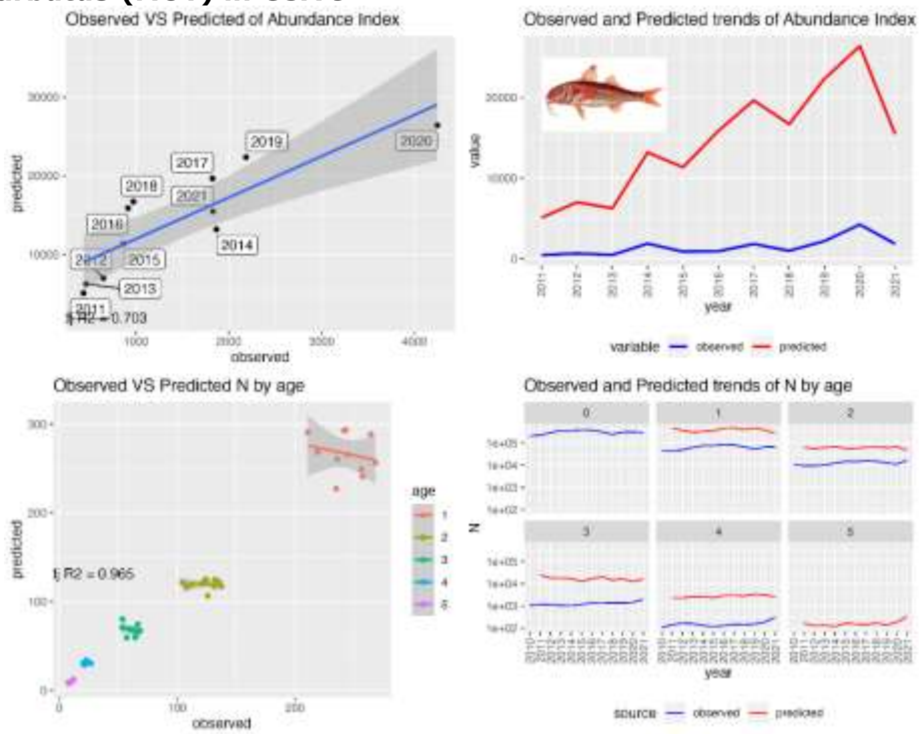
In the case of *Nephrops norvegicus* (NEP), the trained SMART model evidences a very good ability to capture the trends of abundance of these stocks.

***Nephrops norvegicus* (NEP) in GSA 9**



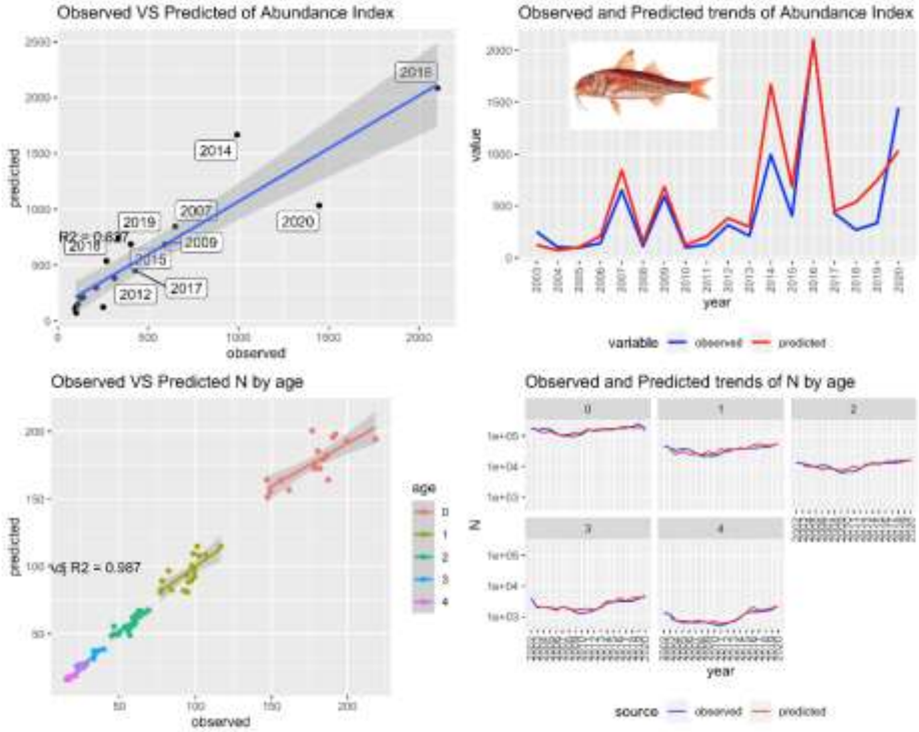
In the case of *Mullus barbatus* (MUT) in GSA 9, the trained SMART model was able to capture the trends of abundance of these stocks, but showed ad unnatural growth in abundance.

***Mullus barbatus* (MUT) in GSA 9**



In the case of *Mullus barbatus* (MUT) in GSA 10, the trained SMART model evidences a very good ability to capture the trends of abundance of these stocks.

***Mullus barbatus* (MUT) in GSA 10**



5.4.7 Implementation progresses in EWG 22-11

The version of the SMART model used during EWG 22-11 is substantially the same as the one adopted in the last working group, except for an updated feature for the evaluation of the effort reduction: as the simulation goes on, the algorithm tends to exclude the vessels with worst economic performance (lower profits), especially in scenarios with an increased fuel price.

5.4.8 Mid (2030) and long term (2040) projections

Due to time restrictions, it was only possible to simulate scenarios up to years 2025. That said, due to the way this model is structured and the short time series of the input data, results can be considered representative in short-mid periods, while long simulations could provide unrealistic results. The reason for this low reliability of the model on long-term forecasts is basically due to the fact that the spatial returns (LPUE) are "static" and do not update progressively along the time series (see next section).

5.4.9 Relationship between biomass increase and economic gains

Within SMART, the estimation of spatial productivity (LPUE), one of the key parameters for modelling the behaviour of fishing units and the value of individual areas (fishing grounds), is one of the first steps in the workflow and allows (at the end of the process of optimizing the distribution of fishing effort) to obtain an estimate of the new exploitation pattern. In the second part of the workflow, the new exploitation pattern (catch by species/age) is used as input to estimate the effect on exploited stocks. However, the estimated fluctuations for stocks (e.g. in terms of SSB) do not translate into an update of spatial LPUE. In this way, at the moment, SMART is not able to evaluate a relationship between biomass increase and economic gains. That is because the aforementioned increase is a direct product of the reduction of effort (and, consequentially, of fishing mortality), and the model does not take account of a secondary raise in fishing productivity as a result of a higher available biomass.

5.4.1 References

Russo T, D'Andrea L, Franceschini S, Accadia P, Cucco A, Garofalo G, Gristina M, Parisi A, Quattrocchi G, Sabatella RF, Sinerchia M, Canu DM, Cataudella S and Fiorentino F (2019) Simulating the Effects of Alternative Management Measures of Trawl Fisheries in the Central Mediterranean Sea: Application of a Multi-Species Bio-economic Modeling Approach. Front. Mar. Sci. 6:542. doi: 10.3389/fmars.2019.00542.

Russo T, Parisi A, Garofalo G, Gristina M, Cataudella S, et al. (2014) SMART: A Spatially Explicit Bio-Economic Model for Assessing and Managing Demersal Fisheries, with an Application to Italian Trawlers in the Strait of Sicily. PLoS ONE 9(1): e86222. doi:10.1371/journal.pone.0086222.

Russo T, Morello EB, Parisi A, Scarcella G, Angelini S, Labanchi L, Martinelli M, D’Andrea L, Santojanni A, Arneri E, Cataudella S (2018). A model combining landings and VMS data to estimate landings by fishing ground and harbor. Fisheries Research 199, 218- 230.

Russo T, D'Andrea L, Franceschini S, Accadia P, Cucco A, Garofalo G, Gristina M, Parisi A, Quattrocchi G, Sabatella RF, Sinerchia M (2019). Simulating the effects of alternative management measures of trawl fisheries in the Central Mediterranean Sea: application of a multi-species bio-economic modelling approach. Frontiers in Marine Science, 6, p.542.

D’Andrea L, Parisi A, Fiorentino F, Garofalo G, Gristina M, Russo T, Cataudella S. (2020). smartR: a R package for spatial modelling of fisheries and simulation of effort management. Methods in Ecology and Evolution 00:1-10. 10.1111/2041-210X.13394

6 MANAGEMENT SCENARIOS AND RESULTS (TOR 4)

6.1 Scenarios NOT accounting for an additional fuel price increase after 2022

6.1.1 IAM in EMU 1

6.1.1.1 Management scenarios considered

The scenarios that were tested are based on table of scenarios from the TORs. The scenarios applied in IAM simulations are summarized in table 6.1.1.1.1.

For each scenario, the models are run with the management measures adopted at EU and national level in 2022, which include both effort and catch management measures. For trawlers a succession of effort reduction were applied from 2020 to 2022, and this is reflected in the 2022 fishing effort simulated. Namely, in EMU1 10% reduction of effort applied in 2020, 7,5% reduction of effort applied in 2021 and 6% reduction of effort applied in 2022, except for French and Spanish vessels active in GSA 7 in France where the reduction is of 4% due to the compensation mechanism. As in previous EWGs, the percentages of reduction of trawlers, netters and longliners effort given in the scenarios are calculated in reference to the baseline period 2015-2017 (i.e. average value of FDI fishing effort by fleet between 2015 and 2017).

IAM simulations start in 2021, with the 2021 FDI fishing effort and number of vessels used to calibrate the model. Then reduction of effort from the 2022 regulation is taken into account in 2022, therefore the fishing effort of Spanish trawlers in 2022 is equal to E2015-2017*0.765; and the French trawler effort in 2022 is equal to E2015-2017*0.785.

Fishing mortalities coming from the non-modelled fleets are estimated constant (and based on 2021 values). As shown in figure 5.1.4.2, catches of the species of the plan by those non-modelled fleets is almost null, therefore they do not have an impact on the species of the plan.

To note that while number of trawlers are reduced, according to the specifications of the different scenarios, the fishing capacity, i.e. numbers of vessels, of longliner and netter fleets remain constant through the simulation (based on the number of vessels in 2021). It was discussed and decided during the group that when a reduction in fishing effort of a gear within a fleet segment is simulated, there is no report of effort to other gears in the fleet segment.

Except for the scenarios with changes in selectivity (i.e. scenarios B and D), the catchability values are set to the 2021 values, reflecting the effects of the spatial closures already implemented in France and Spain.

Table 6.1.1.1.1 Management scenarios implemented in IAM model. To note that scenario E was not implemented.

Scenario	Trawler effort reduction**	Longliner effort reduction**	Netter effort reduction**	Combined catch limits for ARA and ARS	Selectivity measures	Reduction in trawler number
A (-5%)	2023: -5% 2024: -5% onwards: -5% each year (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% each year (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% each year (until MSY is reached)	2023: -5% 2024: -5% 2025 - 2030: Spanish trawler effort adjusted to reach FMSY level for the three ARA stocks	∅	2023: -5% 2024: -5% 2025-2030: constant
B (-7,5%)	2023: -7,5% 2024: -7,5% onwards: -7.5% each year (until MSY is reached)	2023: -7,5% 2024: -7,5% onwards: -7.5% each year (until MSY is reached)	2023: -7,5% 2024: -7,5% onwards: -7.5% each year (until MSY is reached)	2023: -7,5% 2024: -7,5% 2025 - 2030: Spanish trawler effort adjusted to reach FMSY level for the three ARA stocks	Change in catchabilities for French and Spanish trawlers. 2023: 50% of all fleet with more selective gear (50mm square mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of all fleet with more selective gear	2023: -5% 2024: -5% 2025-2030: constant
C (-10%)	2023: -10% 2024: -6,5% onwards: -6.5% each year (until MSY is reached)	2023: -10% 2024: -10% onwards: -10% each year (until MSY is reached)	2023: -10% 2024: -10% onwards: -10% each year (until MSY is reached)	2023: -10% 2024: -10% 2025 - 2030: Spanish trawler effort adjusted to reach FMSY level for the three ARA stocks	∅	2023: -5% 2024: -5% 2025-2030: constant
D (MS-specific)	No reduction in effort (except for the reduction in effort of Spanish trawlers due to the MCL on ARA)	No reduction in effort	No reduction in effort	Catch limits transition path to MSY calculated by EWG 22-09 2025 - 2030: Spanish trawler effort adjusted to reach FMSY level for the three ARA stocks	Change in catchabilities for Spanish trawlers. 2023: 50% of Spanish fleet with more selective gear (50mm square mesh for coastal fleet and 50mm square mesh for deep-water fleet)	2023 : - 5 vessels for French trawlers (minus 2 for FR DTS 18-24m and minus 3 for FR DTS >=24m) 2024: - 5 vessels for French trawlers (minus 2 for FR DTS 18-24m and minus 3 for FR DTS >=24m)

					2024: 100% of Spanish fleet with more selective gear	2025 : - 5 vessels for French trawlers (minus 2 for FR DTS 18-24m and minus 3 for FR DTS >=24m)
F (Status quo)	***2023: ∅*** ***2024: ∅***	***2023: ∅*** ***2024: ∅***	***2023: ∅*** ***2024: ∅***	***2023: ∅*** ***2024: ∅***	∅	∅

Table 6.1.1.1.2 EMU1 (IAM model). Catch limit paths (in tons) for ARA for scenarios A, B, C and D.

Year	Scenario A		Scenario B		Scenario C		Scenario D	
	FRA	ESP	FRA	ESP	FRA	ESP	FRA	ESP
2022	56	872	56	872	56	872	56	872
2023	53.20	828.40	51.80	806.60	50.40	784.80	45.43	707.41
2024	50.40	784.8	47.60	741.20	44.8	697.6	34.74	540.95

Scenario F corresponds to a status quo scenario where parameters are constant and where fishing efforts by fleet are set to the fishing effort from 2022 regulation.

Scenarios A to D simulate the implementation of the maximum catch limit (MCL) on ARA. In 2022, 2023 and 2024, a global MCL for Spanish trawlers and one for French trawlers are implemented, based on the 2022 regulation and the reductions of these MCLs in 2023 and 2024 described in the table 6.1.1.1.1. The corresponding value of ARA MCL by member state for the years 2022, 2023 and 2024 and by scenario, are reported in table 6.1.1.1.2. After 2025, the fishing effort of Spanish trawlers is adjusted to reach the Fmsy for the three stocks of ARA. It should be noted that the implementation of the MCL, and therefore the associated changes in fishing effort, only affects the trawler fleets catching ARA in the FDI database (i.e. Spanish trawlers of 12-18m, Spanish trawlers of 18-24m and Spanish trawlers of >24m). The OTB_DWS and OTB "other" efforts of these fleets are adjusted in proportion to their landings (in weight) of ARA stocks (based on the 2021 EDI data).

Scenarios A, B and C simulate various decreases in fishing effort for all modelled fleets in 2023 and 2024. After 2024, the reduction in fishing effort per year for each fleet (with the percentage decrease changing according to the scenario) continues. If at the end of a year, for a given fleet segment, the stocks that this fleet segment lands are all at (or below) Fmsy level, there is no further reduction in fishing effort for this fleet segment in the following years.

Scenarios B and D simulate the implementation of a more selective gear for trawlers. It was discussed during EWG 22-11 that instead of an implementation of a 45mm square mesh for coastal fleet, the scenarios will simulate the implementation of a 50mm square mesh for coastal fleet, as for deep-water fleet. To simulate the change in selectivity, we used the same delta in selectivity (at age) calculated in EWG 21-13 report (for ARA, HKE, MUT and NEP), and used the same methodology described in EWG 21-13 report to estimate the delta in selectivity at age for DPS.

For all scenarios, fuel prices are differentiated by fleet segment. AER fuel price estimates in 2021 are used in 2021, and AER projections for fuel price in 2022 are used in 2022 and onwards. Table 6.1.1.1.2 displays the values of these fuel prices per IAM fleet segment.

Table 6.1.1.1.2 Fuel prices (in €/l) per fleet segment in 2020, 2021 and projections for 2022, as well as percentage of change between 2020 and 2022. The Years 2021 and 2022 are the one used in IAM simulations. Source: AER data and projections.

IAM fleet segments	AER 2020 data	AER 2021 estimates	AER 2022 projections	Ratio 2022/2020 fuel price
DTS_FRA_18-24m	0,544	0,767	1,553	2,85
DTS_FRA_>=24m	0,542	0,763	1,546	2,85
DFN_FRA_<12m	0,663	0,921	1,865	2,81
DFN_FRA_>=12m	0,680	1,008	2,041	3,00
HOK_FRA_<12m	0,623	0,863	1,748	2,80
HOK_FRA_>=12m	0,663	0,921	1,865	2,81
DTS_SP_inf12m	0,358	0,484	0,912	2,55
DTS_SP_1218m	0,351	0,473	0,890	2,53
DTS_SP_1824m	0,343	0,460	0,866	2,53
DTS_SP_sup24m	0,318	0,437	0,823	2,59
DFN_SP_<12m	0,362	0,439	0,827	2,29
DFN_SP_>=12m	0,232	0,257	0,484	2,09
HOK_SP_<12m	0,475	0,479	0,827	1,74
HOK_SP_>=12m	0,421	0,431	0,812	1,93

6.1.1.2 Results

The 5 alternative scenarios described in section 6.1.1.1. were investigated using the IAM model. Simulations of the IAM model starts in 2021 and run to 2030 (the year 2025 is represented in a vertical black line in each figure).

Results of IAM simulations regarding **fishing effort**, **number of vessels** per fleet segment, **total landings** of Hake in GSAs 1-5-6-7, blue and red shrimp in GSAs 1-2, GSA 5 and in GSAs 6-7, Norway lobster in GSA6, red mullet in GSA1, GSA6 and GSA7, and deep-water rose shrimp in GSA 1, and in GSAs 5-6-7 by fleet segments, **Gross Value of Landings (GVL)** by fleet segment, and **mean Gross Value Added (GVA) per vessel** by fleet segment are, respectively, displayed in Figures 6.1.1.2.1 to 6.1.1.2.5. Note that GVA is a proxy for profits.

For each stock, Figures 6.1.1.2.6 to 6.1.1.2.15 compares the evolutions of their Fbar, SSB and total landings according to the different scenarios. Finally, Table 6.1.1.2.1 compares biological performances of each scenario in terms of ratios of Fbar in 2023 to Fmsy, Fbar in 2025 to Fmsy, and Fbar in 2030 to Fmsy per stock. Table 6.1.1.2.2 compares the performances of each scenario in terms of ratio of landings (in weight) in 2023 to landings in 2021, landings in 2025 to landings in 2021 and ratio of landings in 2030 to landings in 2021 per stock. And table 6.1.1.2.3 compares the socio-economic performances of each scenario in terms of average GVA per vessel in 2023, in 2025 and in 2030, and ratio of fishing effort in 2025 to fishing effort in 2021, and ratio of fishing effort in 2030 to fishing effort in 2021 per fleet segment. This last indicator can be used as a proxy of the percentage of change in terms of Full Time Equivalent, if this one is considered proportional to fishing effort.

To compare in more detail the outputs of the different scenarios on hake (HKE1567) landings, Figure 6.1.1.2.16 shows the **landings at ages of hake** in GSAs 1-5-6-7 by **trawlers** (French and Spanish DTS together), which are the vessels for which a change in selectivity is simulated in scenarios B and D. For additional information, landings at the ages of hake by **netters** (French and Spanish DFN together) and by **vessels using hooks** (French and Spanish HOK together) are displayed in Figures 6.1.1.2.17 and 6.1.1.2.18, respectively. Note that in scenario B, the selectivity improvement is applied to both French and Spanish trawlers, while in scenario D only Spanish trawlers are simulated with selectivity improvement.

As a reminder, the fishing mortalities, SSBs and total Gross Value of Landings per fleet are displayed in section 1.2.

It should be noted that the results for French netters over 12 meters (i.e., FR_DFN >=12m) are not displayed. Indeed, in 2021, in the FDI database, there was only one vessel in this fleet segment. Therefore, for reasons of confidentiality, we do not present indicators for this fleet segment. However, we can report that the GVA for this fleet segment is positive throughout the simulation period with each scenario, although it tends towards zero in 2030 with scenario C. Scenario D is the most favourable for this fleet segment, with GVA increasing slightly over time, especially after 2025.

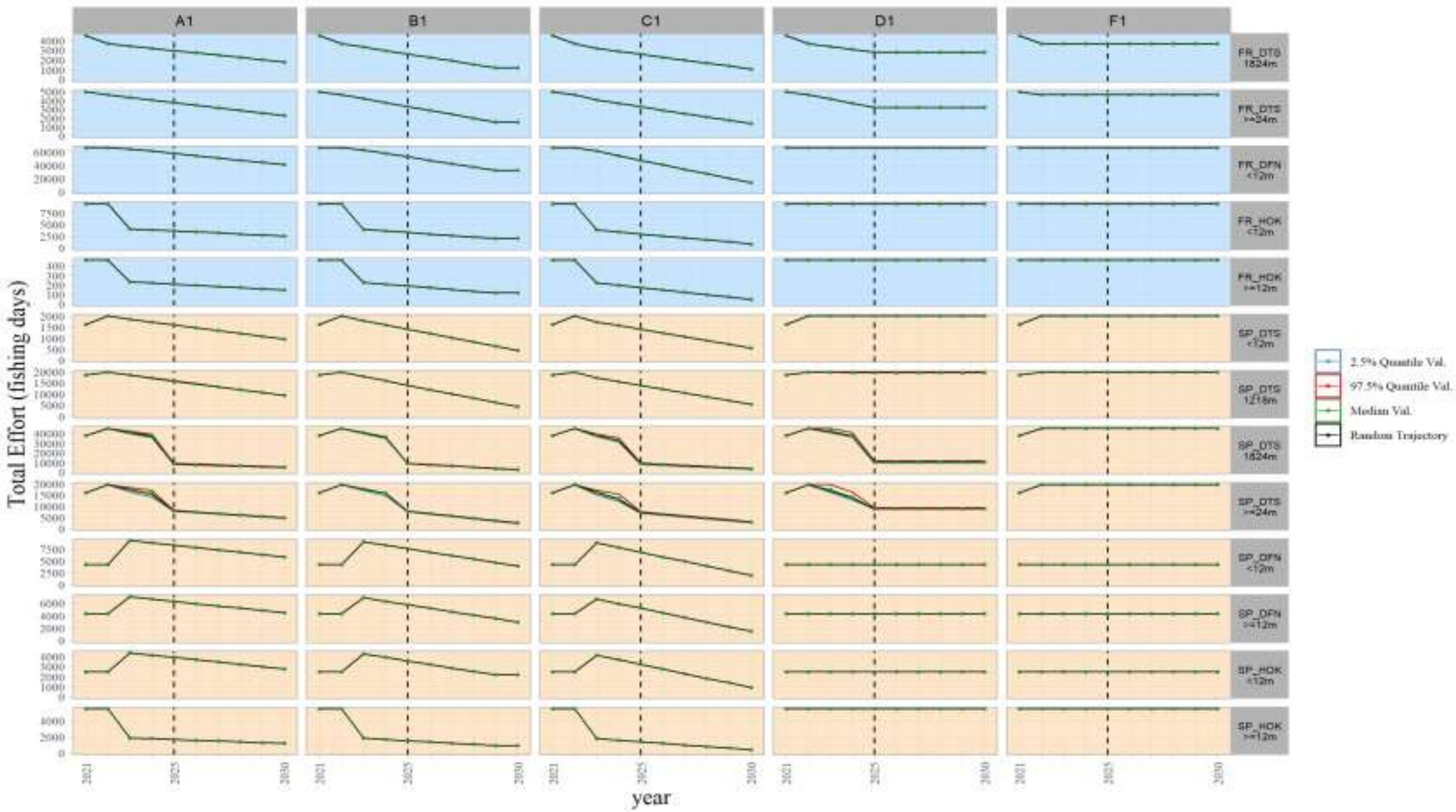


Figure 6.1.1.2.1. EMU1 (IAM model). Evolution of the annual fishing effort (in fishing days) by fleet segment for each alternative scenario from 2021 to 2030. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m.

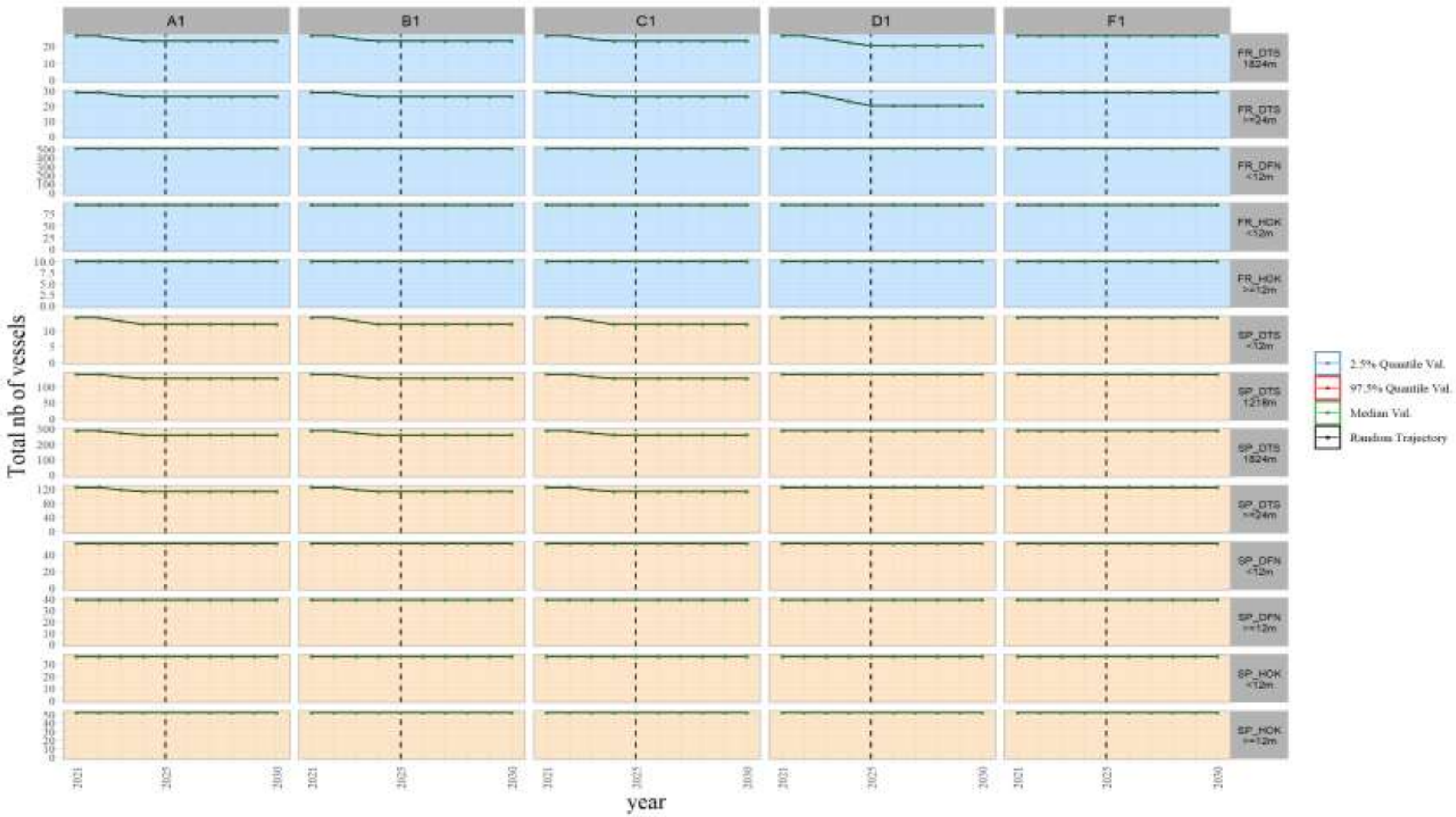


Figure 6.1.1.2.2. EMU1 (IAM model). Evolution of the annual number of vessels by fleet segment for each alternative scenario from 2021 to 2030. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m.

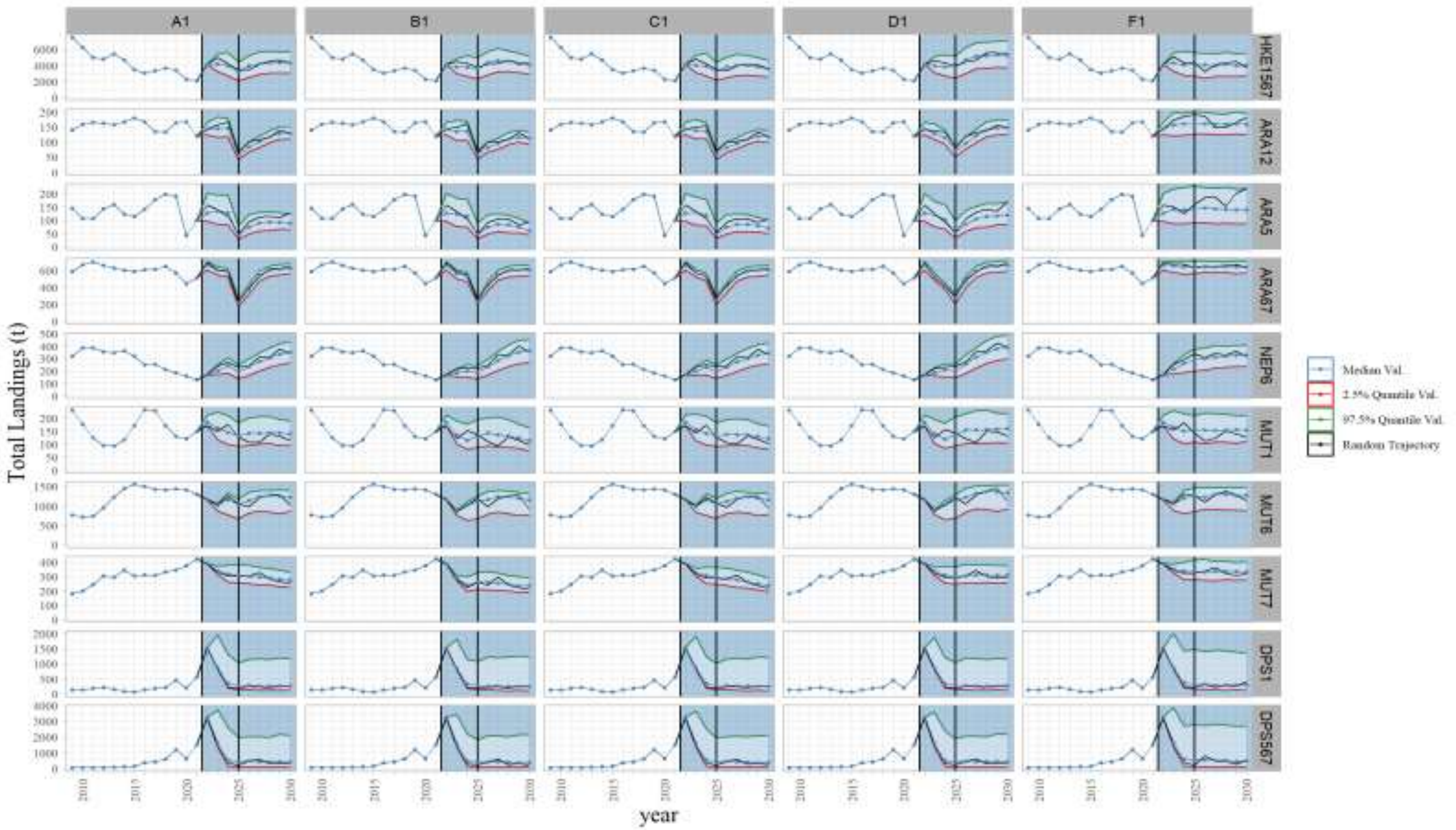


Figure 6.1.1.2.3. EMU1 (IAM model). Evolution of the total annual landings (in tonnes) of the modelled stocks for each alternative management scenario up to 2030. Historical values of landings are given in the white areas and simulated values in the blue area. Vertical black lines indicate the year 2025. Scenarios are in column and stocks in row. The stocks are as follow (from top to bottom): hake GSAs1-5-6-7 (HKE1567), blue and red shrimp GSAs1-2 (ARA12), blue and red shrimp GSA5 (ARA5), blue and red shrimp GSAs6-7 (ARA67), Norway lobster GSA6 (NEP6), red mullet GSA1 (MUT1), red mullet GSA6 (MUT6), red mullet GSA7 (MUT7), deep-water rose shrimp GSA1 (DPS1), and deep-water rose shrimp GSAs5-6-7 (DPS567).

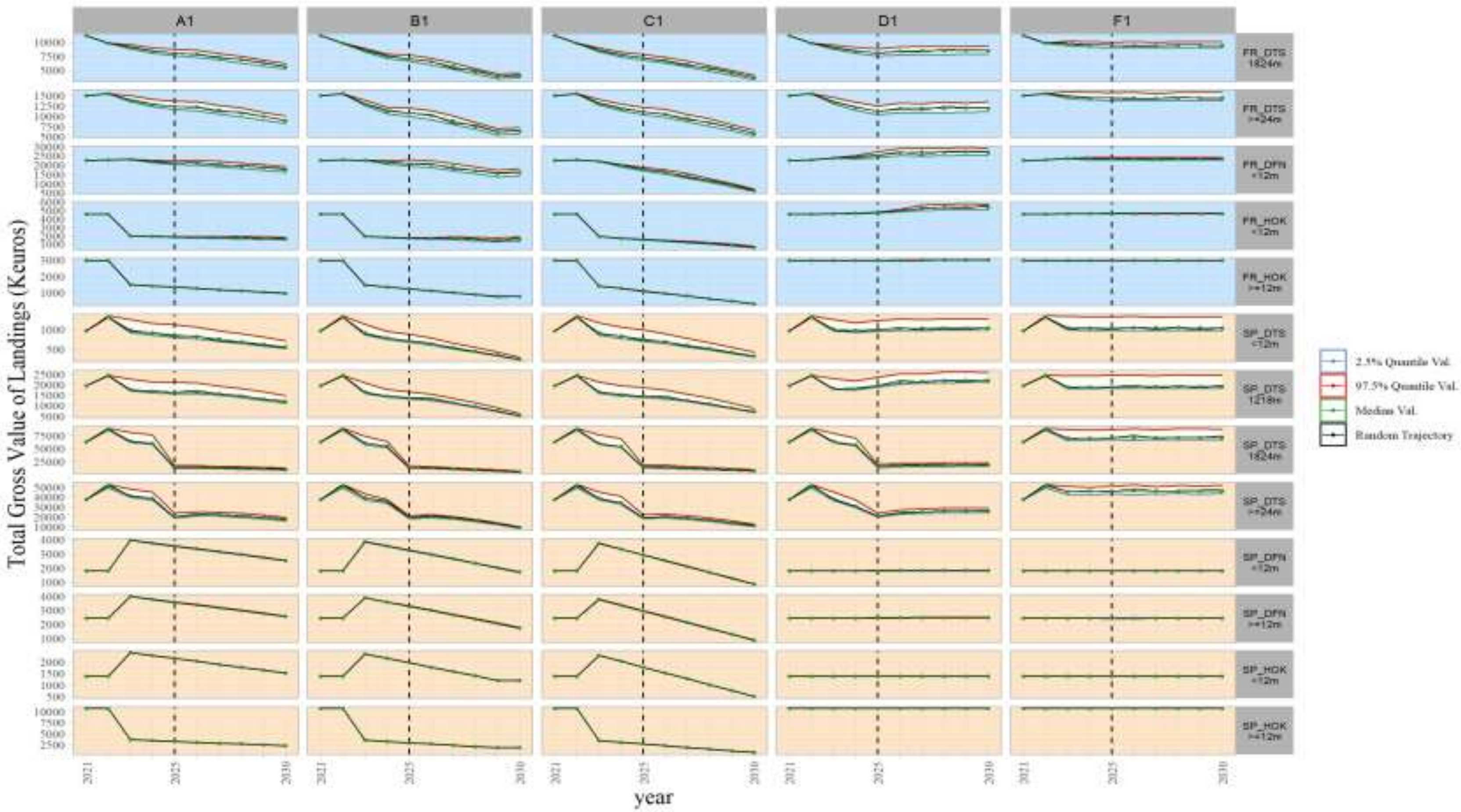


Figure 6.1.1.2.4. EMU1 (IAM model). Evolution of the total Gross Value of Landings (GVL, i.e. revenues, in K euros) by fleet segment for each alternative scenario from 2021 to 2031. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. . The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m.

