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Study on the evaluation of specific management scenarios for the preparation of multiannual management plans in the Mediterranean and the Black Sea

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STRUCTURE OF THE REPORT

To ease the reading and consultation of the report a macrostructure is below outlined. This Final Report is structured in the following main components.

1. An Executive Summary and a Résumé that provide an overview and a synthesis of the project objectives, tasks, approaches and methods applied, achieved results, including a very short summary of the achievements during the first phase (task 1), assumptions, gaps, limitations, constraints regarding the case studies and main conclusion on the bioeconomic scenario modelling.

2. 6 Summary sheets, corresponding to 9 case studies and containing the main background information, the approach followed, the implementation of MSY approach, the main results from bioeconomic scenario modelling.

3. The Section 1 in which the project objectives, activities and workplan are summarized.

4. The Section 2, with 9 extended Reports for the 9 case studies. The reports related to the case studies are preceeded by the chapter on Material and Methods. Each report on the case study is structured in 11 chapters reporting the background information, the approach followed, the evaluation framework, the MSY implementation strategy, the results from bioeconomic scenario modelling and the discussion and conclusions. Each case study report is completed by an Annex with 5 chapters where all the inputs for the model are specified.

5. The section 3 focused on the delay of the size at first capture through a possible approach for area management.

6. The section 4 focused on the interactions with stakeholders through the organization of the meeting with MEDAC, where preliminary project results were presented and discussed.

7. Section 5 with concluding remarks.

8. References.

9. 4 Annexes related to the meeting reports, the data call specifications, the list of acronyms.

10. An electronic attachment with the model outputs.

EXECUTIVE SUMMARY

Study objectives and tasks

The objective of the study is the assessment of specific fishery management scenarios in order to establish the relevant multiannual plans in accordance with the CFP (Common Fishery Policy) objectives and with the guidelines adopted by the GFCM (General Fishery Commission for the Mediterranean).

For this purpose, **four case studies** are envisaged:

1. small pelagic and demersal fisheries in the Gulf of Lion and the North of Spain (Geographical Sub Areas - GSAs - 6 and 7);
2. small pelagic and demersal fisheries in the Ligurian and North Tyrrhenian Seas and Sardinia (GSAs 8, 9 and 11);
3. small pelagic and demersal fisheries in the Adriatic Sea (GSAs 17 and 18);
4. fisheries targeting turbot and its associated species in the Black Sea (GSA 29).

Two management scenarios for each case study were foreseen in the project:

- achieve Maximum Sustainable Yield –MSY- by 2018;
- achieve MSY by 2020.

The project is organized in 4 tasks:

- ***task 0 – Organization of the work: coordination and project management;***
- ***task 1 - State of the art;***
- ***task 2 – Maximum Sustainable Yield;***
- ***task 3 – Regional cooperation.***

Among the coordination activities the sharepoint has been set and populated with the collected documentation.

For running case studies using the more updated information, a Data Call has been issued and a presentation letter was prepared by the European Commission to facilitate the access to information at national scale.

The project technical Workshop, planned to discuss and validate the results of management strategies based on MSY or MSY related reference points (e.g. fishing mortality reference points as: F_{MSY}, $F_{0.1}$) for the different case studies, was held in the week 21-25 September, 2015 in Bari.

The main objectives of TASK 1 were:

- identification and description of the target stocks (biology, status, geographical distribution, etc.) (subtask 1.1);
- identification and description of the fisheries, in terms of number of vessels, catches, discards, average effort deployed and economic performance of these fisheries (subtask 1.2);
- description of the current management measures at national, European and international level (subtask 1.3).

The work under task 1 was carried out for the 4 case studies above specified.

The main objectives of TASK 2 were:

- ✓ identifying the main elements that contribute to define MSY;

- ✓ exploring different management options to achieve MSY objective;
- ✓ investigating how technical measures can affect the exploitation pattern towards MSY objective, evaluating biological and economic consequences of implementing MSY objective in two different timeframe scenarios, by 2018 and by 2020.

The main objective of TASK 3 was to establish an interaction with stakeholders, in particular with the Mediterranean Advisory Council - MEDAC**,** through the organization of a meeting to present and discuss the project results and receive feedback.

Methods applied

The methods applied in task 1 were based on reviewing peer review papers, grey literature, STECF reports and on the analysis of the data received from the Data Call and National Authorities.

Task 2 was based on bio-economic modelling. In the case studies of small pelagic fisheries in GSA17 and GSA18, small pelagic fisheries in GSA9; demersal fisheries in GSA17, GSA18, GSA9 and GSA11, BEMTOOL (Bio Economic Management tool) model was used to carry out the projections of the different management scenarios. BEMTOOL is a bioeconomic platform incorporating 6 operational modules (Biological, Pressure, Economic, Behavioural, Policy/Harvest Rules and Multi-Criteria Decision Analysis – MCDA) characterized by components communicating by means of relationships and equations. The MCDA model component eases the evaluation of the performances of different fishery management scenarios from the biological and socioeconomic points of view, using a selection of indicators to score management measures against objectives. BEMTOOL follows a multi-fleet approach simulating the effects of a number of management trajectories on stocks and fisheries on a fine set time frame (month). The model accounts for length/age-specific selection effects, discards, economic and social performances, effects of compliance with landing obligation and reference points.

In the case studies of demersal fisheries in GSA06 and GSA07, Scenario modelling was based on the MEFISTO bioeconomic model, modified for the present study to produce the necessary adaptations to answer the terms of the Tender, particularly Scenario 6 and new economic indicators.

The uncertainty on recruitment (process error) implemented in the models following Monte Carlo paradigm allows a risk evaluation in terms of biological sustainability of the different management strategies. Uncertainty is propagated to all the indicators estimated by the model, thus giving a range to the economic outputs.

The framework used for the reference points was based on F_{MSY} (generally of the more exploited stock) using Fupper through the calculation of F_{MSY} ranges. To test if exploiting a stock at the upper limit of the provisional F_{MSY} ranges was still safe, a Management Strategy Evaluation (MSE) was applied. Alternatively, a F_{MSY} combined among the considered stocks was applied following the approach of the Balance Indicators (http://stecf.jrc.ec.europa.eu/reports/balance). The combined F_{MSY} was obtained by a weighted average of the F_{MSY} of the single stocks using their economic values as weighing factor.

For small pelagic stocks the exploitation rate E0.4 was also used, in a complementary way to Fupper or as an alternative, depending on the characteristics of the assessment.

Considering the possible social and economic consequences of the reduction of the fishing effort, the scenarios to be modelled were projected in two time frames (2018 and 2020), taking into account two possible different patterns of reduction: linear and adaptive.

Results were expressed and evaluated from the biological and economic perspectives following a traffic light approach besides the MCDA from BEMTOOL.

Results from task 1

The area related to the **case study** of small pelagic and demersal fisheries in the Gulf of Lion and northern Spain (**GSA06 and GSA07**) encompasses the coasts of Spain and France. Benthic and demersal species are exploited by the semi-industrial trawler fleets of the two countries, as well as by artisanal vessels. The main fishing gears involved are trawlers, netters, and longliners. Time series of DCF data on biological variables, landings and effort are available for France and Spain at GSA level by metier, while transversal variables (landings and effort) at fleet segment level are available at sub-regional level (e.g. 37.1.2 FAO area for the Gulf of Lion). Economic data are available at supra-region level (FAO AREA 37) for France. For GSAs 06 and 07 there is a proposal of the European Commission for a multiannual plan for demersal fisheries. This plan shall cover demersal stocks, in particular the stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), blue whiting (*Micromesistius poutassou*), monkfishes (*Lophius* spp.), poor cod (*Trisopterus minutus*) and the crustaceans deep-water rose shrimp (*Parapenaeus longirostris*), blue and red shrimp (*Aristeus antennatus*) and Norway lobster (*Nephrops norvegicus*). The recent stock assessments attempted for small pelagic (sardine and anchovy) in both GSAs were either not based on age-structured methods or of insufficient quality to be accepted (except for sardine in GSA06, 2013; in EWG14-19), but due to the importance of anchovy as main species driving the fishery and the absence of a valid recent assessment for anchovy, scenario modelling for small pelagic was not carried out.

The Case study on GSAs 8, 9 and 11 encompasses the coasts of two European countries: France and Italy and comprises the Ligurian Sea, the northern and central Tyrrhenian Sea, and the seas around Sardinia. The ecological features are very heterogeneous, producing a variety of habitats and biological communities. The large majority of the operating vessels (about 3300) is involved in small scale fisheries, while trawling is carried out by 640 vessels, almost exclusively located in the GSAs 9 and 11. The production of the area mostly comes from the fisheries of GSA9, particularly from trawlers and purse seiners. Small pelagic fishery is present only in GSA9, where about 50 purse seiners are currently working. Among small pelagics, anchovy is largely the most important species, both in terms of landings and economic value. Several demersal stocks, such as European hake, red mullet and Norway lobster are relevant in both GSA9 and GSA11, even though some differences are present (e.g. deep water rose shrimp and horned octopus are more important in GSA9, while giant red shrimp in GSA11). Regarding demersal stocks, data are still scarce and scattered **in GSA8**, where only time series from scientific trawl surveys at sea (MEDITS) are available, while **stock assessments are not available**. Fishery economic data are also not available for this GSA, thus it was not included in the scenario modelling.

The Adriatic Sea (GSA17 and GSA18) is characterised by the largest shelf area of the Mediterranean. Its notable marine and coastal habitats provide valuable ecosystem and offer a fertile ground for different kinds of fisheries. *Engraulis encrasicolus* and *Sardina pilchardus* are the main target of the small pelagic fishery in Italy and Croatia and represent more than 80% of the catches.

Two kinds of fishing gears are currently used to catch small pelagic species in the Adriatic sea: the mid-water pelagic trawl net towed by two vessels, mostly operating in the northern and central areas; the second gear is purse seine (purse seiners are the main gear operating in Croatia).

According to 2014 DCF data, Italian demersal fleet operating in GSA 17 is targeting mainly cuttlefish, spottail mantis shrimp, European hake, red mullet, and common sole. The Croatian demersal fleet operating in GSA 17 is targeting mainly common sole using set nets; common octopus and Norway lobster using traps; European hake and red mullet, using otter trawl, and European hake and gurnards using long lines. The Slovenian demersal fleet operating in GSA 17 is targeting mainly whiting, musky octopus common sole, common Pandora, gilthead sea bream.

In the GSA 18 the Italian demersal fleet is targeting mainly European hake, red mullet, cuttlefish, Norway lobster, deep water rose shrimp and spottail mantis shrimp. The demersal fishery takes place mainly on the entire continental shelf and on the continental slope of the southern Adriatic. The use of fixed gear is usually limited to the area unsuitable for trawling.

In the GSA29 the specific environmental traits of the Black Sea (e.g. low salinity) determine the low number of fish species (193), which is 2.3 times lower compared to the number of fish species in the Mediterranean (500) and the high sensitivity of the basin to the anthropogenic stress. Being a semi-closed sea and having shared stocks, the Black Sea countries are obliged to manage fishery resources with common measures. From six coastal countries, Turkey, Bulgaria and Romania have ratified GFCM, and recently the non -contracting party status was granted to Georgia and Ukraine in light of their increasing involvement in GFCM activities in the Black Sea (GFCM, 2015). Romania and Bulgaria became members of the EU in 2007. After the accession of Bulgaria and Romania to the EU and the position of Turkey as a candidate country, the Black Sea has become an area of interest to EU, in which all fishery activities need to be managed in accordance with the Common Fisheries Policy (CFP) rules.

The fishing effort, in terms of activity and capacity (fishing days and number of vessels) seems generally decreasing in the western Mediterranean (GSA06, 07, 09, 11) and in the Adriatic, although there are not detailed information available on the change in fishing power.

The preferential habitats of small pelagics, as well as the nursery and spawning grounds of demersal species have been studied in detail in the GSAs 06, 07, 9, 11, 17, 18 also thanks to the recent EU Project MEDISEH (Mediterranean Sensitive Habitats - MAREA Framework project). This information has been summarized in this project in the area pertinent to the case studies and can be thus used to suggest areas for protection.

Gaps, limitations, constraints regarding the case studies as highlighted from task 1.

i. Generally the assessed small pelagic species are fully representative of the production of small pelagic fisheries, while the situation is differentiated for the demersal fisheries, especially among fleet segments of vessels using polyvalent passive gears and, to a lesser extent, trawlers. For the latter, though with some exemptions, the assessed species are fairly representative of the demersal production.
ii. The availability of economic data in the western Mediterranean is limited and the level of aggregation is not in line with the biological one. This implies to make some assumptions in the simulations of bioeconomic modelling or deriving the data at a more fine aggregation level through estimation processes.
iii. In the Tyrrhenian sea acoustic surveys are not performed and thus fishery independent data are not available; this impedes the procedure of tuning commercial data in the assessment, that, in its turn, influences the robustness of assessment results.
iv. In many situations the economic and social indicators used to describe the current performance of the sector evidenced an existing situation of deterioration, revealed by the recent negative trend of the examined indicators: revenues, salary, employment and economic balance indicator.
v. Most of the considered small pelagics and demersal stocks are overexploited, in some situations are chronically overexploited (e.g. European hake in the Gulf of Lion), with the exemption of deep water rose shrimp in GSA9, that is sustainably exploited, and the stock of red mullet in GSA18.
vi. The review on the Black Sea has revealed some major gaps related to the information needed for the assessment of the turbot fisheries in the Black Sea and to design suitable management measures. Some of the major gaps are:

a. Catch data: low quality of official landings statistics by countries; lack of estimates of IUU fishing; lack of data about discards and by-catch rates of turbot in trawl and gillnet fisheries;

b. Fishing effort: scarce and not reliable data for some fleets; lack of standardized fishing effort data;

c. Fleet structure: lack of information about fleet segments structure from Ukraine, Russia and Georgia; lack of data about fishing capacity in Turkey,

d. Fishery-independent data: lack of survey data about turbot abundance from Georgia, Russia and Ukraine since 1997; incomplete data sets from Bulgaria and Turkey;

e. Lack of data about balance indicators from non-EU countries; f) Lack of data about economic performance from non-EU countries.

Results from task 2

For small pelagics in GSA17 and GSA18, all the performed scenarios allow to obtain a benefit on the SSB of the 2 stocks in respect of the status quo. The best performance for anchovy and sardine SSB is showed by Scenario 2 (respectively 23 % and 24 % higher than status quo). These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on this indicator if applied in a short time range. For both stocks the catches by fleet segment change according to the percentage of reduction applied and to the impact of the fleet segment on anchovy stock. A Multi-Criteria Decision Analysis approach shows that the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.548), while the scenarios allowing to reach the highest overall utility (overall utility about 0.75) were those using as reference point the exploitation rate E0.4, because they are less impacting the economic and social components.

For demersal stock in GSA06, the results of the projections show that, given the high ratio of current fishing mortality to F_{MSY}, the biomass of all stocks would strongly benefit from the required large reductions in fishing effort (80 to 90%, depending on the scenario). In the case of the more exploited species (European hake and blue whiting) reducing fishing effort towards F_{MSY} would imply an increase in landings shortly after 2018 or 2020. However, most of the stocks remained underutilized.

Overall, for **demersal resources in GSA07**, considering the results from the traffic lights approach, reducing the present high fishing mortality rates by 2018 (either the linear reduction to Fupper of the more overexploited stock or to the F_{MSY} combined) would allow increasing in the long term catches and revenues, wages, as well as spawning stock biomass, though at the price of a very significant loss of employment. Delaying the reduction of fishing mortality to 2020 would result in worse values of these indicators than at present, except for spawning stock biomass that would be kept at a high level. Improving selectivity allows to obtain from moderate to high increase in all indicators, keeping employment and vessels, but at the price of not complying with F_{MSY} targets.

For GSA9 small pelagic stocks, both the tested scenarios (reduction to 2018 or 2020) alternative to status quo allow to obtain a benefit in terms of SSB for both anchovy and sardine, and they appear to produce the same effect. Considering all fleet, the catches of anchovy are decreasing by a low percentage (around 1-3%), while those of sardine are expected to decrease by around 10%. Revenues and employment are expected to decrease similarly in the two scenarios, with a percentage around 3%. The reduction of employees is limited, given the limited amount of scraping. Salary and CR/BER (Current Revenues to Break Even Revenues) indicators are expected to improve in both scenarios of around 8-11%.

For GSA9 demersal stocks, all the scenarios alternative to the status quo produced an increase in SSB, although the best performance was shown by Scenarios based on Fupper as target. In all the scenarios, catches of all stocks showed a decreasing pattern, with the only exception of Scenario 6 (increase selectivity), which produced a slight increase in catches for European hake and Norway lobster. However, Scenario 6 was not improving the SSB of the four stocks as the other scenarios. In socio-economic terms, scenarios entail a high decrease in revenues, and a decrease in employment by about 5%.

For GSA11 demersal stocks, the SSB of all the three demersal stocks remarkably increased, especially that of European hake, and the better performing scenarios were those based on Fupper target. For European hake, catches will increase in the long term under all the scenarios alternative to the status quo. Instead, Stocks of red mullet and giant red shrimp will remain underutilised. Results showed decrease revenues in the fleet segments more affected by management measures.

For GSA17 demersal stocks, all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect of the status quo. The best performance for SSB is showed by the Scenario applied in a short timeframe (2018), consistently with the greater benefit that generally the reduction of fishing mortality produces on this indicator, if applied in a short time range. The worse result is observed in the status quo. According to the strategy by which the management measures have been applied, the Scenario using an F_{MSY} combined is more effective, given that, in the specific situation of the local fisheries, it implies a wider safeguard from an ecological perspective. This because the target stocks of the fleets are different, and not all the fleets are targeting the more exploited species (European hake) used as benchmark in the Fupper approach. From a social viewpoint, all alternative scenarios are expected to have a better impact on the average salary, that would improve in all scenarios, as a consequence of reduced costs determined by the remarkable decrease of activity, except in the scenario 6 (selectivity), which does not implies such cost reduction. As a consequence of this dynamic the CR_BER indicator will fairly improve in all scenarios (between 19 and 28%) except in scenario 6. The indicator ROI (Return of Investments) also will improve.

For GSA18 demersal stocks, on an overall basis, the best performing scenarios are the ones characterized by the strongest reduction in the shortest timeframe. The SSB would have remarkable rebuilding especially for Norway lobster and European hake. Considering all the fleets, the best results in terms of catches is produced by Scenario 6 (selectivity) compared to the status quo. This is quite reasonable, as change of selectivity affects the exploitation pattern, but the effort is unchanged. Considering the other scenarios, there is a worse result for catches of the 4 stocks in scenarios that apply the reduction in a prolonged time frame. The worst result is however observed in the status quo. The rebuilding of stocks such as European hake and Norway lobster would mitigate the situation of losses of stocks such as deep water pink shrimp and red mullet that will be underutilized. It should be considered that Italian trawlers are expected to have a performance worse than status quo in Scenarios based on Fupper. More particularly, all these fleet segments will have a severe reduction of revenues, up to -50%. As effect of cost reduction the overall economic performance is improving if the salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping. The indicator ROI will also improve.

Regarding the **case study on GSA29** – Black Sea (the present simulation studies encompassed that of the turbot fisheries in GSA 29), the most important management action would be to establish an effective control on the illegal fishing. If this is done, than a total ban on the fishery would bring the SSB above the reference points Blim and Bpa, by 2018 and 2020, respectively. On the other hand, successful recovery by 2020 is impossible, if IUU fishing is not controlled (continue fishing at its status quo level), by any option applied only to the "legal" fisheries, including their ban (but not stopping the IUU). Scenario versions with immediate or fast restrictive effects (e.g. linear reduction until 2018) are more efficient in achieving recovery, than delaying action (adaptive) scenarios, because of the heavily overfished state of the stock. Given that turbot stock is at its historical minimum (the STECF EWGs have repeatedly advised the closure of the fishery as the most appropriate management action that should be taken to assure the recovery of the stock) action should be taken. Our study demonstrates, that given the biological characteristics of the stock, a relatively fast recovery (in 5 years) can be achieved, by completely closing the fishery and not allowing any IUU fishing.

Spatial considerations

An analysis on the possibility of introducing management measures based on spatial considerations has been made using MEDITS (Mediterranean Trawl Survey) time series (chapter 9 of this report) and taking into account the results from MEDISEH project. There are parts of the populations of some key demersal species that could be protected extending the area to be forbidden to trawlers for example to 80-100 m depth, at least in some seasons (i.e. late spring-summer), when the young of the year of some key species are still present in more coastal waters. This will not, however, protect juveniles of those species as European hake, which concentrate in deeper waters (100-200mt of depth). In this case, measures for protecting nursery areas can complement the protection of the young of the year. Such areas were identified in the MEDISEH project and were overviewed in this project in task 1.

Assumptions and limitations regarding the case studies from task 2.

i. The limited number of stocks for which assessments are available, in some cases, can be a factor affecting the bioeconomic analysis. In addition, in some situations, the assessments go back to some years ago (for example 2010 for anchovy in GSA9, or 2011 for spottail mantis in GSA17). This implies to make some assumptions in the scenario modelling related to the fishing mortality and recruitment for the years following the benchmark time of the assessment.

ii. Stock-recruitment relationships are not available for almost all the stocks, thus geometric mean was used to project the stocks. This is considered a conservative approach, nevertheless, because the influence of environmental trends cannot be taken into account, the results of the scenarios should be considered as indicative.

iii. F_{MSY} ranges approach was applied to all case studies (except small pelagics in GSA9 in which E0.4 approach only was used). In some of the case studies this approach was also complemented by a combined F_{MSY}, or E0.4, depending on the stocks and fisheries. Is some situations, the approach of the F_{MSY} combined was helpful in taking more into account a multispecies component of the fisheries, in particular the underutilization of some stocks, though F_{MSY} of the more exploited stocks was not reached.

iv. The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly or will randomly change in the period 2015-2020.

v. The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability. However, even in presence of severe reductions, the effort limitations applied might be not enough to reach the F_{MSY} objectives, or be excessive, given that the effort used for setting the management measures is not, in most of the cases, a specific effort directed to the target species (for the multispecific nature of the Mediterranean fishery).

vi. The availability of economic data in the western Mediterranean is limited and the level of aggregation is not in line with the biological one. This will imply in the simulations of bioeconomic modelling to making some assumptions or deriving the data at a more fine aggregation level through estimation processes.

vii. To bring the stocks for which the ratio between the current fishing mortality and target fishing mortality is high (for example European hake with Fcurrent/F_{MSY} ratios ranging between 4 and 15) in safe conditions, strong reductions of fishing mortality are necessary.

Given the multispecies nature of Mediterranean fisheries and the co-occurrence of species with different life history traits and stocks with different productivity, drastic management measures will unavoidably imply an underutilization of some stocks.

viii. Large reductions in fishing mortality for stocks that have been subject to high exploitation rates for decades are difficult to achieve only with the current paradigm of effort control in the Mediterranean. This should be complemented with changes in exploitation patterns (gear selectivity, seasonal and spatial area closures).

ix. The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan to focus on stock-by-stock effort reduction to achieve individual stocks F_{MSY} (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile.

Results from task 3 - Perspectives from the stakeholders

The final workshop with the stakeholders was held in Malta on November 10, 2015, back to back with the MEDAC Executive Committee meeting.

The main items in the agenda were:

a. criteria, trajectories and MSY approach for the preparation of multiannual management plans in the Mediterranean;

b. management scenarios for the preparation of multi-annual management plans of demersal and pelagic stocks in selected GSAs (case study presentations);

c. general discussion.

The stakeholders underlined the utility of the project results for the MEDAC. It was highlighted the importance of considering the project results as an input for the internal work of the Advisory Council (AC). Indeed, the worst scenario for the AC would be if the European Commission would consider such project results like unilateral emergency measures to be taken. In such case, the AC would have lost the opportunity to negotiate the long term management plans. Taking into account the socio-economic impacts of a drastic reduction of the fishing effort (or fishing capacity), it was expressed the need to further explore how to achieve MSY by combining spatio-temporal measures with a less drastic reduction of fishing effort. Moreover, scenarios based on a weighted average F_{MSY} derived from a mix of species, instead of using the F_{MSY} range of the most heavily exploited species, were considered an appropriate alternative. Hopefully this view could be of interest for the European Commission and the Member States. On the other hands, it is duty of MEDAC to advice the Commission on which measures can be more welcomed by the fishing sector.

RÉSUMÉ

Objectifs de l'étude et tâches

L'objectif de l'étude est l'évaluation de scénarios spécifiques de la gestion de la pêche afin d'établir le plan pluriannuel pertinent en conformité avec les objectifs du PCP (Politique Commune de la Pêche) et les lignes directrices adoptées par le CGPM Commission Générale des Pêches pour la Méditerranée).

À ce fin, **quatre études** de cas ont été menés :

1. Petites pêcheries pélagiques et démersales du Golfe du Lion et du Nord de l'Espagne (sous-régions géographiques - GSA6 et 7);
2. Petites pêcheries pélagiques et démersales en Ligure, du Nord de la mer Tyrrhénienne et de la Sardaigne (GSA8, 9 et 11);
3. Petites pêcheries pélagiques et démersales de la mer Adriatique (GSA17 et 18);
4. Pêcheries ciblant le turbot et les espèces associées à ce dernier dans la Mer Noire (GSA 29).

Dans le projet ont été envisagés deux scénarios de gestion pour chacun des études de cas menées:

- Atteindre le rendement maximal durable - MSY - d'ici 2018;
- Atteindre le MSY d'ici 2020.

Le projet est organisé en quatre tâches :

- ***Tâche 0 - Organisation du travail : coordination du projet et gestion ;***
- ***Tâche 1 - l'état de l'art ;***
- ***Tâche 2 - rendement maximal durable ;***
- ***Tâche 3 - Coopération régionale.***

Parmi les activités de coordination on a choisi un sharepoint qui a été approvisionné avec la documentation collectionnée.

Afin de mener des études de cas en utilisant les informations les plus actualisées on a activé une communication de données (Data Call) et une lettre de présentation a été préparée par la Commission Européenne afin de faciliter l'accès à ces informations sur le plan national.

L'atelier technique du projet ayant comme but celui de valider les résultats des stratégies de gestion basées sur l'MSY ou basées sur des points de référence liés à ce dernier (par ex. niveau de mortalité par pêche F_{MSY}, $F_{0.1}$) pour les différentes études de cas a eu lieu à Bari, du 21 au 25 de septembre 2015.

Les objectifs principaux de la tâche 1 ont été :

- Identification et description des stocks cibles (biologie, état, distribution géographique, etc.) (sous-tâche 1.1);
- Identification et description des pêcheries, quantification en termes de numéro de navires, captures, rejets en mer, effort moyen déployé et performance économique de ces pêcheries (sous-tâche 1.2);
- Description des mesures de gestion actuelles sur le plan national, Européen et International (sous-tâche 1.3).

Ce travail a été mené pour les 4 études de cas spécifiés précédemment..

Les objectifs principaux de la tâche 2 ont été :

- ✓ Identifier les éléments principaux qui contribuent à définir l'MSY;
- ✓ Analyser les différentes options de gestion pour atteindre les objectifs du MSY;

- ✓ Étudier comme les mesures techniques peuvent influencer le modèle d'exploitation qui permet d'atteindre les objectifs du MSY, évaluer les conséquences biologiques et économiques de l'implémentation des objectifs du MSY en deux temps, d'ici 2018 et d'ici 2020.

L'objectif principal de la tâche 3 a été d'établir une interaction avec les parties intéressées (Stakeholders), en particulier avec le Conseil Consultatif Méditerranéen MEDAC à travers l'organisation d'une rencontre visée à la présentation, discussion des résultats du projet et à la réception de commentaires.

Méthodes appliquées

Les méthodes appliquées dans la tâche 1 ont été fondées sur l'analyse des papiers concernant le sujet, de la « littérature grise », des rapports du STECF et des analyses des données reçues des Autorités Nationales et grâce à la « Data Call ».

La tâche 2 a été basée sur une modélisation bioéconomique. Dans les études menées sur des petites pêcheries pélagiques en GSA17 et GSA18; sur des petites pêcheries pélagiques en GSA9; sur des pêcheries démersales en GSA17, GSA18, GSA9 et GSA11, des projections de gestion des différentes zones ont été faites avec le modèle BEMTOOL. BEMTOOL (Bio Economic Management tool) est une plateforme bioéconomique qui incorpore 6 modèles opérationnels (biologique, de pression, économique, comportementale, politique/gestion de capture et une analyse des décisions multicritères - MCDA) caractérisés par des composantes qui communiquent entre eux à travers des relations fixes et des équations. Le modèle MCDA facilite l'évaluation des performances des différents scénarios de gestion des pêcheries et sur le plan biologique et sur le plan socioéconomique, en utilisant une sélection d'indicateurs pour l'implémentation de mesures de gestion par rapport aux objectifs. BEMTOOL suit une démarche multi-flotte qui simule les effets causés par une gestion des trajectoires des stocks et des pêcheries sur une échelle de temps relativement petite (en mois). Le modèle analyse les effets d'une sélection spécifique basée sur longueur/âge, rejets en mer, performances économiques et sociales, les effets de la conformité avec l'obligation de débarquement et les points de référence.

Dans l'étude de cas concernant les pêcheries démersales en GSA06 et GSA07, le modèle a été basé sur le modèle bioéconomique MEFISTO, modifié pour l'étude courant afin de produire les adaptations nécessaires pour répondre aux termes de Tender, en particulier, le scénario 6 et les nouveaux indicateurs économiques.

L'incertitude du recrutement (erreur de processus) implémenté dans les modèles qui suivent le paradigme de Monte Carlo, permet de faire une évaluation des risques en termes de durabilité biologique des différentes stratégies de gestion. L'incertitude est ainsi partagée par tout indicateur considéré par le modèle.

L'encadrement utilisé pour les points de référence est basé sur F_{MSY} (généralement les ressources les plus exploitées) en utilisant Fupper pour le calcul des gammes de F_{MSY}. On a appliqué une Évaluation de la Stratégie de Gestion (MSE - Management Strategy Evaluation) pour tester si l'exploitation du stock jusqu'aux limites imposés par les gammes du F_{MSY} était en sécurité. Alternativement, en suivant l'approche des Indicateurs d'équilibre (Balance Indicators: http://stecf.jrc.ec.europa.eu/reports/balance), on a appliqué un F_{MSY} combiné entre les stocks considérés. Ce F_{MSY} combinée a été obtenu par la moyenne pondérée de la F_{MSY} des stocks uniques de la même pêcherie, en appliquant leur valeur économique comme facteur de pondération.
Pour des petits stocks pélagiques a été utilisé un taux d'exploitation E0.4, de manière complémentaire à Fupper ou comme alternative, en fonction des caractéristiques de l'analyse d'évaluation.

En considérant les possibles conséquences sociales et économiques de la réduction de l'effort pêcher, les scénarios ò modeler ont été projetés en deux périodes de temps (2018 et 2020), en considérant deux différentes méthodes de réduction: linéaire et adaptive.

Les résultats ont été exprimés et évalués d'un point de vue et biologique et économique en suivant une approche «traffic light» outre que le MCDA de BEMTOOL.

Résultats de la tâche 1

La zone relative au **cas étudié**, c'est-à-dire petites pêcheries pélagiques et démersales du Golfe du Lion et du Nord de l'Espagne **(GSA06 et GSA07)** concerne les côtes de l'Espagne et de la France. Les espèces benthiques et démersales sont pêchées par flottes de chalutiers semi-industriels des deux pays et par d'autres navires artisanaux. Les principales typologies de navires utilisés à ce propos sont : chalutiers, le filets maillants et les palangres pour poissons démersales. Séries chronologiques de données de DCF à propos des variables biologiques, des débarquements et de l'effort sont disponibles pour France et Espagne, organisées par métier à niveau de GSA, pendant que les variables transversales (débarquements et effort) sont organisées par segment de flotte sur un niveau sous-régional (par ex. FAO sous-zone 37.1.2 pour le Golfe du Lion). Les données économiques sont disponibles à niveau supra-régional (FAO Zone 37) pour la France. Pour les GSA 06 et 07 il y a une proposition de la Commission Européenne pour un plan pluriannuel concernant les pêcheries démersales. Ce plan devrait couvrir les stocks démersales, en particulier les stocks de merlu Européen (*Merluccius merluccius*), rouget de vase (*Mullus barbatus*), merlan bleu (*Micromesistius poutassou*), baudroies (*Lophius* spp.), capelan de Méditerranée (*Trisopterus minutus capelanus*); et pour les crustacés: la crevette rose du large (*Parapenaeus longirostris*), la crevette rouge (*Aristeus antennatus*) et la langoustine (*Nephrops norvegicus*). Les récents évaluations des stocks ont tenté sur les petites pélagiques (sardines et anchois) dans les deux GSA n'étaient pas basées sur des méthodes structurés selon l'âge ou de qualité insuffisante pour être acceptée (sauf pour les sardines du GSA06 de 2013 en EWG14-19), mais en considérant l'importance de l'anchois comme principales espèces de la pêche et l'absence d'une évaluation récente du stock, le scénario de modélisation pour les petites pélagiques n'a pas été réalisée.

L'étude de cas menée sur les GSA 8,9 et 11 concerne les côtes de deux pays Européens : La France et l'Italie, en particulier la Mer Ligure, la Mer Tyrrhénienne du nord et central et les mers autour de la Sardaigne. Les caractéristiques écologiques sont très hétérogènes, produisant ainsi une variété d'habitats et communautés biologiques. La grande majorité des navires opérants (environ 3300) es liée à des petites pêcheries, tandis que le chalutage est utilisé par 640 navires, quasi exclusivement localisés en GSA 9 et 11. La production dans cette zone est exploitée presque complètement par GSA9, en particulier grâce aux chalutiers et aux senneurs à senne coulissante. Des pêcheries aux petites pélagiques existent seulement en GSA9, où actuellement 50 senneurs à senne coulissante travaillent activement. D'entre ces pêcheries des petites pélagiques, l'anchois est sans doute l'espèce la plus importante et en termes de débarquement et en termes de valeur économique. Plusieurs stocks démersales, comme le merlu Européen, les rougets de vase et les langoustines sont présents et en GSA9 et en GSA11, même s'il y a des différences (par ex. la crevette rose du large et le poulpe blanc sont plus importants en GSA9, tandis que le gambon rouge est plus importante en GSA11). Pour ce qui concerne les stocks démersales, les données sont incomplètes et fragmentaires **en GSA8**, où seulement des données chronologiques dérivées des campagnes au chalut (MEDITS) sont disponibles, tandis que **l'evaluation des stocks n'est pas disponible**. Les données économiques relatives à la pêche ne sont pas disponibles pour ce GSA et donc ces données n'ont pas été inclus dans la modélisation de scénario.

La mer Adriatique (GSA17 et GSA18) est caractérisée par la plus grande plateau continental de la Méditerranée. Son remarquable habitat marine et côtier fournit un valable écosystème et offre un terrain fertile pour plusieurs typologies de pêcheries. *Engraulis encrasicolus* et *Sardina pilchardus*

représentent les cibles principales de la pêcherie aux petite poissons pélagiques de l'Italie et de la Croatie et représentent le 80% des captures.
Deux types d'engins de pêche sont couramment utilisés pour capturer les petites espèces pélagiques dans la mer Adriatique : le chalutier de moyenne profondeur avec un filet de pêche remorqué par deux bateaux, méthode utilisée surtout dans les zones centrales et du nord. Le second engin travaille avec une seine coulissante: les senneurs à seine coulissante sont les principaux engins utilisés en Croatie.
Selon les données de 2014 du DCF, la flotte italienne démersale opérant en GSA17 a comme cibles: seiche, squille ocellée, merlu, rouget de vase et sole commune. La flotte démersale croate qui opère en GSA17 a comme cibles: sole commune en utilisant des filets fixes; le poulpe commun et la langoustine en utilisant des pièges; le merlu Européen et le rouget de vase, en utilisant des chaluts et le merlu Européen et le grondin en utilisant des palangres. La flotte démersale slovène qui opère en GSA17 a comme cibles : le merlu, la pieuvre musquée, la sole commune, le pageot commun et la dorade royale.
En GSA18 la flotte démersale italienne a comme cible principalement le merlu européen, le rouget de vase, la seiche, la langoustine, la crevette rose du large et les squille ocellée. Le pêcherie démersale a lieu principalement sur la totalité de le plateau continental et sur le talus continental. L'utilisation d'un engin fixe est normalement limitée aux zones inadaptées pour le chalutage.

En GSA29 les traits écologiques spécifiques de la Mer Noire (par ex. faible salinité) déterminent un numéro inférieur d'espèces de poisson (193), c'est-à-dire 2,3 fois en moins par rapport au numéro d'espèces présentes dans la Méditerranée (500) et la haute sensibilité du bassin au stress anthropique. En étant une mer presque fermée et en ayant des stocks partagés, les pays qui donnent sur la Mer Noire ont l'obligation de gérer les ressources de pêche de manière partagée. Des six pays côtiers impliqués: Turquie, Bulgarie, et Roumanie ont ratifié GFCM et récemment on a reconnu à la Géorgie et à l'Ukraine, à la lumière de leur participation croissante aux activités du GFCM dans la Mer Noire (GFCM, 2015), le statut de « partie non contractante ». Roumanie et Bulgarie sont devenus membres de l'Union Européenne en 2007. Après l'adhésion de Bulgarie et Roumanie à l'UE et après l'acceptation de la Turquie comme pays candidat à l'adhésion, la Mer Noire est devenue une zone très intéressante de l'UE où toute activité de pêche doit être gérée selon les normes du PCP (Politique Commune de la Pêche - Common Fishery Policy).

L'effort de pêche, en termes d'activité et capacité (jours de pêche, numéro de navires utilisés) semble généralement décroissant dans la mer Méditerranéenne (GSA06, 07, 09, 11) et dans la mer Adriatique, même s'il y a un manque d'informations à propos du changement de la capacité de capture.

L'habitat préféré pour les petits pélagiques, comme pour les nourriceries et zones de frai des espèces démersales ont été étudiés en détail dans le GSA 06, 07, 9, 11, 17, 18 et grâce au récent projet MEDISEH (Mediterranean Sensitive Habitats - projet-cadre MAREA). Cette information a été résumée dans ce projet dans la partie pertinente aux cas d'étude et pourtant elle peut être utilisée pour suggérer des zones de protection.

Lacunes, limitations, contraintes concernant les cas d'étude comme soulignés en tâche 1.

i. Généralement les petites espèces pélagiques évaluées représentent pleinement la production des petites pêcheries pélagiques, tandis que la situation est différente pour les pêcheries démersales, en particulier quand on analyse les segments de flotte des navires en utilisant des engins passifs polyvalents et dans une moindre mesure, les chalutiers. Pour ces derniers, avec quelques exceptions, les espèces analysées sont relativement représentatives de la production démersale.

ii. La disponibilité de données économiques de l'ouest Méditerranéen est limitée et le niveau d'agrégation n'est pas en ligne avec le niveau des données biologiques. Cela a déterminé qu'on a fait quelques assomptions et dans la simulation du modèle bioéconomique et dans la dérivation des données au niveau le plus détaillé de l'agrégation à travers un processus d'estimation.

iii. Dans la mer Tyrrhénienne les campagnes acoustiques ne sont pas menés et pour cette raison il n'y a pas de données indépendantes sur la pêche; cela empêche le procédé de syntonisation de données commerciales, en affectant, inévitablement, la robustesse des résultats de l'évaluation.

iv. Dans des plusieurs situations les indicateurs sociaux et économiques utilisés pour décrire la performance courante du secteur ont souligné une situation préexistante de détérioration, mise en évidence par une récente tendance dans les indicateurs analysés: les revenus, les salaires, les politiques d'emploi et les indicateurs d'équilibre économique et biologique.

v. La plupart des petits stocks pélagiques et démersales sont surexploités, parfois ils sont chroniquement surexploités (par ex. le merlu Européen dans le Golfe du Lion), à l'exception de la crevette rose du large en GSA9, qui est durablement exploitée, et le stock de rouget de vase en GSA18.

vi. L'examen de la Mer Noire a montré certaines lacunes principales relatives à l'information nécessaire pour l'évaluation de la pêcherie du turbot dans la Mer Noire afin de concevoir des mesures de gestion appropriées. Les lacunes majeures sont:

   a. Données de capture : faible qualité des statistiques relatives aux débarquements officiels pour chaque pays ; manque d'estimations de la pêche INN; manque de données relatives aux rejets en mer et niveaux de captures accessoires de turbot avec le chalut ou avec la pêche au filet maillant;
   b. Effort de pêche : données incomplètes et non fiables pour certaines flottes ; manque d'une standardisation des données relatives à l'effort de pêche;
   c. Structure de la flotte : manque d'informations à propos des segments des flottes depuis l'Ukraine, la Russie et la Géorgie; manque de donnée sur la capacité de pêche en Turquie;
   d. Données de pêche indépendante: manque de données d'enquête à propos de l'abondance de turbot en Géorgie, Russie et Ukraine depuis 1997 ; Bases de données incomplètes provenant de Bulgarie et Turquie;
   e. Manque de données des indicateurs d'équilibre économique et biologique depuis les pays non-UE;
   f. manque de données à propos de la performance économique des pays non-UE.

Résultats de la tâche 2

Pour le petits pélagiques en GSA17 et GSA18 tout scénario analysé permet un avantage du SSB de 2 stock par rapport au status quo. La performance meilleure de SSB pour l'anchois et la sardine est montrée dans le scénario 2 (respectivement 23% et 24% plus que le status quo). Ces résultats semblent compatibles avec l'avantage que généralement la réduction du niveau de mortalité par pêche des poissons produit sur les indicateurs quand on l'applique à un court laps de temps. Pour les deux stocks, les captures par segment de flotte changent conformément au pourcentage de réduction appliquée et à l'incidence du segment de flotte sure le stock d'anchois. Une Analyse Décisionnelle Multicritères, montre que l'utilité plus baisse est donné par le scénario 1, i.e. Status quo (utilité globale de 0.548), tandis que les scénarios permettant de rejoindre les niveaux d'utilité globale les plus hautes (utilité globale de 0.75) ont été ceux qui ont utilisé le taux d'exploitation E0.4 comme point de référence en raison d'un moindre impact sur les composants sociaux et économiques.

Pour les stocks démersales en GSA06, les résultats de la prévision montrent que, considérant le niveau actuelle de mortalité par pêche, la F_{MSY}, la biomasse de tout stock pourrait tirer profit des demandes de réduction de l'effort de pêche (de 80% à 90% selon le scénario). Dans le cas des espèces les plus exploitées (merlu Européen et merlan bleu) diminuer l'effort de pêche vers la F_{MSY} pourrait augmenter les débarquements peu après le 2018 ou 2020. Toutefois la plupart de stocks est restée sous-utilisée.

Globalement pour les **ressources démersales en GSA07**, en considérant les résultats de l'approche «traffic light», qui vont réduire le taux de mortalité par pêche jusqu'au 2018 (et la réduction linéaire pour rejoindre le Fupper du stock le plus exploité et la réduction pour rejoindre le F_{MSY} combiné) permettrait dans la longue période une amélioration des captures, revenus, salaires et aussi de la biomasse du stock reproducteur, mais au prix d'une perte très importante de l'emploi. Retarder la réduction de la mortalité par pêche à 2020 pourrait résulter en pire valeurs des indicateurs par rapport à aujourd'hui, exception faite pour la biomasse du stock reproducteur que qui restera à un haute niveau. L'amélioration de la sélectivité permet d'obtenir une amélioration des indicateurs qui passeront de niveau moyen à un niveau haut, en sauvegardant les emplois et la flotte, mais au prix de ne pas respecter les objectifs de $F_{MSY.}$

Pour ce qui concerne les petits stocks pélagiques en GSA9, les deux scénarios testés loin du status quo (réduction au 2018 ou 2020) permet d'obtenir une amélioration en termes de SSB dans les deux stocks, ils semblent en effet produire le même effet. En considérant toute flotte, les captures d'anchois sont en train de diminuer (environ 1-3%) tandis que pour les captures de sardines on attend une diminution d'environ 10%. Pour les revenus et les emplois on attend une diminution similaire en deux scénarios avec une pourcentage d'environ 3%. La réduction d'employés est limitée, étant donné le niveau limité de réduction de le nombre des bateaux de pêche. Les salaires et les indicateurs CR/BER (Current Revenues to Break Even Revenues) devraient augmenter et améliorer dans les deux scénarios d'environ 8-11%.

Pour ce qui concerne les stocks démersales en GSA9, tout scénario différent du status quo a produit une augmentation en SSB, bien que la meilleure performance ait été développée par les scénarios basée sur le niveau cible Fupper. Dans tout scénario, les captures de tout stock ont montré une diminution, exception faite pour le scénario 6 (sélectivité augmentée), qui a produit une légère augmentation des captures du merlu Européen et de la langoustine. De toute façon le scénario 6 n'a pas amélioré le SSB des quatre stocks comme dans les autres scénarios. En termes socioéconomiques, les scénarios comportent une haute diminution des revenus, et une diminution des emplois d'environ 5%.

Pour ce qui concerne les stocks démersales en GSA11, les SSB de tout démersal stock ont augmenté remarquablement, spécialement ceux du merlu Européen où les scénarios les plus performants ont été ceux ayant un cible Fupper. Pour le merlu Européen, les captures vont augmenter à long terme en tout scénario différent du status quo. Les stocks de rouget de vase et de gambon rouge vont rester donc sous-utilisés. Les résultats ont montré une diminution des revenus dans les segments de flotte plus affectés par des mesures de gestion.

Pour les stocks pélagiques en GSA17, tout scénario analysé permet un avantage sur le plan du SSB de 4 stocks par rapport au status quo. La meilleure performance pour SSB est montrée par le scénario appliqué dans un délai très court (2018), en cohérence avec le plus grand bénéfice que généralement la réduction de la mortalité par pêche produit sur ces indicateurs si appliqués dans un délai très court. Le résultat le plus mauvais est observé dans le status quo. Selon la stratégie appliquée avec ses mesures de gestion, le scénario utilisant une F_{MSY} combinée est plus efficace, étant donné que dans cette situation spécifique les pêcheries locales sont sauvegardée le plus du point de vue écologique. Cela parce que les stocks cibles des flottes sont différents, pas toutes les flottes ont comme cible les espèces les plus exploitées (merlu Européen) utilisé en qualité de critère dans l'approche Fupper. D'un point de vue social, tout scénario alternatif semble avoir une incidence meilleure sur le salaire moyen, cela pourrait améliorer dans tout scénario comme conséquence de la réduction des coûts, étant donnée la diminution remarquable de l'activité, exception faite pour le scénario 6 (sélectivité), qui ne implique pas cette réduction des coûts. Comme conséquence de cette dynamique, l'indicateur CR_BER va améliorer dans tout scénario (entre 19 et 28%), sauf dans le scénario 6. L'indicateur ROI (Return of Investments) améliorera également.

Pour les stocks démersals en GSA18, globalement, les scénarios les plus performants sont ceux caractérisés par la plus forte réduction dans un délai nettement court. L'SSB pourrait avoir un taux de reconstitution remarquable, spécialement pour la langoustine et pour le merlu Européen. En considérant toutes les flottes, les résultats meilleurs en termes de captures se produit dans le scénario 6 (sélectivité) comparée au status quo. Ce qui est raisonnable est que comme un changement de sélectivité influence le modèle d'exploitation, l'effort reste inchangé. En considérant les autres scénarios, il y a un pire résultat dans les captures des 4 stocks dans les scénarios qui appliquent la réduction dans un délai de temps prolongé. Le pire résultat est toutefois observé dans le status quo. La reconstitution des stocks comme pour le merlu Européen et la langoustine atténuerait la situation des pertes de stocks comme celle de la crevette rose du large et du rouget de vase que seront sous-utilisés. On devrait considérer que les chalutiers italiens devraient avoir une performance pire par rapport au status quo dans les scénarios basés sur Fupper, en particulier tout segment de flotte devrait avoir une sévère réduction des revenus, jusqu'à -50%. En qualité d'effet de la réduction des coûts, globalement, la performance économique peut améliorer au moment où l'indicateur CR/BER et les salaires sont considérés. La réduction d'employés est limitée, étant donné le niveau limité de réduction de le nombre des bateaux de pêche. L'indicateur ROI améliorera également.

En considérant **le cas d'études de GSA29** - La Mer Noire, cet étude de simulation englobe l'idée que dans le cas des pêcheries de turbot en GSA29, l'action la plus importante du point de vue de la gestion serait celle d'établir un contrôle effectif sur la pêche illégale. Une fois qu'on a fait cela, une interdiction absolue de la pêche pourrait mener le SSB au-dessus de Blim et Bpa, respectivement en 2018 et 2020. D'un autre côté, une reprise de succès d'ici 2020 est impossible, si la pêche de l'IUU n'est pas contrôlée (pêche continuée aux niveaux du status quo) avec toute option appliquée aux pêcheries « légales », interdiction absolue incluse (mais sans arrêter l'IUU). Versions de scénario avec effets restrictifs rapides or immédiats (par ex. Réduction linéaire jusqu'à 2018) sont plus efficaces pour reconstituer les stocks par rapport à scénarios (adaptatifs) avec un retard dans l'action, à cause de l'état fortement surexploitée du stock. En considérant que le stock de turbot est actuellement aux niveaux les plus bas dans son histoire (le STECF EWGs ont conseillé à plusieurs reprises la fermeture de la pêche comme l'action la plus appropriée afin de garantir la reconstitution du stock), une action devrait être menée. Notre étude montre que, étant données les caractéristiques biologiques du stock, une reconstitution plutôt vite (environ 5 ans) peut être obtenue à travers une fermeture complète de la pêche et ne pas permettant pêche de l'IUU.

Considérations spatiales

Une analyse sur la possibilité d'introduire des mesures de gestion basées sur des considérations spatiales a été réalisée en utilisant le série temporelle MEDITS (Mediterranean Trawl Survey) (chapitre 9 de ce report) et en tenant compte des résultats du projet MEDISEH (projet-cadre - MAREA). Il y a des parties des populations de certaines d'espèces démersales clé que pourraient être sauvegardées en agrandissant la zone interdite aux chalutiers même à plus 50 mètres de profondeur et, par exemple, à 80-100 mètres de profondeur, au moins dans certaines saisons (i.e. fin de printemps-été), quand les recrues de certaines espèces clé sont encore présentes dans les eaux côtières. Malheureusement, cela ne va pas protéger les juvéniles de certaines espèces comme le merlu Européen, car les jeunes poissons de cette espèce se concentrent à des profondeurs plus hautes (100-200 mètres de profondeur). Dans ce cas, des mesures de protection des zones de nurserie peuvent compléter la protection des jeunes poissons de l'année. Ces zones ont été identifiés dans le projet MEDISEH et nous les avons analysées dans ce projet à la tâche 1.

Assomptions et limitations concernant les cas d'étude de la tâche 2.

i. Le numéro limité de stocks pour lequel des évaluations sont disponibles, dans certains cas, peut être un facteur qu'influence l'analyse bioéconomique. En plus, dans certaines situations, l'évaluation est plutôt datée (par exemple 2010 pour les anchois en GSA9, ou 2011 pour les squille ocellée en GSA17). Cela oblige à faire des assomptions dans la modélisation de scénario par rapport à la mortalité par pêche et le recrutement dans les années suivants au point de repères temporels de l'évaluation.

ii. Les relations entre stock et recrutement ne sont pas disponibles pour tout stock, et pour cette raison on a utilisé des moyens géométriques pour projeter les stocks. Cet approche est considéré comme conservateur, néanmoins, parce que l'influence de l'environnement ne peut pas être prise en considération, les résultats des scénarios devrait être considérés comme indicatifs.

iii. L'approche F_{MSY} range a été appliquée à tout cas d'études (exception faite pour les petits pélagiques en GSA9 où on a utilisé seulement l'approche E0.4). Dans certains cas d'études cet approche était complété par l'approche F_{MSY} combiné et l'approche E0.4, en fonction des stocks et des pêcheries. Dans certaines situations, l'approche F_{MSY} combiné a été d'aide en permettant une analyse multi-espèce des pêcheries, en particulier la sous-utilisation de certains stocks, cependant le F_{MSY} des stocks les plus exploités n'a pas été atteint.

iv. Les méthodes supposent que la situation bioéconomique actuelle (recrutement, abondance de stock, structure des coûts, prix des poissons et des combustibles) ne va pas changer fortement ou changera de manière aléatoire dans la période de temps 2015-2020.

v. La réduction de la mortalité par pêche se traduit linéairement en une réduction de l'effort de pêche (manque d'autres informations spécifiques), sous l'assomption d'une quasi constante ou aléatoirement variable capturabilité. Toutefois, même en présence de sévères réductions, les limitations d'effort appliquées pourraient ne pas être suffisantes à rejoindre les objectifs de l'F_{MSY} ou même pourraient être excessives à ce propos, étant donné l'effort utilisé pour régler les mesures de gestion n'est pas, dans la plupart des cas, un effort spécifique adressé à des espèces cibles (pour la nature multi-spécifique de la pêche Méditerranéenne).

vi. La disponibilité de données économiques de l'ouest Méditerranéen est limitée et le niveau d'agrégation n'est pas en ligne avec le niveau biologique. Cela va impliquer que dans les simulations du modèle bioéconomique il y aura des assomptions car la dérivation des données au niveau le plus détaillé de l'agrégation sera réalisée à travers un processus d'estimation de données.

vii. Pour amener les stocks pour lesquels le rapport entre l'actuelle mortalité par pêche et la mortalité de pêche cible est haute (par exemple au cas du merlu Européen avec un rapport Factuel/F_{MSY} peut osciller entre 4 et 15) dans des conditions de sécurité, des grandes réductions dans la mortalité des poissons sont nécessaires. Étant donnée la nature multi-espèce des pêcheries méditerranéennes et la cooccurrence d'espèces avec différents histories de vie et stocks avec différente productivité, des mesures de gestion drastique impliquent nécessairement une sous-utilisation de certains stocks.

viii. Une haute réduction de la mortalité par pêche pour les stocks qui ont été surexploités pour des décennies, est difficile à obtenir avec les paramètres actuels de contrôle de l'effort dans la Méditerranée. Cela devrait être complété avec des changements dans le modèle d'exploitation (sélectivité de l'engin, fermetures saisonnières et fermetures spatiales de zones entières).

ix. La flotte démersale a un accès légal à tous les stocks démersaux, et donc ce n'est pas possible, dans le cadre du plan de gestion actuel, de mettre l'accent sur une réduction d'effort visée à analyser individuellement chaque stock F_{MSY} (cela pourrait minimiser le problème de la sous-utilisation d'un stock). En outre, les segments de flotte sont hétérogènes par rapport à la capturabilité, coûts et sélectivité des engins de pêche.

Résultats de la tâche 3 - Perspectives des parties intéressées (Stakeholders)

L'atelier final avec les parties intéressées s'est tenu en Malte le 10 Novembre 2015 dos à dos avec la réunion du Comité de Direction de MEDAC.

Les éléments les plus importants de l'ordre du jour ont été:

a. Critères, trajectoires et approche MSY pour la préparation des plans pluriannuels de gestion de la Méditerranée;
b. Scénarios de gestion pour la préparation des plans pluriannuels de gestion des stocks démersals et pélagiques dans des zones sélectionnées du GSA (présentation des cas d'études);
c. Discussion générale.

Les parties intéressées (Stakeholders) ont souligné l'utilité des résultats du projet pour le MEDAC. L'importance des résultats a été souligné et ces derniers ont été marqués comme une contribution au travail interne du Conseil Consultatif (Advisory Council - AC). Enfin, le pire scénario pour l'AC serait que la Commission Européenne considère les résultats du projet seulement comme des mesures unilatérales à prendre en cas d'émergence. Dans ce cas, l'AC aurait perdu la possibilité de négocier un plan de gestion à long terme. En considérant l'effet socioéconomique d'une drastique réduction de l'effort de pêche (ou de la capacité de pêche), le besoin d'une ultérieure investigation a été souligné pour ce qui concerne la réalisation de MSY à travers des mesures de gestion spatio-temporelles combinées avec une réduction moins drastique de l'effort de pêche. De plus, les scénarios basés sur une moyenne pondérée de F_{MSY} dérivée d'un ensemble d'espèces ont été considérés comme l'alternative la plus appropriée au lieu d'utiliser l' approche de F_{MSY} range des espèces les plus exploitées. Heureusement, cette vue pourrait accroitre l'intérêt de la Commission Européenne et des États Membres. Par ailleurs, c'est une obligation de MEDAC de fournir des conseils à la Commission à propos des mesures les plus ou moins appréciées par le secteur de la pêche.

SUMMARY SHEETS

1.0 SUMMARY SHEET ON THE CASE STUDY OF SMALL PELAGIC FISHERY IN GSA 17 AND GSA18

Engraulis encrasicolus and *Sardina pilchardus* are the main target of the small pelagic fishery in Italy and Croatia and represent more than 80% of the catches.
Two kind of fishing gears are currently used to catch small pelagic species in the Adriatic sea: the mid-water pelagic trawl net towed by two vessels, mostly operating in the northern and central areas. The second gear is purse seine that is the main gear operating in Croatia.

Fisheries: Small pelagic fisheries in the Adriatic sea

GSA: GSA 17 and GSA 18

Stocks assessed: anchovy (*Engraulis encrasicolus*); sardine (*Sardina pilchardus*)

Fleets involved

10 main fleet segments operating in the Adriatic, by country, geographical sub-areas, fisheries and vessel length stratum have been identified (Table. 1.0.1). Small pelagic is a mixed fishery with a higher catch of sardine in the eastern side, whilst of anchovy in the western side. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 1.0.1.

Table 1.0.1 - Main fleet segments involved in the small pelagics fishery in GSA17 and GSA18. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	*Fleet code*	*% of landings (all species)*
1	Italian GSA17 pelagic trawlers with vessel length 12-18 m	ITA17_TM_1	6.2
2	Italian GSA17 pelagic trawlers with vessel length 18-24 m	ITA17_TM_1	7.7
3	Italian GSA17 pelagic trawlers with vessel length 24-40 m	ITA17_TM_2	16.2
4	Italian GSA17 purse seine with vessel length 24-40 m	ITA17_PS_2	2.4
5	Croatian GSA17 purse seine with vessel length 12-18 m	HRV17_PS_1	5.7
6	Croatian GSA17 purse seine with vessel length 18-24 m	HRV17_PS_1	18.8
7	Croatia GSA17 purse seine with vessel length 24-40 m	HRV17_PS_2	34.7
8	Slovenian GSA17 purse seine with vessel length 12-18 m	SVN17_PS_1	0.1
9	Italian GSA18 pelagic trawlers with vessel length 24-40 m	ITA18_TM_2	6.5
10	Italian GSA18 purse seine with vessel length 24-40 m	ITA18_PS_2	1.7

Effort of these fleets is stable or decreasing in GSA18 western side and GSA17 eastern side.

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the total production of the small pelagics is reported in the table 1.0.2. This contribution is represented by the production of a single species (e.g. anchovy) in a given GSA (e.g. GSA17) in a given country (e.g. Italy) to the total production of the small pelagics fishery (all the species) in the same GSA and country. The average of the production (by species and overall) of the last three years has been used for computation.

For the small pelagic fishery in GSA17 and GSA18, the assessed stocks account for percentages comprised between about 67% (Slovenia) to about 95% (Italy GSA18).

It is worth mentioning that Croatian data are under revision.

Table 1.0.2 Contribution of the stocks assessed (for a given stock in a given GSA and country) to the production volume (all species of the small pelagic fishery in a given GSA and country) of the main fleet segments of small pelagic fisheries in GSA17 and GSA18 (the percentage is computed on the average production of the last three years).

Stock	***Percentage*** *(%) (average last three years)*
Anchovy GSA17 Italy	54
Sardine GSA17 Italy	37
Anchovy GSA17 Slovenia	39
Sardine GSA17 Slovenia	28
Anchovy GSA17 Croatia	17
Sardine GSA17 Croatia	76
Anchovy GSA18 Italy	85
Sardine GSA18 Italy	9

Development of stocks over time and current status

The assessment of anchovy and sardine was presented during the EWG-15-11 (STECF 15-14). This assessment used DCF data together with the historical time series available for GSA17 and GSA18 from 1975 to 2013 (sardine) and from 1976 to 2013 (anchovy). The year 2014 was not included in the assessment since problems were encountered with some data, that were inconsistent in respect to the rest of the dataset (e.g. Croatian data for 2013 only). EWG-15-11 thus used the data of the previous years integrated by expert knowledge.

Fishing mortality (F_{bar1-2}) and SSB of anchovy are varying along the time, catch and recruitment are decreasing, fishing mortality (F_{bar1-2}) is decreasing in the last two years.

Fishing mortality (F_{bar1-3}) and SSB of sardine are varying along the time, catch and recruitment are recently increasing.

Table 1.0.3 reports the metrics from the last assessment available (STECF 15-14). Discard in these fisheries is considered negligible.

Tab. 1.0.3 – Fishing mortality, Spawning Stock Biomass, landings and Recruitment from the last stock assessments.

Stock	***Fishing mortality**** *(Fcurrent)*	***Spawning Stock Biomass**** *(tons)*	***Landings**** *(tons)*	***Recruitment**** *(in thousands)*
Anchovy	$F_{bar\ (1-2)}$= 1.04	91,679	32,150	57,771,146
Sardine	$F_{bar\ (1-3)}$= 0.54	336,082	63,612	12,698,571

*estimates refer to assessment EWG 15-11 (STECF 15-14)

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The framework used for the reference points is summarised in the table Tab. 1.0.4.

In EWG-15-11 Eqsim (ICES, 2015[1]) was used to estimate stock recruitment relationship (S-R), F_{MSY} and F_{MSY} ranges (based on 5% reduction in MSY).

On the basis of median simulated catches for anchovy the following ranges were obtained:

F_{MSY} = 0.3; F_{lower} = 0.23, F_{upper} = 0.364 (EWG-15-11).

In the table 1.0.4. Method 1 refers to the approach based on F_{MSY} ranges. This approach was suggested by DGMARE, because developed in the "ad-hoc contract to support the preparation of a multiannual plan for small pelagic species in the Northern Adriatic" (Minto, 2015) and successively implemented in the stock assessment of small pelagics carried out during EWG 15-11 and endorsed by STECF 15-14. This approach was also discussed during the preparatory Workshop of the present project held in Bari on September 21-25, 2015 (see Annex III to this report). During the same Workshop also the approach referred as Method 2, which is based on the Exploitation Rate (Reference point E0.4; Patterson, 1992) was discussed and adopted for sake of comparison, given that the reference point E0.4 is adopted in the GFCM Recommendation GFCM/37/2013/1 (A multiannual management plan for fisheries on small pelagic stocks in the GFCM-GSA 17 - Northern Adriatic Sea - and on transitional conservation measures for fisheries on small pelagic stocks in GSA 18 - Southern Adriatic Sea).

Tab. 1.0.4 Reference points and their technical basis

Framework	**MSY approach**			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for anchovy method 1	Fmsy from a segmented stock recruitment relationship (EWG-15-11)	From Eqsim		fixed segmented fit of the S-R; half of the breakpoint SSB	Breakpoint of the segmented S-R
Technical basis for anchovy method 2	Exploitation rate (E0.4) from Patterson	-		**B_{lim}** as above*	**B_{pa}** as above*
Values for anchovy method 1	**0.3**	**0.36**	**2.9**	**69,500**	**139,000**
Values for anchovy method 2	**0.64**	**-**	**1.66**	**69,500***	**139,000***
Technical basis for sardine method 1	F_{MSY} of anchovy was adopted	The F_{MSY} upper range of anchovy was adopted		The lower level of SSB in the time series after which a good recruitment was observed	2*B_{lim}
Technical basis for sardine method 2	Exploitation rate (E0.4) from Patterson	**-**		The lower level of SSB in the time series after which a good recruitment was observed	2*B_{lim}

[1] ICES (2015). Report of the joint ICES -MyFISH workshop to consider the basis for fmsy ranges for all stocks (WKMSYREF3), 17-21 november 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64 2(4): 156pp.

Framework	MSY approach			Precautionary approach	
Values for sardine method 1	**0.3**	**0.36**	**1.48**	**180,000**	**360,000**
Values for sardine method 2	**0.55**	**-**	**1**	**180,000**	**360,000**

*the same values as for method 1 were adopted given that an empirical approach applied to anchovy (lower levels of SSB in the time series after which a good recruitment was observed) gave similar results (~70,000 and 140,000 tons respectively for B_{lim} and B_{pa}).

A Management Strategy Evaluation (MSE) was performed in line with EWG-15-11 for both anchovy and sardine using a segmented stock recruitment relationships together with the reference points derived.

Regarding anchovy the findings of the MSE are (according to EWG-15-11):

1. moving to MSY will result in considerable decrease in catches in the short-term though they increase and stabilise over the longer-term;
2. the catches are variable (high CVs) throughout reflecting the variable, autocorrelated nature of recruitment in the stock.
3. the probability of being below B_{lim} is initially very high but decreases over the time of management.

For sardine, the forward simulation proved very difficult, and the segmented stock recruitment relationship resulting in a very low F_{MSY} (<0.1). This is considered erratic, given that the catches are very variable (high CVs) throughout reflecting the variable, autocorrelated nature of recruitment in the stock.

An attempt to run an MSE on sardine using the geometric mean of the last 3 years and setting F_{MSY} equal to the F_{MSY} estimated for anchovy (F_{upper}=0.36) did not give any plausible results, being the catches oscillating cyclically between really high and really low values.

For sardine the lower level of SSB in the time series after which a good recruitment was observed was thus used as a proxy of B_{lim} and B_{pa} was set as $2*B_{lim}$[2].

Stock advice

The current fishing mortality for anchovy exceed Fupper of approximately 3 times. The Spawning Stock Biomass of sardine is close to the value of the precautionary SSB (Bpa=360.000 tons), while that of anchovy is in between the limit value of SSB (Blim=69,500 tons) and the precautionary value (139.000 tons). F_{MSY} of anchovy was also used for sardine, considering the similar life history traits of the two species.

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments is evaluated using key social and economic indicators and a traffic light table is below reported (Tab. 1.0.5 red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). From the economic indicators it seems that the fisheries of small pelagics mainly relies upon the revenues of sardine, that had a recent positive trend for 4 fleet segments out of ten (Italian pelagic trawlers and croatian purse seiner operating with bigger vessels.

[2] In order to estimate this reference point, a log-normal distribution of Blim is assumed, with a coefficient of variation of 40%. This results in approximately B_{pa} = $2*B_{lim}$ (GFCM approach, Report of the Working Group on Stock Assessment of Small Pelagic Species (WGSASP) Rome, Italy, 24–27 November 2014.

Tab. 1.0.5 - - Traffic light table on the economic performance of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

	Salary (euro)	CR.BER	ROI	Overall Revenues (thousand euros)	Revenues anchovy (thousand euros)	Revenues sardine (thousand euros)	Employment (number of units)
All fleets	13500÷11726	0.68÷0.77*	(-0.1)÷(-0.06)	83555÷75489	58348÷38958	19629÷29768	2017÷2011
ITA17_TM_1218	°32823÷17295	°3.55÷2.81	°0.91÷0.59	8113÷6041	°7574÷3455	184÷1042	°97÷124
ITA17_TM_1824	17080÷6690	1.24÷0.55	0.02÷-0.19	6386÷5118	5352÷2125	403÷2563	110÷153
ITA17_TM_2440	17714÷16980	1.38÷0.72	0.043÷-0.15	20084÷17417	16341÷11159	2820÷4827	262÷264
ITA17_PS_2440	18637÷13484	1.88÷1.24	0.14-0.07	11623÷5160	7506÷3824	126÷138	224÷142
HRV17_PS_1218	6033÷5408	6.2÷7.9	0.82÷1.09	2994÷3279	567÷968	1862÷1956	45÷47
HRV17_PS_1824	10416÷10410	(-0.5)÷(-0.06)**	(-0.95)÷(-0.7)	7437÷9248	2234÷2746	4859÷6074	473÷497
HRV17_PS_2440	10414÷10397	-0.07÷0.93	-0.2÷-0.01	11467÷17905	4094÷4122	6663÷12714	478÷505
SVN17_PS_1218	10232÷3976	°3.3÷2.1	°0.56-0.11	°523-197	177÷71	245÷53	°16-16
ITA18_TM_VL_2440	16826÷13388	1.57÷0.86	0.1÷-0.1	15619÷8673	13073÷8139	2436÷376	238÷181
ITA18_PS_VL_2440	15897÷10379	2.89÷1.17	0.44÷0.047	4409÷2449	4194÷2349	30÷24	97÷82

*decreasing except the last value; **stable except the last value; °initil value is referred to 2009, as 2008 values seems anomalous.

Strategy and timeframe to reach the RP

The two stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels, anchovy that is the most heavily exploited stock in the mix has been used as a benchmark. The percentages of reduction to reach F_{MSY} are reported in the table 1.0.6 for both the reference points taken into consideration, F_{MSY} (method 1) or E0.4 (method 2). The percentage of reduction, whatever the method applied, does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The percentages of reduction were based on the advices from STECF and GFCM that indicated the needing of reaching F_{MSY} or E0.4, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point F_{upper} of anchovy (the more exploited species) (=0.36) and the current level of fishing mortality (method 1) (Fcurr=1.04)

or

- the reference point E0.4 and the current exploitation rate (method 2). In this case the level of natural mortality in the age range 1-2 (M=0.955), the same age range as the fishing mortality, was used.

Tab. 1.0.6 - Percentages of reduction to reach F_{MSY}

Stock	***Fishing mortality reduction** (in %)*
Anchovy (Reference point method 1)	65%
Anchovy (Reference point method 2)	40%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability. For sake of comparison both reductions were applied according to the scenario described in the table 1.0.8.

This reduction is proportionally applied to the different fleet segments, accounting for their relative impact (Tab. 1.0.7). This is measured computing by each fleet segment a coefficient given by the production of anchovy, which is the benchmark species, to the overall production of anchovy. The overall fishing mortality F and Fupper are thus split among fleet segments using such coefficient. Thus the reduction by fleet segment is commensurate to its current F and its target FMSY (pathway B). An alternative approach is to reduce to a greater extent the F of the fleet segments with a higher impact (pathway A). In particular, under scenarios 2 and 3, the fleet segments HRV17_PS_2440 and ITA17_TM_2440 were subject to a higher reduction as regards the proportion of decrease applied to the number of vessels, that was 20 and 40% respectively (see table A. 5.4 in the Annex A to this report).

Table 1.0.7– Allocation of fishing mortality reduction to the fleet segments according to different reference points (Fupper and E0.4) and pathway.

	Fleet code	*Relative contribute to F (%)**	*Proposed reduction (pathway A) to F_{upper} anchovy(in % to SQ)*	*Proposed reduction (pathway B) to F_{upper} anchovy (in % to SQ)*	*Proposed reduction (pathway A) to E0.4 anchovy (in % to SQ)*	*Proposed reduction (pathway B) to E0.4 anchovy (in % to SQ)*

1	ITA17_TM_12-18	10.0	31	65	18	40
2	ITA17_TM_18-24	8.0	25		16	
3	ITA17_TM_24-40	24.7	88		64	
4	ITA17_PS_2440	6.3	15		9	
5	HRV17_PS_1218	2.7	13		8	
6	HRV17_PS_1824	10.7	46		28	
7	HRV17_PS_2440	17.7	80		45	
9	ITA18_TM_2440	14.7	76		31	
10	ITA18_PS_2440	5.0	24		14	
8	SVN17_PS_1218	0.1	-	-	-	-

*F average of the last 3 years; SQ=Status quo

Given the very low impact, the fleet segment SVN17_PS_1218 was excluded from the reduction plan.

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term; the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range.

2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY in 2020; the reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range.

The reduction is applied from 2015 to account for the implementation of management actions taken on the basis of the GFCM Recommendations 38/2014 and 39/2015 Member States have presumably undertaken.

Proposed scenarios

Proposed scenarios are reported in the table 1.0.8.

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition. Scenario 2 and 4 share the same strategy, the difference is in the reference point, in the scenario 2 F_{MSY} is that of anchovy and the reduction is applied both to anchovy and sardine. Besides F_{MSY} also the empirical reference point E0.4 of anchovy has been adopted in the scenario 4 and 5, given the uncertainty on stock recruitment relationships, especially for sardine. Scenarios 6, 7, 8 and 9 are the counterparts of scenarios 2, 4, 5 and 6, using a different pathway of allocating F reduction among fleet segments.

The scenario of the reduction towards E0.4 of sardine was not applied given the level $F_{current}$ (F_{bar1-3}) very close to the E0.4 (=0.53 vs. 0.55) and the mixed nature of fisheries.

Table 1.0.8 – Scenarios modelling for the forecasts.

Scenario 1	**Status quo to 2020**
Scenario 2	Linear reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Starting year of reduction 2015. Application of reduction higher for the fleets more impacting the stocks (pathway A).

Scenario 3	Adaptive reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Starting year of reduction 2015. Application of reduction higher for the fleets more impacting the stocks (pathway A).
Scenario 4	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Starting year of reduction 2015. Application of reduction higher for the fleets more impacting the stocks (pathway A).
Scenario 5	Adaptive reduction towards E0.4 of anchovy in 2020, from 2018 to 2020 applied only on activity. Starting year of reduction 2015.Application of reduction higher for the fleets more impacting the stocks (pathway A) .
Scenario 6	Linear reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Starting year of reduction 2015. Application of reduction partitioned according to the proportion of F_{MSY} of the single fleet (pathway B).
Scenario 7	Adaptive reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Starting year of reduction 2015. Application of reduction partitioned according to the proportion of F_{MSY} of the single fleet (pathway B).
Scenario 8	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Starting year of reduction 2015. Application of reduction partitioned according to the proportion of F_{MSY} of the single fleet (pathway B).
Scenario 9	Adaptive reduction towards E0.4 of anchovy in 2020 applied both to activity and capacity, up to 2017 included, then on the activity only. Starting year of reduction 2015. Application of reduction partitioned according to the proportion of F_{MSY} of the single fleet (pathway B).

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for both stocks a multiplicative error (on the recruitment of last year, considering the presence of a trend in both stocks).

Forecast of the effects of proposed scenarios

According to the traffic light summary (table 1.0.9), all the performed scenarios allow to obtain a benefit on the SSB of the 2 stocks in respect to the status quo. The best performance for anchovy and sardine SSB is showed by Scenario 2 (respectively 23 % and 24 % higher than Scenario 1), whilst the worse result is observed in the status quo (table 1.0.9). These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on this indicators if applied in a short time range.

Adaptive scenarios (Scenario 3 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 4), but also a reduced decrease in landing of the overall catch of both stocks in the short term.

Considering all fleets, under scenarios 4-5 as well as 8-9, the catches are decreasing in the short term, with a fairly low percentage (around 15%) and revenues are decreasing with a lower percentage (10%), while the economic performance is improving if salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping (10%) and the impact is less for scenarios 8-9. Also the indicator ROI shows an improvement in all the scenarios compared to the status quo, except in scenario 7 in which the change is negative, while in scenario 6 the effect is neutral.

Considering the catches of the whole fleet, both for anchovy and sardine there is a decrease that is more marked for Scenario 2 and 3, that apply the 65% of reduction, as well as for scenarios 6 and 7. Scenario 2 and 3, as well as 6 and 7, are also the most impacting on revenues with reductions in 2021 higher than 25% if compared with the Scenario 1. Nevertheless, Scenario 2 has the best performance for the ratio between current and break-even revenues (CR/BER), the ROI as well as in terms of average salary (10% higher than that expected from the status quo in 2021).

On an overall basis, scenarios 4 and 5 as well as 8 and 9, are those performing better, because allow to obtain a quite stable trade off among the different indicators.
For both stocks the catches by fleet segment change according to the percentage of reduction applied and to the impact of the fleet segment on anchovy stock:

- under the pathway A, some fleet segments (ITA17_TM_1218, ITA17_TM_1824, ITA17_PS_2440, HRV17_PS_1218, ITA18_PS_VL_2440 and SVN17_PS_1218) benefit of the higher reduction applied to the other fleet segments: higher is the reduction applied (Scenarios 2 and 3) more is their benefit, while in the status quo situation no significant improvement in catches is observed;
- some fleet segments (ITA17_TM_2440, HRV17_PS_1824, HRV17_PS_2440 and ITA18_TM_VL_2440) see their catches and revenues quite stable in the status quo scenario, while these decrease considerably for Scenarios 2 and 3, that apply a stronger reduction. In particular, under scenarios 2 and 3 the fleet segments HRV17_PS_2440 and ITA17_TM_2440 were subject to a higher reduction as regards the proportion of decrease applied to the number of vessels, that was 20 and 40% respectively (see table A.5.4 in the Annex A to this report).
- under pathway B the all the fleet segments are more impacted by the management measures, but productive fleet segments as ITA17_TM_2440, HRV17_PS_2440 and ITA18_TM_VL_2440 are relatively less impacted (scenarios from 6 to 9).

As regards anchovy and sardine catches, the best scenario is the scenario 2 for all fleet segments, except for ITA17_TM_2440 (-78%), HRV17_PS_1824, HRV17_PS_2440 (-63%) and ITA18_TM_VL_2440 (-56%), that are the fleet segments more penalized by the management strategies (being the more impacting on anchovy stock).

This seems quite consistent with the way the management measures have been implemented, because Scenario 2 applies a reduction of 65% proportionally to the impact of the fleet segments on anchovy stock, but penalising more those with a higher share of fishing mortality. Under scenarios 6-9 the situation among the fleets is more compensated.

In 2018, (excluding status quo) forecast scenarios produce a reduction in total landings weight of the whole fleet of the GSA, ranging from 13% (Scenario 5) to 42% (Scenario 2) compared to the status quo. In 2021, the foreseen reduction in total landing of the whole fleet ranges from 17% (Scenario 5) to 36% (Scenario 3).

In 2018, (excluding status quo) forecast scenarios produce a reduction in total landings value of the whole GSAs fleet ranging from 9% (Scenario 5) to 33% (Scenario 2) compared to the status quo. In 2021, the foreseen reduction in total landing of the whole fleet ranges from 12% (Scenario 5) to the 27% (Scenario 3).

Table 1.0.9 Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and overall catches of anchovy and sardine, salary, CR/BER, ROI, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F or of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline both F and E are reported.

Scenario, year 2021	**ALL fleets**										
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (euros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	SSB Anchovy (tons)	SSB Sardine (tons)	F or E (value) (year) Anchovy	F or E (value) (year) Sardine
Status quo (values in 2014 – baseline year)	11727	0.77	-0.066	75489002	2011	24969	73423	68298	383710	1.05/0.52	0.54/0.4
Status quo (values in 2021)	12146	0.88	-0.03	78369714	12146	24318	85789	68879	358387	1.05/0.52	0.54/0.4
Scenario 2 - FmsyUpper2018	9.7	17.1	126	-25.4	-12.8	-30.1	-32.2	24.0	22.8	0.39	0.2
Scenario 3 - FmsyUpper2020Adaptive	6.4	13.2	100	-27.1	-12.8	-31.3	-36.0	21.2	22.0	0.56 (2018) 0.39	0.29 (2018) 0.2
Scenario 4 - E04 ANE 2018	8.7	12.5	97	-10.6	-3.6	-15.4	-14.7	9.3	11.8	0.4	0.29
Scenario 5 - E04 ANE 2020 Adaptive	6.3	9.5	73	-12.1	-3.6	-15.6	-18.3	10.1	9.8	0.45 (2018) 0.41	0.33 (2018) 0.29
Scenario 6 - FmsyUpperAnchovy2018	0.9	-1.0	0.0	-25.4	-6.4	-29.4	-31.5	18.8	19.8	0.41	0.21
Scenario 7 - FmsyUpperAnchovyAdaptive2020	-2.1	-4.7	-27	-27.2	-6.4	-29.8	-35.2	22.2	17.6	0.66 (2018) 0.41	0.34 (2018) 0.21
Scenario 8 - E04Anchovy2018	6.2	6.6	53	-12.4	-4.0	-13.4	-17.3	10.9	9.8	0.4	0.29
Scenario 9 - E04AnchovyAdaptive2020	3.1	2.6	23	-14.4	-4.0	-16.4	-19.0	7.5	8.8	0.46 (2018) 0.4	0.34 (2018) 0.29

Scenario 2 and 3 are the ones with the highest decrease in catches for the more impacting fleet segments (ITA17_TM_2440 , HRV17_PS_1824 , HRV17_PS_2440 and ITA18_TM_VL_2440), but are also the scenarios characterized by the highest improvement in the SSB and in the catches of the other fleet segments. A similar performance also show the scenarios 6 and 7, that are however less impacting on the above mentioned fleet segments.

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the scenarios allowing to reach the highest overall utility are scenarios 4 and 5 (overall utility 0.753 and 0.749 respectively), that share a comparable level of utility with scenarios 8 and 9, while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.548) (Fig.1.0.1). This result is comparable with that obtained by the traffic light approach. Scenarios 4 and 5 were considered to perform better than scenarios 2 and 3, because of the factors linked to production and employment. This despite in the MCDA the biological component weight relatively more than the economic and social ones.

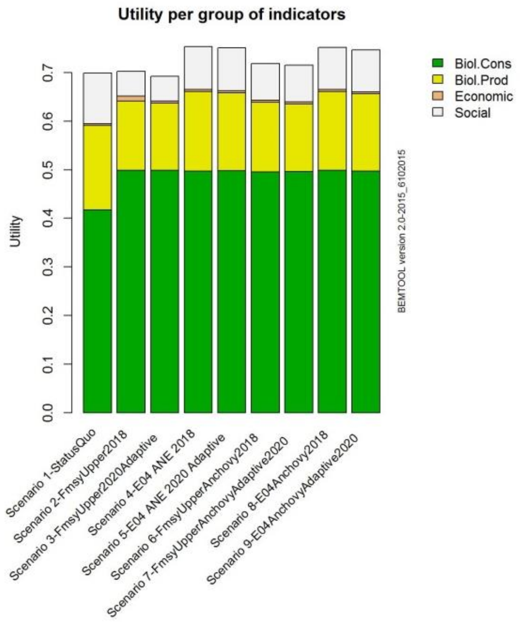


Figure 1.0.1 MCDA results: evaluation of the overall utility associated to each management scenario.

The methodology and the scenarios tested cover a wide range of different options and provide a general and complete overview of the situation of small pelagics in the Adriatic Sea. The results are consistent with the advice that has been provided so far in different fora and gives a more robust evaluation of the efficiency of each of the measures proposed. There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment in small pelagic species. These species are in fact strongly influenced from environmental variables and the recruitment can show dramatic variability from one year to the next. However, the measure proposed from BEMTOOL are conservative enough to be efficient if against recruitment failures.

In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.
The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability.

However, even in presence of severe reductions, the effort limitations applied might be not completely enough to reach the F_{MSY} objectives, given that the effort used for setting the management measures is not, in most of the cases, a specific effort directed to the target species (for the multispecific nature of the Mediterranean fishery).

Catch option and advice

On the basis of the estimated limit management reference point for sustainable exploitation (F_{upper}=0.36 and E0.4 both for anchovy and sardine), catches in 2016 should be according to the following table 1.0.10.

The catch advice is reported for scenarios 2 and 4 as for the other scenarios with Fmsy upper as reference point the same catch advice as for scenario 2 should apply and for the other scenarios using E0.4 as reference point the same advice as for scenario 4 should apply.

In this case the reduction to reach the reference point is fully applied in 2016 and the values of the catches can be considered the maximum that can be taken to fulfil the objective of the reference point.

Table 1.0.10 Catch advice

		Catch advice (tons)*	
Scenario	**Year**	**Anchovy**	**Sardine**
Scenario 2 FmsyUpper2018	2016	18301	60488
Scenario 4 E04 ANE 2018	2016	20851	70923

*basis of estimates current F and catches

2.0 SUMMARY SHEET ON THE CASE STUDY OF GSA 06 AND GSA07

Time series of DCF data on biological variables, landings and effort are available for France and Spain at GSA level by metier, while transversal variable (landings and effort) at fleet segment level are available at sub-regional level (e.g. 37.1.2 for the Gulf of Lion). Economic data are available at supra-region level (AREA 37) for France.

For GSAs 06 and 07 there is a proposal of the European Commission for a multiannual plan for demersal fisheries. This plan shall cover demersal stocks, in particular the stocks of hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), blue whiting (*Micromesistius poutassou*), monkfishes (*Lophius* spp.), poor cod (*Trisopterus minutus*), and the crustaceans deep-water rose shrimp (*Parapenaeus longirostris*), blue and red shrimp (*Aristeus antennatus*) and Norway lobster (*Nephrops norvegicus*).

Regarding small pelagic, recent stock assessments attempted (sardine and anchovy) in both GSAs were either not based on age-structured methods or of insufficient quality to be accepted (except for sardine in GSA06). The recent stock assessment of anchovy in GSA06 was rejected by the STECF (STECF 15-06 = EWG14-19). The assessments of sardine and anchovy for GSA07 in the same working group EWG14-19 were rejected, or more exactly, were not considered valid due to poor model fitting and several data issues. In general, the biological data for small pelagic stocks in the two areas do not allow for robust stock assessment results, hence assessments of these stocks were critically evaluated before including them used in scenario modelling. The only recent valid stock assessment, based on age-structured populations, corresponds to sardine in GSA06 (2013; in EWG14-19), but due to the importance of anchovy as main species driving the fishery and the absence of a valid recent assessment for anchovy, scenario modelling for small pelagic was not attempted.

Fisheries: Demersal fisheries in the Northern Spain

GSA: GSA 06, Northern Spain

Stocks assessed: hake (*Merluccius merluccius*) (HKE), red mullet (*Mullus barbatus*) (MUT), blue and red shrimp (*Aristeus antennatus*) (ARA), deepwater shrimp (*Parapenaeus longirostris*) (DPS) and blue whiting (*Micromesistius poutassou*) (WHB)

Modelling tools used: MEFISTO bioeconomic model.

Fleets involved

Seven main fleet segments operating in GSA 06 and carrying out demersal fisheries have been identified. These fleet segments belong to 4 vessel length strata: 06-12m, 12-18 m, 18-24 m and 24-40 m; and use 3 fishing techniques: bottom trawler, nets and longline (Table 2.0.1). The percentage of landings of all landed species due to each identified fleet segment is reported in the table 2.0.1.

Demersal fisheries are carried out on the continental shelf (50-200 m depth) by all fleet segments and on the continental slope by the two trawl fleet segments with largest length (18-40 m).

Table 2.0.1 Main fleet segments involved in the demersal fishery in GSA06. The percentage of landings of all landed species due to each identified fleet segment is also reported.

	Fleet name of demersal fisheries in GSA 06	***Fleet code GSA06***	***% of landings (all species)***

1	Spanish bottom trawlers with vessel length 12-18 m	ESP06_DTS_12-18	15.74
2	Spanish bottom trawlers with vessel length 18-24 m	ESP06_DTS_18-24	40.24
3	Spanish bottom trawlers with vessel length 24-40 m	ESP06_DTS_24-40	31.86
4	Spanish netters with vessel length 6-12 m	ESP06_DFN_06-12	3.69
5	Spanish netters with vessel length 12-18 m	ESP06_DFN_12-24	4.44
6	Spanish longliners with vessel length 6-12 m	ESP06_HOK_06-12	1.21
7	Spanish longliners with vessel length 12-18 m	ESP06_HOK_12-18	2.81

The number of fishing vessels is decreasing in the last ten years, as well as the fishing effort (gross tonnage *days at sea or days at sea) of trawlers, while the fishing effort of fixed gears is almost stable in the period 2008-2013. The fleet segments more contributing to the total production are: Spanish bottom trawlers with vessel length 18-24 m and Spanish bottom trawlers with vessel length 24-40 m (Tab. 2.0.1).

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the specific fisheries, as identified by the fishing technique and vessel length is reported in the table 2.0.2 (the percentage is computed on the average production of the last three years). These stocks account for a low percentage, of less than 5%, for the artisanal fishing gear (DFN and HOK, except for European hake), but are important for the two largest bottom trawl fleets (25% and 42% respectively for DTS_VL1824 and DTS_VL2440), which are, in turns, those contributing more to the total production (Tab. 2.0.1).

The stocks considered are the only ones for which recent (2014) assessments are available. Among the assessed ones, which are relevant stock in the GSA fisheries, the stock more important on the overall production is European hake.

Table 2.0.2 Contribution of the stocks assessed to the production volume (in tons) of the main fleet segments of demersal fisheries in GSA06 (the percentage is computed on the average production of the last three years). The values in the column “assesed%” is calculated as ratio between landings of assessed species to total landings, the same calculation has been done for the row “Total”.

Assessed species/fleet segments GSA06	**ARA**		**DPS**		**HKE**		**MUT**		**WHB**		**Total**		
	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing assessed (tons)	Landing total (tons)	assessed %
DFN VL_0612	0	0.0	0	0.0	35	5.7	10	1.7	0	0.0	45	612	**7.4**
DFN VL_1224	0	0.0	0	0.0	44	6.0	8	1.1	0	0.0	52	736	**7.1**
DTS VL_1218	8	0.3	2	0.1	145	5.6	145	5.6	32	1.2	332	2609	**12.7**
DTS VL_1824	221	3.3	6	0.1	925	13.9	270	4.0	307	4.6	1729	6670	**25.9**
DTS VL_2440	354	6.7	11	0.2	1052	19.9	305	5.8	476	9.0	2197	5281	**41.6**
HOK VL_0612	0	0.0	0	0.0	16	8.0	0	0.1	0	0.1	16	200	**8.2**
HOK VL_1218	0	0.0	0	0.0	26	5.5	1	0.2	0	0.1	27	466	**5.8**

Total	582	3.5	19	0.1	2243	13.5	740	4.5	816	4.9	4399	16575	**26.5**

Development of stocks over time and current status

The assessment of the main demersal stocks was presented during the STECF 13-22 (EWG 13-09) (deepwater shrimp), STECF 2014 (STECF 14-17; EWG 14-09) (European hake, blue whiting and red mullet) and (WGSAD) GFCM/SCSA Rome (Italy), 24-27 November 2014, (blue and red shrimp). These assessments used official DCF data together with the historical time series available for GSA06 from 2002 to 2012 for deepwater shrimp, 2002 – 2013 for European hake and red mullet, 2008-2013 for blue whiting and 2002-2014 for blue and red shrimp.

The summary diagnosis of the stocks is the following:

- European hake: Fishing mortality (F_{bar0-3}) and SSB relatively stable along the time series, but strong decrease in recruitment.
- Blue and red shrimp: Fishing mortality (F_{bar0-3}) and SSB decreasing along the time series. Recruitment shows high values in recent years.
- Red mullet: Fishing mortality (F_{bar0-2}), recruitment and SSB increasing in recent years, after low values in 2005-2008.
- Deepwater rose shrimp: Fishing mortality (F_{bar2-4}) and SSB with large variations, while recruitment is increasing along the time series.
- Blue whiting: the time series is relatively short (6 years) and the variation in Fishing mortality (F_{bar1-3}), recruitment and SSB is large.

No meaningful stock recruitment relationship exist for the main species considered.

Discards of European hake, red mullet and blue whiting is suspected to be important, but official data only reports relatively low amounts (<10% of landings) in the two most recent years. Due to the lack of reliable information, landings are usually equated with catches in the stock assessments.

For the high valued shrimps, discards is considered negligible.

Table 2.0.3 summarizes the level of fishing mortality, landings and discards in the last year (2014).

Table 2.0.3 Current level of fishing mortality ($F_{current}$), of F_{MSY}, of the ratio between $F_{current}$ anf F_{MSY} ($F_{current}/F_{MSY}$), landings and discards of the assessed species (HKE=European hake, ARA=blue and red shrimp, MUT=red mullet; DPS=deep water rose shrimp, WHB=blue whiting).

Assessed stock GSA06	$F_{current}$	F_{MSY}	F_{curr}/F_{MSY}	*Landings (tons)**	*Discards(tons)**
HKE	1.466	0.15	9.77	2924	152
ARA	1.742	0.36	4.84	1030	1
MUT	1.581	0.45	3.51	1100	3
DPS	1.488	0.269	5.53	115	2
WHB	1.669	0.16	10.43	800	13

*2014 data

Stock advice

All five demersal stocks are assessed as being exploited unsustainably at levels considerably higher than F_{MSY}. All stocks are considered overexploited by the recent assessments. In the case of the two gadiforms (European hake and blue whiting) the current fishing mortality to F_{MSY} ratio is around 10.

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The framework used for the reference points is summarised in the table 2.0.4, taken from STECF 13-22 (EWG 13-09), STECF 14-17 (EWG 14-09) and STECF 15-11 (EWG 15-09). Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.0.4 Reference point and their technical basis

Framework					
	MSY approach			**Precautionary approach**	
Reference point	F_{MSY}	F_{MSY} **upper range**	F_{curr}/F_{MSY} **ratio**	$B_{lim\ (tons)}$	$B_{pa\ (tons)}$
Technical basis for all stocks	F01 as proxy for Fmsy	From empirical equation (EWG 15-11)		1.4 x B_{loss}	N/A
Values for European hake	**0.15**	**0.21**	**9.771**	**1418**	
Values for blue and red shrimp	**0.36**	**0.49**	**4.838**	**1287**	
Values for red mullet	**0.45**	**0.62**	**3.514**	**883**	
Values for deepwater shrimp	**0.27**	**0.37**	**5.530**	**159**	
Values for blue whiting	**0.16**	**0.22**	**10.433**	**336**	

Development of economic indicators over time and current status

The economic performance of the main fleet segments of the demersal fisheries is evaluated using key social and economic indicators showed in the traffic light table 2.0.4 (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend. "Recent" refers to 2011-2014).

Note that even if revenues from the main stocks are stable or increasing, the overall fleet revenues are mostly negative because the dependency of these mixed fleets on the main species is usually low and lesser than 50%. In the recent 2-3 years, the landings and revenues of the main target species are stable or revenues increasing (blue and red shrimp, red mullet), but the size of the fleets in general has been decreasing for a period of more than 10 years, and overall revenues, employment and salaries have in general decreased for demersal fleets. CR.BER and ROI show a recent positive trend.

Tab. 2.0.4 Traffic light table on the economic performance of the fleets targeting demersal resources (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend; white= does not apply). The values in the cells are referred to 2011 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

	Salary (Euro)	CR/BER	ROI	Overall Revenues (thousand Euro)	Revenues HKE (thousand Euro)	Revenues ARA (thousand Euro)	Revenues MUT (thousand Euro)	Revenues DPS (thousand Euro)	Revenues WHB (thousand Euro)	Employment (number of units)
All fleets	12734÷8596	2.15÷2.45	(-0.11÷0.06)	186700÷174254	18577÷17224	16770÷17597	24475÷32278	3231÷2981	18077÷20736	5430÷4480
ESP06_DTS_12-18	18390÷14062	0.87÷1.67	(-0.03÷0.04)	41164÷38977	3778÷3503	4096÷4298	6095÷7161	789÷728	4416÷5065	1116÷1001
ESP06_DTS_18-24	39515÷30216	0.78÷1.57	(-0.04÷0.05)	88541÷83751	8118÷7527	8802÷9236	13098÷15387	1696÷1565	9488÷10884	2399÷2151
ESP06_DTS_24-40	17380÷13290	3.32÷ 4.02	(-0.05÷0.06)	38904÷36837	3571÷331	3872÷4062	5761÷6768	746÷688	4173÷4787	1055÷946
ESP06_DFN_06-12	3561÷1717	3.15÷4.10	(-0.19÷0.07)	5051÷4081	864÷801		1394÷1638			239÷106
ESP06_DFN_12-24	2880÷1389	3.07÷4.05	(-0.15÷0.08)	4086÷3301	699÷648		1127÷1325			193÷86
ESP06_HOK_06-12	4043÷3478	3.01÷4.15	(-0.14÷0.05)	4934÷3986	844÷782					234÷104
ESP06_HOK_12-18	3367÷2897	3.03÷4.25	(-0.20÷0.04)	4109÷3320	703÷652					195÷86

Strategy and timeframe to reach the RP

The five stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on F levels, European hake and blue whiting are the most heavily exploited stocks in the mix. European hake has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA06, as well as in other Mediterranean areas. The percentages of reduction to reach F_{MSY} are reported in the table 2.0.5.

The percentages of reduction were based on the advices from STECF that indicated the needing of reaching F_{MSY}, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report).

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

Tab. 2.0.5 – Fishing mortality reduction needed to reach Fupper, by stock

Stock	***Fishing mortality reduction*** *(in %)*
HKE	90%
ARA	79%
MUT	72%
DPS	82%
WHB	90%

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term; the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term; the reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range.

Proposed scenarios

Proposed scenarios are reported in the table 2.0.6.

Table 2.0.6 – Scenario modelling

Case Study	**Demersals in GSA 06**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species in 2018 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using value of landings as weighting factor) in 2018 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.

Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using value of landings for weighting) in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity accounting for the survivability issue (in case of gear selectivity). Starting year 2015.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability. Under Scenarios 2 and 4 the reduction in fishing mortality is assumed on the most overexploited species (European hake) to ensure that all species are fished at Fmsy at the target year (2018 or 2020). In this case the target is Fupper of European hake, which value is 0.210.

A second set of scenarios (Scenarios 3 and 5) propose a reduction in fishing effort proportionally applied to the different fleet segments, accounting for their relative impact to a weighted overall Fmsy (value of landings as weighting factor).

Due to the low value of the production of artisanal fishing gears (longline and nets) the weighting factor of these fleets was combined. In the table 2.0.7 the relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of each stock by fleet segment for 2014. The combined Fmsy target computed on the basis of Fmsy by species was 0.218.

Tab. 2.0.7 – Relative impact on the assessed stocks of the 4 fleet segment strata.

	ARA	HKE	MUT	DPS	WHB
DFN + HOK		0.01	0.13		
DTS_VL1218	0.02	0.13	0.28	0.10	0.05
DTS_VL1824	0.28	0.29	0.28	0.28	0.30
DTS_VL2440	0.70	0.58	0.31	0.62	0.65
	1.00	1.00	1.00	1.00	1.00

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018 and a reduction of 20% of capacity is covered in the official Spanish management plan.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for both stocks a multiplicative error (on the recruitment computed for the last three years).

Forecast of the effects of proposed scenarios

For all main stocks, the projection of status quo conditions produced SSB and Catches in the higher end of the observed historical variation, in the mid (to 2018 – 2020) and long (after 2020) term. These relatively optimistic results are due to the fact that all stocks are assessed in improving conditions (growing SSB) in the recent years and average or low F. Additionally, considering that Effort has been decreasing steadily for the last 10 years or more, the costs related to effort are projected to be lower than the historical observed effort costs (since 2011). Under these conditions, the status quo projections forecast stable labour costs but increasing profits to the company owners over the mid and long term[3].

In all scenarios (except 6) the strong reduction in fishing effort (of the order of 90%) results in a rapid increase in biomass of all stocks, to levels much higher than those observed historically. For hake, catches would decrease in the mid term (i.e. to 2018 or 2020), as a consequence of the lower F applied, but then increase to a new, high equilibrium level in the long term (after 2020).

In some scenarios (2 and 6), the catches of blue whiting would likewise be higher than at present. However, the equilibrium catches of blue and red shrimp, red mullet and deepwater shrimp would be lower than present catches, except in Scenario 6, because the low F applied is below the corresponding Fmsy of each stock, leading to underutilization of these stocks. Only scenario 6, with a change in selectivity that does not ensure reaching Fmsy woul permit higher catches than status quo catches for all stocks.

In socio-economic terms, scenarios 2 to 6 entail a decrease in employment because of the anticipated capacity reduction of 20% by 2017. Additionally, scenarios 3, 4 and 5 would imply lower labour costs and revenues than status quo situation.

In summary, the best performing scenario is 6, although it does not ensure reaching Fmsy. Strictly enforcing Fmsy based on the most overexploited species (hake) would lead to underutilization of the remaining stocks.

The following table summarized the performances of the management scenarios in terms of SSB and overall catches of the main 5 stocks, salaries (average wage), CR/BER, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value in Scenario 1, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

The methodology and the scenarios tested focus on the current paradigm of fisheries management in the Mediterranean, based on effort control (reduction of capacity or activity: Scenarios 2-5) and technical measures aiming to delay the size at first capture (Scenario 6). The results are consistent with the advice of STECF relevant working groups that stress the need to strongly reduce fishing effort to achieved Fmsy. However, the approach has some limitations because:

- The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020
- The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan to focus on stock-by-stock effort reduction to achieve individual stocks' Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the 7 fleet segments are heterogeneous in fishing capacity, costs, and fish size selection profile
- Better selection of fish size can be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatio-temporal closures.

The limitations listed should be considered in the light of present knowledge (i.e. data available, models available) and the reactive capacities of all actors involved.

In GSA06, areas with high persistence indices of hake recruits, that could be the subject of temporary closures, are located in the extreme north of the area (province of Girona, from 100 to 200 m approximately) and on the deeper areas of the continental shelf around the Ebro Delta. In GSA06, persistent high density areas of deep-water rose shrimps are located on the continental shelf break, facing the southern coast of Alicante, adjacent with GSA01.

[3] it is important to recall that under the prevailing remuneration scheme in Mediterranean fisheries, common costs are deducted from landings income and the resulting gross profits are shared between the vessel owner and the crew. Vessel owners will meet all non-variable costs from their share.

Table 2.0.8 – Summary of the performances of the management scenarios (% change respect to status quo) simulated in terms of SSB and overall catches of the main demersal species, salary, CR/BER, ROI, employment and revenues for all fleet segments combined. The green values are higher than +5%, the red ones are smaller than -5%; the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis.

	Salary (thousand Euro)	CR/BR	ROI	Revenues (million Euro)	Emp. (units)	HKE catch (tons)	ARA catch (tons)	MUT catch (tons)	DPS catch (tons)	WHB catch (tons)	HKE SSB (tons)	ARA SSB (tons)	MUT SSB (tons)	DPS SSB (tons)	WHB SSB (tons)	F (value) (year) HKE	F (value) (year) ARA	F (value) (year) MUT	F (value) (year) DPS	F (value) (year) WHB
Status quo (values in 2014 – baseline year)	40.7	2.17	0.013	139	4481	3472	839	1346	129	1088	1494	1266	2011	145	341	1.47	1.74	1.58	1.49	1.67
Status quo (values in 2021)	59.7	9.30	0.12	199	4481	6429	1028	889	73	1166	1997	2124	2070	162	540	1.47	1.74	1.58	1.49	1.67
Scenario 2	15	125	367	15	-20	22	23	26%	33	31	1459	154	177	196	974	0.21	0.25	0.23	0.21	0.24
Scenario 3	-21	132	242	-21	-20	-16	-14%	-19	-16	-17	2055	204	231	261	1272	0.22	0.22	0.22	0.22	0.22
Scenario 4	-15	117	242	-15	-20	-23	9%	14	4	-4	791	117	129	139	606	0.59 (2018) 0.21	0.705 (2018) 0.25	0.63 (2018) 0.23	0.60 (2018) 0.21	0.67 (2018) 0.24
Scenario 5	-44	125	142	-44	-20	-50	-29%	-27	-32	-41	1124	161	174	186	797	0.54 (2018) 0.22	0.64 (2018) 0.22	0.58 (2018) 0.22	0.55 (2018) 0.22	0.61 (2018) 0.22
Scenario 6	29	46	192	30	-20	15	52%	82	95	43	301	23	54	34	398	0.90	1.35	0.86	1.15	0.50

Fisheries: Demersal fisheries in the Gulf of Lion

GSA: GSA 07

Stocks assessed: hake (*Merluccius merluccius*) (HKE), red mullet (*Mullus barbatus*) (MUT)

Modelling tools used: MEFISTO bioeconomic model.

Fleets involved

Nine main fleet segments operating in GSA 07 and carrying out demersal fisheries have been identified (Table 2.0.5). These fleet segments belong to 5 strata of vessel length (0-6 m, 6-12 m, 12-18 m, 18-24 m, 24-40 m) and use 3 fishing techniques: bottom trawl, gillnet and longline. Demersal fisheries are carried out on continental shelf (50-200 m depth) by gillnetters and trawlers, and on the continental slope targeting large hake by longliners. The percentage of landings of all landed species due to each identified fleet segment is reported in the table 2.0.5.

Table 2.0.5 Main fleet segments involved in the demersal fishery in GSA 07. The percentage of landings of all landed species due to each identified fleet segment is also reported.

N	*Fleet name demersal fisheries in GSA 07*	*Fleet code GSA 07*	*% of landings (all species)*
1	Spanish bottom trawlers with vessel length 12-18	ESP07_DTS_12-18	0.13
2	Spanish bottom trawlers with vessel length 18-24	ESP07_DTS_18-24	2.71
3	French bottom trawlers with vessel length 12-18	FRA07_DTS_12-18	7.35
4	French bottom trawlers with vessel length 18-24	FRA07_DTS_18-24	24.41
5	French bottom trawlers with vessel length 24-40	FRA07_DTS_24-40	51.52
6	French gillnetters with vessel length 0-6 m	FRA07_DFN_00-06	5.35
7	French gillnetters with vessel length 6-12 m	FRA07_DFN_06-12	7.97
8	French gillnetters with vessel length 12-18 m	FRA07_DFN_12-18	0.54
9	Spanish longliners with vessel length 12-18 m	ESP07_HOK_12-18	0.01

As regards fishing effort, the number of fishing vessels is steadly declining since 2002, while the average power of vessels is decreasing since 2006, after a period of increasing from 1999 to 2006. The fleet segments more contributing to the total production are: France bottom trawlers with vessel length 18-24 and 24-40 m (Tab. 2.0.5).

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the specific fisheries, as identified by the fishing technique and vessel length is reported in the table 2.0.6. This contribution is different if Spain and France are considered separately, given that the assessed species are more representative for the Spain fisheries, both trawlers and longliners. In the France fisheries these stocks account for a lower percentage (5-8%for the artisanal fishing gear), but are relatively more important for the two bottom trawl fleets with largest length(about 18% of the landings of DTS fishery for France).

The stocks considered are the only ones for which recent (2014) assessments are available. Among the assessed ones, which are relevant stock in the GSA fisheries, the stock more important on the overall production is European hake.

Table 2.0.6 Contribution of the stocks assessed to the production volume (in tons) of the main fleet segments of demersal fisheries in GSA 07 (percentage computed on the average production of the last three years). The values in the column "assesed%" is calculated as ratio between landings of assessed species to total landings, the same calculation has been done for the rows "Total".

Assessed species/fleet segments GSA06	**HKE**		**MUT**		**Total**		
	Landing (tons)	**%**	**Landing (tons)**	**%**	**Landing assessed (tons)**	**Landing total (tons)**	**assessed %**
ESP DTS VL1218	1.7	12.0	0.5	3.8	2.2	14	**15.8**
ESP DTS VL1824	99	34.1	13	4.6	112	290	**38.7**
ESP HOK VL1218	1	89.7	0	0.0	1	1	**89.7**
Total Spain	102	33.3	14	4.6	116	306	**37.9**
FRA DFN VL0006	0	0.0	1	0.2	1	573	**0.2**
FRA DFN VL0612	50	5.8	19	2.3	69	854	**8.1**
FRA DFN VL1218	7	12.1	0	0.3	7	58	**12.4**
FRA DTS VL1218	33	4.3	8	1.0	41	787	**5.2**
FRA DTS VL1824	383	14.7	93	3.6	476	2614	**18.2**
FRA DTS VL2440	804	14.6	151	2.7	956	5517	**17.3**
Total France	1278	12.3	272	89.1	1551	10403	**14.9**
Total GSA07	1380	13.3	286	93.6	1666	10708	**15.6**

Development of stocks over time and current status

The assessment of the main demersal stocks was presented during the the STECF 2014 (STECF 14-17; EWG 14-09) (red mullet) and STECF 2014 (STECF 14-17; EWG 14-09) (hake). These assessments used official DCF data together with the historical time series available for GSA07, from 2004 to 2012 for red mullet, and from 2002 to 2013 for European hake.

According to the available stock assessments, the summary diagnosis of the stocks is the following:

- Hake: Fishing mortality (F_{bar0-2}; i.e. between age 0 and age 2) increasing in recent years and SSB decreasing along the time series. Strong fluctuations in recruitment and landings.

- Red mullet: Fishing mortality (F_{bar0-3}; i.e. between age 0 and age 3) fluctuating. Increasing recruitment, SSB and landings since 2004.

Discards of hake and red mullet are suspected to be important, but official data only reports relatively low amounts (<10% of landings) in the two most recent years. Due to the lack of reliable information, landings are usually equated with catches in the stock assessments. Table 2.0.7 summarizes the level of fishing mortality, landings and discards in the last year.

Table 2.0.7 Current level of fishing mortality ($F_{current}$), of F_{MSY}, of the ratio between $F_{current}$ anf F_{MSY} ($F_{current}/F_{MSY}$), Spawning Stock Biomass, landings and Recruitment of the assessed species (HKE=European hake, MUT=red mullet)

Stock	*Current F*	*F_{MSY}*	*F_{curr}/F_{MSY}*	*Spawning Stock Biomass (tons)*	*Landings (tons)*	*Recruitment (thousands)*
HKE	1.64	0.11	14.9	1115	1552	44 364
MUT	0.45	0.14	3.21	1240	240	35 078

Stock advice

Both demersal stocks are assessed as being exploited unsustainably at levels considerably higher than F_{MSY}. In the case of European hake, the current fishing mortality to F_{MSY} ratio is almost 15.

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The framework used for the reference points is summarised in the table 2.0.8, taken from STECF 14-17 (EWG 14-09) and STECF 15-11 (EWG 15-09). Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.0.8 - Reference points and their technical basis for demersal resources in GSA07.

Framework					
	MSY approach			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for all stocks	F01 as proxy for Fmsy	From empirical equation (EWG 15-11)		1.4 x B_{loss}	N/A
Values for hake	**0.11**	**0.16**	**14.9**	**1077**	
Values for red mullet	**0.14**	**0.20**	**3.21**	**574**	

Development of economic indicators over time and current status

The economic performance of the demersal fleet and of the main fleet segments is evaluated using key social and economic indicators and a traffic light table (Table 2.0.9; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend. "Recent" refers to 2011-2014). Note that even if revenues from main stocks are stable or increasing, the overall fleet revenues are mostly negative, because the dependency of these mixed fleets on the main species is usually lower than 30%. Employment has remained approximately stable for all fleets, but economic performance (salary, overall revenues) is decreasing, except in the case netters and longliners. Recent trend of CR.BER is negative for most fleet segment, while ROI shows a positive recent trend.

Tab. 2.0.9 Traffic light table on the economic performance of the fleets targeting demersal resources (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend; white= does not apply). The values in the cells are referred to 2011 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleets	Salary (Euro)	CR.BER	ROI	Overall Revenues (thousand Euro)	Revenues HKE (thousand Euro)	Revenues MUT (thousand Euro)	Employment (number of units)
All fleets	35213÷25357	1.33÷0.35	(-2.14)÷3.45	66116.2÷49736.6	9700÷13370	1142.6÷1487.5	1334÷1293
ESP07_DTS_12-18	24312÷18656	1.16÷1.08	(-0.04)÷0.03)	1028.3÷925.7	402.2;554.4	53.3÷69.4	38÷35
ESP07_DTS_18-24	45214÷40598	1.15÷0.87	(-0.05)÷0.03)	2752.3÷2007.6	482.6÷665.2	64.0÷83.3	34÷34
FRA07_DTS_12-18	47950÷46258	3.52÷0.48	(-12.44)÷(-2.66)	1217.3÷1095.8	476.1÷656.3	63.1÷82.1	101÷95
FRA07_DTS_18-24	58789÷44512	(-2.07) ÷0.99	(-6.50) ÷ (-0.42)	9129.8÷8218.6	3570.8÷4921.8	473.2÷616.1	304÷298
FRA07_DTS_24-40	44257÷43169	0.35÷0.35	(-8.56) ÷ (-3.48)	21042.0÷15348.6	3689.9÷5085.9	489.0÷636.6	212÷197
FRA07_DFN_00-06	31925÷322369	(-0.67) ÷ (-3.12)	2.57÷9.48	3325.4÷2316.3	154.7÷231.2		62÷64
FRA07_DFN_06-12	29015÷31504	(-0.82) ÷3.73	0.66÷4.30	26324.8÷18853.4	767.3÷1057.6		504÷495
FRA07_DFN_12-18	25064÷24312	6.2÷ (-0.74)	2.47÷5.17	942.7÷652.4	18.2÷25.1		25÷25
ESP07_HOK_12-18	15214÷17264	0.33÷(-0.84)	(-0.25)÷0.06	353.5÷318.2	138.3÷190.6		54÷50

Strategy and timeframe to reach the RP

Both stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on F levels, hake is the most heavily exploited stock in the mix. Hake has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA07, as well as in other Mediterranean areas. The percentages of reduction to reach F_{msy} are reported in the table 2.0.10.

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The percentages of reduction were based on the advices from STECF that indicated the needing of reaching F_{MSY}, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using: the reference point Fupper of European hake which value is 0.16 and the current fishing mortality Fcurrent which value is 1.64 (Tab. 2.0.7).

Tab. 2.0.10 - Fishing mortality reduction needed to reach Fupper, by stock

Stock	***Fishing mortality reduction*** *(in %)*
HKE	93%
MUT	69%

Two strategies to reach F_{msy} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term, the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term; the reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range..

Proposed scenarios

Proposed scenarios are reported in the table 2.0.11.

Table 2.0.11. Scenarios for modelling.

Case Study	**Demersals in GSA 7**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species in 2018 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using value of landings as weighting factor) in 2018 applied on both activity and

	capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using value of landings for weighting) in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity accounting for the survivability issue (in case of gear selectivity). Starting year 2015.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Under Scenarios 2 and 4 the reduction in fishing mortality is assumed on the most overexploited species (European hake) to ensure that all species are fished at Fmsy at the target year (2018 or 2020). Fupper of European hake, which value is 0.156, has been used.

A second set of scenarios (Scenarios 3 and 5) proposes a reduction in fishing effort proportionally applied to the different fleet segments, accounting for their relative impact to a weighted overall Fmsy (value of landings as weighting factor). The table 2.0.12 reports the relative impact of the different fleet segments in terms of percentage of fishing mortality of each stock by fleet segment for 2014. The combined Fmsy target computed on the basis of Fupper by species was 0.162. In this case study, given that only 2 species were assessed, it was decided to use Fupper to compute Fmsy combined, to account for the complexity of catches of OTB metier in GSA07.

Table 2.0.12. Relative impact of the different fleet segments in terms of percentage of fishing mortality of each stock.

Fleets	HKE	MUT	reduction factor
FR-DFN0006	0.00	0.01	0.00
FR-DFN0612	0.06	0.16	0.11
FR-DFN1218	0.00	0.00	0.00
ES-DTS1218	0.06	0.05	0.06
ES-DTS1824	0.07	0.07	0.07
FR-DTS1218	0.05	0.04	0.05
FR-DTS1824	0.37	0.33	0.35
FR-DTS2440	0.38	0.34	0.36
ES-HOK1824	0.00	0.00	0.00
	1.00	1.00	1.00

The reduction of effort was split in a reduction of 10% in terms of capacity and 90% in terms of activity.

In all the scenarios the uncertainty on recruitment has been taken into account, applying for both stocks a multiplicative error (on the stock recruitment relationship/geometric mean of recruitment computed for the last three years).

Forecast of the effects of proposed scenarios

Under status quo conditions, continuing at the same level of fishing mortality than present, the spawning stock biomass of hake would remain at historically low levels, with a high probability of stock level below the reference value (probability of SSB < Blim = 64%), while catches would be similar to the catches observed in recent years. In the case of red mullet, due to the recent high values observed between 2010 and 2014 in SSB and recruitment, maintaining exploitation at status quo level, would result in historically high yield and spawning stock biomass. However, under status quo conditions, overall income would remain at a low level and net profits would continue to be negative for the fleets.

The results of the projections under Scenarios 2 to 5 show that, given the high ratio of current fishing mortality to Fmsy, particularly in hake, which is of the order of 15, the biomass of all stocks would strongly benefit from the required large reductions in fishing effort (close to 90%, depending on the scenario). However, depending on the target year of the simulation (2018 in Scenarios 2 and 3; 2020 in Scenarios 4 and 5) a short term decrease in yield of hake and overall income can be expected. For red mullet, all scenarios 2 to 5 lead to underexploitation of the species, with the result that spawning stock biomass is forecast to reach very high levels but catches lower than historically. In addition, to the high increase in stock biomass of both species, overall income and profits of the fleets are expected to increase substantially.

Scenario 6 does not allow reaching Fmsy for any of the 2 target species, but the results show a significant increase in spawning stock biomass of both species and keeping landings at high levels. The overall income would remain similar to the level of recent years and profits would stabilize to lower, negative values than at present, after 1-2 years of large negative profits immediately after the year of selectivity change.

Overall, considering the summary traffic lights table, reducing the present high fishing mortality rates by 2018 (Scenarios 2 and 3) would allow increasing catches and revenues, wages, as well as spawning stock biomass, at the price of a very significant loss of employment and fishing units. Delaying the reduction of fishing mortality to 2020 would result in worse values of these indicators than at present (Scenarios 4 and 5), except for biomass that would be kept at a high level. Scenario 6 allows to obtain moderate to high increases in all indicators, allowing to keep employment and vessels, at the price of not complying with Fmsy targets.

The following table 2.0.12 summarizes the performances of the management scenarios.

Table 2.0.12 Traffic light table summarizing the performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and overall catches of the main demersal species, salary, CR/BER, ROI, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis.

	Salary (thousand Euro)	CR/BR	ROI	Revenues (million Euro)	Emp. (units)	HKE.catch (t)	MUT.catch (t)	HKE.SSB (t)	MUT.SSB (t)	F (value) (year) HKE	F (value) (year) MUT
Status quo (values in 2014 –baseline year)	25.4	0.35	3.45	49.7	1293	2119	305	1115	1271	1.64	0.44
Status quo (values in 2021)	10.3	-1.9	-0.04	37.9	1293	2020	452	994	1427	1.64	0.44
Scenario 2	28	581	582	28	-90	55	-77	1164	91	0.16	0.04
Scenario 3	1428	567	623	45	-87	63	-33	938	58	0.16	0.16
Scenario 4	547	535	428	-18	-90	-3	-79	620	75	0.65 (2018) 0.16	0.17 (2018) 0.04
Scenario 5	968	527	477	2	-87	12	-36	545	44	0.68 (2018) 0.16	0.18 (2018) 0.16
Scenario 6	926	89	98	29	0	35	4	133	29	1.14	0.33

The methodology and the scenarios tested focus on the current paradigm of fisheries management in the Mediterranean, based on effort control (reduction of capacity or activity: Scenarios 2-5) and technical measures (Scenario 6). The results are consistent with the advice of STECF relevant working groups that stress the need to strongly reduce fishing effort to achieved Fmsy. However, the approach has some limitations because:

- the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020;
- the demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan focus on stock-by-stock effort reduction to achieve individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the 7 fleet segments are heterogeneous in fishing capacity, costs, and fish size selection profile;
- better selection of fish size can be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatio-temporal closures.

The limitations listed should be considered in the light of present knowledge (i.e. data available, models available) and the reactive capacities of all actors involved.
In GSA07, high and persistent concentrations of hake juveniles are found over the continental shelf, especially in the southwest near the border with GSA06 and in the southeast, facing the Rhone river delta. These areas can be protected, in particular not permitting the fishery at least in the periods in which the peaks of recruitment occur, that is in spring and summer (March-June).

3.0 SUMMARY SHEET ON THE CASE STUDY OF SMALL PELAGIC FISHERY IN GSA09

In the Ligurian Sea, northern and central Tyrrhenian Sea, and the seas around Sardinia, the small pelagic fishery is present only in GSA9, where about 50 purse seiners are currently working.

Among small pelagics, anchovy is largely the most important species, both in terms of landings and economic value.

Fisheries: Small pelagic fisheries in the Ligurian and northern Tyrrhenian Seas

GSA: GSA 09

Stocks assessed at STECF-EWG or at GFCM-WG: anchovy (*Engraulis encrasicolus*) (ANE); sardine (*Sardina pilchardus*) (PIL)

Modelling tools used: BEMTOOL bioeconomic platform.

Fleets involved

Three main fleet segments are operating in the Ligurian and northern Tyrrhenian Seas targeting small pelagics (table 3.0.1). This is a mixed fishery with a higher catch of anchovy, whilst sardine is mainly caught as a by-catch and/or in periods when anchovy is available in low quantity. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 3.0.1

Table 3.0.1 - Main fleet segments involved in the small pelagics fishery in GSA9. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N	*Fleet name small pelagic GSA9*	*Fleet code GSA9*	*% of landings (all species)*
1	Italian GSA09 purse-seiners with vessel length 12-18 m	ITA9_PS_VL1218	14.3
2	Italian GSA09 purse-seiners with vessel length 18-24 m	ITA9_PS_VL1824	24.9
3	Italian GSA09 purse-seiners with vessel length 24-40 m	ITA9_PS_VL2440	60.7

After 2009 the fishing effort of purse seiners is decreasing.

Contribution of the small pelagic stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the small pelagics fisheries (percentage computed on the average production of the last three years) is between 87% (PS_VL1218) and 95% (PS_VL1824). Thus the management measures to be taken would target almost the whole mix of this fishery.

Development of stocks over time and current status

The assessment of sardine is reported in STECF 15-06 (STECF, 2015b), while the assessment of anchovy in the STECF report 11-14 (STECF, 2011). These assessments used DCF data. The assessment of anchovy was conducted using pseudocohort analysis under equilibrium assumption (by means of VIT package; see Lleonart and Salat, 1992). The use of alternative and more suitable approaches was not possible, given the shortness of data time series and the lack of fishery independent data (i.e. acoustic surveys). Indeed, steady state, which is the main assumption of the pseudocohort analysis, is difficult to occur for a small pelagic stock, which dynamics is remarkably influenced by environmental variations.

The approach used for sardine was a separable VPA (i.e. Virtual Population Analysis). This method is more suitable compared to pseudocohort analysis, although, given the absence of tuning data from independent fishery source (acoustic surveys) the results are more uncertain compared to those of a tuned VPA. Therefore, these assessments can be considered only indicative of trends of fishing mortality F or exploitation rate E, while absolute estimates of recruitment and Spawning Stock Biomass are dependent from model assumption.

Discards in these fisheries are considered negligible.

Status of the small pelagic stock is reported in the Table 3.0.2.

Tab. 3.0.2 – Fishing mortality, exploitation rate E and landings, ratio between the current exploitation rate and the reference exploitation rate (0.4 from Patterson, 1992) from the stock assessment reports, and landing by stock.

Stock	***Fishing mortality**** *(Fcurrent)*	***Exploitation Rate (E[4])***	***E/E0.4***	***Landings*** *(tons)***	***SSB*** *(tons)*
Anchovy	Fbar $_{(1-3)}$= 1.85	0.81	2	3451	2567
Sardine	Fbar $_{(1-3)}$= 1.11	0.56	1.4	1805	2912

*estimates refer to assessment reported in STECF11-14 for anchovy, and STECF 15-06 for sardine. **2014 data.

No Management Strategy Evaluation (MSE) was performed so far for the two small pelagic species in GSA 09, given that very simple models were used in the assessment. This because the time series was short (in the assessment of anchovy) and fishery independent information (e.g. acoustic surveys) were not available for both stocks.

Reference points and stock advice

The exploitation rate E estimated at STECF11-14 for anchovy, and STECF 15-06 for sardine was respectively 0.81 and 0.49, being the reference year for the estimates 2010 for anchovy and 2013 for sardine. For both stocks the current exploitation rate E is above the reference point, being the ratio between the current value and the reference level 2.03 for anchovy and 1.23 for sardine (Tab. 3.0.3), thus evidencing unsustainable exploitation in the long term.

Tab. 3.0.3 Reference points and their technical basis

[4] Exploitation rate is the ratio between the fishing mortality and the total mortality (E=F/Z)

	MSY approach		
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**$E_{curr}/E_{0.4}$ ratio**
Technical basis for anchovy	Exploitation rate (E0.4) from Patterson (corresponding to F=0.28)	-	2.03
Technical basis for sardine	Exploitation rate (E0.4) from Patterson (corresponding to F=0.56)	-	1.23

Development of economic indicators over time and current status

The economic performance by the whole fleet and the main fleet segments are evaluated using key social and economic indicators using a traffic light table (table 3.0.4) for the period 2008-2013.

This analysis evidenced a deteriorated performances of the revenues of sardine and also for anchovy, which affect the overall revenues and employment of two fleet segments (PS_VL1218 and PS_VL1824).

Tab. 3.0.4 Traffic light table on the economic performance (2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

GSA9 Small Pelagic fisheries	Salary (euro)	CR.BER	ROI	Overall Revenues (thousand euros)	Revenues anchovy (thousand euros)	Revenues sardine (thousand euros)	Employment (number of units)
All fleets*	16339÷15886	1.709÷2.544	0.215÷0.	11630÷113	7065÷7960	3252÷928	257÷258
ITA9_PS_VL1218	7419÷14316	0.64÷2.53	0.108÷0.	3579÷2878	1625÷1685	1274÷52	136-80
ITA9_PS_VL1824	9847÷17563	1.33÷1.82	0.107÷0	4448÷2356	3469÷1793	316÷280	139-50
ITA9_PS_VL2440*	18030÷16212	1.84÷2.91	0.237÷0.	5920÷6078	2627÷4482	2792÷597	108÷128

*for these fleets the starting year is 2009 as in 2008 data for PS_VL2440 were missing

Strategy and timeframe to reach the RP

The two stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels, anchovy is the most heavily exploited stock in the mix; however, sardine is the stock that was assessed more recently and assessment was based on a more suitable approach, therefore it was decided to use sardine as a benchmark.

The percentage of reduction to reach F_{MSY} proxies (E0.4 approach) is reported in the table 3.0.5. The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach

FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point E0.4 and the current exploitation rate. In this case the level of natural mortality in the age range 1-3 (M=0.88), the same age range as the fishing mortality, was used.

Table 3.0.5 Percentage of reduction to reach F_{MSY} proxies (E0.4 approach).

Stock	***Fishing mortality reduction** (in %)*
Sardine (Reference point E = 0.4)	30%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

This reduction has been applied to the different fleet segments, considering their respective proportion of fishing mortality based on the ratio between the sardine production of the fleet segment to the overall sardine production.

In table 3.0.6 the percentage of fishing mortality of sardine of the different fleet segments is expressed in terms of percentage by fleet segment and year.

Table 3.0.6 Proportion of fishing mortality of sardine by fleet segment

Species	**Percentage F due to ITA9_PS_VL1218**	**Percentage F due to ITA9_PS_VL1824**	**Percentage F due to ITA9_PS_VL2440**
S. pilchardus	4	27	68

Proposed scenarios

Proposed scenarios are reported in the table 3.0.7.

In scenario 1, the current situation is projected to 2018 and 2020 under status quo condition.

In scenario 2, a linear reduction towards E0.4 of sardine in 2018 is applied both to activity and capacity (up to 2017, then on the activity only). In scenario 3, a linear reduction towards E0.4 of sardine in 2020 is applied from 2018 to 2020 only on activity.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 exploitation rate is assumed to remain around E0.4.

Table 3.0.7 Proposed scenarios

Case Study	**small pelagics in GSA 09**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards E0.4 of sardine in 2018 applied both to activity and capacity up to 2017, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards E0.4 of sardine in 2020, from 2018 to 2020 applied only on activity. Application can be differentiated by fleet. Starting year of reduction 2015.

The reduction to each fleet segment was applied for 3% on vessels until 2017 and for 27% to the fishing days until 2018 (Scenario 2) or 2020 (Scenario 3). The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

In all the scenarios, the uncertainty on recruitment has been taken into account (process error), applying for both stocks a multiplicative error on the recruitment of the last year.

Forecast of the effects of proposed scenarios

According to the traffic light summary (Table 3.0.8) the two scenarios alternative to status quo allow to obtain a benefit in terms of SSB for both stocks, and they appear to produce the same effect. For the stock of sardine the target exploitation rate E0.4 was reached by 2018 or 2020, depending on the scenario.

Considering all fleet, the catches of anchovy are decreasing by a low percentage (around 1-3%), while those of anchovy are expected to decrease by around 10%. Revenues and employment are expected to decrease similarly in the two scenarios with a percentage around 3%. The reduction of employees is limited, given the limited amount of scraping. Salary and CR/BER indicators are expected to improve in both scenarios around 8-11%. Also the indicator ROI shows the same pattern with an increase of 15-12% depending on the scenarios.

At fleet segment level PS_VL1218 would have a reduced impact compared to the other 2 fleets.

Table 3.0.8 Performances of the simulated management scenarios (% of change respect to status quo) in terms of SSB and overall catches of anchovy and sardine, salary, CR/BER, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev.=Revenues; Employ.=Employment. The baseline of 2014 is also reported. The values of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline E is reported. SQ= Status quo.

Small pelagics in GSA 9	**ALL fleets**										
Scenario, year 2021	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB Anchovy (tons)	SSB Sardine (tons)	Catch Anchovy (tons)	Catch Sardine (tons)	E (value) (year) Anchovy	E (value) (year) Sardine
SQ (values in 2014 –baseline year)	15886	2.544	0.48	11312	258	2599	3335	4033	1421	0.85	0.45
Scenario 1 (values in 2021)	16149	2.436	0.44	11290	265	2698	3698	4159	1775	0.85	0.45
Scenario 2	9.9	11.0	15.1	-2.1	-3.0	25.3	10.4	-1.5	-9.0	0.8	0.4
Scenario 3	8.1	9.0	11.7	-3.4	-3.0	25.3	10.5	-3.2	-10.9	0.82 (2018) 0.8	0.44 (2018) 0.4

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the two scenarios provide similar results in terms of overall utility compared to the status quo (values around 0.31), although, if the only biological conservation component is taken into account, the two alternative scenarios perform slightly better compared to the status quo.

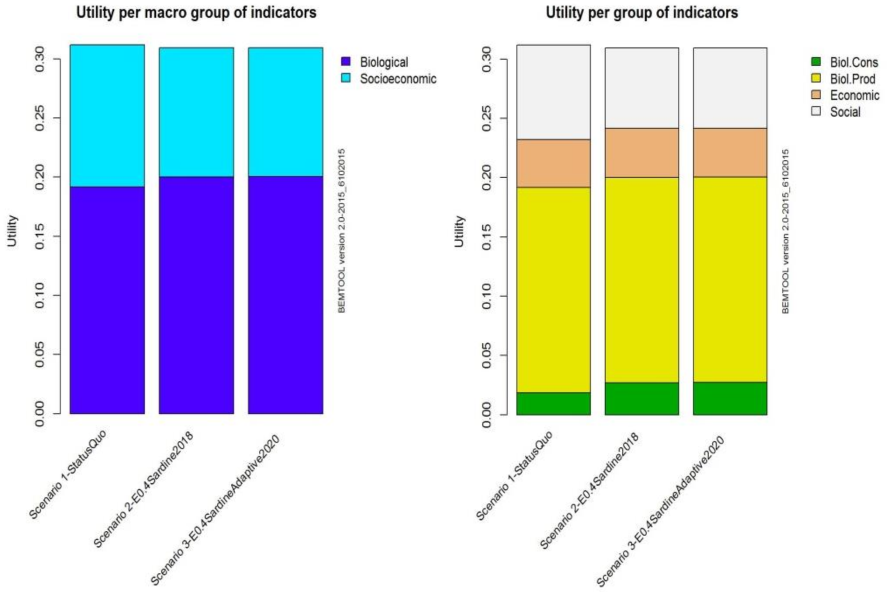


Figure 3.0.1 MCDA results: evaluation of the overall utility associated to each management scenario.

Limitations in the used approach mainly regard the update of the assessments and the availability of fishery indpendent data (e.g. acoustic survey) for the two stocks; in addition, one of the main issues is the difficulty in forecasting recruitment in small pelagic species. These species are in fact strongly influenced from environmental variables and the recruitment can show dramatic variability from one year to the next. In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.

Catch option and advice

On the basis of the estimated limit management reference point for sustainable exploitation (E0.4 for sardine), catches in 2016 should be according to the following table 3.0.8. The reduction to reach the reference point is fully applied in 2016 and the values of the catches can be considered the maximum that can be taken to fulfil the objective of the reference point.

Table 3.0.8 Catch advice by scenario.

		Catch advice (tons)	
Scenario	Year	Anchovy	Sardine
Scenario 2	2016	3936	1611
Scenario 3	2016	3990	1685

4.0 SUMMARY SHEET ON THE CASE STUDY OF DEMERSAL FISHERIES IN GSA09 AND GSA11

The production of the area mostly comes from the fisheries of GSA9, in particular from trawlers.

Several demersal stocks, such as European hake, red mullet and Norway lobster are relevant in both GSA9 and GSA11, even though some differences are present (e.g. giant red shrimp is more relevant in GSA11 and Norway lobster in GSA9).

Regarding demersal stocks, data are still scarce and scattered **in GSA8**, where only time series from scientific trawl surveys at sea (MEDITS) are available, while **stock assessments are not available**. Fishery economic data are also not available for this GSA.

Fisheries: Demersal fisheries in the Ligurian and northern Tyrrhenian Seas

GSA: GSA 09

Stocks assessed: European hake (*Merluccius merluccius*) (HKE), red mullet (*Mullus barbatus*) (MUT), deep-water rose shrimp (*Parapenaeus longirostris*) (DPS) and Norway lobster (*Nephrops norvegicus*) (NEP)

Modelling tools used: BEMTOOL bioeconomic platform; Management Strategy Evaluation by STECF-EWG 15 11 Working Group.

Fleets involved

Five main fleet segments are operating in demersal fisheries of GSA 09 (table 4.0.1). All fleet segments generally work on continental shelf (50-200 m depth), while the two trawl fleet segments with larger vessel length and the PGP with largest vessel length (mostly using gill nets targeting European hake) operate also on the continental slope. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 4.0.1

Table 4.0.1 - Main fleet segments operating in GSA 09 carrying out demersal fisheries. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N	*Fleet name demersal fisheries GSA9*	*Fleet code GSA9*	*% of landings (all species)*
1	Bottom trawlers with vessel length 12-18 m	ITA9_DTS_VL1218	23.9
2	Bottom trawlers with vessel length 18-24 m	ITA9_DTS_VL1824	38.9
3	Bottom trawlers with vessel length 24-40 m	ITA9_DTS_VL2440	2.4
4	Vessels using polyvalent passive gears length 00-12 m	ITA9_PGP_VL0012	27.8
5	Vessels using polyvalent passive gears length 12-18 m	ITA9_PGP_VL1218	7.0

Effort of trawlers is decreasing and that of vessels using polyvalent passive gears as well, though in this case the pattern is more variable along the time.

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years of all demersal and benthic species) is reported in the table 4.0.2. These stocks account for a low percentage, less than 10%, in the small scale fishery operated by smaller vessels (ITA9_PGP_VL0012), but are important for the bottom trawl fleets and the artisanal fisheries carried out by vessels in the class 12-18 m LOA (Length Over All). In these cases the assessed stocks represent, on average, from 30 to about 40% of the fleet segment production.

Table 4.0.2 - Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA9.

Assessed species/fleet segments ***GSA9***	***ITA9_DTS VL1218***	***ITA9_DTS VL1824***	***ITA9_DTS VL2440***	***ITA9_PGP VL0012***	***ITA9_PGP VL1218***
NEP	2.03	2.75	3.91	0.00	0.00
DPS	6.42	6.50	13.50	0.00	0.00
HKE	9.23	13.70	14.78	6.69	29.98
MUT	12.70	8.84	6.34	1.80	0.13
Total assessed %	30.38	31.79	38.53	8.49	30.11

Development of stocks over time and current status

The assessment of the main demersal stocks was carried out at STECF 14-17 (EWG 14-09; red mullet and Norway lobster; see STECF, 2014c), STECF 15-06 (EWG 14-19 deep-water rose shrimp see STECF, 2015b) and STECF EWG 15-11 (European hake; STECF, in press).

All stocks are considered overexploited (red mullet is considered slightly overexploited) by the recent assessments, with the only exception of deep-water rose shrimp, which is considered as exploited sustainably (Table 4.0.3). Discards of hake and deep-water rose shrimp were included in the assessment; discards of Norway lobster was considered negligible and thus not included.

Table 4.0.3 – Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA9.

Stock	***Fishing mortality* (Fcurrent)***	***Catch (tons)***	***Landings (tons)*****	***Discards (tons)***	***Spawning Stock Biomass*current (tons)***	***Recruitment (in thousands)***
European hake	0.82	1560	1274	286	2000	55 923
Norway lobster	0.56	113	112	0.5	453	73 678
Red mullet	0.56	1287	1181	106	1290	165 897
Deep water rose shrimp	0.4	606	561	45	906	338 251

* = Mean of the last 3 years; **2013 data

Stock advice

Two out of the four stocks are assessed as being exploited unsustainably at levels higher than F_{MSY}; namely European Hake (HKE) ($F_{current}$ about 3.6 times F_{MSY}) and Norway lobster (NEP). Red mullet is considered slightly overexploited, while deep-water rose shrimp is considered to be exploited sustainably ($F_{current}$ close to F_{MSY}).

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

F_{MSY} = 0.23; Fupper = 0.32 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.7.

The framework used for the reference points is summarised in the table below, taken from EWG 14-09, EWG 14-19 and EWG 15-11. Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Tab. 4.0.4 – Summary of the reference points for the four demersal stocks in GSA09.

	Framework				
	MSY approach			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**Fcurr/ F_{MSY}**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for European hake method 1	$F_{0.1}$ used as proxy of Fmsy from YpR analysis	STECF EWG 15-11 approach (empirical)		MSE (lowest level of SSB in the time series)	MSE (1.4* Blim)
Technical basis for all the species method 2	F combined according to Balance indicators approach				
Technical basis for all the other species method 1	F_{upper} of European hake	STECF EWG 15-11 approach (empirical)			
Values for European hake method 1	**0.23**	**0.32**	**3.6**	1569	2197
Values for deep water rose shrimp method 1	0.71	0.97	0.8		
Values for red mullet method 1	0.59	0.80	0.95		
Values for Norway lobster method 1	0.21	0.29	1.8		

	Framework				
	MSY approach			Precautionary approach	
Values for all the other species method 2	**0.39**		**1.78**		

*B_{lim}=B_{loss} (B_{loss} is the lowest value of SSB in the time series, that was estimated in the last year).

A Management Strategy Evaluation (MSE) was performed in line with EWG-15-11 for hake to evaluate if the MSY ranges were precautionary and assuming a constant recruitment. The F_{MSY} ranges were derived using the formula provided by STECF 15-09.

The MSE shows:

1. moving F toward Fupper (0.32) in the long term will result in a slight decrease of catches in the long term and wide fluctuation in the short-term;
2. the probability of being below B_{lim} (B_{lim} = B_{loss}= 1569 tons) is equal to 0.

Development of economic indicators over time and current status

The economic performance of the fleet segments is evaluated using key social and economic indicators and a traffic light table for the years 2008-2013 (Table 4.0.4; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

Overall revenues of almost all fleet segments are negative given the negative performance of the different fleet segments for the different species. Revenues from European hake, red mullet and deep-water rose shrimp are showing increasing patterns for some fleet segments only (ITA9_DTS_VL1218; ITA9_DTS_VL2440 and PGP_VL0012). Excluding salary all the other economic indicators are deteriorated, except for the fleet ITA9_PGP_VL0012.

Tab. 4.0.4 Traffic light table on the economic performance (2008-2013) of the fleets targeting demersal stocks (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues red mullet (thousands euros)	Revenues pink shrimp (thousands euros)	Revenues Norway lobster (thousands euros)	Employment (number of unit)
ALL *	10874 ÷ 10082	1.865 ÷ 1.034	0.302 ÷ 0.011	108317 ÷ 89285	11317 ÷ 9516	4676 ÷ 4194			
ITA9_DTS_VL1218	12828 ÷ 17395	1.926 ÷ 1.556	0.296 ÷ 0.181	21626 ÷ 22076	1891 ÷ 2065	2305 ÷ 1617	822 ÷ 2151	2365 ÷ 1469	392 ÷ 342
ITA9_DTS_VL1824	14717 ÷ 16901	0.856 ÷ 0.429	-0.045 ÷ -0.173	37791 ÷ 27960	5217 ÷ 4400	2295 ÷ 1478	2625 ÷ 2173	4938 ÷ 2096	494 ÷ 390
ITA9_DTS_VL2440 *	33328 ÷ 17217	1.098 ÷ 0.508	0.029 ÷ -0.13	4000 ÷ 2653	341 ÷ 393	138 ÷ 86	705 ÷ 253	527 ÷ 515	30 ÷ 31
ITA9_PGP_VL0012	5013 ÷ 6799	2.566 ÷ 1.341	0.62 ÷ 0.15	34750 ÷ 31275	2519 ÷ 2115	89 ÷ 1100			1849 ÷ 1608
ITA9_PGP_VL1218	11395 ÷ 9439	1.641 ÷ 1.811	0.194 ÷ 0.256	5503 ÷ 5320	1583 ÷ 937	4 ÷ 0			135 ÷ 158

* All the values of the indicators in the starting year are referred to 2009, as in 2008 DTS_VL2440 has no days at sea

Strategy and timeframe to reach the RP

The four stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on F levels, hake and Norway lobster are the most heavily exploited stocks in the mix. Hake has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA 09, as well as in other Mediterranean areas. The percentages of reduction to reach F_{upper} and F_{MSY} combined are reported in the table 4.0.5 below. The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of European hake (the more exploited species) = 0.32 (method 1) and the current level of fishing mortality (method 1) (Fcurr=0.82);
- the reference point F_{MSY} combined = 0.39 (method 2) and the current level of fishing mortality combined (F=0.69).

Table 4.0.5 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{UPPER} (method 1) or combined F_{MSY} (method 2).

Stock	Fishing mortality reduction (in %)
European hake (Reference point method 1)	61%
All stocks (Reference point method 2)	44%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

In the table 4.0.6 below the relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of European hake by fleet segment and year.

Tab. 4.0.6 – Relative impact on fishing mortality by fleet segment and year.

Year	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	17.8	15.6	17.9	22.7	20.8	21.1
ITA9_DTS_VL1824	58.8	53.0	44.6	41.4	48.6	53.7
ITA9_DTS_VL2440	0.0	4.0	2.8	3.3	2.6	5.4
ITA9_PGP_VL0012	13.5	12.3	14.9	13.7	10.1	13.7
ITA9_PGP_VL1218	9.9	15.0	19.7	18.8	17.9	6.2

The reduction has been equally split among fleet segments, considering the relative portion of $F_{current}$ of each one to own relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of F_{upper} a reduction of 61% is necessary.

The value of the overall combined fishing mortality is 0.7, while the combined F_{MSY} is 0.39. A reduction of 44% on the overall fishing mortality is thus needed. The reductions have been applied according to the proportions of combined fishing mortality by fleet segment (Table 4.0.7).

Table 4.0.7 Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	% F current European hake	Reduction applied%	% F current combined	Reduction applied %
1	ITA9_DTS_VL1218	21.1	61	19.7	44
2	ITA9_DTS_VL1824	53.7		32.8	
3	ITA9_DTS_VL2440	5.4		3.2	
4	ITA9_PGP_VL0012	13.7		10.2	
5	ITA9_PGP_VL1218	6.2		3.5	

Two strategies to reach the set reference Point were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

A further scenario, the scenario 6, has been designed that aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

Proposed scenarios

Proposed scenarios are reported in the table 4.0.8

Table 4.0.8 – Proposed scenarios.

Case Study	demersals in GSA 9
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using

	landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

Forecast of the effects of proposed scenarios

For all stocks, all the scenarios alternative to the status quo produced an increase in SSB, although the best performance was shown by Scenario 2 and 4. Under all the scenarios, catches of all stocks showed a decreasing pattern, with the only exception of Scenario 6, which produced a slight increase in catches for European hake and Norway lobster. However, Scenario 6 was not improving the SSB of the four stocks as Scenarios 2 and 4.

In socio-economic terms, scenarios 2 and 4 entail a high decrease in revenues, and a decrease in employment that is slightly higher than 5%. Theeconomic indicators CR.BER, Salary and ROI are improving.

The following table 4.0.9 summarized the performances of the management scenarios in terms of SSB and overall catches of the four stocks, salary, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Tab. 4.0.9 Performances of the management scenarios (% of change respect to status quo) in terms of SSB and overall catches of the four stocks, salary, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are smaller than -5% and the yellow ones are between -5% and +5%. The baseline of 2014 is also reported. The values of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo.

Demersals in GSA 09	**All fleet**																
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB HKE (tons)	SSB MUT (tons)	SSB DPS (tons)	SSB NEP (tons)	Catch HKE (tons)	Catch MUT (tons)	Catch DPS (tons)	Catch NEP (tons)	F HKE	F MUT	F DPS	F NEP
SQ (values in 2014 – baseline year)	10082	1.034	0.011	89285	2529	3119	1491	904	435	1436	772	654	156	0.82	0.56	0.56	0.39
Scenario 1 (values in 2021)	9516	0.814	-0.063	84345	2555	2590	1881	910	400	1186	985	659	148	0.82	0.56	0.56	0.39
Scenario 2	28.9	37.2	159	-17.1	.	181,7	57.1	70.8	85.4	-7.1	-33.8	-29.2	-29.5	0.35	0.24	0.24	0.16
Scenario 3	30.0	39.1	168	-8.0	-4.4	108.3	37.9	46.4	55.9	0.7	-20.4	-16.8	-17.0	0.47	0.32	0.32	0.22
Scenario 4	23.6	30.0	130	-19..7	-6.1	121.6	50.8	63.4	63.4	-9.8	-36.3	-32.4	-34.0	0.35 (2018) 0.54	0.24 (2018) 0.37	0.24 (2018) 0.36	0.16 (2018) 0.25
Scenario 5	27.3	35.5	152	-9.3	-4.4	76.7	33.5	43.5	42.7	0.2	-23.1	-18.7	-20.1	0.47 (2018) 0.61	0.32 (2018) 0.42	0.32 (2018) 0.42	0.22 (2018) 0.29
Scenario 6	22.9	30.3	133	11.7	0.0	18.0	14.1	20.5	21.5	17.7	1.0	2.0	9.8	0.76	0.56	0.48	0.36

The following figure 4.0.1 show the results of the MCDA. The scenarios allowing to reach the highest overall utility are scenarios 2 and 4 (overall utility 0.45 and 0.42 respectively), while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.25).

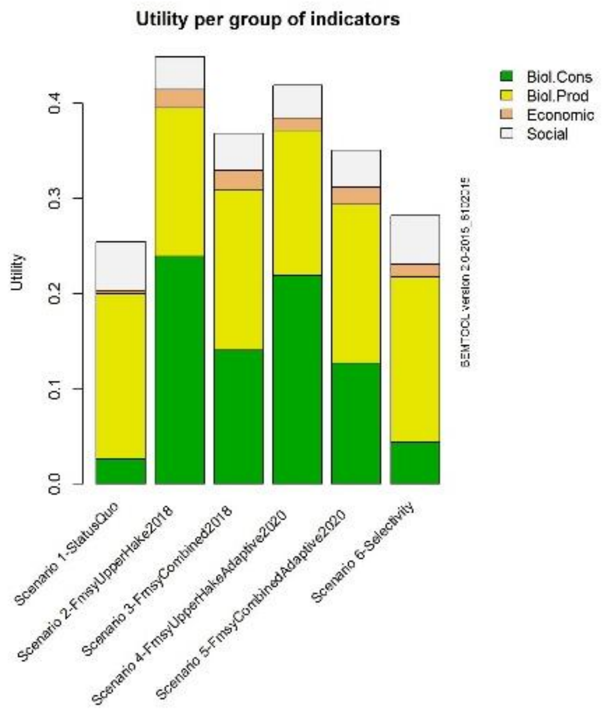


Figure 4.0.1 MCDA results: evaluation of the overall utility associated to each management scenario.

The methodology and the scenarios tested focus on the current paradigm of fisheries management in the Mediterranean, based on effort control (reduction of capacity or activity: Scenarios 2-5) and technical measures (Scenario 6). The results are consistent with the advice of STECF relevant working groups that stress the need to strongly reduce fishing effort to achieved Fmsy. However, the approach has some limitations because:

- The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.
- The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan to focus on stock-by-stock effort reduction for achieving individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile;
- Better selection of fish size can be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatial closures.

The limitations listed should be considered in the light of present knowledge (i.e. data available, models available) and the reactive capacities of all actors involved.

Fisheries: Demersal fisheries in Sardinia

GSA: GSA 11

Stocks assessed: European hake (HKE, *Merluccius merluccius*), red mullet (MUT, *Mullus barbatus*), giant red shrimp (ARS, *Aristaeomorpha foliacea*)

Modelling tools used: BEMTOOL bioeconomic platform; Management Strategy Evaluation by STECF-EWG 15 11 Working Group.

Fleets involved

Five main fleet segments operating in GSA 11 carrying out demersal fisheries were identified. Demersal fisheries are carried out on continental shelf (50-200 m depth) by all fleet segments and on the continental slope by the two largest trawl fleet segments targeting giant red shrimp (Tab. 4.0.5). The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 4.0.10.

Table 4.0.10 Main fleet segments operating in GSA11 carrying out demersal fisheries. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N.	***Fleet name demersal fisheries GSA11***	***Fleet code GSA11***	***% of landings (all species)***
1	Bottom trawlers with vessel length 12-18 m	ITA11_DTS_VL1218	10.0
2	Bottom trawlers with vessel length 18-24 m	ITA11_DTS_VL1824	12.0
3	Bottom trawlers with vessel length 24-40 m	ITA11_DTS_VL2440	10.6
4	Vessels using polyvalent passive gears length 00-12 m	ITA11_PGP_VL0012	52.1
5	Vessels using polyvalent passive gears length 12-18 m	ITA11_PGP_VL1218	15.2

Fishing effort from trawlers is decresing from 2008 to 2012, while that of vessels using polyvalent passive gears was increasing from 2008 to 2011 and then decreasing.

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is reported in the table 4.0.11 below. These stocks account for a low percentage in the small scale fishery operated by small scale vessels using polyvalent gears (PGP), but are relatively important for the bottom trawlers, especially for the fleet segment with larger length (ITA11_DTS_VL2440).

Table 4.0.11 Contribution of the stocks assessed to the production of the main fleet segments of demersal fisheries in GSA11

Assessed species/fleet segments	ITA11_***DTS VL1218***	ITA11_***DTS VL1824***	ITA11_***DTS VL2440***	ITA11_***PGP VL0012***	ITA11_***PGP VL1218***

GSA11					
ARS	1.2	2.4	11.3		
HKE	7.2	6.9	12.6	1.6	1.5
MUT	5.7	7.8	2.9	0.3	0.2
Total assessed%	14.1	17.1	26.8	1.9	1.7

Development of stocks over time and current status

The assessment of the three demersal stocks was carried out at STECF EWG 13-19 (red mullet see STECF, 2013), and EWG 15-11 (European hake and giant red shrimp; see STECF, in press). These assessments used official DCF data.

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the needing of estimating this parameter when the assessment was not recent are reported in the table 4.0.12, as well as landings, discards, spawning stock biomass and recruitment. These values were in line with the assessments.

Table 4.0.12 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA11.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)*	*Discards (tons)*	*Spawning Stock Biomass**	*Recruitment (in thousands)*
European hake	F=1.66	354	259	95	73	15 475
Red mullet	F=1.02	367	264	103	137	13 184
Giant red shrimp	F=0.58	30	30	0	92	18 418

* = Mean of the last 3 years

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

F_{MSY} = 0.17; Fupper = 0.24 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.26.

The framework used for the F_{MSY} reference points is summarised in the Table 4.0.13.

Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 4.0.13 – Reference point framework for the selected 3 stocks.

	.	
	MSY approach	**Precautionary approach**

	.				
	MSY approach			**Precautionary approach**	
Reference point	F_{MSY}	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	$B_{lim\ (tons)}$	$B_{pa\ (tons)}$
Technical basis for all stocks	F0.1 as proxy for Fmsy	From empirical equation (EWG 15-11)		$B_{lim} = B_{loss}$ lowest value of the time series	1.4 * B_{lim} from empirical equation (EWG 15-11)
Technical basis for all the species method 2	F combined according to Balance indicators approach (weight from landing value)				
Values for European hake	0.17	0.24	7.0	73	102
Values for red mullet	0.32	0.44	3.2		
Values for Giant red shrimp	0.31	0.43	1.89		
Values for all the other species method 2	0.26		4.48	-	-

A Management Strategy Evaluation (MSE) for European hake in GSA 11 was run at STECF EWG 15-11 to evaluate if the MSY ranges were precautionary.

The F_{MSY} ranges were derived using the formula provided by STECF 15-09. F ranges results were F_{upper}=0.24 and F_{lower}=0.12. B_{lim} was estimated as B_{loss}=73 (t). The following figure shows the results of the MSE. The probability that the SSB falls below B_{lim} fishing at F equal to F_{MSY} upper level is equal to 0.

Stock advice

All the three stocks are assessed as being exploited unsustainably at levels much higher than F_{MSY} (Table 4.0.13). Discards of hake and red mullet were included in the assessment; discards of giant red shrimp was instead considered negligible.

Development of economic indicators over time and current status

The economic performance of the fleet segments is evaluated using key social and economic indicators (on the period 2008-2013) and a traffic light table (Table 4.0.14; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

Revenues of European hake and red mullet are generally declining, though small scale fleet (ITA11_PGP_VL0012) is performing better compared to trawlers,while revenues from giant red shrimp are improving.. Among trawlers the fleet segment ITA11_DTS_VL1824 has a better economic performance. Considering the whole fleet, economic indicators (Salary, CR.BER, ROI) have a good short term performance.

Table 4.0.14 Traffic light table on the economic performance (in 2008-2013) of the fleets targeting demersal resources in the GSA11 (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues red mullet (thousands euros)	Revenues red giant shrimp (thousands euros)	Employment (number of unit)
ALL	5542 ÷ 5698	0.942 ÷ 0.791	-0.016 ÷ -0.065	56507 ÷ 45822	2272 ÷ 1693	2311 ÷ 800	1182 ÷ 2149	2205 ÷ 2136
ITA11_DTS_VL1218	5813 ÷ 9033	0.61 ÷ 0.948	-0.127 ÷ -0.016	6944 ÷ 5574	484 ÷ 315	904 ÷ 219	10 ÷ 557	199 ÷ 142
ITA11_DTS_VL1824	8641 ÷ 15422	0.489 ÷ 1.434	-0.131 ÷ 0.117	5442 ÷ 6552	442 ÷ 529	709 ÷ 435	120 ÷ 165	117 ÷ 122
ITA11_DTS_VL2440	12509 ÷ 19707	0.423 ÷ 0.218	-0.131 ÷ -0.195	9832 ÷ 4688	872 ÷ 446	677 ÷ 94	1052 ÷ 1427	138 ÷ 84
ITA11_PGP_VL0012	3592 ÷ 3484	1.159 ÷ 0.843	0.059 ÷ -0.057	22212 ÷ 21813	190 ÷ 328	14 ÷ 44		1429 ÷ 1565
ITA11_PGP_VL1218	9912 ÷ 8511	1.527 ÷ 0.748	0.131 ÷ -0.078	12077 ÷ 7195	284 ÷ 76	8 ÷ 7		322 ÷ 223

Strategy and timeframe to reach the RP

The three stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on Fcurrent levels, European hake is the most heavily exploited species. thus it has been used as the benchmark species.

The percentages of reduction to reach F_{MSY} are reported in the Table 4.0.15. The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of European hake (the more exploited species) = 0.24 (method 1) and the current level of fishing mortality (method 1) (Fcurr=1.66);
- the reference point F_{MSY} combined = 0.26 (method 2) and the current level of fishing mortality combined (F=1.17).

In case of Fupper a reduction of 86% is necessary. In case of fishing mortality combined, the needed reduction is 77%.

Table 4.0.15 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{MSY} (method 1) or combined F (method 2).

Stock	Fishing mortality reduction (in %)
European hake (Reference point method 1)	86%
All stocks (Reference point method 2)	77%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of hake by fleet segment and year (Tab. 4.0.16).

Tab. 4.0.16 Percentage of fishing mortality of European hake by fleet segment (2014).

	HKE	MUT	ARS
ITA11_PGP_VL0012	21.1	7.7	
ITA11_PGP_VL1218	5.9	1.5	
ITA11_DTS_VL1218	18.3	28.6	7.6
ITA11_DTS_VL1824	20.9	46.9	17.6
ITA11_DTS_VL2440	33.7	15.2	74.7
	100	100	100

The reduction has been equally split among fleet segments, considering the relative portion of Fcurrent to own relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species (Table 4.0.17).

Tab. 4.0.17 Proportion of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	**% F current European hake**	**Reduction applied%**	**% F current combined**	**Reduction applied %**
1	ITA11_DTS_VL1218	18.3	86	26.9	77
2	ITA11_DTS_VL1824	20.9		29.3	
3	ITA11_DTS_VL2440	33.7		35.9	
4	ITA11_PGP_VL0012	21.1		19.5	
5	ITA11_PGP_VL1218	5.9		5.1	

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term;
2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

According to the method 1 theapplied reduction of fishing days was 77.4%, to be reached by 2018 or 2020 depending by the scenario, and reduction of vessels was 8.6%, while according to the method 2 theapplied reduction of fishing days was 69.3% and reduction of vessels was 7.7%. Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns corresponding to SM40 (square mesh of 40 mm opening).

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

Proposed scenarios

Proposed scenarios are reported in the table 4.0.18.

Table 4.0.18 Proposed scenarios

Case Study	demersals in GSA 11
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018. In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

Forecast of the effects of proposed scenarios

All the performed scenarios alternative to the Status Quo allow to obtain a benefit on the SSB for the three stocks under investigation and, as can be seen in the table 4.0.19, if the rebuilding of SSB is expected to be remarkable for all the stock it appears extraordinary for hake. The productivity of this stock would increase, as reflected by the increase of catches, that however will be neutralised by the decrease of catches for the other stocks, which will remain severely underutilised, especially the giant red shrimp. As a consequence of increasing of hake catches revenues are expected to increase, while the other indicators as CR/BER are expected to improve given the cost decrease following the considerably reduced activity of the fleet. ROI is also increasing as a results of improved revenues. Also salary is expected to increase, while employment would suffer with a decrease of 8%. Scenarios 2 and 3 are those performing better considering the results of the traffic light (table 4.0.19).

Results show that the fleet segments more negatively impacted by the management measures are DTS_VL1218 and DTS_VL2440.

In general, all the scenarios alternative to the Status Quo show a decreasing pattern in terms of revenues and employment in all the fleet segments. However, the total revenues in PGP_VL0012 and PGP_VL1218 show a significant increase under all the scenarios alternative to the Status Quo. Also in this case, the best performing scenarios are Scenario 2 and 3.

In 2021, both the ratio between current and break-even revenues (CR/BER) and the salary show an improvement in all the fishing fleets under all alternative scenarios compared to the Status Quo. In general, the best performance for these indicators is expected under Scenario 2 and 3.

Tab. 4.0.19 Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catches of hake, red mullet and giant red shrimp, salary, CR/BER, employment and revenues for all the fleet. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo.

Demersals in GSA 11	ALL fleets													
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB HKE (tons)	SSB MUT (tons)	SSB ARS (tons)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)	F HKE	F MUT	F ARS
SQ (values in 2014 – baseline year)	5698	0.791	-0.065	45822	2136	163	104	116	152	120	108	1.66	1.02	0.58
Scenario 1 (values in 2021)	2969	0.327	-0.209	33807	2133	51	97	120	204	113	111	1.66	1.02	0.58
Scenario 2	290.6	405.3	189	43.9	-8.6	2764.6	376.2	197.4	108.1	-13.2	-50.2	0.34	0.21	0.12
Scenario 3	290.3	403.4	189	49.8	-7.7	1743.3	301.1	160.8	111.3	1.0	-38.8	0.47	0.29	0.17
Scenario 4	228.1	318.5	150	22.9	-8.6	1371.3	291.0	158.7	75.4	-28.8	-55.9	0.34 (2018) 0.87	0.21 (2018) 0.54	0.12 (2018) 0.31
Scenario 5	237.4	330.3	156	31.9	-7.7	943.1	236.2	132.4	83.2	-15.3	-44.6	0.47 (2018) 0.95	0.29 (2018) 0.59	0.17 (2018) 0.33
Scenario 6	101.2	141.8	69	37.4	0.0	39.5	43.2	2.8	53.3	15.8	0.5	1.5	1.02	0.58

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process(AHP), has been used to assess the performances of the alternative fisheries management policies.

According to MCDA (Fig. 4.0.2), the scenarios 2 and 4, based on Fupper of hake, allow to reach a higher overall utility, with value respectively of 0.42 and 0.39; these are followed by scenario 3 based on the target of Fmsy combined to 2018 (0.34), while the lowest utility is reached by the status quo (0.22). These results are slightly different from those of the traffic light tables, from which scenario 3, based on Fmsy combined, is expected to perform better than scenario 4. This is probably a consequence of the fact that the conservation component in the MCDA, as implemented in BEMTOOL, has a higher weight than the economic and social component.