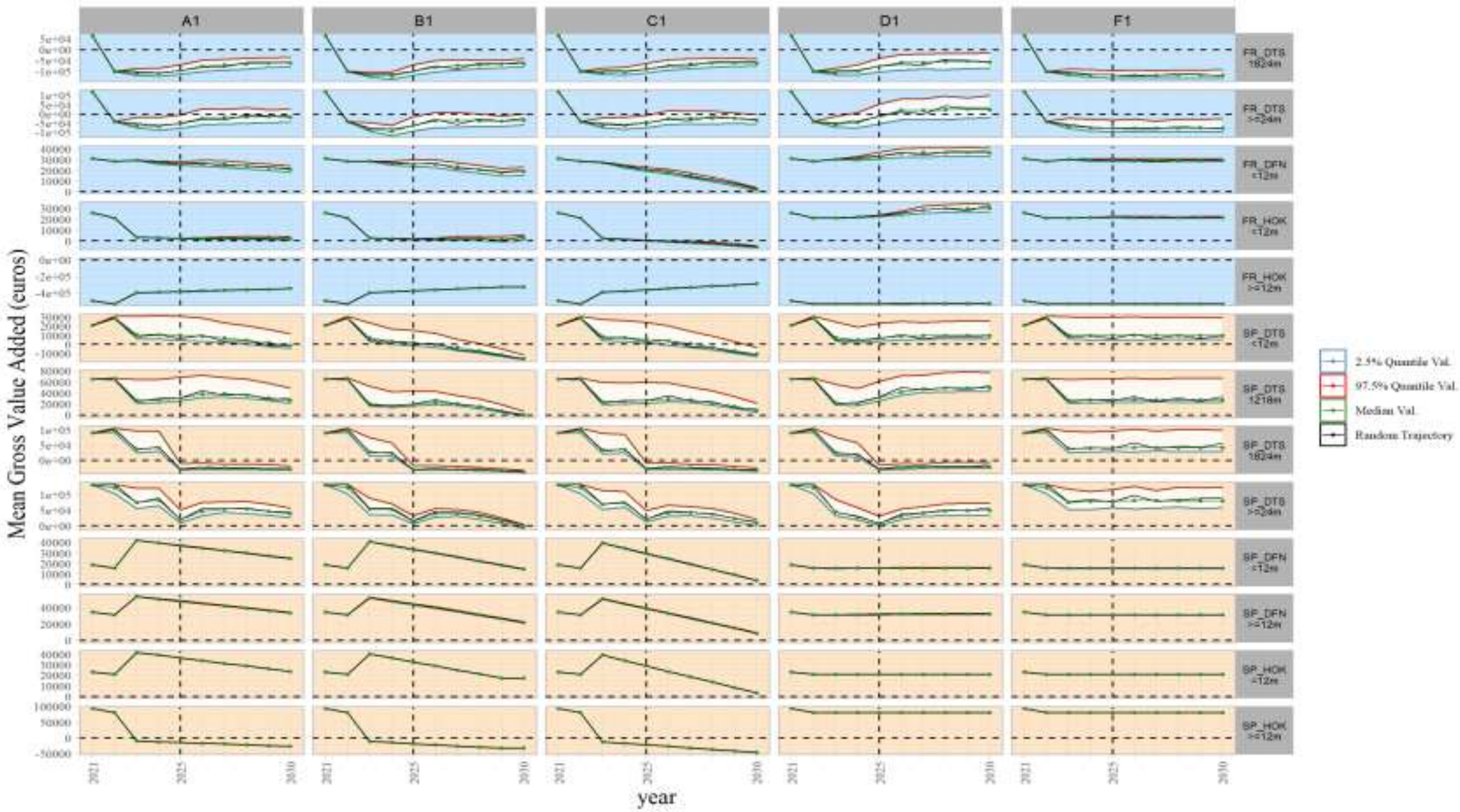


Figure 6.1.1.2.5. EMU1 (IAM model). Evolution of the average Gross Value Added (GVA, i.e. proxy for the profit, in K euros) per vessel by fleet segment for each alternative scenario from 2021 to 2030. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m.

HKE1567

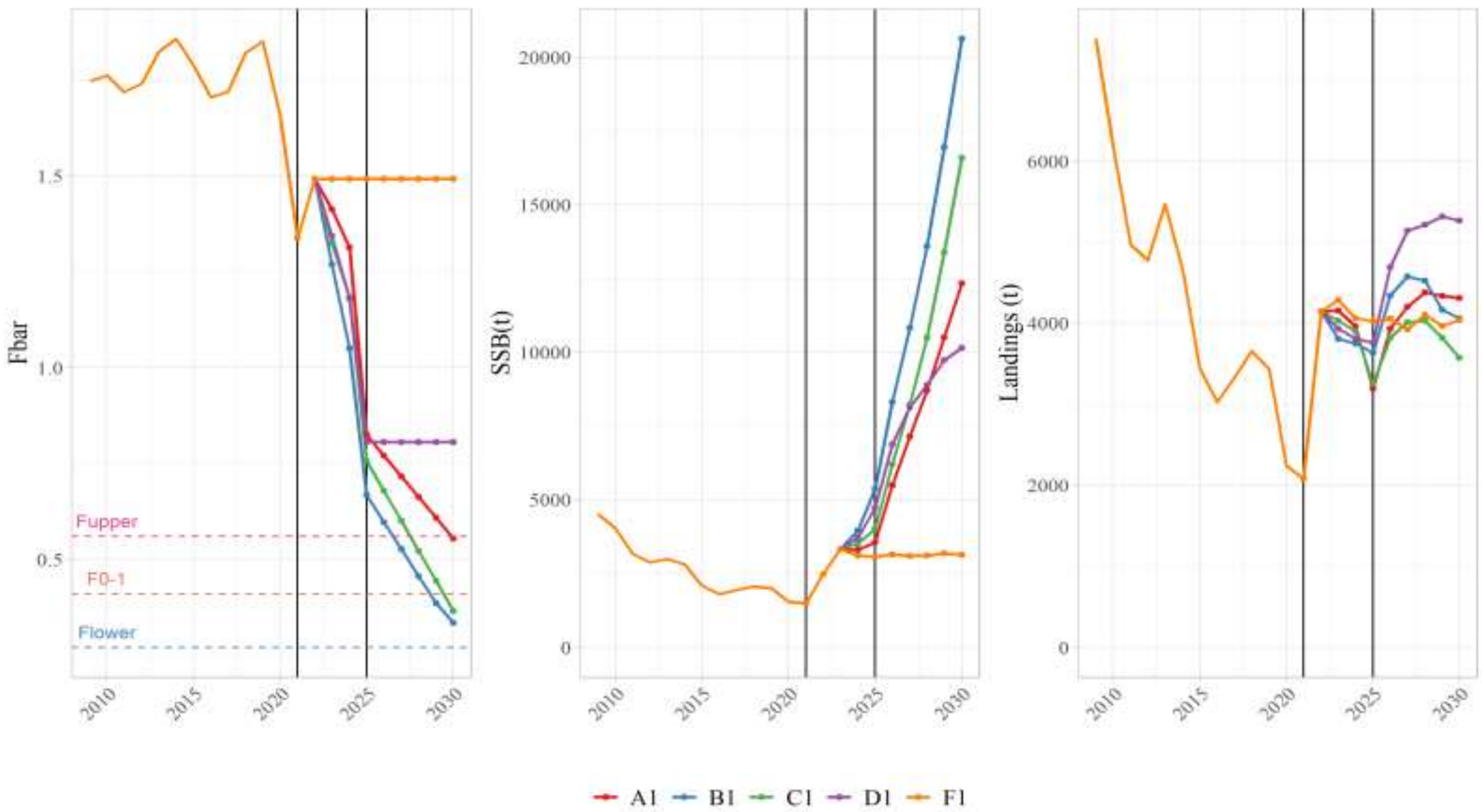


Figure 6.1.1.2.6. EMU1 (IAM model). Predicted median values for Hake in GSAs 1-5-6-7 (HKE1567) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

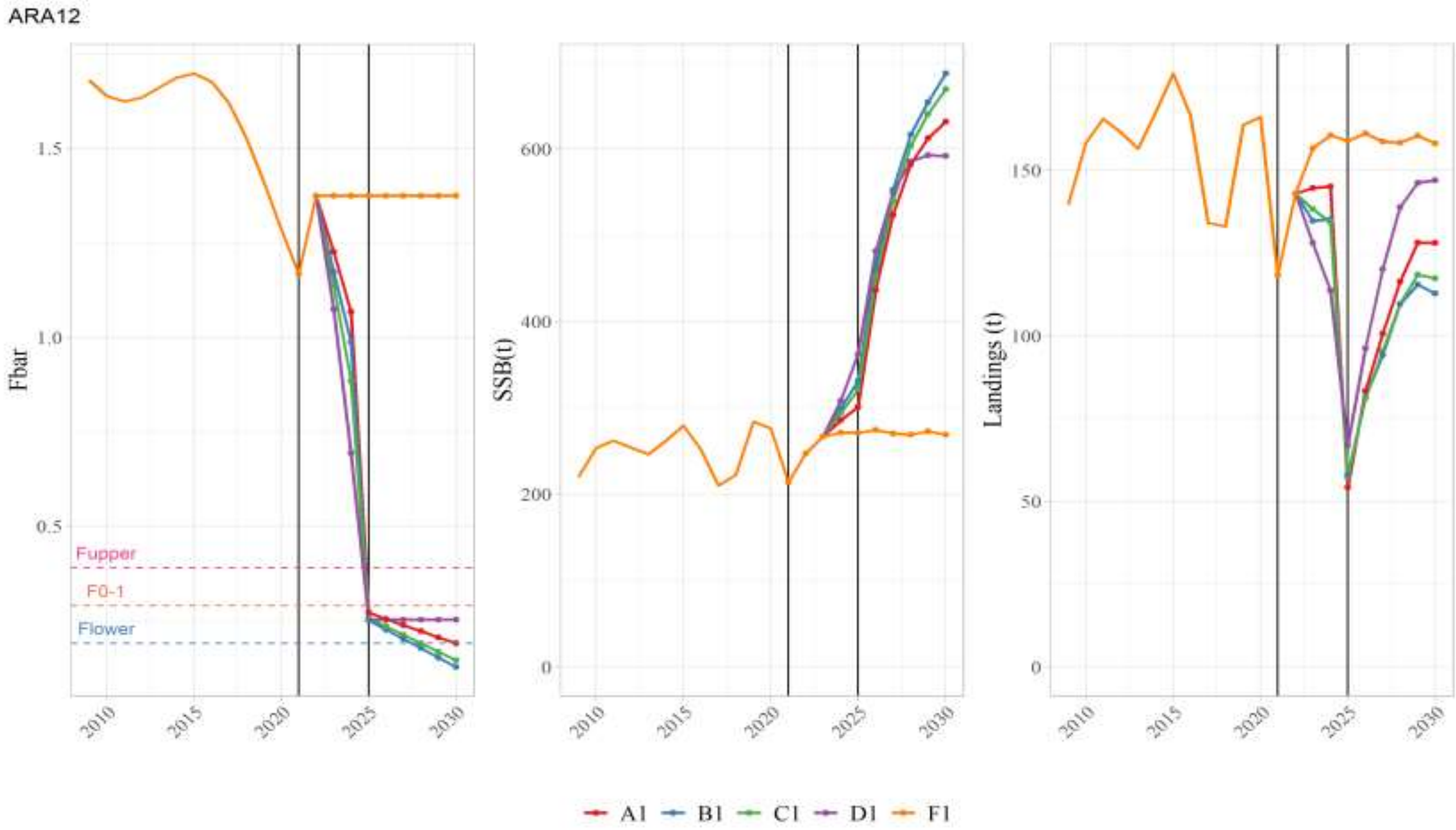


Figure 6.1.1.2.7. EMU1 (IAM model). Predicted median values for blue and red shrimp GSAs1-2 (ARA12) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

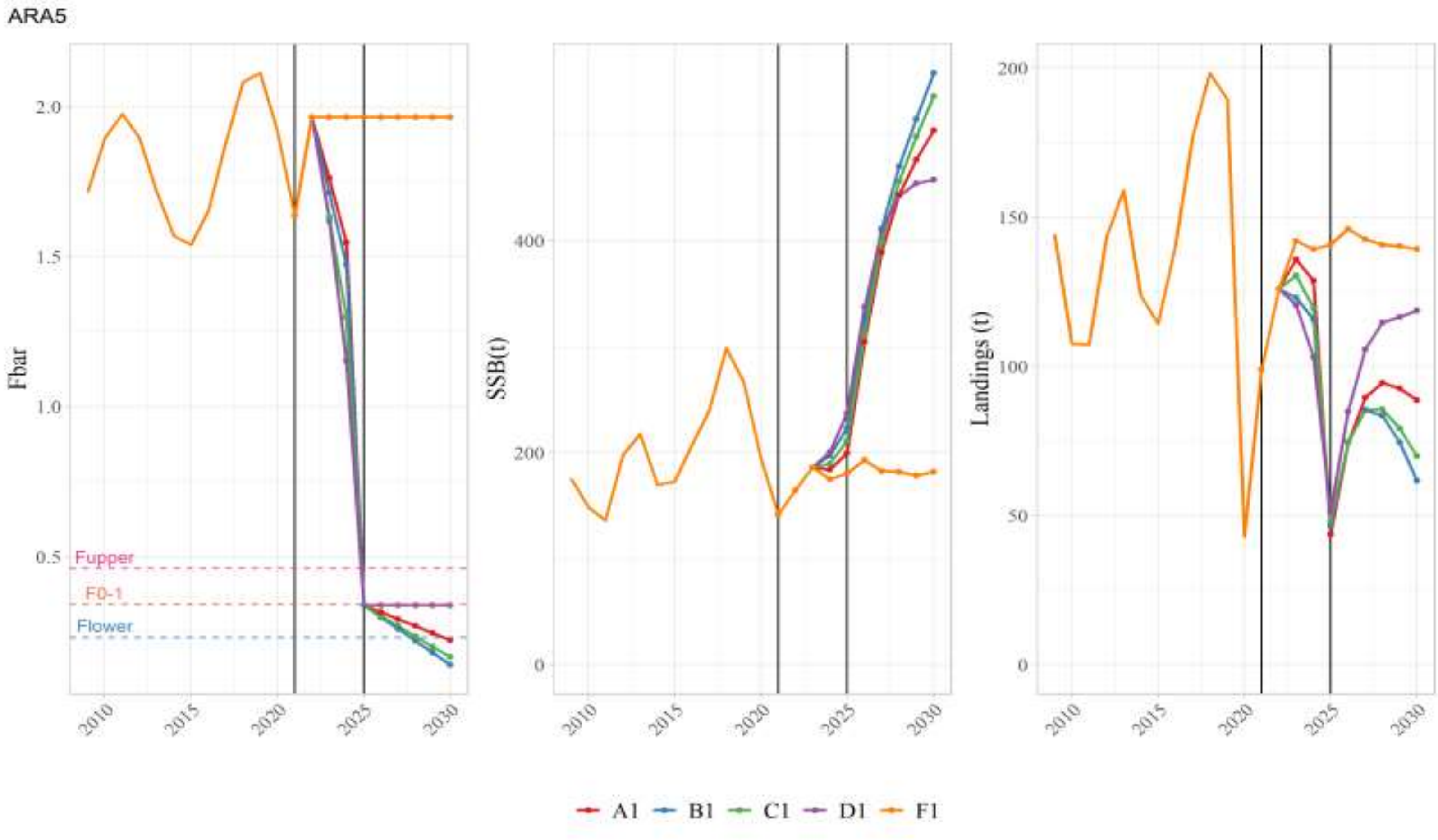


Figure 6.1.1.2.8. EMU1 (IAM model). Predicted median values for blue and red shrimp GSA5 (ARA5) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

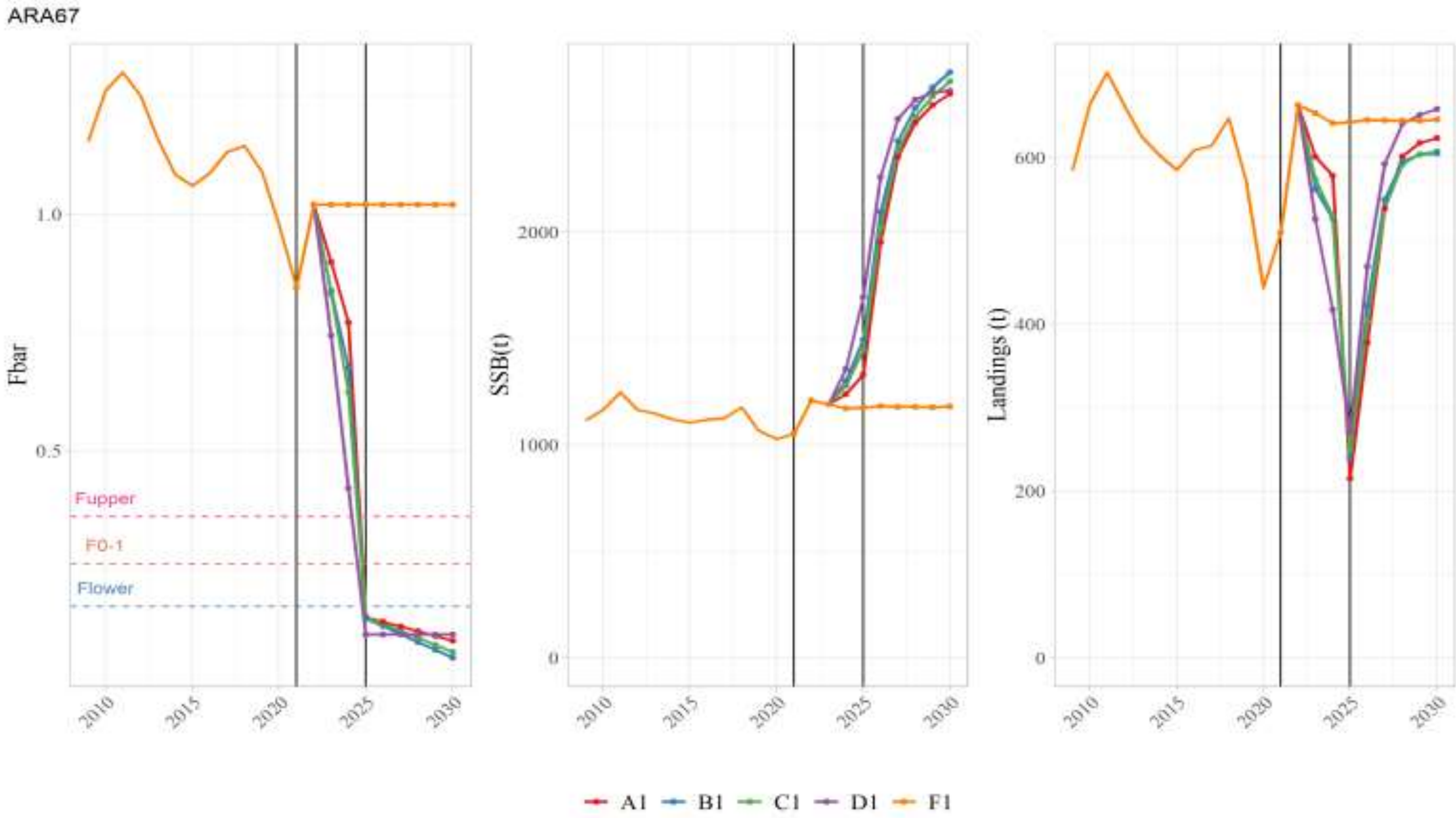


Figure 6.1.1.2.9. EMU1 (IAM model). Predicted median values for blue and red shrimp GSAs6-7 (ARA67) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

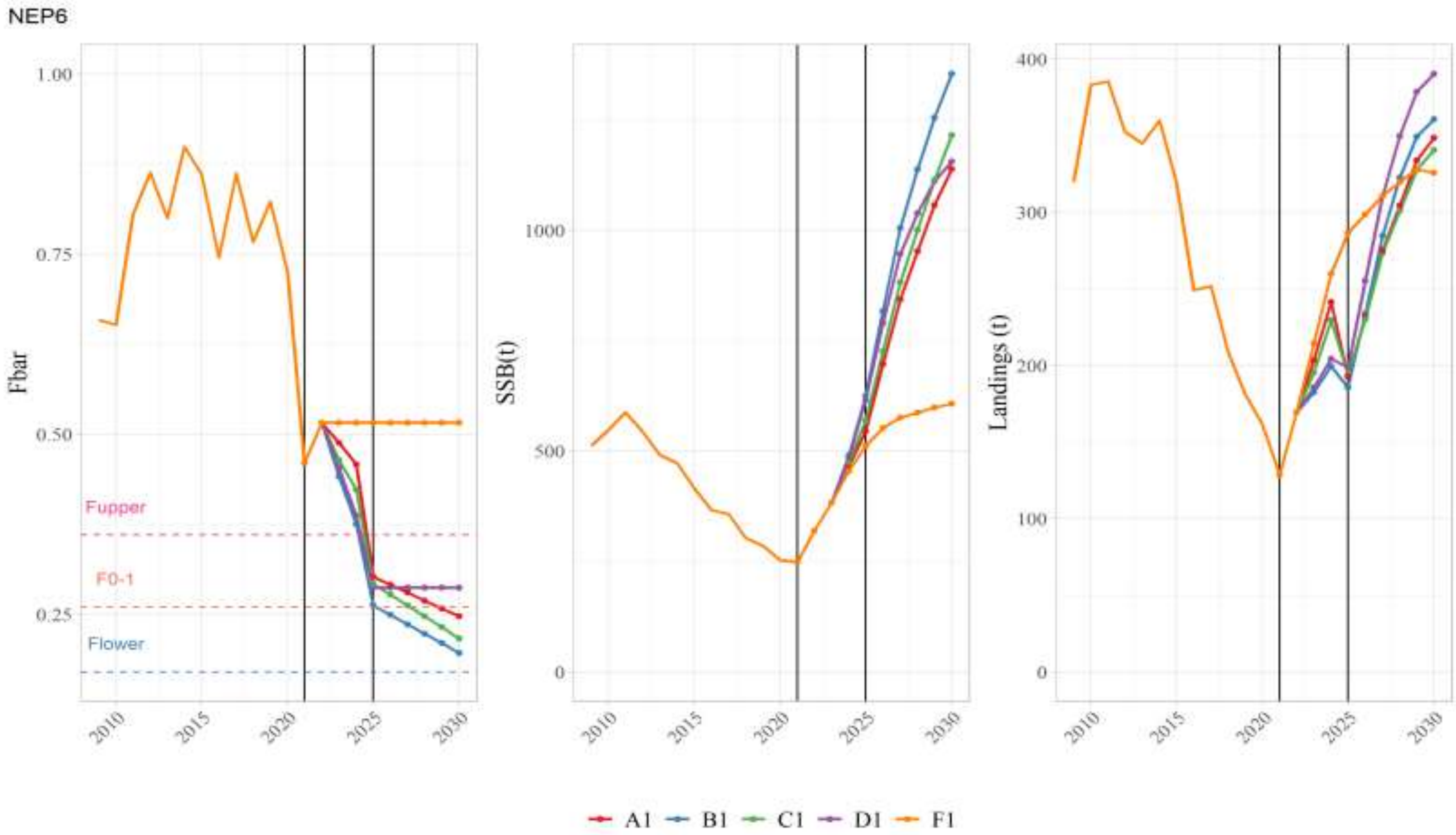


Figure 6.1.1.2.10. EMU1 (IAM model). Predicted median values for Norway lobster GSA6 (NEP6) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

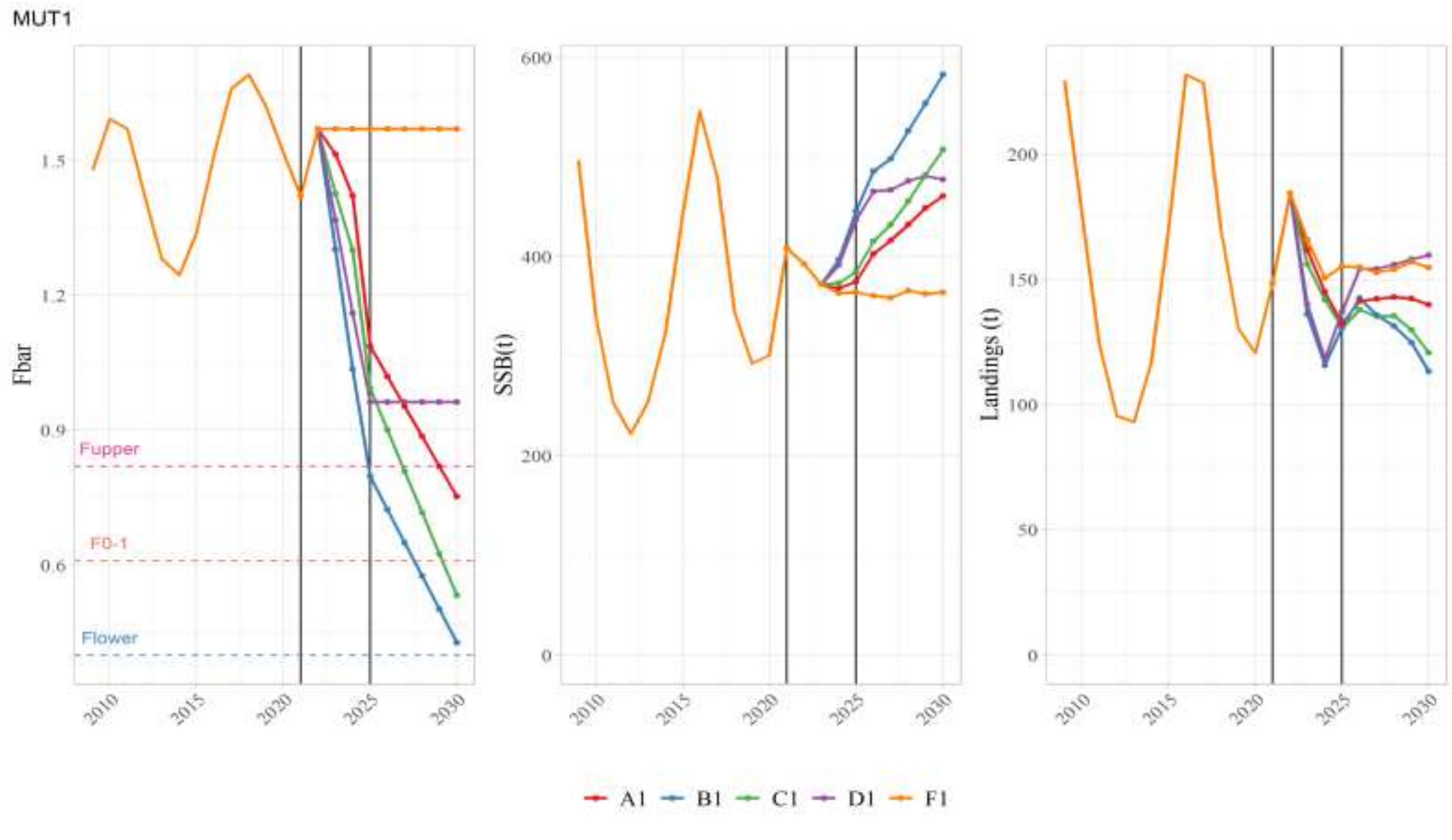


Figure 6.1.1.2.11. EMU1 (IAM model). Predicted median values for red mullet GSA1 (MUT1) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

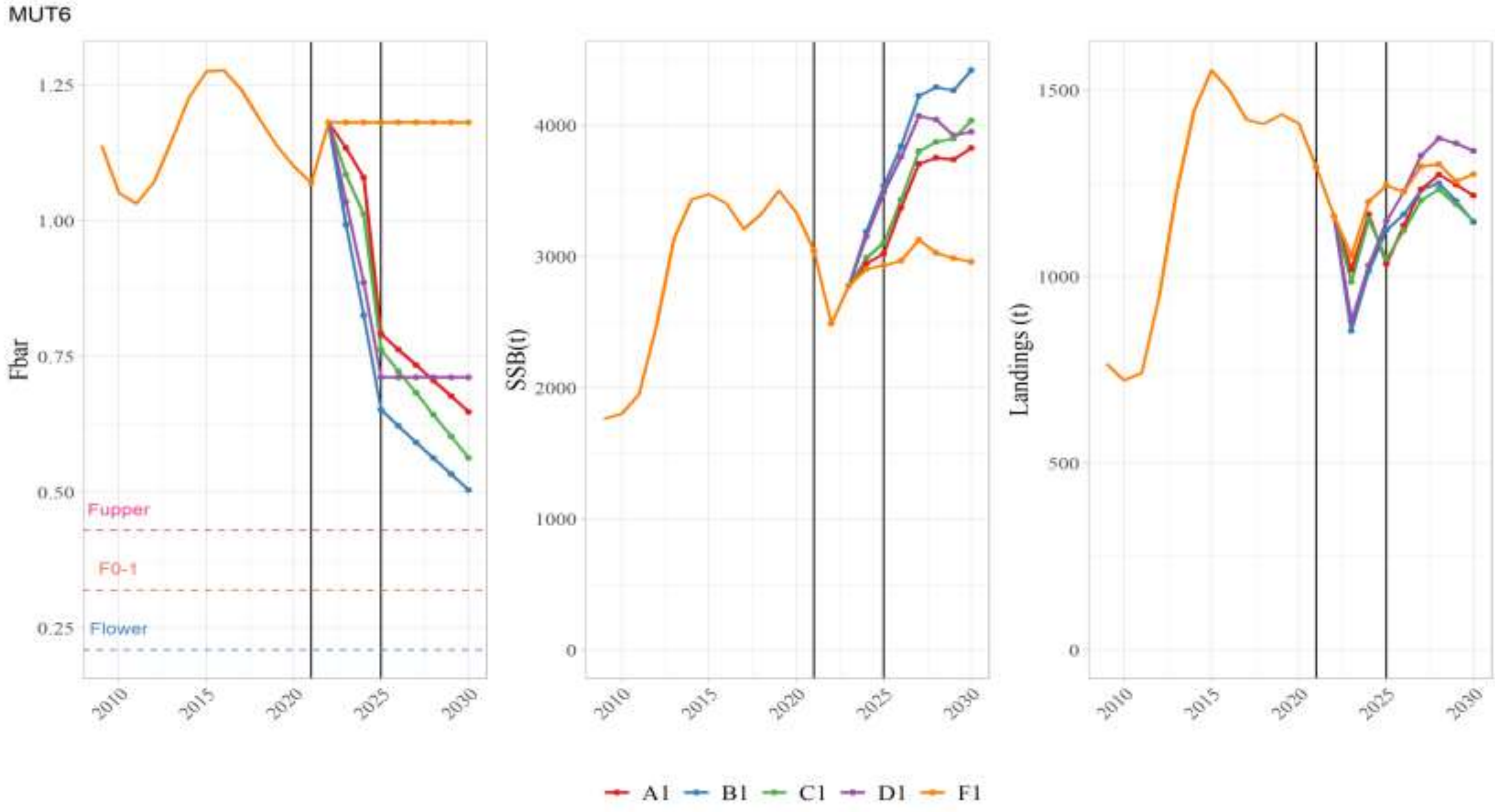


Figure 6.1.1.2.12. EMU1 (IAM model). Predicted median values for red mullet GSA6 (MUT6) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

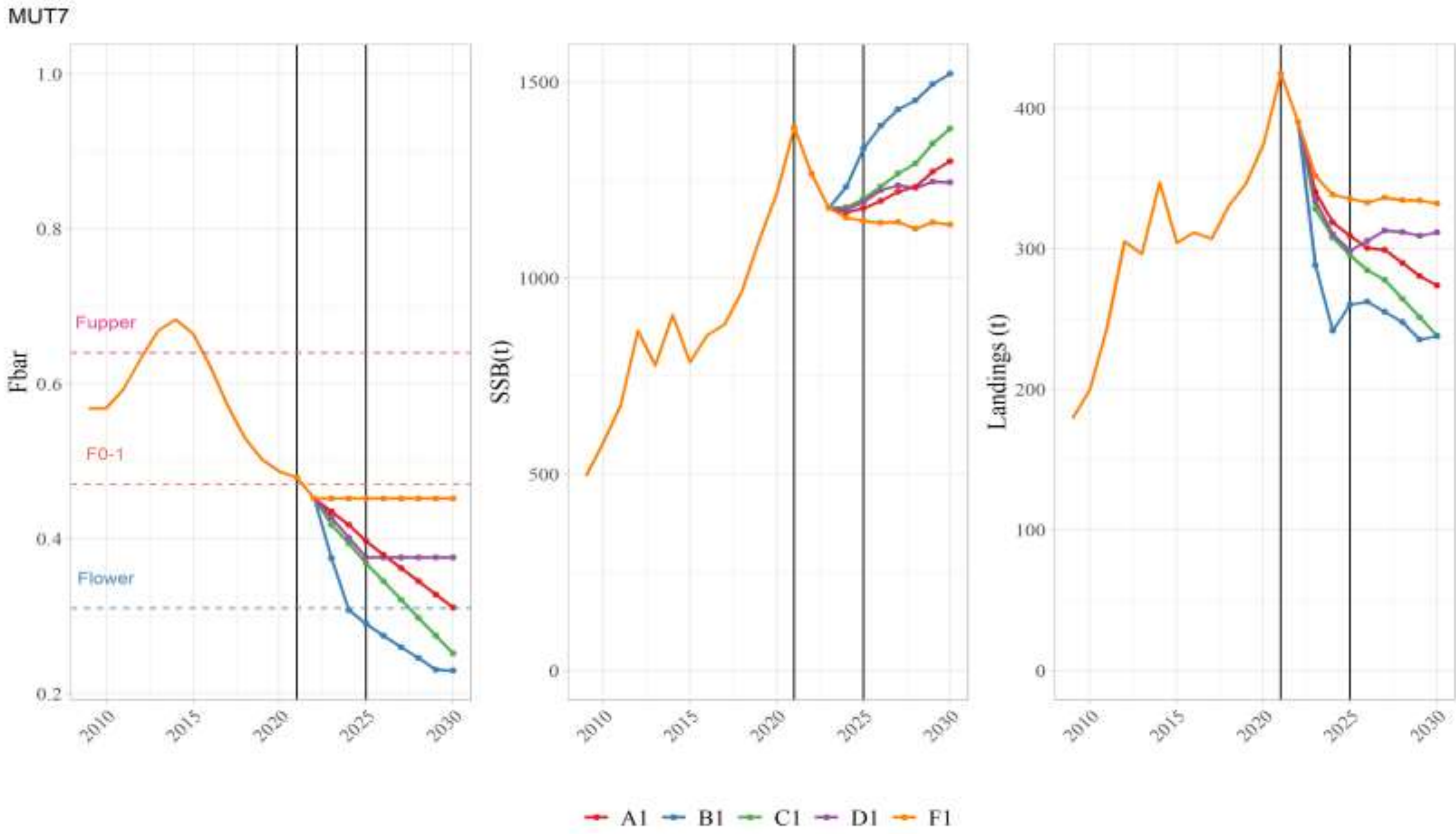


Figure 6.1.1.2.13. EMU1 (IAM model). Predicted median values for red mullet GSA7 (MUT7) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