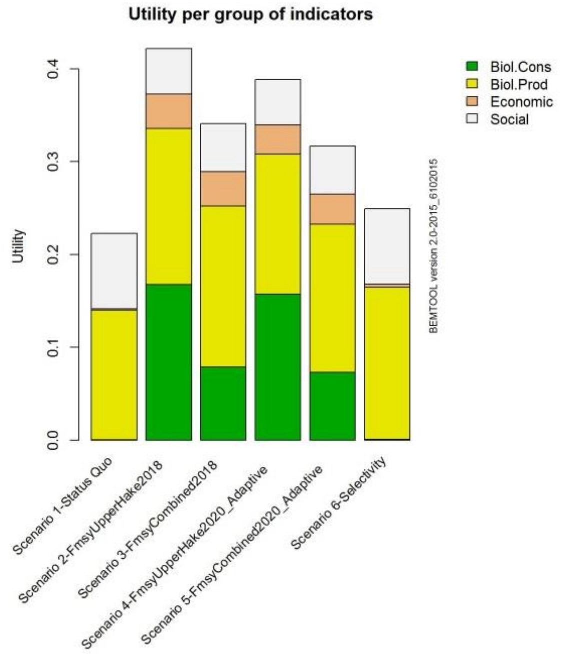


Figure 4.0.2 MCDA results: evaluation of the overall utility associated to each management scenario.

The methodology and the scenarios tested focus on the current paradigm of fisheries management in the Mediterranean, based on effort control (reduction of capacity or activity: Scenarios 2-5) and technical measures (Scenario 6). The results are consistent with the advice of STECF relevant working groups that stress the need to strongly reduce fishing effort to achieved Fmsy. However, the approach has some limitations because:

- The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed;
- The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan focus on stock-by-stock effort reduction to achieve individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile;

- Better selection of fish size can be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatial closures.

The limitations listed should be considered in the light of present knowledge (i.e. data available, models available) and the reactive capacities of all actors involved.

5.0 SUMMARY SHEET ON THE CASE STUDY OF DEMERSAL FISHERIES IN GSA17 AND GSA18

According to 2014 DCF data, Italian demersal fleet operating in GSA 17 is targeting mainly cuttlefish, spottail mantis shrimp, hake, red mullet, and common sole.
In GSA 18 the Italian demersal fleet is targeting mainly hake, red mullet, cuttlefish, Norway lobster and spottail mantis shrimp. The Croatian demersal fleet operating in GSA 17 is targeting mainly common sole using set nets; common octopus and Norway lobster using traps; hake and red mullet using otter trawl and hake and gurnards using long lines. The Slovenian demersal fleet operating in GSA 17 is targeting mainly whiting, musky octopus common sole, common Pandora, gilthead sea bream.
The demersal fishery takes place on the entire continental shelf and on the continental slope in the southern Adriatic. The use of fixed gear is usually limited to the area unsuitable for trawling.

Fisheries: Demersal fisheries in the Northern Adriatic Sea

GSA: GSA 17

Stocks assessed: European hake (*Merluccius merluccius*) (HKE), red mullet (*Mullus barbatus*) (MUT), spottail mantis shrimp (*Squilla mantis*) (MTS) and common sole (*Solea solea*) (SOL)

Modelling tools used: BEMTOOL bioeconomic platform. Management Strategy Evaluation by STECF-EWG 15 11 Working Group.

Fleets involved

In GSA 17 eleven fleet segments carrying out demersal fisheries using 3 main fishing techniques and aggregated in 4 vessel length strata have been identified (Table 5.0.1). Given the high number of fleet segments selected in the ranking system, some have been aggregated (e.g. the stratum Italian GSA17 trawlers with vessel length 18-40 m includes both vessels in the cluster of length 18-24 m and those in the cluster 24-40 m), when sharing similar characteristics in terms of fishing targets and economic performance. Two main fishing techniques exploit demersal resources in the area: DTS (corresponding to bottom trawl: OTB and TBB only in Italy), DFN-PGP (mainly corresponding to trammel nets: GTR in Croatia and Slovenia and to gillnets: GNS in Italy). However DTS produces the majority of catches and has the higher rates of activity and employment. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 5.0.1

Tab. 5.0.1 Main fleet segments involved in the demersal fishery in the GSA17. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	*Fleet code*	*% of landings (all species)*
1	Italian GSA17 trawlers with vessel length 6-12 m	ITA17_DTS_0612	1.63
2	Italian GSA17 trawlers with vessel length 12-18 m	ITA17_DTS_1218	18.16
3	Italian GSA17 trawlers with vessel length 18-40 m	ITA17_DTS_1840	31.19

4	Italian GSA17 polyvalent passive gears only with vessel length 0012 m	ITA17_PGP_0012	23.47
5	Italian GSA17 beam trawlers with vessel length 12-18	ITA17_TBB_1218	1.51
6	Italian GSA17 beam trawlers with vessel length 18-40	ITA17_TBB_1840	9.26
7	Croatia GSA17 Drift and/or fixed netters with vessel length 06-12 m	HRV17_DFN_0612	1.75
8	Croatia GSA17 trawlers with vessel length 06-12 m	HRV17_DTS_0612	2.65
9	Croatia GSA17 trawlers with vessel length 12-18 m	HRV17_DTS_1218	5.68
10	Croatia GSA17 trawlers with vessel length 18-40 m	HRV17_DTS_1840	4.20
11	Slovenia Drift and/or fixed netters with vessel length 06-12 m and trawlers with vessel length 12-18 m	SVN17_DFN_0612_ DTS_1218	0.51

The fleet segments more contributing to the production are the Italian trawlers with length larger than 12 m.

Fishing effort has a decreasing trend on the western side and a slight increasing trend on the eastern site. It should be mentioned that Croatian data are under revision.

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is reported in the table 5.0.2. Hake is representing approximately 22% of the production of Italian trawlers and 32% of the Croatian trawlers, while spottail mantis represents about 47% of production of Italian trawlers and 9% of passive gears fishery. Red mullet is representing about 40% of the production of Croatian trawlers. Common sole respresents approximately 26% of the production of Italian beam trawlers and 12% of the Croatian Drift and/or fixed netters. Overall the % of the assessed species on the production is low only for the fleet segments HRV17_DFN_0612, HRV17_DTS_0612, ITA17_TBB_1218 and very low for the fleet segment SVN17_DFN_DTS_0612 (Slovenia fleet).

Table 5.0.2 - Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA17.

Fleet	**HKE**	**MTS**	**MUT**	**SOL**	**Total assessed %**
HRV17_DFN_0612	1.47			12.58	14.05
HRV17_DTS_0612	4.98		7.07		12.05
HRV17_DTS_1218	13.03		22.32		35.35
HRV17_DTS_1840	12.38		9.18		21.56
ITA17_DTS_0612	1.69	25.02	9.55	2.94	39.2
ITA_DTS_1218	7.13	15.80	12.22	1.94	37.09
ITA17_DTS_1840	12.72	6.48	9.40	2.47	31.07
ITA17_PGP_0012	0.05	8.65	0.23	7.60	16.53
ITA17_TBB_1218	0.04	2.05	0.01	8.08	10.18
ITA17_TBB_1840		7.07		39.05	46.12
SVN17_DFN_DTS_0612		0.04	0.14	0.82	1

Development of stocks over time and current status

Assessment of European hake and common sole were endorsed by FAO-GFCM 2015 (SAC report; WGSAD, Rome 2014). Reference year was 2013. That of spottail mantis was approved by SAC in 2012 (WG demersal 2012 – Split) (reference year 2011), while that of red mullet by SAC 2015 (FAO GFCM. 2015a report; WG demersal 2013 – Bar, Montenegro) (reference year 2012).

According to the used stock assessments, the summary diagnosis of the stocks is the following:

-European hake: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Spottail mantis shrimp: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Red mullet: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Common sole: Fishing mortality (Fbar0-4) decreasing and above F_{MSY}, SSB stable and recruitment increasing in the last years.

The current level of fishing mortality, the F_{MSY} value, catch , landings and discards are eported in the table 5.0.3. Discards of hake, spottail mantis shrimp and red mullet is quite important. For sole discard is considered negligible.

Table 5.0.3 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA17.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)***	*Discards (tons)*	*Spawning Stock Biomass**	*Recruitment (in thousands)*
European hake	$(Fbar_{0-4})$=0.66	2228	2225	3.09	5334	28594
Spottail mantis shrimp	$(Fbar_{0-4})$=0.46	2518	2260	258	6945	2861854
Red mullet	$(Fbar_{0-4})$=0.66	2282	1991	291	4575	1235821
Common sole	$(Fbar_{0-4})$=0.44	1078	1078	-	1022	59360

* = Mean of the last 3 years; **2013 data

Reference points, their technical basis and MSE

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

Fmsy = 0.18; Fupper = 0.28 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.76.

The framework used for the F_{MSY} reference points is summarised in the Table 5.0.4. Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Stock advice

European hake, red mullet and common sole stocks are assessed as being exploited unsustainably at levels considerably higher than F_{MSY}. In the case of European hake and of red mullet the current fishing mortality to F_{MSY} ratio is around 3.3. Based on the last assessment stock of spottail mantis is exploited at sustainable levels.

Table 5.0.4 Reference points, their technical basis.

	Framework				
	MSY approach			Precautionary approach	
Reference point	F_{MSY}	F_{MSY} upper range	Fcurr/ F_{MSY}	$B_{lim\ (tons)}$ *	$B_{pa\ (tons)}$
Technical basis for method 1	$F_{0.1}$ used as proxy of Fmsy from YpR analysis	STECF EWG 15-11 approach (empirical) F_{upper} of European hake		(lowest level of SSB in the time series)	(1.4 Blim*)
Technical basis for all the species method 2	F combined according to Balance indicators approach (weight from landing value)				
Values for European hake method 1	0.2	0.28	3.3	4729	6621
Values for spottail mantis method 1	0.50	0.68	0.92	6471	9059
Values for red mullet method 1	0.2	0.28	3.3	2780	3892
Values for common sole method 1	0.31	0.43	1.42	715	1001
Values for all the other species method 2	0.31		2.46		

*B_{lim}=B_{loss} (B_{loss} is the lowest value of SSB in the time series).

A **Management Strategy Evaluation (MSE)** was performed in line with EWG-15-11 for hake assuming a constant recruitment.

The MSE shows:

1. moving F toward Fupper (0.28) in the long term will result in a slight decrease of catches in the long term and wide fluctuation in the short-term;
2. the probability of being below B_{lim} (B_{lim} = B_{loss}= 4729 tons) is equal to 0.

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments are evaluated using key social and economic indicators and a traffic light table (Tab. 5.0.5 red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

From this analysis the indicators appear rather stable for most fleet segments in the period 2008-2013. The performance of Croatian fleet seems to benefit of goor trend revenues of European hake, which is an important species for demersal fleet, as well as red mullet. Positive trends are also observed for the revenues of common sole and spottail mantis of the beam trawl fleet segment with smaller size of vessels. The economic performace of trawlers, especially belonging to the Italian fleet segments seems quite deteriorated on the basis of the recent trend.

Tab. 5.0.5 - Traffic light table on the economic performance (period: 2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. Blank cell corresponds to the absence of the value for that species in the fleet segment. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues spottail mantis shrimp (thousands euros)	Revenues red mullet (thousands euros)	Revenues common sole (thousands euros)	Employment (number of unit)
ALL	12741 ÷ 8982	2.467 ÷ 1.633	0.404 ÷ 0.18	265959 ÷ 176777	23137 ÷ 18509	29970 ÷ 15382	14033 ÷ 8739	18943 ÷ 14084	4929 ÷ 4980
ITA_DTS_0612	6061 ÷ 4984	2.591 ÷ 0.969	0.629 ÷ -0.012	3767 ÷ 2744	19 ÷ 128	795 ÷ 661	151 ÷ 175	121 ÷ 113	94 ÷ 135
ITA_DTS_1218	14811 ÷ 10721	2.9 ÷ 1.277	0.645 ÷ 0.093	56179 ÷ 34681	4546 ÷ 2902	13183 ÷ 5783	4206 ÷ 2096	1773 ÷ 1588	884 ÷ 908
ITA_DTS_1840	20584 ÷ 16178	1.831 ÷ 1.321	0.231 ÷ 0.088	93504 ÷ 58229	16324 ÷ 12098	5194 ÷ 4115	8380 ÷ 4391	1543 ÷ 1391	1118 ÷ 917
ITA_PGP_0012	8722 ÷ 5213	3.483 ÷ 1.368	0.928 ÷ 0.136	66046 ÷ 38511		8884 ÷ 3696		6910 ÷ 4071	2230 ÷ 2472
ITA_TBB_1218	9401 ÷ 15452	1.869 ÷ 3.531	0.31 ÷ 0.923	2355 ÷ 2560		89 ÷ 136		471 ÷ 717	51 ÷ 47
ITA_TBB_1840	14569 ÷ 14845	0.938 ÷ 1.126	-0.016 ÷ 0.036	18859 ÷ 13849		1788 ÷ 990		7084 ÷ 4856	255 ÷ 225
HRV_DFN_0612	7413 ÷ 7383	11.452 ÷ 8.477	0.805 ÷ 0.568	3541 ÷ 2592	25 ÷ 95			985 ÷ 1171	43 ÷ 46
HRV_DTS_0612	13731 ÷ 11781	27.429 ÷ 25.232	1.949 ÷ 3.092	4897 ÷ 4379	296 ÷ 428		200 ÷ 368		30 ÷ 29
HRV_DTS_1218	9154 ÷ 7769	26.458 ÷ 27.421	2.199 ÷ 2.273	9496 ÷ 9936	566 ÷ 1215		605 ÷ 1162		45 ÷ 44
HRV_DTS_1840	7977 ÷ 8690	0.911 ÷ 2.814	-0.012 ÷ 0.312	6499 ÷ 8430	585 ÷ 1520		292 ÷ 423		119 ÷ 108
SVN_DFN_0612_DTS_1218	6504 ÷ 11709	-0.562 ÷ -1.121	-0.129 ÷ -0.22	815 ÷ 867		37 ÷ 2	10 ÷ 8	56 ÷ 177	60 ÷ 49

Strategy and timeframe to reach the RP

The four stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on Fcurrent levels, European hake and red mullet are the most heavily exploited species. European hake has thus been used as the benchmark species.

The percentages of reduction to reach F_{MSY} are reported in the Table 5.0.6.

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of European hake (the more exploited species) = 0.28 (method 1) and the current level of fishing mortality (method 1) (Fcurr=0.66);
- the reference point F_{MSY} combined = 0.31 (method 2) and the current level of fishing mortality combined (F=0.76).

Table 5.0.6 Fishing mortality reduction (in %) needed by each stock to reach its own F_{MSY}, the Fupper of hake and the combined F_{MSY}.

Stock	% reduction of Fcurrent according to F_{MSY}	% reduction of Fcurrent according to F upper of Europen hake	% reduction of Fcurrent combined according to F_{MSY} combined
M. merluccius	73	58	59
S. mantis	-		
M. barbatus	70		
S. solea	30		

The reduction has been applied to each fleet segment, considering its relative portion of $F_{current}$ to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of fishing mortality combined, the needed reduction is 59%. In case of F_{upper} a reduction of 58% is necessary. However this reduction, which is apparently the same as F_{MSY} combined, is split in a slight different manner in the two cases, because the fleet segments not catching hake are not included in the reduction program when F_{upper} is the target. These fleet segments are however considered when the approach based on F combined is applied.

In table 5.0.7. the relative impact in terms of fishing mortality by fleet segment is reported, taking into account the different approach to be applied to the reduction (Fupper reference fishing mortality or F combined fishing mortality). The reduction in percentage to be applied by fleet segment are also reported. The fleet segments impacting less than 3% on the overall fishing mortality in exam were excluded from the the reduction plan. These fleets were different according to the followed approach.

Table 5.0.7. Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	% F current hake	Reduction applied%	% F current combined	Reduction applied %
1	ITA_DTS_0612	<3%	-	<3%	-
2	ITA_DTS_1218	14.1	58	16	59
3	ITA_DTS_1840	50.6	58	27	59
4	ITA_PGP_0012	<3%	-	9	59
5	ITA_TBB_1218	<3%	-	<3%	-
6	ITA_TBB_1840	<3%	-	12	59
7	HRV_DFN_0612	<3%	-	4	59
8	HRV_DTS_0612	4.5	58	4.3	59
9	HRV_DTS_1218	13.8	58	14	59
10	HRV_DTS_1840	14.9	58	11	59
11	SVN_DFN_0612_DTS_1218	<3%	-	<3%	-

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Two strategies to reach the set reference Point were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;

2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

Proposed scenarios

Proposed scenarios are reported in the Table 5.0.8

Table 5.0.8 Proposed management scenarios to reach the reference point

Case Study	Demersal case study in GSA 17
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application be differentiated by fleet. Starting year of reduction 2015.

Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture. Starting year 2015.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 5.0.9.

Table 5.0.9. Split reduction by vessels and average fishing days per year.

Reduction on VESSELS needed to F_{upper}	Reduction on DAYS needed to F_{upper}
6	52*

*in case of F_{MSY} combined this percentage is 53%

The scenario 6 (fig. 5.0.1) aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

The figure 5.0.1 shows the differences in selectivity implemented in this specific scenario for each species.

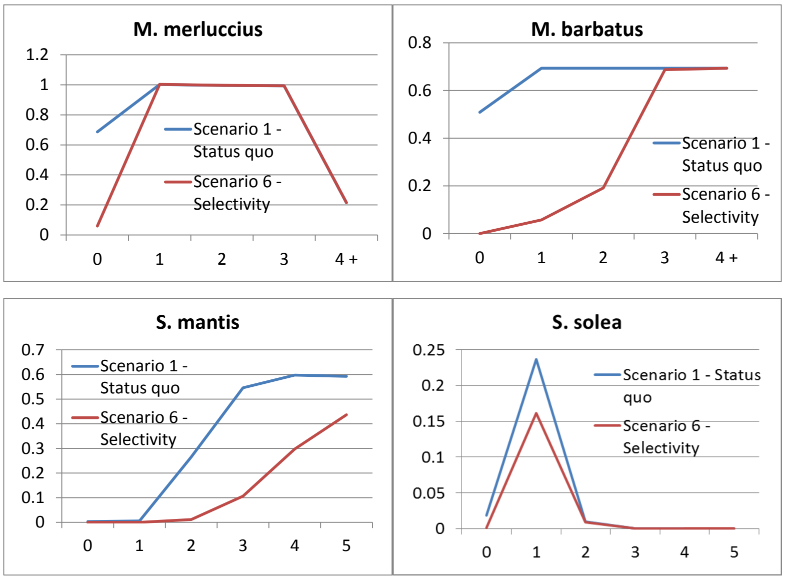


Figure 5.0.1 Comparison between the F by age (only trawlers) in the status quo and in selectivity scenario by species.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

Forecast of the effects of proposed scenarios

- According to the traffic light approach (Tab. 5.0.9), all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect to the status quo. The best performance for SSB is showed by Scenario 3 and 2, compared with 4 and 5, consistently with the greater benefit that generally the reduction of fishing mortality produces on this indicators if applied in a short time range. The worse result is observed in the status quo.
- Adaptive scenarios (Scenario 4 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 3), but also a reduced decrease in landing of the overall catch of all stocks in the short term.
- However, according to the strategy by which the management measures have been applied, the Scenario 3 is more effective, given that it is using an F_{MSY} combined, that in the specific situation of the local fisheries implies a wider safeguard from an ecological perspective, given that the target stocks of the fleets are different, as not all the fleet are targeting the more exploited species (hake) used as benchmark.
- Considering the catches of the whole fleet, there is an important increase of the catch of hake, as a consequence of stock rebuilding, but a decrease of catches of red mullet, spottail mantis shrimp and sole, that would be only partially compensated by the increased catches of hake.
- Revenues are also more impacted by scenarios based on F_{MSY} combined as target, because these scenarios affect the catches of more assessed species compared to the scenarios based on F*upper* of hake. The decrease in revenues would be anyhow rather limited, being maximum about 15%, while the impact on the employment would be less, i.e. about 6%.
- From a social viewpoint, all alternative scenarios are expected to have a better impact on the average salary, that would improve in all scenarios, as consequence of reduced costs, given the remarkable decrease of activity, except in the scenario 6 (selectivity), which does not implies such cost reduction. As a consequence of this dynamic the CR_BER indicator will fairly improve in all scenarios (between 19 and 28%) except in scenario 6.
- The Management Strategy Evaluation (MSE) showed that moving to F_{MSY} upper of hake will result in considerable decrease and fluctuation in catches in the short-term, though they will increase and stabilise over the longer-term. In addition, the probability of being below Blim is initially high but decreases practically to null values over the time of management.

Table 5.0.9 Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catches of hake, spottail mantis, red mullet and sole, salary, CR/BER, ROI, employment and revenues by all fleet segments. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the fishing mortality F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo. GSA17.

GSA17 demersal	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB hake	SSB spottail mantis	SSB red mullet	SSB sole	Catch hake	Catch spottail mantis	Catch red mullet	Catch sole	F hake	F spottail mantis	F red mullet	F sole
SQ (values in 2014 – baseline year)	8982	1.633	0.18	176777	4980	4729	7469	5051	1501	2969	2757	3539	1866	0.66	0.46	0.66	0.44
Scenario 1 (values in 2021)	8348	1.621	0.177	179108	5664	2032	7929	5489	7655	1875	3011	3847	2358	0.66	0.46	0.66	0.44
Scenario 2	16.6	28	66.7	-3.5	-2.2	295.5	21.6	85.2	8.1	28.7	-24.2	-16.3	-3.5	0.31	0.3	0.34	0.4
Scenario 3	18.4	24.8	55.4	-11.8	-5.7	319.4	30.5	87.2	75	29.8	-33.5	-17	-31.6	0.29	0.29	0.34	0.21
Scenario 4	15.1	23.6	55.4	-5.2	-2.2	201.1	22.9	68.5	5.2	16.7	-23	-23.7	-2.5	0.31 (2018) 0.45	0.3 (2018) 0.37	0.34 (2018) 0.47	0.4 (2018) 0.42
Scenario 5	14.7	18.7	40.7	-14.6	-5.7	215.4	30.6	70.6	54.7	16.9	-34.3	-24	-32.9	0.29 (2018) 0.44	0.29 (2018) 0.36	0.34 (2018) 0.47	0.21 (2018) 0.3
Scenario 6	-7.9	-6.4	-16.4	-4.1	0	47	36.9	119.2	4.6	40.4	-29.7	-3.3	1.6	0.55	0.25	0.45	0.43

- Finally, according to MCDA, the scenarios that allows to reach the highest overall utility are scenarios 3 and 2 with utility respectively of 0.60 and 0.58, given the higher contribute at improving the biological conservation component, while the lowest utility is given by Scenario 1, the status quo (0.39). Scenarios 4 and 5 had an equivalent utility, respectively 0.56 and 0.57. Scenario 6 instead had an utility only a bit higher than the status quo (0.43), because applied alone it was contributing less to the biological conservation objective, while affecting with a negative sign the economic component. Overall these results are in agreement with the traffic light tables, which simply compares percentage of change to the status quo.

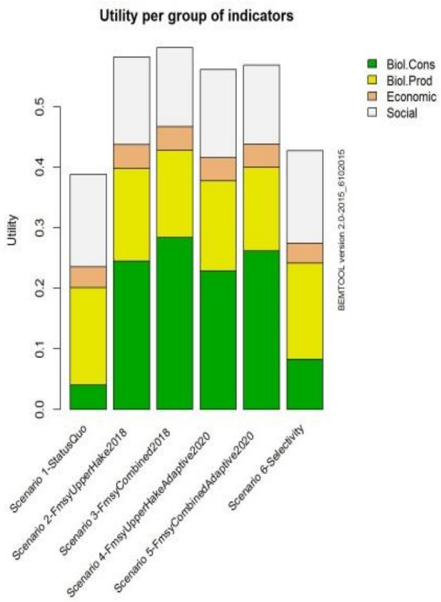


Figure 5.0.2 MCDA results: evaluation of the overall utility associated to each management scenario.

Fisheries: Demersal species in Southern Adriatic sea

GSA: GSA 18

Stocks assessed: European hake (*Merluccius merluccius*) (HKE); Norway lobster (*Nephrops norvegicus*) (NEP); red mullet (*Mullus barbatus*) (MUT), deep-water pink shrimp (*Parapenaeus longirostris*) (DPS).

Modelling tools used: BEMTOOL bioeconomic platform; Management Strategy Evaluation by STECF-EWG 15 11 Working Group.

Fleets involved

Data for the Eastern Adriatic side are from the SEDAF project.

In the south Adriatic 10 main fleet segments operating, by country, fisheries and vessel length stratum have been identified (Tab. 5.0.5). Among the assessed species *N. norvegicus* is exploited essentially by Italy. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 5.0.5

Tab. 5.0.5 Main fleet segments involved in the demersal fishery in the GSA18. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N	*Fleet name*	*Fleet code*	*% of landings (all species)*
1	Italian bottom trawlers with vessels length from 6 to 12 m	ITA18_DTS_0612	3.2
2	Italian bottom trawlers with vessels length from 12 to 18 m	ITA18_DTS_1218	46.6
3	Italian bottom trawlers with vessels length from 18 to 40 m	ITA18_DTS_1824_2	24.4
4	Italian longlines with vessels length from 12 to 18 m	ITA18_HOK_1218	3.0
5	Italian small scale with vessels length up to 12 m	ITA18_PGP_0006_0	10.2
6	Albanian bottom trawlers with vessels length from 12 to 24	ALB18_DTS_1224	11.1
7	Montenegrin small scale with vessels length up to 12 m	MNE18_DFN_0012	0.3
8	Montenegrin bottom trawlers with vessels length from 6 to	MNE18_DTS_0612	0.1
9	Montenegrin bottom trawlers with vessels length from 12	MNE18_DTS_1224	0.9
10	Montenegrin longlines with vessels length up to 12 m	MNE18_HOK_0012	0.1

The fleet segments more contributing to the total landing are the Italian trawlers.

Fishing effort has a decreasing trend.

Contribution of the stocks assessed to the production of the specific fisheries

The deep water rose shrimp has been retained for further analysis and bioeconomic modelling instead of spottail mantis because it is a target of mixed fisheries (co-occurrence with European hake and Norway lobster, depending on the area and fleet segment) and because updated assessment for the whole area is available.

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is differentiated among species and fleet segments. In general European hake gives the higher contribution, representing up to 60% in the longliner fleet segement. It has also a remarkable share for almost all the trawl fleet segments (Tab.5.0.6).

For the most important fleet segments in terms of fishery production, the pool of assessed species has a considerable weight contributing for a percentage around 40%.

Table 5.0.6 - Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA18.

Fleet	**HKE**	**MUT**	**NEP**	**DPS**	**Total assessed %**
ITA18_DTS_0612	11.4	20.7	1.0	1.1	34.2
ITA18_DTS_1218	21.1	10.4	4.4	5.0	40.9
ITA18_DTS_1824_2440	24.3	3.4	9.1	8.5	45.3
ITA18_HOK_1218	60.0				60
ITA18_PGP_0006_0612	5.9	2.2			8.1
ALB18_DTS_1224	16.6	8.2		17.2	42
MNE18_DFN_0012	4.2	2.5			6.7
MNE18_DTS_0612	24.6	21.1		19.3	65
MNE18_DTS_1224	19.1	16.6		12.1	47.8
MNE18_HOK_0012	19.3				19.3

Development of stocks over time and current status

The assessment of *P. longirostris* has been conducted on the whole GSA18 using XSA model during the Working Group on Stock Assessment of Demersal Species of GFCM (WGSADS report) held in November 2014. For *N. norvegicus* assessment is from STECF, 2015 (Expert Working Group EWG 14-19). For *M. merluccius* and *M. barbatus* the stock assessments are from ADRIAMED demersal working group and GFCM WGSAD held in 2015.

Discards in these fisheries is considered low for European hake and deep water rose shrimp due to uncertainty on the eastern side and to the low levels observed in western side, thus it was not included in the joint assessment as well); for Norway lobster the discard observed is almost null. For red mullet the discard has been considered, because it was occurring, especially in 2012 due to the high recruitment observed (Tab. 5.0.7).

Table 5.0.7 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA18.

Stock	***Fishing mortality* (Fcurrent)***	***Catch (tons)***	***Landings (tons)*****	***Discards (tons)***	***Spawning Stock Biomass****	***Recruitment (in thousands)***
European hake	($Fbar_{1-4}$)=0.66	2895	2895		3160	90 732
Deep water rose shrimp	($Fbar_{0-2}$)=1.31	1097	1097		656	714 582
Norway lobster	($Fbar_{1-6}$)=0.8	834	834		717	36 058
Red mullet	($Fbar_{0-2}$)=0.39	1680	1560	120	4695	235 205

* = Mean of the last 3 years; **2013 data

Stock advice

According to the available stock assessments, in summary the diagnosis of the stocks is the following:

- Recruitment of hake is varying along the time, while fishing mortality (F_{bar1-4}), SSB and catch are decreasing in the last two years.
- Recruitment of pink shrimp is increasing in the last two years, fishing mortality (F_{bar0-2}) and catch are increasing in the last year. SSB is decreasing along the years.
- Recruitment of Norway lobster is decreasing along the time, as well as SSB; fishing mortality (F_{bar1-6}) and catch are decreasing until 2012 and then, in 2013, are increasing.
- Recruitment of red mullet is increasing in the last years, while fishing mortality (F_{bar0-2}) and SSB, after a strong increase in 2012, show lower values in the last two years.

Fishing mortality of three out four stocks is well above the reference point, thus evidencing unsustainable exploitation levels in the long term.

Reference points, their technical basis and Management Strategy Evaluation (MSE)

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

Fmsy = 0.13; Fupper = 0.18 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.83.

The framework used for the F_{MSY} reference points is summarised in the Table 5.0.8. Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 5.0.8 Reference point framework for the selected 4 stocks.

	Framework				
	MSY approach			**Precautionary approach**	
Reference point	F_{MSY}	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**$B_{lim\ (tons)}$**	**$B_{pa\ (tons)}$**
Technical basis for all stocks	F0.1 as proxy for Fmsy	From empirical equation (EWG 15-11)		$B_{lim} = B_{loss}$ lowest value of the time series	1.4 * B_{lim} from empirical equation (EWG 15-11)
Technical basis for all the species method 2	F combined according to Balance indicators approach (weight from landing value)				
Values for European hake	0.2	0.28	3.3	2967	4154
Values for deep-water	0.74	1.01	1.77	600	840

	Framework				
	MSY approach			Precautionary approach	
rose shrimp					
Values for red mullet	0.42	0.57	0.76	3081	4313
Values for Norway lobster	0.13	0.18	6.15	626	877
Values for all the other species method 2	0.29		2.86	-	-

A Management Strategy Evaluation (MSE) was performed in line with the approach used during the STECF EWG 15-11 on the assessment carried out within ADRIAMED working group and GFCM WGSAD 2015, assuming a constant recruitment.

The MSE shows that

1. moving F toward Fupper (0.2) in the long term will result in oscillations in catches in the short-term and then an increase and stabilization over the longer-term;

2. the probability of being below Blim (Blim = Bloss =877 tons) is equal to 0.

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments in the period 2008-2013 is evaluated using key social and economic indicators and a traffic light table (Tab. 5.0.9; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

The traffic light approach stresses that the main fleet segments suffer of deteriorated performance (e.g. ITA_DTS_1824_2440) especially as regards overall revenues and revenues of European hake and deep water pink shrimp in the period 2008-2013. These species being among the most important of the demersal fisheries also affect the overall revenues. The fleet segments ITA_PGP_0006_0612 and ITA_HOK_1218 show a similar performance, the latter for the negative recent trend of the revenues from European hake, the former also for the negative revenues of red mullet. Also the economic performance indicators as CR.BER and ROI have a negative performance. The situation of the other fleet segments is quite heterogeneous though the Montenegrin fleet seems performing better compared to the other ones.

Tab. 5.0.9 - Traffic light table on the economic performance (period 2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR.BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues deep water rose shrimp (thousands euros)	Revenues Norway lobster (thousands euros)	Revenues red mullet (thousands euros)	Employment (number of unit)
ALL	7886 ÷ 8487	2.15 ÷ 2.98	0.331 ÷ 0.575	132907 ÷ 135151	28071 ÷ 17843	8012 ÷ 7027	18742 ÷ 14195	8642 ÷ 6982	3541 ÷ 3350
ITA_DTS_0612*	11674 ÷ 18720	0.859 ÷ 9.136	-0.058 ÷ 3.12	3002 ÷ 5242	154 ÷ 240	45 ÷ 0	84 ÷ 21*	577 ÷ 588	74 ÷ 70
ITA_DTS_1218	14403 ÷ 19750	1.137 ÷ 6.25	0.043 ÷ 1.682	45109 ÷ 66490	9720 ÷ 9089	3419 ÷ 3150	3888 ÷ 7092	4782 ÷ 3865	795 ÷ 708
ITA_DTS_1824_2440	17780 ÷ 17377	2.748 ÷ 1.546	0.489 ÷ 0.16	49774 ÷ 28586	12769 ÷ 5449	3170 ÷ 2189	14855 ÷ 7081	1673 ÷ 657	467 ÷ 368
ITA_HOK_1218	8788 ÷ 3891	6.627 ÷ 2.798	1.784 ÷ 0.78	8024 ÷ 3813	4829 ÷ 966				150 ÷ 147
ITA_PGP_0006_0612	4674 ÷ 5012	2.245 ÷ 1.447	0.461 ÷ 0.132	14512 ÷ 17923	351 ÷ 242			495 ÷ 298	887 ÷ 866
ALB_DTS_1224**	1460 ÷ 1460	1.055 ÷ 1.055	0.01 ÷ 0.01	10692 ÷ 10692	2552 ÷ 1567**	1104 ÷ 1436		956 ÷ 1383	1026 ÷ 1026
MNE_DFN_0012	989 ÷ 959	1.677 ÷ 14.632	0.1 ÷ 1.788	311 ÷ 789	6 ÷ 16			6 ÷ 15	70 ÷ 97
MNE_DTS_0612	4564 ÷ 4564	2.468 ÷ 4.667	0.189 ÷ 0.404	119 ÷ 132	28 ÷ 30	38 ÷ 35		17 ÷ 20	8 ÷ 5
MNE_DTS_1224	4147 ÷ 4157	0.271 ÷ 2.471	-0.086 ÷ 0.162	1264 ÷ 1147	208 ÷ 222	235 ÷ 217		135 ÷ 157	46 ÷ 39
MNE_HOK_0012	2622 ÷ 2361	-2.524 ÷ 5.455	-0.319 ÷ 0.467	101 ÷ 338	6 ÷ 23				18 ÷ 24

* The value of revenues of Norway lobster in the starting year is referred to 2008, as in 2007 for ITA_DTS_0612 there is no landing of Norway lobster.

** The value of revenues of European hake in the starting year is referred to 2009, as in 2007 and 2008 the values of revenues for European hake is not available for Albania fleet.

Strategy and timeframe to reach the RP

The four stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels Norway lobster is used as a benchmark although its level of exploiation is comparable with that of European hake and these two species are altogether the most important even for landings. The percentages of reduction to reach F_{UPPER} are reported in the table 5.0.10 for both the reference points taken into consideration, Fupper (method 1) or $F_{MSYcombined}$ (method 2).

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of Norway lobster (the more exploited species) = 0.18 (method 1) and the current level of fishing mortality (method 1) (Fcurr=0.8);
- the reference point F_{MSY} combined = 0.29 (method 2) and the current level of fishing mortality combined (F=0.83).

Table 5.0.10 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{MSY} (method 1) or combined F (method 2).

Stock	Fishing mortality reduction (in %)
Norway Lobster (Reference point method 1)	77%
All stocks (Reference point method 2)	64%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

The reduction has been applied to each fleet segment, considering its relative portion of $F_{current}$ to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of fishing mortality combined, the needed reduction is 64%. This reduction is applied to all the fleet segments that are catching the assessed species, provided that their relative impact is higher than 3% of the overall fishing mortality.

In case of F_{upper} a reduction of 77% is necessary. In the table 5.0.11 the relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of Norway lobster by fleet segment and year.

Table 5.0.11 - Percentage of fishing mortality of Norway lobster by fleet segment.

Year	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	0.00	0.60	1.62	1.30	0.63	0.13	0.07
ITA18_DTS_1218	21.10	38.25	42.25	45.11	46.24	38.80	48.33
ITA18_DTS_1824_2440	78.90	61.16	56.13	53.60	53.13	61.07	51.60

In table 5.0.12. the relative impact in terms of fishing mortality by fleet segment is reported, taking into account the different approach to be applied to the reduction (Fupper reference fishing mortality or F combined fishing mortality). The reduction in percentage to be applied by fleet segment are also reported. The fleet segments impacting less than 3% on the overall fishing mortality in exam were excluded from the the reduction plan. These fleets were different according to the followed approach.

Table 5.0.12. Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	% F current Norway lobster	Reduction applied%	% F current combined	Reduction applied %
1	ITA_DTS_0612	0.07	77	<3%	-
2	ITA_DTS_1218	48.33	77	43	64
3	ITA_DTS_1824_2440	51.60	77	32	64
4	ITA_HOK_1218			5	64
5	ITA_PGP_0006_0612			<3%	-
6	ALB_DTS_1224			16	64
7	MNE_DFN_0012			<3%	-
8	MNE_DTS_0612			<3%	-
9	MNE_DTS_1224			<3%	-
10	MNE_HOK_0012			<3%	-

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;

2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY in 2020.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

The 5 scenarios have been implemented according to 2 main objectives:

- to reduce the fishing mortality of Norway lobster (the stock more overexploited) until its reference point (Fupper);
- to reduce the overall combined fishing mortality towards a combined reference point, (Fcombined).

A further strategy is characterized by a change in selectivity of trawlers with no reduction in effort. The selectivity of the gears different from trawlers has been maintained unchanged.

Proposed scenarios

Proposed scenarios are reported in the table 5.0.12.

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

According to the state of exploitation of the four demersal stocks in GSA 18 case study, 5 forecast scenarios alternative to status quo have been performed in order to evaluate the consequences of several management strategies in terms of costs and befits for the renewal of stocks, productivity, fishery sustainability and economic performances of different fleet segments.

Table 5.0.12 – Scenarios modelling for the forecasts.

Case Study	**demersals in GSA 18**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species (for which we have stock assessment) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture. Starting year 2015.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 5.0.13.

Table 5.0.13. Split reduction by vessels and average fishing days per year.

Reduction on VESSELS needed to F_{upper}	Reduction on DAYS needed to F_{upper}
8**	69*

*in case of F_{MSY} combined this percentage is 58%
** in case of F_{MSY} combined this percentage is 6

The scenario 6 (fig. 5.0.1) aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

The figure 5.0.1 shows the differences in selectivity implemented in this specific scenario for each species.

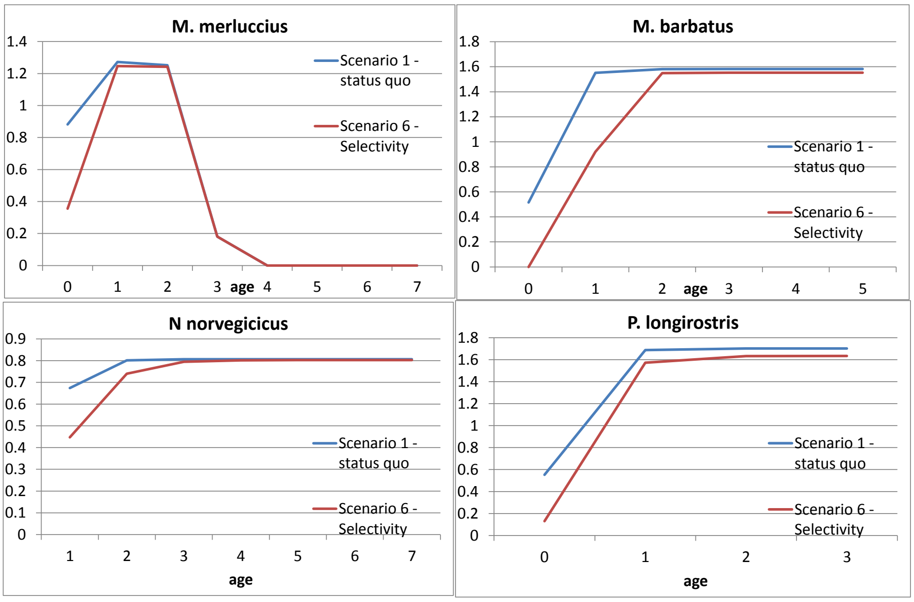


Figure 5.0.1 - Comparison between the F by age (only trawlers) in the status quo and in selectivity scenario by species.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

Forecast of the effects of proposed scenarios

The projections performed with BEMTOOL model showed that all the performed scenarios allow to obtain a benefit on the SSB for the 4 stocks under consideration respect to the status quo; on an overall basis, the best performing scenarios are the ones characterized by the strongest reduction in the shortest timeframe. In addition, the rebuilding of stocks such as European hake and Norway lobster would mitigate the situation of losses of stocks such as deep water pink shrimp and red mullet that will be underutilized (Table 5.0.14).

Under the economic viewpoint and considering the overall fleet, revenues are highest for Scenario 3, while the lowest value is given by the Scenario 4. The overall economic performance is improving if salary and the indicators CR/BER and ROI are considered. The reduction of employees is limited, given the limited amount of scraping.

On an overall basis, the scenarios better performing seem Scenario 2, followed by Scenario 3, that allows to obtain a quite stable trade off among the different indicators, when considered having all the same weight. A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that all the scenarios allow to reach the same overall utility (overall utility about 0.34), except for Scenario 6 with the lowest utility (0.25), as the status quo (Fig. 5.0.2).

These results seems to confirm the higher efficiency when the management measure is applied in a shortest timeframe.

However it should be considered that Italian trawlers are expected to have a performance worse than status quo in Scenario 2 and 4, in particular all these fleet segments will have a severe reduction of revenues, till -50% for the fleet ITA_DTS_0612, because its catches are probably less compensated by the rebuilding of hake and Norway lobster stocks, compared to the losses of catches for red mullet and pink water deep shrimp. The losses of revenues for the fleets ITA_DTS_1218 and

ITA_DTS_1824_2440 will be more limited compared to the fleet ITA_DTS_0612, but however in the order of -20%. Only the fleet ITA_DTS_1824_2440 is expected to see an improvement of salary and CR/BER, given the likely compensation due to the improvement of catches deriving from the rebuilding of stocks as hake and Norway lobster.

Table 5.0.14 Performances of the simulated management scenarios (% respect to status quo) in terms of SSB and overall catches of hake, pink shrimp, red mullet and Norway lobster, salary, CR/BER, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the fishing mortality F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo. GSA18.

Demersal species in GSA 18	**ALL fleets**																
Scenario, year 2021	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Catch European hake (tons)	Catch deep water rose shrimp (tons)	Catch Norway lobster (tons)	Catch red mullet (tons)	F European hake	F deep water rose shrimp	F Norway lobster	F red mullet
SQ (values in 2014 – baseline year)	8487	2.98	0.575	135151	3350	3470	745	627	5460	3407	1233	634	1665	0.72	1.31	0.8	0.32
Scenario 1 (values in 2021)	7530	2.561	0.453	122767	3276	3742	778	496	7120	2612	1307	518	1646	0.72	1.31	0.8	0.32
Scenario 2	47.0	50.7	79.3	11.6	-2.4	262	83	368	46	29.3	-4.7	11.9	-47.5	0.34	0.74	0.23	0.13
Scenario 3	60.9	60.7	96.3	16.2	-4.1	278	124	256	37	24.0	-10.3	19.1	-37.1	0.31	0.53	0.31	0.16
Scenario 4	38.6	39.7	62.7	5.5	-2.4	167	79	256	37	20.3	-6.6	-14.0	-47.7	0.33 (2018) 0.48	0.74 (2018) 0.97	0.23 (2018) 0.45	0.13 (2018) 0.21
Scenario 5	52.8	51.2	80.1	10.8	-4.1	175	116	188	29	16.3	-13.6	-2.7	-37.5	0.31 (2018) 0.47	0.53 (2018) 0.85	0.31 (2018) 0.5	0.16 (2018) 0.23
Scenario 6	21.0	21.6	41.7	13.5	0.0	33	48	33	31	40.3	5.6	11.3	-10.3	0.73	1.16	0.75	0.21

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that, all the scenarios allow to reach the same overall utility (overall utility about 0.34), except for Scenario 6 with the lowest utility (0.25), as the status quo (0.25).

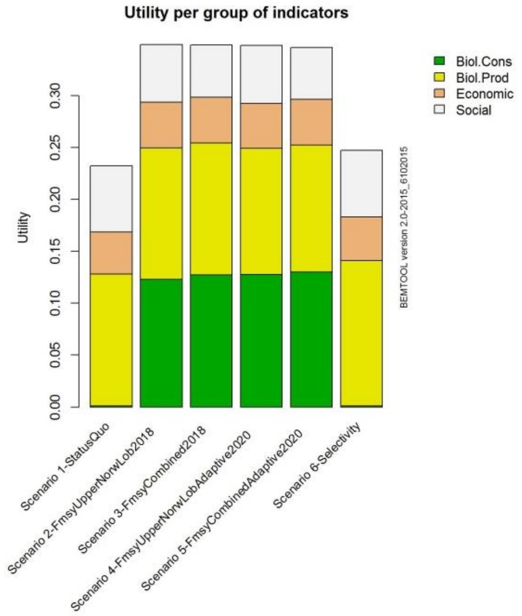


Figure 5.0.2 MCDA results: evaluation of the overall utility associated to each management scenario.

The methodology and the scenarios tested cover a wide range of different options and provide a general overview of the situation of demersal in the Southern Adriatic Sea. The results are consistent with the advice that has been provided so far in different fora and gives a more robust evaluation of the efficiency of each of the measures proposed. There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment due to the shortness of time series and thus to the lack of a reliable stock recruitment relationship. However, the measure proposed from BEMTOOL are conservative enough to be efficient if against recruitment failures.

6.0 SUMMARY SHEET ON THE CASE STUDY OF GSA29

Fisheries: Turbot fisheries in GSA 29

GSA: GSA 29

Stocks assessed: turbot (*Scophthalmus maximus*)

Modelling tools used: Mid-term forecasting, expert system decision analysis

The main fishing gears in the area are midwater otter trawl (OTM), bottom trawls, and demersal gillnets (GNS). Fleet segments including boats with length between 12-18 m operates with mid-otter trawls, long lines and gillnets for fishing of small pelagic fish (sprat, horse mackerel) and for demersals – turbot, red mullet and spiny dogfish. These fleets have taken about 50 % of the total catches in Bulgarian and Romanian Black Sea waters on average.

Fleets involved

6 fleets are defined based on catch and gear information and the goals of the present study. The IUU (Illegal, Unregulated and Unreported) fishing of turbot was explicitly presented as a separate fleet as it is assumed to represent about 65 % of the total catch (2011-2013 average) (Table 6.0.1).

Table 6.0.1 Main fleet segments involved in the Black Sea fishery (GSA29).

	Fleet name	Fleet code	% of catch
1	Bulgarian GNS fisheries	Bul_GNS	2.34%
2	Romanian GNS fisheries	Rom_GNS	2.66%
3	Ukraine, Russia, and Georgia GNS fisheries	URG_GNS	15.34%
4	Turkish OTB fisheries	Tur_OTB	10.51%
5	Sprat OTM fisheries from all countries (turbot bycatch)	SPR_OTM	4.22%
6	IUU fishing	IUU	64.93%

Development of turbot stock over time and current status

Stock assessment of turbot was performed at the STECF-EWG 14-14. This assessment used DCF data together with the historical time series available for Black Sea from 1950 to 2013.

Turbot has attained higher abundance in 1977 – 1982 and very low values after 2009. For the period after 2002, the misreporting of actual catches (IUU catch) is assumed to be around 4.7 the official catches of Bulgaria, Romania and Ukraine). Fishing mortality reached its peak (F = 1.33) during recent years (2012 – 2013). Fcurrent is estimated as average fishing mortality over 2011-2013.

Current stock situation is reported in the table 6.0.2.

Table 6.0.2 Current level of fishing mortality (Fcurrent), Spawning Stock Biomass, Recruitment and landings of turbot in the Black Sea (GSA29).

Stock	Fishing mortality* (Fcurrent)	Spawning Stock Biomass* (tons)	Landings* (tons)	Recruitment* (in thousands)
Turbot	$F_{bar\ (4\text{-}8)}$= 1.058	1634	1522	504

*estimates refer to assessment STECF-EWG 14-14

Reference points

The framework used for the reference points is summarised in the table below 6.0.3.

In STECF 14-14 Eqsim was used to estimate stock recruitment relationship (S-R), F_{MSY} and F_{MSY} ranges (based on 5% reduction in MSY).

On the basis of median simulated catches for turbot the following ranges were obtained: F_{MSY} = 0.26; F_{lower} = 0.23, F_{upper} = 0.364. Table 6.0.3 reports the evaluation framework and reference points of turbot in the Black Sea.

Table 6.0.3 – Evaluation framework and reference points of turbot in the Black Sea (GSA29).

	Framework					
	MSY approach				Precautionary approach	
Reference point	F_{MSY}	F_{MSY} upper range	F_{curr}/F_{MSY} ratio	Bmsy	$B_{lim\ (tons)}$	$B_{pa\ (tons)}$
Technical basis for turbot	Fmsy from hockey stick SR function (STECF, 2014)				Defined as Blim = Bpa/1.4	Defined as 0.39*Bmax
Values for turbot	0.26	0.364	4.07		3535	4949

Stock advice

The recent stock assessment indicates that the spawning stock biomass is at very low level (around 1634 t) and it is estimated to be around half of Blim (3535 t). Fcurrent (1.06) is about four times higher than F_{MSY} (0.26).

The STECF EWG 14 14 (STECF 2014) has classified the stock of turbot in the Black Sea as being exploited unsustainably and at risk of collapse. The STECF EWG has advised that on the basis of precautionary considerations, there should be no directed fisheries for turbot and bycatch should be minimised.

Development of economic indicators over time and current status

Information about economic performance of fleets is available only for the EU member states – Bulgaria and Romania through DCF. There is no data available for the calculation of the CR/BER ratio for most of the Bulgarian and Romanian fleet segments in 2008-2012. All segments for which the

CR/BER ratio could be estimated for Bulgaria have an indicator value below 1 since 2010. For Romania - those segments for which data is available are predominantly characterized by indicator values above 1 in 2010, 2011 and 2012.

Strategy and timeframe to reach the RP

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;

2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY in 2020.

Proposed scenarios

Proposed scenarios for the management of turbot stock are reported in the table 6.0.4.

In the Scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

In Scenario 2 a gradual linear reduction to 2018 is applied, afterward fishing continues at Fmsy.

In Scenario 3 an adaptive strategy is applied which implies, a lower reduction in the short term and a sharp reduction thereinafter, in order to achieve MSY in 2020.

Given the specifics characteristics of the turbot fisheries and mainly the fact that about 65 % of the catch is IUU, four versions of each scenario were formulated:

- Version 1, the condition of each scenario are applied to all fleets;
- Version 2 the scenarios are applied, but IUU is assumed to be completely eliminated (IUU catch=0);
- Version 3, the bycatch is assumed to be completely eliminated (bycatch=0);
- Version 4 simulates effects of a reduction or ban of the fisheries where the IUU is not controlled and stays at the status quo level.

Under these assumptions, the scenarios are thus summarized in the table 6.0.4.

Table 6.0.4 Proposed scenarios for the management of turbot in GSA29

Scenario 1	**Status quo to 2020**
SQ_version1	Status quo fishing applied to all fleets
SQ_version2	Status quo fishing applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
SQ_version3	Status quo fishing applied to all fleets and, but no bycatch is allowed (bycatch =0)
SQ_version4	Ban on legal fishing, but IUU is allowed (IUU catch at status quo level)
Scenario 2	**Linear reduction towards upper F_{MSY} of turbot in 2018,**
Lin_ version1	Linear reduction applied to all fleets
Lin_ version2	Linear reduction applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
Lin_ version3	Linear reduction applied to all fleets, but no bycatch is allowed (bycatch =0)
Lin_ version4	Linear reduction applied to all fleets, but IUU is allowed (IUU at status quo

	level)
Scenario 3	**Adaptive reduction towards upper F_{MSY} of turbot from 2018 to 2020**
Adapt_version1	Adaptive reduction applied to all fleets
Adapt_version2	Adaptive reduction applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
Adapt_version3	Adaptive reduction applied to all fleets, but no bycatch is allowed (bycatch =0)
Adapt_version4	Adaptive reduction applied to all fleets, but IUU is allowed (IUU at status quo level)

Linear reduction toward Fmsy $_{upper}$ = 0.364 was applied in 2014-2018 (Table 6.0.5). In Lin_ version 2, staring value of F=0.382 in 2014 is lower than F in 2013 by about 65%, because of substituting of the IUU catch from the total catch. Conversely in Lin_ version 4, Fmsy is not achieved because IUU catch is allowed.

Table 6.0.5. Reduction of F in management scenarios for turbot in GSA29

Year	Lin_ version1	Lin_ version2	Lin_ version3	Lin_ version4
2013	1.058	1.058	1.058	1.058
2014	1.058	0.382	1.024	1.058
2015	0.885	0.378	0.859	0.962
2016	0.712	0.374	0.695	0.867
2017	0.539	0.370	0.530	0.771
2018	0.364	0.364	0.364	0.676
2019	0.364	0.364	0.364	0.676
2020	0.364	0.364	0.364	0.676

All scenarios are based on reductions in in fishing mortality (F) that are only hypothetically related to actual fishing effort - representative data for which are not available. Turkish and former Soviet fisheries are taking most of the legal catch, and only about 5% of the total catch is taken by specialised legal fisheries in EU waters (Table 6.0.1). The IUU fishing, which is a dominant part of the catch (65%), partly take place in EU waters, the other part of it is situated in the waters of the former Soviet countries (Georgia, Russia and Ukraine). Under these circumstances we have based our simulations on catch proportions only (Table 6.0.1), and cannot advise on specific fleet effort scenarios.

Forecast the effects of proposed scenarios

As shown in the traffic light summary (Table 6.0.5), the total control of IUU (version 2, no IUU catch) allows the SSB to double and the catch to increase by about 10% by 2021 in all 3 scenarios. In all other versions the catches decrease form 12% to 43%. In a case of a total ban on the fishery (as suggested by the STECF EWG) and complete control over IUU, the SSB is expected to increase by the 2021 by about 5 times and to reach 8450 t, a value more than two times the Blim. If only “legal” fisheries are stopped, but IUU fishing is allowed at the status quo level (Scenario 1, Status quo, version 4), SSB is expected to increase by only 20% to 1723 t that is less than a half of the Blim, and therefore recovery of the stock is not going to happen. If linear or adaptive strategies toward Fmsy are applied, but IUU fishing is allowed at the status quo level (Scenarios 2 and 3, version 4), SSB be would increase by 6% only, or decrease by 11%, respectively.

Table 6.0.5 Performances of the simulated management scenarios in 2021 (% with respect to status quo) in terms of SSB and overall catches of turbot

Scenarios		Catch			SSB		
		Status quo	Linear	Adaptive	Status quo	Linear	Adaptive
All fisheries	version 1	-37.8	-14.9	-42.7	-35.4	68.1	24.7
No IUU	version 2	10.1	10.4	8.7	113.1	118.9	117.0
No Bycatch	version 3	-36.0	-15.8	-39.8	-32.1%	66.6	43.2
Ban on legal fishing	version 4	-12.5	-22.3	-37.0	20.9	6.0	-10.7
	no catch				493.0		

If all scenarios and versions are ranked using an expert system accounting for both effects on SSB and catches in 2021 (Table 6.0.6), it is seen that the versions 2 of all 3 scenarios (no IUU fishing) acquire the highest ranks, as bring highest SBBs and, in case of version 2 also higher catches. Versions with linear reduction, that produces a sharper decreases than the adaptive strategies during early years of simulations are ranked next with higher increase in biomass and less decreases in catches (Tables 6.0.5 and 6.0.6).

Table 6.0.6 Scenarios versions and respective SSB and catches in 2021, ranked with a two factors expert system

Rank	Scenario	SSB, t	Catch, t
1	SQ_version 1	921	492
2	SQ_version 3	967	506
3	Adapt_ version 4	1273	498
4	Adapt_ version 1	1777	453
5	Adapt_ version 3	2041	476
6	Lin_ version 4	1510	615
7	SQ_version 4	1723	692
8	Lin_ version 3	2374	666
9	Lin_ version 1	2396	673
10	SQ_version 2	3036	871
11	Adapt_ version 2	3092	860
12	Lin_ version 2	3120	873

Management advice

The present simulation studies encompassed that in the case of the turbot fisheries in GSA 29, the most important management action would be to establish an effective control on the illegal fishing. If this is done, than a total ban on the fishery would bring the SSB above Blim and Bpa, by 2018 and 2019, respectively. On the other hand, successful recovery by 2020 is impossible, if IUU fishing is not controlled (continue fishing at its status quo level), by any option applied only to the “legal” fisheries, including their ban (but not stopping the IUU). Scenario versions with immediate or fast restrictive effects (e.g. linear reduction until 2018) are more efficient in achieving recovery, than delaying action (adaptive) scenarios, because of the heavily overfished state of the stock.

Given that turbot stock is at its historical minimum (the STECF EWGs have repeatedly advised the closure of the fishery as the most appropriate management action that should be taken to assure the recovery of the stock) action should be taken. Our study demonstrate, that given the biological characteristics of the stock, a relatively fast recovery (in 5 years) can be achieved, by completely closing the fishery and not allowing any IUU fishing.

SECTION 1 - PROJECT OBJECTIVES AND ACTIVITIES

1.1 BACKGROUND AND PROJECT OBJECTIVES

The subject matter of the EASME/EMFF/2014/1.3.2.7/SI2.703 193 contract is the preparation of multiannual management plans which are considered as a crucial mechanism to manage fish stocks according to MSY (Maximum Sustainable Yield).

The multiannual plans should fix mortality rates at a level that can help to obtain larger stocks over time.

The ultimate objective of the study is the assessment of specific management scenarios in order to establish the relevant multiannual plans in accordance with the CFP objectives and with the guidelines adopted by the GFCM.

For this purpose, four case studies are envisaged:

- small pelagic and demersal fisheries in the Gulf of Lion and the North of Spain (GSAs 6 and 7);
- small pelagic and demersal fisheries in the Ligurian and North Tyrrhenian Seas and Sardinia (GSAs 8, 9 and 11);
- small pelagic and demersal fisheries in the Adriatic Sea (GSAs 17 and 18);
- fisheries targeting turbot and its associated species in the Black Sea (GSA 29).

Two management scenarios for each case study have to be performed:

- achieve MSY by 2018;
- achieve MSY by 2020.

The project has been organized in 4 tasks:

- task 0 – Organization of the work: coordination and project management;
- task 1 - State of the art;
- task 2 – Maximum sustainable yield;
- task 3 – Regional cooperation.

The work under task 0 is based on the preparation of workplan, guidelines, working documents, reporting, organization of the project Workshop and Meeting with Stakeholders and organization of the project sharepoint for exchange of the information among the partners, with EASME and DGMARE.

The work foreseen under the Project TASK 1 is based on:

- identification and description of the target stocks (biology, status, geographical distribution, etc.) (subtask 1.1);
- identification and description of the fisheries, quantifying in terms of number of vessels, catches, discards, average effort deployed and economic performance of these fisheries (subtask 1.2);
- description of the current management measures at national, European and international level (subtask 1.3).

This task has the specific objective of providing the basic knowledge useful for designing specific management measures. Indeed, the establishment of appropriate management measures for sustainable fisheries requires an understanding of the status of the different fish stocks involved and of the technical characteristics of the fisheries, as well as a clear knowledge of the socio-economic aspects pertaining to these fisheries. The case studies have thus exploited and combined all the various sources of information on: biological aspects, production, discarding, fishing effort and socio-economic aspects.

TASK 2 has been based on:

- ✓ identification of the main elements that contribute to define MSY (inter alia key species, stratified fleet stratus);
- ✓ specifying the criteria that could be used to select the most suitable approach to attain the MSY objectives;
- ✓ exploring the different management possibilities to achieve MSY (e.g. MSY based on single-species, multiple-species, or stratified fleet stratus);
- ✓ explore how technical measures could modify the fisheries exploitation pattern;
- ✓ evaluate the biological and socio-economic implications of establishing exploitation levels that could bring the maximum sustainable yield, while ensuring the economic income of the fleet involved by 2018 and 2020.

TASK 3 has been based on:

- ✓ Identify elements of overall governance and potential involvement of stakeholders;
- ✓ Involvement of stakeholder through the participation to the project workshop of the MEDAC secretariat (see ANNEX III to this report) and the organization of a meeting with MEDAC to present and discuss the project's results and receive feedback (results in the Section 3 of this report).

1.2 PROJECT MANAGEMENT AND COORDINATION

The first phase of the coordination activities has been focused on the administrative issues. The contract was received and signed by COISPA on March 06, 2015.

However, the formalization of the administrative procedures, for obtaining by the national Authorities the valid documentary evidences demonstrating that the tenderers are not in one of the situations referred to in the exclusion criteria of the tender specifications, took considerable time. This especially for the type of procedure and the time taken by the National Authorities to release the requested documentation.

The documentation was completed and the procedure was considered concluded with the signature of the contract by EASME on May 4, 2015.

The activities of the project started with the kick off meeting that was organised by skype among the partners and subcontractors on May 14, 2015. All participated to this meeting, during which the project partners discussed the following items:

- the comments received from the project evaluation;
- the preparation of the workshop foreseen at month 3;
- the workplan for the first two months of the project life, including the contents of the Case Study reporting as foreseen by the project under TASK1;
- the administrative issues.

The kick-off meeting highlighted the needing of making some changes to the workplan, considering that the start date of the project was put forward than expected and organizing the workshop at month 3, i.e. in early August, was deemed very difficult, especially for travelling.

The complete report of the kick-off meeting is reported in the ANNEX I to this Report.

As foreseen in the project a sharepoint has been set and populated with the documentation collected during the project activities. The sharepoint is accessible at the following address:

http://mare27partner.coispa.eu

after invitation and communication of user name and password by the webmaster, this password can be changed by the user.

A second skype meeting has been held with project partners on July 22, 2015 to refine the structure of the case study reporting previously circulated and to put forwards reflections regarding the scenarios to be modelled. In this meeting also details on the specifications to be included in a Data Call were discussed and agreed (the Data Call is reported in the ANNEX II to this report). This Workshop has been held in Bari the week 21-25 September, 2015. The report of the Workshop is reported in the ANNEX III to this report.

Following such meeting the coordinator prepared the structure and specifications of the Data Call and circulated the final template to organize the information already collected for the case studies.

1.3 CHANGES TO THE ORIGINAL WORK PLAN

A table reporting the revised activities, milestones and deliverables (interim report, final report and workshops) compared to the proposal is reported in the following table 1.3.1.

This workplan was discussed with DGMARE and EASME representatives during a web meeting held on June 26, 2015. During this meeting several aspects related to the case studies were discussed, in particular as regards the data availability and the quality and quantity of information. It was decided to launch a Data Call and to prepare a presentation letter, possibly to facilitate the access to relevant information at national level by the project partners.

In addition, aspects related to the organization of the project Workshop were discussed as well as the needing of examining the scenarios to be modelled in order to receive comments and suggestions from DGMARE.

It was also suggested to activate the channel of communication with stakeholders in order to facilitate their participation and advice.

Table 1.3.1 - Revised table of the activities, milestones and deliverables (interim and final reports and workshops)

	Months						
	1	**2**	**3**	**4**	**5**	**6**	**7**
activities and milestones	- preparation of toolbox and guidelines; - data call and collection of information for task 1; - organization of standing alone outputs of task 1	- inputs for task 2 - preparatory work for the implementation of the case studies at own desk by the experts, following the results of task 1	- implementation and running of the case studies at own desk (preparatory activity)	- compilation of the data used in the case studies; - implementation of task 3	-running of the case studies at the Workshop - fine tuning of the work done, - compilation of outputs of the case studies; - preparation of the draft Final Report	- revision process of the draft final Report	- revision process of the draft Final Report- - progress in task 3 and public hearing
Meetings and workshops	**kick off meeting by skype or other web-based communication supports**	skype or other web communication supports	skype or other web communication supports	skype or other web communication supports	**Workshop (one week duration)**	- skype or other web communication supports	**Meeting with stakeholder**
reports			**Interim Report finalization and delivery**		**draft Final Report finalization and delivery**		**Final Report**

SECTION 2 - REPORTS OF CASE STUDIES

Conceptual and operational framework, materials and methods applied are reported in the following chapters. Details on the input for bioeconomic modelling are reported in a dedicated ANNEX for each case study.

A list of Acronyms is reported in the ANNEX IV.

2.1 MATERIALS AND METHODS

2.1.1 BIOECONOMIC MODELLING

BEMTOOL

In the case study of small pelagic fisheries in GSA17 and GSA18, small pelagic fisheries in GSA9; demersal fisheries in GSA17, GSA18, GSA9 and GSA11, the tool used to carry out the projections of the different management scenarios is BEMTOOL bioeconomic model.

BEMTOOL (Accadia et al., 2013; Facchini et al., 2014; Bitetto et al., 2015; Rossetto et al., 2015) is a bioeconomic platform incorporating 6 operational modules (Biological, Pressure, Economic, Behavioural, Policy/Harvest Rules and Multi-Criteria Decision Analysis – MCDA) characterized by components communicating by means of relationships and equations.

Characteristics of the BEMTOOL operational modules are below summarised:

- Biological, which simulates the evolution of the biomass and the demographic structure for each stock affected by the fishing activity of single or multiple fleet segments or metier.
- Impact, which simulates the evolution of fishing mortality and the related outputs in terms of total production (landings and discards) and production by fleet segment or metier.
- Economic, which simulates the evolution of the economic variables of the fishery.
- Behavioural, which simulates the dynamic transformation of the profit obtained from fishing into the fishing effort through assumptions on fishermen behaviour (investments, disinvestments). This includes fleet dynamics like entity-exit decisions of fishing vessels and changes due to technological progress.
- Policy, which core factors are the Harvest rules that simulate the implementation of one management measure or a set of management measures, as well as the application of taxes and subsidies, all of which directly or indirectly affecting the economic and biological processes.
- Multi Criteria Decision Analysis (MCDA) for evaluating the performances of different fishery management scenarios from the biological and socioeconomic points of view, using a selection of indicators to score management measures against objectives.

The process of the bio-economic modelling can be summarized in the following steps:

1. **Case study configuration**, including the name of the case study, species, fleet segments, simulation and forecast period;

2. Parameterization of the **biological simulation** entering biological parameters by species in ALADYM (Lembo et al., 2009) or, optionally, selecting the assessment tool (VIT, XSA, SURBA or Report) and importing the results;
3. Input of **effort and landing data** time series;
4. **Diagnosis** to visualize the state of the stocks, the impact, the state of the fleet and the economic indicators in the past/present time;
5. Parameterization of the **economic simulation;**
6. Selection of the **management** (**harvest) rules** for the planning of the forecast scenario or, alternatively, the selection of the option for the **MEY calculation**;
7. Implementation of the **forecast** to predict the state of the stocks, the impact/pressure and the state of the fleet and the economic indicators in future after the implementation of management trajectories;
8. Parameterization of the **Multi Criteria Decision Analysis (MCDA)** entering the utility parameters and weights for the indicators and estimation of the results.

The word *simulation* indicates the past and current years, while the word *forecast* the future years.

BEMTOOL follows a multi-fleet approach simulating the effects of a number of management trajectories on stocks and fisheries on a fine time scale (month). The model accounts for length/age-specific selection effects, discards, economic and social performances, effects of compliance with landing obligation and reference points. The implementation of decision modelling (Multicriteria Decision Analysis and Multi-attribute utility theory) allows that stakeholder perception is encompassed to weight model-based indicators and rank different management strategies. A wide set of biological, pressure and economic indicators is the default output.

The uncertainty (process error) implemented in the model following Monte Carlo paradigm allows a risk evaluation in terms of biological sustainability of the different management strategies. Uncertainty is propagated to all the indicators estimated by the model, thus accounting of the economic outputs.

In the case studies BEMTOOL is used to assessthe consequences of different scenarios from the biological, impact and economic point of view.

BEMTOOL v.1 (June, 2013) was developed and released for the first time as an output of the BEMTOOL project, Specific Project N.4 (SI2.613770) of MAREA (Mediterranean hAlieutic Resources Evaluation and Advice) Framework contract (MARE/2009/05_Lot1).
BEMTOOL v.2 (December, 2014) the model was upgraded in the LANDMED project, Specific Project N.11 (SI2.678902) of MAREA Framework Contract with new functions regarding the uncertainty modelling and the relationship between fishing mortality by fleet, stock and effort. Discard and selectivity modelling were further improved. Some technical aspects to improve the user accessibility were also implemented.
BEMTOOL v.2.0.6 (current release) The relevant upgrades implemented in BEMTOOL v.2.0.6 in the context of SEDAF project, Specific Project N.10 (SI2.666117) of MAREA Framework Contract regarded the economic module with a more refined association of a price to the discard (options: constant price or price depending on the discard volume through an elasticity coefficient), so that the revenues take into account both the income related to the sale of landing of the target species and the income from the sale of the discard of the target species, if any.

In ALADYM (Lembo et al., 2009) core a new facility was introduced in order to parameterize the biological simulation with entry by F (fishing mortality) in case the F by fleet segment is not available. Also a revision of all the tables and graphs produced by BEMTOOL and ALADYM has been done in order to avoid redundancy in the variables and graphs saved in BEMTOOL and ALADYM folders.

BEMTOOL platform is an application in R language with a GUI to ease the model inputs. BEMTOOL app is tested with 2.14.2, R 3.0.1, R 3.0.2, R 3.0.3 versions. The model is open source.

The requirements to run BEMTOOL application are listed below:
1. The BEMTOOL application works under Windows XP SP3, Windows Vista, Windows 7, both Bit and 64Bit versions. The correct functioning is not guarantee on Linux-like Operative systems.
2. R-CRAN software version > 2.14.2 must be installed on your computer. R installer for Windows and other OS can be found at http://cran.r-project.org.
3. In the R-CRAN installation the following R packages must be installed: FLXSA library and linked FLAdvice, Flash, FLAssess, FLBRP, FLCore packages; also akima, ggplot2, ggplotFL, plyr, proto and reshape are required to be installed; also RGtk2 package is needed to run R graphical interface.
4. RGtk2 package requires the installation of the GTK+ Toolkit. It can be found at http://ftp.gnome.org/pub/GNOME/binaries/win32/gtk+/2.22/gtk+-bundle_2.22.1-20101227_win32.zip.

MEPHISTO

In the case study of demersal fisheries in GSA06 and GSA07 Scenario modelling was based on the MEFISTO bioeconomic model (Lleonart et Maynou, 2003; Maynou et al. 2006; Maynou 2014), modified for the present study to produce the necessary adaptations to answer the terms of the Tender, particularly Scenario 6 and new economic indicators.
Note also that Spanish Economic data are not always complete and only the period 2011 - 2013 could be used fully to explore all cost categories.
Briefly, the MEFISTO model is a population dynamics simulator for age-structured fish populations coupled to an economic model based on the revenues and costs structure of Mediterranean fisheries. This approach allows to directly use the output of STECF EWG stock assessments (based on XSA) as input data for the biological part of the bioeconomic simulations. The economic parameters of MEFISTO were derived from the DCF Data Call 2015, checked against own data used in previous publications (e.g. Maynou 2014). Certain features of the MEFISTO model were turned off in order to avoid discussing the results in terms not contemplated in the Tender (for example, the internal investment module or the quantity/price relationships were not used).

2.1.2 METHOD FOR CALCULATING THE REDUCTION OF AN OVERALL (ALL THE ASSESSED SPECIES COMBINED) FISHING MORTALITY TOWARDS A COMBINED REFERENCE POINT FOR A GIVEN FLEET SEGMENT

The reduction of an overall combined fishing mortality (all the assessed species combined) towards a combined reference point, is estimated weighing the fleet segments and the species caught by each of them as follows:

$$F_{2013,f,combined} = \frac{\sum_{s=1}^{4}(ValueLand_{2013,s} * F_{2013,f,s})}{\sum_{s=1}^{4} ValueLand_{2013,s}}$$

$$F_{2013,combined} = \sum_{f=1}^{10} F_{2013,f,combined}$$

$$F_{MSY,combined} = \frac{\sum_{s=1}^{4}(ValueLand_{2013,s} * F_{MSY,s})}{\sum_{s=1}^{4} ValueLand_{2013,s}}$$

where:

$F_{2013,f,combined}$ is the fishing mortality combined (taking into account all the target species together) for the fleet segment *f* in 2013;

$F_{2013,combined}$ is the overall fishing mortality combined (taking into account all the target species together and the fleet segments) in 2013;

$F_{MSY,combined}$ is a combination of the reference points F_{MSY} of all the species;

$ValueLand_{2013,s}$ is the overall landing value of species s.

2.1.3 APPROACH BASED ON F_{MSY} RANGES

F_{MSY} ranges were computed based on a meta-analysis carried out using the estimates provided by ICES for the Baltic and North Sea (STECF 2015a).

Upper and Lower limit of the F_{MSY} ranges were computed using two linear models:

$$Flow = 0.00296635 + 0.66021447*F_{0.1}$$

$$Fupp = 0.007801555 + 1.349401721*F_{0.1}$$

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

Afterwards, to test if exploiting a stock at the upper limit of the provisional Fmsy ranges obtained through the predictive linear models a Management Strategy Evaluation (MSE) was developed.

The test included testing the robustness of the upper limit to mis-specifications of natural mortality and low recruitment levels, with regards to keep the stock below 5% of biological risk.

Here we intended biorisk as the risk of SSB being below the minimum historical Spawning Stock Biomass (Blim=Bloss).

The FLR code distributed at the STECF 15-11 was used.

2.1.4 MANAGEMENT POSSIBILITIES, CRITERIA AND PLANNED SCENARIOS TO REACH FMSY.

Reference point	F_{MSY} or related proxies as $F_{0.1}$
Timeframes to reach F_{MSY} or related proxies	2018 and 2020.
Species and fleets	Species are as from the ranking system in task 1 (assessments are available for few species) of the project and fleets according fleet strata as identified in task1 as well.
Strategy to reach the RP in the timeframe	1) gradual linear reduction 2) adaptive strategy which implies for example a lower reduction in the short term and a sharp reduction thereinafter, or viceversa, case by case.
Amount of reduction	Defined on the basis of the results from the assessments and the related diagnosis, except in case of selectivity scenarios.

MSY approach	F_{MSY} range approach is proposed (F_{MSY} upper and lower ranges). These are derived to deliver no more than 5% reduction in long term yield compared with MSY. At first glance the upper and lower boundaries of the FMSY ranges will be used empirically, i.e based on a linear relationship[5] derived for stocks with different life history traits in the ICES area (ICES, 2015). The objective is to get provisional estimates of FMSY ranges for the stocks harvested, thus accounting for mixed fishery considerations. Fupper could be used associated with a Management Strategy Evaluation (MSE) to test if the upper levels of the ranges are precautionary (i.e. the risk of the SSB falling below Blim is less than 5%). The MSE can be applied if the assessment workspaces are available and assessment models applied are in line with such an approach.
Translate reduction of fishing mortality into effort reduction	The reduction of fishing mortality (F) towards the RP will be applied for the timeframe of 2018 to both activity and capacity as follows, up to 2017: Reduction of F 40% applied by its 90% on activity (i.e. activity reduced of 36%) and its 10% on capacity (i.e. capacity reduced of 4%). Scenarios of reduction of activity or capacity designed taking into account considerations of social/management components based on existing management decisions and feedback from the sector. Reduction of fishing mortality (F) towards the RP will be applied for the timeframe of 2020 only on activity from 2017 to 2020.
Translate reduction of fishing mortality into harvest pattern changes	F_{MSY} ranges are calculated based on current fishery selectivity (using northern stocks for deriving regression parameters) with the possibility of higher yields if selectivity is altered through changes in gear design, fishing area, or season. Changing the current size at first capture based on possible changes to the current gear selectivity, while also considering the effectiveness of such changes (survivability of individuals escaped to the gear, from pertinent literature).
Flexibility	Adapt the approach to the specific characteristics of the areas and fisheries (evaluating which are the main gears/fleet strata and their relative impact) case by case.
Uncertainty	Applying a process error on recruitment (a noise component representing deviations from expected pattern/value) to the forecasts. Management Strategy Evaluation (MSE), where possible, on the basis of the

[5] FMSY ranges for EWG 15 09 Notes Ernesto Jardim, JRC May 22, 2015

	available information.

2.1.5 MAIN ASSUMPTIONS

Recruitment is projected in the forecast applying a process error, that is a process noise component representing deviations from the expected pattern/values (as from a geometric mean of the last three years) driven by uncharacterised variability in the physical and biotic environment.

The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced.

A full compliance to the applied management measures is also assumed.
The reductions to be applied are commensurate to the objective of achieving the reference points in terms of fishing mortality (Fmsy or Fupper).

The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability. However, even in presence of severe reductions, the effort limitations applied might be in some situations not enough to reach the F_{MSY} objectives, or be excessive, given that the effort used for setting the management measures is not, in most of the cases, a specific effort directed to the target species (for the multispecific nature of the Mediterranean fishery).

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year. The reduction is applied since 2015 and after 2018 or 2020, depending on the timeframe used in setting scenarios, fishing mortality is assumed to remain around the set reference point, while the fishing effort remain around the level reached as a consequence of the reductions.

In general, as the stock assessment were not updated to 2014 this year was assumed equal to 2013. Management measures were applied since 2015, accounting for possible measures taken at national level under some circumstancies, as for the small pelagics in the Adriatic sea.

2.1.6 METHODS FOR CALCULATING INDICATORS OF ECONOMIC PERFORMANCE

The current revenue to break even revenue ratio (CR.BER)

The current revenue to break even revenue ratio and net profit have been estimated according to the Economic performance indicator calculations provided in: "The 2014 Annual Economic Report on the EU Fishing Fleet" (STECF-14-16).

BER is calculated as Current Revenue (CR) divided by the Break Even Revenue (BER), where:

Current Revenue (CR) = income from landings + other income

Break Even Revenue (BER) = fixed costs / (1-[variable costs / current revenue]).

Fixed costs include non-variable costs, annual depreciation, opportunity cost of capital.

Variable costs include crew wage, unpaid labour, energy costs, repair costs and other variable costs.

Net profit

Net profit is the difference between revenue and explicit costs and opportunity costs. It includes all operational costs, such as wages, energy, repair, other variable, fixed costs and depreciation and opportunity costs of capital. It measures the efficiency of a producer in society's view by evaluating the total costs of inputs (excluding natural resource costs) in comparison to outputs or revenue. Therefore, economic profit is the primary indicator of economic performance and is often used as a proxy of resource rent in fisheries. The excess of revenue over the opportunity cost of producing the good is also referred to as supernormal or abnormal profits. Abnormal profits in a sector is an incentive for other firms to enter the industry. Zero or a negative profit may indicate high competition in the sector and can be used as one of the indicators of overcapacity.

Return on Investment (ROI)

ROI (Return on Investment) is a measure of the efficiency of an investment and is generally used to compare a number of different investments. ROI, which is expressed as a percentage, is calculated by the ratio between the return of an investment and its costs. For an economic sector, it can be estimated by comparing profits to the capital invested. In this case, ROI measures the profitability of a sector in relation to its total assets. The higher the return, the more efficient the sector is in utilising its assets. The capital invested in the sector should include both tangible and intangible assets. In the fishing sector, vessels, fishing gears and other equipment can be considered as tangible assets; while intangible assets are generally referred to the fishing rights. When data on intangible assets (fishing rights) is not included in the calculation of this indicator, the name "Return on Fixed Tangible Assets (ROFTA)" is preferred to ROI. In the Mediterranean fishing sectors, where fishing rights exist just in few cases, like tuna fisheries, ROI and ROFTA are generally equivalent.

ROI is calculated in BEMTOOL as the ratio between net profits and capital value:

$$ROI_{f,t} = \frac{N\Pi_{f,t}}{K_{f,t}},$$

where net profits are given by total income (income from landings and other income) minus total costs (labour costs, variable costs, maintenance and other fixed costs, capital costs):

$$N\Pi_{f,t} = R_{f,t} + OI_{f,t} - (LC_{f,t} + VC_{f,t} + MC_{f,t} + OFC_{f,t} + CC_{f,t}),$$

and the capital value is given by the capital value in the previous year minus the depreciation plus the value of investments, which are calculated by multiplying the value of a vessel by the number of new vessels:

$$K_{f,t} = K_{f,t-1} - DC_{f,t} + vi_f N_{f,t}.$$

A description of the variables follows:

$ROI_{f,t}$ is the Return on Investment ratio for the fleet segment f at time t;

$N\Pi_{f,t}$ is the net profit for the fleet segment f at time t;

$K_{f,t}$ is the capital value for the fleet segment f at time t;

$R_{f,t}$ are the total revenues (or income from landings) for the fleet segment f at time t;

$OI_{f,t}$ are the other income for the fleet segment f at time t;

$LC_{f,t}$ is the labour cost of the fleet segment f at time t;

$VC_{f,t}$ are the variable costs for fleet segment f at time t;

$MC_{f,t}$ are the maintenance costs for the fleet segment f at time t;

$OFC_{f,t}$ are the other fixed costs for the fleet segment f at time t;

$CC_{f,t}$ are the total capital costs for the fleet segment f at time t;

$DC_{f,t}$ are the depreciation costs for the fleet segment f at time t;

$N_{f,t}$ is the number of vessels for fleet segment f at time t;

vi_f is the average value of a single vessel in the fleet segment f.

2.2 CASE STUDY ON SMALL PELAGIC FISHERY IN GSA17 AND GSA18

2.2.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The main stocks identified for the GSA 17 and 18 small pelagic case study are *E. encrasicolus* and *S. pilchardus*. Both stocks are shared among the countries belonging to GSA 17 and 18 (European countries: Italy, Croatia, Slovenia).

The main fishing gears targeting anchovy and sardine are pelagic trawlers and purse seine. The former ones are more common along the western Adriatic coast, while purse seines are more present in the eastern Adriatic countries. The Italian pair trawlers tend to target anchovy (Italy is the country contributing more to catch of anchovy in the Adriatic Sea), while Croatia is the main contributor to the catch of sardine. Slovenia contribution to the small pelagic catch is much lower, due also to the dimension and organization of its fleets.

In order to take into account that the two stocks under consideration are shared among different Countries, Slovenia has been included in the case study though representing less than 1% of the total production and total revenues.

10 main fleet segments operating in the Adriatic, by country, geographical sub-areas, fisheries and vessel length stratum have been identified (Table. 2.2.1.1). Small pelagic is a mixed fishery with a higher catch of sardine in the eastern side, whilst of anchovy in the western side. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 2.2.1.1.

Table 2.2.1.1 - Main fleet segments involved in the small pelagics fishery in GSA17 and GSA18. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	***Fleet code***	***% of landings (all species)***
1	Italian GSA17 pelagic trawlers with vessel length 12-18 m	ITA17_TM_12-18	6.2
2	Italian GSA17 pelagic trawlers with vessel length 18-24 m	ITA17_TM_18-24	7.7
3	Italian GSA17 pelagic trawlers with vessel length 24-40 m	ITA17_TM_24-40	16.2
4	Italian GSA17 purse seine with vessel length 24-40 m	ITA17_PS_2440	2.4
5	Croatian GSA17 purse seine with vessel length 12-18 m	HRV17_PS_1218	5.7
6	Croatian GSA17 purse seine with vessel length 18-24 m	HRV17_PS_1824	18.8
7	Croatia GSA17 purse seine with vessel length 24-40 m	HRV17_PS_2440	34.7
8	Slovenian GSA17 purse seine with vessel length 12-18 m	SVN17_PS_1218	0.1
9	Italian GSA18 pelagic trawlers with vessel length 24-40 m	ITA18_TM_2440	6.5
10	Italian GSA18 purse seine with vessel length 24-40 m	ITA18_PS_2440	1.7

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the two assessed stocks to the total production of the small pelagics is reported in the table 2.2.1.2. This contribution is represented by the production of a single species (e.g. anchovy) in a given GSA (e.g. GSA17) in a given country (e.g. Italy) to the total production of the small pelagics fishery (all the species) in the same GSA and country. The average of the production (by species and overall) of the last three years has been used. For the small pelagic fishery in GSA17 and GSA18, the assessed stocks account for percentages comprised between about 67% (Slovenia) to about 95% (Italy GSA18).

Discard in these fisheries is considered negligible.

Table 2.2.1.2 - Contribution of the stocks assessed (for a given stock in a given GSA and country) to the production volume of the main fleet segments of small pelagic fisheries in GSA17 and GSA18 (the percentage is computed on the average production of the last three years).

Stock	***Percentage** (%) (average last three years)*
Anchovy GSA17 Italy	54
Sardine GSA17 Italy	37
Anchovy GSA17 Slovenia	39
Sardine GSA17 Slovenia	28
Anchovy GSA17 Croatia	17
Sardine GSA17 Croatia	76
Anchovy GSA18 Italy	85
Sardine GSA18 Italy	9

Nowadays, the management of these stocks is regulated through a multiannual management plan established by the General Fisheries Commission for the Mediterranean in 2012. Besides that, Italy has been enforcing for years a general regulation concerning the fishing gears and since 1988 a suspension (about one month until 2010, 60 days in 2011-2012 and 42 days in 2013) of fishing activity of pair trawlers in summer (Cingolani *et al.,* 1996). Also, a closure period is observed from 15th December to 15th January from Croatian purse seiners.

2.2.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The assessment of anchovy and sardine was presented during the EWG-15-11. This assessment used DCF data together with the historical time series available for GSA17 and GSA18 from 1975 to 2013 (sardine) and from 1976 to 2013 (anchovy). The 2014 was not included in the assessment since problems were encountered with some data, that were inconsistent in respect to the rest of the dataset (e.g. Croatian data for 2013 only). EWG-15-11 thus used the data of the previous years integrated by expert knowledge. It is worth mentioning that Croatian data are under revision.

2.2.2.1 EXPLORATORY ANALYSIS OF RESULTS OF SEGMENTED STOCK RECRUITMENT RELATIONSHIP FOR ANCHOVY

In the STECF EWG 15-11 stock recruitment relationships for anchovy and sardine were presented.

Eqsim (ICES, 2015[6]) was used to estimate stock recruitment relationship (S-R), F_{MSY} and F_{MSY} ranges. On the basis of median simulated catches for anchovy the following ranges were obtained:

F_{MSY} = 0.3; F_{lower} = 0.23, F_{upper} = 0.364 (EWG-15-11).

The stock recruitment relationship for anchovy accounted for a wide range of stock productivity.

Several trials have been carried in the context of this project MARE2014_27 to apply the segmented regression stock recruitment relationship estimated during STECF EWG 15-11. The median stock recruitment relationship is a segmented regression characterized by the breakpoint equal to 139 000 tons and the slope in the origin around 540. Applying this stock recruitment relationship, the scenario 1, 2 and 3 have been performed deterministically, in order to evaluate the consequences of this assumptions on the projections of SSB and overall catches in the near future.

Moreover, the same scenarios have been performed according to a more optimistic hypothesis on recruitment, represented by the upper bound of the stock recruitment relationship estimated during the same STECF EWG 15-11 meeting, taking into account high levels of stock productivity. The difference from the median stock recruitment relationship is in the slope that under the high productivity assumption is around 1080 (breakpoint is the same as in the median productivity and equal to 139 000 tons).

The use of the median stock recruitment relationship produced a steep decrease in SSB and in the catches also when management measures are applied, due to the current level of SSB that is very far from the breakpoint and thus not able to produce a number of recruits so high to replace the SSB in the following years with that slope. On the other hand, the use of the optimistic stock recruitment relationship produces, for all the scenarios performed, and also for status quo, a strong increase both in catches and in SSB, for the opposite considerations made for the median stock-recruitment hypothesis (Figure 2.2.2.1.1 and 2.2.2.1.2).

Both hypotheses (median and high productivity) resulted in opposite behaviour of the stock making difficult to ascertain the effect of any management measure. Thus the hypothesis of a randomly varying recruitment, projecting a value equal to the level of last year, that is a quite conservative assumption, has been used in the final projections for anchovy.

The second point concern the stock recruitment relationship proposed for sardine during the STECF EWG 15-11 (an hockey-stick with a fixed breakpoint of the mean SSB). As discussed in the final report of STECF EWG 15-11 "many attempts were made to simulate the sardine populations using specifically developed code but many of these populations crashed". In the end, the resulting F_{MSY} was set equal to 0.08, with Fupper being equal to 0.11. These values, besides being lower than most of the F_{MSY} proxy ($F_{0.1}$) used for demersal species in the Med –that are in general longer living but overexploited species- are also lower than F_{MSY} estimates for analogous small pelagics stocks carried out in other areas, that in general ranges around a value of 0.2-0.3.

For sardine, the forward simulation at STECF EWG 15-11 proved very difficult, and the segmented stock recruitment relationship resulting in a really low MSY was the only way for not collapsing the stock. Catches are variable (high CVs) throughout reflecting the variable, autocorrelated nature of recruitment in the stock.

Therefore, during the Workshop of this MARE 2014_27 project held in Bari on September 21-25 the working group agreed in using for sardine the same reference point estimated for anchovy (F_{MSY} = 0.36).

[6] ICES (2015). Report of the joint ICES -MyFISH workshop to consider the basis for fmsy ranges for all stocks (WKMSYREF3), 17-21 november 2014, charlottenlund, denmark. ICES CM 2014/ACOM:64 2(4): 156pp.

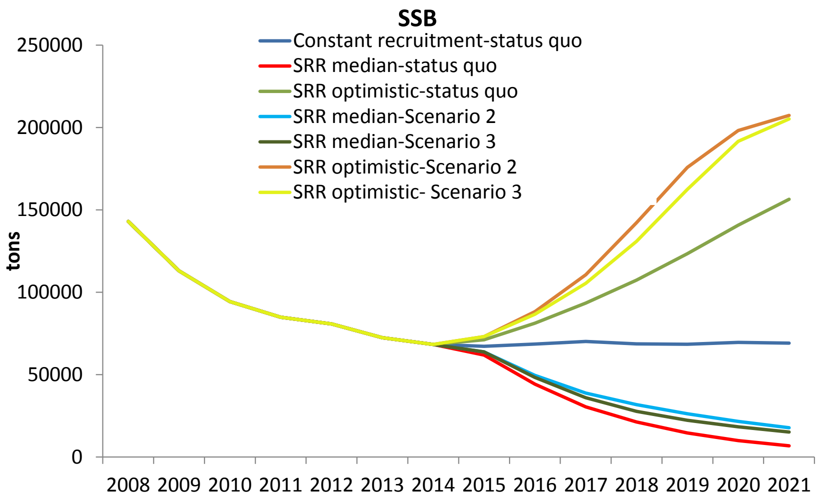


Figure 2.2.2.1.1 SSB estimated for different scenarios with median and upper stock recruitment relationship obtained during the STECF EWG 15-11.

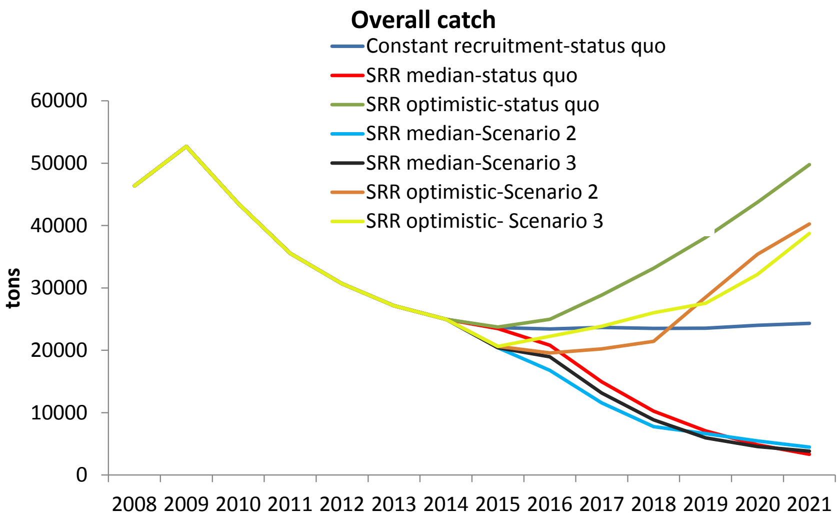


Figure 2.2.2.1.2 Overall catch estimated for different scenarios with median and upper stock recruitment relationship obtained during the STECF EWG 15-11.

Considering the high level of uncertainty in the stock recruitment relationships, during the Workshop of this project MARE 2014_27 held in Bari on September 21-25, the working group agreed also to continue to explore the E0.4 as reference point, besides F_{MSY}, as estimated at STECF EWG 15-11.

Stock advice, Reference points, and their technical basis

The framework used for the Fmsy reference points is summarised in the table 2.2.1.3 .

The approach of MSY ranges was adopted for setting reference points.

On the basis of median simulated catches for anchovy the following F_{MSY} ranges were obtained:

Fmsy = 0.3; Flower = 0.23, Fupper = 0.364 (STECF EWG-15-11).

Regarding anchovy both F_{upper} (0.36) from a stock recruitment relationship as well as F derived from the current exploitation rate E (F/Z=0.64) were well below the current fishing mortality level, thus evidencing unsustainable exploitation in the long term.

The current exploitation rate E for sardine was instead in line with the empirical reference point E0.4.

F_{MSY} of anchovy was also used for sardine, considering the similar life history traits of the two specie and the high uncertainty characterising the estimation of F_{MSY} for sardine.

For sardine the lower level of SSB in the time series after which a good recruitment was observed was thus used as a proxy of B_{lim} and B_{pa} was set as $2*B_{lim}$[7].

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month, were 1.05 for anchovy with F at level E=0.4 being 0.64, and 0.54 for sardine with a value at level E=0.4 of 0.55. These values were the same as the assessment.

In the table 2.2.1.3 Method 1 is referring to the approach based on F_{MSY} ranges. This approach was suggested by DGMARE, because developed in the "ad-hoc contract to support the preparation of a multiannual plan for small pelagic species in the Northern Adriatic" (Minto, 2015) and successively implemented in the stock assessment of small pelagics carried out during EWG 15-11 and endorsed by STECF 15-14. This approach was also discussed during the preparatory Workshop of the present project held in Bari on September 21-25 2015 (see Annex III to this report). During the same Workshop also the approach referred as Method 2, which is based on the Exploitation Rate (Reference point E0.4) was discussed and adopted for sake of comparison. This because the reference point E0.4 is considered, inter alia, in the Recommendation GFCM/37/2013/1 on a multiannual management plan for fisheries on small pelagic stocks in the GFCM-GSA 17 (Northern Adriatic Sea) and on transitional conservation measures for fisheries on small pelagic stocks in GSA 18 (Southern Adriatic Sea).

Table 2.2.1.3 – Reference point framework for anchovy and sardine and their technical basis.

	Framework					
	MSY approach				**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**Bmsy**	**$B_{lim\ (tons)}$**	**$B_{pa\ (tons)}$**
Technical basis for anchovy method 1	Fmsy from a segmented stock recruitment relationship (EWG-15-11)	From Eqsim			fixed segmented fit of the S-R; half of the breakpoint SSB	Breakpoint of the segmented S-R
Technical basis for anchovy method 2	Exploitation rate (E0.4) from Patterson	-			**B_{lim}** as above*	**B_{pa}** as above*
Values for anchovy method 1	**0.3**	**0.36**	**2.9**		**69,500**	**139,000**

[7] In order to estimate this reference point, a log-normal distribution of Blim is assumed, with a coefficient of variation of 40%. This results in approximately $B_{pa} = 2*B_{lim}$ (GFCM approach, Report of the Working Group on Stock Assessment of Small Pelagic Species (WGSASP) Rome, Italy, 24–27 November 2014.

	Framework					
	MSY approach				Precautionary approach	
Values for anchovy method 2	**0.64**	**-**	**1.66**		**69,500***	**139,000***
Technical basis for sardine method 1	Fmsy of anchovy was adopted	The F_{MSY} upper range of anchovy was adopted			The lower level of SSB in the time series after which a good recruitment was observed	$2*B_{lim}$
Technical basis for sardine method 2	Exploitation rate (E0.4) from Patterson	-			The lower level of SSB in the time series after which a good recruitment was observed	$2*B_{lim}$
Values for sardine method 1	**0.3**	**0.36**	**1.48**		**180,000**	**360,000**
Values for sardine method 2	**0.55**	**-**	**1**		**180,000**	**360,000**

*the same values as for method 1 were adopted given that an empirical approach applied to anchovy (lower levels of SSB in the time series after which a good recruitment was observed) gave similar results (~70,000 and 140,000 tons respectively for B_{lim} and B_{pa}).

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments is evaluated using key social and economic indicators and a traffic light table is below reported (Table 2.2.1.4 red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

From the economic indicators it seems that the fisheries of small pelagics mainly relies upon the revenues of sardine, that had a recent positive trend for 4 fleet segments out of ten (Italian pelagic trawlers and croatian purse seiner operating with bigger vessels.

Table 2.2.1.4 - Traffic light table on the economic performance of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

	Salary (euro)	CR.BER	ROI	Overall Revenues (thousand euros)	Revenues anchovy (thousand euros)	Revenues sardine (thousand euros)	Employment (number of units)
All fleets	13500÷11726	0.68÷0.77*	(-0.1)÷(-0.06)	83555÷75489	58348÷38958	19629÷29768	2017÷2011
ITA17_TM_1218	°32823÷17295	°3.55÷2.81	°0.91÷0.59	8113÷6041	°7574÷3455	184÷1042	°97÷124
ITA17_TM_1824	17080÷6690	1.24÷0.55	0.02÷-0.19	6386÷5118	5352÷2125	403÷2563	110÷153
ITA17_TM_2440	17714÷16980	1.38÷0.72	0.043÷-0.15	20084÷17417	16341÷11159	2820÷4827	262÷264
ITA17_PS_2440	18637÷13484	1.88÷1.24	0.14-0.07	11623÷5160	7506÷3824	126÷138	224÷142
HRV17_PS_1218	6033÷5408	6.2÷7.9	0.82÷1.09	2994÷3279	567÷968	1862÷1956	45÷47
HRV17_PS_1824	10416÷10410	(-0.5)÷(-0.06)**	(-0.95)÷(-0.7)	7437÷9248	2234÷2746	4859÷6074	473÷497
HRV17_PS_2440	10414÷10397	-0.07÷0.93	-0.2÷-0.01	11467÷17905	4094÷4122	6663÷12714	478÷505
SVN17_PS_1218	10232÷3976	°3.3÷2.1	°0.56-0.11	°523-197	177÷71	245÷53	°16-16
ITA18_TM_VL_2440	16826÷13388	1.57÷0.86	0.1÷-0.1	15619÷8673	13073÷8139	2436÷376	238÷181
ITA18_PS_VL_2440	15897÷10379	2.89÷1.17	0.44÷0.047	4409÷2449	4194÷2349	30÷24	97÷82

*decreasing except the last value; **stable except the last value; °initil value is referred to 2009, as 2008 values seems anomalous.

2.2.3. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

The two stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels, anchovy that is the most heavily exploited stock in the mix is used as a benchmark. Overall a remarkable reduction of the fishing mortality is necessary to reach F_{MSY} in 2020.

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term; the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the FMSY range.
2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY in 2020. The reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the FMSY range.

The reduction is applied from 2015 to account for the implementation of management actions taken on the basis of the GFCM Recommendations 38/2014 and 39/2015 Member States have presumably undertaken.

The percentages of reduction to reach F_{MSY} are reported in the table 2.2.3.1 for both the reference points taken into consideration, F_{MSY} (method 1) or E0.4 (method 2). The percentage of reduction, whatever the method, does not change if the target year is 2018 or 2020, given that only the amount of reduction by year is changing, depending on the target year.

The percentages of reduction were based on the advices from STECF and GFCM that indicated the needing of reaching F_{MSY} or E0.4, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point F_{upper} of anchovy (the more exploited species) (=0.36) and the current level of fishing mortality (method 1) (Fcurr=1.04)

or

- the reference point E0.4 and the current exploitation rate (method 2). In this case the level of natural mortality in the age range 1-2 (M=0.955), the same age range as he fishing mortality was used.

Table 2.2.3.1 – Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{MSY} (method 1) or E0.4 (method 2).

Stock	***Fishing mortality reduction*** *(in %)*
Anchovy (Reference point method 1)	65%
Anchovy (Reference point method 2)	40%

This reduction is proportionally applied to the different fleet segments, accounting for their relative impact. This is measured computing by each fleet segment a coefficient given by the production of anchovy, which is the benchmark species, to the overall production of anchovy. The overall fishing mortality F and Fupper are thus split among fleet segments using such coefficient. Thus the reduction by fleet segment is commensurate to its current F and its target F_{MSY} (pathway B). An alternative approach is to reduce to a greater extent the F of the fleet segments with a higher impact (pathway A).

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability. For sake of comparison both reductions, 65 and 40%, were applied according to the scenario described in the table 2.2.4.1.

2.2.4. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios are reported in the table 2.2.4.1.

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

Scenario 2 and 4 share the same strategy, the difference is in the reference point, in the scenario 2 it is F_{UPPER} of anchovy and the reduction is applied both to anchovy and sardine.

Besides F_{UPPER} also the empirical reference point E0.4 of anchovy has been adopted, given the high uncertainty on stock recruitment relationships, especially for sardine. E0.4 of anchovy is contemplated in the scenario 4 and 5.

Scenarios 6, 7, 8 and 9 are the counterparts of scenarios 2, 3, 4, and 5, using a different pathway of allocating F reduction among fleet segments.

The scenario of the reduction towards E0.4 of sardine was not applied given the level $F_{current}$ (F_{bar1-3}) very close to the E0.4 (=0.53 vs. 0.55).

Table 2.2.4.1 – Scenarios modelling for the forecasts.

Scenario 1	**Status quo to 2020**
Scenario 2	Linear reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Application of reduction higher for the flees more impacting the stocks (pathway A). Starting year of reduction 2015.
Scenario 3	Adaptive reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Application of reduction higher for the flees more impacting the stocks (pathway A). Starting year of reduction 2015.
Scenario 4	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Application of reduction higher for the fleets more impacting the stocks (pathway A). Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards E0.4 of anchovy in 2020, from 2018 to 2020 applied only on activity. Application of reduction higher for the flees more impacting the stocks (pathway A). Starting year of reduction 2015.
Scenario 6	Linear reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Application of reduction partitioned according to the proportion of

	F_{MSY} of the single fleet (pathway B). Starting year of reduction 2015.
Scenario 7	Adaptive reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Application of reduction partitioned according to the proportion of FMSY of the single fleet (pathway B). Starting year of reduction 2015.
Scenario 8	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Application of reduction partitioned according to the proportion of FMSY of the single fleet (pathway B). Starting year of reduction 2015.
Scenario 9	Adaptive reduction towards E0.4 of anchovy in 2020 applied both to activity and capacity, up to 2017 included, then on the activity only. Application of reduction partitioned according to the proportion of FMSY of the single fleet (pathway B). Starting year of reduction 2015.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

In all the scenarios the uncertainty on recruitment (process error) has been taken into account, applying for both stocks a multiplicative error (on the stock recruitment relationship/geometric mean of recruitment computed for the last three years).

The reduction related to the method 1 (total reduction of F 65%) has been applied by 6.5% (10% of the overall reduction) on the vessels and by 58.5% on the fishing days. This split was in agreement with the decision taken during the project Workshop held in Bari on September 21-25, 2015, on the basis of informal feedback received by stakeholders.

Allocation of fishing mortality reduction to the fleet segments according to different reference points (Fupper and E0.4) and pathway is reported in table 2.2.4.2. Details on the dynamics of percentage reductions by fleet segment, year and scenario are reported in the Annex A to this report (Table A.5.4).

Given the very low impact, the fleet segment SVN17_PS_1218 was excluded from the reduction plan.

Table 2.2.4.2 – Allocation of fishing mortality reduction to the fleet segments according to different reference points (Fupper and E0.4) and pathway.

	Fleet code	*Relative contribute to F (%)**	*Proposed reduction (pathway A) to F_{upper} anchovy(in % to SQ)*	*Proposed reduction (pathway B) to F_{upper} anchovy (in % to SQ)*	*Proposed reduction (pathway A) to E0.4 anchovy (in % to SQ)*	*Proposed reduction (pathway B) to E0.4 anchovy (in % to SQ)*
1	ITA17_TM_12-18	10.0	31		18	
2	ITA17_TM_18-24	8.0	25		16	
3	ITA17_TM_24-40	24.7	88		64	
4	ITA17_PS_2440	6.3	15		9	
5	HRV17_PS_1218	2.7	13	65	8	40
6	HRV17_PS_1824	10.7	46		28	
7	HRV17_PS_2440	17.7	80		45	
9	ITA18_TM_2440	14.7	76		31	
10	ITA18_PS_2440	5.0	24		14	
8	SVN17_PS_1218	0.1	-	-	-	-

*F average of the last 3 years; SQ=Status quo

2.2.5. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1 for description).

The inputs to the biological and pressure components of BEMTOOL model have been derived from the last endorsed stock assessment (STECF EWG 15-11); socio-economic data and parameters are from DCF and SEDAF -MAREA project.
Moreover, a Management Strategy Evaluation (MSE) has been performed in line with EWG-15-11 for both anchovy and sardine using the same segmented stock recruitment relationships together with the derived reference points.

2.2.6. REPORT OF INPUTS FOR MODELLING SMALL PELAGIC FISHERY IN GSA17 AND GSA18

All the inputs for modelling are fully reported in the Annex A.

2.2.7 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.2.7.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

Projecting the current effort for all the fleet segments and assuming a recruitment varying respectively from 20 509 826 to 179 759 131 thousands for anchovy and from 17 611 931 to 168 214 746 thousands for sardine, the proxy of the probability that the SSB of anchovy was less than the biomass reference point (Blim = 69 500 tons) is 52.2 %, while for sardine the proxy of the probability that the SSB was less than the biomass reference point (Blim = 180 000 tons) is 0% due to the increasing trend in recruitment observed in the last years and, consequently, in the recruitment value used in the projections.

Figure 2.2.7.1 shows the SSB of anchovy and sardine in the status quo scenarios; the SSB of anchovy shows a slight oscillation from 2015 probably due to a propagation of the previous oscillations in the time series; however, this oscillation has an amplitude of about 4% around the SSB value estimated for 2014, thus the pattern can be considered quite stable.

Sardine SSB shows a similar slightly oscillatory behaviour (it is hidden by the scale of the graph, due to the order of magnitude); this oscillation has an amplitude of about 17% around the SSB value estimated for 2014, thus the pattern can be considered quite stable.

As expected, also the landings (overall and by fleet segment) for the 2 stocks show a stable trend in the projections of the status quo scenario (Figure 2.2.7.2 and Figure 2.2.7.3).

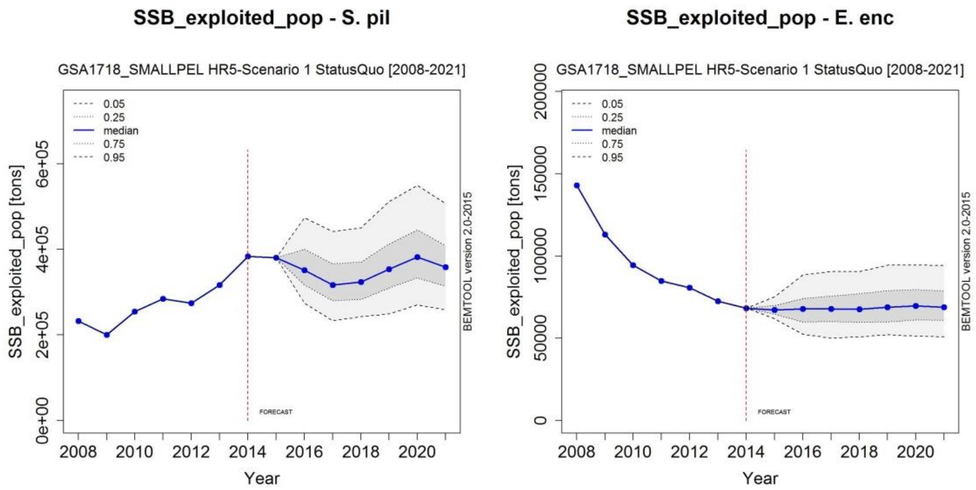
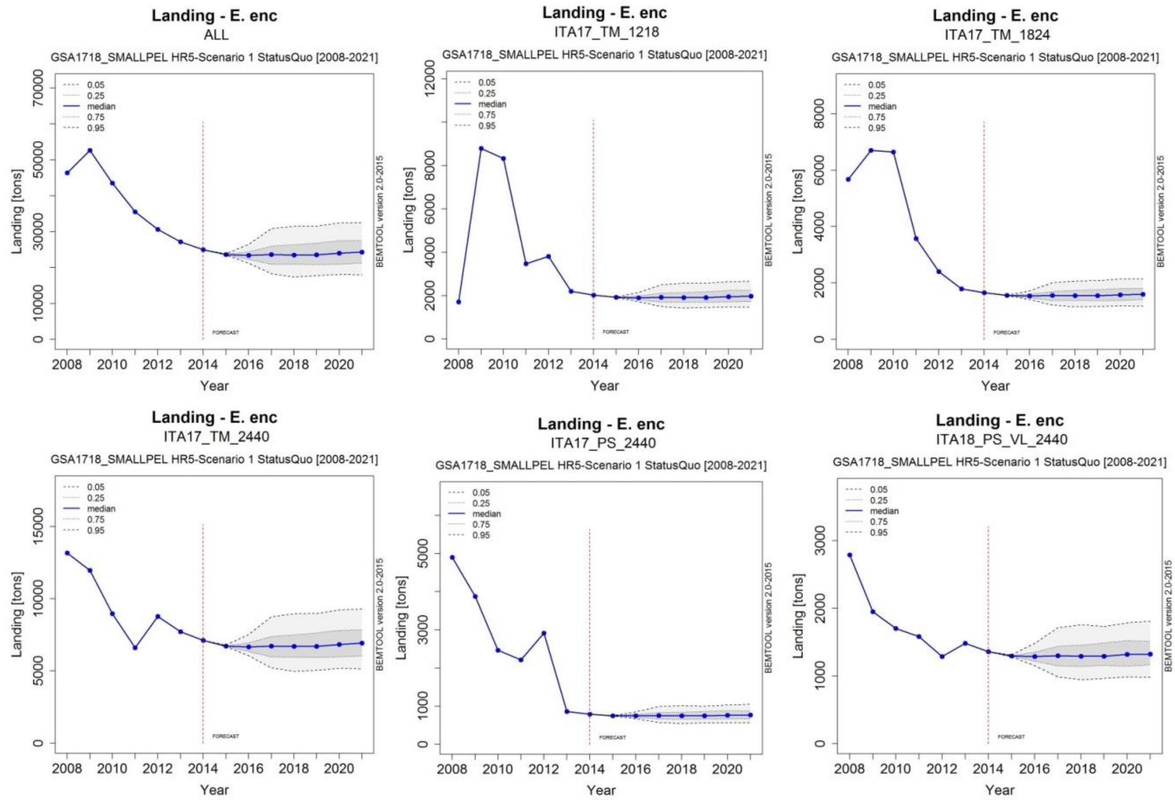


Figure 2.2.7.1 - SSB for anchovy and sardine in the status quo scenario with confidence intervals.



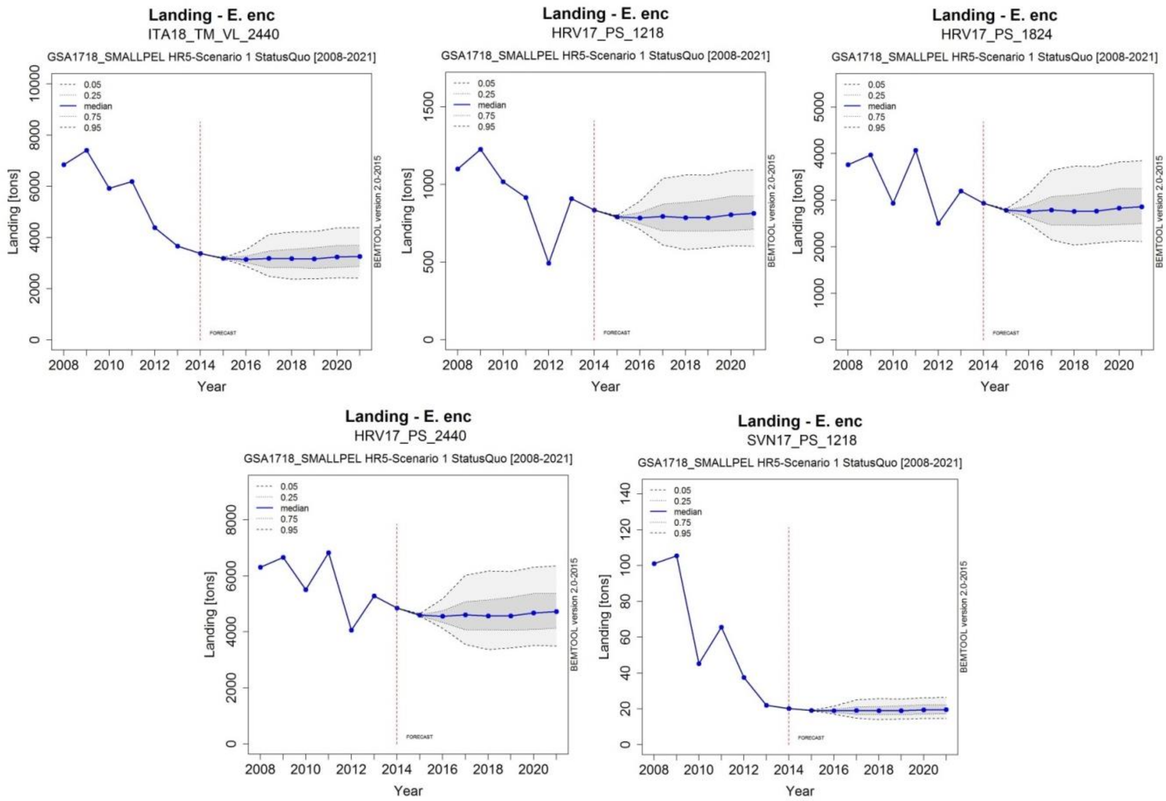
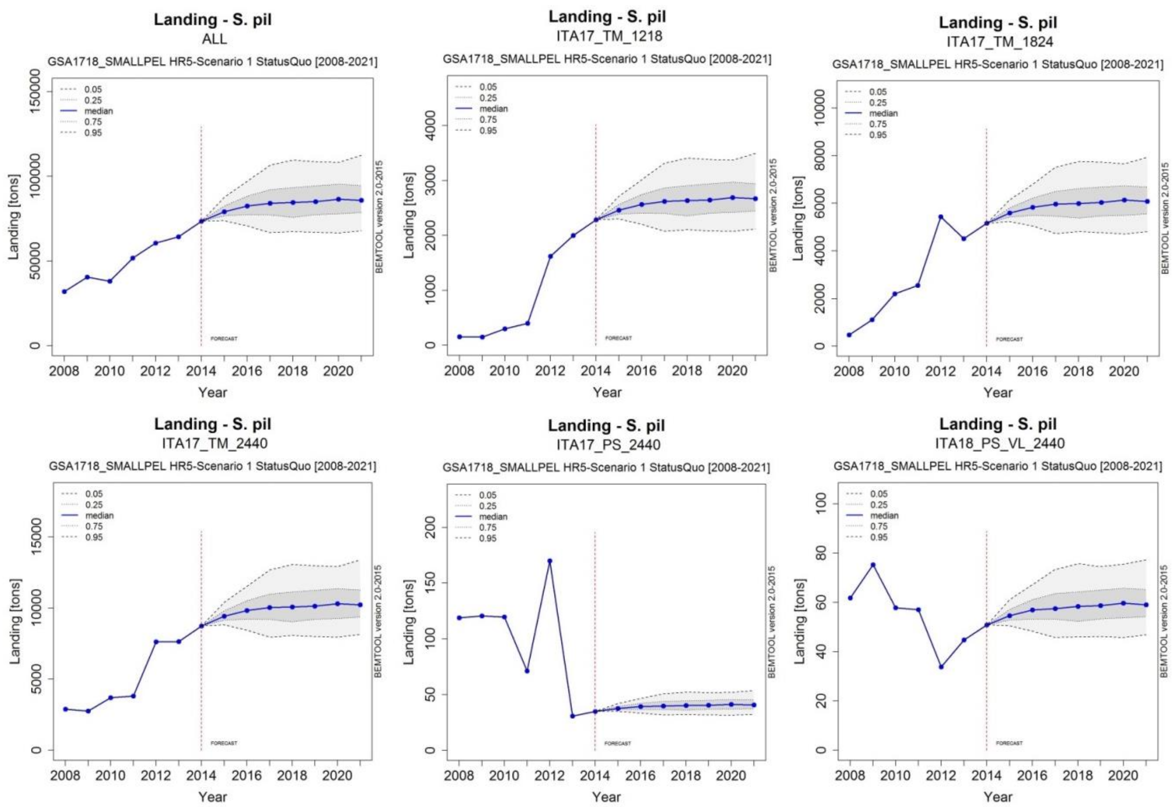


Figure 2.2.7.2 - Landing for anchovy by fleet segment in the status quo scenario with confidence intervals.



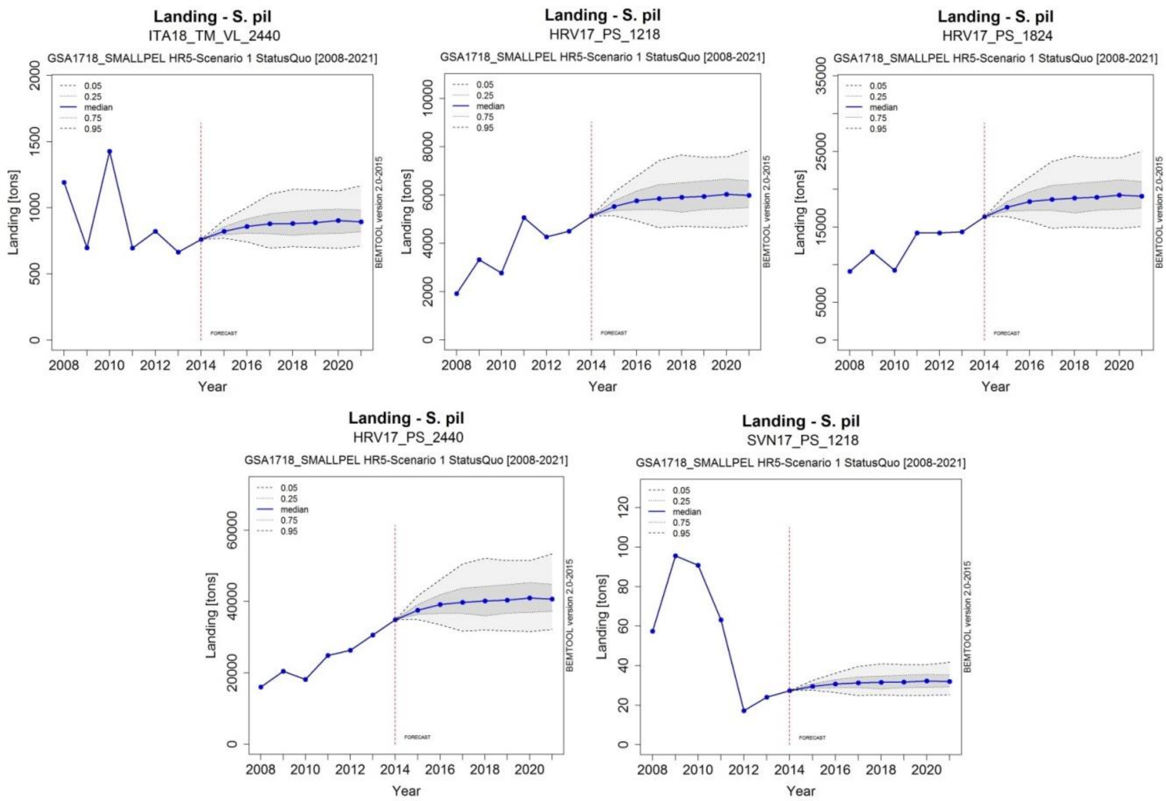


Figure 2.2.7.3 Landing for sardine by fleet segment in the status quo scenario with confidence intervals.

2.2.7.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 103 thousand tons of total production generating 75 million euro, an increase by 3% in quantity and a decrease by 4% in value compared to 2012. The most important fleet segments are the Croatian purse seiners VL2440 (producing 24% of total revenues) and the Italian pelagic trawlers VL2440 operating in GSA 17 (producing 23% of total revenues), which produces around a half of total revenues.

As reported in Figure 2.2.7.2.1, total revenues of pelagic fleets operating in GSAs 17 and 18 show a slight negative trend in the period 2008-2013. The reduction in revenues (around 10% in the period) was due to Italian fleets, which represented around 60% of total revenues in 2013. Both Italian pelagic trawlers and purse seiners in GSA 18 show a decrease in revenues by 44%, and the Italian purse seiners VL2440 operating in GSA 17 shows a decrease by 56%. The Slovenian purse seine fleet, which represents less than 0.5% of total revenues, shows a negative trend too. On the contrary, Croatian purse seiners show a positive variation between 2008 and 2013 even though there is not a clear positive trend in the revenues.

In the forecast period, total revenues for the overall fishing sector show a slight increasing trend with an increase by almost 4% in 2021 compared with 2013. Increasing trends are registered for Croatian and Slovenian fleet segments as well as for the Italian fleet segments operating in GSA 18. On the contrary, the Italian pelagic trawlers in GSA 17 show a declining trend and the Italian purse seiners VL2440 in GSA 17 a stable trend. The worst performance is registered for Italian pelagic trawlers VL2440 in GSA 17 with a reduction of around 7% in 2021 compared with 2013.

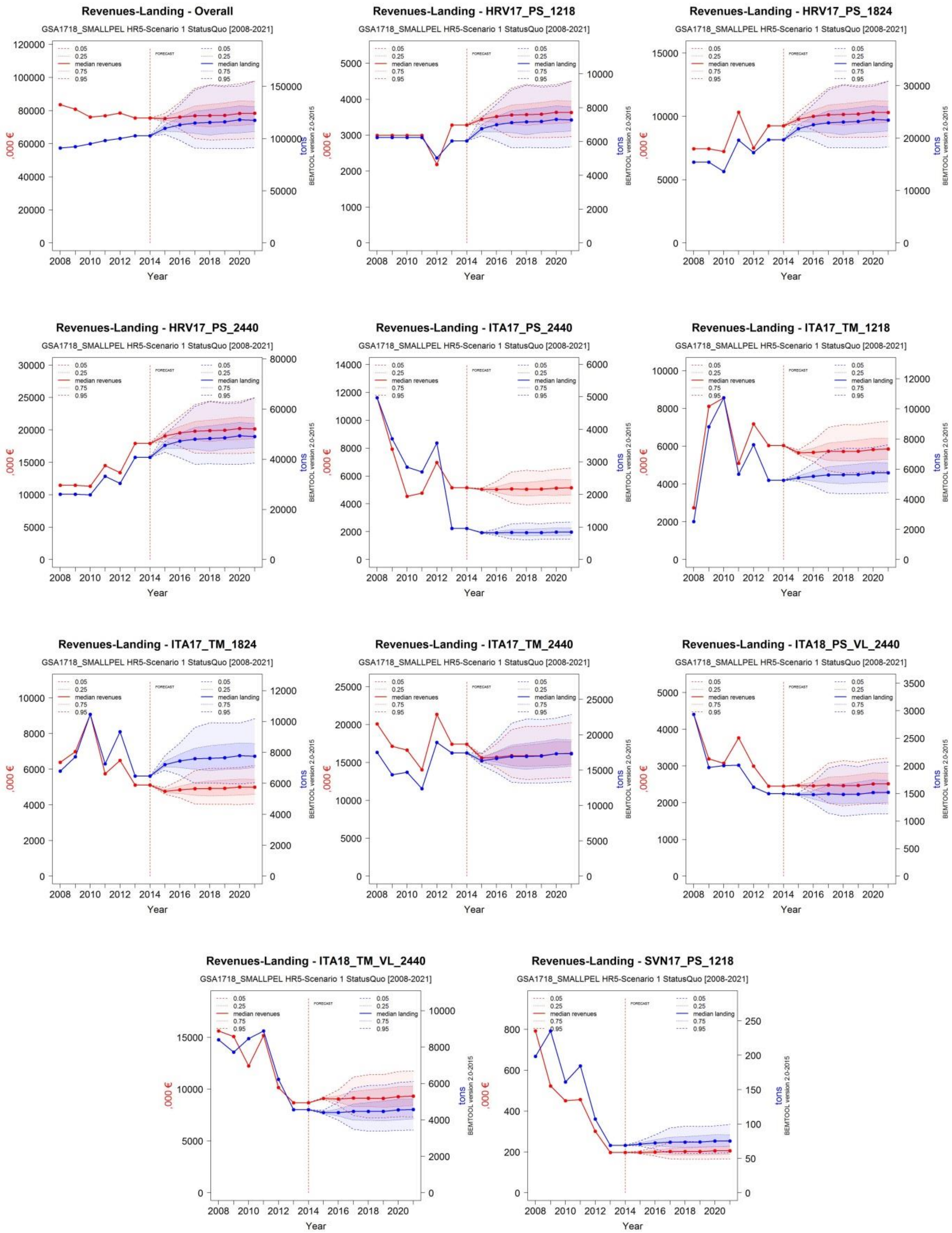


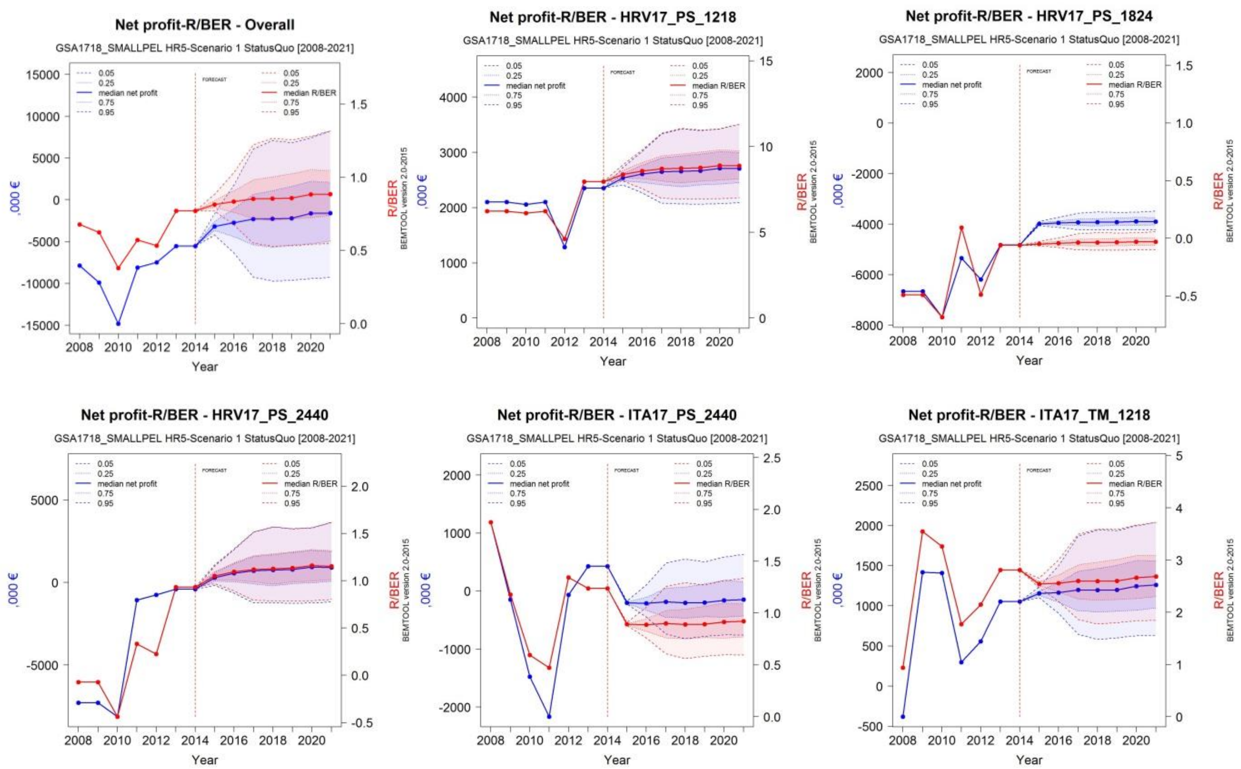
Figure 2.2.7.2.1 - Landings weight and value by fleet segment with confidence intervals.

In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is negative. The whole pelagic fleet operating in GSAs 17 and 18 shows negative values for net profit in the period 2008-2013. Negative values are registered for the Croatian purse seiners VL1824 and VL2440, for the Italian pelagic trawlers VL1824 and VL2440, operating in GSA 17, and for the Italian pelagic trawlers VL2440 operating in GSA 18. Even though the net profit of the whole fleet remains negative in the period 2008-2013, it shows an improvement during the last 3 years, from 2011 to 2013.

In the forecast period, net profit for the overall fishing sector shows a positive trend. Even though net profits is expected to be still negative in 2021, the net loss shows a reduction from -5.5 to -1.5 million euro. All fleet segments are expected to reduce their losses with the exception of Italian purse seiners VL2440 operating in GSA 17.

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is lower than 1 if the whole fleet is considered, this because it is greater than 1 for half of the fleet segments and lower than 1 for the others. The most critical condition is registered for the Croatian purse seiners VL1824, which shows a negative value for this indicator, while the Croatian purse seiners VL1218 shows the best performance in the period 2008-2013 (Figure 2.2.7.2.2).

The ratio between current and break-even revenues (CR/BER) in the forecast period does not show any significant change and it remains lower than 1 for the whole fleet. The only improvement is registered for the Croatian purse seiners VL2440, where the indicator moves from lower to higher than 1 from 2013 to 2021, as a propagated effect of the change between 2010 and 2013. The other four fleet segments with values lower than 1 in 2013 are expected to continue that condition until 2021.



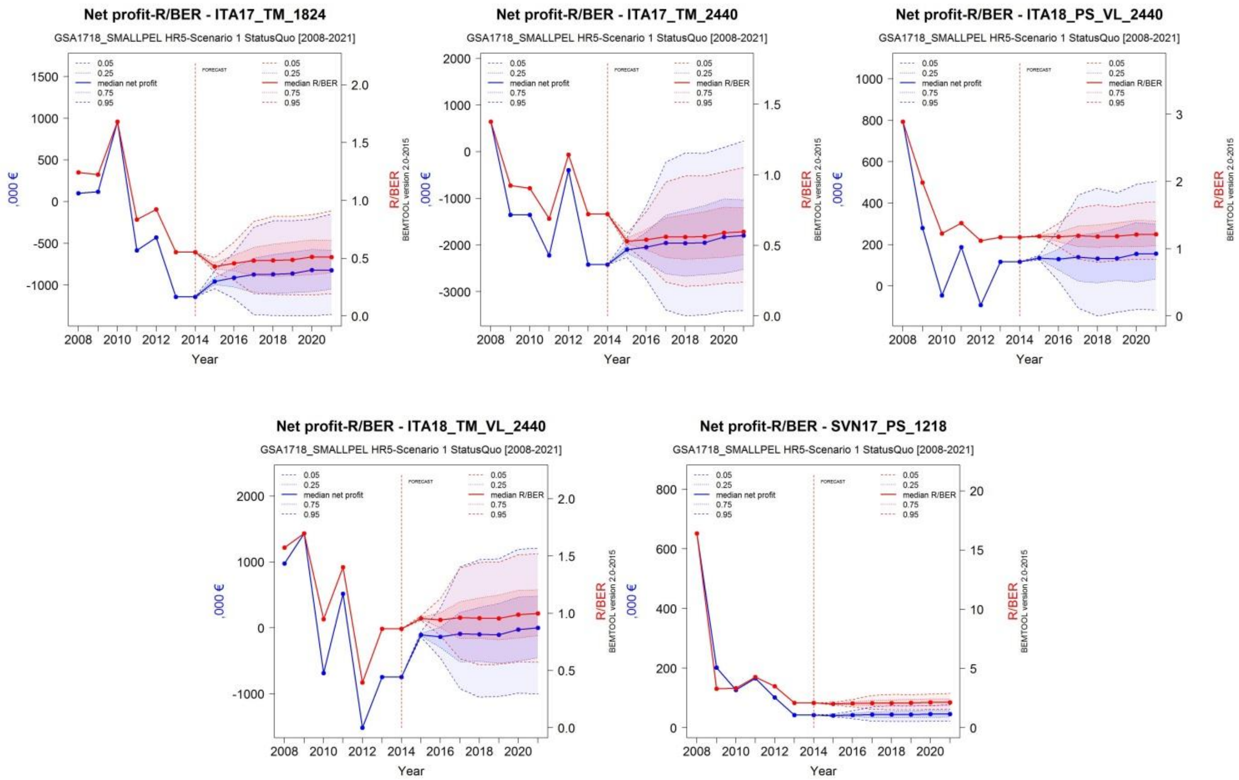


Figure 2.2.7.2.2 Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment with confidence intervals.

2.2.8 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

2.2.8.1 BIOLOGICAL AND PRESSURE INDICATORS

In this section only the figures of the trajectories of indicators under scenarios from 2 to 5 are shown for sake of clarity, however the effects of the scenarios from 6 to 9 are fully represented in the chapter 2.2.10 in terms of traffic light.

As expected SSB of both anchovy and sardine shows the best performance under Scenario 2 and the worst result in the status quo scenario; this result seems consistent with the greater benefit that generally the reduction in fishing mortality produce on the indicators if applied in a short timeframe Moreover, Scenario 2 allows to obtain immediately the highest benefit on SSB, respect to the other scenarios, which produce an increase in SSB less marked from the first years of the application of the management measures (Figure 2.2.8.1.1). As expected, both scenarios towards Fupper of anchovy perform better than the scenarios towards E0.4 of anchovy, these gave a results almost comparable for the two forms, adaptive and not adaptive, in the long term (2021).

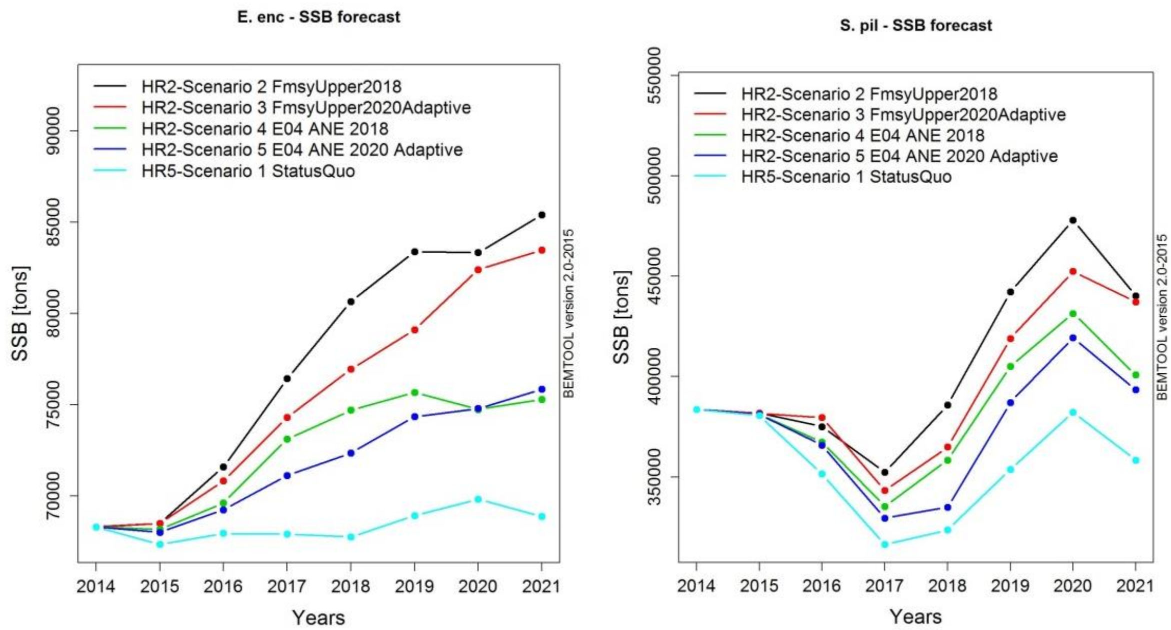


Figure 2.2.8.1.1 - SSB of anchovy and sardine in GSA 17 and 18: comparison among the management scenarios.

As regards the overall catches, the best performing scenario is the status quo for both stocks; this result is strictly linked to the hypothesis of constant recruitment with process error used in the projections.
For both stocks the catches by fleet segment change accordingly to the percentage of reduction applied:

- fleet segments ITA17_TM_1218, ITA17_TM_1824, ITA17_PS_2440, HRV17_PS_1218, ITA18_PS_VL_2440 and SVN17_PS_1218 benefit of the higher reduction applied to the other fleet segments: higher is the reduction applied (Scenarios 2 and 3) and more is their benefit, while in the status quo situation they do not see any significant improvement in catches;
- fleet segments ITA17_TM_2440, HRV17_PS_1824, HRV17_PS_2440 and ITA18_TM_VL_2440 see their catches quite stable in the status quo scenario, while these decrease considerably in Scenarios 2 and 3, that apply a stronger reduction to them: higher is the reduction and smaller are their catches.

The main results of the projections carried out in terms of overall catches of the two stocks and by fleet segment are shown in the figures Figure 2.2.8.1.2 and Figure 2.2.8.1.3.

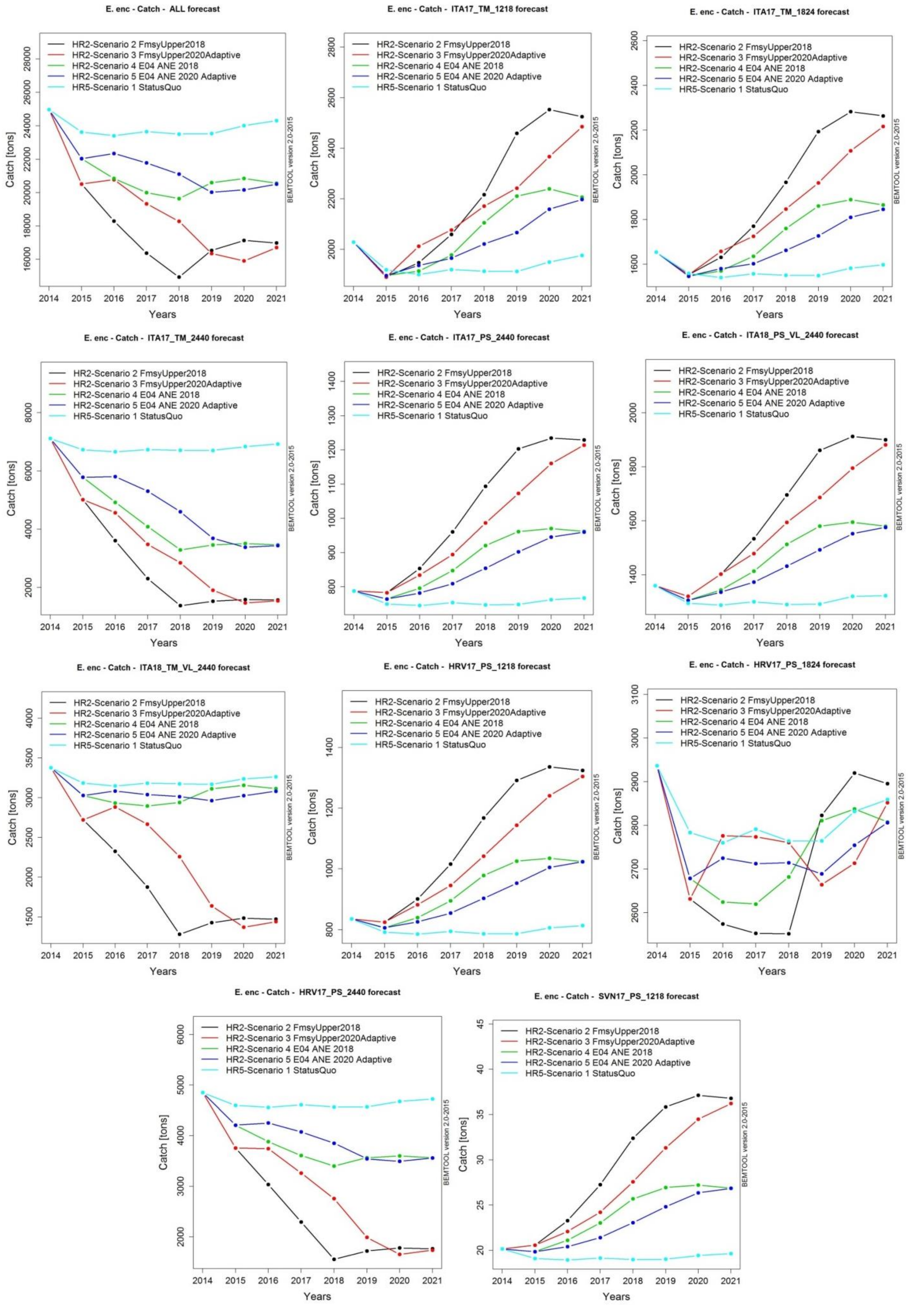


Figure 2.2.8.1.2 Catch of anchovy in GSA 17 and 18 overall and by fleet segment: comparison among 5 management scenarios.

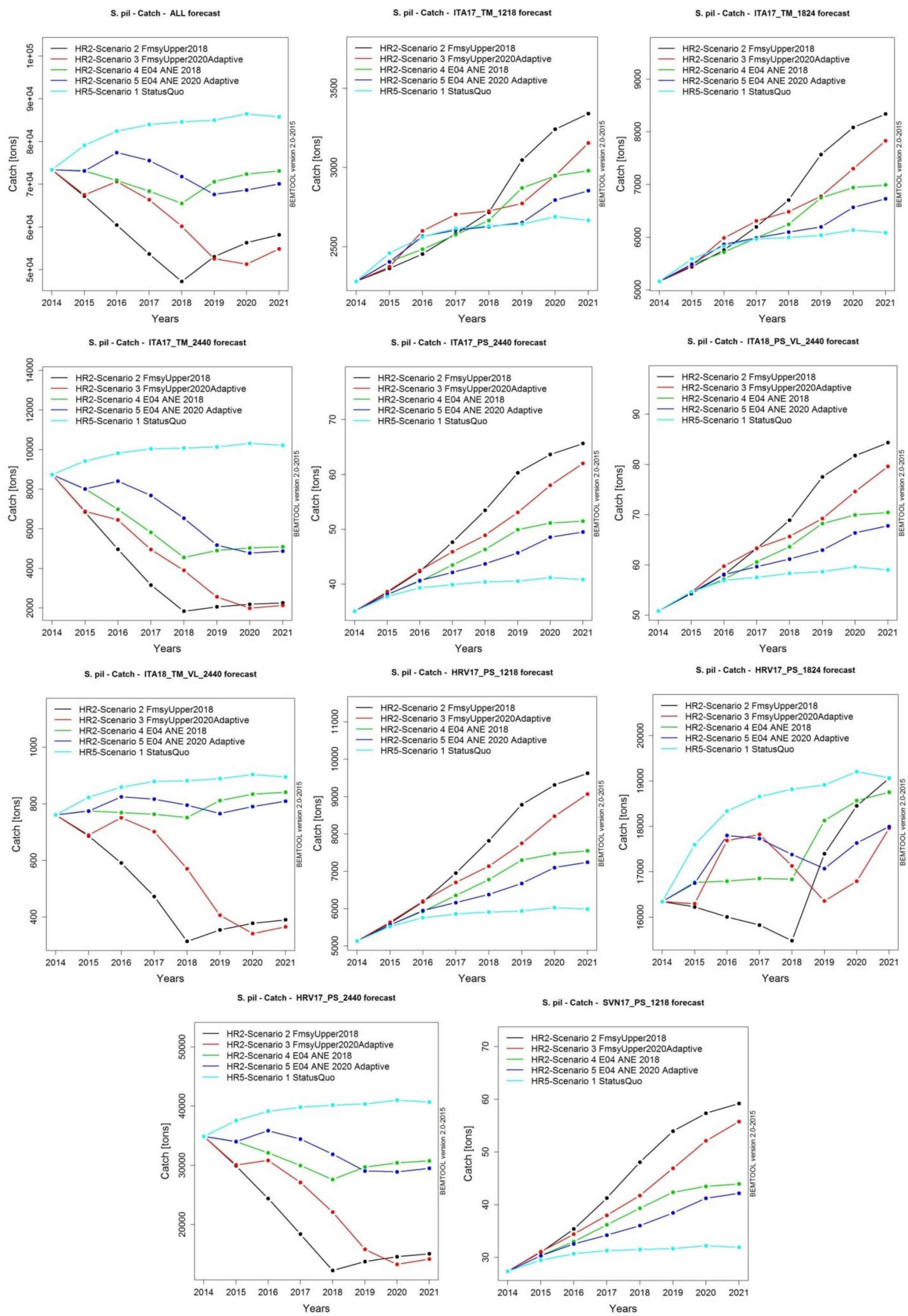


Figure 2.2.8.1.3 Catch of sardine in GSA 17 and 18 overall and by fleet segment: comparison among 5 management scenarios.

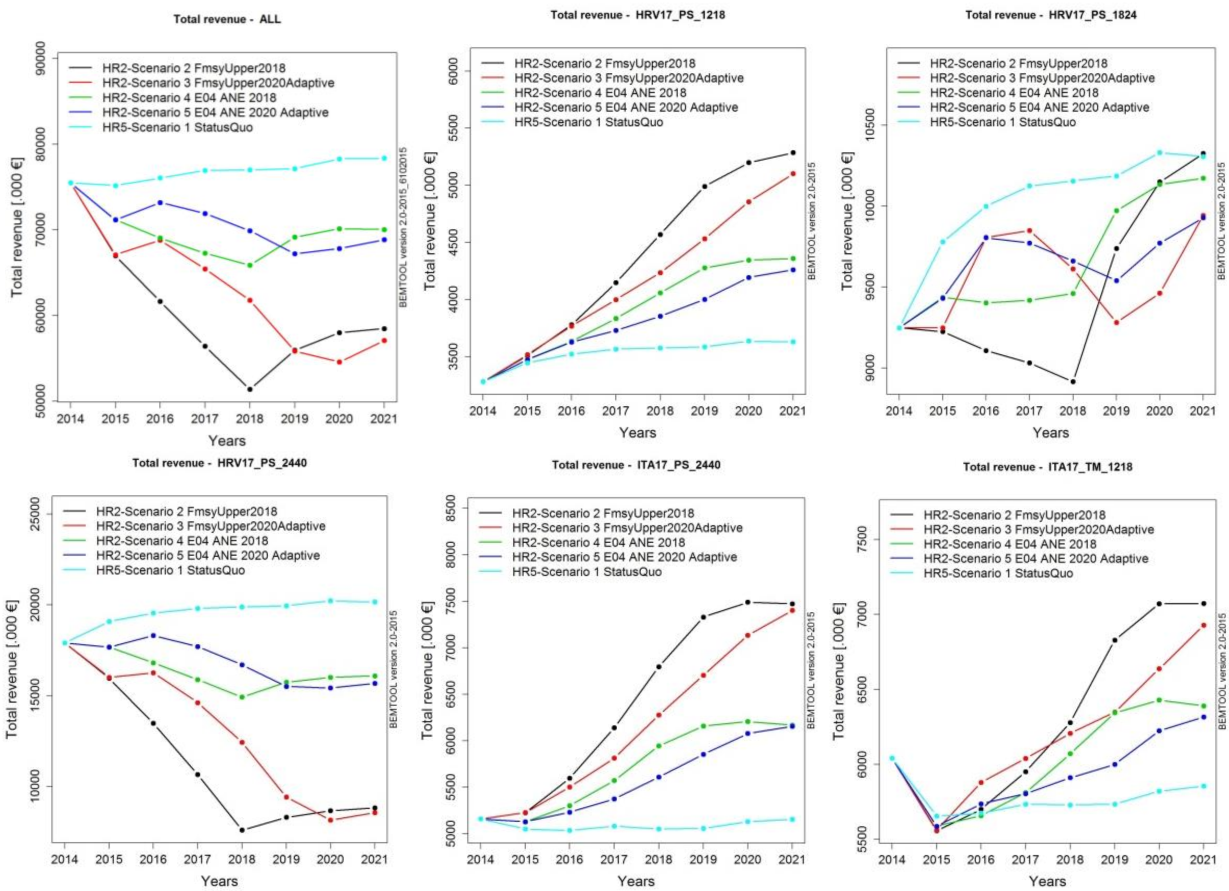
2.2.8.2 SOCIO-ECONOMIC INDICATORS

In this section only the figures of the trajectories of indicators under scenarios from 2 to 5 are shown for sake of clarity, however the effects of the scenarios from 6 to 9 are fully represented in the chapter 2.2.10 in terms of traffic light.

Figure 2.2.8.2.1 shows the expected impacts on total revenues deriving from each of 5 scenarios. The simulation outcomes are compared with the status quo scenario.

Compared with the Status Quo, all alternative scenarios show a reduction in the total revenues for the overall fishing fleet. Scenario 2 and 3 are the most impacting on revenues with reductions in 2021 higher than 25% if compared with the Status Quo. Scenario 4 is the less impacting on revenues with a reduction by 10.6% if compared with Status Quo.

The reduction in revenues does not impact equally on each fleet segment. The highest negative impact on revenues in all scenarios is expected for the Italian pelagic trawlers VL2440 in GSA 17, followed by the Croatian purse seiners VL2440, Croatian purse seiners VL1824 and the Italian pelagic trawlers VL2440 in GSA 17 and 18. The fleet segment which benefits more by the alternative scenarios is the Slovenian purse seiners VL1218, followed by the Croatian purse seiners VL1218, the Italian purse seiners VL2440 in GSAs 17 and 18 and the Italian pelagic trawlers VL1218 and VL1824 in the GSA17.



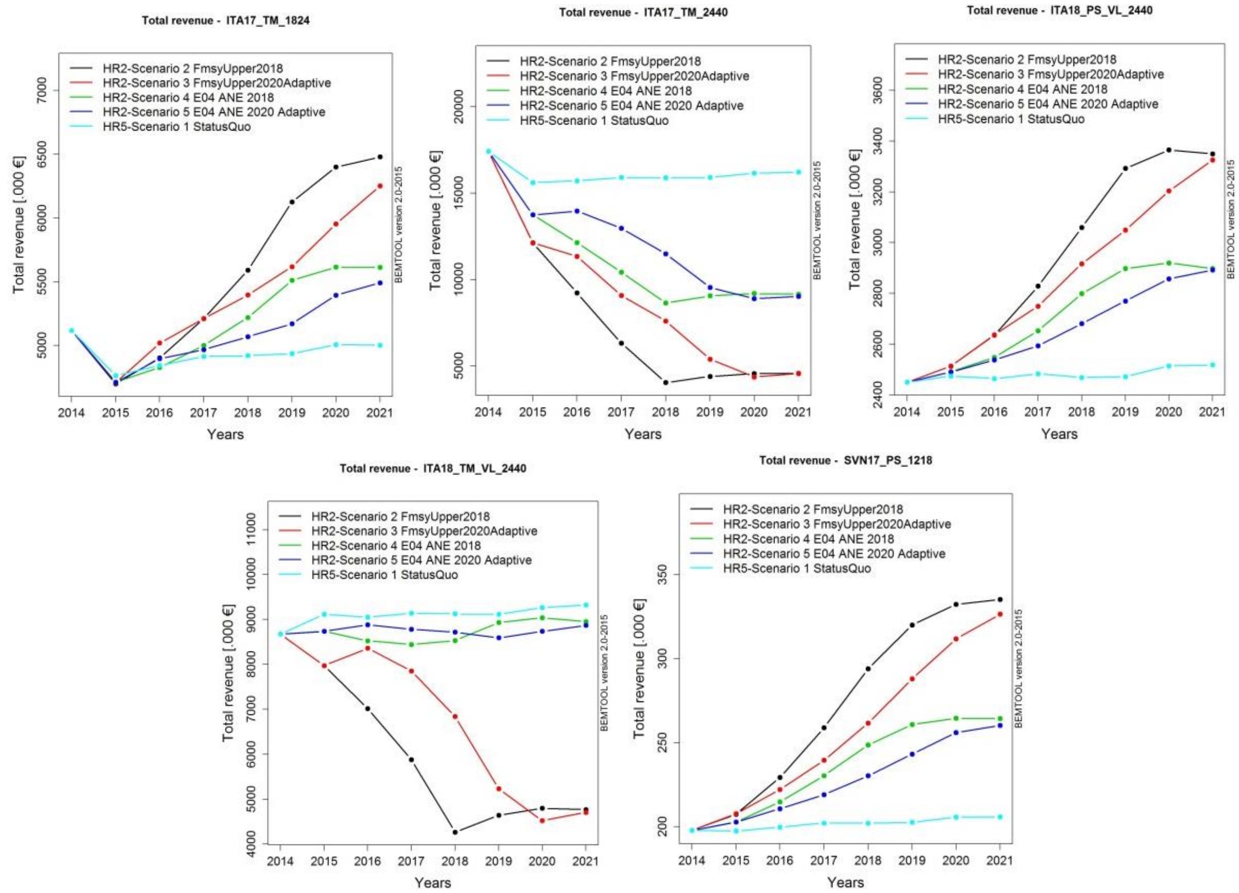


Figure 2.2.8.2.1 Revenues by fleet segment and scenario.

In 2015, the first year of simulation, the CR/BER ratio is less than 1 for half of the fleet segments included in the case study (five on ten), indicating that income is insufficient to cover operational costs.

In 2021, the Status Quo shows a slight improvement with CR/BER lower than 1 for four fleet segments instead of the original five. The same results is obtained in scenarios 2 and 3, while scenarios 4 and 5 show only three fleet segments with this indicator under 1.

The CR/BER in 2021 for the overall fishing fleet shows an improvement under scenarios 2, 3, 4 and 5 compared with the Status Quo. A slightly better performance for this indicator is expected under scenario 2. Most of the fleet segments shows improvements under the alternative scenarios compared with the Status Quo and the best performance for these fleet segments is registered under scenario 2. Fleets segments performing better under Status Quo than alternative scenarios are the Italian pelagic trawlers VL2440 in GSA 17, the Croatian purse seiners VL2440 and VL1824, and partially the Italian pelagic trawlers VL2440 in GSA 18. The last fleet segment shows a CR/BER lower than that resulting from the Status Quo for Scenarios 2 and 3, and higher for Scenario 4 and 5 (Figure 2.2.8.2.2).

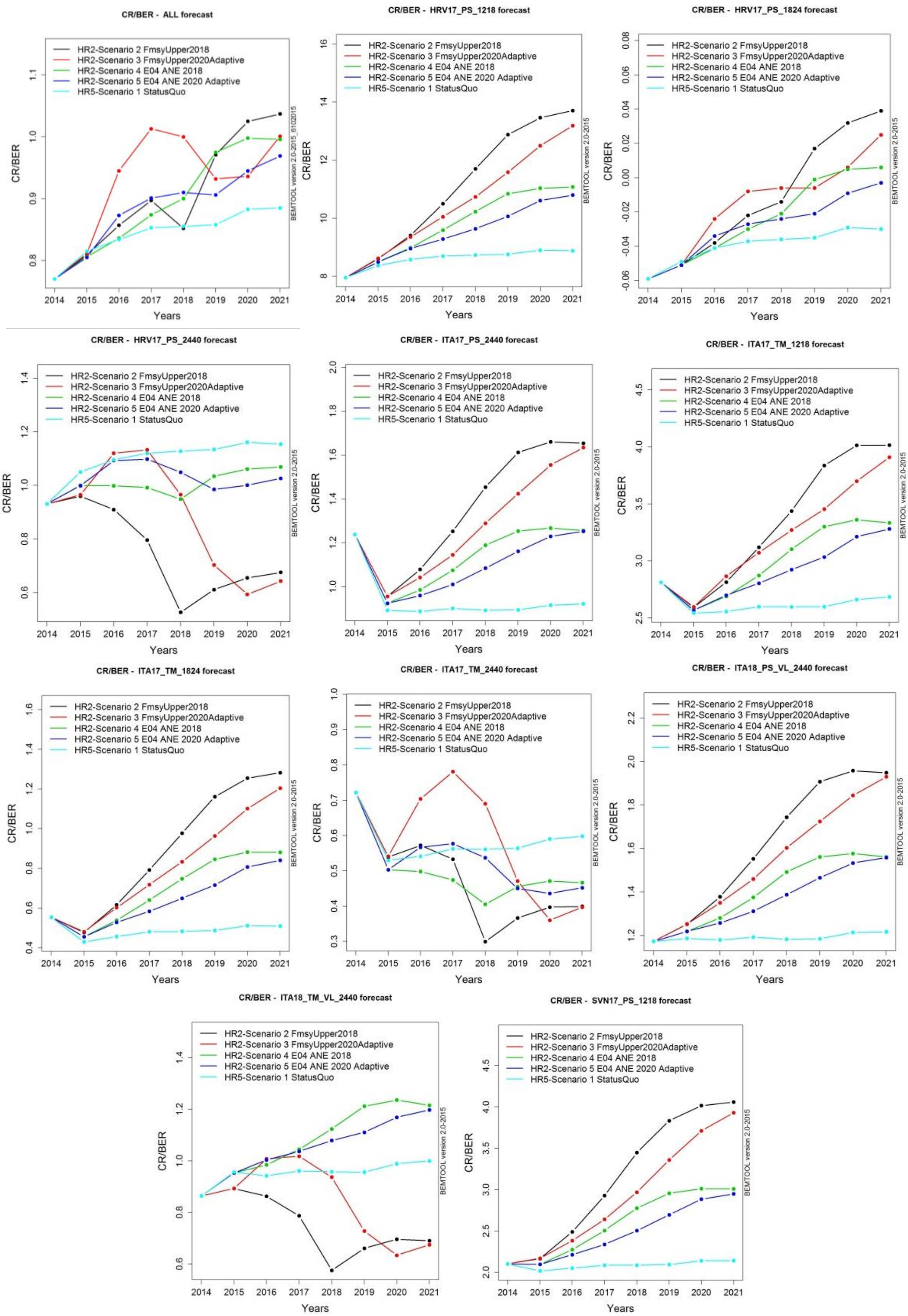


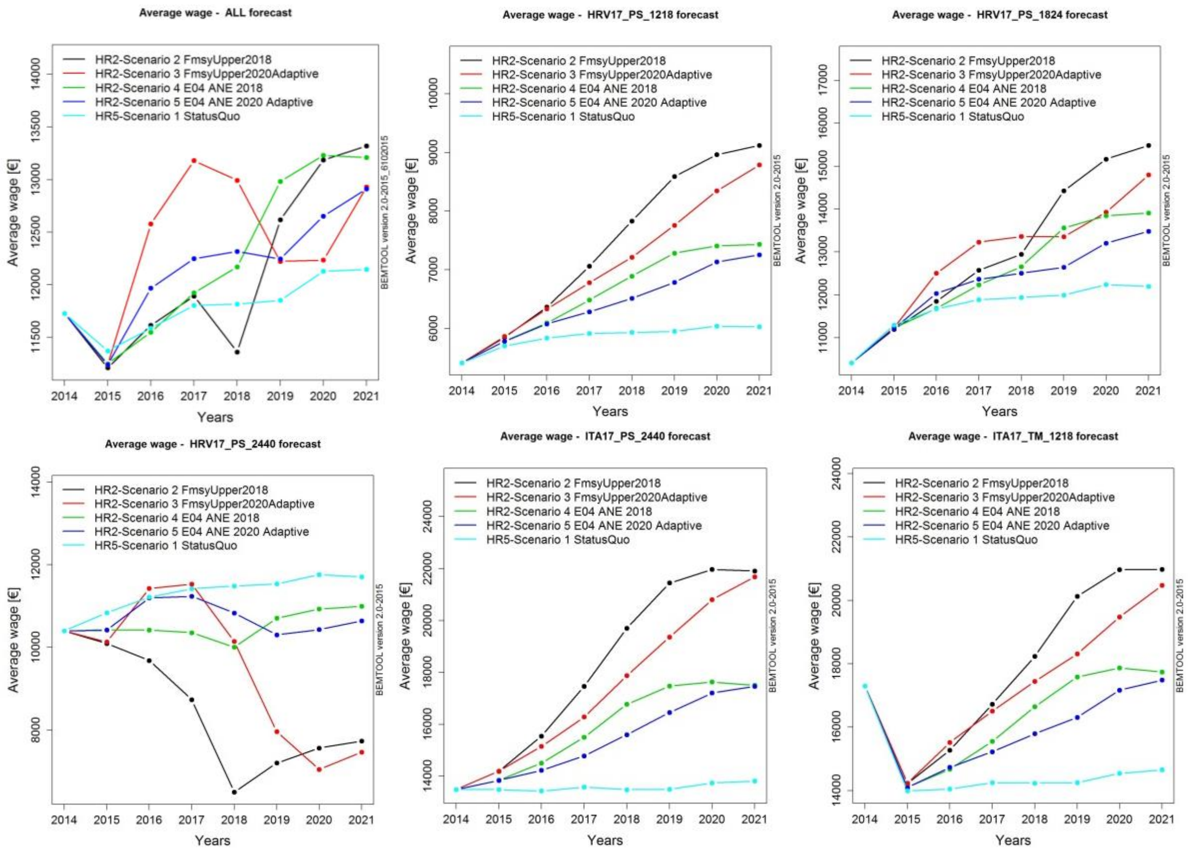
Figure 2.2.8.2.2 Current Revenue to the Break-Even Revenue ratio (CR/BER) by fleet segment and scenario

Figure 2.2.8.2.3 show the effects simulated by the different scenarios on average salary per man employed.

All alternative scenarios are expected to have a better impact on the average salary for the overall fishing fleet rather than the Status Quo scenario. Scenario 2 is the best scenario with an average salary almost 10% higher than that expected from the Status Quo in 2021. Good performance are expected also for Scenario 4, almost 9% higher than the Status Quo, and for the other two scenarios with improvements higher than 6%.

Comparing with Status Quo results in 2021, all fleet segments are expected to benefit from alternative scenarios with exceptions for the Italian pelagic trawlers VL2440 in GSA 17, the Croatian purse seiners VL2440 and partially the Italian pelagic trawlers VL2440 in GSA 18. The last fleet segment shows an average salary lower than that resulting from the Status Quo for Scenarios 2 and 3, and higher for Scenario 4 and 5.

The negative impact of alternative scenarios on Italian pelagic trawlers VL2440 in GSA 17 and Croatian purse seiners VL2440 is particularly relevant from a social point of view. This is due to both the reduction in average salary and the reduction in the number of employed people given the particularly strong reduction in the number of vessels foreseen by the different alternative scenarios for these fleets.



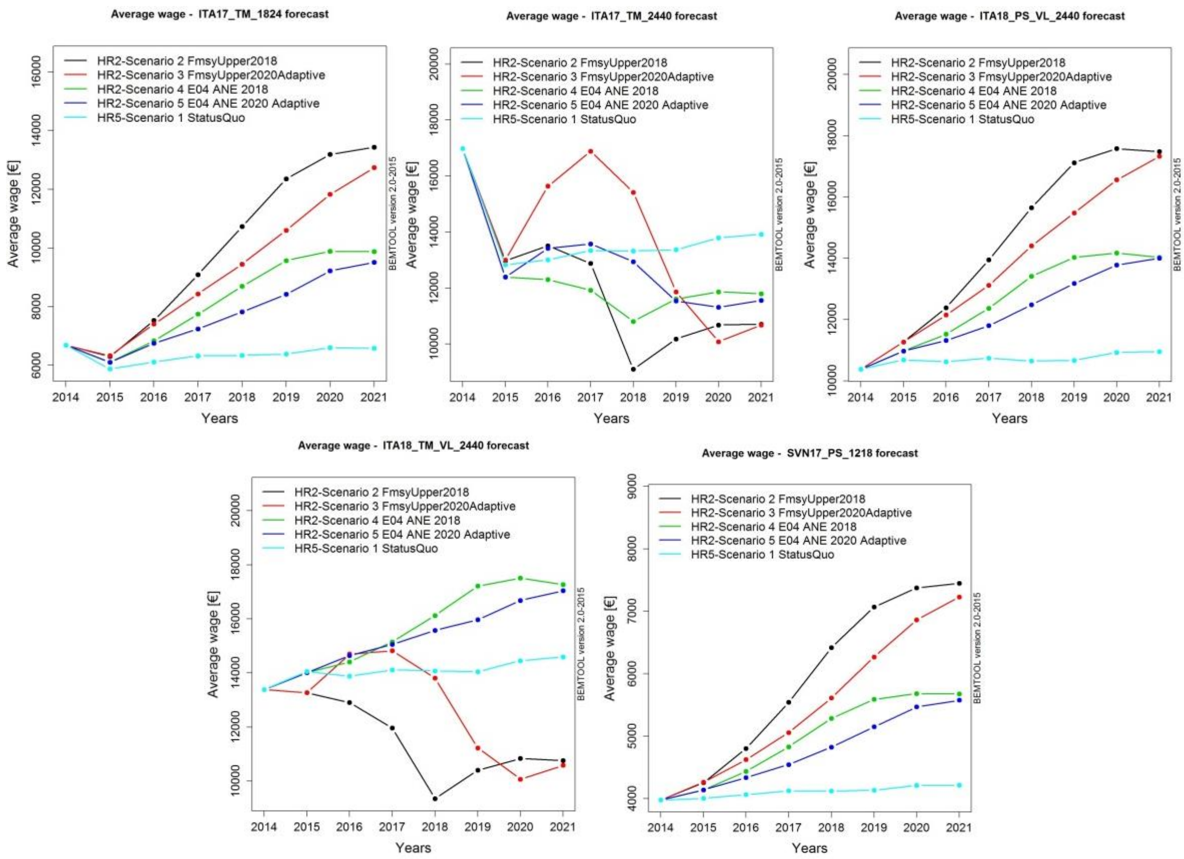


Figure 2.2.8.2.3 Average salary by fleet segment and scenario

2.2.9 MANAGEMENT STRATEGY EVALUATION

Management Strategy Evaluation (MSE) was performed in line with what was presented during the STECF EWG 15-11. For anchovy results were quite consistent: moving to MSY will result in considerable decrease in catches in the short-term though they increase and stabilise over the longer-term and probability of being below Blim over the time of management is 0.

During the Project Workshop held in Bari on September 21-25, 2015 it was also decided to test the effect of a Management Strategy Evaluation based on reaching the F_{MSY} corresponding to an exploitation rate of E=0.4 for anchovy (Figure 2.2.9.1), that is the reference point commonly used in the GFCM for small pelagics. The use of the exploitation rate equal to 0.4 is an empirical approach, whose validity has been widely debated. However, given all the uncertainties related to the stock recruitment relationship, it seemed reasonable to test the use of a different reference point.

An attempt to run an MSE on sardine without using a stock recruitment relationship (only the geometric mean of the last 3 years) and setting F_{MSY} equal to the F_{MSY} estimated for anchovy (F=0.36) was made. However, the attempt did not give plausible results, being the catches oscillating cyclically between really high and really low values. Therefore, for sardine it was decided to project the current recruitment with random variations and the average Fbar of the last 3 years.

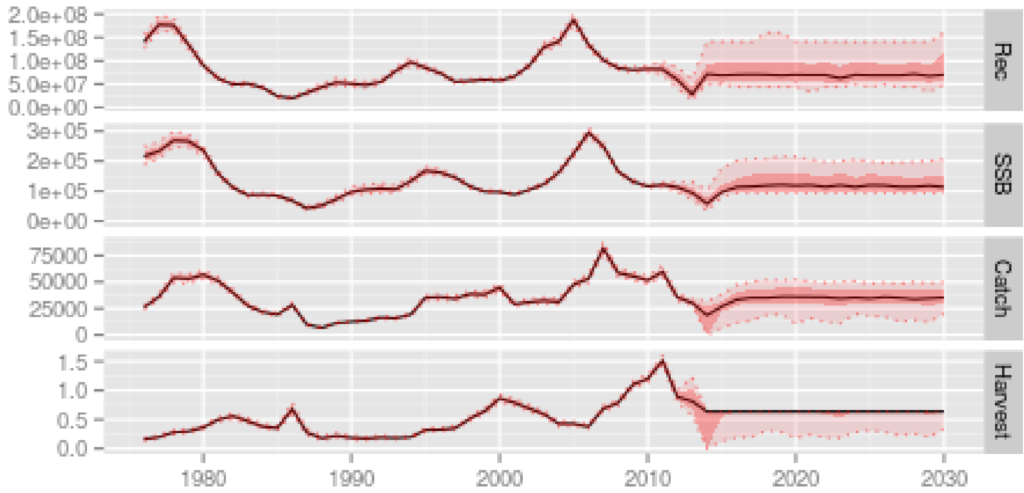


Figure 2.2.9.1 Management Strategy Evaluation based on reaching the F_{MSY} corresponding to an exploitation rate of E=0.4 for anchovy.

2.2.10 REPORT OF THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

According to the traffic light approach reported in table 2.2.10.1 and the radar graphs in figure 2.2.10.1, all the performed management scenarios allow to obtain a benefit on the SSB for the 2 stocks under consideration respect to the status quo.

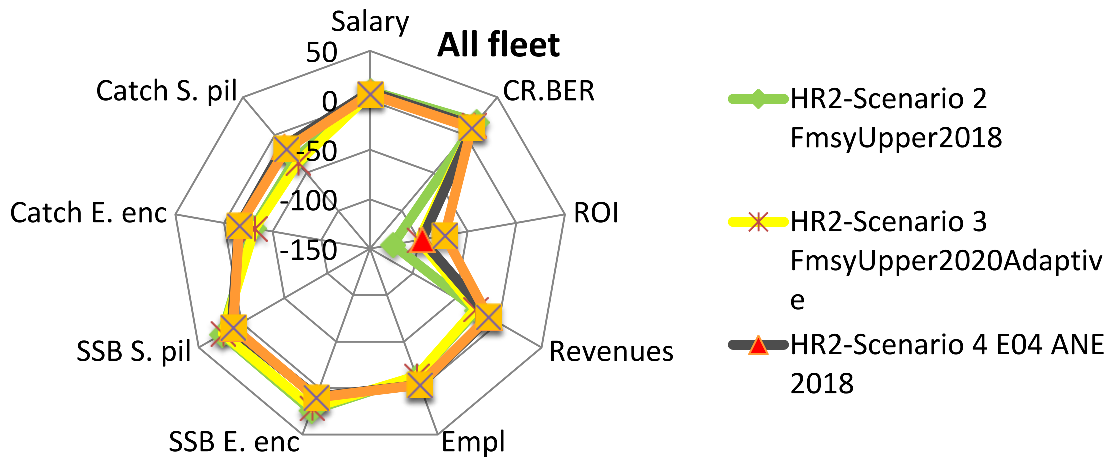
Considering the catches of the whole fleet, both for anchovy and sardine there is a decrease that is more marked for Scenario 2 and 3, as well as in the scenarios 6 and 7, all applying 65% of reduction, though differently partitioned among fleet segments. In particular, under scenarios 2 and 3 the fleet segments HRV17_PS_2440 and ITA17_TM_2440 were subject to a higher reduction as regards the proportion of decrease applied to the number of vessels, that was 20 and 40% respectively (see table A.5.4 in the Annex A to this report).

The better performing scenarios are scenario 4 and 8, that allow to obtain a better trade off among the different indicators, when considered having all the same weight (table 2.2.10.1).

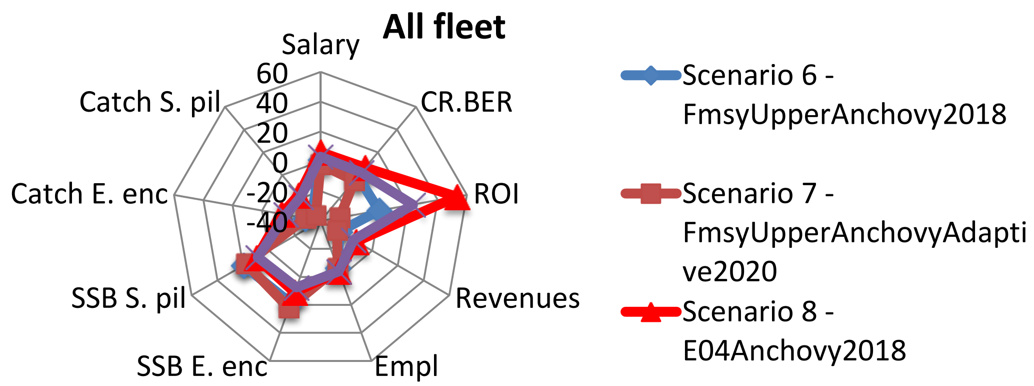
Results show that the fleet segments mostly affected by management measures when considering scenarios from 2 to 5 are: ITA17_TM_2440, HRV17_PS_1824, HRV17_PS_2440 and ITA18_TM_VL_2440 (tables from 2.2.10.2 to 2.2.10.4). This is not surprising, considering that under scenario 2-5 these fleet segments were more reduced (in particular ITA17_TM_2440 and HRV17_PS_2440) , and they have, in addition, a high share of anchovy catch. The other fleet segments show generally an improving situation for all the scenarios. This because they take advantage of the increased productivity of the stocks following the management measures, under the assumption that their impact in terms of fishing effort, and in turn fishing mortality, is kept constant.

Under scenarios from 6 to 9 all the fleet segments are more impacted by the management measures, but productive fleet segments as ITA17_TM_2440, HRV17_PS_2440 and ITA18_TM_VL_2440 are relatively less impacted compared to scenarios 2 and 3.
Compared with the Status Quo, all alternative scenarios show a reduction in the total revenues for the overall fishing fleet. Scenario 2, 3, 6 and 7 (Table 2.2.10.1) are the most impacting on revenues with reductions in 2021 higher than 25% if compared with the Status Quo. Scenario 4 is the less impacting on revenues with a reduction by 10.6% if compared with Status Quo.

The economic performance indicator, the ratio between current and break-even revenues (CR/BER), in 2021 shows an improvement for the overall fishing fleets under all alternative scenarios compared with the Status Quo. The best performance for this indicator is expected under Scenario 2. Also the indicator ROI (Return of Investments) shows an improvement in all the scenarios compared to the status quo, except in scenario 7, in which the change is negative, while in scenario 6 the effect is neutral.
From a social viewpoint, all alternative scenarios are expected to have an impact on the average salary for the overall fishing fleets improving the Status Quo scenario. Scenario 2 is the best scenario with an average salary almost 10% higher than that expected from the Status Quo in 2021. Good performance are expected also for Scenario 4, almost 9% higher than the Status Quo, and for the other two scenarios with improvements higher than 6%. Scenarios from 6 to 9 are relatively less impacting on the employment compared to scenario 2-5.
At the end of the forecast period the reference points were approximated, on average, with a difference of -0.04 for Fupper (i.e. F in 2018 or at 2020 reached the value of about 0.4 compared to the target of 0.36), while for E 0.4 no differences were observed (table 2.2.10.1).



A)



B)

Figure 2.2.10.1 Radar plots for all the fleets; in A) scenarios from 2 to 5 are represented, in B) scenario from 6 to 9.Each line represents a scenario and each point the corresponding percentage of each indicators in respect to status quo.

Table 2.2.10.1 Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and overall catches of anchovy and sardine, salary, CR/BER, ROI, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F or of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline both F and E are reported.

Scenario, year 2021	**ALL fleets**										
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	SSB Anchovy (tons)	SSB Sardine (tons)	F or E (value) (year) Anchovy	F or E (value) (year) Sardine
Status quo (values in 2014 –baseline year)	11727	0.77	-0.066	75489	2011	24969	73423	68298	383710	1.05/0.52	0.54/0.4
Status quo (values in 2021)	12146	0.88	-0.03	78370	12146	24318	85789	68879	358387	1.05/0.52	0.54/0.4
Scenario 2 - FmsyUpper2018	9.7	17.1	126	-25.4	-12.8	-30.1	-32.2	24.0	22.8	0.39	0.2
Scenario 3 - FmsyUpper2020Adaptive	6.4	13.2	100	-27.1	-12.8	-31.3	-36.0	21.2	22.0	0.56 (2018) 0.39	0.29 (2018) 0.2
Scenario 4 - E04 ANE 2018	8.7	12.5	97	-10.6	-3.6	-15.4	-14.7	9.3	11.8	0.4	0.29
Scenario 5 - E04 ANE 2020 Adaptive	6.3	9.5	73	-12.1	-3.6	-15.6	-18.3	10.1	9.8	0.45 (2018) 0.41	0.33 (2018) 0.29
Scenario 6 - FmsyUpperAnchovy2018	0.9	-1.0	0.0	-25.4	-6.4	-29.4	-31.5	18.8	19.8	0.41	0.21
Scenario 7 - FmsyUpperAnchovyAdaptive2020	-2.1	-4.7	-27	-27.2	-6.4	-29.8	-35.2	22.2	17.6	0.66 (2018) 0.41	0.34 (2018) 0.21
Scenario 8 - E04Anchovy2018	6.2	6.6	53	-12.4	-4.0	-13.4	-17.3	10.9	9.8	0.4	0.29
Scenario 9 - E04AnchovyAdaptive2020	3.1	2.6	23	-14.4	-4.0	-16.4	-19.0	7.5	8.8	0.46 (2018) 0.4	0.34 (2018) 0.29

Table 2.2.10.2 Performances of the management scenarios (% of change respect to status quo) simulated in terms of catches of anchovy and sardine, salary, CR/BER, employment and revenues by fleet segment (ITA17_TM_1218, ITA17_TM_1824, ITA17_TM_2440 and ITA17_PS_2440 fleet segments). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021.

Scenario, year 2021	**ITA17_TM_1218**						**ITA17_TM_1824**					
	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)
Status quo (values in 2014 –baseline year)	17296	2.81	6041	124	2029	2281	6690	0.55	5118	153	1654	5162
Status quo (values) 2021	14655	2.68	5856	140	1976	2667	6584	0.51	5002	148.8	1598	6086
Scenario 2	43.1	49.6	20.8	-3.0	27.8	25.2	104.0	151.9	29.5	-3.0	41.7	37.0
Scenario 3	39.7	45.6	18.3	-3.0	25.8	18.3	93.5	136.5	25.0	-3.0	38.7	28.6
Scenario 4	21.0	24.2	9.1	-2.0	11.7	11.7	50.0	73.1	12.2	-2.0	16.7	14.9
Scenario 5	19.3	22.2	7.9	-2.0	11.2	7.0	44.5	65.0	9.8	-2.0	15.5	10.6
Scenario 6	-6.9	-8.0	-25.3	-6.5	-29.1	-31.4	26.9	39.3	-25.7	-6.5	-28.1	-31.7
Scenario 7	-8.8	-10.1	-26.5	-6.5	-29.7	-35.2	20.5	29.9	-28.3	-6.5	-29.3	-36.0
Scenario 8	1.1	1.3	-12.0	-4.0	-13.5	-17.2	24.0	35.0	-12.9	-4.0	-13.0	-17.5
Scenario 9	-1.8	-2.0	-14.1	-4.0	-16.3	-19.0	19.7	28.9	-14.7	-4.0	-15.6	-19.5
Scenario, year 2021	**ITA17_TM_2440**						**ITA17_PS_2440**					
	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)
Status quo (values in 2014 –baseline year)	16981	0.72	17417	264	7116	8743	13484	1.24	5160	142	788	35
Status quo (values) 2021	13919	0.60	16220382	276	6927	10229	10955	1.22	2517314	81	1323	59
Scenario 2	-23.1	-33.3	-71.8	-40.0	-77.4	-77.9	59.6	60.1	33.1	-2.0	60.2	60.7
Scenario 3	-23.3	-33.6	-71.9	-40.0	-77.7	-79.1	58.2	58.7	32.1	-2.0	58.2	51.8
Scenario 4	-15.3	-22.1	-43.6	-7.0	-50.1	-50.2	28.1	28.3	15.1	-1.0	25.4	26.1
Scenario 5	-16.9	-24.4	-44.3	-7.0	-50.4	-52.3	27.8	28.1	14.9	-1.0	25.1	21.2

Scenario 6	22.6	32.4	-25.3	-6.5	-28.9	-31.4	-13.4	-18.1	-26.3	-6.5	-30.9	-31.5
Scenario 7	19.2	27.6	-26.8	-6.5	-29.5	-35.2	-13.6	-18.3	-26.4	-6.5	-31.0	-35.0
Scenario 8	21.9	31.4	-12.3	-4.0	-13.5	-17.2	-2.4	-3.3	-11.9	-4.0	-14.2	-17.4
Scenario 9	17.6	25.3	-14.2	-4.0	-16.2	-19.0	-5.8	-7.8	-14.5	-4.0	-17.6	-18.8

Table 2.2.10.3 Performances of the management scenarios (% of change respect to status quo) simulated in terms of catches of anchovy and sardine, salary, CR/BER, employment and revenues by fleet segment (HRV17_PS_1218, HRV17_PS_1824, HRV17_PS_2440 and SVN_PS_1218). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021.

Scenario, year 2021	**HRV17_PS_1218**						**HRV17_PS_1824**					
	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)
Status quo (values in 2014 –baseline year)	5408	7.95	3279	47	835	5131	10410	-0.06	9248	497	2937	16346
Status quo (values) 2021	6026	8.88	3629	45	813	5986	12198	-0.03	10307	486	2859	19071
Scenario 2	51.3	54.4	45.7	-1.0	62.9	60.8	26.9	230	0.2	-5.0	1.3	0.0
Scenario 3	45.8	48.6	40.6	-1.0	60.5	51.5	21.3	183	-3.5	-5.0	-0.3	-5.8
Scenario 4	23.3	24.7	20.1	-1.0	26.0	26.1	14.0	120	-1.3	-3.0	-1.8	-1.6
Scenario 5	20.4	21.6	17.4	-1.0	25.9	21.1	10.5	90	-3.7	-3.0	-1.9	-5.6
Scenario 6	-18.4	-19.4	-26.1	-6.5	-29.7	-31.6	-4.4	-40.0	-26.2	-6.5	-29.7	-31.6
Scenario 7	-21.0	-22.3	-28.5	-6.5	-30.2	-35.2	-8.1	-70.0	-28.5	-6.5	-30.2	-35.2
Scenario 8	-7.7	-8.2	-13.2	-4.0	-13.5	-17.3	2.0	16.7	-13.3	-4.0	-13.5	-17.3
Scenario 9	-9.7	-10.2	-14.9	-4.0	-16.7	-18.9	-0.5	-6.7	-15.0	-4.0	-16.7	-18.9
Scenario, year 2021	**HRV17_PS_2440**						**SVN17_PS_1218**					
	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)
Status quo (values in 2014 –baseline year)	19398	0.93	17905	505	4852	34887	3976	2.10	198	16	20	27

Status quo (values) 2021	11708	1.15	20159	536	4725	40703	4216	2.14	206	16	20	32
Scenario 2	-34.0	-41.5	-56.2	-20.0	-62.6	-63.1	76.7	89.4	62.8	0.0	87.4	85.3
Scenario 3	-36.2	-44.3	-57.6	-20.0	-63.2	-65.2	71.5	83.4	58.6	0.0	84.5	74.6
Scenario 4	-6.1	-7.4	-20.2	-5.0	-24.6	-24.5	34.6	40.4	28.4	0.0	36.8	37.6
Scenario 5	-9.1	-11.1	-22.3	-5.0	-24.7	-27.5	32.3	37.6	26.4	0.0	36.7	32.0
Scenario 6	-6.8	-8.3	-26.2	-6.5	-29.7	-31.5	70.9	82.7	58.1	0.0	81.5	77.2
Scenario 7	-10.6	-12.9	-28.8	-6.5	-30.1	-35.2	67.0	78.1	54.8	0.0	80.4	67.8
Scenario 8	0.2	0.3	-13.4	-4.0	-13.6	-17.2	35.3	41.2	28.9	0.0	40.8	34.9
Scenario 9	-2.2	-2.6	-15.1	-4.0	-16.7	-18.9	31.8	37.1	26.0	0.0	35.7	32.0

Table 2.2.10.4 Performances of the management scenarios (% of change respect to status quo) simulated in terms of catches of anchovy and sardine, salary, CR/BER, employment and revenues by fleet segment (ITA18_TM_2440 and ITA18_PS_2440). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021.

Scenario, year 2021	ITA18_TM_VL_2440						ITA18_PS_VL_2440					
	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)	Salary (euros)	CR.BER (ratio)	Rev. (Keuros)	Emp. (units)	Catch Anchovy (tons)	Catch Sardine (tons)
Status quo (values in 2014 –baseline year)	13388	0.86	8673	181	3378	761	10379	1.17	2449	82	1361	51
Status quo (values) 2021	14595	1.00	9319	189	3265	895	10955	1.22	2517	81	1323	59
Scenario 2	-26.2	-31.0	-48.8	-5.0	-54.9	-56.4	59.6	60.1	33.1	-2.0	43.6	43.0
Scenario 3	-27.5	-32.5	-49.5	-5.0	-55.9	-59.1	58.2	58.7	32.1	-2.0	42.1	35.0
Scenario 4	18.3	21.6	-4.0	-3.0	-4.6	-6.0	28.1	28.3	15.1	-1.0	19.4	19.4
Scenario 5	16.8	19.8	-4.9	-3.0	-5.6	-9.6	27.8	28.1	14.9	-1.0	19.1	15.0
Scenario 6	8.3	9.8	-24.2	-6.5	-28.1	-31.7	-4.8	-4.8	-25.8	-6.5	-30.4	-31.6
Scenario 7	6.3	7.4	-25.3	-6.5	-29.2	-35.9	-4.8	-4.8	-25.8	-6.5	-30.4	-34.9
Scenario 8	12.4	14.7	-11.0	-4.0	-12.9	-17.4	4.1	4.2	-11.4	-4.0	-13.7	-17.4
Scenario 9	8.7	10.3	-13.2	-4.0	-15.6	-19.4	-0.2	-0.2	-14.3	-4.0	-17.4	-18.8

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process (AHP) (Rossetto et al., 2015), has been used to assess the performances of the alternative fisheries management policies.

The eight indicators used in the analysis are listed in table 2.2.10.5, along with the weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the 'current condition'. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021. In the case study of small pelagics discard was assumed to be negligible; that was positively weighed in the MCDA, with the same weight in all the scenarios.

Table 2.2.10.5 Summary of the indicators used in the MCDA

Top level hierarchy	**Low level hierarchy**	**Indicator***	**Weight**
Socioeconomic	Economic	GVA, ROI or Profit	0.0080
Socioeconomic	Economic	CR.BER	0.0421
Socioeconomic	Social	EMP.	0.1914
Socioeconomic	Social	WAGE (Salary)	0.0641
Biological	Biological conservation	SSB	0.2605
Biological	Biological conservation	F	0.2605
Biological	Biological production	Y (Landing**)	0.1373
Biological	Biological production	D	0.0361

* GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; WAGE: Average wage; EMPL: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y=Landing; D: Discard rate; **Landing=catches as discard was considered negligible.

According to MCDA (Figure 2.2.10.2), the scenarios that allows to reach the highest overall utility are scenarios 4 and 5 with utility respectively equal to 0.753 and 0.749, while the lowest utility is given by Scenario 1, the status quo (0.548). This result is in agreement with the traffic light table, which simply compares percentage of change to the status quo. Scenarios 4 and 5 were considered to perform better than scenarios 2 and 3, which had almost an equivalent utility, because of the factors linked to production and employment. This despite in the MCDA the biological component weight relatively more than the economic and social ones. Scenarios 6 and scenario 7 performed a bit better than scenario 2 and scenario 3; while scenarios 8 and 9 were equivalent to scenarios 4 and 5.

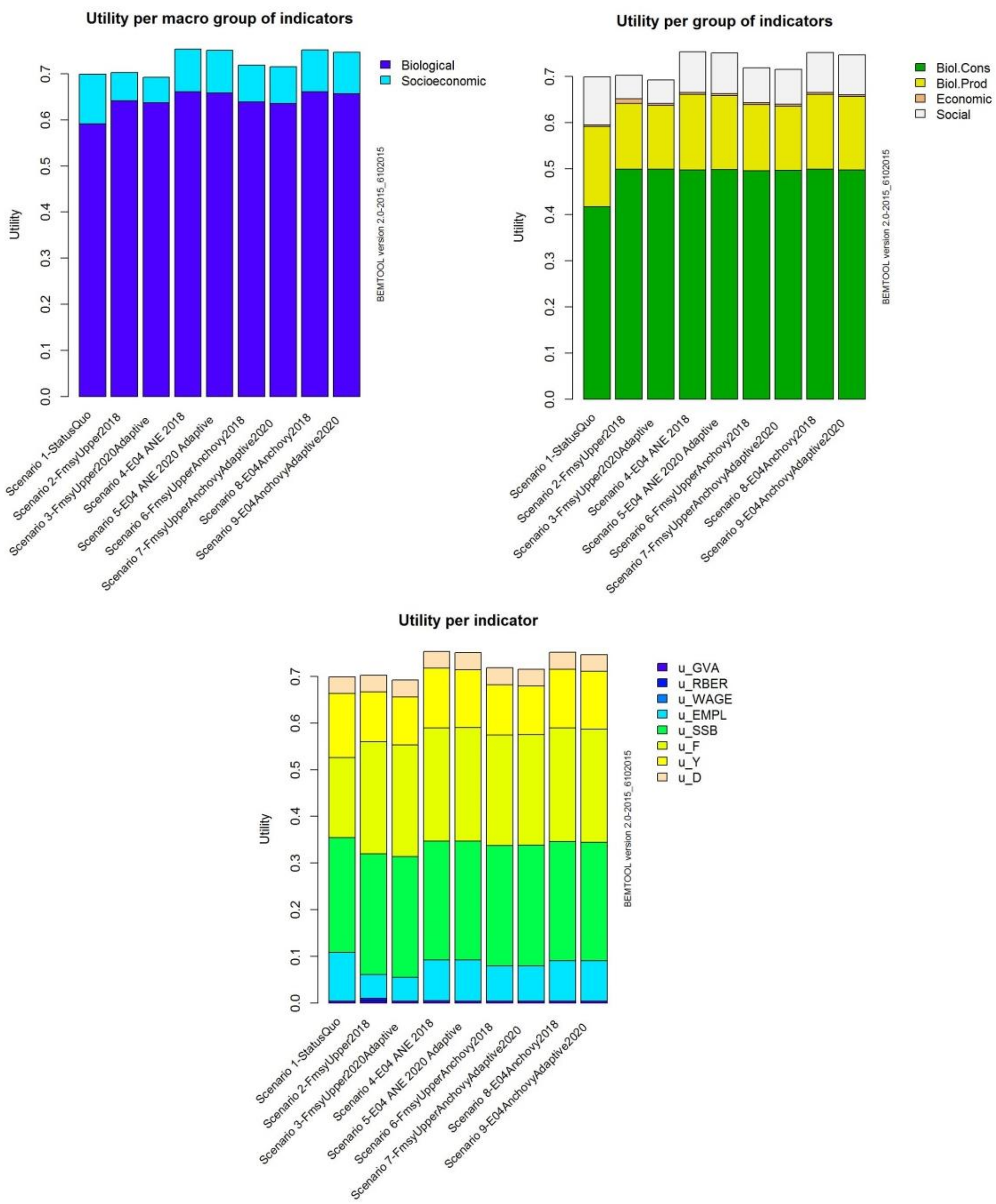


Figure 2.2.10.2 MCDA results: evaluation of the overall utility associated to each management scenario.

2.2.11 DISCUSSION AND CONCLUSION ON SMALL PELAGIC CASE STUDY IN GSA 17 AND GSA18

According to the traffic light approach, all the performed scenarios allow to obtain a benefit on the SSB of the 2 stocks under consideration in respect to the status quo. The best performance for anchovy and sardine SSB is showed by Scenario 2 (respectively 23 % and 24 % higher than Scenario 1), whilst the worse result is observed in the status quo. These results seem consistent with the higher reduction under scenario 2 and a greater benefit that generally the reduction in fishing mortality produces on this indicators if applied in a short time range.

Adaptive scenarios (Scenario 3 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 4), but also a reduced decrease in landing of the overall catch of both stocks in the short term. Similar results are obtained by the scenarios 8 and 9.

Considering all fleets, under scenarios 4-5 as well as 8-9, the catches are decreasing in the short term, with a fairly low percentage (around 15%) and revenues are decreasing with a lower percentage (10%), while the economic performance is improving if salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping (about 10%) and the impact is less for scenarios 8-9.

Considering the catches of the whole fleet, both for anchovy and sardine there is a decrease that is more marked for Scenario 2 and 3, that apply the 65% of reduction, as well as for scenarios 6 and 7. Scenario 2 and 3, as well as 6 and 7, are also the most impacting on revenues with reductions in 2021 higher than 25% if compared with the Scenario 1. Nevertheless, Scenario 2 has the best performance for the ratio between current and break-even revenues (CR/BER) as well as in terms of average salary (10% higher than that expected from the status quo in 2021).

On an overall basis, scenarios 4 and 5 as well as 8 and 9, are those performing better, because allow to obtain a quite stable trade off among the different indicators.

For both stocks the catches by fleet segment change both according to the percentage of reduction applied and to the impact of the fleet segment on anchovy stock:

- under the pathway A, some fleet segments (ITA17_TM_1218, ITA17_TM_1824, ITA17_PS_2440, HRV17_PS_1218, ITA18_PS_VL_2440 and SVN17_PS_1218) benefit of the higher reduction applied to the other fleet segments: higher is the reduction applied (Scenarios 2 and 3) more is their benefit, while in the status quo situation no significant improvement in catches is observed;
- some fleet segments (ITA17_TM_2440, HRV17_PS_1824, HRV17_PS_2440 and ITA18_TM_VL_2440) see their catches and revenues quite stable in the status quo scenario, while these decrease considerably for Scenarios 2 and 3, that apply a stronger reduction. In particular, under scenarios 2 and 3 the fleet segments HRV17_PS_2440 and ITA17_TM_2440 were subject to a higher reduction as regards the proportion of decrease applied to the number of vessels, that was 20 and 40% respectively (see table A.5.4 in the Annex A to this report).
- under pathway B the all the fleet segments are more impacted by the management measures, but productive fleet segments as ITA17_TM_2440, HRV17_PS_2440 and ITA18_TM_VL_2440 are relatively less impacted (scenarios from 6 to 9).

As regards anchovy and sardine catches, the best scenario is the scenario 2 for all fleet segments, except for ITA17_TM_2440 (-78%), HRV17_PS_1824, HRV17_PS_2440 (-63%) and ITA18_TM_VL_2440 (-56%), that are the fleet segments more penalized by the management strategies (being the more impacting on anchovy stock).

This seems quite consistent with the way the management measures have been implemented, because Scenario 2 applies a reduction of 65% proportionally to the impact of the fleet segments on anchovy stock, but penalising more those with a higher share of fishing mortality. Under scenarios 6-9 the situation among the fleets is more compensated.

In 2018, (excluding status quo) forecast scenarios produce a reduction in total landings weight of the whole fleet of the GSA, ranging from 13% (Scenario 5) to 42% (Scenario 2) compared to the status quo. In 2021, the foreseen reduction in total landing of the whole fleet ranges from 17% (Scenario 5) to 36% (Scenario 3).

In 2018, (excluding status quo) forecast scenarios produce a reduction in total landings value of the whole GSAs fleet ranging from 9% (Scenario 5) to 33% (Scenario 2) compared to the status quo. In 2021, the foreseen reduction in total landing of the whole fleet ranges from 12% (Scenario 5) to the 27% (Scenario 3).

Scenario 2 and 3 are the ones with the highest decrease in catches for the more impacting fleet segments (ITA17_TM_2440 , HRV17_PS_1824 , HRV17_PS_2440 and ITA18_TM_VL_2440), but are also the scenarios characterized by the highest improvement in the SSB and in the catches of the other fleet segments. A similar performance also show the scenarios 6 and 7, that are however less impacting on the above mentioned fleet segments.

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the scenarios allowing to reach the highest overall utility are scenarios 4 and 5 (overall utility 0.753 and 0.749 respectively), that share a comparable level of utility with scenarios 8 and 9, while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.548). This result is comparable with that obtained by the traffic light approach. Scenarios 4 and 5 were considered to perform better than scenarios 2 and 3, because of the factors linked to production and employment. This despite in the MCDA the biological component weight relatively more than the economic and social ones.

The methodology and the scenarios tested cover a wide range of different options and provide a general and complete overview of the situation of small pelagics in the Adriatic Sea. The results are consistent with the advice that has been provided so far in different fora and gives a more robust evaluation of the efficiency of each of the measures proposed. There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment in small pelagic species. These species are in fact strongly influenced from environmental variables and the recruitment can show dramatic variability from one year to the next. However, the measure proposed from BEMTOOL are conservative enough to be efficient if against recruitment failures. In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.
The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability. However, even in presence of severe reductions, the effort limitations applied might be not completely enough to reach the F_{MSY} objectives, given that the effort used for setting the management measures is not, in most of the cases, a specific effort directed to the target species (for the multispecific nature of the Mediterranean fishery).

The projections performed with BEMTOOL model showed that all the performed scenarios allow to obtain a benefit on the SSB for the 2 stocks under consideration respect to the status quo; on an overall basis, the best performing scenarios are the ones characterized by the strongest reduction in the shortest timeframe.

Moreover, the Management Strategy Evaluation (MSE) showed that moving to MSY will result in considerable decrease in catches in the short-term though they will increase and stabilise over the longer-term and that the probability of being below Blim is initially high but decreases over the time of management.

On the basis of the estimated limit management reference point for sustainable exploitation (F_{upper}=0.36 both for anchovy and sardine and E0.4 of anchovy), catches in 2016 should be according to the following table 2.2.11.1. In this case the reduction to reach the reference point is fully applied in 2016 and the values of the catches can be considered the maximum that can be taken to fulfil the objective of the reference point.

The catch advice is reported for scenarios 2 and 4 as for the other scenarios, using Fmsy upper as reference point, the same catch advice as for scenario 2 should apply and for the other scenarios, using E0.4 as reference point, the same advice as for scenario 4 should apply.

Table 2.2.11.1 Catch advice.

		Catch advice (tons)	
Scenario	**Year**	**Anchovy**	**Sardine**
Scenario 2 FmsyUpper2018	2016	18301	60488
Scenario 4 E04 ANE 2018	2016	20851	70923

ANNEX A - INPUTS FOR MODELLING SMALL PELAGIC FISHERY IN GSA17 AND GSA18

A.1 INPUT OF THE BIOLOGICAL MODULE OF SMALL PELAGIC FISHERIES IN GSA17 AND GSA18

The data used for the parameterization of the biological and the pressure modules come from the stock assessment revised during the STECF EWG 15-11 held in September 2015 provided by JRC for the purposes of this project.

The methodologies used is the State-Space Model (SAM, Nielsen A. and Sibert J. R., 2007) for both stocks, tuned with fishery independent information from acoustic surveys. The assessment covers the GSAs 17 and 18, combining data from Italy, Croatia and Slovenia.

For anchovy, split year assumption has been used, therefore assuming the birth date at the first of June (Cingolani *et al.,* 1993) and, respect to the assessment presented suring the GFCM small pelagic stock assessment working group (held in November 2014), the SSB has been re-estimated, after correcting the settings related to maturity (M and F before spawning and the maturity at age 0).

For sardine the calendar year has been used, assuming the birth day at the first of January and, respect to the assessment presented during the GFCM small pelagic stock assessment working group (held in November 2014), the SSB has been calculated at the beginning of the year (spawning season), correcting the settings related to maturity (M and F before spawning set equal to 0).

GROWTH PARAMETERS OF SMALL PELAGICS IN GSA17 AND GSA18

The growth parameters (Sinovcic, 2000) and the length-weight relationship coefficients for the two species are listed in the TableA.1.1. The growth functions are for sex combined.

The life span has been set equal to 5 years (from age 0 to age 4) for anchovy, and to 7 years (from age 0 to 6) for sardine.

Table A.1.1 **-** Growth parameters for anchovy and sardine in GSA 17 and GSA18.

Parameter	Sex combined anchovy	Sex combined sardine
Linf (cm)	19.4	20.5
K	0.57	0.46
t_0	-0.5	-0.5
a (mm/g)	4.00E-06	0.000005
b (mm/g)	3	3.03

RECRUITMENT OF SMALL PELAGICS IN GSA17 AND GSA18

Recruitment vectors (Table A.1.2) have been used for simulations, whilst a constant value for projections. The recruitment used in BEMTOOL is the one estimated during the STECF EWG 15-11.

For sardine the recruitment figures from the STECF EWG 15-11 stock assessment were related to age 1, being age 0 poorly represented in commercial catches. In order to have an estimate of the recruitment at age 0.5, the recruitment related to age 1 from SAM has been projected backward for a half year, assuming a total mortality of 3 (consistent with the value of natural mortality at age 0.5) and assuming that a small part of the fishing mortality impact also individuals at age 0, being present in the catches though in small part. Input recruitment is reported in the **Error! Reference source not found.**

Table A.1.2 - Recruitment by year used in simulation phase for anchovy and sardine in GSA 17 and GSA18.

Year	R (thousands)	R (thousands) sardine
2008	86 012 225	27 646 231
2009	83 136 966	31 295 975
2010	76 286 001	43 925 254
2011	75 000 100	35 819 393
2012	60 976 555	45 127 391
2013	57 771 146	56 911 047
2014*	57 771 146	56 911 047

*The value of 2013 has been used for projections..

The number of recruits entering in the population has been split by month in order to take into account the seasonal recruitment, according to the characteristics of anchovy, that recruits more from May to September, and sardine that recruits more from December to April (Table). The age of recruitment has been set at 1 month for anchovy and at 6 months for sardine, coherently with the age class used in the assessment.

The proportion of recruits entering each year by month in the population for both species in GSA 17 and GSA18 is reported in the table A.1.3

Table A.1.3 Proportion of recruits entering each year in the population for sardine in GSA 17 and 18.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anchovy	0	0.025	0.05	0.1	0.15	0.15	0.15	0.15	0.15	0.05	0.025	0
Sardine	0.2	0.2	0.2	0.1	0.05	0.025	0	0	0.025	0.05	0.05	0.1

MATURITY AND SEX RATIO OF SMALL PELAGICS IN GSA17 AND GSA18

The size at first maturity used for anchovy is 8.14 cm TL with a maturity range of 6 mm TL (Rampa *et al.*, 2005); the size at first maturity used for sardine is 7.9 cm TL with a maturity range of 6 mm TL (Sinovcic *et al.*, 2008).

NATURAL MORTALITY OF SMALL PELAGICS IN GSA 17 AND GSA18

According to the assessment, the natural mortality at age was estimated using the Gislason's methodology (Gislason *et al.,* 2010) with no distinctions between sexes. The vectors by age of the two species are reported in the Table A1.4.

Table A.1.4 Natural mortality for anchovy and sardine in GSA 17 and GSA18.

Age	M anchovy	M sardine
0	2.36	2.51
1	1.10	1.1
2	0.81	0.76
3	0.69	0.62
4+	0.64	0.56
5	-	0.52
6+		0.5

A.2 INPUT OF THE PRESSURE MODULE OF SMALL PELAGIC FISHERIES IN GSA 17 AND GSA18

FISHING MORTALITY OF SMALL PELAGICS IN GSA 17 AND GSA18

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The F-mode of ALADYM (Lembo et al., 2009) model has been used in BEMTOOL for both stocks. The overall fishing mortality by year and age from SAM model (STECF EWG 15-11) for anchovy and sardine have been split among the fleet segments according to the respective proportions in weight in the landings, thus assuming that all the fleets have the same exploitation pattern. For 2014 the same fishing mortality of 2013 has been assumed. The age range used for anchovy in the output calculation of average F was 1-2, while for sardine was 1-3, with no distinction between sexes, in agreement with the assessments. Fishing mortality by age and year is reported in the Table A.2.1 for anchovy and in Table A.2.2 for sardine

Table A.2.1 Overall fishing mortality for anchovy (SAM model).

age	2008	2009	2010	2011	2012	2013
0	0.02	0.01	0.02	0.03	0.03	0.02
1	0.28	0.41	0.55	0.49	0.50	0.37
2	1.29	1.77	1.89	2.34	1.59	1.71
3	2.12	2.11	2.45	2.98	1.82	2.13
4	2.12	2.11	2.45	2.98	1.82	2.13

Table A.2.2 Overall fishing mortality for sardine (SAM model).

Age	2008	2009	2010	2011	2012	2013
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.04	0.04	0.05	0.09	0.11	0.13
3	0.27	0.30	0.37	0.63	0.82	0.77
4	0.63	1.27	1.22	1.45	1.68	0.70
5	0.90	0.93	0.95	0.96	0.99	0.97
6+	4.27	4.27	4.30	4.32	4.29	4.28

EFFORT OF SMALL PELAGIC FISHERIES IN GSA 17 AND GSA18

The monthly effort variables used to simulate the past and current years by fleet segment are listed in Table A.2.3. For 2014 the same effort as 2013 has been assumed.

Table A.2.3 Effort for the selected fleet segment in GSA 17 and 18.

Effort Variable	ITA17_TM_VL_1218						ITA17_TM_VL_1824					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	23	24	22	29	23	28	67	81	73	71	72	81
average monthly KW	147	152	152	171	171	187	318	321	331	343	358	411
number of vessels	32	33	38	25	47	35	25	25	25	22	21	25
annual fishing days	69	184	154	123	111	123	116	156	167	138	170	139
Effort Variable	**ITA17_TM_VL_2440**						**ITA17_PS_VL_2440**					
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**

average monthly GT	117	117	117	115	109	109	105	114	120	114	102	101
average monthly KW	478	475	480	467	438	439	373	379	395	377	371	380
number of vessels	45	44	41	41	54	46	21	16	10	15	15	14
annual fishing days	158	169	167	142	150	167	105	111	150	93	108	77
Effort Variable	**HRV_PS_VL1218**						**HRV_PS_VL1824**					
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	6	6	6	6	6	7	75	75	73	75	77	79
average monthly KW	51	51	51	51	83	89	319	319	317	283	332	340
number of vessels	43	43	43	42	45	45	59	59	61	61	57	54
annual fishing days	76	76	76	88	76	76	110	110	120	98	98	98
Effort Variable	**HRV_PS_VL2440**						**SVN_PS_VL1218**					
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	155	155	151	133	136	149	10	10	12	12	12	10
average monthly KW	557	557	542	383	489	536	105	96	118	118	118	105
number of vessels	67	67	72	69	68	67	4	5	4	4	4	4
annual fishing days	110	110	132	110	110	110	96	108	120	108	72	84
Effort Variable	**ITA18_TM_VL_2440**						**ITA18_PS_VL_2440**					
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	84	84	84	82	82	83	102	102	102	109	117	117
average monthly KW	432	432	432	416	430	432	455	455	455	476	494	494
number of vessels	34	34	34	31	27	27	5	5	5	4	5	5
annual fishing days	142	137	145	152	133	112	129	123	109	138	115	132

LANDINGS AND DISCARDS OF SMALL PELAGIC FISHERIES IN GSA 17 AND 18

Landing data 2008-2013 for Italy and Slovenia were obtained from the National Programs of the EU Data Collection Framework and are in line with data collected in the WP2 - Collation and review on the main socio-economic information on the main fisheries of the SEDAF project. Croatian socio- economic data were obtained from the data collected and reviewed by the SEDAF project (SEDAF-D6 Report economic and structural overview).

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The landing data for anchovy by fleet segment used to parameterize the model are listed in the table A.2.4. For 2014 the same landing as 2013 has been assumed.

Table A.2.4 Landing for anchovy by fleet segment in GSA 17 and 18 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	1753	8336	9508	4240	4498	2196
ITA17_TM_VL_1824	5794	6317	7498	4334	2880	1813
ITA17_TM_VL_2440	13373	11323	10168	7976	10368	7737
ITA17_PS_VL_2440	4655	3515	2705	2564	3214	789
HRV_PS_VL_1218	1083	1145	1139	1061	564	883
HRV_PS_VL_1824	3711	3711	3285	4722	2866	3105
HRV_PS_VL_2440	6224	6224	6170	7921	4652	5134
SVN_PS_VL_1218	100	99	51	76	43	21

ITA18_TM_VL_2440	6870	6958	6736	7600	5180	3714
ITA18_PS_VL_2440	2623	1768	1845	1881	1438	1388
Total	46188	49396	49104	42375	35703	26781

According to DCF data and the recent results of MAREA LANDMED project, the discard has been considered as negligible both for pelagic trawlers and for purse seine.

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The landing data for sardine by fleet segment used to parameterize the model are listed in the Table A.2.5. For 2014 the same landing as 2013 has been assumed.

Table A.2.5 Landing for sardine by fleet segment in GSA 17 and 18 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	189	137	312	393	1515	2151
ITA17_TM_VL_1824	557	1027	2248	2518	5138	4909
ITA17_TM_VL_2440	3393	2549	3786	3733	7170	8261
ITA17_PS_VL_2440	137	109	119	69	156	32
HRV_PS_VL_1218	2240	3042	2821	4839	3931	4780
HRV_PS_VL_1824	10676	10676	9449	13584	13069	15233
HRV_PS_VL_2440	18685	18685	18522	23779	24226	32531
SVN_PS_VL_1218	67	87	92	60	16	26
ITA18_TM_VL_2440	1395	638	1428	701	782	722
ITA18_PS_VL_2440	70	69	59	58	32	47
Total	37409	37021	38835	49734	56035	68693

According to DCF data and the recent results of MAREA LANDMED project, the discard has been be considered as negligible both for pelagic trawlers and for purse seine.

Total landing

The total landing data by fleet segment used to parameterize the model are listed in the table A.2.6. For 2014 the same landing as 2013 has been assumed.

Table A.2.6 Total landing by fleet segment in GSA 17 and 18 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	2519	8817	10746	5675	7625	5262
ITA17_TM_VL_1824	6794	7719	10470	7262	9341	6469
ITA17_TM_VL_2440	17516	14371	14713	12392	18939	17454
ITA17_PS_VL_2440	4973	3710	2840	2695	3583	955
HRV_PS_VL_1218	6240	6240	6240	6240	5030	6034
HRV_PS_VL_1824	15421	15421	13649	19621	17261	19678
HRV_PS_VL_2440	26086	26086	25857	33196	30418	40754
SVN_PS_VL_1218	198	235	161	185	107	69
ITA18_TM_VL_2440	8405	7721	8464	8888	6230	4567
ITA18_PS_VL_2440	2937	1971	2006	2015	1615	1498

Total	91089	92292	95146	98170	100149	102739

A.3 INPUT OF THE ECONOMIC MODULE SMALL PELAGIC FISHERIES IN GSA 17 AND 18

Data 2008-2013 for the estimation of the socio-economic parameters for Italy and Slovenia were obtained from the National Programs of the EU Data Collection Framework and are in line with data collected in the WP2 - Collation and review on the main socio-economic information on the main fisheries. Taking into account that official Croatian socio- economic data are under revision for the purpose of this study scientist presumed data needed for this exercise. Croatian socio- economic data were obtained from the data collected and reviewed by the SEDAF project. For all fleet segments, 2014 data were assumed equal to 2013.

The economic data of the selected fleet segments used to parameterize the economic function in the projections have been reported in the following paragraphs.

REVENUES OF SMALL PELAGIC FISHERY IN GSA17 AND GSA18

The revenues by fleet segment for anchovy, sardine and the total revenues are reported in the tables A.3.1, A.3.2, A.3.3, According to the revenues and the landings by fleet segment the prices in the projections have been modelled.

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Table A.3.1 Revenues (€) of anchovy by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	1673609	7573644	7444215	3733108	4405337	3454688
ITA17_TM_VL_1824	5351637	5632733	7118840	3896844	2557411	2125463
ITA17_TM_VL_2440	16341141	14090618	12507196	10086650	14897657	11158593
ITA17_PS_VL_2440	10456217	7506328	4428387	4490999	5495818	3823897
HRV_PS_VL1218	566716	566716	566716	566716	373517	968445
HRV_PS_VL1824	2234425	2234425	2172358	3103368	2101167	2745990
HRV_PS_VL2440	4094434	4094434	4042606	5182828	3386541	4122380
SVN_PS_VL1218	362604	177272	138314	176687	114224	70688
ITA18_TM_VL_2440	13073484	14555042	10697086	12904588	9432117	8138954
ITA18_PS_VL_2440	4193597	3027368	2917341	3623140	2816154	2349163
Total	**58347864**	**59458580**	**52033059**	**47764928**	**45579943**	**38958261**

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Table A.3.2 Revenues (€) of sardine by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	184366	87462	225221	302917	1232099	1042262
ITA17_TM_VL_1824	403006	762618	1253694	1405249	3021998	2563310
ITA17_TM_VL_2440	2820477	2450474	3236267	3123202	4961159	4826675
ITA17_PS_VL_2440	125709	109718	91577	45585	126849	138378
HRV_PS_VL1218	1862814	1862814	1862814	1862814	1360430	1956088
HRV_PS_VL1824	4859220	4859220	4724241	6748916	4931034	6074783
HRV_PS_VL2440	6662500	6662500	6578165	8433545	8481631	12713813

SVN_PS_VL1218	245066	140206	219338	114100	29747	53008
ITA18_TM_VL_2440	2436454	423960	1198311	472964	434560	375893
ITA18_PS_VL_2440	29636	35591	33591	36417	16623	24080
Total	**19629248**	**17394563**	**19423219**	**22545709**	**24596130**	**29768290**

Total revenues

Table A.3.3 Total Revenues (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	2742110	8113294	8572863	5104098	7183903	6041431
ITA17_TM_VL_1824	6385558	6988394	9086260	5750189	6493183	5117546
ITA17_TM_VL_2440	20084253	17153415	16631584	14039900	21366175	17416791
ITA17_PS_VL_2440	11623294	7934372	4539655	4770133	6963075	5159950
HRV_PS_VL1218	2994272	2994272	2994272	2994272	2185184	3279056
HRV_PS_VL1824	7437141	7437141	7230554	10329363	7498727	9248474
HRV_PS_VL2440	11467596	11467596	11322436	14515944	13420002	17905450
SVN_PS_VL1218	792829	523187	450725	456613	301652	197824
ITA18_TM_VL_2440	15619100	15079577	12233412	15160005	10149189	8673406
ITA18_PS_VL_2440	4409513	3194496	3075806	3766814	2998762	2449074
Total	**83555666**	**80885744**	**76137567**	**76887331**	**78559852**	**75489002**

PROFIT OF SMALL PELAGIC FISHERIES IN GSA17 AND GSA18

In the following table A.3.4.the profit of small pelagic fishery in gsa9 are preported by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table A.3.4 - Profit by fleet segment in GSA17-GSA18 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	-381259	1421163	1410971	298770	557633	1054544
ITA17_TM_VL_1824	100765	118173	959190	-585491	-430577	-1140720
ITA17_TM_VL_2440	645277	-1354063	-1352871	-2221141	-393903	-2417258
ITA17_PS_VL_2440	1188145	-148581	-1476114	-2167231	-62998	429293
HRV_PS_VL1218	2006378	2006378	1961776	2006378	1222559	2271463
HRV_PS_VL1824	-7614237	-7614237	-8646065	-6305607	-7267572	-4997273
HRV_PS_VL2440	-7284487	-7284487	-1E+07	-5420810	-4393659	-404473
SVN_PS_VL1218	652206.8	193609.5	127233.6	155650.4	101897.9	43005.62
ITA18_TM_VL_2440	977564	1434171	-685234	516484	-1513989	-742959
ITA18_PS_VL_2440	793584	280023	-45710	187245	-92094	116639
Total	-8916063	-1.1E+07	-1.8E+07	-1.4E+07	-1.2E+07	-5787739

COSTS OF SMALL PELAGIC FISHERIES IN GSA17 AND GSA18

In the following tables from A.3.5 to A.3.17 all the data are reported on the costs by fleet segment taken into account in the simulation phase (past and present years) of the case study.

Table A.3.5 Total variable costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	1063604	2111573	2449889	2008785	2635909	1491532
ITA17_TM_VL_1824	2145098	2240255	2906459	2555494	2733456	2774383
ITA17_TM_VL_2440	8422323	6601622	7023174	6963217	9382573	8531484
ITA17_PS_VL_2440	2261307	1517508	1302597	1420774	1771110	896806
HRV_PS_VL1218	171866	171866	216468	171866	197281	214475
HRV_PS_VL1824	3603544	3603544	4194582	3164251	3120238	2993959
HRV_PS_VL2440	5418305	5418305	7377074	5305080	5385106	5671828
SVN_PS_VL1218	17218	45701	32926	46456	32118	38320
ITA18_TM_VL_2440	6928229	4982209	5856128	7000562	5725746	3807874
ITA18_PS_VL_2440	1078932	841813	806305	923737	822991	742982
Total	**31110426**	**27534396**	**32165602**	**29560222**	**31806528**	**27163643**

Table A.3.6 Other variable costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	309852	638229	799094	270177	565617	443425
ITA17_TM_VL_1824	718619	903738	1086583	708015	807765	482202
ITA17_TM_VL_2440	2855522	2683153	2581270	2176986	2849415	3402264
ITA17_PS_VL_2440	1185758	942549	716470	663265	854491	442505
HRV_PS_VL1218	55214	55214	55214	55214	53460	54337
HRV_PS_VL1824	2360444	2360444	2747582	2085451	2043838	1961159
HRV_PS_VL2440	2056438	2056438	2799860	2085451	2043838	2152659
SVN_PS_VL1218	5870	4990	5604	8763	5966	7118
ITA18_TM_VL_2440	1804098	1717080	1579482	1781099	1419655	1101303
ITA18_PS_VL_2440	413679	393840	347309	351999	313856	349869
Total	**11765494**	**11755675**	**12718468**	**10186420**	**10957901**	**10396841**

Table A.3.7 Fuel costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	753752	1473344	1650795	1738608	2070292	1048107
ITA17_TM_VL_1824	1426479	1336517	1819877	1847480	1925691	2292180
ITA17_TM_VL_2440	5566801	3918469	4441903	4786231	6533159	5129221
ITA17_PS_VL_2440	1075549	574959	586127	757509	916619	454301
HRV_PS_VL1218	116652	116652	161254	116652	143821	160138
HRV_PS_VL1824	1243100	1243100	1447000	1078800	1076400	1032800
HRV_PS_VL2440	3361867	3361867	4577214	3219629	3341268	3519169
SVN_PS_VL1218	11348	40711	27322	37693	26152	31202
ITA18_TM_VL_2440	5124131	3265129	4276646	5219462	4306091	2706571
ITA18_PS_VL_2440	345329	218440	237991	301083	293667	301082
Total	**19025008**	**15549188**	**19226129**	**19103147**	**20633160**	**16674771**

Table A.3.8 Maintenance costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	341451	350543	374666	256902	376229	301166
ITA17_TM_VL_1824	301681	313421	307028	276454	272020	392587
ITA17_TM_VL_2440	1005118	977129	905034	913492	1120897	1178246
ITA17_PS_VL_2440	842392	631301	576226	619665	662848	18791
HRV_PS_VL1218	161549	161549	161549	161549	190831	176190
HRV_PS_VL1824	1409160	1409160	1415831	1250855	1397823	1358858
HRV_PS_VL2440	1564184	1564184	1645533	1250855	1397823	1502183
SVN_PS_VL1218	9456	19470	18470	9500	17096	13894
ITA18_TM_VL_2440	536656	536078	536078	529192	424401	426298
ITA18_PS_VL_2440	227536	227543	227543	181384	195037	8065
Total	**6399183**	**6190378**	**6167958**	**5449848**	**6055005**	**5376278**

Table A.3.9 Total fixed costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	664910	684024	752339	515218	730185	587386
ITA17_TM_VL_1824	882399	923918	889490	823866	962336	551071
ITA17_TM_VL_2440	1937927	1900959	1703320	1718504	2061870	1801036
ITA17_PS_VL_2440	1378301	1033583	940049	1022531	1137206	222169
HRV_PS_VL1218	197481	197481	197481	197481	208366	230772
HRV_PS_VL1824	1504923	1504923	1512047	1321008	1492815	1451202
HRV_PS_VL2440	1670481	1670481	1757358	1321008	1492815	1604267
SVN_PS_VL1218	1982	23945	3373	2590	1221	993
ITA18_TM_VL_2440	895280	895382	895382	838650	676640	722607
ITA18_PS_VL_2440	402465	402521	402521	320867	345018	63453
Total	**9536149**	**9237217**	**9053360**	**8081723**	**9108472**	**7234956**

Table A.3.10 Other fixed costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	323459	333481	377674	258316	353956	286220
ITA17_TM_VL_1824	580718	610497	582462	547411	690317	158484
ITA17_TM_VL_2440	932809	923830	798286	805012	940974	622790
ITA17_PS_VL_2440	535909	402282	363822	402866	474357	203378
HRV_PS_VL1218	197481	197481	197481	197481	208366	202924
HRV_PS_VL1824	1504923	1504923	1512047	1321008	1492815	1451202
HRV_PS_VL2440	1670481	1670481	1757358	1321008	1492815	1604267
SVN_PS_VL1218	1982	23945	3373	2590	1221	993
ITA18_TM_VL_2440	358624	359304	359304	309458	252240	296308
ITA18_PS_VL_2440	174929	174978	174978	139482	149981	55388
Total	**6281315**	**6201202**	**6126785**	**5304632**	**6057042**	**4881954**

Table A.3.11 Labour costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013

ITA17_TM_VL_1218	741403	3183846	3172628	1564243	2423041	2144702
ITA17_TM_VL_1824	1878850	2080624	2750057	1356678	1591379	1023509
ITA17_TM_VL_2440	4641090	4868782	4430297	3230790	5091402	4482947
ITA17_PS_VL_2440	4174629	2615418	1336184	1338090	2185793	1914730
HRV_PS_VL1218	271514	271514	271514	271514	236871	254192
HRV_PS_VL1824	4927100	4927100	5132300	5262075	5364994	5173800
HRV_PS_VL2440	4978100	4978100	5398200	5262075	5364994	5250800
SVN_PS_VL1218	71623	180147	217697	197631	109739	63614
ITA18_TM_VL_2440	4004666	4770660	3013048	3990086	3287631	2423283
ITA18_PS_VL_2440	1542049	1103086	1064085	1333013	1020138	851067
Total	**27231024**	**28979277**	**26786010**	**23806195**	**26675982**	**23582644**

Table A.3.12 Depreciation costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	295005	323476	370691	413922	421209	408646
ITA17_TM_VL_1824	1025203	1193317	1157258	1198260	1246142	1341602
ITA17_TM_VL_2440	3262516	3717053	3522971	3058327	3709252	3356606
ITA17_PS_VL_2440	1679967	2041577	1683911	2278404	1151595	1481809
HRV_PS_VL1218	81864	81864	81864	81864	77858	79861
HRV_PS_VL1824	3212450	3212450	3227658	5242580	3186604	3097777
HRV_PS_VL2440	3565857	3565857	3751306	5242580	3186604	3424513
SVN_PS_VL1218	33925	48430	46281	35931	27868	22649
ITA18_TM_VL_2440	2162529	2209904	2368473	2051983	1406596	1806045
ITA18_PS_VL_2440	344382	298520	563050	748527	650737	592890
Total	**15663698**	**16692448**	**16773463**	**20352378**	**15064465**	**15612398**

Table A.3.13 Opportunity costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	16996	38668	41679	46258	39697	53455
ITA17_TM_VL_1824	51562	118685	116778	124928	118427	175114
ITA17_TM_VL_2440	170002	441934	399659	376710	394084	483730
ITA17_PS_VL_2440	98554	243567	176802	257899	117521	196353
HRV_PS_VL1218	103620	103620	103620	103620	51418	48545
HRV_PS_VL1824	394201	394201	394201	394201	203825	170151
HRV_PS_VL2440	1555156	1555156	1555156	1555156	986319	856332
SVN_PS_VL1218	6419	11885	4744	8855	11712	15348
ITA18_TM_VL_2440	114176	251173	249537	233048	142164	230258
ITA18_PS_VL_2440	20565	40991	58012	72042	56935	73978
Total	**2531250**	**3199879**	**3100188**	**3172716**	**2122102**	**2303265**

Table A.3.14 Total capital costs (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	312001	362145	412370	460180	460906	462101
ITA17_TM_VL_1824	1076765	1312003	1274036	1323188	1364569	1516716
ITA17_TM_VL_2440	3432518	4158986	3922630	3435038	4103336	3840336

ITA17_PS_VL_2440	1778520	2285143	1860713	2536304	1269116	1678161
HRV_PS_VL1218	185484	185484	185484	185484	129276	131964
HRV_PS_VL1824	3606651	3606651	3621859	5636781	3390429	3267928
HRV_PS_VL2440	5121013	5121013	5306462	6797736	4172923	4280845
SVN_PS_VL1218	40343	60315	51025	44786	39580	37997
ITA18_TM_VL_2440	2276705	2461077	2618010	2285031	1548760	2036303
ITA18_PS_VL_2440	364947	339510	621062	820568	707672	666868
Total	**18194947**	**19892326**	**19873651**	**23525095**	**17186567**	**17919220**

Table A.3.15 Other income (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	0	0	0	0	0	0
ITA17_TM_VL_1824	0	0	0	0	0	0
ITA17_TM_VL_2440	0	0	0	0	0	0
ITA17_PS_VL_2440	0	0	0	0	0	0
HRV_PS_VL1218	96902	96902	96902	96902	64673	82041
HRV_PS_VL1824	948600	948600	961600	963695	1083010	170300
HRV_PS_VL2440	0	0	2025047	4360245	3644281	0
SVN_PS_VL1218	0	8570	0	10466	0	0
ITA18_TM_VL_2440	0	0	0	0	0	0
ITA18_PS_VL_2440	0	0	0	0	0	0
Total	**1045502**	**1054072**	**3083549**	**5431308**	**4791964**	**252341**

Table A.3.16 Number of employees by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	83	97	102	92	171	124
ITA17_TM_VL_1824	110	113	109	135	148	153
ITA17_TM_VL_2440	262	243	241	246	344	264
ITA17_PS_VL_2440	224	170	145	152	137	142
HRV_PS_VL1218	45	45	45	45	44	47
HRV_PS_VL1824	473	473	493	493	529	497
HRV_PS_VL2440	478	478	493	529	505	505
SVN_PS_VL1218	7	16	12	18	19	16
ITA18_TM_VL_2440	238	238	238	205	175	181
ITA18_PS_VL_2440	97	97	96	80	89	82
Total	**2017**	**1970**	**1974**	**1995**	**2161**	**2011**

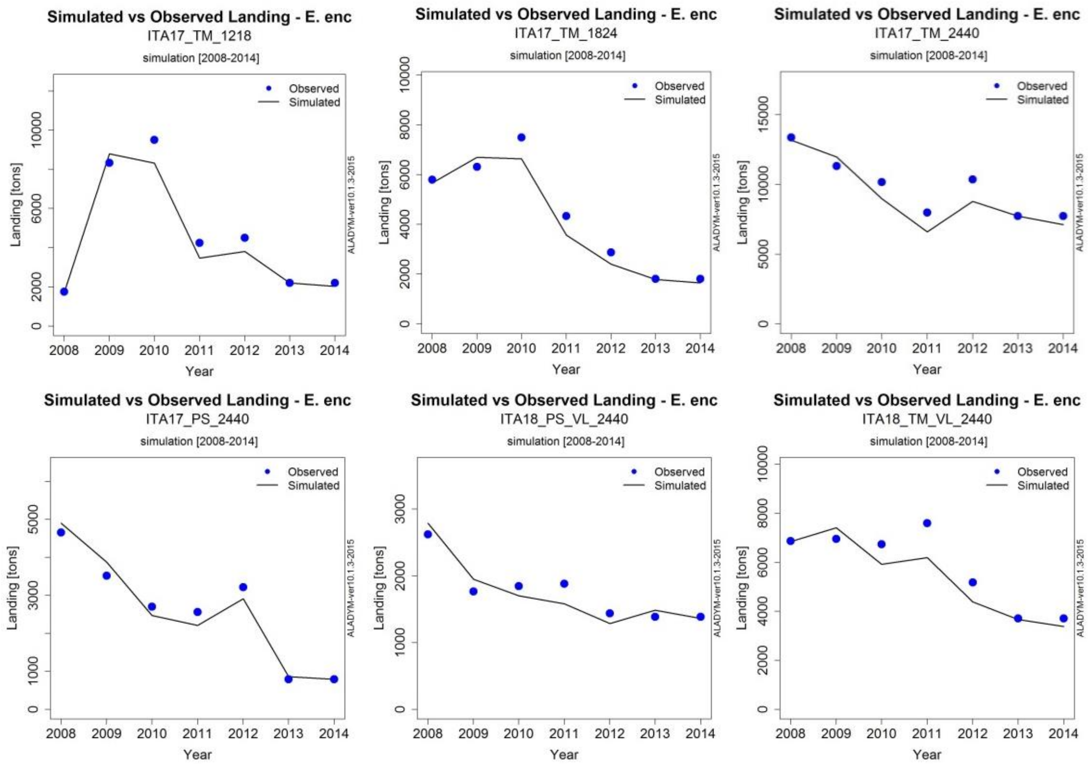
Table A.3.17 Capital value (€) by fleet segment in GSA 17 and 18.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_TM_VL_1218	1490775	1568297	1738433	1886805	1870168	1795191
ITA17_TM_VL_1824	4522628	4813618	4870786	5095653	5579240	5880899
ITA17_TM_VL_2440	14911190	17923840	16669745	15365561	18565833	16245221
ITA17_PS_VL_2440	8644322	9878514	7374399	10519396	5536595	6594160
HRV_PS_VL1218	2440073	2440073	2440073	2440073	1947497	2086604
HRV_PS_VL1824	7990836	7990836	8261711	9282795	7719960	7313646

HRV_PS_VL2440	36807905	36807905	39554763	36621415	37357276	36807905
SVN_PS_VL1218	186100	344583	280000	315000	400000	400000
ITA18_TM_VL_2440	10014546	10187012	10408190	9505749	6697527	7732811
ITA18_PS_VL_2440	1803804	1662498	2419674	2938487	2682285	2484410
Total	**88812179**	**93617176**	**94017774**	**93970934**	**88356381**	**87340847**

A.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS

The fitting of the model is quite satisfactory for both the species, with an average difference of 5.7% by year for anchovy and of 1% for sardine. The differences between simulated and observed landing data by fleet segment and year are reported in the figures A.4.1 – A.4.2.



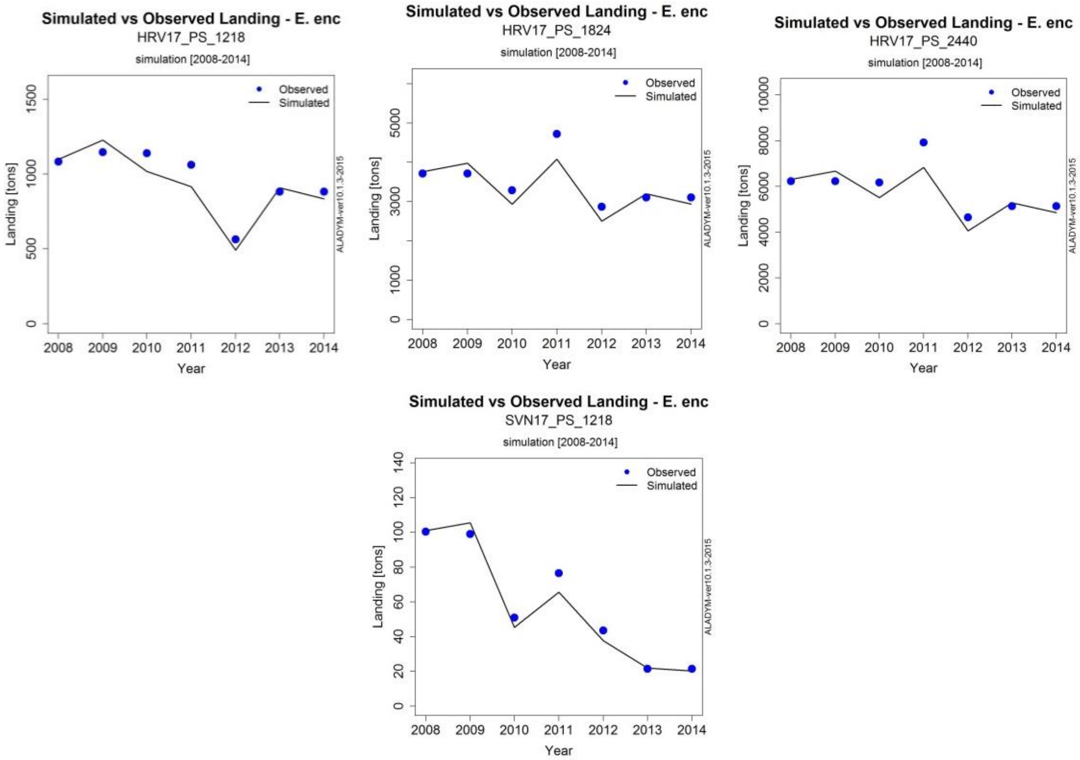
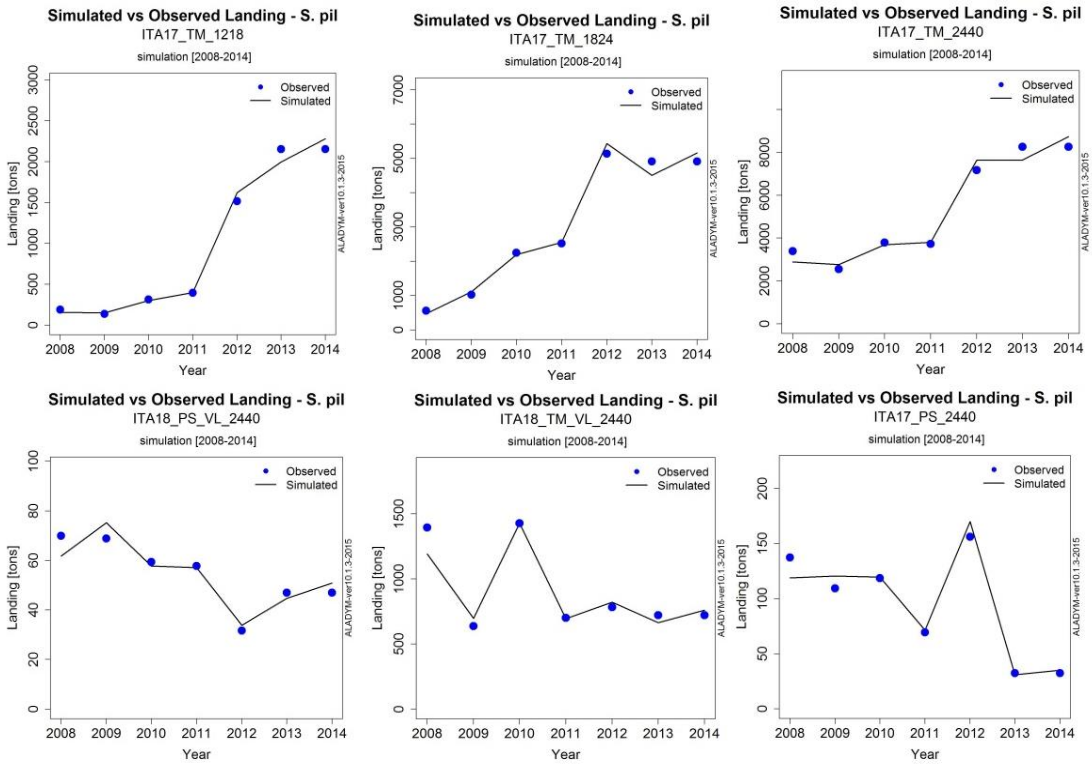


Figure A.4.1. Comparison between simulated and observed landings by fleet segment for anchovy in GSA 17 and 18.



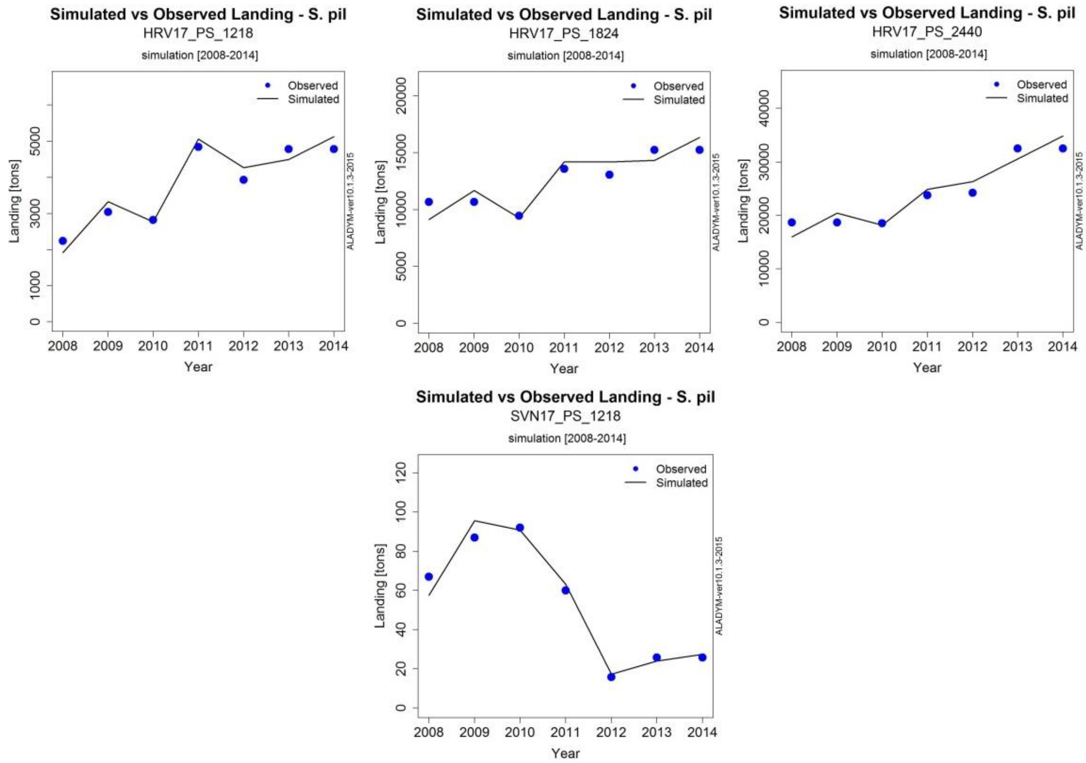


Figure A.4.2. Comparison between simulated and observed landings by fleet segment for sardine in GSA 17 and 18.

The comparison between the Spawning Stock Biomass (SSB) from the assessment models and the BEMTOOL simulation is shown in figure A.4.3. BEMTOOL model estimates for anchovy an SSB smaller than the one of the assessment (the difference is about 20%), probably due to the hypothesis of split year in the assessment, while in BEMTOOL the calendar year has been used. However, the SSB estimated by BEMTOOL and by the assessment are much more similar respect to the comparison obtained within SEDAF project, thanks to the revision of the assumptions on maturity in SAM model carried out at STECF EWG 15-11. This produced a SSB much lower than the value from GFCM held in November 2014.

For sardine, the fitting of the SSB is much satisfactory as it shows a good level of agreement between BEMTOOL and the new SAM estimated SSB at the beginning of the year. The average difference between BEMTOOL and SAM model is around 5-6%. Some initial shift can be due to the fact that BEMTOOL is considering the last 7 years, while the assessment worked on a longer time series.

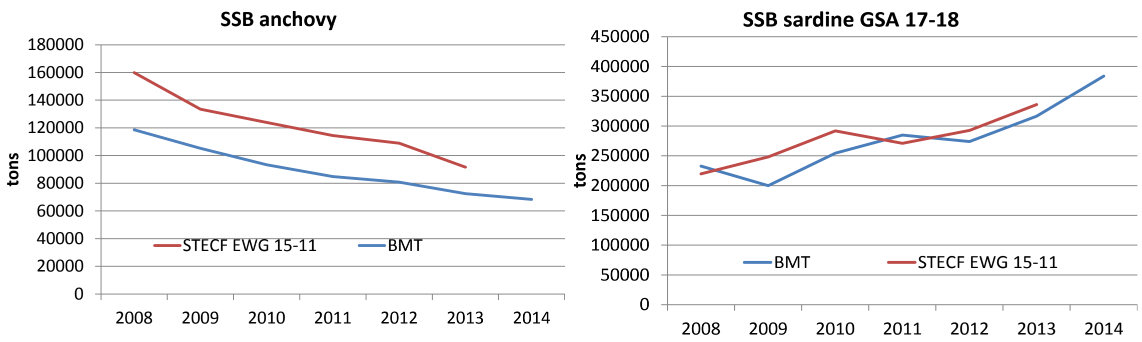


Figure A.4.3 Comparison between BEMTOOL and stock assessment SSB by fleet segment for anchovy and sardine in GSA 17 and 18.

A.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT

A.5.1 INPUT OF THE BIOLOGICAL AND PRESSURE MODULES

In order to perform the projections of the stock in the future, the recruitment of anchovy and sardine at the beginning of the forecast phase has been assumed equal to the recruitment in 2013 (respectively 57 771 146 and 56 911 047 thousand).

A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the geometric mean of recruitment in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL.

Error! Reference source not found.5.1 shows the recruitment of anchovy and sardine with confidence nterval used in all the performed scenarios.

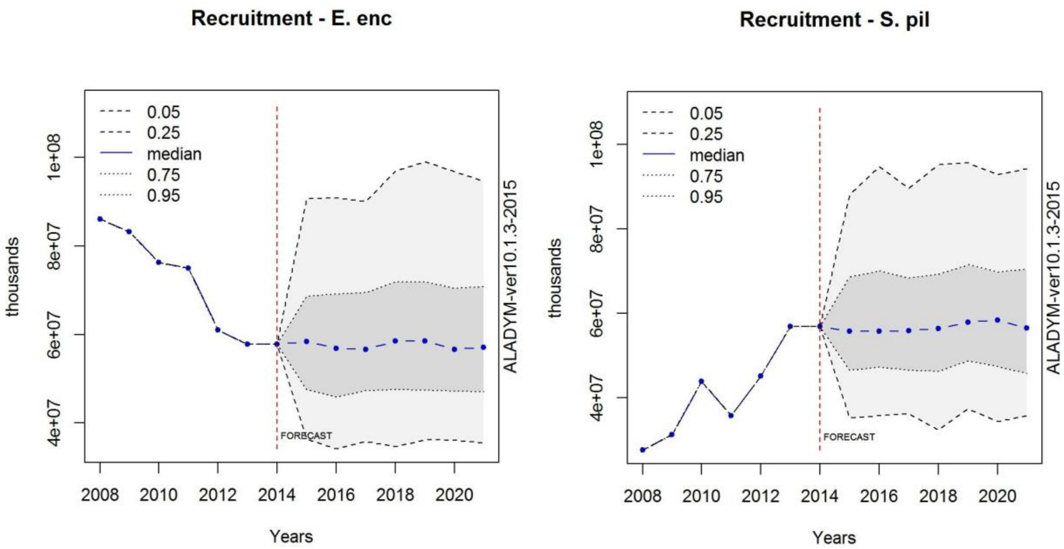


Figure A.5.1 Recruitment used for anchovy and sardine in the forecast scenarios with confidence intervals.

All the other biological inputs have been maintained unchanged in the projections.

For the status quo the effort has been maintained constant and equal to 2013 for all the years (until 2021).

A.5.2 INPUT OF THE ECONOMIC MODULE

Due to the presence of relevant fluctuations in the time series of most fleet segments, the socio economic parameters to be used in the forecast have been estimated on the basis of the most recent economic data available, i.e. in 2012 and 2013, as described in the next paragraphs.

PRICES DYNAMICS

The price of European anchovy and European sardine are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \Bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}} .$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2 for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

1) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
2) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
3) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.

Due to the lack of reliable estimations, the elasticity coefficient was computed exogenously on the basis the existing literature on seafood demand related to small pelagic species in Northern Adriatic (Camanzi *et al.,* 2010). This study estimated price-quantity relationship equal to -0.2 for both species considered in the ex-vessel markets of the Emilia Romagna and Veneto Regions in Italy. This resulted in the parameterization reported in the table A.5.1.

Table A.5.1 Price parameterization by fleet segment and stock in GSA 17 and 18.

Fleet segment	Model	coeff. price-landings	coeff. price-landings
ITA17_TM_VL_1218	1	-0.2	-0.2
ITA17_TM_VL_1824		-0.2	-0.2
ITA17_TM_VL_2440		-0.2	-0.2
ITA17_PS_VL_2440		-0.2	-0.2
HRV_PS_VL1218		-0.2	-0.2
HRV_PS_VL1824		-0.2	-0.2
HRV_PS_VL2440		-0.2	-0.2
SVN_PS_VL1218		-0.2	-0.2
ITA18_TM_VL_2440		-0.2	-0.2
ITA18_PS_VL_2440		-0.2	-0.2

COSTS DYNAMICS

Variable costs

Variable costs were considered as a single item (as sum of fuel and other variable costs) and estimated in a single equation as a linear function of fishing effort EFF and the coefficient β :

$$TVC_{f,t} = \beta_f EFF_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$EFF_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*.

Maintenance costs and fixed costs

According to option 1 of BEMTOOL model, both fixed costs OFC and maintenance costs MC are directly linked to the total annual gross tonnage GT. These functions can be represented as follows:

$MC_{f,t} = \alpha''_f GT_{f,t}$ where:

$MC_{f,t}$ are the maintenance costs for the fleet segment *f* at time *t* (€);

$GT_{f,t}$ is the annual gross tonnage;

αf' is other fixed costs per unit of *GT*.

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

where:

$OFC_{f,t}$ are the other fixed costs for the fleet segment *f* at time *t* (€);

$GT_{f,t}$ is the annual gross tonnage for fleet segment *f* at time *t*;

αf'' is the maintenance costs per unit of *GT*.

Capital costs

Depreciation costs (DC)) have been estimated as an average of the gross tonnage of the fleet segment, corresponding to option one of the BEMTOOL software.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

As suggested in the 2014 Annual Economic Report on the EU Fishing Fleet "(STECF-14-16), opportunity costs of capital (*OC)* are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Variable cost are directly related to the number of estimated days at sea. Similarly, fixed and capital costs are function of the estimated fleet capacity, expressed in terms of number of vessels and gross tonnage.

Labour costs

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is estimated as a percentage of the difference between total revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t} \right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

Thus, labour cost are directly related to total revenues and variable cost.

As highlighted in Table A.5.2, the crew share ranges from 0.08 of Croatian Purse seiners 12-18 m to 0.83 of Croatian Purse seine fleet 18-24 m.

Table A.5.2 Costs parameterization by fleet segment in GSA 17 and 18 pelagic case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	opportunity costs per unit of GT
ITA17_TM_VL_1218	347	0.47	313	298	425	56
ITA17_TM_VL_1824	804	0.44	196	79	670	87
ITA17_TM_VL_2440	1112	0.50	234	124	668	96
ITA17_PS_VL_2440	832	0.45	437	144	1049	139

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	opportunity costs per unit of GT
HRV_PS_VL1218	70	0.08	559	644	254	154
HRV_PS_VL1824	598	0.83	318	339	724	40
HRV_PS_VL2440	755	0.43	151	161	344	86
SVN_PS_VL1218	111	0.4	361	26	588	398
ITA18_TM_VL_2440	1254	0.5	190	132	806	103
ITA18_PS_VL_2440	1255	0.5	15	106	1129	141

Revenues and total landings

Revenues by fleet segment and species are calculated by multiplying landings produced in the biological sub-model by the prices estimated on the basis of the price module.

As assessed species account for 60-90% of total revenues and production for all fleet segments, the remaining part of landings value and weight was assumed to be as a fixed percentage of the estimated revenues and production of anchovy and sardine according to BEMTOOL option 1 of revenues modelling:

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

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

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to pass from the landings of assessed species to the total landings of the fleet segment *f*.

Total revenues and production are thus function of the estimated landings value and weight of the two target assessed species.

Average employees per vessel

Employment in the future has been estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html.

Parameterization of socio-economic indicators by fleet segment is reported in the table A.5.3.

Table A.5.3 Socio-economic indicators parameterization by fleet segment in GSA 17 and 18 pelagic case study.

	correction factor for landings	correction factor for revenue	average employees per vessel	value of a single vessel	discount rate
ITA17_TM_VL_1218	1.24	1.33	3.5	51291	4.3%
ITA17_TM_VL_1824	1.01	1.01	6.2	237612	4.3%
ITA17_TM_VL_2440	1.01	1.02	5.7	353157	4.3%
ITA17_PS_VL_2440	1.05	1.32	10.2	473018	4.3%
HRV_PS_VL1218	1.07	1.12	1.0	46369	4.7%
HRV_PS_VL1824	1.07	1.05	9.0	135438	4.7%
HRV_PS_VL2440	1.08	1.06	8.0	549372	4.7%
SVN_PS_VL1218	1.46	1.6	4.0	100000	5.8%
ITA18_TM_VL_2440	1.1	1.2	6.7	286400	4.3%
ITA18_PS_VL_2440	1.1	1.1	18.2	552091	4.3%

A.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The Table A.5.4 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute number of average number of annual fishing days per vessel and the number of active vessels are reported.

Table A. 5.4 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Average number of annual fishing days per vessel							**Number of active vessels**						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	123	123	123	123	123	123	123	35	35	35	35	35	35	35
ITA17_TM_1824	139	139	139	139	139	139	139	25	25	25	25	25	25	25
ITA17_TM_2440	167	167	167	167	167	167	167	46	46	46	46	46	46	46
ITA17_PS_2440	77	77	77	77	77	77	77	14	14	14	14	14	14	14
HRV17_PS_1218	76	76	76	76	76	76	76	45	45	45	45	45	45	45
HRV17_PS_1824	98	98	98	98	98	98	98	54	54	54	54	54	54	54
HRV17_PS_2440	110	110	110	110	110	110	110	67	67	67	67	67	67	67
ITA18_TM_VL_2440	112	112	112	112	112	112	112	27	27	27	27	27	27	27
ITA18_PS_VL_2440	132	132	132	132	132	132	132	5	5	5	5	5	5	5
SVN17_PS_1218	84	84	84	84	84	84	84	4	4	4	4	4	4	4

	Reduction on fishing days							**Reduction on vessels**						
Scenario 2 - FmsyUpper2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-7%	-15%	-22%	-30%	-30%	-30%	-30%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA17_TM_1824	-6%	-12%	-17%	-23%	-23%	-23%	-23%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA17_TM_2440	-20%	-40%	-60%	-80%	-80%	-80%	-80%	-13%	-27%	-40%	-40%	-40%	-40%	-40%
ITA17_PS_2440	-3%	-6%	-9%	-12%	-12%	-12%	-12%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1218	-3%	-6%	-9%	-12%	-12%	-12%	-12%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1824	-11%	-22%	-32%	-43%	-43%	-43%	-43%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
HRV17_PS_2440	-19%	-38%	-56%	-75%	-75%	-75%	-75%	-7%	-13%	-20%	-20%	-20%	-20%	-20%
ITA18_TM_VL_2440	-19%	-37%	-56%	-75%	-75%	-75%	-75%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
ITA18_PS_VL_2440	-5%	-11%	-16%	-21%	-21%	-21%	-21%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							**Reduction on vessels**						
Scenario 3 - FmsyUpper2020Adaptive	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**

ITA17_TM_1218	-7.5%	-7.5%	-12.0%	-19.2%	-26.8%	-30.0%	-30.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA17_TM_1824	-5.7%	-5.7%	-9.2%	-14.7%	-20.5%	-23.0%	-23.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA17_TM_2440	-20.0%	-20.0%	-32.0%	-51.2%	-71.4%	-80.0%	-80.0%	-13%	-27%	-40%	-40%	-40%	-40%	-40%
ITA17_PS_2440	-3.0%	-3.0%	-4.8%	-7.7%	-10.7%	-12.0%	-12.0%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1218	-3.0%	-3.0%	-4.8%	-7.7%	-10.7%	-12.0%	-12.0%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1824	-10.8%	-10.8%	-17.2%	-27.5%	-38.4%	-43.0%	-43.0%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
HRV17_PS_2440	-18.8%	-18.8%	-30.0%	-48.0%	-66.9%	-75.0%	-75.0%	-7%	-13%	-20%	-20%	-20%	-20%	-20%
ITA18_TM_VL_2440	-18.7%	-18.7%	-30.0%	-48.0%	-66.9%	-75.0%	-75.0%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
ITA18_PS_VL_2440	-5.3%	-5.3%	-8.4%	-13.4%	-18.7%	-21.0%	-21.0%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
SVN17_PS_1218	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							Reduction on vessels						
Scenario 4 - E04 ANE 2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-4%	-9%	-13%	-17%	-17%	-17%	-17%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
ITA17_TM_1824	-3%	-7%	-11%	-14%	-14%	-14%	-14%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
ITA17_TM_2440	-15%	-30%	-46%	-61%	-61%	-61%	-61%	-2%	-5%	-7%	-7%	-7%	-7%	-7%
ITA17_PS_2440	-2%	-3%	-5%	-7%	-7%	-7%	-7%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1218	-2%	-4%	-5%	-7%	-7%	-7%	-7%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1824	-7%	-13%	-20%	-26%	-26%	-26%	-26%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
HRV17_PS_2440	-11%	-21%	-32%	-42%	-42%	-42%	-42%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
ITA18_TM_VL_2440	-7%	-15%	-22%	-29%	-29%	-29%	-29%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA18_PS_VL_2440	-3%	-6%	-9%	-12%	-12%	-12%	-12%	0%	-1%	-1%	-1%	-1%	-1%	-1%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							Reduction on vessels						
Scenario 5 - E04 ANE 2020 Adaptive	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-4%	-4%	-7%	-11%	-15%	-17%	-17%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
ITA17_TM_1824	-3%	-3%	-6%	-9%	-12%	-14%	-14%	-1%	-1%	-2%	-2%	-2%	-2%	-2%
ITA17_TM_2440	-15%	-15%	-24%	-39%	-54%	-61%	-61%	-2%	-5%	-7%	-7%	-7%	-7%	-7%
ITA17_PS_2440	-2%	-2%	-3%	-4%	-6%	-7%	-7%	0%	-1%	-1%	-1%	-1%	-1%	-1%

HRV17_PS_1218	-2%	-2%	-3%	-4%	-6%	-7%	-7%	0%	-1%	-1%	-1%	-1%	-1%	-1%
HRV17_PS_1824	-7%	-7%	-10%	-17%	-23%	-26%	-26%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
HRV17_PS_2440	-11%	-11%	-17%	-27%	-37%	-42%	-42%	-2%	-3%	-5%	-5%	-5%	-5%	-5%
ITA18_TM_VL_2440	-7%	-7%	-12%	-19%	-26%	-29%	-29%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA18_PS_VL_2440	-3%	-3%	-5%	-8%	-11%	-12%	-12%	0%	-1%	-1%	-1%	-1%	-1%	-1%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							**Reduction on vessels**						
Scenario 6 - FmsyUpperAnchovy2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_TM_1824	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_TM_2440	-14.6%	-29.2%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_PS_2440	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_1218	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_1824	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_2440	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA18_TM_VL_2440	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA18_PS_VL_2440	-14.6%	-29.3%	-43.9%	-58.5%	-58.5%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							**Reduction on vessels**						
Scenario 7 - FmsyUpperAnchovyAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_TM_1824	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_TM_2440	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA17_PS_2440	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_1218	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_1824	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
HRV17_PS_2440	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
ITA18_TM_VL_2440	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%

ITA18_PS_VL_2440	-14.6%	-14.6%	-23.4%	-32.2%	-45.3%	-58.5%	-58.5%	-2.2%	-4.3%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							**Reduction on vessels**						
Scenario 8 - E04Anchovy2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_TM_1824	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_TM_2440	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_PS_2440	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_1218	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_1824	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_2440	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA18_TM_VL_2440	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA18_PS_VL_2440	-9%	-18%	-27%	-36%	-36%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on fishing days							**Reduction on vessels**						
Scenario 9 - E04AnchovyAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA17_TM_1218	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_TM_1824	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_TM_2440	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA17_PS_2440	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_1218	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_1824	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
HRV17_PS_2440	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA18_TM_VL_2440	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
ITA18_PS_VL_2440	-9%	-9%	-14%	-20%	-28%	-36%	-36%	-1%	-3%	-4%	-4%	-4%	-4%	-4%
SVN17_PS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

2.3 CASE STUDY ON DEMERSAL FISHERY IN GSA 06

2.3.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The demersal fisheries in GSA 06 are of mixed nature.

Three fishing techniques exploit demersal resources in the area:

- ✓ DTS (corresponding to bottom trawl: OTB);
- ✓ DFN (corresponding to trammel nets: GTR, and drift nets: GNS);
- ✓ HOK (set longlines: LLS).

DTS produces the majority of catches and has the higher rates of activity and employment. Trawl fishing, as traditionally practiced, has low size selection on demersal resources, effectively catching all fish from approximately 15 cm TL onwards (for crustaceans, length at first catch is even lower). This has led to inefficient fisheries that apply rates of fishing mortality (F) much in excess of that estimated as F to produce the maximum sustainable yield (Fmsy). The current F (Fcurr) for most stocks is 3 to 5 times higher than Fmsy, but in the case of hake the figure is closer to 10 in GSA 06. This situation is well known and has been diagnosed repeatedly (see for example, Colloca et al. 2014 for a recent summary) and, in recent years, steps have been taken to reverse the situation: the trawl fleet has substituted the traditional diamond mesh trawl of 40 mm with a square mesh trawl of 40 mm, and in many ports of GSA 06, the Fishers' Associations ("cofradías") are actively seeking to avoid undersize fish by setting internal agreements on seasonal or spatial closures. It is important to note that technological changes to promote better selective fisheries have some limitations in their effectiveness to avoid catching undersize fish, while higher lengths at first capture can also be achieved by avoiding areas or seasons of peak recruitment (Colloca et al., 2014).

Seven main fleet segments operating in GSA 06 and carrying out demersal fisheries have been identified. These fleet segments belong to 4 vessel length strata: 06-12m, 12-18 m, 18-24 m and 24-40 m; and use 3 fishing techniques: bottom trawler, nets and longline (Table 2.3.1.1). The percentage of landings of all landed species due to each identified fleet segment is reported in the table 2.3.1.1.

Demersal fisheries are carried out on the continental shelf (50-200 m depth) by all fleet segments and on the continental slope by the two trawl fleet segments with largest length (18-40 m).

Table 2.3.1.1 - Main fleet segments operating in GSA 06 carrying out demersal fisheries. The percentage of landings of all landed species due to each identified fleet segment is also reported.

	Fleet name	*Fleet code*	*% of landings (all species)*
1	Spanish bottom trawlers with vessel length 12-18 m	ESP06_DTS_12-18	15.74
2	Spanish bottom trawlers with vessel length 18-24 m	ESP06_DTS_18-24	40.24
3	Spanish bottom trawlers with vessel length 24-40 m	ESP06_DTS_24-40	31.86
4	Spanish netters with vessel length 6-12 m	ESP06_DFN_06-12	3.69
5	Spanish netters with vessel length 12-18 m	ESP06_DFN_12-24	4.44
6	Spanish longliners with vessel length 6-12 m	ESP06_HOK_06-12	1.21

7	Spanish longliners with vessel length 12-18 m	ESP06_HOK_12-18	2.81

The number of fishing vessels is decreasing in the last ten years, as well as the fishing effort (gross tonnage *days at sea or days at sea) of trawlers, while the fishing effort of fixed gears is almost stable in the period 2008-2013. The fleet segments more contributing to the total production are: Spanish bottom trawlers with vessel length 18-24 m and Spanish bottom trawlers with vessel length 24-40 m.

Main stock assessed are: hake (*Merluccius merluccius*) (HKE), red mullet (*Mullus barbatus*) (MUT), blue and red shrimp (*Aristeus antennatus*) (ARA), deepwater shrimp (*Parapenaeus longirostris*) (DPS) and blue whiting (*Micromesistius poutassou*) (WHB).

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production volume of the specific fisheries, as identified by the fishing technique and vessel length is reported in the table 2.3.1.2a (the percentage is computed on the average production of the last three years). The contribution to the total production in terms of landing value is reported in the table 2.3.1.2b. The assessed stocks account for a low percentage, of less than 5%, for the artisanal fishing gear (DFN and HOK, except for European hake), but are important for the two largest bottom trawl fleets (25% and 42% respectively for DTS_VL1824 and DTS_VL2440), which are, in turns, those contributing more to the total production. If the contribution in terms of production value is considered, the relevance of the assessed stocks increases remarkably compared to the production volume, reaching a percentage of about 42% overall.

The stocks assessed in experts working groups (STECF or GFCM) are those that are considered relevant for the fisheries, although due to the mixed nature of demersal Mediterranean fisheries the assessed species may be a small fraction of the total landings in value or weight (42% for French DTS, but usually lower for other fleet segments). Other important species that are rarely or never assessed are: sparids, such as *Sparus aurata*, *Pagellus erythrinus* and *P. bogaraveo* or *Diplodus sargus*; cephalopods, such as *Octopus vulgaris* or *Sepia officinalis*; *Solea solea*; *Nephrops norvegicus* and *Lophius* spp. (STECF 15-19 "Landings Obligation Part 6; STECF, 2015c).

The stocks considered in this case study are the only ones for which recent (2014) assessments are available. Among the assessed ones, which are relevant stock in the GSA fisheries, the stock more important for the overall production is European hake.

Table 2.3.1.2a - Contribution of the stocks assessed to the production volume (in tons) of the main fleet segments of demersal fisheries in GSA06 (the percentage is computed on the average production of the last three years). The values in the column “assesed%” is calculated as ratio between landings of assessed species to total landings, the same calculation has been done for the row “Total”.

Assessed species/fleet segments GSA06	**ARA**		**DPS**		**HKE**		**MUT**		**WHB**		**Total**		
	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing (tons)	%	Landing assessed (tons)	Landing total (tons)	assessed %
DFN VL_0612	0	0.0	0	0.0	35	5.7	10	1.7	0	0.0	45	612	**7.4**
DFN VL_1224	0	0.0	0	0.0	44	6.0	8	1.1	0	0.0	52	736	**7.1**
DTS VL_1218	8	0.3	2	0.1	145	5.6	145	5.6	32	1.2	332	2609	**12.7**
DTS VL_1824	221	3.3	6	0.1	925	13.9	270	4.0	307	4.6	1729	6670	**25.9**
DTS VL_2440	354	6.7	11	0.2	1052	19.9	305	5.8	476	9.0	2197	5281	**41.6**
HOK VL_0612	0	0.0	0	0.0	16	8.0	0	0.1	0	0.1	16	200	**8.2**
HOK VL_1218	0	0.0	0	0.0	26	5.5	1	0.2	0	0.1	27	466	**5.8**
Total	582	3.5	19	0.1	2243	13.5	740	4.5	816	4.9	4399	16575	**26.5**

Table 2.3.1.2b - Contribution of the stocks assessed to the production value (in Keuro) of the main fleet segments of demersal fisheries in GSA06 (the percentage is computed on the average production of the last three years). The values in the column “assesed%” is calculated as ratio between landings of assessed species to total landings, the same calculation has been done for the row “Total”.

Assessed species/fleet segments GSA06	**ARA**		**DPS**		**HKE**		**MUT**		**WHB**		**Total**		
	Landing value (Keuro)	%	Landing value (Keuro)	%	Landing value (Keuro)	%	Landing value (Keuro)	%	Landing value (Keuro)	%	Landing assessed value (Keuro)	Landing total value (keuro)	assessed %

DFN VL_0612	0	0.0	0	0.0	201	7.72	57	2.2	0	0.00	258	2606	**9.9**
DFN VL_1224	0	0.0	0	0.0	254	10.09	45	1.8	0	0.00	299	2516	**11.9**
DTS VL_1218	196	2.1	37	0.4	832	8.78	803	8.5	64	0.67	1932	9477	**20.4**
DTS VL_1824	5553	17.3	93	0.3	5296	16.53	1494	4.7	610	1.90	13047	32047	**40.7**
DTS VL_2440	8906	30.5	182	0.6	6022	20.62	1686	5.8	945	3.24	17740	29200	**60.8**
HOK VL_0612	0	0.0	0	0.0	92	10.47	1	0.1	0	0.04	93	879	**10.6**
HOK VL_1218	0	0.0	0	0.0	146	6.27	6	0.3	1	0.02	153	2333	**6.6**
Total	14655	18.5	312	0.4	12843	16.2	4092	5.2	1620	2.0	33522	79058	**42.4**

2.3.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The assessments of the main demersal stocks were presented during the STCEF 13-22 (EWG 13-09: deep water shrimp), STECF 14-17 (EWG 14-09: hake, blue whiting and red mullet) and STECF 15-11 (EWG 15-09: blue and red shrimp). These assessments used official DCF data together with the historical time series available for GSA06 from 2002 to 2012 for deep water shrimp, 2002 – 2013 for European hake and red mullet, 2008-2013 for blue whiting and 2002-2014 for blue and red shrimp. The population dynamics of the first four stocks was propagated to 2014 using FLR methods.

MEFISTO simulation used 2014 as the base, or status quo year, with 2015 as first year of the simulation. According to the stock assessments used, the summary diagnosis of the stocks is the following:

- Hake: Fishing mortality ($F_{bar0\text{-}3}$) and SSB relatively stable along the time series, but strong decrease in recruitment.
- Blue and red shrimp: Fishing mortality ($F_{bar0\text{-}3}$) decreasing and SSB stable along the time series. Recruitment shows high values in recent years
- Red mullet: Fishing mortality ($F_{bar0\text{-}2}$), recruitment and SSB increasing in recent years, after low values in 2005-2008
- Deepwater shrimp: Fishing mortality ($F_{bar2\text{-}4}$) and SSB with large variations, while recruitment is increasing along the time series.
- Blue whiting: The time series is relatively short (6 years) and the variation in Fishing mortality ($F_{bar1\text{-}3}$), recruitment and SSB is large.

Discards of hake, red mullet and blue whiting are suspected to be important, but official data only reports relatively low amounts (<10% of landings) in the two most recent years. Due to the lack of reliable information, landings are usually equated with catches in the stock assessments. For the high valued shrimps discards is considered negligible.

Table 2.3.2.1 Current level of fishing mortality ($F_{current}$), of F_{MSY}, of the ratio between $F_{current}$ anf F_{MSY} ($F_{current}/F_{MSY}$), Spawning Stock Biomass, landings and Recruitment of the assessed species (HKE=European hake, ARA=blue and red shrimp, MUT=red mullet; DPS=deep water rose shrimp, WHB=blue whiting).

Stock	*F current*	*Fmsy*	*Fcurr/Fmsy*	*Spawning Stock Biomass (tons)*	*Landings (tons)*	*Recruitment (thousands)*
HKE	1.466	0.15	9.77	1476.4	2924	101 309
ARA	1.742	0.36	4.84	2144.1	1030	146 758
MUT	1.581	0.45	3.51	2011.6	1100	82 580
DPS	1.488	0.269	5.53	141	115	110 014
WHB	1.669	0.16	10.43	341	800	103 339

Stock advice, Reference points, and their technical basis

All stocks are considered overexploited by the recent assessments. In the case of the two gadiforms (European hake and blue whiting) the current fishing mortality to Fmsy ratio is around 10.

The framework used for the reference points is summarised in the table Table 2.3.2.2, taken from STECF 13-22 (EWG 13-09), STECF 14-17 (EWG 14-09) and STECF 15-11 (EWG 15-09). Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Error! Reference source not found. – Reference point framework for demersal stocks in GSA06.

Framework					
	MSY approach			Precautionary approach	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**$B_{lim\ (tons)}$**	**$B_{pa\ (tons)}$**
Technical basis for all stocks	F01 as proxy for Fmsy	From empirical equation (EWG 15-11)		1.4 x B_{loss}	N/A
Values for European hake	**0.15**	**0.21**	**9.771**	**1418**	
Values for blue and red shrimp	**0.36**	**0.49**	**4.838**	**1287**	
Values for red mullet	**0.45**	**0.62**	**3.514**	**883**	
Values for deepwater shrimp	**0.27**	**0.37**	**5.530**	**159**	
Values for blue whiting	**0.16**	**0.22**	**10.433**	**336**	

Development of economic indicators over time and current status

The economic performance of the main fleet segments of the demersal fisheries is evaluated using key social and economic indicators showed in the traffic light table Table 2.3.2.3 (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend. "Recent" refers to 2011-2014).

Note that even if revenues from the main stocks are stable or increasing, the overall fleet revenues are mostly negative because the dependency of these mixed fleets on the main species is usually low and lesser than 50%. In the recent 2-3 years, the landings and revenues of the main target species are stable or revenues increasing (blue and red shrimp, red mullet), but the size of the fleets in general has been decreasing for a period of more than 10 years, and overall revenues, employment and salaries have in general decreased for demersal fleets. CR.BER and ROI show a recent positive trend.

Tab. 2.3.2.3 Traffic light table on the economic performance of the fleets targeting demersal resources (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend; white= does not apply). The values in the cells are referred to 2011 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

	Salary (Euro)	CR/BER	ROI	Overall Revenues (thousand Euro)	Revenues HKE (thousand Euro)	Revenues ARA (thousand Euro)	Revenues MUT (thousand Euro)	Revenues DPS (thousand Euro)	Revenues WHB (thousand Euro)	Employment (number of units)
All fleets	12734÷8596	2.15÷2.45	(-0.11÷0.06)	186700÷174254	18577÷17224	16770÷17597	24475÷32278	3231÷2981	18077÷20736	5430÷4480
ESP06_DTS_12-18	18390÷14062	0.87÷1.67	(-0.03÷0.04)	41164÷38977	3778÷3503	4096÷4298	6095÷7161	789÷728	4416÷5065	1116÷1001
ESP06_DTS_18-24	39515÷30216	0.78÷1.57	(-0.04÷0.05)	88541÷83751	8118÷7527	8802÷9236	13098÷15387	1696÷1565	9488÷10884	2399÷2151
ESP06_DTS_24-40	17380÷13290	3.32÷ 4.02	(-0.05÷0.06)	38904÷36837	3571÷331	3872÷4062	5761÷6768	746÷688	4173÷4787	1055÷946
ESP06_DFN_06-12	3561÷1717	3.15÷4.10	(-0.19÷0.07)	5051÷4081	864÷801		1394÷1638			239÷106
ESP06_DFN_12-24	2880÷1389	3.07÷4.05	(-0.15÷0.08)	4086÷3301	699÷648		1127÷1325			193÷86
ESP06_HOK_06-12	4043÷3478	3.01÷4.15	(-0.14÷0.05)	4934÷3986	844÷782					234÷104
ESP06_HOK_12-18	3367÷2897	3.03÷4.25	(-0.20÷0.04)	4109÷3320	703÷652					195÷86

2.3.3. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

Fmsy objectives can be achieved by reducing fishing mortality of the fleets in order to avoid the catch of juvenile fish. Because bottom trawl has the largest amount of demersal catches in the area and the highest contribution to fishing mortality of juveniles, Fmsy objectives can only be achieved by strongly reducing the impact of this fleet on the target species.

The reduction of current high fishing mortality rates can be achieved, in general, by reducing effort (understood as the combination of activity and capacity) or improving selectivity patterns. A mixed strategy combining effort reduction and selectivity improvement could also be effective and it is explored here. In the next section (section 2.3.4) the scenarios tested are detailed.

Among the capacity reduction schemes, current legislation in GSA 06 ("Orden AAA/2808/2012") calls for a reduction in 20% of fishing capacity (number of vessels) from 2013 to 2017. The reduction in terms of activity is not specified in legislation, so the scenarios of effort reduction assume a reduction of F split in 20% due to capacity reduction and 80% activity reduction (number of fishing days[8]).

Selectivity improvement was explored here by assuming that length at first capture is postponed by 2 cm from the current selection patterns corresponding to SM40. Current selection ogives were constructed from a variety of published results (Bahamón et al., 2006; Guijarro and Massutí, 2006; Sala et al., 2008) based on the logistic model for the target species of this study. It is important to note that the effect of delaying the length at first catch on the population can be achieved by a variety of technical means (improving trawl selectivity, reducing fishing in nursery areas or temporarily closing the fishery at specific times of the year). In the present study, the selection curve on lengths was transformed to a selection curve on age following the standard procedure of applying the von Bertalanffy inverse model (Sparre and Venema, 1998).

2.3.4. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term; the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term; the reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range.

Proposed scenarios are reported in the table 2.3.4.1.

Table 2.3.4.1 – Scenarios modelling for the forecasts.

[8] because fishing trips last only one day (more precisely, a maximum of 12 h), fishing trips and fishing days are made equivalent in this section.

Case Study	demersals in GSA 6
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using value of landings as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using value of landings for weighting) in 2020 applied only on activity from 2018 to 2020. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity accounting for the survivability issue (in case of gear selectivity). Starting year 2015.

Strategy and timeframe to reach the RP

The five stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on F levels, European hake and blue whiting are the most heavily exploited stocks in the mix. European hake has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA06, as well as in other Mediterranean areas.

The percentages of reduction by stock to reach F_{MSY} are reported in the table 2.3.4.2.

The percentages of reduction were based on the advices from STECF that indicated the needing of reaching F_{MSY}, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). In addition, the official Spanish management plan calls for a reduction in capacity of 20% by 2017 (compared to the capacity of 1st Jan 2014). Note that the management plan does not specify the distribution of capacity reduction among fleet segments.

Tab. 2.3.4.2 – Fishing mortality reduction needed to reach Fupper, by stock.

Stock	Fishing mortality reduction (in %)
HKE	90%
ARA	79%
MUT	72%
DPS	82%
WHB	90%

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Under Scenarios 2 and 4 (in the sections 2.3.8.1 and 2.3.8.3, respectively) the reduction of fishing mortality is assumed on the most overexploited species (European hake) to ensure that all species are fished at Fmsy at the target year (2018 or 2020). The target has been thus the Fupper of European hake, which value is 0.210.

A second set of scenarios (Scenarios 3 and 5 in the sections 2.3.8.2 and 2.3.8.4, respectively) propose a reduction in fishing effort proportionally applied to the different fleet segments, accounting for their relative impact, to a weighted overall Fmsy (value of landings as weighting factor, as in the approach used for Balance Indicators). Due to the low value of the production of artisanal fishing gears (longline and nets) the weighting factor of these fleets was combined. In the table 2.3.4.2 the relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of each stock by fleet segment for 2014. The combined Fmsy target computed on the basis of Fmsy by species was 0.218.

Tab. 2.3.4.2 – Relative impact on the assessed stocks of the 4 fleet segment strata.

	ARA	HKE	MUT	DPS	WHB
DFN + HOK		0.01	0.13		
DTS_VL1218	0.02	0.13	0.28	0.10	0.05
DTS_VL1824	0.28	0.29	0.28	0.28	0.30
DTS_VL2440	0.70	0.58	0.31	0.62	0.65
	1.00	1.00	1.00	1.00	1.00

2.3.5. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is MEPHISTO bio-economic model (cfr chapter 2.1).

2.3.6. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA06

All the inputs for modelling are fully reported in the Annex B.

2.3.7 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.3.7.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

The projection of the demersal fishery under current conditions from 2015 to 2030 is shown in the following figures (2.3.7.1.1 to 2.3.7.1.5).

For each species, the variables shown are the standard quantities produced in SGMED working groups: average fishing mortality (F, yr^{-1}), recruitment (R, thousands), spawning stock biomass (SSB, tons) and catches (Yield, tons).

In all figures the vertical grey bar separates the historical (2002 – 2014) data series from the projected (2015 – 2030) series. In the SSB panel, a horizontal line shows the reference point limit SSB (Blim, estimated at 1.4 times the lowest observed SSB, Bloss).

All projections were carried out with constant recruitment (average of last 4 years) with 95% confidence interval given by the standard deviation of the historical recruitment series, following a lognormal model.

The simulation results in Fig. 2.3.7.1.1 indicate that the projection of status quo conditions for hake (fixed fishing mortality and low recruitment) would result in SSB slightly higher than recent values over the simulation period 2015-2030, while catches would vary around historically mean observed catches. This is a direct result of the population numbers estimated by stock assessment in the recent years (see trends before 2015), the assumption of constant recruitment around a mean (i.e the absence of a SSB/R relationship) and fixed F.

The simulation results in Fig. 2.3.7.1.2 indicate that the projection of status quo conditions for blue and red shrimp (fixed fishing mortality and recruitment around typical values observed) would result in SSB slightly higher than recent values over the simulation period 2015-2030, and high catches continuing the progression observed in the last decade.

The simulation results in Fig. 2.3.7.1.3 indicate that the projection of status quo conditions for red mullet (fixed fishing mortality and recruitment around typical values observed) would result in high SSB and catches, continuing the observed recent trend in the series, over the simulation period 2015-2030.

The simulation results in Fig. 2.3.7.1.4 indicate that the projection of status quo conditions for deep-water pink shrimp (fixed fishing mortality and recruitment around typical values observed) would result in SSB slightly higher than recent values over the simulation period 2015-2030, continuing with the increasing trend observed since 2003, and catches of the same order than the average catches observed in the last decade.

The simulation results in Fig. 2.3.7.1.5 indicate that the projection of status quo conditions for blue whiting (fixed fishing mortality on the lower range of that historically observed and recruitment around typical values observed) would result in rebuild of SSB towards the high values observed in the recent series (2009) over the simulation period 2015-2030, while catches would be of the same order than the average catches observed in the historical series.

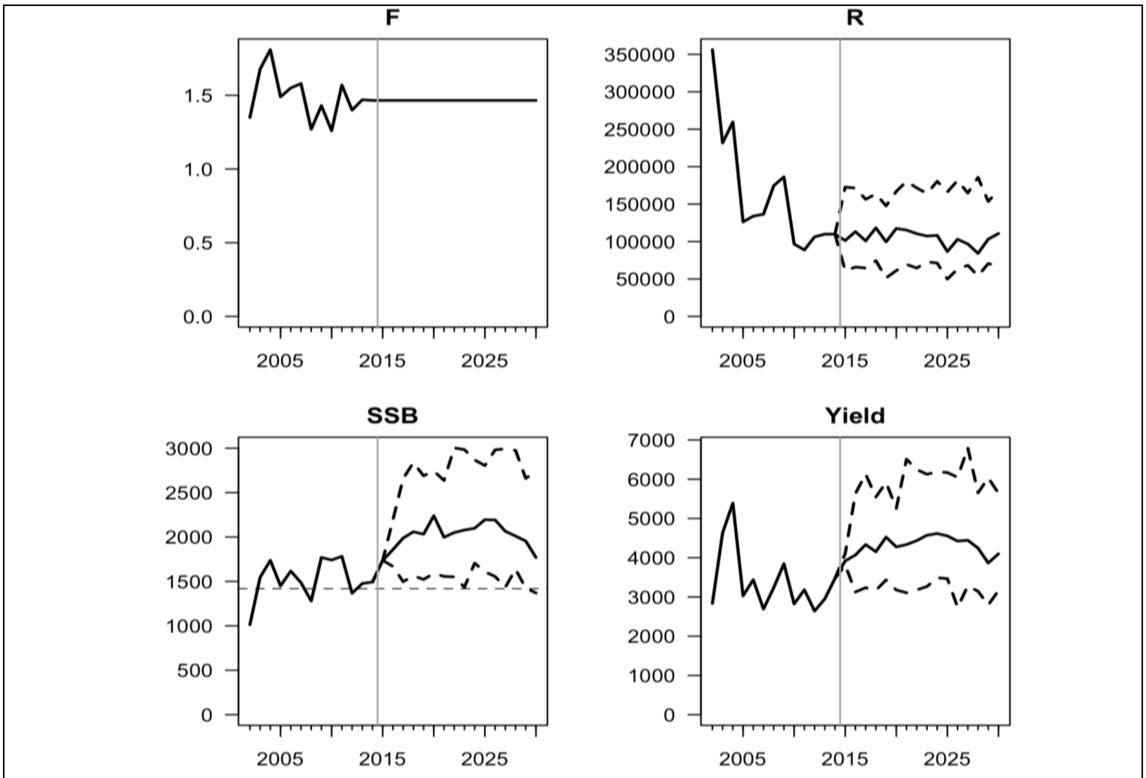


Fig. 2.3.7.1.1. European hake in GSA 06, Scenario 1. Biological and pressure variables

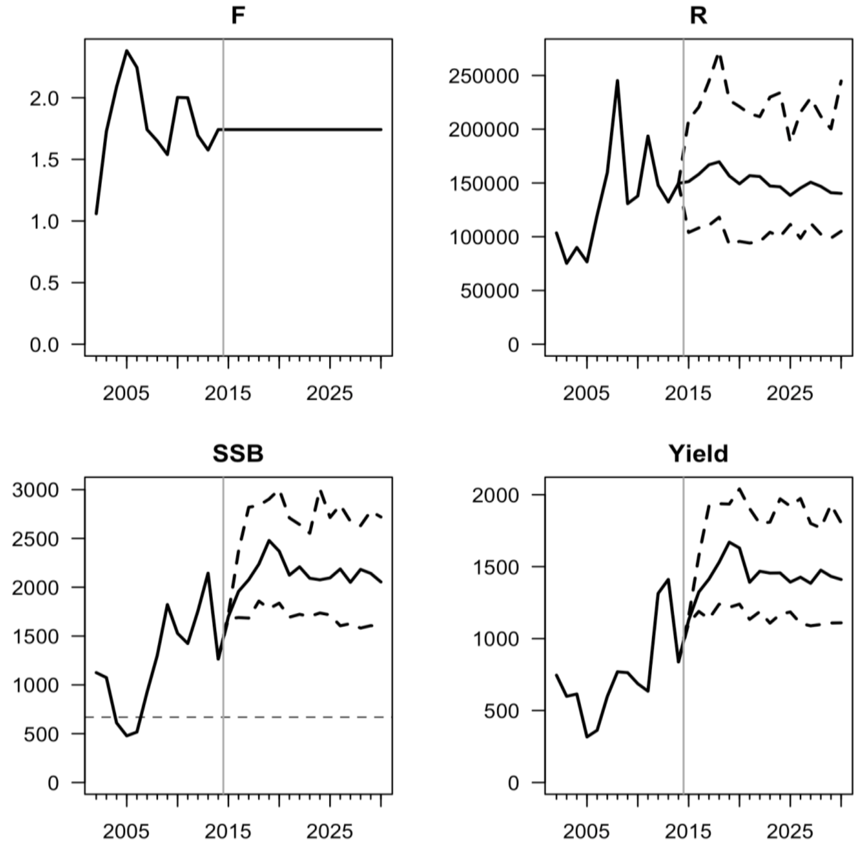


Fig. 2.3.7.1.2. Blue and red shrimp in GSA 06, Scenario 1. Biological and pressure variables

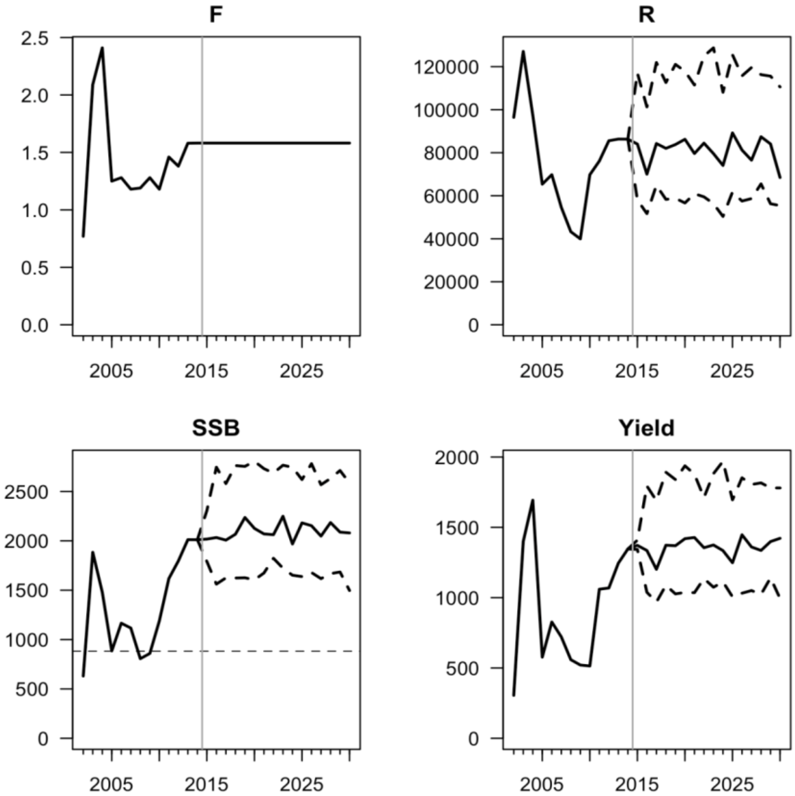


Fig. 2.3.7.1.3. Red mullet in GSA 06, Scenario 1. Biological and pressure variables

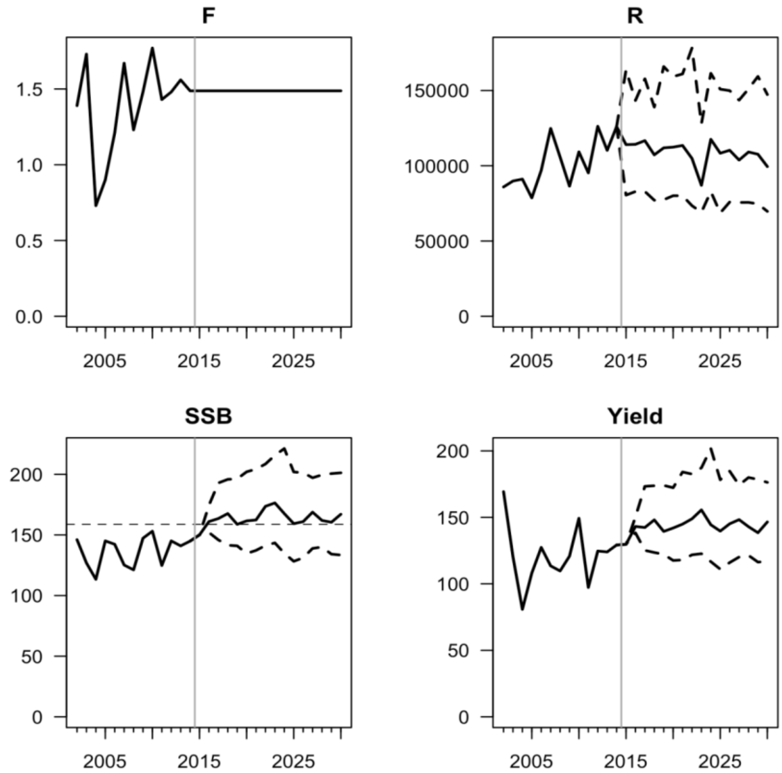


Fig. 2.3.7.1.4. Deep water pink shrimp in GSA 06, Scenario 1. Biological and pressure variables

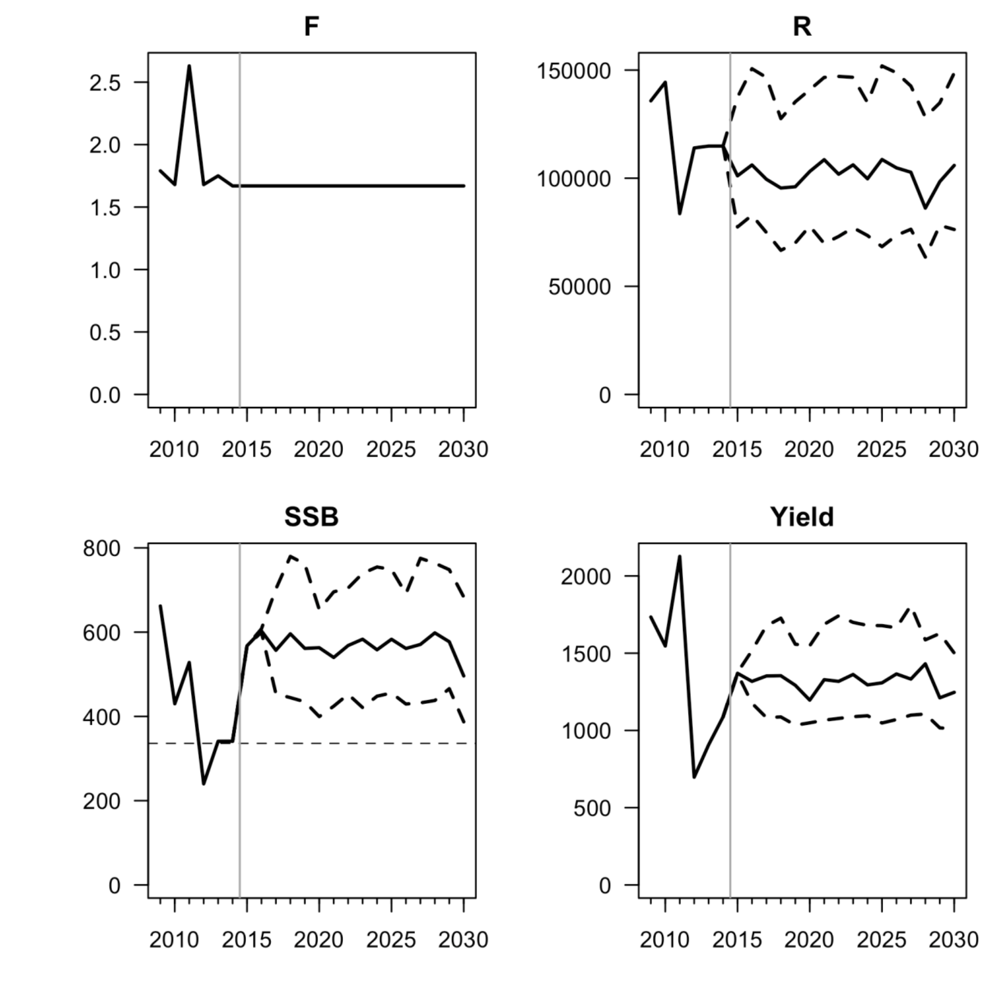


Fig. 2.3.7.1.5. Blue whiting in GSA 06, Scenario 1. Biological and pressure variables

2.3.7.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

The output of the Economic indicators under Scenario for all fleets combined are reported in the figure 2.3.7.2.1.

The simulation results in Fig. 2.3.7.2.1. show the projection of status quo condition for 4 selected socio-economic indicators compared with the (short 2011-2014) historical series.

The income due to landings is expected to stabilize at ca. 200 M€, similar to the value recorded in 2011. Because effort would be frozen at the level of 2014 (projection of status quo fishing mortality in the previous figures 3.4.1 – 3.4.5), effort costs are expected to be on the lowest range observed.

Due to the cost-sharing scheme prevalent in the Mediterranean, increased landing value would translate into increased wages and consequently, labour costs. The forecast high value of landings and the low value of effort costs would result in high gross profits.

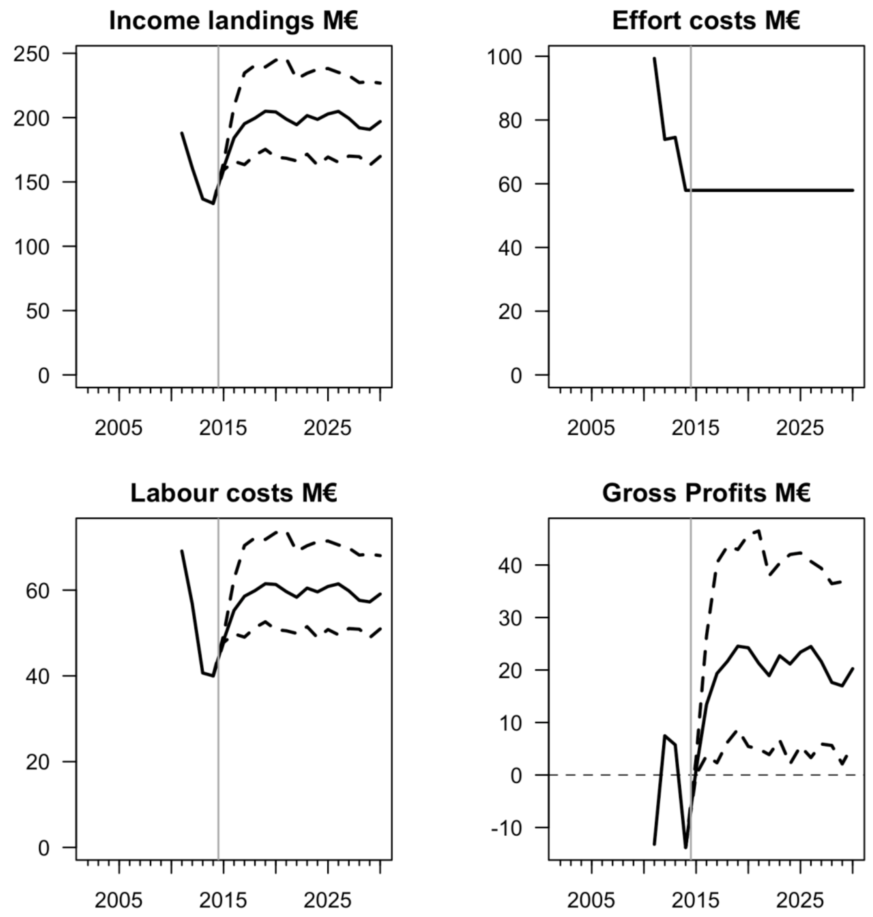


Fig. 2.3.7.2.1. Economic indicators, Scenario 1. All fleets combined.

2.3.8 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

2.3.8.1 SCENARIO 2 LINEAR REDUCTION TOWARDS UPPER FMSY OF THE MOST HEAVILY EXPLOITED IN 2018

European hake was considered the most overexploited species, even if blue whiting has slightly higher ratio Fcurr/Fmsy, because of hake being more represented in terms of catches and value and because it is the species traditionally diagnosed with highest exploitation rates in the Mediterranean (Colloca et al. 2014).

The upper range of hake Fmsy was computed with the empirical formula used in STCEF 15-11 EWG 15-09 :

Fupper = 0.007801555 + 1.349401721*Fmsy, where Fmsy = 0.15. The resulting Fupper is 0.21 for hake.

The Scenario was built by computing an effort vector that ensures that average F of the relevant age classes (1-4 for hake) is 0.21 by 2018.

The effort reduction to achieve the objective in 2018 (table 2.3.8.1.1) was carried out by first computing a global vector of effort (days at sea * number of vessels) that ensures the target F and then allocating this vector among fleet segments (conditioned to a maximum capacity reduction of 20% by fleet segment by 2017), as capacity reduction, and distributing the remaining days (activity) proportionally among fleet segments. Number of vessels and number of fishing days permitted to reach the target are reported in tables 2.3.8.1.2 and 2.3.8.1.3.

Table 2.3.8.1.1 Effort reduction required to achieve target

yr	Effort (days at sea x vessel)
2014	72318
2015	56832
2016	41345
2017	25859
2018	10372
2019	10373
2020	10374

Table 2.3.8.1.2. Number of vessels required to achieve target, conditioned to current management plan (20% capacity reduction by 2017).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK0612	HOK1218	Demersal fleet
2014	400	300	124	253	113	90	47	1327
2015	373	280	116	236	105	84	44	1238
2016	347	260	107	219	98	78	41	1150
2017	320	240	99	202	90	72	38	1061
2018	320	240	99	202	90	72	38	1061
2019	320	240	99	202	90	72	38	1061
2020	320	240	99	202	90	72	38	1061

Table 2.3.8.1.3. Number of days permitted by fleet segment to achieve target (having deducted the number of days lost corresponding to the 20% capacity reduction).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK0612	HOK1218	Demersal fleet
2014	6211	5017	13565	29153	12821	3027	2523	72318
2015	4876	3943	10689	22895	10023	2379	1990	56795
2016	3556	2869	7704	16637	7338	1731	1457	41291
2017	2221	1794	4829	10378	4539	1082	924	25768
2018	891	720	1924	4136	1794	434	383	10281
2019	891	720	1924	4136	1794	434	383	10281
2020	891	720	1924	4136	1794	434	383	10281

OUTPUTS OF BIOLOGICAL AND PRESSURE INDICATORS

Outputs of the biological and pressure indicators are reported in figures from 2.3.8.1.1 to 2.3.8.1.5.

Fig. 2.3.8.1.1 shows that under Scenario 2, the strong decrease in fishing mortality of hake and the condition of low, stable recruitment would result in very high SSB after year 2020 (more than 10 times compared to Scenario 1, Fig. 2.3.7.1.1) and very high catches (5-6 times compared to Scenario 1), after a transition period (2017-2019) of low catches.

Fig. 2.3.8.1.2 shows that under Scenario 2, the strong decrease in fishing mortality of blue and red shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 (more than 2 times compared to Scenario 1, 2.3.7.1.2) and catches on the lower range of those projected for Scenario 1, after a transition period (2017-2019) of low catches.

Fig. 2.3.8.1.3 shows that under Scenario 2, the strong decrease in fishing mortality of red mullet and the condition of average, stable recruitment would result in very high SSB after year 2020 (around 3 times compared to Scenario 1, Fig. 2.3.7.1.3) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of low catches (on the lower end than the observed catches).

Fig. 2.3.8.1.4 shows that under Scenario 2, the strong decrease in fishing mortality of deep water pink shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 (more than 4 times compared to Scenario 1, Fig. 2.3.7.1.4) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of catches less than half of the catches projected under Scenario 1.

Fig. 2.3.8.1.5 shows that under Scenario 2, the strong decrease in fishing mortality of blue whiting and the condition of average, stable recruitment would result in very high SSB after year 2020 (around 10 times compared to Scenario 1, Fig. 2.3.7.1.5) and catches similar to those projected for Scenario 1, after a transition period (2017-2019) of low catches, corresponding to less than half the projected catches in Scenario 1.

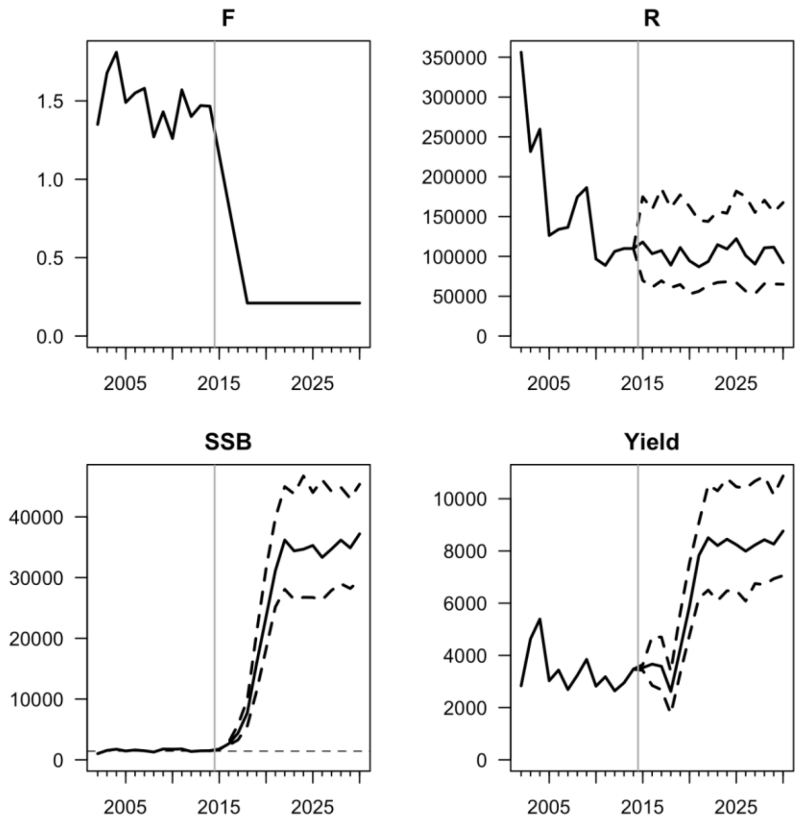


Fig. 2.3.8.1.1. European hake in GSA 06, Scenario 2. Biological and pressure variables

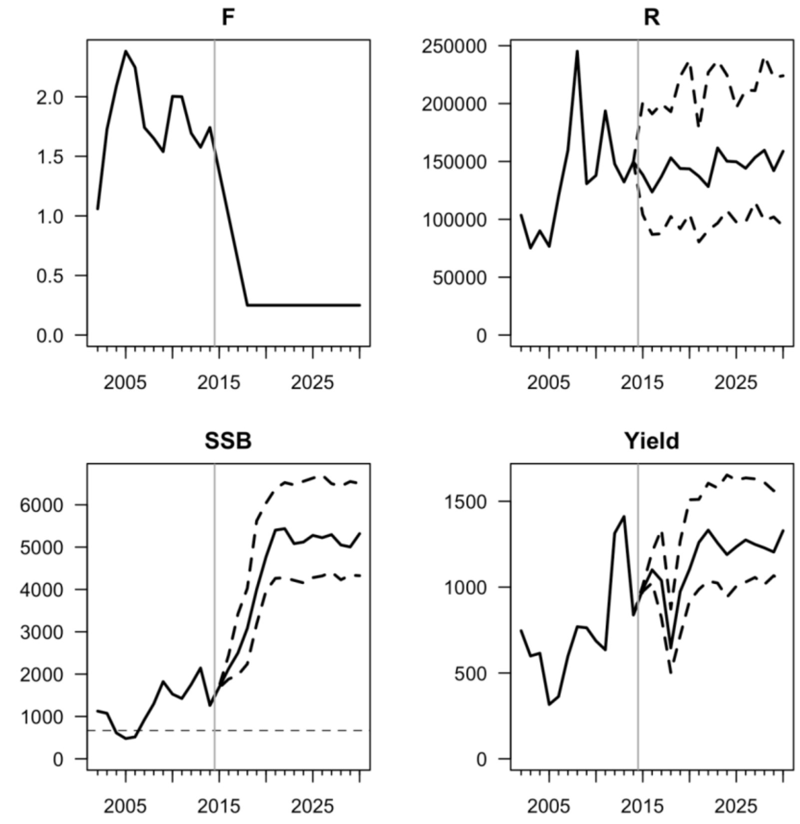


Fig. 2.3.8.1.2. Blue and red shrimp in GSA 06, Scenario 2. Biological and pressure variables

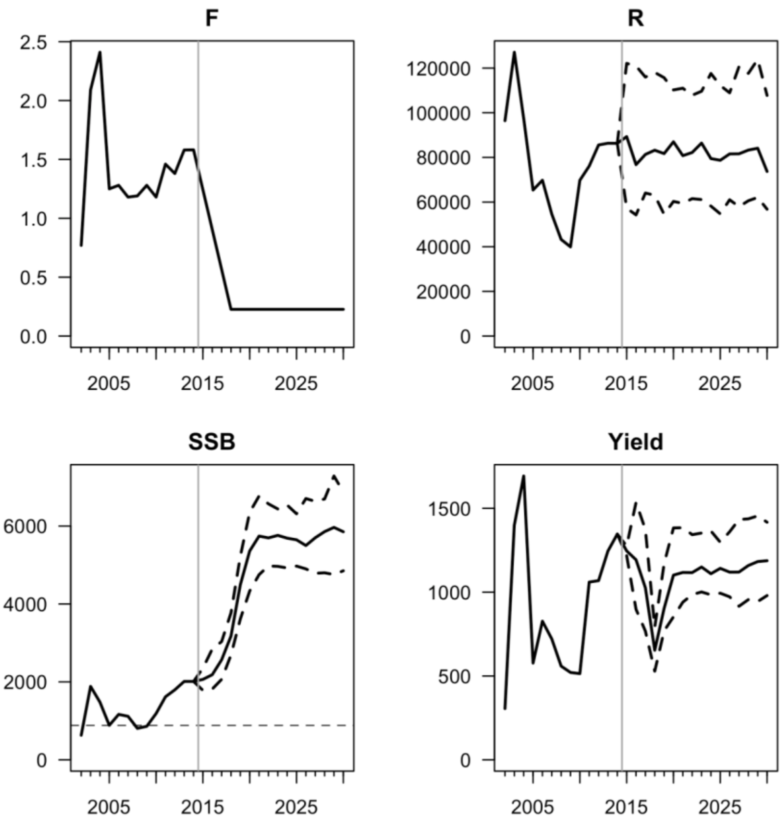


Fig. 2.3.8.1.3 Red mullet in GSA 06, Scenario 2. Biological and pressure variables

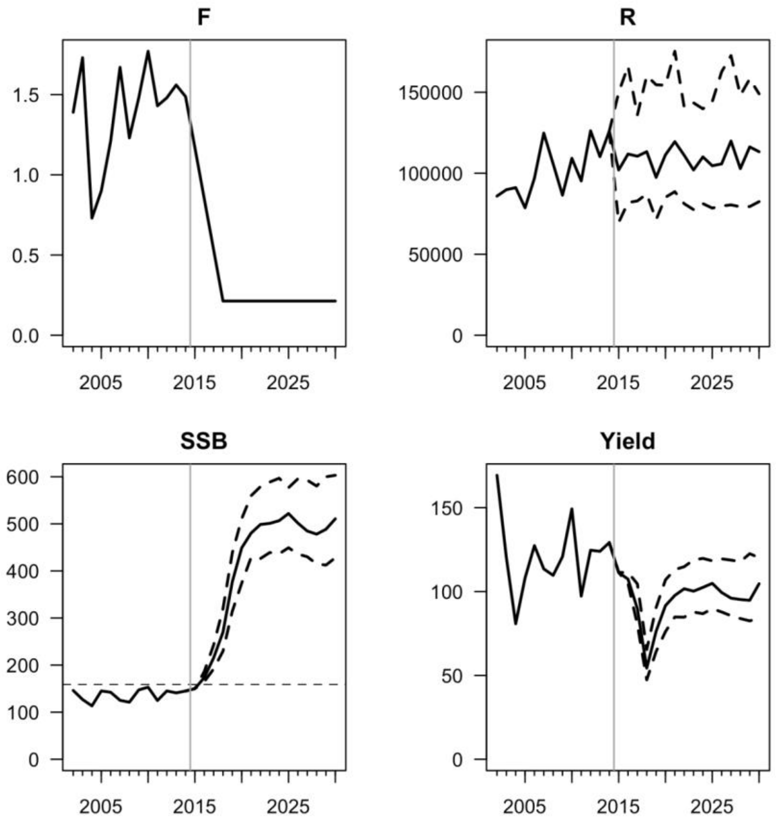


Fig. 2.3.8.1.4 Deep water pink shrimp in GSA 06, Scenario 2. Biological and pressure variables

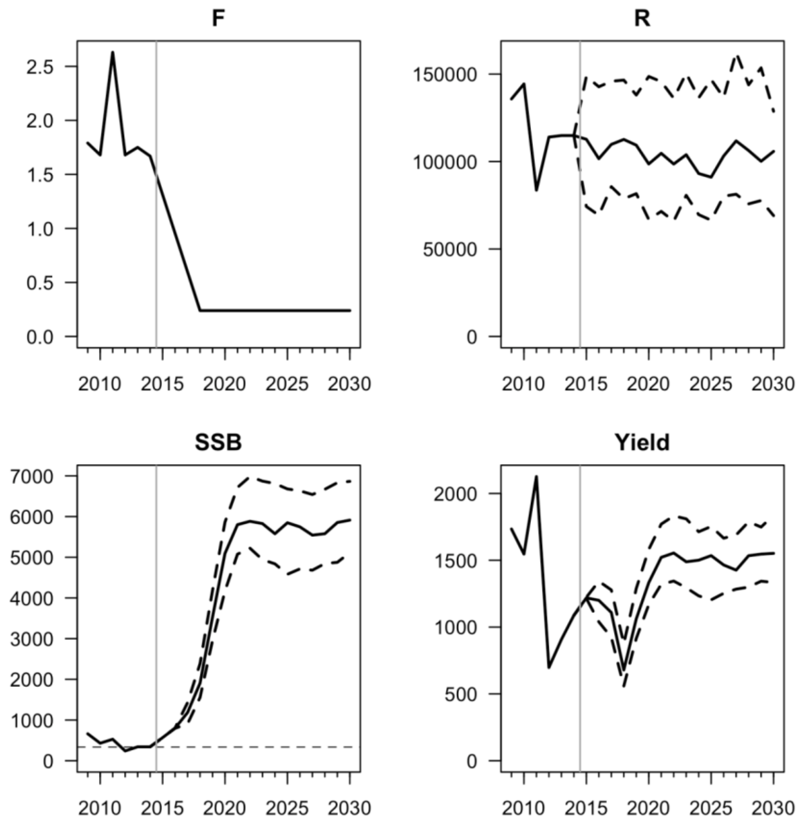


Fig. 2.3.8.1.5. Blue whiting in GSA 06, Scenario 2. Biological and pressure variables

OUTPUTS OF THE ECONOMIC INDICATORS

Outputs of the economic indicators for all fleets combined are reported in figure 2.3.8.1.6.

Fig. 2.3.8.1.6 shows that the income from landings would stabilize around 250 M€ after 2020 (higher than under Scenario 1), with a transition period with a low 100 M€ in 2017. However, due to the very low effort costs corresponding to this Scenario, profits are expected to increase considerably, with a corresponding increase in wages (reflected as labour costs). However, the lowest point in income corresponding to year 2017 would represent a decrease in labour costs to a value of half the forecast labour costs under Scenario 1.

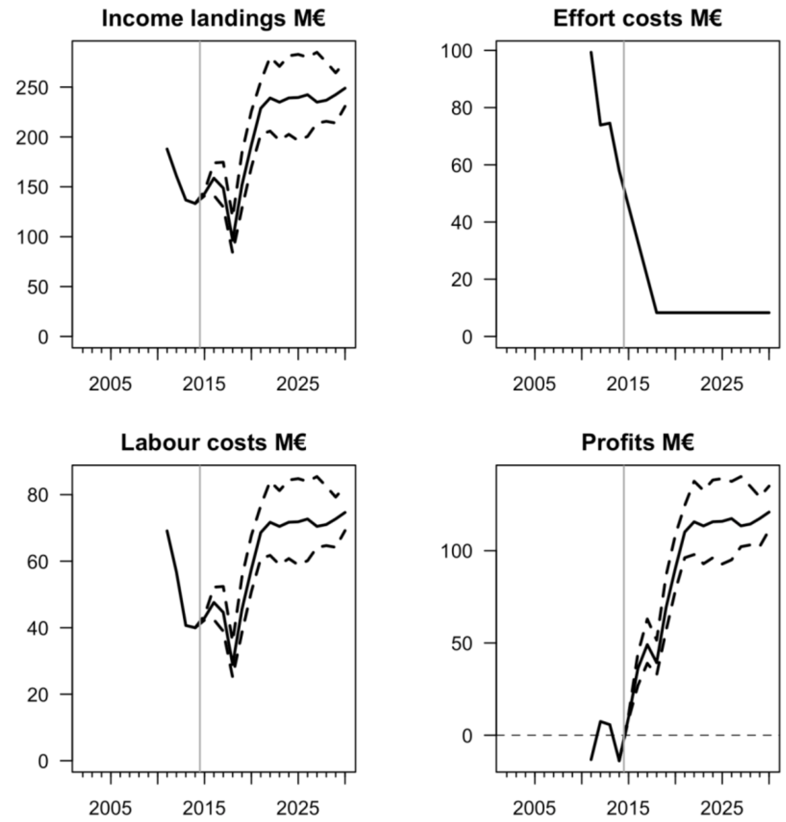


Fig. 2.3.8.1.6. Economic indicators, Scenario 2. All fleets combined.

2.3.8.2 SCENARIO 3 LINEAR REDUCTION TOWARDS A WEIGHTED AVERAGE FMSY IN 2018

A linear reduction towards Fmsy in 2018 taking into account the mixed nature of the fishery was performed by weighting the Fmsy of individual species by their importance in the value of landings, according to the following table 2.3.8.2.1.

Table 2.3.8.2.1. Effort reduction required to achieve target

yr	Effort (days at sea x vessel)
2014	72318
2015	55531
2016	38743
2017	21956
2018	5169
2019	5169
2020	5169

Due to the low value of the production of artisanal fishing gears (longline and nets) the weighting factor was combined. The following table 2.3.8.2.2 shows how the two largest trawl segments are responsible for 50% or more of the fishing mortality applied to all stocks. Only red mullet is significantly impacted by small trawlers and artisanal fishing gear. Note that ARA, DPS and WHB are continental slope resources not impacted by artisanal fishing gears.

Table 2.3.8.2.2. Proportion of fishing mortality on each target species by fleet segment. To achieve the target weighted Fmsy, a reduction factor averaging the contribution of each fleet segment is computed.

	ARA	HKE	MUT	DPS	WHB	reduction factor
DFN + HOK		0.01	0.13			0.07
DTS_VL1218	0.02	0.13	0.28	0.1	0.05	0.11
DTS_VL1824	0.28	0.29	0.28	0.28	0.3	0.27
DTS_VL2440	0.7	0.58	0.31	0.62	0.65	0.55
	1	1	1	1	1	1

Table 2.3.8.2.2 shows that large trawlers (DTS_VL2440) are responsible for 55% of the fishing mortality in excess of a weighted Fmsy, so the capacity reductions shown in Table. 2.3.8.2.1 (Scenario 2) are weighted accordingly, as shown in Table 2.3.8.2.3. Because this algorithm produced negative values for the largest trawlers, this fleet was set to 0 and the corresponding capacity reduction split between the other two trawl segments.

Table 2.3.8.2.3. Number of vessels required to achieve target, conditioned to current management plan (20% capacity reduction by 2017).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK0612	HOK1218	demersal fleet
2014	400	300	124	253	113	90	47	1327
2015	399	299	114	229	64	89	46	1238
2016	397	297	104	205	16	87	44	1150
2017	396	296	92	150	0	86	43	1061
2018	396	296	92	150	0	86	43	1061
2019	396	296	92	150	0	86	43	1061
2020	396	296	92	150	0	86	43	1061

This capacity reduction is insufficient to achieve the target by 2018 and a further reduction in terms of activity and capacity was implemented, as shown in the following table 2.3.8.2.4.

Table 2.3.8.2.4. Number of days permitted by fleet segment to achieve target (having deducted the number of days lost corresponding to the 20% capacity reduction).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK1218	HOK1824	Demersal fleet
2014	6211	5017	13565	29153	12821	3027	2523	72318
2015	4770	3853	10416	22386	9845	2324	1937	55531
2016	3328	2688	7267	15618	6869	1622	1352	38743
2017	1886	1523	4118	12743	0	919	766	21956
2018	444	359	970	3000	0	216	180	5169
2019	444	359	970	3000	0	216	180	5169
2020	444	359	970	3000	0	216	180	5169

Outputs of biological and pressure indicators under Scenario 3 are reported in the following figures from 2.3.8.2.1 to 2.3.8.2.5

Fig. 2.3.8.2.1 shows that under Scenario 3 the projected SSB and catches of hake would have similar trajectories than in the case of Scenario 2, although SSB would stabilize at a higher value (around 50 000 t compared to 35 000 t in Scenario 2). Catches would stabilize at a lower value (around 6 000 t) but the transition period in 2017-2019 would produce lower catches than in Scenario 2 and, naturally, than in Scenario 1.

Fig. 2.3.8.2.2 shows that under Scenario 3, the strong decrease in fishing mortality of blue and red shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 (although lower than in Scenario 2, Fig. 2.3.8.1.2) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of low catches, similar to the lowest values observed in the series (corresponding to year 2004-2005).

Fig. 2.3.8.2.3 shows that under Scenario 3, the strong decrease in fishing mortality of red mullet and the condition of average, stable recruitment would result in very high SSB after year 2020 (slightly higher than in Scenario 2, Fig. 2.3.8.1.3) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of even lower catches, similar to the low values observed in the series.

Fig. 2.3.8.2.4 shows that under Scenario 3, the strong decrease in fishing mortality of deep water pink shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 and catches lower than those projected for Scenario 1, well under the lowest values observed in the historical series.

Fig. 2.3.8.2.5 shows that under Scenario 3, the strong decrease in fishing mortality of blue whiting and the condition of average, stable recruitment would result in very high SSB after year 2020 (even higher than in Scenario 2, Fig. 2.3.8.1.5) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of very low catches.

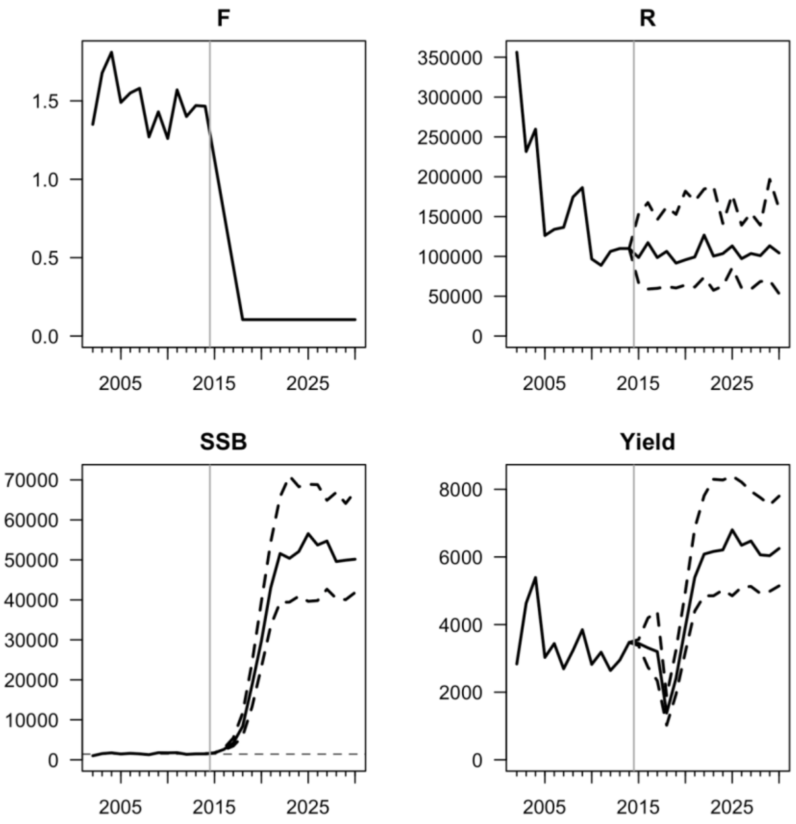


Fig. 2.3.8.2.1. European hake in GSA 06, Scenario 3. Biological and pressure variables

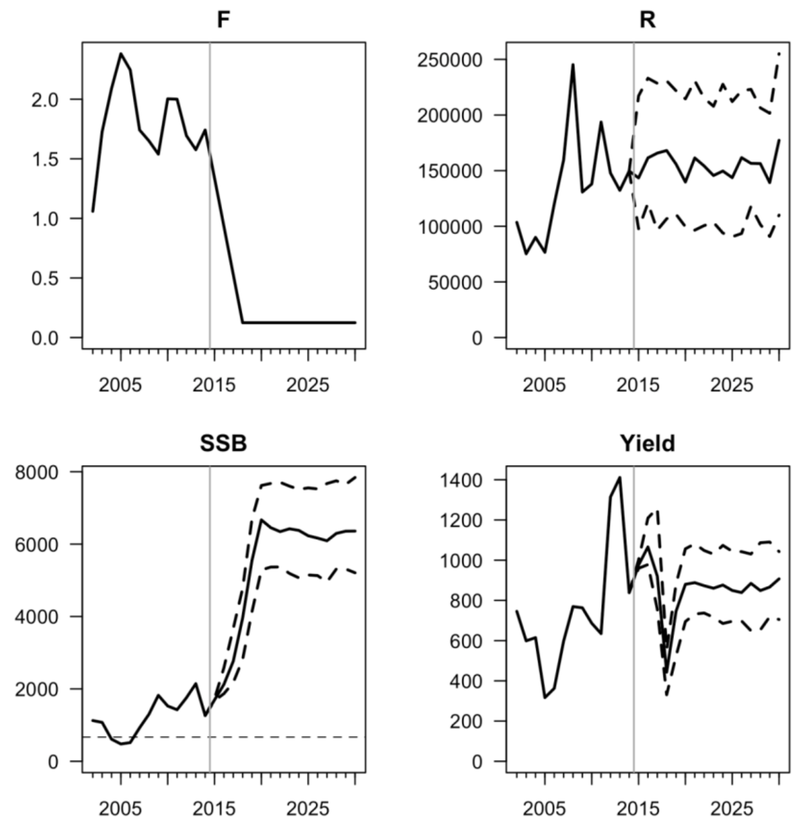


Fig. 2.3.8.2.2. Blue and red shrimp in GSA 06, Scenario 3. Biological and pressure variables

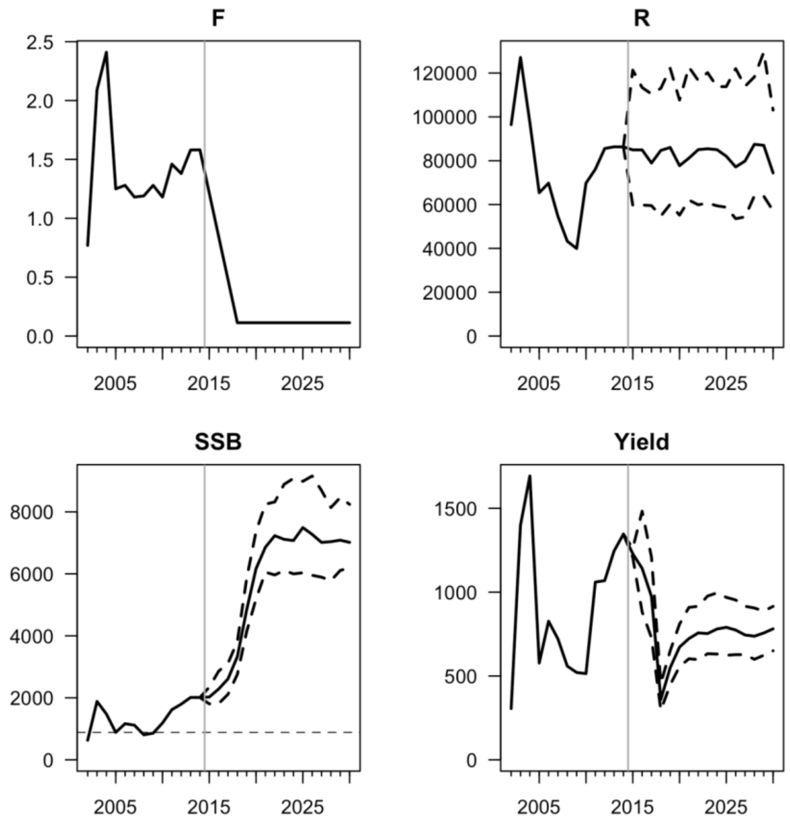


Fig. 2.3.8.2.3. Red mullet in GSA 06, Scenario 3. Biological and pressure variables

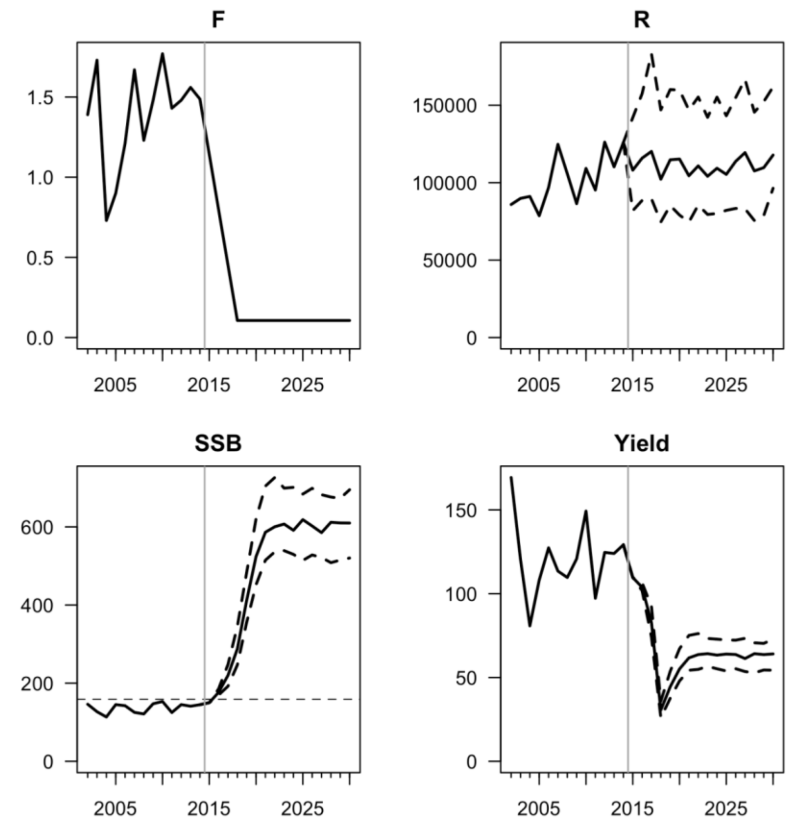


Fig. 2.3.8.2.4. Deep water pink shrimp in GSA 06, Scenario 3. Biological and pressure variables

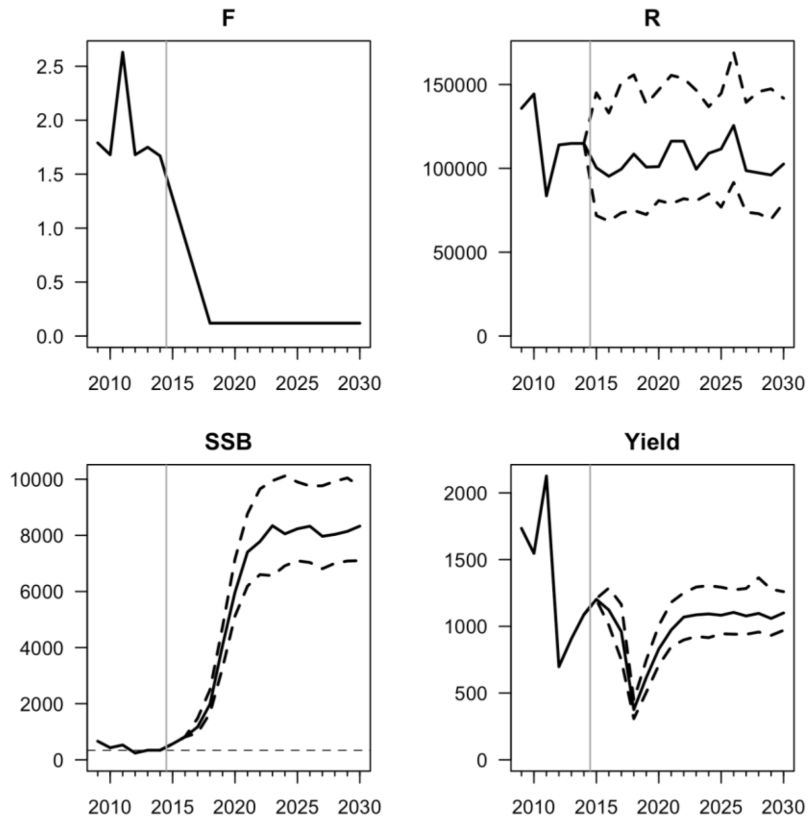


Fig. 2.3.8.2.5. Blue whiting in GSA 06, Scenario 3. Biological and pressure variables.