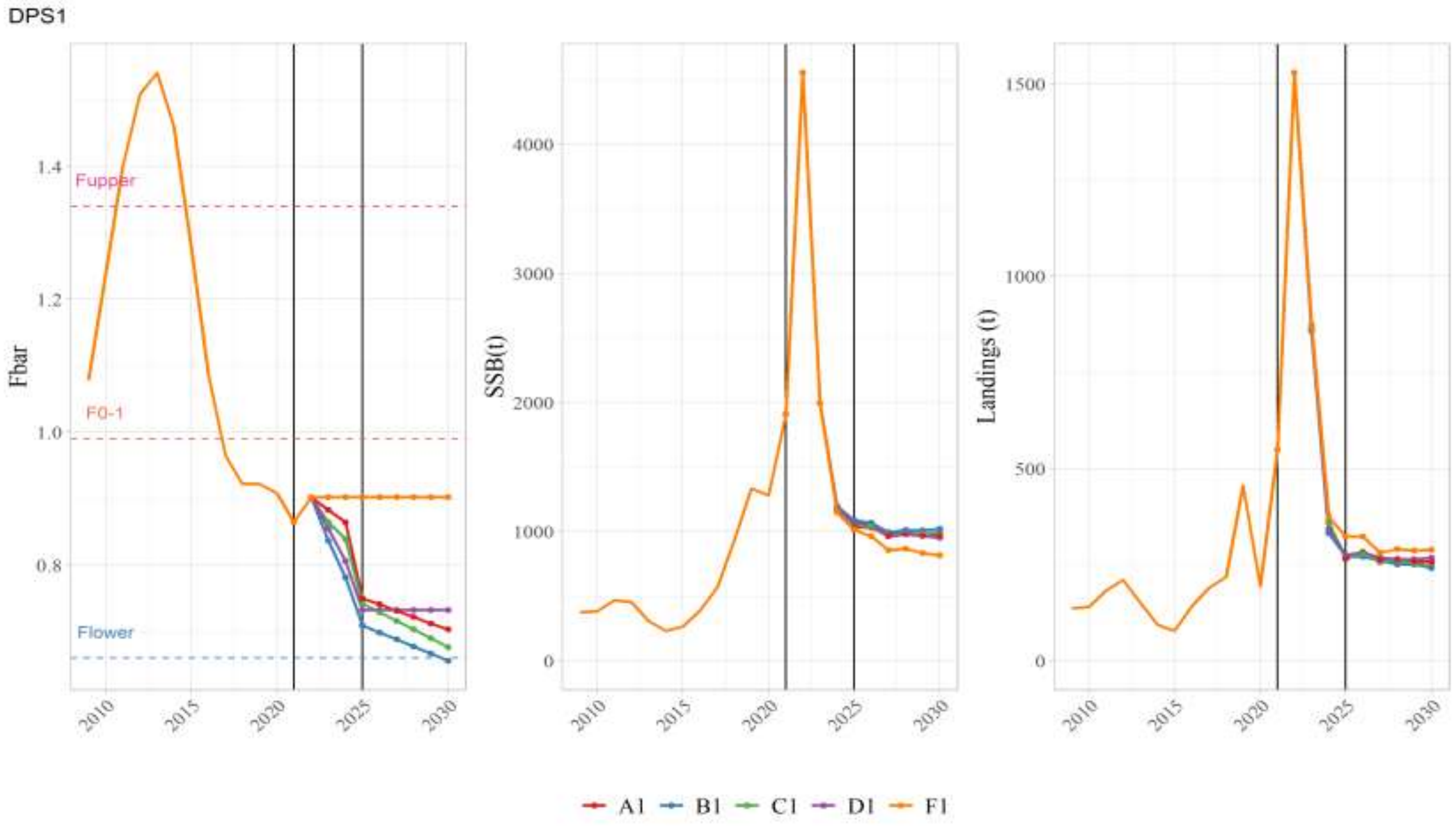


Figure 6.1.1.2.14. EMU1 (IAM model). Predicted median values for deep-water rose shrimp GSA1 (DPS1) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

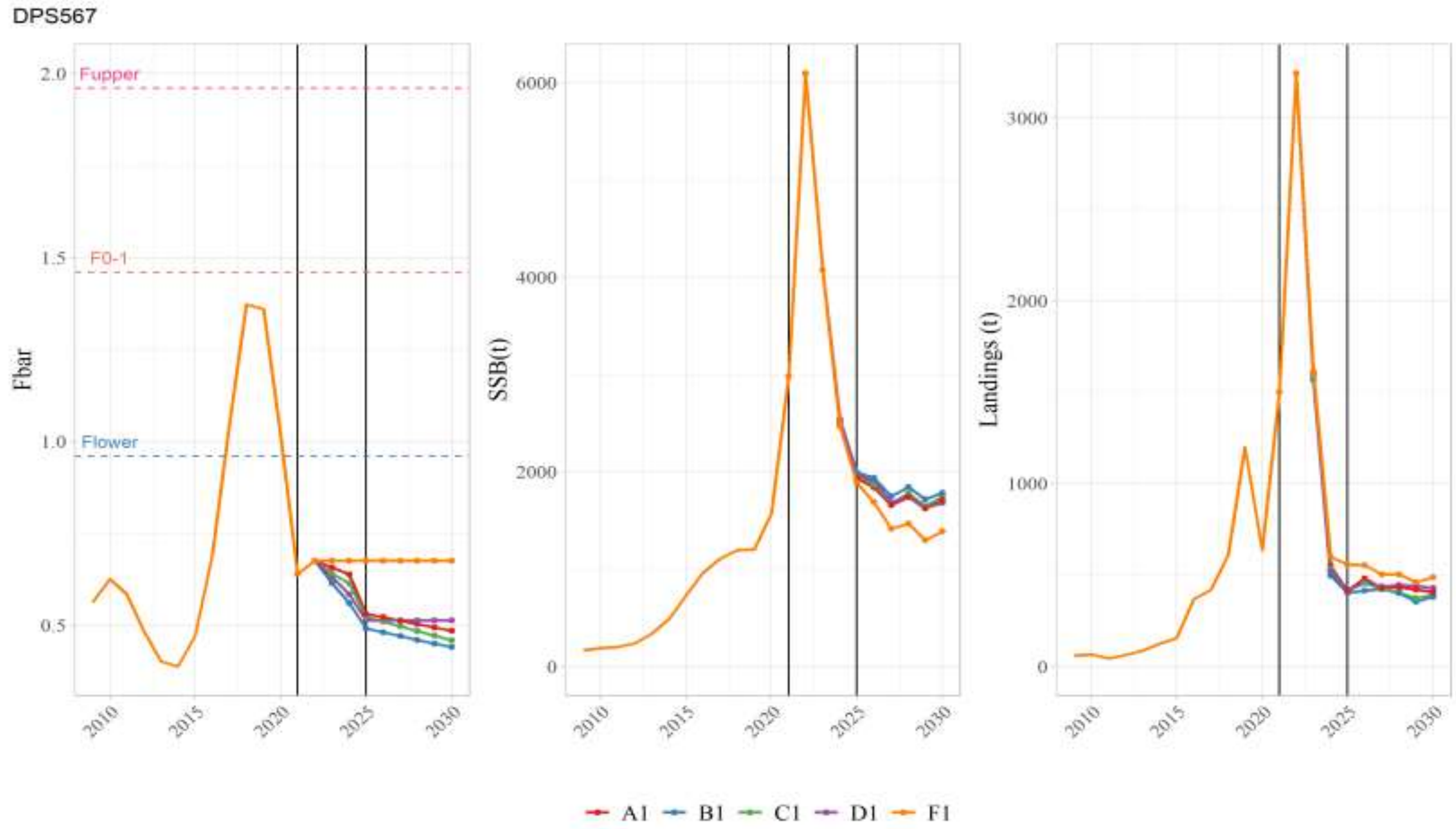


Figure 6.1.1.2.15. EMU1 (IAM model). Predicted median values for deep-water rose shrimp GSAs5-6-7 (DPS567) fishing mortality (left), SSB (middle) and total landings (right) under the five alternative scenarios (in colors). Historical values are shown on the left of the first vertical black line, which indicates the year 2021, and the simulated values on the right of this first vertical line. The second vertical black line indicates the year 2025.

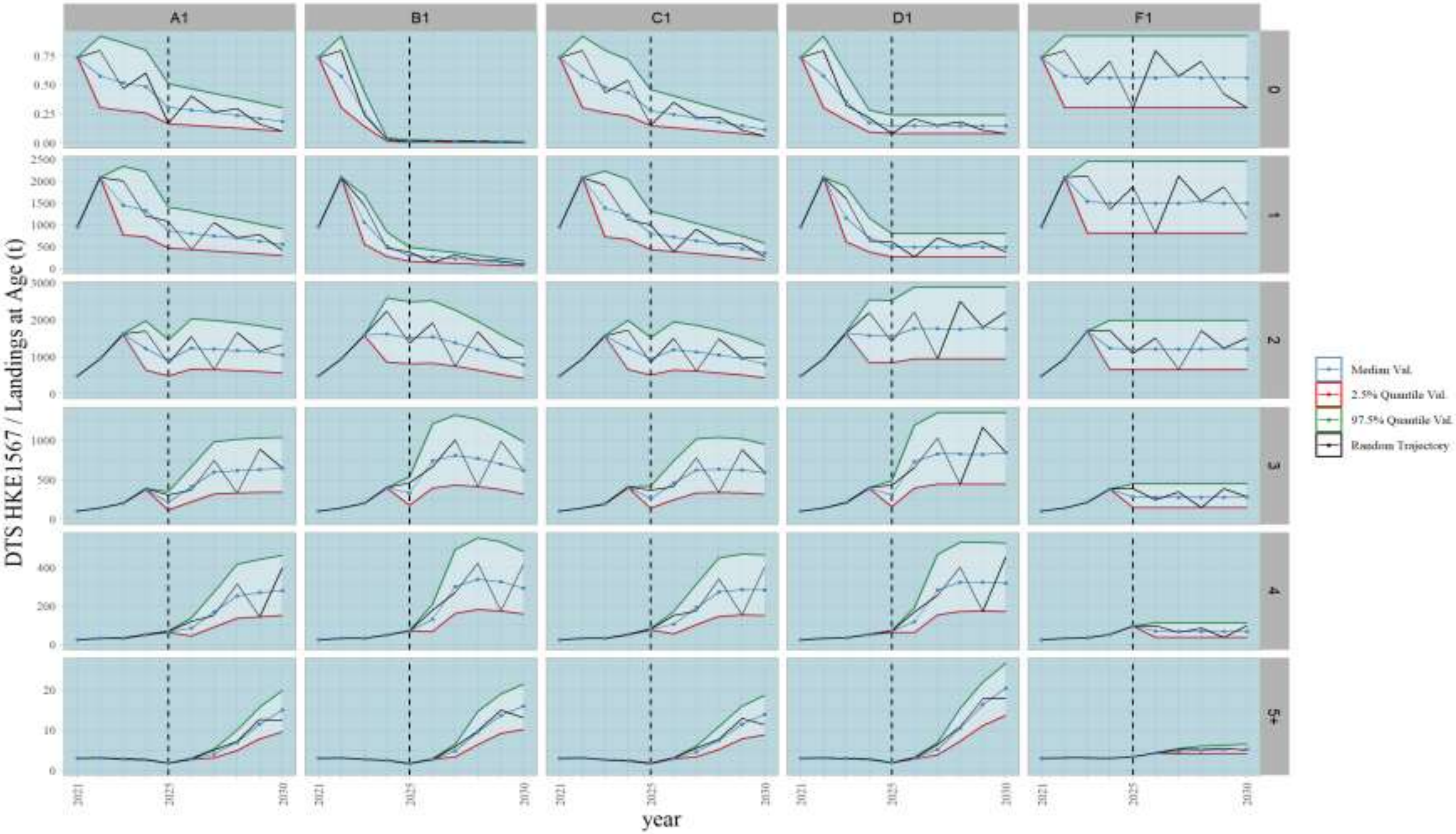


Figure 6.1.1.2.16. EMU1 (IAM model). Evolution of the total annual landings at ages (in tonnes) of hake GSAs1-5-6-7 (HKE1567) by French and Spanish trawlers (DTS) from 2021 to 2030. Vertical black dotted lines indicate the year 2025. Scenarios are in column and ages in row.

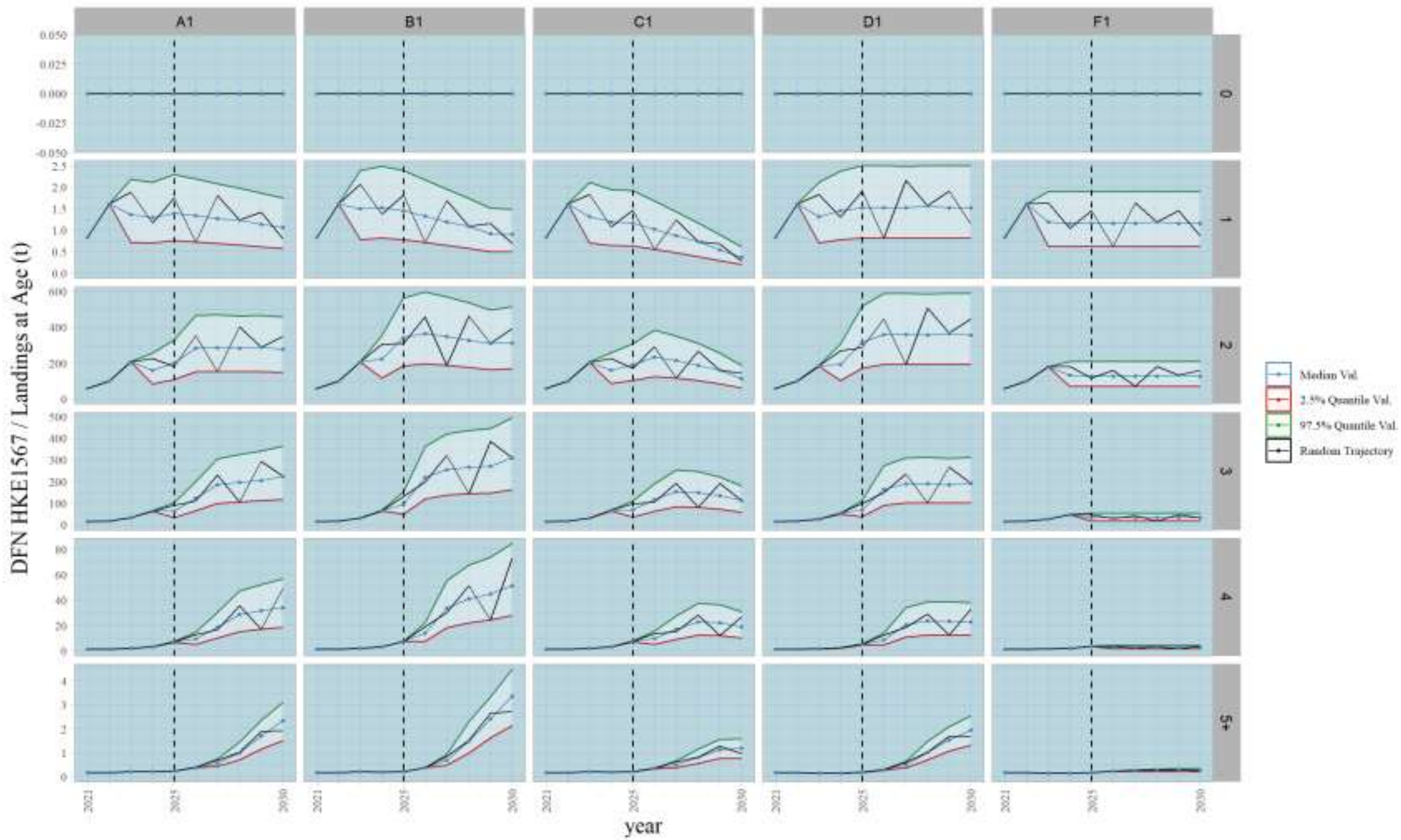


Figure 6.1.1.2.17. EMU1 (IAM model). Evolution of the total annual landings at ages (in tonnes) of hake GSAs1-5-6-7 (HKE1567) by French and Spanish netters (DFN) from 2021 to 2030. Vertical black dotted lines indicate the year 2025. Scenarios are in column and ages in row.

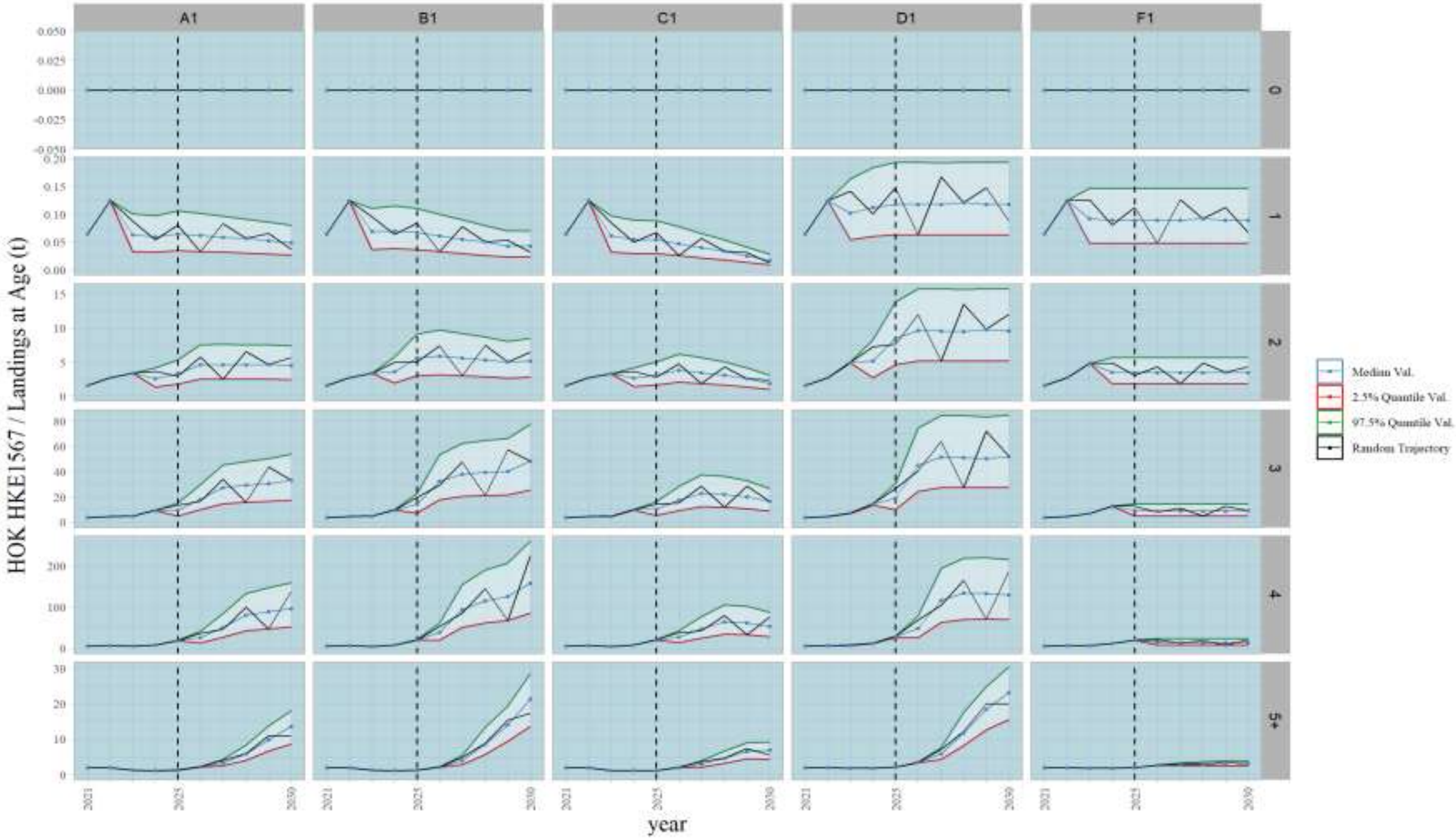


Figure 6.1.1.2.18. EMU1 (IAM model). Evolution of the total annual landings at ages (in tonnes) of hake GSAs1-5-6-7 (HKE1567) by French and Spanish vessels using hooks (HOK) from 2021 to 2030. Vertical black dotted lines indicate the year 2025. Scenarios are in column and ages in row.

Table 6.1.1.2.1. EMU1 (IAM model). Ratio Fbar 2023/Fmsy, ratio Fbar 2025/Fmsy, ratio Fbar 2030/Fmsy, per stock by scenario. The median values are used.

		Scenario F (baseline) (E=E 2022 regulation)	Scenario A	Scenario B	Scenario C	Scenario D
Fbar in 2023/ Fmsy	HKE1567	3.639	3.471	3.095	3.254	3.349
	ARA12	4.808	4.510	4.101	4.213	4.486
	ARA5	5.809	5.439	5.061	5.070	5.560
	ARA67	3.917	3.668	3.218	3.418	3.529
	NEP6	2.000	1.911	1.709	1.822	1.822
	MUT1	2.582	2.497	2.141	2.354	2.266
	MUT6	3.726	3.591	3.133	3.436	3.304
	MUT7	0.960	0.924	0.796	0.887	0.907
	DPS1	0.911	0.893	0.845	0.876	0.868
	DPS56	0.466	0.454	0.423	0.442	0.439
Fbar in 2025/ Fmsy	HKE1567	3,639	2,000	1,627	1,822	1,941
	ARA12	4,808	0,962	0,878	0,930	0,923
	ARA5	5,809	0,999	0,999	0,999	0,999
	ARA67	3,917	0,588	0,557	0,611	0,469
	NEP6	2,000	1,167	1,016	1,124	1,105
	MUT1	2,582	1,781	1,313	1,620	1,571
	MUT6	3,726	2,489	2,057	2,385	2,231
	MUT7	0,960	0,843	0,616	0,781	0,798
	DPS1	0,911	0,757	0,716	0,746	0,736
	DPS56	0,466	0,366	0,339	0,359	0,352
Fbar in 2030/ Fmsy	HKE1567	3.639	1.344	0.815	0.880	1.941
	ARA12	4.808	0.675	0.448	0.521	0.923
	ARA5	5.809	0.656	0.414	0.488	0.999
	ARA67	3.917	0.388	0.238	0.300	0.469
	NEP6	2.000	0.957	0.760	0.837	1.105
	MUT1	2.582	1.235	0.704	0.870	1.571
	MUT6	3.726	2.038	1.590	1.767	2.231

	MUT7	0.960	0.660	0.488	0.535	0.798
	DPS1	0.911	0.709	0.663	0.682	0.736
	DPS56	0.466	0.334	0.304	0.316	0.352

Table 6.1.1.2.2. EMU1 (IAM model). Ratio of landings (in weight) in 2023/landings in 2021. ratio in landings in 2025/landings in 2021. ratio landings in 2030/landings in 2021. per stock by scenario. The median values are used.

		Scenario F (baseline) (E=E 2022 regulation)	Scenario A	Scenario B	Scenario C	Scenario D
Landings in 2023/ Landings in 2021	HKE1567	2.061	1.998	1.828	1.937	1.891
	ARA12	1.324	1.223	1.139	1.169	1.083
	ARA5	1.436	1.374	1.244	1.319	1.219
	ARA67	1.282	1.178	1.103	1.126	1.032
	NEP6	1.669	1.581	1.421	1.521	1.445
	MUT1	1.118	1.091	0.918	1.052	0.944
	MUT6	0.817	0.788	0.661	0.762	0.681
	MUT7	0.829	0.802	0.679	0.774	0.788
	DPS1	1.593	1.585	1.561	1.576	1.571
	DPS56	1.075	1.066	1.044	1.057	1.054
Landings in 2025/ Landings in 2021	HKE1567	1.934	1.534	1.747	1.562	1.806
	ARA12	1.343	0.458	0.490	0.483	0.565
	ARA5	1.424	0.442	0.469	0.484	0.519
	ARA67	1.260	0.422	0.470	0.487	0.530
	NEP6	2.229	1.499	1.444	1.511	1.546
	MUT1	1.046	0.892	0.882	0.880	0.924
	MUT6	0.963	0.800	0.870	0.810	0.889
	MUT7	0.791	0.729	0.613	0.696	0.704
	DPS1	0.590	0.483	0.495	0.490	0.502
	DPS56	0.371	0.276	0.267	0.276	0.277
Landings in 2030/	HKE1567	1.942	2.071	1.949	1.718	2.532
	ARA12	1.336	1.082	0.954	0.992	1.243

Landings in 2021	ARA5	1.408	0.896	0.624	0.707	1.200
	ARA67	1.266	1.223	1.187	1.191	1.291
	NEP6	2.535	2.711	2.807	2.649	3.035
	MUT1	1.043	0.943	0.763	0.814	1.076
	MUT6	0.986	0.942	0.886	0.888	1.035
	MUT7	0.783	0.646	0.560	0.561	0.734
	DPS1	0.526	0.469	0.439	0.448	0.488
	DPS56	0.325	0.270	0.254	0.262	0.285

Table 6.1.1.2.3 EMU1 (IAM model). Average Gross Value Added (GVA) per vessel (in €) in 2023, in 2025 and in 2030 per fleet segment and by scenario. ratio in landings in 2025/landings in 2021. ratio landings in 2030/landings in 2021. per stock by scenario. The median values are used.

		Scenario F (baseline, E=E 2022 regulation)	Scenario A	Scenario B	Scenario C	Scenario D
Mean GVA per vessel in 2023 (in €)	DTS_FRA_18-24m	-112200	-110900	-120600	-107500	-108300
	DTS_FRA_>=24m	-64300	-61100	-81700	-61000	-57000
	DFN_FRA_<12m	30000	29200	28300	27300	30100
	HOK_FRA_<12m	21300	3100	2700	2400	21300
	HOK_FRA_>=12m	-530400	-396900	-393400	-389800	-530400
	DTS_SP_inf12m	10100	10600	6800	8200	7600
	DTS_SP_1218m	26300	26400	20400	23600	22500
	DTS_SP_1824m	38300	37500	27000	33000	25200
	DTS_SP_sup24m	75600	75100	54400	69500	44400
	DFN_SP_<12m	15300	42100	40800	39500	15300
	DFN_SP_>=12m	31100	53500	52100	50500	31100
	HOK_SP_<12m	20800	41600	40300	39000	20800
	HOK_SP_>=12m	80000	-10100	-11300	-12500	80000
Mean GVA per vessel in 2025 (in €)	DTS_FRA_18-24m	-117800	-97000	-98900	-90100	-76800
	DTS_FRA_>=24m	-77000	-50200	-62000	-48200	-10800
	DFN_FRA_<12m	29200	25900	25900	20500	33000
	HOK_FRA_<12m	21900	2200	1400	200	23000

	HOK_FRA_>=12m	-530200	-382500	-371700	-361000	-529900
	DTS_SP_inf12m	9600	9600	1800	5600	7000
	DTS_SP_1218m	27200	30900	19400	26100	31400
	DTS_SP_1824m	40300	-28300	-30000	-26300	-28300
	DTS_SP_sup24m	79100	19800	14600	21700	7100
	DFN_SP_<12m	15400	37200	33500	29400	15600
	DFN_SP_>=12m	31100	47800	44000	38800	31700
	HOK_SP_<12m	20800	36500	32700	28800	20800
	HOK_SP_>=12m	80000	-15000	-18700	-22400	80000
Mean GVA per vessel in 2023 (in €)	DTS_FRA_18-24m	-118500	-61700	-63400	-61700	-57300
	DTS_FRA_>=24m	-76800	-19400	-33600	-34700	22200
	DFN_FRA_<12m	29200	20900	18900	2400	36400
	HOK_FRA_<12m	21800	2000	2600	-5600	30200
	HOK_FRA_>=12m	-530300	-345700	-327100	-289200	-528000
	DTS_SP_inf12m	9500	-1300	-15900	-11000	9500
	DTS_SP_1218m	27500	26400	0	8300	49200
	DTS_SP_1824m	41700	-29900	-37700	-33800	-21800
	DTS_SP_sup24m	80500	38100	-2500	9400	48900
	DFN_SP_<12m	15400	24700	14500	3700	15700
	DFN_SP_>=12m	31100	33700	22000	8800	32300
	HOK_SP_<12m	20800	23800	17400	3400	20800
	HOK_SP_>=12m	80000	-27300	-33500	-47000	80000
Fishing Effort in 2025/ Fishing effort in 2021	DTS_FRA_18-24m	0.814	0.658	0.581	0.575	0.626
	DTS_FRA_>=24m	0.931	0.753	0.664	0.658	0.642
	DFN_FRA_<12m	1.000	0.872	0.795	0.718	1.000
	HOK_FRA_<12m	1.000	0.385	0.351	0.317	1.000
	HOK_FRA_>=12m	1.000	0.451	0.411	0.371	1.000

	DTS_SP_inf12m	1.225	0.985	0.865	0.857	1.225
	DTS_SP_1218m	1.066	0.856	0.752	0.744	1.060
	DTS_SP_1824m	1.197	0.228	0.239	0.240	0.285
	DTS_SP_sup24m	1.226	0.495	0.484	0.451	0.554
	DFN_SP_<12m	1.000	1.974	1.799	1.625	1.000
	DFN_SP_>=12m	1.000	1.466	1.337	1.207	1.000
	HOK_SP_<12m	1.000	1.569	1.431	1.292	1.000
	HOK_SP_>=12m	1.000	0.305	0.279	0.252	1.000
Fishing Effort in 2030/ Fishing effort in 2021	DTS_FRA_18-24m	0.814	0.399	0.270	0.238	0.626
	DTS_FRA_>=24m	0.931	0.457	0.308	0.273	0.642
	DFN_FRA_<12m	1.000	0.615	0.487	0.205	1.000
	HOK_FRA_<12m	1.000	0.271	0.215	0.090	1.000
	HOK_FRA_>=12m	1.000	0.318	0.252	0.106	1.000
	DTS_SP_inf12m	1.225	0.584	0.264	0.336	1.225
	DTS_SP_1218m	1.066	0.508	0.230	0.292	1.060
	DTS_SP_1824m	1.197	0.135	0.073	0.094	0.285
	DTS_SP_sup24m	1.226	0.294	0.148	0.177	0.554
	DFN_SP_<12m	1.000	1.393	0.929	0.464	1.000
	DFN_SP_>=12m	1.000	1.035	0.690	0.345	1.000
	HOK_SP_<12m	1.000	1.108	0.877	0.369	1.000
	HOK_SP_>=12m	1.000	0.216	0.171	0.072	1.000

6.1.1.3 Discussion

The main objective of the management plan is to achieve fishing mortality values in between Fmsy ranges for each of the stocks mentioned in the management plan by 2025. The results of the IAM simulations suggest that none of the proposed scenarios achieved this objective. Red mullet in GSA 6 (MUT6) never reaches its Fmsy range during the simulation period (2022-2030) under any scenario, and hake in GSA 1-5-6-7 (HKE1567) is still above Fmsy in 2025, although between 2025 and 2030 it is below its Fupper under some scenarios. The other stock that is slightly behind the objectives is red mullet in GSA 1 (MUT1), in 2025 this stock is at the level of Fupper only with scenario B (MUT1 is above the Fmsy range with all other scenarios). However, the other stocks (ARA12, ARA5, ARA67, NEP6, MUT7, DPS1 and DPS567) reach their Fmsy range in 2025 with scenarios A to D. Only with the business-as-usual scenario (scenario F) is the Fmsy ranges not reached in 2025 for some of those stocks. This leads to the conclusion that effort measures must be implemented to achieve the objectives of the management plan.

With scenario B, Fmsy is reached between 2028 and 2029 for HKE1567 and between 2027 and 2028 for MUT1, and with scenario C, Fmsy is reached between 2029 and 2030 for hake and in 2029 for MUT1.

In the simulations, a **peak in SSB estimates** is observed between 2021 and 2022 for **DPS1** and **DPS567**, while fishing mortality on these stocks increases slightly between 2021 and 2022 (Figures 6.1.1.2.14 and 6.1.1.2.15). This peak is explained by the fact that in the stock assessment group EWG 22-09 data, **recruitments in 2021 are extremely high** (4 times more than in 2020 for DPS1 and about 2 times more than in 2020 for DPS567, 2020 being already a very good year for DPS567 recruitment compared to previous years). Individuals at age 1 of DPS1 are fully mature, and 50% of individuals at age 1 of DPS567 are mature, which means that by 2022 these exceptional recruitments in 2021 are reflected in the SSB estimates in 2022. For these stocks, it is therefore questionable whether the random draw with replacement approach to simulating recruitment from the available historical period (2009-2021) is relevant. Indeed, the results of the EWG 22-09 stock assessments show that recent years have seen better recruitment than past years, and this is particularly true for 2021. The way of simulating recruitments for DPS in EMU1 should thus be discussed with the stock experts. If good recruitment years are expected in the future, randomly drawing recruitment in the historical period 2009-2021 would mean that the IAM model underestimates the abundances and therefore the catches of DPS1 and DPS567, and consequently the part of the revenues coming from DPS landings.

The maximum catch limit (MCL) measures on ARA are implemented in all scenarios from A to D. As in IAM simulations, by construction, the fishing effort of Spanish trawlers is adjusted so that the Fmsy for these stocks is reached after 2025, these stocks are within their Fmsy range in 2025 and beyond. These measures lead to a reduction in the profits (GVA) of Spanish trawlers over 18 meters from 2025.

It seems that selectivity measures (i.e. scenarios B and D) are beneficial for the stocks, without impacting economic performances too much. It is important to note, however, that since several measures are implemented at the same time in each scenario and that from one scenario to another there is a difference of more than one measure, it is difficult to separate the effects of one measure. It is therefore impossible to correctly interpret the impact of a single measure.

Figures 6.1.1.2.16 to 6.1.1.2.18 show the evolution in hake landings at age by trawlers, netters and vessels using hooks. As expected, there is an increase in landings of hake aged 3 and over by trawlers, and a decrease in landings of hake aged 0 and 1 year. Interestingly landings of hake over 2 years old are also increasing for netters and vessels using hooks. Avoiding catching younger hake has an impact on future landings of larger hake.

In terms of biological indicators, scenario B shows the most increases in SSB and, overall, Fmsy is reached earlier than the other scenarios. For French trawlers, the economic performance in terms of GVA per fleet and average GVA per vessel is better under this scenario than under scenario F (status quo scenario), while the GVA of Spanish trawlers decreases and becomes negative after 2025 for trawlers under 12 meters and trawlers between 18 to 24 meters. The other two Spanish trawler fleets (12-18 meters and >= 24 meters) are still positive but very close to zero at the end of the simulation.

Scenario D is the scenario where the economic indicators (i.e., total GVA per fleet and mean GVA per vessel) perform best, especially towards 2030. It is with this scenario that overall landings levels are at the level of, or even above (depending on the stock), the landings with scenario F, and this is all the more true the closer we get to 2030. It is however important to note that under this scenario the fishing mortality of HKE1567, MUT1 and MUT6 is higher than their Fupper.

Reduction in effort for French and Spanish vessels using hooks (scenarios A, B and C) is detrimental to the economy of vessels under 12 meters of this type, with a negative or close to zero GVA.

As said in EWG 21-13 (and detailed in section 7.1), it is important to note that landings per unit of effort of other species (than the ones that are explicitly modelled) are assumed constant in time. Consequently, potential positive impacts of effort reduction on those other stock biomasses are not simulated and total landings might thus be underestimated. As the proportion of the landings of those other species are very high for most fleet segments, the negative economic impacts of the effort reduction management scenarios displayed might be overestimated in our simulations. This is true especially in the long run, as positive effect of effort reduction in stock biomasses are not instantaneous.

Tables 6.1.1.2.1 to 6.1.1.2.3 synthesize IAM outputs across scenarios for all stocks and fleets, through the examination of two statistics, Fbar2025/FMSy (for stocks) and GVA2025/GVA 2021 for fleets. Upon examination of this table, the trade-off between achieving sustainable harvesting by targeting Fmsy, and ensuring the economic viability of all fleet segments becomes evident, as scenarios B and C - the most successful at reaching Fmsy for all stocks, are also the most detrimental for the economic performances per fleet segment, especially for Spanish trawlers.

6.1.2 BEMTOOL in EMU 2

Four scenarios among the ones listed in the ToRs have been implemented:

Scenario A: annual trawler, longlines and netter effort reduction of 5% (until FMSY is reached), combined catch limit for ARS and ARA 5% in 2023, 5% 2024 and MSY level in 2025, spatio-temporal closure of 2020-2021 and reduction of trawler number if 5% in 2023 and 5% in 2024;

Scenario B: annual trawler, longlines and netter effort reduction of 7.5% (until FMSY is reached), combined catch limit for ARS and ARA 7.5% in 2023, 7.5% 2024 and MSY level in 2025, spatio-temporal closure of 2020-2021 and reduction of trawler number if 5% in 2023 and 5% in 2024, change in selectivity of all the fleet (50 mm square mesh);

Scenario D: annual trawler, longlines and netter effort reduction of 8% (until FMSY is reached), combined catch limit for ARS and ARA according to transition path calculated by EWG 22-09, spatio-temporal closure of 2020-2021 and reduction of trawler number (125 vessels between 2023 and 2027);

Scenario F: A status quo (SQ) scenario was carried out assuming no change in the effort of 2022.

For all scenarios, except F (SQ), considering that for reaching the F_{MSY} for hake a reduction of 87% was needed, the annual percentage of reduction in fishing days was applied both on DTS and PGP until 2030 (for scenario D this is corresponding to a total reduction of 64%). Moreover, the fishing days reductions were calculated using as reference the average 2015-2017, corresponding to a value higher than the current one (2022). For the interpretation of results is important to specify that the baseline used in the model are referred to the effort of the metier targeting the MAP species (thus only to OTB_DEF, OTB_MDD ,OTB_DWS, GNS, GTR and LLS) in the years 2015-2017.

The maximum catch limit by year was estimated for each species in order to have a gradual reduction from the maximum catch limit in the EU Reg 2022/110 and the catch associated to Fmsy as estimated by EWG 22-09.

To define the catch limit transition path for Scenario F for ARS we used the catch at Fmsy transition as catch limit for 2023, the catch at F0.1 as catch limit for 2025 and an average for 2024. For ARA catch limits transition path for ARA we used the catch advice as catch limit for 2025 and the path (7.5% decreasing each year) of Scenario B for 2023 and 2024.

The maximum catch limits of ARS and ARA have been split among the fleet segments and quarters according to their proportion in the landing in the FDI data in the reference period 2015-2017. The catch limits for the stocks by year and scenario are reported in Table 6.1.2.1.

Table 6.1.2.1 Catch limit paths for ARS and ARA for Scenarios A, B and D.

Year	**Scenario A**		**Scenario B**		**Scenario D**	
	ARA	**ARS**	**ARA**	**ARS**	**ARA**	**ARS**
2021	209	370	209	370	209	370
2022	250	365	250	365	250	365
2023	238	347	231	338	231	318
2024	225	329	213	310	213	294
2025	145	270	145	270	145	270

First deterministic runs were done to get a first feedback on:

1) the completeness and coherence of inputs and of the BEMTOOL parameterization;
2) the different scenarios settings.

Then, given the computation time, stochastic runs were performed in a second step and are here reported.

For all scenarios the basis was given by the number of fishing days by fleet as the average in the period 2015-2017.

Scenarios A, B and to D were carried out with the hypothesis that the fleet stops fishing in the metier OTB_DWS and OTB_MDD when one of the two catch limits are reached and the remaining effort is re-allocated on the metier OTB_DEF, increasing the pressure on the stocks targeted by this metier. The model works at monthly level, checking every month and for each trawl fleet if the catch limit is reached or not. This is to simulate that, when a catch limit on ARA and/or ARS is reached, the fleet moves on other fishing grounds, inhabited by other stocks.

The effort in the projections is assumed to be distributed among the months as in the last year of simulation; the monthly ratio between each fleet segment catch to the total catch (p coefficient, used to split the total F among the fleet segments in the BEMTOOL F formulation) in the forecast is the same of the last year of simulation.

In scenario B the basis followed during STECF EWG 21-11 for the change in selectivity. For HKE an SL50 of 22 cm is assumed for this scenario, while for MUT 9 and MUT 10 an SL50% of 17 cm; for DPS 22.62 mm f carapax length is assumed, while for ARA 26.2 mm (Gorelli et al, 2017). A proportional increase in SL50% was assumed also for ARS, while for NEP 28 mm of carapax length was assumed.

6.1.2.1 Runs performed and analysed during EWG 22-11: discussion

The scenarios were implemented on the basis of historical information on the stocks status (SSB, F, catch) mimicked in BEMTOOL model that was observed in agreement with the outcomes of the STECF EWG 22-09.

The performance of the scenarios was evaluated on the basis of spawning stock biomass, catch, F, revenues and gross value added. The formulation of gross value added follows:

Gross value added:

$$\boldsymbol{GVA = R_{f,t} - VC_{f,t} - FC_{f,t} - MC_{f,t}},$$

where $R_{f,t}$ are the total revenues for fleet f at time t, VC the variable costs, FC the fixed costs and MC the maintenance costs;

Figure 6.1.2.1.1 reports the reached F for each scenario and stock. For European hake the results show that due to the re-allocation of the effort from the DWS and MDD metier to the DES, the F is expected to increase until 2024 and then decrease until 2030. B and D are the scenarios that allow to reach an F value closer to the reference point range in 2030. Specifically scenario B return an F path lower respect to A and D due to the increase in mesh size from 2023 to the whole DTS fleet. For red mullet in 10, after an increase in F due also in this case to the re-allocation of the effort driven by the catch limit on ARS and ARA, scenarios A allow to reach FMSY range in 2028, while D in 2026. Scenario B shows a level of F well below F_{MSY} due to the increase in mesh size, highlighting the risk of underutilization of this stock. This stock, according to the last endorsed stock assessment, is already exploited in line with the reference point. For red mullet in GSA 9, scenario D allow to reach FMSY in 2025, while for scenario A in 2026. Also in this case, scenario B shows a level of F well below, highlighting the risk of underutilization; this is due to current state of the stock that is already exploited below the reference point. Regarding the DPS, scenario A allow to reach FMSY in 2030, scenario B in 2028 and scenario D in 2027. For giant red shrimp scenarios A, B and D allow to reach the F reference point in 2024. To maintain the catch limit until the end of the simulation reduce too much the F respect to the reference point. This is probably due to the use of static catch limits paths based on MSY estimated in 2022, with reference year 2021. This does not take into account dynamically the annual improvement of the stock biomass. Indeed, the hypothesis of a gradually decreasing catch limit, representing the "run to fish" hypothesis, could not completely accommodate the dynamic of the stock, that is expected to recover when the catch limit is implemented. A smaller catch limit in the second year of implementation, would be reached before, respect to the previous year and so on. For ARA all the scenarios reduce importantly the F well below the current level. It is not possible for this stock to evaluate the F respect the reference point. ARS results a choke species for ARA, indeed the total catch of ARS is driven by its catch limit paths, while the total catch of ARA is below the catch limit. This indicates that the fleet stops fishing before reaching the ARA catch limit, because has reached the catch limit for ARS (Figure 6.1.2.1.3). Concerning the NEP9, the stock is exploited at F_{MSY} for scenario A in 2027, while in 2025 for scenarios B and D. Also for this stock, for scenarios B and D there is the risk of underutilization in the long term.

It is important to notice that Fmsy value is expected to change in time, due to the application of management measures, but, for simplicity, it was assumed to be fixed along the years.

In Figure 6.1.2.1.2 are shown the SSB for the seven stocks under the 4 implemented scenarios. Regarding HKE scenarios A, B and D return a level of SSB below the SQ level (scenario F); this is due again to the effort re-allocation, increasing the fishing pressure exerted on demersal fishing grounds inhabited by hake. Despite the SQ returns higher level of biomass than the other scenarios until 2028, scenario D show an SSB level close to F in 2030 and scenario B higher than F. This is due to the increase in mesh size that allows to compensate the increase in effort of OTB_DEF. A is the most penalizing scenario, being characterized by the smallest reduction in effort and in the number of vessels, without any change in selectivity. Red mullet in 10 shows the more pronounced improvement in SSB for scenario B, due to the important increase in the size of first capture corresponding to the 50m square mesh. In the short and medium term scenarios A and D return a value below the F (SQ) and in 2029-2030 scenario D is slightly higher than F. Taking into account that the SSB of MUT9 and DPS was already in line with Bpa, all scenarios show SSB above Bpa, with a more marked increase for scenario B. For DPS scenario B is followed by scenario D, while scenario A after an SSB level below scenario F, shows in 2030 a level very close to SQ. The results of SSB for ARS and ARA show that scenarios A, B and D allow to importantly improve the SSB respect to the SQ. Scenario B respect to the others has an additional positive effect on the SSB, allowing to anticipate its improvement in time. For ARS all scenarios, including F, SSB is above Bpa. Concerning NEP9, also in this case the stock is currently above the Bpa, thus all scenarios show an improvement in SSB, that is more important for B and D (Figure 2.3.4.2).

For ARS and ARA scenarios A, B and D scenarios return a catch value that is below or in line with the SQ (scenario F), while for the other stocks the catches show an increase in the short term (due to the reduction of fishing effort calculated on the baseline 2015-2017) and then a value approaching the status quo or values slightly lower. In general the scenario B, including the increase in mesh size, returns lower catches (Figure 2.3.4.3).

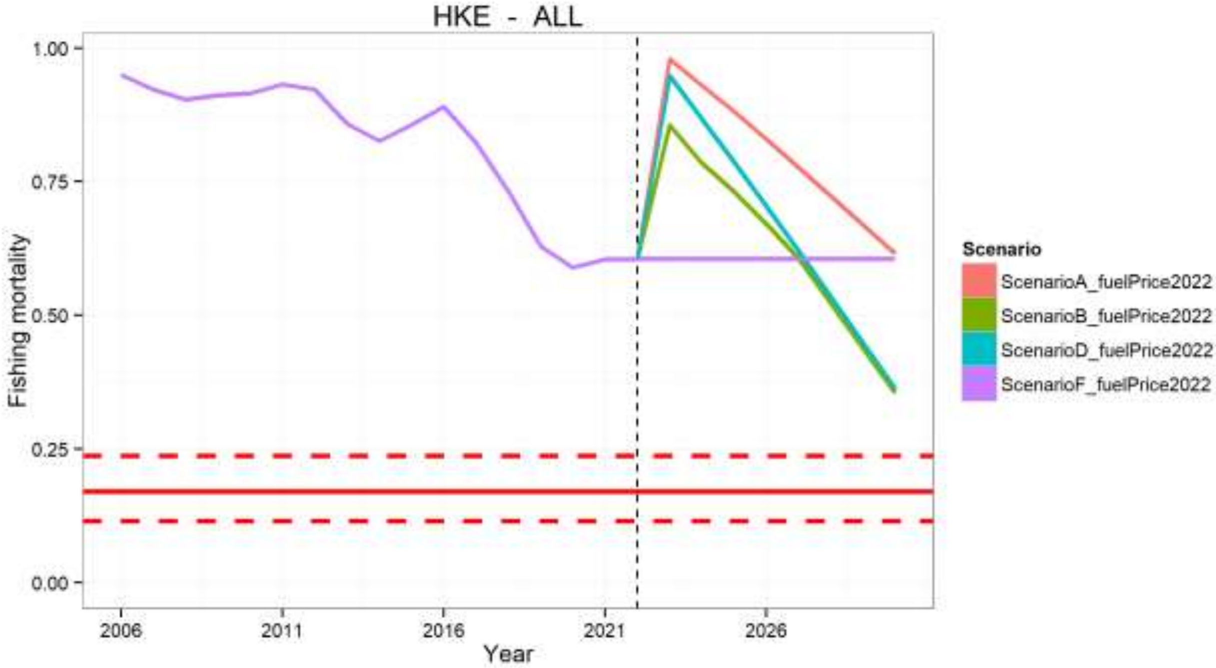
Total revenues and gross value added for the overall fleet are predicted to slightly increase respect to the lowest values of the time series reached in 2020-2021 (Figure 2.3.4.4-5). For scenarios A, B and D total revenues across all fleets will decrease respect to the situation under the SQ, remaining above the recent values. A similar pattern is observed for gross value added.

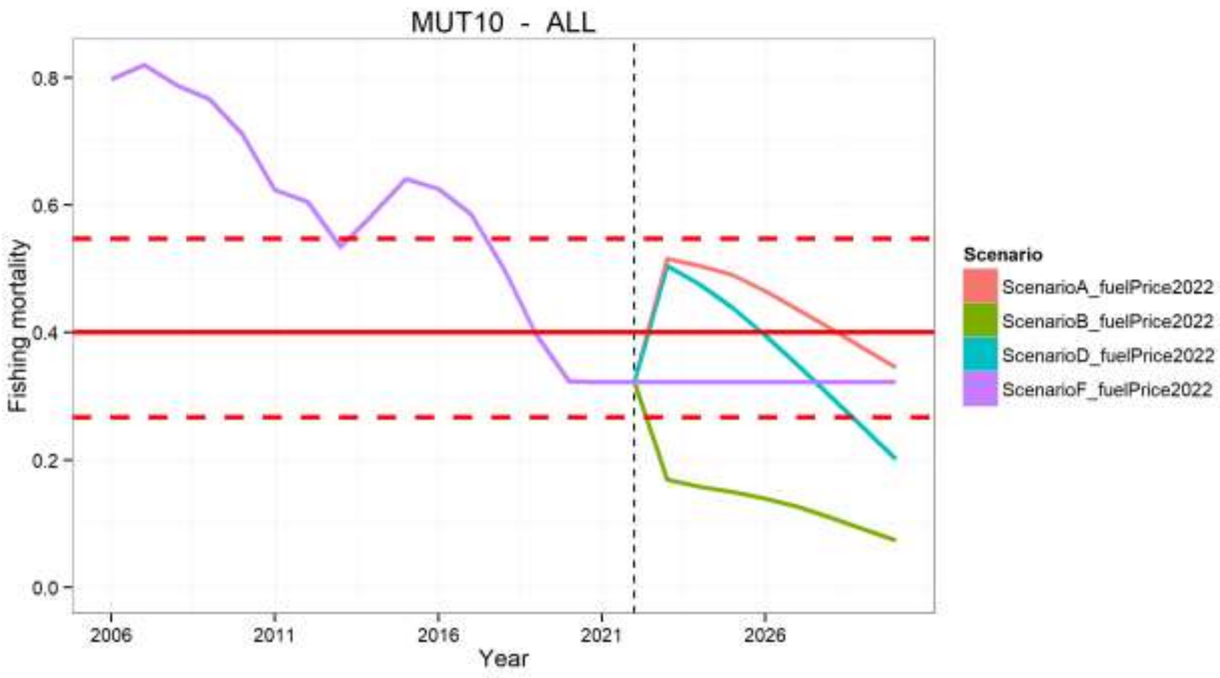
Scenario B, implementing effort reduction (in fishing days and number of vessels) in combination with the improvement in selectivity, show an higher level of revenues respect to A and D. This is also true in terms of GVA, indicating that the increase in revenues of scenario B compensates the higher operational costs of scenarios A and D.

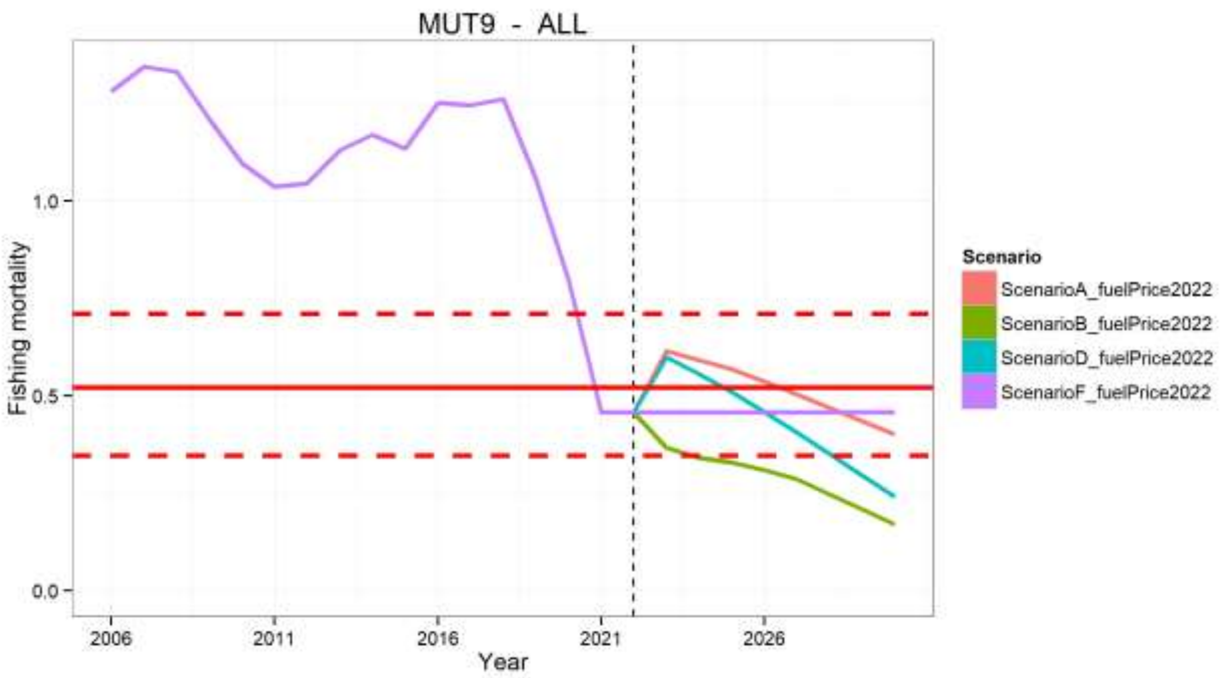
The total revenues are driven by the revenues of the target stocks (Table 6.1.2.1.4 and Table 6.1.2.1.5). The change in revenues of target stocks and GVA is different among the fleet segments: in 2025 for several fleet segments (e.g. GSA11_DTS_VL0612, GSA10_DTS_VL2440, GSA9_DTS_VL2440 and GSA9_DTS_VL1824) the change of scenario B respect to SQ is lower than scenario A and D, while for others (e. g. GSA11_DTS_VL2440) scenario A is the lower respect to SQ. For PGP fleet segments, scenario B is the best performing in terms of GVA and revenues (after SQ), highlighting that these segment benefit from the additional technical measures applied to trawlers.

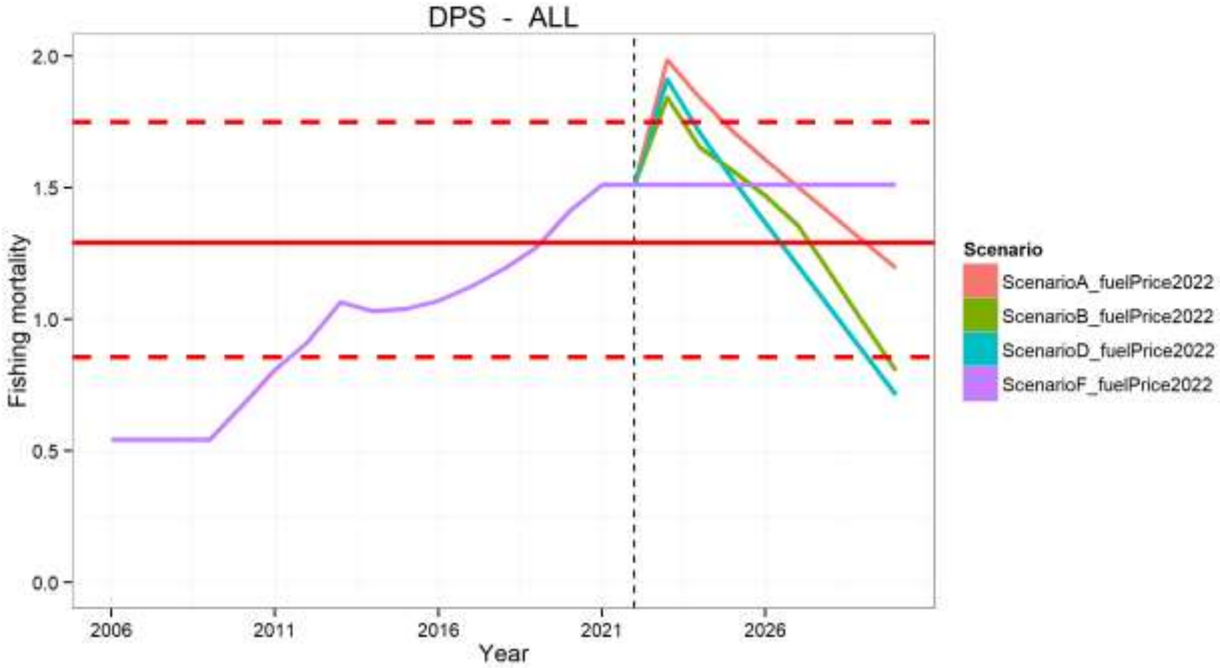
Following EWG 19-01 and 19-14, it is important to highlight that the results from EWG 22-11 for all scenarios are based on the assumption that a reduction in F is a direct consequence of an effort reduction. Inclusion of hyperstability in BEMTOOL was explored by EWG 19-01 and EWG 20-13, where the relationship between fishing effort and fishing mortality was assumed non-linear.

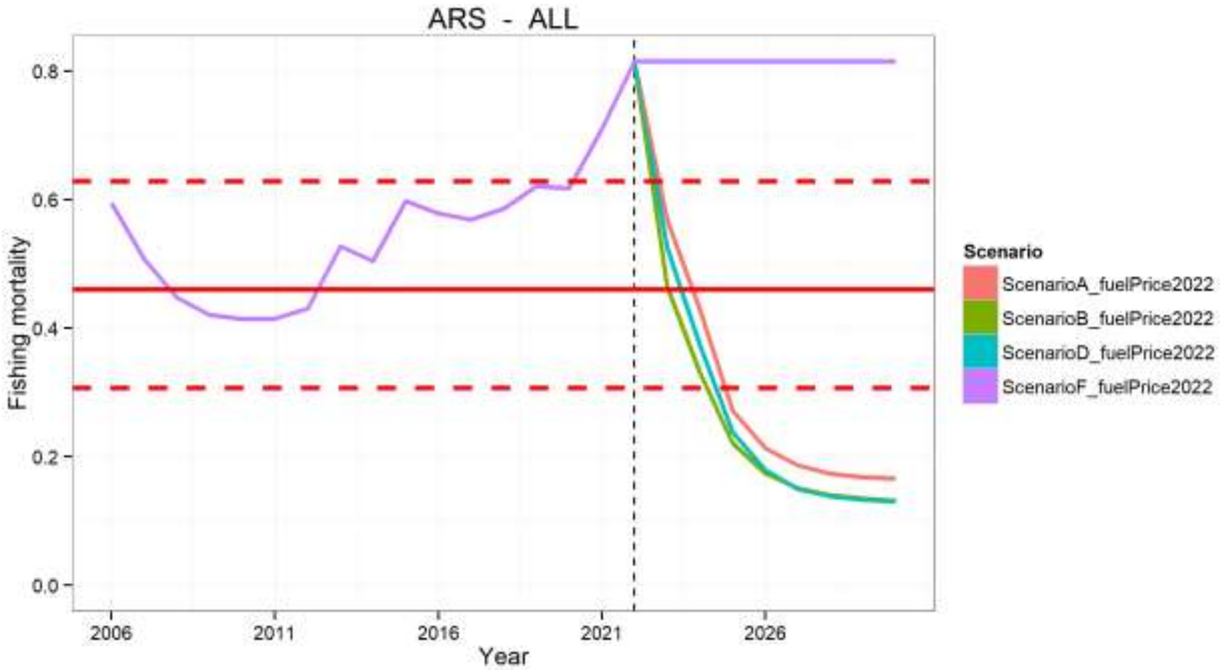
In the next figures, for F, Catch and SSB, the historical part (until 2022) is represented by the stock assessment results replicated by BEMTOOL.

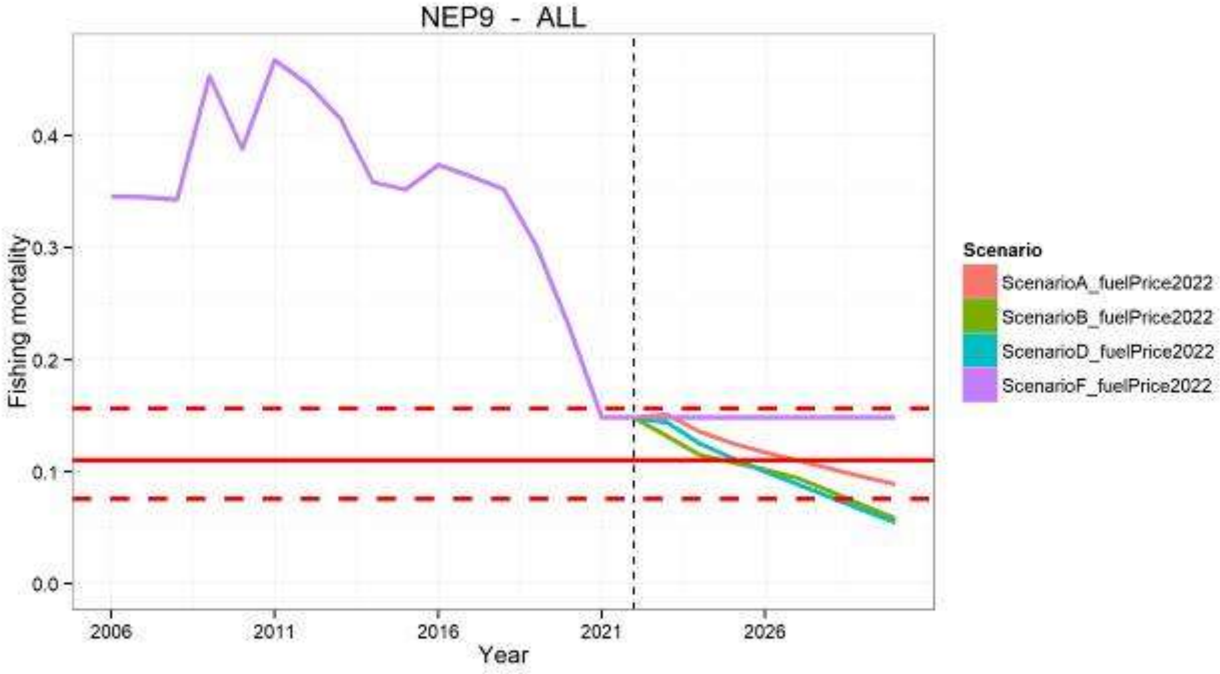



MUT10 - ALL
Fishing mortality
Year
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


MUT9 - ALL
Fishing mortality
Year
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


DPS - ALL
Fishing mortality
Year
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


ARS - ALL
Fishing mortality
Year
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022



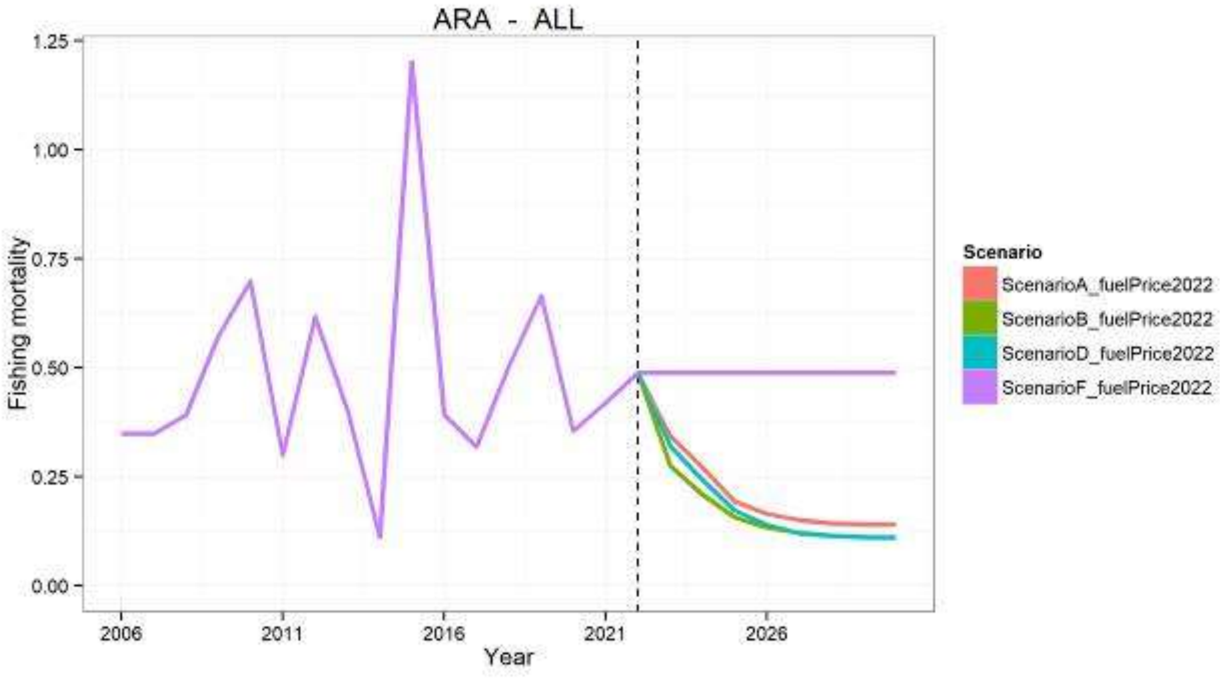
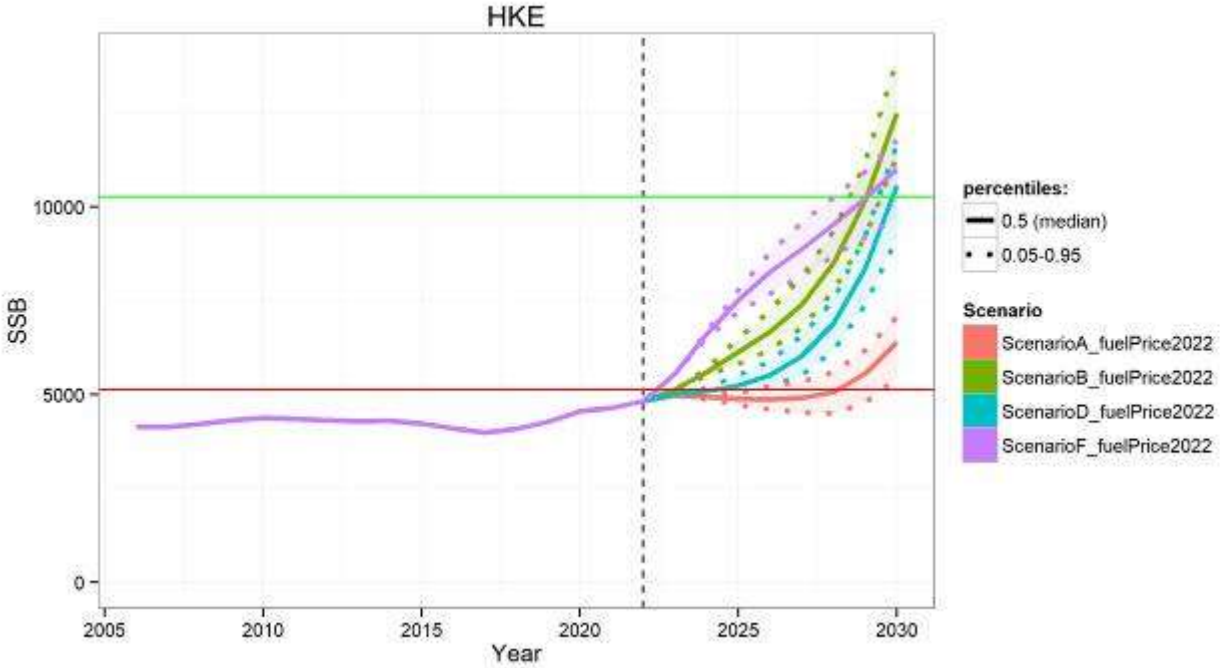
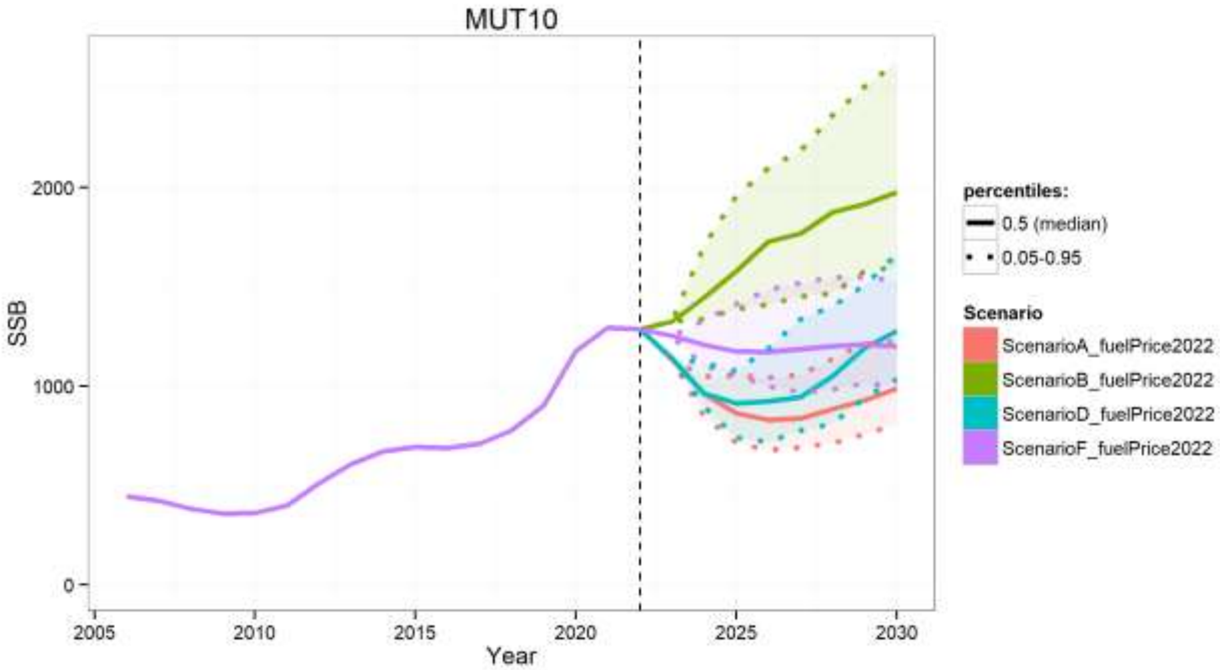
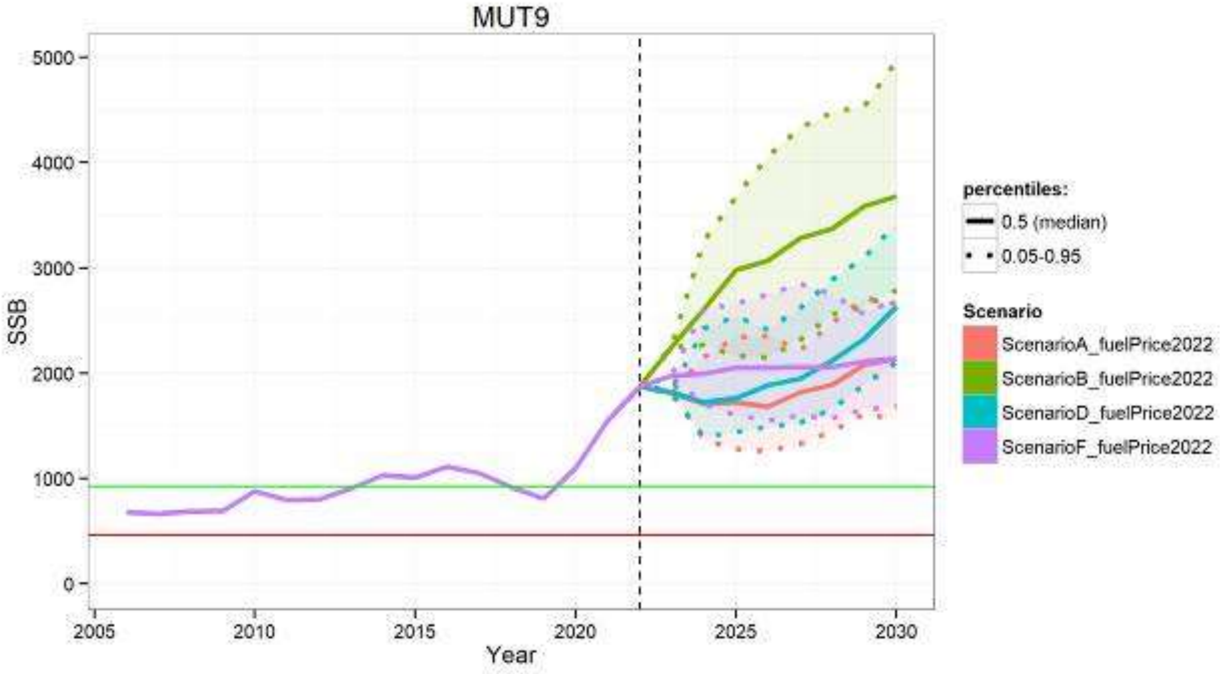
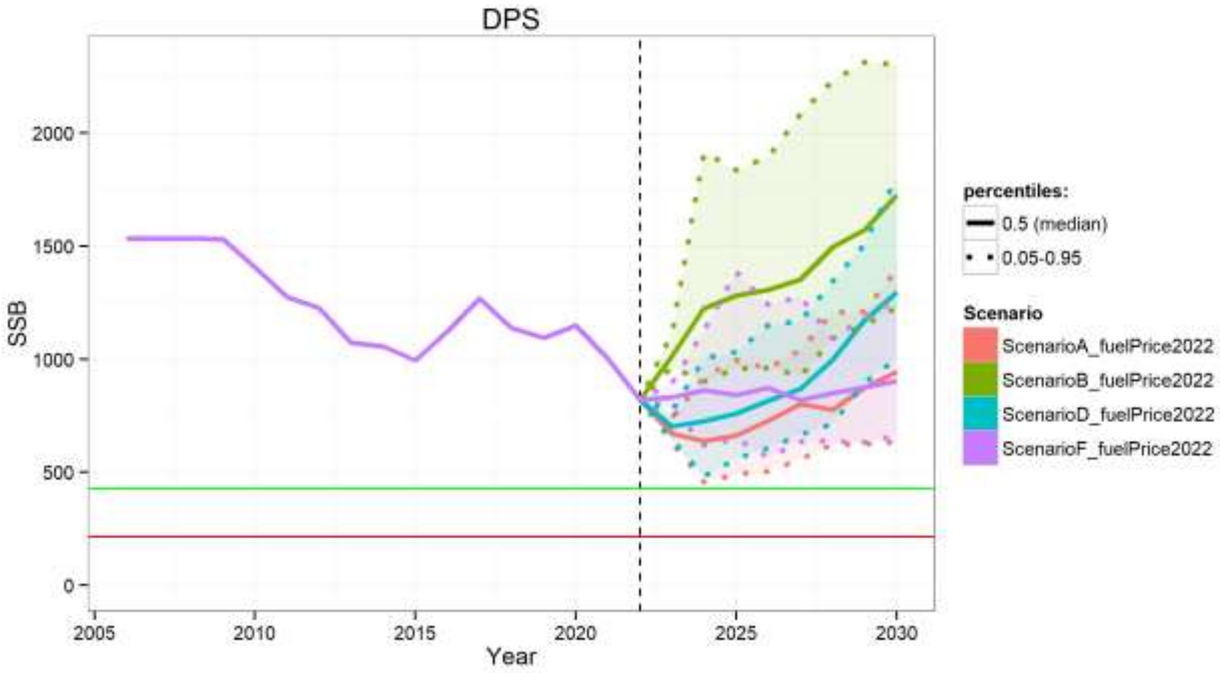