OUTPUTS OF ECONOMIC INDICATORS

Outputs of the economic indicators for all the fleets combined are reported in the figure 2.3.8.2.6.

Fig. 2.3.8.2.6 shows that the income from landings would stabilize around 175 M€ after 2020 (lower than under Scenario 1), with a transition period of low income of less than 100 M€ in 2017. However, due to the very low effort costs corresponding to this Scenario, profits are expected to increase considerably, with a corresponding increase in wages (reflected as labour costs). However, the lowest point in income corresponding to year 2017 would represent a decrease in labour costs to a value less than the half the forecast labour costs under Scenario 1.

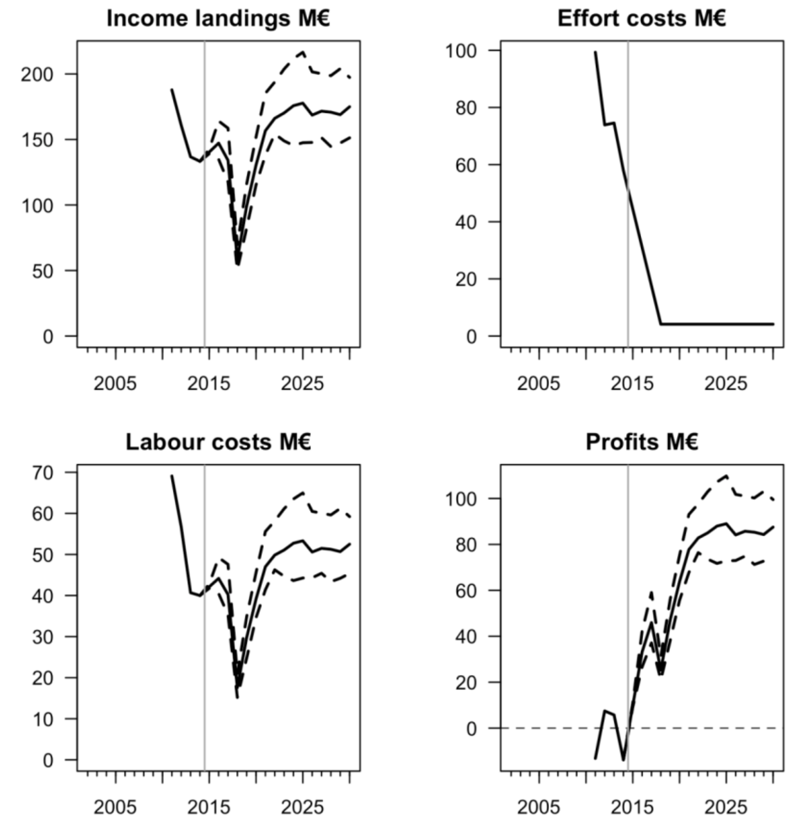


Fig. 2.3.8.2.6. Economic indicators, Scenario 3. All fleets combined.

2.3.8.3 SCENARIO 4. ADAPTIVE REDUCTION TOWARDS UPPER FMSY OF THE MOST HEAVILY EXPLOITED SPECIES IN 2020

Similarly to Scenario 2, hake was considered the most overexploited species, even if blue whiting has slightly higher ratio Fcurr/Fmsy. The upper range of hake Fmsy was computed with the empirical formula used in STCEF 15-11 EWG 15-09:

Fupper = 0.007801555 + 1.349401721*Fmsy, where Fmsy = 0.15. The resulting Fupper is 0.21 for hake.

The Scenario was built by computing an effort vector that ensures that average F of the relevant age classes (1-4 in hake) is 0.21 by 2020.

The effort reduction to achieve the objective in 2020 was carried out by first computing a global vector of effort (days at sea x number of vessel; table 2.3.8.3.1) that ensures the target F and then allocating this vector among fleet segments (conditioned to a maximum capacity reduction of 20% by fleet segment by 2017), as capacity reduction, and distributing the remainder days (activity) proportionally among fleet segments.

Table 2.3.8.3.1. Effort reduction required to achieve target

yr	Effort (days at sea x vessel)
2014	72318
2015	61492
2016	50665

2017	39839
2018	29012
2019	18186
2020	7360

The number of vessels required to achieve target, conditioned to current management plan (20% capacity reduction by 2017) is the same as in Scenario 2 and reported in Table 2.3.8.1.1.

Table 2.3.8.3.2. reports the number of days permitted by fleet segment to achieve target.

Table 2.3.8.3.2. Number of days permitted by fleet segment to achieve target (having deducted the number of days lost corresponding to the 20% capacity reduction).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK0612	HOK1218	Demersal fleet
2014	6211	5017	13565	29153	12821	3027	2523	72318
2015	5278	4264	11527	24774	10895	2572	2144	61492
2016	4347	3511	9493	20403	8973	2118	1766	50665
2017	3414	2758	7456	16023	7047	1664	1387	39839
2018	2484	2007	5425	11659	5127	1211	1009	29012
2019	1554	1255	3394	7295	3208	757	631	18186
2020	624	504	1363	2930	1289	304	254	7360

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Outputs of the biological and pressure indicators for the scenario 4 are reported from the figure 2.3.8.3.1 to the figure 2.3.8.3.5.

Fig. 2.3.8.3.1 shows that under Scenario 4, the strong decrease in fishing mortality of hake and the condition of low, stable recruitment would result in very high SSB after year 2020 (almost 20 times compared to Scenario 1, Fig. 2.3.7.1.1) and high catches (twice compared to Scenario 1), after a transition period (2017-2019) of low catches, in the range of the average historically observed catches (3000 t).

The simulation results in Fig. 2.3.8.3.2 indicate that the projection of status quo conditions for blue and red shrimp (fixed fishing mortality and recruitment around typical values observed) would result in SSB more than twice as high as those projected under Scenario 1, but catches lower than those predicted under Scenario 1.

Fig. 2.3.8.3.3 shows that under Scenario 4, the strong decrease in fishing mortality of red mullet and the condition of average, stable recruitment would result in very high SSB after year 2020 (around 3 times compared to Scenario 1, Fig. 2.3.7.1.3) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of low catches (of similar values than the historically average observed catches) (these results are similar to the results of Scenario 2 for this species)

Fig. 2.3.8.3.4 shows that under Scenario 4, the strong decrease in fishing mortality of deep water pink shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 (more than 4 times compared to Scenario 1, , Fig. 2.3.7.1.4) and catches lower than those projected for

Scenario 1, after a transition period (2017-2019) of catches less than half of the catches projected under Scenario 1 (these results are similar to the results of Scenario 2 for this species).

Fig. 2.3.8.3.5 shows that under Scenario 4, the strong decrease in fishing mortality of blue whiting and the condition of average, stable recruitment would result in very high SSB after year 2020 (around 10 times compared to Scenario 1, Fig. 2.3.7.1.5) and catches similar to those projected for Scenario 1, after a transition period (2017-2019) of low catches, corresponding to less than half the projected catches in Scenario 1 (these results are similar to the results of Scenario 2 for this species).

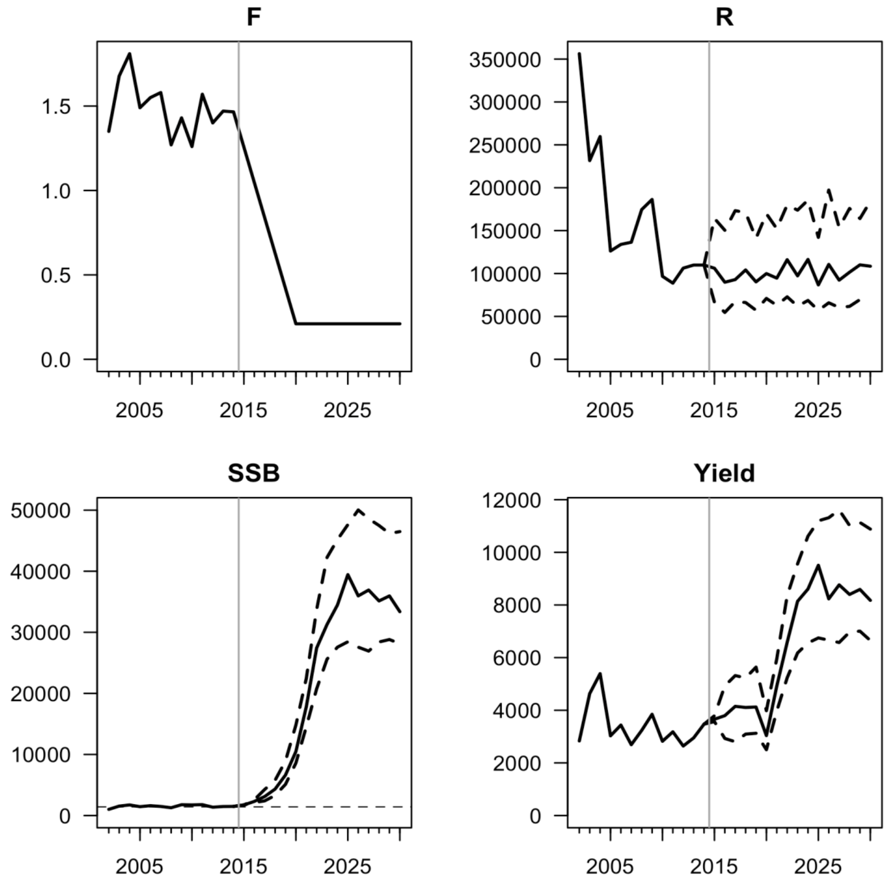


Fig. 2.3.8.3.1. European hake in GSA 06, Scenario 4. Biological and pressure variables

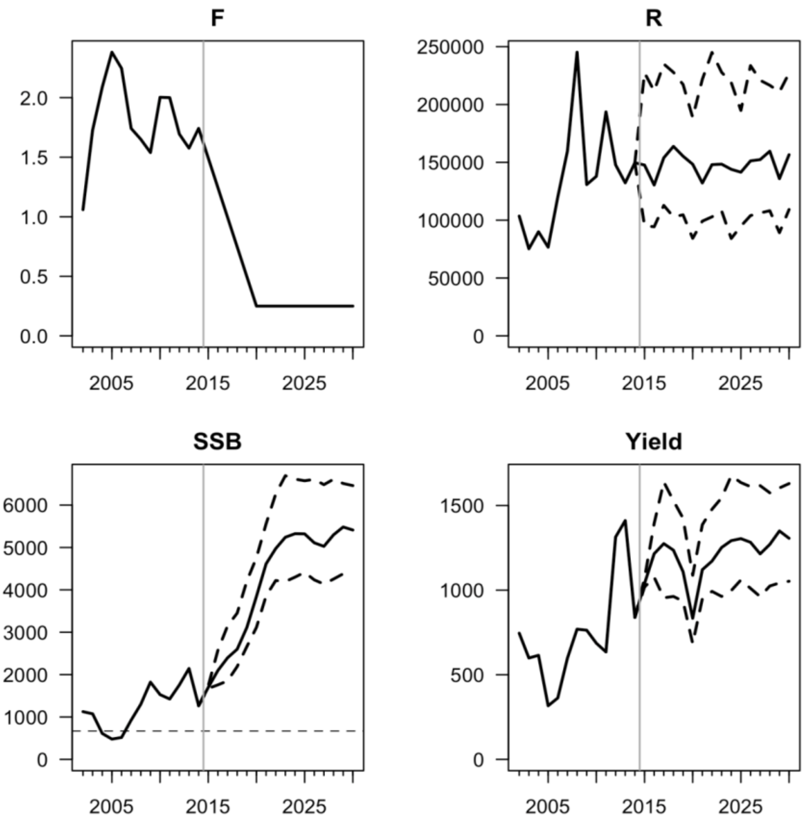


Fig. 2.3.8.3.2. Blue and red shrimp in GSA 06, Scenario 4. Biological and pressure variables

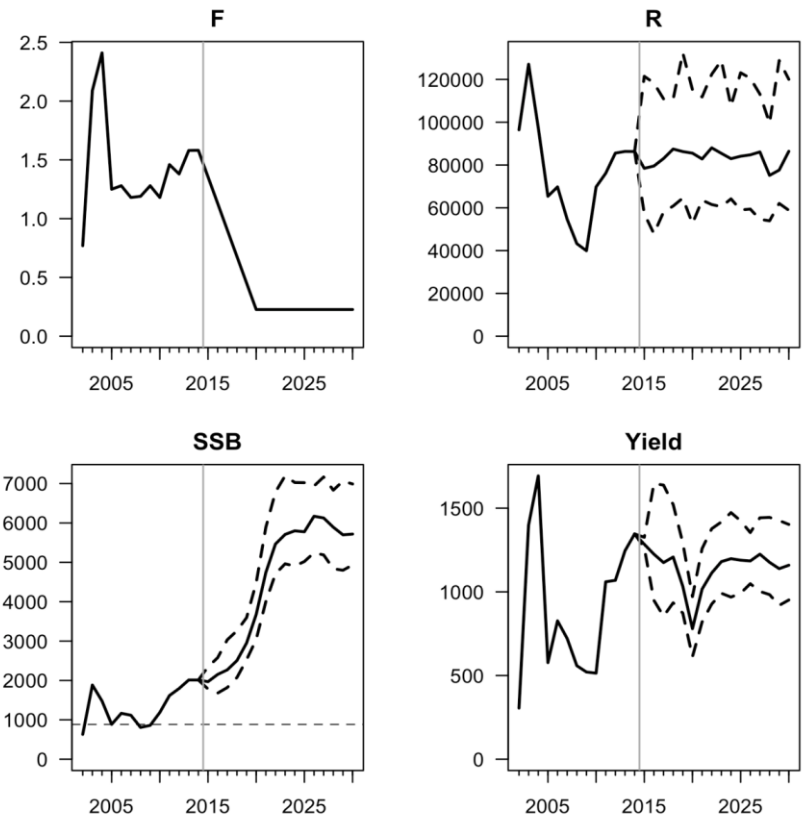


Fig. 2.3.8.3.3. Red mullet in GSA 06, Scenario 4. Biological and pressure variables.

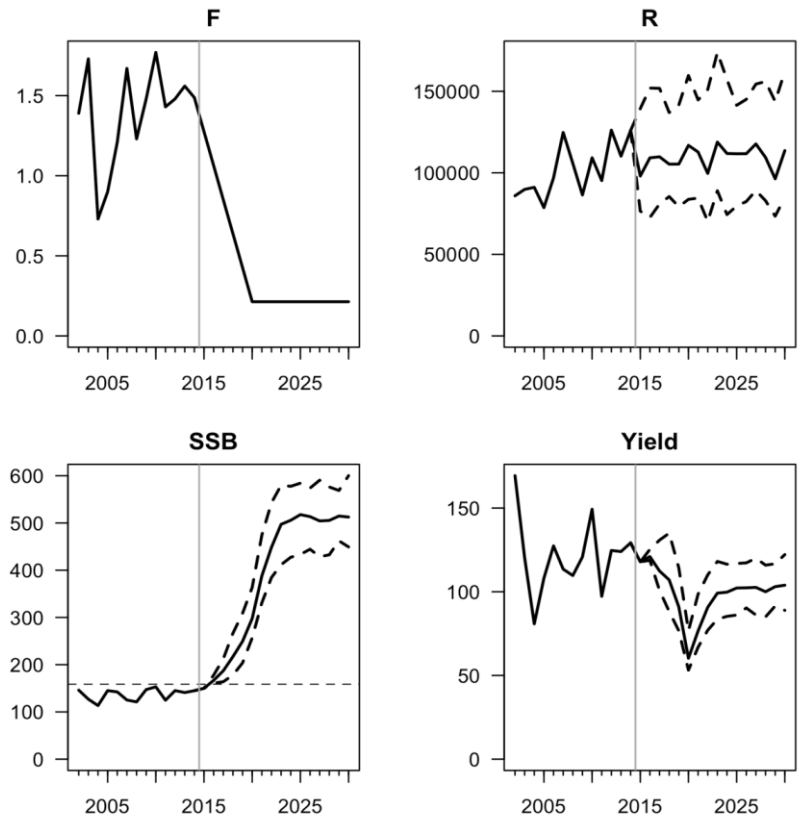


Fig. 2.3.8.3.4. Deep water shrimp in GSA 06, Scenario 4. Biological and pressure variables.

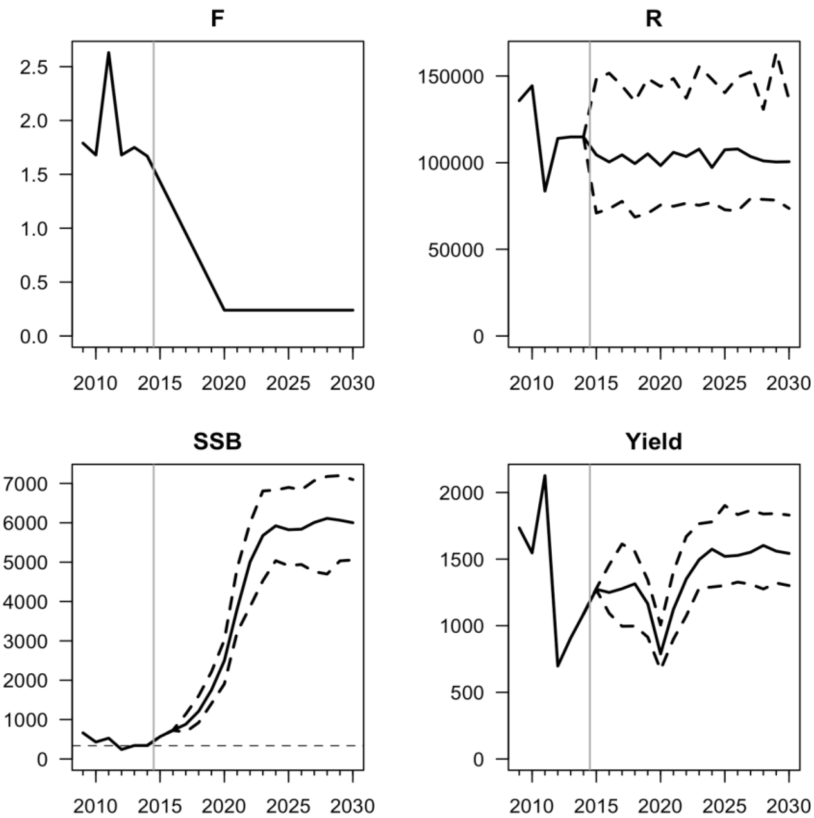


Fig. 2.3.8.3.5. Blue whiting in GSA 06, Scenario 4. Biological and pressure variables

OUTPUTS OF THE ECONOMIC INDICATORS

Outputs of the economic indicators for all fleets combined are reported in the figure 2.3.8.3.6.
Fig. 2.3.8.3.6 shows that the income from landings would stabilize around 250 M€ after 2020 (higher than under Scenario 1), with a transition period with a low 110 M€ in 2017. However, due to the very low effort costs corresponding to this Scenario, profits are expected to increase considerably, with a corresponding increase in wages (reflected as labour costs). However, the lowest point in income corresponding to year 2017 would represent a decrease in labour costs to a value lower than the forecast labour costs under Scenario 1.

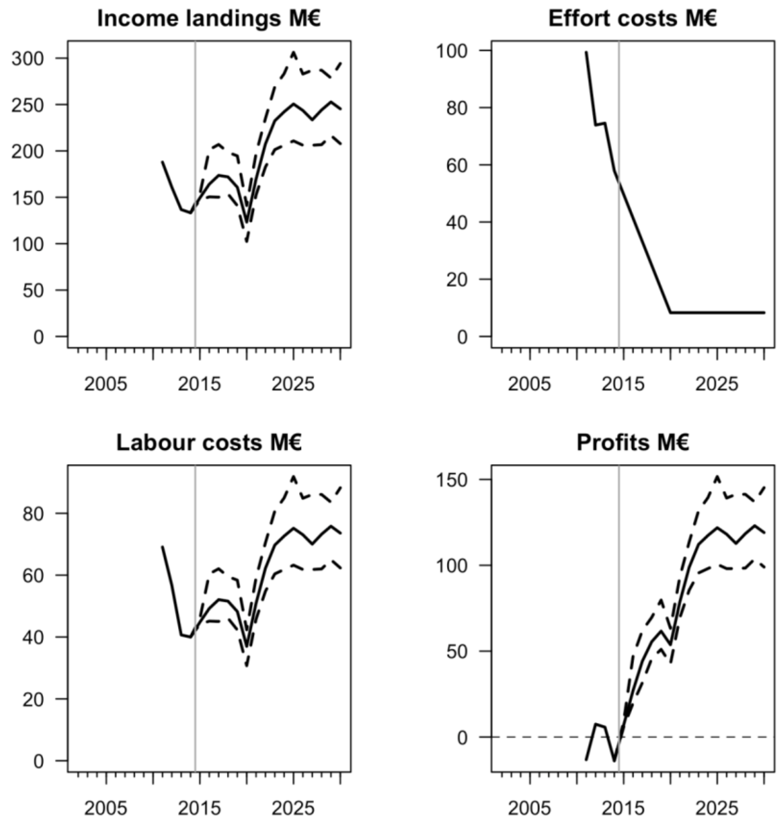


Fig. 2.3.8.3.6. Economic indicators, Scenario 4. All fleets combined.

2.3.8.4 SCENARIO 5. ADAPTIVE REDUCTION TOWARDS A WEIGHTED AVERAGE FMSYS IN 2020

A linear reduction towards Fmsy in 2020 taking into account the mixed nature of the fishery was performed by weighting the Fmsy of individual species by their importance in the value of landings, according to the table 2.3.8.4.1

Table 2.3.8.4.1. Effort reduction required to achieve target

yr	Effort (days at sea x vessel)
2014	**72318**
2015	60867
2016	49415

2017	37964
2018	26512
2019	15061
2020	3610

The number of vessels required to achieve the target conditioned by the 20% capacity reduction foreseen for 2017 is given in Table 2.3.8.2.3 of Scenario 3. As in Scenario 3, this capacity reduction is insufficient to achieve the target by 2020 a further reduction in terms of activity was implemented, as shown in the following table 2.3.8.4.2.

Table 2.3.8.4.2. Number of days permitted by fleet segment to achieve target (having deducted the number of days lost corresponding to the 20% capacity reduction).

yr	DFN0612	DFN1218	DTS1218	DTS1824	DTS2440	HOK1218	HOK1824	Demersal fleet
2014	**6211**	**5017**	**13565**	**29153**	**12821**	**3027**	**2523**	**72318**
2015	5228	4223	11417	24537	10791	2548	2124	60867
2016	4244	3428	9269	19920	8761	2068	1724	49415
2017	3261	2634	7121	22035	0	1589	1325	37964
2018	2277	1839	4973	15388	0	1110	925	26512
2019	1294	1045	2825	8742	0	630	525	15061
2020	310	250	677	2095	0	151	126	3610

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Outputs of the biological and pressure indicators are reported in the tables from 2.3.8.4.1 to 2.3.8.4.5.

Fig. 2.3.8.4.1 shows that under Scenario 5 the projected SSB and catches of hake would have similar trajectories than in the case of Scenario 3, and SSB would stabilize at a similar (around 50 000 t). Cacthes would stabilize also at a similar value (around 6 000 t) but the transition period in 2017-2019 would produce higher catches than in Scenario 3 and, naturally, than in Scenario 1.

Fig. 2.3.8.4.2 shows that under Scenario 5, the strong decrease in fishing mortality of blue and red shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 but catches lower than those projected for Scenario 1, after a transition period (2017-2019) of even lower catches. (These results are similar to the results of Scenario 3 for this species)

Fig. 2.3.8.4.3 shows that under Scenario 5, the strong decrease in fishing mortality of red mullet and the condition of average, stable recruitment would result in very high SSB after year 2020 and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of even lower catches, similar to the low values observed in the series. (These results are similar to the results of Scenario 2 for this species)

Fig. 2.3.8.4.4 shows that under Scenario 5, the strong decrease in fishing mortality of deepwater pink shrimp and the condition of average, stable recruitment would result in very high SSB after year 2020 and catches lower than those projected for Scenario 1, well under the lowest values observed in the historical series. (These results are similar to the results of Scenario 2 for this species)

Fig. 2.3.8.4.5 shows that under Scenario 5, the strong decrease in fishing mortality of blue whiting and the condition of average, stable recruitment would result in very high SSB after year 2020 (with similar values to Scenario 3, Fig. 2.3.8.2.5) and catches lower than those projected for Scenario 1, after a transition period (2017-2019) of very low catches. (These results are similar to the results of Scenario 3 for this species).

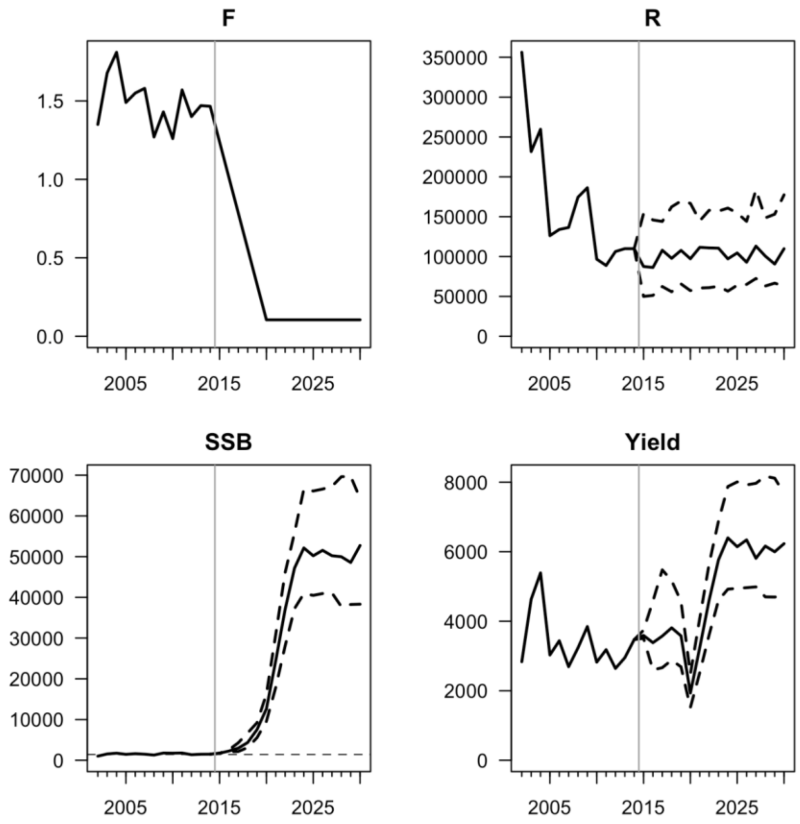


Fig. 2.3.8.4.1. European h**ake** in GSA 06, Scenario 5. Biological and pressure variables

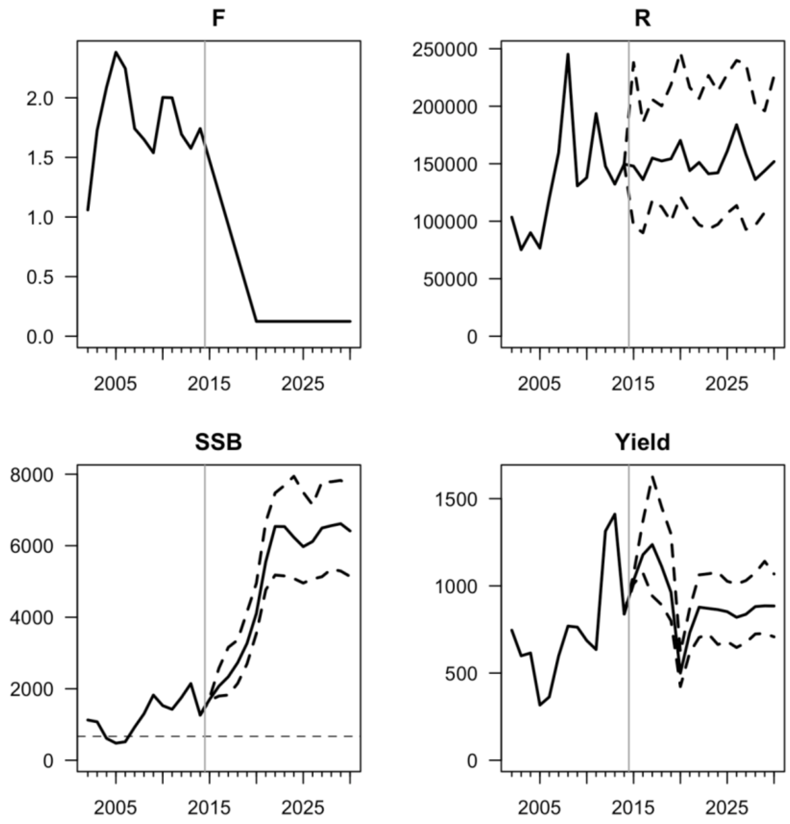


Fig. 2.3.8.4.2. **Blue and red shrimp** in GSA 06, Scenario 5. Biological and pressure variables.

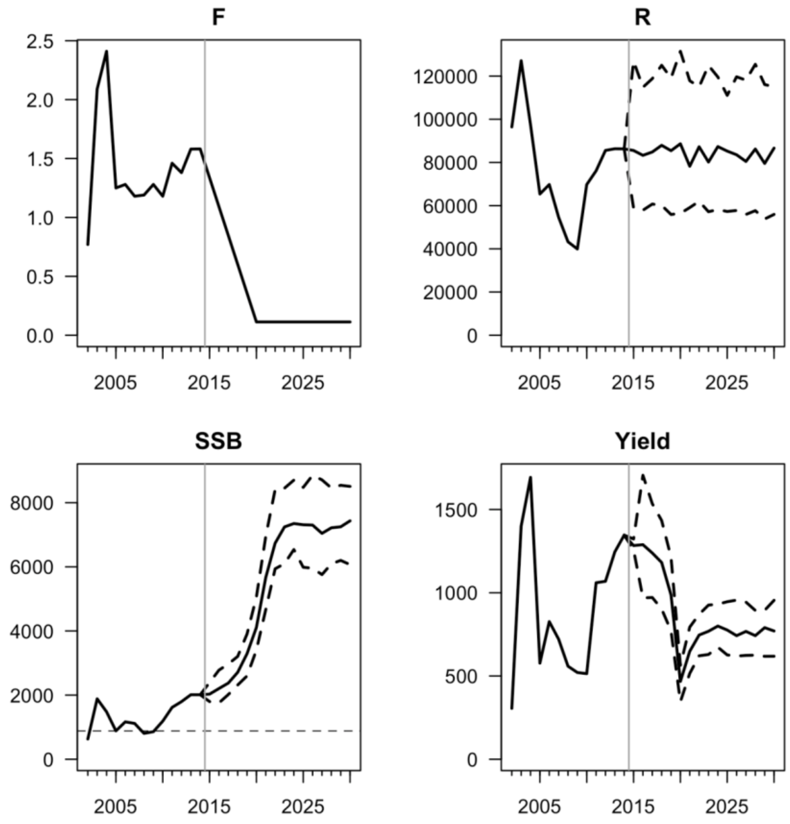


Fig. 2.3.8.4.3. **Red mullet** in GSA 06, Scenario 5. Biological and pressure variables

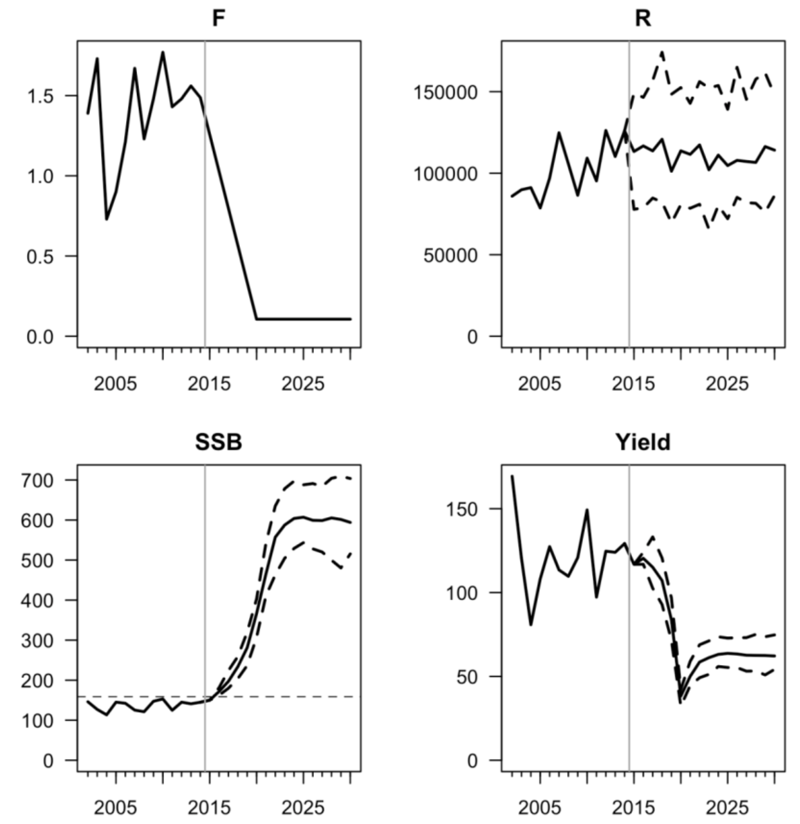


Fig. 2.3.8.4.4. **Deep water pink shrimp** in GSA 06, Scenario 5. Biological and pressure variables.

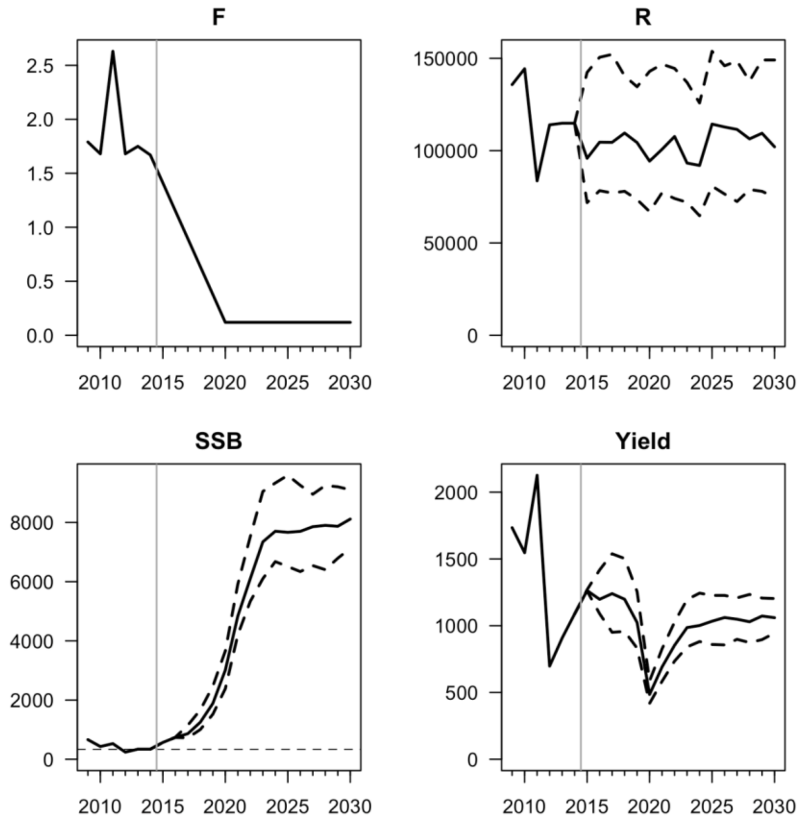


Fig. 2.3.8.4.5. **Blue whiting** in GSA 06, Scenario 5. Biological and pressure variables

OUTPUTS OF THE ECONOMIC INDICATORS

Outputs of the economic indicators for all the fleets combined are reported in the figure 2.3.8.4.6 showing that the income from landings would stabilize around 175 M€ after 2020 (lower than under Scenario 1), with a transition period of low income of less than 100 M€ in 2017. However, due to the very low effort costs corresponding to this Scenario, profits are expected to increase considerably, with a corresponding increase in wages (reflected as labour costs). However, the lowest point in income corresponding to year 2017 would represent a decrease in labour costs to a value less than the half the forecast labour costs under Scenario 1. (These results are similar to the results of Scenario 3 for economic indicators).

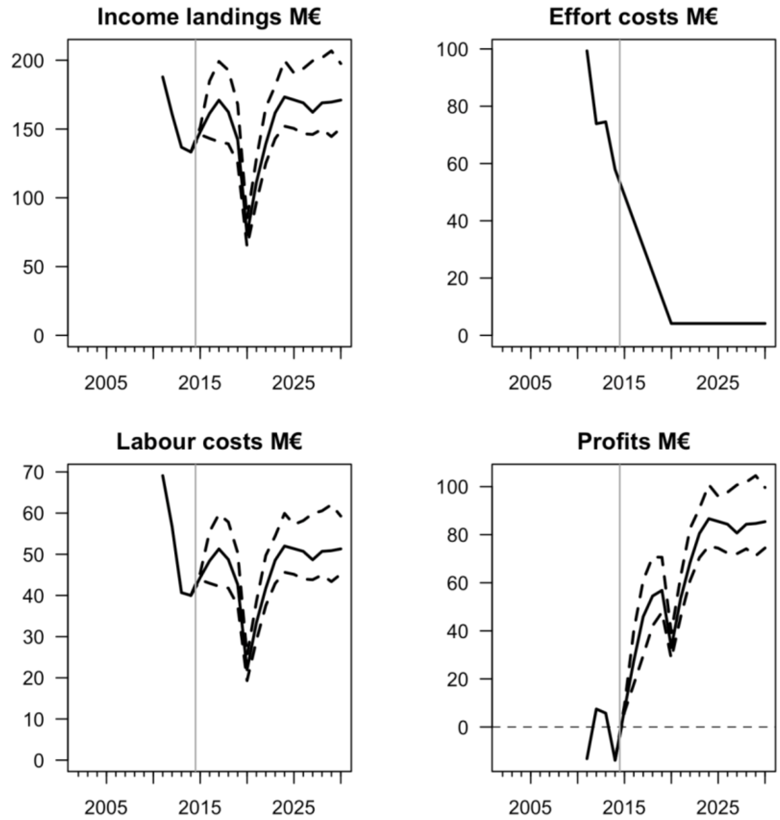


Fig. 2.3.8.4.6. Economic indicators, Scenario 5. All fleets combined.

2.3.8.5 SCENARIO 6. IMPROVING SELECTIVITY

As in the previous scenarios, a capacity reduction of 20% by 2017 was implemented. In Scenario 6, a change in selectivity was additionally produced. The selectivity change represents delaying the median length at capture (L50) by 2 cm TL (or 2 mm CL for crustaceans). The length-based selection ogives were transformed into age-based selection ogives using the inverse von Bertalanffy growth function. The following table 2.3.8.6.1 summarizes the old and new selection patterns by species.

Table 2.3.8.5.1 Old and new selection patterns by species

age	0	1	2	3	4	5	6
HKE original	0.0001	0.2057	0.9997	1	1	1	1
HKE modified	0.0001	0.0649	0.9988	1	1	1	1

ARA original	0.0001	0.8802	1	1	1	1	1
ARA modified	0.0001	0.7093	1	1	1	1	1
MUT original	0.0001	0.7231	1	1	1	1	1
MUT modified	0.0001	0.2504	0.9998	1	1	1	1
DPS original	0.0001	0.0036	0.9635	1	1	1	1
DPS modified	0.0001	0.0011	0.8116	0.9999	1	1	1
WHB original	0.0001	0.0002	0.02	0.691	0.9959	1	1
WHB modified	0.0001	0.0001	0.0054	0.303	0.972	0.9996	1

In the present analysis it is assumed that all fish encountering the art is killed (survivability = 0).

In this analysis, no Fmsy target is implemented.

An additional limitation to the specification of Scenario 6 is that changes in selectivity also imply a change in the Fmsy to a higher value (of the order of 10-20%: Scott and Sampson 2011), so our results are conservative and probably higher effort could be achieved than that shown.

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Outputs of the biological and pressure indicators referred to the scenario 6 are reported in the figures from 2.3.8.5.1 to 2.3.8.5.5.

Fig. 2.3.8.5.1 shows that the changes in size selection patterns result in a decrease of fishing mortality to ca. 60% of the historically observed values in hake. Together with the assumption of stable, low recruitment, the simulation Scenario 6 forecasts an increase of SSB to values near 4 times those forecast in Scenario 1 and catches of the order of twice in Scenario 1.

Fig. 2.3.8.5.2 shows that the changes in size selection patterns result in a decrease of fishing mortality to ca. 80% of the historically observed values in blue and red shrimp. Together with the assumption of stable recruitment, the simulation Scenario 6 forecasts an increase of SSB to values 1/3 higher than those forecast in Scenario 1 but catches similar to those in Scenario 1.

Fig. 2.3.8.5.3 shows that the changes in size selection patterns result in a decrease of fishing mortality to ca. 60% of the historically observed values in red mullet. Together with the assumption of stable recruitment, the simulation Scenario 6 forecasts an increase of SSB to values 1/3 higher than those forecast in Scenario 1 after 2020, and catches ca. 10% higher than those in Scenario 1.

Fig. 2.3.8.5.4 shows that the changes in size selection patterns result in a decrease of fishing mortality to ca. 80% of the historically observed values in deep waterpink shrimp. Together with the assumption of stable recruitment, the simulation Scenario 6 forecasts an increase of SSB to values 1/3 higher than those forecast in Scenario 1 after 2020, and catches very similar to those in Scenario 1.

Fig. 2.3.8.5.5 shows that the changes in size selection patterns result in a decrease of fishing mortality to ca. 30% of the historically observed values in blue whiting. Together with the assumption of stable recruitment, the simulation Scenario 6 forecasts an increase of SSB to values almost 5 times higher than those forecast in Scenario 1 after 2020, and catches ca. 1/3 higher than those in Scenario 1.

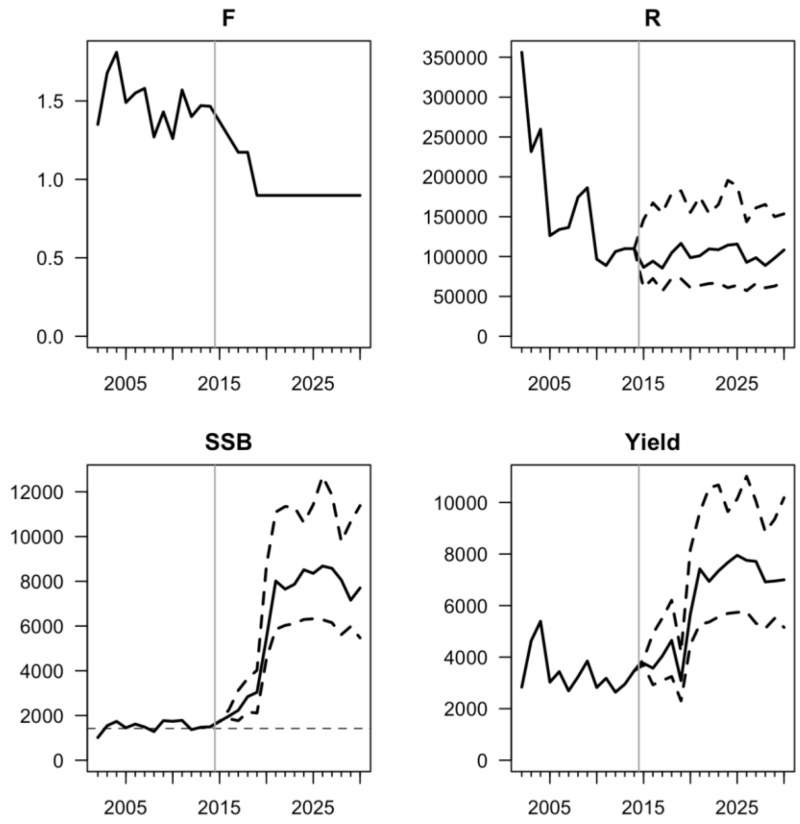


Fig. 2.3.8.5.1 European **hake** in GSA 06, Scenario 6. Biological and pressure variables.

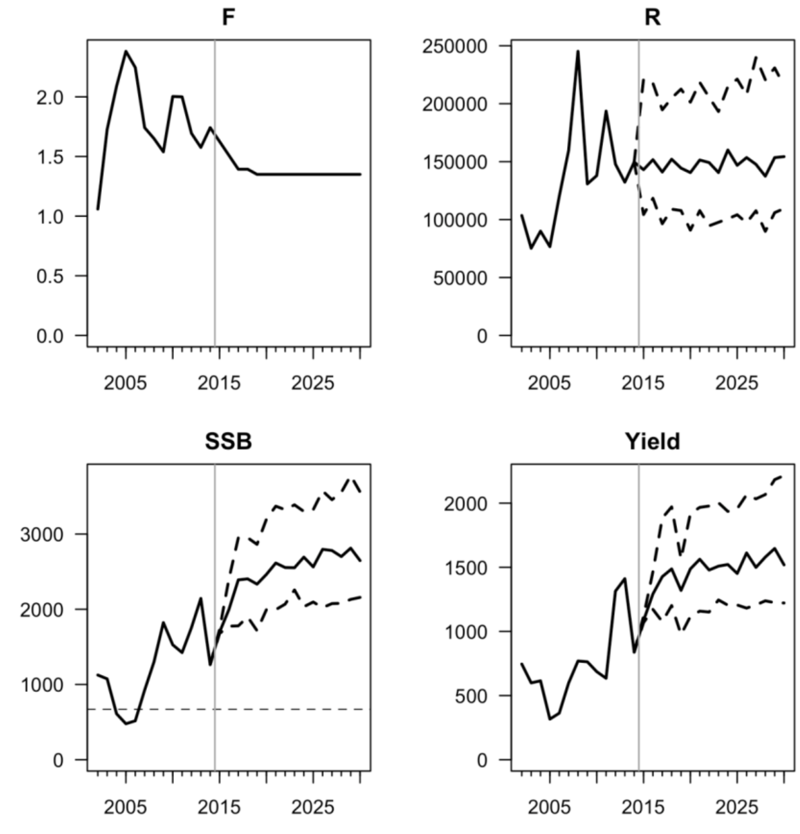


Fig. 2.3.8.5.2. **Blue and red shrimp** in GSA 06, Scenario 6. Biological and pressure variables.

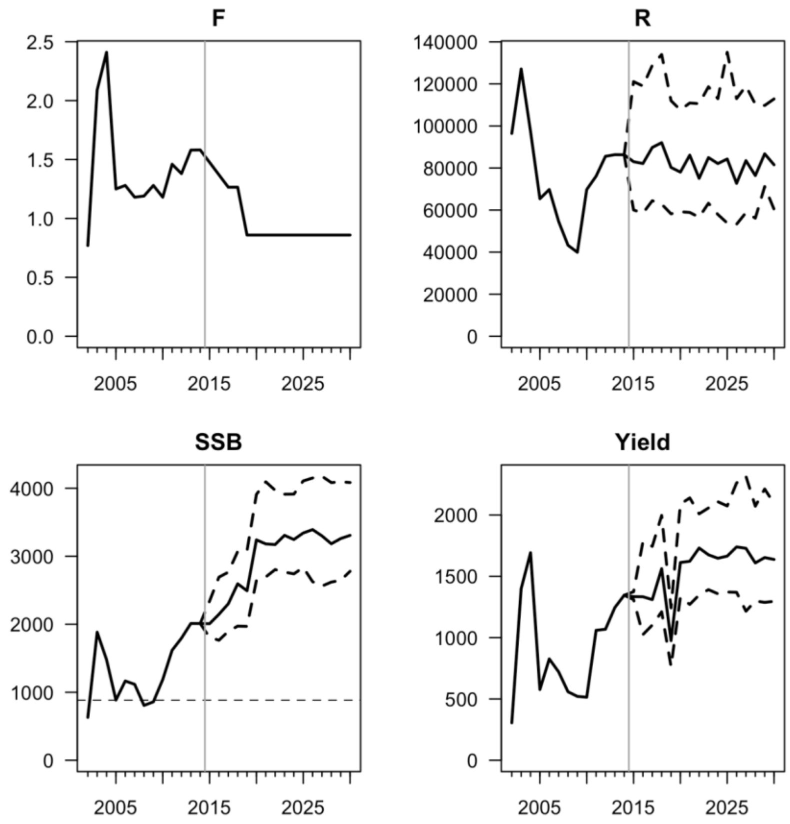


Fig. 2.3.8.5.3. **Red mullet** in GSA 06, Scenario 6. Biological and pressure variables.

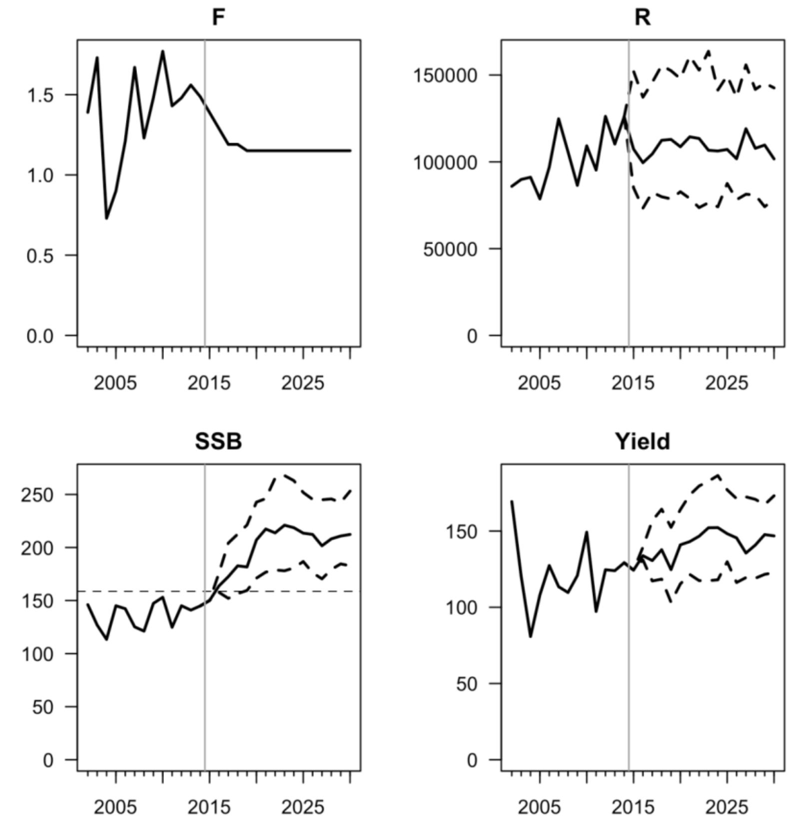


Fig. 2.3.8.5.4. **Deep water pink shrimp** in GSA 06, Scenario 6. Biological and pressure variables.

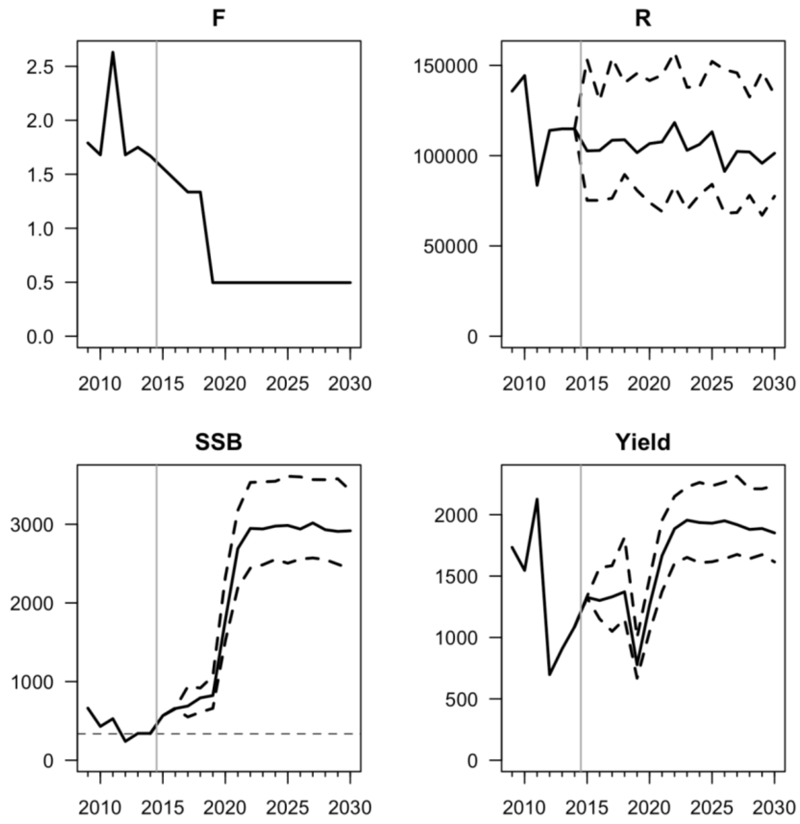


Fig. 2.3.8.5.5. **Blue whiting** in GSA 06, Scenario 6. Biological and pressure variables.

OUTPUTS OF THE ECONOMIC INDICATORS

The outputs of the economic indicators for the scenario 6 for all the fleets combined are reported in the figure 2.3.8.5.6.

Fig. 2.3.8.5.6 shows that landings income is expected to stabilize around 250 M€ after 2020, with a transition period of lower income around 2017-2019. Both profits and labour costs would reach higher values than under Scenario 1, with expected profits stablizaing at 80 M€ after 2020 (4 times those observed in Scenario 1).

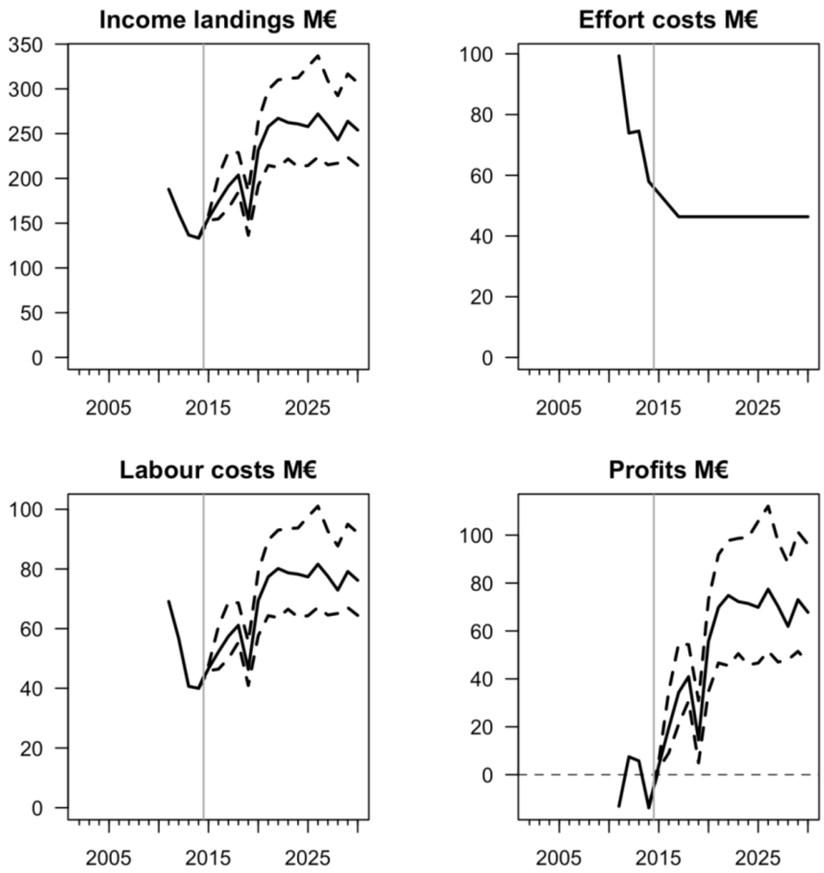


Fig 2.3.8.5.6 Economic indicators, Scenario 6. All fleets combined.

2.3.9 MANAGEMENT STRATEGY EVALUATION

Management Strategy Evaluation (MSE) was performed to evaluate the probability that the SSB falls below Blim. As shown in Table 2.3.9.1 the probability of SSB falling below Blim for HKE, DPS and WHB is higher than 5% under Scenario 1 (i.e. projecting the status quo). Under scenarios 2 to 6 this probability is lower than 5% for all species, except DPS because the forecast SSB of this species takes longer to increase as it is the longest lived species in this data set (ages up to 6 years).

Table 2.3.9.1 Biological risk: probability that SSB falls below Blim in the period 2015-2030 for each scenario.

	HKE	ARA	MUT	DPS	WHB
SCE 1	0.169	0.001	0.002	0.497	0.059
SCE 2	0	0	0	0.124	0
SCE 3	0	0	0	0.12	0
SCE 4	0.001	0	0	0.146	0
SCE 5	0.001	0	0	0.135	0
SCE 6	0.011	0	0	0.27	0.002

2.3.10 REPORT OF THE RESULTS IN TERMS OF TRAFFIC LIGHT APPROACH

The following table 2.3.10.1 summarized the performances of simulated management scenarios in terms of SSB and overall catches of the main 5 stocks, salaries (average wage), CR/BER, ROI, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value in Scenario 1, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Table 2.3.10.1 Summary of the performances of the management scenarios (% change respect to status quo) simulated in terms of SSB and overall catches of the main demersal species, salary, CR/BER, ROI, employment and revenues for all fleet segments combined. The green values are higher than +5%, the red ones are smaller than -5%; the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis.

	Salary (thousand Euro)	CR/BR	ROI	Revenues (million Euro)	Emp. (units)	HKE catch (tons)	ARA catch (tons)	MUT catch (tons)	DPS catch (tons)	WHB catch (tons)	HKE SSB (tons)	ARA SSB (tons)	MUT SSB (tons)	DPS SSB (tons)	WHB SSB (tons)	F (value) (year) HKE	F (value) (year) ARA	F (value) (year) MUT	F (value) (year) DPS	F (value) (year) WHB
Status quo (values in 2014 – baseline year)	40.7	2.17	0.013	139	4481	3472	839	1346	129	1088	1494	1266	2011	145	341	1.47	1.74	1.58	1.49	1.67
Status quo (values in 2021)	59.7	9.30	0.12	199	4481	6429	1028	889	73	1166	1997	2124	2070	162	540	1.47	1.74	1.58	1.49	1.67
Scenario 2	15	125	367	15	-20	22	23	26%	33	31	1459	154	177	196	974	0.21	0.25	0.23	0.21	0.24
Scenario 3	-21	132	242	-21	-20	-16	-14%	-19	-16	-17	2055	204	231	261	1272	0.22	0.22	0.22	0.22	0.22
Scenario 4	-15	117	242	-15	-20	-23	9%	14	4	-4	791	117	129	139	606	0.59 (2018) 0.21	0.705 (2018) 0.25	0.63 (2018) 0.23	0.60 (2018) 0.21	0.67 (2018) 0.24
Scenario 5	-44	125	142	-44	-20	-50	-29%	-27	-32	-41	1124	161	174	186	797	0.54 (2018) 0.22	0.64 (2018) 0.22	0.58 (2018) 0.22	0.55 (2018) 0.22	0.61 (2018) 0.22
Scenario 6	29	46	192	30	-20	15	52%	82	95	43	301	23	54	34	398	0.90	1.35	0.86	1.15	0.50

2.3.11 DISCUSSION AND CONCLUSION ON DEMERSAL FISHERY IN GSA06

The bioeconomic simulation analyses carried out on the demersal fisheries in GSA06 have the following main features:

- The parameters of the biological component and fishing mortality vectors are derived from the most recent stock assessments available from STECF Mediterranean working groups for the target species of the fishery: hake (HKE), blue and red shrimp (ARA), red mullet (MUT), deepwater shrimp (DPS) and blue whiting (WHB). All assessments were conducted originally with FLR XSA routines.
- For stock assessments of the years 2012 or 2013, the population has been propagated to 2014 as starting point for all scenarios (using methods in FLR).
- Seven fleets segments are involved in the fishery: DFN 0612, DFN 1218, HOK 0612, HOK 1218, DTS 1218, DTS 1824 and DTS2440. However the bulk of production in volume of landings and economic value belongs to the last 2 fleet segments (Bottom Trawl larger than 18 m).
- All simulations were run for the period 2015 to 2030, although the target years were 2018 or 2020. The simulations were run for a longer period in order to estimate the biological risk (next table) over a sufficiently long period.
- Only process uncertainty due to variation in recruitment around a constant value with the mean of the last 3 years was considered as source of uncertainty. Other aspects, such as price formation of fish prices, cost structure, assessment error could not be considered in the simulations and represent limitations to this exercise, that should be taken into account when interpreting the results.

The results of the projections show that, given the high ratio of current fishing mortality to Fmsy, the biomass of all stocks would strongly benefit from the required large reductions in fishing effort (80 to 90%, depending on the scenario). In the case of the more overexploited species (European hake and blue whiting) reducing fishing effort towards Fmsy would imply an increase in landings shortly after 2018 or 2020 (e.g. Fig. 2.3.8.1.1; 2.3.8.1.5). However, in some scenarios the large reduction in fishing effort required would imply that certain stocks would be fished below their Fmsy and underutilized, both during the effort reduction period and after (e.g Figure 2.3.8.2.4).

As shown in Table 2.3.9.1 the probability of SSB falling below Blim for HKE, DPS and WHB is higher than 5% under Scenario 1 (i.e. projecting the status quo). Under scenarios 2 to 6 this probability is lower than 5% for all species, except DPS because the forecast SSB of this species takes longer to increase as it is the longest lived species in this data set (ages up to 6 years).

In economic terms, all scenarios show a possibility of increasing revenues from the demersal fishery in GSA06 in the long term, after an important decrease during the effort reduction period (e.g. in Fig. 2.3.8.1.6 total income of the demersal fleet is expected to halve between 2015 and 2018). Given the large decrease in effort necessary, the amount of costs related to effort (fuel cost and other variable costs) would decrease substantially, resulting in apparently very high profits in the medium and long term.

On the other hand, it is necessary to stress that the large effort reduction required (80-90%) cannot be accomplished solely by the prescribed 20% capacity reduction in the current Spanish management plan. Additional large reductions in activity would be necessary, resulting in the apparent paradox of the remaining vessels having to be active a few weeks annually at most.

The results of Scenario 6 show that a realistic delay in the size at first capture of 2 cm TL (or 2 mm CL for crustaceans) would permit maintaining a larger fleet and activity rate than in scenarios 2 to 5, but this selectivity measure by itself cannot ensure achieving Fmsy in any of the stocks by 2020 (e.g. Figs. 2.3.8.5.1-2.3.8.5.5).

As shown in Maynou (2014) large reductions in fishing mortality for stocks that have been subject to high exploitation rates for decades are difficult to achieve with the current paradigm of effort control (Lleonart & Maynou 2003; Colloca et al. 2014) in the Mediterranean. Instead, re-orienting the exploitation of Mediterranean fish stocks to help meet the policy goals of fishing mortality levels compatible with MSY by 2020 can only be achieved with management measures that combine changes in exploitation patterns with seasonal or spatial area closures.

Colloca's recent work provided useful results for GSA06 and GSA07, regarding concentration of juveniles for hake and deepwater rose shrimp (Colloca et al., 2015, fig. 3A and 4B).

In GSA06, areas with high persistence indices of hake recruits, that could be the subject of temporary closures, are located in the extreme north of the area (province of Girona, from 100 to 200 m approximately) and on the deeper areas of the continental shelf around the Ebro Delta (Fig. 3A in Colloca et al., 2015).

In GSA06, persistent high density areas of deep-water rose shrimps are located on the continental shelf break, facing the southern coast of Alicante, adjacent with GSA01 (Fig. 4B in Colloca et al., 2015).

Thus these areas can be protected, in particular non permitting the fishery at least in the periods in which the peaks of recruitment occur, that is at least in spring (May-June).

ANNEX B - INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA06

B.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL FISHERY IN GSA06

The population dynamics of the five main species used in the bioeconomic analysis are shown in the following tables.

GROWTH PARAMETERS AND MEAN RECRUITMENT OF DEMERSAL STOCKS IN GSA06

Growth parameters and mean recruitment are reported in table B.1.1.

Table B.1.1. Growth parameters and mean recruitment of the main demersal target stocks in GSA 06.

species	Linf (cm TL or mm CL)	k (yr-1)	t0 (yr)	mean recruitment 2011 - 2014 (thousands)	source
HKE	106	0.2	-0.003	101,309	EWG 14-17
ARA	77	0.38	-0.065	146,758	EWG 15-11
MUT	29	0.6	-0.1	82,580	EWG 14-17
DPS	45	0.39	0.102	110,014	EWG 13-22
WHB	45.3	0.35	0	103,339	EWG 14-17

MATURITY AND SEX RATIO OF DEMERSAL STOCKS IN GSA06

The maturity parameters used for the analysis are shown in the following table B.1.2. Sex ratio was taken as 1:1, ignoring that in the largest sizes females predominate in the populations of hake, blue and red shrimp and deepwater shrimp. This limitation is not usually taken into account in stock assessment because the abundance of large sizes in the population is relatively low. However, the growth parameters in the previous table for blue and red shrimp correspond to females because they make > 80% of the population.

Table B.1.2. Maturity parameters of the main demersal target stocks in GSA 06.

species	age 0	age 1	age 2	age 3	age 4	age 5	age 6	source
HKE	0	0.14	0.82	0.98	1	1	--	STECF 14-17
ARA	0.08	0.77	0.99	1	1	--	--	STECF 15-11
MUT	0.46	0.76	0.88	0.93	1	--	--	STECF 14-17
DPS	0	0.134	0.504	0.787	0.901	0.973	1	STECF 13-22
WHB	0	0.013	0.61	1	1	1	--	STECF 14-17

NATURAL MORTALITY OF DEMERSAL STOCKS IN GSA06

The natural mortality parameters (Table B.1.3) were assumed to follow the ProdBioM model (Abella et al., 1997), except for blue and red shrimp where a constant mortality value has been used in all recent assessments.

Table B.1.3. Natural mortality vectors of the main demersal target stocks in GSA 06.

species	age 0	age 1	age 2	age 3	age 4	age 5	age 6	source
HKE	1.12	0.55	0.44	0.39	0.36	0.36	--	STECF 14-17
ARA	0.46	0.46	0.46	0.46	0.46	--	--	STECF 15-11
MUT	0.99	0.46	0.3	0.24	0.21	--	--	STECF 14-17
DPS	1.25	0.82	0.39	0.28	0.24	0.22	0.21	STECF 13-22
WHB	1.18	0.53	0.39	0.34	0.31	0.29	--	STECF 14-17

B.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERY IN GSA06

FISHING MORTALITY OF DEMERSAL STOCKS IN GSA06

The following table B.2.1 shows the fishing mortality vectors estimated from the assessments of 2012, 2013 or 2014 and propagated to 2014 when necessary using the original stock object derived from FLR XSA.

Table B.2.1. Fishing mortality vectors of the main demersal target stocks in GSA 06.

species	age 0	age 1	age 2	age 3	age 4	age 5	age 6	source
HKE	0.16	1.8	2.14	1.77	1.95	1.95	--	STECF 14-17
ARA	0.1	0.66	2.4	3.82	3.02	--	--	STECF 15-11
MUT	0.1	2.2	2.45	1.35	1.35	--	--	STECF 14-17
DPS	0	0.11	0.93	1.52	2.01	1.49	1.49	STECF 13-22
WHB	0.02	1.11	2.39	1.51	1.97	1.97	--	STECF 14-17

EFFORT OF DEMERSAL FISHERY IN GSA06

The fishing effort (in number of fishing trips, equivalent to actual fishing days in GSA 06) are shown in the following table B.2.2 for the main fleet segments carrying out the demersal fishery. As shown in the last row of the table, the largest share of effort (ca. 75%) is taken by the bottom otter trawl segments, especially the vessels 18 m and larger.

Table B.2.2. Fishing effort (fishing trips) of the fleets targeting demersal stocks in GSA 06.

		DTS	DTS	DTS	DFN	DFN	DFN	DFN	HOK	HOK
yr	**fishing trips**	**OTB_VL1218**	**OTB_VL1824**	**OTB_VL2440**	**GNS_VL0612**	**GNS_VL1218**	**GTR_VL0612**	**GTR_VL1218**	**LLS_VL0612**	**LLS_VL1218**
2002	112,643	21,129	45,409	19,970	4,838	3,908	4,838	3,908	4,715	3,930
2003	109,816	20,599	44,269	19,469	4,716	3,809	4,716	3,809	4,597	3,831
2004	108,477	20,347	43,729	19,231	4,659	3,763	4,659	3,763	4,541	3,785
2005	107,435	20,152	43,310	19,047	4,614	3,727	4,614	3,727	4,497	3,748
2006	106,542	19,985	42,950	18,889	4,576	3,696	4,576	3,696	4,460	3,717
2007	102,822	19,287	41,450	18,229	4,416	3,567	4,416	3,567	4,304	3,587
2008	92,852	17,417	37,431	16,461	3,988	3,221	3,988	3,221	3,887	3,239
2009	83,032	15,575	33,472	14,720	3,566	2,880	3,566	2,880	3,475	2,897
2010	81,246	15,240	32,752	14,404	3,489	2,818	3,489	2,818	3,401	2,835
2011	80,353	15,072	32,392	14,246	3,451	2,787	3,451	2,787	3,363	2,803
2012	80,353	15,072	32,392	14,246	3,451	2,787	3,451	2,787	3,363	2,803
2013	73,661	13,817	29,695	13,059	3,163	2,555	3,163	2,555	3,083	2,570
2014	72,318	13,565	29,153	12,821	3,106	2,509	3,106	2,509	3,027	2,523
proportion		0.1876	0.4031	0.1773	0.0429	0.0347	0.0429	0.0347	0.0419	0.0349

LANDINGS OF DEMERSAL FISHERY IN GSA06

The landings (t) of the main demersal species since 2002 are shown in the following table B.2.3 (data for blue whiting for the period 2002 – 2008 are not available but certainly of the order of 1500 t annually). The landings of hake and deep water rose shrimp are relatively stable during the period, while the landings of blue and red shrimp and red mullet have increased significantly over the last 3 – 4 years.

Table B.2.3. Landings (t) of main demersal stocks in GSA 06.

yr	HKE	ARA	MUT	DPS	WHB
2002	2835	746	305	169	
2003	4633	599	1400	120	
2004	5391	615	1693	81	
2005	3029	317	577	108	
2006	3438	363	827	127	
2007	2692	598	721	113	
2008	3234	769	559	110	
2009	3847	763	521	121	1734
2010	2822	687	514	149	1547
2011	3182	635	1060	97	2126
2012	2641	1314	1069	125	697
2013	2950	1411	1245	124	907
2014	2924	1030	1100	115	800

B.3 INPUT OF THE ECONOMIC MODULE OF DEMERSAL FISHERY IN GSA06

The economic data of the selected fleet segments used to parameterize the economic function in the projections have been reported in the following paragraphs.

REVENUES OF DEMERSAL FISHERY IN GSA06

The revenues (in M€) of the main target species are shown in the following table B.3.1 (data for blue whiting for the period 2002 – 2008 are not available but certainly of the order of 3 M€ annually). The main species in terms of value are the hake, because of its quantity landed, and the blue and red shrimp because of its high average price. Note that the five main species produce only ca. 25 - 30% of the value of landings, the remainder being obtained from a list of over 60 species of commercial bycatch.

Table B.3.1. Revenues (M€) of main demersal stocks in GSA 06.

yr	HKE	ARA	MUT	DPS	WHB	all demersal
2002	17.95	19.32	1.68	2.25		102.99
2003	29.33	15.52	7.70	1.60		135.36
2004	34.13	15.94	9.31	1.07		151.11

2005	19.17	8.21	3.17	1.43		79.97
2006	21.76	9.41	4.55	1.69		93.52
2007	17.04	15.49	3.96	1.51		95.01
2008	20.47	19.94	3.07	1.46		112.34
2009	24.36	19.78	2.86	1.60	4.32	132.33
2010	17.86	17.79	2.83	1.98	3.86	110.80
2011	20.14	16.45	5.83	1.29	5.30	122.54
2012	16.72	34.06	5.88	1.65	1.74	150.12
2013	18.67	36.58	6.85	1.65	2.26	165.01
2014	18.51	26.69	6.05	1.53	2.00	136.92

COSTS OF DEMERSAL FISHERY IN GSA06

The costs estimated for 2014 (extrapolating from the costs 2011 – 2013 shown previously) are given in the following table B.3.2. Note that due to the nature of the data it is not possible to estimate different costs for driftnets (GNS) and trammel nets (GTR), but they are likely to be similar as these fleets have similar vessel composition (combined as DFN). The estimation for bottom trawlers combines data from fishing technique DTS and vessels 12-18, 18-24 and 24-40 m length. The costs of the other small scale fishing gear were estimated from the corresponding data in fishing techniques DFN (drift and fixed nets) and HOK (longlines) for vessels 12-18 and 16-24 m length.

Table B.3.2. Costs of the fleet segments targeting demersal stocks in GSA 06.

	OTB = DTS	GTR and GNS = DFN	LLS = HOK	TOTAL
Income from landings (M€)	87.36	37.48	12.08	136.92
Income incl. subsidies (M€)	89.98	37.48	12.08	139.54
Energy,Other variable costs and Repair Costs (M€)	57.93	11.03	5.68	74.64
Non variable costs (M€)	5	0.82	0.82	6.65
Labour costs (M€)	24.65	12.07	4.01	40.72
Annual wage (k€ / person)	20.59	11.08	17.48	49.16
Depreciation (M€)	3.85	2.72	1.34	7.91
Opportunity costs (M€)	1.54	1.09	0.54	3.17
Total costs (M€)	92.97	27.72	12.38	133.08

2.4 CASE STUDY ON DEMERSAL FISHERY IN GSA 07

2.4.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The demersal fisheries in GSA 07 are of mixed nature. Three fishing techniques exploit demersal resources in the area:

- ✓ DTS (corresponding to bottom trawl, OTB, of French or Spanish flag);
- ✓ DFN (corresponding to netters GTR, but specially GNS, exclusively of French flag);
- ✓ HOK (set longlines, LLS, of exclusively Spanish flag).

French OTB produces the largest share of catches, activity and employment. French and Spanish OTB have low selectivity on demersal resources, with large proportion of catches of hake and red mullet well under size (mean size of hake in French trawlers: 21 cm TL; in Spanish trawlers: 24 cm TL). Artisanal fishing gear (nets and longlines) have better selection profiles, with mean landing sizes above minimum landing size and larger than age at maturity of females (L50: 38 cm TL): average length of hake produced by gillnetters is 39 cm TL and that produced by longliners is 52 cm TL.

Due to the inappropriate selection pattern of trawl and excessive capacity of the fleet for many years, the current situation is that of inefficient fisheries that apply rates of fishing mortality (F) much in excess of that estimated as F to produce the maximum sustainable yield (Fmsy). The current F (Fcurr) for most stocks is 3 to 5 times higher than Fmsy (e.g. red mullet), but in the case of hake the ratio is as high as 15 in GSA 07. This situation is well known and has been diagnosed repeatedly (see for example, Colloca et al. 2014 for a recent summary) and in recent years steps have been taken to reverse the situation: the trawl fleet has substituted the traditional diamond mesh trawl of 40 mm with a square mesh trawl of 40 mm (Council Regulation (EC) No 1967/2006 coming into force on 1st June 2010). It is important to note that technological changes to promote better selective fisheries have some limitations in their effectiveness to avoid catching undersize fish and higher lengths at first capture can also be achieved by avoiding areas or seasons of peak recruitment (Colloca et al. 2014).

Nine main fleet segments operating in GSA 07 carrying out demersal fisheries with 3 fishing techniques in 4 vessel length strata have been identified (Table 2.4.1.1). Demersal fisheries are carried out on continental shelf (50-200 m depth) by gillnetters and trawlers, and on the continental slope targeting large hake by longliners. The percentage of landings of all landed species due to each identified fleet segment is reported in the table2.4.1.1

Table 2.4.1.1 - Main fleet segments operating in GSA 07 carrying out demersal fisheries. The percentage of landings of all landed species due to each identified fleet segment is reported.

	Fleet name	***Fleet code***	***% of landings (all species)***
1	Spanish bottom trawlers with vessel length 12-18 m	ESP07_DTS_12-18	0.13
2	Spanish bottom trawlers with vessel length 18-24 m	ESP07_DTS_18-24	2.71
3	French bottom trawlers with vessel length 12-18 m	FRA07_DTS_12-18	7.35

4	French bottom trawlers with vessel length 18-24 m	FRA07_DTS_18-24	24.41
5	French bottom trawlers with vessel length 24-40 m	FRA07_DTS_24-40	51.52
6	French gillnetters with vessel length 0-6 m	FRA07_DFN_00-06	5.35
7	French gillnetters with vessel length 6-12 m	FRA07_DFN_06-12	7.97
8	French gillnetters with vessel length 12-18 m	FRA07_DFN_12-18	0.54
9	Spanish longliners with vessel length 12-18 m	ESP07_HOK_12-18	0.01

As regards fishing effort, the number of fishing vessels is steadily declining since 2002, while the average power of vessels is decreasing since 2006, after a period of increasing from 1999 to 2006. The fleet segments more contributing to the total production are: France bottom trawlers with vessel length 18-24 and 24-40 m

Main stock assessed are: hake (*Merluccius merluccius*) (HKE) and red mullet (*Mullus barbatus*) (MUT).

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the specific fisheries (percentage computed on the average production of the last three years) in terms of production volume and value is reported in the table 2.4.1.2a and 2.4.1.2b respectively.

This contribution is different if Spain and France are considered separately, given that the assessed species are more representative for the Spain fisheries, both trawlers and longliners. In the France fisheries these stocks account for a lower percentage (5-8%for the artisanal fishing gear), but are relatively more important for the two bottom trawl fleets with largest length(about 18% of the landings of DTS fishery for France and similarly for value).

The stocks considered are the only ones for which recent (2014) assessments are available. Among the assessed ones, which are relevant stock in the GSA fisheries, the stock more important on the overall production is European hake.

Table 2.4.1.2a Contribution of the stocks assessed to the production volume (in tons) of the main fleet segments of demersal fisheries in GSA07 (the percentage is computed on the average production of the last three years) by country. The values in the column "assesed%" is calculated as ratio between landings of assessed species to total landings, the same calculation has been done for the rows "Total".

Assessed species/fleet segments GSA06	**HKE**		**MUT**		**Total**		
	Landing (tons)	**%**	**Landing (tons)**	**%**	**Landing assessed (tons)**	**Landing total (tons)**	**assessed %**
ESP DTS VL1218	1.7	12.0	0.5	3.8	2.2	14	**15.8**
ESP DTS VL1824	99	34.1	13	4.6	112	290	**38.7**
ESP HOK VL1218	1	89.7	0	0.0	1	1	**89.7**
Total Spain	102	33.3	14	4.6	116	306	**37.9**
FRA DFN VL0006	0	0.0	1	0.2	1	573	**0.2**
FRA DFN VL0612	50	5.8	19	2.3	69	854	**8.1**

FRA DFN VL1218	7	12.1	0	0.3	7	58	**12.4**
FRA DTS VL1218	33	4.3	8	1.0	41	787	**5.2**
FRA DTS VL1824	383	14.7	93	3.6	476	2614	**18.2**
FRA DTS VL2440	804	14.6	151	2.7	956	5517	**17.3**
Total France	1278	12.3	272	89.1	1551	10403	**14.9**
Total GSA07	1380	13.3	286	93.6	1666	10708	**15.6**

Table 2.4.1.2b Contribution of the stocks assessed to the production value (in euro) of the main fleet segments of demersal fisheries in GSA07 (the percentage is computed on the average production of the last three years) by country. The values in the column "assesed%" is calculated as ratio between value of assessed species to total value, the same calculation has been done for the rows "Total"..

Assessed species/fleet segments GSA06	**HKE**		**MUT**		**Total**		
	Landing value (Keuro)	**%**	**Landing value (Keuro)**	**%**	**Landing value (Keuro)**	**Landing value (Keuro)**	**assessed %**
ESP DTS VL1218	8.9	13.6	3.1	4.7	12.0	66	**18.3**
ESP DTS VL1824	522	33.3	78	5.0	600	1569	**38.3**
ESP HOK VL1218	7	94.6	0	0.0	7	7	**94.6**
Total Spain	538	32.8	81	5.0	620	1643	**37.7**
FRA DFN VL0006	0	0.0	8	1.2	0	710	**0.0**
FRA DFN VL0612	260	4.8	210	3.9	470	5386	**8.7**
FRA DFN VL1218	38	7.9	2	0.5	41	484	**8.5**
FRA DTS VL1218	134	4.0	43	1.3	177	3380	**5.2**
FRA DTS VL1824	1616	17.9	444	4.9	2061	9045	**22.8**
FRA DTS VL2440	3087	16.2	764	4.0	2748	19006	**14.5**
Total France	5135	13.8	1464	89.1	5497	37302	**14.7**
Total GSA07	5673	15.2	1546	94.1	6116	38945	**15.7**

The stocks assessed in experts working groups (STECF or GFCM) are those that are considered relevant for the fisheries, although due to the mixed nature of demersal Mediterranean fisheries the assessed species may be a small fraction of the total landings in value or weight. Other important species that are rarely or never assessed are: sparids, such as *Sparus aurata*, *Pagellus erythrinus* and *P. bogaraveo* or *Diplodus sargus*; cephalopods, such as *Octopus vulgaris* or *Sepia officinalis*; *Solea solea*; *Nephrops norvegicus* and *Lophius* spp. (cf Section 2 of Final Report of STECF 15-19 "Landings Obligation Part 6".

2.4.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The assessments of the main demersal stocks were presented during the STECF 14-17 (EWG 14-09: red mullet) and STECF 15-11 (EWG 15-09:hake). These assessments used official DCF data together with the historical time series available for GSA07 from 2004 to 2012 for red mullet and 2002 – 2013 for hake. Red mullet population dynamics were propagated to 2014 using FLR methods.

MEFISTO simulation used 2014 as the base, or status quo year, with 2015 as first year of the simulation. According to the stock assessments used, the summary diagnosis of the stocks is the following:

- Hake: Fishing mortality (F_{bar0-2}) increasing in recent years and SSB decreasing along the time series. Strong fluctuations in recruitment and landings.
- Red mullet: Fishing mortality (F_{bar0-3}) fluctuating. Increasing recruitment, SSB and landings since 2004.

Both main stocks are considered overexploited by the recent assessments. In the case of hake, the current fishing mortality to Fmsy ratio is almost 15 (Table 2.4.2.1) .

Discards of hake and red mullet are suspected to be important, but official data only reports relatively low amounts (<10% of landings) in the two most recent years. Due to the lack of reliable information, landings are usually equated with catches in the stock assessments.

Table 2.4.2.1 Current level of fishing mortality ($F_{current}$), of F_{MSY}, of the ratio between $F_{current}$ anf F_{MSY} ($F_{current}/F_{MSY}$), Spawning Stock Biomass, landings and Recruitment of the assessed species (HKE=European hake, MUT=red mullet)

Stock	***Current F***	***F_{MSY}***	***F_{curr}/F_{MSY}***	***Spawning Stock Biomass (tons)***	***Landings (tons)***	***Recruitment (thousands)***
HKE	1.64	0.11	14.9	1115	1552	44 364
MUT	0.45	0.14	3.21	1240	240	35 078

Stock advice, Reference points, and their technical basis

Both demersal stocks are assessed as being exploited unsustainably at levels considerably higher than F_{MSY}. In the case of European hake, the current fishing mortality to F_{MSY} ratio is almost 15.

The framework used for the reference points is summarised in the table 2.4.2.2, taken from STECF 14-17 (EWG 14-09) and STECF 15-11 (EWG 15-09). Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.4.2.2 - Reference point framework for demersal resources in GSA07.

Framework					
	MSY approach			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for all stocks	F01 as proxy for Fmsy	From empirical equation		1.4 x B_{loss}	N/A

		(EWG 15-11)			
Values for hake	**0.11**	**0.16**	**14.9**	**1077**	
Values for red mullet	**0.14**	**0.20**	**3.21**	**574**	

Development of economic indicators over time and current status

The economic performance of the demersal fleet and of the main fleet segments is evaluated using key social and economic indicators and a traffic light table (Table 2.4.2.3; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend. "Recent" refers to 2011-2014).

Note that even if revenues from main stocks are stable or increasing, the overall fleet revenues are mostly negative, because the dependency of these mixed fleets on the main species is usually lower than 30%. Employment has remained approximately stable for all fleets, but economic performance (salary, overall revenues) is decreasing, except in the case netters and longliners. Recent trend of CR.BER is negative for most fleet segment, while ROI shows a positive recent trend.

Tab. 2.4.2.3 Traffic light table on the economic performance of the fleets targeting demersal resources (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend; white= does not apply). The values in the cells are referred to 2011 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleets	Salary (Euro)	CR.BER	ROI	Overall Revenues (thousand Euro)	Revenues HKE (thousand Euro)	Revenues MUT (thousand Euro)	Employment (number of units)
All fleets	35213÷25357	1.33÷0.35	(-2.14)÷3.45	66116.2÷49736.6	9700÷13370	1142.6÷1487.5	1334÷1293
ESP07_DTS_12-18	24312÷18656	1.16÷1.08	(-0.04)÷0.03)	1028.3÷925.7	402.2;554.4	53.3÷69.4	38÷35
ESP07_DTS_18-24	45214÷40598	1.15÷0.87	(-0.05)÷0.03)	2752.3÷2007.6	482.6÷665.2	64.0÷83.3	34÷34
FRA07_DTS_12-18	47950÷46258	3.52÷0.48	(-12.44)÷(-2.66)	1217.3÷1095.8	476.1÷656.3	63.1÷82.1	101÷95
FRA07_DTS_18-24	58789÷44512	(-2.07) ÷0.99	(-6.50) ÷ (-0.42)	9129.8÷8218.6	3570.8÷4921.8	473.2÷616.1	304÷298
FRA07_DTS_24-40	44257÷43169	0.35÷0.35	(-8.56) ÷ (-3.48)	21042.0÷15348.6	3689.9÷5085.9	489.0÷636.6	212÷197
FRA07_DFN_00-06	31925÷322369	(-0.67) ÷ (-3.12)	2.57÷9.48	3325.4÷2316.3	154.7÷231.2		62÷64
FRA07_DFN_06-12	29015÷31504	(-0.82) ÷3.73	0.66÷4.30	26324.8÷18853.4	767.3÷1057.6		504÷495
FRA07_DFN_12-18	25064÷24312	6.2÷ (-0.74)	2.47÷5.17	942.7÷652.4	18.2÷25.1		25÷25
ESP07_HOK_12-18	15214÷17264	0.33÷(-0.84)	(-0.25)÷0.06	353.5÷318.2	138.3÷190.6		54÷50

2.4.3. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

Fmsy objectives can be achieved by reducing fishing mortality of the fleets in order to avoid the catch of juvenile fish. Because bottom trawl has the largest amount of demersal catches in the area and the highest contribution to fishing mortality of juveniles, Fmsy objectives can only be achieved by strongly reducing the impact of this fleet on the target species. Because hake is by far the species with the highest Fcurr/Fmsy ratio in GSA07, simulation scenarios that ensure MSY on hake will lead to underexploitation of other demersal resources in the mid to long term.

The reduction of current high fishing mortality rates can be achieved, in general, by reducing effort (understood as the combination of activity and capacity) or improving selectivity patterns. A mixed strategy combining effort reduction and selectivity improvement could also be effective and it is explored here. In the next section (section 6.2.3) the scenarios tested are detailed.

Current legislation in GSA 07 ("*Arrêté du 28 février 2013 portant adoption d'un plan de gestion pour la pêche professionnelle au chalut en mer Méditerranée par les navires battant pavillon français* »), identifies only hake as subject to a reference point (Fmsy = 0.20 in 2020, with a progressive reduction starting in 2015). The reduction in terms of activity is not specified in legislation, so the scenarios of effort reduction assume a reduction of F split in 10% due to capacity reduction and 90% activity reduction (number of fishing days).

Selectivity improvement was explored by assuming that length at first capture is postponed by 2 cm from the current selection patterns corresponding to SM40. Current selection ogives were constructed from a variety of published results (Bahamón et al. 2006; Guijarro and Massutí 2006; Sala et al. 2008) based on the logistic model for the target species of this study. It is important to note that the effect of delaying the length at first catch on the population can be achieved by a variety of technical means (improving trawl selectivity, reducing fishing in nursery areas or temporarily closing the fishery at specific times of the year). In the present study, the selection curve on lengths was transformed to a selection curve on age based following the standard procedure of applying the von Bertalanffy inverse model (Sparre and Venema 1998).

2.4.4. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Both stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account.

Two strategies to reach F_{msy} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term, the reduction is applied since 2015 and after 2018 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term; the reduction is applied since 2015 and after 2020 fishing mortality is assumed to remain around the upper bound of the F_{MSY} range.

Proposed scenarios are reported in the table 2.4.4.1.

Table 2.4.4.1 – Scenarios modelling for the forecasts.

Case Study	demersals in GSA 07
Scenario 1	Status quo
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species in 2018 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using value of landings as weighting factor) in 2018 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using value of landings for weighting) in 2020 applied on both activity and capacity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity accounting for the survivability issue (in case of gear selectivity). Starting year 2015.

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

Based on F levels, European hake is the most heavily exploited stock in the mix, thus it has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA07, as well as in other Mediterranean areas.

The percentages of reduction by stock to reach F_{msy} are reported in the table 2.4.4.2.

The percentages of reduction were based on the advices from STECF that indicated the needing of reaching F_{MSY}, while keeping the spawning stock biomass at safe levels. The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach F_{MSY}) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using: the reference point Fupper of European hake which value is 0.16 and the current fishing mortality of the different stocks.

Tab. 2.4.4.2- Fishing mortality reduction needed to reach Fupper, by stock

Stock	***Fishing mortality reduction*** *(in %)*
HKE	93%
MUT	69%

Under Scenarios 2 and 4 the reduction in fishing mortality is assumed on the most overexploited species (European hake) to ensure that all species are fished at Fmsy at the target year (2018 or 2020). The target has been thus the Fupper of European hake, which value is 0.156.

A second set of scenarios (Scenarios 3 and 5) proposes a reduction in fishing effort proportionally applied to the different fleet segments, accounting for their relative impact to a weighted overall Fmsy (value of landings as weighting factor). The table 2.4.4.3 reports the relative impact of the different fleet segments in terms of percentage of fishing mortality of each stock by fleet segment for 2014. The combined Fmsy target computed on the basis of Fupper by species was 0.162. In this case study, given that only 2 species were assessed, it was decided to use Fupper to compute Fmsy combined, to account for the complexity of catches of OTB metier in GSA07.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Table 2.4.4.3. Relative impact of the different fleet segments in terms of percentage of fishing mortality of each stock.

Fleets	HKE	MUT	reduction factor
FR-DFN0006	0.00	0.01	0.00
FR-DFN0612	0.06	0.16	0.11
FR-DFN1218	0.00	0.00	0.00
ES-DTS1218	0.06	0.05	0.06
ES-DTS1824	0.07	0.07	0.07
FR-DTS1218	0.05	0.04	0.05
FR-DTS1824	0.37	0.33	0.35
FR-DTS2440	0.38	0.34	0.36
ES-HOK1824	0.00	0.00	0.00
	1.00	1.00	1.00

The reduction of effort was split in a reduction of 10% in terms of capacity and 90% in terms of activity.

In all the scenarios the uncertainty on recruitment has been taken into account, applying for both stocks a multiplicative error (on the stock recruitment relationship/geometric mean of recruitment computed for the last three years).

2.4.5. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is MEPHISTO bio-economic model (cfr chapter 2.1).

2.4.6. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA07

All the inputs for modelling are fully reported in the Annex C.

2.4.7 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.4.7.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

The projection of the demersal fishery under current conditions from 2015 to 2030 is shown in the following figures (2.4.7.1.1 to 2.4.7.1.5).

For each species, the variables shown are the standard quantities produced in SGMED working groups: average fishing mortality (F, yr^{-1}), recruitment (R, thousands), spawning stock biomass (SSB, tons) and catches (Yield, tons).

In all figures the vertical grey bar separates the historical (2002 – 2014) data series from the projected (2015 – 2030) series. In the SSB panel, a horizontal line shows the reference point limit SSB (Blim, estimated at 1.4 times the lowest observed SSB, Bloss).

All projections were carried out with constant recruitment (average of last 4 years) with 95% confidence interval given by the standard deviation of the historical recruitment series, following a lognormal model.

The simulation results in Fig. 2.4.7.1.1 indicate that the projection of status quo conditions for European hake (fixed fishing mortality and average recruitment) would result in SSB over the simulation period 2015-2030 on the lowest range of historically observed values, while catches would vary around historically high observed catches.

The simulation results in Fig. 2.4.7.1.2 indicate that the projection of status quo conditions for red mullet (fixed fishing mortality and recruitment around typical values observed in recent years) would result in high SSB and catches, continuing the observed recent trend in the historical series, over the simulation period 2015-2030.

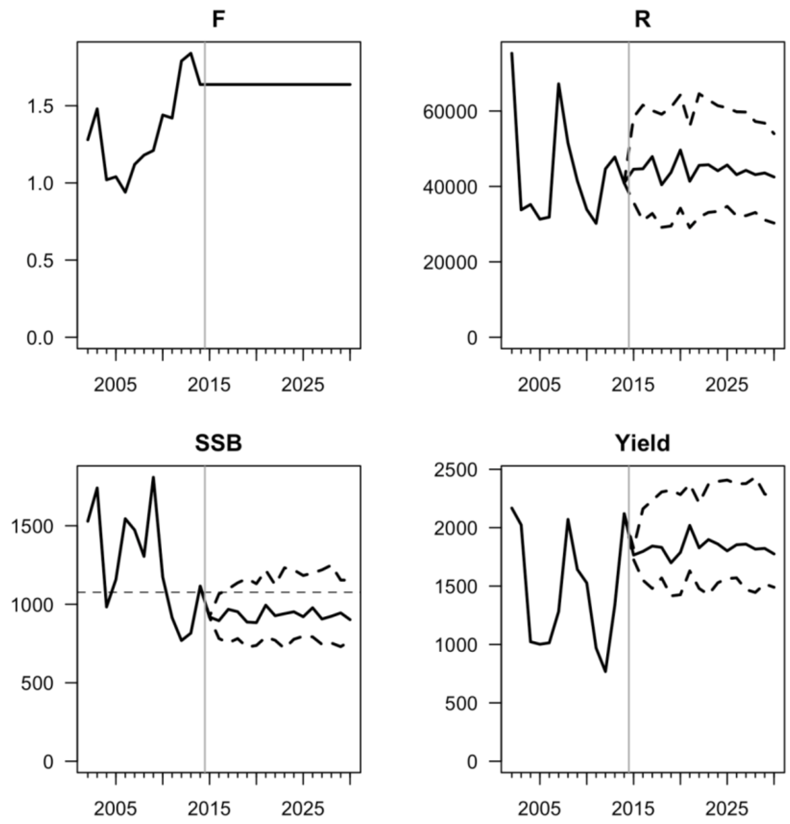


Fig. 2.4.7.1.1. **Hake** in GSA 07, Scenario 1. Biological and pressure variables

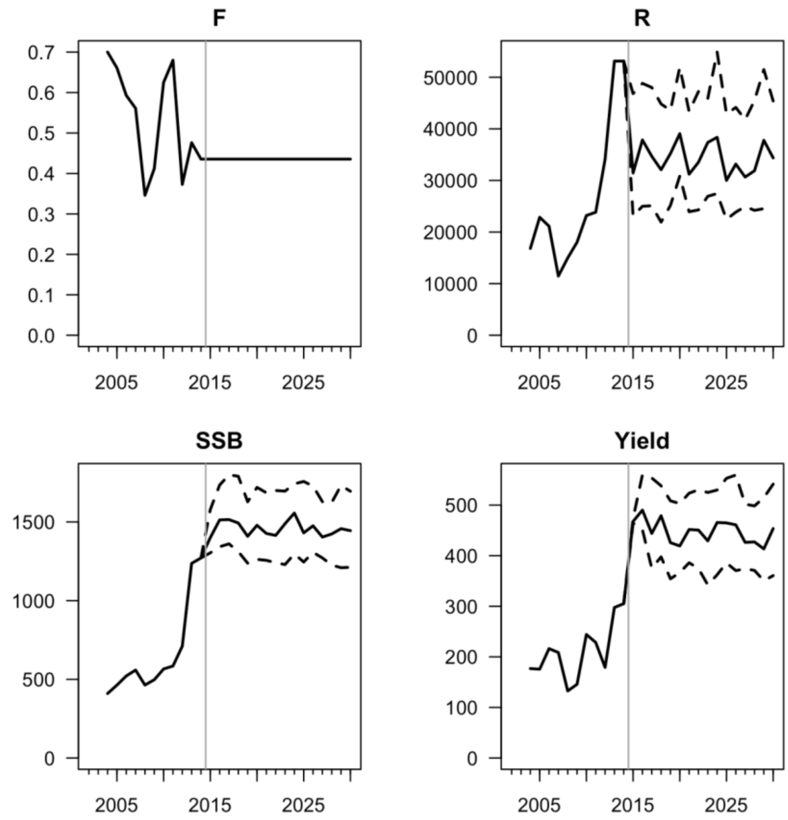


Fig. 2.4.7.1.2. **Red mullet** in GSA 07, Scenario 1. Biological and pressure variables.

2.4.7.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

The simulation results in Fig 2.4.7.2.1 show the projection of status quo condition for 4 selected socio-economic indicators compared with the (short 2011-2014) historical series.

The income due to landings is expected to stabilize at ca. 38 M€, similar to the value recorded in 2014. Because effort would be frozen at the level of 2014 (projection of status quo fishing mortality in the previous figures 2.4.7.1.1 – 2.4.7.1.2), effort costs are expected to be similar to the values historically observed. Due to the cost-sharing scheme prevalent in the Mediterranean, lower landing income would translate into decreased wages and consequently, labour costs. The forecast low value of landings and the constant value of effort costs would result in higher negative gross profits (sustained losses of the order of 14 M€, similar to the value observed in 2014).

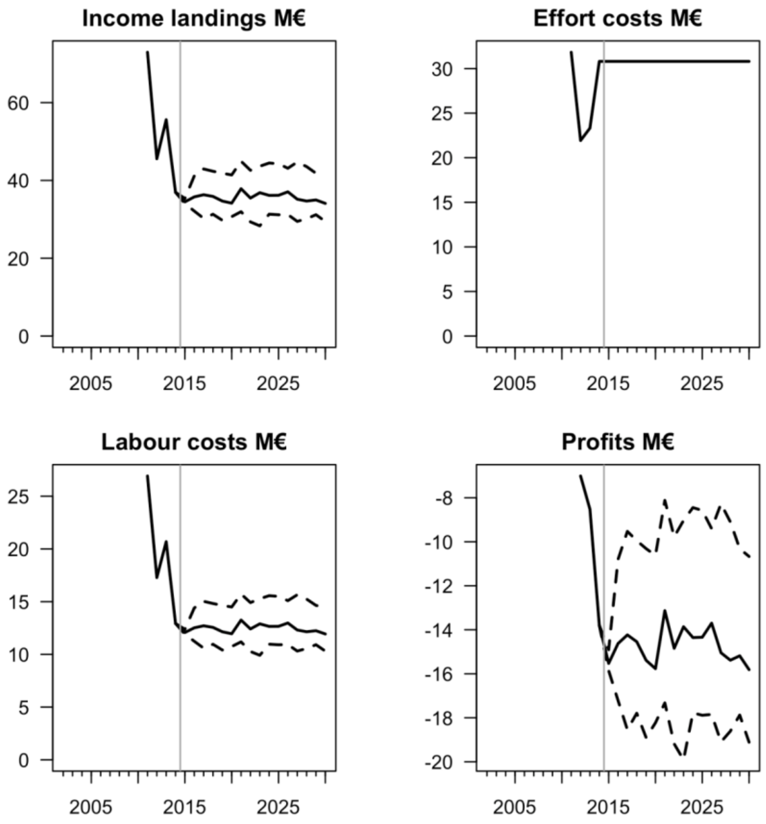


Fig. 2.4.7.2.1 Economic indicators GSA 07, Scenario 1. All fleets combined.

2.4.8 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

2.4.8.1 SCENARIO 2 LINEAR REDUCTION TOWARDS UPPER FMSY OF THE MOST HEAVILY EXPLOITED STOCK IN 2018

Hake was considered the most overexploited species. The upper range of hake Fmsy was computed with the empirical formula used in EWG 15-11:

Fupper = 0.007801555 + 1.349401721*Fmsy, where Fmsy = 0.11. The resulting Fupper is 0.16 for European hake. The Scenario was built by computing an effort vector that ensures that average F of the relevant age classes (0-2 in hake) is 0.16 by 2018.

The effort reduction to achieve the objective in 2018 was carried out by first computing a global vector of effort (days at sea x number of vessel) that ensures the target F and then allocating this vector among fleet segments (conditioned to a maximum capacity reduction of 10% by fleet segment by 2018), as capacity reduction, and distributing the remainder days (activity) proportionally among fleet segments.

Table 2.4.8.1.1. Effort reduction required to achieve target

yr	Effort (days at sea x vessels)
2014	133000

2015	102922
2016	72844
2017	42766
2018	12688
2019	12688
2020	12688

The partial fishing mortality vector computed in EWG 15-11 for the fleets targeting hake in the Gulf of Lions was used to allocate the required effort decrease proportionally among fleets. Within each fleet, the corresponding partial F was allocated proportionally according to the number of fishing units (Table 2.4.8.1.2).

Table 2.4.8.1.2. Partial fishing mortality vector on each target species by fleet segment (source EWG 15-11).

Fleet	Year	Catches	Partial_f	%
FR_OTB	2015	1538	1.399	0.80
FR_GN	2015	125	0.17	0.10
SP_OTB	2015	195	0.16	0.09
SP_LL	2015	12	0.025	0.01

Table 2.4.8.1.2 shows that French trawlers are responsible for 80% of the fishing mortality ofEuropean hake in the area, hence the largest share of effort decrease is allocated to this fishing gear.

Table 2.4.8.1.3 reports the number of vessels required to achieve the target reference point by demersal fleet segments, while table 2.4.8.1.4 reports the number of days permitted by fleet segment to achieve target.

Table 2.4.8.1.3. Number of vessels required to achieve the target (F[hake] = Fupper[hake] by 2018) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	102	506	12	5	6	4	30	31	15	711
2015	79	392	9	4	5	3	23	24	12	550
2016	56	277	7	3	3	2	16	17	8	389
2017	33	163	4	2	2	1	10	10	5	229
2018	10	48	1	0	1	0	3	3	1	68
2019	10	48	1	0	1	0	3	3	1	68
2020	10	48	1	0	1	0	3	3	1	68

Table 2.4.8.1.4 Number of days permitted by fleet segment to achieve target (F[hake] = Fupper[hake] by 2018) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	19380	96140	2280	950	1140	760	5700	5890	2850	13300
2015	1500	7440	176	74	88	59	441	456	221	10292
2016	1061	5266	125	52	62	42	312	323	156	7284
2017	623	3091	73	31	37	24	183	189	92	4277
2018	185	917	22	9	11	7	54	56	27	1269
2019	185	917	22	9	11	7	54	56	27	1269
2020	185	917	22	9	11	7	54	56	27	1269

OUTPUTS OF BIOLOGICAL AND PRESSURE INDICATORS

Fig. 2.4.8.1.1 shows that under Scenario 2, the strong decrease in fishing mortality of European hake and the condition of stable recruitment would result in very high SSB after year 2020 (more than 10 times compared to Scenario 1, Fig. 2.4.7.1.1) and catches 1/3 higher than under Scenario 1, after a transition period (2017-2019) of low catches (but within the low values observed in the historical series).

Fig. 2.4.8.1.2 shows that under Scenario 2, the strong decrease in fishing mortality of red mullet and the condition of stable recruitment would result in high SSB after year 2020 (about 50% higher than under Scenario 1, Fig. 2.4.7.1.2) but catches 80% lower than under Scenario 1, and lower than the values observed in the historical series).

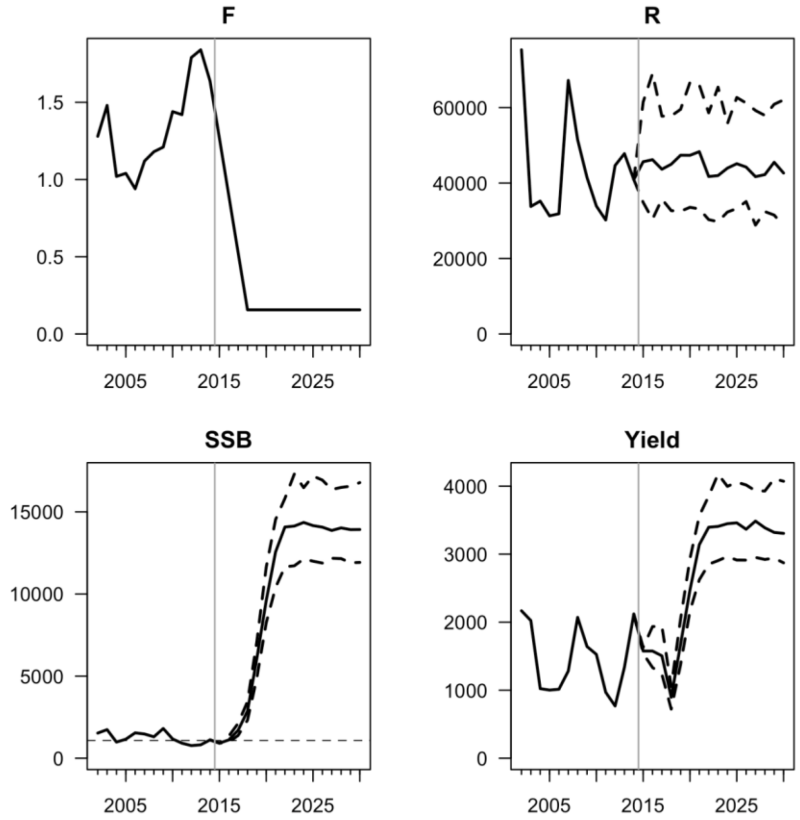


Fig. 2.4.8.1.1 **Hake** in GSA 07, Scenario 2. Biological and pressure variables.

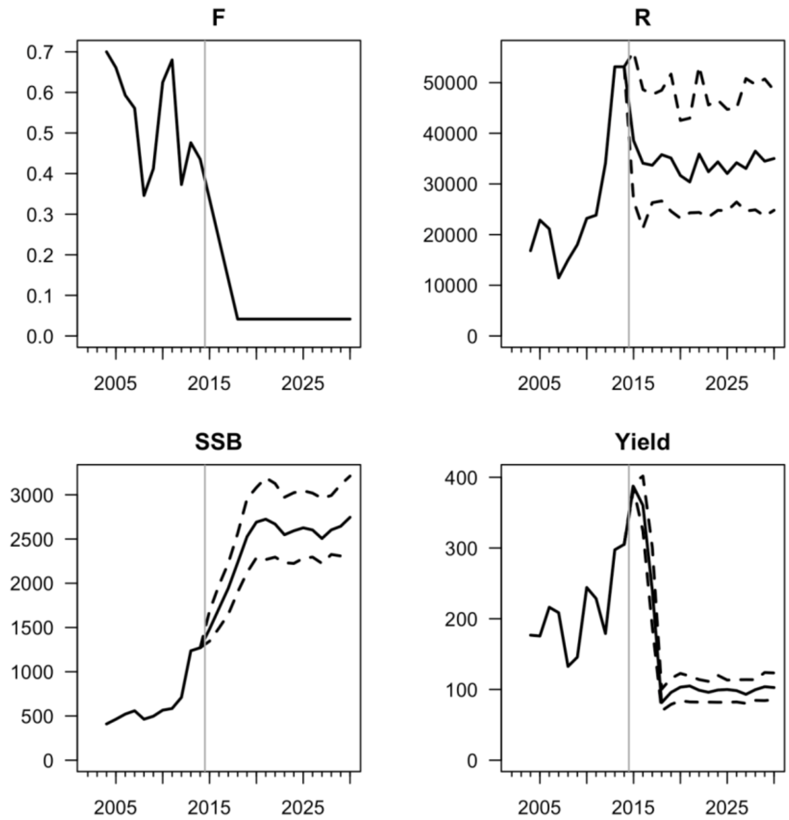


Fig. 2.4.8.1.2 **Red mullet** in GSA 07, Scenario 2. Biological and pressure variables.

OUTPUTS OF THE ECONOMIC INDICATORS

The simulation results shown in Fig. 2.4.8.1.3 indicate that landings value would recover to values similar to the average observed landings after 2020 and to a higher value than that observed under Scenario 1. However, a transition period of low income between 2016 and 2019 could be expected.

The strong decrease in effort costs associated to the simulation scenario would imply large positive profits after 2016, but the profits would not accrue directly as wages to fishers because labour costs are proportional to landings income. Scenario 2 would allow reversing the decrease in labour costs observed since 2011.

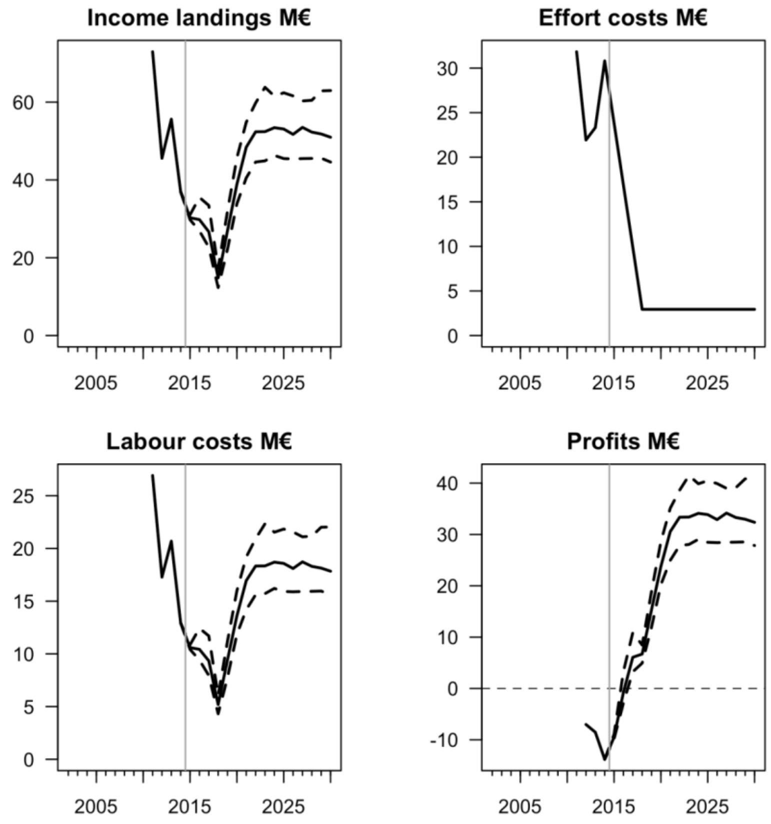


Fig. 2.4.8.1.3. Economic indicators GSA 07, Scenario 2. All fleets combined.

2.4.8.2 SCENARIO 3 LINEAR REDUCTION TOWARDS A WEIGHTED AVERAGE F_{MSY} IN 2018

A linear reduction towards Fmsy in 2018 taking into account the mixed nature of the fishery was performed by weighting the Fmsy of individual species by their importance in the value of landings.

Effort reduction required to achieve target reference point is reported in the Table 2.4.8.2.1.

Table 2.4.8.2.1. Effort reduction required to achieve target reference point.

yr	Effort (days at sea x vessels)
2014	**133000**
2015	103953
2016	74906
2017	45858
2018	16811
2019	16811
2020	16811

Table 2.4.8.2.2. reports the proportion of fishing mortality on each target species by fleet segment and the reduction factor to be applied for each fleet segment to achieve the target reference point (F_{MSY} weighed by 2018).

As shown in the table 2.4.8.2.2, the largest French trawl fleet segments FR-DTS1824 FR-and DTS2440 contribute to 71% of the weighted value of landings of both target species. The fishing effort decrease was allocated proportionally to this reduction factor.

The combined Fmsy target computed on the basis of Fupper by species was 0.162. In this case study, given that only 2 species were assessed, it was decided to use Fupper to compute Fmsy combined, to account for the complexity of catches of OTB metier in GSA07.

Table 2.4.8.2.2. Proportion of fishing mortality on each target species by fleet segment. To achieve the target weighted Fmsy, a reduction factor averaging the contribution of each fleet segment is computed.

	HKE	MUT	reduction factor
FR-DFN0006	0.00	0.01	0.00
FR-DFN0612	0.06	0.16	0.11
FR-DFN1218	0.00	0.00	0.00
ES-DTS1218	0.06	0.05	0.06
ES-DTS1824	0.07	0.07	0.07
FR-DTS1218	0.05	0.04	0.05
FR-DTS1824	0.37	0.33	0.35
FR-DTS2440	0.38	0.34	0.36
ES-HOK1824	0.00	0.00	0.00
	1.00	1.00	1.00

Table 2.4.8.2.3. reports the number of vessels required to achieve target reference point, while table 2.4.8.2.4 the number of days permitted by fleet segment to achieve the target reference point (F_{MSY} weighed by 2018).

Table 2.4.8.2.3. Number of vessels required to achieve target (F_{MSY} weighed by 2018) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	102	506	12	5	6	4	30	31	15	711
2015	80	395	9	4	5	3	23	24	12	556
2016	57	285	7	3	3	2	17	17	8	400
2017	35	174	4	2	2	1	10	11	5	245
2018	13	64	2	1	1	1	4	4	2	90
2019	13	64	2	1	1	1	4	4	2	90
2020	13	64	2	1	1	1	4	4	2	90

Table 2.4.8.2.4. Number of days permitted by fleet segment to achieve target (F_{MSY} weighed by 2018) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	19380	96140	2280	950	1140	760	5700	5890	2850	13300
2015	1515	7514	178	74	89	59	446	460	223	10395
2016	1091	5415	128	54	64	43	321	332	161	7491
2017	668	3315	79	33	39	26	197	203	98	4586
2018	245	1215	29	12	14	10	72	74	36	1681
2019	245	1215	29	12	14	10	72	74	36	1681
2020	245	1215	29	12	14	10	72	74	36	1681

OUTPUTS OF BIOLOGICAL AND PRESSURE INDICATORS

Fig. 2.4.8.2.1 shows that under Scenario 3, the strong decrease in fishing mortality of hake and the condition of stable recruitment would result in very high SSB after year 2020 (ca. 10 times compared to Scenario 1, Fig. 2.4.7.1.1) and catches 1/3 higher than under Scenario 1, after a transition period (2017-2019) of low catches (but within the low values observed in the historical series).

Fig. 2.4.8.2.2 shows that under Scenario 3, the strong decrease in fishing mortality of red mullet and the condition of stable recruitment would result in high SSB after year 2020 (about 1/3 higher than under Scenario 1, Fig. 2.4.7.1.2) but catches would be similar to the values observed in recent years of the historical series.

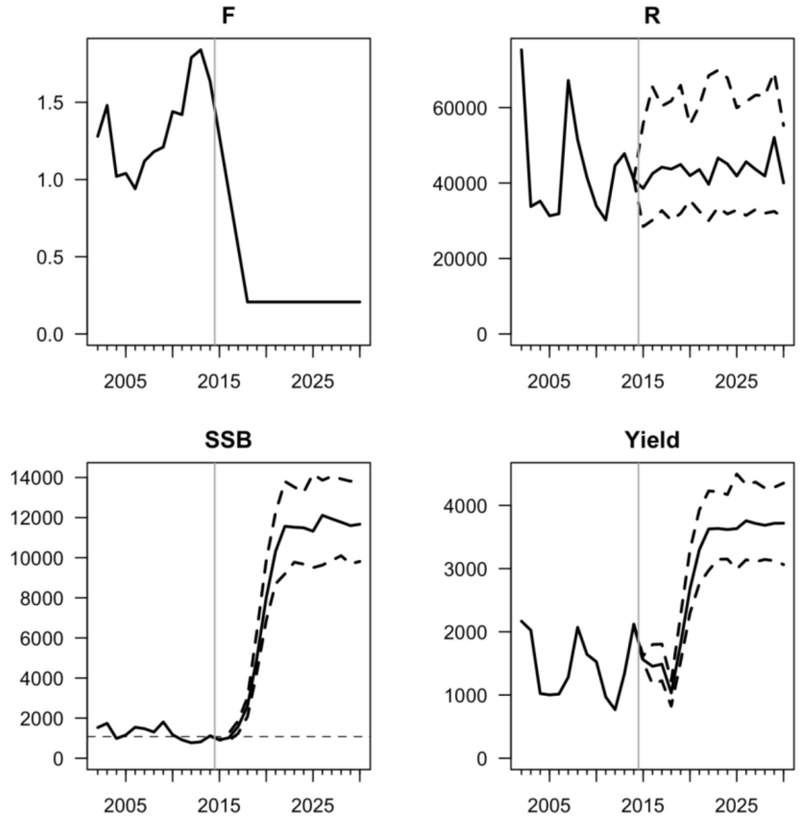


Fig. 2.4.8.2.1. European **hake** in GSA 07, Scenario 3. Biological and pressure variables.

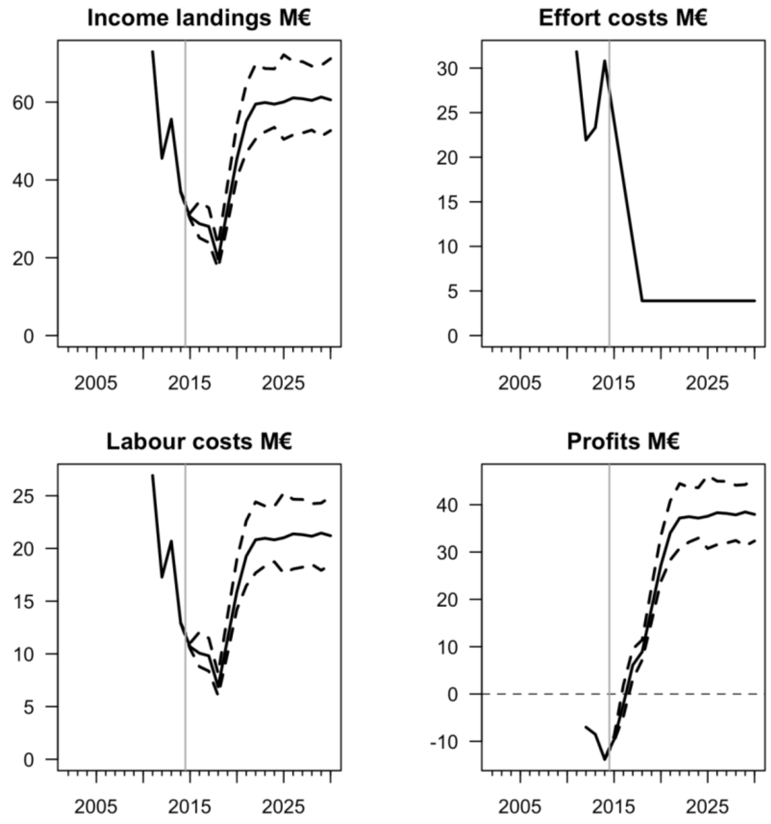


Fig. 2.4.8.2.3. Economic indicators GSA 07, Scenario 3. All fleets combined.

2.4.8.4 SCENARIO 4. ADAPTIVE REDUCTION TOWARDS UPPER F_{MSY} OF THE MOST HEAVILY EXPLOITED SPECIES IN 2020

Table 2.4.8.4.1 reports the effort reduction required to achieve the target reference point (Fupper of European hake). Similarly to Scenario 2, the number of vessels required to achieve target, conditioned to achieving upper Fmsy for hake in 2020 (as established in the current national management plan) is shown in Table 2.4.8.4.2 for the number of vessels and in the table 2.4.8.4.3. for the number of days permitted by fleet segment.

See also Table 2.4.8.1.2. for the allocation of effort reduction across fishing fleets weighted by the partial mortality vector.

Table 2.4.8.4.1 Effort reduction required to achieve target (F[hake] = Upper Fmsy[hake] in 2020).

yr	Effort (days at sea x vessels)
2014	**133000**
2015	112948
2016	92896
2017	72844
2018	52792
2019	32740
2020	12688

Table 2.4.8.4.2. Number of vessels required to achieve target (F[hake] = Fupper[hake] by 2020) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	102	506	12	5	6	4	30	31	15	711
2015	87	430	10	4	5	3	25	26	13	604
2016	71	353	8	3	4	3	21	22	10	497
2017	56	277	7	3	3	2	16	17	8	389
2018	40	201	5	2	2	2	12	12	6	282
2019	25	125	3	1	1	1	7	8	4	175
2020	10	48	1	0	1	0	3	3	1	68

Table 2.4.8.4.3. Number of days permitted by fleet segment to achieve target (F[hake] = Fupper[hake] by 2020) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	19380	96140	2280	950	1140	760	5700	5890	2850	13300
2015	1646	8165	194	81	97	65	484	500	242	11295
2016	1354	6715	159	66	80	53	398	411	199	9290
2017	1061	5266	125	52	62	42	312	323	156	7284
2018	769	3816	91	38	45	30	226	234	113	5279
2019	477	2367	56	23	28	19	140	145	70	3274
2020	185	917	22	9	11	7	54	56	27	1269

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Fig. 2.4.8.4.1 shows that under Scenario 4, the strong decrease in fishing mortality of hake and the condition of stable recruitment would result in very high SSB after year 2020 (close to. 15 times compared to Scenario 1, Fig. 2.4.7.4.1) and catches higher than under Scenario 1, after a transition period (2017-2019) of low catches (but within the low values observed in the historical series) (These simulation results are similar to those observed under Scenario 2)

Fig. 2.4.8.4.2 shows that under Scenario 4, the strong decrease in fishing mortality of red mullet and the condition of stable recruitment would result in high SSB after year 2020 (about 50% higher than under Scenario 1, Fig. 2.4.7.4.2) but catches 80% lower than under Scenario 1, and lower than the values observed in the historical series) (These simulation results are similar to those observed under Scenario 2)

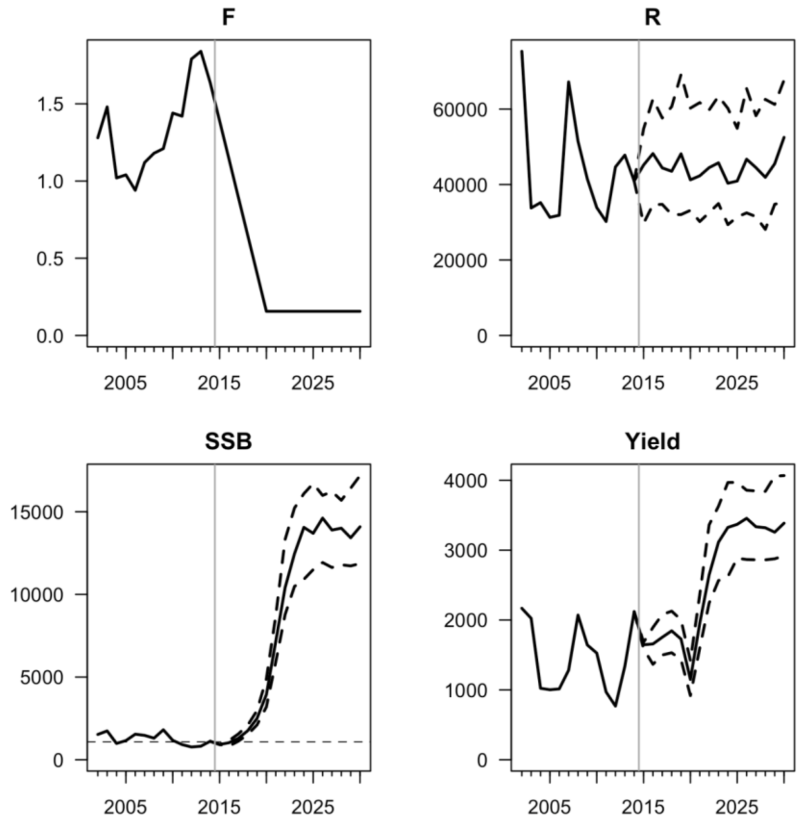


Fig. 2.4.8.4.1. European h**ake** in GSA 07, Scenario 4. Biological and pressure variables.

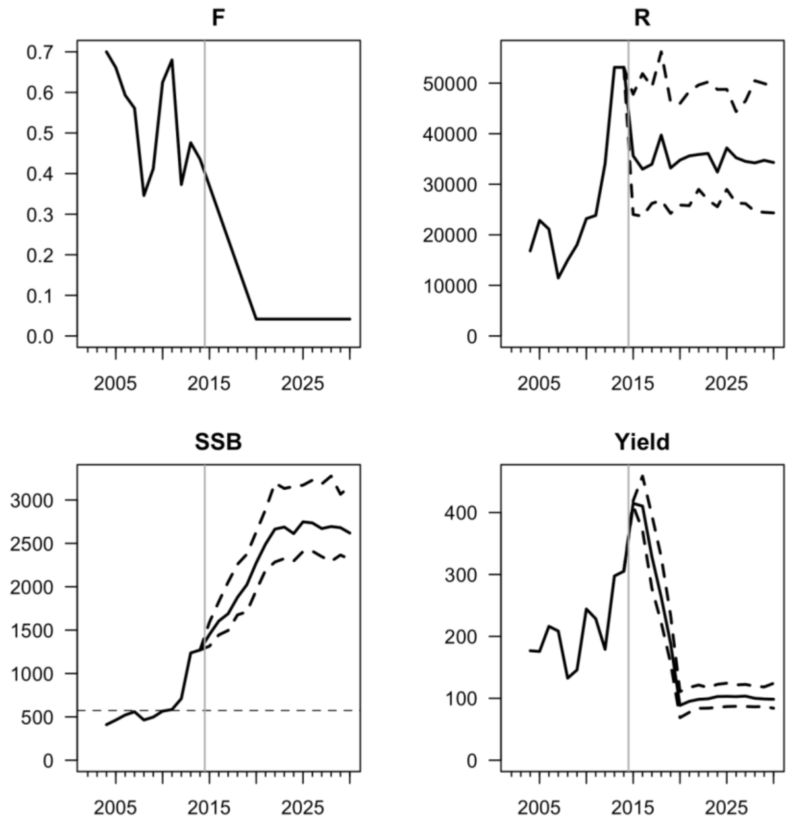


Fig. 2.4.8.4.2. **Red mullet** in GSA 07, Scenario 4. Biological and pressure variables.

OUTPUTS OF THE ECONOMIC INDICATORS

The simulation results in Fig. 2.4.8.4.3 indicate that landings value would recover to values similar to the average observed landings after 2020 and to a higher value than that observed under Scenario 1. However, a transition period of low income between 2016 and 2019 could be expected.

The strong decrease in effort costs associated to the simulation scenario would imply large positive profits after 2016, but the profits would not accrue directly as wages to fishers because labour costs are proportional to landings income. Scenario 2 would allow reversing the decreasing trend in labour costs observed since 2011 (these simulation results are similar to those observed under Scenario 2).

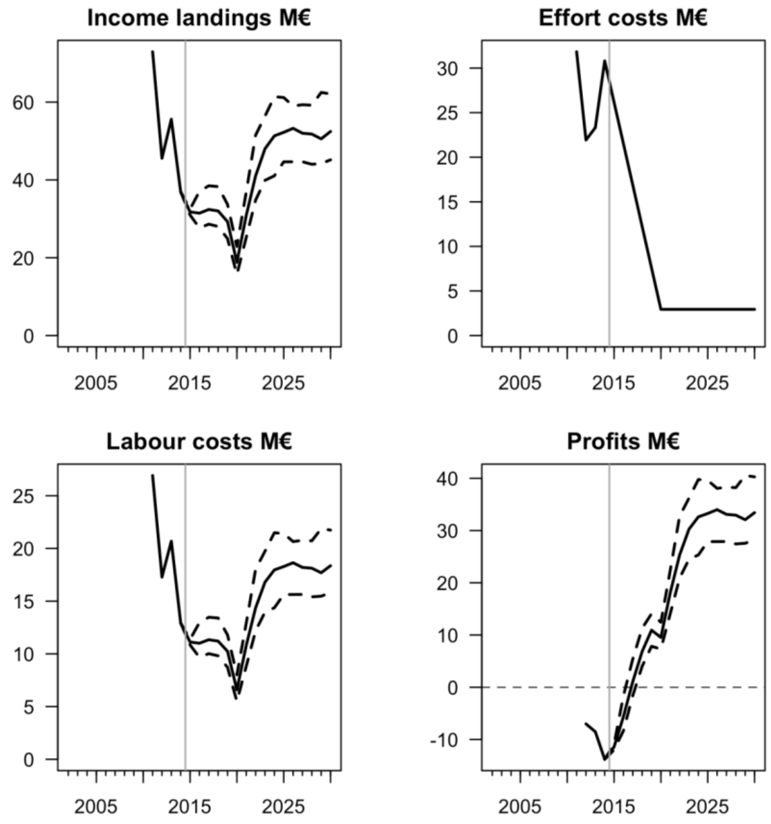


Fig. 2.4.8.4.3. Economic indicators GSA 07, Scenario 4. All fleets combined.

2.4.8.5. SCENARIO 5. ADAPTIVE REDUCTION TOWARDS A WEIGHTED AVERAGE F_{MSY} IN 2020

Table 2.4.8.5.1 reports the effort reduction required to achieve the target reference point (F_{MSY} weighed by 2020).

A linear reduction towards F_{MSY} in 2020 taking into account the mixed nature of the fishery was performed by weighting the F_{MSY} of individual species by their importance in the value of landings (see also previous Table 2.4.8.2.2).

Table 2.4.8.5.1 Effort reduction required to achieve target reference point (F_{MSY} weighed).

yr	Effort (days at sea x vessels)
2014	**133000**
2015	113635
2016	94270
2017	74906
2018	55541
2019	36176
2020	16811

Table 2.4.8.5.2. reports the number of vessels required to achieve target (F_{MSY} weighed by 2020) in the French (FR) and Spanish (ES) demersal fleet segments, while table 2.4.8.5.3. the number of days permitted by fleet segment.

Table 2.4.8.5.2. Number of vessels required to achieve target (F_{MSY} weighed by 2020) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	FR-DFN0006	FR-DFN0612	FR-DFN1218	ES-DTS1218	ES-DTS1824	FR-DTS1218	FR-DTS1824	FR-DTS2440	ES-HOK1824	Demersal fleet
2014	102	506	12	5	6	4	30	31	15	711
2015	87	432	10	4	5	3	26	26	13	607
2016	72	359	9	4	4	3	21	22	11	504
2017	57	285	7	3	3	2	17	17	8	400
2018	43	211	5	2	3	2	13	13	6	297
2019	28	138	3	1	2	1	8	8	4	193
2020	13	64	2	1	1	1	4	4	2	90

Table 2.4.8.5.3. Number of days permitted by fleet segment to achieve target (F_{MSY} weighed by 2020) in the French (FR) and Spanish (ES) demersal fleet segments.

yr	**FR-DFN0006**	**FR-DFN0612**	**FR-DFN1218**	**ES-DTS1218**	**ES-DTS1824**	**FR-DTS1218**	**FR-DTS1824**	**FR-DTS2440**	**ES-HOK1824**	**Demersal fleet**
2014	19380	96140	2280	950	1140	760	5700	5890	2850	13300
2015	1656	8214	195	81	97	65	487	503	244	11364
2016	1374	6814	162	67	81	54	404	417	202	9427
2017	1091	5415	128	54	64	43	321	332	161	7491
2018	809	4015	95	40	48	32	238	246	119	5554
2019	527	2615	62	26	31	21	155	160	78	3618
2020	245	1215	29	12	14	10	72	74	36	1681

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Fig. 2.4.8.5.1 shows that under Scenario 5, the strong decrease in fishing mortality of hake and the condition of stable recruitment would result in very high SSB after year 2020 (ca. 12 times compared to Scenario 1, Fig. 2.4.8.1.1) and catches twice as high as those forecast under Scenario 1, after a transition period (2017-2019) of low catches (but within the low values observed in the historical series) (these simulation results are similar to those observed under Scenario 3 for the species)

Fig. 2.4.8.5.2 shows that under Scenario 5, the strong decrease in fishing mortality of red mullet and the condition of stable recruitment would result in high SSB after year 2020 (about 1/3 higher than under Scenario 1, Fig. 2.4.8.1.2) but catches would be similar to the higher range values observed in recent years of the historical series (these simulation results are similar to those observed under Scenario 3 for the species).

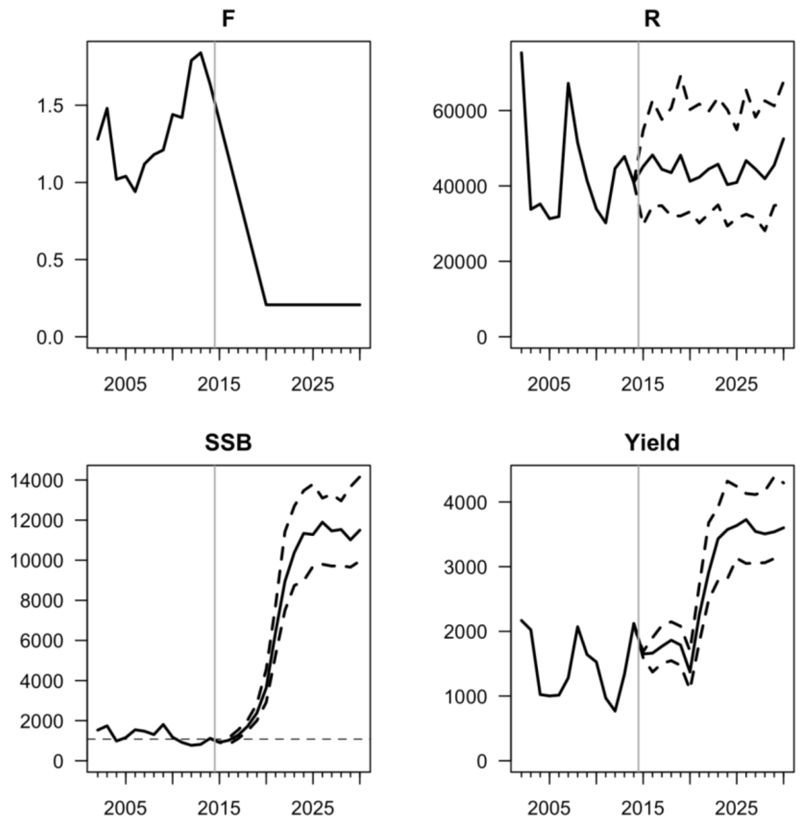


Fig. 2.4.8.5.1.European h**ake** in GSA 07, Scenario 5. Biological and pressure variables.

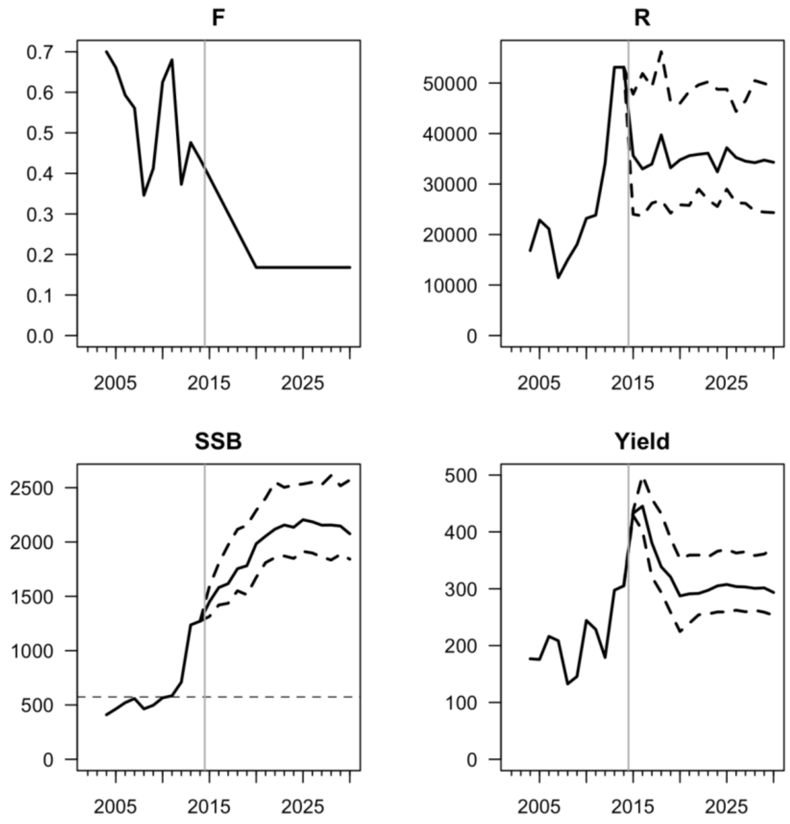


Fig. 2.4.8.5.2. **Red mullet** in GSA 07, Scenario 5. Biological and pressure variables

OUTPUTS OF THE ECONOMIC INDICATORS

Outputs of the economic indicators for all the fleets combined are reported in the figure 2.4.8.5.3. The simulation results shown indicate that landings value would recover to values similar to the high range of the observed landings value after 2020 (ca. 60 M€) and to a higher value than that observed under Scenario 1. However, a transition period of low income between 2016 and 2019 could be expected (albeit higher than in Scenario 3).

The strong decrease in effort costs associated with the simulation scenario would imply large positive profits after 2016 (stabilizing at 40 M€ after 2020), but the profits would not accrue directly as wages to fishers because labour costs are proportional to landings income. Scenario 3 would allow reversing the decrease in labour costs observed since 2011 (these simulation results are similar to those observed under Scenario 3)

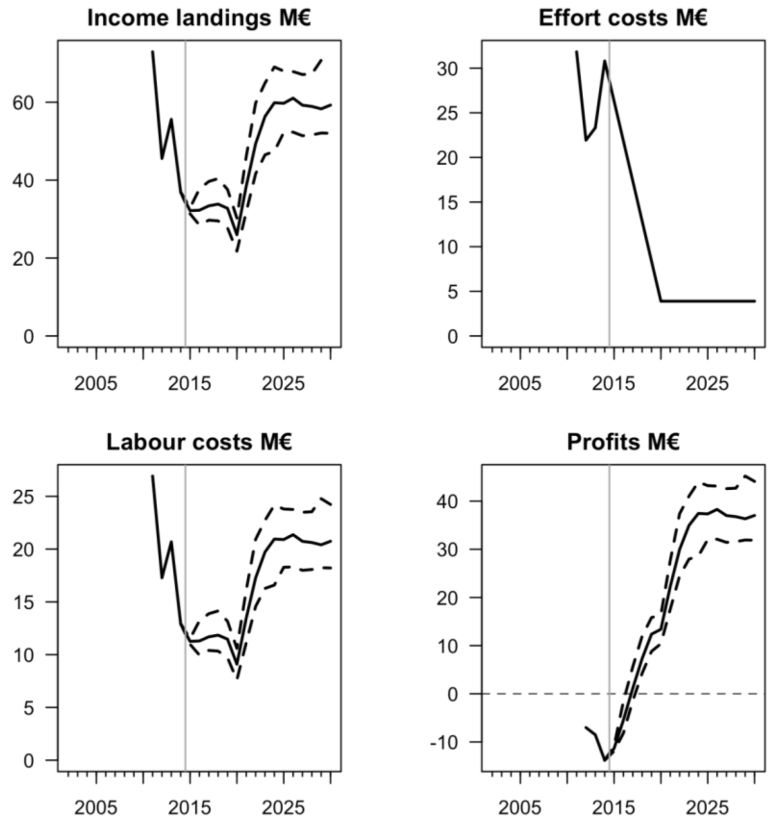


Fig. 2.4.8.5.3. Economic indicators GSA 07, Scenario 5. All fleets combined.

2.4.8.6 SCENARIO 6. IMPROVING SELECTIVITY

In Scenario 6, a change in selectivity was tested. The selectivity change represents delaying the median length at capture (L50) by 2 cm TL for hake and red mullet. The length-based selection ogives were transformed into age-based selection ogives using the inverse von Bertalanffy growth function.
The following table 2.4.8.6.1 summarizes the old and new selection patterns by species.

Table 2.4.8.6.1. Vectors of original and modified selectivity by species.

age	**0**	**1**	**2**	**3**	**4**	**5**	**6**
HKE original	0.0001	0.2057	0.9997	1.0000	1.0000	1.0000	1.0000
HKE modified	0.0001	0.0649	0.9988	1.0000	1.0000	1.0000	1.0000
MUT original	0.0001	0.7231	1.0000	1.0000	1.0000	1.0000	1.0000
MUT modified	0.0001	0.2504	0.9998	1.0000	1.0000	1.0000	1.0000

In the present analysis it is assumed that all fish encountering the art is killed (survivability = 0).
In this analysis, no Fmsy target is implemented.
An additional limitation to the specification of Scenario 6 is that changes in selectivity also imply a change in the Fmsy to a higher value (of the order of 10-20%: Scott and Sampson, 2011) so our results are conservative and probably higher effort could be achieved than that shown.

OUTPUTS OF THE BIOLOGICAL AND PRESSURE INDICATORS

Fig. 2.4.8.6.1 shows that under the simulation conditions of fishing mortality around the average of historically observed values and stable recruitment, spawning stock biomass would rebuild to around 2200 t after 2017 (more than double as the value of forecast in Scenario 1), while catches would increase and stabilize at a higher level than under Scenario 1 by more than 50%.

Fig. 2.4.8.6.2 shows that under the simulation conditions of fishing mortality 1/3 lower than the historically observed values and stable recruitment on the high end range of the historical series, spawning stock biomass would continue to increase, following recent observed trends and stabilize to a level of ca. 20% higher than under Scenario 1. Catches would only marginally increase by ca. 10% compared to Scenario 1.

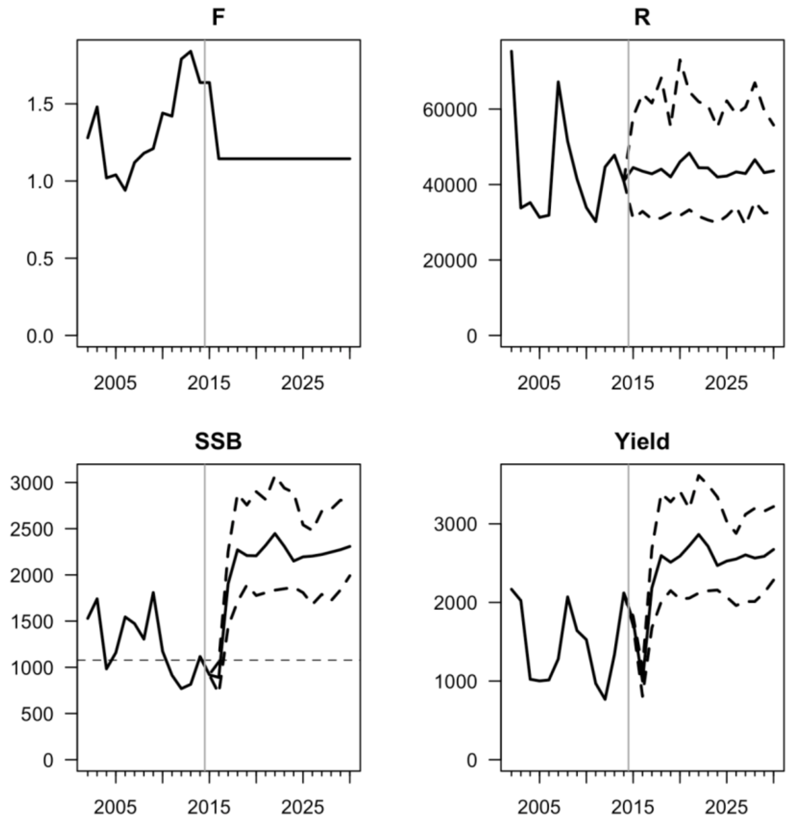


Fig. 2.4.8.6.1. European h**ake** in GSA 07, Scenario 6. Biological and pressure variables.

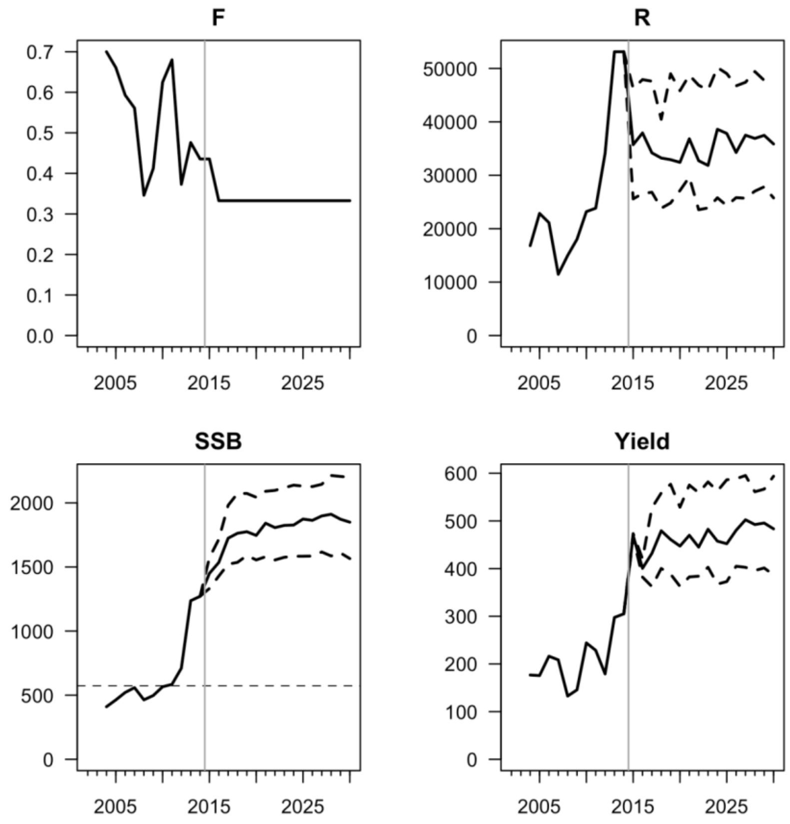


Fig. 2.4.8.6.2. **Red mullet** in GSA 07, Scenario 6. Biological and pressure variables.

OUTPUTS OF THE ECONOMIC INDICATORS

The simulation results shown in Fig. 2.4.8.6.3 show that landings income would stabilize around the average of the historical observations (ca. 50 M€). With effort costs constant around the value observed in 2014, profits would remain negative after 2017, although less than in the observed series. However, a strong decrease in profits would correspond to the transition period before 2017, when the fish population dynamics is adapting to the new selectivity regime. Labour costs (and fishers wages) would remain at the average observed values (ca. 17 M€) after 2017, but higher than in the transition process.

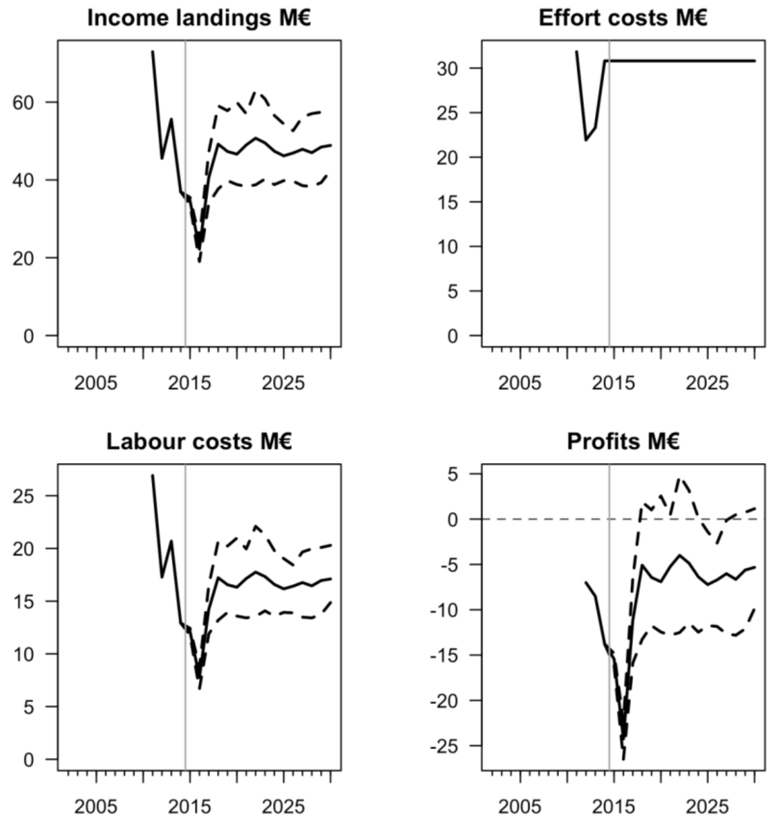


Fig. 2.4.8.6.3. Economic indicators GSA 07, Scenario 6. All fleets combined.

2.4.9 MANAGEMENT STRATEGY EVALUATION

Management Strategy Evaluation (MSE) was performed to evaluate the probability that the SSB falls below Blim. As shown in Table 2.4.9.1 the probability of SSB falling below Blim for HKE is higher than 5% under all scenarios, while for MUT it is equal to 0 for all scenarios.

Table 2.4.9.1. Biological risk: probability that SSB falls below Blim in the period 2015-2030 for each scenario. Note than under all Scenarios, the biological risk for hake is higher than 5%.

	HKE	MUT
SCE 1	0.642	0
SCE 2	0.088	0
SCE 3	0.098	0
SCE 4	0.107	0
SCE 5	0.108	0
SCE 6	0.114	0

2.4.10 REPORT OF THE RESULTS IN TERMS OF TRAFFIC LIGHT APPROACHES

The following table 2.4.10.1 summarized the performances of simulated management scenarios in terms of SSB and overall catches of the main 2 stocks, salaries (average wage), CR/BER, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value in Scenario 1, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Table 2.4.10.1 Traffic light table summarizing the performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and overall catches of the main demersal species, salary, CR/BER, ROI, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The status quo is related to the forecast to 2021. The baseline of 2014 is also reported. The values of F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis.

	Salary (thousand Euro)	CR/BR	ROI	Revenues (million Euro)	Emp. (units)	HKE.catch (t)	MUT.catch (t)	HKE.SSB (t)	MUT.SSB (t)	F (value) (year) HKE	F (value) (year) MUT
Status quo (values in 2014 –baseline year)	25.4	0.35	3.45	49.7	1293	2119	305	1115	1271	1.64	0.44
Status quo (values in 2021)	10.3	-1.9	-0.04	37.9	1293	2020	452	994	1427	1.64	0.44
Scenario 2	28	581	582	28	-90	55	-77	1164	91	0.16	0.04
Scenario 3	1428	567	623	45	-87	63	-33	938	58	0.16	0.16
Scenario 4	547	535	428	-18	-90	-3	-79	620	75	0.65 (2018) 0.16	0.17 (2018) 0.04
Scenario 5	968	527	477	2	-87	12	-36	545	44	0.68 (2018) 0.16	0.26 (2018) 0.16
Scenario 6	926	89	98	29	0	35	4	133	29	1.14	0.33

2.4.11 DISCUSSION AND CONCLUSION ON DEMERSAL FISHERY IN GSA07

The bioeconomic simulation analyses carried out on the demersal fisheries in GSA07 have the following characteristics:

- The parameters of the biological component and fishing mortality vectors are derived from the most recent stock assessments available from STECF Mediterranean working groups for the target species of the demersal fishery: hake (HKE) and red mullet (MUT). All assessments were conducted originally with FLR XSA routines.
- For stock assessment of the years 2013 (MUT), the population has been propagated to 2014 as starting point for all scenarios (using methods in FLR).
- Nine fleets segments are involved in the fishery, mainly from France (FR) but also from the 2 northern-most ports in Spain (ES, GSA06) for historical reasons: French gillnetters in fleet segments DFN 0006, DFN 0612 and DFN 1218, Spanish longliners HOK 1218, Spanish trawlers in fleet segments DTS 1218, DTS 1824 and French trawlers in DTS 1218, DTS 1824 and DTS2440. However the bulk of production in volume of landings and economic value belongs to the last 2 fleet segments (French bottom trawlers larger than 18 m).
- All simulations were run for the period 2015 to 2030, although the target years to achieve the prescribed Fmsy for hake in the national management plan were 2018 (Scenarios 2 and 3) or 2020 (Scenarios 4 and 5). Scenario 6 did not simulate a target Fmsy, rather a change in selectivity applied immediately (2015). The simulations were run for a longer period (to 2030) in order to estimate the biological risk over a sufficiently long period.
- Only process uncertainty due to variation in recruitment around a constant value with the mean of the last 3 years was considered as source of uncertainty. Other aspects, such as price formation of fish prices, cost structure, assessment error could not be considered in the simulations and represent limitations to this exercise, which should be taken into account when interpreting the results.

Under status quo conditions, continuing at the same level of fishing mortality than present, the spawning stock biomass of hake would be kept at historically low levels, with a high probability of stock level below the reference value (probability of SSB < Blim = 64%), and catches would be similar to the catches observed in recent years (Fig. 2.4.7.1.1). In the case of red mullet, due to the recent high values observed between 2010 and 2014 in SSB and recruitment, continuing the exploitation at present levels, yield and spawning stock biomass would continue to be high (Fig. 2.4.7.1.2). However, under status quo conditions, overall income would remain at a low level and net profits would continue to be negative (Fig. 2.4.7.1.3).

The results of the projections under Scenarios 2 to 5 show that, given the high ratio of current fishing mortality to Fmsy, particularly for hake, which is of the order of 15, the biomass of all stocks would strongly benefit from the required large reductions in fishing effort (close to 90%, depending on the scenario). However, depending on the target year of the simulation (2018 in Scenarios 2 and 4; 2020 in Scenarios 3 and 5) a short term decrease in yield of hake and of overall income can be expected. For red mullet, all scenarios 2 to 5 lead to underexploitation of the species, with the result that spawning stock biomass is forecast to reach very high levels but catches lower than historically. In addition to the high increase in stock biomass of both species, overall income and profits of the fleets are expected to increase substantially.

Scenario 6 does not allow reaching Fmsy for any of the 2 target species, but the results show a significant increase in spawning stock biomass of both species and keeping landings at high levels. The overall income would remain similar to the level of recent years and profits would stabilize to lower, negative values than at present, after 1-2 years of large negative profits immediately after the year of selectivity change.

Overall, considering the summary traffic lights table (Table 2.4.10.1), reducing the present high fishing mortality rates by 2018 (Scenarios 2 and 3) would allow increasing catches and revenues, wages, as well as spawning stock biomass, at the price of a very significant loss of employment and fishing units. Delaying the reduction of fishing mortality to 2020 would result in worse values of these indicators than at present (Scenarios 4 and 5), except for biomass that would be kept at a high level. Scenario 6 allows to obtain moderate to high increases in all indicators, allowing to keep employment and vessels, at the price of not complying with Fmsy targets.

Recruitment of hake (age 0) takes place the whole year, though it is more important in spring and summer (Recasens *et al*., 1998). The spawning areas are located at the edge of the shelf, whereas nursery areas are located on the continental shelf. Juveniles are found between 60 and 160 m depth in autumn and winter, while in spring and summer their depth range extended down to 300 m depth (Maynou *et al*., 2003). Juvenile individuals undertake daily feeding migrations towards the sea surface at night.

Colloca's recent work provided useful results for GSA07, regarding concentration of juveniles for hake and deepwater rose shrimp (Colloca et al. 2015, fig. 3A and 4B).

In GSA07, high and persistent concentrations of hake juveniles are found over the continental shelf, especially in the southwest near the border with GSA06 and in the southeast, facing the Rhone river delta (Fig. 3A in Colloca et al. 2015

Thus these areas can be protected, in particular not permitting the fishery at least in the periods in which the peaks of recruitment occur, that is in spring and summer (March-June).

ANNEX C - INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA07

C.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL FISHERY IN GSA07

The population dynamics of the five main species used in the bioeconomic analysis are shown in the following tables.

GROWTH PARAMETERS AND RECRUITMENT OF DEMERSAL STOCKS IN GSA07

Growth parameters and mean recruitment are reported in table C.1.

Table C.1. Growth parameters and mean recruitment of the main demersal target stocks in GSA 07.

species	Linf (cm TL or mm CL)	k (yr^{-1})	t0 (yr)	mean recruitment 2011 - 2014 (thousands)	source
HKE	100.7	0.236	0	40890	STECF 14-17 (EWG 14-09)
MUT	29	0.25	-1.28	37015	STECF 14-17 (EWG 14-09)

MATURITY AND SEX RATIO OF DEMERSAL STOCKS IN GSA07

The maturity parameters used for the analysis are shown in the following table C.2. Sex ratio was taken as 1:1, ignoring that in the largest sizes females predominate in the populations of hake. This limitation is not usually taken into account in stock assessment because the abundance of large sizes in the population is relatively low.

Table C.2. Maturity parameters of the main demersal target stocks in GSA 07.

species	age 0	age 1	age 2	age 3	age 4	age 5	source
HKE	0.08	0.28	0.61	0.94	1	1	STECF 14-17 (EWG 14-09)
MUT	0.61	0.85	0.95	0.97	0.99	-	STECF 14-17 (EWG 14-09)

NATURAL MORTALITY OF DEMERSAL STOCKS IN GSA07

The natural mortality parameters were assumed to follow the ProdBioM model (Abella et al. 1997), those in the following table C3 have been used in all recent assessments.

Table C.3. Natural mortality vectors of the main demersal target stocks in GSA 07.

species	age 0	age 1	age 2	age 3	age 4	age 5	source
HKE	0.88	0.43	0.33	0.25	0.22	0.20	STECF 14-17 (EWG 14-09)
MUT	0.83	0.35	0.26	0.18	0.15	-	STECF 14-17 (EWG 14-09)

B.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERY IN GSA07

FISHING MORTALITY OF DEMERSAL STOCKS IN GSA07

The following table C.4shows the fishing mortality vectors estimated from the assessments of 2013 or 2014 and propagated to 2014 when necessary using the original stock object derived from FLR XSA:

Table C.4. Fishing mortality vectors of the main demersal target stocks in GSA 07.

species	age 0	age 1	age 2	age 3	age 4	age 5	source
HKE	0.281	1.790	2.842	3.166	2.640	2.640	STECF 14-17 (EWG 14-09)
MUT	0.030	0.588	0.810	0.314	0.314	-	STECF 14-17 (EWG 14-09)

EFFORT OF DEMERSAL FISHERY IN GSA07

The fishing effort (in number of fishing fishing days, or capacity indicators GT and kW) is shown in the following table C.5 for the main fleet segments carrying out the demersal fishery. As shown, gillnetters and longliners in the 6-12 m length class are the main fleet segments in the artisanal fishing classes, while the largest share of effort is taken by the bottom otter trawl segments, especially the vessels 18 m and larger.

Table C.5. Fishing effort (fishing days; GT and kW) of the fleets targeting demersal stocks in GSA 07.

Fishing	**Vessel**	**year**	**Total**	**Total**	**Total**
DFN	**VL0006**	2008		78	2,393
		2009		91	2,879
		2010	1,937	93	2,853
		2011	2,439	97	3,045
		2012	4,388	99	3,216
		2013	8,151	110	3,382
	VL0006 Total		**16,915**	**569**	**17,768**
	VL0612	2008		1,543	36,190
		2009		1,887	47,007
		2010	17,303	1,721	43,569
		2011	17,241	1,735	45,100
		2012	30,317	1,746	44,575
		2013	58,497	1,654	42,434
	VL0612 Total		**123,358**	**10,285**	**258,875**
	VL1218	2008		293	2,741
		2009		270	2,362
		2010	258	271	2,079
		2011	302	216	1,347
		2012	997	238	1,664
		2013	1,101	238	1,716
	VL1218 Total		**2,658**	**1,526**	**11,909**
DFN Total			**142,930**	**12,380**	**288,552**
DTS	**VL1218**	2009		230	1,957
		2010	255	143	1,112
		2011		118	908

		2012		118	894
		2013	621	113	967
	VL1218 Total		**876**	**723**	**5,838**
	VL1824	2008		1,712	9,253
		2009		1,777	9,109
		2010	5,799	2,041	10,373
		2011	5,317	1,943	9,425
		2012	9,120	1,800	8,793
		2013	12,293	1,631	7,989
	VL1824 Total		**32,528**	**10,903**	**54,942**
	VL2440	2008		3,542	10,112
		2009		3,609	9,796
		2010	7,376	5,023	13,272
		2011	7,569	5,107	13,272
		2012	10,338	3,970	10,428
		2013	13,838	3,057	8,216
	VL2440 Total		**39,121**	**24,308**	**65,096**
DTS Total			**72,525**	**35,935**	**125,876**
HOK	**VL0006**	2008		7	110
		2009		6	122
		2010	121	13	272
		2011	158	7	175
		2012	490	10	308
		2013	828	13	353
	VL0006 Total		**1,597**	**54**	**1,340**
	VL0612	2008		144	3,659
		2009		214	5,170
		2010	2,055	233	5,896
		2011	1,804	206	4,786
		2012	2,395	205	4,990
		2013	6,437	279	7,236
	VL0612 Total		**12,691**	**1,281**	**31,737**
	VL1218	2008		68	921
		2010	59	75	637
		2011		45	146
		2012	50	78	493
		2013	436	46	410
	VL1218 Total		**544**	**311**	**2,607**
HOK Total			**14,833**	**1,646**	**35,684**

LANDINGS OF DEMERSAL FISHERY IN GSA07

The landings (t) of the main demersal species since 2002 are shown in the following table C.6. The landings of hake oscillate during the period between a low 1100 t in 2011 to a high 2700 in 2002, while the landings of red mullet in recent years are among the highest over the period.

Table C.6. Landings (t) of main demersal stocks in GSA 07.

yr	HKE	MUT
2002	2727	
2003	2590	
2004	1301	177
2005	1484	176
2006	1599	216
2007	1700	209
2008	2506	132
2009	2270	146
2010	1984	244
2011	1365	228
2012	1124	179
2013	1735	298
2014	1983	253

C.3 INPUT OF THE ECONOMIC MODULE OF DEMERSAL FISHERY IN GSA07

The economic data of the selected fleet segments used to parameterize the economic function in the projections have been reported in the following paragraphs.

REVENUES OF DEMERSAL FISHERY IN GSA07

The revenues (in M€) of the main target species are available for 2012 and 2013 only, and the values are shown in the following table C7:

Table C.7. Revenues (M€) of main demersal stocks in GSA 07.

yr	HKE	MUT	all demersal
2012	4.51	1.11	29.66
2013	5.31	1.58	31.77

COSTS OF DEMERSAL FISHERY IN GSA07

The costs estimated for 2014 (extrapolating from the costs 2012 – 2013) are given in the following table C.8. Note that due to the nature of the data it is not possible to estimate different costs for driftnets (GNS) and trammel nets (GTR), but they are likely to be similar as these fleets have similar vessel composition (combined as DFN). The estimation for bottom trawlers combines data from fishing technique DTS and vessels 18-24 and 24-40 m length, which are the predominant fleet segments in the fishery.

The costs of the other small scale fishing gear were estimated from the corresponding data in fishing techniques DFN (drift and fixed nets) for vessels 6-12 m length and HOK (longlines) for vessels 12-18 length. Income and Costs (M€) of the fleet segments targeting demersal stocks in GSA 07 are reported in the table C.8.

Table C.8. Income and Costs (M€) of the fleet segments targeting demersal stocks in GSA 07.

	OTB = DTS	GTR and GNS = DFN	LLS = HOK	TOTAL
Income from landings (M€)	27.30	19.18	0.398	46.48
Income incl. subsidies (M€)	29.54	19.20	0.398	49.13
Energy, Other variable costs and Repair Costs (M€)	17.19	2.90	0.069	20.16
Non variable costs (M€)	1.88	2.73	0.065	4.67
Labour costs (M€)	6.57	9.86	0.23	18.00
Annual wage (k€ / person)	41	28	24	31
Depreciation (M€)	4.12	3.72	0.89	7.93
Opportunity costs (M€)	1.65	1.49	0.036	3.17
Total costs (M€)	32.74	20.71	0.49	53.94

2.5 CASE STUDY ON SMALL PELAGIC FISHERY IN GSA09

2.5.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The main stocks identified for the GSA 09 small pelagic case study are *E. encrasicolus* and *S. pilchardus*.

Three main fleet segments involved in the small pelagics fishery in GSA9 (Table 2.5.1.1). The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 2.5.1.1.

Table 2.5.1.1 – Fleet segment operating in GSA09 and identified for the present study. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N	*Fleet name small pelagic GSA9*	*Fleet code GSA9*	*% of landings (all species)*
1	Italian GSA09 purse-seiners with vessel length 12-18 m	ITA09_PS_VL1218	14.3
2	Italian GSA09 purse-seiners with vessel length 18-24 m	ITA09_PS_VL1824	24.9
3	Italian GSA09 purse-seiners with vessel length 24-40 m	ITA09_PS_VL2440	60.7

Since 2010 the fishing effort of purse seiners is decreasing.

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the small pelagics fisheries (percentage computed on the average production of the last three years) is between 87% (PS_VL1218) and around 95% (PS_VL1824). Thus the management measures to be taken would target almost the whole mix of this fishery. The selected fleet segments represent more than 95% of production and revenues of anchovy and sardine in GSA 09 in 2014 (Table 2.5.1.2).

Table 2.5.1.2 - Percentages covered by the fleet segments considered in the case study.

Variable	Tot case study	Tot GSA 09	Percentage covered by the case study fleet segments
Landings Weight ANE (kg)	3391	3451	98%
Landings Weight PIL (kg)	1782	1805	98%

Landings value ANE (€)	6685537	6868514	97%
Landings value PIL (€)	1266965	1309559	97%

Source: EU DCF 2014

Nowadays, there are no specific management measures for these two stocks in GSA 09.

General fishery rules

In GSA 09, management regulations are based on technical measures, as closed number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the number of Italian fishing licenses has been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size) and minimum landing sizes (EC 1967/06).

2.5.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The assessment of anchovy was reviewed by STECF 11-14, while that of sardine by STECF 15-06. These assessments used DCF data.

According to the assessment results:

- ✓ fishing mortality (F_{bar1-3}) and SSB of anchovy are varying along the time, catch and recruitment are decreasing;
- ✓ fishing mortality (F_{bar1-2}) and SSB of sardine are varying along the time, catch and recruitment are increasing.

Discards in these fisheries are considered negligible.

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the needing of estimating this parameter when the assessment was not recent are reported in the table 2.5.2.1, as well as exploitation rate, landings, spawning stock biomass and recruitment.

Tab. 2.5.2.1– Fishing mortality, exploitation rate E and landings, ratio between the current exploitation rate and the reference exploitation rate (0.4 from Patterson, 1992) from the stock assessment reports, and landing by stock.

Stock	***Fishing mortality**** *(Fcurrent)*	***Exploitation Rate (E[9])***	***Landings*** *(tons)***	***Spawning Stock Biomass*current*** *(tons)*	***Recruitment (in thousands)***
Anchovy	Fbar (1-3)= 1.85	0.81	3451	2567	646 333
Sardine	Fbar (1-3)= 1.11	0.56	1805	2912	1 988 500

*estimates refer to assessment reported in STECF11-14 for anchovy, and STECF 15-06 for sardine. **2014 data.

Stock advice, Reference points, and their technical basis

The current (2014) exploitation rate E, simulated using BEMTOOL and taking into account the effort modulated by month in the simulation model, is 0.81 for anchovy, while for sardine the current value of E is 0.49, with a F value of 0.56 at the level of the reference point E=0.4.

[9] Exploitation rate is the ratio between the fishing mortality and the total mortality (E=F/Z)

Regarding both sardine and anchovy, the current exploitation rate E is higher than the reference one, evidencing for these stocks an unsustainable exploitation level in the long term.

The framework used for the Fmsy reference points is summarised in the table 2.5.2.2 below.

Table 2.5.2.2 – Reference point framework for anchovy and sardine.

	MSY approach		
Reference point	F_{MSY}	**F_{MSY} upper range**	**$E_{curr}/E_{0.4}$ ratio**
Technical basis for anchovy	Exploitation rate (E0.4) from Patterson (corresponding to F=0.28)	-	2.03
Technical basis for sardine	Exploitation rate (E0.4) from Patterson (corresponding to F=0.56)	-	1.23

Development of economic indicators over time and current status

The economic performance for the period 2008-2013 of the whole fleet as well as the main fleet segments separately are evaluated using key social and economic indicators in a traffic light table (table 2.5.2.3). This analysis evidenced a deteriorated performances of the revenues of sardine and also for anchovy, which affects the overall revenues and employment of two fleet segments (PS_VL1824 and PS_VL2440) and, in turns, the salary.

Tab. 2.5.2.3 Traffic light table on the economic performance (2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

GSA9 Small Pelagic fisheries	Salary (euro)	CR.BER	ROI	Overall Revenues (thousand euros)	Revenues anchovy (thousand euros)	Revenues sardine (thousand euros)	Employment (number of units)
All fleets*	16339÷15886	1.709÷2.544	0.215÷0.48	11630÷11312	7065÷7960	3252÷928	257÷258
ITA09_PS_VL1218	7419÷14316	0.64÷2.53	-0.108÷0.508	3579÷2878	1625÷1685	1274÷52	136-80
ITA09_PS_VL1824	9847÷17563	1.33÷1.82	0.107÷0259	4448÷2356	3469÷1793	316÷280	139-50
ITA09_PS_VL2440	18030÷16212	1.84÷2.91	0.237÷0.569	5920÷6078	2627÷4482	2792÷597	108÷128

*for these fleets the starting year is 2009 as in 2008 data for PS_VL2440 were missing

2.5.3 MANAGEMENT STRATEGY EVALUATION

No Management Strategy Evaluation (MSE) was performed so far for the two small pelagic species in GSA 09, given that very simple models were used in the assessment. This is because the time series was short (in the assessment of anchovy) and fishery independent information (e.g. acoustic surveys) were not available for both stocks.

2.5.4. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term;
2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

Strategy and timeframe to reach the Reference Point

The two stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels, anchovy is the most heavily exploited stock in the mix. However, sardine was used as a benchmark, as stock assessment of this species is more recent than that of anchovy and is based on a more suitable approach (separable VPA; i.e Virtual Population Analysis) compared to that of anchovy. The assessment of anchovy was conducted using pseudocohort analysis under equilibrium assumption (by means of VIT package; see Lleonart and Salat, 1992), given the limitation to the use of alternative approach represented by the short time series and the lack of fishery independent data (i.e. acoustic surveys) . However, steady state is difficult to achieve for a small pelagic stock, which dynamics is remarkably influenced by the environmental variations.

In the case of sardine and anchovy stocks in GSA9, the reference point considered as a proxy of Fmsy is the exploitation rate E (ratio between fishing and total mortality: F/Z) at the level 0.4, following Patterson (1992).

The percentage of reduction to reach F_{MSY} proxies (E0.4 approach) is reported in the table 2.5.4.1 (E0.4 approach). The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point E0.4 and the current exploitation rate. In this case the level of natural mortality in the age range 1-3 (M=0.88), the same age range as the fishing mortality, was used.

Table 2.5.4.1 - Reduction to reach the fishing mortality reference points for sardine in GSA 09 small pelagic fisheries according to the reference (E0.4 method)

Stock	***Fishing mortality reduction*** *(in %)*

Sardine	30%

2.5.5. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios are reported in the Table 2.5.5.1.

Table 2.5.5.1 – Proposed management scenarios to reach the reference point

Case Study	**small pelagics in GSA 09**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards E0.4 of sardine to be reached in 2018 applied both to activity and capacity up to 2017, then on the activity only. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards E0.4 of sardine to be reached in 2020, from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet. Starting year of reduction 2015.

In scenario 1, the current situation is projected to 2018 and 2020 under status quo condition.

In scenario 2 and 3 the choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 exploitation rate is assumed to remain around E0.4.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

This reduction is proportionally applied to the different fleet segments, accounting for their relative impact on the stock of sardine. The relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of sardine by fleet segment and year (Table 2.5.5.2).

Table 2.5.5.2 Percentage of F of sardine due the different fleet segments.

Species	**Percentage F due to PS_VL1218**	**Percentage F due to PS_VL1824**	**Percentage F due to PS_VL2440**
S. pilchardus	4	27	68

The reduction to each fleet segment was applied for the 10% on vessels until 2017 and for the 90% until 2018 (Scenario 2) and 2020 (Scenario 3). This split was in agreement with the decision taken during the project Workshop held in Bari on September 21-25, 2015, on the basis of informal feedback received by stakeholders.

Details on the reductions by fleet segment, year and scenario are reported in the Annex D to this report (Table D.5.3).

2.5.6. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1).

The biological and pressure input for BEMTOOL model are derived from the last endorsed stock assessments (STECF11-14 for anchovy, and STECF 15-06 for sardine) and the socio-economic data and parameters are from EU DCF.

2.5.7. REPORT OF INPUTS FOR MODELLING SMALL PELAGIC FISHERY IN GSA09

All the inputs for modelling are fully reported in the Annex D.

2.5.8 EVALUATION OF THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.5.8.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

Figure 2.5.8.1.1 shows SSB of anchovy and sardine in the status quo scenarios. SSB of anchovy shows a slight oscillation from 2015 probably due to a propagation of the previous oscillations in the time series; however, this oscillation has an amplitude of about 4% around the SSB value estimated for 2014, thus the pattern can be considered stable.

Sardine SSB shows a similar slightly oscillatory behaviour (it is hidden by the scale of the graph, due to the order of magnitude); this oscillation has an amplitude of about 17% around the SSB value estimated for 2014, thus the pattern can be considered quite stable.

As expected, also the landings (overall and by fleet segment) for the 2 stocks show a stable trend in the projections of the status quo scenario (Figure 2.5.8.1.2 and Figure 2.5.8.1.3).

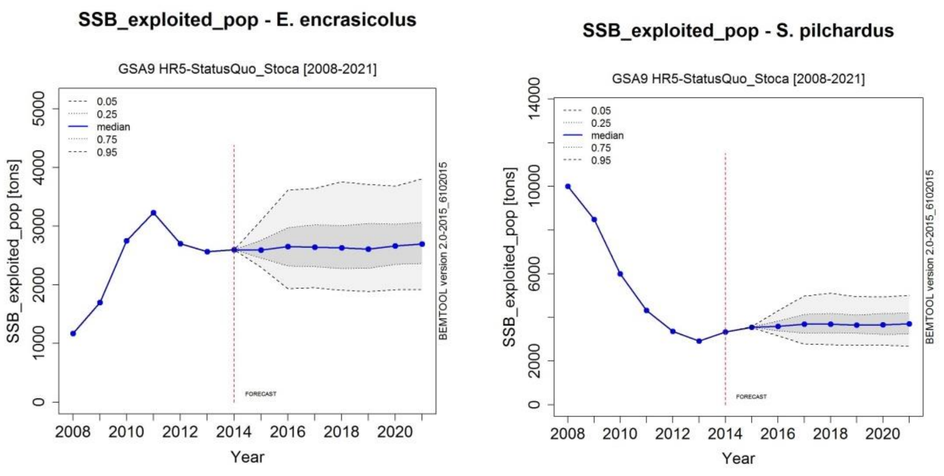


Figure 2.5.8.1.1 SSB of anchovy and sardine with confidence intervals in the status quo scenario.

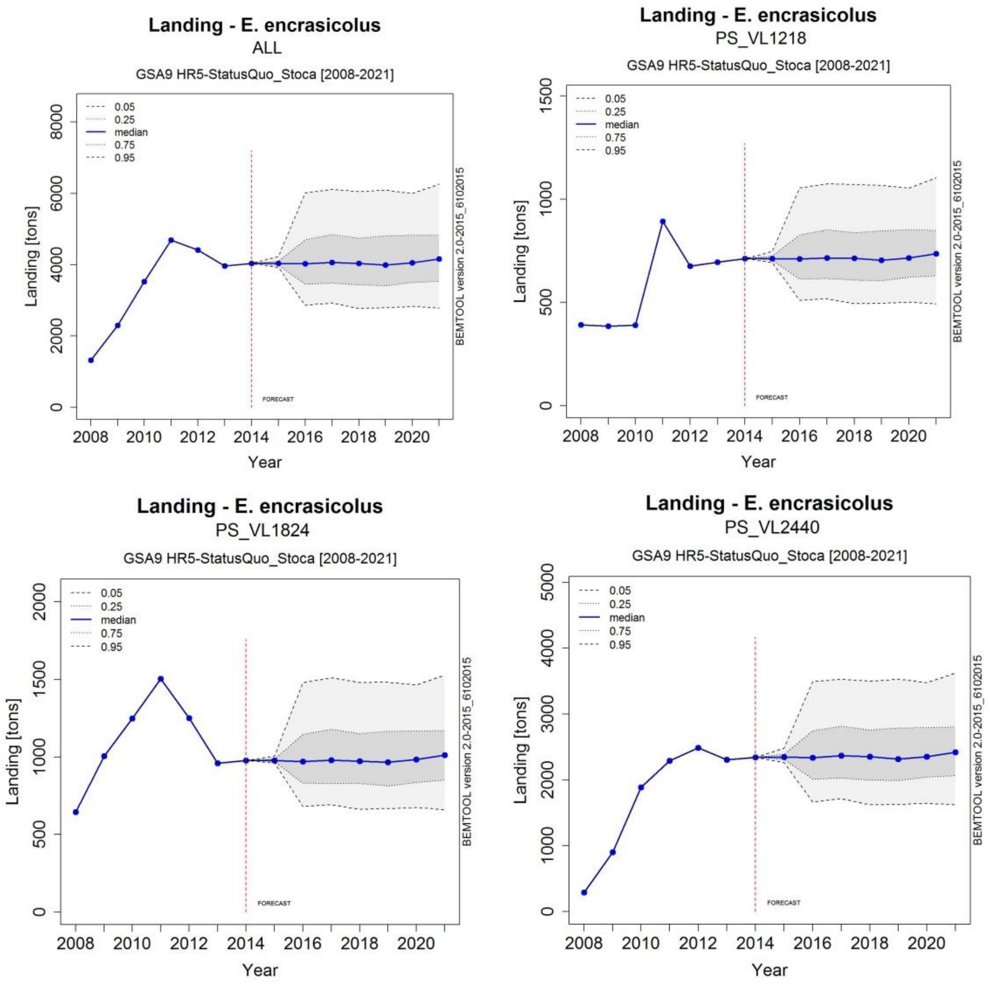


Figure 2.5.8.1.2 Landings of anchovy by fleet segment in the status quo scenario with confidence intervals.

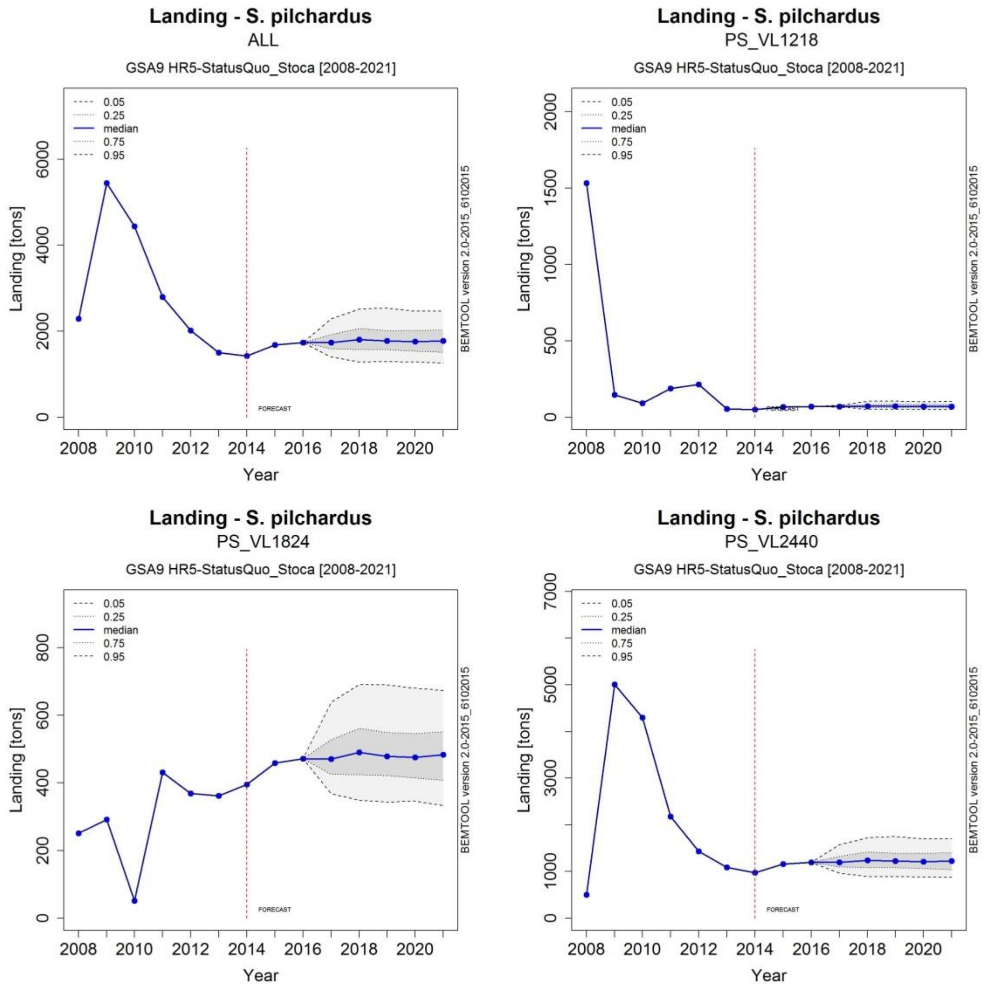


Figure 2.5.8.1.3 Landings of sardine by fleet segment in the status quo scenario with confidence intervals.

2.5.8.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 6.2 thousand tons of total production generating 11.3 million euro, a decrease by 8% in quantity and 12% in value compared to 2012. The most important fleet segment is the purse seiner VL2440 (producing 54% of total revenues), followed by the purse seiners VL1218 (producing 25% of total revenues).

As reported in Figure 2.5.8.2.1, total revenues of pelagic fleets operating in GSA 9 does not show a significant change from 2009 to 2013. In that period, a reduction by 33% for purse seiners VL1824 was almost completely counterbalanced by an increase by 30% for purse seiners VL1218. Total revenues of purse seiners VL2440 were stable with an increase by just 3%.

In the forecast period, total revenues for the overall fishing sector are expected to be constant. A high variation is registered for purse seiners VL1824 with an increase by 2.1%, while the other two fleet segments show decreases lower than 1%.

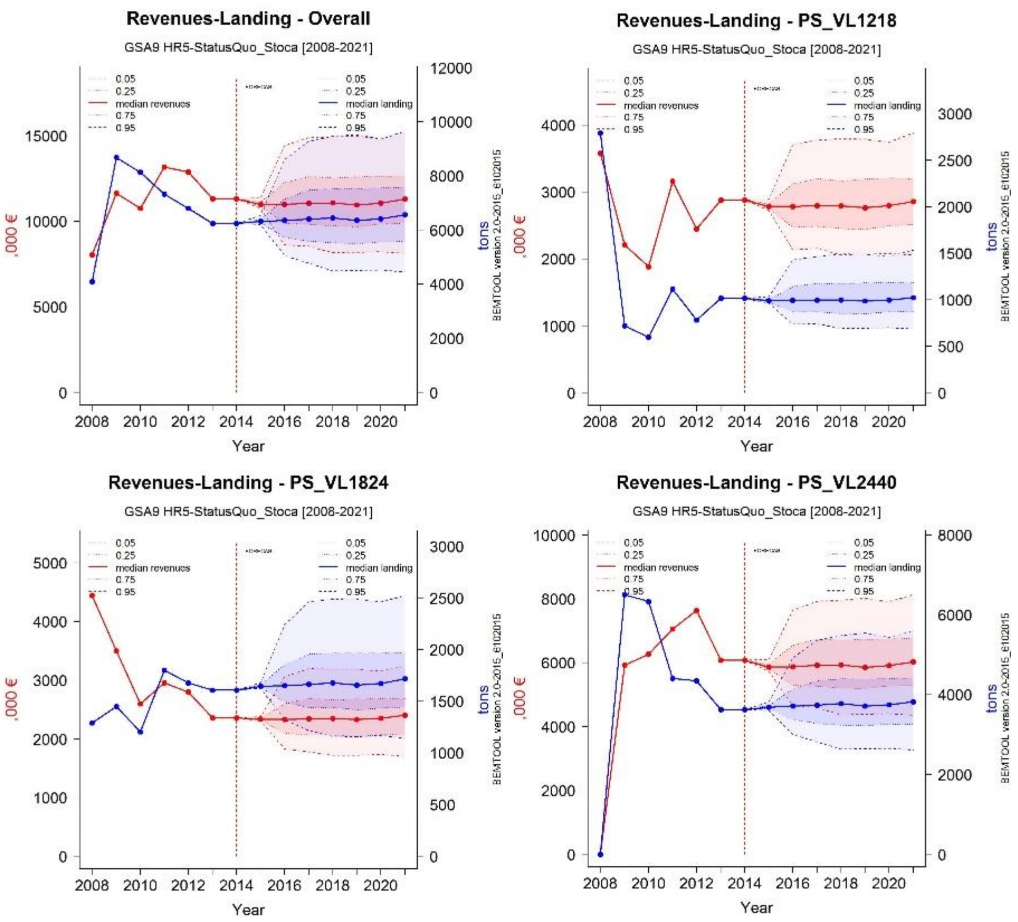


Figure 2.5.8.2.1 Landings weight and value by fleet segment and quantile.

In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is positive.

All pelagic fleets operating in GSA 9 show positive values for net profit in the period 2009-2013. The trend for the whole fleet is increasing from 2009 to 2012, while in 2013 a reduction by 10% is registered. This reduction is mainly due to purse seiners VL1824, which registered a decrease in net profit by 30% from 2012 to 2013.

In the forecast period, net profits for the overall fishing sector show a positive trend (Figure 2.5.8.2.2). In 2021, the indicator for the whole fleet is expected to increase by 7%. The better performance is due to purse seiners VL1824, which net profit would increase by 19%, while purse seiners VL2440 are expected to register a reduction by 16%. The other fleet segment would register no significant change.

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is greater than 1 for all fleet segments, showing a good economic performance of the fleet. The best performance is registered for the purse seiners VL2440 (2.9), followed by purse seiners VL1218 (2.5). From 2009 to 2013, the indicator is improved for these fleet segments and slightly decreased for the purse seiners VL1824.

The ratio between current and break-even revenues (CR/BER) in the forecast period does not show any change for purse seiners VL1218. It is expected to improve slightly for purse seiners VL1824 and decreasing from 2.9 to 2.6 for purse seiners VL2440 (Figure 2.5.8.2.2).

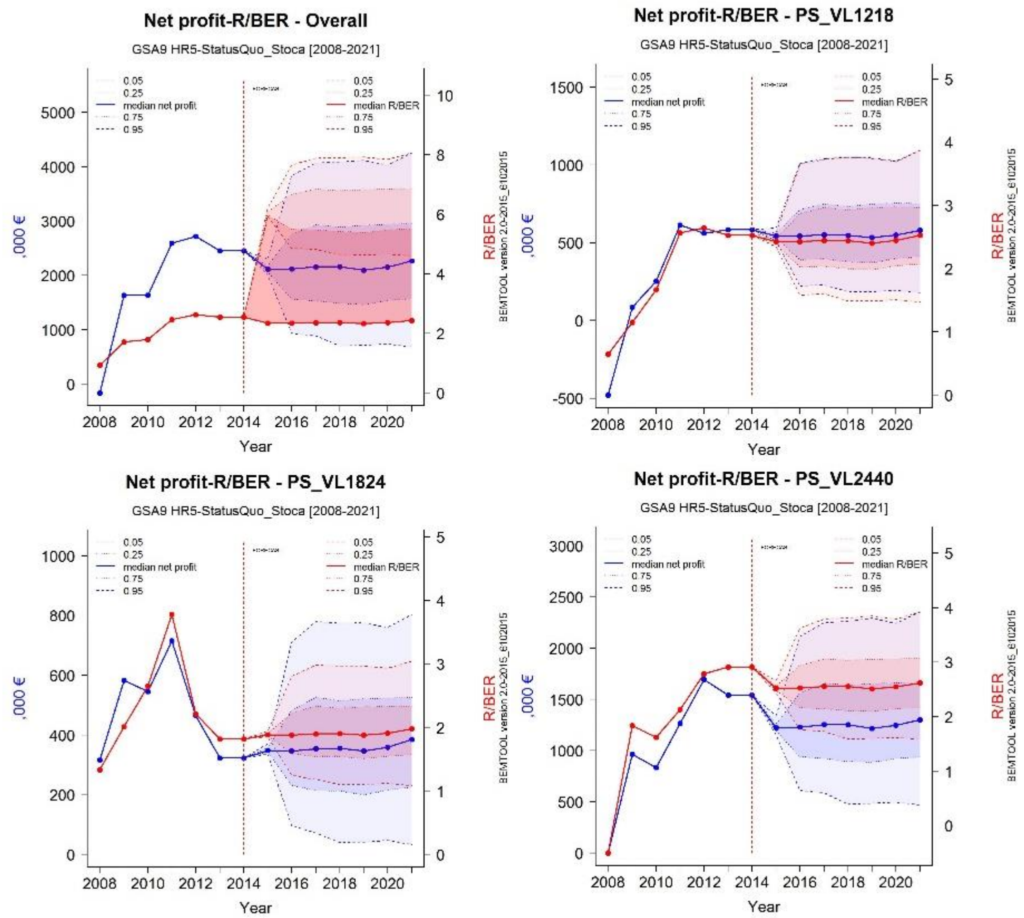


Figure 2.5.8.2.2 Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment and quantile

2.5.9 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

According to the state of exploitation of the two small pelagic stocks in GSA 9 case study, 2 forecast scenarios alternative to status quo have been performed to evaluate the consequences of management strategies in terms of costs and benefits for the renewal of stocks, fishery sustainability and productive and economic performances of different fleet segments.

2.5.9.1 FORECAST OF BIOLOGICAL AND PRESSURE INDICATORS

As expected, SSB of both anchovy and sardine shows the best performance in Scenario 2, and the worst result in the status quo scenario; these results are consistent with the great benefit that generally the reduction of fishing mortality produces on the indicators when applied in a short timeframe. Moreover, Scenario 2 allows to obtain immediate benefit in SSB, compared to Scenario 3 that produces a less steep increase in SSB from the first years of the application of the management measures (Figure 2.5.9.1.1). For anchovy and sardine in 2021 the effect of both scenarios would be equal.

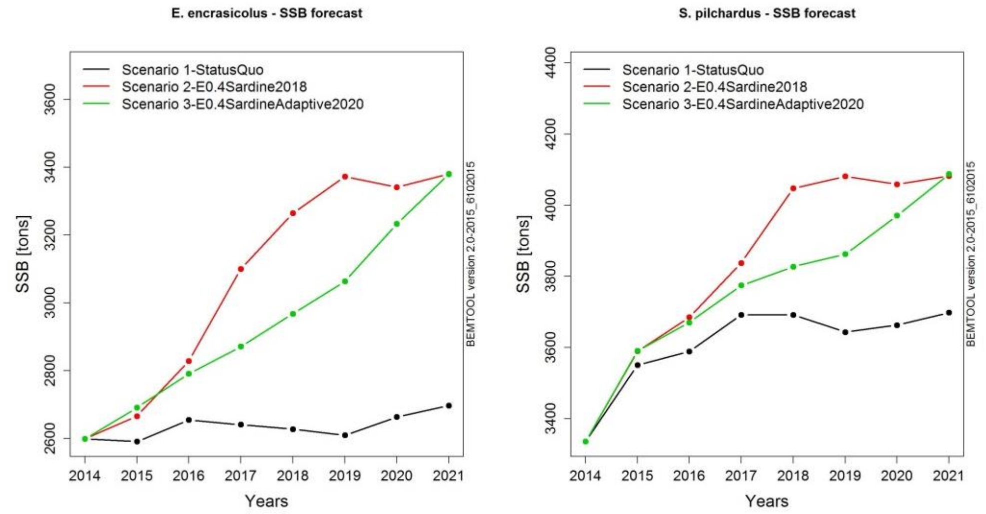
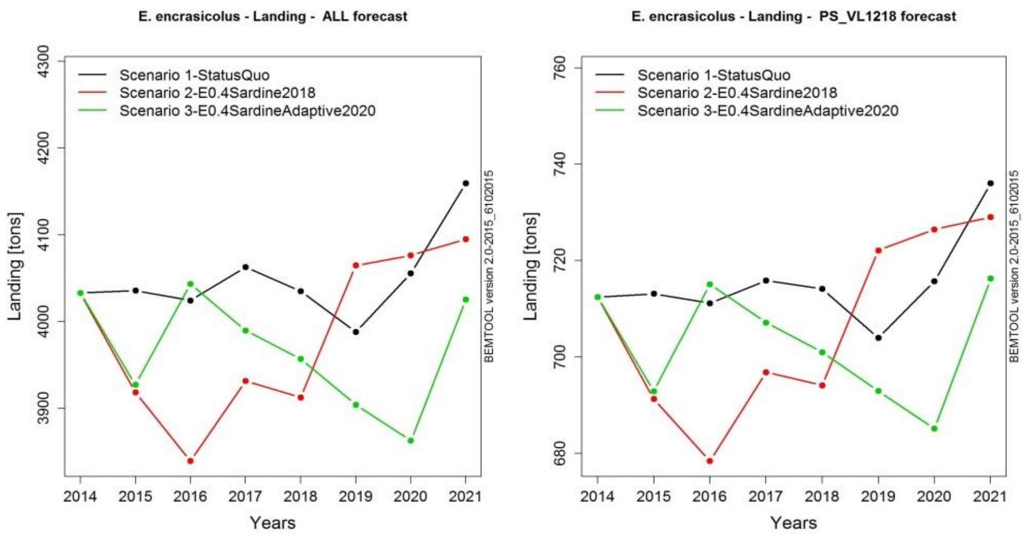
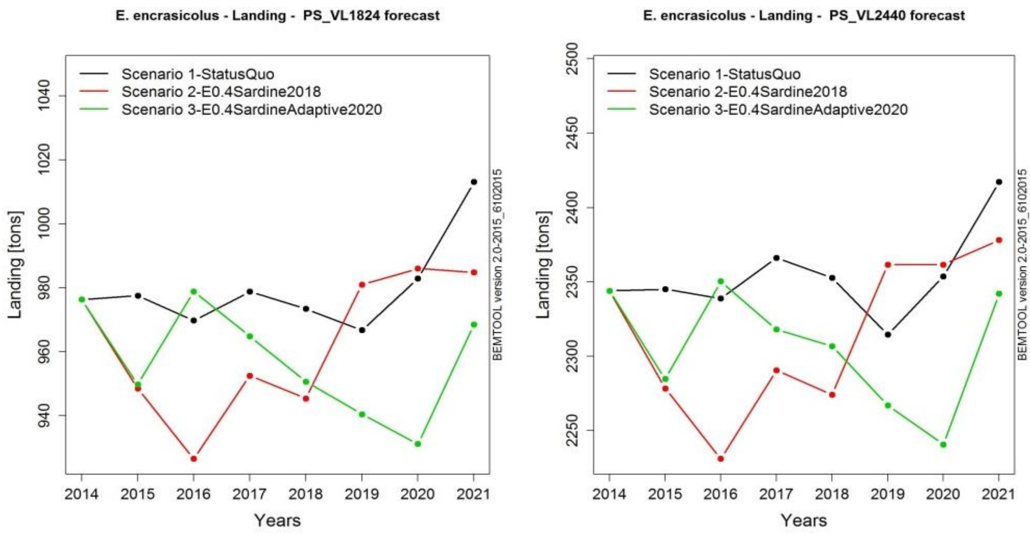


Figure 2.5.9.1.1 SSB of anchovy and sardine in GSA 09: comparison among the management scenarios.

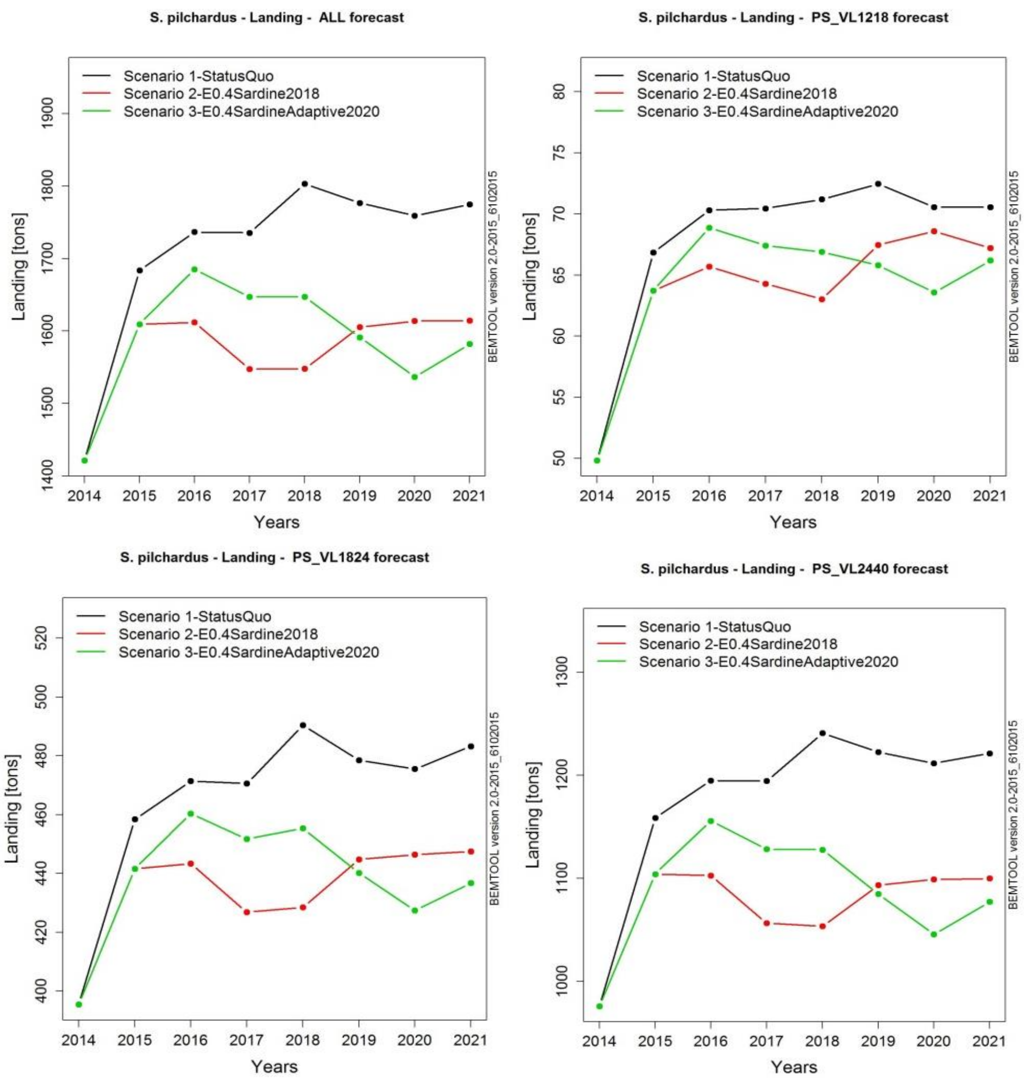
As regards overall catches, the best performing scenario is the status quo for both stocks, especially in the short terms; this result is strictly linked to the hypothesis of constant recruitment with associated process error (a noise component representing deviations from expected pattern or value) as used in the projections.

As concerns both anchovy and sardine the catch forecast at fleet segment level reflects the forecast of the overall fleet with a slight difference for the catch of sardine by the fleet segment PS VL1218, likely due to a minor share of sardine catch by this fleet segment (Figures 2.5.9.1.2- Figure 2.5.9.1.3).





Figures 2.5.9.1.2 Catch of anchovy in GSA 09 by fleet segment: comparison among the three management scenarios.



Figures 2.5.9.1.3 Catch of sardine in GSA 09 by fleet segment: comparison among the 3 management scenarios.

2.5.9.2 FORECAST OF SOCIO-ECONOMIC INDICATORS

Figures 2.5.3.2.1 shows the expected impacts on total revenues deriving from each scenario. The simulation outcomes are compared with the status quo scenario.

The two alternative scenarios show a reduction of the total revenues all the fleet segments compared to the status quo, however in scenario 2, after the short term decrease, revenues improve rapidly and become close to status quo in 2021 for the fleet segment PS_VL1218 (Figure 2.5.3.2.1).

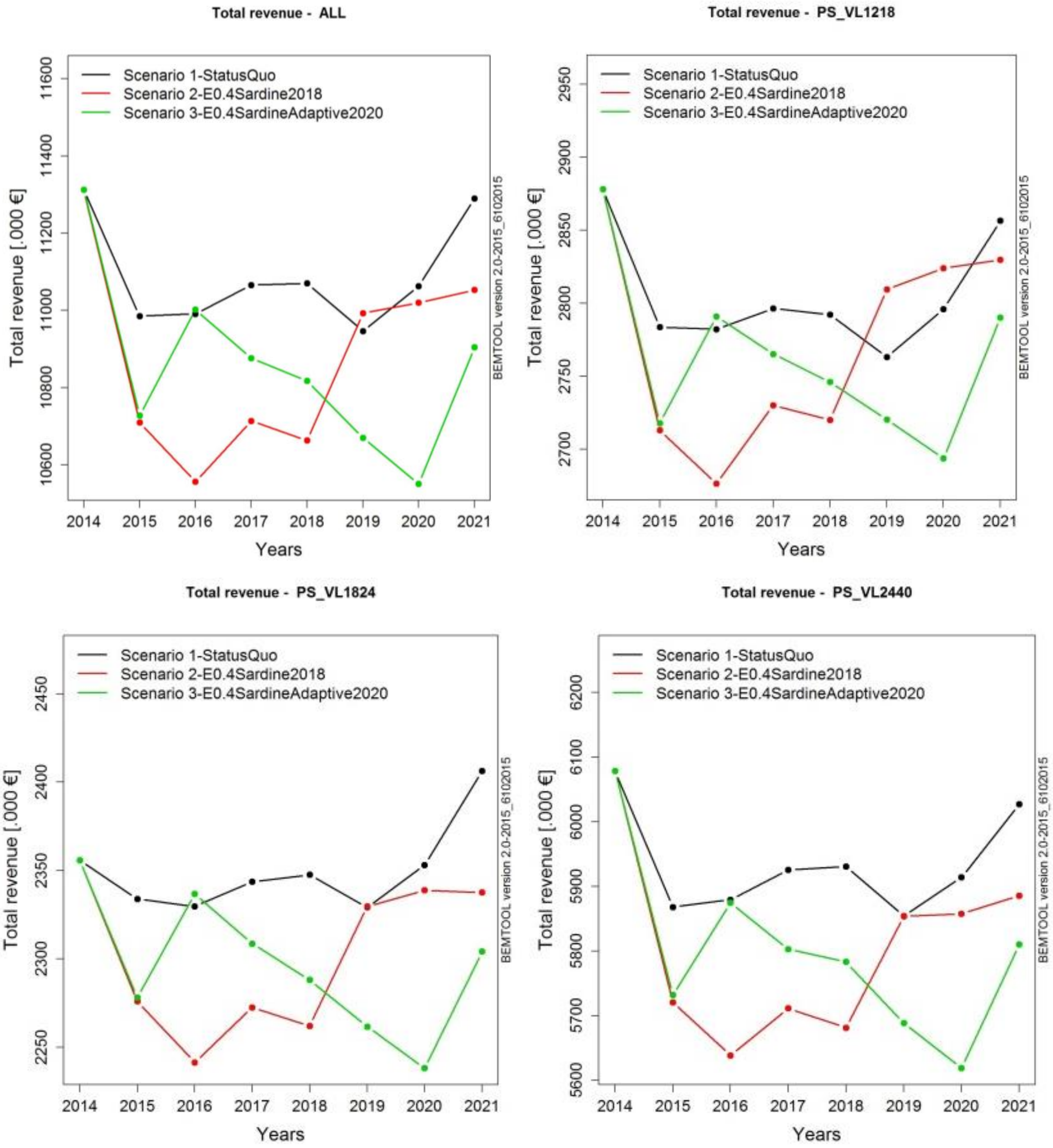


Figure 2.5.9.2.1 Total revenues by fleet segment and scenario.

CR/BER indicator improves considerably under the two alternative scenarios compared to the status quo for all the fleet segments with a better performance for scenario 2 (Figure 2.5.9.2.2).

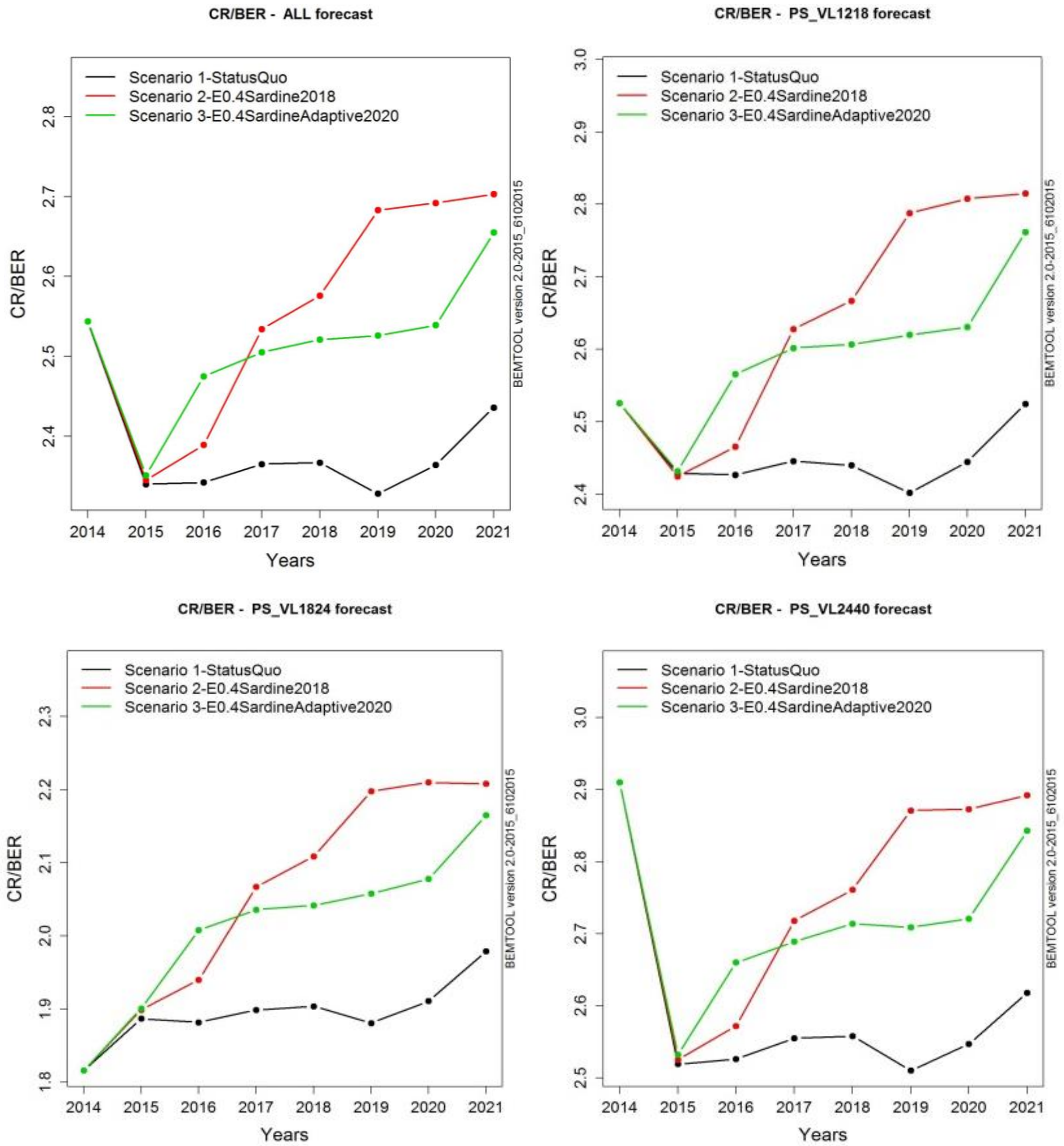


Figure 2.5.9.2.2 Current Revenue to the Break-Even Revenue ratio (CR/BER) by fleet segment and scenario

Figure 2.5.9.2.3 shows the effects of the two alternative scenarios on average salary per man employed. As for the CR/BER indicator also average wage improves considerably under the two alternative scenarios compared to the status quo for all the fleet segments with a better performance for scenario 2.

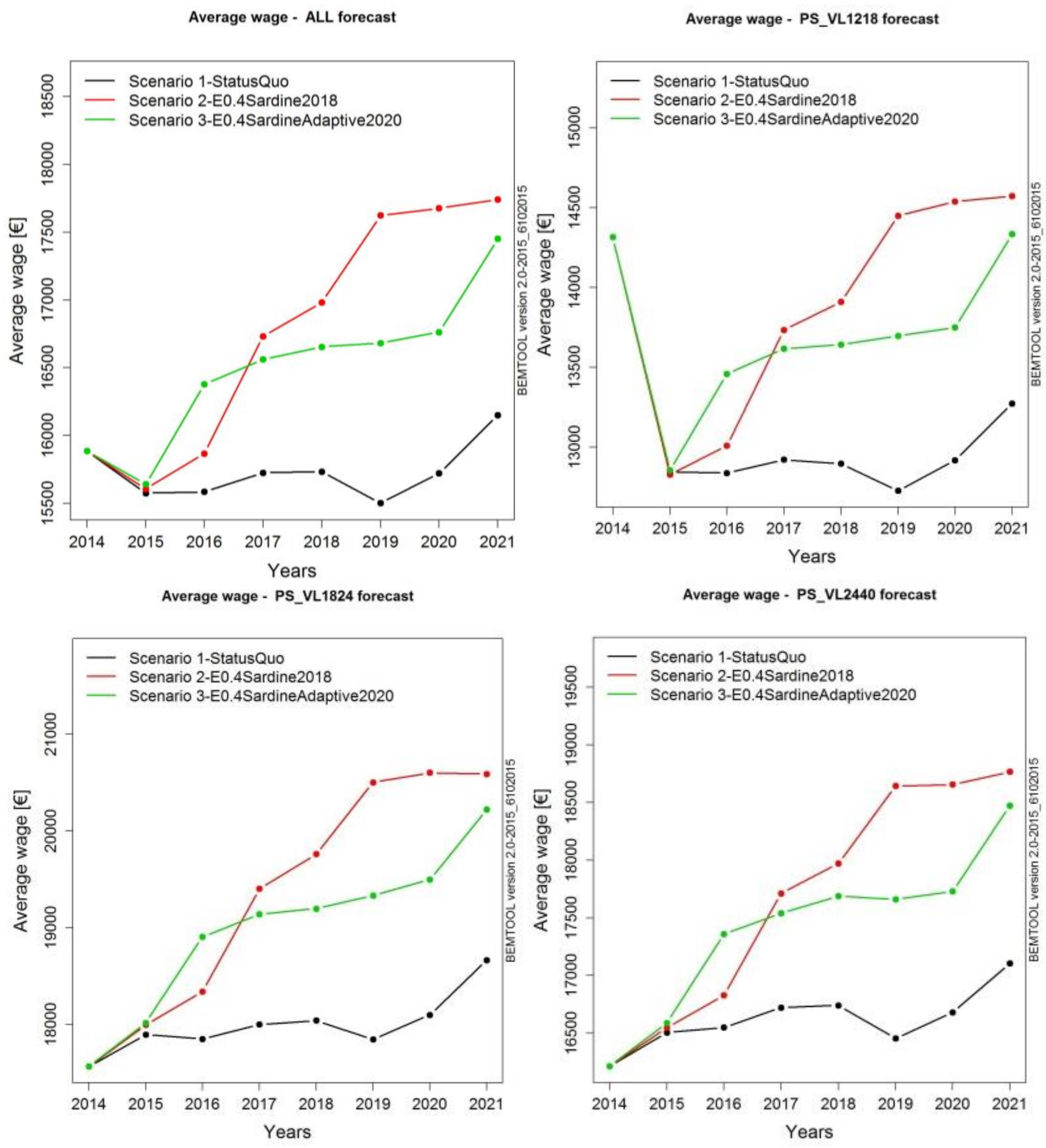


Figure 2.5.9.2.3 Average salary by fleet segment and scenario

2.5.10 REPORT THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

According to the traffic light summary (Tables 2.5.10.1 and 2.5.10.2) and the radar plot in Fig. 2.5.10.1, the twomanagement scenarios alternative to status quo allow to obtain a benefit in terms of SSB for both stocks, and they appear to produce the same effect. For the stock of sardine the target exploitation rate E0.4 was reached by 2018 or 2020, depending on the scenario.

Considering all fleet, the catches of anchovy are decreasing by a low percentage (around 1-3%), while those of anchovy are expected to decrease by around 10%. Revenues and employment are expected to decrease similarly in the two scenarios with a percentage around 3%. The reduction of employees is limited, given the limited amount of scraping. Salary and CR/BER indicators are expected to improve in both scenarios around 8-11%. Also the indicator ROI shows the same pattern with an increase of 15-12% depending on the scenarios.

At fleet segment level PS_VL1218 would have a reduced impact compared to the other 2 fleets.

Table 2.5.10.1 – Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catch of sardine and anchovy, salary, CR.BER., employment and revenues by all the fleet segments combined. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Employ.=Employment. The baseline of 2014 is also reported. The values of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline E is reported. SQ= Status quo.

Small pelagics in GSA 9	ALL fleets										
Scenario, year 2021	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB Anchovy (tons)	SSB Sardine (tons)	Catch Anchovy (tons)	Catch Sardine (tons)	E (value) (year) Anchovy	E (value) (year) Sardine
SQ (values in 2014 –baseline year)	15886	2.544	0.48	11312	258	2599	3335	4033	1421	0.85	0.45
SQ (values in 2021)	16149	2.436	0.44	11290	265	2698	3698	4159	1775	0.85	0.45
Scenario 2	9.9	11.0	15.1	-2.1	-3.0	25.3	10.4	-1.5	-9.0	0.8	0.4
Scenario 3	8.1	9.0	11.7	-3.4	-3.0	25.3	10.5	-3.2	-10.9	0.82 (2018) 0.8	0.44 (2018) 0.4

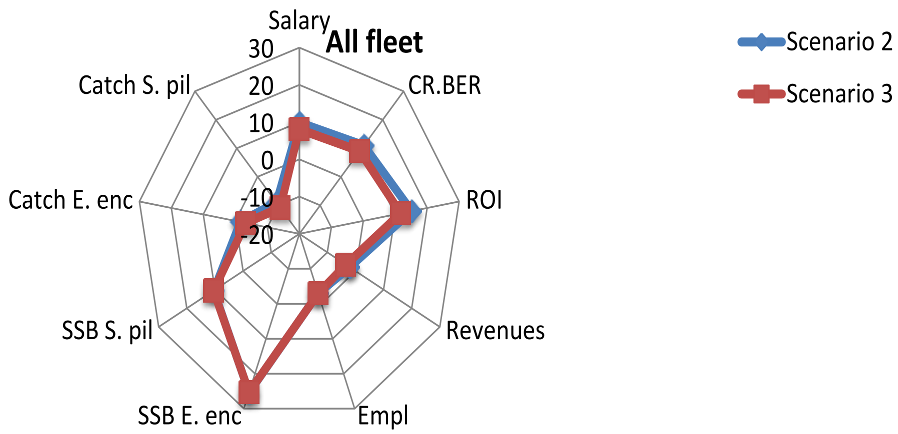


Figure 2.5.10.1. Radar plot for all the fleet. Each line represents a scenario and each point the corresponding percentage of each indicators respect to status quo.

Table 2.5.10.2 – Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catch of sardine and anchovy, salary, CR.BER., employment and revenues by fleet segment. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Employ.=Employment.

Fleet segment	ITA9_PS_VL1218					
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch E. enc (tons)	Catch S. pil (tons)

SQ (values in 2014 – baseline year)	14317	2.526	2878	80	752	49
Scenario 1 (values in 2021)	13274	2.525	2857	85	736	71
Scenario 2	9.8	11.5	-0.9	-3.0	-1.0	-4.8
Scenario 3	8.0	9.4	-2.3	-3.0	-2.7	-6.2
Fleet segment	ITA9_PS_VL2440					
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch E. enc (tons)	Catch S. pil (tons)
SQ (values in 2014 – baseline year)	16212	2.91	6078	128	2565	881
Scenario 1 (values in 2021)	17105	2.62	6027	133	2417	1221
Scenario 2	9.7	10.5	-2.3	-3.0	-1.6	-9.9
Scenario 3	8.0	8.6	-3.6	-3.0	-3.1	-11.8
	ITA9_PS_VL1824					
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch E. enc (tons)	Catch S. pil (tons)
SQ (values in 2014 – baseline year)	17563	1.816	2356	50	1023	378
Scenario 1 (values in 2021)	18664	1.979	2406	47	1013	483
Scenario 2	10.3	11.6	-2.9	-3.0	-2.8	-7.4
Scenario 3	8.4	9.4	-4.2	-3.0	-4.4	-9.6

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis (MCDA) that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process (AHP), has been used to assess the performances of the alternative fisheries management policies (Rossetto et al., 2015). The eight indicators used in the analysis are listed in table 2.7.3, along with the weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the 'current condition'. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021. In the case study of small pelagics discard was assumed to be negligible; that was positively weighed in the MCDA, with the same weight in all the scenarios.

Table 2.5.10.3 Summary of the indicators used in the MCDA

Top level hierarchy	Low level hierarchy	Indicator*	Weight
Socioeconomic	Economic	GVA, ROI or Profit	0.0080
Socioeconomic	Economic	CR.BER	0.0421
Socioeconomic	Social	EMP.	0.1914
Socioeconomic	Social	WAGE (Salary)	0.0641
Biological	Biological conservation	SSB	0.2605
Biological	Biological conservation	F	0.2605
Biological	Biological production	Y (Landing)**	0.1373
Biological	Biological production	D	0.0361

* GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; WAGE: Average wage; EMPL: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y: Landing; D: Discard rate. **Landing=catches as discard was considered negligible.

The MCDA (Figure 2.5.10.2) shows that the two scenarios provide similar results in terms of overall utility compared to the status quo (values around 0.31), although, if the only biological conservation component is taken into account, the two alternative scenarios perform slightly better compared to the status quo.

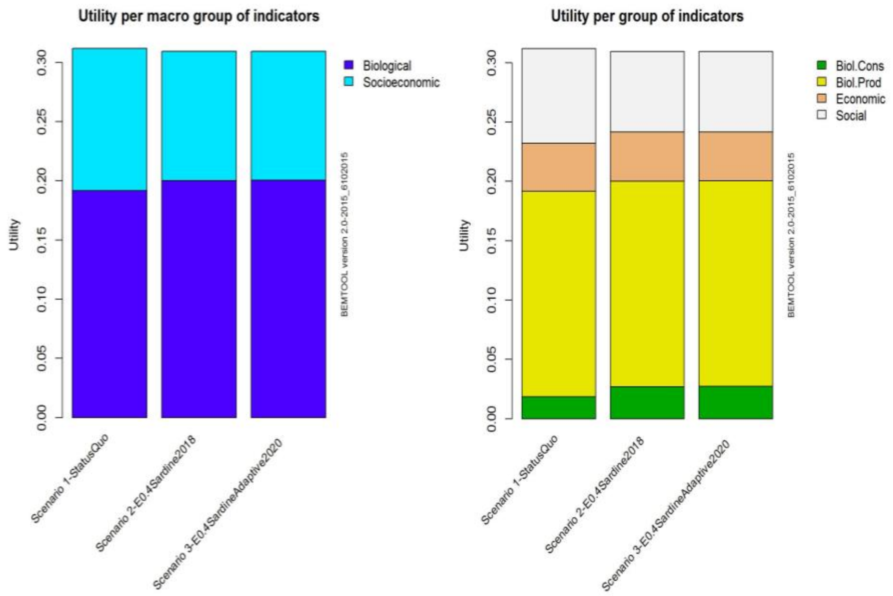


Figure 2.5.10.2. MCDA results: evaluation of the overall utility associated to each management scenario.

2.5.11 DISCUSSION AND CONCLUSIONS OF SMALL PELAGIC FISHERIES CASE STUDY IN GSA09

The two scenarios alternative to status quo allow to obtain the same benefit in terms of SSB for both stocks.

Considering all fleets, the catches of sardine are decreasing by a higher percentage (around 10%, worse in scenario 3), compared to anchovy. Revenues are not much impacted (between -2 and -3%), while the economic performance is expected to improve if salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping.

At fleet segment level fleets more affected by the management measures are PS_VL2440 and PS_VL1824.
From a social viewpoint, all alternative scenarios are expected to have an impact on the average salary for the overall fishing fleets improving the Status Quo scenario.
According to the MCDA the two scenarios alternative to the status quo are equivalent under biological, economic and social viewpoints.

There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment in small pelagic species. These species are in fact strongly influenced by environmental variables and the recruitment can show dramatic variability from one year to the next. However, the measure proposed from BEMTOOL are conservative enough to be efficient against recruitment failures.

In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed. The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability.

Catch advice

On the basis of the estimated limit management reference point for sustainable exploitation (E0.4 for sardine), catches in 2016 should be according to the following table 2.8.1. The reduction to reach the reference point is fully applied in 2016 and the values of the catches can be considered the maximum that can be taken to fulfil the objective of the reference point.

Table 2.8.1 Catch advice by scenario.

		Catch advice (tons)	
Scenario	**Year**	**Anchovy**	**Sardine**
Scenario 2	2016	3936	1611
Scenario 3	2016	3990	1685

ANNEX D –INPUTS FOR MODELLING SMALL PELAGIC FISHERIES IN GSA09

D.1 INPUT OF THE BIOLOGICAL MODULE OF SMALL PELAGIC FISHERIES IN GSA09

The data used for the parameterization of the biological and pressure modules are from the stock assessments performed by STECF 11-14 and STECF 15-06. The assessments of anchovy and sardine were carried out using pseudo-cohort analysis and seperable VPA, respectively in STECF 11-14 and STECF 15-06. Socio-economic data and parameters are from DCF.

GROWTH PARAMETERS OF SMALL PELAGICS IN GSA09

The growth parameters and the length-weight relationship coefficients for the two species are listed in the table D.1.1. The growth functions are for sex combined. The life span was set equal to 5 years (from age 0 to age 4) for both anchovy and sardine.

Table D.1.1 **-** Growth parameters for anchovy and sardine in GSA 09.

Parameter	Sex combined anchovy	Sex combined sardine
Linf (cm)	18.6	20.0
K	0.6	0.39
t_0	-0.8	-0.48
a (mm/g)	0.000006	0.000007
b (mm/g)	3.08	3.04

RECRUITMENT OF SMALL PELAGICS IN GSA09

Recruitment vectors (Table D.1.2) have been used for simulating the stocks of anchovy and sardine in BEMTOOL, whilst a constant value incorporating uncertainty has been used for projecting the stocks. The recruitment used in BEMTOOL is the one estimated during the STECF 11-14 for anchovy and during STECF 15-06 for sardine.

Table D.1.2 Recruitment by year used in simulation phase for anchovy and sardine in GSA 09.

Year	R (thousands) anchovy	R (thousands) sardine
2008	342699	4546800
2009	632187	2399200
2010	774909	2326100
2011	*646332	1240200
2012	*646332	**1988500
2013	*646332	**1988500
2014	*646332	**1988500

* As the assessment was updated to 2010, for 2011-2014 the mean value calculated on the years available from assessment (2006-2010) has been used; ** For 2012-2014 the mean value of the last three years (2009-2011) has been used, as it was more consistent with the expected values from simulations.

The number of recruits entering in the population has been split by month. The proportion of recruits entering each year by month in the population for anchovy and sardine in GSA 09 has been assumed equal to 0.083. The age of recruitment has been set at 3 months for anchovy and 5 months for sardine coherently with the age class used in the assessment.

MATURITY AND SEX RATIO OF SMALL PELAGICS IN GSA09

The size at first maturity used for both anchovy and sardine is 11.0 cm TL with a maturity range of 1.5 cm TL.

NATURAL MORTALITY OF SMALL PELAGICS IN GSA09

The natural mortality at age was according to the assessment which used the Prodbiom method (Abella et al., 1997) with no distinctions between sexes. Table D.1.3 shows the values for anchovy and sardine.

Table D.1.3 Natural mortality for anchovy and sardine in GSA 09.

Age	M anchovy	M sardine
0	1.32	2.34
1	0.52	1.1
2	0.4	0.82
3	0.35	0.7
4+	0.35	0.65

TOTAL MORTALITY OF SMALL PELAGICS IN GSA09

Total mortality Z by year for anchovy and sardine used as input in BEMTOOL is summarized in the following Table D.1.4.

Table D.1.4 Total mortality Z for anchovy and sardine in GSA 09.

Year	Anchovy	Sardine
2008	1.81	1.32
2009	2.69	1.92
2010	2.28	2.17*
2011	2.28	2.17*
2012	2.62	2.42
2013	2.74**	2.42
2014	2.74	2.42

*The total mortality of sardine averaged on years 2009 and 2012 has been used in 2010 and 2011 as it was more consistent with the shape of production trends. **The total mortality of anchovy in 2012 has been rescaled to a factor of 1.18 in 2013 as it was more consistent with the shape of production trend.

D.2 INPUT OF THE PRESSURE MODULE OF SMALL PELAGIC FISHERIES IN GSA09

FISHING MORTALITY OF SMALL PELAGICS IN GSA09

The overall fishing mortality by year and age from the assessment models (STECF 11-14 for anchovy and STECF 15-06 for sardine) was split among the fleet segments according to the respective proportions in weight in the landings and the selectivity shaped for each fleet segment. The age range used for anchovy in the output calculation of average F was 1-3, while for sardine was 1-2, with no distinction between sexes, in agreement with the assessments. Fishing mortality by age and year is reported in the Table D.2.1 for anchovy and in Table D.2.2 for sardine

Table D.2.1 Overall fishing mortality for anchovy.

age	2008	2009	2010	2011	2012	2013	2014
0	0.04	0.08	0.15	0.16	0.16	0.16	0.16
1	1.00	2.25	3.42	2.12	2.12	2.12	2.12
2	1.68	1.58	1.97	1.95	1.95	1.95	1.95
3	1.49	3.00	0.19	1.52	1.52	1.52	1.52
4+	0.61	0.61	0.00	0.49	0.49	0.49	0.49

Table D.2.2 Overall fishing mortality for sardine.

Age	2008	2009	2010	2011	2012	2013	2014
0	0.00	0.01	0.02	0.02	0.01	0.01	0.01
1	0.39	1.13	2.61	3.34	1.75	1.75	1.75
2	0.24	0.69	1.59	2.03	1.07	1.07	1.07
3	0.11	0.32	0.74	0.95	0.50	0.50	0.50
4+	0.11	0.32	0.74	0.95	0.50	0.50	0.50

SELECTIVITY OF SMALL PELAGIC FISHERIES IN GSA09

In the following tables, the selectivity for each fleet segment used for the modelling in BEMTOOL is reported.

Table D.2.3 – Selectivities for anchovy in GSA 09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation
ITA9_PS_VL1218	2008-2021	Classical Ogive	115	2.5
ITA9_PS_VL1824	2008-2021	Classical Ogive	115	2.5
ITA9_PS_VL2440	2008-2021	Classical Ogive	115	2.5

Table D.2.4 – Selectivities for sardine in GSA 09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation
ITA9_PS_VL1218	2008-2014	Classical Ogive	139	2.5
	2015-2021	Classical ogive	142*	2.5
ITA9_PS_VL1824	2008-2014	Classical Ogive	128	2.5
	2015-2021	Classical ogive	135*	2.5
ITA9_PS_VL2440	2008-2014	Classical Ogive	128	2.5
	2015-2021	Classical ogive	135*	2.5

* the parameters used for the projections are those used in 2014, while the values of the parameters reported for 2008-2014 are mean values on the simulated years.

EFFORT OF SMALL PELAGIC FISHERIES IN GSA09

The monthly effort variables by fleet segment used for simulating the dynamics of the fishery in BEMTOOL for the past and current years are listed in Table D.2.5.

Table D.2.5 Effort for the selected fleet segments in GSA 09.

Effort Variable	ITA9_PS_VL1218						
	2008	2009	2010	2011	2012	2013	2014
average monthly GT	45.7	20.9	23.1	18.6	21.2	20.5	20.5
average monthly KW	253.7	166.4	183.8	165.7	168.1	182	182
number of vessels	26.5	22.7	14.1	13.7	11.9	14.2	14.2
mean annual fishing days	68	87	70	86	64	94	94
Effort Variable	**ITA9_PS_VL1824**						
	2008	2009	2010	2011	2012	2013	2014
average monthly GT	29.7	50.1	46.1	46.1	46.1	46.1	46.1
average monthly KW	195.3	275.9	269.4	269.4	269.4	269.4	269.4
number of vessels	20.6	8.8	6.7	6.4	6.8	6.7	6.7
mean annual fishing days	102	139	112	144	143	128	128
Effort Variable	**ITA9_PS_VL2440**						
	2008	2009	2010	2011	2012	2013	2014
average monthly GT	53.2	53.2	54.2	54.2	55.4	55.4	55.4
average monthly KW	268.6	268.6	268.3	268.3	279	279	279
number of vessels	16.8	16.8	18.6	18.1	16.6	16.6	16.6
mean annual fishing days	0	150	131	141	158	121	121

LANDINGS AND DISCARDS OF SMALL PELAGIC FISHERIES IN GSA09

Landings data 2008-2014 for GSA 09 were obtained from the National Programme of the EU Data Collection Framework.

Landings data for anchovy and sardine by fleet segment used to parameterize the model are listed in the Table D.2.6 and Table D.2.7, respectively.

Table D.2.6 Landing for anchovy by fleet segment in GSA 09 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	464	353	285	783	564	752
ITA9_PS_VL1824	778	1141	1059	1334	1297	1023
ITA9_PS_VL2440	-	887	1549	2239	2933	2565
Total	**1242**	**2382**	**2893**	**4357**	**4794**	**4340**

Table D.2.7 Landing for sardine by fleet segment in GSA 09 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	2030	128	102	196	178	49
ITA9_PS_VL1824	258	294	44	428	373	378
ITA9_PS_VL2440	-	5252	4330	1919	1154	881
Total	**2288**	**5674**	**4476**	**2543**	**1705**	**1309**

According to DCF data and the recent results of MAREA LANDMED project, the discard has been considered as negligible for small pelagic fisheries in GSA9.

Total landings by fleet segment used to parameterize the model are listed in the Table D.2.8.

Table D.2.8 Total landings by fleet segment in GSA 09 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	2796	721	597	1116	781	1017
ITA9_PS_VL1824	1291	1450	1203	1799	1678	1607
ITA9_PS_VL2440	-	6505	6334	4405	4343	3621
Total	**4087**	**8675**	**8134**	**7320**	**6802**	**6267**

D.3 INPUT OF THE ECONOMIC MODULE SMALL PELAGIC FISHERIES IN GSA09

Data 2008-2013 for the estimation of the socio-economic parameters were obtained from the National Programs of the EU Data Collection Framework. The economic data of the selected fleet segments used to parameterize the economic functions in the projections are reported in the following paragraphs.

REVENUES OF SMALL PELAGIC FISHERIES IN GSA09

The revenues by fleet segment for anchovy, sardine and the total revenues are reported in the tables below. In the projections the prices have been modelled according to the revenues and the landings by fleet segment. The same value as 2013 was assumed for 2014.

Table D.3.1 - Revenues of anchovy by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	1624887	1229494	1026374	2412900	1869934	1685420
ITA9_PS_VL1824	3469286	3209797	2430308	2534356	2462858	1793228
ITA9_PS_VL2440		2626591	3042178	4918618	6167311	4481630
Total	**5094173**	**7065882**	**6498860**	**9865874**	**10500103**	**7960278**

Table D.3.2 - Revenues of sardine by fleet segment in GSA 9(€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	1274433	215203	174175	266064	510511	51807
ITA9_PS_VL1824	315584	255003	50269	379175	324943	279841
ITA9_PS_VL2440		2782487	2427936	1138704	691507	597075
Total	**1590017**	**3252693**	**2652380**	**1783943**	**1526961**	**928723**

Table D.3.3 - Total revenues by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	3579452	2209068	1885390	3159470	2447216	2878078
ITA9_PS_VL1824	4448184	3501885	2598597	2955124	2798006	2355880
ITA9_PS_VL2440		5919558	6266830	7055273	7640370	6078399
Total	**8027636**	**11630511**	**10750817**	**13169867**	**12885592**	**11312357**

PROFIT OF SMALL PELAGIC FISHERIES IN GSA09

In the following table D.3.3a.the profit of small pelagic fishery in gsa9 are preported by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table D.3.3a - Profit by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	-478426	84924	254872	614894	562462	583977
ITA9_PS_VL1824	315724	583436	545943	716004	464885	323325
ITA9_PS_VL2440	-0.004	964357	835558	1264210	1692141	1544009
Total	**-162702.004**	**1632717**	**1636373**	**2595108**	**2719488**	**2451311**

COSTS OF SMALL PELAGIC FISHERIES IN GSA09

In the following tables all the data of costs by fleet segment as taken into account in the simulation phase of the case study (past and present years) in BEMTOOL are reported. The same value as 2013 was assumed for 2014.

Table D.3.4 - Total variable costs by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	1379803	594881	384420	737557	481672	596511
ITA9_PS_VL1824	1678870	847443	593544	788583	856656	660978
ITA9_PS_VL2440		1629338	1805749	2282419	2393100	1487743
Total	**3058673**	**3071662**	**2783713**	**3808559**	**3731428**	**2745232**

Table D.3.5 - Other variable costs by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	547480	273787	169773	238099	166858	242235
ITA9_PS_VL1824	784579	502102	329796	376678	397454	359301
ITA9_PS_VL2440		790025	798681	848768	913742	541018
Total	**1332059**	**1565914**	**1298250**	**1463545**	**1478054**	**1142554**

Table D.3.6 - Fuel costs by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	832323	321094	214647	499457	314815	354276
ITA9_PS_VL1824	894291	345341	263748	411905	459203	301677
ITA9_PS_VL2440		839313	1007067	1433650	1479357	946725
Total	**1726614**	**1505748**	**1485462**	**2345012**	**2253375**	**1602678**

Table D.3.7 - Maintenance costs by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	326608	134391	86621	77462	91193	169534
ITA9_PS_VL1824	142262	63084	47313	45913	47313	97253
ITA9_PS_VL2440		227276	254212	258611	227276	163046
Total	**468870**	**424751**	**388146**	**381986**	**365782**	**429833**

Table D.3.8 - Total fixed costs by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	190125	113620	70985	67740	78309	63166

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1824	163720	72920	54690	53748	54690	35342
ITA9_PS_VL2440		131273	146831	131145	131273	112944
Total	**353845**	**317813**	**272506**	**252633**	**264272**	**211452**

Table D.3.9 - Other fixed costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	190125	113620	70985	67740	78309	63166
ITA9_PS_VL1824	163720	72920	54690	53748	54690	35342
ITA9_PS_VL2440		131273	146831	131145	131273	112944
Total	**353845**	**317813**	**272506**	**252633**	**264272**	**211452**

Table D.3.10 - Labour costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	1008945	820153	775989	1336961	970031	1145333
ITA9_PS_VL1824	1368730	1431746	1081481	1147227	1047120	878127
ITA9_PS_VL2440		1947328	2024882	2131803	2381733	2075143
Total	**2377675**	**4199227**	**3882352**	**4615991**	**4398884**	**4098603**

Table D.3.11 - Depreciation costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	1101915	420342	282448	294233	240991	285345
ITA9_PS_VL1824	745214	457302	249896	182824	302801	323616
ITA9_PS_VL2440		919763	1091995	893963	747306	614747
Total	**1847129**	**1797407**	**1624339**	**1371020**	**1291098**	**1223708**

Table D.3.12 - Opportunity costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	50482	40757	30055	30623	22558	34211
ITA9_PS_VL1824	33664	45954	25730	20826	24540	37239
ITA9_PS_VL2440		100223	107603	93122	67541	80767
Total	**84146**	**186934**	**163388**	**144571**	**114639**	**152217**

Table D.3.13 - Total capital costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_PS_VL1218	1152397	461099	312503	324856	263549	319557
ITA9_PS_VL1824	778878	503256	275626	203649	327342	360855

ITA9_PS_VL2440		1019986	1199598	987085	814847	695514
Total	**1931275**	**1984341**	**1787727**	**1515590**	**1405738**	**1375926**

Table D.3.14 - Number of employees by fleet segment in GSA 9 (N).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	136	99	96	58	95	80
ITA9_PS_VL1824	139	50	50	68	68	50
ITA9_PS_VL2440		108	110	166	155	128
Total	**275**	**257**	**256**	**292**	**318**	**258**

Table D.3.15 - Capital value by fleet segment in GSA 9 (€).

Fleet segment	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
ITA9_PS_VL1218	4427904	1652994	1253605	1249084	1062739	1148931
ITA9_PS_VL1824	2952711	1863783	1073191	849448	1156136	1250600
ITA9_PS_VL2440		4064822	4488114	3798318	3181941	2712417
Total	**7380615**	**7581599**	**6814910**	**5896850**	**5400816**	**5111948**

D.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS

In the simulation phase the fitting of the model is quite satisfactory for both the species. The differences between simulated and observed data by fleet segment and year are reported in the D4.1 and D4.2. Considering all the fleet segments, these differences were on average lower than 10% both for anchovy and sardine.

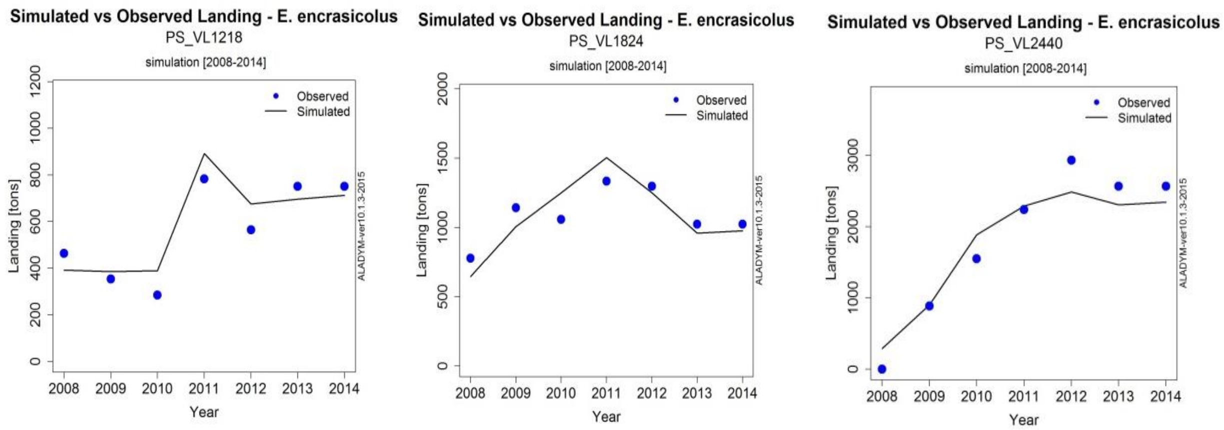


Figure D 4.1 Comparison between simulated and observed landings by fleet segment for anchovy in GSA 09.

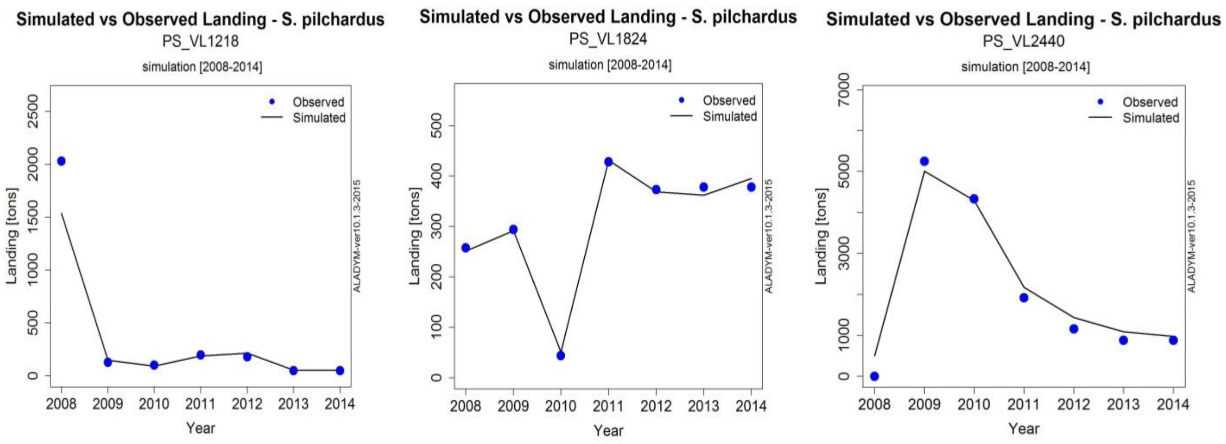


Figure D 4.2 Comparison between simulated and observed landings by fleet segment for sardine in GSA 09.

The comparison in terms of Spawning Stock Biomass (SSB) between the assessment models and the BEMTOOL simulations are shown in the D 4.3. For anchovy, BEMTOOL model estimated an SSB slightly higher than that obtained by the stock assessment model (Pseudo-cohort analysis by means of VIT package; see Lleonart and Salat, 1992); however, the two trends showed a rather similar pattern. In addition the assessment estimates were referred to 2011, so current values are from the simulation model in BEMTOOL. Also for sardine, the SSB fittings obtained with the assessment model and the BEMTOOL model showed a similar trend, however the difference of values were high. The difference between SSB estimated by the assessment (separable VPA approach) and the one estimated in BEMTOOL could be due to the different proportions of maturity by age used in the two models. Using growth parameters from assessment (Linf=20, k=0.39 and t0=-0.48) and length at first maturity equal to 11 cm, the proportion of matures calculated by ALADYM model at the age 0 is equal to zero; while the maturity vector used in the assessment reports 50% of mature individuals at age 0, that lead to a higher estimation of the sardine SSB.

No stock recruitment relationships were available for anchovy and sardine in GSA 09.

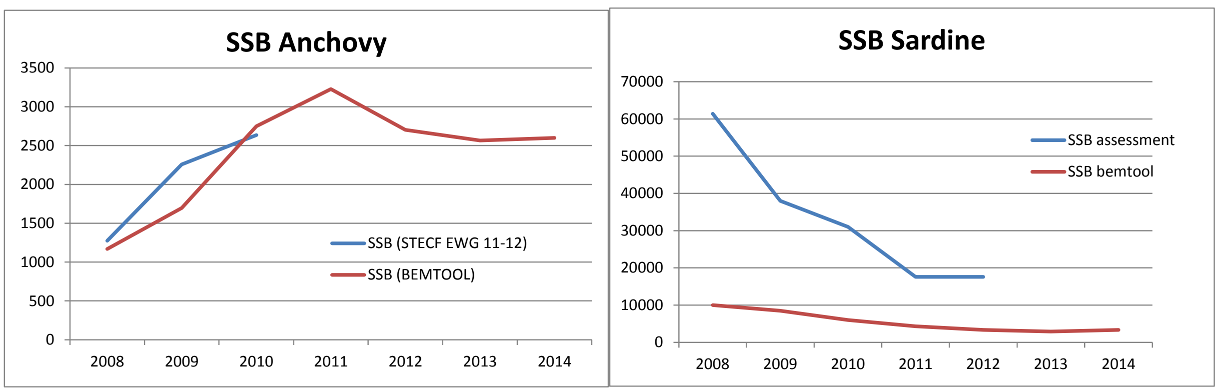


Figure D 4.3 Comparison between BEMTOOL and stock assessment SSB by fleet segment for anchovy and sardine in GSA 09.

D.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT

D.5.1 INPUT OF THE BIOLOGICAL AND PRESSURE MODULES

In order to perform the projections of the stock in the future, the recruitment of anchovy and sardine at the beginning of the forecast phase has been assumed equal to the recruitment in 2014 (646332 thousands and 1988500 thousands, respectively).

A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the geometric mean of recruitment in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL. Figure D.5.1 shows the recruitment of anchovy and sardine with confidence interval used in all the performed scenarios.

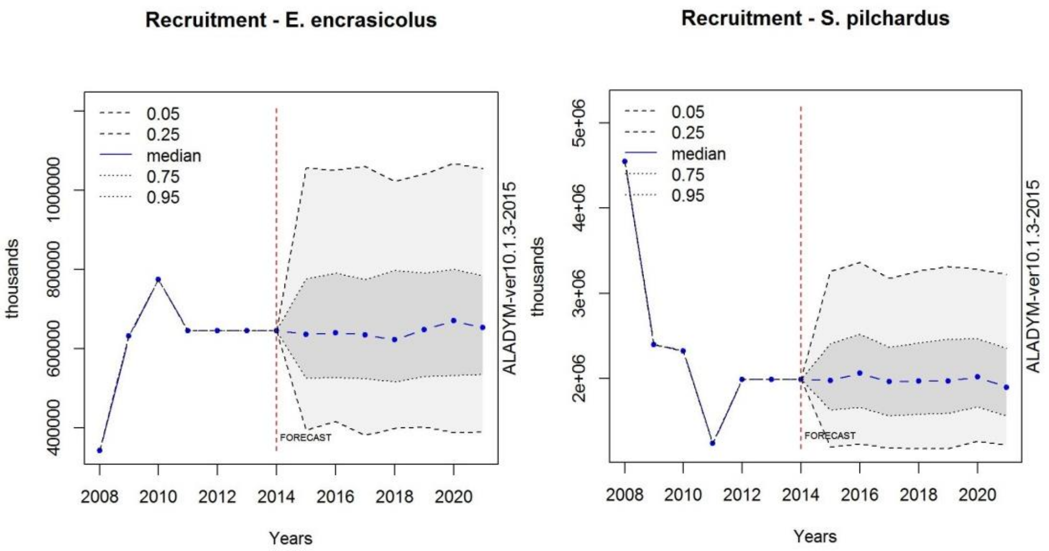


Figure D.5.1 Recruitment used for anchovy and sardine in the forecast scenarios with confidence intervals.

All the other biological inputs have been maintained unchanged in the projections.

For the status quo the effort has been maintained constant for all the years (until 2021) and equal to 2013.

D.5.2 INPUT OF THE ECONOMIC MODULE

The main equations in the socio-economic model are related to the dynamics of prices and costs. Each equation has been tested on the basis of available historical series of data in order to check that the functional relationships are correctly specified. Economic parameters for each fleet segment and model equations are described below.

PRICES DYNAMICS

The price of European anchovy and European sardine are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \Bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}.$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2

for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

1) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
2) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
3) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.

Due to the lack of reliable estimations, the elasticity coefficient was computed exogenously on the basis the existing literature on seafood demand related to small pelagic species in Northern Adriatic (Camanzi *et al.,* 2010). This study estimated price-quantity relationship equal to -0.2 for both species considered in the ex-vessel markets of the Emilia Romagna and Veneto Regions in Italy. This resulted in the parameterization reported in the table A.27.

Table D 5.2.1 Price parameterization by fleet segment and stock in GSA 9 pelagic case study.

Fleet segment	coeff. price-landings E. encrasicolus	coeff. price-landings S. pilchardus

Fleet segment	coeff. price-landings E. encrasicolus	coeff. price-landings S. pilchardus
ITA9_PS_VL1218	-0.2	-0.2
ITA9_PS_VL1824	-0.2	-0.2
ITA9_PS_VL2440	-0.2	-0.2

The flexibility coefficient price-landings was assumed equal to -0.2 for all target species, which means that given a 1% fall in the production of a given species, it is assumed an increase in price of 0.2%.

COSTS DYNAMICS

Variable costs

Variable costs were modelled as a single item, which is the sum of fuel costs and other variable costs. Total variable costs are a function of the fishing effort (expressed in terms of days at sea):

$$TVC_{f,t} = \beta_f E_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$E_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*

Maintenance costs and fixed costs

Maintenance costs (MC) and other fixed costs (OFC) are assumed to be proportional to the gross tonnage (GT) of the fleet segment, corresponding to option 1 of the BEMTOOL software.

$$MC_{f,t} = \alpha''_f GT_{f,t}$$

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

Capital costs

Capital costs are function of the estimated fleet capacity, expressed in terms of capital value and gross tonnage.

Depreciation costs DC are estimated by a linear function of the annual gross tonnage GT as well.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

Following the approach of "The 2014 Annual Economic Report on the EU Fishing Fleet (STECF-14-16)", opportunity costs of capital (OC) are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Capital costs include annual depreciation and the opportunity costs of capital.

Labour costs

Labour cost are directly related to total revenues and variable cost.

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is assumed to be proportional to revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t}\right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

Revenues and total landings

Revenues by fleet segment and species are calculated by multiplying landings produced in the biological sub-model by the prices estimated on the basis of the price module.

As assessed species account for more than 90% of total revenues and production for all fleet segments, the remaining part of landings value and weight was assumed to be a fixed percentage of the estimated revenues and production of anchovy and sardine according to option 1 of revenues modelling in BEMTOOL:

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

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

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to pass from the landings of assessed species to the total landings of the fleet segment *f*.

Total revenues and production are thus function of the estimated landings value and weight of the two target assessed species.

Average employees per vessel

Employment was estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html.

Table D.5.2.2 Cost parameterization by fleet segment in GSA 9 pelagic case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA9_PS_VL1218	445	0.5	580	216	976	117
ITA9_PS_VL1824	762	0.5	313	114	1040	120
ITA9_PS_VL2440	740	0.5	177	122	666	88

Table D.5.2.3 Socio-economic indicators parameterization by fleet segment in GSA 9 pelagic case study.

Fleet segment	correction factor for landings	correction factor for revenue	coefficient u landings	coefficient v landings	value of a single vessel	average employees per vessel	discount rate
ITA9_PS_VL1218	1.27	1.66			80627	6	0.043
ITA9_PS_VL1824	1.15	1.14			185274	7	0.043
ITA9_PS_VL2440	1.05	1.20			162991	8	0.043

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D.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The Table D.5.3.1 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute values of the average number of annual fishing days per vessel and the number of active vessels are reported.

Table D. 5.3.1 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Reduction on days							**Reduction on vessels**						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_PS_VL1218	94.1	94.1	94.1	94.1	94.1	94.1	94.1	14.2	14.2	14.2	14.2	14.2	14.2	14.2
ITA9_PS_VL1824	128.4	128.4	128.4	128.4	128.4	128.4	128.4	6.7	6.7	6.7	6.7	6.7	6.7	6.7
ITA9_PS_VL2440	120.8	120.8	120.8	120.8	120.8	120.8	120.8	16.6	16.6	16.6	16.6	16.6	16.6	16.6

	Reduction on days							**Reduction on vessels**						
Scenario 2 - E0.4Sardine2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_PS_VL1218	-6.8%	-13.5%	-20.2%	-27.0%	-27.0%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA9_PS_VL1824	-6.8%	-13.5%	-20.3%	-27.0%	-27.0%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA9_PS_VL2440	-6.8%	-13.5%	-20.3%	-27.0%	-27.0%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%

	Reduction on days							**Reduction on vessels**						
Scenario 3 - E0.4SardineAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_PS_VL1218	-6.8%	-6.8%	-10.8%	-14.9%	-20.9%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA9_PS_VL1824	-6.8%	-6.8%	-10.8%	-14.8%	-20.9%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%
ITA9_PS_VL2440	-6.8%	-6.8%	-10.8%	-14.9%	-20.9%	-27.0%	-27.0%	-1%	-2%	-3%	-3%	-3%	-3%	-3%

2.6. CASE STUDY ON DEMERSAL FISHERY IN GSA9

2.6.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The main stocks identified for the demersal fisheries in the Ligurian and northern Tyrrhenian Seas - GSA 09 are European hake (HKE, *Merluccius merluccius*), red mullet (MUT, *Mullus barbatus*), deep-water rose shrimp (DPS, *Parapenaeus longirostris*) and Norway lobster (NEP, *Nephrops norvegicus*).

Five main fleet segments operating in GSA 09 carrying out demersal fisheries have been identified. Demersal fisheries are carried out on the continental shelf (50-200 m depth) by all fleet segments and on the continental slope by the two largest trawl fleet segments and the largest Polyvalent passive Gear (PGP) segment (mostly using gill nets targeting European hake). The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 2.6.1.1.

Table 2.6.1.1 – Fleet segment operating in GSA09 and identified for the present study. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	***Fleet code***	***% of landings (all species)***
1	Bottom trawlers with vessel length 12-18 m	ITA9_DTS_VL1218	23.9
2	Bottom trawlers with vessel length 18-24 m	ITA9_DTS_VL1824	38.9
3	Bottom trawlers with vessel length 24-40 m	ITA9_DTS_VL2440	2.4
4	Vessels using polyvalent passive gears length 00-12 m	ITA9_PGP_VL0012	27.8
5	Vessels using polyvalent passive gears length 12-18 m	ITA9_PGP_VL1218	7.0

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years of all demersal and benthic species) is reported in the table 2.6.1.2. These stocks account for a low percentage, less than 10%, in the small scale fishery operated by smaller vessels (ITA9_PGP_VL0012), but are important for the bottom trawl fleets and the artisanal fisheries carried out by vessels in the class 12-18 m LOA (Length Over All). In these cases, the assessed stocks represent, on average, from 30 to about 40% of the fleet segment production.

Table 2.6.1.2 – Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA9.

Assessed species/fleet segments GSA9	***ITA9_DTS VL1218***	***ITA9_DTS VL1824***	***ITA9_DTS VL2440***	***ITA9_PGP VL0012***	***ITA9_PGP VL1218***

NEP	2.03	2.75	3.91	0.00	0.00
DPS	6.42	6.50	13.50	0.00	0.00
HKE	9.23	13.70	14.78	6.69	29.98
MUT	12.70	8.84	6.34	1.80	0.13
Total assessed %	30.38	31.79	38.53	8.49	30.11

General fishery rules

In GSA 09, management regulations are based on technical measures, as closed number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban. Regarding small scale fishery, management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. A biological conservation zone (ZTB) was permanently established in 2005 off Giglio Island (50 km^2, between about 160 and 220 m depth) (Decree of Ministry of Agriculture, Food and Forestry Policy of 16.06.1998). Professional small scale fishery using fixed nets and long-lines is permanently allowed, while trawling is allowed from July 1st to December 31st and the small scale fishery all year round; recreational fishery using no more than 5 hooks is also allowed (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009). Another ZTB area has been established off the coasts of southern Latium with the same rules as the above mentioned ZTB off the Giglio Island.

Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

These management regulations have been taken into account to model the current situation in the case study.

2.6.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The assessment of the main demersal stocks was carried out at STECF 14-17 (EWG 14-09; red mullet and Norway lobster; see STECF, 2014c), STECF 15-06 (EWG 14-19 deep water rose shrimp see STECF, 2015b) and STECF EWG 15-11 (European hake; STECF, in press).

All stocks are considered overexploited (red mullet is considered slightly overexploited) by the recent assessments, with the only exception of deep-water rose shrimp, which is considered as exploited sustainably (Table 2.6.2.2). Discards of hake and deep-water rose shrimp were included in the assessment; discards of Norway lobster was considered negligible and thus not included (Table 2.6.2.1).

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the needing of estimating this parameter when the assessment was not recent are reported in the table 2.6.2.1, as well as landings, discards, spawning stock biomass and recruitment.

Table 2.6.2.1 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA9.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)***	*Discards (tons)*	*Spawning Stock Biomass*current (tons)*	*Recruitment (in thousands)*
European hake	0.82	1560	1274	286	2000	55 923

Norway lobster	0.56	113	112	0.5	453	73 678
Red mullet	0.56	1287	1181	106	1290	165 897
Deep water rose shrimp	0.4	606	561	45	906	338 251

* = Mean of the last 3 years; **2013 data

Stock advice, Reference points, and their technical basis

Two out of the four stocks are assessed as being exploited unsustainably at levels higher than F_{MSY}; namely European Hake (HKE) ($F_{current}$ about 3.6 times F_{MSY}) and Norway lobster (NEP). Red mullet is considered slightly overexploited, while deep-water rose shrimp is considered to be exploited sustainably ($F_{current}$ close to F_{MSY}).

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

F_{MSY} = 0.23; Fupper = 0.32 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.7.

The framework used for the reference points is summarised in the table below, taken from EWG 14-09, EWG 14-19 and EWG 15-11. Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Tab. 2.6.2.2 – Summary of the reference points for the four demersal stocks in GSA09.

	Framework				
	MSY approach			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**Fcurr/ F_{MSY}**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for European hake method 1	$F_{0.1}$ used as proxy of Fmsy from YpR analysis	STECF EWG 15-11 approach (empirical)		MSE (lowest level of SSB in the time series)	MSE (1.4* Blim)
Technical basis for all the species method 2	F combined according to Balance indicators approach				
Technical basis for all the other species method 1	F_{upper} of European hake	STECF EWG 15-11 approach (empirical)			
Values for European hake method 1	**0.23**	**0.32**	**3.6**	1569	2197
Values for deep water rose shrimp method 1	0.71	0.97	0.8		
Values for red mullet method 1	0.59	0.80	0.95		

	Framework				
	MSY approach			Precautionary approach	
Values for Norway lobster method 1	0.21	0.29	1.8		
Values for all the other species method 2	**0.39**		**1.78**		

*B_{lim}=B_{loss} (B_{loss} is the lowest value of SSB in the time series, that was estimated in the last year).

Development of economic indicators over time and current status

The economic performance of the fleet segments is evaluated using key social and economic indicators and a traffic light table (Table 2.6.2.3; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

Overall Rrevenues from of almost all fleet segments are negative the assessed stocks are stable given the negative performance of the different fleet segments for the different species, with the only exception of Norway lobster. The revenues from this species are showing a slightly decreasing trend. Only Revenues from European hake, red mullet and deep-water rose shrimp are showing increasing patterns for some of the fleet segments only (ITA9_DTS_VL1218; ITA9_DTS_VL2440 and PGP_VL1218VL0012). Excluding salary all the other economic indicators are deteriorated, except for the fleet ITA9_PGP_VL0012.

Tab. 2.6.2.3 – Traffic light table on the economic performance (2008-2013) of the fleets targeting demersal stocks (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues red mullet (thousands euros)	Revenues pink shrimp (thousands euros)	Revenues Norway lobster (thousands euros)	Employment (number of unit)
ALL *	10874 ÷ 10082	1.865 ÷ 1.034	0.302 ÷ 0.011	108317 ÷ 89285	11317 ÷ 9516	4676 ÷ 4194			
ITA9_DTS_VL1218	12828 ÷ 17395	1.926 ÷ 1.556	0.296 ÷ 0.181	21626 ÷ 22076	1891 ÷ 2065	2305 ÷ 1617	822 ÷ 2151	2365 ÷ 1469	392 ÷ 342
ITA9_DTS_VL1824	14717 ÷ 16901	0.856 ÷ 0.429	-0.045 ÷ -0.173	37791 ÷ 27960	5217 ÷ 4400	2295 ÷ 1478	2625 ÷ 2173	4938 ÷ 2096	494 ÷ 390
ITA9_DTS_VL2440 *	33328 ÷ 17217	1.098 ÷ 0.508	0.029 ÷ -0.13	4000 ÷ 2653	341 ÷ 393	138 ÷ 86	705 ÷ 253	527 ÷ 515	30 ÷ 31
ITA9_PGP_VL0012	5013 ÷ 6799	2.566 ÷ 1.341	0.62 ÷ 0.15	34750 ÷ 31275	2519 ÷ 2115	89 ÷ 1100			1849 ÷ 1608
ITA9_PGP_VL1218	11395 ÷ 9439	1.641 ÷ 1.811	0.194 ÷ 0.256	5503 ÷ 5320	1583 ÷ 937	4 ÷ 0			135 ÷ 158

* All the values of the indicators in the starting year are referred to 2009, as in 2008 DTS_VL2440 has no days at sea

2.6.3 MANAGEMENT STRATEGY EVALUATION

During the Workshop held in Bari on September 21-25, 2015 it was also decided to test the effect of a Management Strategy Evaluation based on reaching the F_{MSY} corresponding to the F_{upper} (STECF EWG 15-11) for hake representing the stock with the highest ratio F_c/F_{MSY}.

A Management Strategy Evaluation (MSE) was performed in line with what was presented during the STECF EWG 15-11 to evaluate if the MSY ranges were precautionary.

For European hake in GSA 09 the F_{MSY} ranges were derived using the formula provided by STECF EWG 15-11. F ranges results were F_{upper}=0.32 and F_{lower}=0.16. Blim was estimated as B_{loss}=1569 (t).

The following figure 2.6.3.1 shows the results of the MSE on European hake in GSA 09. Results were consistent and probability to fall below B_{lim} at F = Fupper is equal to 0.

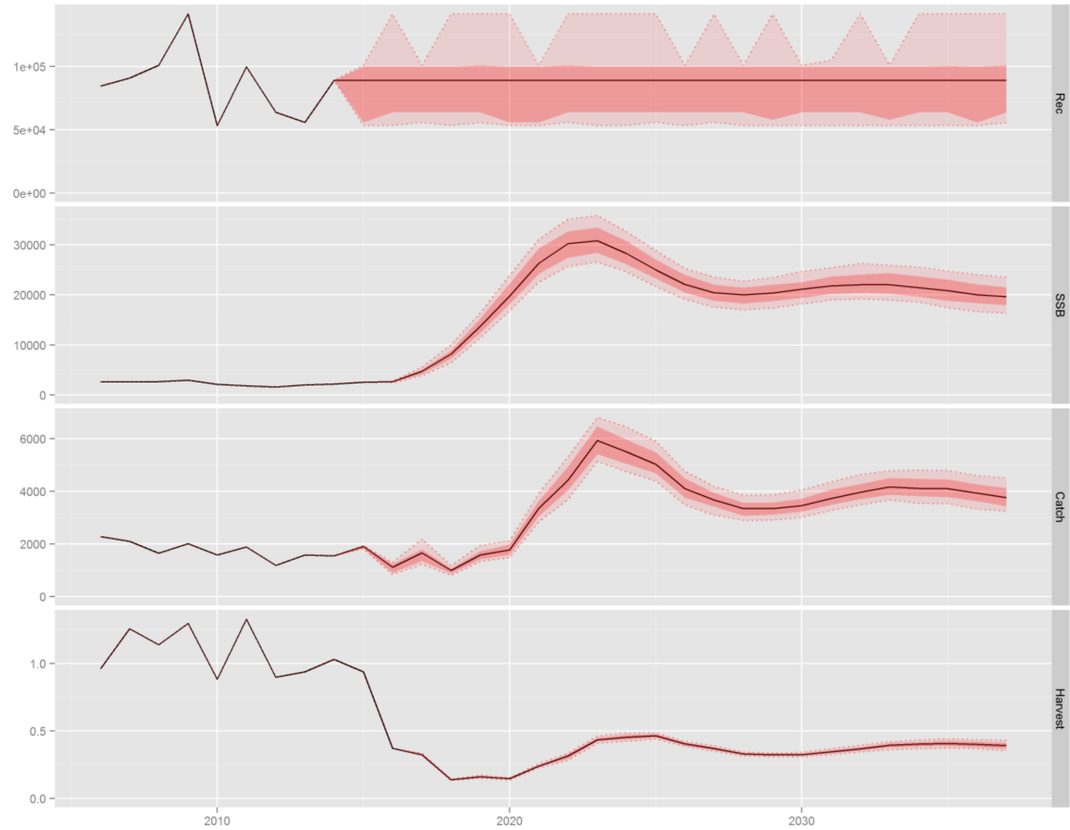


Figure 2.6.3.1. Management Strategy Evaluation for hake based on reaching the F_{upper} of European hake in GSA09.

2.6.4. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

The improvement of the stock conditions in terms of fishing mortality and spawning stock biomass can be achieved through combining effort reduction (both capacity and days at sea) and selectivity improvement. Such mixed strategy is explored in the next section, through the 6 scenarios implemented.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns.

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term;

2) a gradual linear reduction to 2020, that implies the same reduction in each year until the reference point is reached, allowing to evaluate a milder approach over the medium term.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns corresponding to SM40 (square mesh of 40 mm opening).

The selectivity of the gears different from trawlers has been maintained unchanged.

Strategy and timeframe to reach the RP

The four stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on F levels, European hake and Norway lobster are the most heavily exploited stocks in the mix. European hake has been used as the benchmark species because it has been historically assessed as the most overexploited species in GSA 09, as well as in other Mediterranean areas. The percentages of reduction to reach F_{upper} and F_{MSY} combined are reported in the table 2.6.4.1 below.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the FMSY ranges and Fupper as reference point (details in the chapter 2.6.2) of European hake (the more exploited species) = 0.32 (method 1, Tab. 2.6.2.2) and the current level of fishing mortality (method 1) (Fcurr=0.82);

- a combined FMSY using a concept similar to that of Balance Indicators in which the impact of each fleet segment in respect to FMSY is estimated using landing value as weighing factors (STECF 2014a); the reference point FMSY combined = 0.39 (method 2) and the current level of fishing mortality combined (F=0.69).

Table 2.6.4.1 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{UPPER} (method 1) or combined F_{MSY} (method 2).

Stock	Fishing mortality reduction (in %)
European hake (Reference point method 1)	61%
All stocks (Reference point method 2)	44%

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

2.6.5. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

In scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

Scenario 2 and 4 share the same reference point that is the F_{UPPER} of European hake because it is more exploited, but the strategy is different in terms of timeframe and shaping of the reduction along the time.

Also scenario 3 and 5 share the same reference point, that is the F_{MSY} combined among the assessed species using the economic value as weighing factor of the average.

The scenario 6 aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

Tab. 2.6.5.1 – Proposed scenarios.

Case Study	**demersals in GSA 9**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture.

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year estimated in the assessment (see Annex E for details). A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the recruitment of the last year in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

For both methods (according to Fmsy upper of European hake and according to F_{MSY} combined) the identified reduction has been applied for the 10% on vessels until 2017 and for 90% on fishing days until 2018 (linearly) and 2020 (in an adaptive way).The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.6.5.2.

Table 2.6.5.2. Split reduction by vessels and average fishing days per year.

Reduction on VESSELS needed to F_{upper}	Reduction on DAYS needed to F_{upper}

6**	55*

*in case of F_{MSY} combined this percentage is 40%
** in case of F_{MSY} combined this percentage is 4

The shape of the reduction by fishing days and activity according to the different scenario is reported in the figure 2.6.5.2.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

The value of the overall fishing mortality estimated by BEMTOOL in 2013 for hake is 0.82, its F_{MSY} is 0.2 and its F_{MSY} upper is 0.32; according to the state of exploitation, a reduction of 61% is needed. The reduction has been split by fleet segment, according to their relative impact on the fishing mortality of hake (Table 2.6.5.3).

Tab. 2.6.5.3 – Relative impact (percentage of fishing mortality of hake by fleet segment and year) of fishing mortality by fleet segment and year.

Year	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	17.8	15.6	17.9	22.7	20.8	21.1
ITA9_DTS_VL1824	58.8	53.0	44.6	41.4	48.6	53.7
ITA9_DTS_VL2440	0.0	4.0	2.8	3.3	2.6	5.4
ITA9_PGP_VL0012	13.5	12.3	14.9	13.7	10.1	13.7
ITA9_PGP_VL1218	9.9	15.0	19.7	18.8	17.9	6.2

The reduction has been applied to each fleet segment, considering its relative portion of $F_{current}$ to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of fishing mortality combined, the needed reduction is 44%. In case of F_{upper} a reduction of 61% is necessary.

The value of the overall combined fishing mortality is 0.7, while the combined F_{MSY} is 0.39. A reduction of 44% on the overall fishing mortality would be needed. The reductions have been applied according to the proportions of combined fishing mortality by fleet segment (Table 2.6.5.4).

The fleet segments impacting less than 3% on the overall fishing mortality in exam were excluded from the reduction plan. These fleets were different according to the followed approach.

Table 2.6.5.4 Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	**% F current European hake**	**Reduction applied%**	**% F current combined**	**Reduction applied %**
1	ITA9_DTS_VL1218	21.1	61	19.7	44
2	ITA9_DTS_VL1824	53.7		32.8	
3	ITA9_DTS_VL2440	5.4		3.2	
4	ITA9_PGP_VL0012	13.7		10.2	
	ITA9_PGP_VL1218	6.2		3.5	

A further scenario implemented the scenario 6 (fig. 2.6.5.1) aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

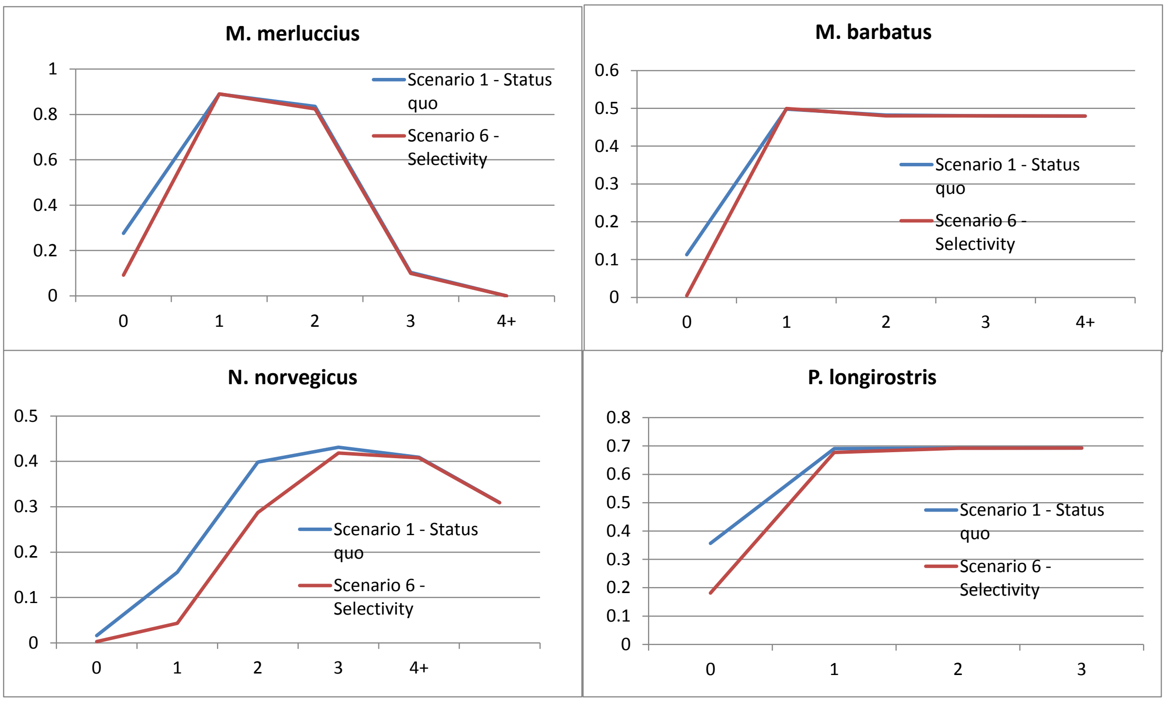
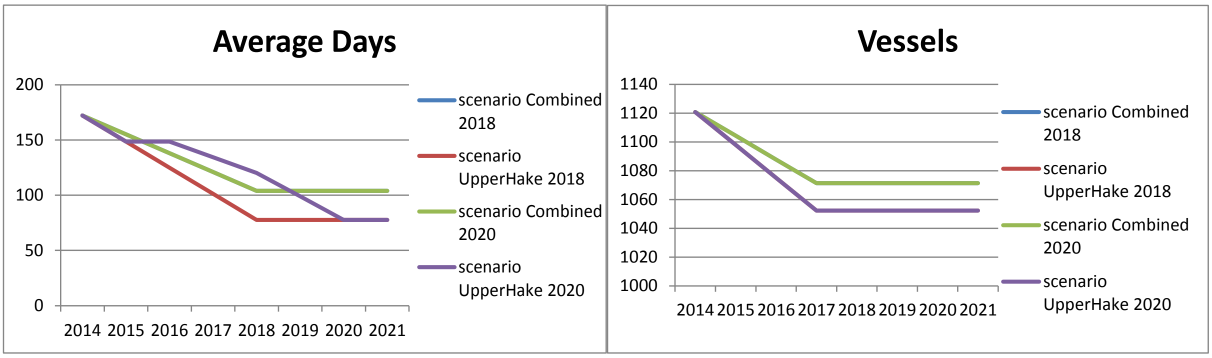


Figure 2.6.5.1 - Comparison between F by age (only trawlers) in the status quo and in selectivity scenario by species.



Error! Reference source not found. Figure 2.6.5.2 - Shape of the reduction in terms of annual average ishing days and annual vessels according to the different scenarios.

Further details on the shaping of reduction by fleet segment, year and scenario are reported in the Annex E5.3.

2.6.6. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1).

The biological and pressure input for BEMTOOL model are derived from the last endorsed stock assements (STECF EWG 14-09, EWG 14-19, EWG 15-11) and the socio-economic data and parameters are from EU DCF.

A Management Strategy Evaluation (MSE) was performed in line with EWG-15-11 hake (stock more overexploited) using $F_{0.1}$ as proxy of Fmsy.

2.6.7. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA09

All the inputs for modelling are fully reported in the Annex E.

2.6.8 EVALUATION OF THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.6.8.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

Figure **2.6.8.1**2.6.8.1 shows the SSB of the four stocks for status quo scenario. The SSB of deep-water pink shrimp remains constant for the whole period of forecast. The SSB of Norway lobster shows a slightly decreasing pattern. The SSB of hake remains stable until 2017, then shows a decreasing trend. As concerns red mullet, the SSB shows an increasing trend reaching a plateau by the end of the period investigated by the forecasts.

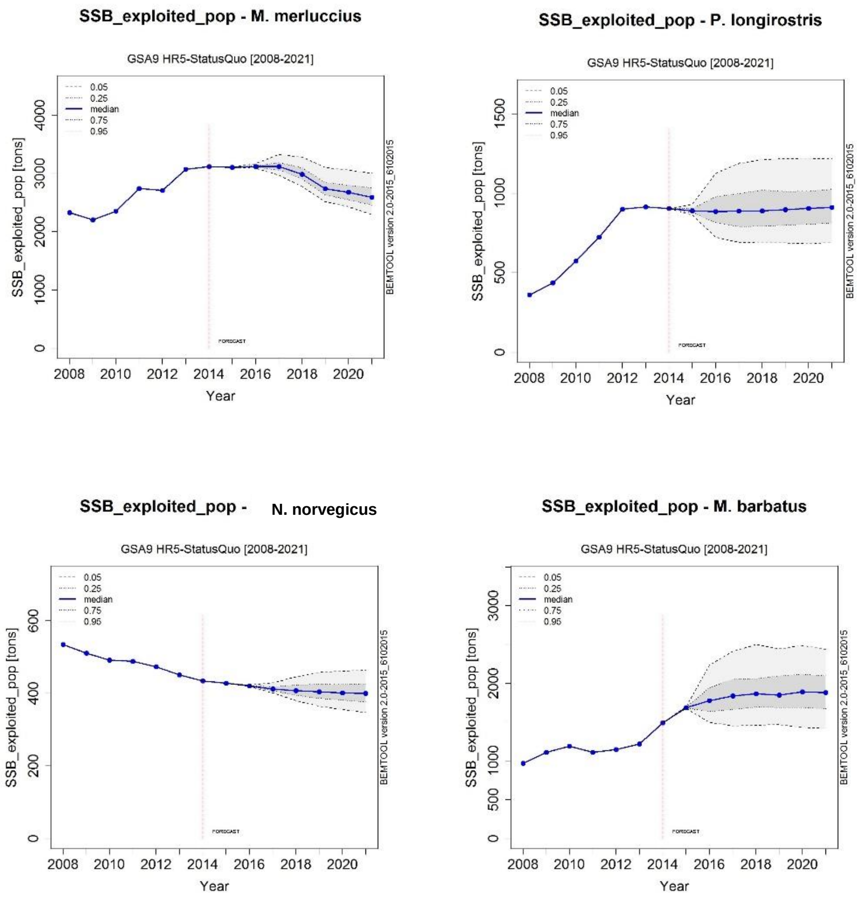


Figure 2.6.8.1. SSB for hake, deep-water pink shrimp, Norway lobster and red mullet in the status quo scenario with confidence intervals.

The landings of Norway lobster show a slightly decreasing trend in all the fleet segments. Landings and discards of hake and deep water pink shrimp remain stable, while landings of red mullet show a slightly increasing trend, except for the segment PGP_VL1218 were they remain equal to zero (Figure 2.6.8.2-2.6.8.5).

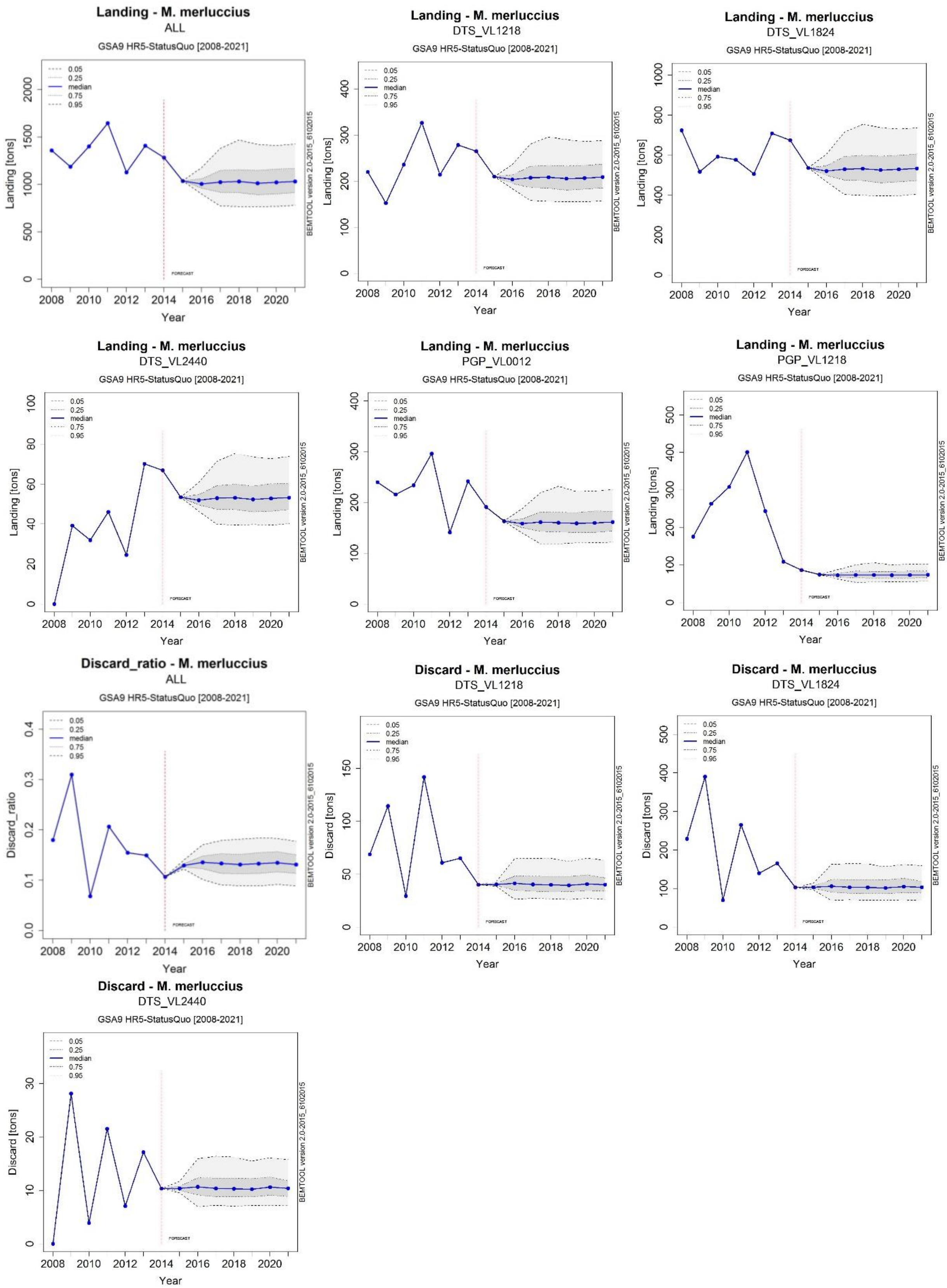


Figure 2.6.8.2. Landings and discards for hake in the status quo scenario with confidence intervals.

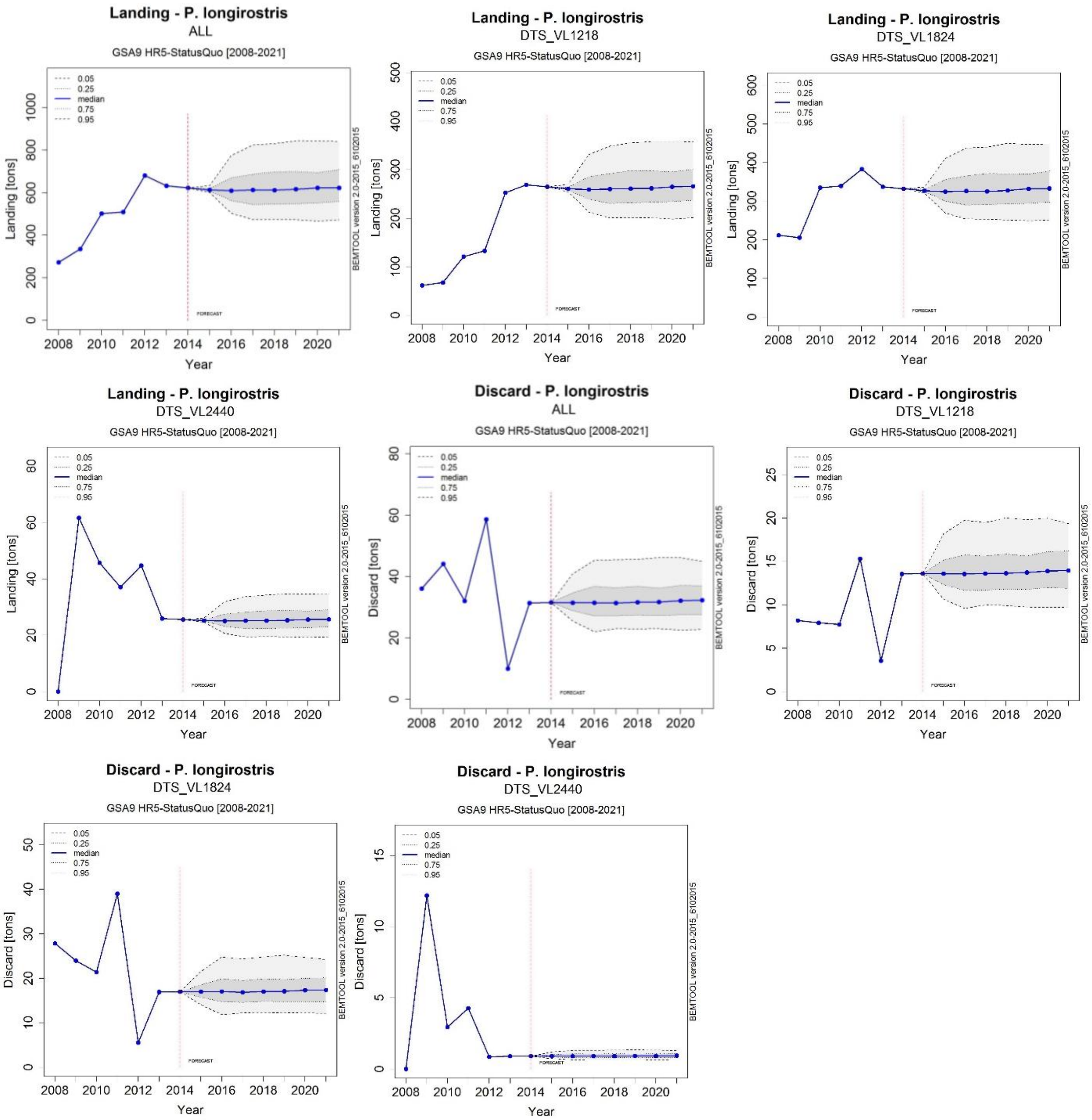


Figure 2.6.8.3. Landings and discards for deep water pink shrimp in the status quo scenario with confidence intervals.

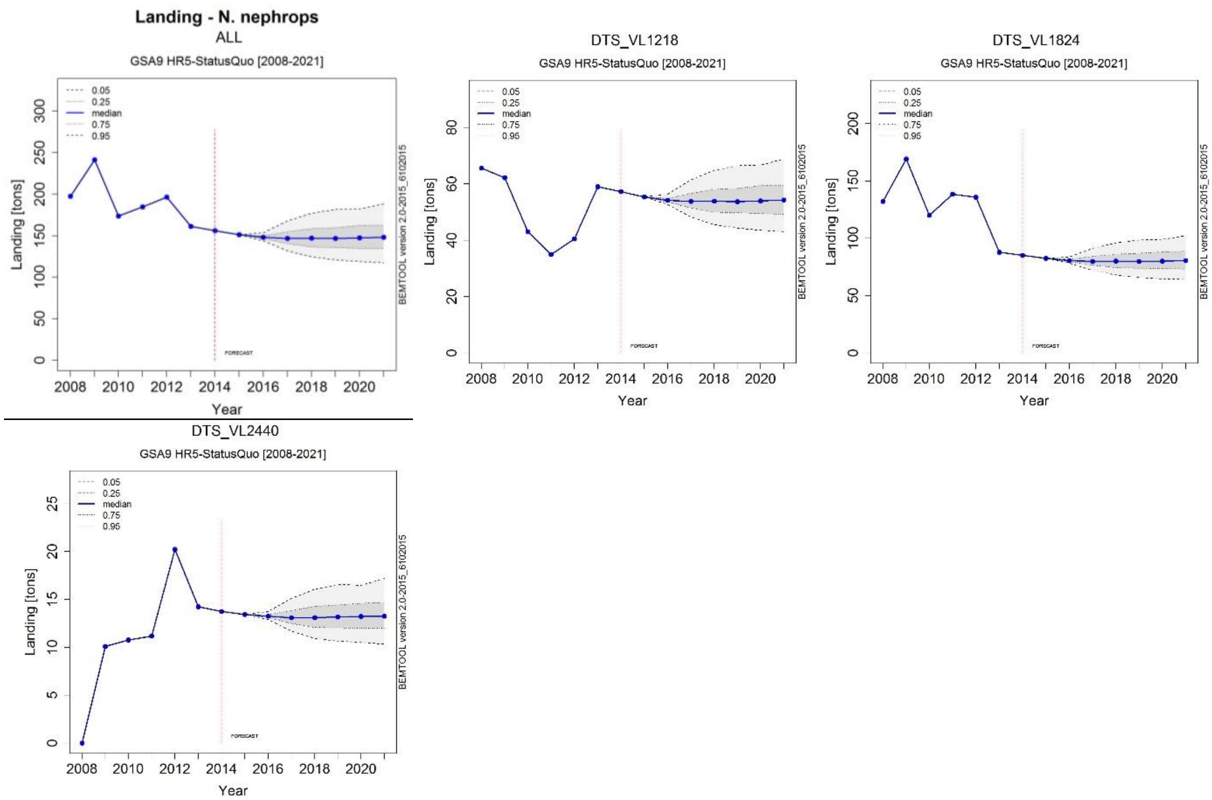


Figure 2.6.8.4. Landings for Norway lobster in the status quo scenario with confidence intervals.

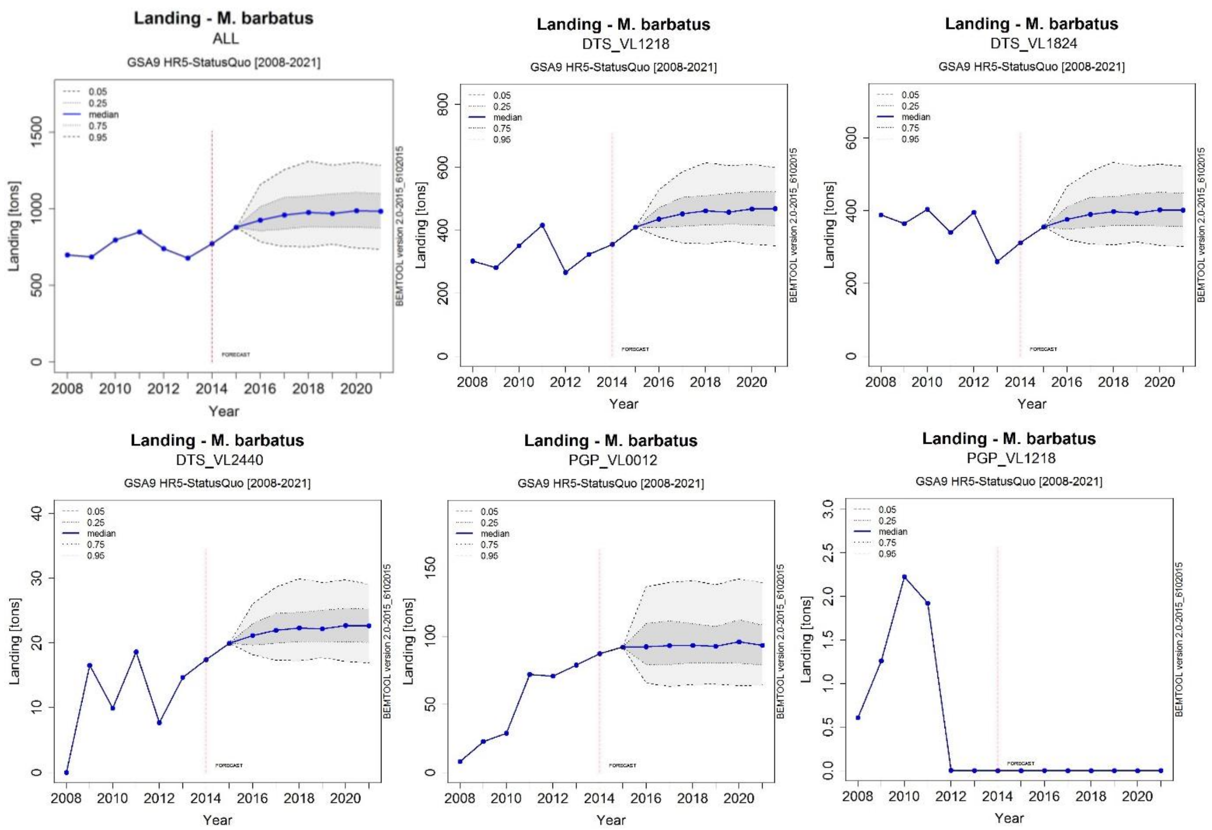


Figure 2.6.8.5. Landings for red mullet in the status quo scenario with confidence intervals.

2.6.8.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 11 thousand tons of total production generating almost 90 million euro, an increase by 16% in quantity and a decrease by 1% in value compared to 2012. The most important fleet segment is the small scale fleet PGP_VL0012, accounting for more than a third of total revenues. Other relevant fleet segments are the demersal trawlers VL1824, which account for 31% of total revenues and the demersal trawlers VL1218, which account for 25% of total revenues. In terms of total landings, the demersal trawlers VL1824 are the most productive fleet segment with 40% of the total production.

Total revenues of demersal fleets operating in GSA 9 show a reduction by 10% from 2008 to 2013. As in the same period, total landings show an increase by 4%, the lower revenues are mainly due to a decrease in landings prices. The reduction in revenues is observed in all fleet segments with the exception of the demersal trawlers VL1218, which show an increase by just 2%.

In the forecast period, from 2013 to 2021, total landings for the overall fishing sector in the area are expected to decrease by 3% in weight and 6% in value. Among the main fleet segments, the small scale vessels lower than 12m show the strongest reductions (20% in weight and 16% in value), while landings of the demersal trawlers VL1218 are expected to increase by 16% in weight and 6% in value. Landings in weight and value for the demersal trawlers VL1824 would be quite stable in the forecast period (Figure 2.6.8.6)**.**

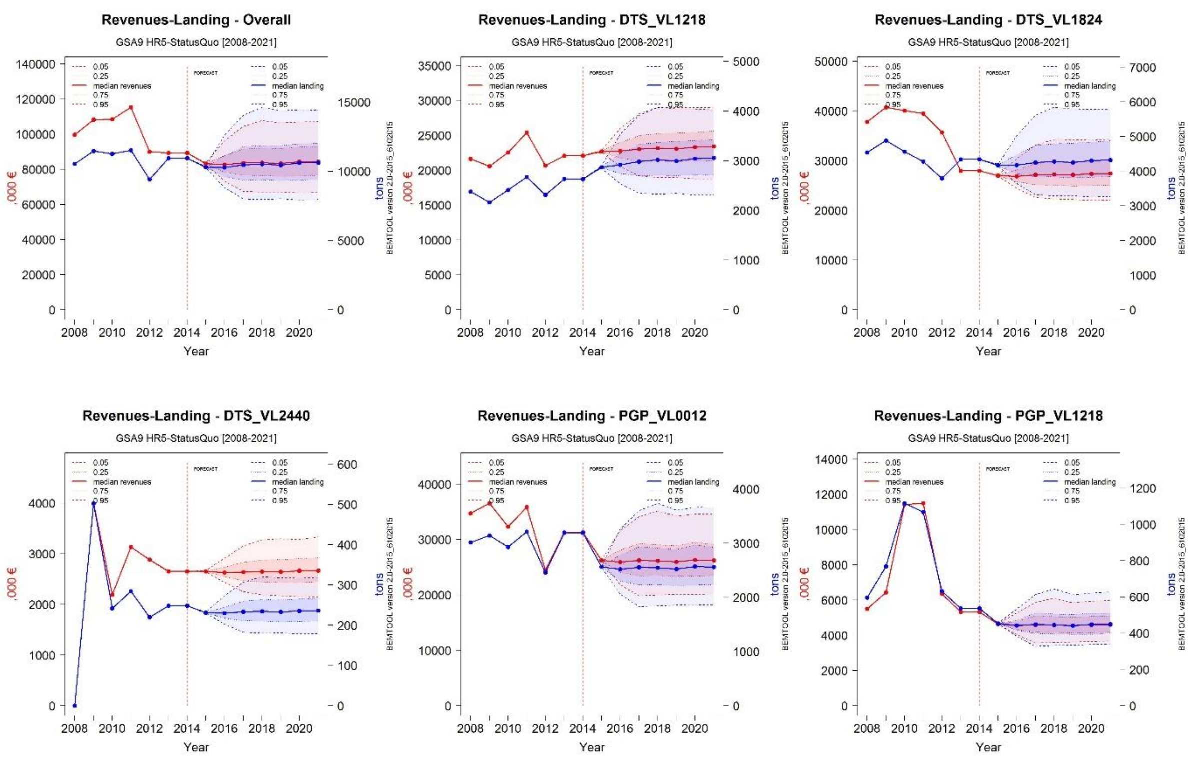


Figure 2.6.8.6. Landings weight and value by fleet segment and quantile.

In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is negative for the demersal trawlers VL1824 and VL2440, and positive for the other fleet segments. The whole demersal fleet operating in GSA 9 show positive values for net profit in the period 2008-2013 with a significant reduction in 2012 and 2013. The worst performance is registered for the demersal trawlers VL2440 with negative values from 2010 to 2013. In 2013, net profit for the whole demersal fleet in the area shows a strong reduction by around 90% compared with 2012.

In the forecast period, net profit for the overall fishing sector is expected to become negative. Negative values are expected for the small scale fleet under 12m as well as the demersal trawlers VL1824 and

VL2440. Even though PGP_VL1218 is expected to register a positive profit in 2021, this is around a half of the value registered in 2013. All fleet segments are expected to have a negative performance under the Status Quo scenario with the exception of the demersal trawlers VL1218, which would see an increase in net profits by around 40% (Figure 2.6.8.7).

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is lower than 1 for the demersal trawlers VL1824 and VL2440, and greater than 1 for the other fleet segments. This indicator shows a deterioration when compared with 2012, when the demersal trawlers VL1824 registered a value greater than 1.

The ratio between current and break-even revenues (CR/BER) in the forecast period shows a deterioration for all fleet segments with the exception of the demersal trawlers VL1218. In addition to the demersal trawlers VL1824 and VL2440, values lower than 1 are expected also for the small scale fleet under 12m (Figure 2.6.8.7).

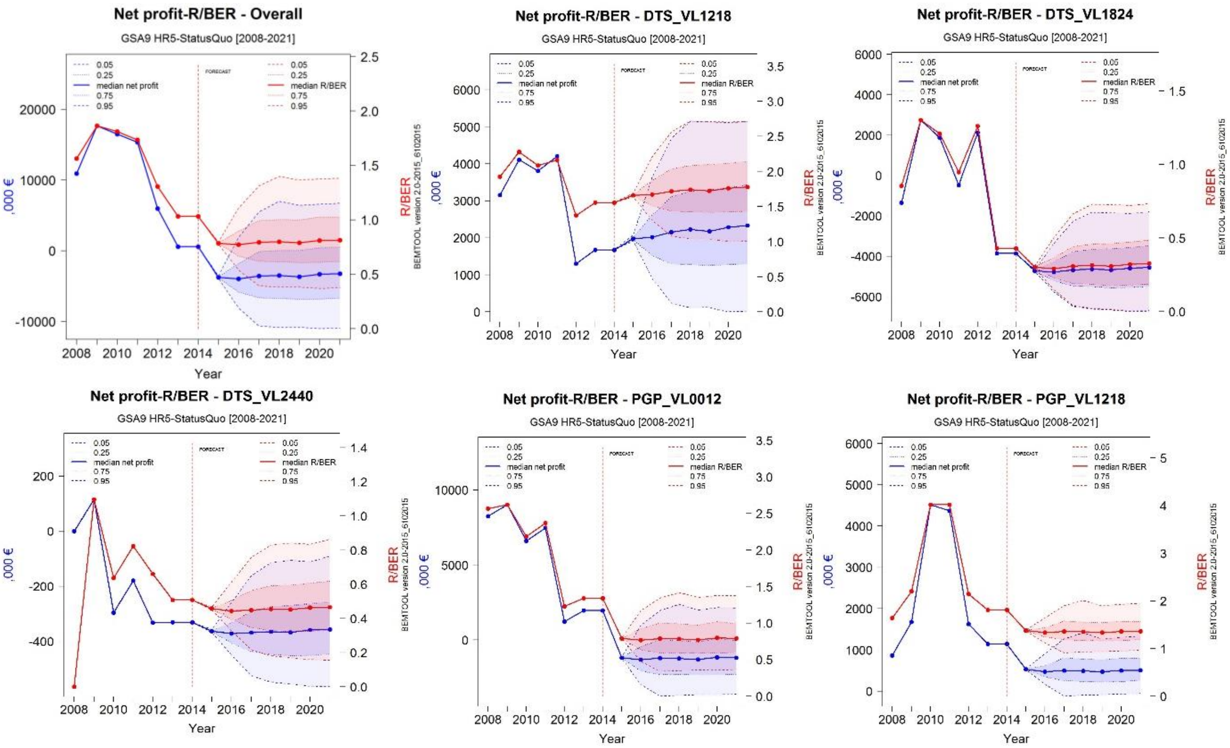


Figure 2.6.8.7. Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment and quantile.

2.6.9 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

According to the state of exploitation of the four demersal stocks in the GSA 9 case study, 5 forecast scenarios alternative to status quo have been performed to evaluate the consequences of several management strategies in terms of costs and benefits for the renewal of stocks, fishery sustainability and productive and economic performances of different fleet segments.

2.6.9.1 FORECAST OF BIOLOGICAL AND PRESSURE INDICATORS

The main results of the projections carried out in terms of SSB of the four stocks are shown in the graphs in Figure 2.6.9.1.1. As expected, SSB of all the four species shows an increasing trend in all the scenarios alternative to status quo. The best performance for all the species was in Scenario 2, followed by

Scenario 4; these results seem consistent with the greater benefit that generally the reduction in fishing mortality produce on the indicators if applied in a short timeframe. Moreover, Scenarios 2 and 4 allow to obtain immediately the highest benefit in SSB, respect to the other scenarios that produce an increase in SSB less marked from the first years of the application of the management measures (Figure 2.6.9.1.1).

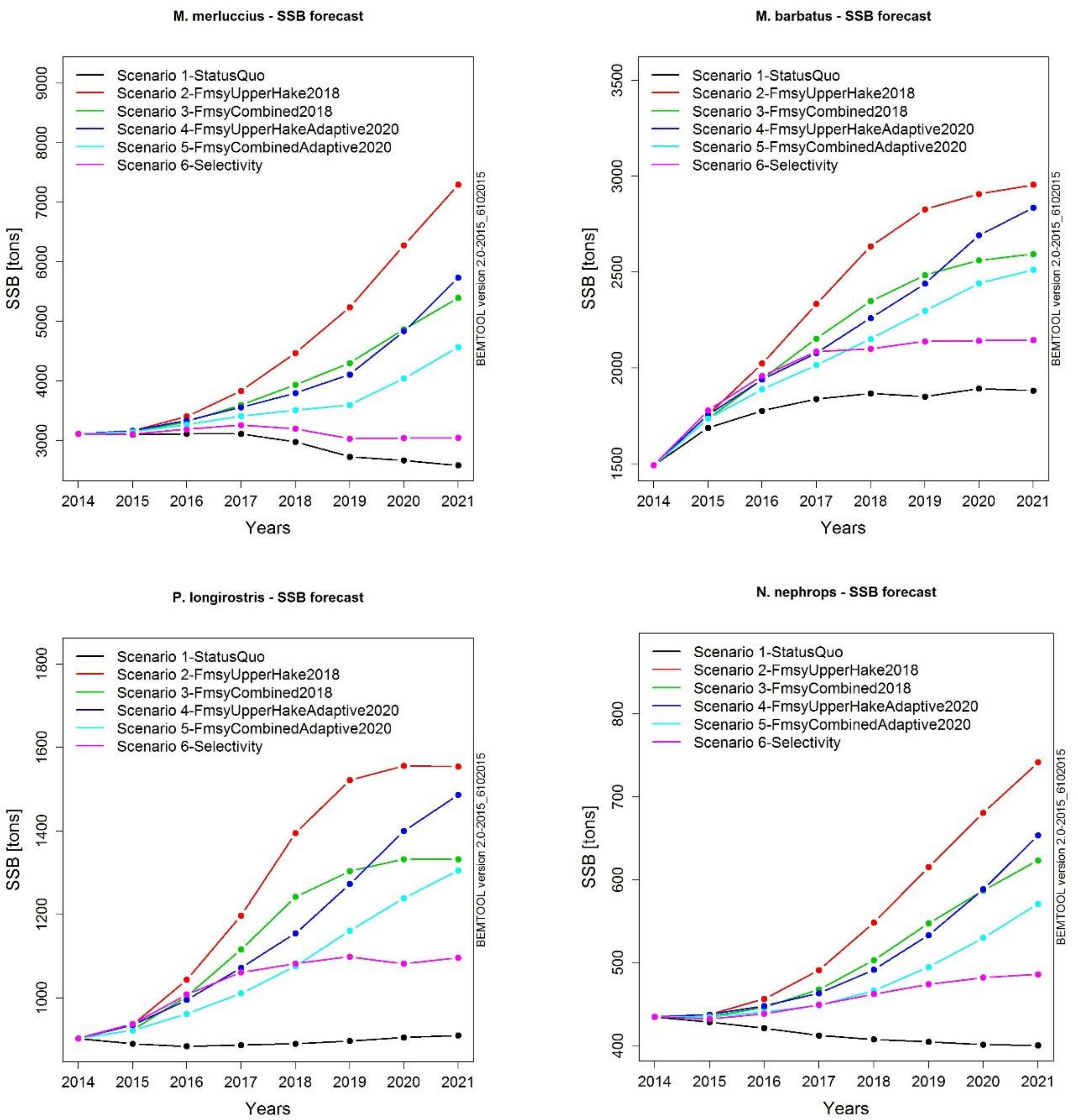
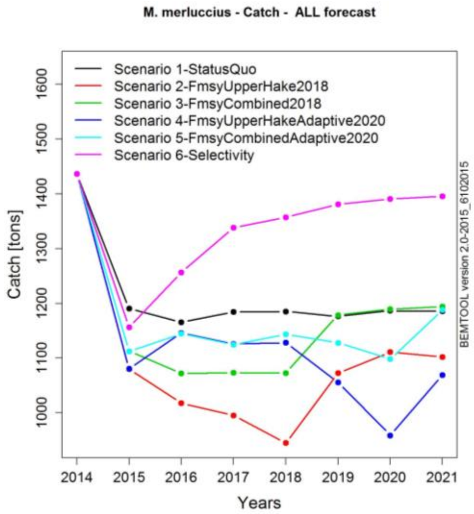
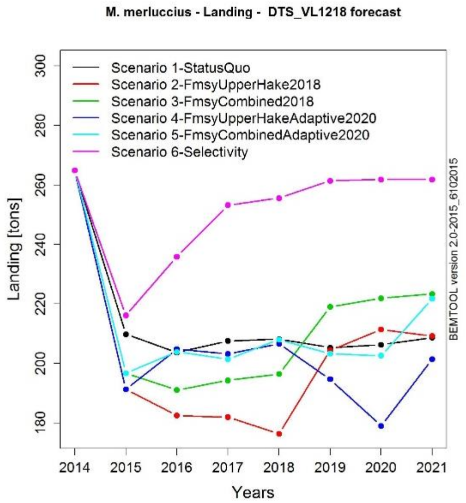


Figure 2.6.9.1.1 SSB of hake, red mullet, deep-water pink shrimp, and Norway lobster in GSA 9: comparison among the management scenarios.

As regards landings, hake shows an increase under Scenario 6 for PGP_VL0012, PGP_VL1218, and DTS_VL2440. For red mullet, Status Quo and Scenario 6 show the best performance in terms of landings. The same results as for red mullet were obtained for Norway lobster and deep-water pink shrimp (Fig. 2.6.9.1.2).

In terms of discards, Scenarios 2 and 4 are those showing the sharpest reduction of discards in hake, while Scenario 6 shows the best results in terms of reduction of discards of deep water pink shrimp (Fig. 2.6.9.1.3).


M. merluccius - Catch - ALL forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Catch [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Landing - DTS_VL1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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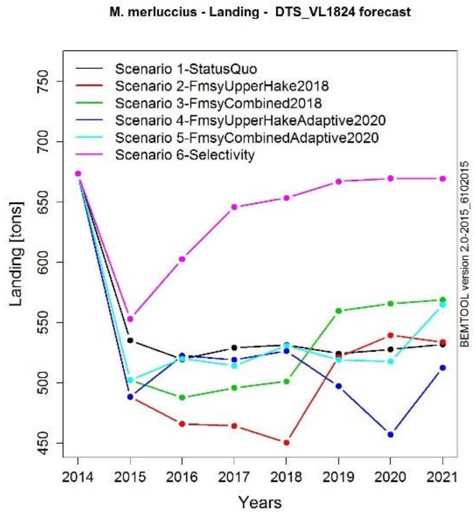
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Landing - DTS_VL1824 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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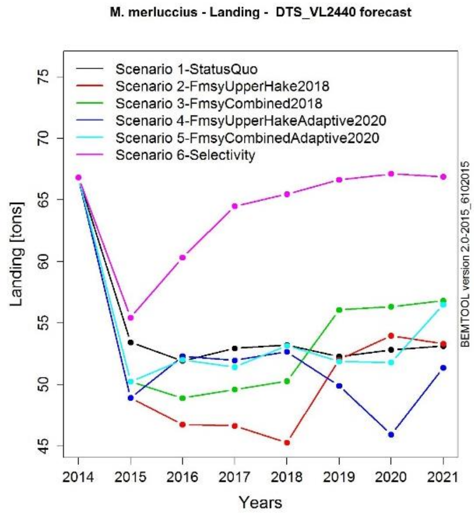
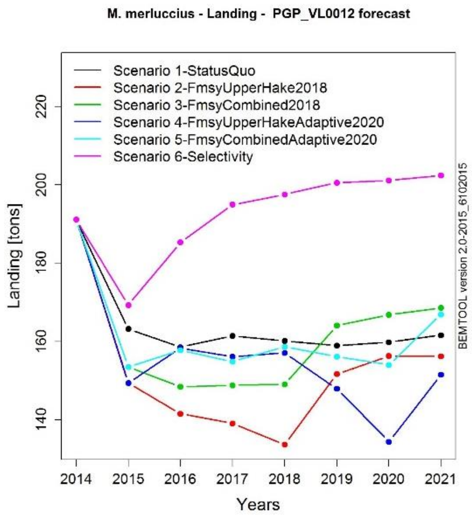
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Landing - DTS_VL2440 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Landing - PGP_VL0012 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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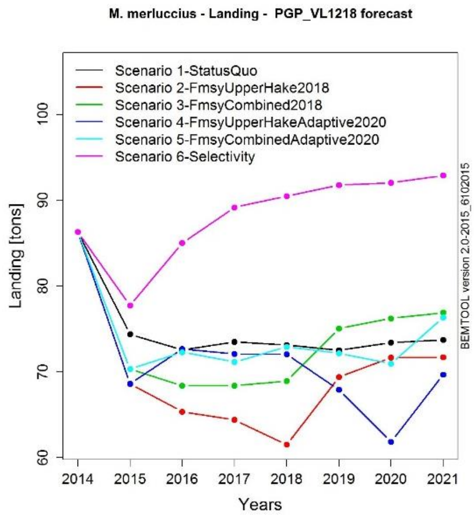
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Landing - PGP_VL1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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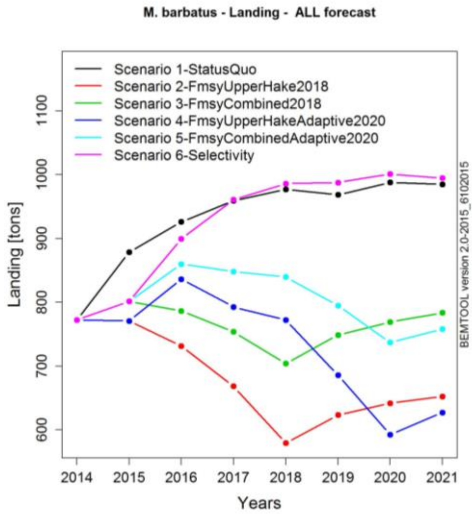
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - ALL forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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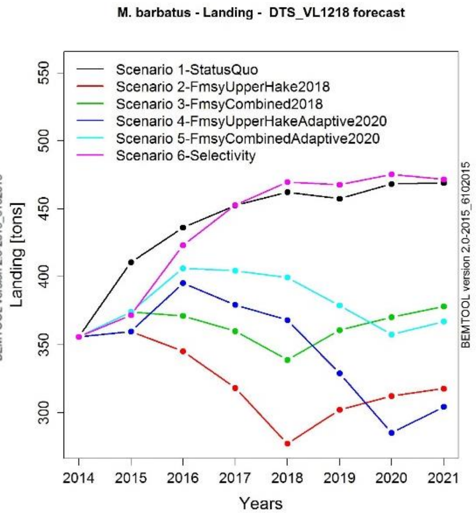
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - DTS_VL1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
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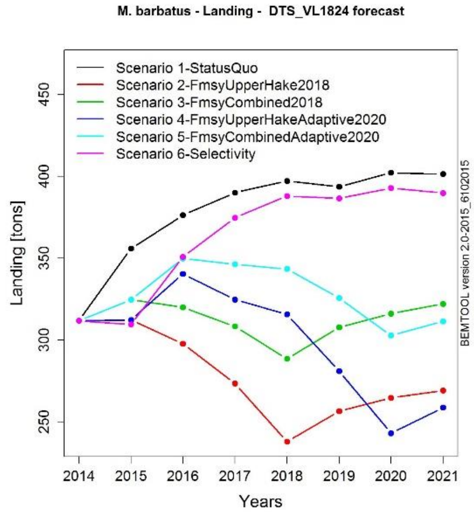
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - DTS_VL1824 forecast
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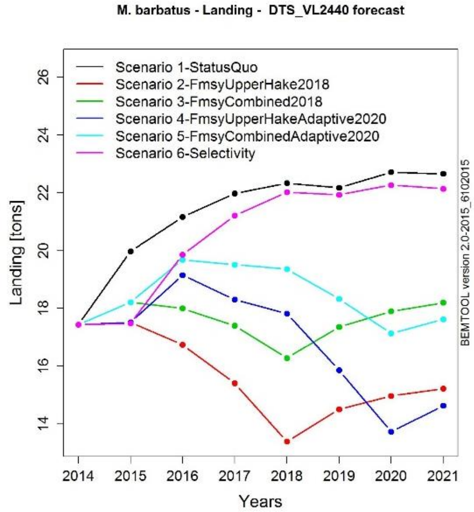
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - DTS_VL2440 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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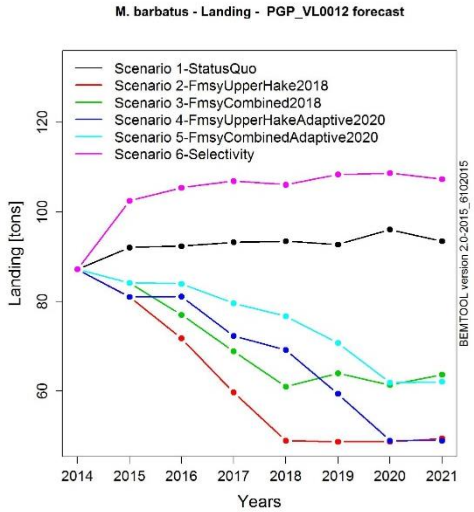
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - PGP_VL0012 forecast
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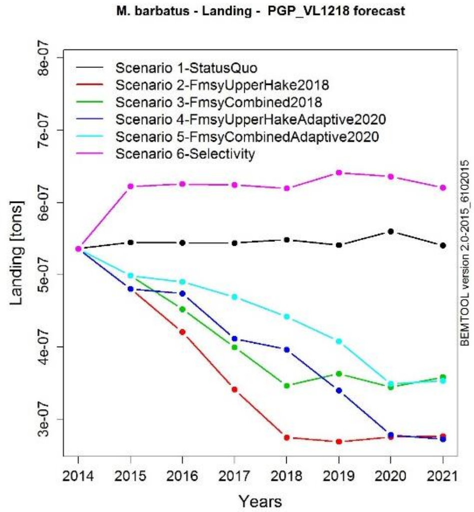
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. barbatus - Landing - PGP_VL1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
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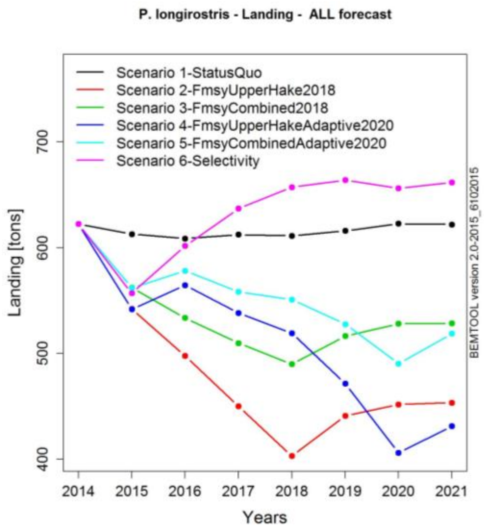
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


P. longirostris - Landing - ALL forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
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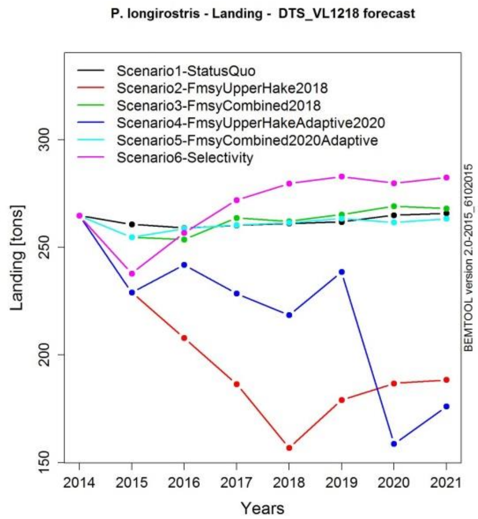
P. longirostris - Landing - DTS_VL1218 forecast
Scenario1-StatusQuo
Scenario2-FmsyUpperHake2018
Scenario3-FmsyCombined2018
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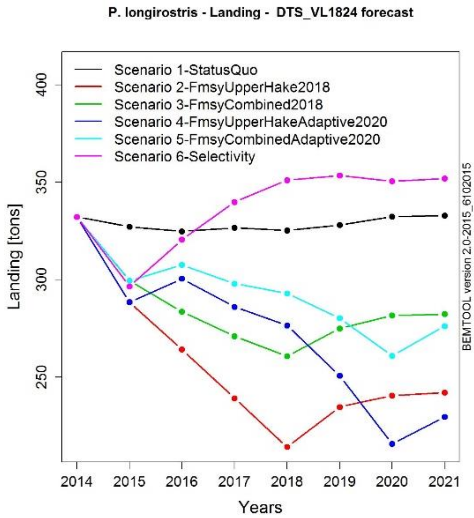
Scenario5-FmsyCombined2020Adaptive
Scenario6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


P. longirostris - Landing - DTS_VL1824 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
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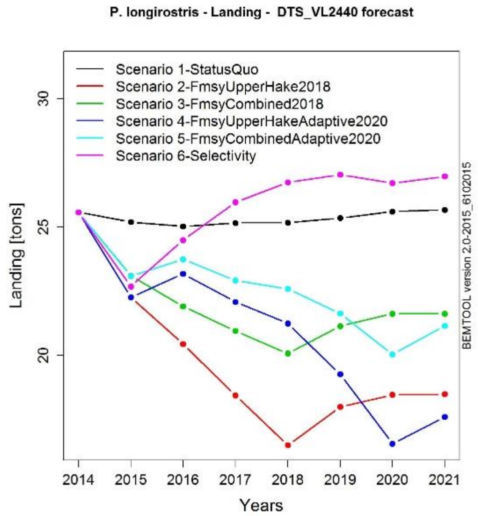
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


P. longirostris - Landing - DTS_VL2440 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
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Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015

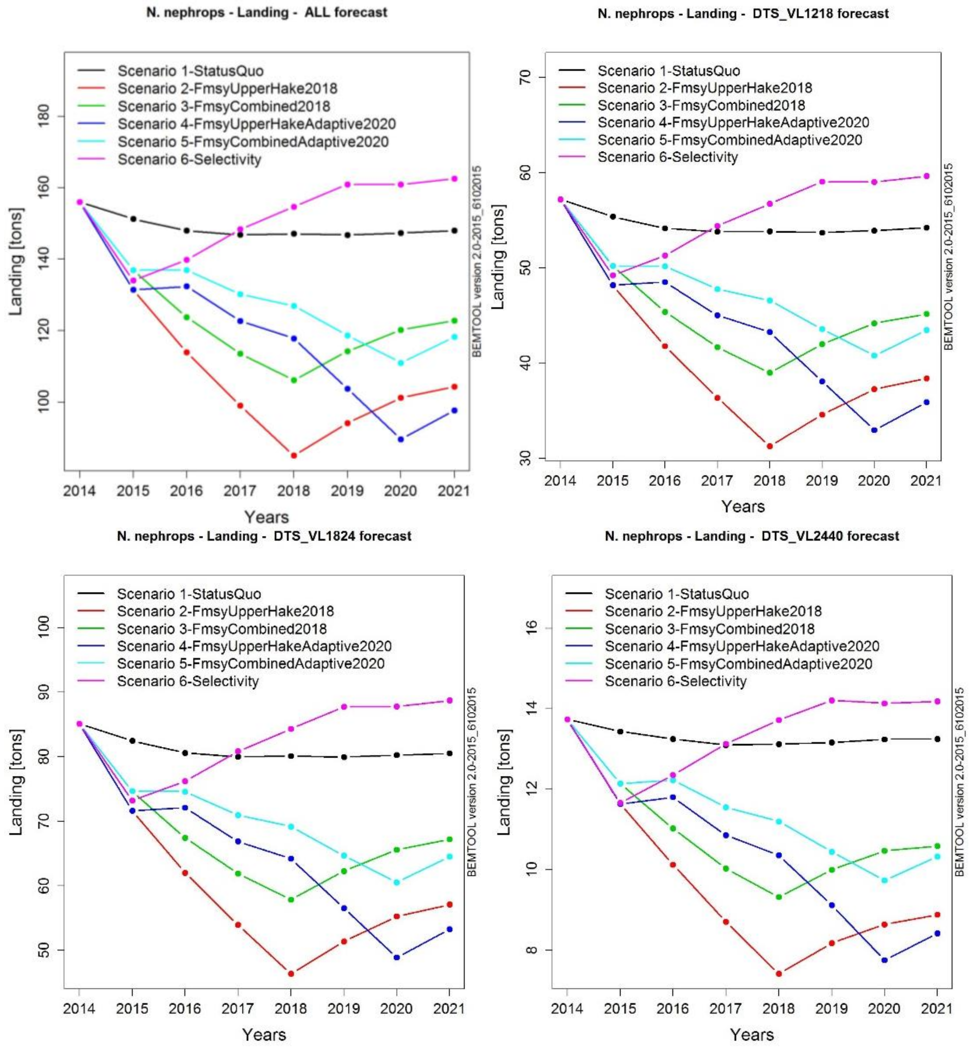
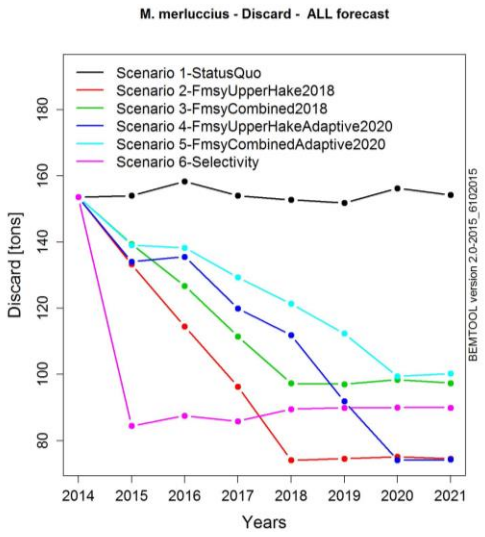
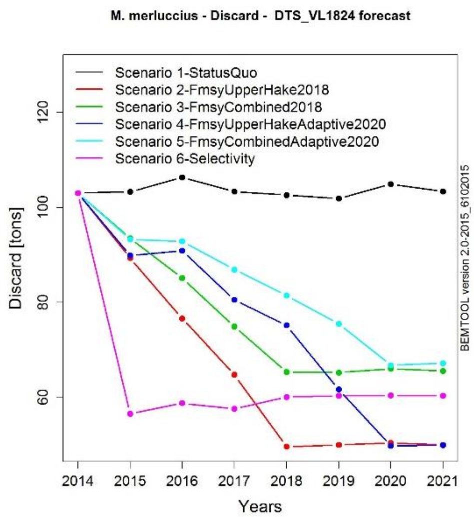


Figure 2.6.9.1.2. Landings of hake, red mullet, deep-water pink shrimp, and Norway lobster in GSA 9 overall and by fleet segment: comparison among the management scenarios.