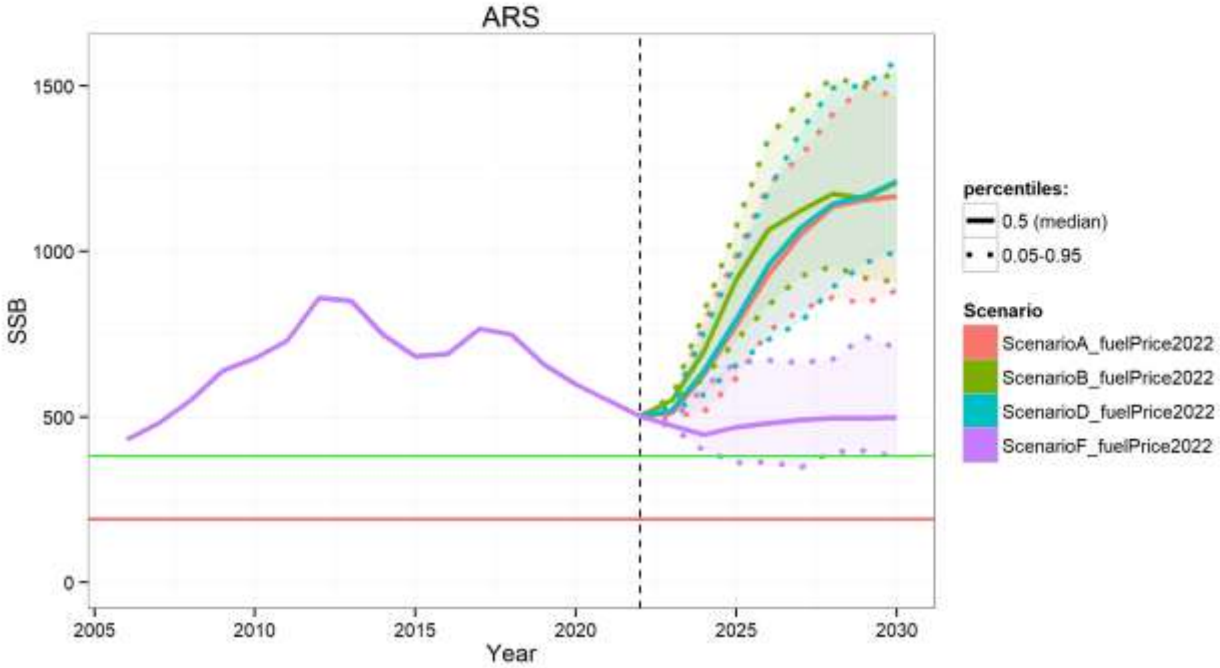
Figure 6.1.2.1.1– BEMTOOL. Trajectories of the fishing mortality (F) for the seven stocks in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios. The black vertical dashed lines corresponds to 2021. Red horizontal solid line correspond to the F_{MSY}=F0.1, and red horizontal dashed lines correspond to Fupper and Flower.

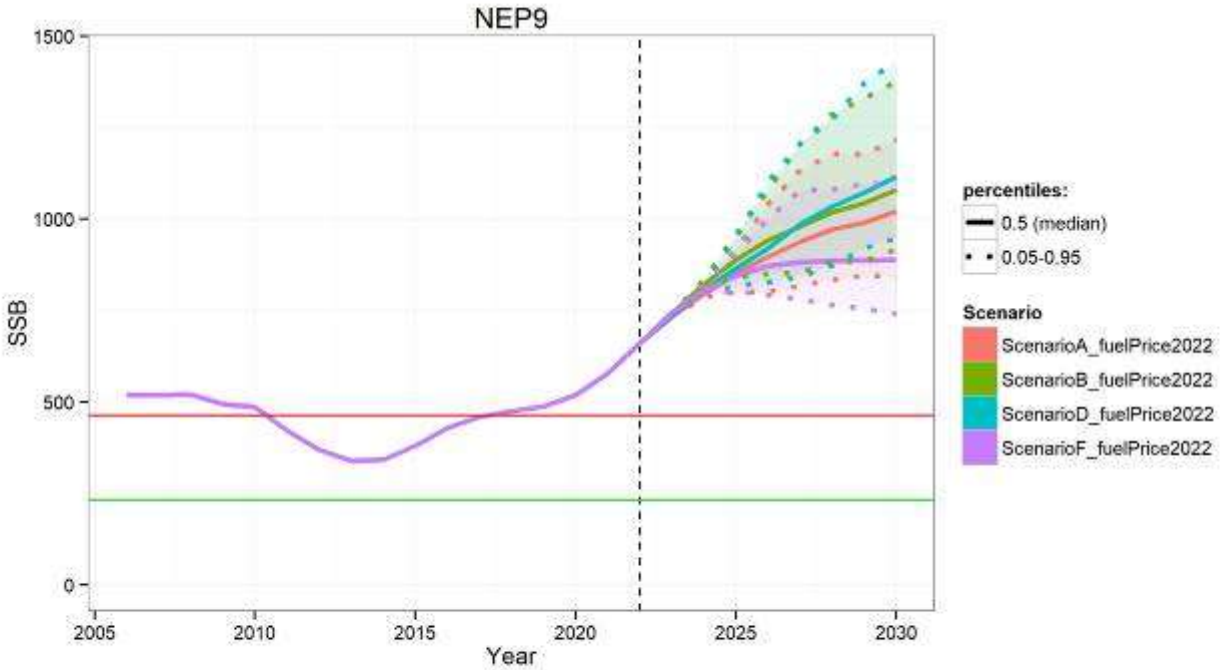

HKE
SSB
10000
5000
0
2005
2010
2015
2020
2025
2030
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


MUT10
SSB
2000
1000
0
2005
2010
2015
2020
2025
2030
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


MUT9
SSB
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


DPS
SSB
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


ARS
SSB
1500
1000
500
0
2005
2010
2015
2020
2025
2030
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


NEP9
SSB
1500
1000
500
0
2005
2010
2015
2020
2025
2030
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022

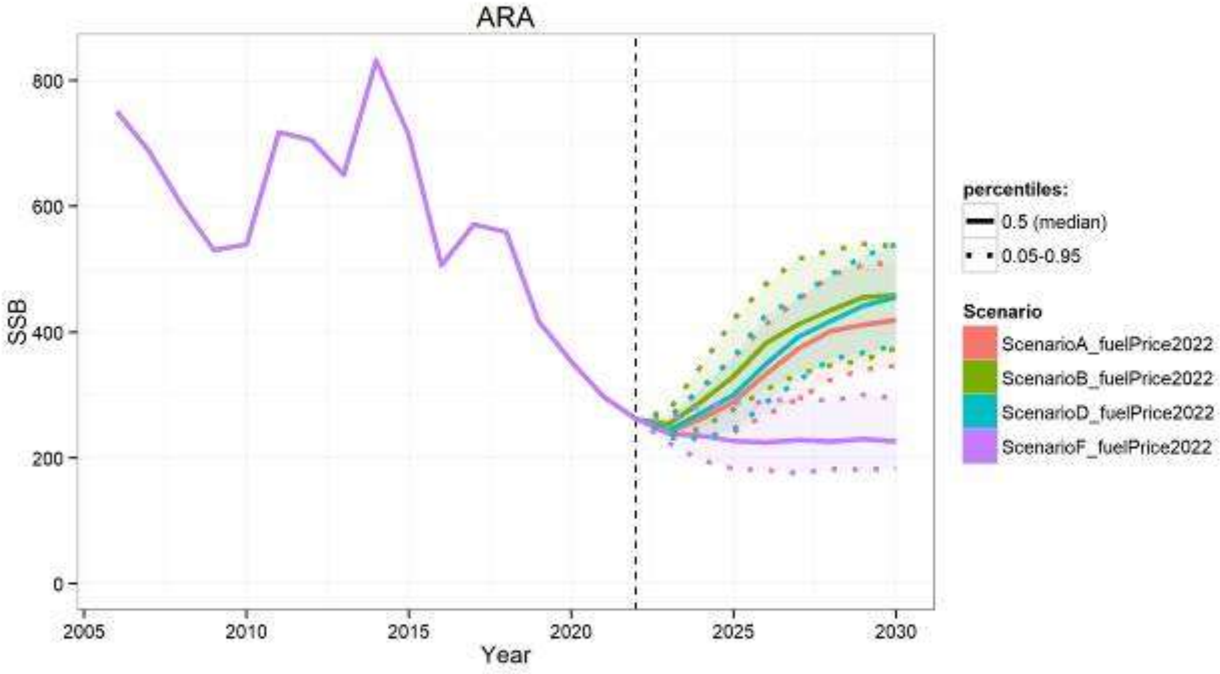
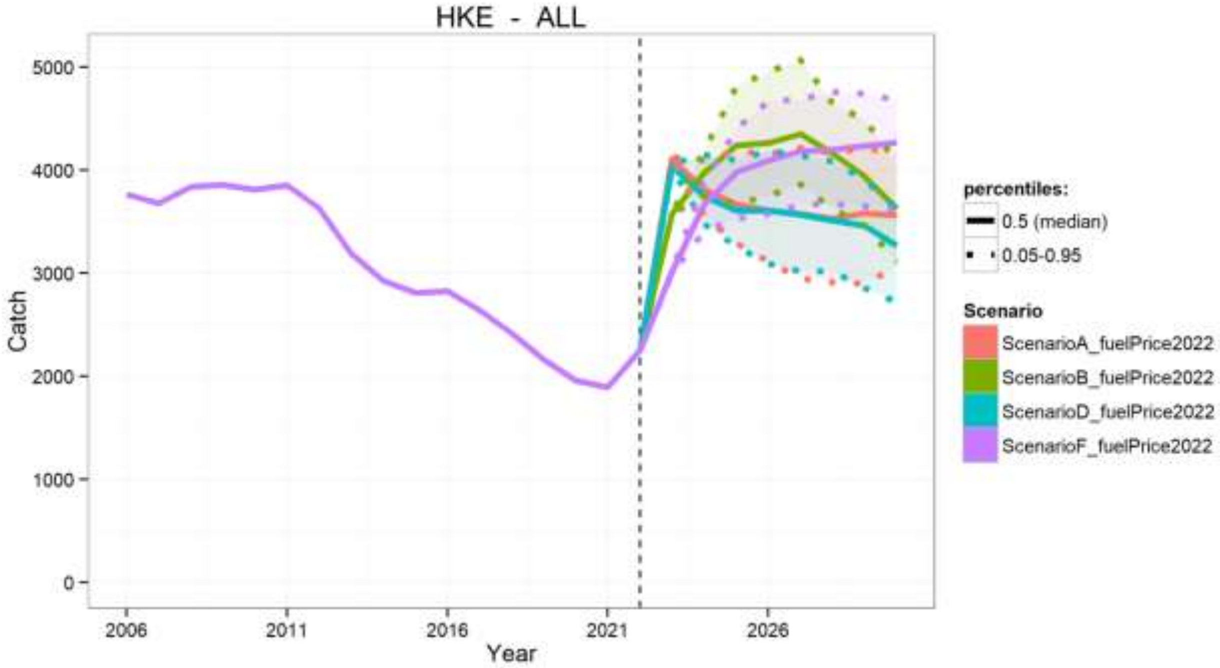
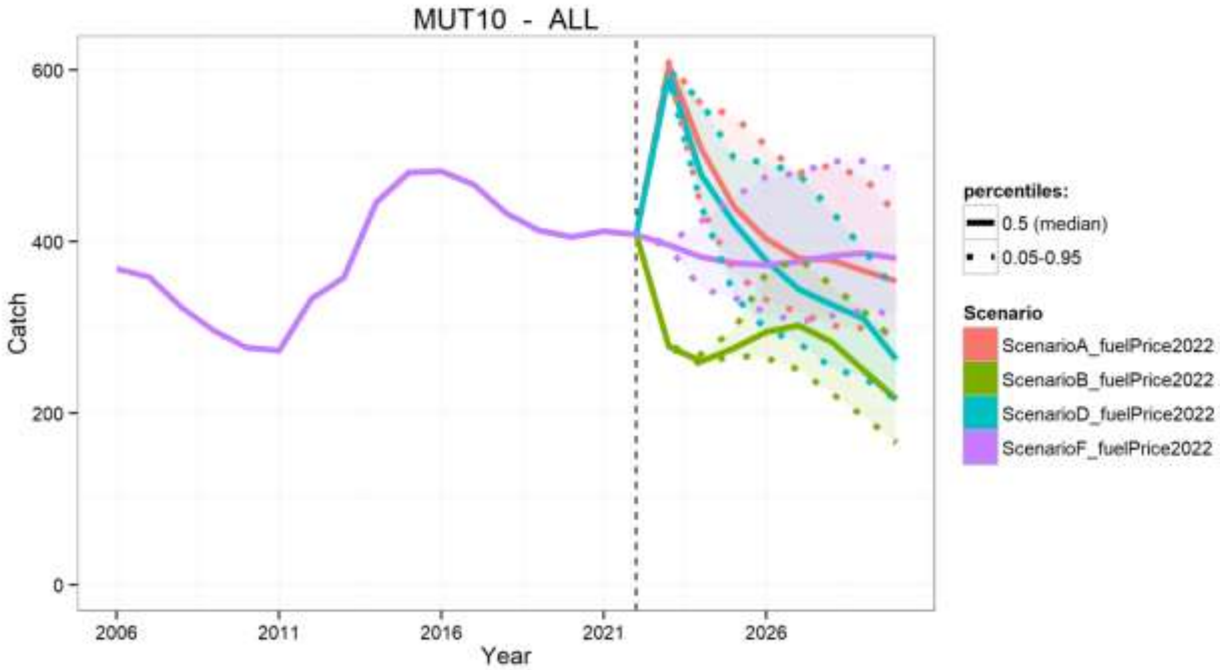
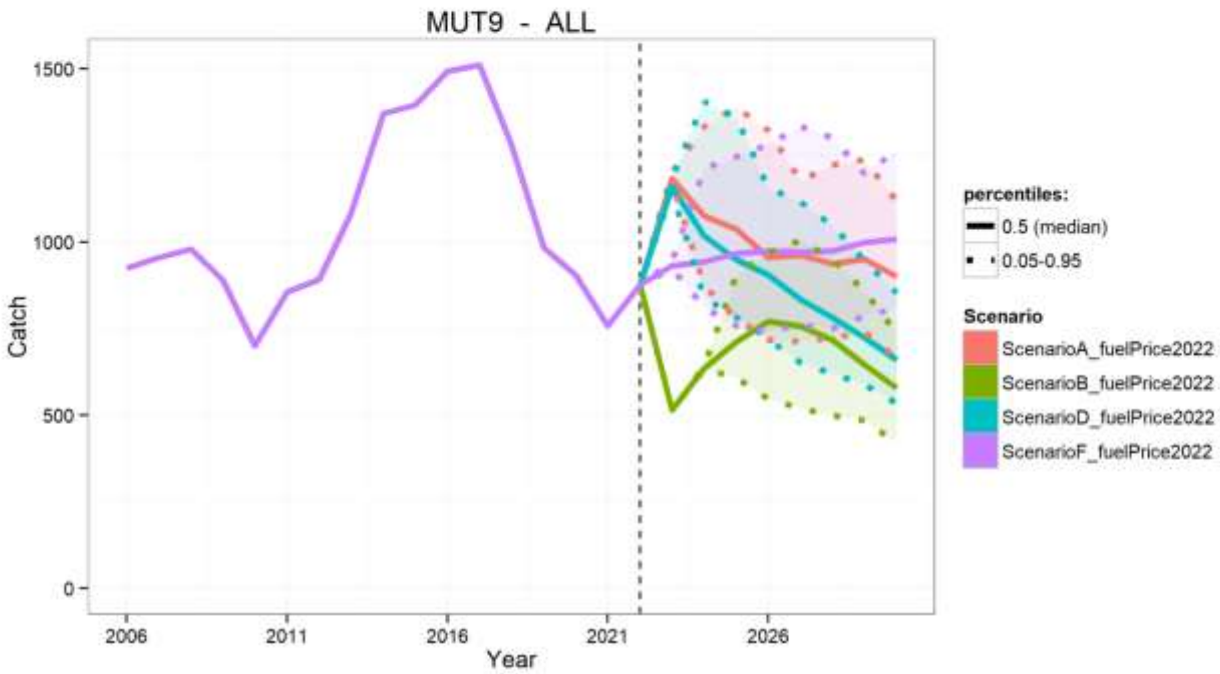
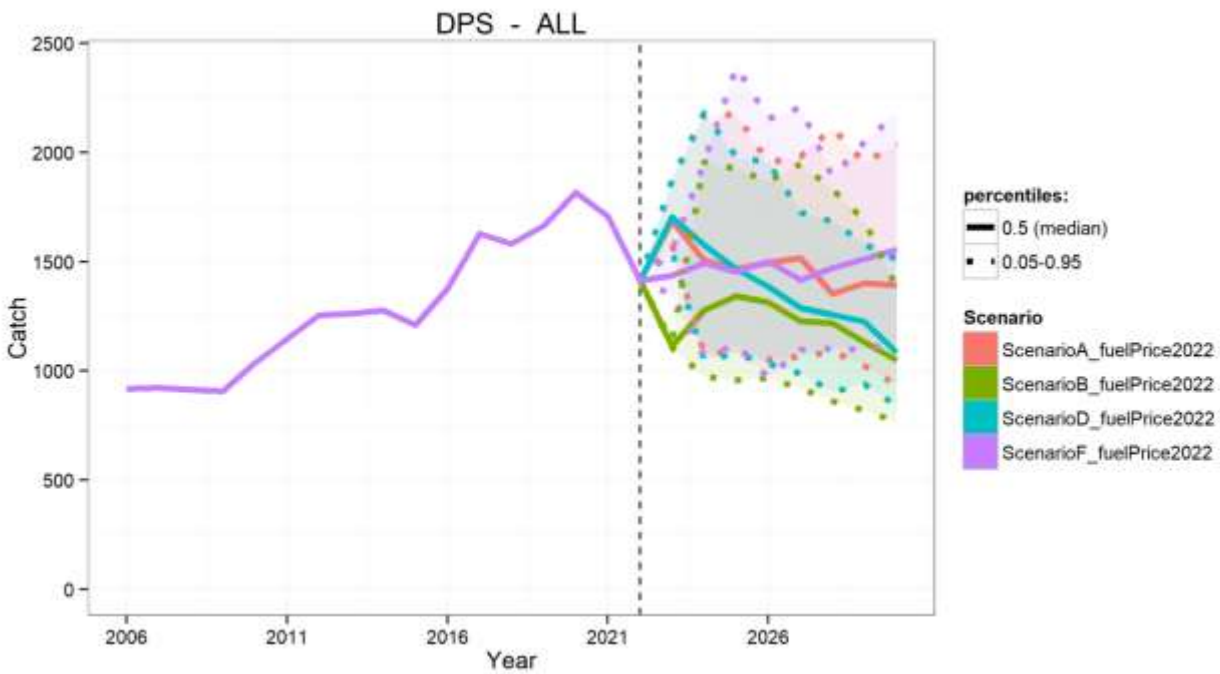


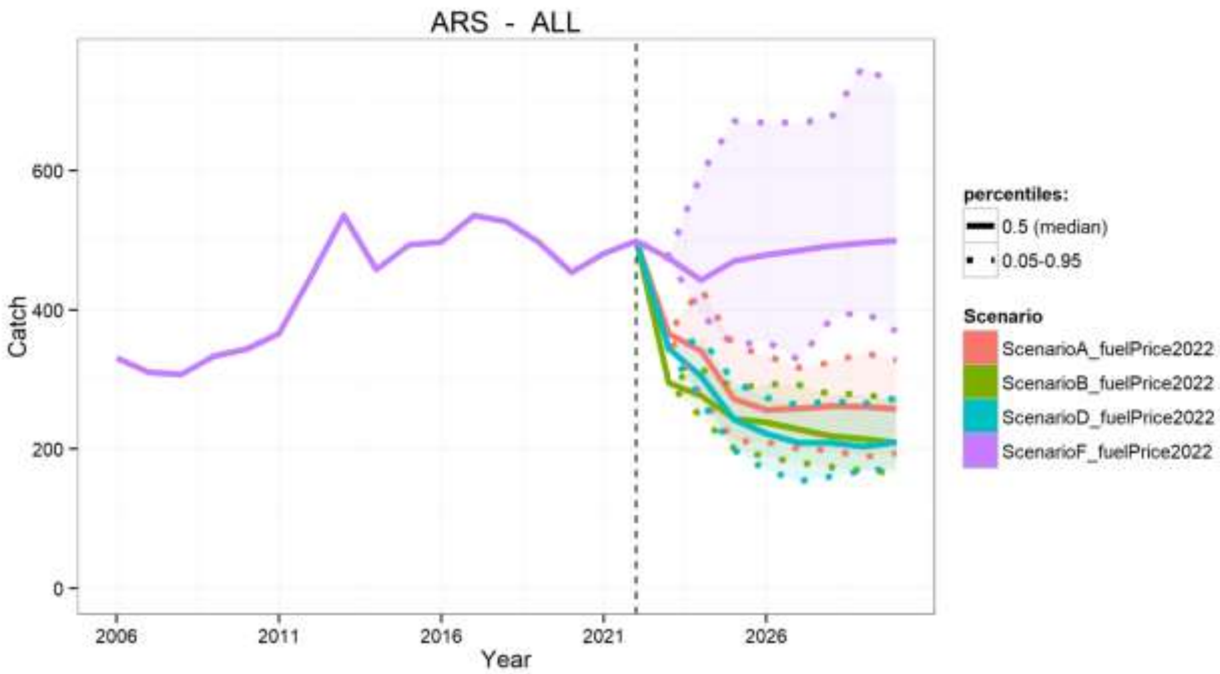
Figure 6.1.2.1.2– BEMTOOL. Trajectories of the SSB (in tons) for the seven stocks in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios. Solid lines correspond to medians, while shaded area correspond to interquantile range between 5th and 95th quantiles, indicated by the dashed lines. The black dashed lines corresponds to 2022. Red horizontal line corresponds to Blim (when available) and green horizontal line corresponds to Bpa (when available).

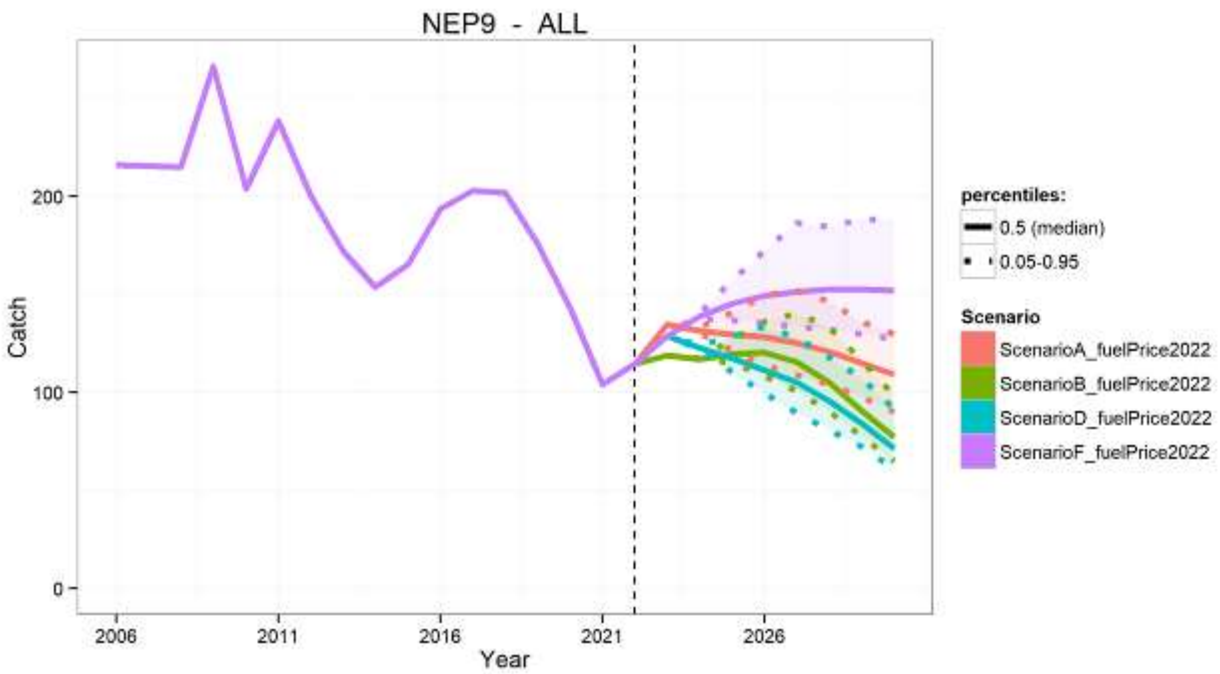

HKE - ALL
Catch
Year
0
1000
2000
3000
4000
5000
2006
2011
2016
2021
2026
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


MUT10 - ALL
Catch
Year
0
200
400
600
2006
2011
2016
2021
2026
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


MUT9 - ALL
1500
1000
500
0
Catch
2006
2011
2016
2021
2026
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


DPS - ALL
2500
2000
1500
1000
500
0
Catch
2006
2011
2016
2021
2026
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


ARS - ALL
Catch
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022


NEP9 - ALL
Catch
Year
percentiles:
0.5 (median)
0.05-0.95
Scenario
ScenarioA_fuelPrice2022
ScenarioB_fuelPrice2022
ScenarioD_fuelPrice2022
ScenarioF_fuelPrice2022

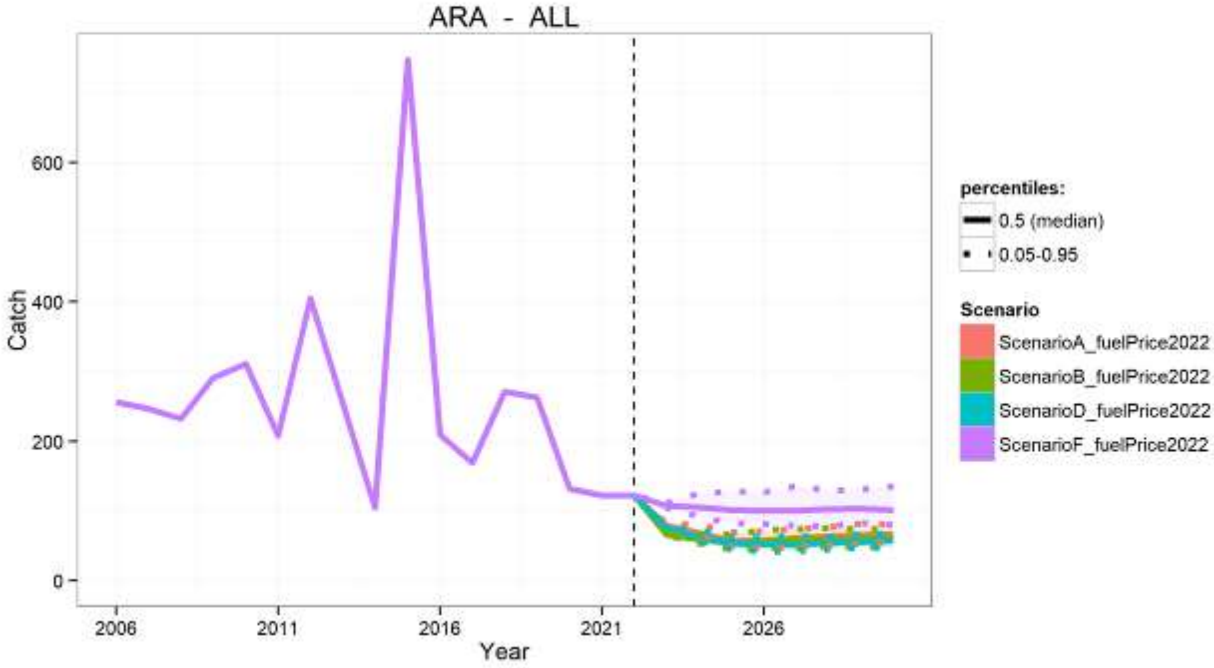


Figure 6.1.2.1.3– BEMTOOL. Trajectories of catches (tons) for the seven stocks in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios. Solid lines correspond to medians, while shaded area correspond to interquantile range between 5th and 95th quantiles, indicated by the dashed lines. The black dashed lines corresponds to 2022.

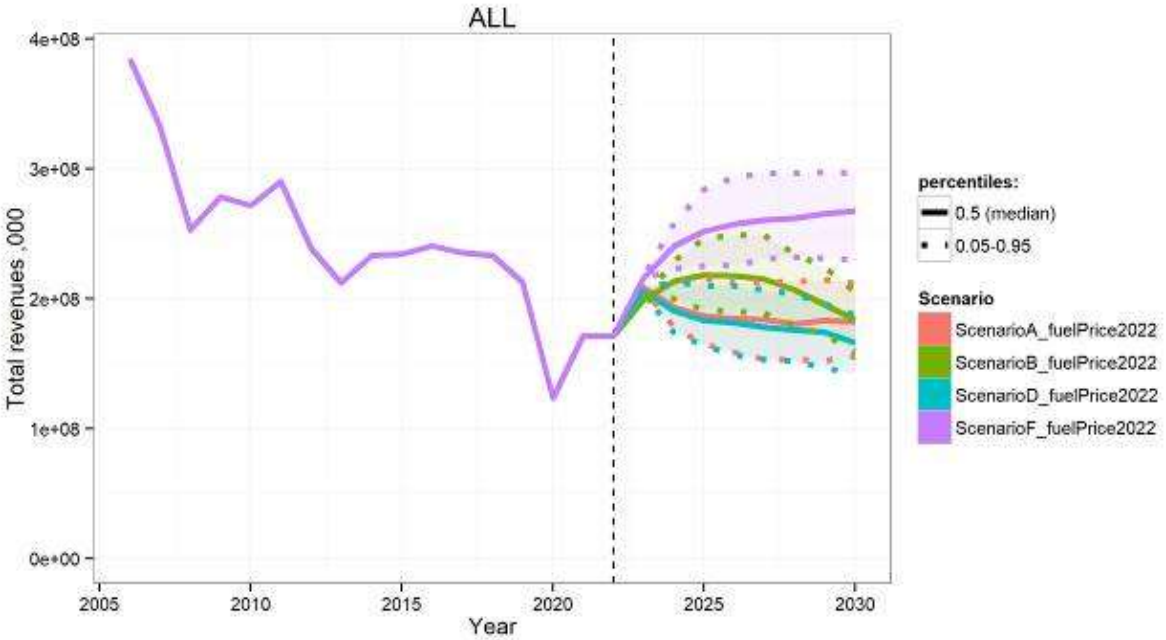


Figure 6.1.2.1.4– BEMTOOL. Trajectories of revenues (thousand Euro) for all fleets combined in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios. Solid lines correspond to medians, while shaded area correspond to interquantile range between 5th and 95th quantiles, indicated by the dashed lines. The black dashed lines corresponds to 2022.