M. merluccius - Discard - ALL forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Discard - DTS_VL1824 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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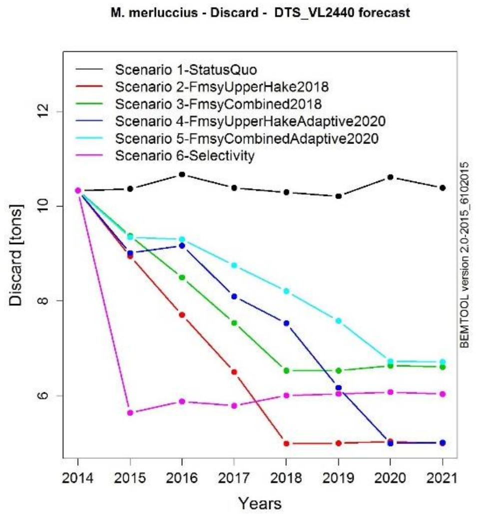
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Discard - DTS_VL2440 forecast
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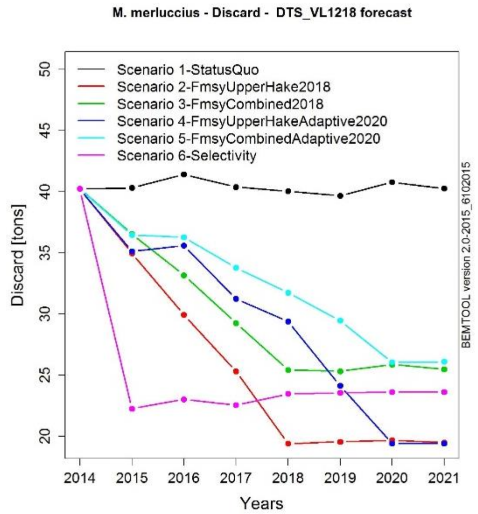
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. merluccius - Discard - DTS_VL1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015

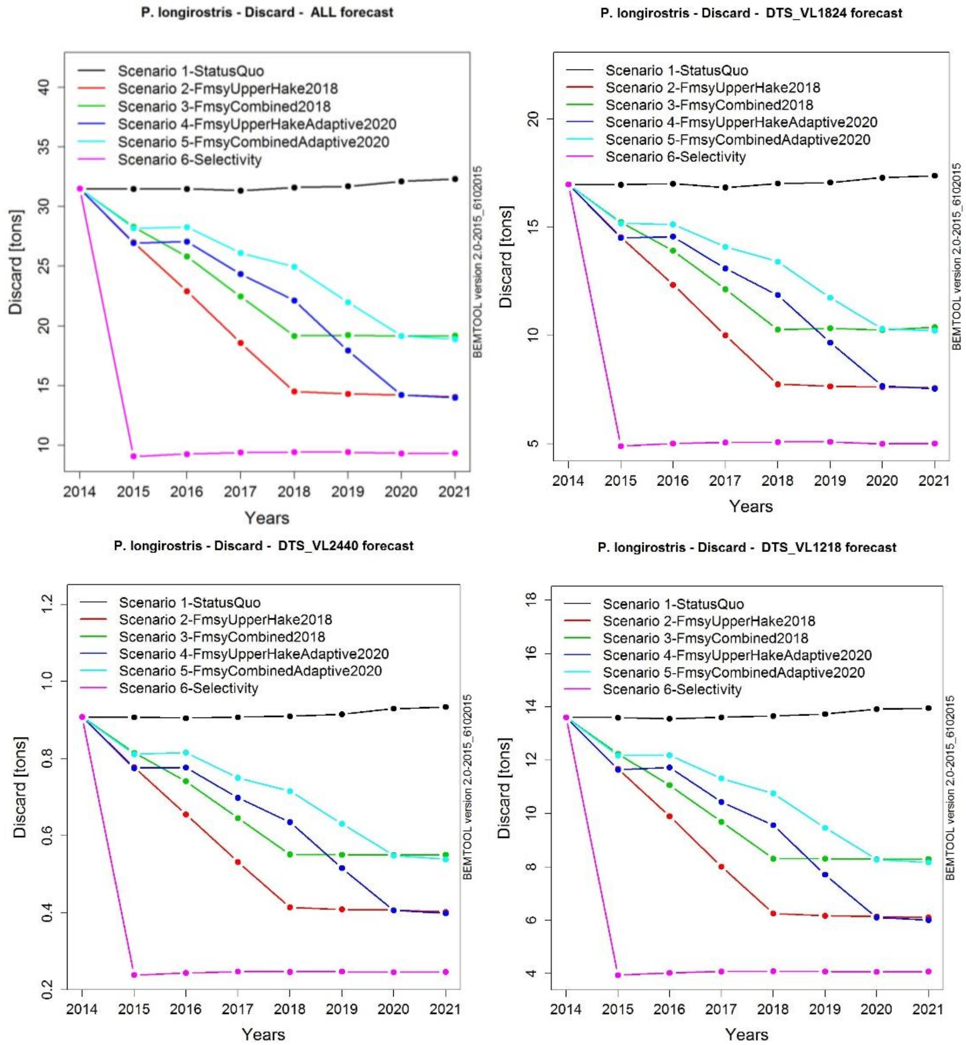


Figure 2.6.9.1.3. Discards of hake and deep-water pink shrimp in GSA 9 overall and by fleet segment: comparison among the 7 management scenarios.

2.6.9.2 FORECAST OF SOCIO-ECONOMIC INDICATORS

Figure 2.6.9.2.1 shows the expected impacts on total revenues deriving from each of the five alternative scenarios. The simulation outcomes are compared with the status quo scenario.

Compared with the Status Quo, in 2021 total revenues for the overall fishing fleet is expected to decrease under Scenarios 2 and 4, increase under Scenario 6 and decrease less under Scenarios 3 and 5. Scenario 4 shows the worst impact on total revenues with a reduction by 20% compared with Status Quo, while Scenario 6 would produce the best performance with an increase by almost 12% compared with the Status Quo outcome in 2021.

Negative impacts on revenues are expected for the demersal trawlers VL1824 under all the alternative scenarios with the exception of Scenario 6. Under Scenarios 2 and 4, a worse performance than Status Quo is expected also for the demersal trawlers VL1218. In case of PGP VL1218, scenario 4 and 5 are more similar to the status quo.

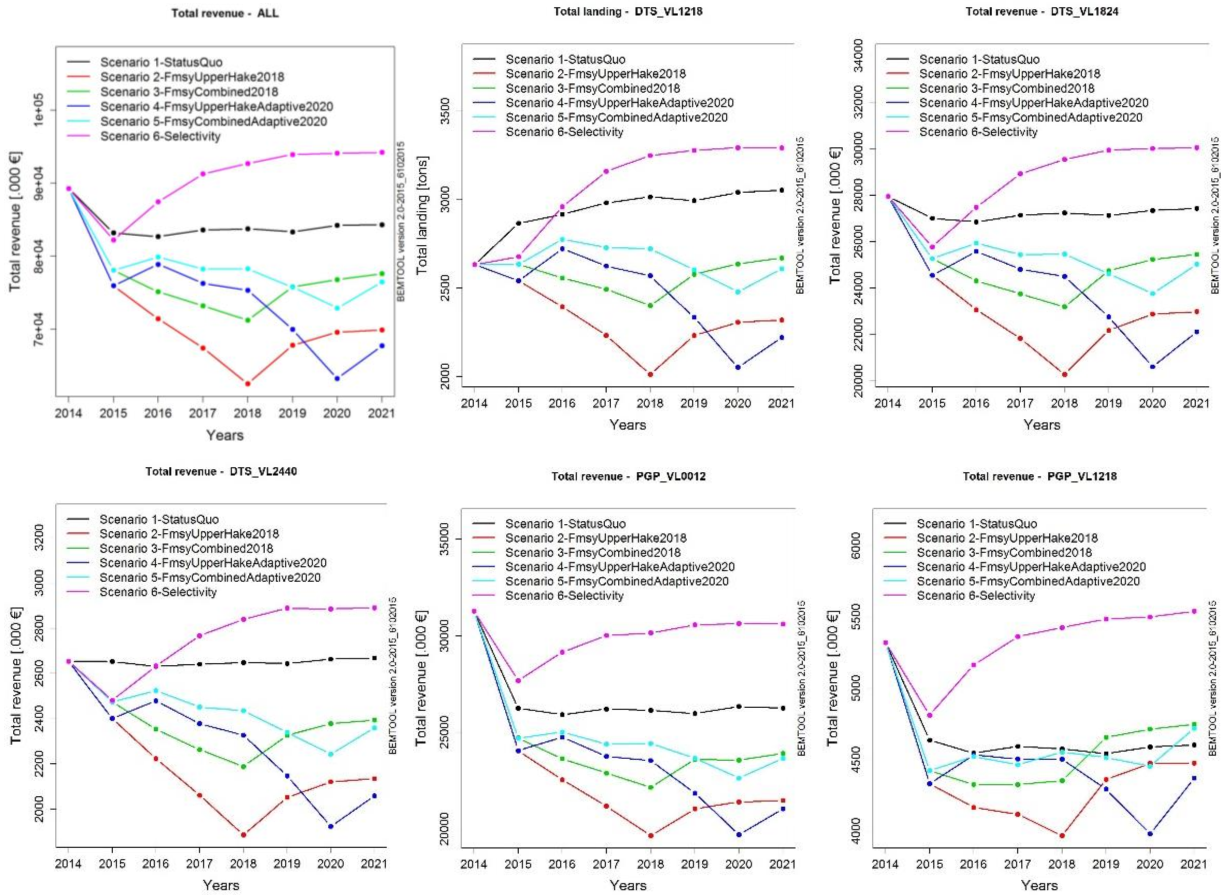


Figure 2.6.9.2.1. Revenues overall, by fleet segment and scenario.

In 2021, the CR/BER ratio under the Status Quo scenario shows values lower than 1 for three fleet segments - the small scale fleet under 12m, the demersal trawlers VL1824 and the demersal trawlers VL2440 - and for the whole demersal fishing sector in the area (Figure 2.6.9.2.2). All alternative scenarios would produce benefits for this indicator. The demersal fishing sector, as a whole, would register values greater than 1, as well as the small scale fleet under 12m, in all the alternative scenarios. However, the best performance in terms of CR/BER is expected under Scenarios 2 and 3 for the trawlers, while Scenario 6 is giving the best results for PGP_VL0012 and PGP_VL1218.

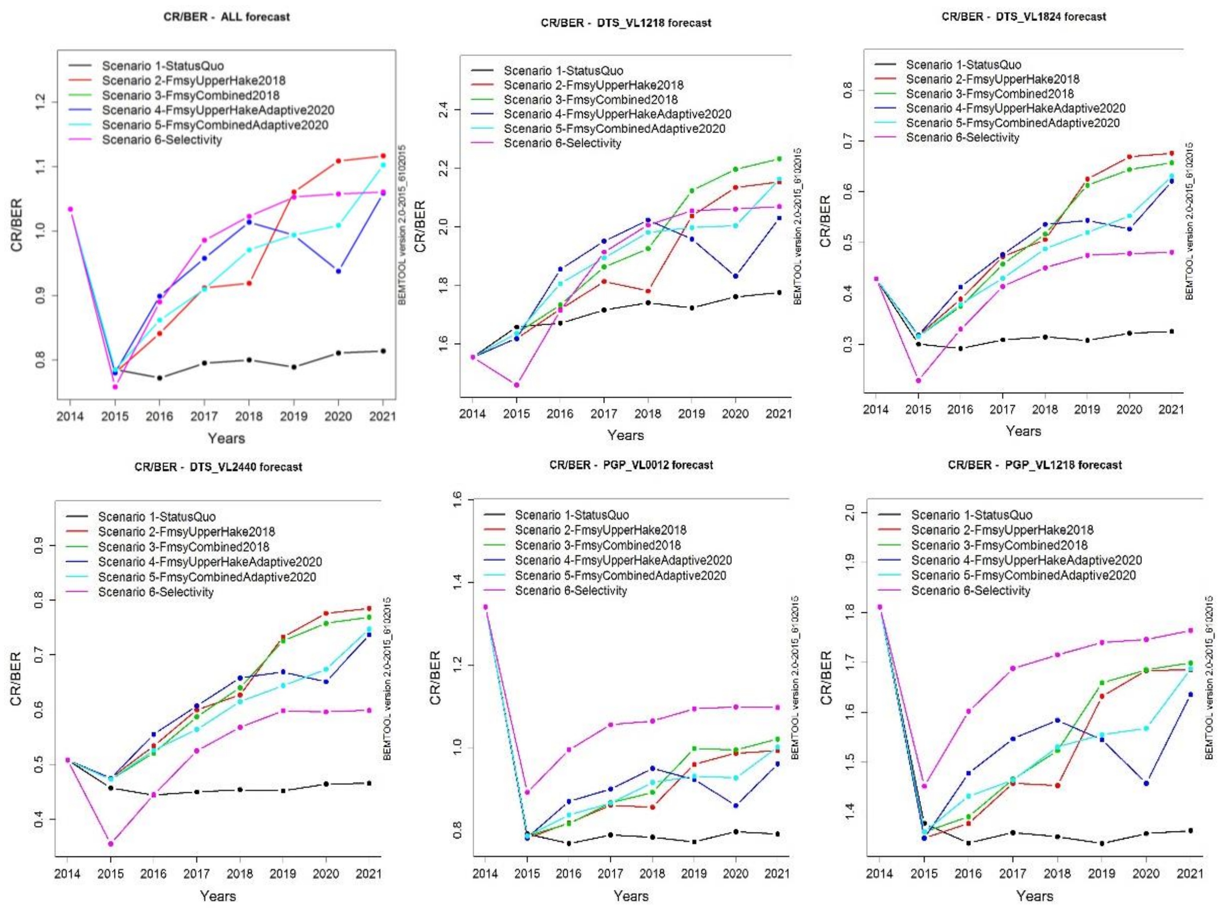
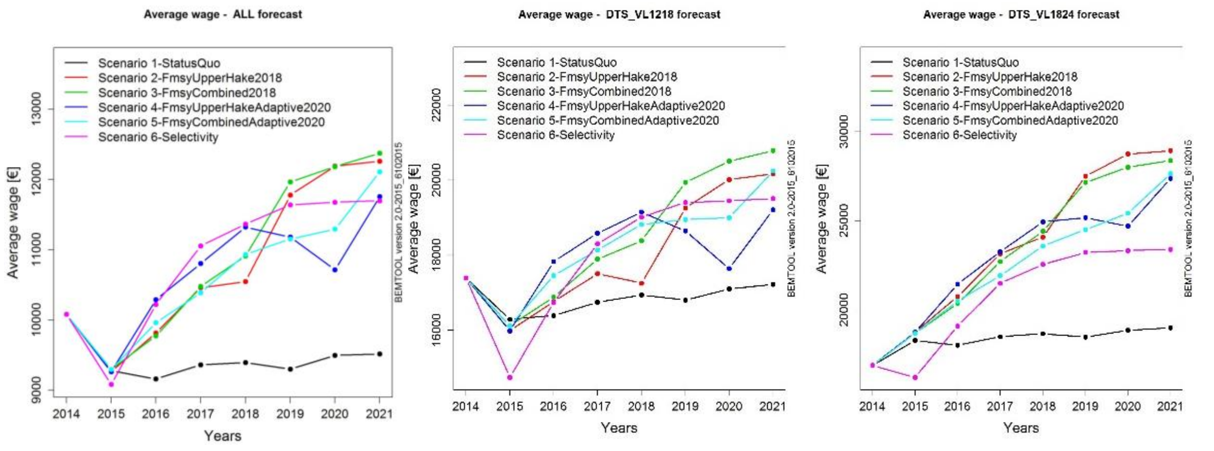


Figure 2.6.9.2.2. Current Revenue to the Break-Even Revenue ratio (CR/BER) overall, by fleet segment and scenario.

Figure 2.6.9.2.3 shows the effects simulated by the different scenarios on average salary per man employed. All alternative scenarios are expected to have a better impact on the average salary for the overall fishing fleet rather than the Status Quo scenario. Scenarios 2 and 3 are the best scenarios with an average salary 29% and 30% respectively higher than that expected from the Status Quo in 2021. Scenario 6 is giving the best results for PGP_VL0012 and PGP_VL1218.



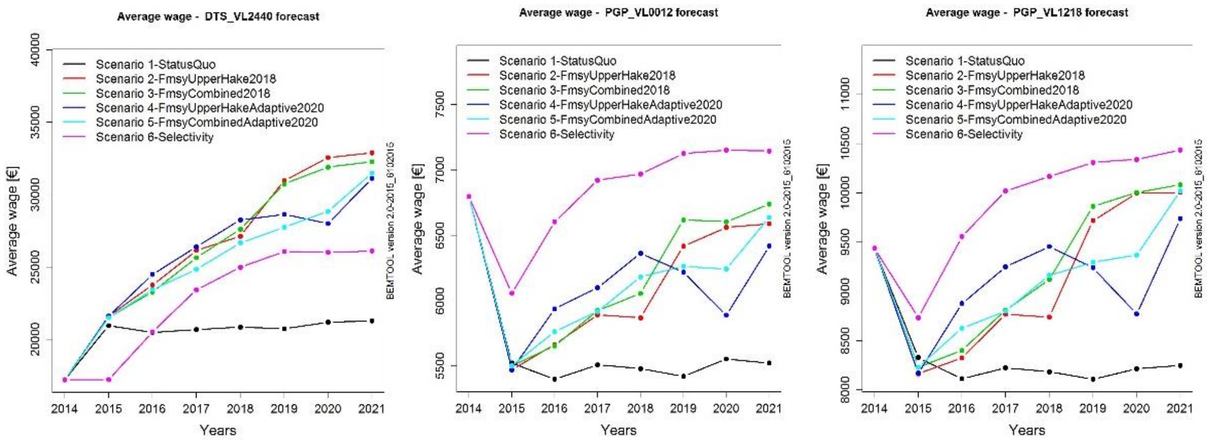


Figure 2.6.9.2.3. Average salary overall, by fleet segment and scenario.

2.6.10 REPORT THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

Table 2.6.10.1 summarizes the performances of the management scenarios in terms of SSB and overall catches of the four stocks, salary, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

According to the traffic light approach reported in Table 2.6.10.1 and the radar plot in Figure 2.6.10.1, all the performed scenarios allow to obtain a benefit on the SSB for the 4 stocks compared to the status quo, although the best performance is shown by Scenario 2 and 4.

Under all the scenarios, catches of all stocks showed a decreasing pattern, with the only exception of Scenario 6, which produced a slight increase in catches for hake and Norway lobster. However, Scenario 6 was not improving the SSB of the four stocks as Scenarios 2 and 4. Catches of European hake are less affected compared to the other species, that are expected to be underutilized, especially red mullet and deep water rose shrimp. The scenarios 2 and 4 are expected to have a higher impact on the catches compared with the other scenarios.

In socio-economic terms, scenarios 2 and 4 entail a significant decrease in revenues, while the decrease in employment is slightly higher than 5%.%.

Table 2.6.10.1 – Performances of the management scenarios (% of change respect to status quo) in terms of SSB and overall catches of the four stocks, salary, employment and revenues for all fleet segments combined. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are smaller than -5% and the yellow ones are between -5% and +5%. The baseline of 2014 is also reported. The values of the fishing mortality F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo.

Demersals in GSA 09	All fleet																
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB HKE (tons)	SSB MUT (tons)	SSB DPS (tons)	SSB NEP (tons)	Catch HKE (tons)	Catch MUT (tons)	Catch DPS (tons)	Catch NEP (tons)	F HKE	F MUT	F DPS	F NEP
SQ (values in 2014 – baseline year)	10082	1.034	0.011	89285	2529	3119	1491	904	435	1436	772	654	156	0.82	0.56	0.56	0.39
Scenario 1 (values in 2021)	9516	0.814	-0.063	84345	2555	2590	1881	910	400	1186	985	659	148	0.82	0.56	0.56	0.39
Scenario 2	28.9	37.2	159	-17.1	.	181,7	57.1	70.8	85.4	-7.1	-33.8	-29.2	-29.5	0.35	0.24	0.24	0.16
Scenario 3	30.0	39.1	168	-8.0	-4.4	108.3	37.9	46.4	55.9	0.7	-20.4	-16.8	-17.0	0.47	0.32	0.32	0.22
Scenario 4	23.6	30.0	130	-19..7	-6.1	121.6	50.8	63.4	63.4	-9.8	-36.3	-32.4	-34.0	0.35 (2018) 0.54	0.24 (2018) 0.37	0.24 (2018) 0.36	0.16 (2018) 0.25
Scenario 5	27.3	35.5	152	-9.3	-4.4	76.7	33.5	43.5	42.7	0.2	-23.1	-18.7	-20.1	0.47 (2018) 0.61	0.32 (2018) 0.42	0.32 (2018) 0.42	0.22 (2018) 0.29
Scenario 6	22.9	30.3	133	11.7	0.0	18.0	14.1	20.5	21.5	17.7	1.0	2.0	9.8	0.76	0.56	0.48	0.36

At level of fleet segment, results show that the ones mostly affected by management measures are DTS_VL1218 and DTS_VL1824. This is not surprising, considering the high share of catches of such fleet segments. The other fleet segments show generally an improving situation for all the scenarios.

Compared to the Status Quo, all the fleet segments show a decrease in the total revenues under all alternative scenarios (except under Scenario 6). Scenario 2 and 4 are the most impacting on revenues with decrease in 2021 of about 20%.

However, the economic performance indicators, as the ratio between current and break-even revenues (CR.BER), the average wage and the Return of Investments (ROI) are showing an increasing pattern for all the fleet segments under all scenarios alternative to status quo.. From a social viewpoint, all alternative scenarios are expected to have a positive impact on the average salary for the overall fishing fleets improving the Status Quo scenario.

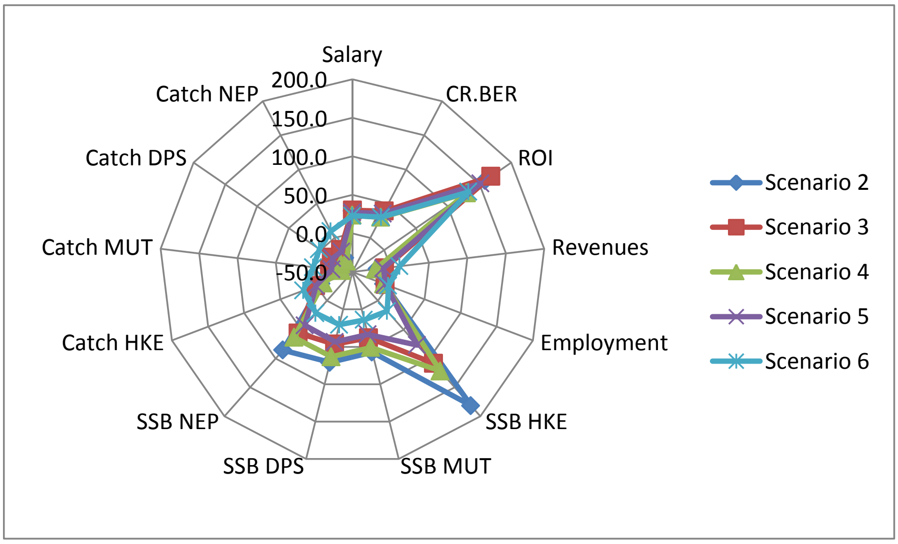


Figure 2.6.10.1. Radar plot for all the fleet. Each line represents a scenario and each point the corresponding percentage of each indicators respect to status quo.

Table 2.6.10.2 – Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catch of hake, red mullet, deep water pink shrimp, and Norway lobster, salary, CR.BER., employment and revenues by fleet segment (DTS_VL1218, DTS_VL1824, DTS_VL2440). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Employ.=Employment.

Fleet segment	**DTS_VL1218**							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch DPS (tons)	Catch NEP (tons)
SQ (values in 2014 – baseline year)	17395	1.56	22076	342	268	293	243	56
Scenario 1 (values in 2021)	17221	1.78	23386	383	209	469	266	54
Scenario 2	17,1	21,2	-19,5	-6,1	-8,1	-32,3	-29,1	-29,2
Scenario 3	20,7	25,7	-9,7	-4,4	-0,1	-19,4	-16,6	-16,7
Scenario 4	11,5	14,3	-22,4	-6,1	-10,5	-35,1	-32,1	-33,8
Scenario 5	17,6	21,8	-11,4	-4,4	-0,5	-21,7	-18,5	-19,8
Scenario 6	13,3	16,5	7,5	0,0	15,3	0,6	2,5	10,0
Fleet segment	**DTS_VL1824**							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch DPS (tons)	Catch NEP (tons)
SQ (values in 2014 – baseline year)	16901	0.429	27960	390	689	277	307	79
Scenario 1 (values in 2021)	18672	0.315	27237	357	532	401	333	81
Scenario 2	52,3	107,4	-16,2	-6,1	-8,2	-32,9	-29,1	-29,1
Scenario 3	49,4	101,5	-7,2	-4,4	-0,1	-19,8	-17,0	-16,6
Scenario 4	44,1	90,5	-19,3	-6,1	-10,6	-35,5	-32,6	-33,9
Scenario 5	45,5	93,6	-8,7	-4,4	-0,6	-22,4	-18,6	-19,9
Scenario 6	23,2	47,5	9,5	0,0	15,4	-2,9	1,8	10,2
Fleet segment	**DTS_VL2440**							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch DPS (tons)	Catch NEP (tons)
SQ (values in 2014 – baseline year)	17217	0.508	2653	31	70	16	23	12
Scenario 1 (values in 2021)	20858	0.454	2648	28	53	23	26	13
Scenario 2	54,5	68,5	-20,0	-6,1	-7,8	-32,8	-29,3	-32,9
Scenario 3	51,6	65,0	-10,3	-4,4	0,2	-19,7	-16,9	-20,1
Scenario 4	46,2	58,2	-22,8	-6,1	-10,4	-35,4	-32,5	-36,4
Scenario 5	47,9	60,3	-11,6	-4,4	-0,3	-22,2	-18,8	-22,0
Scenario 6	22,6	28,5	8,3	0,0	15,7	-2,3	2,0	7,1

Table 2.6.10.3 – Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catch of hake, red mullet, deep water pink shrimp, and Norway lobster, salary, CR.BER., employment and revenues by fleet segment (PGP_VL0012, PGP_VL1218). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Employ.=Employment.

Fleet segment	**PGP_VL0012**					
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)
SQ (values in 2014 – baseline year)	6799	1.341	31275	1608	221	97
Scenario 1 (values in 2021)	5482	0.783	26143	1615	162	93
Scenario 2	19,3	25,5	-18,2	-6,1	-3,3	-47,2
Scenario 3	22,0	29,1	-8,9	-4,4	4,3	-31,9
Scenario 4	16,2	21,5	-19,8	-6,1	-6,3	-47,7
Scenario 5	20,2	26,7	-9,9	-4,4	3,3	-33,6
Scenario 6	29,3	38,8	16,6	0,0	25,2	14,8
Fleet segment	**PGP_VL1218**					
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	
SQ (values in 2014 – baseline year)	9439	1.811	5320	158	89	
Scenario 1 (values in 2021)	8184	1.351	4576	171	74	
Scenario 2	21,3	23,6	-2,8	-6,1	-2,7	
Scenario 3	22,3	24,7	3,1	-4,4	4,3	
Scenario 4	18,1	20,0	-5,1	-6,1	-5,5	
Scenario 5	21,5	23,8	2,5	-4,4	3,6	
Scenario 6	26,5	29,4	20,3	0,0	26,0	

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process(AHP), has been used to assess the performances of the alternative fisheries management policies (Rossetto et al., 2015).

The eight indicators used in the analysis are listed in **Error! Reference source not found.**, along with he weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the 'current condition'. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021.

Table 2.6.10.4 – Summary of the indicators used in the MCDA.

Top level hierarchy	Low level hierarchy	Indicator*	Weight
Socioeconomic	Economic	GVA, ROI or Profit	0.0080
Socioeconomic	Economic	CR.BER	0.0421
Socioeconomic	Social	EMP.	0.1914
Socioeconomic	Social	WAGE (Salary)	0.0641
Biological	Biological conservation	SSB	0.2605
Biological	Biological conservation	F	0.2605
Biological	Biological production	Y (Landing)	0.1373
Biological	Biological production	D	0.0361

*GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; WAGE: Average wage; EMPL: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y: Landing; D: Discard rate.

According to MCDA (Figure 2.6.10.2), the scenarios that allows to reach the highest overall utility are scenarios 2 and 4 with utility respectively equal to 0.45 and 0.42, while the lowest utility is given by Scenario 1, the status quo (0.25). These results are in agreement with those shown by the traffic light table, which simply compares percentage of change to the status quo. Scenarios 2 and 4 were considered to perform better than scenarios 3, 5 and 6 because in the MCDA the biological component weight relatively more than the economic and social ones.

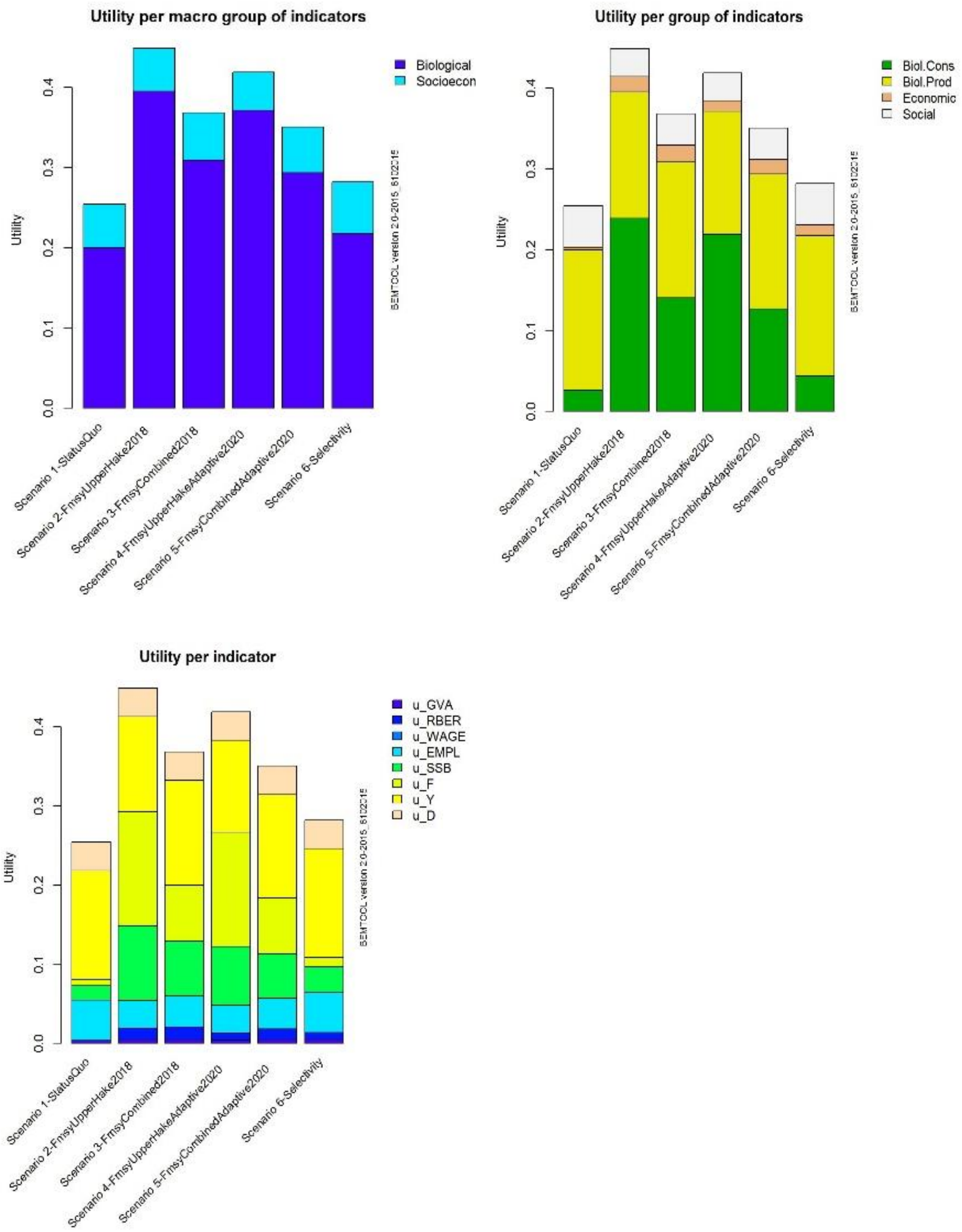


Figure 2.6.10.2. MCDA results: evaluation of the overall utility associated to each management scenario.

2.6.11 DISCUSSION AND CONCLUSIONS OF DEMERSAL FISHERIES CASE STUDY IN GSA09

According to the traffic light approach, all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect to the status quo. The best performance for SSB is showed by Scenario 2 followed by 4, whilst the worse result is observed in the status quo. These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on this indicators if applied in a short time range.

Adaptive scenarios (Scenario 3 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 4), but also a reduced decrease in landing of the overall catch of all stocks in the short term.

Catches are remarkably decreasing and species as red mullet and deep water pink shrimp are expected to be underutilized.

Results show that the fleet segments mostly affected by management measures are DTS_VL1218 and DTS_VL1824. This is not surprising, considering the high share of catches of such fleet segments.

Compared to the Status Quo, all the fleet segments show a decrease in the total revenues under all alternative scenarios with the exception of Scenario 6. Scenario 2 and 4 are the most impacting on revenues with decrease of around 20%. The economic performance indicator, the ratio between current and break-even revenues (CR.BER), is showing an increasing pattern for all the fleet segments under all scenarios alternative to status quo. On the other hands the indicator ROI is decreasing in all scenarios. From a social viewpoint, all alternative scenarios are expected to have a positive impact on the average salary for the overall fishing fleets improving the Status Quo scenario.

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the scenarios allowing to reach the highest overall utility are scenarios 2 and 4 (overall utility 0.45 and 0.42 respectively), while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.25). This result is comparable with that obtained by the traffic light approach. Scenarios 2 and 4 were considered to perform better than scenarios 3, 5, and 6 because the biological component weight is relatively more than the economic and social ones in MCDA.

The methodology and the scenarios tested cover a wide range of different options and provide a general and complete overview of the situation of demersal species fisheries in GSA 9. The results are consistent with the advice that has been provided so far in different fora and gives a more robust evaluation of the efficiency of each of the measures proposed.

There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment due to the lack of a reliable stock-recruitment relationship. However, the measures proposed from BEMTOOL are conservative enough to be efficient even against recruitment failures.

In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020, unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.

The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan to focus on stock-by-stock effort reduction for achieving individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile.

Better selection of fish size can be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatial closures.

ANNEX E –INPUTS FOR MODELLING DEMERSAL FISHERIES IN GSA09

E.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL FISHERIES IN GSA09

The data used for the parameterization of the biological and the pressure module for *M. merluccius* come from the assessment carried out at the STECF EWG 15-11 held in September 2015. The input for biological and pressure modules for *N. norvegicus* and *M. barbatus* are from the STECF EWG 14-19 held in January 2015, while those for *P. longirostris* are from the STECF EWG 14-09 held in July 2014.

The methodologies used for the assessment are Extended Survivor Analyses (XSA, Darby and Flatman, 1994) for all the stocks.

GROWTH PARAMETERS OF DEMERSAL SPECIES IN GSA09

The growth parameters and the length-weight relationship coefficients for the four species are listed in table E.1.1-.

The life span has been set equal to 7 years for European hake, 8 for Norway lobster, 5 for red mullet, and 4 years for deep-water pink shrimp.

Table E.1.1 – Growth parameters for European hake in GSA 09.

Parameter	European hake (Sex combined)	deep-water pink shrimp (Males)	deep-water pink shrimp (Females)	Norway lobster (Sex combined)	Red mullet (Sex combined)
Linf (mm)	1020	33.1	43.5	74	290
K	0.21	0.93	0.74	0.17	0.6
t_0	-0.03	-0.05	-0.13	0.0	-0.1
a (mm/g)	0.000004		0.0045	0.0004	0.000021
b (mm/g)	3.1022		2.377	3.183	2.786

RECRUITMENT OF DEMERSAL SPECIES IN GSA09

For all the stocks a reliable stock recruitment relationship is not available, given also the shortness of the time series. For this reason a recruitment vector has been used for the simulation (past and present time) and a constant value for the projections.

In the case of European hake, the recruitment figures from the stock assessment results were related to age 0 and are from XSA results; the age of recruitment has been set equal to 3 months (Table E.1.2). The recruitment of 2010 has been rescaled with factor 0.8 in order to improve the matching between simulated and observed catch.

The recruitment figures of *P. longirostris* from the stock assessment results (Table E.1.2) were related to age 0 and are from XSA results. The age of recruitment has been set equal to 3 months. The recruitment figures of *N. norvegicus* from the stock assessment results are from XSA and were related to the age 0. The age of recruitment in BEMTOOL has been set equal to 3 months. The recruitment figures of *M. barbatus* from the stock assessment (XSA results) were related to the age 0. The age at recruitment has been set equal to 2 months.

Table E.1.2 – Recruitment by year used in simulation phase for European hake in GSA 09.

Year	European hake (R thousands)	Deep water pink shrimp R (thousands)	Norway lobster R (thousands)	Red mullet R (thousands)
2008	100830	222641	102490	146358
2009	141620	320787	96781	137420
2010	42706	368756	82536	127993
2011	99813	415470	59147	134195
2012	63723	333439	90520	125902
2013	55923	338251	71367	165897
2014	55923*	338251*	73678**	165897*

*This value has been assumed equal to the value of 2013.**This value has been assumed equal to the average of 2011-2013 in order to improve the matching between simulated and observed catch.

The number of recruits entering in the population has been monthly split according to the characteristics of the recruitment of the different species. For European hake, which is recruiting almost all year round in GSA 09, the same value equal to 0.083 has been used for all the months. The same coefficient has been applied to *P. longirostris* and *N. norvegicus* given the recruitment characteristics of these species.For *M. barbatus* the number of recruits entering in the population has been monthly split in order to take into account the characteristics of red mullet which recruits more from June to September (Table E. 1.3).

Table E.1.3 – Proportions of recruits entering each year in the population for red mullet in GSA 09.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	0.2	0.3	0.3	0.2	0	0	0

MATURITY AND SEX RATIO OF DEMERSAL SPECIES IN GSA09

The size at first maturity (Lm50%) and maturity range by species are reported in the table E.1.4. These parameters have been estimated within DCF on biological sampling data.

Table E.1.4 – Maturity parameters for the 4 stocks in demersal fisheries GSA 09 case study

Length in mm	Lm50%			MR =Lm75%-Lm25%		
Species	Males	Females	Combined	Males	Females	Combined
M. merluccius			320			80
N. norvegicus	32	28		8	8	
P. longirostris	17	20		5	6	
M. barbatus	100	110		20	20	

NATURAL MORTALITY OF DEMERSAL SPECIES IN GSA09

The natural mortality at age was estimated using the Prodbiom method (Abella et al., 1997) in all the assessment. In the following tableE.1.5- the natural mortality rates by age class for the 4 stocks are reported.

Table E.1.5 – Natural mortality (M) for the four stocks considered in the case study of GSA 09.

Age	European hake M	Deep water pink shrimp M	Norway lobster M	Red mullet M
0	1.64	1.45	1.78	1.46
1	0.62	0.6	0.61	0.79
2	0.44	0.43	0.48	0.62
3	0.37	0.35**	0.42	0.54
4	0.33		0.39	0.5
5	0.31		0.37	
6	0.29*		0.36	
7			0.35	

*This value corresponds to the age group 6+; **This value corresponds to the age group 3+

TOTAL MORTALITY OF DEMERSAL SPECIES IN GSA09

The total mortality for the 4 stocks has been derived from the natural mortality and the overall fishing mortality (Tab. E.1.6).

Table E.1.6 – Total mortality of the 4 stocks in demersal fisheries GSA 09 case study.

Stock	2008	2009	2010	2011	2012	2013	2014
M. merluccius	1.86	2.04	1.42	2.13	1.48	1.58	1.58
P. longirostris	1.43	1.42	1.49	1.46	1.43	1.40	1.40
N. norvegicus	0.79	0.90	0.77	0.83	0.86	0.87	0.87
M. barbatus	1.485	1.37	1.435	1.59	1.48	1.37	1.37

For 2014 total mortality was assumed equal to 2013.

The total mortality in 2011 for deep-water pink shrimp was assumed to be equal to the average in 2010 and 2012 to improve the matching between simulated and observed catch.

E.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERIES IN GSA09

FISHING MORTALITY OF DEMERSAL SPECIES IN GSA09

The Z-mode of ALADYM model has been used in BEMTOOL for all the stocks.

The F-at-age by year from XSA model is summarized in the following tables from E.2.1 to E.2.4 for the four stocks.

M. merluccius

The age range used for calculation of average F (Tab. E.2.1) for hake was 0-2.

Table E.2.1 – Overall fishing mortality for European hake in GSA 09 (XSA model).

age	2008	2009	2010	2011	2012	2013	2014
0	1.03	1.52	0.52	1.4	0.45	0.56	0.99
1	1.71	1.59	1.35	1.88	1.53	1.63	1.55
2	0.67	0.78	0.77	0.71	0.71	0.63	0.55
3	0.27	0.5	0.86	0.4	0.28	0.22	0.37
4	0.04	0.21	0.64	1.49	0.28	0.11	0.11
5	0.22	0.03	0.23	0.36	1.15	0.04	0.02
6+	0.22	0.03	0.23	0.36	1.15	0.04	0.02

P. longirostris

F-at-age by year from XSA model is summarized in the following table E.2.2. For 2014, the average of F-at-age for the period 2011-2013 was assumed. The age range used for calculation of average F for deep-water pink shrimp was 0-2.

Table E.2.2 – Overall fishing mortality for pink shrimp in GSA 09 (XSA model).

Age	2008	2009	2010	2011	2012	2013	2014
0	0.09	0.093	0.04	0.18	0.05	0.08	0.10
1	1.21	0.99	1.55	1.05	1.37	1.45	1.29
2	0.86	1.05	0.73	0.45	0.75	0.54	0.58
3+	0.86	1.05	0.73	0.45	0.75	0.54	0.58

N. norvegicus

The F-at-age by year from XSA model is summarized in the following table E.2.3. For 2014, the average of F-at-age for the period 2011-2013 was assumed. The age range used for calculation of average F for Norway lobster was 2-5.

Table E.2.3 – Overall fishing mortality for Norway lobster in GSA 09 (XSA model).

age	2008	2009	2010	2011	2012	2013	2014
0	0.00	0.00	0.00	0.01	0.00	0.00	0.00
1	0.00	0.01	0.00	0.01	0.01	0.01	0.01
2	0.07	0.20	0.09	0.11	0.10	0.13	0.11
3	0.36	0.30	0.34	0.45	0.45	0.38	0.43
4	0.42	0.42	0.36	0.44	0.46	0.50	0.47
5	0.57	0.91	0.53	0.54	0.65	0.70	0.63
6	0.79	0.89	0.64	0.55	0.67	0.65	0.62
7+	0.79	0.89	0.64	0.55	0.67	0.65	0.62

M. barbatus

The F-at-age by year from XSA model is summarized in the following table E.2.4. For 2014, the average of F-at-age for the period 2011-2013 was assumed. The age range used for the calculation of average F for red mullet was 1-2.

Table E.2.4 – Overall fishing mortality for red mullet in GSA 09 (XSA model).

Age	2008	2009	2010	2011	2012	2013	2014
0	0.17	0.18	0.08	0.11	0.10	0.28	0.17
1	0.70	0.59	0.67	0.73	0.61	0.66	0.66
2	0.73	0.61	0.66	0.91	0.81	0.54	0.75
3	0.64	0.57	0.33	0.35	0.53	0.46	0.45
4+	0.64	0.57	0.33	0.35	0.53	0.46	0.45

SELECTIVITY OF DEMERSAL FISHERIES IN GSA09

In the following tables (from E.2.5 to E.2.8) for each fleet segment the selectivity parameters used for the modelization of the past/present and future are reported. In the case of trawlers the parameters of the different forecast scenarios are specified.

Table E.2.5 – Selectivity for European hake in GSA09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA9_DTS_VL1218	2008-2010	Ogive with deselection	107.906	6.936	500
	2011-2014	Ogive with deselection	133.712	8.422	488
	2015-2021 (StatusQuo)	Ogive with deselection	133.712	8.422	488
	2015-2021 (Selectivity scenario)	Ogive with deselection	182.188	8.422	500
ITA9_DTS_VL1824	2008-2010	Ogive with deselection	107.906	6.936	500
	2011-2014	Ogive with deselection	133.712	8.422	488
	2015-2021 (StatusQuo)	Ogive with deselection	133.712	8.422	488
	2015-2021 (Selectivity scenario)	Ogive with deselection	182.188	8.422	500
ITA9_DTS_VL2440	2008-2010	Ogive with deselection	107.906	6.936	500
	2011-2014	Ogive with deselection	133.712	8.422	488
	2015-2021 (StatusQuo)	Ogive with deselection	133.712	8.422	488
	2015-2021 (Selectivity scenario)	Ogive with deselection	182.188	8.422	500
ITA9_PGP_VL0012	2008-2012	Gaussian function	332	96	0
	2013-2014	Gaussian function	340	100	0
	2015-2021 (StatusQuo)	Gaussian function	340	100	0
ITA9_PGP_VL1218	2008-2012	Gaussian function	332	96	0
	2013-2014	Gaussian function	340	100	0
	2015-2021 (StatusQuo)	Gaussian function	340	100	0

Table E.2.6 – Selectivity for deep-water pink shrimp in GSA09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA9_DTS_VL1218	2008-2010	Classical ogive	12.0754	3.9125	0
	2011-2014	Classical ogive	15.98	5.12	0
	2015-2021 (StatusQuo)	Classical ogive	15.98	5.12	0
	2015-2021 (Selectivity scenario)	Classical ogive	20.54	5.12	0
ITA9_DTS_VL1824	2008-2010	Classical ogive	12.0754	3.9125	0
	2011-2014	Classical ogive	15.98	5.12	0
	2015-2021 (StatusQuo)	Classical ogive	15.98	5.12	0
	2015-2021 (Selectivity scenario)	Classical ogive	20.54	5.12	0
ITA9_DTS_VL2440	2008-2010	Classical ogive	12.0754	3.9125	0
	2011-2014	Classical ogive	15.98	5.12	0
	2015-2021 (StatusQuo)	Classical ogive	15.98	5.12	0
	2015-2021 (Selectivity scenario)	Classical ogive	20.54	5.12	0

Table E.2.7 – Selectivity for Norway lobster in GSA09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA9_DTS_VL1218	2008-2010	Ogive with deselection	14.87	4.86	52
	2011-2014	Ogive with deselection	18.7205	6.0038	50
	2015-2021 (StatusQuo)	Ogive with deselection	18.7205	6.0038	50
	2015-2021 (Selectivity scenario)	Ogive with deselection	23.729	6.0038	48
ITA9_DTS_VL1824	2008-2010	Ogive with deselection	14.87	4.86	52
	2011-2014	Ogive with deselection	18.7205	6.0038	50
	2015-2021 (StatusQuo)	Ogive with deselection	18.7205	6.0038	50
	2015-2021 (Selectivity scenario)	Ogive with deselection	23.729	6.0038	48
ITA9_DTS_VL2440	2008-2010	Ogive with deselection	14.87	4.86	52
	2011-2014	Ogive with deselection	18.7205	6.0038	48
	2015-2021 (StatusQuo)	Ogive with deselection	18.7205	6.0038	48
	2015-2021 (Selectivity scenario)	Ogive with deselection	23.729	6.0038	44

Table E.2.8 – Selectivity for red mullet in GSA09 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA9_DTS_VL1218	2008-2010	Classical ogive	91.204	3.389	0
	2011-2014	Classical ogive	116.9455	2.7585	0
	2015-2021 (StatusQuo)	Classical ogive	122*	2*	0
	2015-2021 (Selectivity scenario)	Classical ogive	141.511	2	0

ITA9_DTS_VL1824	2008-2010	Classical ogive	91.204	3.389	0
	2011-2014	Classical ogive	109.5865	3.38775	0
	2015-2021 (StatusQuo)	Classical ogive	108.782*	3.517*	0
	2015-2021 (Selectivity scenario)	Classical ogive	141.511	3.517	0
ITA9_DTS_VL2440	2008-2010	Classical ogive	91.204	3.389	0
	2011-2014	Classical ogive	104.3875	3.485	0
	2015-2021 (StatusQuo)	Classical ogive	108.782*	3.517*	0
	2015-2021 (Selectivity scenario)	Classical ogive	141.511	3.517	0
ITA9_PGP_VL0012	2008-2012	Gaussian function	153.6	33	0
	2013-2014	Gaussian function	155	40	0
	2015-2021 (StatusQuo)	Gaussian function	155	35*	0
ITA9_PGP_VL1218	2008-2012	Gaussian function	154	26	0
	2013-2014	Gaussian function	155	15	0
	2015-2021 (StatusQuo)	Gaussian function	155	15	0

* the parameters used for the projections are those used in 2014, while the values reported for 2011-2014 are mean values on the years.

EFFORT OF DEMERSAL FISHERIES IN GSA09

The monthly effort variables used to simulate the past and current years by fleet segment are listed in the following table E.2.9.

Table E.2.9 – Effort for the selected fleet segment in GSA 09. The same value as 2013 was assumed for 2014.

Effort Variable	**ITA9_DTS_VL1218**							**ITA9_DTS_VL1824**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
average monthly GT	23.3	20.3	21.4	21.3	21.5	21.3	21.3	53.1	51	53.4	53	54	54.2	54.2
average monthly KW	159.1	151.2	154.2	152.8	154.9	156.1	156.1	276.7	258.6	265.6	265.4	269.9	277	277
number of vessels	140.8	123.7	134.7	131.4	127.4	127.8	127.8	154.9	158.3	144.6	140.8	126.9	119	119
annual fishing days	152	163	164	162	164	182	182	167	182	184	183	190	193	193
Effort Variable	**ITA9_DTS_VL2440**							**ITA9_PGP_VL0012**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
average monthly GT	81	81	84.1	88.6	88.6	86.1	86.1	1.9	1.9	1.9	1.9	1.9	1.9	1.9
average monthly KW	457.9	457.9	487.4	449.4	449.3	472.5	472.5	30.5	30.7	30.7	31.1	31.2	31.5	31.5
number of vessels	9.5	9.5	7.4	8.8	9.2	9.2	9.2	834	832.5	830	831.3	810.9	807.6	807.6
annual fishing days	0	199	168	182	181	221	221	140	165	138	173	135	152	152

Effort Variable	**ITA9_PGP_VL1218**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
average monthly GT	12.6	12.7	13.1	12.8	12.9	12.7	12.7
average monthly KW	141.8	147	150.3	153.6	159.6	156.4	156.4
number of vessels	59.6	57.8	63.5	61.2	62.3	57.1	57.1
annual fishing days	142	154	150	166	117	114	114

LANDINGS AND DISCARDS OF DEMERSAL FISHERIES IN GSA09

Landings were obtained from the DCF 2015.

M. merluccius

The landing data for hake by fleet segment used to parameterize the model are listed in the following table E. 2.10.

Table E.2.10 – Landings for European hake by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	211 943	182 340	228 115	260 640	190 491	268 253
ITA9_DTS_VL1824	691 778	618 591	561 865	488 516	435 305	689 382
ITA9_DTS_VL2440		43 941	34 492	38 226	22 677	68 962
ITA9_PGP_VL0012	238 732	212 500	236 282	232 964	129 494	220 696
ITA9_PGP_VL1218	176 338	263 235	414 681	344 525	237 370	87 956
Total	1 318 791	1 320 607	1 475 435	1 364 870	1 015 337	1 335 248

P. longirostris

The landing data for pink shrimp by fleet segment used to parameterize the model are listed in the following table.

Table E.2.11 – Landings for pink shrimp by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	57 093	59 961	110 570	145 921	226 348	243 270
ITA9_DTS_VL1824	196 399	181 684	311 109	365 000	353 428	307 450
ITA9_DTS_VL2440		61 496	51 005	39 997	40 910	23 233
Total	253 492	303 141	472 683	550 917	620 685	573 953

N. norvegicus

The landing data for Norway lobster by fleet segment used to parameterize the model are listed in the table E.2.12.

Table E.2.12 – Landings for Norway lobster by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	75 104	59 679	39 695	33 361	35 382	55 940
ITA9_DTS_VL1824	152 570	179 377	111 589	139 942	124 710	79 492
ITA9_DTS_VL2440		11 182	10 290	10 592	17 646	12 185

Fleet segment	2008	2009	2010	2011	2012	2013
Total	227 674	250 239	161 573	183 894	177 738	147 616

M. barbatus

The landing data for red mullet by fleet segment used to parameterize the model are listed in table E.2.13.

Table E.2.13 – Landings for red mullet by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014. Landings for red mullet by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	291 236	275 046	302 250	357 036	243 241	292 825
ITA9_DTS_VL1824	394 311	380 575	381 481	318 323	358 302	276 833
ITA9_DTS_VL2440	0	16 472	11 049	18 535	12 751	15 855
ITA9_PGP_VL0012	10 523	19 803	26 988	83 453	62 638	97 063
ITA9_PGP_VL1218	665	1 136	1 888	2 436	6	0
Total	696 735	693 032	723 656	779 784	676938	682 576

Total landings

The total landings data by fleet segment used to parameterize the model are listed in the table E.2.14. For 2014 the same landings as 2013 has been assumed.

Table E.2.14 – Total landings by fleet segment in GSA 09 (kg). The same value as 2013 was assumed for 2014.

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2 378 070	2 163 100	2 410 682	2 672 791	2 308 075	2 633 175
ITA9_DTS_VL1824	4 537 317	4 883 289	4 561 503	4 274 424	3 791 000	4 337 260
ITA9_DTS_VL2440		503 175	241 507	284 732	219 681	247 983
ITA9_PGP_VL0012	3013819	3 144 159	2 929 956	3 212 013	2 458 382	3 190 191
ITA9_PGP_VL1218	595868	768 795	1 117 267	1 068 348	631 626	536 435
Total	10 525 073	11 462 517	11 260 914	11 512 309	9 408 764	1 0945 044

In the following tables E.2.15 and E.2.16the discards observed for European hake and deep-water pink shrimp are reported.

Table E.2.15 – Discards of European hake by fleet segment in GSA 09 (tons). The same value as 2013 was assumed for 2014.

	ITA9_DTS_VL1218	ITA9_DTS_VL1824	ITA9_DTS_VL2440	Total
2008	76	249	0	325
2009	150	511	36	697
2010	32	79	5	116
2011	175	327	26	528

2012	51	117	6	174
2013	63	163	16	242
2014	63	163	16	242

Table E.2.16 – Discards of deep-water pink shrimp by fleet segment in GSA 09 (tons). The same value as 2013 was assumed for 2014.

	ITA9_DTS_VL1218	ITA9_DTS_VL1824	ITA9_DTS_VL2440	Total
2008	9	32	0	41
2009	8	23	18	49
2010	6	18	3	27
2011	17	42	4	63
2012	3	4	1	8
2013	13	16	1	30
2014	13	16	1	30

IN ALADYM simulations the discard for both species have been modelled by a reverse ogive with a SL50% of 23 cm for hake and 15 mm for deep water pink shrimp.

In the simulations the discard has been modelled for hake and deep-water rose shrimp, while for Norway lobster not, being the discard negligible. Although used in the last assessment carried out by STECF EWG 14-09, discards of red mullet were not included in the modelling with Aladym as the catches used in the assessment were more similar to the official landings from ITAFISH source

E.3 INPUT OF THE ECONOMIC MODULE DEMERSAL FISHERIES IN GSA09

Data 2008-2013 for the estimation of the socio-economic parameters were obtained from the National Programs of the EU Data Collection Framework. The economic data of the selected fleet segments used to parameterize the economic functions in the projections are reported in the following paragraphs.

REVENUES OF DEMERSAL FISHERIES IN GSA09

The revenues by fleet segment for hake, pink shrimp, Norway lobster, red mullet and the total revenues are reported in the tables from E.3.1 to E.3.5. In the projections, the prices have been modelled according to the revenues and the landings by fleet segment.

M. merluccius

Table E.3.1 – Revenues of hake by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	1891435	1623796	2078578	2482268	1657829	2064974
ITA9_DTS_VL1824	5216691	4739328	4400320	4431721	3995989	4399792
ITA9_DTS_VL2440		340811	273786	341661	236511	392776
ITA9_PGP_VL0012	2519246	2309771	2598742	2810566	1503331	2114949
ITA9_PGP_VL1218	1582883	2303572	3644959	3706309	2517468	936567
Total	**11210254**	**11317278**	**12996385**	**13772526**	**9911129**	**9909059**

P. longirostris

Table E.3.2 – Revenues of deep water pink shrimp by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	822477	887578	1574709	1652481	2129256	2150635
ITA9_DTS_VL1824	2624667	2387064	3134850	3811329	3226649	2172698
ITA9_DTS_VL2440		704926	451921	459175	414810	252617
Total	**3447143**	**3979568**	**5161480**	**5922985**	**5770715**	**4575950**

N. norvegicus

Table E.3.3 – Revenues of Norway lobster by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2365474	1975135	1265588	1114468	1177341	1469114
ITA9_DTS_VL1824	4937974	5565445	3551400	4406136	3802789	2096251
ITA9_DTS_VL2440		526931	423143	465625	675596	515052
Total	**7303449**	**8067511**	**5240132**	**5986230**	**5655726**	**4080416**

M. barbatus

Table E.3.4 – Revenues of red mullet by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2305379	2167610	2297365	2647582	1571433	1616720
ITA9_DTS_VL1824	2295257	2182286	2495889	2188810	2234334	1477690
ITA9_DTS_VL2440		138250	65462	109640	45467	85877
ITA9_PGP_VL0012	89301	178853	277886	836651	641916	1099602
ITA9_PGP_VL1218	3690	9087	16317	20470	44	
Total	**4693627**	**4676085**	**5152918**	**5803154**	**4493194**	**4279889**

Total revenues

Table E.3.5 – Total revenues by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	21625716	20545849	22539598	25374634	20648705	22076071
ITA9_DTS_VL1824	37791498	40765505	40079467	39511292	35676915	27960439
ITA9_DTS_VL2440		4000269	2192778	3136210	2886134	2653447
ITA9_PGP_VL0012	34749504	36573744	32335671	35881815	24491072	31274516
ITA9_PGP_VL1218	5503354	6431864	11433145	11504099	6355022	5320264
Total	**99670072**	**108317231**	**108580659**	**115408050**	**90057848**	**89284737**

PROFIT OF DEMERSAL FISHERIES IN GSA09

In the following table E.3.6 the profit of demersal fishery in GSA9 are preported by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table E.3.6 - Profit by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	3156400	4113778	3808774	4205057	1297904	1672169
ITA9_DTS_VL1824	-1346214	2756357	1867460	-478896	2138724	-3860801
ITA9_DTS_VL2440	0	115534	-295962	-179478	-332134	-330614
ITA9_PGP_VL0012	8251929	9021923	6599383	7461451	1234240	1968786
ITA9_PGP_VL1218	861337	1679178	4519006	4372098	1628757	1141104
Total	10923452	17686770	16498661	15380232	5967491	590644

COSTS OF DEMERSAL FISHERIES IN GSA09

In the following tables from E.3.7 to E.3.17 all the data of costs by fleet segment as taken into account in the simulation phase of the case study (past and present years) are reported.

Table E.3.7 – Total variable costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	9376594	6430354	8237516	9906104	9693519	10178986
ITA9_DTS_VL1824	21101473	17333802	18593377	21429966	15652648	16148904
ITA9_DTS_VL2440		1595723	1155654	1519138	1589929	1697821
ITA9_PGP_VL0012	9719822	8385146	8229680	10413757	9554279	11134765
ITA9_PGP_VL1218	1549369	1353545	1816441	2100541	1422002	1071707
Total	**41747258**	**35098570**	**38032668**	**45369506**	**37912377**	**40232183**

Table E.3.8 – Other variable costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2047266	1994639	2166667	2248553	2097078	1720666
ITA9_DTS_VL1824	5347322	5750079	5449551	5433918	4907819	4186456
ITA9_DTS_VL2440		666386	392855	538881	520446	469848
ITA9_PGP_VL0012	2882092	3434229	2927989	3438005	2655653	3278625
ITA9_PGP_VL1218	569934	648751	852873	915207	705651	411283
Total	**10846614**	**12494084**	**11789935**	**12574564**	**10886647**	**10066878**

Table E.3.9 – Fuel costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	7329328	4435715	6070849	7657551	7596440	8458319
ITA9_DTS_VL1824	15754151	11583723	13143826	15996048	10744830	11962447
ITA9_DTS_VL2440		929337	762799	980258	1069483	1227973
ITA9_PGP_VL0012	6837730	4950917	5301691	6975752	6898626	7856140
ITA9_PGP_VL1218	979435	704794	963568	1185334	716351	660424
Total	**30900644**	**22604486**	**26242733**	**32794943**	**27025730**	**30165303**

Table E.3.10 - Maintenance costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	654758	605226	647208	630884	689457	1268580
ITA9_DTS_VL1824	1440564	1491911	1351409	1312730	1266658	2314855
ITA9_DTS_VL2440		108570	87435	103847	108570	80465
ITA9_PGP_VL0012	2239290	2251128	2252122	2248312	2253892	1469877
ITA9_PGP_VL1218	211253	207905	223864	228201	213956	208995
Total	**4545865**	**4664740**	**4562038**	**4523974**	**4532533**	**5342772**

Table E.3.11 - Total fixed costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	776495	740019	790494	777378	857320	598027
ITA9_DTS_VL1824	1761528	1813813	1655928	1610444	1555099	672912
ITA9_DTS_VL2440		126400	101794	120902	126400	28795
ITA9_PGP_VL0012	1653471	1654656	1654566	1625780	1649261	1993320
ITA9_PGP_VL1218	183855	179882	197181	183834	185995	168698
Total	**4375349**	**4514770**	**4399963**	**4318338**	**4374075**	**3461752**

Table E.3.12 - Labour costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	5028681	6177786	6329176	7017830	5474168	5949087
ITA9_DTS_VL1824	7270292	10103112	9384058	7905385	8456993	6591564
ITA9_DTS_VL2440		999848	431253	672404	538983	533737
ITA9_PGP_VL0012	9268994	11350983	9678392	10312671	6065266	10932544
ITA9_PGP_VL1218	1538267	1794313	3377649	3355866	1664699	1491342
Total	**23106234**	**30426042**	**29200528**	**29264156**	**22200109**	**25498274**

Table E.3.13 - Depreciation costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2511062	2246309	2477159	2577665	2423893	2134526
ITA9_DTS_VL1824	7223876	6603969	6581307	7041170	6079685	5430260
ITA9_DTS_VL2440		957389	645897	819090	783952	567658
ITA9_PGP_VL0012	3464229	3568891	3587482	3489250	3452367	3385674
ITA9_PGP_VL1218	1108633	1107200	1183254	1148128	1140795	1105757
Total	**14307800**	**14483758**	**14475099**	**15075303**	**13880692**	**12623875**

Table E.3.14 - Opportunity costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	121726	232377	249271	259716	212444	274696
ITA9_DTS_VL1824	339979	662541	645928	690493	527108	662745
ITA9_DTS_VL2440		96805	66707	80308	70434	75586
ITA9_PGP_VL0012	151769	341017	334046	330594	281767	389550
ITA9_PGP_VL1218	50639	109841	115750	115431	98818	132661
Total	**664113**	**1442581**	**1411702**	**1476542**	**1190571**	**1535238**

Table E.3.15 - Total capital costs by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	2632788	2478686	2726430	2837381	2636337	2409222
ITA9_DTS_VL1824	7563855	7266510	7227235	7731663	6606793	6093005
ITA9_DTS_VL2440		1054194	712604	899397	854386	643243
ITA9_PGP_VL0012	3615998	3909908	3921528	3819844	3734134	3775224
ITA9_PGP_VL1218	1159273	1217041	1299004	1263559	1239613	1238418
Total	**14971914**	**15926339**	**15886801**	**16551844**	**15071263**	**14159112**

Table E.3.16 - Number of employees by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	392	335	368	353	342	342
ITA9_DTS_VL1824	494	502	484	438	391	390
ITA9_DTS_VL2440		30	30	28	30	31
ITA9_PGP_VL0012	1849	1810	1905	1532	1525	1608
ITA9_PGP_VL1218	135	121	126	166	182	158
Total	**2870**	**2798**	**2913**	**2517**	**2470**	**2529**

Table E.3.17 - Capital value by fleet segment in GSA 9 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA9_DTS_VL1218	10676809	9424699	10397079	10593496	10008553	9225165
ITA9_DTS_VL1824	29820186	26871187	26941639	28164371	24832766	22257119
ITA9_DTS_VL2440		3926199	2782354	3275647	3318237	2538413
ITA9_PGP_VL0012	13311970	13830882	13933037	13484513	13274446	13082356
ITA9_PGP_VL1218	4441659	4454893	4827945	4708293	4655436	4455179
Total	**58250624**	**58507860**	**58882054**	**60226320**	**56089438**	**51558232**

E.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS

The fitting of the landing data to BEMTOOL model simulations is quite satisfactory for all the species, with an average difference of 8.5% by year for hake (E.4.1-2) and deep water rose shrimp (Figure E.4.3-4), 6.2 % for red mullet (Figure E.4.5) and 7.1 for Norway lobster (Figure E.4.6). The observed data for 2014 has been assumed equal to 2013.

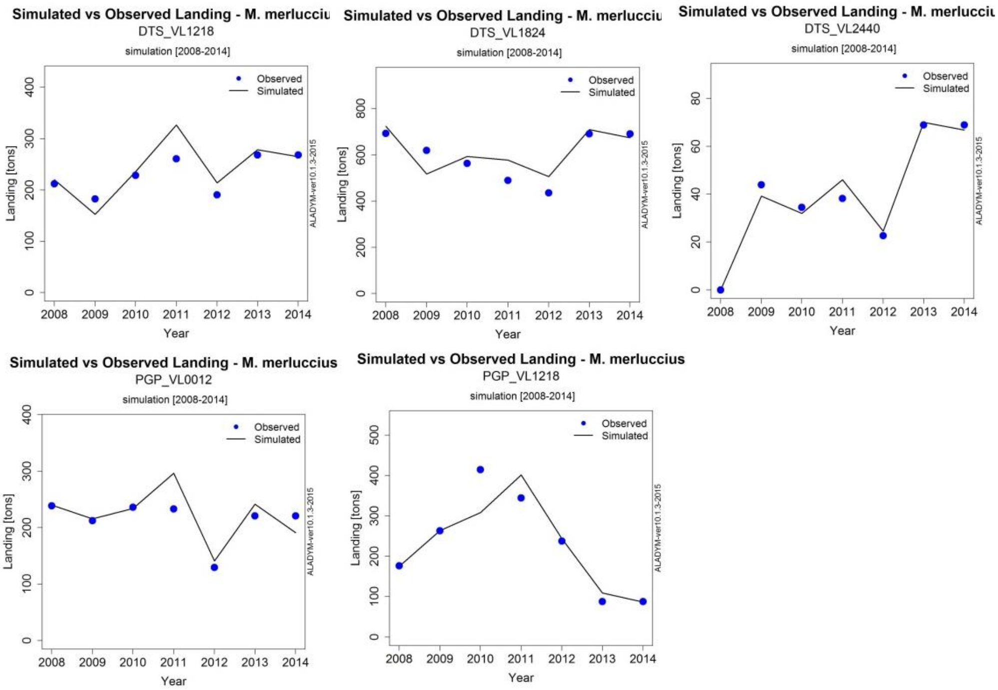


Figure E.4.1 Comparison between simulated and observed landings by fleet segment for hake in GSA 9.

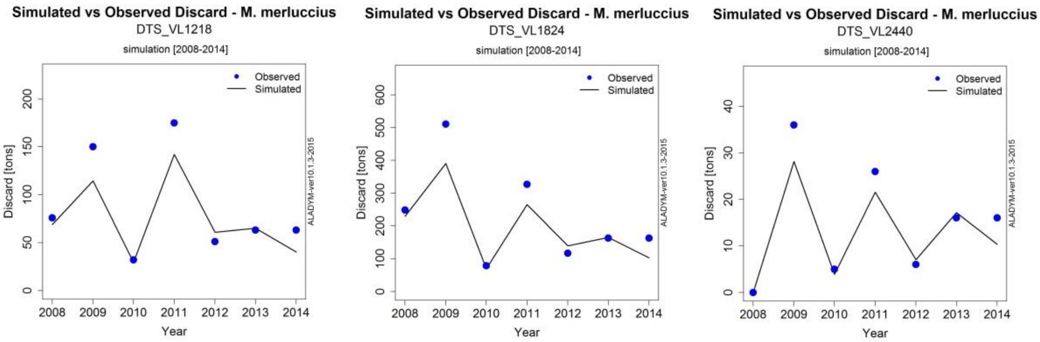


Figure E.4.2 Comparison between simulated and observed discards by fleet segment for hake in GSA 9.

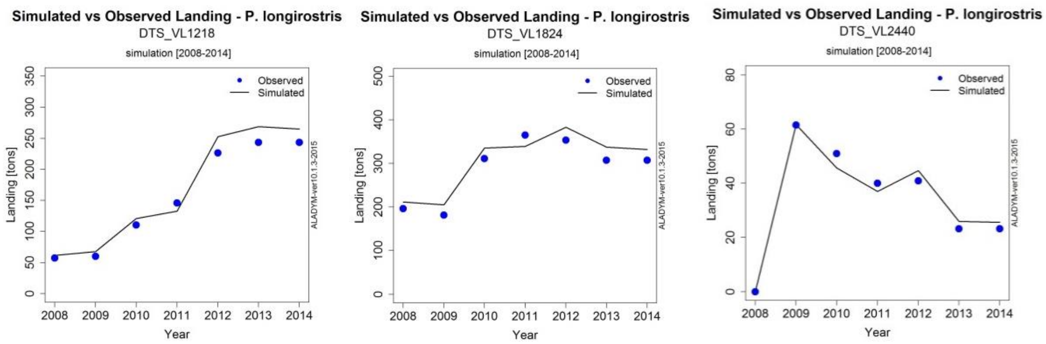


Figure E.4.3 Comparison between simulated and observed landings by fleet segment for deep water rose shrimp in GSA 9.

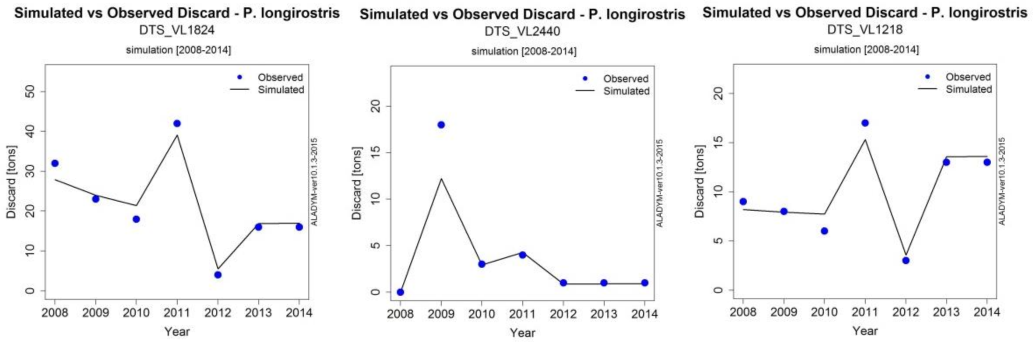


Figure E.4.4 Comparison between simulated and observed discard by fleet segment for for deep water rose shrimp in GSA 9.

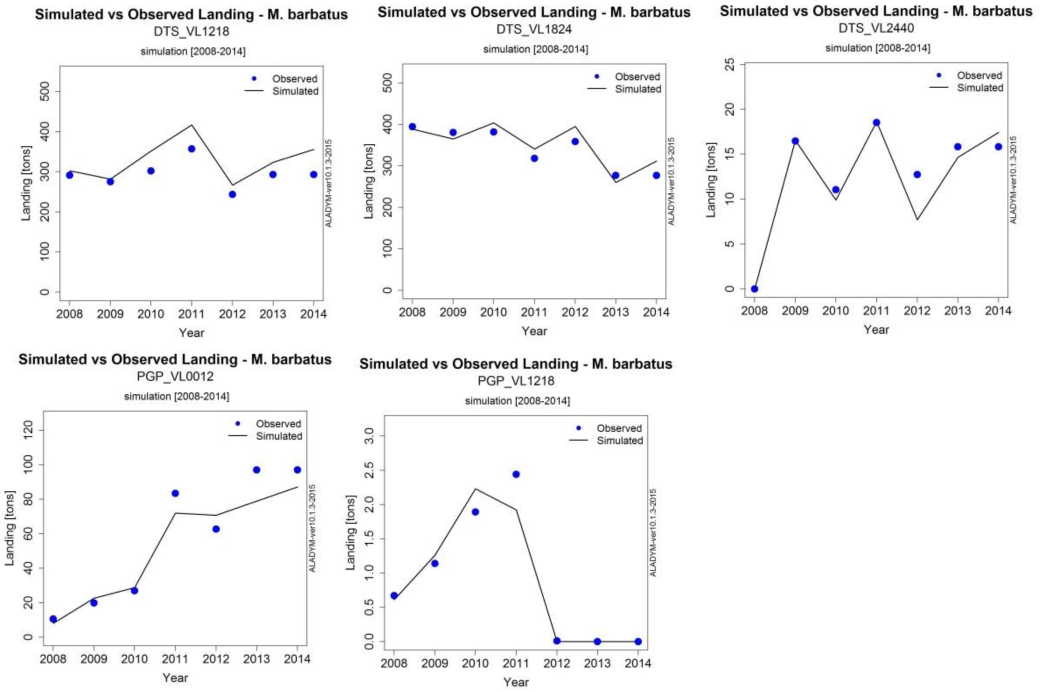


Figure E.4.5 Comparison between simulated and observed landings by fleet segment for red mullet in GSA 9.

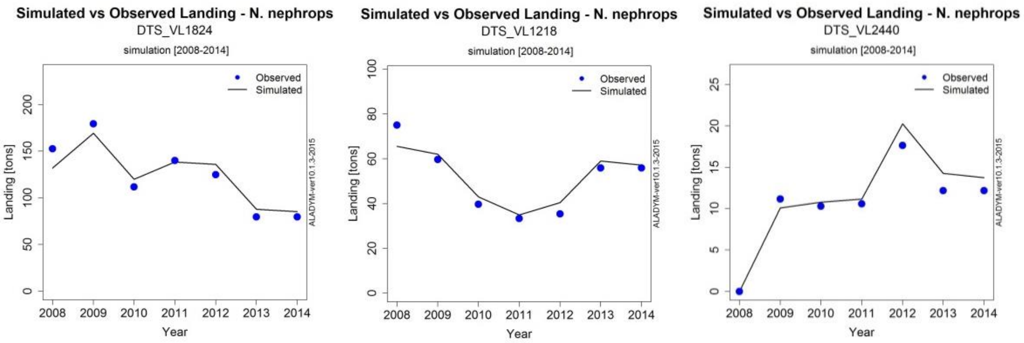


Figure E.4.6 Comparison between simulated and observed landings by fleet segment for Norway lobster in GSA 9.

The comparison between the Spawning Stock Biomass (SSB) from the assessment models and the BEMTOOL simulations are shown in Figure E.4.7.

The simulated SSBs of Norway lobster and deep-water pink shrimp are close to those estimated by XSA; for hake, from 2012 SSB shows a similar trend to that estimated by XSA with a sligthly increasing trend, though BEMTOOL estimates a higher SSB; instead as regards red mullet, BEMTOOL estimates a SSB lower than XSA, as the estimate of maturity at age was revised after the assessment.

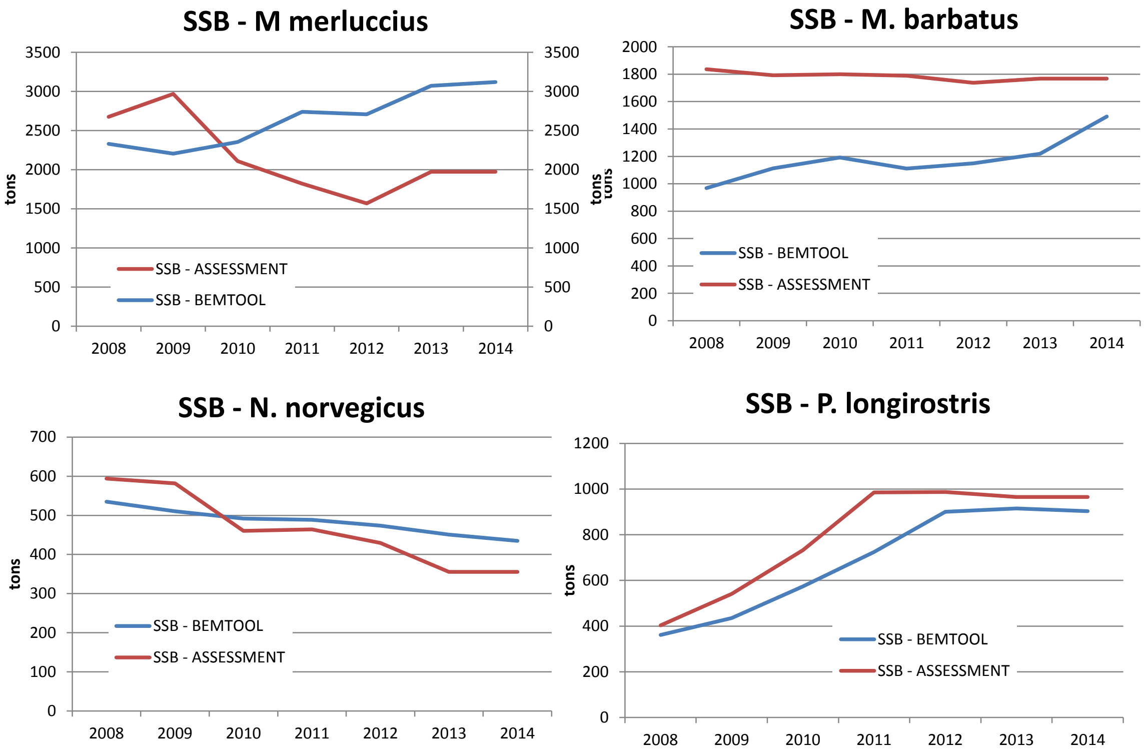


Figure E.4.7. Comparison between BEMTOOL and stock assessment SSB for hake, deep water rose shrimp, red mullet and Norway lobster in GSA 9.

E.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT

E.5.1 INPUT OF THE BIOLOGICAL AND PRESSURE MODULES

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year estimated in the assessment. A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the recruitment of the last year in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL (Figure E.5.1.1). Figure E.5.1.1 shows the recruitment of the four stocks with confidence interval used in all the performed scenarios.

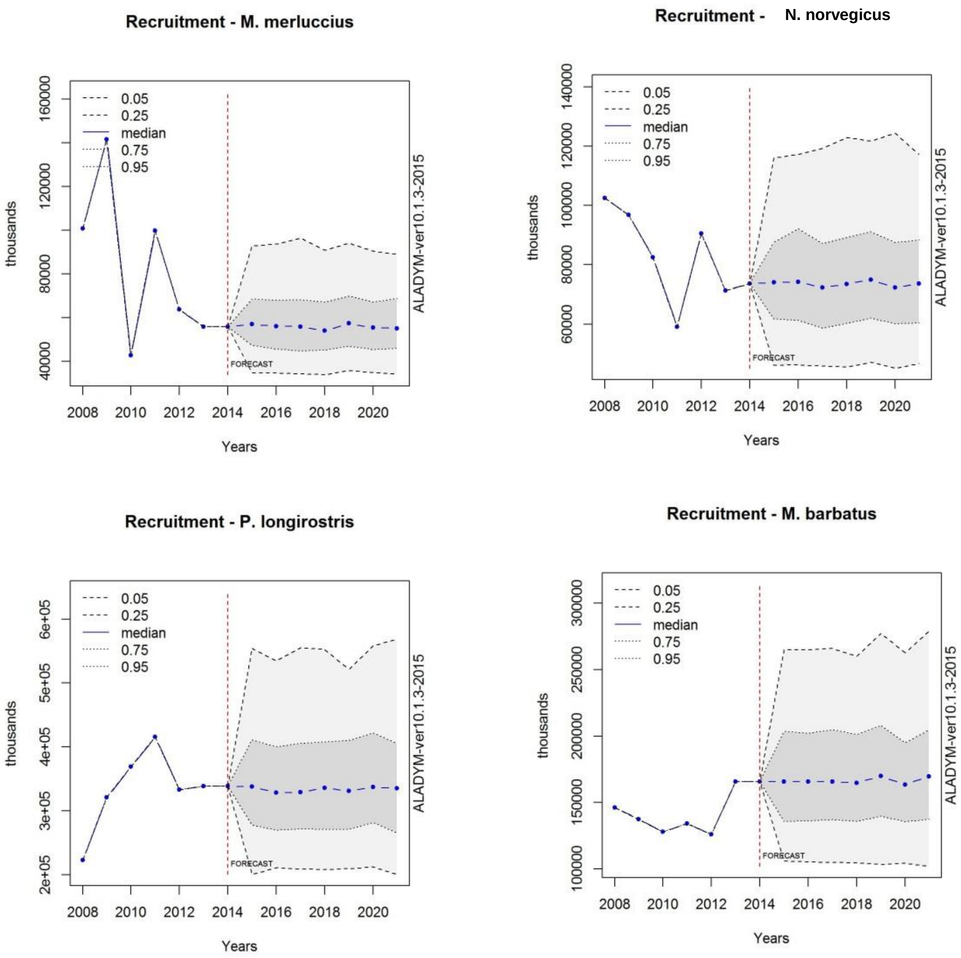


Figure E.5.1.1 Recruitment used for European hake, deep water rose shrimp, red mullet and Norway lobster in the forecast scenarios with confidence intervals.

All the other biological inputs have been maintained unchanged in the projections.

For the status quo the effort has been maintained constant for all the years (until 2021) and equal to 2013.

E.5.2 INPUT OF THE ECONOMIC MODULE

The main equations in the socio-economic model are related to the dynamics of prices and costs. Each equation has been tested on the basis of available historical series of data in order to check that the functional relationships are correctly specified. The economic parameters for each fleet segments and model equations are described below.

Given the presence of relevant fluctuations in the time series of most fleet segments, the socio economic parameters have been estimated on the basis of the most recent economic data.

For all fleets included in the case study, 2014 data were assumed equal to 2013.

PRICES DYNAMICS

The price of European hake, red mullet, deep water rose shrimp and Norway lobster are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}.$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2 for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

1) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
2) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
3) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.

Due to the lack of reliable estimations based on available data, the flexibility coefficient was computed exogenously. Sector studies (Nielsen, 2000 and Camanzi *et al.,* 2010) confirm that the flexibility coefficient normally ranges between -0.1 and -0.4. In this case study flexibility coefficients estimated for the Italian management plans have been applied, which estimated an average coefficient of -0.2 for all target species (Table E.5.2.1).

Table E.5.2.1 Price parameterization by fleet segment and stock in GSA 9 demersal case study.

Fleet segment	coeff. price-landings M. merluccius	coeff. price-landings P. longirostris	coeff. price-landings N. norvegicus	coeff. price-landings M. barbatus
ITA9_DTS_VL1218	-0.2	-0.2	-0.2	-0.2
ITA9_DTS_VL1824	-0.2	-0.2	-0.2	-0.2
ITA9_DTS_VL2440	-0.2	-0.2	-0.2	-0.2
ITA9_PGP_VL0012	-0.2	-0.2	-0.2	-0.2
ITA9_PGP_VL1218	-0.2	-0.2	-0.2	-0.2

The flexibility coefficient price-landings was assumed equal to -0.2 for all target species, which means that given a 1% fall in the production of a given species, it is assumed an increase in price of 0.2%.

COSTS DYNAMICS

Variable costs

Variable costs were modelled as a single item, which is the sum of fuel costs and other variable costs. Total variable costs are a function of the fishing effort (expressed in terms of days at sea):

$$TVC_{f,t} = \beta_f E_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$E_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*

Maintenance costs and fixed costs

Maintenance costs (MC) and other fixed costs (OFC) are assumed to be proportional to the gross tonnage (GT) of the fleet segment, corresponding to option 1 of the BEMTOOL software.

$$MC_{f,t} = \alpha''_f GT_{f,t}$$

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

Capital costs

Capital costs are function of the estimated fleet capacity, expressed in terms of capital value and gross tonnage.

Depreciation costs DC are estimated by a linear function of the annual gross tonnage GT as well.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

Following the approach of "The 2014 Annual Economic Report on the EU Fishing Fleet (STECF-14-16)", opportunity costs of capital (OC) are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Capital costs include annual depreciation and the opportunity costs of capital.

Labour costs

Labour cost are directly related to total revenues and variable cost.

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is assumed to be proportional to revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t} \right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

Revenues and total landings

Revenues by fleet segment and species are calculated by multiplying landings produced in the biological sub-model by the prices estimated on the basis of the price module.
The remaining part of landings value and weight was assumed to be as a fixed percentage of the estimated revenues and production of hake, pink shrimp, Norway lobster and red mullet according to option 1 of revenues modelling:

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

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

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to pass from the landings of assessed species to the total landings of the fleet segment *f*.
Total revenues and production are function of the estimated landings value and weight of the four target assessed species.

Average employees per vessel

Employment was estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html.

Table E.5.2.2 Cost parameterization by fleet segment in GSA 9 demersal case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA9_DTS_VL1218	437	0.5	465	219	783	101
ITA9_DTS_VL1824	704	0.6	359	104	841	103
ITA9_DTS_VL2440	830	0.6	101	36	713	95
ITA9_PGP_VL0012	93	0.6	944	1282	2175	250
ITA9_PGP_VL1218	165	0.4	287	232	1520	182

Table E.5.2.3 Socio-economic indicators parameterization by fleet segment in GSA 9 demersal case study.

Fleet segment	correction factor for landings	correction factor for revenue	value of a single vessel	average employees per vessel	discount rate
ITA9_DTS_VL1218	3.06	3.02	72175	3	0.043
ITA9_DTS_VL1824	3.21	2.76	186982	3	0.043
ITA9_DTS_VL2440	2.06	2.13	274562	3	0.043
ITA9_PGP_VL0012	10.04	9.73	16192	2	0.043
ITA9_PGP_VL1218	6.10	5.68	78047	3	0.043

E.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The table E.5.3.1 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute values of the average number of annual fishing days per vessel and the number of active vessels are reported.

Table E. 5.3.1 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Reduction on days							Reduction on vessels						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_DTS_VL1218	182	182	182	182	182	182	182	128	128	128	128	128	128	128
ITA9_DTS_VL1824	193	193	193	193	193	193	193	119	119	119	119	119	119	119
ITA9_DTS_VL2440	221	221	221	221	221	221	221	9	9	9	9	9	9	9
ITA9_PGP_VL0012	152	152	152	152	152	152	152	808	808	808	808	808	808	808
ITA9_PGP_VL1218	114	114	114	114	114	114	114	57	57	57	57	57	57	57

	Reduction on days							Reduction on vessels						
Scenario 2 - FmsyUpperHake2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_DTS_VL1218	-13.7%	-27.4%	-41.2%	-54.9%	-54.9%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_DTS_VL1824	-13.7%	-27.4%	-41.2%	-54.9%	-54.9%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_DTS_VL2440	-13.7%	-27.4%	-41.2%	-54.9%	-54.9%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_PGP_VL0012	-13.7%	-27.4%	-41.2%	-54.9%	-54.9%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_PGP_VL1218	-13.7%	-27.5%	-41.2%	-54.9%	-54.9%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%

	Reduction on days							Reduction on vessels						
Scenario 3 - FmsyCombined2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_DTS_VL1218	-9.9%	-19.8%	-29.7%	-39.6%	-39.6%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_DTS_VL1824	-9.9%	-19.8%	-29.7%	-39.6%	-39.6%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_DTS_VL2440	-9.9%	-19.8%	-29.7%	-39.6%	-39.6%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_PGP_VL0012	-9.9%	-19.8%	-29.7%	-39.6%	-39.6%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_PGP_VL1218	-9.9%	-19.8%	-29.7%	-39.6%	-39.6%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%

	Reduction on days							Reduction on vessels						
Scenario 4 - FmsyUpperHakeAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_DTS_VL1218	-13.7%	-13.7%	-22.0%	-30.2%	-42.5%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_DTS_VL1824	-13.7%	-13.7%	-22.0%	-30.2%	-42.5%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_DTS_VL2440	-13.7%	-13.7%	-22.0%	-30.2%	-42.5%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_PGP_VL0012	-13.7%	-13.7%	-22.0%	-30.2%	-42.5%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%
ITA9_PGP_VL1218	-13.7%	-13.7%	-22.0%	-30.2%	-42.5%	-54.9%	-54.9%	-2.0%	-4.1%	-6.1%	-6.1%	-6.1%	-6.1%	-6.1%

	Reduction on days							Reduction on vessels						
Scenario 5 - FmsyCombinedAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA9_DTS_VL1218	-9.9%	-9.9%	-15.8%	-21.8%	-30.7%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_DTS_VL1824	-9.9%	-9.9%	-15.8%	-21.8%	-30.7%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_DTS_VL2440	-9.9%	-9.9%	-15.8%	-21.8%	-30.7%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_PGP_VL0012	-9.9%	-9.9%	-15.8%	-21.8%	-30.7%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%
ITA9_PGP_VL1218	-9.9%	-9.9%	-15.8%	-21.8%	-30.7%	-39.6%	-39.6%	-1.5%	-2.9%	-4.4%	-4.4%	-4.4%	-4.4%	-4.4%

2.7. CASE STUDY ON DEMERSAL GSA11

2.7.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The main stocks identified in Sardinia seas (GSA 11) are European hake (HKE, *Merluccius merluccius*), red mullet (MUT, *Mullus barbatus*), giant red shrimp (ARS, *Aristaeomorpha foliacea*)

For the purpose of this study 5 fleet segments have been considered as listed in the table 2.7.1.1.

The fleet segment ITA11_PGP_VL0012 is a result of post-stratification (e.g. ITA11_PGP_0006 + ITA11_PGP_0612), because sharing similar characteristics.

All these fleet segments operating in GSA 11 are carrying out demersal fishery on the continental shelf (50-200 m depth), while the two largest trawl fleet segments targeting giant red shrimp are operating on the continental slope. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 2.7.1.1

Table 2.7.1.1 Main fleet segments operating in GSA11 carrying out demersal fisheries. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

N.	***Fleet name demersal fisheries GSA11***	***Fleet code GSA11***	***% of landings (all species)***
1	Bottom trawlers with vessel length 12-18 m	ITA11_DTS_VL1218	10.0
2	Bottom trawlers with vessel length 18-24 m	ITA11_DTS_VL1824	12.0
3	Bottom trawlers with vessel length 24-40 m	ITA11_DTS_VL2440	10.6
4	Vessels using polyvalent passive gears length	ITA11_PGP_VL0012	52.1
5	Vessels using polyvalent passive gears length	ITA11_PGP_VL1218	15.2

Fishing effort from trawlers is decreasing from 2008 to 2012, while that of vessels using polyvalent passive gears was increasing from 2008 to 2011 and then decreasing.

The association between stocks and demersal fisheries for this case study are reported in –table 2.7.1.2.

2.7.1.2 - Associations among stocks and fleet segments for demersal fisheries in GSA 11 case study.

Stock	ITA11_DTS_VL1218	ITA11_DTS_VL1824	ITA11_DTS_VL2440
M. merluccius	X	X	X
A. foliacea	X	X	X
M. barbatus	X	X	X
Stock	ITA11_PGP_0012	ITA11_PGP_VL1218	
M. merluccius	X	X	
A. foliacea			
M. barbatus	X	X	

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is reported in the table 2.7.1.3. These stocks account for a low percentage in the small scale fishery operated by small scale vessels using Polyvalent Passive Gears (PGP), but are relatively important for the bottom trawlers, especially for the fleet segment with larger length (ITA11_DTS_VL2440).

Table 2.7.1.3- Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA11.

Assessed species/fleet segments GSA11	***ITA11_DTS VL1218***	***ITA11_DTS VL1824***	***ITA11_DTS VL2440***	***ITA11_PGP VL0012***	***ITA11_PGP VL1218***
ARS	1.2	2.4	11.3		
HKE	7.2	6.9	12.6	1.6	1.5
MUT	5.7	7.8	2.9	0.3	0.2
Total assessed%	14.1	17.1	26.8	1.9	1.7

General fishery rules

Different types of area-based conservation measures have already been established and implemented at national and regional level in GSA 11, going from Marine Protected Areas (MPA) or marine parks, to areas with different degrees of fishery restriction and regulation for multiple uses. Among these, several areas prohibiting or limiting access to fishing activities have been implemented, such as the "Zone di Tutela Biologica" (ZTB, Italian Ministry Regulation DM 16/06/1998). In addition, in 1999, France, Italy and the Principality of Monaco signed an agreement to create the Pelagos Sanctuary for Mediterranean Marine Mammals aimed at the protection of marine mammals through regulations of maritime traffic and guidelines for responsible fishery and the multiple uses of the sea. The area of the Sanctuary spreads over 84,000 km² and it is mostly overlapping with GSAs 9 and 11. In GSA 11, management regulations are based on technical measures, as closed number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of the fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing bans. Regarding small scale fishery, management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. Three biological conservation zones (ZTB) were permanently established in Palmas Gulf, Oristano Gulf, Cagliari Gulf. Professional small scale fishery using fixed nets and long-lines is permanently allowed, while trawling is allowed from July 1st to December 31st; recreational fishery using no more than 5 hooks is allowed (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009).

Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

These management regulations have been taken into account to model the current situation in the case study.

2.7.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The data used for the parameterization of the biological and the pressure modules of BEMTOOL come from the assessment of the three demersal stocks carried out at STECF EWG 13-19 (red mullet see STECF, 2013), and EWG 15-11 (European hake and giant red shrimp; see STECF, in press). These assessments used official DCF data.

According to the used stock assessments, the summary diagnosis of the stocks is the following:

-European hake: Fishing mortality above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Red mullet: Fishing mortality above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

- Giant red shrimp: Fishing mortality above F_{MSY}, SSB increasing and recruitment stable in the last years.

Discards of red mullet and European hake seems quite high (Table 2.7.2.1).

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the necessity of estimating this parameter when the assessment was not recent are reported in the table 2.7.2.1, as well as landings, discards, spawning stock biomass and recruitment. These values were in line with the assessments.

Table 2.7.2.1 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA11.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)*	*Discards (tons)*	*Spawning Stock Biomass**	*Recruitment (in thousands)*
European hake	F=1.66	354	259	95	73	15 475
Red mullet	F=1.02	367	264	103	137	13 184
Giant red shrimp	F=0.58	30	30	0	92	18 418

* = Mean of the last 3 years

Stock advice, Reference points, and their technical basis

All the three stocks are assessed as being exploited unsustainably at levels much higher than F_{MSY} (Table 2.7.2.2). Discards of hake and red mullet were included in the assessment; discards of giant red shrimp was instead considered negligible.

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

F_{MSY} = 0.17; Fupper = 0.24 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according to the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.26.

The framework used for the F_{MSY} reference points is summarised in the Table 2.7.2.2.

Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.7.2.2 – Reference point framework for the selected 3 stocks.

	.				
	MSY approach			**Precautionary approach**	
Reference point	F_{MSY}	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for all stocks	F0.1 as proxy for Fmsy	From empirical equation (EWG 15-11)		$B_{lim} = B_{loss}$ lowest value of the time series	1.4 * B_{lim} from empirical equation (EWG 15-11)
Technical basis for all the species method 2	F combined according to Balance indicators approach (weight from landing value)				
Values for European hake	0.17	0.24	7.0	73	102
Values for red mullet	0.32	0.44	3.2		
Values for Giant red shrimp	0.31	0.43	1.89		
Values for all the other species method 2	0.26		4.48	-	-

Development of economic indicators over time and current status

The economic performance of the fleet segments is evaluated using key social and economic indicators and a traffic light table (Table 2.7.2.3; red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

Revenues of European hake and red mullet are generally declining, though small scale fleet (ITA11_PGP_VL0012) is performing better compared to trawlers,while revenues from giant red shrimp are improving.. Among trawlers the fleet segment ITA11_DTS_VL1824 has a better economic performance. Considering the whole fleet, economic indicators (Salary, CR.BER, ROI) have a good short term performance.

Tab. 2.7.2.3 - Traffic light table on the economic performance (2008-2013) of the fleets targeting demersal stocks in GSA11 (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues red mullet (thousands euros)	Revenues red giant shrimp (thousands euros)	Employment (number of unit)
ALL	5542 ÷ 5698	0.942 ÷ 0.791	-0.016 ÷ -0.065	56507 ÷ 45822	2272 ÷ 1693	2311 ÷ 800	1182 ÷ 2149	2205 ÷ 2136
ITA11_DTS_VL1218	5813 ÷ 9033	0.61 ÷ 0.948	-0.127 ÷ -0.016	6944 ÷ 5574	484 ÷ 315	904 ÷ 219	10 ÷ 557	199 ÷ 142
ITA11_DTS_VL1824	8641 ÷ 15422	0.489 ÷ 1.434	-0.131 ÷ 0.117	5442 ÷ 6552	442 ÷ 529	709 ÷ 435	120 ÷ 165	117 ÷ 122
ITA11_DTS_VL2440	12509 ÷ 19707	0.423 ÷ 0.218	-0.131 ÷ -0.195	9832 ÷ 4688	872 ÷ 446	677 ÷ 94	1052 ÷ 1427	138 ÷ 84
ITA11_PGP_VL0012	3592 ÷ 3484	1.159 ÷ 0.843	0.059 ÷ -0.057	22212 ÷ 21813	190 ÷ 328	14 ÷ 44		1429 ÷ 1565
ITA11_PGP_VL1218	9912 ÷ 8511	1.527 ÷ 0.748	0.131 ÷ -0.078	12077 ÷ 7195	284 ÷ 76	8 ÷ 7		322 ÷ 223

2.7.3. MANAGEMENT STRATEGY EVALUATION

A Management Strategy Evaluation (MSE) for European hake in GSA 11 was run at STECF EWG 15-11 to evaluate if the MSY ranges were precautionary.

The F_{MSY} ranges were derived using the formula provided by STECF 15-09. F ranges results were F_{upper}=0.24 and F_{lower}=0.12. B_{lim} was estimated as B_{loss}=73 (t). The following figure 2.7.3.1 shows the results of the MSE. The probability that the SSB falls below B_{lim} fishing at F equal to F_{MSY} upper level is equal to 0.

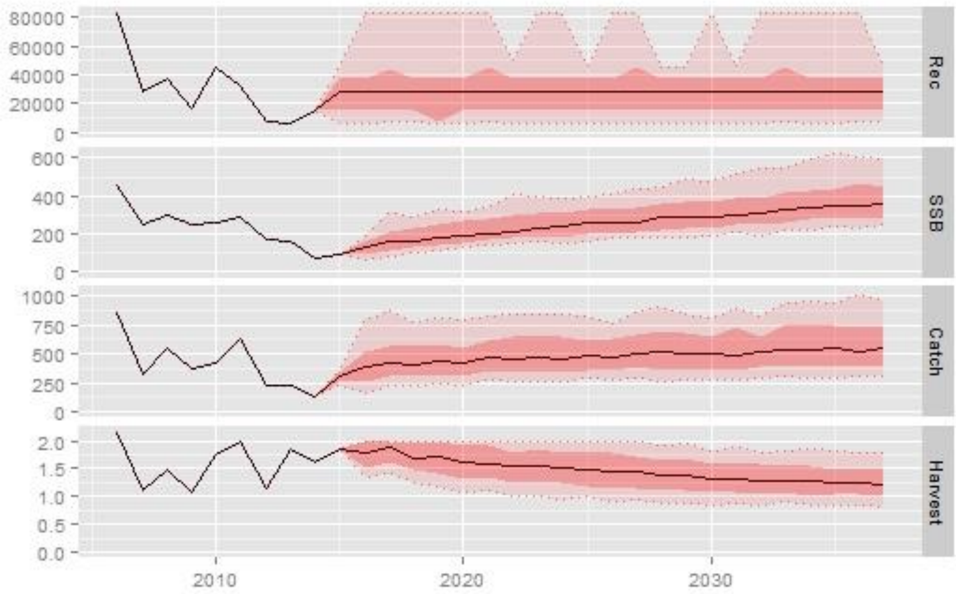


Fig. 2.7.3.1 Management Strategy Evaluation Results for hake in GSA11.

2.7.4. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

The improvement of the stock conditions in term of fishing mortality and spawning stock biomass can be achieved through combining effort reduction (both capacity and days at sea) and selectivity improvement. Such mixed strategy is explored in the next section, through the 6 scenarios implemented.

Among the capacity reduction schemes, the current action plan presented by Italy in the last fleet report foresees a 7% reduction in of fishing capacity of DTS fleets in term of GT from 2015 to 2017.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns.

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluate a severe approach in a shorter term;

2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns corresponding to SM40 (square mesh of 40 mm opening). The selectivity of the gears different from trawlers has been maintained unchanged.

Strategy and timeframe to reach the RP

The three stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on Fcurrent levels, European hake is the most heavily exploited species. thus it has been used as the benchmark species.

The percentages of reduction to reach F_{MSY} are reported in the Table 2.7.4.1.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of European hake (the more exploited species) = 0.24 (method 1) and the current level of fishing mortality (method 1) (Fcurr=1.66);
- the reference point F_{MSY} combined = 0.26 (method 2) and the current level of fishing mortality combined (F=1.17).

In case of fishing mortality combined, the needed reduction is 77%. In case of Fupper a reduction of 86% is necessary.

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

Table 2.7.4.1 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{MSY} (method 1) or combined F (method 2).

Stock	Fishing mortality reduction (in %)
European hake (Reference point method 1)	86%
All stocks (Reference point method 2)	77%

2.7.5. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios are reported in the Table 2.7.5.1

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

Scenario 2 and 4 share the same reference point that is the F_{UPPER} of European hake because it is more exploited, but the strategy is different in terms of timeframe and shaping of the reduction along the time.

Also scenario 3 and 5 share the same reference point, that is the F_{MSY} combined among the assessed species using the economic value as weighing factor of the average.

The scenario 6 aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

Table 2.7.5.1 Proposed management scenarios to reach the reference point.

Case Study	demersals in GSA 11
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture.

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year estimated in the assessment (see Annex F for details). A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the recruitment of the last year in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

For both methods (according to Fmsy upper of hake and according to the F combined) the reduction has been applied for the 10% on vessels until 2017 and for 90% on fishing days until 2018 (linearly) and 2020 (in an adaptive way). The value of 10% was agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report), on the basis of informal inputs from stakeholders. The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.7.5.2.

The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.7.5.2.

Table 2.7.5.2. Split reduction by vessels and average fishing days per year (in percentage).

Reduction on VESSELS	Reduction on

needed to F_{upper}	DAYS needed to F_{upper}
9**	77*

*in case of F_{MSY} combined this percentage is 70%
** in case of F_{MSY} combined this percentage is 7

The shape of the reduction by fishing days and activity according to the different scenario is reported in the figure 2.7.5.1.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

The value of the overall fishing mortality estimated by BEMTOOL in 2013 for European hake is 1.66, its F_{MSY} is 0.17 and its F_{MSY} upper is 0.24; according to the state of exploitation, a reduction of 86% is needed.

Table 2.7.5.3 - Percentage of fishing mortality of European hake by fleet segment (2014).

	HKE	MUT	ARS
ITA11_PGP_VL0012	21.1	7.7	
ITA11_PGP_VL1218	5.9	1.5	
ITA11_DTS_VL1218	18.3	28.6	7.6
ITA11_DTS_VL1824	20.9	46.9	17.6
ITA11_DTS_VL2440	33.7	15.2	74.7
	100	100	100

The value of the overall combined fishing mortality, for GSA 11, is 1.17, while the combined F_{MSY} is 0.26. A reduction of 77% on the overall fishing mortality would be needed. The reductions have been split by fleet segment according to the proportions of combined fishing mortality by fleet segment (Table 2.7.5.4).

The reduction has been applied to each fleet segment, considering its relative portion of Fcurrent to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species.

Table 2.7.5.4 Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction applied.

	Fleet code	**% F current European hake**	**Reduction applied%**	**% F current combined**	**Reduction applied %**
1	ITA11_DTS_VL1218	18.3	86	26.9	77
2	ITA11_DTS_VL1824	20.9		29.3	
3	ITA11_DTS_VL2440	33.7		35.9	
4	ITA11_PGP_VL0012	21.1		19.5	
5	ITA11_PGP_VL1218	5.9		5.1	

A further scenario implemented, the scenario 6 (fig. 2.7.5.1) aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

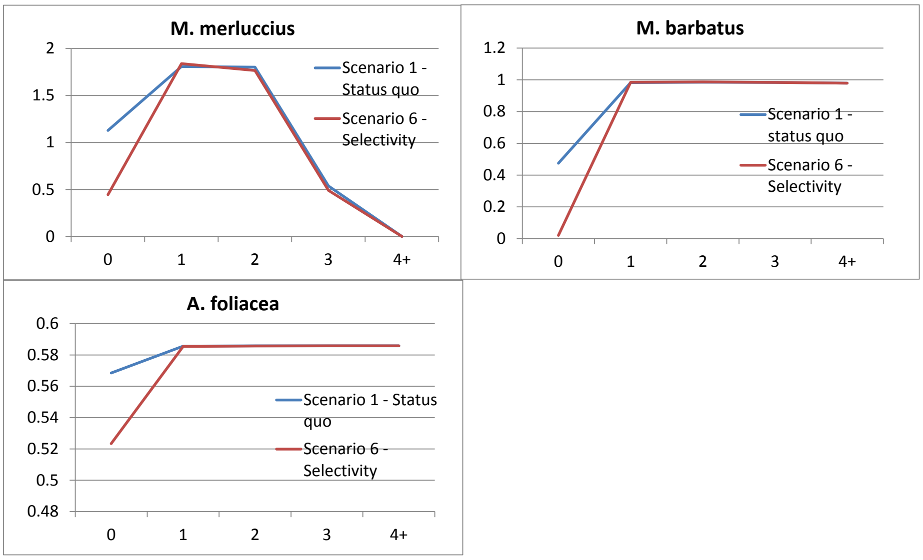
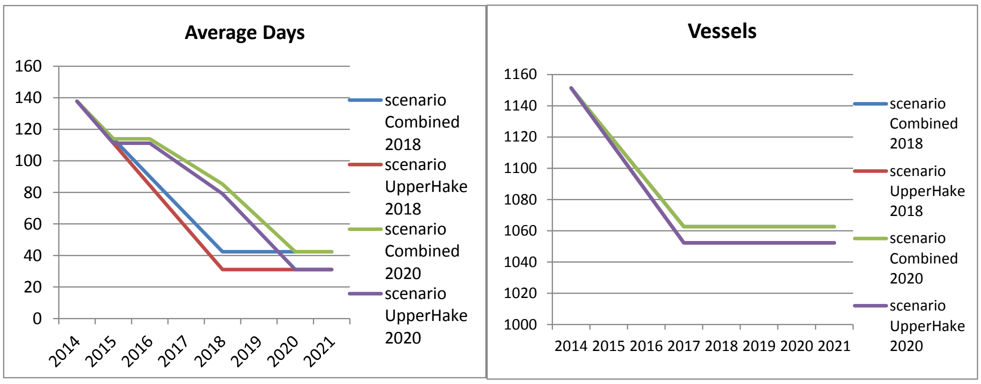


Figure 2.7.5.1 - Comparison between the F by age (only trawlers) in the status quo and in selectivity scenario by species.



Error! Reference source not found. Figure 2.7.5.2 - Shape of the reduction in terms of annual average ishing days and annual vessels according to the different scenarios.

Further details on the shaping of reduction by fleet segment, year and scenario are reported in the Annex F5.3.

2.7.6. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1).

The inputs to the biological and pressure components of BEMTOOL model have been derived from the last endorsed stock assessments; socio-economic data and parameters are from DCF.
A Management Strategy Evaluation (MSE) has been performed in line with EWG-15-11 for hake (see chapter 2.7.3).

2.7.7. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERIES IN GSA11

All the inputs for modelling are fully reported in the Annex F.

2.7.8 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.7.8.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

Figure 2.7.8.1 shows the SSB of the three stocks for status quo scenario. SSB of red mullet and giant red shrimp remain quite stable until 2021, while SSB of hake shows a decreasing trend.

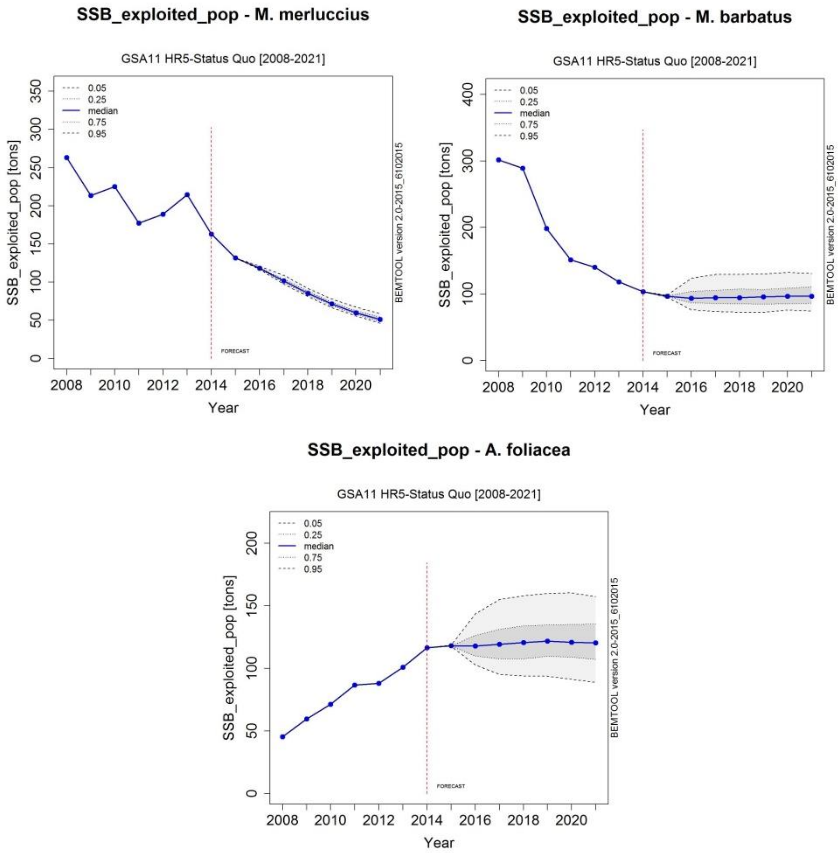


Figure 2.7.8.1.1 SSB for giant red shrimp, red mullet, and hake in the status quo scenario with confidence intervals

Landings of hake show a slight increasing pattern until 2016; then, they remain stable until 2021. Landings of giant red shrimp do not show any trend, while those of red mullet decrease slightly until 2016, and then they remain constant until 2021 (2.7.8.1.2-4).

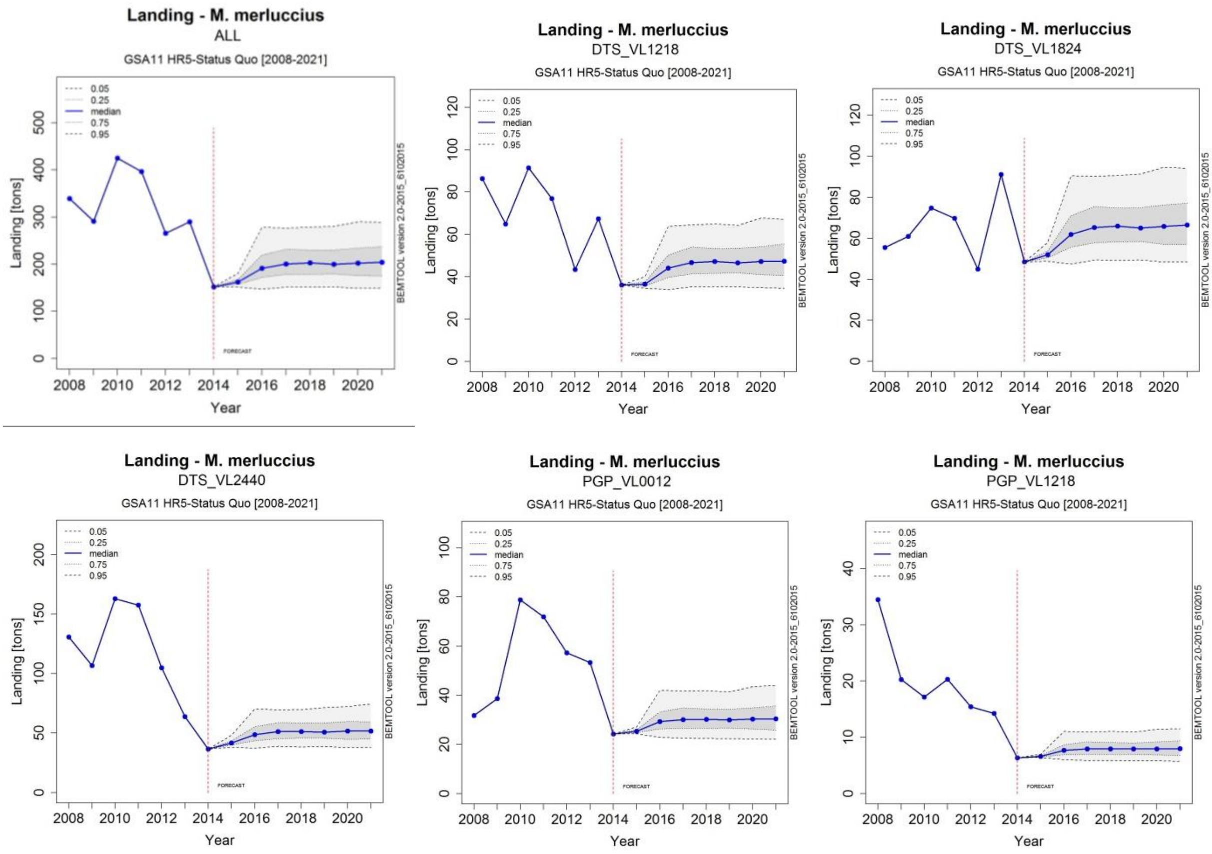


Figure 2.7.8.1.2 Landings of hake in the status quo scenario with confidence intervals.

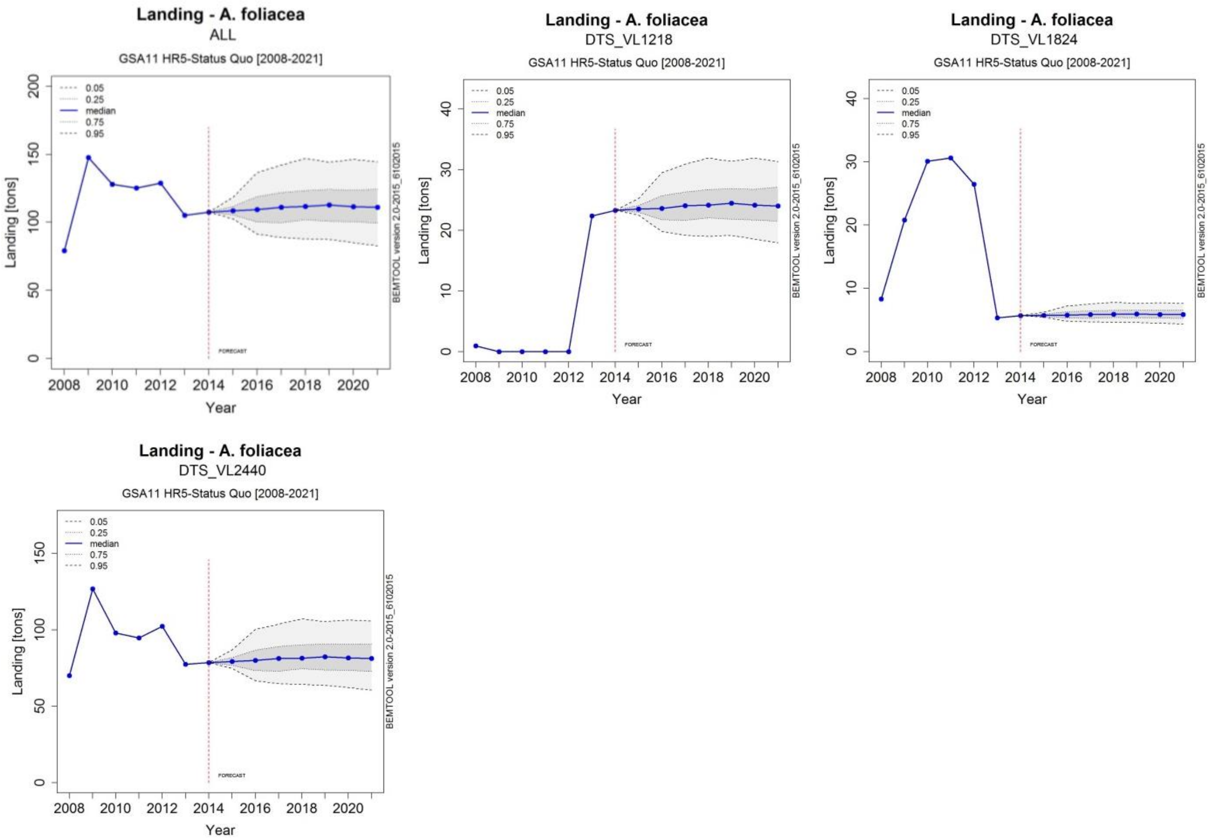


Figure 2.7.8.1.3 Landings of giant red shrimp in the status quo scenario with confidence intervals.

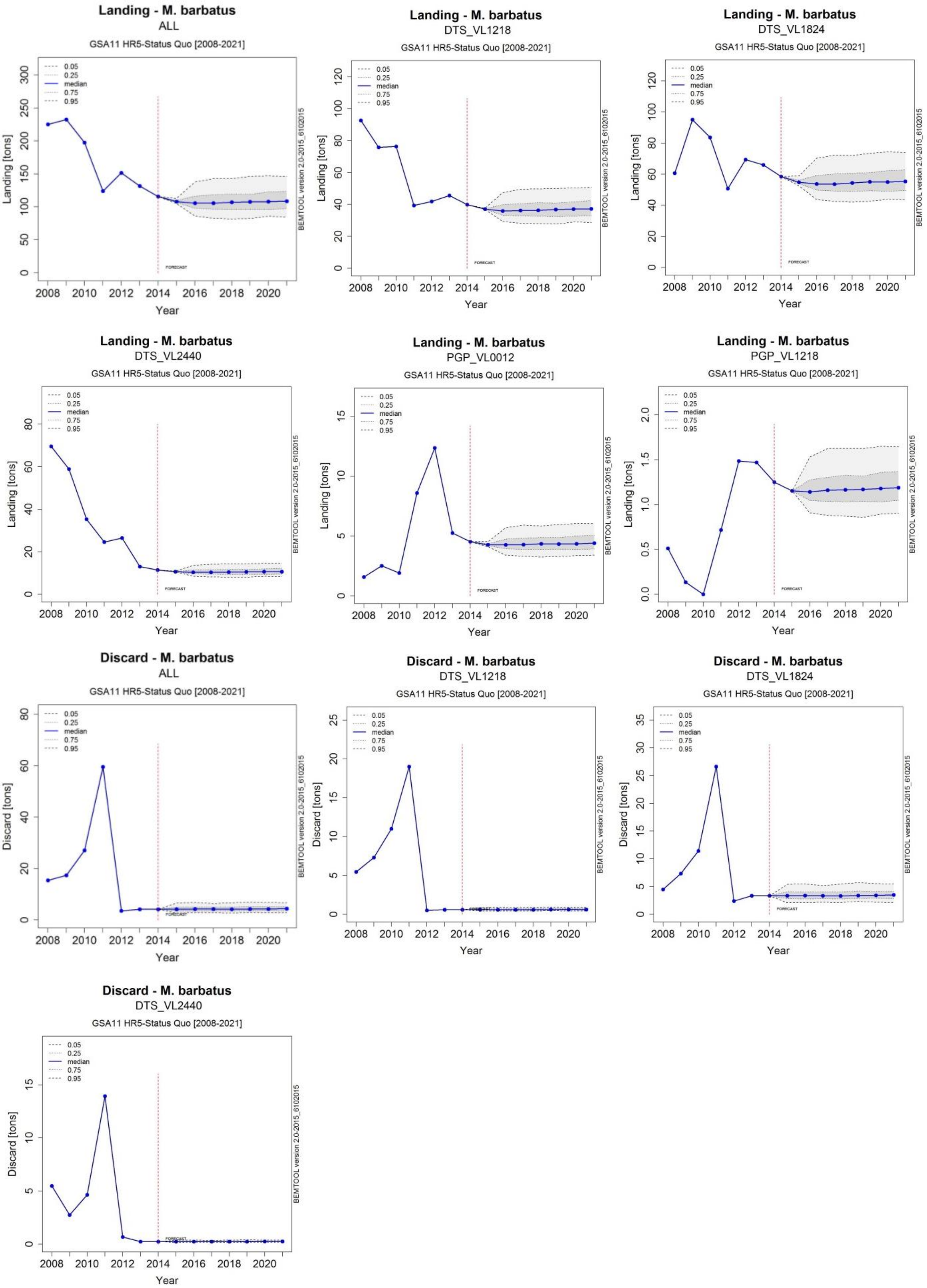


Figure 2.7.8.1.4 Landings and discards of red mullet in the status quo scenario with confidence intervals.

2.7.8.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 5.8 thousand tons of total production generating almost 46 million euro, a decrease by 26% in quantity and 17% in value compared to 2012. The most important fleet segment is the small scale fleet PGP_VL0012, accounting for almost a half of total revenues and total landings. The other fleet segments contribute to the total revenues with similar percentages between 10% by demersal trawlers VL2440 and 16% by the fleet segment PGP VL1218.

As reported in figure 2.7.8.2.1, total revenues of demersal fleets operating in GSA 11 show a reduction by 19% from 2008 to 2013. This is mainly due to the reduction by 22% in total landings registered in the same period. The reduction in revenues is registered for all fleet segments with the exception of the demersal trawlers VL1824, which show an increase by 20%.

In the forecast period, from 2013 to 2021, total landings for the overall fishing sector in the area are expected to decrease by 29% in weight and 26% in value. PGP fleet segments show the strongest reductions in landings, 38% in weight (34% in value) for vessels under 12m and 33% in weight (30% in value) for vessels over 12m.

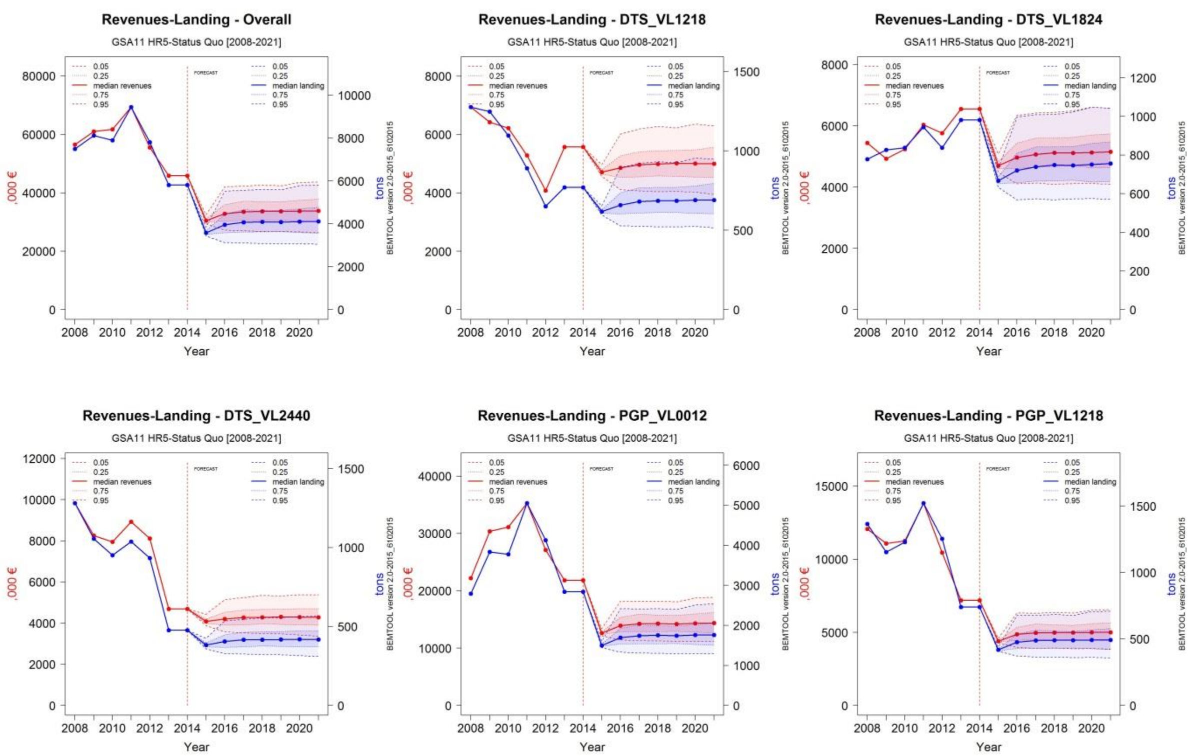


Figure 2.7.8.2.1 Landings weight and value by fleet segment and quantile.

In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is negative for all fleet segments with the exception of the demersal trawlers VL1824. This determines a negative profit for the whole demersal fleet operating in GSA 11 estimated at -2.8 million euro. The negative economic performance for the demersal trawlers was registered also in the previous years, while PGP fleet segments show a strong deterioration in 2012 and 2013.

In the forecast period, net profit for the overall fishing sector is expected to be negative. Negative values are expected for all fleet segments, including the demersal trawlers VL1824. The negative trend is expected to continue under the Status Quo scenario with a further deterioration, which would determine a net loss in 2021 estimated in -9 million euro for the whole fishing sector in the area.

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is lower than 1 for all fleet segments with the exception of the demersal trawlers VL1824. This indicator confirms the negative economic performance of the demersal fleet in GSA 11 for the current and the previous years. The value is lower than 1 for almost all years in the period 2008-2013 for demersal trawlers and show a deterioration for PGP fleet segments in 2012 and 2013.

The ratio between current and break-even revenues (CR/BER) in the forecast period shows a further deterioration for all fleet segments including the demersal trawlers VL1824. Values lower than 1 are expected for all fleet segments in 2021.

Average wage and employment were increasing in the period 2008-2013 for demersal trawlers VL1824 and VL2440. For the forecast period a deterioration of these indicators is expected, that is less marked for the trawlers VL2440.

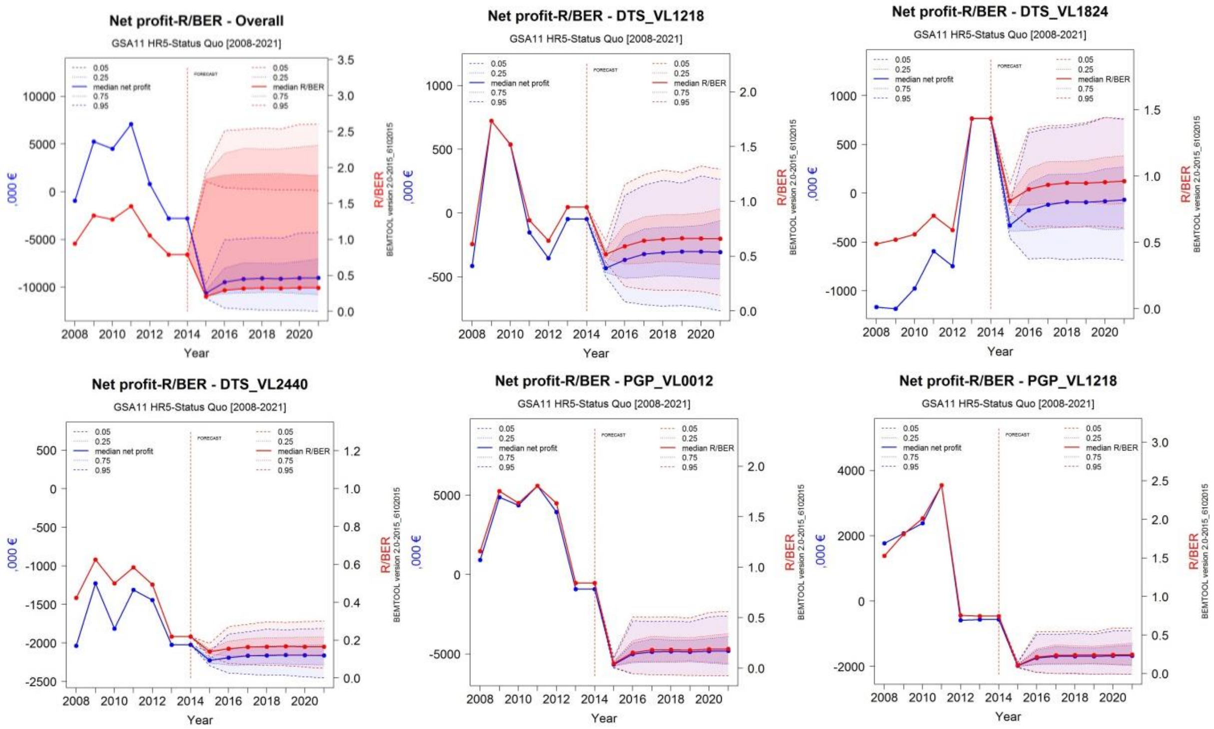


Figure 2.7.8.2.2 Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment and quantile.

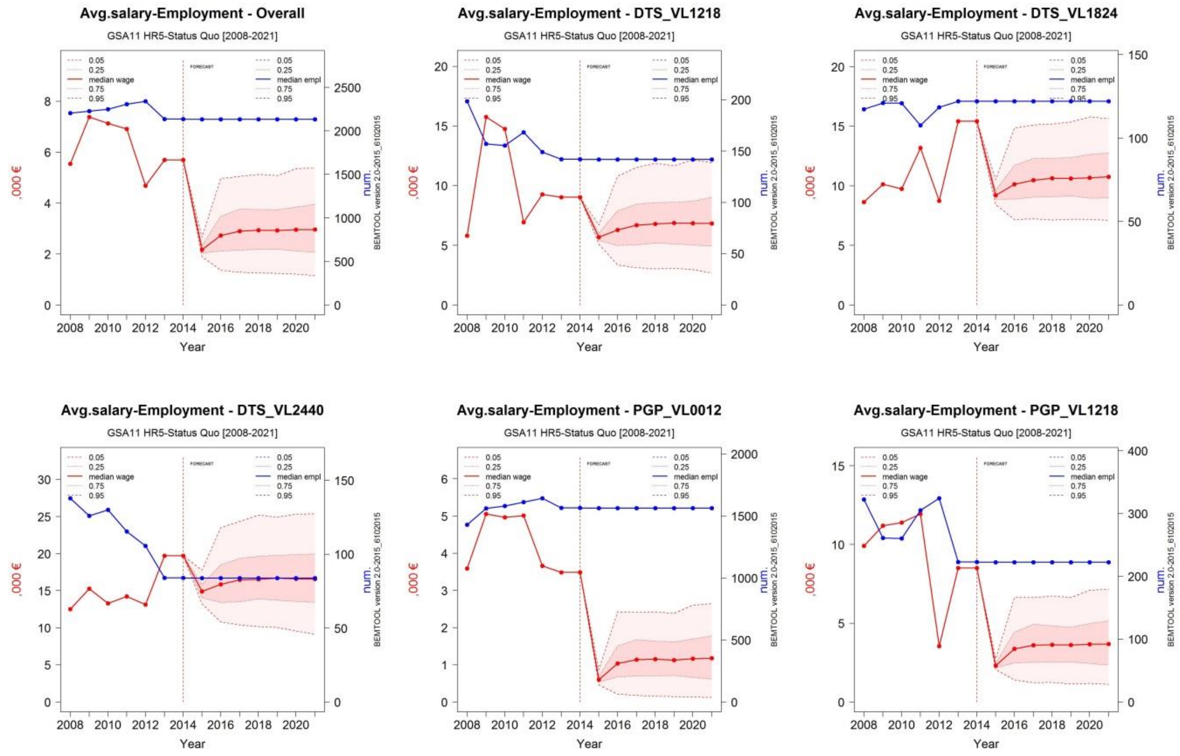


Figure 2.7.8.2.3 Average wage and employment by fleet segment and quantile.

2.7.9 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

According to the state of exploitation of the three demersal stocks in GSA 11, 5 forecast scenarios alternative to status quo have been performed to evaluate the consequences of several management strategies in terms of costs and benefits for the renewal of stocks, fishery sustainability and productive and economic performances of different fleet segments.

2.7.9.1 BIOLOGICAL AND PRESSURE INDICATORS

SSB of all the three stocks considered for the analysis using BEMTOOL showed a sharp increase under Scenario 2 and 4, i.e. those targeting F_{upper} of hake in 2018 and 2020, respectively. The best performance for all the species was observed under Scenario 2, followed by Scenario3 (Fig. 2.7.9.1.1).

These results are consistent with the great benefit that generally the reduction in fishing mortality produces on the indicators if applied in a short timeframe. In addition, Scenario 2 allows to obtain immediately the highest benefit in SSB, respect to the other scenarios that produce an increase in SSB less marked from the first years of the application of the management measures.

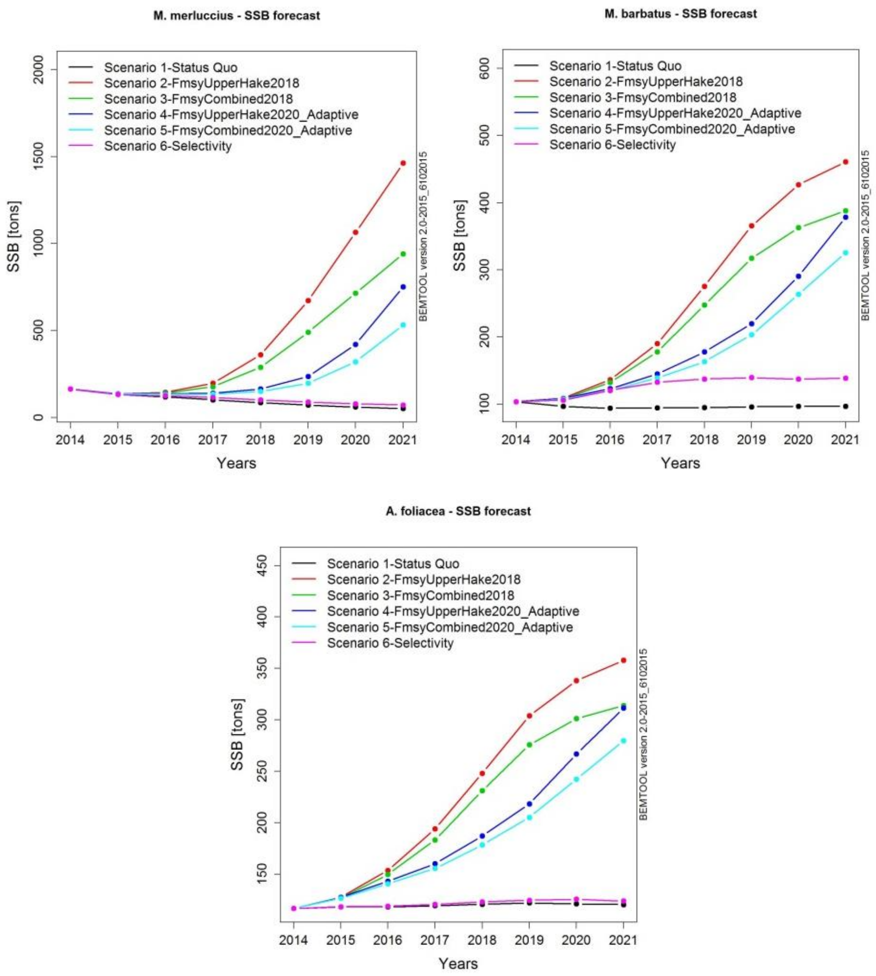


Figure 2.7.9.1.1 **-** SSB of European hake, red mullet, and giant red shrimp in GSA 11: comparison among the different management scenarios.

The main results of the projections carried out in terms of landings and discards of the three stocks by fleet segment are showed in Figures 2.7.9.1.2-2.7.9.1.4.

As regards landings, the best performing scenarios for European hake are Scenarios 2 and 3 in all the fleet segments. Scenario 6 produces a sharp increase in landings in the short period in all the fleet segments, then reaching a plateau. Scenarios 4 and 5 have an intermediate result, with a higher value of Scenario 6 in the long term. Status quo is the worst scenario for the overall fleet and all the fleet segments.

For red mullet, the best performing scenario is Scenario 6, for both landings and discards (increase of landings, decrease in discards). This scenario is better than Status quo, that however is better of all the other scenarios. Scenarios 2 and 3 allow a more rapid rebuilding of the stock than scenarios 4 and 5.

As concerns giant red shrimp landings, all the scenarios reduce remarkably the landings, except scenario 6 that is performing as status quo.

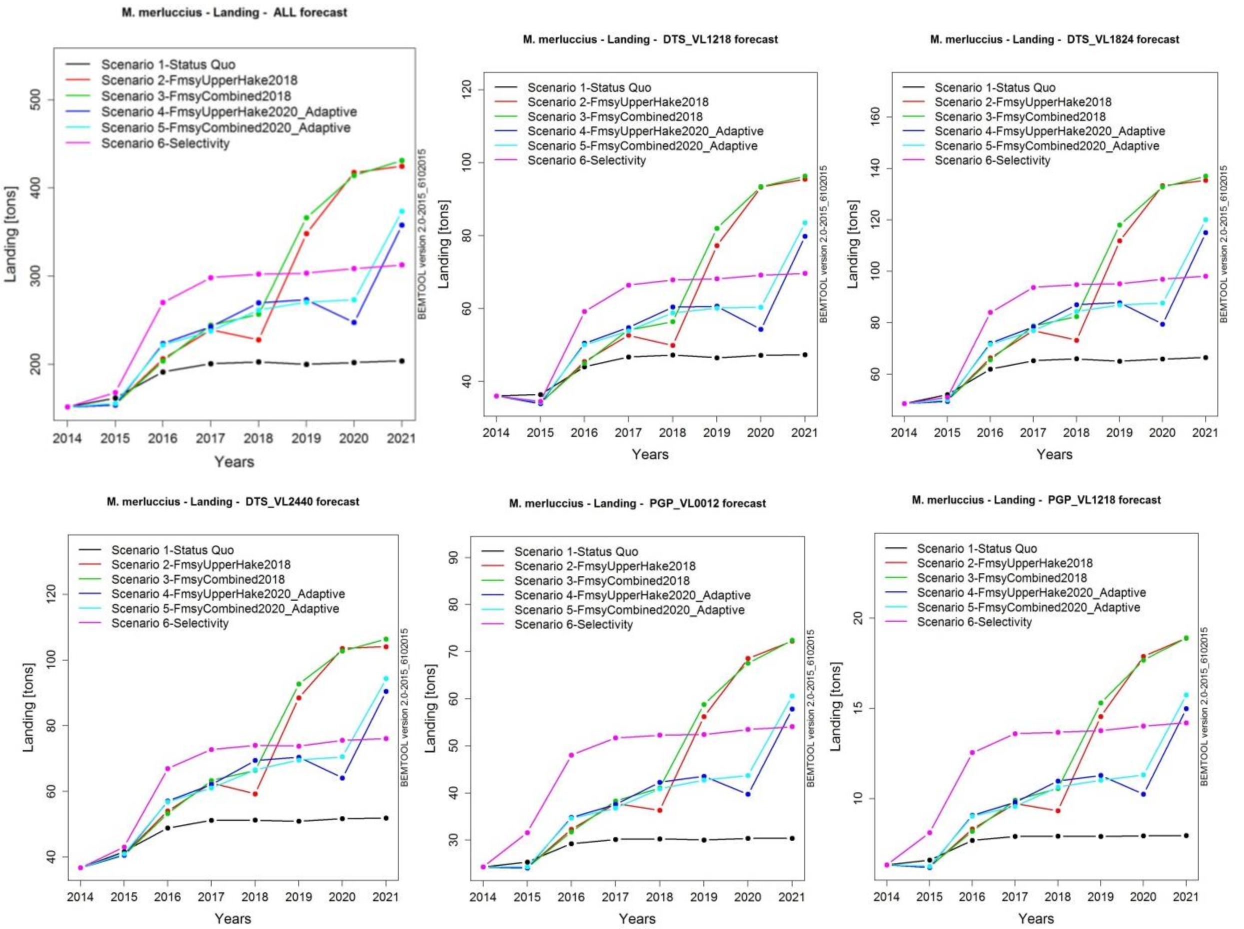
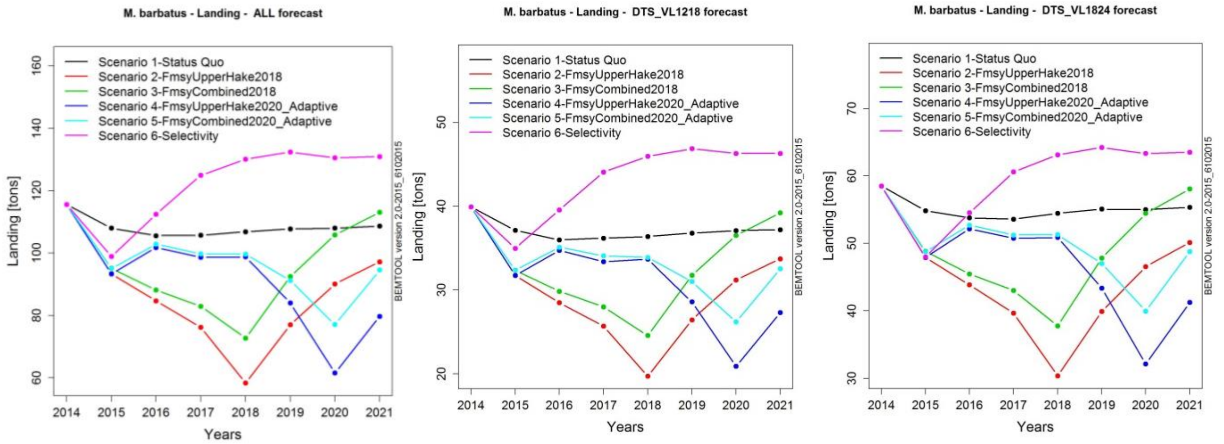


Figure 2.7.9.1.2 Landings of European hake in GSA 11 by fleet segment: comparison among the different management scenarios.



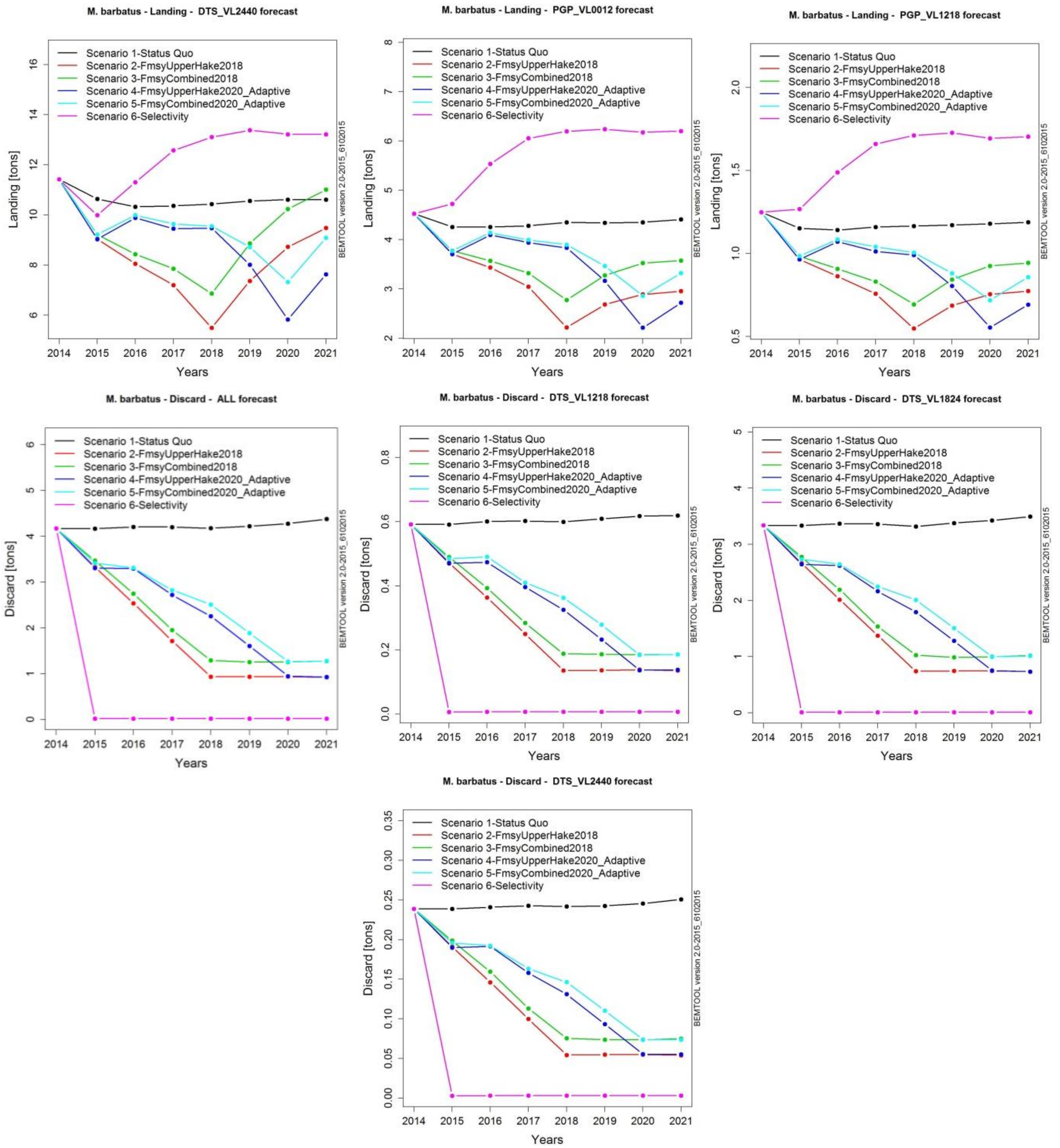


Figure 2.7.9.1.3 Landing and discards of red mullet in GSA 11 by fleet segment: comparison among the different management scenarios.

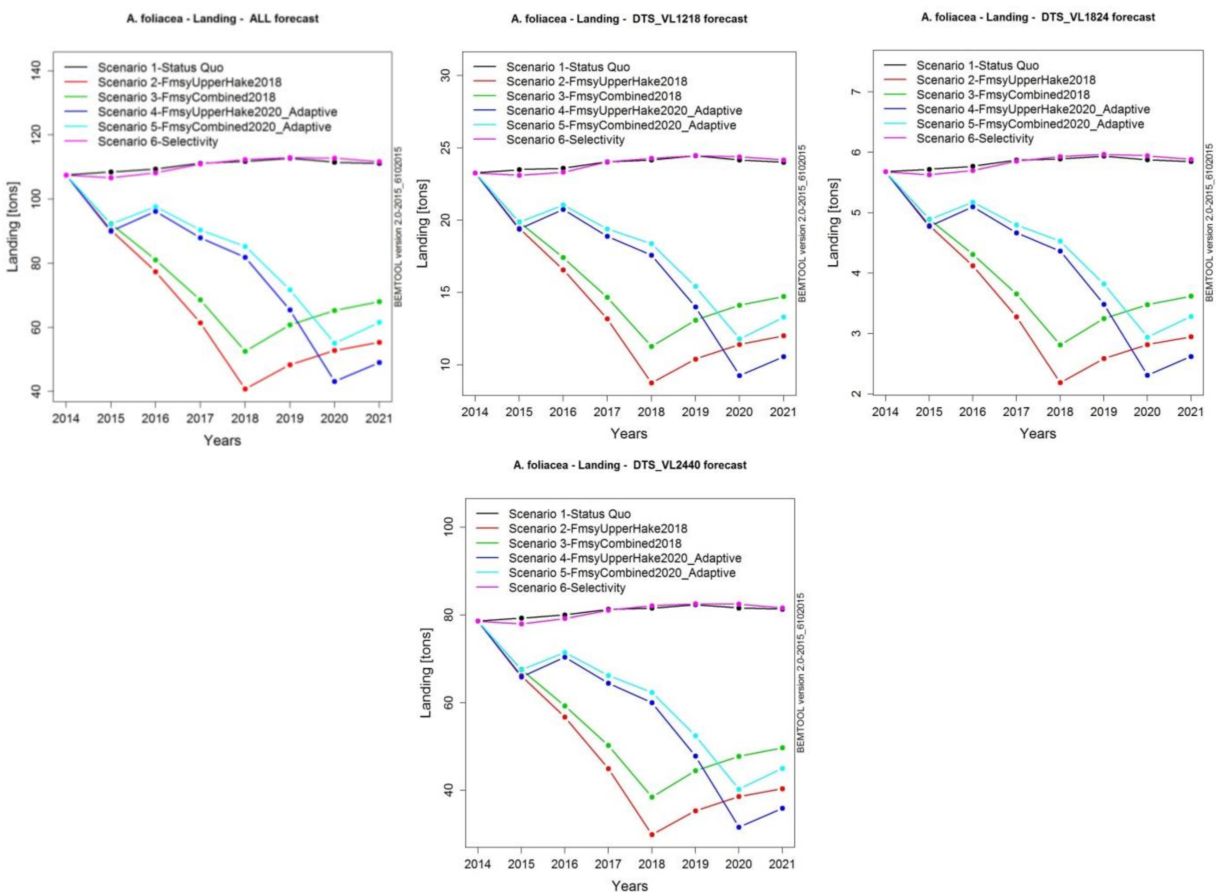


Figure 2.7.9.1.4 Landings of giant red shrimp in GSA 11 by fleet segment: comparison among the different management scenarios.

2.7.9.2 FORECAST OF SOCIO-ECONOMIC INDICATORS

Figure 2.7.9.2.1 shows the expected impact on total revenues deriving from each of the five alternative scenarios. The simulation outcomes are compared with the status quo scenario.

Compared with the Status Quo, in 2021 total revenues for the overall fleet are expected to increase under all the alternative scenarios, except for the trawlers VL1218 and VL2440, for which only scenario 6 performs better than status quo. Scenario 3 is expected to positively influence revenues more than the other scenarios. Also if the adaptive approach for reduction is applied the scenario based on Fmsy combined (scenario 5) performs better than the one based on Fupper of hake (scenario 4). Only for the fleet segments of PGP the status quo is always the worst scenario.

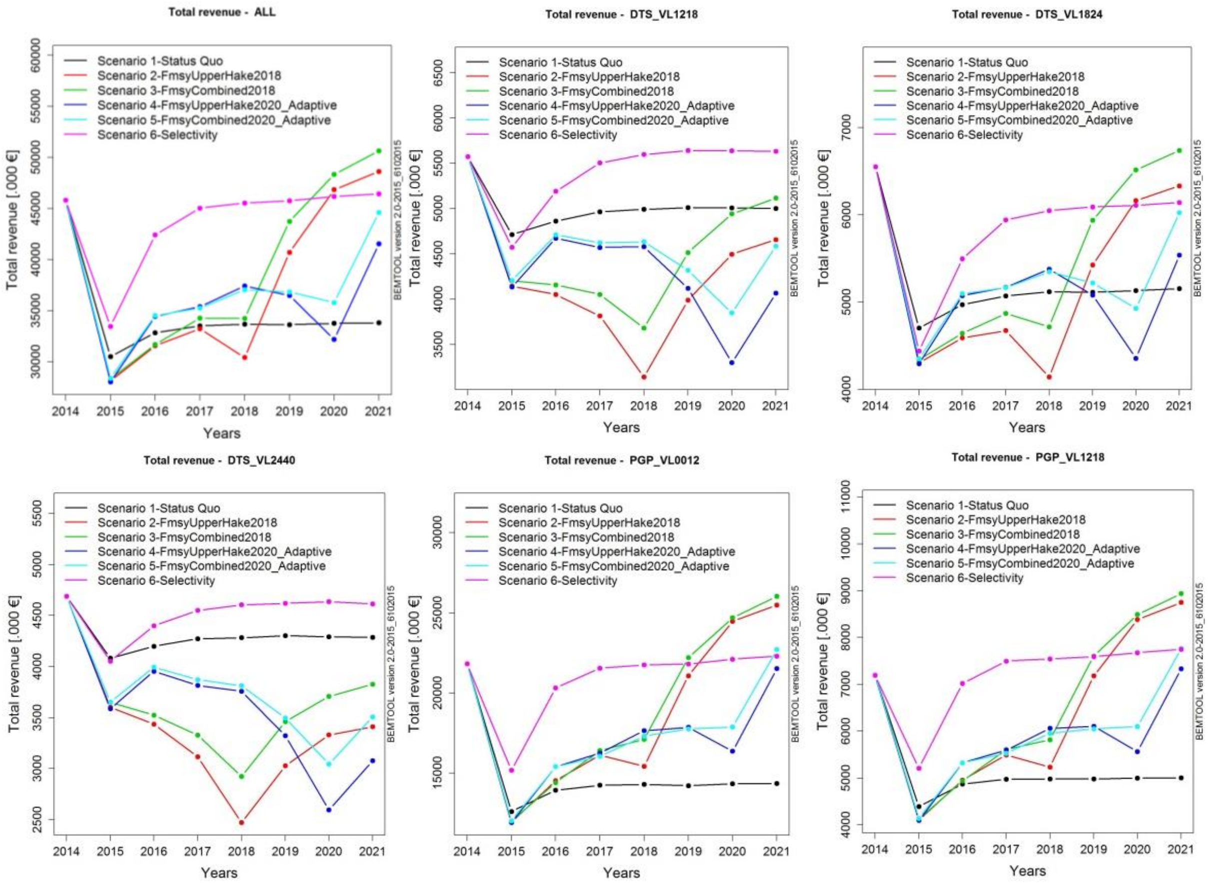


Figure 2.7.9.2.1 Revenues by fleet segment and scenario.

In 2021, the CR/BER ratio under the Status Quo scenario shows values lower than 1 for all fleet segments and for the demersal fishing fleet as a whole. All alternative scenarios would produce benefits for this indicator. All the scenarios, excluding scenario 6, are expected to move the indicator to values higher than 1, except for the trawlers VL2440. Under all scenarios, indeed only the demersal trawlers VL2440 would be still inefficient with a value of CR/BER lower than 1.

Figure 2.7.9.2.3 show the effects simulated by the different scenarios on average salary per man employed. All alternative scenarios are expected to have a better impact on the average salary for the overall fishing fleet rather than the Status Quo scenario. Scenarios 2 and 4 are the best scenarios with an average salary that is 188% and 144% respectively higher than that expected from the Status Quo in 2021.

Comparing with Status Quo results in 2021, all fleet segments are expected to have a higher average salary under all alternative scenarios. Among the alternative scenarios, Scenario 3, followed by scenario 2, are the best ones for all fleet segments.

Even though the average salary is expected to increase significantly for the people employed in the local fishing sector under Scenario 2 and 4, these scenarios would have a relevant social impact. The reduction in the number of vessels foreseen by these scenarios would produce an equivalent decrease in the number of employed people (-7.7%).

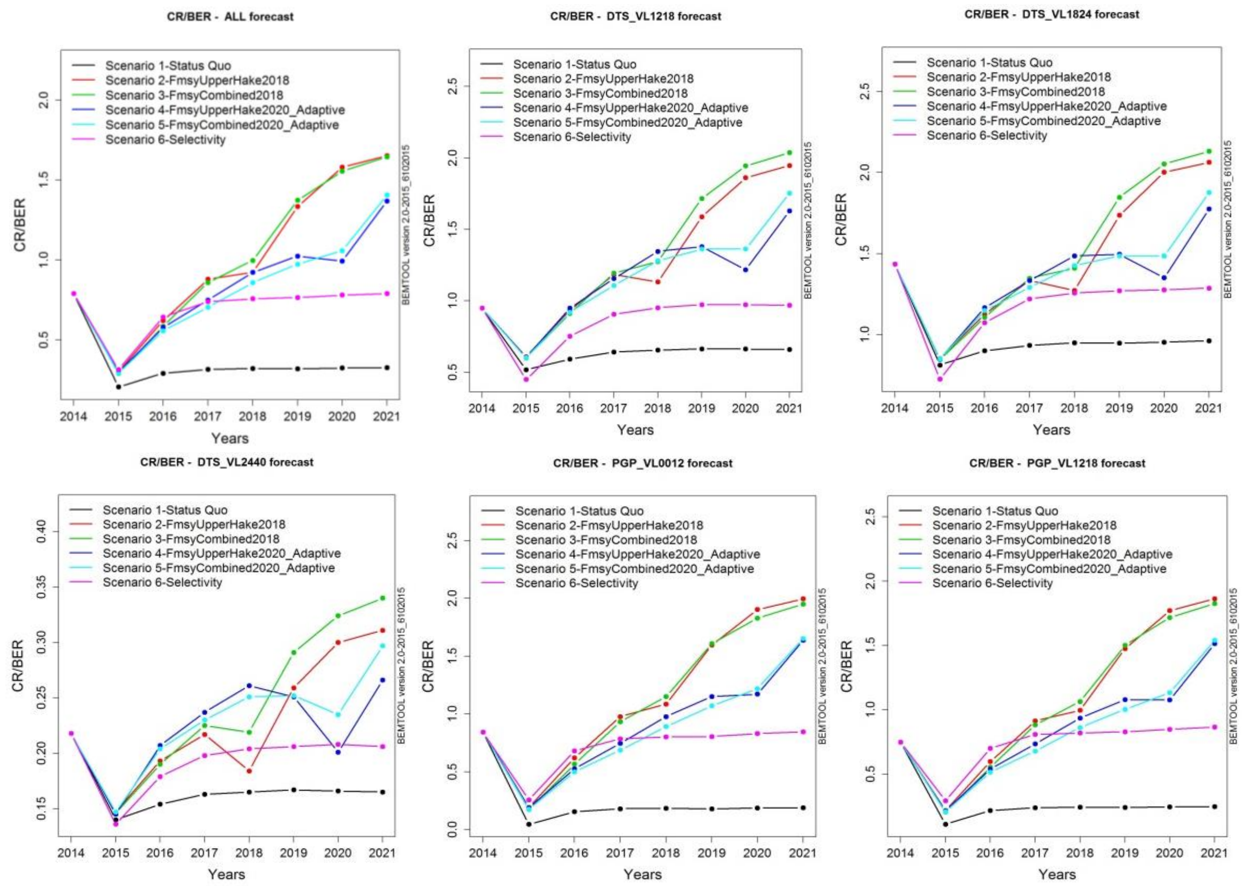


Figure 2.7.9.2.2 Current Revenue to the Break-Even Revenue ratio (CR/BER) by fleet segment and scenario

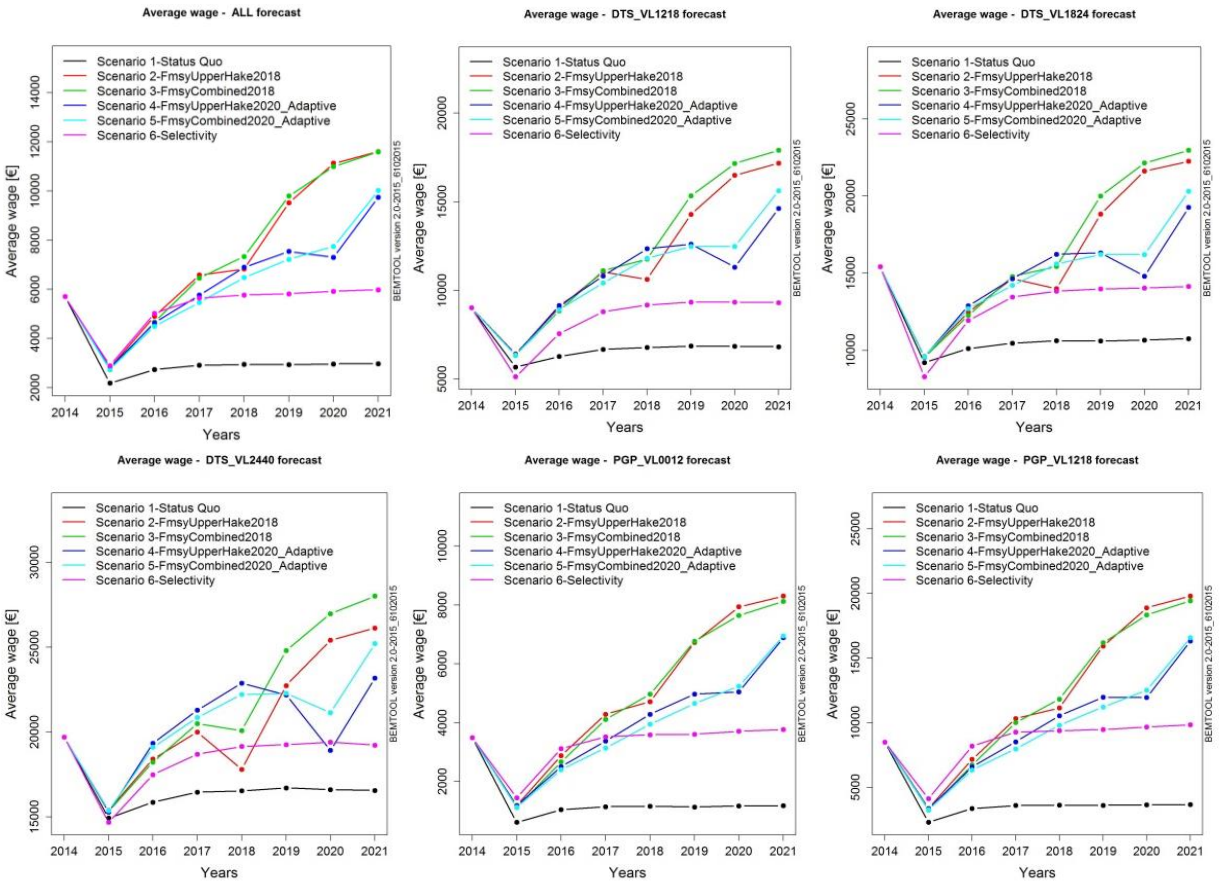


Figure 2.7.9.2.3 Average salary by fleet segment and scenario

2.7.10 REPORT OF THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

According to the radar graph in Figure 2.7.10.1, all the performed scenarios alternative to the Status Quo allow to obtain a benefit on the SSB for the three stocks under investigation and, as can be seen in the table 2.7.10.1, if the rebuilding of SSB is expected to be remarkable for all the stock it appears extraordinary for hake. The productivity of this stock would increase, as reflected by the increase of catches. This will however be neutralised by the decrease of catches for the other stocks, which will remain severely underutilised, especially the giant red shrimp. As a consequence of the increase of hake catches, revenues are expected to increase, while the other indicators as CR/BER are expected to improve given the cost decrease following the considerably reduced activity of the fleet. Also salary is expected to increase, while employment would suffer with a decrease of 8%. Scenarios 2 and 3 are those performing better considering the results of the traffic light table 2.7.10.1.

Results show that the fleet segments more negatively impacted by the management measures are DTS_VL1218 and DTS_VL2440.

In general, all the scenarios alternative to the Status Quo show a decreasing pattern in terms of revenues and employment in all the fleet segments. However, the total revenues in PGP_VL0012 and PGP_VL1218 show a significant increase under all the scenarios alternative to the Status Quo. Also in this case, the best performing scenarios are Scenario 2 and 3.

In 2021, economic performance indicator, the ratio between current and break-even revenues (CR/BER), the ROI and the salary show an improvement in all the fishing fleets under all alternative scenarios compared with the Status Quo. In general, the best performance for these indicators is expected under Scenario 2 and 3.

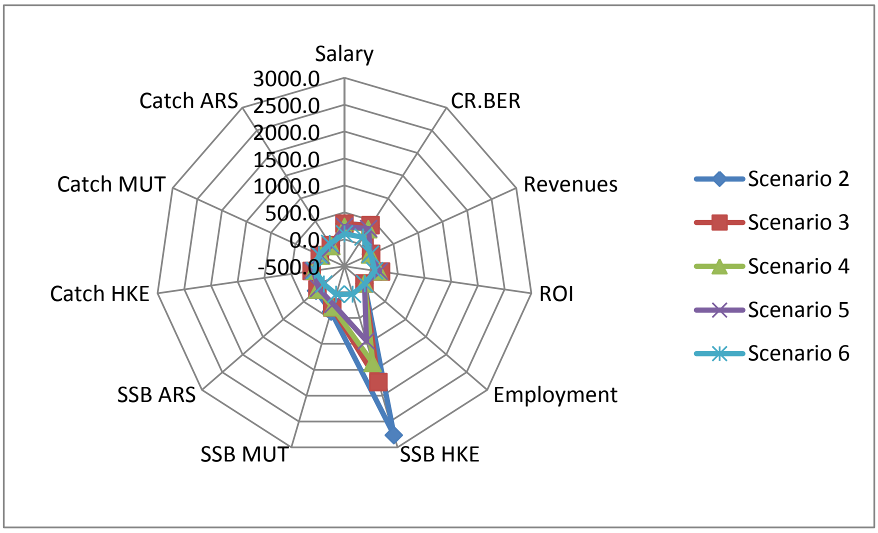


Figure 2.7.10.1 Radar plot for all the fleet. Each line represents a scenario and each point the corresponding percentage of each indicators respect to status quo.

Table 2.7.10.1 Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catches of hake, red mullet and giant red shrimp, salary, CR/BER, employment and revenues for all the fleet. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the exploitation rate E by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo.

Demersals in GSA 11	ALL fleets													
	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB HKE (tons)	SSB MUT (tons)	SSB ARS (tons)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)	F HKE	F MUT	F ARS
SQ (values in 2014 – baseline year)	5698	0.791	-0.065	45822	2136	163	104	116	152	120	108	1.66	1.02	0.58
Scenario 1 (values in 2021)	2969	0.327	-0.209	33807	2133	51	97	120	204	113	111	1.66	1.02	0.58
Scenario 2	290.6	405.3	189	43.9	-8.6	2764.6	376.2	197.4	108.1	-13.2	-50.2	0.34	0.21	0.12
Scenario 3	290.3	403.4	189	49.8	-7.7	1743.3	301.1	160.8	111.3	1.0	-38.8	0.47	0.29	0.17
Scenario 4	228.1	318.5	150	22.9	-8.6	1371.3	291.0	158.7	75.4	-28.8	-55.9	0.34 (2018) 0.87	0.21 (2018) 0.54	0.12 (2018) 0.31
Scenario 5	237.4	330.3	156	31.9	-7.7	943.1	236.2	132.4	83.2	-15.3	-44.6	0.47 (2018) 0.95	0.29 (2018) 0.59	0.17 (2018) 0.33
Scenario 6	101.2	141.8	69	37.4	0.0	39.5	43.2	2.8	53.3	15.8	0.5	1.5	1.02	0.58

Table 2.7.10.2 - Performances of the management scenarios (% of change respect to status quo) simulated in terms of catches of hake, red mullet and giant red shrimp,, salary, CR/BER, employment and revenues by fleet segment. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the fishing mortality Fby target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo.

Fleet segment	ITA11_**DTS_VL1218**							ITA11_**DTS_VL1824**						
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)
SQ (values in 2014 – baseline year)	9033	0.948	5574	142	58.1	34.7	28.2	15422	1.434	6552	122	84.8	71.7	9.0
Scenario 1 (values in 2021)	6836	0.659	5003	142	47.3	37.2	24.0	10763	0.962	5155	122	66.5	55.3	5.8
Scenario 2	151.4	195.4	-6.9	-8.6	101.8	-10.2	-50.0	106.7	114.4	22.8	-8.6	103.7	-13.4	-49.6
Scenario 3	161.9	209.1	2.3	-7.7	103.5	4.5	-38.6	113.4	121.5	30.7	-7.7	106.1	0.5	-38.1
Scenario 4	114.1	147.2	-18.7	-8.6	68.7	-27.3	-56.0	79.0	84.6	7.4	-8.6	73.1	-28.7	-55.1
Scenario 5	128.7	166.2	-8.4	-7.7	76.5	-13.3	-44.6	88.7	95.1	16.9	-7.7	80.6	-15.6	-43.8
Scenario 6	36.4	47.0	12.6	0.0	47.2	22.6	0.7	31.5	33.8	19.1	0.0	47.6	7.8	0.6
Fleet segment	ITA11_DTS_VL2440							ITA11_PGP_VL0012						
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)
SQ (values in 2014 – baseline year)	19707	0.218	4688	84	64.3	12.5	86.9	3484	0.843	21813	1565	47.8	8.3	-
Scenario 1 (values in 2021)	16565	0.165	4286	84	51.8	10.6	81.3	1176	0.190	14359	1563	30.4	4.4	-
Scenario 2	57.8	88.5	-20.4	-8.6	100.9	-12.2	-50.3	606.3	950.0	77.5	-8.6	137.9	-33.0	
Scenario 3	69.1	106.1	-10.7	-7.7	105.3	2.2	-38.9	590.7	925.8	81.2	-7.7	138.4	-18.9	
Scenario 4	39.9	61.2	-28.2	-8.6	74.6	-29.3	-55.8	486.0	761.6	49.9	-8.6	90.3	-38.3	
Scenario 5	52.2	80.0	-18.1	-7.7	82.0	-15.6	-44.7	491.0	769.5	58.1	-7.7	99.5	-24.7	
Scenario 6	16.1	24.8	7.7	0.0	46.8	21.7	0.3	220.3	345.3	55.3	0.0	78.0	40.6	

Fleet segment	ITA11_PGP_VL1218						
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch HKE (tons)	Catch MUT (tons)	Catch ARS (tons)
SQ (values in 2014 – baseline year)	8511	0.748	7195	223	12.4	1.3	-
Scenario 1 (values in 2021)	3684	0.247	5005	222	8.0	1.2	-
Scenario 2	437.5	653.8	74.8	-8.6	137.4	-34.8	
Scenario 3	427.6	639.3	78.6	-7.7	137.5	-20.6	
Scenario 4	343.1	513.0	46.5	-8.6	88.3	-41.7	
Scenario 5	350.3	523.5	55.2	-7.7	97.9	-27.8	
Scenario 6	167.3	250.2	54.8	0.0	78.5	43.3	

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process(AHP), has been used to assess the performances of the alternative fisheries management policies (Rossetto et al., 2015).

The eight indicators used in the analysis are listed in table 2.7.10.3, along with the weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the 'current condition'. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021.

Table 2.7.10.3 Summary of the indicators used in the MCDA

Top level hierarchy	Low level hierarchy	Indicator*	Weight
Socioeconomic	Economic	GVA, ROI or Profit	0.0080
Socioeconomic	Economic	CR.BER	0.0421
Socioeconomic	Social	EMP.	0.1914
Socioeconomic	Social	WAGE (Salary)	0.0641
Biological	Biological conservation	SSB	0.2605
Biological	Biological conservation	F	0.2605
Biological	Biological production	Y (Landing)	0.1373
Biological	Biological production	D	0.0361

* GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; WAGE: Average wage; EMPL: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y: Landing; D: Discard rate.

According to MCDA (Fig. 2.7.10.2), the scenarios 2 and 4, based on Fupper of hake, allow to reach a higher overall utility, with values of 0.42 and 0.39 respectively; these are followed by scenario 3 based on the target of Fmsy combined to 2018 (0.34), while the lowest utility is reached by the status quo (0.22). These results are slightly different from those of the traffic light tables, from which scenario 3, based on Fmsy combined, is expected to perform better than scenario 4. This is probably a consequence of the fact that the conservation component has in the MCDA, as implemented in BEMTOOL, a higher weight than the economic and social component.

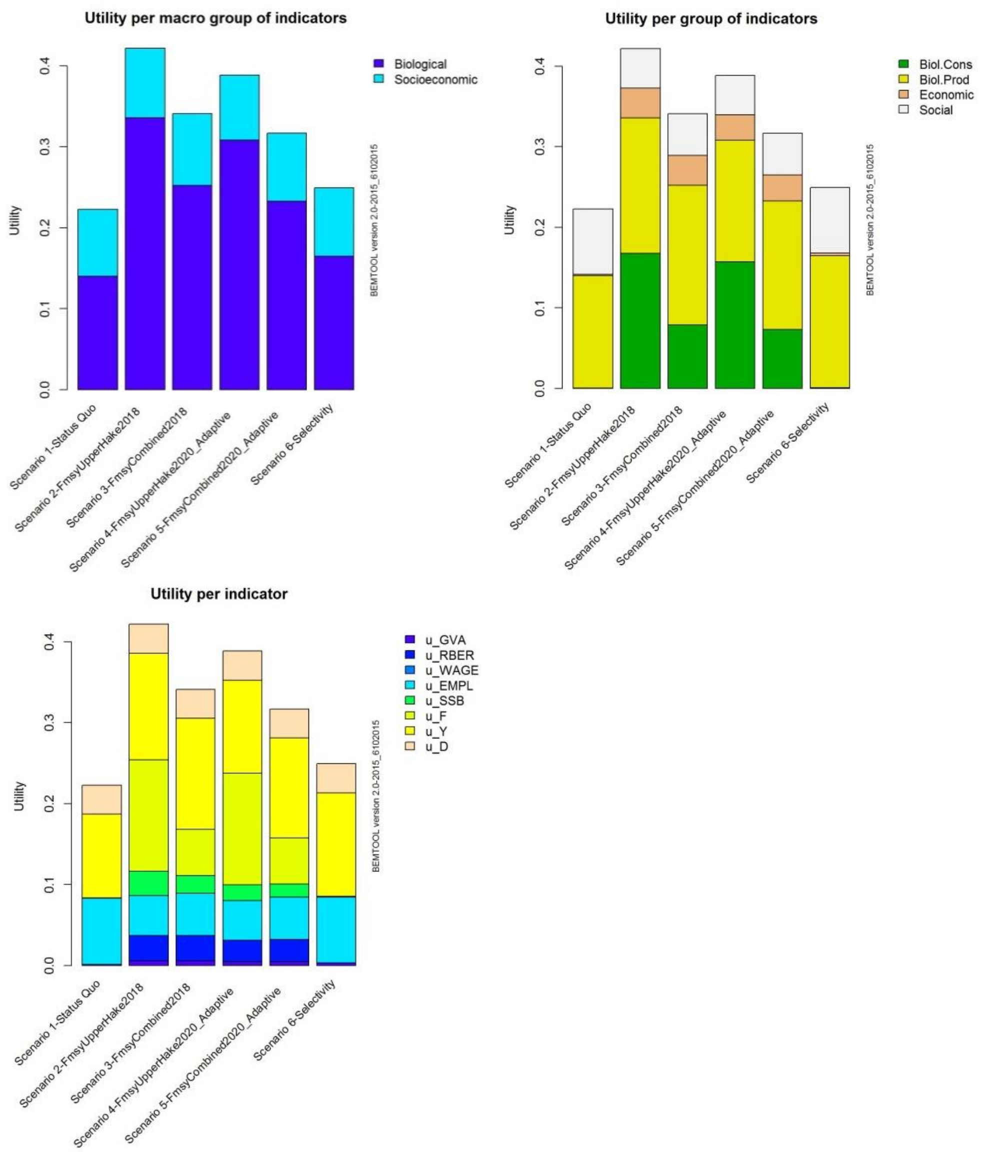


Figure 2.7.10.2 MCDA results: evaluation of the overall utility associated to each management scenario.

2.7.11 DISCUSSION AND CONCLUSION ON DEMERSAL CASE STUDY IN GSA11

The SSB of all the three stocks is expected to remarkably increase, especially for hake, and the better performing scenarios are Scenario 2 and 4.

For European hake, catches will increase in the long term under all the scenarios alternative to the Status Quo. The best performing scenario is Scenario 2, which shows an increase in hake catches of 108% by 2021, compared to those obtained under the Status Quo scenario. Stocks of red mullet and giant red shrimp will remain instead underutilised.

Results show that the fleet segments mostly affected by management measures are expected to be DTS_VL1218 and DTS_VL2440, which revenues will become negative. For these segments all the scenarios alternative to the Status Quo produce some improvements in both social-economic and biological point of view, and the scenarios with better results are expected to be Scenario 2 and 4.

In general, scenarios alternative to the Status Quo show a decreasing pattern in terms of revenues and employment for the fleet segments DTS_VL1218 and DTS_VL2440.

Also in socio-economic terms, Scenarios 2 and 4 show the best performance, although they are associated with a decrease in terms of employment.

In 2021, the economic performance indicator, i.e. the ratio between current and break-even revenues (CR/BER), the Return of Investments (ROI) and the salary are expected to improve in all the fishing fleets under all alternative scenarios compared with the Status Quo. In general, the best performance for these indicators is expected under Scenarios 2 and 4.

A Multi-Criteria Decision Analysis approach (MCDA), combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the scenarios allowing to reach the highest overall utility are scenarios 2 and 4 (overall utility 0.42 and 0.39, respectively), while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.22). Scenarios 2 and 4 were considered to perform better than the other scenarios because biological components weight relatively more than the economic and social ones in MCDA.

There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment due to the lack of a reliable stock-recruitment relationships. However, the measures proposed from BEMTOOL are conservative enough to be efficient even against recruitment failures.

In addition, the methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly in the period 2015-2020; unless as a consequence of the management measure enforced. Further a full compliance to the measures applied is also assumed.

The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan to focus on stock-by-stock effort reduction for achieving individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile.

Better selection of fish size could be achieved by fishing gear modification, as well as spatio-temporal fishing closures. However, current data and models available do not permit to fully explore the effect of spatial closure.

ANNEX F –INPUTS FOR MODELLING DEMERSAL FISHERIES IN GSA11

F.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL FISHERIES IN GSA11

The data used for the parameterization of the biological and the pressure module for *M. merluccius* and *A. foliacea* come from the assessment carried out at the STECF EWG 15-11 held in September 2015. The input for biological and pressure modules for M. barbatus are from the STECF EWG 13-19 held in March 2013.

The methodologies used for the assessment are Extended Survivor Analyses (XSA, Darby and Flatman, 1994) for all the stocks.

GROWTH PARAMETERS OF DEMERSAL SPECIES IN GSA11

The growth parameters and the length-weight relationship coefficients for the three species are listed in the table F.1.1.

The life span has been set to 6 years for European hake, 5 for red mullet, and 5 years for giant red shrimp.

Tab. F.1.1 - Growth parameters for European hake in GSA 11.

Parameter	European hake	Red mullet	Giant red	Giant red
Linf (mm)	1007	291	42.71	70.7
K	0.2	0.41	0.77	0.583
t_0	-0.1	-0.39	-0.27	-0.27
a (mm/g)	0.00000227	0.0000053	0.0006	0.0006
b (mm/g)	3.2	3.12	2.8347	2.8347

RECRUITMENT OF DEMERSAL SPECIES IN GSA11

For all the stocks a reliable stock recruitment relationship is not available, given also the shortness of the time series. For this reason a recruitment vector has been used for the simulation (past and present time) and a constant value for the projections.

The recruitment figures of *M. merluccius*, *M. barbatus* and *A. foliacea* were from stock assessments (XSA results) and are related to age 0 (Table F.1.2).

The age of recruitment of the three species has been set to 2 months.

Tab. F.1.2 - Recruitment by year used in simulation phase European hake in GSA 11.

Year	European hake	Red mullet	Giant red shrimp
2008	294555.4	358690.4	320988
2009	134497.8	151258.7	329184
2010	360000	258561.3	302256
2011	258144.6	276961	236388
2012	53720.59	158210.9	292896
2013	49986.19	158210.9	221011.2
2014	185695.2	158210.9	221011.2

For European hake ,the number of recruits entering in the population has been equally split among months (monthly proportion 0.083) according to the recruiting characteristics ofthe species. Same split was used for giant red shrimp, while for red mullet the number of recruits entering in the population has been monthly split in order to take into account the seasonal recruitment (from April to August, Tab. F.1.3).

Tab. F.1.3 - Proportions of recruits entering each year in the population for red mullet in GSA 11.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0.1	0.2	0.4	0.2	0.1	0	0	0	0

MATURITY AND SEX RATIO OF DEMERSAL SPECIES IN GSA11

The size at first maturity (Lm50%) and maturity range by species are reported in the table F.1.4. These parameters have been estimated within DCF on biological sampling data.

Tab. F.1.4 - Maturity parameters for the 3 stocks in demersal fisheries GSA 11 case study

Length in mm	**Lm50%**			**MR =Lm75%-Lm25%**		
Species	**Males**	**Females**	**Combined**	**Males**	**Females**	**Combined**
M. merluccius	330	330		40	80	
M. barbatus			110			10
A. foliacea			40			2

NATURAL MORTALITY OF DEMERSAL SPECIES IN GSA11

The natural mortality at age was estimated using the Prodbiom method (Abella et al., 1997). In the table F.1.5 the natural mortality rates by age class for the 3 stocks are reported.

Tab. F.1.5 - Natural mortality for European hake in GSA 11.

Age	European hake M	Red mullet M	Giant red shrimp M
0	1.15	1.3	1.17
1	0.57	0.45	0.58
2	0.46	0.27	0.46
3	0.41	0.24	0.41
4	0.38	0.24	0.36
5+	0.37		

TOTAL MORTALITY OF DEMERSAL SPECIES IN GSA11

The total mortality for the 3 stocks has been derived from the natural mortality and the overall fishing mortality, it is reported in the table F.1.6.

Tab. F.1.6 Total mortality by species and year

Stock	2008	2009	2010	2011	2012	2013	2014
M. merluccius	2.00	1.60	2.30	2.50	1.60	2.30	2.73
M. barbatus	1.29	1.31	1.58	1.50	1.50	1.50	1.50
A. foliacea	1.35	1.76	1.44	1.39	1.41	1.17	1.17

F.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERIES IN GSA11

The Z-mode of ALADYM model has been used in BEMTOOL for all the stocks.

M. merluccius

The F-at-age by year from XSA model is summarized in the following table. The age range used for calculation of average F for hake was 0-3.

Table F.2.1 - Overall fishing mortality for hake in GSA 11 (XSA model).

age	2008	2009	2010	2011	2012	2013	2014
0	1.38	0.96	1.15	1.81	0.41	0.98	0.95
1	2.47	1.71	1.53	2.66	2.02	2.50	2.47
2	1.52	1.08	2.20	1.83	1.50	2.35	1.88
3	0.61	0.52	2.16	1.62	0.59	1.53	1.12
4	1.57	1.23	2.20	1.96	1.38	2.26	1.86
5+	1.57	1.23	2.20	1.96	1.38	2.26	1.86

A. foliacea

The F-at-age by year from XSA model is summarized in the following table. The age range used for calculation of average F for giant red shrimp was 0-3.

Table F.2.2 - Overall fishing mortality for giant red shrimp in GSA 11 (XSA model).

Age	2008	2009	2010	2011	2012	2013	2014
0	0.10	0.25	0.06	0.33	0.15	0.05	0.13
1	0.47	1.01	0.90	0.99	0.83	0.56	0.96
2	0.85	1.14	0.98	1.02	0.68	1.02	0.58
3	0.06	1.39	0.71	0.42	0.99	0.18	0.32
4+	0.06	1.39	0.71	0.42	0.99	0.18	0.32

M. barbatus

The F-at-age by year from XSA model is summarized in the following table. For 2013 and 2014, the average of F-at-age for the period 2010-2012 was assumed. The age range used for the calculation of average F for red mullet was 1-3.

Table F.2.3 - Overall fishing mortality for red mullet in GSA 11 (XSA model).

Age	2008	2009	2010	2011	2012	2013	2014
0	0.72	0.25	0.24	0.76	0.10	0.37	0.37
1	1.59	1.09	1.75	1.57	1.54	1.62	1.62
2	1.10	0.71	1.05	1.18	0.86	1.03	1.03
3+	1.10	0.71	1.05	1.18	0.86	1.03	1.03

SELECTIVITY OF DEMERSAL SPECIES IN GSA11

In the following tables for each fleet segment the selectivity used for the modelization of the past/present and future are reported and in case of trawlers the parameters of the different forecast scenarios are specified.

Table F.2.4 – Selectivity for European hake in GSA 11 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA11_DTS_VL1218	2008-2010	Ogive with deselection	88	7.5	483
	2011-2014	Ogive with deselection	88	7.5	488
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	88	7.5	488
	2015-2021 (SM)	Ogive with deselection	146	7.5	500
ITA11_DTS_VL1824	2008-2010	Ogive with deselection	88	7.5	500
	2011-2014	Ogive with deselection	88	7.5	488
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	88	7.5	488
	2015-2021 (SM)	Ogive with deselection	146	7.5	500
ITA11_DTS_VL2440	2008-2010	Ogive with deselection	88	7.5	500
	2011-2014	Ogive with deselection	88	7.5	488
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	88	7.5	488
	2015-2021 (SM)	Ogive with deselection	146	7.5	500
ITA11_PGP_VL0012	2008-2012	Ogive with deselection	300	150	0
	2013-2014	Ogive with deselection	300	150	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	300	150	0
	2015-2021 (SM)	Ogive with deselection	300	150	0
ITA11_PGP_VL1218	2008-2012	Ogive with deselection	304	160	0
	2013-2014	Ogive with deselection	300	150	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	300	150	0
	2015-2021 (SM)	Ogive with deselection	300	150	0

Table F.2.5 – Selectivity for giant red shrimp in GSA 11 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA11_DTS_VL1218	2008-2010	Ogive with deselection	14.5	7.4	0
	2011-2014	Ogive with deselection	14.5	7.4	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	14.5	7.4	0
	2015-2021 (SM)	Ogive with deselection	18.7	7.4	0
ITA11_DTS_VL1824	2008-2010	Ogive with deselection	14.5	7.4	0
	2011-2014	Ogive with deselection	14.5	7.4	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	14.5	7.4	0
	2015-2021 (SM)	Ogive with deselection	18.7	7.4	0
ITA11_DTS_VL2440	2008-2010	Ogive with deselection	14.5	7.4	0
	2011-2014	Ogive with deselection	14.5	7.4	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	14.5	7.4	0
	2015-2021 (SM)	Ogive with deselection	18.7	7.4	0

Table F.2.6 – Selectivity for red mullet in GSA 11 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA11_DTS_VL1218	2008-2010	Ogive with deselection	84	2.32	0
	2011-2014	Ogive with deselection	78	2.32	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	78	2.32	0
	2015-2021 (SM)	Ogive with deselection	116	2.32	0
ITA11_DTS_VL1824	2008-2010	Ogive with deselection	84	2.32	0
	2011-2014	Ogive with deselection	78	2.32	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	78	2.32	0
	2015-2021 (SM)	Ogive with deselection	116	2.32	0
ITA11_DTS_VL2440	2008-2010	Ogive with deselection	84	2.32	0
	2011-2014	Ogive with deselection	78	2.32	0
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	78	2.32	0
	2015-2021 (SM)	Ogive with deselection	116	2.32	0
ITA11_PGP_VL0012	2008-2012	Ogive with deselection	104	10	224
	2013-2014	Ogive with deselection	100	10	230
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	100	10	230
	2015-2021 (SM)	Ogive with deselection	100	10	230
ITA11_PGP_VL1218	2008-2012	Ogive with deselection	104	10	224
	2013-2014	Ogive with deselection	100	10	230
	2015-2021 (StatusQuo - DM50)	Ogive with deselection	100	10	230
	2015-2021 (SM)	Ogive with deselection	100	10	230

EFFORT OF DEMERSAL FISHERIES IN GSA11

The monthly effort variables used to simulate the past and current years by fleet segment are listed in the following table. Data for 2014 were assumed equal to 2013.

Table F.2.7 - Effort for the selected fleet segment in GSA 11.

Effort Variable	ITA11_DTS_VL1218													
	2008	2009	2010	2011	2012	2013								
average monthly GT	14.4	16.1	16.7	15.9	14.4	15.2								
average monthly KW	121.4	129.4	131.	130.5	115.9	124.5								
number of vessels	53	47	49	45	49	55								
annual fishing days	193	204	175	160	130	159								
Effort Variable	**ITA11_DTS_VL1824**							**ITA11_DTS_VL2440**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
average monthly GT	58.4	59.1	60.1	60.5	61.5	60.5		144.1	144	142.9	146.2	145.4	144.3	
average monthly KW	268.8	267.3	262.	271	274.2	268.3		424.3	422.7	416.5	423	424.8	417.2	
number of vessels	35	34	32	27	30	31		25	23	22	20	19	18	
annual fishing days	124	126	136	154	148	156		195	197	181	206	205	130	
Effort Variable	**ITA11_PGP_VL0012**							**ITA11_PGP_VL1218**						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
average monthly GT	2.2	2.1	2.1	2.1	2	2.1		14	13.1	13.2	13.7	13.2	12.7	
average monthly KW	34	33.6	33.7	32.9	31.4	33		154.6	155.8	155.2	160.5	163.1	163.2	
number of vessels	932	940	949	970	993	941		123	113	108	115	115	106	
annual fishing days	100	138	134	147	132	128		116	135	131	127	121	115	

LANDINGS AND DISCARDS OF DEMERSAL FISHERIES IN GSA11

Landings were obtained from the data collected and reviewed by the SEDAF project and presented in the *WP2-Collation and review on the main socio-economic information on the main fisheries* deliverable. Data for 2014 were assumed equal to 2013.

M. merluccius

The landing data for hake by fleet segment used to parameterize the model are listed in the following table. Data for 2014 were assumed equal to 2013.

Table F.2.8 - Landings for European hake by fleet segment in GSA 11 (kg).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	87320	76778	85515	68761	40692	58081
ITA11_DTS_VL1824	56790	61788	70996	65275	41253	84840
ITA11_DTS_VL2440	134583	118049	159879	145673	98389	64263
ITA11_PGP_VL0012	28989	48685	89535	81031	64411	47766
ITA11_PGP_VL1218	31465	26888	16637	25115	16609	12426
Total	339147	332188	422562	385855	261354	267376

A. foliacea

The landing data for pink shrimp by fleet segment used to parameterize the model are listed in the following table. Data for 2014 were assumed equal to 2013.

Table F.2.9 - Landings for giant red shrimp by fleet segment in GSA 11 (kg).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	681	0	0	0	0	28246
ITA11_DTS_VL1824	6985	14814	30580	32388	23782	8984
ITA11_DTS_VL2440	59450	102620	100798	95697	93475	86885
Total	67116	117434	131378	128085	117257	124115

M. barbatus

The landing data for red mullet by fleet segment used to parameterize the model are listed in table below. Data for 2014 were assumed equal to 2013.

Table F.2.10 1 - Landings for red mullet by fleet segment in GSA 11 (kg).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	108602	75512	85096	57988	38815	34674
ITA11_DTS_VL1824	71224	84876	99131	72436	71283	71676
ITA11_DTS_VL2440	83185	47466	36490	31696	25615	12541
ITA11_PGP_VL0012	2017	2707	4684	8465	18326	8322
ITA11_PGP_VL1218	684	184	0	3174	2635	1299
Total	265712	210745	225401	173759	156674	128512

Total landing

The total landing data by fleet segment used to parameterize the model are listed in the table below. For 2014 the same landings as 2013 were assumed.

Table F.2.11 2 - Total landing by fleet segment in GSA 11 (kg).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	1276619	1247860	1096430	890045	651152	770055
ITA11_DTS_VL1824	779085	826865	837697	945009	837670	981774
ITA11_DTS_VL2440	1281731	1055384	950790	1037774	933520	476721
ITA11_PGP_VL0012	2791176	3837984	3777417	5056088	4130667	2843021
ITA11_PGP_VL1218	1366189	1154627	1229182	1523237	1254150	740550
Total	7494801	8122721	7891516	9452152	7807159	5812121

F.3 INPUT OF THE ECONOMIC MODULE OF DEMERSAL FISHERIES IN GSA11

Data 2008-2013 for the estimation of the socio-economic parameters were obtained from the National Programs of the EU Data Collection Framework and are in line with data collected in the WP2 - Collation and review on the main socio-economic information on the main fisheries. The economic data of the selected fleet segments used to parameterize the economic functions in the projections are reported in the following paragraphs.

REVENUES OF DEMERSAL FISHERIES IN GSA11

The revenues by fleet segment for hake, giant red shrimp, red mullet and the total revenues are reported in the tables below. In the projections, the prices have been modelled according to the revenues and the landings by fleet segment.

M. merluccius

Table F.3.1 - Revenues of hake by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	484174	477863	522058	457620	285641	314575
ITA11_DTS_VL1824	441821	464511	413006	443237	315805	528710
ITA11_DTS_VL2440	871745	680496	746314	833152	721694	445910
ITA11_PGP_VL0012	190223	379964	828857	666980	481176	328276
ITA11_PGP_VL1218	284228	228177	139112	180164	123845	75916
Total	**2272191**	**2231012**	**2649348**	**2581154**	**1928161**	**1693387**

A. foliacea

Table F.3.2 - Revenues of giant red shrimp by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	9727	0	0	0	0	557327

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1824	120447	281821	549340	565685	341422	165037
ITA11_DTS_VL2440	1051596	1891318	1741455	1733789	1455464	1426619
Total	**1181770**	**2173139**	**2290795**	**2299474**	**1796886**	**2148982**

M. barbatus

Table F.3.3 Revenues of red mullet by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	903709	545199	527517	349745	215548	218876
ITA11_DTS_VL1824	708999	584721	787780	576548	600831	435290
ITA11_DTS_VL2440	676509	271293	302509	239392	222087	94337
ITA11_PGP_VL0012	13672	20580	22180	58380	106296	43977
ITA11_PGP_VL1218	8196	1822	0	23308	15776	7419
Total	**2311084**	**1423615**	**1639986**	**1247374**	**1160539**	**799899**

Total revenues

Table F.3.4 - Total revenues by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	6944264	6427395	6223184	5288155	4079011	5574425
ITA11_DTS_VL1824	5441939	4929708	5237778	6035421	5761314	6551824
ITA11_DTS_VL2440	9832384	8253897	7945323	8926983	8112272	4687790
ITA11_PGP_VL0012	22211720	30344333	31097367	35294788	27098017	21812716
ITA11_PGP_VL1218	12076845	11077360	11259653	13841897	10457989	7195158
Total	**56507152**	**61032692**	**61763305**	**69387245**	**55508602**	**45821913**

PROFIT OF DEMERSAL FISHERIES IN GSA11

The following table F.3.5 reports the profit of demersal fishery in GSA11 by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table F.3.5 - Profit by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	-415519	723545	536263	-151472	-353652	-46424
ITA11_DTS_VL1824	-1166182	-1184506	-974321	-593277	-746578	763382
ITA11_DTS_VL2440	-2036997	-1225972	-1812348	-1311047	-1443315	-2024243
ITA11_PGP_VL0012	917928	4869130	4375796	5600744	3940161	-922604
ITA11_PGP_VL1218	1770254	2074893	2380986	3547609	-581148	-561751
Total	-930516	5257090	4506376	7092557	815469	-2791641

COSTS OF DEMERSAL FISHERIES IN GSA11

In the following tables from F.3.6 to F.3.17 all the data of costs by fleet segment as taken into account in the simulation phase of the case study (past and present years) are reported.

Table F.3.6 - Total variable costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	4953992	2096754	2206145	3244040	1926402	3272128
ITA11_DTS_VL1824	3066561	2176520	2586444	3030479	3432597	2023454
ITA11_DTS_VL2440	5972224	3706228	3849107	4900886	4828902	2240706
ITA11_PGP_VL0012	8332417	9047099	9913068	12658648	9205494	10768142
ITA11_PGP_VL1218	3570300	3263123	3325091	3929967	7358264	3361852
Total	**25895494**	**20289724**	**21879855**	**27764021**	**26751660**	**21666282**

Table F.3.7 - Other variable costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	867879	591475	555368	483490	360782	529144
ITA11_DTS_VL1824	582741	540106	557391	585970	592124	274030
ITA11_DTS_VL2440	1405807	901768	839777	944921	844042	341766
ITA11_PGP_VL0012	3638344	4888796	4877054	5368986	3578177	3127651
ITA11_PGP_VL1218	2260152	2234358	2162552	2563149	1904501	2392192
Total	**8754923**	**9156503**	**8992141**	**9946516**	**7279627**	**6664783**

Table F.3.8 - Fuel costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	4086113	1505279	1650777	2760550	1565620	2742984
ITA11_DTS_VL1824	2483820	1636414	2029054	2444509	2840473	1749424
ITA11_DTS_VL2440	4566417	2804460	3009329	3955965	3984860	1898940
ITA11_PGP_VL0012	4694073	4158303	5036013	7289663	5627317	7640491
ITA11_PGP_VL1218	1310148	1028765	1162539	1366819	5453763	969660
Total	**17140571**	**11133221**	**12887713**	**17817505**	**19472033**	**15001499**

Table F.3.9 - Maintenance costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	184447	148952	158736	144833	136900	170977
ITA11_DTS_VL1824	244692	237667	222195	195797	209706	123909
ITA11_DTS_VL2440	639770	575685	554363	539458	490398	226710
ITA11_PGP_VL0012	2046721	2050951	2064663	2012002	1713971	632524
ITA11_PGP_VL1218	184254	250336	237088	262419	164916	271970
Total	**3299884**	**3263591**	**3237045**	**3154509**	**2715892**	**1426090**

Table F.3.10 - Total fixed costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	235937	198615	211735	193750	219336	137876

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1824	192991	187681	175463	147031	165601	44930
ITA11_DTS_VL2440	431366	388364	373980	369612	330829	170738
ITA11_PGP_VL0012	1580228	1576503	1587670	1495130	1190735	1136689
ITA11_PGP_VL1218	152713	225945	213350	226102	131330	182765
Total	**2593235**	**2577108**	**2562198**	**2431626**	**2037831**	**1672998**

Table F.3.11 - Other fixed costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	235937	198615	211735	193750	219336	137876
ITA11_DTS_VL1824	192991	187681	175463	147031	165601	44930
ITA11_DTS_VL2440	431366	388364	373980	369612	330829	170738
ITA11_PGP_VL0012	1580228	1576503	1587670	1495130	1190735	1136689
ITA11_PGP_VL1218	152713	225945	213350	226102	131330	182765
Total	**2593235**	**2577108**	**2562198**	**2431626**	**2037831**	**1672998**

Table F.3.12 - Labour costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	1154932	2475631	2292372	1169235	1381612	1282720
ITA11_DTS_VL1824	1013565	1225702	1180357	1417911	1036730	1881504
ITA11_DTS_VL2440	1726269	1922989	1732091	1643398	1388378	1655420
ITA11_PGP_VL0012	5132191	7904162	7859817	8082490	6019722	5453179
ITA11_PGP_VL1218	3194143	2924527	2968228	3644788	1152935	1897989
Total	**12221100**	**16453011**	**16032866**	**15957823**	**10979376**	**12170812**

Table F.3.13 - Depreciation costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	793248	709412	742408	622403	705076	672101
ITA11_DTS_VL1824	1989185	2051874	1851914	1655436	1518351	1519920
ITA11_DTS_VL2440	2922099	2543981	2895359	2465074	2269894	2109709
ITA11_PGP_VL0012	4025497	4474802	4857727	4985947	4657411	4266766
ITA11_PGP_VL1218	3050871	2111803	1932092	2022176	2061065	1827360
Total	**12780900**	**11891871**	**12279499**	**11751036**	**11211797**	**10395856**

Table F.3.14 - Opportunity costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	37227	74486	75526	65366	63337	85048
ITA11_DTS_VL1824	101126	234770	195725	182044	144906	194725
ITA11_DTS_VL2440	177653	342622	352770	319601	247186	308751
ITA11_PGP_VL0012	176738	421686	438627	459827	370522	478019
ITA11_PGP_VL1218	154312	226734	202817	208835	170626	214972
Total	**647056**	**1300298**	**1265465**	**1235674**	**996578**	**1281515**

Table F.3.15 - Total capital costs by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	830475	783898	817933	687769	768413	757149
ITA11_DTS_VL1824	2090312	2286644	2047639	1837480	1663257	1714645
ITA11_DTS_VL2440	3099752	2886603	3248129	2784675	2517080	2418460
ITA11_PGP_VL0012	4202235	4896488	5296354	5445774	5027933	4744785
ITA11_PGP_VL1218	3205182	2338536	2134909	2231011	2231691	2042332
Total	**13427957**	**13192169**	**13544964**	**12986710**	**12208375**	**11677371**

Table F.3.16 - Number of employees by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	199	157	155	168	149	142
ITA11_DTS_VL1824	117	121	121	108	119	122
ITA11_DTS_VL2440	138	126	130	116	106	84
ITA11_PGP_VL0012	1429	1562	1581	1611	1644	1565
ITA11_PGP_VL1218	322	261	260	305	324	223
Total	**2205**	**2227**	**2248**	**2308**	**2342**	**2136**

Table F.3.17 - Capital value by fleet segment in GSA 11 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA11_DTS_VL1218	3265260	3020985	3150180	2666202	2983897	2856179
ITA11_DTS_VL1824	8869988	9521758	8163676	7425355	6826734	6539496
ITA11_DTS_VL2440	15582291	13895993	14714024	13036129	11645273	10368865
ITA11_PGP_VL0012	15502025	17102640	18295103	18755792	17455824	16053428
ITA11_PGP_VL1218	13534955	9195808	8459487	8518142	8038442	7219458
Total	**56754519**	**52737184**	**52782471**	**50401619**	**46950171**	**43037426**

F.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS

The fitting of the model is quite satisfactory for all the stocks. The differences between simulated and observed data by fleet segment and year in percentage are reported in from figure F.4.1 to figure F.4.4.

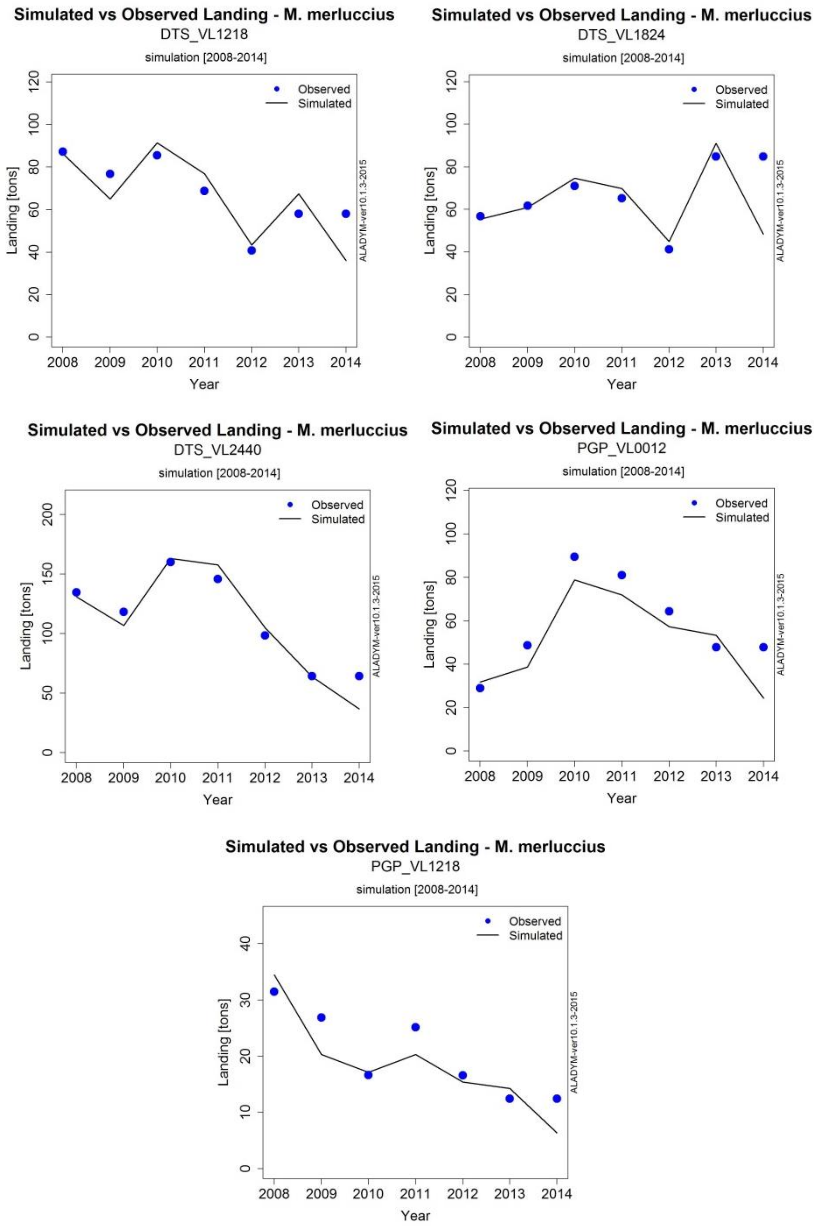


Figure F.4.1 Comparison between simulated and observed landings by fleet segment for hake in GSA 11

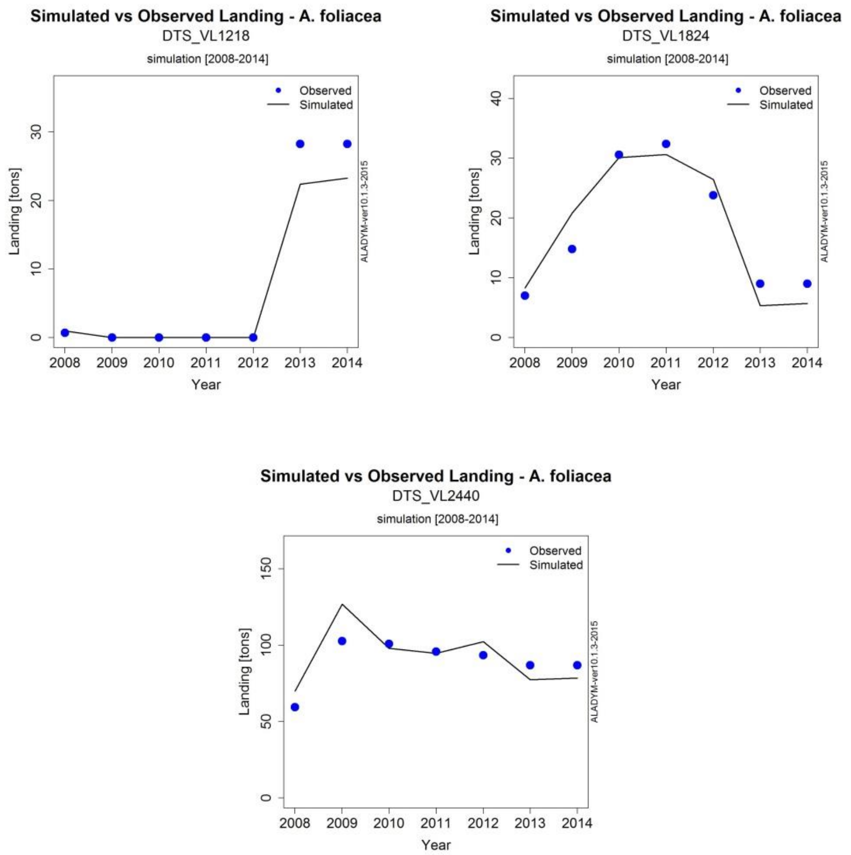
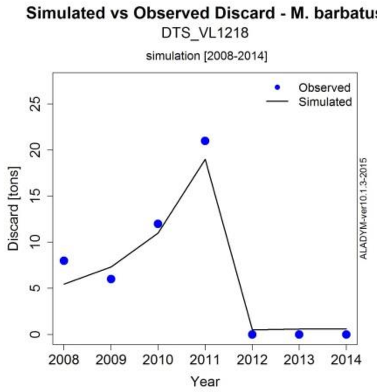
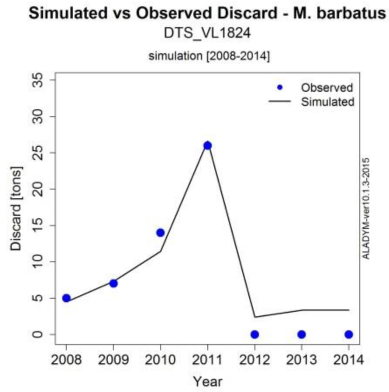
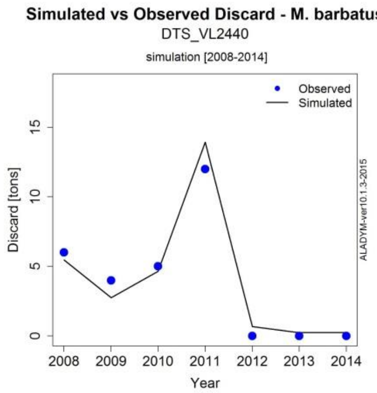
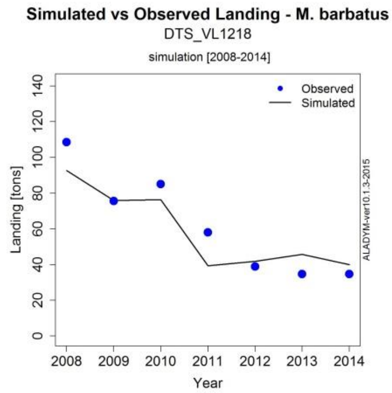


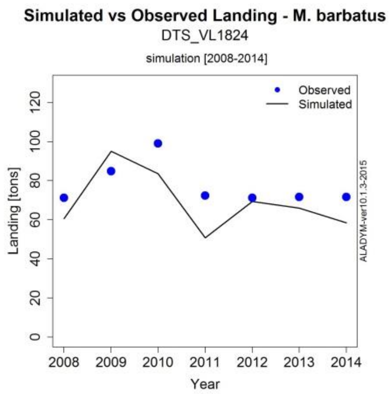
Figure F.4.2 Comparison between simulated and observed landings by fleet segment for giant red shrimp in GSA 11

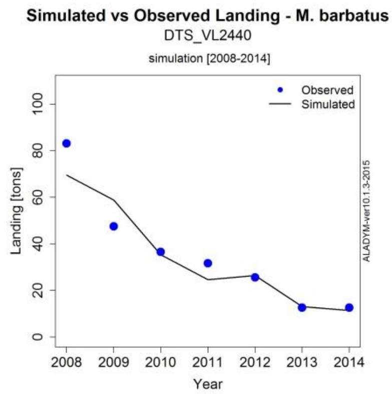

Simulated vs Observed Discard - M. barbatus
DTS_VL1218
simulation [2008-2014]
Observed
Simulated
Discard [tons]
Year
ALADYM-ver10.1.3-2015

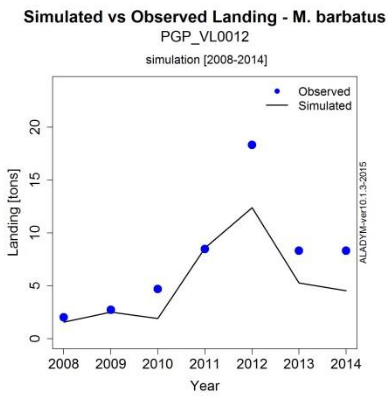

Simulated vs Observed Discard - M. barbatus
DTS_VL1824
simulation [2008-2014]
Observed
Simulated
Discard [tons]
Year
ALADYM-ver10.1.3-2015


Simulated vs Observed Discard - M. barbatus
DTS_VL2440
simulation [2008-2014]
Observed
Simulated
Discard [tons]
Year
ALADYM-ver10.1.3-2015


Simulated vs Observed Landing - M. barbatus
DTS_VL1218
simulation [2008-2014]
Observed
Simulated
Landing [tons]
Year
ALADYM-ver10.1.3-2015


Simulated vs Observed Landing - M. barbatus
DTS_VL1824
simulation [2008-2014]
Observed
Simulated
Landing [tons]
Year
ALADYM-ver10.1.3-2015


Simulated vs Observed Landing - M. barbatus
DTS_VL2440
simulation [2008-2014]
Observed
Simulated
Landing [tons]
Year
ALADYM-ver10.1.3-2015


Simulated vs Observed Landing - M. barbatus
PGP_VL0012
simulation [2008-2014]
Observed
Simulated
Landing [tons]
Year
ALADYM-ver10.1.3-2015

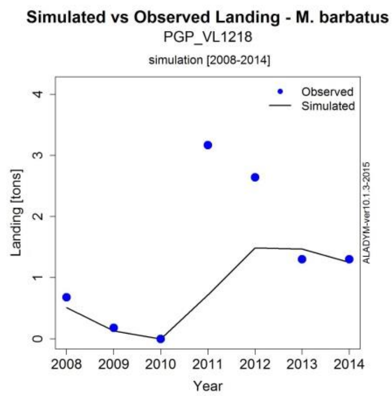

Simulated vs Observed Landing - M. barbatus
PGP_VL1218
simulation [2008-2014]
Observed
Simulated
Landing [tons]
Year
ALADYM-ver10.1.3-2015

Figure F.4.3 Comparison between simulated and observed discards and landings by fleet segment for red mullet in GSA 11

The comparison between the Spawning Stock Biomass (SSB) from the assessment model and the BEMTOOL simulations are shown in Figure F.4.4.

The simulated SSB of hake is quite close to the one estimated by XSA; the two approaches produce a rather similar trend in SSB. As concerns red mullet and giant red shrimp, SSB estimated by BEMTOOL is higher than those provided by XSA. However, The pattern followed by SSb is similar in all cases.

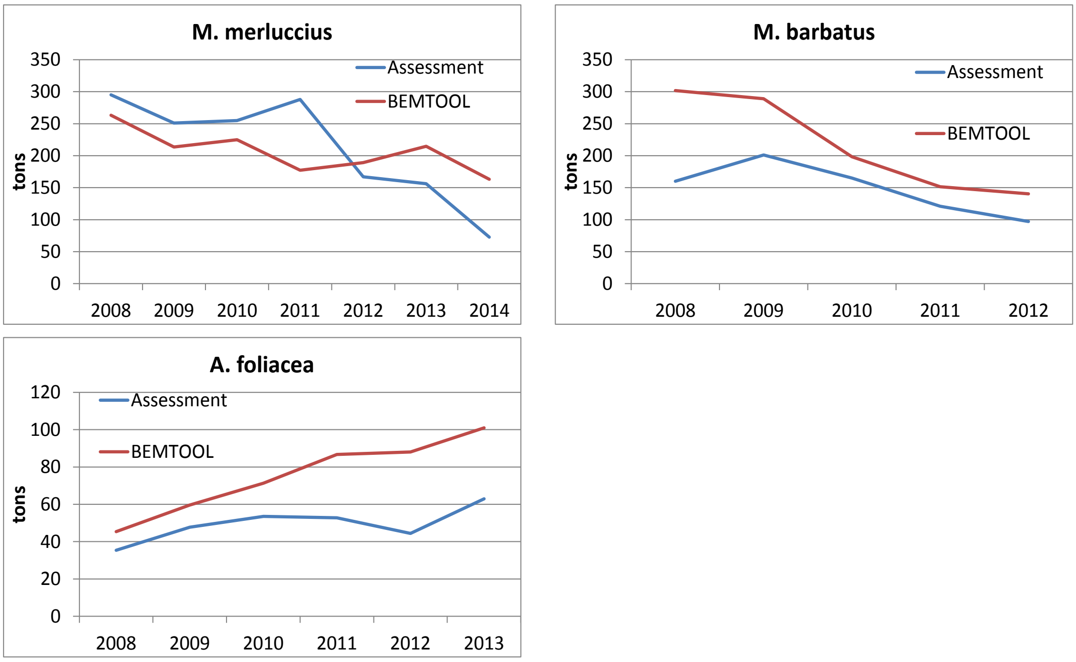


Figure F.4.4 Comparison between BEMTOOL and stock assessment SSB by fleet segment for the 3 stocks under consideration

F.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT

F.5.1 INPUT OF THE BIOLOGICAL AND PRESSURE MODULES

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year. A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the geometric mean of recruitment in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL. Figure F.5.1.1 shows the recruitment of the three stocks with confidence interval used in all the performed scenarios.

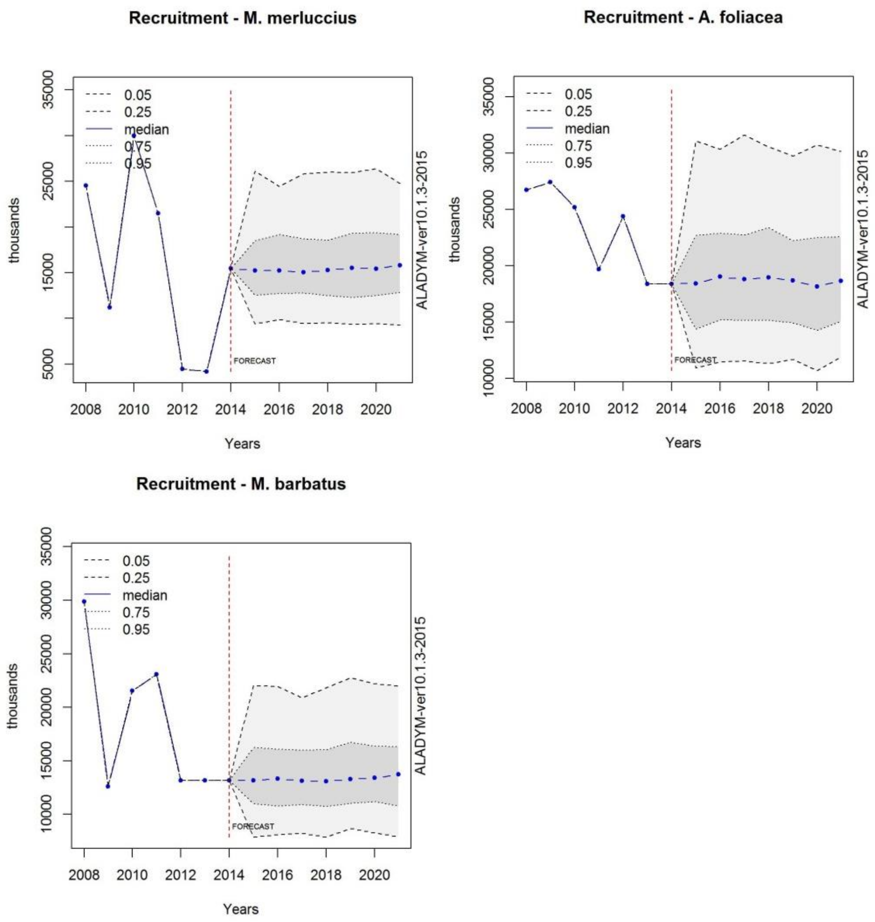


Figure F.5.1.1 Recruitment with confidence intervals used for hake, giant red shrimp, and red mullet in the forecast scenarios.

All the other biological inputs have been maintained unchanged in the projections.

For all the scenarios the effort has been maintained constant for all the years (until 2021) and equal to 2013.

F.5.2 INPUT OF THE ECONOMIC MODULE of DEMERSAL fisheries in GSA11

The main equations in the socio-economic model are related to the dynamics of prices and costs. Each equation has been tested on the basis of available historical series of data in order to check that the functional relationships are correctly specified. The economic parameters of the selected fleet segments and the equations applied are given below.

Due to the presence of relevant fluctuations in the time series of most fleet segments, socio economic parameters have been estimated on the basis of the most recent economic data.

For all fleets included in the case study, 2014 data were assumed equal to 2013.

PRICES DYNAMICS

The price of European hake, red mullet and giant red shrimp are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}} .$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2 for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

1) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
2) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
3) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.

Due to the lack of reliable estimations based on available data, the flexibility coefficient was computed exogenously. Sector studies (Nielsen, 2000 and Camanzi *et al.,* 2010) confirm that the flexibility coefficient normally ranges between -0.1 and -0.4. In this case study flexibility coefficients estimated for the Italian management plans have been applied, which estimated an average coefficient of -0.2 for all target species (Table F.5.2.1). .

Table F.5.2.1 Price parameterization by fleet segment and stock in GSA 11 demersal case study.

Fleet segment	coeff. price-landings M. merluccius	coeff. price-landings A. foliacea	coeff. price-landings M. barbatus
ITA11_DTS_VL1218	-0.2	-0.2	-0.2
ITA11_DTS_VL1824	-0.2	-0.2	-0.2
ITA11_DTS_VL2440	-0.2	-0.2	-0.2
ITA11_PGP_VL0012	-0.2	-0.2	-0.2
ITA11_PGP_VL1218	-0.2	-0.2	-0.2

The flexibility coefficient price-landings was assumed equal to -0.2 for all target species, which means that given a 1% fall in the production of a given species, it is assumed an increase in price of 0.2%.

COSTS DYNAMICS

Variable costs

Variable costs were modelled as a single item, which is the sum of fuel costs and other variable costs. Total variable costs are a function of the fishing effort (expressed in terms of days at sea):

$$TVC_{f,t} = \beta_f E_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$E_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*

Maintenance costs and fixed costs

Maintenance costs (MC) and other fixed costs (OFC) are assumed to be proportional to the gross tonnage (GT) of the fleet segment, corresponding to option 1 of the BEMTOOL software.

$$MC_{f,t} = \alpha''_f GT_{f,t}$$

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

Capital costs

Capital costs are function of the estimated fleet capacity, expressed in terms of capital value and gross tonnage.

Depreciation costs DC are estimated by a linear function of the annual gross tonnage GT as well.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

Following the approach of "The 2014 Annual Economic Report on the EU Fishing Fleet "(STECF-14-16), opportunity costs of capital (OC) are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Capital costs include annual depreciation and the opportunity costs of capital.

Labour costs

Labour costs are directly related to total revenues and variable cost.

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is assumed to be proportional to revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t}\right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

Revenues and total landings

Revenues by fleet segment and species are calculated by multiplying landings produced in the biological sub-model by the prices estimated on the basis of the price module.

The remaining part of landings value and weight was assumed to be as a fixed percentage of the estimated revenues and production of hake, red mullet and giant red shrimp according to option 1 of revenues modelling:

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

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

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to pass from the landings of assessed species to the total landings of the fleet segment *f*.

Total revenues and production are function of the estimated landings value and weight of the four target assessed species.

Average employees per vessel

Employment was estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html.

Table F.5.2.2 Cost parameterization by fleet segment in GSA 11 demersal case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA11_DTS_VL1218	374	0.56	206	166	808	102

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA11_DTS_VL1824	418	0.42	66	24	810	104
ITA11_DTS_VL2440	976	0.68	89	67	825	121
ITA11_PGP_VL0012	89	0.51	324	583	2174	243
ITA11_PGP_VL1218	274	0.50	201	135	1348	159

Table F.5.2.3 Socio-economic indicators parameterization by fleet segment in GSA 11 demersal case study.

Fleet segment	correction factor for landings	correction factor for revenue	value of a single vessel	average employees per vessel	discount rate
ITA11_DTS_VL1218	6.36	5.11	52109	2.6	0.043
ITA11_DTS_VL1824	5.93	5.8	210951	3.9	0.043
ITA11_DTS_VL2440	2.91	2.38	585536	4.7	0.043
ITA11_PGP_VL0012	50.69	58.6	16591	1.7	0.043
ITA11_PGP_VL1218	53.96	86.34	67820	2.1	0.043

F.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The table F.5.3.1 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute values of the average number of annual fishing days per vessel and the number of active vessels are reported.

Table F. 5.3.1 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Reduction on days							Reduction on vessels						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA11_DTS_VL1218	159.49	159.491	159.49	159.49	159.491	159.491	159.491	54.812	54.812	54.812	54.812	54.812	54.812	54.812
ITA11_DTS_VL1824	156.32	156.323	156.32	156.32	156.323	156.323	156.323	31	31	31	31	31	31	31
ITA11_DTS_VL2440	129.66	129.668	129.66	129.66	129.668	129.668	129.668	17.708	17.708	17.708	17.708	17.708	17.708	17.708
ITA11_PGP_VL0012	128.36	128.369	128.36	128.36	128.369	128.369	128.369	941.344	941.344	941.344	941.344	941.344	941.344	941.34
ITA11_PGP_VL1218	115.38	115.383	115.38	115.38	115.383	115.383	115.383	106.45	106.45	106.45	106.45	106.45	106.45	106.45

	Reduction on days							Reduction on vessels						
Scenario 2 - FmsyUpperHake2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA11_DTS_VL1218	-19.4%	-38.7%	-58.1%	-77.4%	-77.4%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_DTS_VL1824	-19.4%	-38.7%	-58.1%	-77.4%	-77.4%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_DTS_VL2440	-19.4%	-38.7%	-58.0%	-77.4%	-77.4%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_PGP_VL0012	-19.3%	-38.7%	-58.0%	-77.4%	-77.4%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_PGP_VL1218	-19.3%	-38.7%	-58.1%	-77.4%	-77.4%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%

	Reduction on days							Reduction on vessels						
Scenario 3 - FmsyCombined2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ITA11_DTS_VL1218	-17.3%	-34.7%	-52.0%	-69.3%	-69.3%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_DTS_VL1824	-17.3%	-34.7%	-52.0%	-69.3%	-69.3%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_DTS_VL2440	-17.3%	-34.7%	-52.0%	-69.3%	-69.3%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_PGP_VL0012	-17.3%	-34.7%	-52.0%	-69.3%	-69.3%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_PGP_VL1218	-17.3%	-34.6%	-52.0%	-69.3%	-69.3%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%

	Reduction on days	Reduction on vessels

Scenario 4 - FmsyUpperHake2020_Adaptive	2015	2016	2017	2018	2019	2020	2021	2015	2016	2017	2018	2019	2020	2021
ITA11_DTS_VL1218	-19.4%	-19.4%	-31.0%	-42.6%	-60.0%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_DTS_VL1824	-19.4%	-19.4%	-31.0%	-42.6%	-60.0%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_DTS_VL2440	-19.4%	-19.4%	-31.0%	-42.6%	-60.0%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_PGP_VL0012	-19.3%	-19.3%	-31.0%	-42.6%	-60.0%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%
ITA11_PGP_VL1218	-19.3%	-19.3%	-31.0%	-42.6%	-60.0%	-77.4%	-77.4%	-2.9%	-5.7%	-8.6%	-8.6%	-8.6%	-8.6%	-8.6%

	Reduction on days							Reduction on vessels						
Scenario 5 - FmsyCombined2020_Adaptive	2015	2016	2017	2018	2019	2020	2021	2015	2016	2017	2018	2019	2020	2021
ITA11_DTS_VL1218	-17.3%	-17.3%	-27.7%	-38.1%	-53.7%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_DTS_VL1824	-17.3%	-17.3%	-27.7%	-38.1%	-53.7%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_DTS_VL2440	-17.3%	-17.3%	-27.7%	-38.1%	-53.7%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_PGP_VL0012	-17.3%	-17.3%	-27.7%	-38.1%	-53.7%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%
ITA11_PGP_VL1218	-17.3%	-17.3%	-27.7%	-38.1%	-53.7%	-69.3%	-69.3%	-2.6%	-5.1%	-7.7%	-7.7%	-7.7%	-7.7%	-7.7%

2.8. CASE STUDY ON DEMERSAL FISHERIES IN GSA17

2.8.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The demersal fisheries in GSA 17 are of mixed nature. Two main fishing techniques exploit demersal resources in the area: DTS (corresponding to bottom trawl: OTB plus TBB only in Italy) and DFN-PGP (mainly corresponding to trammel nets: GTR in Croatia and Slovenia and to gill nets: GNS in Italy), but DTS produces the majority of catches and has the higher rates of activity and employment.

The main stocks identified for the *GSA 17 demersal* case study are *M .merluccius* (European hake; HKE), *S. mantis* (spottail mantis; MTS), *M. barbatus* (red mullet; MUT) and *S. solea* (common sole; SOL). These stocks are shared among the countries belonging to GSA 17 (Italy, Croatia and Slovenia) and have been subject to stock assessment.

The stock status of the main species exploited is characterized by high values of F in comparison with the proposed F_{MSY}. This situation is well known and has been diagnosed repeatedly (Colloca et al. 2014; Vasilakopoulos et al., 2014).

The main fishing gears targeting the four stocks selected for this case study are bottom trawls, small scale fisheries, longlines and rapido trawlers.

The 11 fleet segments targeting the selected stocks and considered for this case study are reported in the table 2.8.1.1. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table2.8.1.1.

Table 2.8.1.1 - Main fleet segments involved in the demersal fishery in the GSA17. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	***Fleet code***	***% of landings (all species)***
1	Italian GSA17 trawlers with vessel length 6-12 m	ITA17_DTS_0612	1.63
2	Italian GSA17 trawlers with vessel length 12-18 m	ITA17_DTS_1218	18.16
3	Italian GSA17 trawlers with vessel length 18-40 m	ITA17_DTS_1840	31.19
4	Italian GSA17 polyvalent passive gears only with vessel length 0012	ITA17_PGP_0012	23.47
5	Italian GSA17 beam trawlers with vessel length 12-18 m	ITA17_TBB_1218	1.51
6	Italian GSA17 beam trawlers with vessel length 18-40 m	ITA17_TBB_1840	9.26
7	Croatia GSA17 Drift and/or fixed netters with vessel length 06-12 m	HRV17_DFN_0612	1.75
8	Croatia GSA17 trawlers with vessel length 06-12 m	HRV17_DTS_0612	2.65
9	Croatia GSA17 trawlers with vessel length 12-18 m	HRV17_DTS_1218	5.68
10	Croatia GSA17 trawlers with vessel length 18-40 m	HRV17_DTS_1840	4.20
11	Slovenia Drift and/or fixed netters with vessel length 06-12 m and trawlers with vessel length 12-18 m	SVN_DFN_0612_DTS_1218	0.51

The fleet segments more contributing to the production are the Italian trawlers with length larger than 12 m.

Fishing effort has a decreasing trend on the western side and a slight increasing trend on the eastern site. It should be mentioned that Croatian data are under revision.

The associations between stocks and demersal fisheries for this case study are reported in the Table 2.8.1.2.

Table 2.8.1.2 Associations among stocks and fleet segments for demersal fisheries in GSA 17 case study.

Stock	ITA17 DTS_VL0612	ITA17 DTS_VL1218	ITA17 DTS_VL1840	ITA17 PGP_VL0012	ITA17 TBB_VL1218	ITA17 TBB_VL1840
M. merluccius	X	X	X			
S. mantis	X	X	X	X	X	X
M. barbatus	X	X	X			
S. solea	X	X	X	X	X	X
Stock	HRV17 DFN_VL0612	HRV17 DTS_VL0612	HRV17 DTS_VL1218	HRV17 DTS_VL1840	SVN17 DFN_DTS_VL0612	
M. merluccius	X	X	X	X		
S. mantis					X	
M. barbatus		X	X	X	X	
S. solea	X				X	

Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is reported in the table **2.8.1.3**. European hake is representing approximately 22% of the production of Italian trawlers and 32% of the Croatian trawlers, while spottail mantis represents about 47% of production of Italian trawlers and 9% of passive gears fishery. Red mullet is representing about 40% of the production of Croatian trawlers. Common sole respresents approximately 26% of the production of Italian beam trawlers and 12% of the Croatian Drift and/or fixed netters. Overall the percentage of the assessed species on the production is low only for the fleet segments HRV17_DFN_0612, HRV17_DTS_0612, ITA17_TBB_1218 and very low for the fleet segment SVN17_DFN_DTS_0612 (Slovenia fleet).

Table **2.8.1.3** - Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA17.

Fleet	**HKE**	**MTS**	**MUT**	**SOL**	**Total assessed %**
HRV17_DFN_0612	1.47			12.58	14.05
HRV17_DTS_0612	4.98		7.07		12.05
HRV17_DTS_1218	13.03		22.32		35.35
HRV17_DTS_1840	12.38		9.18		21.56
ITA17_DTS_0612	1.69	25.02	9.55	2.94	39.2
ITA17_DTS_1218	7.13	15.80	12.22	1.94	37.09

ITA17_DTS_1840	12.72	6.48	9.40	2.47	31.07
ITA17_PGP_0012	0.05	8.65	0.23	7.60	16.53
ITA17_TBB_1218	0.04	2.05	0.01	8.08	10.18
ITA17_TBB_1840		7.07		39.05	46.12
SVN17_DFN_DTS_0612		0.04	0.14	0.82	1

General fishery rules

In Italy and Slovenia management regulations are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, that in the Adriatic has been mandatory since the late eighties. Regarding long-lines the management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences. Regarding passive gears of small scale fishery management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

Since the accession of Croatia to the EU the 1st of July 2013, the same regulations of Italy and Slovenia are implemented. Moreover, Croatia maintained regulation measures applied before 2013:

- Bottom trawl fisheries is closed one NM from the coast and island in inner sea, 2 NM around island on the open sea, and 3 NM around several island in the central Adriatic. Bottom trawl fisheries is closed also in the majority of channel area and bays.
- About 1/3 of the territorial waters is closed for bottom trawl fisheries over the whole year and additionally 10% is closed from 100 to 300 days per year.

These management regulations have been taken into account to model the current situation in the case study.

2.8.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

Assessment of European hake and common sole were endorsed by FAO-GFCM 2015 (SAC report; WGSAD, Rome 2014). Reference year was 2013. That of spottail mantis was approved by SAC in 2012 (WG demersal 2012 – Split) (reference year 2011), while that of red mullet by SAC 2015 (FAO GFCM. 2015a report; WG demersal 2013 – Bar, Montenegro) (reference year 2012).

According to the used stock assessments, the summary diagnosis of the stocks is the following:

-European hake: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Spottail mantis shrimp: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Red mullet: Fishing mortality (Fbar0-4) increasing and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Common sole: Fishing mortality (Fbar0-4) decreasing and above F_{MSY}, SSB stable and recruitment increasing in the last years.

Discards of hake, spottail mantis shrimp and red mullet is quite important. For sole discard is considered negligible (Table 2.8.2.1).

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the needing of estimating this parameter when the assessment was not recent (e.g. spottail mantis shrimp) are reported in the table 2.8.2.1, as well as landings, discards, spawning stock biomass and recruitment.

Table 2.8.2.1 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA17.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)***	*Discards (tons)*	*Spawning Stock Biomass**	*Recruitment (in thousands)*
European hake	$(Fbar_{0-4})$=0.66	2228	2225	3.09	5334	28594
Spottail mantis shrimp	$(Fbar_{0-4})$=0.46	2518	2260	258	6945	2861854
Red mullet	$(Fbar_{0-4})$=0.66	2282	1991	291	4575	1235821
Common sole	$(Fbar_{0-4})$=0.44	1078	1078	-	1022	59360

* = Mean of the last 3 years; **2013 data

Stock advice, Reference points, and their technical basis

European hake, red mullet and common sole stocks are assessed as being exploited unsustainably at levels considerably higher than Fmsy. In the case of European hake and of red mullet the current fishing mortality to F_{MSY} ratio is around 3.3. Based on the last assessment, the stock of spottail mantis is exploited at sustainable levels.

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

Fmsy = 0.18; Fupper = 0.28 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.76.

The framework used for the F_{MSY} reference points is summarised in the Table 2.8.2.2. Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.8.2.2 Reference points, their technical basis.

	Framework				
	MSY approach			**Precautionary approach**	
Reference point	F_{MSY}	**F_{MSY} upper range**	**Fcurr/ F_{MSY}**	$B_{lim\ (tons)}$ *	$B_{pa\ (tons)}$
Technical basis for method 1	$F_{0.1}$ used as proxy of Fmsy from YpR analysis	STECF EWG 15-11 approach (empirical) F_{upper} of European hake		(lowest level of SSB in the time series)	(1.4 Blim*)

	Framework				
	MSY approach			**Precautionary approach**	
Technical basis for all the species method 2	F combined according to Balance indicators approach (weight from landing value)				
Values for European hake method 1	0.2	0.28	3.3	4729	6621
Values for spottail mantis method 1	0.50	0.68	0.92	6471	9059
Values for red mullet method 1	0.2	0.28	3.3	2780	3892
Values for common sole method 1	0.31	0.43	1.42	715	1001
Values for all the other species method 2	0.31		2.46		

*B_{lim}=B_{loss} (B_{loss} is the lowest value of SSB in the time series).

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments are evaluated using key social and economic indicators and a traffic light table (Tab. 2.8.2.3 red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

From this analysis the indicators appear rather stable for most fleet segments. The performance of Croatian fleet seems to benefit of goor trend revenues of European hake, which is an important species for demersal fleet, as well as red mullet. Positive trends are also observed for the revenues of common sole and spottail mantis of the beam trawl fleet segment with smaller size of vessels. The economic performace of trawlers, especially belonging to the Italian fleet segments seems quite deteriorated on the basis of the recent trend.

Tab. 2.8.2.3 - Traffic light table on the economic performance (period: 2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. Blank cell corresponds to the absence of the value for that species in the fleet segment. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR/BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues spottail mantis shrimp (thousands euros)	Revenues red mullet (thousands euros)	Revenues common sole (thousands euros)	Employment (number of unit)
ALL	12741 ÷ 8982	2.467 ÷ 1.633	0.404 ÷ 0.18	265959 ÷ 176777	23137 ÷ 18509	29970 ÷ 15382	14033 ÷ 8739	18943 ÷ 14084	4929 ÷ 4980
ITA_DTS_0612	6061 ÷ 4984	2.591 ÷ 0.969	0.629 ÷ -0.012	3767 ÷ 2744	19 ÷ 128	795 ÷ 661	151 ÷ 175	121 ÷ 113	94 ÷ 135
ITA_DTS_1218	14811 ÷ 10721	2.9 ÷ 1.277	0.645 ÷ 0.093	56179 ÷ 34681	4546 ÷ 2902	13183 ÷ 5783	4206 ÷ 2096	1773 ÷ 1588	884 ÷ 908
ITA_DTS_1840	20584 ÷ 16178	1.831 ÷ 1.321	0.231 ÷ 0.088	93504 ÷ 58229	16324 ÷ 12098	5194 ÷ 4115	8380 ÷ 4391	1543 ÷ 1391	1118 ÷ 917
ITA_PGP_0012	8722 ÷ 5213	3.483 ÷ 1.368	0.928 ÷ 0.136	66046 ÷ 38511		8884 ÷ 3696		6910 ÷ 4071	2230 ÷ 2472
ITA_TBB_1218	9401 ÷ 15452	1.869 ÷ 3.531	0.31 ÷ 0.923	2355 ÷ 2560		89 ÷ 136		471 ÷ 717	51 ÷ 47
ITA_TBB_1840	14569 ÷ 14845	0.938 ÷ 1.126	-0.016 ÷ 0.036	18859 ÷ 13849		1788 ÷ 990		7084 ÷ 4856	255 ÷ 225
HRV_DFN_0612	7413 ÷ 7383	11.452 ÷ 8.477	0.805 ÷ 0.568	3541 ÷ 2592	25 ÷ 95			985 ÷ 1171	43 ÷ 46
HRV_DTS_0612	13731 ÷ 11781	27.429 ÷ 25.232	1.949 ÷ 3.092	4897 ÷ 4379	296 ÷ 428		200 ÷ 368		30 ÷ 29
HRV_DTS_1218	9154 ÷ 7769	26.458 ÷ 27.421	2.199 ÷ 2.273	9496 ÷ 9936	566 ÷ 1215		605 ÷ 1162		45 ÷ 44
HRV_DTS_1840	7977 ÷ 8690	0.911 ÷ 2.814	-0.012 ÷ 0.312	6499 ÷ 8430	585 ÷ 1520		292 ÷ 423		119 ÷ 108
SVN_DFN_0612_DTS_1218	6504 ÷ 11709	-0.562 ÷ -1.121	-0.129 ÷ -0.22	815 ÷ 867		37 ÷ 2	10 ÷ 8	56 ÷ 177	60 ÷ 49

2.8.3 MANAGEMENT STRATEGY EVALUATION

During the Workshop held in Bari on September 21-25, 2015 it was also decided to test the effect of a Management Strategy Evaluation based on reaching the F_{MSY} corresponding to the F_{upper} (0.25; STECF EWG 15-11) for hake representing the stock more impacted.

Management Strategy Evaluation (MSE) was performed in line with what was presented during the STECF EWG 15-11. For hake (Figure 2.8.3.1) results were quite consistent and probability to fall below Blim was 0.

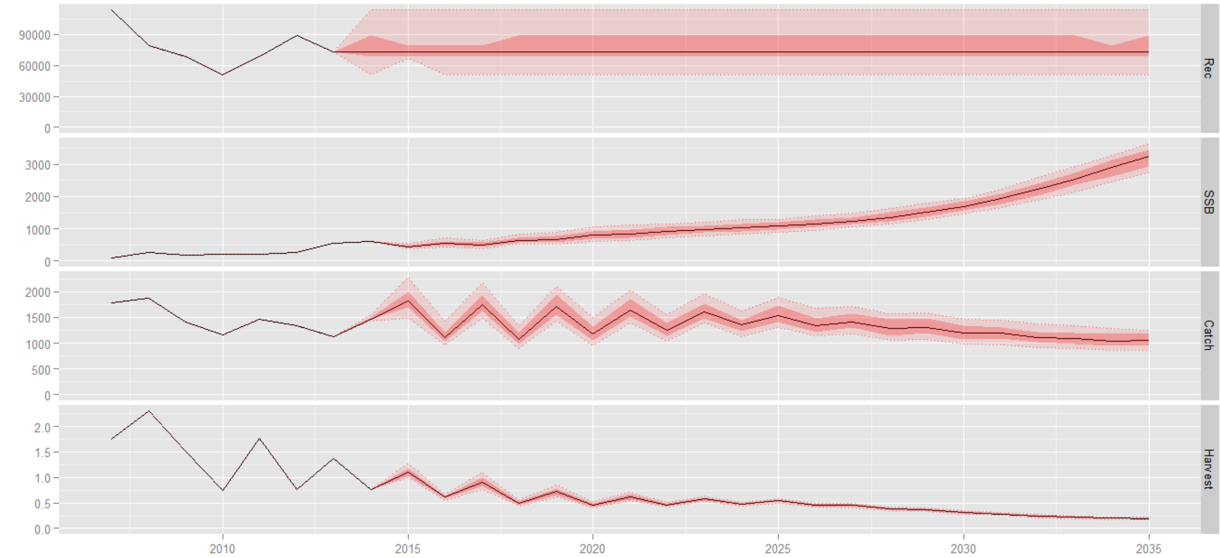


Figure 2.8.3.1 Management Strategy Evaluation for hake based on reaching the F_{upper}.

2.8.4. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

The improvement of the stock conditions in term of fishing mortality and spawning stock biomass can be achieved combining effort reduction (both capacity and days at sea) and selectivity improvement. Such mixed strategy is explored in the next section (section 2.8.5), where the scenarios to be tested are detailed.

Among the capacity reduction schemes, the current action plan presented by Italy in the last fleet report foresees a 7% reduction in of fishing capacity of DTS fleets in term of GT from 2015 to 2017.

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;
2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns corresponding to SM40 (square mesh of 40 mm opening).

In addition, two approaches for reaching F_{MSY} were applied based on:

- the F_{MSY} ranges and Fupper as reference point (details in the chapter 2.8.2);
- a combined F_{MSY} using a concept similar to that of Balance Indicators in which the impact of each fleet segment in respect to F_{MSY} is estimated using landing value as weighing factors (STECF 2014a).

Strategy and timeframe to reach the RP

The four stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on Fcurrent levels, hake and red mullet are the most heavily exploited species. European hake has thus been used as the benchmark species.

The percentages of reduction to reach F_{MSY} are reported in the Table 2.8.4.1.

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of European hake (the more exploited species) = 0.28 (method 1) and the current level of fishing mortality (method 1) (Fcurr=0.66);
- the reference point F_{MSY} combined = 0.31 (method 2) and the current level of fishing mortality combined (F=0.76).

Table 2.8.4.1 Fishing mortality reduction (in %) needed by each stock to reach its own F_{MSY}, the Fupper of hake and the combined F_{MSY}.

Stock	% reduction of Fcurrent according to F_{MSY}	% reduction of Fcurrent according to F upper of European hake	% reduction of Fcurrent combined according to F_{MSY} combined
M. merluccius	73	58	59
S. mantis	-		
M. barbatus	70		
S. solea	30		

The reduction has been applied to each fleet segment, considering its relative portion of $F_{current}$ to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of fishing mortality combined, the needed reduction is 59%. In case of F_{upper} a reduction of 58% is necessary. However this reduction, which is apparently the same as F_{MSY} combined, is split in a slight different manner in the two cases, because the fleet segments not catching hake are not included in the reduction program when F_{upper} is the target. These fleet segments are however considered when the approach based on F combined is applied (cfr. the following chapter 2.8.5 for details).

2.8.5. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios are reported in the Table 2.8.5.1

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

Scenario 2 and 4 share the same reference point that is the F_{UPPER} of European hake because it is more exploited, but the strategy is different in terms of timeframe and shaping of the reduction along the time.

Also scenario 3 and 5 share the same reference point, that is the F_{MSY} combined among the assessed species using the economic value as weighing factor of the average.

The scenario 6 aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

Table 2.8.5.1 Proposed management scenarios to reach the reference point

Case Study	Demersal case study in GSA 17
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (European hake) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture. Starting year 2015.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.8.5.2.

Table 2.8.5.2. Split reduction by vessels and average fishing days per year.

Reduction on VESSELS needed to F_{upper}	Reduction on DAYS needed to F_{upper}
6	52*

*in case of F_{MSY} combined this percentage is 53%

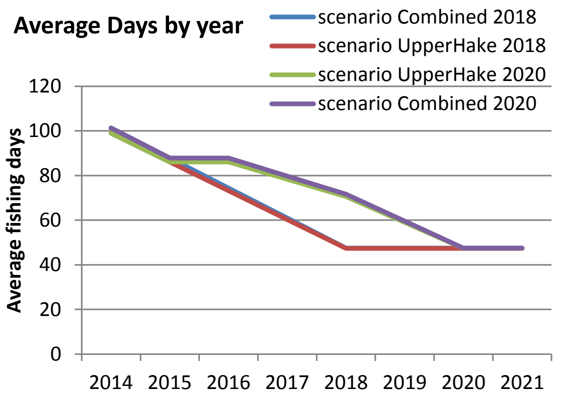
In table 2.8.5.3. the relative impact in terms of fishing mortality by fleet segment is reported, taking into account the different approach to be applied to the reduction (Hake reference fishing mortality or F combined fishing mortality). The reduction in percentage to be applied by fleet segment are also reported. The fleet segments impacting less than 3% on the overall fishing mortality in exam were excluded from the the reduction plan. These fleets were different according to the followed approach.

The shape of the reduction by fishing days and activity according to the different scenario is reported in the figure 2.8.5.1.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

Table 2.8.5.3. Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	% F current hake	Reduction applied%	% F current combined	Reduction applied %
1	ITA_DTS_0612	<3%	-	<3%	-
2	ITA_DTS_1218	14.1	58	16	59
3	ITA_DTS_1840	50.6	58	27	59
4	ITA_PGP_0012	<3%	-	9	59
5	ITA_TBB_1218	<3%	-	<3%	-
6	ITA_TBB_1840	<3%	-	12	59
7	HRV_DFN_0612	<3%	-	4	59
8	HRV_DTS_0612	4.5	58	4.3	59
9	HRV_DTS_1218	13.8	58	14	59
10	HRV_DTS_1840	14.9	58	11	59
11	SVN_DFN_0612_DTS_1218	<3%	-	<3%	-



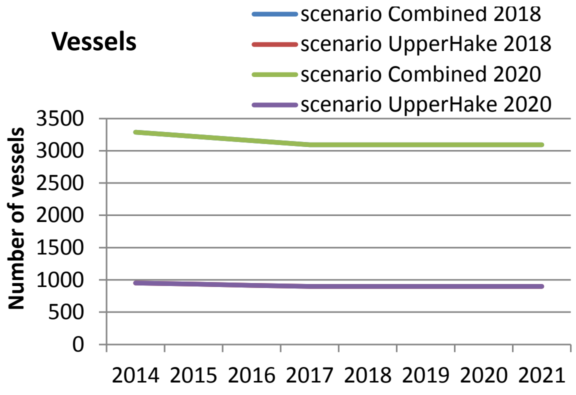


Figure 2.8.5.1. Shape of the reduction by fishing days and activity according to the different scenarios.

Further details on the shaping of reduction by fleet segment, year and scenario are reported in the Annex G5.3.

Selectivity scenario

The scenario 6 is characterized by a change in selectivity of trawlers (representing a delay of size at first capture) with no reduction in effort. The selectivity of the gears different from trawlers has been instead maintained unchanged.

The figure 2.8.5.2 shows the differences in selectivity implemented in this specific scenario for each species.

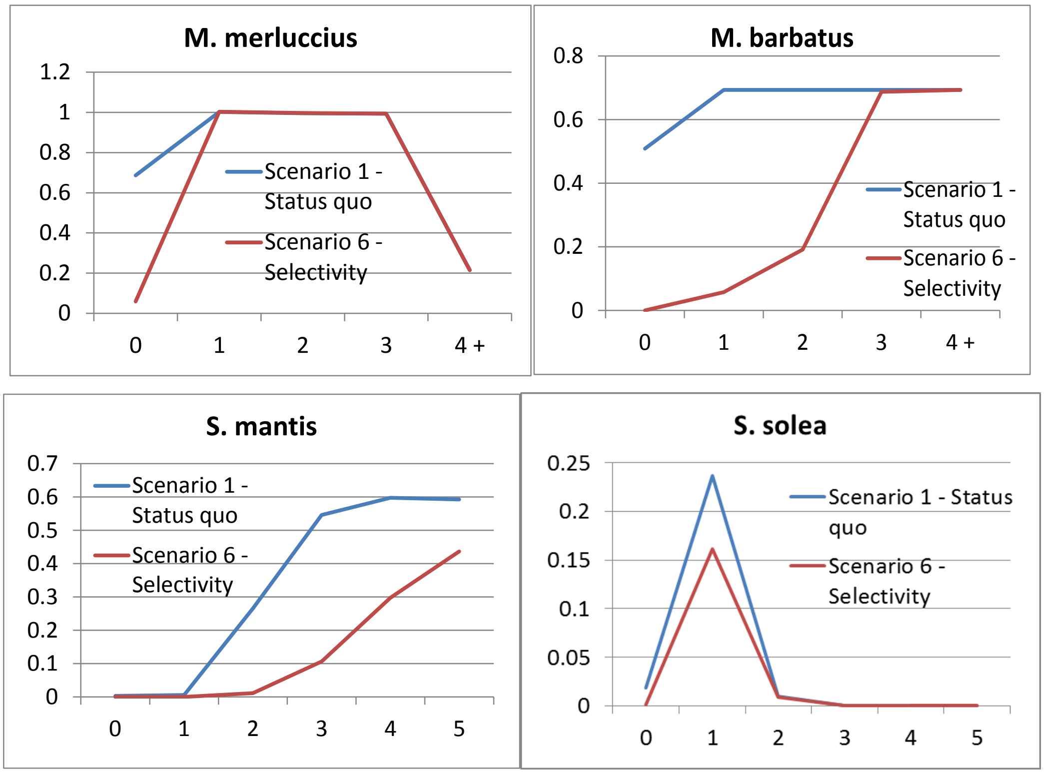


Figure 2.8.5.2 Comparison between the F by age (only trawlers) in the status quo and in selectivity scenario by species.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

2.8.6. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1).

The inputs to the biological and pressure components of BEMTOOL model have been derived from the last endorsed stock assessments; socio-economic data and parameters are from DCF and SEDAF -MAREA project.

Moreover, a Management Strategy Evaluation (MSE) has been performed in line with EWG-15-11 for hake.

2.8.7. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA18

All the inputs for modelling are fully reported in the Annex G.

2.8.8 EVALUATION OF THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.8.8.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

Figure 2.8.8.1 shows the SSB of the four stocks under the status quo scenario.

The SSB of spottail mantis and red mullet after a slight increase until 2017 remains quite stable until 2021. This is due to the low value of fishing mortality in 2013 that influences the SSB in the first years of projection. The SSB of the red mullet and spottail mantis stocks thus reaches in 2021 a value slightly higher than in 2013. SSB of hake shows a sharp decrease until 2019, due to the the high value of fishing mortality in 2013 (about 30% higher than the value of 2012), and then the SSB reaches a plateau that is -45% of the SSB value in 2013. The SSB of common sole gradually and strongly increases from 2015, due to the very high recruitment observed in the last years that consequently influenced the projection.

The landing of hake shows a decrease in 2016 and remains stable until 2021 for all the fleet segments. The discard remains stable until 2021 (Figure 2.8.8.2).

Also the landing and discard of spottail mantis show a slight increase in 2016 and then remain stable until 2021 for all the fleet segments (Figure 2.8.8.3).

The landing of red mullet shows an overall increase from 2015 to 2021 reaching values about 30% higher than the one of 2014 for all the fleet segments, due to the effect of low fishing mortality in 2013. The discard remains quite stable until 2021 (Figure 2.8.8.4).

Finally, the landing of common sole, after a slight increase, remains for all the fleet segments stable until 2021. For effect of the high recruitment value observed in the last years, the overall landing in 2021 is predicted to be about 50% higher than the value of 2013 (Figure 2.8.8.5).

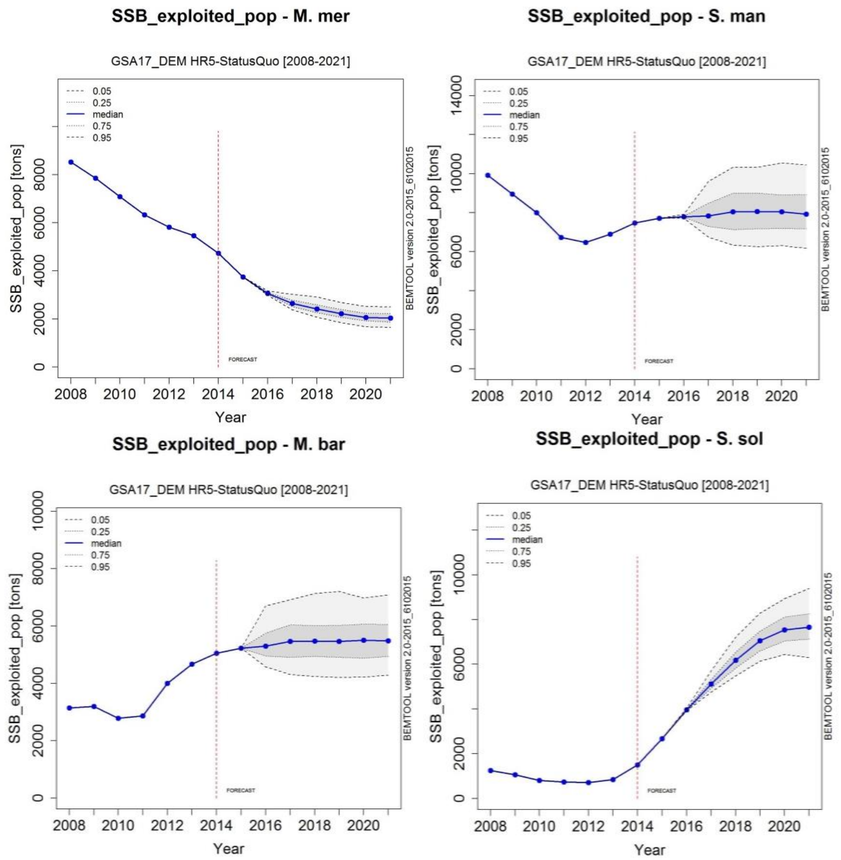
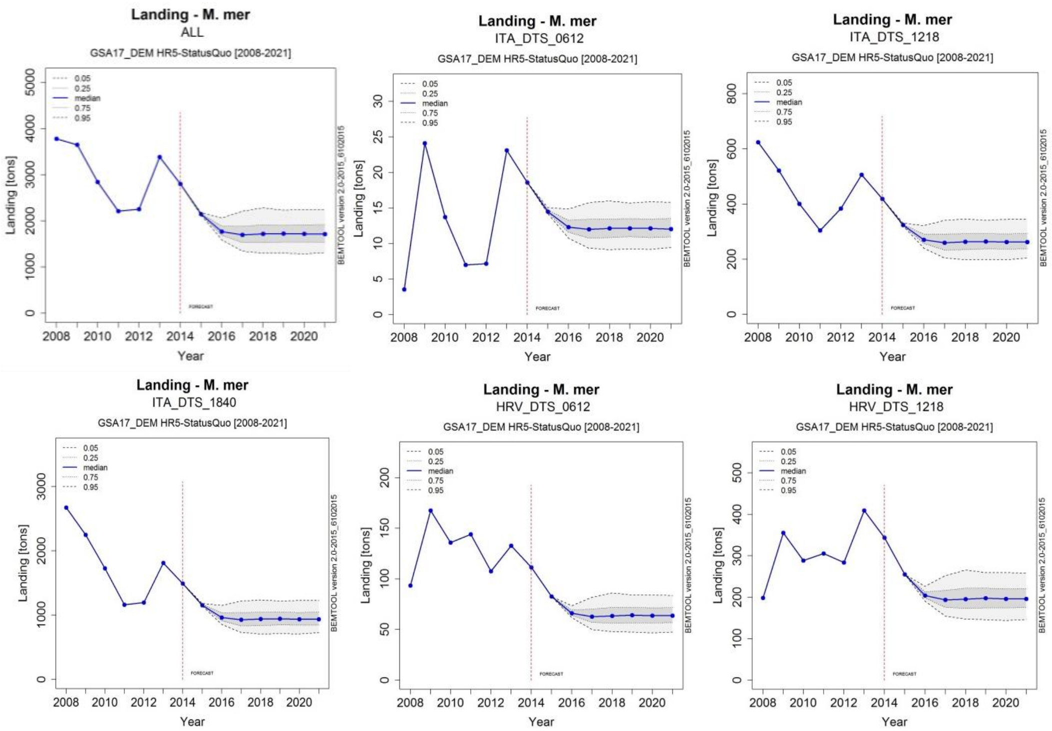


Figure 2.8.8.1 SSB of hake, spottail mantis, red mullet and common sole in the status quo scenario with confidence intervals.



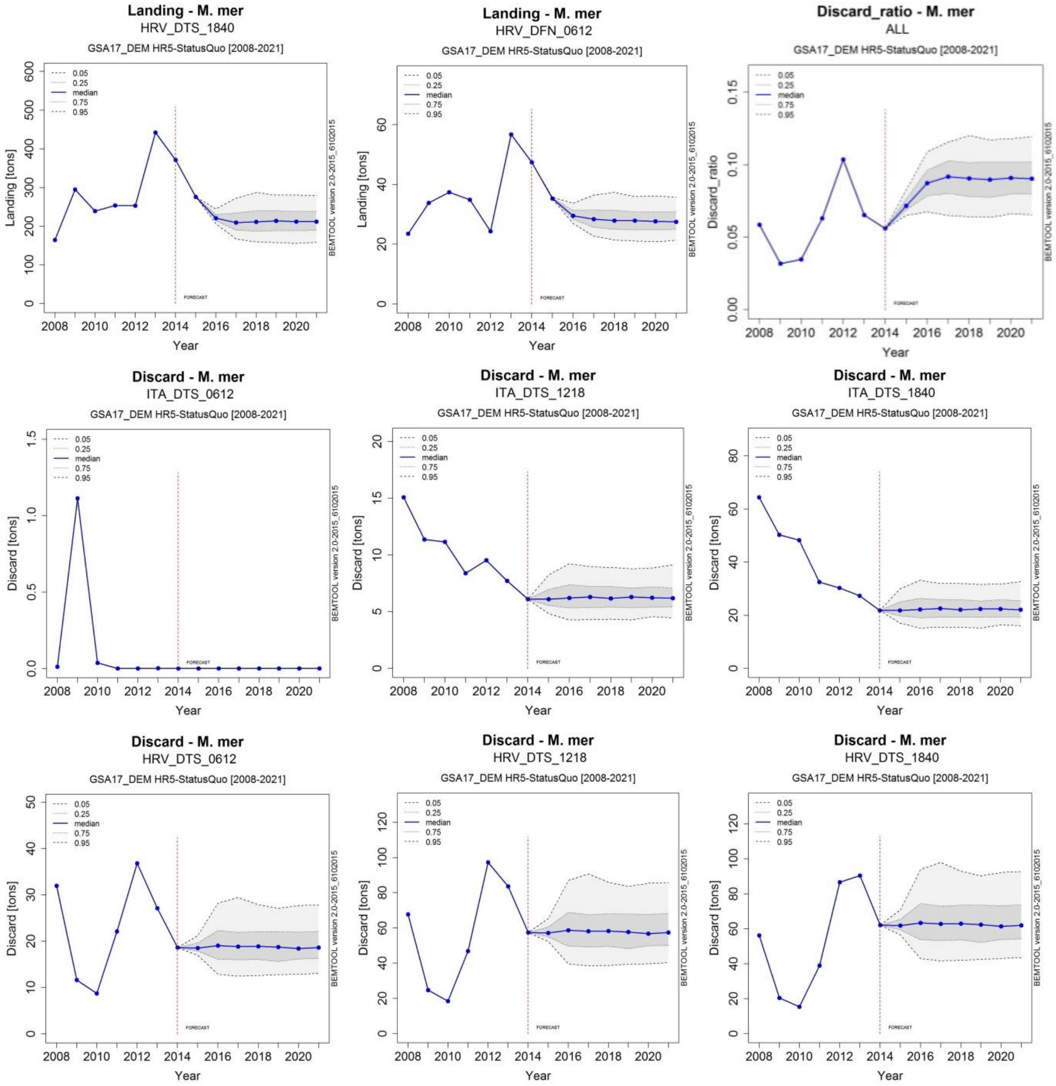
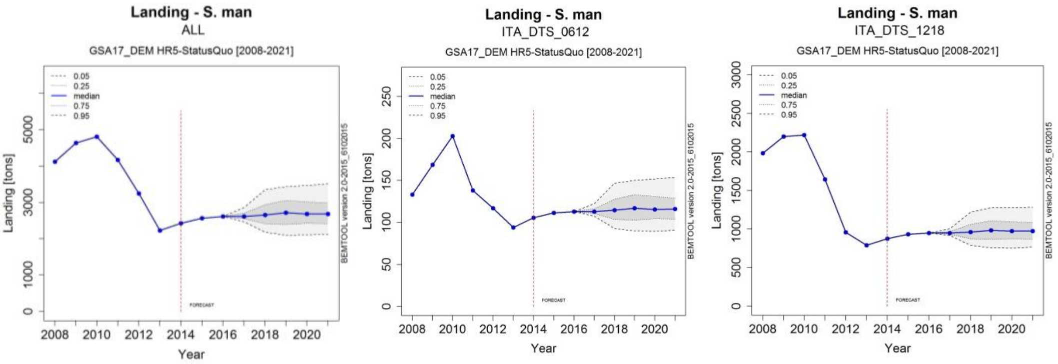


Figure 2.8.8.2 Landing and discard for European hake by fleet segment in the status quo scenario with confidence intervals.



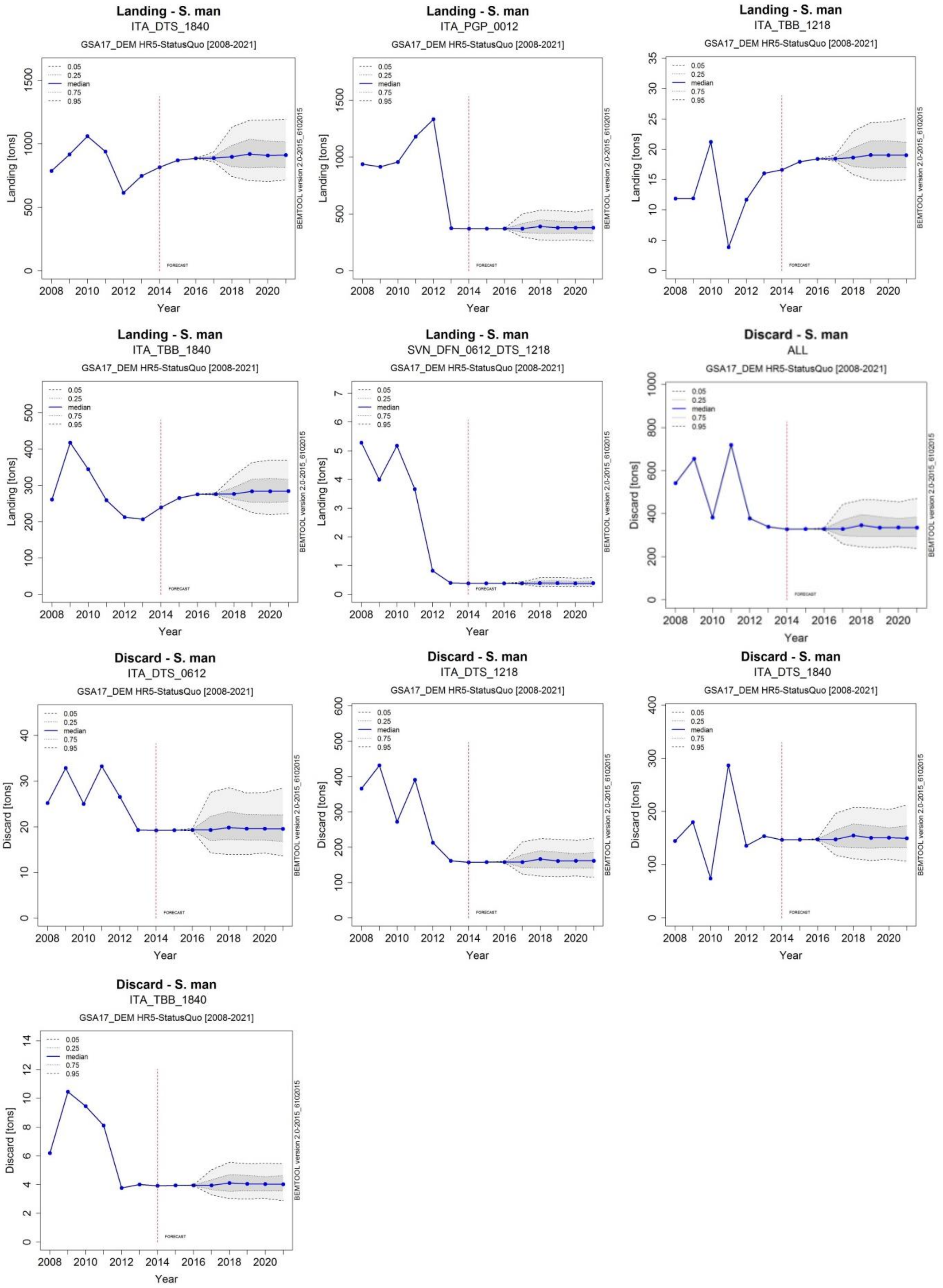


Figure 2.8.8.3 Landing and discard for spottail mantis by fleet segment in the status quo scenario with confidence intervals.

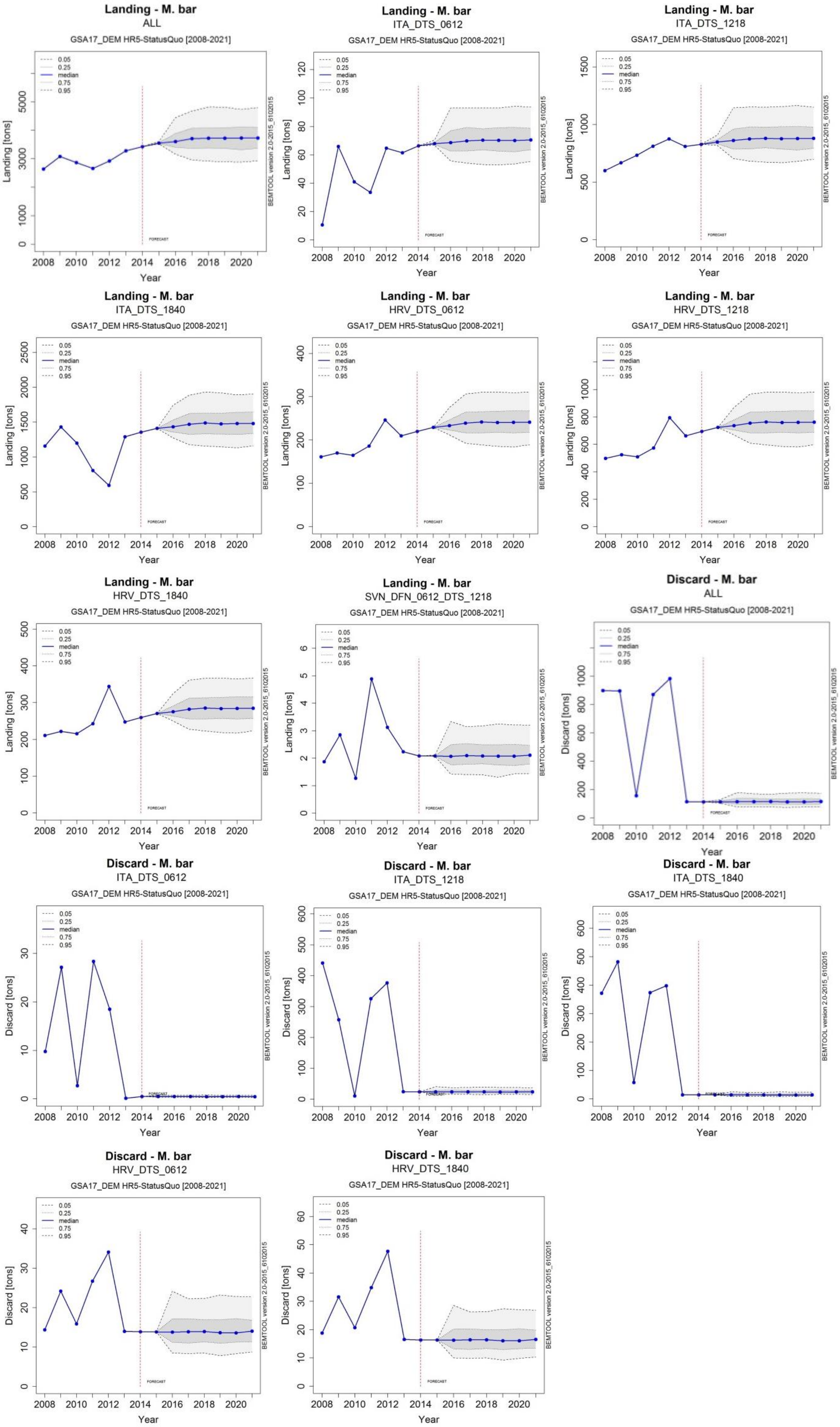


Figure 2.8.8.4 Landing and discard for red mullet by fleet segment in the status quo scenario with confidence intervals.

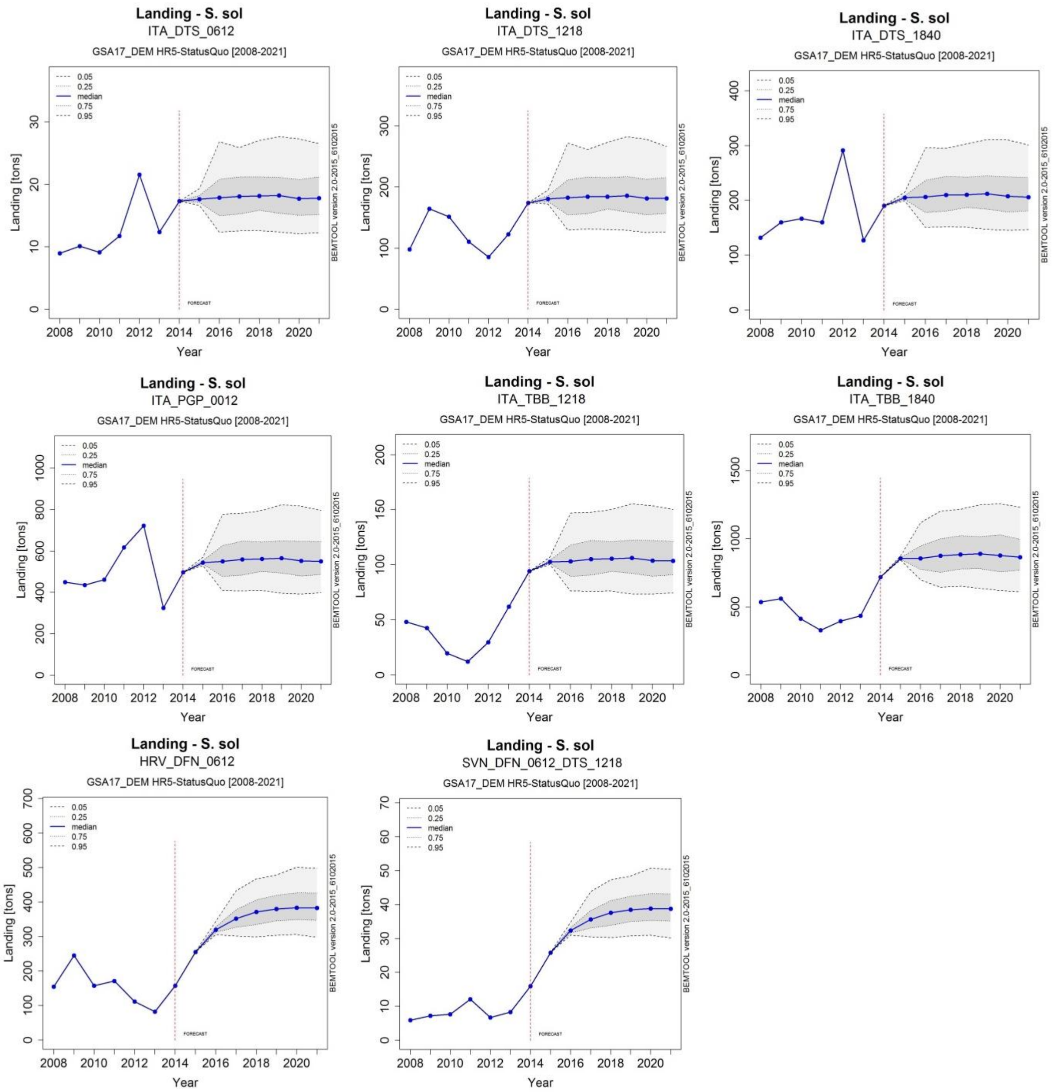


Figure 2.8.8.5 Landing for common sole by fleet segment in the status quo scenario with confidence intervals.

2.8.8.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 36 thousand tons of total production generating 177 million euro, an increase by 9% in quantity and a decrease by 17% in value compared to 2012.

The most important fleet segment is the Italian demersal trawlers VL1840, accounting for a third of total revenues. Other relevant fleet segments are the Italian small scale vessels lower than 12m and the Italian demersal trawlers VL1218, which account for around 20% of total revenues each. In 2013 the Italian fleet produced 85% of total landings, both in weight and value, while the Croatian fleet produced around 14% and the Slovenian fleet less than 1%.

As reported in Figure 2.8.8.2.1, total revenues of demersal fleets operating in GSA 17 show a negative trend in the period 2008-2013. Comparing 2013 to 2008, total landings and revenues have registered a decrease by 16% and 34% respectively. The three main fleet segments mentioned above have registered reductions in revenues by around 40% in the period under analysis.

In the forecast period, total landings for the overall fishing sector show an increasing trend with a variation by 15% in weight and just 1% in value in 2021 compared with 2013. The slight increase in revenues is due to the reduction in landings prices. Among the main fleet segments, the strongest increase is registered for the Italian small scale vessels lower than 12m (46% in weight and 14% in value). In this case, however, the revenues will not reach the levels before 2013. Landings of the Italian demersal trawlers VL1840 are expected to decrease by 8% in weight and 13% in value. The Croatian demersal trawlers are expected to register a decrease in landings and revenues, while the Croatian drift netters and the Slovenian demersal fleet would register an increase in fish production.

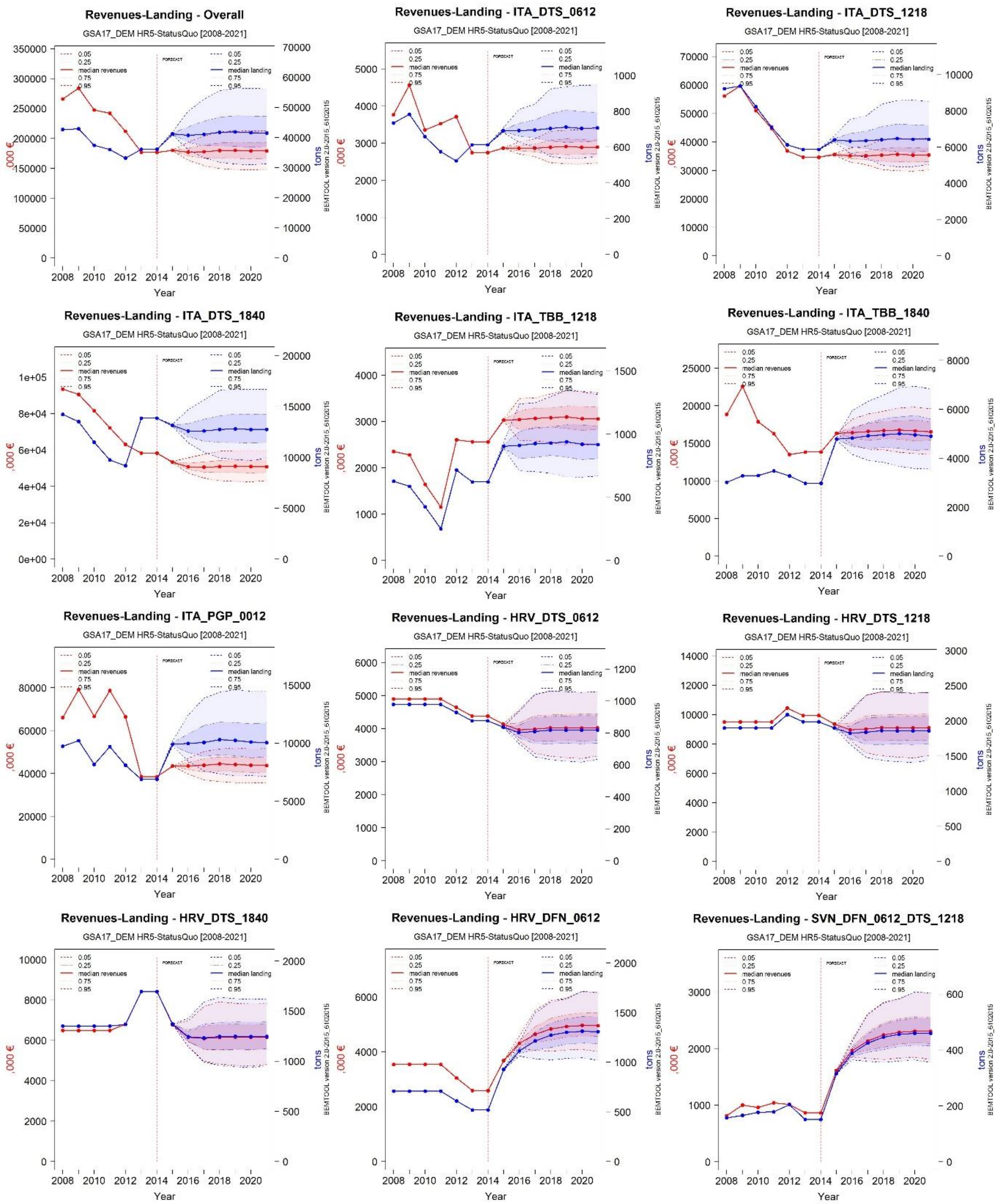


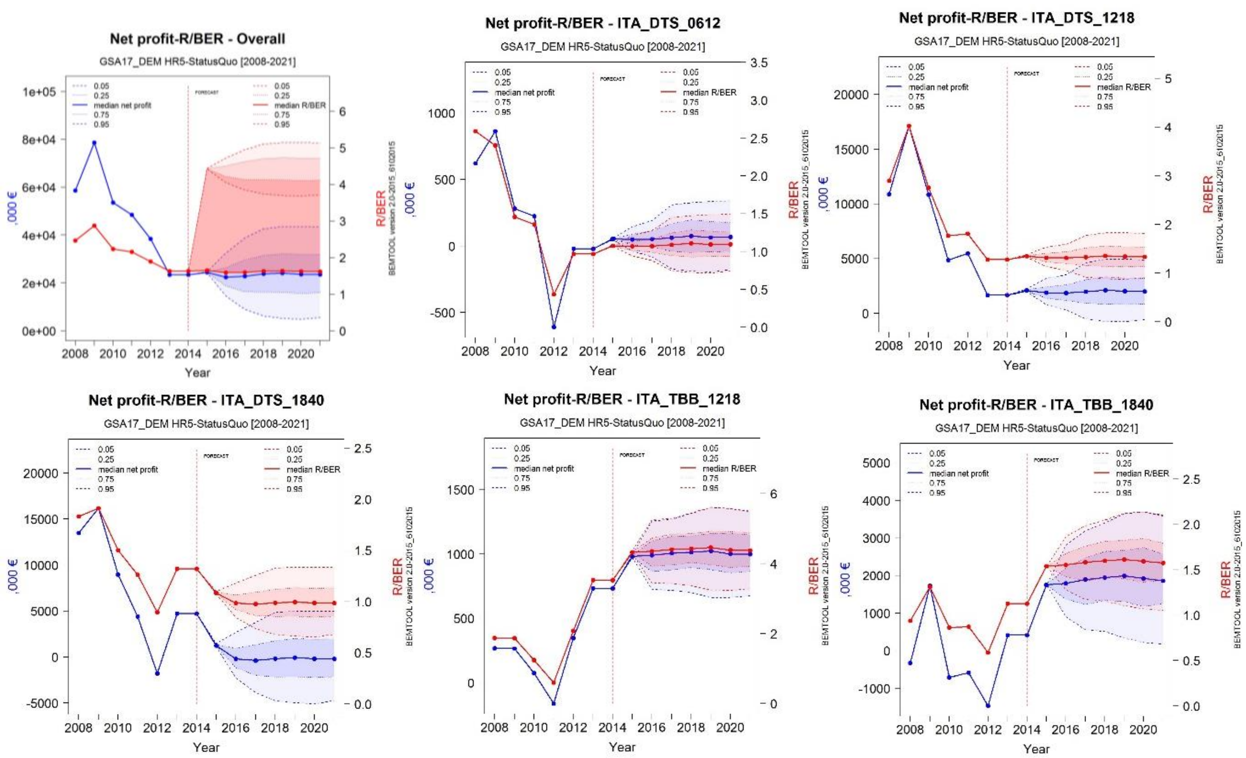
Figure 2.8.7.2.1 Landings weight and value by fleet segment and quantile.

In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is slightly positive for all fleet segments, with the exception of the Italian demersal trawlers VL0612 and the Slovenian demersal fleet. However, this performance in 2013 did not reach the past levels (2008-2010) for some fleet segments (e.g. ITA_VL1218 and ITA_VL1840). Negative values are registered mainly in the period 2010-2012 for some Italian fleet segments; in particular for the Italian beam trawlers VL1840.

In the forecast period, net profit for the overall fishing sector is stable (Figure 2.8.8.2.2). Compared with 2013, net profit does not show significant variation in 2021. However, at fleet segment level, variations are relevant. Net profit for the Italian demersal trawlers VL0612 is expected to become positive, while the Slovenian demersal fleet is expected to reduce its net loss by more than a half. On the contrary, the Italian demersal trawlers VL1840, which registers in the current situation a positive net profit, is expected to have a negative performance in the future. For the other Italian fleet segments as well as the Croatian drift netters, the economic performance is expected to be positive or invariant in the forecast period. On the opposite, the other Croatian fleet segments would register a declining trend in their profits.

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is greater than 1 for all fleet segments with the exception of the Italian demersal trawlers VL0612 and the Slovenian demersal fleet. This indicator shows an improvement if compared with 2012, when, in addition to the fleet segments mentioned above, also the Italian demersal trawlers VL1840 and the Italian beam trawlers VL1840 registered values lower than 1.

The ratio between current and break-even revenues (CR/BER) in the forecast period shows a positive trend for all Italian fleet segments, with the exception of the demersal trawlers VL1840, which is expected to register a value lower than 1 in 2021. The Croatian demersal trawlers show a reduction in 2021 if compared to 2014.



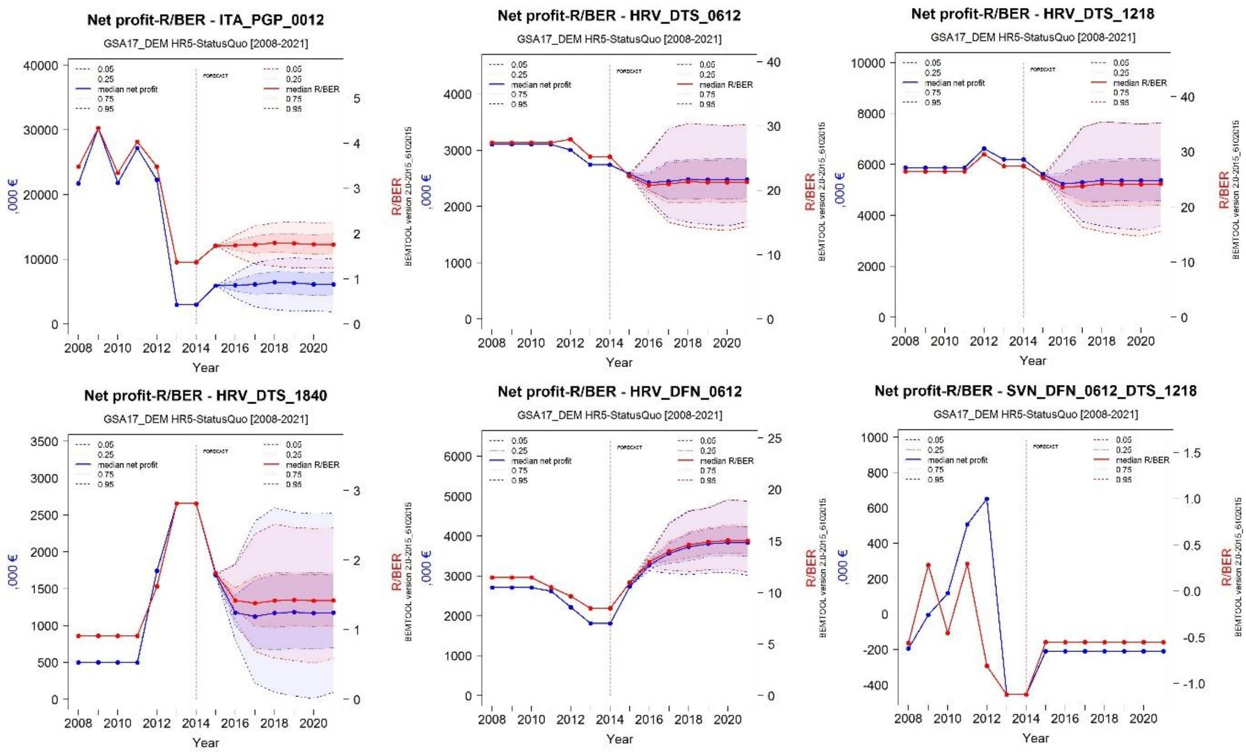


Figure 2.8.8.2.2 Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment and quantile

2.8.9 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

According to the state of exploitation of the four demersal stocks in GSA 17 case study, 5 forecast scenarios alternative to status quo have been performed to evaluate the consequences of several management strategies in terms of costs and benefits for the renewal of stocks, fishery sustainability and productive and economic performances of different fleet segments.

2.8.9.1 FORECAST OF BIOLOGICAL AND PRESSURE INDICATORS

The main results of the projections carried out in terms of SSB of the four stocks are showed in the graphs 2.8.9.1.1.

The best performance for SSB of hake is shown by Scenario 3, whilst the worst result is observed in the status quo (Scenario 1). Scenario 4 and scenario 5 perform similarly determining a very similar result, with SSB around 3 times the SSB status quo.

For spottail mantis the higher SSB value is obtained with Scenario 6 (change in selectivity), while the worst by the status quo (scenario 1).

For red mullet the best result in terms of SSB is given again by Scenario 6 (change in selectivity), that determines an SSB in 2021 around 2 times the status quo scenario.

Finally, the SSB of common sole is the highest in the Scenario 2 and the lowest in status quo scenario.

This result seems to indicate for all the stocks a benefit due to the application of the combined reduction: in particular, common sole and hake benefit more in the case of reduction applied in a short timeframe.

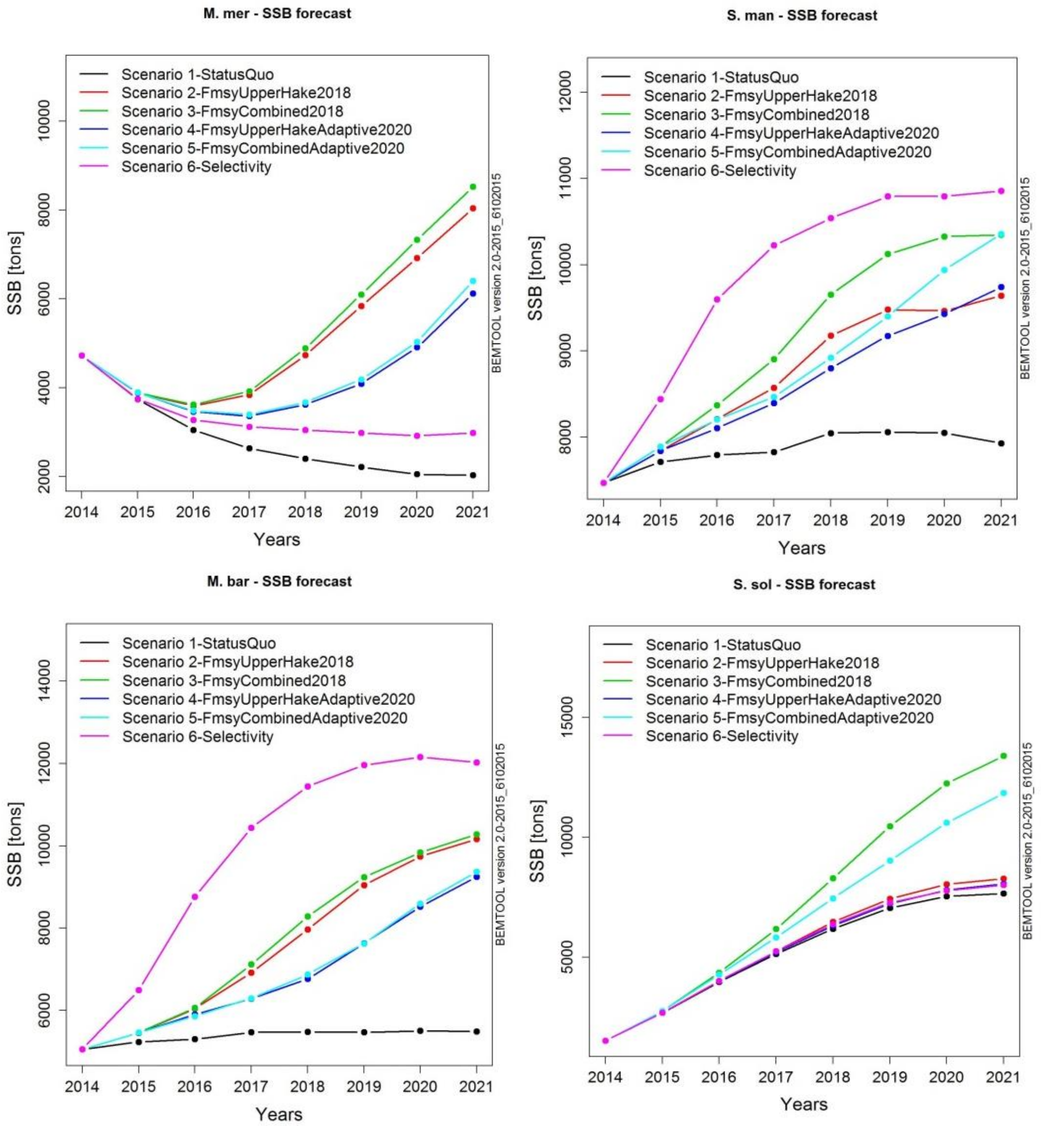


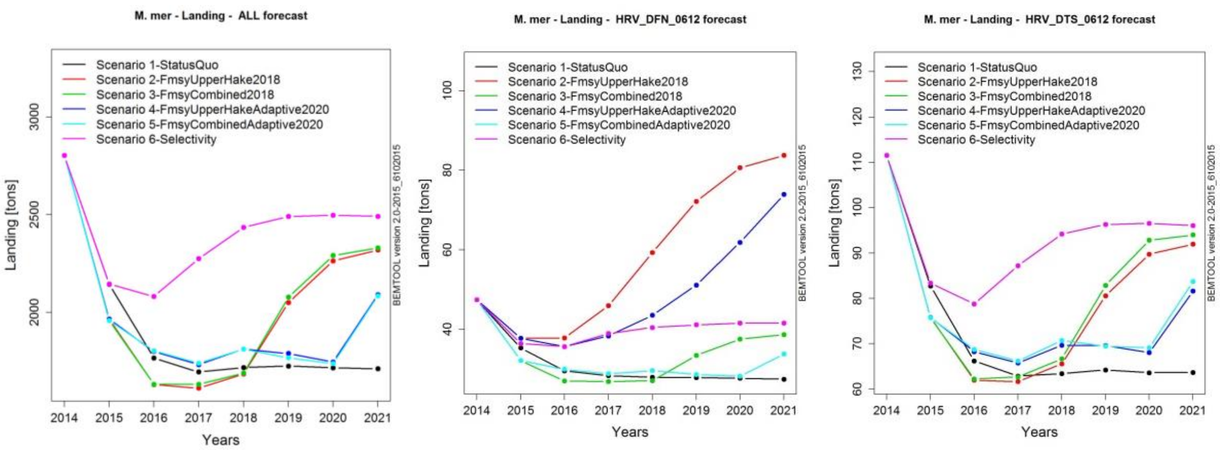
Figure 2.8.9.1.1 SSB of hake, spottail mantis, red mullet and common sole in GSA 17: comparison among the management scenarios.

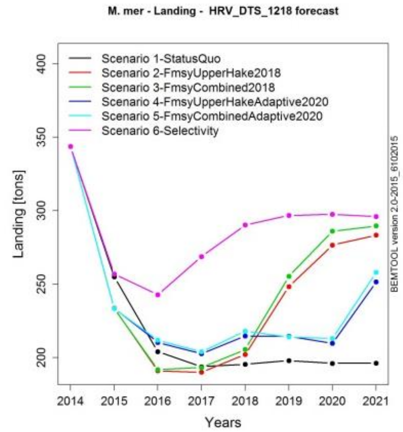
In terms of hake catches (Figure 2.8.9.1.2; only fleets which impact hake stock are considered), the scenarios better performing are generally the scenarios characterized by a reduction applied in a short timeframe (Scenario 2 and 3), however this also depends by the fleet segment and the rule set to apply the management measure. For the fleet segments more impacted by the reduction, the better performing scenario was generally the Scenario 6, as this addresses the change of the fishing pattern, but does not affect the effort in terms of fishing days and vessels; as a consequence, catches are not depressed. Indeed, fleet segments that are not touched by the management measures based on effort, but are affected by the change of selectivity (scenario 6), as HRV_DFN_0612 and ITA_DTS_0612, benefit more by the application of the other scenarios, as their catches increase for reduced competition with the other fleets. For the catches of all the fleet segments the worse scenario was the status quo. Under any scenario the discards is reduced, as effect of reduces catches or increased selectivity.
Also for catches of spottail mantis (Figure 2.8.9.1.3) the situation is differentiated among fleet segments. For example, the fleets ITA_DTS_1218 and ITA_DTS_1840 would perform better in the status quo scenario, being those targeting the stock of spottail mantis shrimp and, thus, more penalised by the management measures. For the fleet ITA_DTS_0612 any management option is better than the status quo, except selectivity (Scenario 6), being this the only measure impacting this fleet. The fleet

ITA_PGP_0012 performs better under scenario 2 and 4, because this fleet is not affected by the measures targeting Fupper of hake (given its poor contribute to the hake fishing mortality). Conversely ITA_PGP_0012 is impacted by the management measures targeting the reference point F_{MSY} combined (scenarios 3 and 5), and thus under this forecast situation the status quo is better, as well as the change of selectivity, since not involving this fleet. A similar situation occurs for ITA_TBB_1840, while the fleets ITA_TBB_1218 and SVN_DFN_0612_DTS_1218 benefit of any management measure, being not affected by such measures. Discards are generally reduced under the scenario 6, based on the change of selectivity. The influence of the management measures on the stock of spottail mantis shrimp is not affecting the fleets of Croatia, for this species, given their poor contribute to fishing mortality and landings.

Regarding the catches of red mullet (Figure 2.8.9.1.4), the status quo scenario is better for almost all the fleets as these are severely impacted by the managemt measures in all the scenarios. In terms of keeping or increasing the catch volumes, the status quo is generally followed by the change in selectivity (scenario 6), although this scenario alone does not allow to reach the reference points. The scenarios based on a reduction applied in a shorter timeframe are the those performing better in terms of stock rebuilding and productivity. For the fleets not affected by the management measures, i.e. ITA_DTS_0612 and SVN_DFN_0612_DTS_1218 any scenario is better then the status quo, given the reduced competition for the access to the resource. Discards of any fleet would be reduced in each management scenario compared to the status quo.

Regarding the catches of common sole (Figure 2.8.9.1.5), the situation if fairly differentiated among the fleet segments. Those affected by all the management measures, as ITA_DTS_1218 and ITA_DTS_1840, show higher catches in the status quo, and to a lesser extent in the scenario 6, which affects the selectivity only. The fleet segment ITA_TBB_1840 has the better performance under all the scenarios except those based on the F_{MSY} combined (scenario 3 and 5), because are impacting its catches. For this fleet segment scenario 3 is better than scenario 5, as the rebuilding of the stock is faster and, in turn, the increase of productivity. Similar pattern is observed for the fleet segments ITA_PGP_0012 and HRV_DFN_0612. Instead, the situation of the fleet segment ITA_DTS_1218 is the opposite to ITA_DTS_1840, as the former is not impacted by the management measures and, thus, benefits of the reduced competition with ITA_DTS_1840 on the sole stock. A similar pattern is observed for the fleet segments SVN_DFN_0612_DTS_1218 and ITA_DTS_0612, with the difference that the latter is affected by the selectivity scenarios (scenario 6), under which its catches are reduced compared to the other scenarios.

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Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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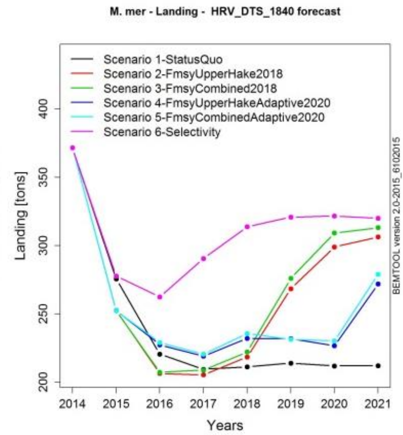
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015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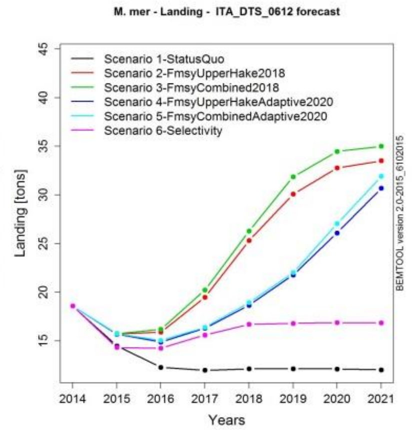
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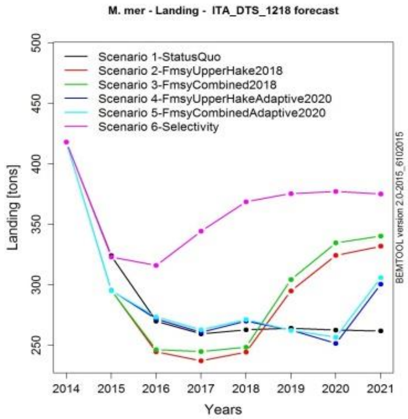
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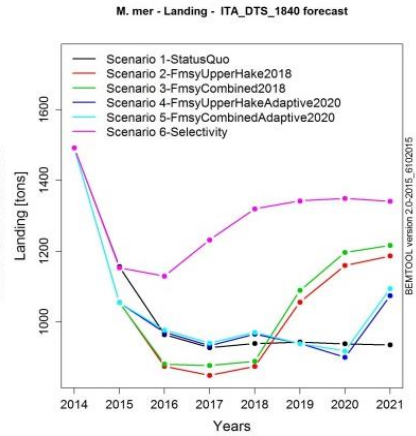
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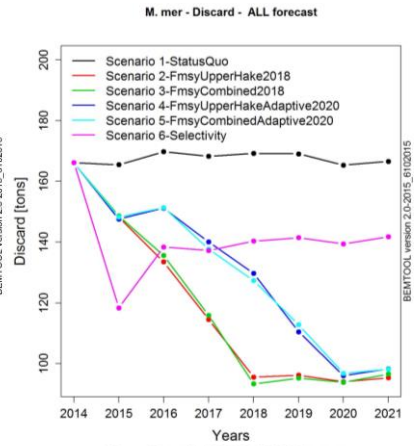
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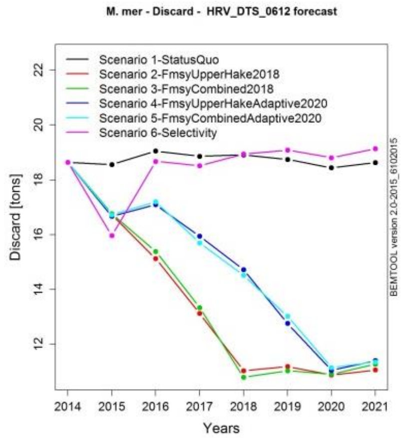
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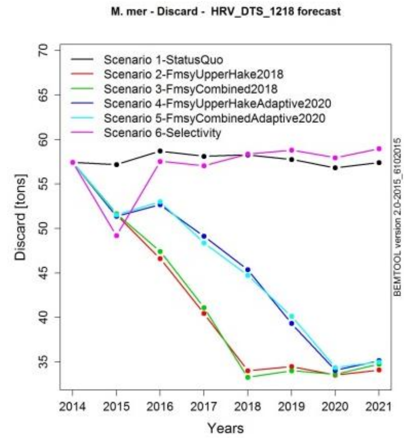
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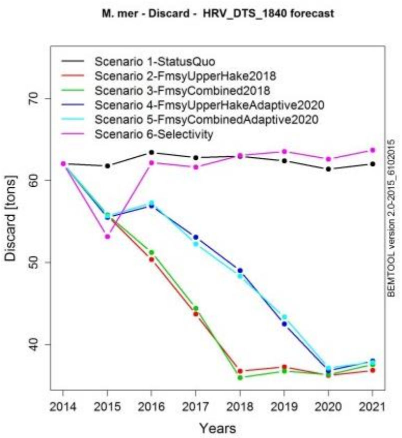
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015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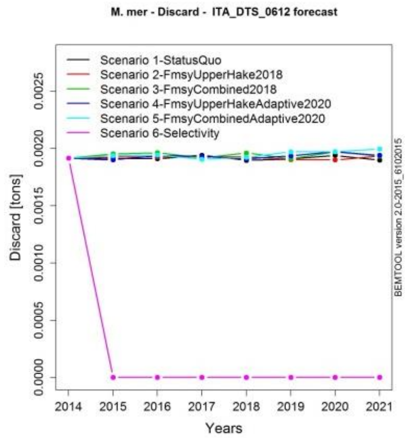
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015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Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
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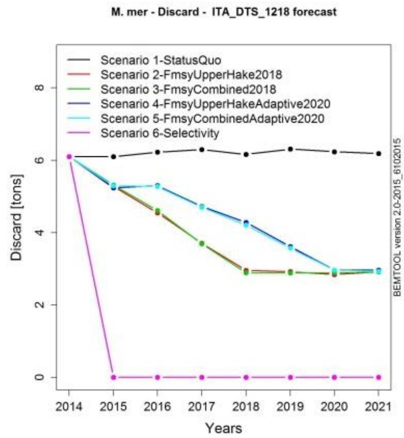
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Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015

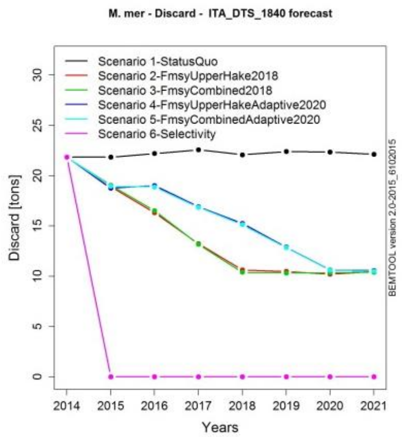
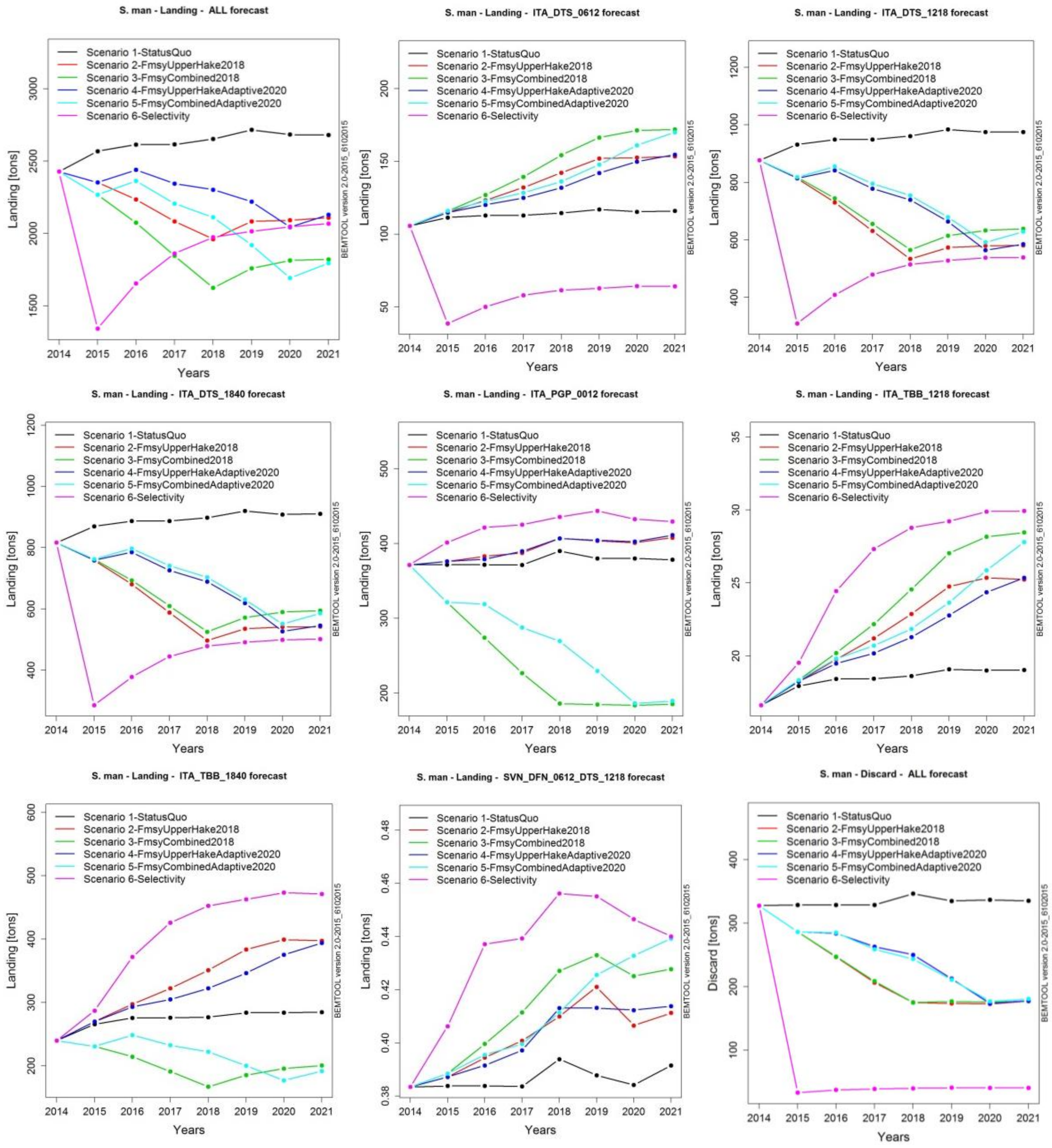

M. mer - Discard - ITA_DTS_1840 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015

Figure 2.8.9.1.2 Landings and Discards for hake by fleet segment: comparison among the different management scenarios.



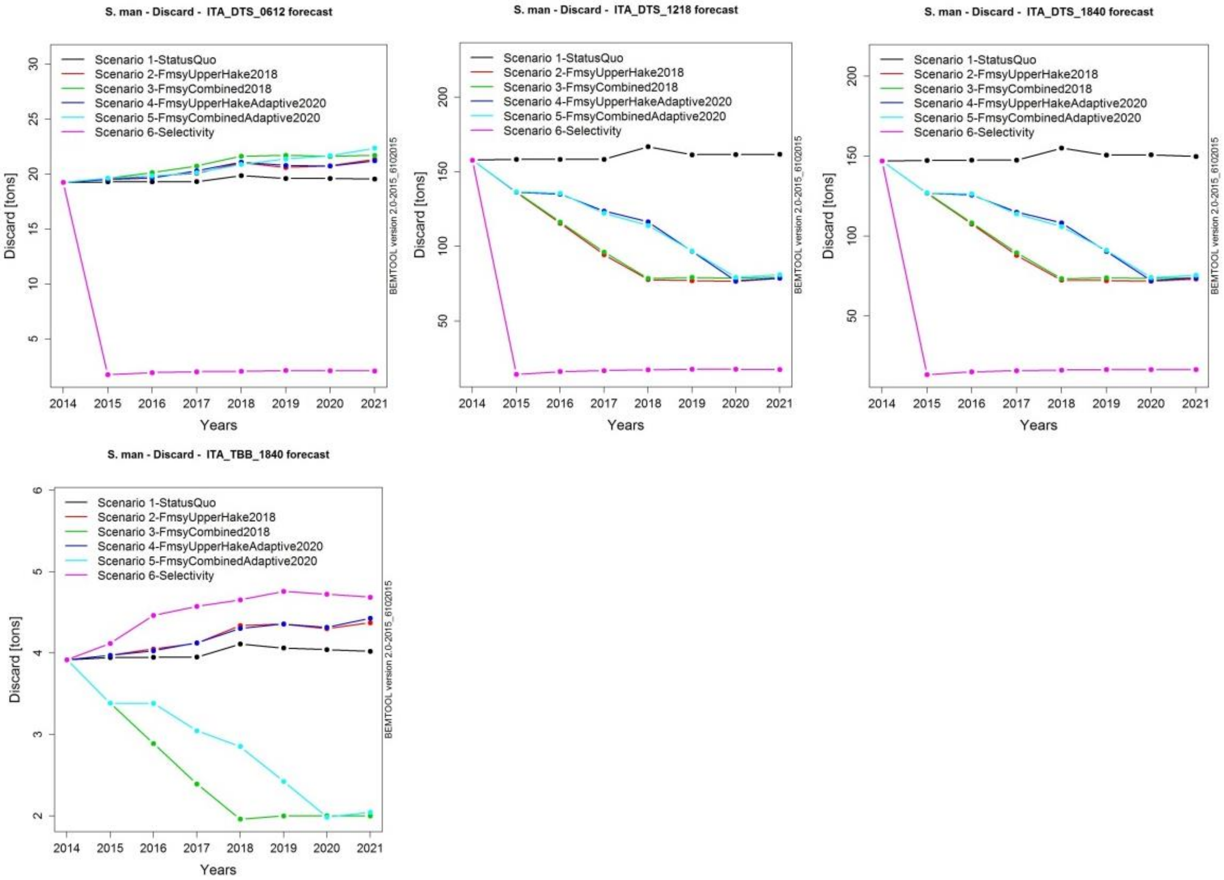
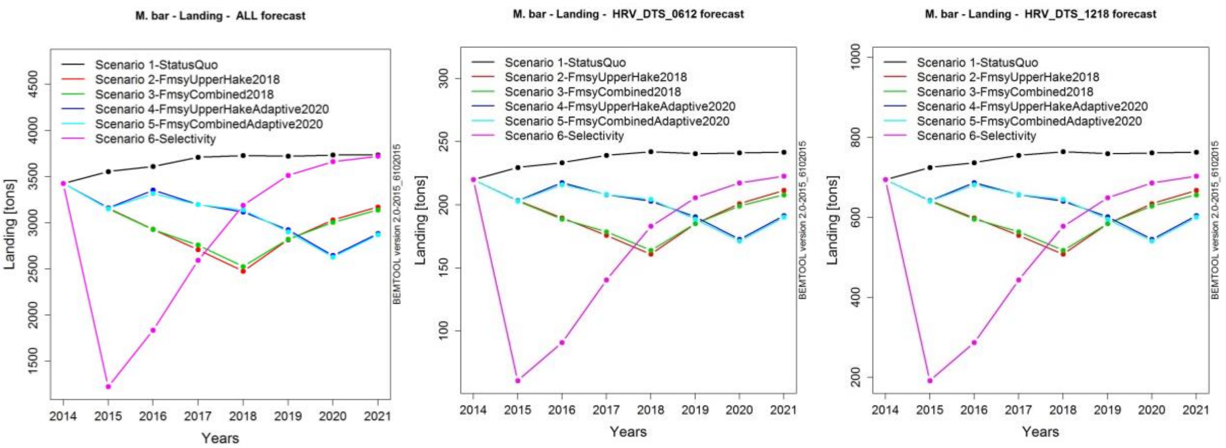
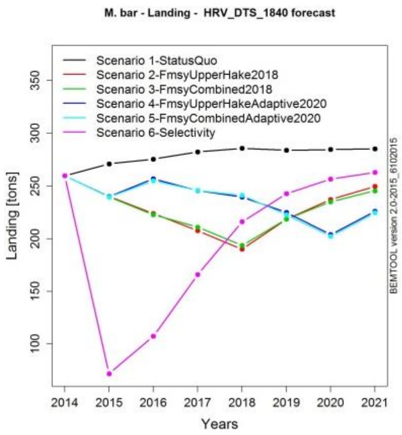


Figure 2.8.9.1.3 Landings and Discards for spottail mantis by fleet segment: comparison among the different management scenarios.