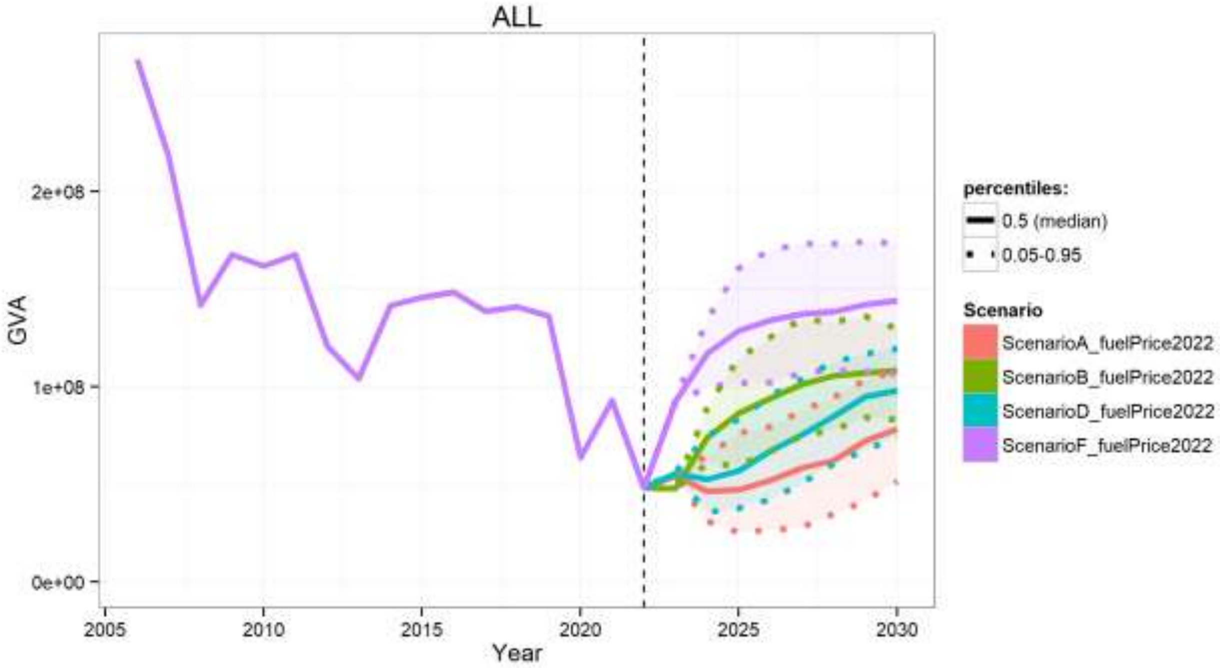


Figure 6.1.2.1.5– BEMTOOL. Trajectories of gross value added for all fleets combined in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios. Solid lines correspond to medians, while shaded area correspond to interquantile range between 5^th^ and 95^th^ quantiles, indicated by dashed lines. The black dashed lines corresponds to 2022.

Changes of the main indicators (F, SSB, Catches, Revenues and GVA) by fleet segment and scenarios are reported in the tables from 6.1.2.1.1 to 6.1.2.1.5. The scenarios more negatively impacting the revenues of all the trawlers fleet are scenarios B and D. The fleets of PGP benefit from the increase in trawlers selectivity of scenario B, showing changes in revenues of lesser extent respect to A and D.

Table 6.1.2.1.1. Changes (in percentage) of F of the seven stocks in the tested scenarios compared to the status quo scenario (F). This is referred to 2025.

Stock	F	A	B	D
ARA	0.49	-60%	-68%	-65%
ARS	0.81	-67%	-73%	-71%
DPS	1.51	14%	4%	1%
HKE	0.60	46%	21%	30%
MUT10	0.32	52%	-53%	36%
MUT9	0.46	24%	-28%	12%
NEP9	0.15	-16%	-27%	-24%

Table 6.1.2.1.2. Changes (in percentage) of the spawning stock biomass (SSB) of the seven stocks in the tested scenarios compared to the scenario SQ (F). This is referred to 2025 (SSB in baseline are reported in tons).

Stock	F	A	B	D
ARA	289	14.2%	4.0%	-21.3%
ARS	778	17.7%	2.2%	-39.7%
DPS	663	93.2%	14.6%	27.1%
HKE	4887	25.7%	7.1%	53.7%
MUT10	864	82.7%	5.6%	35.8%
MUT9	1722	73.0%	2.3%	19.3%
NEP9	851	4.4%	1.7%	-0.7%

Table 6.1.2.1.3. Changes (in percentage) of the catches of the seven stocks by fleet groups (DTS and PGP) in the tested scenarios compared to the status quo scenario (F). This is referred to 2025 (the catches in baseline are reported in tons).

DTS	F	A	B	D
ARA	101	-44%	-47%	-47%
ARS	471	-42%	-48%	-49%
DPS	1453	1%	-8%	2%
HKE	2317	-15%	-16%	-16%
MUT10	318	27%	-33%	22%
MUT9	939	7%	-29%	-1%
NEP9	145	-11%	-18%	-19%
PGP	**F**	**A**	**B**	**D**
HKE	1666	2%	37%	0%
MUT10	57	-35%	12%	-40%
MUT9	28	-9%	61%	-13%

Table 6.1.2.1.4. Changes (in percentage) of the revenues of the seven stocks by fleet groups (DTS and PGP) in the tested scenarios compared to the status quo scenario (F). This is referred to 2025.

DTS Fleet	F	A	B	D
GSA10_DTS_VL0612	136097	-50%	-65%	-52%
GSA10_DTS_VL1218	3582127	-17%	-24%	-19%
GSA10_DTS_VL1824	4690986	-28%	-26%	-31%
GSA10_DTS_VL2440	470174	-45%	-44%	-48%
GSA11_DTS_VL0612	87487	-18%	-15%	-18%
GSA11_DTS_VL1218	1223692	-47%	-49%	-49%
GSA11_DTS_VL1824	1900473	-50%	-53%	-52%
GSA11_DTS_VL2440	2069064	-27%	-30%	-42%
GSA9_DTS_VL0612	534696	-39%	-45%	-36%
GSA9_DTS_VL1218	8792451	-21%	-25%	-25%
GSA9_DTS_VL1824	14554952	-22%	-19%	-24%
GSA9_DTS_VL2440	1735815	-16%	-13%	-18%

DTS Fleet	F	A	B	D
PGP Fleet	**F**	**A**	**B**	**D**
GSA10_PGP_VL0012	8955486	-36%	-18%	-37%
GSA10_PGP_VL1218	28798	-100%	-100%	-100%
GSA11_PGP_VL0012	211184	-38%	-21%	-38%
GSA11_PGP_VL1218	62916	4%	30%	2%
GSA9_PGP_VL0012	3952231	-21%	1%	-21%
GSA9_PGP_VL1218	1427344	-28%	-10%	-29%

Table 6.1.2.1.5. Changes in GVA of the by fleet groups (DTS and PGP) in the tested scenarios compared to the status quo scenario (F). This is referred to 2025.

DTS Fleet	F (SQ)	A	B	D
GSA10_DTS_VL0612	213 712	77 998	21 639	84 027
GSA10_DTS_VL1218	425 573	-1 416 784	-1 686 447	-763 708
GSA10_DTS_VL1824	110 745	-4 800 719	-3 913 531	-3 889 377
GSA10_DTS_VL2440	357 106	-730 392	-636 216	-643 503
GSA11_DTS_VL0012	359 705	161 956	199 651	205 311
GSA11_DTS_VL1218	-1 418 032	-3 079 824	-2 685 735	-2 381 282
GSA11_DTS_VL1824	-3 668 549	-5 411 575	-5 035 149	-4 601 940
GSA11_DTS_VL2440	-3 557 533	-6 164 666	-5 963 931	-5 993 060
GSA9_DTS_1824	917 463	440 010	310 926	499 231
GSA9_DTS_VL0612	4 567 979	989 306	957 685	1 898 678
GSA9_DTS_VL1218	9 502 823	1 572 080	3 774 871	3 567 196
GSA9_DTS_VL2440	1 255 161	896 238	1 080 916	1 033 305
PGP Fleet	**F (SQ)**	**A**	**B**	**D**
GSA10_PGP_VL0012	42 250 873	22 465 547	34 608 328	23 453 596
GSA10_PGP_VL1218	480 625	-4 956 058	-4 433 492	-4 433 492
GSA11_PGP_VL0012	41 495 840	28 257 772	40 878 210	29 268 356
GSA11_PGP_VL1218	6 892 079	4 287 783	6 112 104	4 418 139
GSA9_PGP_VL0012	26 235 162	13 587 787	20 399 054	14 089 108
GSA9_PGP_VL1218	2 219 814	916 667	2 413 707	1 182 716

A dependency analysis by GSA, to understand the contribution of the target species to the total landings and revenues was conducted in the EWG 1901. Data of FDI of 2020 confirm that the target species of the MAP represent in EMU2 45% in volume and 56% in value, compared to the total landing. Generally these species are on the top of the list. Other important species of the trawl fisheries in EMU2 for both landing volume and value are: *Octopus vulgaris, Eledone cirrhosa, Mullus surmuletus and Penaeus keraturus*. Considering these species, the pool of the main ones would be around 59% in volume and 72% in value. Usually these species are not assessed in the Working Groups, for time constraints and for the assessment framework applied so far.

Table 6.1.2.1.6. Summary of BEMTOOL results in EMU2: Estimated level of F for target species in 2023, 2025 and 2030. Estimated % landings of target species change in 2020-2023, 2020-2025 and 2020-2030.

Scenarios	MS	Estimated level of F for target species in 2023	Estimated level of F for target species in 2025	Estimated level of F for target species in 2030	Estimated % landings of target species change 2020-2023	Estimated % landings of target species change 2020-2025	Estimated % landings of target species change 2020-2030
A	**ARA**	0.34	0.19	0.14	-39.6	-56.7	-49.7
	ARS	0.57	0.27	0.17	-19.4	-40.0	-43.2
	DPS	1.98	1.71	1.19	-11.0	-24.0	-26.0
	HKE	0.98	0.88	0.62	107.2	84.7	80.9
	MUT10	0.52	0.49	0.35	49.4	8.7	-12.8
	MUT9	0.61	0.57	0.40	37.4	21.2	4.5
	NEP9	0.15	0.13	0.09	-6.0	-9.5	-23.6
B	**ARA**	0.28	0.16	0.11	-50.2	-58.9	-52.9
	ARS	0.46	0.22	0.13	-35.0	-46.4	-54.0
	DPS	1.84	1.56	0.80	-33.7	-19.9	-37.3
	HKE	0.86	0.73	0.35	85.1	119.3	87.4
	MUT10	0.17	0.15	0.07	-31.2	-31.7	-46.6
	MUT9	0.37	0.33	0.17	-36.1	-11.7	-28.2
	NEP9	0.13	0.11	0.06	-17.0	-16.3	-46.0
D	**ARA**	0.32	0.17	0.11	-42.8	-59.5	-56.1
	ARS	0.52	0.24	0.13	-24.1	-46.5	-53.8
	DPS	1.91	1.53	0.71	-10.6	-22.5	-40.9
	HKE	0.95	0.79	0.36	103.6	82.2	66.8
	MUT10	0.50	0.44	0.20	46.7	4.0	-35.3
	MUT9	0.60	0.51	0.24	34.8	8.9	-22.3
	NEP9	0.14	0.11	0.05	-9.9	-17.9	-50.0
F	**ARA**	0.49	0.49	0.49	-18.4	-23.0	-23.0
	ARS	0.81	0.81	0.81	4.5	3.7	10.1
	DPS	1.51	1.51	1.51	-23.2	-22.3	-15.8
	HKE	0.60	0.60	0.60	52.3	102.5	117.2
	MUT10	0.32	0.32	0.32	-2.2	-7.5	-6.0
	MUT9	0.46	0.46	0.46	8.8	13.4	17.0
	NEP9	0.15	0.15	0.15	-9.9	1.6	6.3

Table 6.1.2.1.7. Summary of BEMTOOL results in EMU2: Estimated level of profitability (in terms of gross value added) in 2023, 2025 and 2030. Estimated % profitability of target species change in 2020-2025 and 2020-2030. Results corresponding to the whole fleet (DTS and PGP fleet segments) in the hypothesis of fuel price as in 2022.

Scenarios	Estimated level of profitability (gross value added) in 2023	Estimated level of profitability (gross value added) in 2025	Estimated level of profitability (gross value added) in 2030	Estimated % gross value added 2020-2025	Estimated % gross value added 2020-2030
A	54 302 864	47 093 129	78 458 400	-26.2	22.9
B	47 854 508	86 402 589	108 376 790	35.4	69.8
D	55 426 045	56 993 300	98 095 070	-10.7	53.7
F	92 358 822	128 640 547	144 124 276	101.5	125.8

6.1.3 ISIS-Fish in EMU 1

Due to time constraints no scenarios were run during EWG 22-11.

6.1.4 SMART in EMU 2

6.1.4.1 Simulated scenarios

The SMART model is devised to estimate the potential effect of whatever management actions (including reduction of fishing capacity, effort, spatial closures, TAC or selectivity changes). The SMART model was used to assess the potential effect of the series of scenarios listed in the following table, without taking account of the longliner and netter effort reduction (highlighted in orange).

Scenario	Trawler effort reduction**	Longliner effort reduction**	Netter effort reduction**	Combined catch limits for ARA and ARS	Spatio-temporal closures*	Selectivity measures	Reduction in trawler number
A (-5%)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% onwards: -5% (until MSY is reached)	2023: -5% 2024: -5% 2025: MSY level	Same as in 2020-2021	∅	2023: -5% 2024: -5%
B (-7,5%)	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	2023: -7,5% 2024: -7,5%	Same as in 2020-2021	2023: 50% of all 3 MS fleet with more selective gear (45mm square mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of all 3 MS fleet with more selective gear	2023: -5% 2024: -5%
C (-10%)	2023: -10% 2024: -6,5%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	2023: -10% 2024: -10%	Same as in 2020-2021	∅	2023: -5% 2024: -5%
D (MS-specific)	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Annual -8% effort reduction in Italy	Catch limits transition path to MSY calculated by EWG 22-09	Same as in 2020-2021	2023: 50% of Spanish fleet with more selective gear (45mm square	*** (see above)

						mesh for coastal fleet and 50mm square mesh for deep-water fleet) 2024: 100% of Spanish fleet with more selective gear	
E (All-in)	2023: -16,5% 2024: ∅	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	2023: proportional to partial fishing mortality by gear (see EWG 21-01)	Catch limits transition path to MSY calculated by EWG 22-09	2023: permanent closure areas	∅	***
F (Status quo)	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	2023: ∅ 2024: ∅	Same as in 2020-2021	∅	∅

The simulations of this EWG including the activation of the restriction of fishing activities have been conducted using the FRA network (Fig. 6.1.4.1.1) currently required by the regulation in Italy. In particular, some specific FRAs are present: off the coasts of Argentario promontory, GSA 9 (50 km^2, from 160 to 220 m depth); in the Gulf of Gaeta, Lazio, GSA 10 (125 km^2 from 100 to 200 m depth); in GSA 11, there are three FRAs closed to trawling according to specific Regional legislations in the Gulf of Cagliari, the Gulf of Palmas and the Gulf of Oristano.

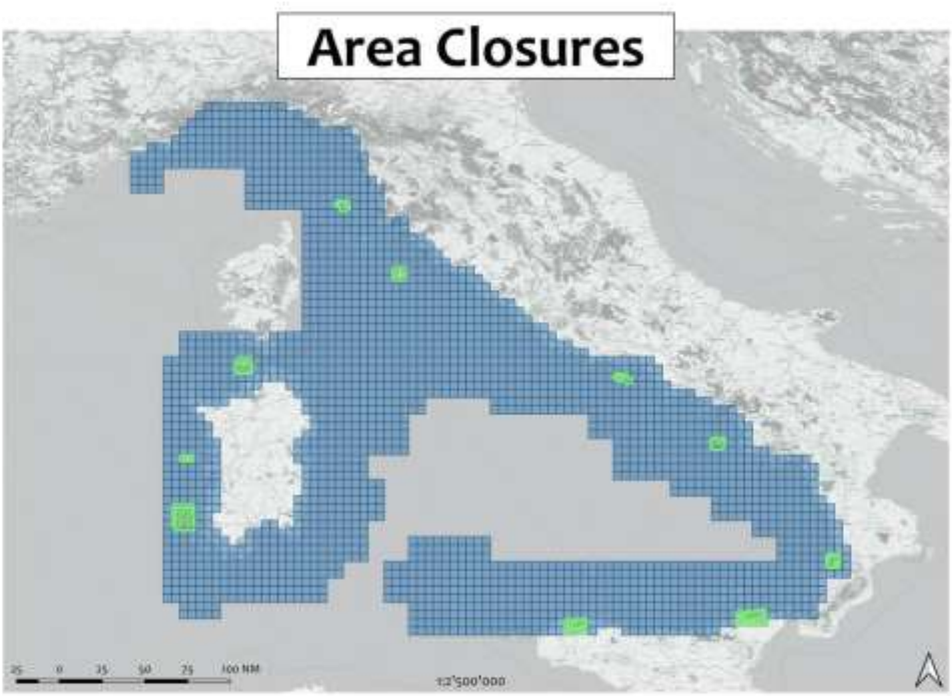


Figure 6.1.4.1.1. - Representation of the grid used for the SMART model in EMU2 with the closure areas implemented by the Italian Ministry (in green).

All the scenarios listed above were simulated twice, using two values for fuel price: the actual fuel price and a potentially higher value (expected under the present geopolitical situation) of 1.16 Euros/liter (120% of the actual value). It is very important to emphasize that the set of scenarios corresponding to the increased fuel price (120%) were simulated under the assumption that the market price of resources is constant (i.e. identical to that considered in the scenarios with current fuel prices). Therefore, given the characteristics of SMART, this leads to a considerable increase in costs related to fishing activities without a corresponding increase in revenues.

In the SMART modelling approach, the effort displacement resulting from the scenario simulation is obtained according to an individual based optimization of the observed pattern of effort of each fishing vessel following a strategy of profit maximization (Fig. 6.1.4.1.2).

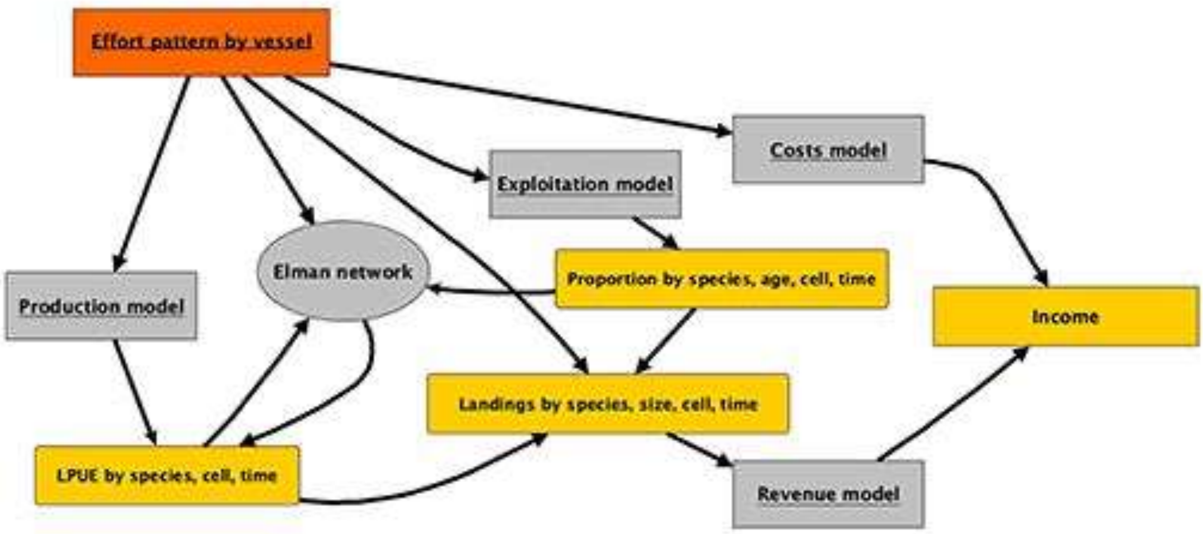


Figure 6.1.4.1.2. - Workflow of the Individual-Based Model used to optimize the effort pattern of each vessel

6.1.4.2 Results

Five scenarios (in addition to the status quo - scenario F - which was used as reference) between the ones listed in the ToRs were implemented:

- Scenario A: annual trawler effort reduction of 5% (until FMSY is reached), catch limit for ARS of 5% in 2023, 5% in 2024 and MSY level in 2025, spatio-temporal closure of 2020-2021 and reduction of trawler number of 5% in 2023 and 5% in 2024;
- Scenario B: annual trawler effort reduction of 7.5% in 2023 and 7.5% in 2024, combined catch limit for ARS of 7.5% in 2023 and 7.5% 2024, spatio-temporal closure of 2020-2021 and reduction of trawler number if 5% in 2023 and 5% in 2024, change in selectivity of all the fleet (50 mm square mesh);
- Scenario C: annual trawler effort reduction of 10% in 2023 and of 6.5% in 2024, combined catch limit for ARS of 10% in 2023 and 10% 2024, spatio-temporal closure of 2020-2021 and reduction of trawler number if 5% in 2023 and 5% in 2024;
- Scenario D: annual trawler effort reduction of 8% (until FMSY is reached), combined catch limit for ARS according to transition path calculated by EWG 22-09, spatio-temporal closure of 2020-2021 and reduction of trawler number (125 vessels between 2023 and 2027);
- Scenario E: annual trawler effort reduction of 16.5% in 2023 and unchanged in 2024, combined catch limit for ARS according to transition path calculated by EWG 22-09, permanent closure areas in 2023 and reduction of trawler number (125 vessels between 2023 and 2027);

For all scenarios, the fishing days reductions were calculated using as reference the average 2015-2017, corresponding to a value higher than that observed during the year 2022. The maximum catch limit by year was estimated for each species in order to have a gradual reduction from the maximum catch limit in the EU Reg 2022/110 and the catch associated to F_{MSY} as estimated by EWG 22-09.

Fig. 6.1.4.2.1 and Table 6.1.4.2.1 show the % of change of landings by species (in 2025) with respect to the Status quo (scenario F).

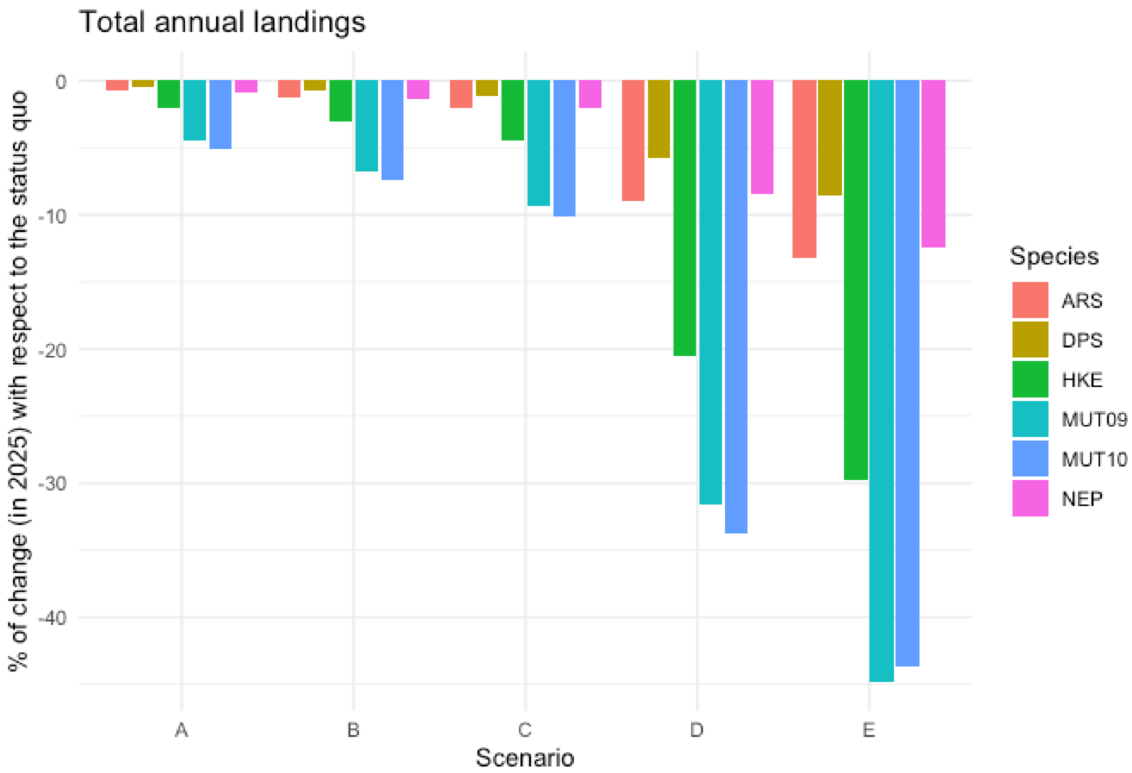


Figure 6.1.4.2.1. - Estimated % landings of target species change 2020-2025

The largest reductions in landings are expected in the mullet stock, followed by hake and crustacean species. As was to be expected, the reductions are progressively more in the sequence of scenarios A to E.

Table 6.1.4.2.1. - Estimated % landings of target species change 2020-2025

Scenario	ARS	DPS	HKE	MUT09	MUT10	NEP
A	-0.76	-0.46	-1.98	-4.4	-5.07	-0.88
B	-1.22	-0.68	-3.08	-6.8	-7.42	-1.38
C	-2.04	-1.08	-4.4	-9.32	-10.09	-2.02
D	-8.94	-5.7	-20.5	-31.56	-33.73	-8.5

E	-13.16	-8.62	-29.76	-44.76	-43.63	-12.46

The corresponding % values of change in the fishing mortality by species (in 2025) with respect to the Status quo (scenario F) are shown in Figure 6.1.4.2.2 and Table 6.1.4.2.2.

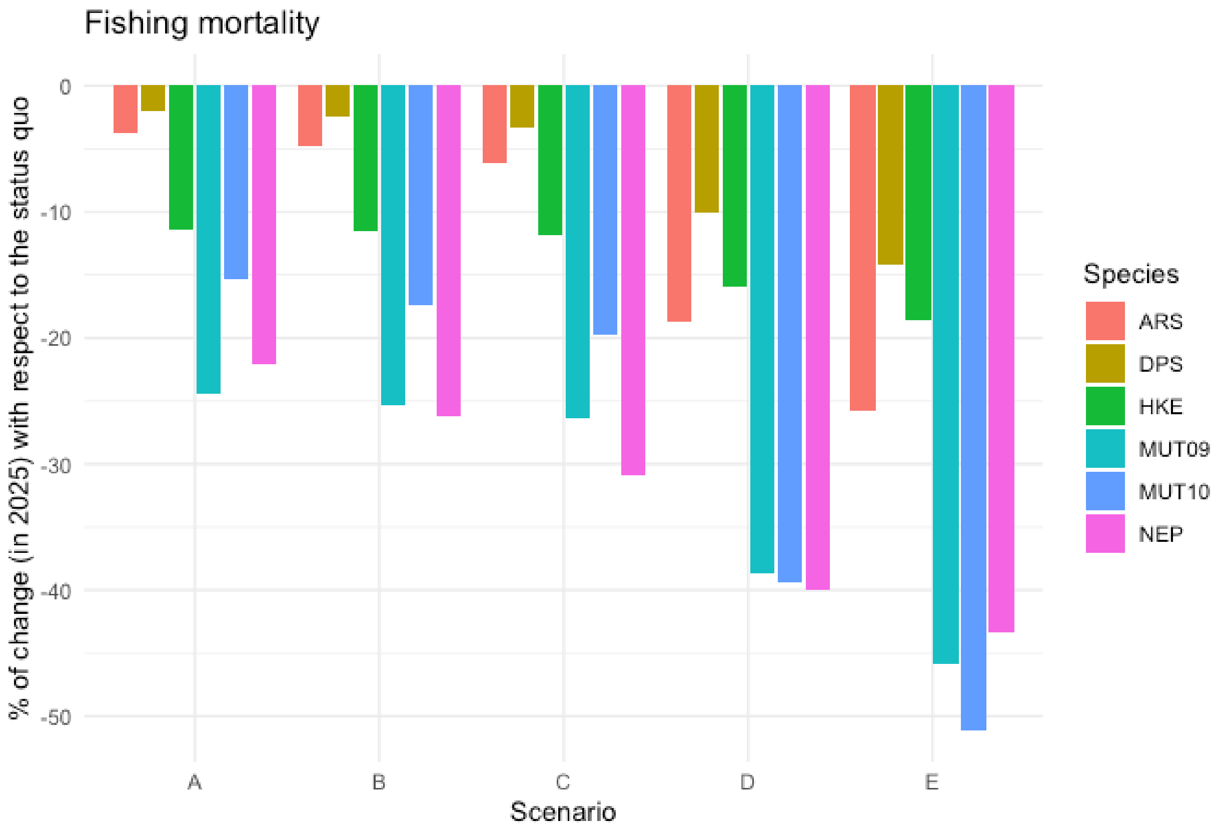


Figure 6.1.4.2.2- Estimated level of F for target species in 2025

The largest variations in fishing mortality are observed for the 2 stocks of MUT, followed by NEP and HKE. The smallest reductions are observed for deep water rose shrimp.

Table 6.1.4.2.2- Estimated level of F for target species in 2025

Scenario	ARS	DPS	HKE	MUT09	MUT10	NEP
A	-3.81	-2.00	-11.32	-24.44	-15.33	-22.12
B	-4.83	-2.45	-11.51	-25.29	-17.45	-26.19
C	-6.08	-3.26	-11.87	-26.31	-19.68	-30.82
D	-18.74	-10.08	-15.99	-38.72	-39.38	-40.00

E	-25.78	-14.25	-18.59	-45.86	-51.07	-43.33

Finally, the % changes of SSB in 2025 with respect to the status quo (scenario F) are represented in Fig 6.1.4.2.3 and Table 6.1.4.2.3. The most 'aggressive' scenarios (D and E) have a strong effect, in terms of SSB growth, on almost all stocks and especially on mullets and ARS. Scenarios A, B and C have a more balanced positive effect. In each case, the least reactive species is HKE.

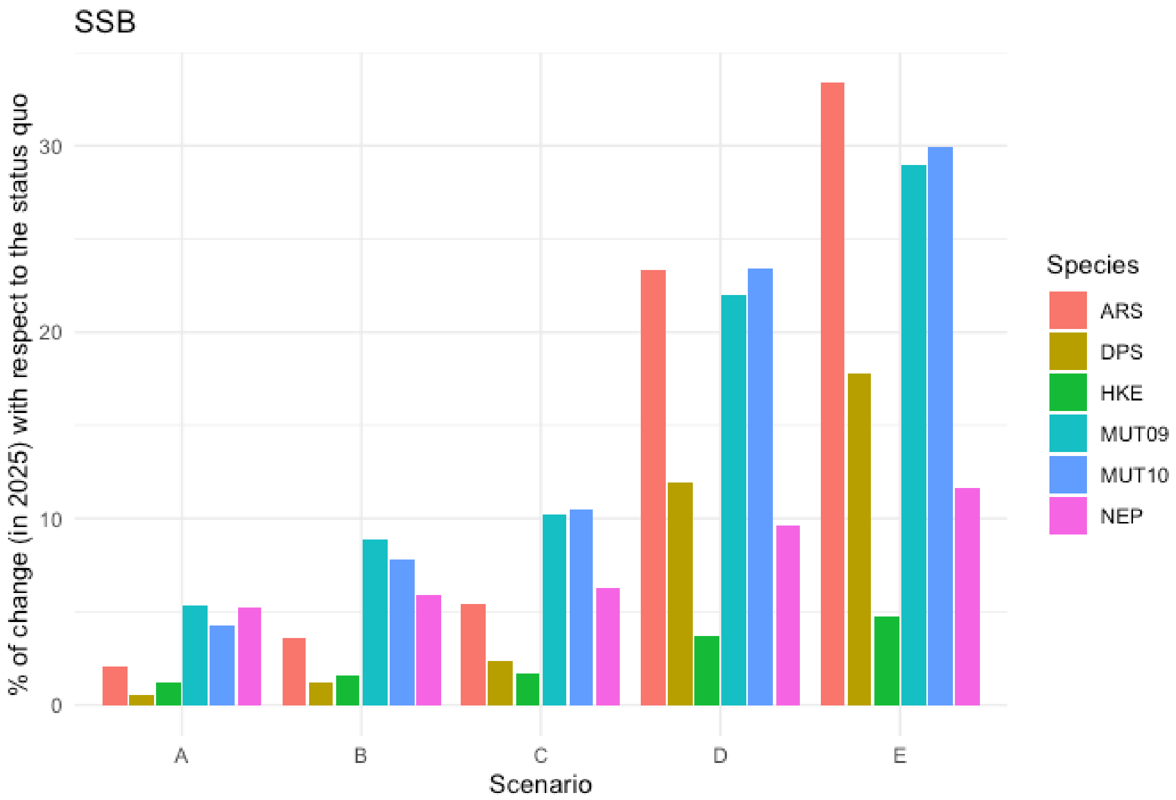


Figure 6.1.4.2.3 - Estimated % change of SSB for target species in 2025

Table 6.1.4.2.3 - Estimated % change of SSB for target species in 2025

Scenario	ARS	DPS	HKE	MUT09	MUT10	NEP
A	2.08	0.57	1.20	5.30	4.30	5.20
B	3.62	1.24	1.57	8.90	7.82	5.92
C	5.42	2.37	1.73	10.24	10.48	6.25
D	23.32	11.94	3.66	22.03	23.39	9.62

E	33.35	17.80	4.77	29.02	29.96	11.68

Table 6.1.4.2.4 – Summary of results expressed in F in 2023, % of landings change between 2023 and 2020, % GPI between 2025 and 2020.

Scenarios	MS	Estimated level of F for target species in 2023	Estimated % landings of target species change 2020-2023	Estimated % Gross profit margin 2020-2025, resp. 2030
A	**IT**	ARS 1.01 DPS 1.57 HKE 0.49 MUT09 0.36 MUT10 0.30 NEP 0.12	ARS -0.76 DPS -0.46 HKE -1.98 MUT09 -4.4 MUT10 -5.07 NEP -0.88	-1.94%
B	**IT**	ARS 1.00 DPS 1.56 HKE 0.49 MUT09 0.36 MUT10 0.29 NEP 0.11	ARS -1.22 DPS -0.68 HKE -3.08 MUT09 -6.8 MUT10 -7.42 NEP -1.38	-2.98%
C	**IT**	ARS 0.99 DPS 1.55 HKE 0.48 MUT09 0.35 MUT10 0.28 NEP 0.10	ARS -2.04 DPS -1.08 HKE -4.4 MUT09 -9.32 MUT10 -10.09 NEP -2.02	-4.26%
D	**IT**	ARS 0.85 DPS 1.44 HKE 0.46 MUT09 0.29 MUT10 0.21 NEP 0.09	ARS -8.94 DPS -5.7 HKE -20.5 MUT09 -31.56 MUT10 -33.73 NEP -8.5	-17.16%

E	**IT**	ARS 0.78 DPS 1.37 HKE 0.45 MUT09 0.26 MUT10 0.17 NEP 0.09	ARS -13.16 DPS -8.62 HKE -29.76 MUT09 -44.76 MUT10 -43.63 NEP -12.46	-24.34%

6.2 Scenarios accounting for an additional fuel price increase after 2022

6.2.1 IAM in EMU 1

Given the current uncertainty on fuel prices and its impact on the socio-economic results, it was requested in the TOR of EWG 22-11 that each scenario should be run with 2 fuel options: 1) fuel price in 2023 onwards = average price of fuel in 2022 and 2) fuel price in 2023 onwards = 120% of the average price of fuel in 2022.

Results presented in section 6.1.1.2 correspond to the results of the IAM model with "fuel option 1", i.e. fuel prices per fleet segment in 2023 and beyond equal to the fuel price in 2022 from the AER 2022 group projections (see section 6.1.1.1 for the prices per fleet segment)

The **"fuel option 2"** only has an **impact** on the economic indicators, for IAM in the EMU1, it therefore only concerns the **gross value added (GVA)**, where fuel costs are taken into account. Therefore, Figures 6.2.1.1 and 6.2.1.2 present respectively the total GVA per fleet and the average GVA per vessel per fleet with option 2 for the fuel price, i.e. with a 20% increase for each fleet compared to the estimated fuel price in 2022 from the AER projections. Table 6.2.1.1 reports the GVA per vessel in Euros in 2023, 2025 and 2030. Values are reported per fleet segment and scenario.

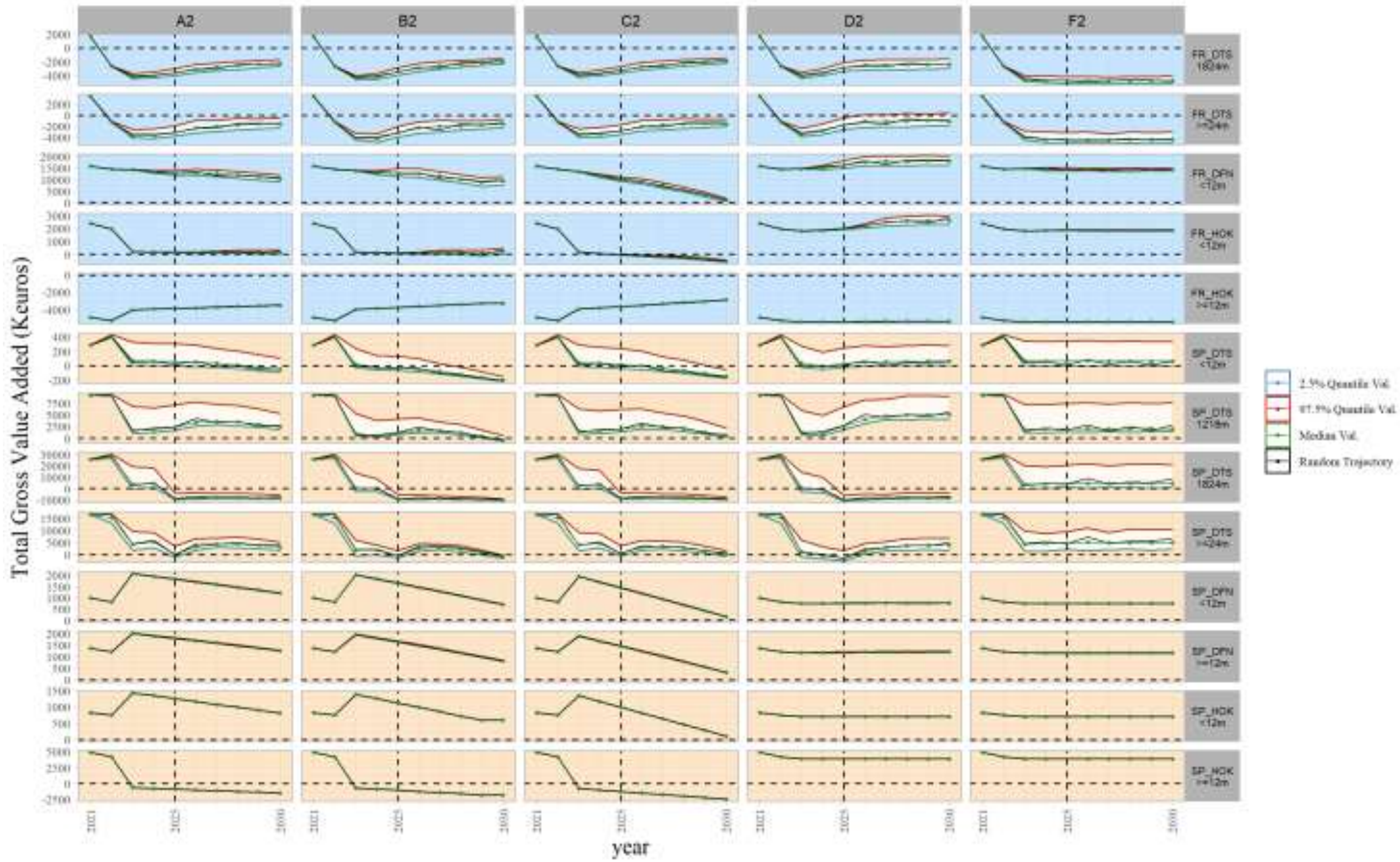


Figure 6.2.1.1. EMU 1 (IAM model). Evolution of the total Gross Value Added (GVA, i.e. proxy for the profit, in K euros) by fleet segment for each alternative management scenario from 2021 to 2030 under a "fuel option 2" scenario with 20% increase of fuel price. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m

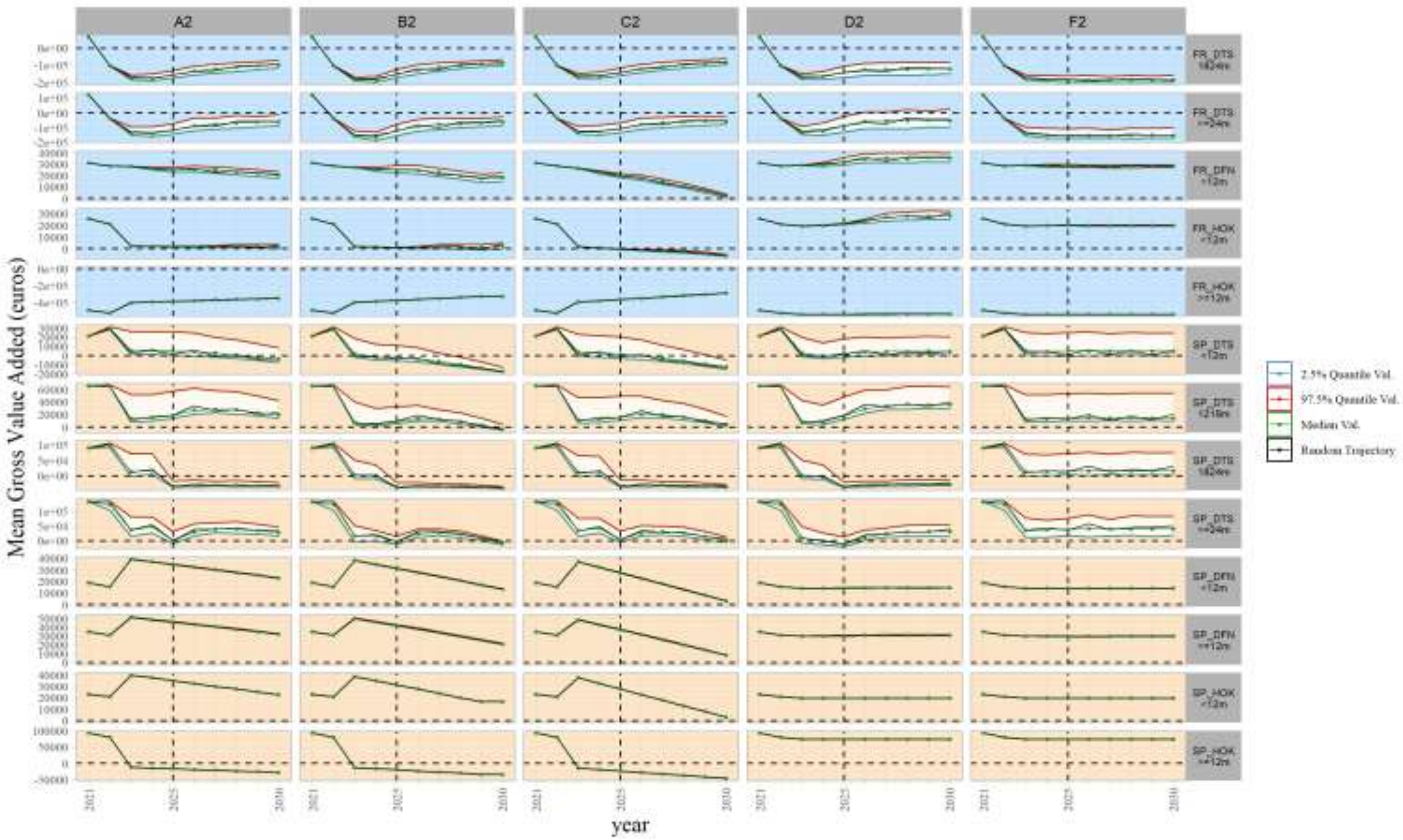


Figure 6.2.1.2. EMU1 (IAM model). Evolution of the average Gross Value Added (GVA, i.e. proxy for the profit, in K euros) per vessel by fleet segment for each alternative scenario from 2021 to 2030 under a "fuel option 2" scenario with 20% increase of fuel price. Vertical black lines indicate the year 2025. Scenarios are in column and fleet segment in row. The fleet segments are as follow (from top to bottom): French demersal trawlers 18-24m, French demersal trawlers >24m, French netters <12m, French vessels using hooks < 12m and >=12m, Spanish trawlers < 12m, Spanish trawlers 12-18m, Spanish trawlers 18-24m, Spanish trawlers >24m, Spanish netters < 12m and >=12m, and Spanish vessels using hooks <12m and >= 12m.

Table 6.2.1.1. EMU1 (IAM model). Average Gross Value Added (GVA) per vessel (in €) in 2023, in 2025 and in 2030 per fleet segment and by management scenario, under a "fuel scenario" with an increase of 20% from estimated 2022 values in fuel price from 2023 and onwards. The median values are used.

		Scenario F2 (baseline, E=E 2022 regulation)	Scenario A2	Scenario B2	Scenario C2	Scenario D2
Mean GVA per vessel in 2023 (in €)	DTS_FRA_18-24m	-178400	-178100	-185500	-170100	-174600
	DTS_FRA_>=24m	-141700	-138900	-156900	-133500	-134400
	DFN_FRA_<12m	28800	27900	27100	26200	28900
	HOK_FRA_<12m	19400	2300	1900	1600	19400
	HOK_FRA_>=12m	-544400	-404000	-400200	-396500	-544400
	DTS_SP_inf12m	4800	5300	1600	3300	2300
	DTS_SP_1218m	13000	13400	7700	11500	9200
	DTS_SP_1824m	12300	12900	2300	10200	1300
	DTS_SP_sup24m	34900	36400	15500	34100	8700
	DFN_SP_<12m	14000	39200	38000	36700	14000
	DFN_SP_>=12m	29600	51200	49800	48300	29700
	HOK_SP_<12m	19700	39800	38500	37300	19700
	HOK_SP_>=12m	74500	-12000	-13200	-14400	74500
Mean GVA per vessel in 2025 (in €)	DTS_FRA_18-24m	-184000	-157500	-152300	-143000	-143000
	DTS_FRA_>=24m	-154400	-120000	-123600	-109300	-88200
	DFN_FRA_<12m	27900	24800	24800	19500	31700
	HOK_FRA_<12m	20000	1500	700	-400	21100
	HOK_FRA_>=12m	-544200	-388800	-377500	-366300	-543900
	DTS_SP_inf12m	4400	4700	-2600	1300	1800
	DTS_SP_1218m	13900	19100	9000	15800	18200
	DTS_SP_1824m	14400	-34000	-35800	-32200	-34700
	DTS_SP_sup24m	38400	1600	-3300	5200	-11200
	DFN_SP_<12m	14000	34500	31200	27300	14200
	DFN_SP_>=12m	29600	45700	42100	37000	30300
	HOK_SP_<12m	19700	34900	31200	27500	19700

	HOK_SP_>=12m	74500	-16700	-20300	-23800	74500
Mean GVA per vessel in 2023 (in €)	DTS_FRA_18-24m	-184700	-98400	-88200	-83700	-123500
	DTS_FRA_>=24m	-154200	-61800	-62200	-60000	-55200
	DFN_FRA_<12m	27900	20100	18300	2100	35100
	HOK_FRA_<12m	19900	1500	2200	-5800	28300
	HOK_FRA_>=12m	-544300	-350200	-330700	-290700	-542000
	DTS_SP_inf12m	4300	-4200	-17200	-12700	4200
	DTS_SP_1218m	14200	19400	-3200	4300	35900
	DTS_SP_1824m	15700	-33100	-39500	-36100	-27900
	DTS_SP_sup24m	39800	27300	-7900	2800	30700
	DFN_SP_<12m	14000	22800	13300	3100	14400
	DFN_SP_>=12m	29700	32200	21100	8300	30800
	HOK_SP_<12m	19700	22600	16500	3000	19700
	HOK_SP_>=12m	74500	-28500	-34400	-47400	74500

6.2.2 BEMTOOL in EMU2

The same scenarios described in the chapter 6.1.2 were implemented assuming an increase in fuel price of 20% from 2023 respect to the fuel price observed in 2022. This assumption affects the GVA as reported in Figures 6.2.2.1 and Table 6.2.2.1.

With respect to the scenarios assuming in the projections the same fuels price of 2022, these scenarios return a lower GVA; in particular, the difference between the best performing scenario, that is B, and the F (SQ) is smaller. Moreover, scenario A show a higher GVA than scenario D until 2027 and then a value slightly lower than scenario D; this is different from the results of scenarios assuming from 2023 the same fuel price of 2022, because A was always lower than D. This is due to the increase in fuel costs that impacts more importantly on the GVA, compared to the decrease in fixed costs imposed by scenario D. When the decrease in the number of vessels stops (in 2027 in scenario D), the balance between variable and fixed costs returns more similar to scenario A, although the GVA is slightly higher.

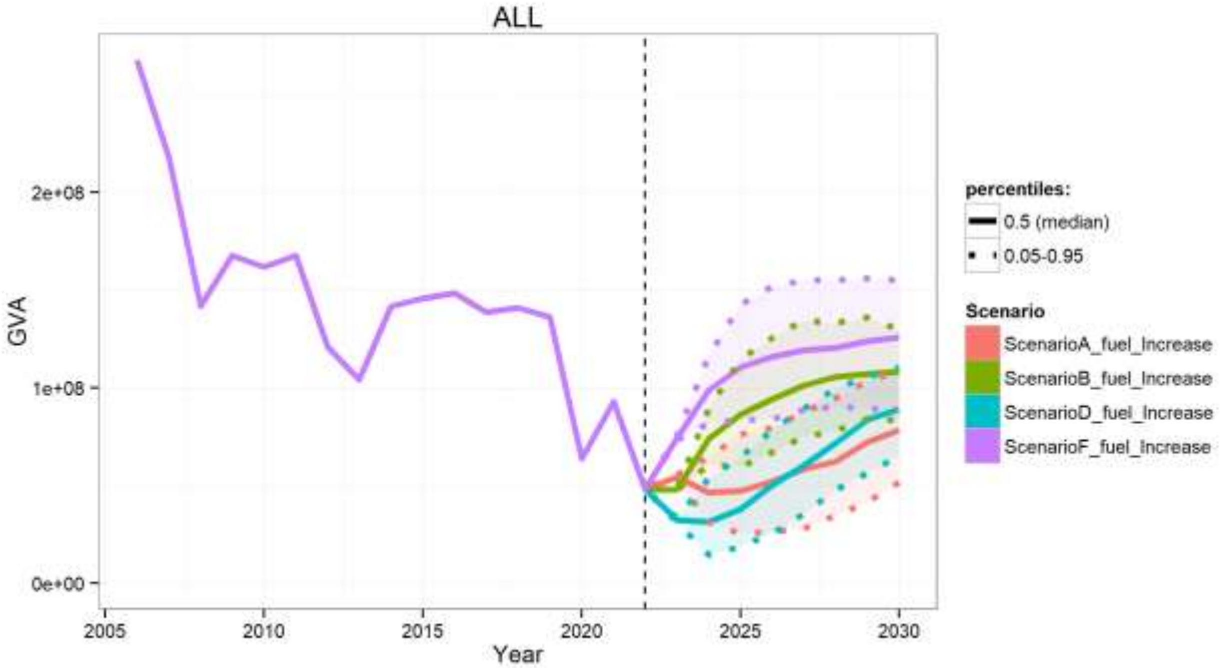


Figure 6.2.2.1 BEMTOOL. Trajectories of gross value added for all fleets combined in the hindcasting phase (until 2022) and in the forecast phase (after 2022) under the alternative scenarios accounting for an additional fuel price increase after 2022 of 20%. Solid lines correspond to medians, while shaded area correspond to interquantile range between 5th and 95th quantiles, indicated by dashed lines. The black dashed lines corresponds to 2022.

Table 6.2.2.1 Changes (in percentage) in GVA of the by fleet groups (DTS and PGP) in the tested scenarios compared to the status quo scenario (F) accounting for an additional fuel price increase after 2022 of 20%. This is referred to 2025.

DTS Fleet	F (SQ)	A	B	D
GSA10_DTS_VL0612	188 669	63 838	8 097	71 367
GSA10_DTS_VL1218	-597 655	-2 656 183	-2 871 833	-1 871 941
GSA10_DTS_VL1824	-1 108 020	-6 642 015	-5 674 429	-5 535 664
GSA10_DTS_VL2440	291 412	-902 603	-800 922	-797 489
GSA11_DTS_VL0012	299 973	88 526	129 424	139 655
GSA11_DTS_VL1218	-2 564 657	-4 202 125	-3 759 105	-3 384 790
GSA11_DTS_VL1824	-5 078 587	-6 859 984	-6 420 360	-5 896 992
GSA11_DTS_VL2440	-4 511 103	-7 494 023	-7 233 337	-7 179 844
GSA9_DTS_1824	849 802	394 081	261 800	453 302
GSA9_DTS_VL0612	2 338 376	-1 441 208	-1 366 710	-274 429
GSA9_DTS_VL1218	6 058 615	-2 585 329	-201 190	-150 075
GSA9_DTS_VL2440	917 639	568 270	766 927	739 752
PGP Fleet	**F (SQ)**	**A**	**B**	**D**
GSA10_PGP_VL0012	39 630 251	20 207 934	32 589 757	21 435 025
GSA10_PGP_VL1218	428 331	-5 893 511	-5 271 686	-5 271 686
GSA11_PGP_VL0012	24 893 050	12 483 401	19 411 603	13 101 657

GSA11_PGP_VL1218	1 931 378	384 048	1 937 483	706 491
GSA9_PGP_VL0012	39 747 182	26 125 941	38 972 102	27 362 248
GSA9_PGP_VL1218	6 714 651	4 101 195	5 945 272	4 251 307

Table 6.2.2.2. Summary of BEMTOOL results in EMU2: Estimated level of profitability (in terms of gross value added) in 2023, 2025 and 2030. Estimated % profitability of target species change in 2020-2025 and 2020-2030. Results corresponding to the whole fleet (DTS and PGP fleet segments) in the hypothesis of fuel price as in 2022.

Scenarios	Estimated level of profitability (gross value added) in 2023	Estimated level of profitability (gross value added) in 2025	Estimated level of profitability (gross value added) in 2030	Estimated % gross value added	Estimated % gross value added
				2020-2025	2020-2030
A	54 302 864	47 093 129	78 458 400	-26.2	22.9
B	47 854 508	86 402 589	108 376 790	35.4	69.8
D	55 426 045	56 993 300	98 095 070	-10.7	53.7
F	92 358 822	128 640 547	144 124 276	101.5	125.8

Table 6.2.2.3. Summary of BEMTOOL results in EMU2: Estimated level of profitability (in terms of gross value added) in 2023, 2025 and 2030. Estimated % profitability of target species change in 2020-2025 and 2020-2030. Results corresponding to the whole fleet (DTS and PGP fleet segments) in the hypothesis of fuel price increased of 20% respect to 2022.

Scenarios	Estimated level of profitability (gross value added) in 2023	Estimated level of profitability (gross value added) in 2025	Estimated level of profitability (gross value added) in 2030	Estimated % gross value added	Estimated % gross value added
				2020-2025	2020-2030
A	30 434 583	25 740 252	63 398 292	-59.7	-0.7
B	24 584 127	66 422 891	98 247 082	4.1	53.9
D	32 311 364	37 897 894	89 054 974	-40.6	39.5
F	74 147 583	110 429 308	125 913 037	73.0	97.3

6.2.3 *SMART in EMU2*

Due to time constraints the scenarios accounting for an increase of fuel price of 20% from 2023 onwards compared to the average price in 2022, could not be run, presented and discussed during the EWG 22-11 plenaries. Therefore they are reported in the report but are not considered in the general discussion of results.

As explained in the methodology section, SMART is an individual based model that processes the activity of individual vessels, optimising their individual response to the various management measures tested. Since the optimisation is based on the economic performance of individual vessels, SMART is able to predict whether extreme cases of negative profits (corresponding to costs exceeding revenues) occur in different scenarios. However, this situation (vessels with negative profits) never occurred in the simulations conducted in previous EWGs. In EWG 22-11, however, a set of scenarios characterised by a strong reduction in activity combined with a significant increase in fuel prices was considered. This particular aspect of fleet dynamics was opportunistically exploited in the simulations conducted to speed up the simulation time and to obtain more realistic projections of the fleet structure. In practice, in all scenarios in which a reduction in fishing capacity was expected, the boats eliminated were selected from those with the worst economic performances.

Fig. 6.2.3.1 and Table 6.2.3.1 show the % of change of landings by species (in 2025) with respect to the Status quo (scenario F). The largest reductions in landings are expected in the red mullet stock, followed by hake and crustacean species. As was to be expected, the reductions are progressively more in the sequence of scenarios A to E.

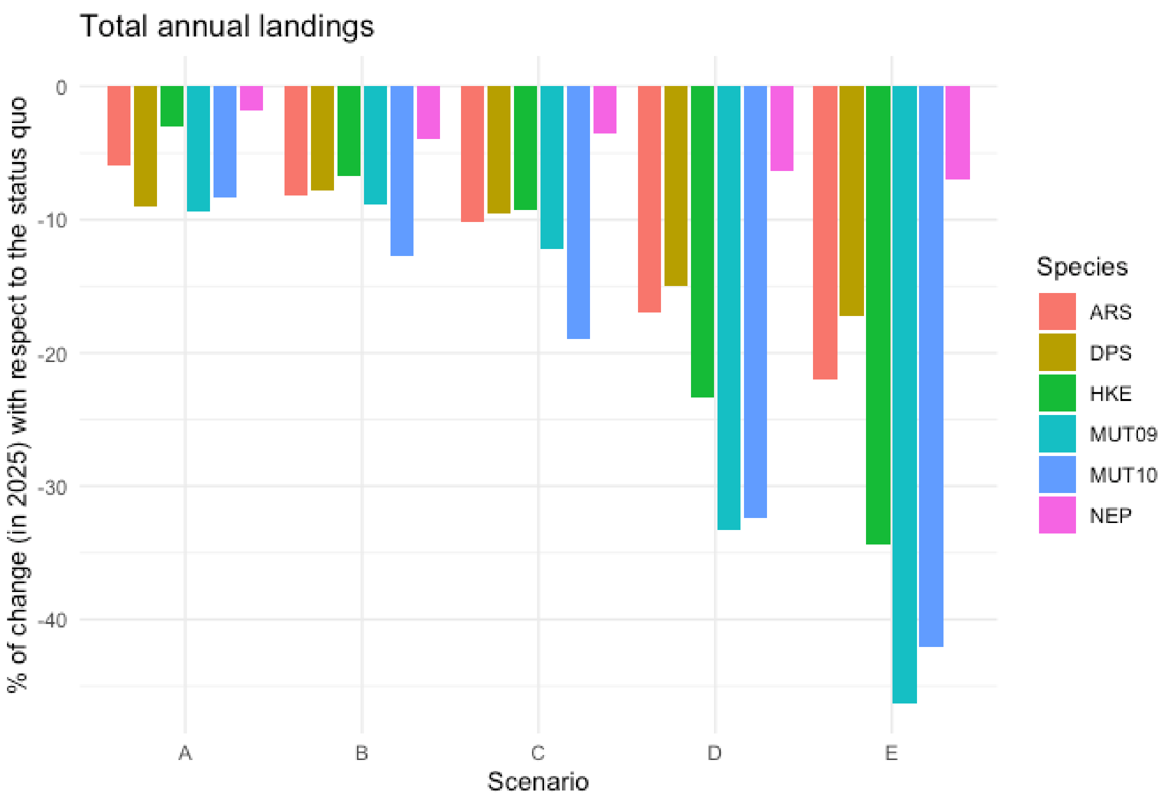


Figure 6.2.3.1 - Estimated % landings of target species change 2020-2025

Table 6.2.3.1 - Estimated % landings of target species change 2020-2025

Scenario	ARS	DPS	HKE	MUT09	MUT10	NEP
A	-6.0	-9.0	-3.0	-9.4	-8.3	-1.8
B	-8.2	-7.8	-6.8	-8.9	-12.7	-3.9

C	-10.2	-9.6	-9.2	-12.1	-19.0	-3.6
D	-16.9	-15.0	-23.3	-33.4	-32.4	-6.3
E	-22.0	-17.2	-34.4	-46.3	-42.1	-7.1

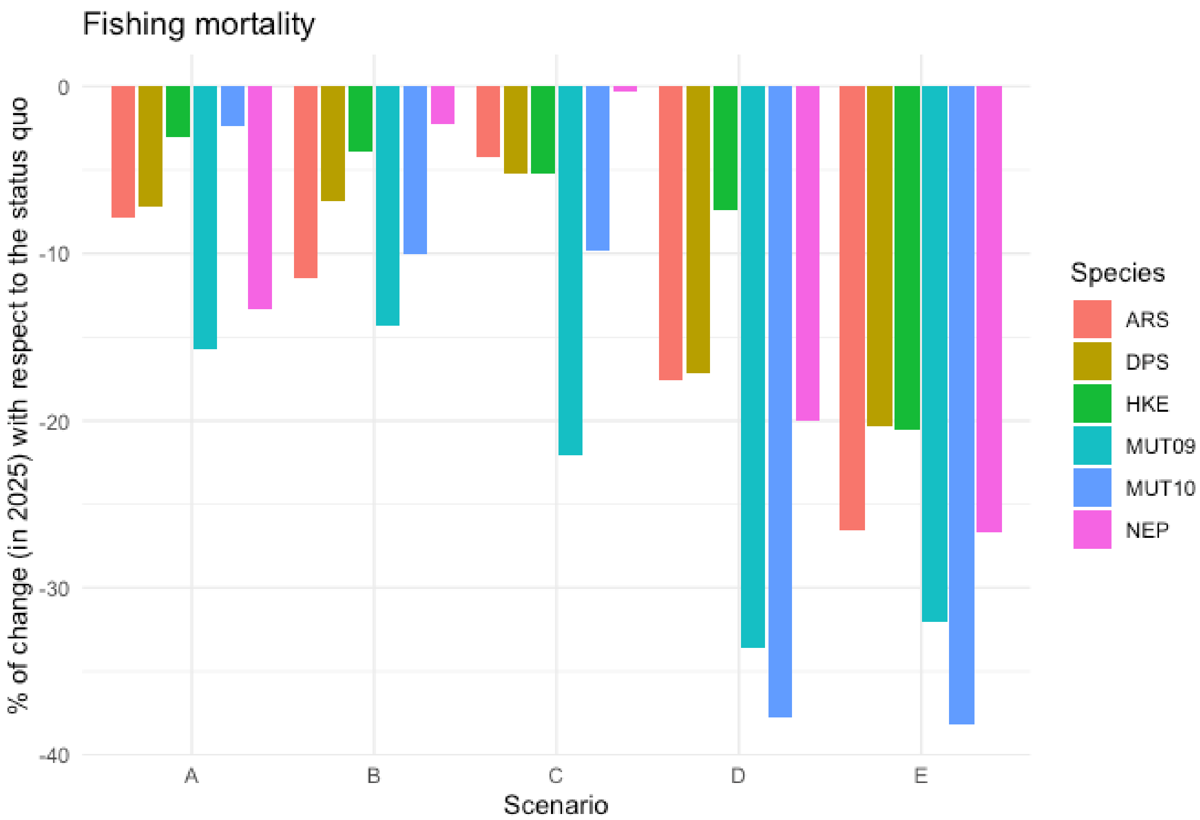


Figure 6.2.3.2 - Estimated level of F for target species in 2025

Table 6.2.3.2 - Estimated level of F for target species in 2025

Scenario	**ARS**	**DPS**	**HKE**	**MUT09**	**MUT10**	**NEP**
A	-7.86	-7.21	-2.98	-15.72	-2.37	-13.35
B	-11.49	-6.88	-3.88	-14.36	-10.00	-2.28

C	-4.26	-5.24	-5.19	-22.12	-9.85	-0.28
D	-17.62	-17.19	-7.43	-33.57	-37.75	-20.00
E	-26.60	-20.37	-20.52	-32.09	-38.13	-26.67

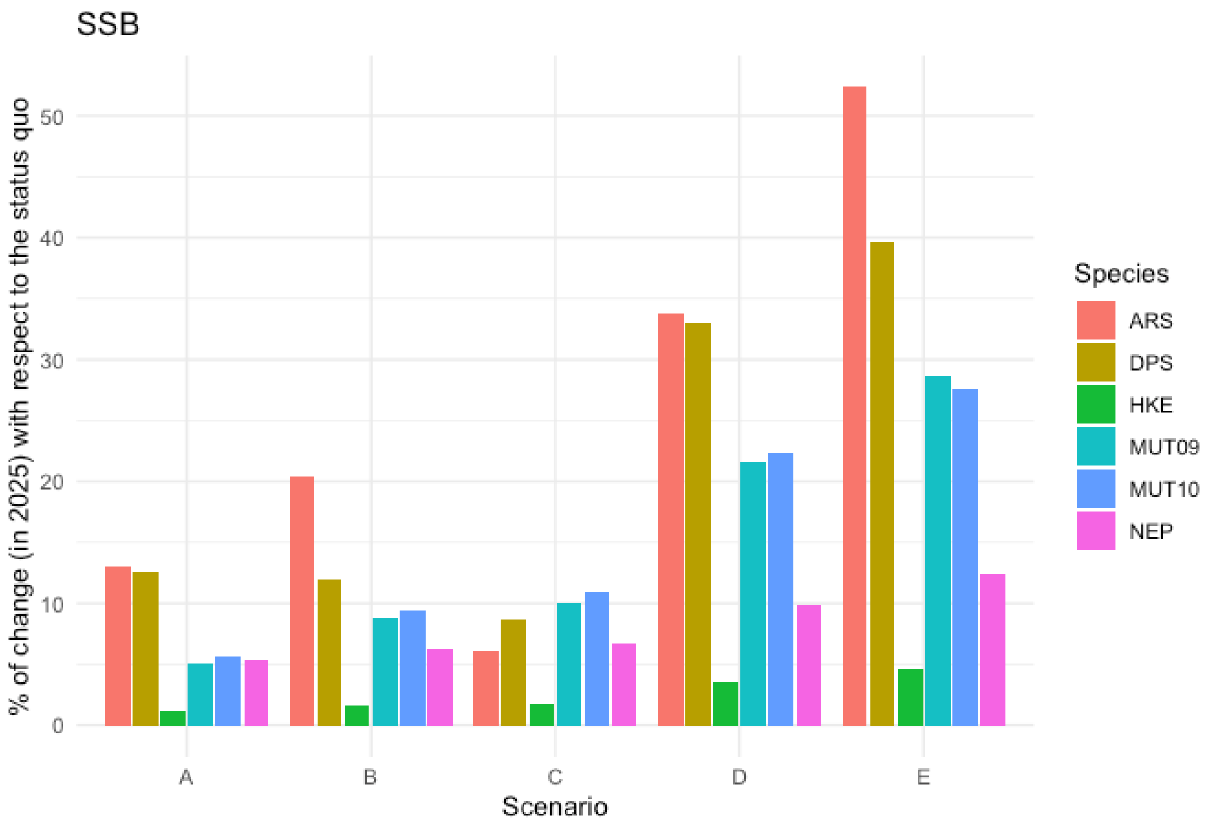


Figure 6.2.3.3. - Estimated % change of SSB for target species in 2025

Table 6.2.3.3. - Estimated % change of SSB for target species in 2025

Scenario	ARS	DPS	HKE	MUT09	MUT10	NEP
A	12.96	12.52	1.20	5.07	5.73	5.38
B	20.41	11.97	1.54	8.76	9.48	6.24
C	6.07	8.68	1.71	9.99	10.93	6.68

D	33.77	33.03	3.62	21.63	22.36	9.87
E	52.36	39.66	4.65	28.59	27.65	12.35

6.2.3.1 Comparison between scenarios accounting for actual fuel price and additional fuel price increase after 2022

In this section, we present a comparison between the status quo and the increased fuel prices scenarios for % of the changes in total annual landings, fishing mortality and SSB up to 2025.

Figure 6.2.3.1.1 – Comparison of the estimated % change of SSB for target species in 2025

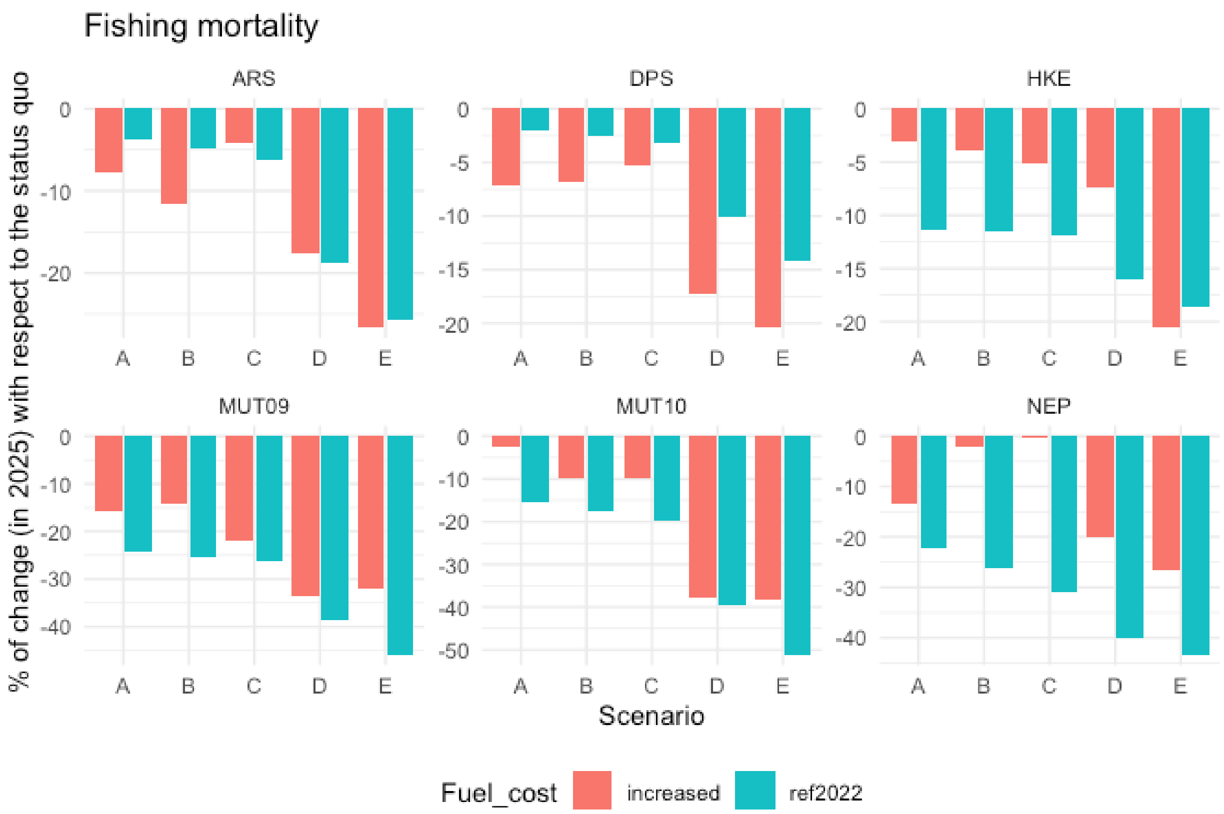


Figure 6.2.3.1.2 - Comparison of the estimated % change of SSB for target species in 2025

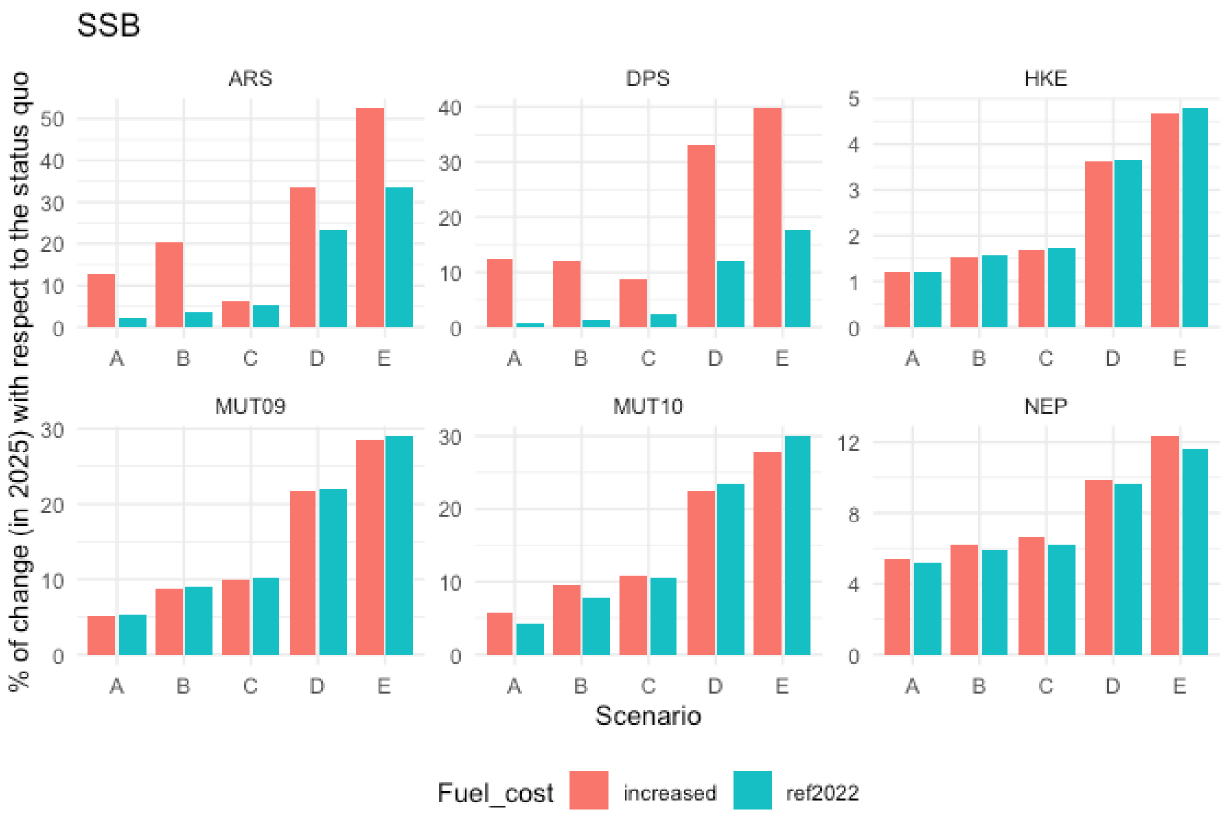


Figure 6.2.3.1.3 - Comparison of the estimated % change of SSB for target species in 2025

7 REMAINING ISSUES AND FUTURE STEPS (TOR 5)

7.1 Issues important for the advice and the interpretation of results

7.1.1 IAM in EMU 1

It is important to note that, as indicated in section 5.1.6., the revenues, and consequently the profits (i.e. GVA) of the different fleet segments assessed in IAM are likely underestimated. This is because the revenues of the fleet segments from landings of species that are not modelled in IAM are based on landings per unit of effort (LPUE) parametrised using 2021 FDI data and these values are constant throughout the simulations. Therefore, potential future increases in biomass of these non-dynamically modelled species/stocks are not reflected in fleet revenue estimates. The percentage of revenue from non-dynamically modelled stocks is more or less important depending on the fleet segment, Figure 5.1.4.2 presents these shares per fleet segment. We can observe that almost 80% of the revenues of Spanish trawlers above 24 meters are based on modelled species, hence biomass changes are taken into account in the profit estimates, whereas for French trawlers above 24 meters, this proportion is below 30%. For netters and vessels using hooks, these proportions are very low (overall less than 10%), so their profits are probably really underestimated.

7.1.2 BEMTOOL in EMU 1

It is important to note that the scenarios results presented do not consider the adaptation of the catch limit to the status of the stock (e.g. F_{MSY}, SSB) that is expected to change during the application of management measures. This aspect needs to be further explored and refined to possibly accommodate the adaptive setting of catch limit year by year in the projections.

It should be noticed also that the simulations here presented are based on an assessment with reference year 2020 for red mullet in GSA 10; moreover, despite ARA is a stock with a catch limit, an analytical assessment was not available; thus the stock was replicated on the basis of MEDITS data (recruitment index and total mortality).

7.1.3 SMART in EMU 1

All the scenarios were simulated twice, using two values for fuel price: the actual fuel price in 2022 and an increase of 120% of the 2022 price. It is very important to emphasize that the set of scenarios corresponding to the increased fuel price (120%) were simulated under the assumption that the market price of resources is constant (i.e. identical to that considered in the scenarios with current fuel prices). Therefore, given the characteristics of SMART, this leads to a considerable increase in costs related to fishing activities without a corresponding increase in revenues.

Within SMART, the estimation of spatial productivity (LPUE), one of the key parameters for modelling the behaviour of fishing units and the value of individual areas (fishing grounds), is one of the first steps in the workflow and allows (at the end of the process of optimizing the distribution of fishing effort) to obtain an estimate of the new exploitation pattern. In the second part of the workflow, the new exploitation pattern (catch by species/age) is used as input to estimate the effect on exploited stocks. However, the estimated fluctuations for stocks (e.g. in terms of SSB) do not translate into an update of spatial LPUE. In this way, at the moment, SMART is not able to evaluate a relationship between biomass increase and economic gains. That is because the aforementioned increase is a direct product of the reduction of effort (and, consequentially, of fishing mortality), and the model does not take account of a secondary raise in fishing productivity as a result of a higher available biomass. Equally this limits the reliability of long-term projections with this kind of model

7.2 Technological creep in the western Mediterranean Sea

7.2.1 Introduction

Technological development, also known as "technological creep" or "creep" (r), is usually positively correlated to the increase of skipper skills, investments in auxiliary equipment and more efficient gears and materials, replacement of old vessels with new ones, and upgraded and more efficient engines (Rijnsdorp et al., 2006).

Technological improvement can be conceptually separated into two groups: (1) major improvements in gear design, fish finding, and catch handling resulting in massive increase in effective fishing effort when they are implemented throughout a fleet within a few years; and (2) small background alterations in the rigging of a vessel or the skills of skippers at handling new technology or applying information technology, etc.

The "creep factor" means that fisheries are depleting fish populations faster than ever, while behaving as though they are accomplishing the same CPUE as they did in the past.

7.2.2 Western Mediterranean

The literature search revealed few scientific publications on this topic in the area covered by the West Med MAP.

Damalas et al. (2015) investigated long-term changes in the Mediterranean marine resources driving the trawl fisheries by analysing fishers' perceptions (Traditional Ecological Knowledge, TEK) throughout the Mediterranean Sea during a period of 80 years, GSA 6 and GSA 9 included in the study. An extended set of interviews were conducted with experienced fishers that enabled authors to classify species (or taxa) as 'decreasing' or 'increasing' both in terms of abundance, as well as average size in the catch. The aspect that most clearly emerged in all the investigated areas over time was the notable increase of fishing capacity indicators, such as engine power and fishing depth range.

During the MINOUW project, a study has been carried out to evaluate the effects of artificial lights (green/blue/white lights) attached to the headline of the trawl net to 1) reducing fish bycatch (and discards), and 2) increasing catches of targeted crustaceans in a OTB fleet in the Northern Tyrrhenian Sea (GSA9) and Catalan sea. Trawl fishermen in Tuscany started to use lights on nets in deep-water rose shrimp fisheries in recent years (2012 more or less). The aim of the study was to evaluate whether those lights are efficient in increasing the catch of the target species, and, at the same time, in decreasing by-catch and discards. Limited experiments has been carried out in the Catalan sea using a similar methodology on a bottom trawler targeting Norway lobster (*Nephrops norvegicus*) at 400 m depth. Due to budget constrain, it was not possible to perform an adequate number of samples and it was not possible to formulate robust conclusions.

Considering that the fisheries management in the Mediterranean is predominantly effort-based, and that out of 6 target species 4 are crustaceans (where it seems that catches are influenced by the light), and considering the conclusions coming from various papers (see below), it should be interesting to investigate if, also in the area of West Med MAP, CPUEs of target species are influenced by the technological creep.

7.2.3 Mediterranean

Damalas et al. (2014) analyzed the relative stock biomass trends for a selected group of demersal species. Official records of landings from the Greek bottom trawl fishery from 1964 to 2009 were used as an example relating it to the technological development of the fishing industry. The findings suggest that measuring "nominal" effort in conventional terms (days at sea, engine capacity, gross tonnage) may yield estimates far from the "effective" effort exerted by the fleet, which may further be unnoticeably escalating.

7.2.4 Other areas

A recent study by Palomares and Pauly (2019) showed that new technology has allowed commercial fishing fleets to double their fishing capacity every 35 years, which in turn increases the pressure on fish stocks.

The researchers examined more than 50 studies related to an increase in catching power, and concluded that the introduction of, for example, GPS, fish finders, echo-sounders, and acoustic cameras has led to an average 2 percent yearly increase in vessels' capacity to capture fish.

The reference period taken into consideration varies according to technological creep considered and to different fisheries.

The influence of technological creep on catchability has been shown also in other scientific publications (Scherrer, K. and Galbraith, E. 2020; Marchal et al, 2007; Kleiven et al., 2022; Eigaard et al., 2014). According to the literature, the influence of technological creep on catchability resulted in significant increases, often ignored in fisheries management. On average, authors estimated that catchability can increase by 1-3% per year due to technological developments.

It should be noted that in all studies the period considered is very long, lasting at least 20 years.

7.2.5 References

D. Damalas, C. D. Maravellas and S. Kavadas, (2014). Advances in Fishing Power: A Study Spanning 50 Years. *Reviews in Fisheries Science & Aquaculture*, 22(1):112–121

Damalas D, Maravelias CD, Osio GC, Maynou F, Sbrana M, Sartor P (2015) "Once upon a Time in the Mediterranean" Long Term Trends of Mediterranean Fisheries Resources Based on Fishers' Traditional Ecological Knowledge. PLoS ONE 10(3): e0119330. https://doi.org/10.1371/journal.pone.0119330

O. R. Eigaard, P. Marchal, H. Gislason, A. D. Rijnsdorp, 2014. Technological Development and Fisheries Management. **Reviews In Fisheries Science & Aquaculture**, Volume 22 Issue 2 Pages 156-174 http://dx.doi.org/10.1080/23308249.2014.899557

A. R. Kleiven, S. Heiberg Espeland, S. Stiansen, K. Ono, F. Zimmermann & E. M. Olsen, 2022. Technological creep masks continued decline in a lobster (*Homarus gammarus*) fishery over a century. *Scientific Reports*, 12:3318 https://doi.org/10.1038/s41598-022-07293-2

P. Marchal, B. Andersen, B. Caillart, O. Eigaard, O. Guyader, H. Hovgaard, A. Iriondo, F. Le Fur, J. Sacchi and M. Santurtún. 2007. Impact of technological creep on fishing effort and fishing mortality, for a selection of European fleets. *ICES Journal of Marine Science* 64 (1) 192-209 http://dx.doi.org/10.1093/icesjms/fsl014

MINOUW. European Commission's Horizon 2020 Research and Innovation Programme Project "Science, Technology and Society Initiative to Minimize Unwanted Catches in European Fisheries-MINOUW, Grant Agreement No. 634495.

Palomares, M. L. D., and D. Pauly. 2019. On the creeping increase of vessels' fishing power. *Ecology and Society* 24(3):31. https://doi.org/10.5751/ES-11136-240331

Scherrer, K. and Galbraith, E. 2020. Regulation strength and technology creep play key roles in global long-term projections of wild capture fisheries. *ICES Journal of Marine Science*, 77: 2518–2528.

7.3 Proposal for a standardized data collection of VMS and logbook data in the western Mediterranean Sea

7.3.1 Issues encountered in the data collection of remote monitoring data

As some bio-economic models used in EWGs related to West Med MAP need as source of information VMS spatial data and associated landings, DG MARE issues ad hoc calls requesting MSs (i.e., Italy, France and Spain) to provide available data. Because these data at national level are not always easily accessible and/or stored in the different ways and/or requested with a short notice, the request has not always been fully addressed by MSs.

In this context, EWG 22-11 drafted data templates and guidelines hoping it will help MSs in addressing such request in future data calls. Additionally, the EWG compiled a review on legal texts concerning data sharing procedures for VMS and log book data.

7.3.2 A review of legal texts declaring how VMS and logbook data can be shared in Mediterranean Spain, France and Italy

The regulations involved are the control regulation 1224/2009 (articles 5, 9 and 12) and the Implementing Regulation (EU) No 404/2011 (article19, 22 and 146f).

From control regulation 1224/2009, Article 9 states that only "When a fishing vessel is in the waters of another Member State, the flag Member State shall make available the vessel monitoring system data of that vessel by automatic transmission to the fisheries monitoring centre of the coastal Member States".

In article 12 is specified that information collected in the framework of this Regulation may be transmitted to Union agencies and competent authorities of the Member States engaged in surveillance operations for the purpose of maritime safety and security, border control, protection of the marine environment and general law enforcement.

Article 19 of 404/2011 defines the informations that are trasmitted to FMC of the flag MS, article 22 define the frequency of transmission and article 146f the format to be used to report vessel monitoring system data between Member States.

As stated in article 9 point 4, also in the case of participation in international fisheries organizations those data shall also be made available to or organisation. For example what is foreseen in ICCAT Reccomendation 21-8 Part IV: Control measures Section G – Vessel Monitoring System (VMS) (see below for detail).

Regarding logbook data, only when the landing took place in the port of another Member State, masters of Union fishing vessels shall transmit, within 48 hours of landing, the information in the fishing logbook the to the competent authorities of the Member State of the port in question (articles 14 and 15 of control regulation 1224/09).

7.3.2.1 COUNCIL REGULATION (EC) No 1224/2009

COUNCIL REGULATION (EC) No 1224/2009 of 20 November 2009 establishing a Union control system for ensuring compliance with the rules of the common fisheries policy, amending Regulations (EC) No 847/96, (EC) No 2371/2002, (EC) No 811/2004, (EC) No 768/2005, (EC) No 2115/2005, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007, (EC) No 676/2007, (EC) No 1098/2007, (EC) No 1300/2008, (EC) No 1342/2008 and repealing Regulations (EEC) No 2847/93, (EC) No 1627/94 and (EC) No 1966/2006

Article 5

General principles

1. Member States shall control the activities carried out by any natural or legal person within the scope of the common fisheries policy on their territory and within waters under their sovereignty or jurisdiction, in particular fishing activities, transhipments, transfer of fish to cages or aquaculture installations including fattening installations, landing, import, transport, processing, marketing and storage of fisheries and aquaculture products.

Article 9

Vessel monitoring system

1. Member States shall operate a satellite-based vessel monitoring system for effective monitoring of fishing activities of the fishing vessels flying their flag wherever those vessels may be and of fishing activities in the Member States' waters.

3. When a fishing vessel is in the waters of another Member State, the flag Member State shall make available the vessel monitoring system data of that vessel by automatic transmission to the fisheries monitoring centre of the coastal Member States. The vessel monitoring system data shall also be made available upon request to the Member State in whose ports a fishing vessel is likely to land its catches or in the waters of which the fishing vessel is likely to continue its fishing activities.

4. If a Union fishing vessel operates in the waters of a third country or in areas of the high sea where the fishing resources are managed by an international organisation and, if the agreement with that third country or the applicable rules of that international organisation so provide, those data shall also be made available to that country or organisation.

7. Member States shall establish and operate fisheries monitoring centres, which shall monitor fishing activities and fishing effort. The fisheries monitoring centre of a particular Member State shall monitor the fishing vessels flying its flag, whatever the waters in which they are operating or the port they are in, as well as Union fishing vessels flying the flag of other Member States and fishing vessels of third countries to which a vessel monitoring system applies operating in the waters under the sovereignty or the jurisdiction of that particular Member State.

Article 12

Transmission of data for surveillance operations

Data from the vessel monitoring system, the automatic identification system and the vessel detection system collected in the framework of this Regulation may be transmitted to Union agencies and competent authorities of the Member States engaged in surveillance operations for the purpose of maritime safety and security, border control, protection of the marine environment and general law enforcement.

7.3.2.2 Commission Implementing Regulation (EU) No 404/2011

Commission Implementing Regulation (EU) No 404/2011 of 8 April 2011 laying down detailed rules for the implementation of Council Regulation (EC) No 1224/2009 establishing a Community control system for ensuring compliance with the rules of the Common Fisheries Policy

CHAPTER IV

Vessel monitoring system

Article 19

Characteristics of satellite-tracking devices

1. The satellite-tracking device installed on board Union fishing vessels shall ensure the automatic transmission to the FMC of the flag Member State, at regular intervals, of data relating to:

(a) the fishing vessel identification;

(b) the most recent geographical position of the fishing vessel, with a position error which shall be less than 500 metres, with a confidence interval of 99 %;

(c) the date and time (expressed in Coordinated Universal Time (UTC)) of the fixing of the said position of the fishing vessel; and

(d) the instant speed and course of the fishing vessel.

2. Member States shall ensure that satellite-tracking devices are protected against input or output of false positions and cannot be manually over-ridden.

Article 22

Frequency of data transmission

1. Each Member State shall ensure that its FMC receives, at least once every 2 hours, through the VMS the information referred to in Article 19 of this Regulation concerning its fishing vessels. The FMC may require the information at shorter time intervals.

2. The FMC shall have the capacity of polling the actual position of each of its fishing vessel.

Article 146f

Exchange of vessel monitoring system data

1. The format to be used to report vessel monitoring system data between Member States, as well as between Member States and the Commission or the body designated by it, shall be the Vessel Position Domain XML Schema Definition based on the UN/CEFACT P1000-7.

2. Flag Member State systems shall be capable of sending vessel monitoring system messages.

3. Flag Member State systems shall also be capable of replying to requests for vessel monitoring system data for fishing trips that started during the previous 36 months.

7.3.3 A standardized data collection as possible solution

With the aim of providing an inclusive and comprehensive template, the EWG 22-11 decided to consider as an example of best practice the approach that France currently uses for collecting spatial information on the fishing trips and the associated catches. Two of the four templates provided by France concerned the VMS data and the other two are describing in details the landings activities (weight, price, gear, etc). EWG 22-11 revised these four documents with the aim of simplifying the number of data requested.

Overall, EWG 22-11 prepared three deliverables (Annex IV):

1) one template (VMS information) with information related to the fishing trip (*i.e.*, TRIP_ID, POSITION_ID, VESSEL CODE, DATE, HOURS, LONGITUDE, LATITUDE, ROUTE, DEPTH, INSTANT_SPEED, AVERAGE_SPEED, FISHING, COUNTRY, HARBOUR_DEPARTURE, HARBOUR_ARRIVAL and HOME_HARBOUR) (see figure 7.3.1);

2) one template (Landing information) including information on the catch (*i.e.*, TRIP_ID, COUNTRY, SUPRAREGION, SUBREGION, VESSEL_CODE, VESSEL_LENGTH, GEAR TYPE, FISHERY, MESH SIZE, SPECIES, CATEGORY, LANDINGS_TOTAL_WEIGHT, LANDINGS_TOTAL_WEIGHT_SOURCE, LANDINGS_TOTAL_PRICE, DISCARDS_TOTAL_WEIGHT and LANDINGS_HARBOUR) (see figure 7.3.2);

3) a word document including a guideline on how to fill in the two templates.

Table 7.3.1 – VMS information template. (Code explanation and values format explained in the Guideline (Annex IV))

VESSEL_CODE	DATE	HOURS	LONGITUDE	LATITUDE	ROUTE	DEPTH	INSTANT_SPEED	AVERAGE_SPEED	FISHING	COUNTRY	HARBOUR_DEPARTURE	HARBOUR_ARRIVAL	HOME_HARBOUR
8029	15/01/2020	01:00:00	9.4516	42.6953	0	NA	0	0	false	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	01:19:00	9.4516	42.6953	0	NA	0	0	false	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	01:59:00	9.4761	42.6801	106	-67	1	2.135187529	false	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	02:58:00	9.5846	42.6005	105	-51	4	6.854801936	false	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	03:58:00	9.6263	42.5706	213	-60	2	2.571365917	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	04:58:00	9.6904	42.5017	77	-405	2	2.531361503	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	05:58:00	9.7113	42.5455	17	-450	2	2.749116722	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	06:58:00	9.7054	42.5802	324	-425	1	2.074065198	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	07:58:00	9.673	42.6125	312	-359	2	2.378053984	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	08:58:00	9.6654	42.6501	318	-395	2	2.2763829	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	09:58:00	9.6477	42.6723	346	-392	8	1.554426693	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	10:58:00	9.6192	42.7146	315	-385	2	2.799490713	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	11:58:00	9.5964	42.7502	349	-395	2	2.392449275	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	12:58:00	9.5766	42.7866	329	-402	2	2.366810563	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	13:58:00	9.5635	42.7909	229	-355	8	0.638448928	true	FRA	Bastia	Bastia	Ajaccio
8029	15/01/2020	14:58:00	9.4551	42.6947	258	NA	9	7.479646983	false	FRA	Bastia	Bastia	Ajaccio

Table 7.3.2 – Landings information template. (Code explanation and values format explained in the Guideline (Annex IV))

TRIP_ID	COUNTRY	SUPRAREGION	SUBREGION	VESSEL_CODE	VESSEL_LENGTH	GEAR TYPE	FISHERY	MESH SIZE	SPECIES	CATEGORY	LANDINGS_TOTAL_WEIGHT	LANDINGS_TOTAL_WEIGHT_SOURCE	LANDINGS_TOTAL_PRICE	DISCARDS_TOTAL_WEIGHT	LANDINGS_HARBOUR
17298604	FRA	37	GSA 8	8029	VL1824	OTB	CRU	400DXX	HKE	C	16.43	Landings declaration	149.07	0	Bastia
In case commercial categories are available please insert as the example below															
17298604	FRA	37	GSA 8	8029	VL1824	OTB	CRU	400DXX	HKE	1	6.43	Landings declaration	100	0	Bastia
17298604	FRA	37	GSA 8	8029	VL1824	OTB	CRU	400DXX	HKE	2	10	Landings declaration	49.07	0	Bastia
If discards are available please insert as the example below															
17298604	FRA	37	GSA 8	8029	VL1824	OTB	CRU	400DXX	HKE	D	0	Landings declaration	0	12	Bastia
In case mixed fish are landed in the same box please insert as the example below															
17298604	FRA	37	GSA 8	8029	VL1824	OTB	CRU	400DXX	OTHER	M	15	Landings declaration	30	0	Bastia

7.4 Economic and social reference points

The West Med management plan includes no specific social or economic objectives (Article 3). However, the plan refers to the general objectives of the CFP (Article 2, Regulation (EU) 1380/2013). The social and economic objectives in Article 2 are unfortunately quite unspecific like "provide conditions for economically viable and competitive fishing capture and processing industry and land-based fishing related activity" (Article 3 (5d)) or "contribute to a fair standard of living for those who depend on fishing activities, bearing in mind coastal fisheries and socio-economic aspects" (Article 3 (5f), see Goti-Aralucea et al., 2018).

Although not straightforward, several indicators can be used in order to evaluate the achievement of the general CFP objectives connected to the management plan to a certain extent. The selection criteria of the indicators should be based primarily on their relevance in comparison with the proposed objectives, on temporal comparability, on analytical validity and on the effective availability of data (OECD, 2002). The methodological approach based on the use of biological and socio-economic indicators is consolidated in the field of scientific research, as per a vast literature on the subject (FAO, 1999; OECD, 2002) and numerous projects and sector studies (eg. "Socio-economic effects of the management measures of the future CFP" – SOCIOEC (Goti-Aralucea et al., 2018)). Since 2007, the European Commission has developed a list of indicators contained in the document "Guidelines for the analysis of the balance between fishing capacity and fishing opportunities, in accordance with Article 22 of Regulation (EU) No 1380 / 2013 of the European Parliament and of the Council on the common fisheries policy ". In this perspective, the so-called "balance indicators" have been classified on the basis of four dimensions: economic, biological, social and technical (STECF, 2011).

Indicators are the main point of contact between a model and its users. In general, indicators are used to provide evidence as to how well pursued objectives are being achieved (Prellezo, 2012). Indicators used in fisheries are defined by the FAO (FAO 1999) in relationship to sustainable development as: "A variable, pointer, or index related to a criterion". Its fluctuation reveals variations in key elements of sustainability, and their position and trend in relation to reference points indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and actions.

Although the models applied by EWG 22-11 vary in terms of structure and dynamics, all of them provide information on three types of indicators, namely, biological indicators, capacity indicators and economic indicators; none of them provide indicators on sociological characteristics. Some of the models give "social" indicators, but in general these are closely related to the economic ones (gross value added, crew share, employment) and they do not actually produce detailed results on the social impact of fisheries policies.

As far as the presentation of the results and their interpretation, all the models applied by EWG 22-11 include economic indicators but each model reports different economic indicators (table 1).

Table 7.4.1. Economic indicators provided by the models as reported in STECF 21-13 report

EMU/Model	*Economic Indicators*
EMU 1 (GSA 1-2-5-6-7) IAM Model	Gross Value Added (GVA)
EMU 2 (GSAs 8-9-10-11) BEMTOOL	revenues, gross profit and current revenues to break-even revenues (CR/BER)

EMU 2 (GSAs 8-9-10-11) SMART	revenues, costs and Gross Profit Margin - GPM

EWG 22-11 suggests that all the different bio-economic modules should report the same economic indicators and specific reference points should be defined in order to evaluate the economic results of the different simulated scenarios in a consistent way. The selected economic indicators should be harmonized with the ones applied by STECF for the assessment of the economic performance of the fleet (AER) and the "balance" indicators. Also, in the STECF report 18-15 (STECF 2018) indicators are proposed which could be possibly applied.

Just as a starting point for a deeper analysis, a first review of the economic and social indicators proposed by the literature on the subject may suggest the following indicators:

7.4.1 Economic indicators

Gross profit margin (%). It is a measure of profitability that can be used to analyse how efficiently a sector is using its inputs to generate profit. It is calculated as the ratio between gross profit and revenue and is expressed as a percentage.

A high gross profit margin indicates that the sector has a low-cost operating model; reflects efficiency in turning inputs into outputs. A low percentage value can indicate a low margin of safety, i.e. a higher risk that declines in production or increases in costs may result in a net loss, or negative profit margin.

Suggested reference point (STECF, 2021):

>10% - High - Profitability is good and segment is generating a good amount of resource rent

0-10% - Reasonable - Segment is profitable generating some resource rents

<0% - Weak - The segment is making losses; economic overcapacity

Revenue to Break-even Revenue Ratio (CR/BER). CR/BER gives an indication of the short-term profitability of the fleet/fleet segment (or over/under capitalised). The ratio of current revenues to break-even revenues (BER) measures the economic capacity of the fleet segment needed to continue fishing on a daily basis. Break-even revenues correspond to the revenues necessary to cover both fixed and variable costs, which are therefore neither such as to entail losses nor to generate profits. Current revenues are given by the total revenues deriving from landings. The ratio calculation provides a short to medium term analysis of financial profitability, as it indicates how close the current revenues of a fleet are to the revenues needed for the fleet to break even.

Suggested reference point: A ratio equal to or greater than one indicates the generation of a profit sufficient to cover variable, fixed and capital costs, which shows that the segment is profitable and potentially undercapitalized. A ratio of just under 1 (between 0.9 and 1) indicates that an acceptable situation because at least in the short term the segment is unprofitable and potentially overcapitalized. A value much lower than the unit outlines a situation of insufficient financial profitability. A negative value indicates that variable costs alone are higher than current revenues, which in turn indicates that the greater the generation of income, the greater the losses (STECF, 2021).

7.4.2 Social indicators

In relation to the social dimension, the specific objective of the plan is the reduction of the social impact resulting from the contraction of the fishing effort; this objective consists in:

• maintenance of the cost of labour so to guarantee minimum level of income

• maintenance of the current level of employment expressed as a function of the FTE (Full Time Equivalent)

The indicators that can be suggested as a starting point for discussion are:

Labour cost/FTE***:*** The cost of labour for FTE represents an important indicator of social sustainability, as it offers a reference of the average salary received by the crew.

Suggested reference point: This indicator can be compared with the guaranteed minimum wage of the sector. The threshold value for the identification of the reference points is represented by the amount of the guaranteed minimum wage (GMW), as envisaged in the national contract agreements. In particular, a value equal to or greater than the guaranteed minimum monetary value is considered a positive situation. On the other hand, an average wage lower than the GMW outlines a critical and therefore negative situation.

Number of FTEs***.*** FTE is the unit of measurement that equates to a person working full time, based on the national reference level for the working hours of crew members on board the vessel (excluding rest time) and for the hours of work at shore.

Suggested reference point: the average value of baseline period (2015-2017). An FTE equal to or greater than the threshold value implies a situation of maintenance of the current employment levels. An intermediate threshold (an FTE value of no more than xx% below the average FTE) may be considered in order to indicate an "acceptable" situation. An FTE lower than the average FTE 2015-2017 by more than intermediate threshold, on the other hand, could imply a negative and very impactful situation in terms of social impact.

Labour productivity (GVA/FTE): Labour productivity - defined as output per unit of labour. Calculated as GVA (measure of output) by full-time equivalent (FTE) employment (unit of labour input). Labour productivity can be used as a measure of economic growth, competitiveness, and living standards within a sector. An increase in labour productivity indicates that a unit of input labour is producing more output or that the same amount of output is being produced with fewer units of labour. Labour productivity may also provide an indicator of worker's wellbeing or living standards, assuming that increases in productivity are matched by wage increases.

In addition to these indicators, other social aspects of the fleet could be considered. According to EUMAP, MS should collect and provide social variables every three years. They include: employment by gender, by age, by education level, by nationality, by employment status.

7.4.3 Conclusions

In preparation of the next EWG meeting on the West Med MAP, STECF should propose the most suitable economic indicators with respect to the objectives of the plan. This would allow the modelers to adjust their models and, if possible, homogenize the presentation of the economic indicators among the different models used by the EWG.

The next EWG should then also investigate how to include the social impact of the management measures apart from the presentation of "social" indicators that only rely on a purely economic perspective.

7.4.4 References

Goti-Aralucea, L., Fitzpatrick, M., Döring, R., Reid, D., Mumford, J., Rindorf, A. (2018) "Overarching sustainability objectives overcome incompatible directions in the Common Fisheries Policy". Mar Policy 91:49-57

OECD, 2002. Fisheries Sustainability Indicators: The OECD experience. Paris

Raúl Prellezo; Paolo Accadia; Jesper Andersen; Bo S. Andersen; Erik Buisman; Alyson Little; J. Rasmus Nielsen; Jan Jaap Poos; Jeff Powell and Christine Röckmann, (2012), A review of EU bio-economic models for fisheries: The value of a diversity of models, Marine Policy, 36, (2), 423-431

STECF (Scientific, Technical and Economic Committee for Fisheries) (2011) - Review of national reports on Member States efforts to achieve balance between fleet capacity and fishing opportunities (STECF- EWG-11-10). 2011. Publications Office of the European Union, Luxembourg, ISBN 978-92-79-22168-2; doi:10.2788/12125.

STECF 2018. CFP Monitoring – expansion of indicators (STECF-18-15). Publications Office of the European Union, Luxembourg, 2018

7.5 Future steps

7.5.1 IAM in EMU 1

In EMU1, the implementation of the IAM model for GSAs 1-5-6-7 carried out during the STECF meeting is still in development. The addition of socio-economic indicators such as employment in terms of Full Time Equivalent (FTE), gross profit and gross profit margin was discussed during EWG 22-11.

Full Time Equivalent (FTE) could be estimated using the same methodology than the one used in AER reports, meaning estimating an average FTE per day at sea by fleet and then multiplying this value with the total annual days at sea of the fleet. As IAM is parametrized using fishing days, instead of days at sea, as it was requested, estimates of FTE in IAM in EMU1 would be:

$$FTE_{f,t} = \frac{FTE_{ref,f}}{E_{ref,f}} * E_{f,t}$$

With $FTE_{f,t}$ the full time equivalent estimate of fleet f at time t, $FTE_{ref,f}$ the FTE of reference of fleet *f* (either FTE of the initial year, like 2021 is the initial year in this report, or another period of time. It would need to be discussed), $Eref_{,f}$ the total fishing effort of reference (in fishing days) of fleet *f* (same year or period than for the FTE of reference), and $E_{f,t}$ the total fishing effort of fleet *f* at time *t.*

Gross profit, which is GVA minus crew cost, is not calculated in this report. In the IAM model, crew costs are estimated based on a percentage of the "what remains to be shared" (i.e. GVL less exploitation costs). With most simulations, some fleet segments had a negative "what remains to be shared", so Gross Profit estimates were not correct. A change in the way Gross Profit is estimated in IAM in EMU1 was discussed during the EWG 22-11 group, and it was decided that one way would be to estimate crew costs based on a minimum wage per FTE (calculated from national minimum wages). This can be adapted for the next groups, provided that French and Spanish minimum wages are provided prior the groups.

The AER methodology for estimating crew wages was not discussed in EWG 22-11, but it could also be a possible option (they estimate crew wages on the basis of an average crew wage per landing value).

These indicators could possibly be made available for the next meeting, to the extent possible and within the time and availability of the team working on IAM. And in any case, if changes in IAM model are needed, as this implies a change in the code, this should be decided well in advance of the next group.

If additional indicators are requested, they should be provided before the meeting, and sufficiently in advance to adapt the model.

7.5.2 BEMTOOL in EMU 2

One of the future developments could be the inclusion of Corsica fleet segments, this will be dependent on availability of the corresponding socio-economic data.

Another improvement to the model is represented by the splitting of PGP fleet segments separating long lines and netters in order to allow to differentiate the management measures for the two gears.

The availability of an updated analytical stock assessment for MUT 10 and ARA is important to improve the reliability of projections.

7.5.3 Requests from EWG 22-11

Due to time constraints, the two spatial modeling groups (SMART and ISIS-Fish) could not fulfill the scenarios requested in the TORs. The parameterization of such models is complex and time consuming, therefore to be able to respond to all TORs EWG 22-11 suggested that it would be very helpful to have scenarios at list a month before the beginning of the working group as it was done for EWG 22-01.

Finally, in order to ease the work of EWGs concerned with the evaluation of effort and catch limit regime in the Western Mediterranean the EWG requested to have specific material ready before the beginning of the working group next to the already available stock objects from the stock assessment EWG:

- catch at age matrices by GSA and gear for HKE and MUT stocks;
- F at age matrices by GSA and gear for HKE and MUT stocks;
- LFDs by GSA and gear for HKE and MUT stocks.

This work could be held either during the western Mediterranean stock assessment EWG (to be evaluated with the chair of the EWG) or by a short ad hoc contract.

8 CONTACT DETAILS OF EWG-22-11 PARTICIPANTS

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

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9 List of Annexes

Electronic annexes are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg2211

List of electronic annexes documents:

EWG-22-11 – Annex I – Complete graphs and tables of effort time series.
EWG-22-11 – Annex II – Official datacalls comparison: data and R scripts and graphs.
EWG-22-11 – Annex III – Quality checks of effort data: data and R scripts and graphs.
EWG-22-11 – Annex IV – VMS template and guidelines.

10 List of Background Documents

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg2211

List of background documents:

EWG-22-11 – Doc 1 - Declarations of invited and JRC experts (see also section 8 of this report – List of participants)

STECF

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