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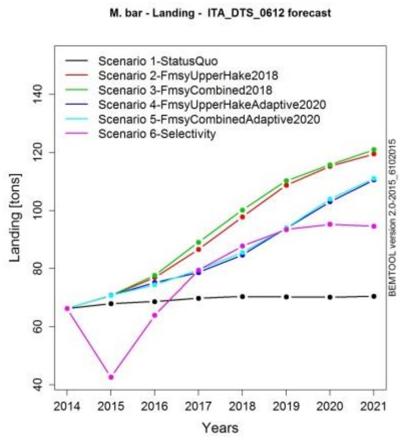
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015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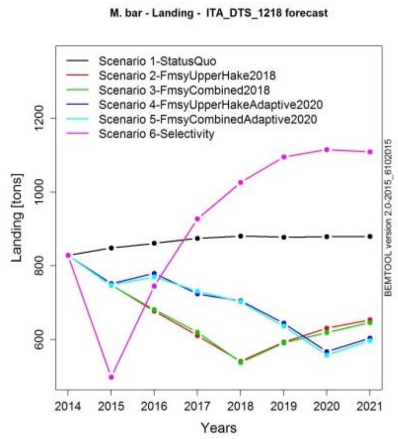
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Landing - ITA_DTS_1218 forecast
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Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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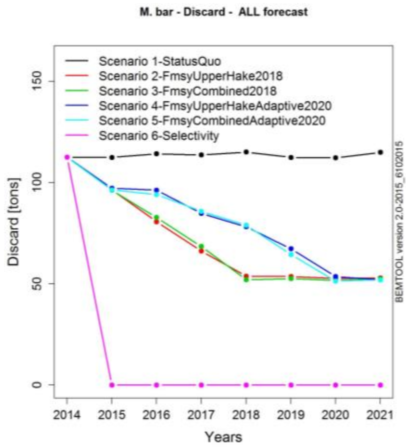
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015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Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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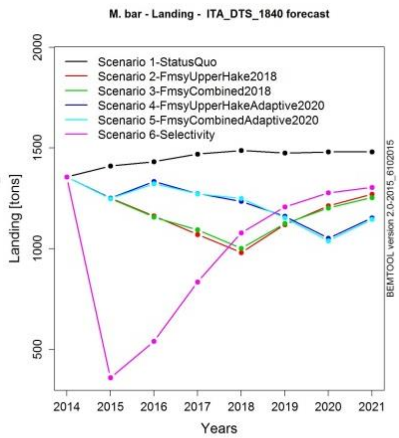
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015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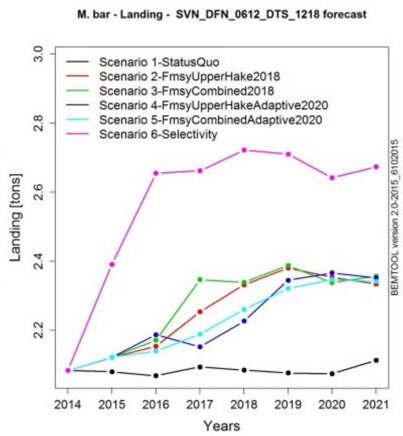
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Landing - SVN_DFN_0612_DTS_1218 forecast
Scenario 1-StatusQuo
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Scenario 3-FmsyCombined2018
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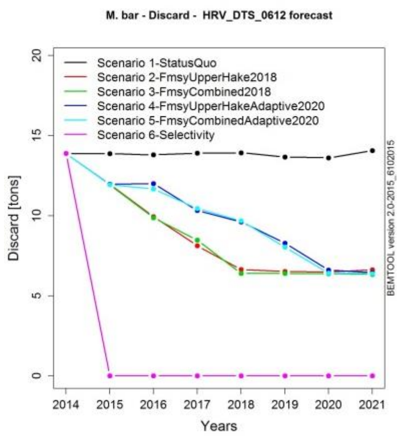
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Landing [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Discard - HRV_DTS_0612 forecast
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Scenario 3-FmsyCombined2018
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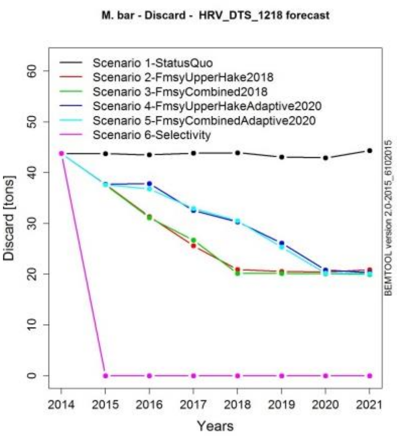
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015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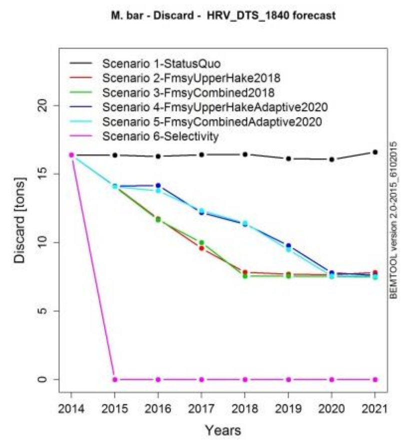
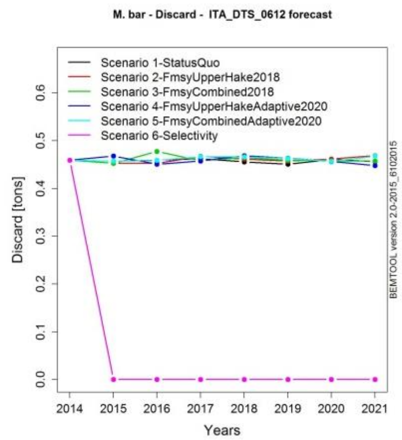
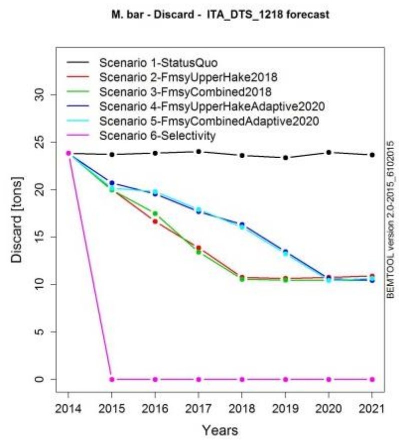
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Discard - HRV_DTS_1840 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Discard - ITA_DTS_0612 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015


M. bar - Discard - ITA_DTS_1218 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
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Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015

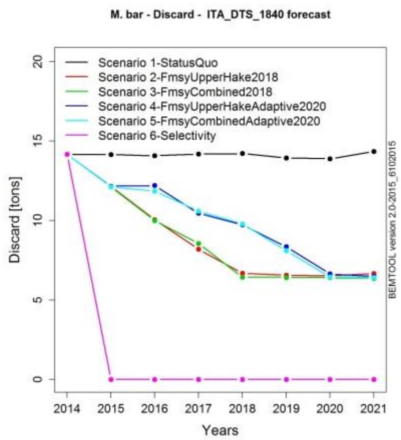

M. bar - Discard - ITA_DTS_1840 forecast
Scenario 1-StatusQuo
Scenario 2-FmsyUpperHake2018
Scenario 3-FmsyCombined2018
Scenario 4-FmsyUpperHakeAdaptive2020
Scenario 5-FmsyCombinedAdaptive2020
Scenario 6-Selectivity
Discard [tons]
Years
BEMTOOL version 2.0-2015_6102015

Figure 2.8.9.1.4 Landings and Discards for red mullet by fleet segment: comparison among the different management scenarios.

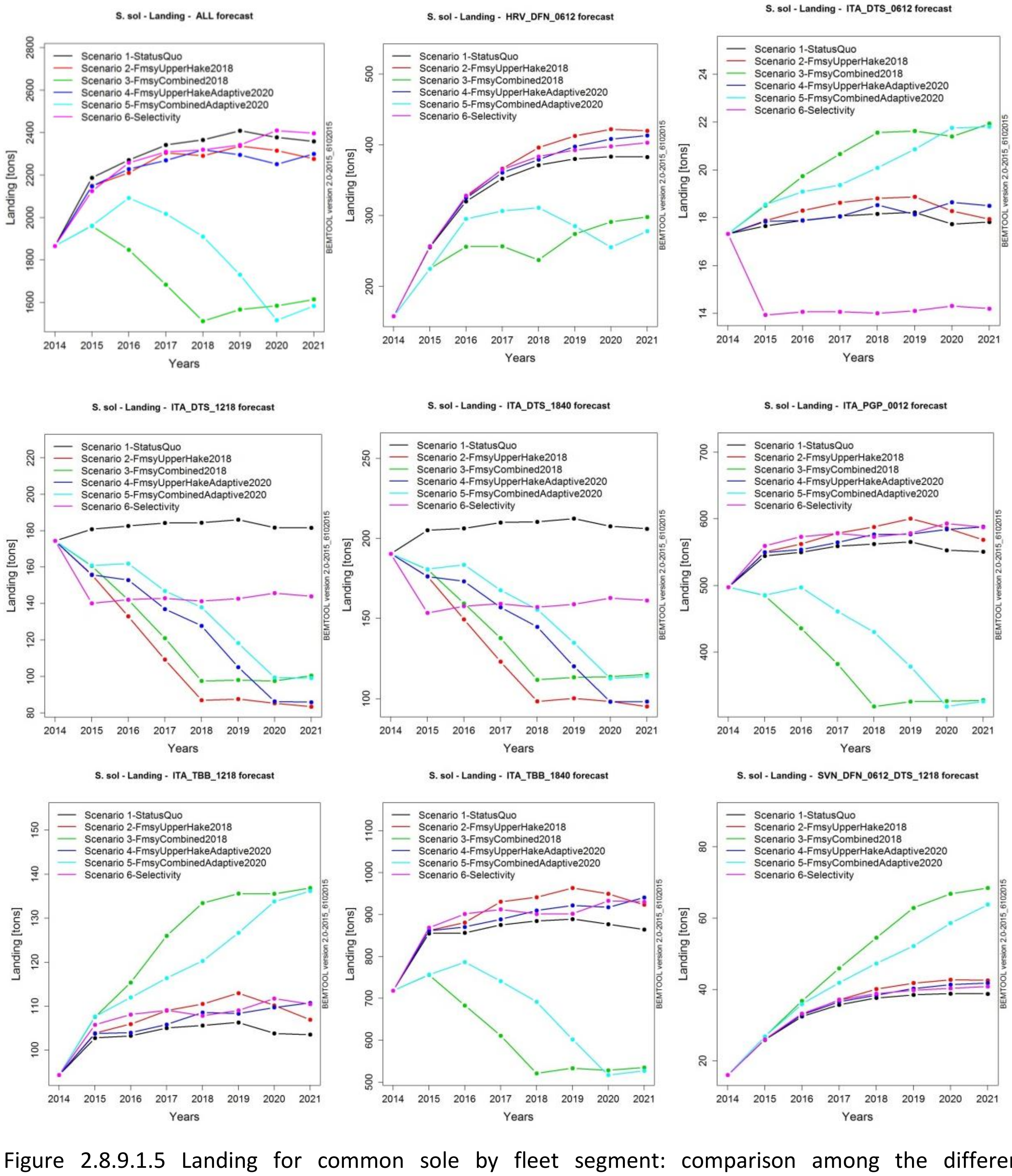


Figure 2.8.9.1.5 Landing for common sole by fleet segment: comparison among the different management scenarios.

2.8.9.2 FORECAST OF SOCIO-ECONOMIC INDICATORS

Figure 2.8.9.2.1 shows the expected impacts on total revenues from each of the five alternative scenarios. The simulation outcomes are compared with the status quo scenario.

Compared with the Status Quo, in 2021 total revenues for the overall fishing fleet is expected to decrease under all the alternative scenarios. Then, alternative scenarios do not produce significant improvements on total revenues for the whole fleet compared with Status Quo. Scenarios 3 and 5 show the worst impact on total revenues with reductions of 11 and 13% compared to Status Quo, while Scenario 2 and 4 produce only 2 and 4% of losses, thus resulting quite similar to the results of Status Quo in 2021 (+1.3% compared to 2014). Analogous result is expected for scenario 6 (increase selectivity) with -3%. However this outcome is quite reasonable, given that scenarios 3 and 5 (both based on F_{MSY} combined) impact more on all the fleet segments, targeting a wider pool of species.

At level of fleet segment, negative impacts on revenues under all the alternative scenarios are expected for the Italian demersal trawlers ITA_DTS_1218 and ITA_DTS_1840, as well as for HRV_DTS_1218, HRV_DTS_0612 and, to a lesser extent, for HRV_DTS_1840. For these fleets, however, scenarios which apply the management measures in the shorter time frame perform better. On the contrary, for the same reasons as for landings, the other fleet segments are positively impacted by the alternative scenarios, with the exceptions of the Italian demersal trawlers ITA_DTS_0612, under Scenario 6 (increase selectivity), and fleet segments HRV_DFN_0612, ITA_PGP_0012 and ITA_TBB_1840, which revenues are negatively impacted only by the management measures based on F_{MSY} combined. Conversely the fleet segments ITA_TBB_1218 and SVN_DFN_0612_DTS_1218 take advantage from all the management measures, given that are not touched by their enforcement.

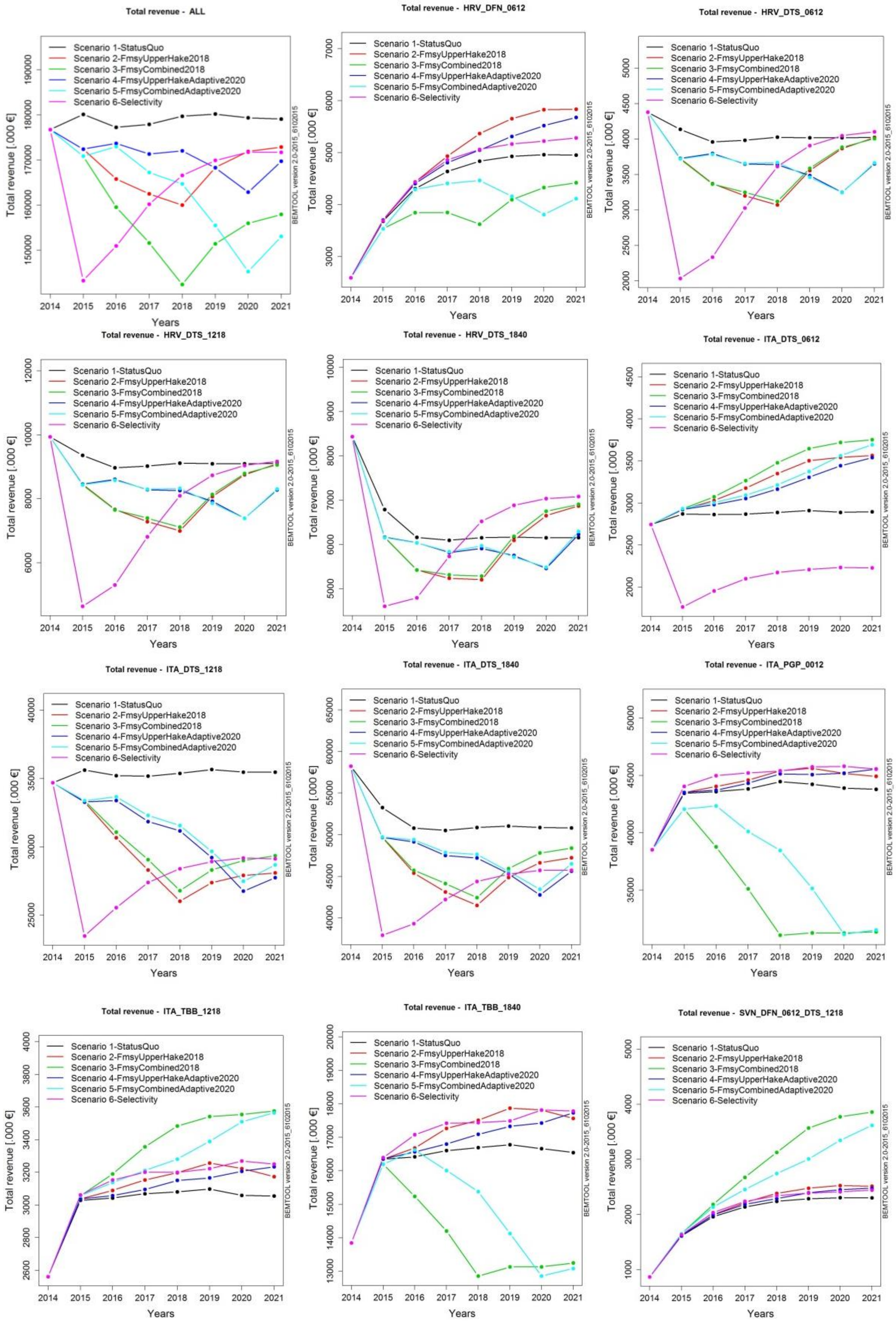
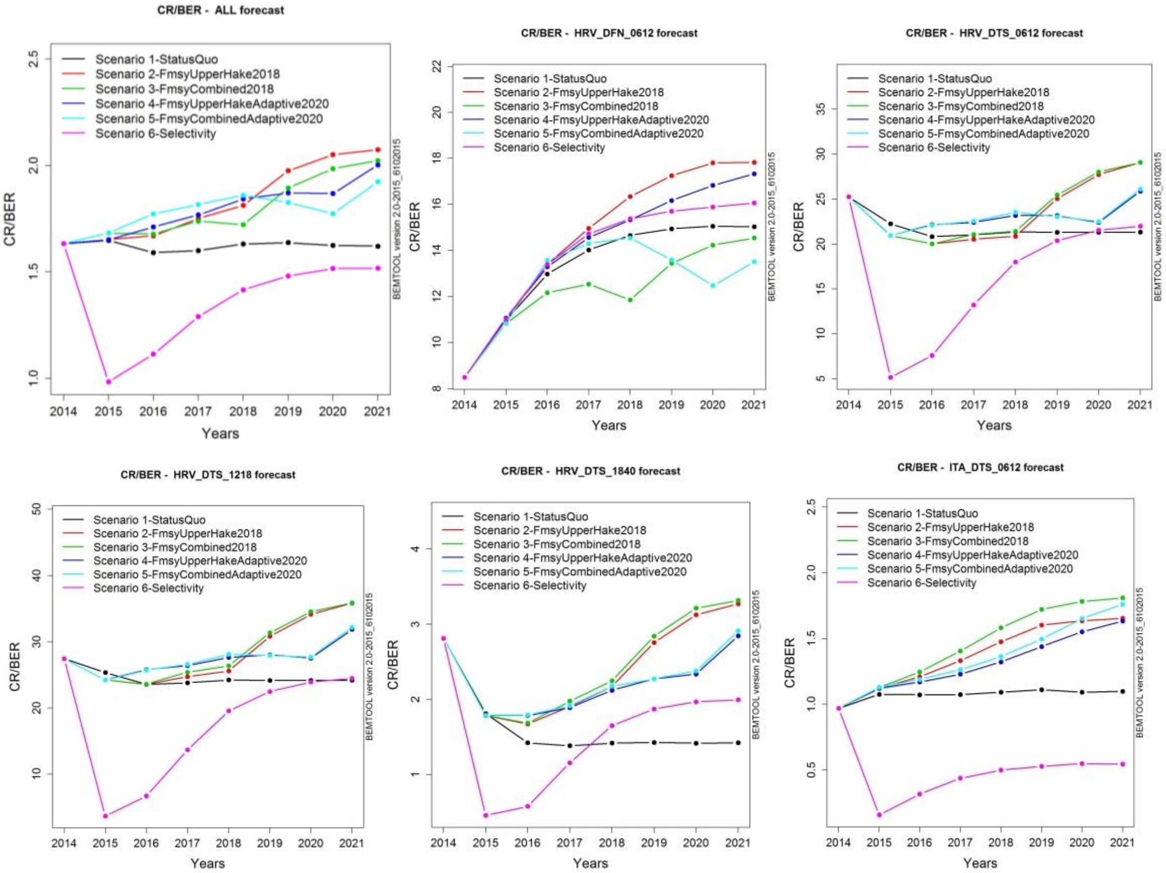


Figure 2.8.9.2.1 Revenues by fleet segment and scenario.

In 2021, the CR/BER ratio under the Status Quo scenario shows values lower than 1 for two fleet segments, the Italian demersal trawlers VL1840 and the Slovenian demersal fleet. The Slovenian demersal fleet will be not affected by the alternative scenarios and the CR/BER is expected to be equal to the Status Quo result. The other fleet segments are expected to register values higher than 1 and improved compared to the status quo in 2021 under all the scenarios (Figure 2.8.9.2.2). The worst performance is expected under Scenario 6 with 4 fleet segments registering values lower than 1 in 2021, these are all the trawlers, of both Italy and Croatia, because would be more impacted by this management measure. With the exception of Scenario 6 for trawlers and scenarios 3 and 5 (based on F_{MSY} combined) for ITA_PGP_0012 and HRV_DFN_0612, alternative scenarios are expected to perform better than Status Quo in terms of economic efficiency, in particular if applied in a shorter timeframe.



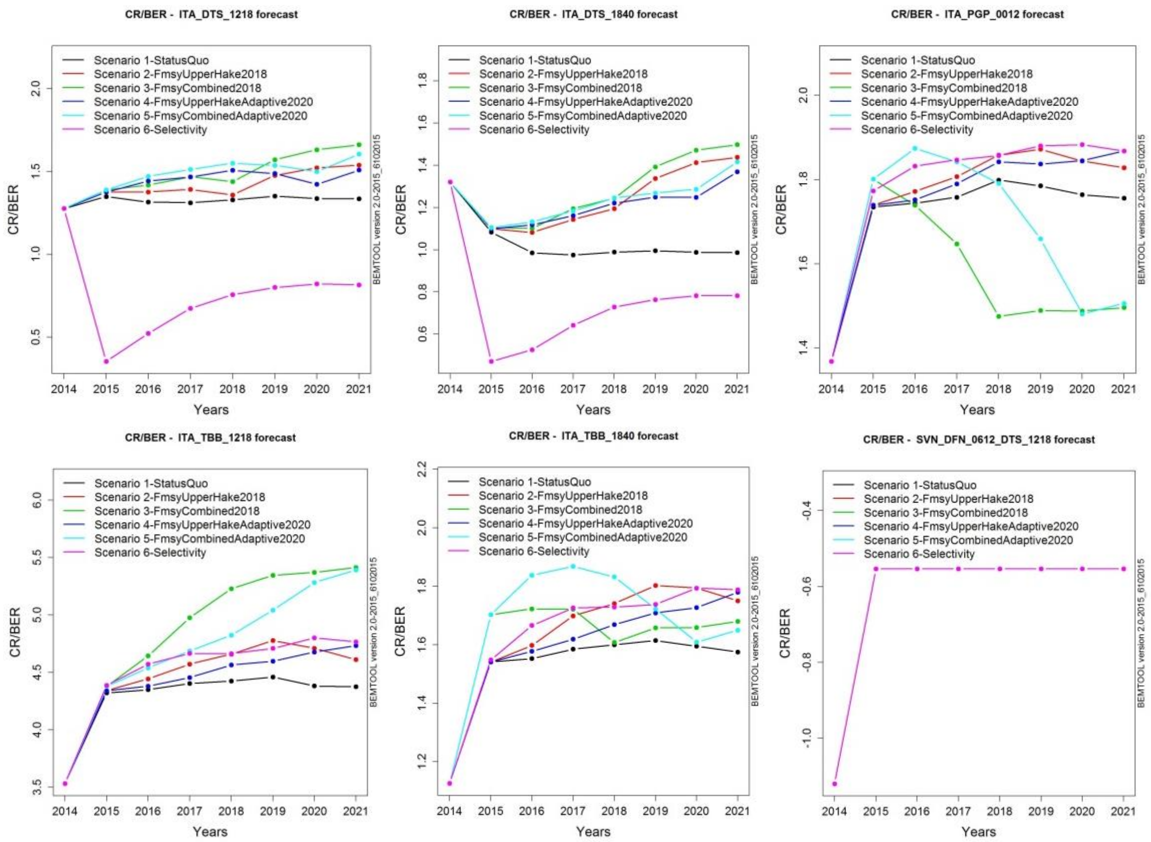


Figure 2.8.9.2.2 Current Revenue to the Break-Even Revenue ratio (CR/BER) by fleet segment and scenario

Figure 2.8.9.2.4 show the effects simulated by the different scenarios on average salary per man employed.

Almost all alternative scenarios are expected to have a better impact on the average salary for all the fishing fleets rather than the Status Quo scenario. The worst performance is expected under Scenario 6 for trawlers, of both Italy and Croatia, because these fleets would be more impacted by this management measure. With the exception of Scenario 6 for trawlers and scenarios 3 and 5 (based on F_{MSY} combined) for ITA_PGP_0012 and HRV_DFN_0612, alternative scenarios are expected to perform better than Status Quo in terms of average salary, in particular if applied in a shorter timeframe. Given the improvement of landings and revenues, positive effects will be registered in particular for the fleet segment SVN_DFN_0612_DTS_1218, taking advantage from the application of the management measures to the rest of the fleets.

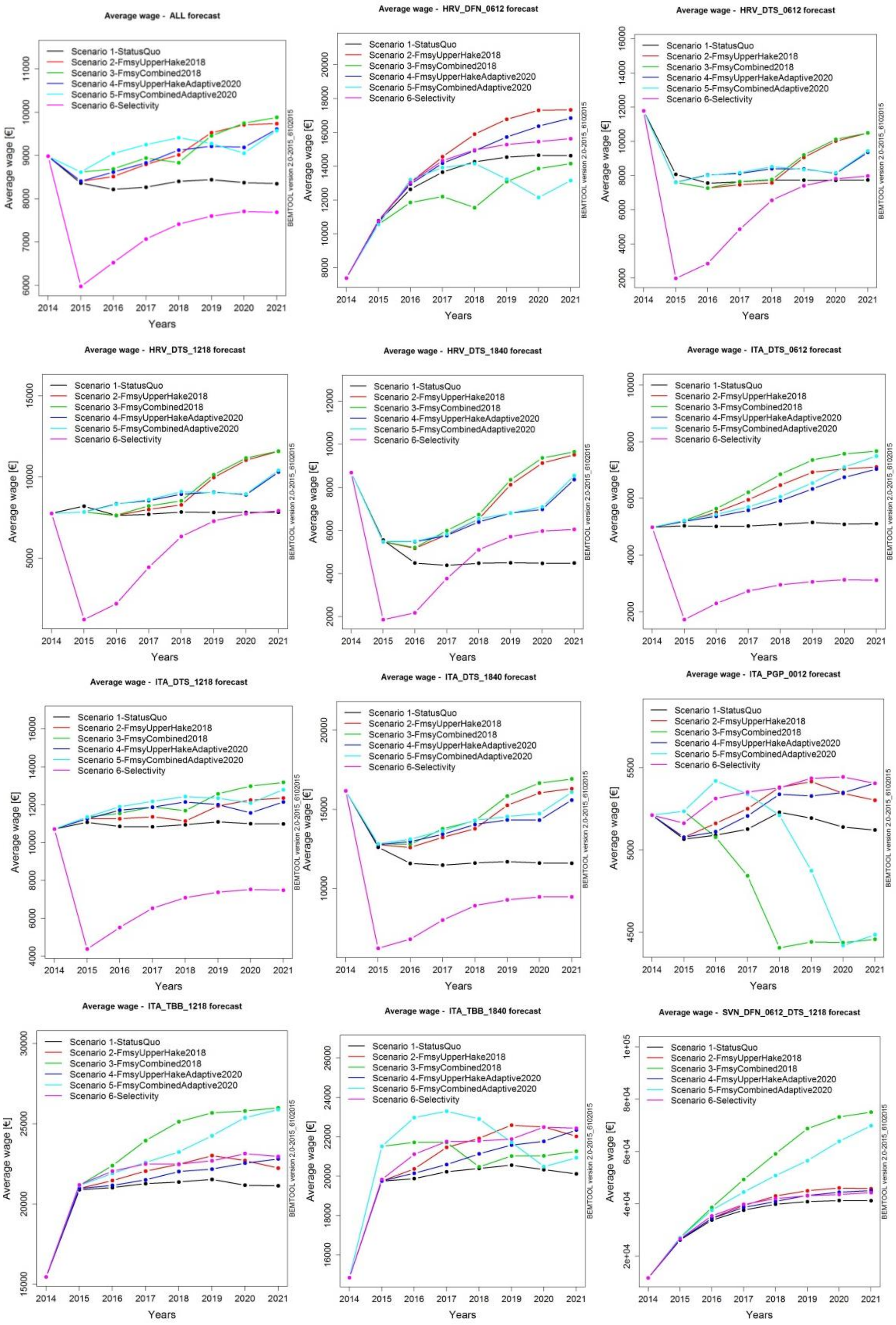


Figure 2.8.9.2.4 Average salary by fleet segment and scenario

2.8.10 REPORT THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

According to the traffic light approach reported in tables 2.8.10.1 -4 and the graph radar in figure 2.8.10.1, all the performed scenarios allow to obtain a benefit on the SSB for the 4 stocks under consideration respect to the status quo, the increase for hake would be higher than all the other stocks.

Considering the catches of the whole fleet, there is an important increase of the catch of hake, as a consequence of stock rebuilding, but a decrease for spottail mantis shrimp in all the scenarios, that is more marked for Scenario 3 and 5, with 25-30% of reduction. This because the species is caught by fleet segments that are not targeting hake and thus is more impacted by the management measures based on F_{MSY} combined. Also catches of common sole are more impacted by the same scenarios, while for the catches of red mullet the higher decrease would occur in scenarios 4 and 5 (adaptive scenarios) given the applied timeframe (2020). The decrease of catches of red mullet, spottail mantis shrimp and sole would be however partially compensated by the increased catches of hake.

Revenues are also more impacted by scenarios 3 and 5, because these scenarios affect the catches of more assessed species compared to scenarios 2 and 4. The decrease in revenues would be anyhow rather limited, being maximum about 15%, while the impact on the employment would be less, i.e. about 6%.

From a social viewpoint, all alternative scenarios are expected to have a better impact on the average salary, that would improve in all scenarios, as consequence of reduced costs given the remarkable decrease of activity, except in the scenario 6 (selectivity), which does not implies such cost reduction. As a consequence of this dynamic the CR_BER indicator will fairly improve in all scenarios (between 19 and 28%) except in scenario 6; also the indicator ROI is improving in all the scenarios, except scenario 6 (Table 2.8.10.1).

Results show that the fleet segments mostly affected by management measures, in terms of catches, are ITA_DTS_1840 and ITA_DTS_1218, because the losses of species as red mullet, spottail mantis and sole are not compensated by the recovery of hake stock (table 2.8.10.2). Similar considerations hold for the fleet segments ITA_PGP_0012, ITA_DTS_1840 and HRV_DFN_0612 under scenarios 3 and 5. Regarding the fleet segments HRV_DTS_0612, HRV_DTS_1218 and HRV_DTS_1840, the loss of red mullet catches would be compensated by the gain of hake catches (these fleets do not catch spottail mantis shrimp), and finally the revenues will not be much penalized, except in the scenarios 4 and 5, with a loss of approximately 9% (Tab. 2.8.10.3).

The fleet segments that will take more advantage by the management measures will be ITA_TBB_1218, ITA_DTS_0612 and SVN_DFN_DTS_0612 because only partially or not affected by the management measures (Tab. 2.8.10.2 and Tab. 2.8.10.4).

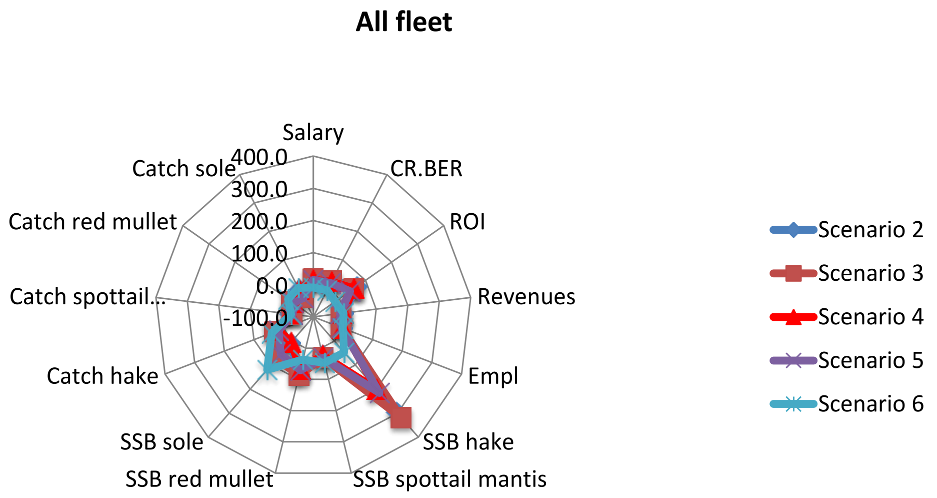


Figure 2.8.10.1 Radar plot for all the fleet. Each line represents a scenario and each point the corresponding percentage of each indicators respect to status quo.

Table 2.8.10.1 - Performances of the management scenarios (% of change respect to status quo) simulated in terms of SSB and catches of hake, spottail mantis, red mullet and sole, salary, CR/BER, ROI, employment and revenues by all fleet segments. The green values are higher than +5% of the baseline value of status quo (Scenario 1), the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the fishing mortality F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo. GSA17.

GSA17 demersal	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB hake	SSB spottail mantis	SSB red mullet	SSB sole	Catch hake	Catch spottail mantis	Catch red mullet	Catch sole	F hake	F spottail mantis	F red mullet	F sole
SQ (values in 2014 – baseline year)	8982	1.633	0.18	176777	4980	4729	7469	5051	1501	2969	2757	3539	1866	0.66	0.46	0.66	0.44
Scenario 1 (values in 2021)	8348	1.621	0.177	179108	5664	2032	7929	5489	7655	1875	3011	3847	2358	0.66	0.46	0.66	0.44
Scenario 2	16.6	28	66.7	-3.5	-2.2	295.5	21.6	85.2	8.1	28.7	-24.2	-16.3	-3.5	0.31	0.3	0.34	0.4
Scenario 3	18.4	24.8	55.4	-11.8	-5.7	319.4	30.5	87.2	75	29.8	-33.5	-17	-31.6	0.29	0.29	0.34	0.21
Scenario 4	15.1	23.6	55.4	-5.2	-2.2	201.1	22.9	68.5	5.2	16.7	-23	-23.7	-2.5	0.31 (2018) 0.45	0.3 (2018) 0.37	0.34 (2018) 0.47	0.4 (2018) 0.42
Scenario 5	14.7	18.7	40.7	-14.6	-5.7	215.4	30.6	70.6	54.7	16.9	-34.3	-24	-32.9	0.29 (2018) 0.44	0.29 (2018) 0.36	0.34 (2018) 0.47	0.21 (2018) 0.3
Scenario 6	-7.9	-6.4	-16.4	-4.1	0	47	36.9	119.2	4.6	40.4	-29.7	-3.3	1.6	0.55	0.25	0.45	0.43

Table 2.8.10.2 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of hake, spottail mantis, red mullet and sole, salary, CR/BER, employment and revenues by Italian fleet segments. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 and the values of scenario 1 in 2021 are also reported.

Demersal GSA17 Fleet segment	ITA17_DTS_0612								ITA17_DTS_1218							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet	Catch sole (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	4984	0.97	2744	135	21	104	52	10	10721	1.28	34681	908	483	812	680	120
Scenario 1 (values in 2021)	10721	1.28	34681	908	483	812	680	120	16178	1.32	58229	917	1696	776	1229	136
Scenario 2	39.2	50.6	23.2	0.0	178.6	28.8	68.9	0.7	12.4	15.2	-20.8	-5.8	25.1	-41.8	-26.5	-54.1
Scenario 3	50.1	64.8	29.6	0.0	191.0	43.5	70.9	23.1	20.0	24.4	-17.2	-5.9	28.4	-36.4	-27.4	-44.7
Scenario 4	37.7	48.7	22.3	0.0	155.2	30.7	56.4	3.8	10.6	12.9	-21.8	-5.8	13.5	-41.3	-32.2	-52.7
Scenario 5	46.6	60.3	27.6	0.0	165.3	42.9	57.0	22.3	16.4	20.1	-19.1	-5.9	15.7	-37.3	-32.9	-45.4
Scenario 6	-39.0	-50.5	-23.1	0.0	40.0	-51.0	33.2	-20.3	-31.8	-38.9	-17.9	0.0	40.3	-50.8	22.6	-20.7

Fleet segment	ITA17_DTS_1840								ITA17_PGP_0012							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet	Catch sole (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	16178	1.32	58229	917	1696	776	1229	136	5213	1.37	38511	2472	0	335	0	285
Scenario 1 (values in 2021)	5213	1.37	38511	2472	0	335	0	285	15452	3.53	2560	47	0	15	0	67
Scenario 2	40.5	45.7	-7.0	-5.8	25.1	-41.9	-14.6	-53.8	3.5	4.1	2.6	0.0		7.8		3,3
Scenario 3	45.9	51.8	-4.8	-5.9	28.5	-36.7	-15.7	-44.1	-13.0	-14.8	-28.4	-5.9		-51.0		-40,5
Scenario 4	34.4	38.7	-10.2	-5.8	13.5	-41.4	-22.6	-52.3	5.6	6.4	4.0	0.0		8.7		6,8
Scenario 5	38.6	43.6	-8.5	-5.9	15.8	-37.6	-23.0	-44.7	-12.4	-14.2	-28.0	-5.9		-49.9		-40,8
Scenario 6	-18.3	-20.7	-10.0	0.0	40.3	-51.0	-12.8	-21.7	5.6	6.4	4.0	0.0		13.5		6,7

Fleet segment	ITA17_TBB_1218								ITA17_TBB_1840							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	15452	3.53	2560	47	0	15	0	67	14845	1.13	13849	225	0	208	0	458
Scenario 1 (values in 2021)	14845	1.13	13849	225	0	208	0	458	11709	-1.12	867	49	0	0	2	11
Scenario 2	5.2	5.4	3.9	0.0		32.8		3.3	9.5	11.1	6.2	0.0		39.2		6.8
Scenario 3	23.0	23.7	17.0	0.0		49.6		32.2	5.7	6.7	-19.9	-5.9		-29.9		-38.1
Scenario 4	7.9	8.2	5.9	0.0		33.1		7.0	11.1	13.0	7.2	0.0		37.6		8.9
Scenario 5	22.5	23.2	16.7	0.0		46.2		31.5	4.1	4.8	-20.9	-5.9		-32.9		-39.0
Scenario 6	8.6	8.9	6.4	0.0		57.2		6.7	11.5	13.5	7.5	0.0		64.6		7.6

Table 2.8.10.3 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of hake, spottail mantis, red mullet and sole, salary, CR/BER, employment and revenues by Croatian fleet segments. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 and the values of scenario 1 in 2021 are also reported.

Demersal GSA17 Fleet segment	HRV17_DFN_0612								HRV17_DTS_0612							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	7383	8.48	2592	46	56	0	0	107	11781	25.23	4379	29	134	0	193	0
Scenario 1 (values in 2021)	11781	25.23	4379	29	134	0	193	0	7769	27.42	9936	44	414	0	609	0
Scenario 2	18.5	18.6	17.8	0.0	204.7			9.7	35.5	36.2	0.0	-5.8	25.4		-14.8	
Scenario 3	-3.2	-3.2	-10.7	-5.9	40.9			-22.1	35.6	36.2	-0.4	-5.9	28.8		-15.8	
Scenario 4	15.3	15.4	14.7	0.0	169.0			7.9	20.8	21.2	-9.2	-5.8	13.8		-22.7	
Scenario 5	-10.0	-10.1	-16.9	-5.9	23.2			-27.4	21.9	22.3	-9.0	-5.9	16.1		-23.1	
Scenario 6	6.9	6.9	6.6	0.0	51.4			5.3	3.0	3.0	2.0	0.0	40.4		-12.8	
Fleet segment	HRV17_DTS_1218								HRV17_DTS_1840							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	7769	27.42	9936	44	414	0	609	0	8690	2.81	8430	108	447	0	228	0
Scenario 1 (values in 2021)	8690	2.81	8430	108	447	0	228	0	4984	0.97	2744	135	21	104	52	10
Scenario 2	47.6	48.0	-0.2	-5.8	25.4		-14.8		112.1	129.9	11.6	-5.8	25.4		-14.8	
Scenario 3	47.8	48.1	-0.5	-5.9	28.8		-15.8		115.0	133.2	12.1	-5.9	28.8		-15.8	
Scenario 4	31.3	31.6	-9.1	-5.8	13.8		-22.7		86.4	100.1	1.1	-5.8	13.8		-22.7	

Scenario 5	32.7	32.9	-8.8	-5.9	16.1		-23.1		90.5	104.8	2.2	-5.9	16.1		-23.1	
Scenario 6	1.1	1.1	0.6	0.0	40.4		-12.8		34.8	40.3	15.0	0.0	40.4		-12.8	

Table 2.8.10.4 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of hake, spottail mantis, red mullet and sole, CR/BER, employment and revenues by Slovenia fleet segment. The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 and the values of scenario 1 in 2021 are also reported.

Demersal GSA17 Fleet segment	SVN17_DFN_DTS_0612							
	Salary (euro)	CR.BER (ratio)	Rev (Keuro)	Emp (units)	Catch hake (tons)	Catch spottail mantis (tons)	Catch red mullet (tons)	Catch sole (tons)
SQ (values in 2014 – baseline year)	11709	-1.12	867	49	0	0	2	11
Scenario 1 (values in 2021)	41278	-0.55	2305	46	0	0	2	39
Scenario 2	10.0	0.0	8.4	0.0		4.8	9.5	8.8
Scenario 3	73.7	0.0	61.8	0.0		8.8	10.5	69.7
Scenario 4	8.3	0.0	6.9	0.0		5.4	10.2	7.2
Scenario 5	62.4	0.0	52.3	0.0		11.6	9.8	58.8
Scenario 6	6.6	0.0	5.5	0.0		11.8	24.0	4.8

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process(AHP), has been used to assess the performances of the alternative fisheries management policies (Rossetto et al., 2015).

The eight indicators used in the analysis are listed in table 2.8.10.5, along with the weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the ‘current condition’. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021.

Table 2.8.10.5 Summary of the indicators used in the MCDA

Top level hierarchy	Low level hierarchy	Indicator*	Weight
Socioeconomic	Economic	GVA, ROI or Profit	0.008
Socioeconomic	Economic	CR.BER	0.042
Socioeconomic	Social	EMP	0.191
Socioeconomic	Social	Salary	0.0641
Biological	Biological conservation	SSB	0.260
Biological	Biological conservation	F	0.260
Biological	Biological production	Landing	0.137
Biological	Biological production	D	0.036

* GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; WAGE: Average wage; EMPL: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y: Landing; D: Discard rate.

According to MCDA (Fig. 2.8.10.1), the scenarios that allows to reach the highest overall utility are scenarios 3 and 2 with utility respectively of 0.60 and 0.58, given the higher contribute at improving the biological conservation component, while the lowest utility is given by Scenario 1, the status quo (0.39). Scenarios 4 and 5 had an equivalent utility, respectively 0.56 and 0.57. Scenario 6 instead had an utility only a bit higher than the status quo (0.43), because applied alone it was contributing less to the biological conservation objective, while affecting with a negative sign the economic component. Overall these results are in agreement with the traffic light tables, which simply compares percentage of change to the status quo.

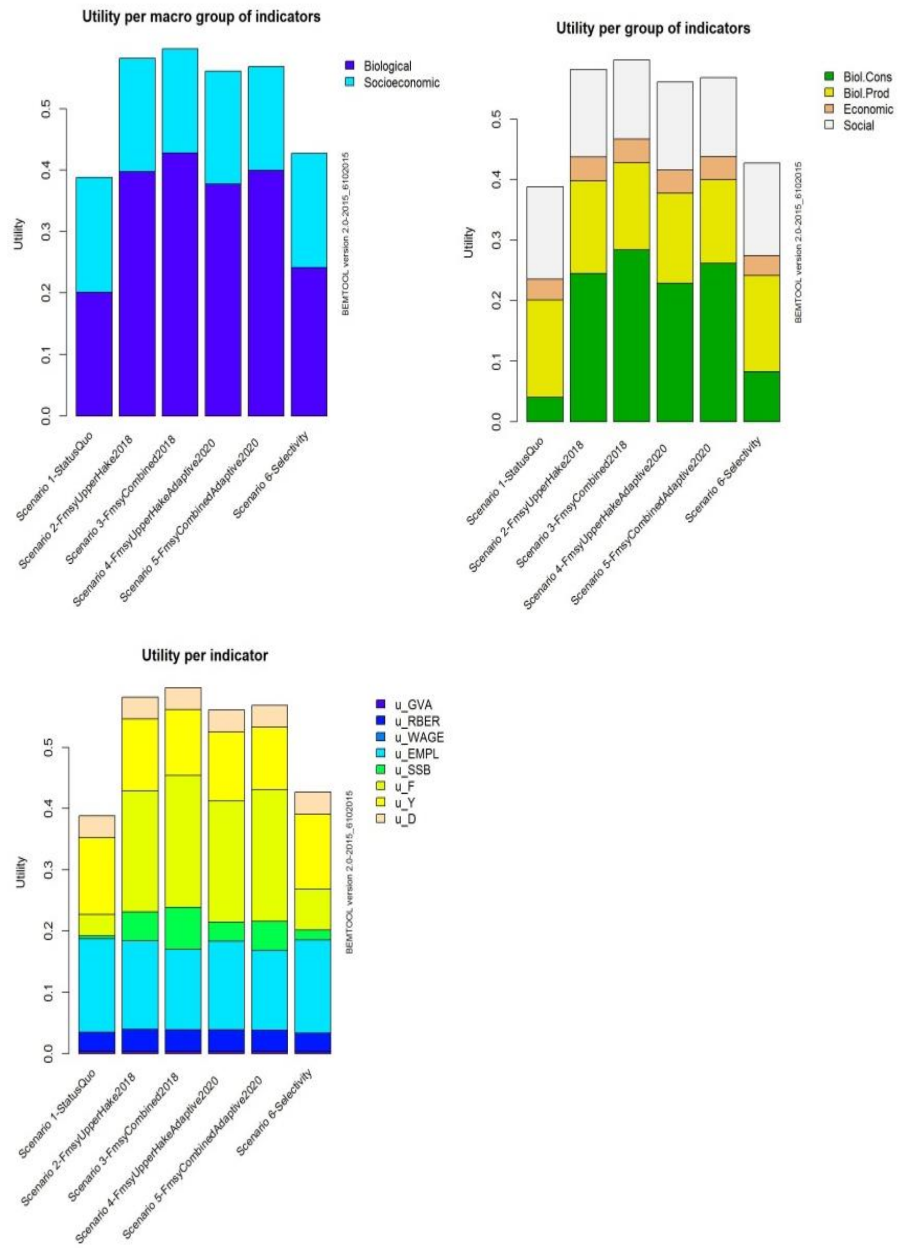


Figure 2.8.10.1 MCDA results: evaluation of the overall utility associated to each management scenario.

2.8.11 DISCUSSION AND CONCLUSIONS OF DEMERSAL FISHERIES CASE STUDY IN GSA17

- According to the traffic light approach, all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect to the status quo. The best performance for SSB is showed by Scenario 3 and 2, compared with 4 and 5, consistently with the greater benefit that generally the reduction of fishing mortality produces on this indicators if applied in a short time range. The worse result is observed in the status quo.
- Adaptive scenarios (Scenario 4 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 3), but also a reduced decrease in landing of the overall catch of all stocks in the short term.
- However, according to the strategy by which the management measures have been applied, the Scenario 3 is more effective, given that it is using an F_{MSY} combined, that in the specific situation of the local fisheries implies a wider safeguard from an ecological perspective, given that the target stocks of the fleets are different, as not all the fleet are targeting the more exploited species (hake) used as benchmark.
- Considering the catches of the whole fleet, there is an important increase of the catch of hake, as a consequence of stock rebuilding, but a decrease of catches of red mullet, spottail mantis shrimp and sole, that would be only partially compensated by the increased catches of hake.
- Revenues are also more impacted by scenarios based on F_{MSY} combined as target, because these scenarios affect the catches of more assessed species compared to the scenarios based on F*upper* of hake. The decrease in revenues would be anyhow rather limited, being maximum about 15%, while the impact on the employment would be less, i.e. about 6%.
- From a social viewpoint, all alternative scenarios are expected to have a better impact on the average salary, that would improve in all scenarios, as consequence of reduced costs, given the remarkable decrease of activity, except in the scenario 6 (selectivity), which does not implies such cost reduction. As a consequence of this dynamic the CR_BER indicator will fairly improve in all scenarios (between 19 and 28%) except in scenario 6.
- The Management Strategy Evaluation (MSE) showed that moving to F_{MSY} upper of hake will result in considerable decrease and fluctuation in catches in the short-term, though they will increase and stabilise over the longer-term. In addition, the probability of being below Blim is initially high but decreases practically to null values over the time of management.
- Finally, according to MCDA, the scenarios that allows to reach the highest overall utility are scenarios 3 and 2 with utility respectively of 0.60 and 0.58, given the higher contribute at improving the biological conservation component, while the lowest utility is given by Scenario 1, the status quo (0.39). Scenarios 4 and 5 had an equivalent utility, respectively 0.56 and 0.57. Scenario 6 instead had an utility only a bit higher than the status quo (0.43), because applied alone it was contributing less to the biological conservation objective, while affecting with a negative sign the economic component. Overall these results are in agreement with the traffic light tables, which simply compares percentage of change to the status quo.

ANNEX G - INPUTS FOR MODELLING DEMERSAL FISHERY IN GSA17

G.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL STOCKS IN GSA17

The data used for the parameterization of the biological and the pressure module for *M. merluccius* (European hake) and *S. solea* (common sole) come from the stock assessments carried out during the Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2014. The input for biological and pressure modules for *S. mantis* (spottail mantis) are from the Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2012, while for *M.barbatus* (red mullet) the stock assessment has been performed during Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2013.

The methodology used is Stock Synthesis SS3 (Methot and Wetzel, 2013) for *M. merluccius* and *S. solea;* for *M. barbatus* Extended Survivor Analyses (XSA, Darby and Flatman, 1994) has been used and finally for *S. mantis*, separable VPA has been carried out. For *S. solea* also ALADYM model (Lembo et al., 2009) has been parameterized during the STECF Expert Working Group on stock assessment held in 2014.

The assessments of *M. merluccius* is a joint assessment covering Italy and Croatia given that the species is poorly represented in Slovenia catches; *S. mantis* assessment covers Italy and Slovenia given that this species is poorly represented in Slovenia catches, while *S. solea* and *M. barbatus* assessments cover Italy, Slovenia and Croatia.

GROWTH PARAMETERS OF DEMERSAL STOCKS IN GSA17

The growth parameters and the length-weight relationship coefficients for the four species are listed in Table G1.1. These parameters were used for sex combined.

For European hake the fast growth pattern has been assumed that is the one agreed in STECF Expert Working Group. The life span of this species has been set equal to 8 years (to be consistent with the SS3 assessment) as for common sole, while 6 and 7 years were used for spottail mantis and red mullet, respectively.

The growth for spottail mantis has been studied by Froglia et al. (1996) using indirect method.
According to Jardas (1996), red mullet grow up to 30 cm, with females growing faster and bigger than males. In the Adriatic sea, growth analyses on common sole have been made using otoliths, scales and tagging experiments. A great variability in the growth rate was noted: some specimens had grown 2 cm in one month, while others, of the same age group, needed a whole year (Piccinetti and Giovanardi, 1984). Von Bertalanffy growth equation parameters have been calculated using various methods. Within the framework of SoleMon project, growth parameters of sole were estimated through the length-frequency distributions obtained from surveys.

Table G1.1 show growth parameters and the length-weight relationship coefficients for the four species of demersal fisheries in GSA17

Table G1.1 Growth parameters and the length-weight relationship coefficients for the four species of demersal fisheries in GSA17

Parameter	European hake sex combined	Red mullet sex combined	Common Sole sex combined	Parameter	Spottail mantis sex combined
Linf (cm)	104	26.9	39.6	Linf (mm)	41.5
K	0.2	0.295	0.4	K	0.49
t_0	-0.01	-1.1	-0.46	t_0	-0.0105
a (mm/g)	2.71E-06	7.56E-06	6.04E-06	a (mm/g)	0.0025

b (mm/g)	3.2	3.076	3.06	b (mm/g)	3.045

RECRUITMENT OF DEMERSAL STOCKS IN GSA17

For all the stocks a reliable stock recruitment relationship is not available, due to the shortness of the time series. For this reason a recruitment vector from the stock assessment results has been used for the simulation of all the considered species and a constant value was the input for projections. To this value a process error was associated to account for uncertainty.

The recruitment figures of the four stocks are reported in Table G.1.2

Recruits of *M. merluccius* are from SS3 stock assessment results and are related to age 0; the age of recruitment has been set equal to 4 months.

The recruitment figures of *S. mantis* were related to age 0 and are from separable VPA results. The age of recruitment has been set equal to 0 months.

The recruitment figures of *M. barbatus* were related to age 0 and are from XSA stock assessment results. The age of recruitment has been set equal to 1 month.

The recruitment figures of *S. solea* were related to age 0 and are from SS3 stock assessment results. The age of recruitment has been set equal to 4 months.

Table G.1.2 Recruitment by year by year used in simulation phase European hake in GSA 17.

Year	European hake R (thousands)	Spottail mantis R (thousands)	Red mullet R (thousands)	Common sole R (thousands)
2008	47 498	4 079 513	12 02 985	23 245
2009	35 074	3 483 038	850 746	36 652
2010	28 646	3 337 315	1 122 388	30 676
2011	38 332	2 861 854**	1 880 597	36 467
2012	49 106	2 861 854**	1 235 821°°	40 183
2013	28 594	2 861 854**	1 235 821°°	59 360
2014	28 594*	**2 861 854	1 235 821°°	59 360*

* This value has been used for projections (the same value of 2013); ** This value has been used for projections (the same value of 2011); °°* This value has been used for projections (the same value of 2012)

The number of recruits entering in the population has been split by month in order to take into account the seasonal recruitment (Table G.1.3). European hake recruits more in spring and autumn; spottail mantis from August to November; red mullet from June to October and common sole more from July to February.

Table G.1.3 Proportion of recruits by species entering each month in the population in GSA 17.

Species/month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
European hake	0.042	0.042	0.125	0.125	0.125	0.042	0.04	0.042	0.125	0.125	0.125	0.042
spottail mantis								0.2	0.5	0.2	0.1	
Red mullet						0.15	0.2	0.3	0.2	0.15		
Common sole	0.1	0.1					0.1	0.1	0.1	0.2	0.2	0.1

MATURITY AND SEX RATIO OF DEMERSAL STOCKS IN GSA17

The size at first maturity (Lm50%) and maturity range by species are reported in the table G.1.4 These parameters have been estimated within DCF on biological sampling data.

Table G.1.4 Maturity parameters for the 4 stocks in demersal fisheries GSA 17 case study.

mm	Sex combined	
Species	Lm50%	MR =Lm75%-Lm25%
M. merluccius	300	40
S. mantis	22	5
M. barbatus	120	3
S. solea	258	24

NATURAL MORTALITY OF DEMERSAL STOCKS IN GSA17

The natural mortality at age of the four stocks under consideration is reported in the Table G.1.5.

Natural mortality was estimated was estimated using the Prodbiom method (Abella et al., 1997) for hake, red mullet and common sole, while for spottail mantis Chen and Watanabe method (1989) was used.

Table G.1.5 Natural mortality of the four stocks in GSA 17. The last year should be always interpreted as a plus group.

Age (years)	European hake M	Spottail mantis M	Red mullet M	Comon sole M
0	0.94	1.62	2.02	0.7
1	0.53	0.94	0.84	0.35
2	0.40	0.69	0.37	0.28
3	0.35	0.6	0.29	0.25
4	0.32	0.5	0.26	0.23
5	0.30	0.4	0.25	0.22
6+	0.29		0.24	0.21
7	0.28			0.2

TOTAL MORTALITY OF DEMERSAL STOCKS IN GSA17

The total mortality vectors used to feed BEMTOOL model are reported in the table Table G.1.6

Table G.1.6 Total mortality for hake, spottail mantis, red mullet and common sole in GSA 17.

Year	Hake	Spottail mantis	Red mullet	Common sole
2008	1.16	1.41	1.37	2.22
2009	1.22	1.54	1.64	3.15
2010	1.15	1.6	1.42	2.4
2011	1.01	2	1.99	2.26
2012	1.06	2	1.58	2.54
2013	1.37	1.6*	1.26	1.41
2014	1.37	1.6	1.26	1.41

*The total mortality of spottail mantis has been rescaled in 2013 to a factor of 0.8 as it was more consistent with the shape of production trend.

G.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERIES IN GSA17

FISHING MORTALITY OF DEMERSAL STOCKS IN GSA17

The Z-mode of ALADYM model has been used in BEMTOOL for all the stocks. The overall fishing mortality and natural mortality have been used to estimate the annual total mortality to be applied in ALADYM model.

M. merluccius

The overall fishing mortality by year and age of European hake from SS3 model is reported in G.2.1. For 2014 the same fishing mortality as 2013 has been assumed. For hake the age range 0-5 was used for calculation of F average (F_{bar}).

Table G.2.1. Overall fishing mortality for hake in GSA 17 (SS3 model).

age	2009*	2010	2011	2012	2013
0	0.12	0.11	0.10	0.12	0.17
1	1.79	1.61	1.29	1.36	2.01
2	0.46	0.42	0.36	0.40	0.59
3	0.22	0.21	0.18	0.21	0.31
4	0.20	0.18	0.17	0.19	0.28
5	0.20	0.18	0.17	0.19	0.28
6+	0.20	0.18	0.17	0.19	0.28

* For 2008 the same fishing mortality of 2009 has been assumed.

S. mantis

The overall fishing mortality for spottail mantis by year and age from separable VPA model has been used (Table G.2.2). For 2014 the same fishing mortality as 2013 has been assumed. The age range 0-2 was used for the calculation of average F.

Table G.2.2. Overall fishing mortality for spottail mantis (separable VPA model).

Age	2008	2009	2010	2011*
0	0.00	0.00	0.00	0.01
1	0.03	0.20	0.15	0.34
2	0.61	0.96	1.25	1.15
3+	1.17	1.17	1.17	1.76

* For 2012 and 2013 the same fishing mortality of 2011 has been assumed.

M. barbatus

The overall fishing mortality for red mullet by year and age from XSA model have been used (Table G.2.3). For 2014 the same fishing mortality as 2013 has been assumed. The age range 0-5 was used for the calculation of average F.

Table G.2.3. Overall fishing mortality for red mullet in GSA 17 (XSA model).

age	2008	2009	2010	2011	2012*
0	0.08	0.03	0.03	0.04	0.05
1	0.74	0.72	0.46	0.53	0.28
2	0.85	1.36	1.12	1.56	1.50
3	1.19	1.46	1.23	2.36	1.64
4	1.09	1.54	1.34	2.17	1.36
5	0.58	1.08	0.70	1.68	0.98
6+	0.58	1.08	0.70	1.68	0.98

* For 2013 the same fishing mortality of 2012 has been assumed.

S. solea

The overall fishing mortality for common sole by year and age from SS3 model has been used (Table G.2.4). For 2014 the same fishing mortality as 2013 has been assumed. The age range 0-4 was used for the calculation of average F.

Table G.2.4 Overall fishing mortality for common sole (SS3model).

Age	2008	2009	2010	2011	2012	2013
0	0.373	0.570	0.409	0.375	0.427	0.201
1	1.821	2.752	1.995	1.863	2.137	1.006
2	0.808	1.303	0.929	0.905	0.917	0.432
3	0.660	1.203	0.853	0.955	0.752	0.354
4	0.557	0.970	0.687	0.726	0.627	0.295
5+	0.494	0.829	0.587	0.588	0.552	0.260

SELECTIVITY OF DEMERSAL FISHERIES IN GSA17

The selectivity used for the 4 stocks and the 11 fleet segments has been derived from the report of GFCM stock assessment working groups and DCF data. Moreover, for *M. merluccius* and *M. barbatus*, the selectivity was also shaped using the information from DISCATCH project (Sala et al., 2015). All the selectivity parameters (in mm) are reported in the Tables G.2.5-G.2.8.

Table G.2.5 Selectivity used for European hake. L_{50} identify the size at first capture, SR the selection range (L_{75}-L_{25}), DSL_{50} the size at which the deselection process takes place at 50%, if an ogive model is used; mean and standard deviation identify the parameters of a normal distribution if a gaussian model is selected, the standard deviation 2 is reported when a bi-sided model is used.

Fleet segment	Period	Model	L_{50} or Mean	SR or Standard Deviation	DSL50 or Standard deviation2
HRV17_DFN_0612	2008-2014	Gaussian	400	140	
HRV17_DTS_0612	2008-2010	Ogive with de-selection	88	8	567
	2011-2014	Ogive with de-selection	108	7	613
	2015-2021 (status quo)	Ogive with de-selection	108	7	600
	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600
HRV17_DTS_1218	2008-2010	Ogive with de-selection	88	8	567
	2011-2014	Ogive with de-selection	108	7	613
	2015-2021 (Status quo)	Ogive with de-selection	108	7	600
	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600
HRV17_DTS_1840	2008-2010	Ogive with de-selection	88	8	567
	2011-2014	Ogive with de-selection	108	7	613
	2015-2021 (Status quo)	Ogive with de-selection	108	7	600
	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600
ITA17_DTS_0612	2008-2010	Ogive with de-selection	88	8	600
	2011-2014	Ogive with de-selection	108	7	600
	2015-2021 (Status quo)	Ogive with de-selection	108	7	600
	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600
ITA17_DTS_1218	2008-2010	Ogive with de-selection	88	8	600
	2011-2014	Ogive with de-selection	108	7	600
	2015-2021 (Status quo)	Ogive with de-selection	108	7	600

	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600
ITA17_DTS_1840	2008-2010	Ogive with de-selection	88	8	600
	2011-2014	Ogive with de-selection	108	7	600
	2015-2021 (Status quo)	Ogive with de-selection	108	7	600
	2015-2021 (selectivity scenario)	Ogive with de-selection	182	7	600

Table G.2.6 Selectivity used for red mullet. L_{50} identify the size at first capture, SR the selection range (L_{75}-L_{25}), DSL_{50} the size at which the deselection process takes place at 50%, if an ogive model is used; mean and standard deviation identify the parameters of a normal distribution if a gaussian model is selected.

Fleet segment	Period	Model	L_{50} or Mean	SR or Standard Deviation
HRV17_DTS_0612	2008-2010	Classical ogive	112	3
	2011-2014	Classical ogive	124	4
	2015-2021 (Status quo)	Classical ogive	120*	4
	2015-2021 (Selectivity scenario)	Classical ogive	186	4
HRV17_DTS_1218	2008-2010	Classical ogive	112	3
	2011-2014	Classical ogive	124	4
	2015-2021 (Status quo)	Classical ogive	120*	4
	2015-2021 (Selectivity scenario)	Classical ogive	186	4
HRV17_DTS_1840	2008-2010	Classical ogive	112	3
	2011-2014	Classical ogive	124	4
	2015-2021 (Status quo)	Classical ogive	120*	4
	2015-2021 (Selectivity scenario)	Classical ogive	186	4
ITA17_DTS_0612	2008-2010	Classical ogive	84	2
	2011-2014	Classical ogive	91	4
	2015-2021 (Status quo)	Classical ogive	95*	4
	2015-2021 (Selectivity scenario)	Classical ogive	141	4
ITA17_DTS_1218	2008-2010	Classical ogive	84	2
	2011-2014	Classical ogive	93	4
	2015-2021 (Status quo)	Classical ogive	91*	4
	2015-2021 (Selectivity scenario)	Classical ogive	141	4
ITA17_DTS_1840	2008-2010	Classical ogive	109	3
	2011-2014	Classical ogive	120	4
	2015-2021 (Status quo)	Classical ogive	120	4
	2015-2021 (Selectivity scenario)	Classical ogive	186	4
SVN17_DFN_DTS_0612	2008-2021	Gaussian	130	13

* the parameters used for the projections are those used in 2014, while the values reported until 2014 are mean values on the years.

Table G.2.7 Selectivity used for Spottail mantis. L_{50} identify the size at first capture, SR the selection range (L_{75}-L_{25}), DSL_{50} the size at which the deselection process takes place at 50%, if an ogive model is used; mean and standard deviation identify the parameters of a normal distribution if a gaussian model is selected.

Fleet segment	Period	Model	L_{50} or Mean	SR or Standard Deviation
ITA17_DTS_0612	2008-2010	Classical ogive	20	5
	2011-2014	Classical ogive	27	5
	2015-2021 (Status quo)	Classical ogive	28*	5
	2015-2021 (Selectivity scenario)	Classical ogive	36	5
ITA17_DTS_1218	2008-2010	Classical ogive	20	5
	2011-2014	Classical ogive	27	5
	2015-2021 (Status quo)	Classical ogive	28*	5
	2015-2021 (Selectivity scenario)	Classical ogive	36	5
ITA17_DTS_1840	2008-2010	Classical ogive	20	5
	2011-2014	Classical ogive	27	5
	2015-2021 (Status quo)	Classical ogive	28*	5
	2015-2021 (Selectivity scenario)	Classical ogive	36	5
ITA17_PGP_0012	2008-2014	Gaussian	28	4
ITA17_TBB_1218	2008-2010	Classical ogive	23	5
	2011-2021	Classical ogive	30	5
ITA17_TBB_1840	2008-2010	Classical ogive	23	5
	2011-2021	Classical ogive	32	5
SVN17_DFN_DTS_0612	2008-2014	Gaussian	28	4

* the parameters used for the projections are those used in 2014, while the values reported until 2014 are mean values on the years.

Table G.2.8 Selectivity used for Common sole. L_{50} identify the size at first capture, SR the selection range (L_{75}-L_{25}), DSL_{50} the size at which the deselection process takes place at 50%, if an ogive model is used; mean and standard deviation identify the parameters of a normal distribution if a gaussian model is selected.

Fleet segment	Period	Model	L_{50} or Mean	SR or Standard Deviation	DSL50 or Standard deviation2
HRV17_DFN_0612	2008-2021	Gaussian	280	40	
ITA17_DTS_0612	2008-2021	Ogive with de-selection	180	15	250
ITA17_DTS_1218	2008-2021	Ogive with de-selection	180	15	250
ITA17_DTS_1840	2008-2021	Ogive with de-selection	180	15	250
ITA17_PGP_0012	2008-2021	Gaussian	220	30	
ITA17_TBB_1218	2008-2021	Ogive with de-selection	190	15	250
ITA17_TBB_1840	2008-2021	Ogive with de-selection	190	15	260
SVN17_DFN_0612_DTS_1218	2008-2021	Gaussian	280	45	

EFFORT OF DEMERSAL FISHERIES IN GSA17

The monthly effort variables used to simulate the past and current years by fleet segment are listed in G.2.9. For 2014 the same effort as 2013 has been assumed.

G.2.9 Effort for the selected fleet segment in GSA 17.

Effort Variable	ITA17_DTS_0612						ITA17_DTS_1218					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	6	6	6	6	5	5	18	20	21	20	20	20
average monthly KW	85	87	90	93	77	82	141	143	145	143	142	142
number of vessels	41	54	52	54	92	72	332	289	292	295	318	308
mean annual fishing days	145	150	122	119	114	92	136	168	149	140	110	111
Effort Variable	**ITA17_DTS_1840**						**ITA17_PGP_0012**					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	73	76	78	79	78	78	2	2	2	2	2	2
average monthly KW	280	289	299	299	300	305	33	34	35	37	37	36
number of vessels	232	219	218	215	210	197	1713	1668	1654	1674	1595	1525
mean annual fishing days	164	166	163	156	150	144	112	137	134	141	136	100
Effort Variable	**ITA17_TBB_1218**						**ITA17_TBB_1840**					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	27	27	27	27	28	28	82	81	83	81	82	80
average monthly KW	216	217	218	222	211	212	362	361	368	357	364	359
number of vessels	13	13	11	9	11	11	60	57	56	55	52	47
mean annual fishing days	151	159	124	104	139	147	158	171	159	131	139	131
Effort Variable	**HRV17_DFN_0612**						**HRV17_DTS_0612**					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	4	4	4	4	4	4	7	7	7	7	7	8
average monthly KW	35	35	35	35	60	60	53	53	53	53	81	87
number of vessels	804	804	804	804	795	760	205	205	205	205	191	190
mean annual fishing days	96	96	96	96	96	84	60	60	60	60	48	48
Effort Variable	**HRV17_DTS_1218**						**HRV17_DTS_1840**					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
average monthly GT	17	17	17	17	17	18	79	79	79	79	84	86
average monthly KW	92	92	92	92	151	153	231	231	231	231	265	309
number of vessels	215	215	215	215	212	203	68	68	68	68	62	56
mean annual fishing days	60	60	60	60	60	60	120	120	120	120	120	132

Effort Variable	SVN17_DFN_DTS_0612					
	2008	2009	2010	2011	2012	2013
average monthly GT	7	7	7	8	8	7
average monthly KW	96	92	96	92	95	109
number of vessels	54	53	55	51	51	46
mean annual fishing days	156	156	180	180	168	180

LANDINGS OF DEMERSAL FISHERIES IN GSA17

Landing were obtained from the data collected and reviewed by the SEDAF project and presented in the *WP2-Collation and review on the main socio-economic information on the main fisheries* deliverable. Also GFCM stock assessment forms have been used as a source of information, especially for discards.

M. merluccius

The landing data for hake by fleet segment used to parameterize the model are listed in Table G.2.10. The discard data from DCF have been split according to the proportions of landing by fleet (Table G.2.11). For 2014 the same landing and discard as 2013 has been assumed.

Table G.2.10 Landing for hake by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	4	23	13	8	8	21
ITA17_DTS_1218	581	480	350	296	426	483
ITA17_DTS_1840	2471	2046	1497	1148	1345	1696
HRV17_DFN_0612	28	32	34	32	29	56
HRV17_DTS_0612	105	149	117	133	130	134
HRV17_DTS_1218	223	315	249	282	343	414
HRV17_DTS_1840	185	261	206	234	306	447
Total	**3598**	**3306**	**2466**	**2134**	**2587**	**3251**

Table G.2.11 Discard for hake by fleet segment in GSA 17 (tons).

Fleet segment	2008*	2009	2010	2011	2012	2013
ITA17_DTS_0612	0	1	0	0	0	0
ITA17_DTS_1218	19	14	12	11	10	7
ITA17_DTS_1840	82	59	52	42	33	25
HRV17_DTS_0612	40	13	7	22	45	26
HRV17_DTS_1218	86	27	16	46	120	79
HRV17_DTS_1840	71	22	13	39	107	86
Total	**298**	**136**	**100**	**160**	**315**	**223**

*2008-2010 Italian discard data have been derived applying an average ratio discard/landing 2011-2013 to the landing of 2008-2010. 2008-2012 Croatian discard data have been derived applying the ratio discard/landing in 2013 to the landing of 2008-2012.

The discard of hake has been modelled with a reverse ogive model for all trawler fleet segments (with parameters DL50% = 20 cm and DL75%-DL25% = 5 mm for Italian fleet segments and DL50% = 24 cm and DL75%-DL25% = 5 mm for Croatian fleet segments).

S. mantis

The landing data for spottail mantis by fleet segment used to parameterize the model are listed in Table G.2.12. The discard data from DCF have been split according to the proportions of landing by fleet segment (Table G.2.13). For 2014 the same landing and discard as 2013 have been assumed.

The discard of spottail mantis has been modelled with a reverse ogive model (with parameters DL50% = 22 mm for DTS and 15 mm for TBB, with a DL75%-DL25% = 5 mm).

Table G.2.12 Landing for spottail mantis by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	117	158	200	115	124	104
ITA17_DTS_1218	1964	2145	2056	1418	1015	812
ITA17_DTS_1840	789	928	983	868	655	776
ITA17_PGP_0012	907	895	980	1118	1160	335
ITA17_TBB_1218	10	10	19	5	12	15
ITA17_TBB_1840	286	412	353	261	180	208
SVN17_DFN_DTS_0612	6	4	5	3	1	0
Total	**4079**	**4552**	**4595**	**3788**	**3147**	**2250**

Table G.2.13 Discard for spottail mantis by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	24	32	23	34	25	21
ITA17_DTS_1218	402	439	238	416	208	166
ITA17_DTS_1840	161	190	114	255	134	159
ITA17_TBB_1218	0	0	1	0	0	0
ITA17_TBB_1840	9	12	11	8	5	6

*2008-2010 Italian discard data has been derived applying an average of ratio discard/landing 2011-2013 to the landing of 2008-2010.

M. barbatus

The landing data for red mullet by fleet segment used to parameterize the model are listed in Table G.2.14. The discard data from DCF have been split according to the proportions of landing by fleet (Table G.2.15). For 2014 the same landing and discard as 2013 have been assumed.

The discard of red mullet has been modelled with a reverse ogive model (with parameters DL50% = 15.7 cm for Croatian DTS and 13.2 cm for Italian DTS, with a DL75%-DL25% = 5 mm).

Table G.2.14.Landing for red mullet by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	47	79	46	50	52	52
ITA17_DTS_1218	1355	958	593	771	694	680
ITA17_DTS_1840	1787	1398	1156	987	730	1229
HRV17_DTS_0612	138	148	139	196	216	193
HRV17_DTS_1218	424	458	429	604	697	609
HRV17_DTS_1840	180	194	182	256	302	228
SVN17_DFN_DTS_0612	2	3	1	6	4	2
Total	**3933**	**3237**	**2546**	**2870**	**2694**	**2993**

Table G.2.15 Discard for red mullet by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	13	21	5	22	24	2
ITA17_DTS_1218	370	261	60	339	320	31
ITA17_DTS_1840	488	382	118	435	336	56
HRV17_DTS_0612	21	22	21	29	32	17
HRV17_DTS_1218	64	68	64	90	104	53
HRV17_DTS_1840	27	29	27	38	45	20
Total	**983**	**783**	**295**	**953**	**861**	**179**

S. solea

The landing data for common sole by fleet segment used to parameterize the model are listed in Table G.2.16. The discard for this species is negligible. For 2014 the same landing as 2013 has been assumed.

Table G.2.16 Landing for common sole by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	8	11	9	9	21	10
ITA17_DTS_1218	94	147	148	96	41	120
ITA17_DTS_1840	120	160	169	140	207	136
ITA17_PGP_0012	455	258	171	282	172	285
ITA17_TBB_1218	50	15	9	3	28	67
ITA17_TBB_1840	504	528	509	380	490	458
HRV17_DFN_0612	135	303	187	195	126	107
SVN17_DFN_DTS_0612	5	9	7	11	6	11
Total	**1371**	**1431**	**1207**	**1116**	**1091**	**1194**

Total landing

The total landing data by fleet segment used to parameterize the model are listed in the Table G.2.17 For 2014 the same landing as 2013 has been assumed.

Table G.2.18 Total landing by fleet segment in GSA 17 (tons).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	734	783	658	575	524	612
ITA17_DTS_1218	9226	9381	8233	7107	6126	5863
ITA17_DTS_1840	14238	13523	11488	9752	9185	13860
ITA17_PGP_0012	9734	10218	8163	9712	8097	6873
ITA17_TBB_1218	628	587	424	251	716	622
ITA17_TBB_1840	3021	3290	3298	3484	3284	2975
HRV17_DFN_0612	708	708	708	708	610	518
HRV17_DTS_0612	979	979	979	979	928	876
HRV17_DTS_1218	1899	1899	1899	1899	2090	1987
HRV17_DTS_1840	1351	1351	1351	1351	1367	1697
SVN17_DFN_DTS_0612	157	166	177	179	204	152
Total	**42675**	**42885**	**37380**	**35998**	**33132**	**36036**

G.3 INPUT OF THE ECONOMIC MODULE OF DEMERSAL FISHERY IN GSA17

Data for the estimation of the socio-economic parameters were obtained from the National Programs of the EU Data Collection Framework and from the data collected and reviewed by the SEDAF project and presented in the WP2-*Collation and review on the main socio-economic information on the main fisheries*. For all fleet segments, 2014 data was assumed equal to 2013.

REVENUES OF DEMERSAL FISHERY IN GSA17

The revenues by fleet segment for European hake, spottail mantis, red mullet, common sole and the total of commercial species are reported in the tables below. In the projections the prices have been modelled according to the revenues and the landings by fleet segment.

M. merluccius

Table G.3.1 - Revenues of hake by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	18845	183848	87377	57899	52772	127876

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_1218	4545790	4092885	3537982	2857204	3529280	2901924
ITA17_DTS_1840	16323526	14397095	12435801	10212877	10574721	12097585
HRV17_DFN_061	24535	27509	29739	27509	36028	95107
HRV17_DTS_061	295503	417617	329491	373835	389929	427649
HRV17_DTS_121	565987	799885	631081	716606	991860	1215238
HRV17_DTS_184	584788	826445	652045	741123	1073891	1519664
Total	**22358974**	**20745284**	**17703516**	**14987053**	**16648481**	**18385043**

S. mantis

Table G.3.2 - Revenues of mantis shrimp by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	794585	991766	1045379	828804	1057897	660597
ITA17_DTS_1218	13183383	13361710	10951224	9029060	6725680	5783070
ITA17_DTS_1840	5194172	5676937	4650660	5107179	3782254	4114592
ITA17_PGP_0012	8883707	8401451	7898468	10305496	9770359	3695630
ITA17_TBB_1218	88654	72094	119689	39126	81316	135762
ITA17_TBB_1840	1788300	2224517	1873619	1612934	1042956	990021
SVN17_DFN_0612_DTS_1218	36705	21797	29036	19867	3691	1952
Total	**29969506**	**30750272**	**26568075**	**26942466**	**22464153**	**15381624**

M. barbatus

Table G.3.3 - Revenues of red mullet by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	151430	306442	171243	133209	172240	174727
ITA17_DTS_1218	4205611	2889986	2410359	2147850	2533359	2096212
ITA17_DTS_1840	8380161	6292253	5388623	3819515	3316421	4390892
HRV17_DTS_0612	199985	215617	202141	284528	326353	368255
HRV17_DTS_1218	604508	651760	611025	859841	1103730	1162317
HRV17_DTS_1840	291808	314618	294954	414760	531870	422729
SVN17_DFN_0612_DTS_1218	10201	14648	4100	22227	13826	8467
Total	**13843704**	**10685324**	**9082445**	**7681930**	**7997799**	**8623599**

S. solea

Table G.3.4 Revenues of common sole by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	121145	241737	174031	218661	404367	113108
ITA17_DTS_1218	1772890	2944349	2285555	1841981	1224273	1588264
ITA17_DTS_1840	1543422	2745007	2293224	2273824	3350803	1390822
ITA17_PGP_0012	6909944	9029142	9693752	13867050	15229877	4071158
ITA17_TBB_1218	470888	585343	381125	200412	480533	716789
ITA17_TBB_1840	7083871	10465226	7326495	5734845	5081668	4856466

Fleet segment	2008	2009	2010	2011	2012	2013
HRV17_DFN_0612	985205	2206881	1361015	1419965	868489	1170999
SVN17_DFN_0612_DTS_1218	55939	123620	102634	155986	88777	176784
Total	**18943304**	**28341305**	**23617831**	**25712724**	**26728787**	**14084390**

Total revenues

Table G.3.5 - Total revenues by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	3766622	4569360	3358312	3527990	3715845	2743597
ITA17_DTS_1218	56178945	59741233	51055208	44786424	36880397	34680597
ITA17_DTS_1840	93503987	90529194	81486384	72207684	62982725	58228939
ITA17_PGP_0012	66046489	79213672	66685947	78715625	66436914	38511078
ITA17_TBB_1218	2355037	2281575	1641726	1155322	2603973	2559956
ITA17_TBB_1840	18859278	22603484	17880667	16285033	13531894	13848922
HRV17_DFN_0612	3541235	3541235	3541235	3541235	3051267	2592115
HRV17_DTS_0612	4896971	4896971	4896971	4896971	4641161	4379276
HRV17_DTS_1218	9496331	9496331	9496331	9496331	10450307	9935972
HRV17_DTS_1840	6499271	6499271	6499271	6499271	6804442	8429748
SVN17_DFN_DTS_0612	814612	1002170	960689	1043295	1014657	866575
Total	**265958778**	**284374496**	**247502741**	**242155181**	**212113582**	**176776775**

PROFIT OF DEMERSAL FISHERIES IN GSA17

In the following table E.3.6 the profit of demersal fishery in GSA17 are preported by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table G.3.6 - Profit by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	621919	863152	279929	223405	-610604	-21280
ITA17_DTS_1218	10890117	17141255	10831405	4863718	5471844	1654921
ITA17_DTS_1840	13498000	16186628	8979548	4395803	-1770761	4726501
ITA17_PGP_0012	21710615	30293607	21789975	27168170	22259572	2993434
ITA17_TBB_1218	268521	265137	74695	-161340	347931	732898
ITA17_TBB_1840	-326448	1729620	-706273	-579316	-1467008	414342
HRV17_DFN_0612	2674470	2674470	2674470	2577429	2185206	1781649
HRV17_DTS_0612	2846356	2846356	2846356	2846356	2760330	2511902
HRV17_DTS_1218	5251318	5251318	5251318	5251318	5932707	5547432
HRV17_DTS_1840	-127087	-127087	-127087	-127087	876750	2359184
SVN17_DFN_DTS_0612	-315089	-149982	-279760	-172274	-412186	-455361
Total	56992692	76974474	51614576	46286182	35573781	22245622

COSTS OF DEMERSAL FISHERY IN GSA17

In the following tables all the data of costs by fleet segment as taken into account in the simulation phase of the case study (past and present years) are reported.

Table G.3.6 - Total variable costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	2063222	1449769	1320123	1653950	1840633	1183354
ITA17_DTS_1218	24502393	17651036	18602075	22129334	13028114	15540126
ITA17_DTS_1840	38233517	27765760	30900882	33423266	33559297	22096111
ITA17_PGP_0012	13300369	12272753	12908200	16899228	14443878	12435490
ITA17_TBB_1218	1241194	963761	741772	600631	1096835	768155
ITA17_TBB_1840	9000775	7123466	7453504	7074838	7370576	5928494
HRV17_DFN_0612	264700	264700	264700	287431	256083	206994
HRV17_DTS_0612	1501984	1501984	1501984	1501984	1461435	1379612
HRV17_DTS_1218	3597807	3597807	3597807	3597807	3992528	3794417
HRV17_DTS_1840	3925992	3925992	3925992	3925992	3164068	3535537
SVN17_DFN_DTS_0612	368511	380063	361351	389561	420991	414332
Total	**98000464**	**76897091**	**81578390**	**91484022**	**80634438**	**67282622**

Table G.3.7 - Other variable costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	784461	467244	307501	360555	480445	437403
ITA17_DTS_1218	5717206	6032877	5305550	4466249	4048053	2778326
ITA17_DTS_1840	9111286	9294632	8589126	7380448	6263865	3533795
ITA17_PGP_0012	5456051	6529821	5974131	6422916	5487134	3689808
ITA17_TBB_1218	318316	318143	218552	149949	296775	240493
ITA17_TBB_1840	1872335	2092615	1753577	1428651	1309452	1353941
HRV17_DFN_0612	64343	64343	64343	61274	62249	50316
HRV17_DTS_0612	30232	30232	30232	30232	66564	63449
HRV17_DTS_1218	30232	30232	30232	30232	66564	61678
HRV17_DTS_1840	367129	367129	367129	367129	309457	317828
SVN17_DFN_DTS_0612	142296	164810	151905	145590	170912	168208
Total	**23893887**	**25392078**	**22792278**	**20843225**	**18561470**	**12695245**

Table G.3.8 - Fuel costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	1278761	982525	1012622	1293395	1360188	745951
ITA17_DTS_1218	18785187	11618159	13296525	17663085	8980061	12761800
ITA17_DTS_1840	29122231	18471128	22311755	26042818	27295432	18562316
ITA17_PGP_0012	7844318	5742932	6934069	10476312	8956744	8745681
ITA17_TBB_1218	922878	645618	523221	450682	800061	527662
ITA17_TBB_1840	7128440	5030851	5699927	5646187	6061124	4574554
HRV17_DFN_0612	200357	200357	200357	226157	193834	156678
HRV17_DTS_0612	1471752	1471752	1471752	1471752	1394871	1316163
HRV17_DTS_1218	3567575	3567575	3567575	3567575	3925964	3732739
HRV17_DTS_1840	3558863	3558863	3558863	3558863	2854611	3217709
SVN17_DFN_DTS_0612	226215	215253	209446	243971	250079	246123
Total	**74106577**	**51505013**	**58786112**	**70640797**	**62072969**	**54587376**

Table G.3.9 - Maintenance costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	120923	189853	162416	162516	339898	221319
ITA17_DTS_1218	1960690	1799004	1834883	1783415	1878047	1776989
ITA17_DTS_1840	2514554	2412164	2431320	2241158	2630652	1866792
ITA17_PGP_0012	2843722	2750361	2741576	2819732	2689131	2051463
ITA17_TBB_1218	56972	57024	47900	38524	48251	43091
ITA17_TBB_1840	1227411	1256701	1240849	1232629	1263392	887758
HRV17_DFN_0612	27432	27432	27432	29475	27076	25547
HRV17_DTS_0612	28999	28999	28999	28999	41910	42460
HRV17_DTS_1218	28999	28999	28999	28999	41910	42307
HRV17_DTS_1840	322622	322622	322622	322622	320657	296249
SVN17_DFN_DTS_0612	169251	146777	203100	115274	141695	119143
Total	**9301575**	**9019936**	**9070096**	**8803343**	**9422619**	**7373118**

Table G.3.10 - Total fixed costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	132321	209084	196655	202920	450375	182362
ITA17_DTS_1218	1581519	1369080	1383778	1372160	1551761	1325754
ITA17_DTS_1840	2727389	2607776	2631398	2410207	2469782	1380721
ITA17_PGP_0012	2667915	2592969	2589165	2691593	2468986	1978307
ITA17_TBB_1218	69182	69078	58026	50699	58451	36381
ITA17_TBB_1840	539697	541639	524121	515359	512034	282114
HRV17_DFN_0612	31752	31752	31752	53445	31339	29569
HRV17_DTS_0612	35240	35240	35240	35240	33693	34135
HRV17_DTS_1218	35240	35240	35240	35240	33693	34012
HRV17_DTS_1840	343560	343560	343560	343560	278569	258955
SVN17_DFN_DTS_0612	10314	11147	6500	12276	12185	10246
Total	**8174129**	**7846565**	**7835435**	**7722699**	**7900868**	**5552556**

Table G.3.11 - Other fixed costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	132321	209084	196655	202920	450375	182362
ITA17_DTS_1218	1581519	1369080	1383778	1372160	1551761	1325754
ITA17_DTS_1840	2727389	2607776	2631398	2410207	2469782	1380721
ITA17_PGP_0012	2667915	2592969	2589165	2691593	2468986	1978307
ITA17_TBB_1218	69182	69078	58026	50699	58451	36381
ITA17_TBB_1840	539697	541639	524121	515359	512034	282114
HRV17_DFN_0612	31752	31752	31752	53445	31339	29569
HRV17_DTS_0612	35240	35240	35240	35240	33693	34135
HRV17_DTS_1218	35240	35240	35240	35240	33693	34012
HRV17_DTS_1840	343560	343560	343560	343560	278569	258955
SVN17_DFN_DTS_0612	10314	11147	6500	12276	12185	10246
Total	**8174129**	**7846565**	**7835435**	**7722699**	**7900868**	**5552556**

Table G.3.12 - Labour costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	569707	1450788	982352	864490	1065247	672886
ITA17_DTS_1218	13092743	17487177	13609042	9642413	9720532	9734583
ITA17_DTS_1840	23013327	26436918	21284634	15346383	11835591	14835059
ITA17_PGP_0012	19449794	24818636	19957432	22869353	18083735	12886993
ITA17_TBB_1218	479444	688281	470037	274944	787163	726257
ITA17_TBB_1840	3715222	6959931	4714900	4003259	2806855	3340101
HRV17_DFN_0612	318751	318751	318751	375714	330342	339630
HRV17_DTS_0612	411935	411935	411935	411935	275168	341642
HRV17_DTS_1218	411935	411935	411935	411935	275168	341854
HRV17_DTS_1840	949250	949250	949250	949250	1034359	938573
SVN17_DFN_DTS_0612	390217	416146	483709	466233	636123	573758
Total	**62802325**	**80349748**	**63593977**	**55615909**	**46850283**	**44731336**

Table G.3.13 - Depreciation costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	247258	370915	380918	384331	580727	452024
ITA17_DTS_1218	3959078	3883862	4353149	4530006	4798853	4117785
ITA17_DTS_1840	12851464	13608592	13753932	12910826	13002983	11732198
ITA17_PGP_0012	5807252	5898054	6113032	5705191	5985467	5509541
ITA17_TBB_1218	229842	217794	228453	323717	246859	229537
ITA17_TBB_1840	4472774	4523779	4232148	3664098	2780810	2657080
HRV17_DFN_0612	21220	21220	21220	14831	20944	19761
HRV17_DTS_0612	19881	19881	19881	19881	18801	19048
HRV17_DTS_1218	19881	19881	19881	19881	18801	18979
HRV17_DTS_1840	520198	520198	520198	520198	596442	548454
SVN17_DFN_DTS_0612	108890	115501	140010	159208	148540	124898
Total	**28257738**	**29199677**	**29782822**	**28252168**	**28199227**	**25429305**

Table G.3.14 - Opportunity costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	11272	35799	35919	36378	49569	52932
ITA17_DTS_1218	192405	409818	440876	465378	431246	530439
ITA17_DTS_1840	665736	1511356	1504670	1480041	1255180	1591557
ITA17_PGP_0012	266822	587292	586567	562358	506145	655850
ITA17_TBB_1218	9883	20500	20844	28147	18483	23637
ITA17_TBB_1840	229847	468347	421417	374166	265235	339033
HRV17_DFN_0612	202910	202910	202910	202910	200276	188964
HRV17_DTS_0612	52576	52576	52576	52576	49823	50477
HRV17_DTS_1218	151151	151151	151151	151151	155500	156971
HRV17_DTS_1840	564736	564736	564736	564736	533598	492796
SVN17_DFN_DTS_0612	82518	82518	45779	73017	67309	79559
Total	**2429856**	**4087003**	**4027445**	**3990858**	**3532364**	**4162215**

Table G.3.15 - Total capital costs by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	258530	406714	416837	420709	630296	504956

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_1218	4151483	4293681	4794025	4995384	5230099	4648224
ITA17_DTS_1840	13517200	15119948	15258602	14390867	14258164	13323755
ITA17_PGP_0012	6074074	6485346	6699599	6267549	6491612	6165391
ITA17_TBB_1218	239724	238294	249296	351864	265342	253174
ITA17_TBB_1840	4702621	4992127	4653566	4038264	3046045	2996113
HRV17_DFN_0612	224130	224130	224130	217741	221221	208726
HRV17_DTS_0612	72457	72457	72457	72457	68625	69525
HRV17_DTS_1218	171032	171032	171032	171032	174301	175950
HRV17_DTS_1840	1084934	1084934	1084934	1084934	1130039	1041250
SVN17_DFN_DTS_0612	191408	198019	185789	232225	215849	204457
Total	**30687593**	**33286682**	**33810267**	**32243026**	**31731593**	**29591521**

Table G.3.16 - Other income by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612						
ITA17_DTS_1218						
ITA17_DTS_1840						
ITA17_PGP_0012						
ITA17_TBB_1218						
ITA17_TBB_1840						
HRV17_DFN_0612	36048	36048	35931	40581	34902	27526
HRV17_DTS_0612	258560	258560	258560	258560	245053	231226
HRV17_DTS_1218	626758	626758	626758	626758	689720	655774
HRV17_DTS_1840	625227	625227	625227	625227	865964	297150
SVN17_DFN_DTS_0612	119893	145493	397673	679870	1064490	0
Total	**1666486**	**1692086**	**1944149**	**2230996**	**2900129**	**1211676**

Table G.3.17 - Number of employees by fleet segment in GSA 17 (N).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	94	126	127	115	174	135
ITA17_DTS_1218	884	1024	1023	933	875	908
ITA17_DTS_1840	1118	1034	1038	957	959	917
ITA17_PGP_0012	2230	2455	2633	2677	2648	2472
ITA17_TBB_1218	51	53	54	32	46	47
ITA17_TBB_1840	255	275	270	268	271	225
HRV17_DFN_0612	43	43	43	43	54	46
HRV17_DTS_0612	30	30	30	30	28	29
HRV17_DTS_1218	45	45	45	45	42	44
HRV17_DTS_1840	119	119	119	119	97	108
SVN17_DFN_DTS_0612	60	60	62	57	54	49
Total	**4929**	**5264**	**5444**	**5276**	**5248**	**4980**

Table G.3.18 - Capital value by fleet segment in GSA 17 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_0612	988721	1451917	1498179	1483818	2335272	1777618
ITA17_DTS_1218	16876208	16621309	18388904	18982202	2031661	17813869

Fleet segment	2008	2009	2010	2011	2012	2013
ITA17_DTS_1840	58392948	61297225	62759710	60369059	5913328	53449621
ITA17_PGP_0012	23403468	23819242	24465681	22937912	2384519	22025564
ITA17_TBB_1218	866839	831448	869383	1148083	870764	793813
ITA17_TBB_1840	20160294	18995121	17577297	15261772	1249560	11385828
HRV17_DFN_0612	3320387	3320387	3320387	2224995	3283218	3138674
HRV17_DTS_0612	1460143	1460143	1460143	1460143	816778	812502
HRV17_DTS_1218	2388423	2388423	2388423	2388423	2549176	2440957
HRV17_DTS_1840	10840089	10840089	10840089	10840089	8747500	7563300
SVN17_DFN_DTS_0612	2446250	2392543	2701775	2597556	2298780	2073409
Total	**141143770**	**143417847**	**146269971**	**139694052**	**1366921**	**12327515**

G.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS FOR DEMERSAL STOCKS IN GSA17

The data used for the parameterization of the biological and the pressure module for *M. merluccius* and *S. solea* come from the stock assessments carried out during the Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2014. The input for biological and pressure modules for *S. mantis* are from the Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2012, while for *M.barbatus* the stock assessment has been performed during Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS) held in 2013.

The methodology used is Stock Synthesis SS3 (Methot and Wetzel, 2013) for *M. merluccius* and *S. solea;* for *M. barbatus* Extended Survivor Analyses (XSA, Darby and Flatman, 1994) has been used and finally for *S. mantis*, separable VPA has been carried out. For *S. solea* also ALADYM model (Lembo et al., 2009) has been parameterized during the STECF Expert Working Group on stock assessment held in 2014.

The assessments of *M. merluccius* is a joint assessment covering Italy and Croatia given that the species is poorly represented in Slovenia catches; *S. mantis* assessment covers Italy and Slovenia given that this species is poorly represented in Slovenia catches, while *S. solea* and red mullet assessments cover Italy, Slovenia and Croatia.

The fitting of the landing data by BEMTOOL model is quite satisfactory for all the species, with an average difference of -5.76% by year for hake (Figure G.4.1-2), 0.34 for spottail mantis (Figure G.4.3-4), 1.27 % for red mullet (Figure G.4.5-6) and -2.68 % for common sole (Figure G.4.7).

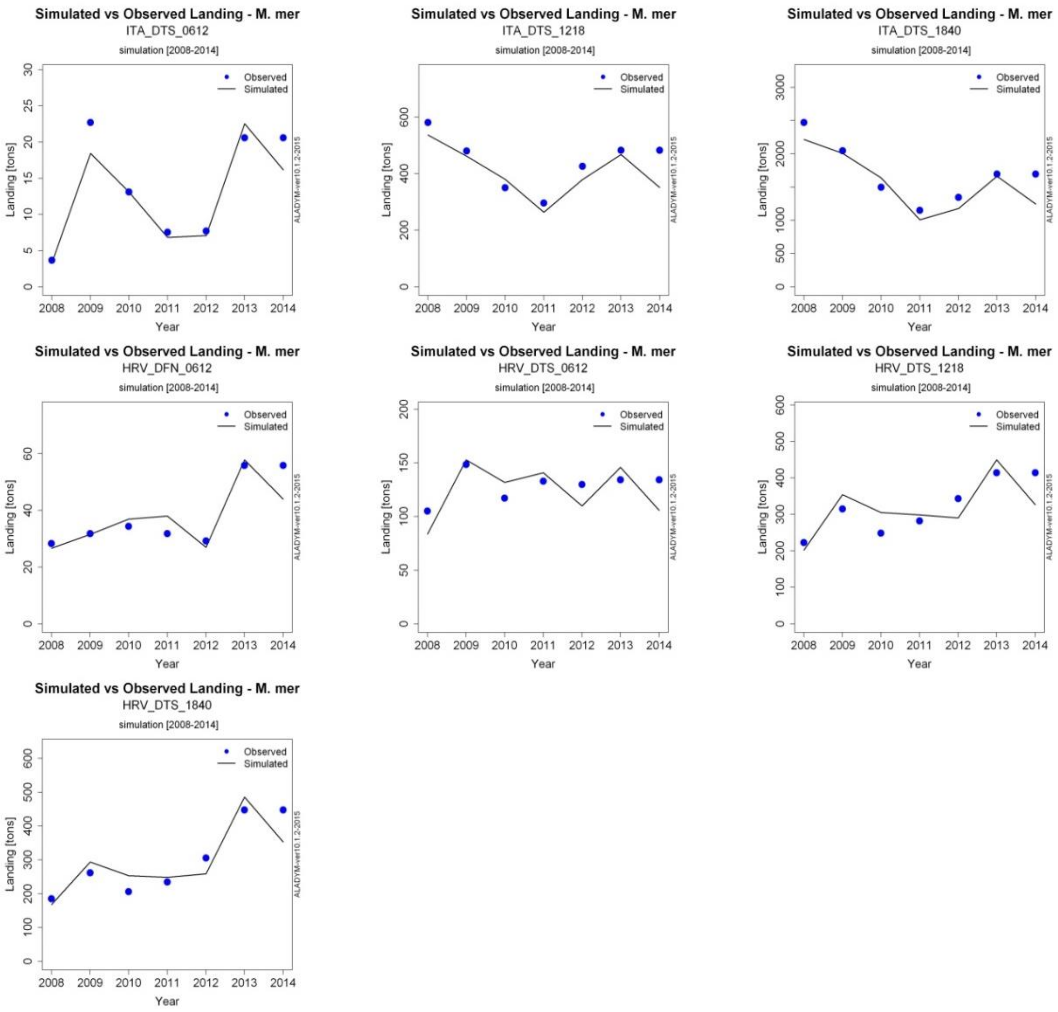


Figure G.4.1 Comparison between simulated and observed landings by fleet segment for hake in GSA 17. The observed data for 2014 has been assumed equal to 2013.

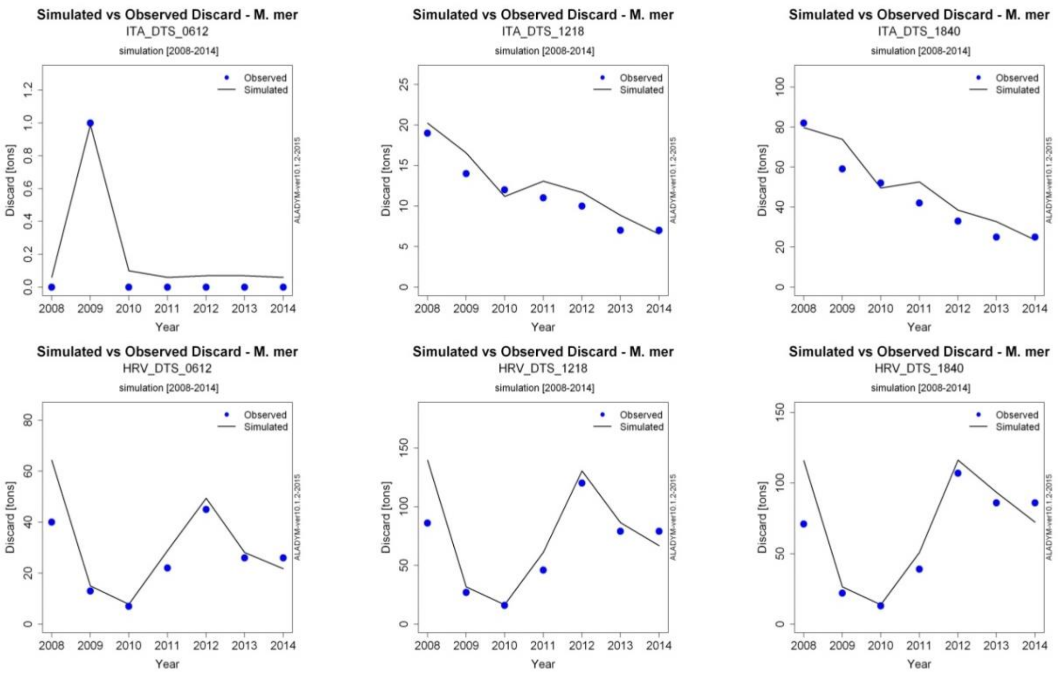


Figure G.4.2 Comparison between simulated and observed discard by fleet segment for hake in GSA 17. The observed data for 2014 has been assumed equal to 2013.

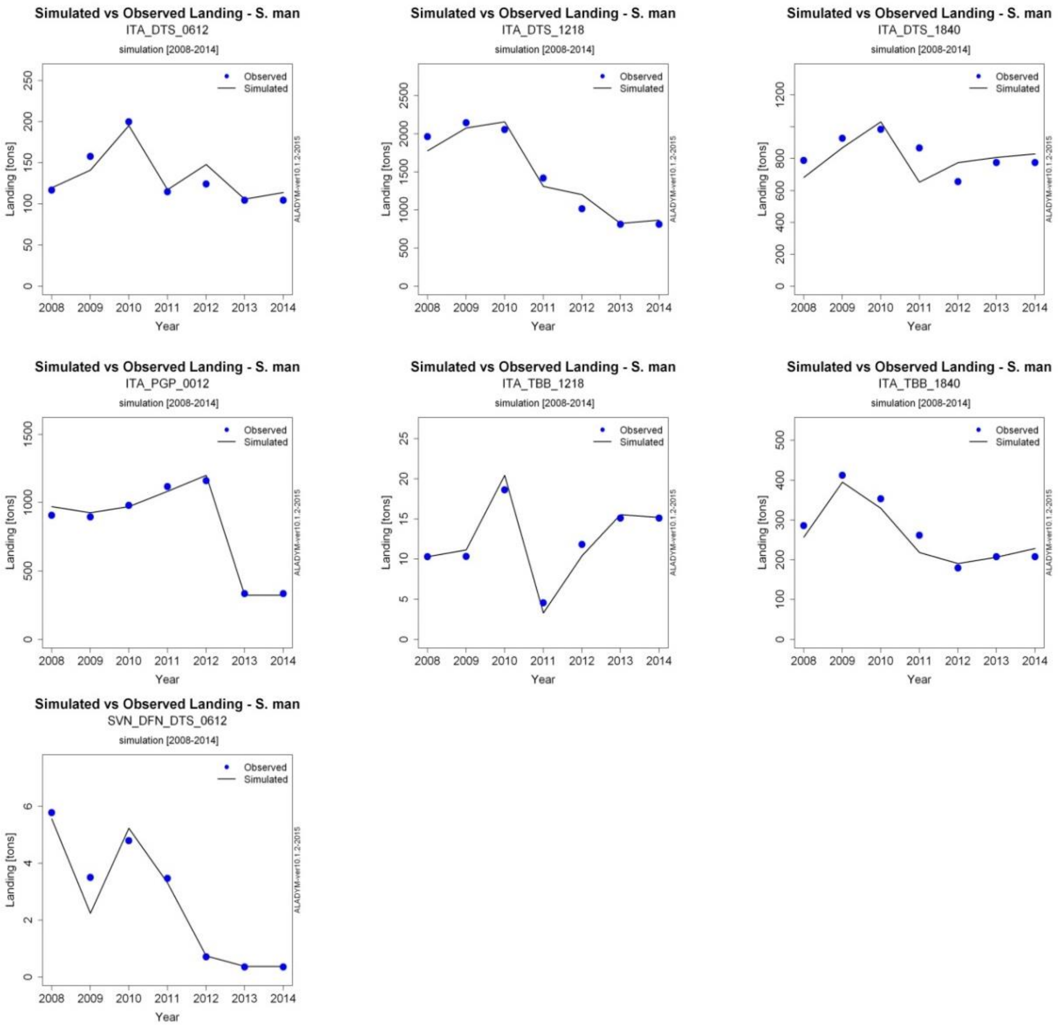


Figure G.4.3 Comparison between simulated and observed landings by fleet segment for spottail mantis in GSA 17. The observed data for 2014 has been assumed equal to 2013.

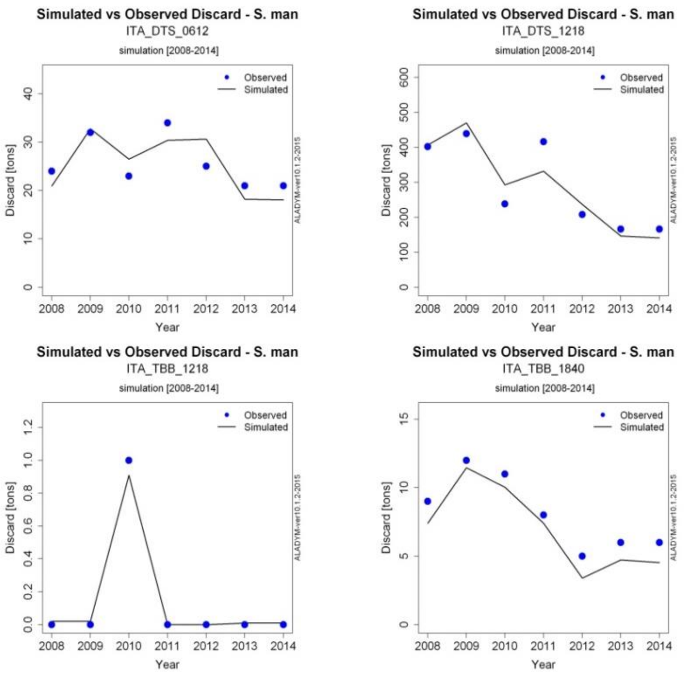


Figure G.4.4 Comparison between simulated and observed discard by fleet segment for spottail mantis in GSA 17. The observed data for 2014 has been assumed equal to 2013.

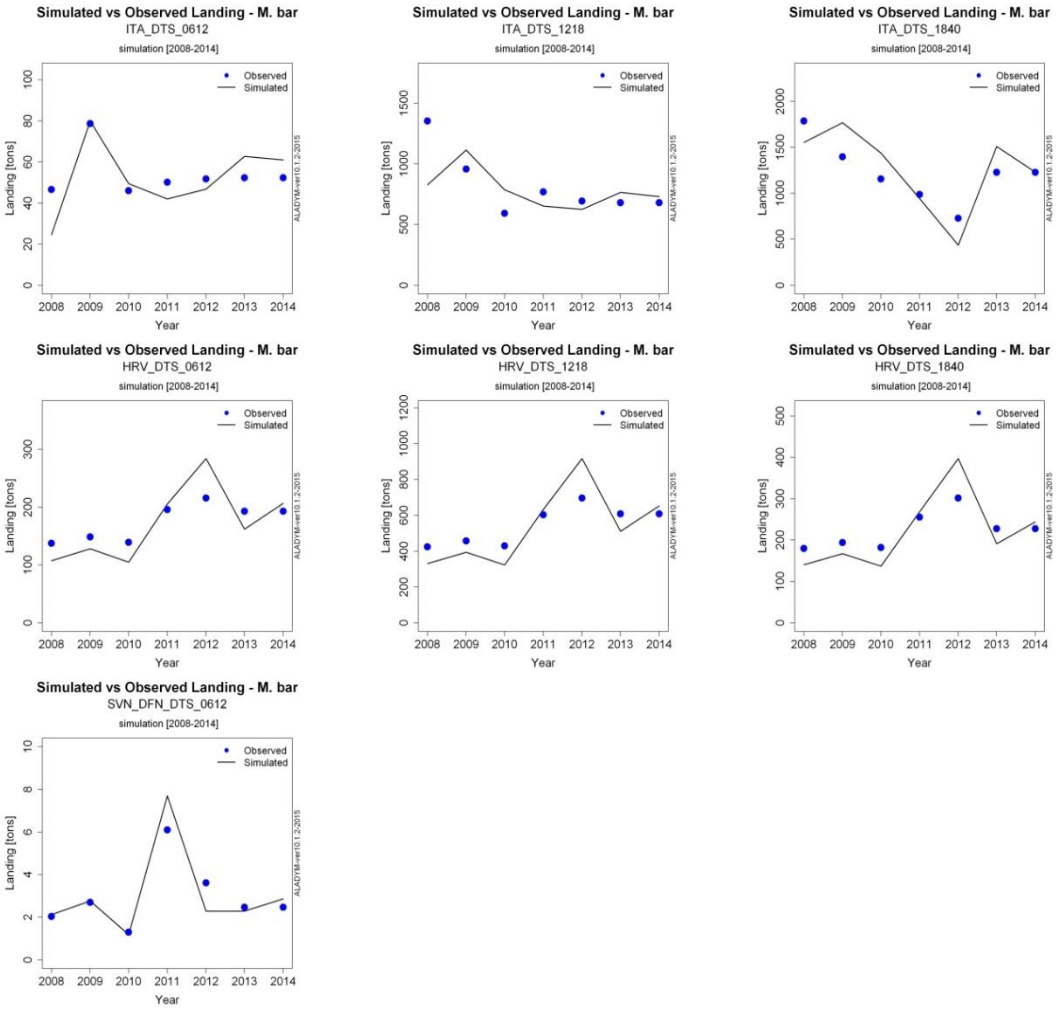


Figure G.4.5 Comparison between simulated and observed landings by fleet segment for red mullet in GSA 17. The observed data for 2014 has been assumed equal to 2013.

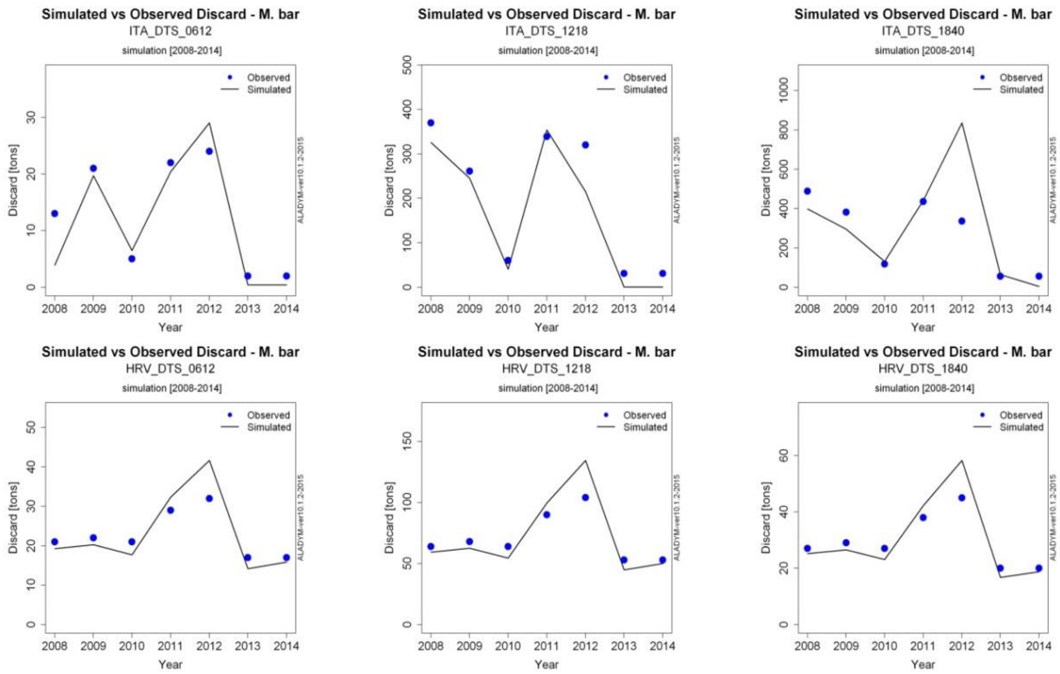


Figure G.4.6 Comparison between simulated and observed discard by fleet segment for red mullet in GSA 17. The observed data for 2014 has been assumed equal to 2013.

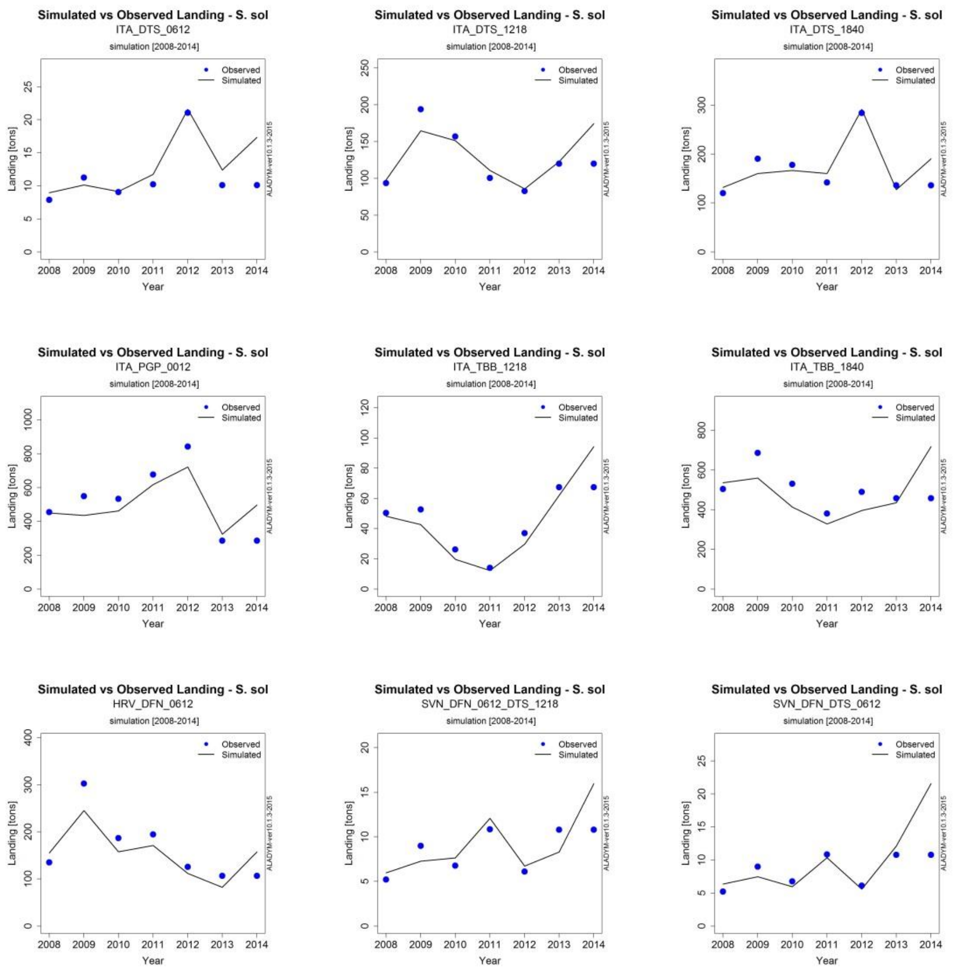


Figure G.4.7 Comparison between simulated and observed landings by fleet segment for common sole in GSA 17. The observed data for 2014 has been assumed equal to 2013.

The comparison between the Spawning Stock Biomass (SSB) from the assessment model and the BEMTOOL simulation are shown in Figure G.4.8

The simulated SSB of spottail mantis and hake in recent years are quite close to the ones estimated by separable VPA and SS3. The SSB for red mullet diverged only in 2011, while that of from 2011 to 2013 was higher in the assessment model.

It is also important to notice that the assessment of spottail mantis is updated to 2011 and the one of red mullet is updated to 2012.

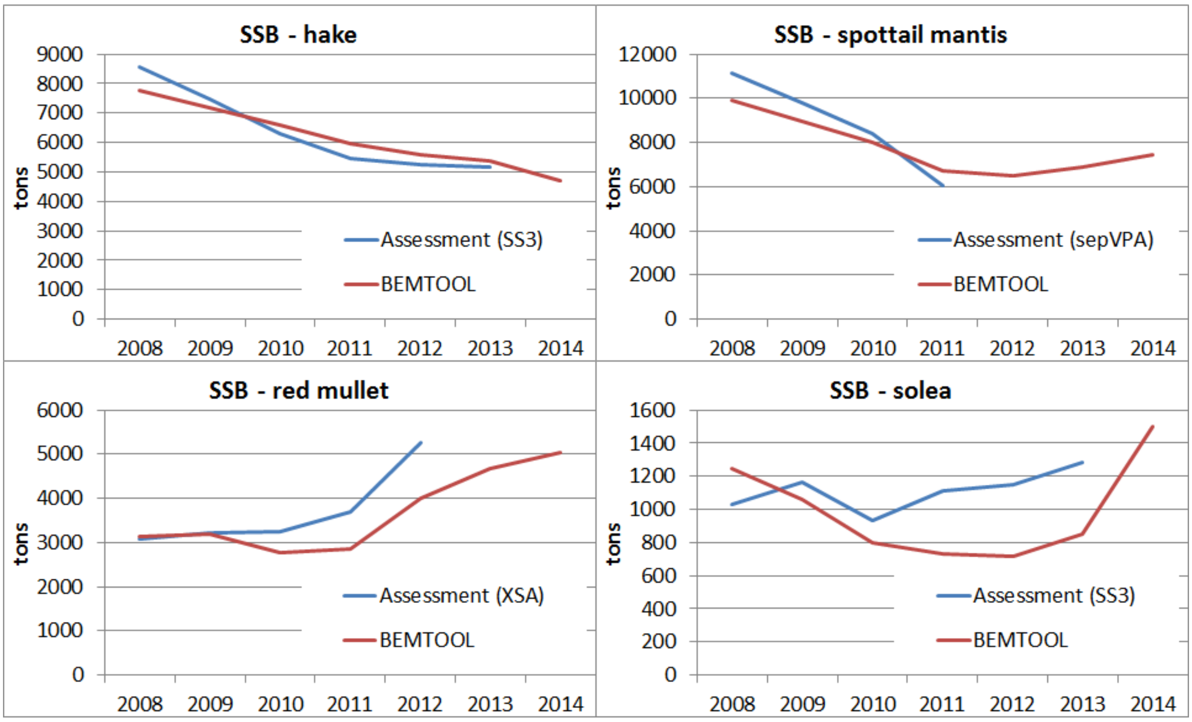


Figure G.4.8 Comparison between BEMTOOL and stock assessment SSB for hake, spottail mantis, red mullet and common sole in GSA 17.

5.4.3 ASSUMPTIONS AND INPUT OF THE BIOLOGICAL, PRESSURE AND ECONOMIC MODULES IN THE STATUS QUO SCENARIO

All the biological inputs (see section G.1) were maintained unchanged in the projection.

For the status-quo the effort has been maintained constant and equal to 2014 for all the years until 2021.

Given the presence of relevant fluctuations in the time series of most fleet segments, the socio economic parameters have been estimated on the basis of the most recent economic data. For all fleets included in the case study, 2014 data were assumed equal to 2013, given that economic data for 2013 were not yet available.

G.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT FOR DEMERSAL STOCKS IN GSA17

G.5.1 INPUT OF THE BIOLOGICAL MODULE

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year estimated in the assessment (see ANNEX 6 for details). A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the geometric mean of recruitment in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL (Figure G.5.1.1). In the figure G.5.1.1the recruitment of the four stocks used in the case study is reported with confidence interval used in all the performed scenarios.

All the other biological inputs have been kept unchanged in the projections.

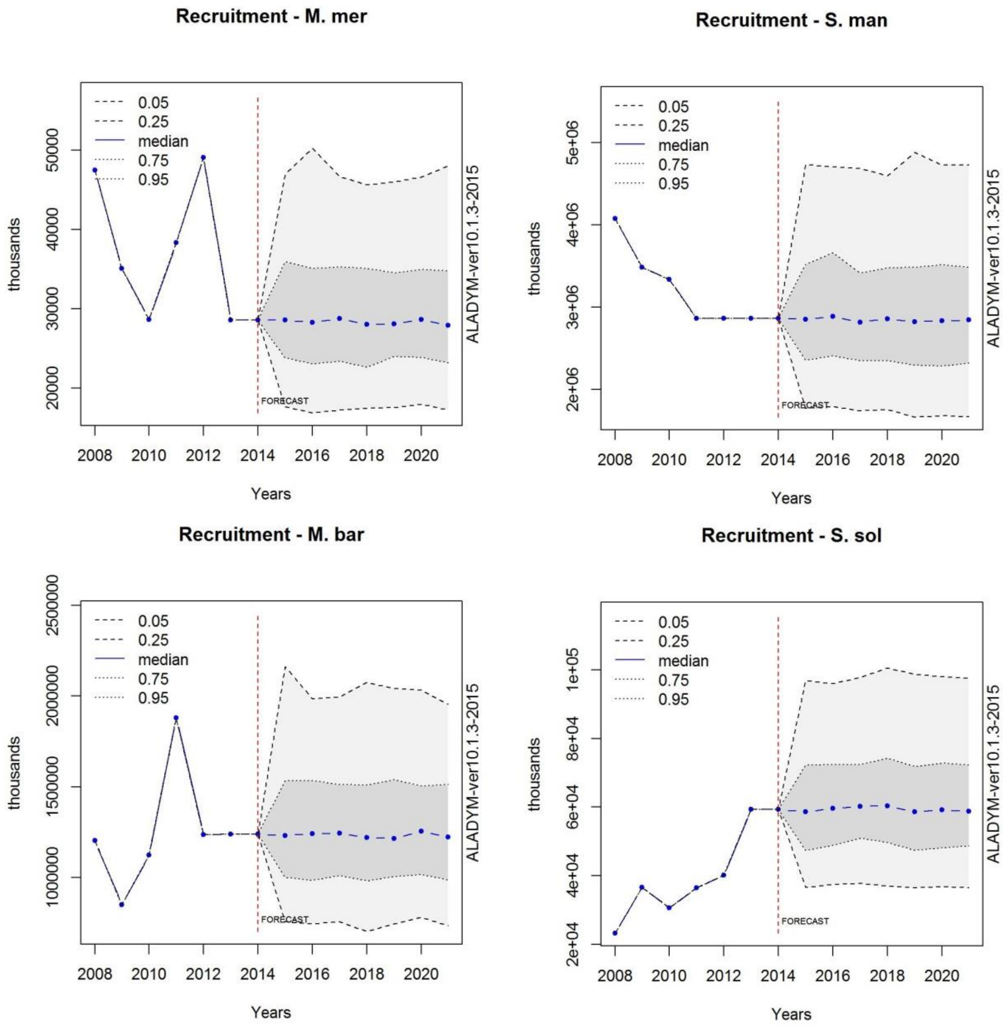


Figure G.5.1.1 Recruitment used for hake, spottail mantis, red mullet and common sole in the forecast scenarios with confidence intervals.

For the status quo the effort has been maintained constant for all the years (until 2021) and equal to 2013.

G.5.2 INPUT OF THE ECONOMIC MODULE

The main equations in the socio-economic model are related to the dynamics of prices and costs. Each equation has been tested on the basis of available historical series of data in order to check that the functional relationships are correctly specified. Economic parameters for each fleet segments and model equations are described below.

Given the presence of relevant fluctuations in the time series of most fleet segments, the socio economic parameters have been estimated on the basis of the most recent economic data.

For all fleets included in the case study, 2014 data were assumed equal to 2013.

PRICES DYNAMICS

The price of European hake, red mullet, spottail-mantis shrimp and common sole are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \Bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}} .$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2 for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

1) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
2) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
3) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.

Due to the lack of reliable estimations based on available data, the flexibility coefficient was computed exogenously. Sector studies (Nielsen, 2000 and Camanzi *et al.* 2010) confirm that the flexibility coefficient normally ranges between -0.1 and -0.4 (Table G.5.2.1). In this case study flexibility coefficients estimated for the Italian management plans have been applied, which estimated an average coefficient of -0.4 for all target species.

Table G.5.2.1 Price parameterization by fleet segment and stock in GSA 17 demersal case study.

Fleet segment	coeff. price-landings M. merluccius	coeff. price-landings S. mantis	coeff. price-landings M. barbatus	coeff. price-landings S. sol
ITA17_DTS_0612	-0.4	-0.4	-0.4	-0.4
ITA17_DTS_1218	-0.4	-0.4	-0.4	-0.4
ITA17_DTS_1840	-0.4	-0.4	-0.4	-0.4
ITA17_PGP_0012	-0.4	-0.4	-0.4	-0.4
ITA17_TBB_1218	-0.4	-0.4	-0.4	-0.4
ITA17_TBB_1840	-0.4	-0.4	-0.4	-0.4
HRV17_DFN_0612	-0.4	-0.4	-0.4	-0.4
HRV17_DTS_0612	-0.4	-0.4	-0.4	-0.4
HRV17_DTS_1218	-0.4	-0.4	-0.4	-0.4
HRV17_DTS_1840	-0.4	-0.4	-0.4	-0.4
SVN17_DFN_DTS_0612	-0.4	-0.4	-0.4	-0.4

The flexibility coefficient price-landings was assumed equal to -0.4 for all target species, which means that given a 1% fall in the production of a given species, it is assumed an increase in price of 0.4%.

COSTS DYNAMICS

Variable costs

Variable costs were modelled as a single item, which is the sum of fuel costs and other variable costs. Total variable costs are a function of the fishing effort (expressed in terms of days at sea):

$$TVC_{f,t} = \beta_f E_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$E_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*

Maintenance costs and fixed costs

Maintenance costs (MC) and other fixed costs (OFC) are assumed to be proportional to the gross tonnage (GT) of the fleet segment, corresponding to option 1 of the BEMTOOL software.

$$MC_{f,t} = \alpha''_f GT_{f,t}$$

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

Capital costs

Capital costs are function of the estimated fleet capacity, expressed in terms of capital value and gross tonnage.

Depreciation costs DC are estimated by a linear function of the annual gross tonnage GT as well.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

Following the approach of "The 2014 Annual Economic Report on the EU Fishing Fleet (STECF-14-16)", opportunity costs of capital (OC) are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Capital costs include annual depreciation and the opportunity costs of capital.

Labour costs

Labour cost are directly related to total revenues and variable cost.

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is assumed to be proportional to revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t} \right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

Revenues and total landings

Total revenues (total landings) are calculated as a function of the sum of the estimated landings value (landings weight) of the target assessed species for the Italian fleet segments. According to option 1 of BEMTOOL model component, total revenues and landings are proportional to the sum of the revenues and landings of target stock of the fleet segment *f* through a correction factor (rr_f and ll_f).

Option 1 :

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

rr_f is correction factor to estimate the total revenues of the fleet segment *f* from the revenues of assessed species;

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to estimte the total landings of the fleet segment *f* from the landings of assessed species.

For non-Italian fleet segments, parametrization was based on the SEDAF project. In this case, total landings are calculated as a sum of landings of not assessed species, estimated as a function of the assessed species, and the landings of the assessed species. According to option 2 of the model component in BEMTOOL, total revenues are estimated as a sum of the revenues of target assessed specie and the revenues of non-assessed species. The latter amount is calculated applying the average price in the last year of available data to the landings estimated as described above.

Option 2:

$$L_{other\_species,f,t} = u_f + v_f \sum_{s=1:n} L_{s,f,t}$$

where:

$L_{other\_species,f,t}$ is the landing of the other species of the fleet segment *f* at time *t*;

$L_{s,f,t}$ is the landing of the species s of the fleet segment *f* at time *t*;

u_f the amount of landings of non-target species independent on the landings of the target species;

v_f the quota of landings of non-target species dependent on the landings of the target species.

The following formulas are used to estimate total landings and total revenues:

$$L_{f,t} = L_{other\_species,f,t} + \sum_{s=1:n} L_{s,f,t}$$

$$p_{other\_species,f} = \frac{R_{f,t=last} - \sum_{s=1:n} R_{s,f,t=last}}{L_{f,t=last} - \sum_{s=1:n} L_{s,f,t=last}}$$

$$R_{f,t} = L_{other\_species,f,t} * p_{other\_species,f} + \sum_{s=1:n} (p_{s,f,t} * L_{s,f,t})$$

where:

$L_{f,t}$ is the total landing of the fleet segment *f* at time *t*;

$p_{other\_species,f}$ is the average price of the non-target species in the last year of simulation;

$R_{f,t=last}$ is the total revenues of the fleet segment *f* in the last year;

$R_{s,f,t=last}$ is the revenues of the target species s for the fleet segment *f* in the last year;

$L_{f,t=last}$ is the total landing of the fleet segment *f* in the last year;

$L_{s,f,t=last}$ is the landing of the target species s for the fleet segment *f* in the last year.

$p_{s,f,t}$ is the price of the target species s for the fleet segment *f* at time *t*.

Average employees per vessel

Employment was estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html (Table G.5.2.2).

Table G.5.2.2 Cost parameterization by fleet segment in GSA 17 demersal case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA17_DTS_0612	178	0.43	591	487	1207	141
ITA17_DTS_1218	454	0.51	286	213	662	85
ITA17_DTS_1840	808	0.41	123	92	770	104
ITA17_PGP_0012	78	0.49	705	681	1888	225
ITA17_TBB_1218	487	0.41	146	123	775	80
ITA17_TBB_1840	942	0.44	242	74	701	89
HRV17_DFN_0612	3	0.14	10	11	7	71
HRV17_DTS_0612	148	0.11	30	24	13	35
HRV17_DTS_1218	312	0.06	11	9	5	42
HRV17_DTS_1840	475	0.19	61	54	114	102
SVN17_DFN_DTS_0612	49	1	366	32	384	245

Table G.5.2.3 Socio-economic indicators parameterization by fleet segment in GSA 17 demersal case study.

Fleet segment	correction factor for landings	correction factor for revenue	coefficient u landings	coefficient v landings	value of a single vessel	average employees per vessel	discount rate
ITA17_DTS_0612	3.27	2.55	0	0	24672	2	0.0431
ITA17_DTS_1218	2.8	2.8	0	0	57761	3	0.0431
ITA17_DTS_1840	3.61	2.65	0	0	276172	5	0.0431
ITA17_PGP_0012	10.82	4.9	0	0	14490	2	0.0431
ITA17_TBB_1218	7.49	2.99	0	0	73843	4	0.0431
ITA17_TBB_1840	4.27	2.32	0	0	238557	5	0.0431
HRV17_DFN_0612			0	2.19	4130	0.06	0.0468
HRV17_DTS_0612			0	1.68	4276	0.2	0.0468
HRV17_DTS_1218			0	0.94	12024	0.2	0.0468

HRV17_DTS_1840			0	1.51	135059	2	0.0468
SVN17_DFN_DTS_0612			0	10.14	45074	1	0.0581

G.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The table G.5.3.1 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute values of the average number of annual fishing days per vessel and the number of active vessels are reported.

Table G. 5.3.1 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Reduction on days							Reduction on vessels						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
HRV17_DFN_0612	84	84	84	84	84	84	84	760	760	760	760	760	760	760
HRV17_DTS_0612	48	48	48	48	48	48	48	190	190	190	190	190	190	190
HRV17_DTS_1218	60	60	60	60	60	60	60	203	203	203	203	203	203	203
HRV17_DTS_1840	132	132	132	132	132	132	132	56	56	56	56	56	56	56
ITA17_DTS_0612	92	92	92	92	92	92	92	72	72	72	72	72	72	72
ITA17_DTS_1218	111	111	111	111	111	111	111	308	308	308	308	308	308	308
ITA17_DTS_1840	144	144	144	144	144	144	144	197	197	197	197	197	197	197
ITA17_PGP_0012	100	100	100	100	100	100	100	1525	1525	1525	1525	1525	1525	1525
ITA17_TBB_1218	147	147	147	147	147	147	147	11	11	11	11	11	11	11
ITA17_TBB_1840	131	131	131	131	131	131	131	47	47	47	47	47	47	47
SVN17_DFN_0612_DTS_1218	180	180	180	180	180	180	180	46	46	46	46	46	46	46

	Reduction on days							Reduction on vessels						
Scenario 2 - FmsyUpperHake2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
HRV17_DFN_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HRV17_DTS_0612	-13.1%	-26.1%	-39.2%	-52.2%	-52.2%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
HRV17_DTS_1218	-13.1%	-26.1%	-39.2%	-52.2%	-52.2%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
HRV17_DTS_1840	-13.1%	-26.1%	-39.2%	-52.2%	-52.2%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_DTS_1218	-13.1%	-26.1%	-39.2%	-52.2%	-52.2%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_DTS_1840	-13.0%	-26.1%	-39.1%	-52.2%	-52.2%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_PGP_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1840	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SVN17_DFN_0612_DTS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days							Reduction on vessels						
Scenario 3 - FmsyCombined2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
HRV17_DFN_0612	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_0612	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_1218	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_1840	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_DTS_1218	-13.3%	-26.5%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_DTS_1840	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_PGP_0012	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_TBB_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1840	-13.3%	-26.6%	-39.8%	-53.1%	-53.1%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
SVN17_DFN_0612_DTS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days							Reduction on vessels						
Scenario 4 - FmsyUpperHakeAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
HRV17_DFN_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HRV17_DTS_0612	-13.1%	-13.1%	-20.9%	-28.7%	-40.5%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
HRV17_DTS_1218	-13.1%	-13.1%	-20.9%	-28.7%	-40.5%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
HRV17_DTS_1840	-13.1%	-13.1%	-20.9%	-28.7%	-40.5%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_DTS_1218	-13.1%	-13.1%	-20.9%	-28.7%	-40.5%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_DTS_1840	-13.0%	-13.0%	-20.9%	-28.7%	-40.5%	-52.2%	-52.2%	-1.9%	-3.9%	-5.8%	-5.8%	-5.8%	-5.8%	-5.8%
ITA17_PGP_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1840	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SVN17_DFN_0612_DTS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days							Reduction on vessels						
Scenario 5 - FmsyCombinedAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
HRV17_DFN_0612	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_0612	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_1218	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
HRV17_DTS_1840	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_DTS_1218	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_DTS_1840	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_PGP_0012	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
ITA17_TBB_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA17_TBB_1840	-13.3%	-13.3%	-21.2%	-29.2%	-41.2%	-53.1%	-53.1%	-2.0%	-3.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
SVN17_DFN_0612_DTS_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

2.9. CASE STUDY ON DEMERSAL FISHERIES IN GSA18

2.9.1. IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The stocks to be investigated in GSA 18 are *M .merluccius*, *P.longirostris*, *N. norvegicus*, *M. merluccius* and *P. longirostris*. These are shared among the countries belonging to GSA 18 (Italy, Albania and Montenegro), except *N. norvegicus* that is exploited essentially by Italy.

The main fishing gears targeting the four stocks selected for this case study are bottom trawls, small scale fisheries and longlines (for hake).

For the purpose of this study 10 fleet segments have been considered as listed in the table 2.9.1.1. Some of these are the results of a stratification (e.g. ITA_DTS_1824_2440), because sharing similar characteristics, in order to avoid excessive fragmentation. The percentage of landings of all landed species due to each fleet segment (percentage has been computed on the average of the last three years) is reported in the table 2.9.1.1.

Table 2.9.1.1 - Main fleet segments involved in the demersal fishery in GSA18. The percentage of landings of all landed species due to each fleet segment is also reported (percentage has been computed on the average of the last three years).

	Fleet name	***Fleet code***	***% of landings (all species)***
1	Italian bottom trawlers from 6 to 12 m	ITA18_DTS_0612	3.2
2	Italian bottom trawlers from 12 to 18 m	ITA18_DTS_1218	46.6
3	Italian bottom trawlers from 18 to 40 m	ITA18_DTS_1824_2440	24.4
4	Italian longlines from 12 to 18 m	ITA18_HOK_1218	3.0
5	Italian small scale up to 12 m	ITA18_PGP_0006_0612	10.2
6	Albanian bottom trawlers from 12 to 24 m	ALB18_DTS_1224	11.1
7	Montenegrin small scale up to 12 m	MNE18_DFN_0012	0.3
8	Montenegrin bottom trawlers from 6 to 12 m	MNE18_DTS_0612	0.1
9	Montenegrin bottom trawlers from 12 to 24 m	MNE18_DTS_1224	0.9
10	Montenegrin longlines up to 12 m	MNE18_HOK_0012	0.1

The fleet segments more contributing to the total landing are the Italian trawlers.

Fishing effort has a decreasing trend.

The association between stocks and demersal fisheries for this case study are reported in –table 2.9.1.2.

2.9.1.2 - Associations among stocks and fleet segments for demersal fisheries in GSA 18 case study.

Stock	ITA18_DTS_VL0612	ITA18_DTS_VL1218	ITA18_DTS_VL1824-2440	ITA18_HOK_VL1218	ITA18_PGP_VL0006-0612
M. merluccius	X	X	X	X	X
P. longirostris	X	X	X		
N. norvegicus	X	X	X		
M. barbatus	X	X	X		X
Stock	ALB18_DTS_1224	MNE18_DFN_VL0012	MNE18_DTS_VL0612	MNE18_DTS_VL1224	MNE18_HOK_VL0012
M. merluccius	X	X	X	X	X
P. longirostris	X		X	X	
N. norvegicus					
M. barbatus	X	X	X	X	

Contribution of the stocks assessed to the production of the specific fisheries

The deep water rose shrimp has been retained for further analysis and bioeconomic modelling instead of spottail mantis because it is a target of mixed fisheries (co-occurrence with European hake and Norway lobster, depending on the area and fleet segment) and because updated assessment for the whole area is available.

The contribution of the stocks assessed to the production of the demersal fisheries (percentage computed on the average production of the last three years) is differentiated among species and fleet segments. In general European hake gives the higher contribution, representing up to 60% in the longliner fleet segment. It has also a remarkable share for almost all the trawl fleet segments (Tab.2.9.1.3).

For the most important fleet segments in terms of fishery production, the pool of assessed species has a considerable weight contributing for a percentage around 40%.

Table 2.9.1.3- Contribution of the stocks assessed to the production volume of the main fleet segments of demersal fisheries in GSA18.

Fleet	**HKE**	**MUT**	**NEP**	**DPS**	**Total assessed %**
ITA18_DTS_0612	11.4	20.7	1.0	1.1	34.2
ITA18_DTS_1218	21.1	10.4	4.4	5.0	40.9
ITA18_DTS_1824_2440	24.3	3.4	9.1	8.5	45.3
ITA18_HOK_1218	60.0				60
ITA18_PGP_0006_0612	5.9	2.2			8.1
ALB18_DTS_1224	16.6	8.2		17.2	42
MNE18_DFN_0012	4.2	2.5			6.7
MNE18_DTS_0612	24.6	21.1		19.3	65
MNE18_DTS_1224	19.1	16.6		12.1	47.8
MNE18_HOK_0012	19.3				19.3

General fishery rules

In Italy management regulations are based on technical measures, as closed number of fishing licenses and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, that in southern

Adriatic has been mandatory since the late eighties. Regarding long-lines the management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences. Regarding small scale fishery management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zones (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) offshore Bari (180 km2, between about 100 and 180 m depth) along the mainland, , and in the vicinity of Tremiti Islands (115 km2 along the bathymetry of 100 m) on the northern border of the GSA, where a marine protected area (MPA) had been established in 1989. In the vicinity of Tremiti Islands only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30th, while in the area offshore Bari the trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Recreational fishery using no more than 5 hooks is allowed in both the areas. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

In Montenegro, management regulations are based on technical regulations, such as mesh size (Official Gazette of Montenegro, 8/2011), including the minimum landing sizes (Official Gazette of Montenegro, 8/2011), and a regulated number of fishing licenses and area limitation (no–fishing zone up to 3 NM from the coastline or 8 NM for trawlers of 24+ m LOA). Currently there are no MPAs or fishing bans in Montenegrin waters.

In Albania, a new law "On fishery" has been approved, repealing the Law n. 7908. The new law is based on the main principles of the CFP, it reflects Reg. 1224/2009 CE ; Reg.1005/2008 CE; Reg. 2371/2002 CE; Reg. 1198/2006 CE; Reg. 1967/2006 CE; Reg. 104/2000; Reg. 1543/2000 as well as the GFCM recommendations. The legal regime governing access to marine resources is being regulated by a licensing system. Regarding conservation and management measures, minimum legal sizes and minimum mesh sizes is those reflected in the EU Regulations. Albania has already an operational vessel register system. It is forbidden to trawl at less than 3 nautical miles (nm) from the coast or inside the 50m isobath when this distance is reached at a smaller distance from the shore.

These management regulations have been taken into account to model the current situation in the case study.

2.9.2. DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

The data used for the parameterization of the biological and the pressure modules of BEMTOOL come from the stock assessments carried out during the Working Group on Stock Assessment of Demersal Species (GFCM-WGSAD), and STECF EWG meetings.

According to the used stock assessments, the summary diagnosis of the stocks is the following:

-European hake: Fishing mortality (Fbar1-4) decreasing but above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Norway lobster: Fishing mortality (Fbar1-6) stable and above F_{MSY}, SSB decreasing trend along the time series as well as the recruitment.

-Red mullet: Fishing mortality (Fbar0-2) variable and in line with F_{MSY}, SSB increasing trend along the time series as well as the recruitment.

-deep water rose shrimp: Fishing mortality (Fbar0-2) increasing and above F_{MSY}, SSB decreasing and recruitment increasing in the last years.

Discards of red mullet is quite important and has been considered in the assessment. For deep water rose shrimp and Norway lobster discard is considered negligible (Table 2.9.2.1).

The current F re-estimated by BEMTOOL, taking into account the effort modulated by month and the needing of estimating this parameter when the assessment was not recent are reported in the table 2.9.2.1, as well as landings, discards, spawning stock biomass and recruitment. These values were in line with the assessments.

Table 2.9.2.1 Current level of fishing mortality ($F_{current}$), landings, catches, discards spawning stock biomass and recruitment of the assessed demersal species in GSA18.

Stock	*Fishing mortality* (Fcurrent)*	*Catch (tons)*	*Landings (tons)***	*Discards (tons)*	*Spawning Stock Biomass**	*Recruitment (in thousands)*
European hake	($Fbar_{1-4}$)=0.66	2895	2895		3160	90 732
Deep water rose	($Fbar_{0-2}$)=1.31	1097	1097		656	714 582
Norway lobster	($Fbar_{1-6}$)=0.8	834	834		717	36 058
Red mullet	($Fbar_{0-2}$)=0.39	1680	1560	120	4695	235 205

* = Mean of the last 3 years; **2013 data

Stock advice, Reference points, and their technical basis

Norway lobster, European hake and deep water rose shrimp assessed as being exploited unsustainably at levels considerably higher than Fmsy, while red mullet is exploited sustainably. In the case of European hake and Norway lobster the current fishing mortality to F_{MSY} ratio is high.

The approach of MSY ranges was adopted for setting reference points. On the basis of median simulated catches for European hake the following F_{MSY} ranges were obtained:

F_{MSY} = 0.13; Fupper = 0.18 (STECF EWG-15-11).

In addition, an F_{MSY} combined for all the assessed species was estimated, using the landing value as weighing factor of the mean, according the approach based on the Balance indicators. The value of the current F_{MSY} combined is 0.83.

The framework used for the F_{MSY} reference points is summarised in the Table 2.9.2.2.

Note that no meaningful stock recruitment relationship could be estimated for the main species considered.

Table 2.9.2.2 – Reference point framework for the selected 4 stocks.

	. Framework				
	MSY approach			**Precautionary approach**	
Reference point	**F_{MSY}**	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**B_{lim} (tons)**	**B_{pa} (tons)**
Technical basis for all stocks	F0.1 as proxy for Fmsy	From empirical equation (EWG 15-11)		$B_{lim} = B_{loss}$ lowest value of the time series	1.4 * B_{lim} from empirical equation (EWG 15-11)
Technical basis for all	F combined according to Balance				

	. Framework				
	MSY approach			Precautionary approach	
the species method 2	indicators approach (weight from landing value)				
Values for European hake	0.2	0.28	3.3	2967	4154
Values for deep-water rose shrimp	0.74	1.01	1.77	600	840
Values for red mullet	0.42	0.57	0.76	3081	4313
Values for Norway lobster	0.13	0.18	6.15	626	877
Values for all the other species method 2	0.29		2.86	-	-

Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments is evaluated using key social and economic indicators in the period 2008-2013 and a traffic light table is below reported (Tab. 2.9.2.3 red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend).

The traffic light approach stresses that the main fleet segments suffer of deteriorated performance (e.g. ITA_DTS_1824_2440) especially as regards overall revenues and revenues of European hake and deep water pink shrimp. These species being among the most important of the demersal fisheries also affect the overall revenues. The fleet segments ITA_PGP_0006_0612 and ITA_HOK_1218 show a similar performance, the latter for the negative recent trend of the revenues from European hake, the former also for the negative revenues of red mullet. Also the economic performance indicators as CR.BER and ROI have a negative performance. The situation of the other fleet segments is quite heterogeneous though the Montenegrin fleet seems performing better compared to the other ones..

Tab. 2.9.2.3 - Traffic light table on the economic performance (period 2008-2013) of the fleets targeting small pelagics (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend). The values in the cells are referred to 2008 and 2014. The color in the cell is assigned on the basis of the percentage change between 2008 and 2014 (unless differently specified); the green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

Fleet segment	Salary (euros)	CR.BER	ROI	Overall Revenues (thousands euros)	Revenues European hake (thousands euros)	Revenues deep water rose shrimp (thousands euros)	Revenues Norway lobster (thousands euros)	Revenues red mullet (thousands euros)	Employment (number of unit)
ALL	7886 ÷ 8487	2.15 ÷ 2.98	0.331 ÷ 0.575	132907 ÷ 135151	28071 ÷ 17843	8012 ÷ 7027	18742 ÷ 14195	8642 ÷ 6982	3541 ÷ 3350
ITA_DTS_0612*	11674 ÷ 18720	0.859 ÷ 9.136	-0.058 ÷ 3.12	3002 ÷ 5242	154 ÷ 240	45 ÷ 0	84 ÷ 21*	577 ÷ 588	74 ÷ 70
ITA_DTS_1218	14403 ÷ 19750	1.137 ÷ 6.25	0.043 ÷ 1.682	45109 ÷ 66490	9720 ÷ 9089	3419 ÷ 3150	3888 ÷ 7092	4782 ÷ 3865	795 ÷ 708
ITA_DTS_1824_2440	17780 ÷ 17377	2.748 ÷ 1.546	0.489 ÷ 0.16	49774 ÷ 28586	12769 ÷ 5449	3170 ÷ 2189	14855 ÷ 7081	1673 ÷ 657	467 ÷ 368
ITA_HOK_1218	8788 ÷ 3891	6.627 ÷ 2.798	1.784 ÷ 0.78	8024 ÷ 3813	4829 ÷ 966				150 ÷ 147
ITA_PGP_0006_0612	4674 ÷ 5012	2.245 ÷ 1.447	0.461 ÷ 0.132	14512 ÷ 17923	351 ÷ 242			495 ÷ 298	887 ÷ 866
ALB_DTS_1224**	1460 ÷ 1460	1.055 ÷ 1.055	0.01 ÷ 0.01	10692 ÷ 10692	2552 ÷ 1567**	1104 ÷ 1436		956 ÷ 1383	1026 ÷ 1026
MNE_DFN_0012	989 ÷ 959	1.677 ÷ 14.632	0.1 ÷ 1.788	311 ÷ 789	6 ÷ 16			6 ÷ 15	70 ÷ 97
MNE_DTS_0612	4564 ÷ 4564	2.468 ÷ 4.667	0.189 ÷ 0.404	119 ÷ 132	28 ÷ 30	38 ÷ 35		17 ÷ 20	8 ÷ 5
MNE_DTS_1224	4147 ÷ 4157	0.271 ÷ 2.471	-0.086 ÷ 0.162	1264 ÷ 1147	208 ÷ 222	235 ÷ 217		135 ÷ 157	46 ÷ 39
MNE_HOK_0012	2622 ÷ 2361	-2.524 ÷ 5.455	-0.319 ÷ 0.467	101 ÷ 338	6 ÷ 23				18 ÷ 24

* The value of revenues of Norway lobster in the starting year is referred to 2008, as in 2007 for ITA_DTS_0612 there is no landing of Norway lobster.

** The value of revenues of European hake in the starting year is referred to 2009, as in 2007 and 2008 the values of revenues for European hake is not available for Albania fleet.

2.9.3. MANAGEMENT STRATEGY EVALUATION

During the Workshop held in Bari on September 21-25, 2015 it was also decided to test the effect of a Management Strategy Evaluation based on reaching the F_{MSY} corresponding to the F_{upper} (0.18; STECF EWG 15-11). Management Strategy Evaluation (MSE) was performed in line with what was presented during the STECF EWG 15-11. Results were quite consistent and probability to fall below Blim was 0.

2.9.4. SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

The improvement of the stock conditions in term of fishing mortality and spawning stock biomass can be achieved combining effort reduction (both capacity and days at sea) and selectivity improvement. Such mixed strategy is explored in the next section, through the 6 scenarios implemented.

Among the capacity reduction schemes, the current action plan presented by Italy in the last fleet report foresees a 7% reduction in of fishing capacity of DTS fleets in term of GT from 2015 to 2017.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns.

Two strategies to reach F_{MSY} can be adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;
2) an adaptive strategy which implies, for example, a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY target in 2020.

Selectivity improvement was also explored by assuming that the exploitation of the smaller individuals is postponed from the current selection patterns corresponding to SM40 (square mesh of 40 mm opening).

The reductions to 2018 or 2020 are applied from 2015 and after 2018 or 2020 fishing mortality is assumed to remain around the reference point.

In addition, two approaches for reaching F_{MSY} were applied based on:

- the F_{MSY} ranges and Fupper as reference point (details in the chapter 2.8.2);
- a combined F_{MSY} using a concept similar to that of Balance Indicators in which the impact of each fleet segment in respect to F_{MSY} is estimated using landing value as weighing factors (STECF 2014a).

A further strategy is characterized by a change in selectivity of trawlers with no reduction in effort. The selectivity of the gears different from trawlers has been maintained unchanged.

Strategy and timeframe to reach the RP

The four stocks are components of a mixed demersal fishery, thus management measures should take this aspect into account. Based on Fcurrent levels, Norway lobster and European hake are the most heavily exploited species. Norway lobster has thus been used as the benchmark species.

The percentages of reduction to reach F_{upper} are reported in the Table 2.9.4.1

Table 2.9.4.1 - Percentage of reduction of the current fishing mortality to reach the reference point according to the method applied: F_{UPPER} (method 1) or combined F_{MSY} (method 2).

Stock	Fishing mortality reduction (in %)
Norway Lobster (Reference point method 1)	77%
All stocks (Reference point method 2)	64%

The percentage of reduction does not change if the target year is 2018 or 2020, only the amount of reduction by year is changing, depending on the target year.

The rationale of reduction is reported in the chapter 2.1.4 of this report (Management Possibilities, Criteria and Planned Scenarios to reach FMSY) agreed with DGMARE during the project Workshop held in Bari, Italy on 21-25 September 2015 (Annex III to this report). These percentages were computed using:

- the reference point Fupper of Norway lobster (the more exploited species) = 0.18 (method 1) and the current level of fishing mortality (method 1) (Fcurr=0.8);
- the reference point F_{MSY} combined = 0.29 (method 2) and the current level of fishing mortality combined (F=0.83).

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

The reduction has been applied to each fleet segment, considering its relative portion of $F_{current}$ to its relative portion of F_{MSY}, on the basis of the ratio between fleet segment landing to the overall landing of the species. In case of fishing mortality combined, the needed reduction is 64%. In case of F_{upper} a reduction of 77% is necessary. This reduction is applied to all the fleet segments that are catching the assessed species, provided that their relative impact is higher than 3% of the overall fishing mortality.

2.9.5. EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios are reported in the Table 2.9.5.1

In the scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

Scenario 2 and 4 share the same reference point that is the F_{UPPER} of Norway lobster because it is more exploited, but the strategy is different in terms of timeframe and shaping of the reduction along the time.

Also scenario 3 and 5 share the same reference point, that is the F_{MSY} combined among the assessed species using the economic value as weighing factor of the average.

The scenario 6 aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

Table 2.9.5.1 Proposed management scenarios to reach the reference point

Case Study	**demersals in GSA 18**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of the most heavily exploited species (Norway lobster) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 3	Linear reduction towards a weighted average F_{MSY} for a mix of species (using landing value as weighting factor) in 2018 applied on both activity and capacity, up to 2017 included. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 4	Adaptive reduction towards upper F_{MSY} of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 5	Adaptive reduction towards a weighted average F_{MSY} for a mix of species (using landing value for weighting) in 2020 applied only on activity from 2018 to 2020. Application can be differentiated by fleet. Starting year of reduction 2015.
Scenario 6	Improving selectivity (in case of gear selectivity)/delaying the size at first capture. Starting year 2015.

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter, relies on the consideration that there will be no more possibility of scraping after 2018.

For both methods (according to Fmsy upper of hake Norway lobster and according to the F combined) the reduction has been applied for the 10% on vessels until 2017 and for 90% on fishing days until 2018 (linearly) and 2020 (in an adaptive way).The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.9.5.2.

The overall reduction to the target RP has been split by vessels and fishing days according to the percentage reported in the Table 2.9.5.2.

Table 2.9.5.2. Split reduction by vessels and average fishing days per year.

Reduction on VESSELS needed to F_{upper}	Reduction on DAYS needed to F_{upper}
8**	69*

*in case of F_{MSY} combined this percentage is 58%

** in case of F_{MSY} combined this percentage is 6

The shape of the reduction by fishing days and activity according to the different scenario is reported in the figure 2.9.5.2.

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

The value of the overall fishing mortality estimated by BEMTOOL in 2013 for Norway lobster is 0.8, its $F_{0.1}$ is 0.13 and its F_{MSY} upper is 0.18; according to the state of exploitation, a reduction of 77% is needed. The reduction has been differentiated by fleet segment, according to their relative impact on the fishing mortality of Norway lobster (Table 2.9.5.3).

Table 2.9.5.3 - Percentage of fishing mortality of Norway lobster by fleet segment and year.

Year	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	0.00	0.60	1.62	1.30	0.63	0.13	0.07
ITA18_DTS_1218	21.10	38.25	42.25	45.11	46.24	38.80	48.33
ITA18_DTS_1824_2440	78.90	61.16	56.13	53.60	53.13	61.07	51.60

The value of the overall combined fishing mortality is, for GSA 18, 0.83, while the combined F_{MSY} is 0.29. A reduction of 64% on the overall fishing mortality would be needed. The reductions have been applied according to the proportions of combined fishing mortality by fleet segment (Table 2.9.5.4).

The fleet segments impacting less than 3% on the overall fishing mortality in exam were excluded from the the reduction plan. These fleets were different according to the followed approach.

Table 2.9.5.4 Relative impact (percentage of the overall fishing mortality of hake or of the overall fishing mortality combined) in terms of fishing mortality by fleet segment and reduction to be applied.

	Fleet code	% F current Norway lobster	Reduction applied%	% F current combined	Reduction applied %
1	ITA18_DTS_0612	0.07	77	<3%	-
2	ITA18_DTS_1218	48.33	77	43	64
3	ITA18_DTS_1824_2440	51.60	77	32	64
4	ITA18_HOK_1218			5	64
5	ITA18_PGP_0006_0612			<3%	-
6	ALB18_DTS_1224			16	64
7	MNE18_DFN_0012			<3%	-
8	MNE18_DTS_0612			<3%	-
9	MNE18_DTS_1224			<3%	-
10	MNE18_HOK_0012			<3%	-

A further scenario has been implemented, the scenario 6 (fig. 2.9.5.1) aims at delaying the size at first capture, but without a specific target in terms of reference point. Such delay can be achieved through change of the gear selectivity (increasing the opening or changing the type of mesh size in the codend) and/or avoiding areas where smaller individuals of the population are mainly concentrated (along all the year or in certain seasons).

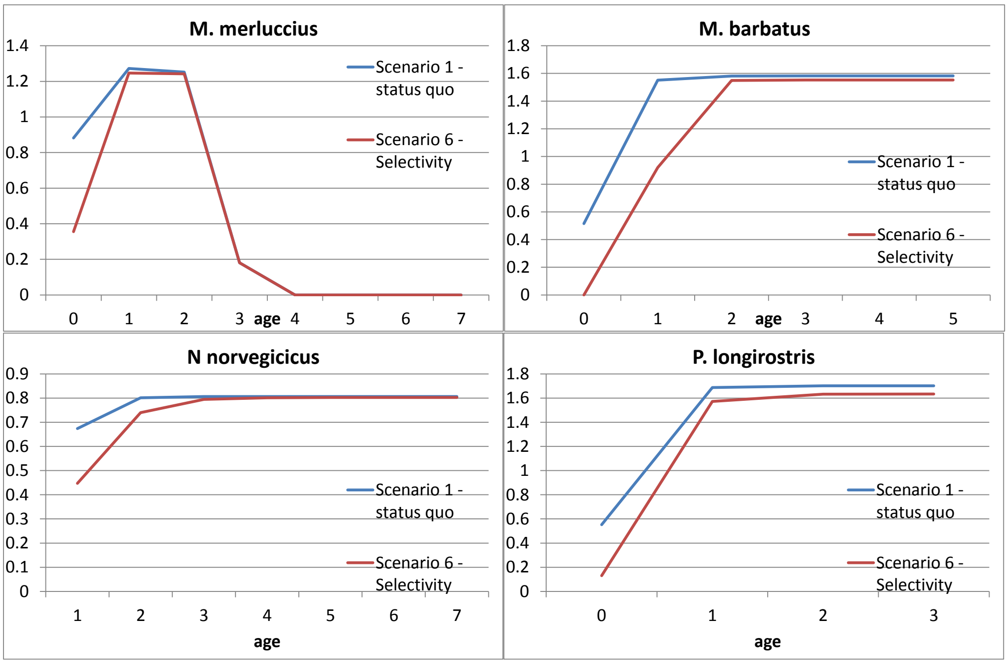
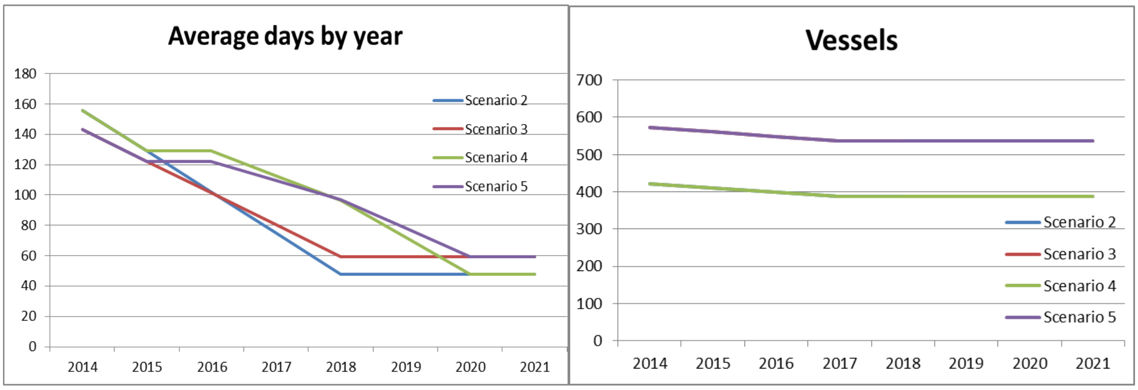


Figure 2.9.5.1 - Comparison between the F by age (only trawlers) in the status quo and in selectivity scenario by species.



Error! Reference source not found. Figure 2.9.5.2 - Shape of the reduction in terms of annual average ishing days and annual vessels according to the different scenarios.

Further details on the shaping of reduction by fleet segment, year and scenario are reported in the Annex H5.3.

In all the scenarios the uncertainty on recruitment has been taken into account (process error), applying for all stocks a multiplicative error (on the recruitment of the last year).

2.9.6. IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

The tool used to carry out the projections of the different management scenarios is BEMTOOL bio-economic model (cfr chapter 2.1).

The inputs to the biological and pressure components of BEMTOOL model have been derived from the last endorsed stock assessments; socio-economic data and parameters are from DCF and SEDAF -MAREA project.
A Management Strategy Evaluation (MSE) has been performed in line with EWG-15-11 for hake.

2.9.7. REPORT OF INPUTS FOR MODELLING DEMERSAL FISHERIES IN GSA18

All the inputs for modelling are fully reported in the Annex H.

2.9.8 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.9.8.1 RESULTS OF THE BIOLOGICAL AND PRESSURE INDICATORS IN THE STATUS QUO SCENARIO

In the status quo scenario, projecting the current effort and selectivity for all the fleet segments and assuming a recruitment varying around the last year value respectively from -42% to +71% for hake, from -70% to +38% for deep water pink shrimp, from -37% to +61% for Norway lobster and from -40% to +65% for red mullet, the proxy of the probability that the SSB of hake is less than the biomass reference point is 100%, for pink shrimp is 99.8%, for Norway lobster is 100%, and for red mullet is 0%.

The SSB of Norway lobster, after a gradual decrease, remains quite stable until 2021 reaching a plateau that is respectively -32% respect to the value of 2013. The SSB of red mullet gradually increases from 2015 to 2021 reaching in 2021 a SSB value that is about 50% greater than the value of 2013, this is a result of the high recruitments of the last years before the forecast. The SSB of hake gradually increases from 2015 to 2021 reaching in 2021 a SSB value that is the 34% greater than the value of 2013. The SSB of pink shrimp increased of the 28% respect to the value of 2013.

The decrease of Norway lobster SSB is due to the increase in fishing mortality from 2013 (in 2013 the fishing mortality is +53% respect to 2012 value), while the increase in the short term of deep water pink shrimp SSB is due to higher value of recruitment in the last year (that is around 28% higher than the value of the 2013 value). The increase in hake SSB is due to the decrease (reduction of about 27%) of fishing mortality from 2012 to 2013.

Figure 2.6.8.1Figure 2.9.8.1.1 - SSB of the four stocks in status quo scenario.

The landing of hake and Norway lobster decreases for all the fleet segments until 2016 and remains stable until 2021. In 2021 the overall landing of hake is about 19% lower than the level of 2013, while the overall landing of Norway lobster in 2021 is about 26% lower than the value of 2013; the catch of red mullet remains quite stable until 2021 (increase of 3% respect to the status quo), while the overall catch of deep water pink shrimp increases until a value that is in 2021 about 28% higher than in 2013 (Figure 2.9.8.1.2 to Figure 2.9.8.1.5).

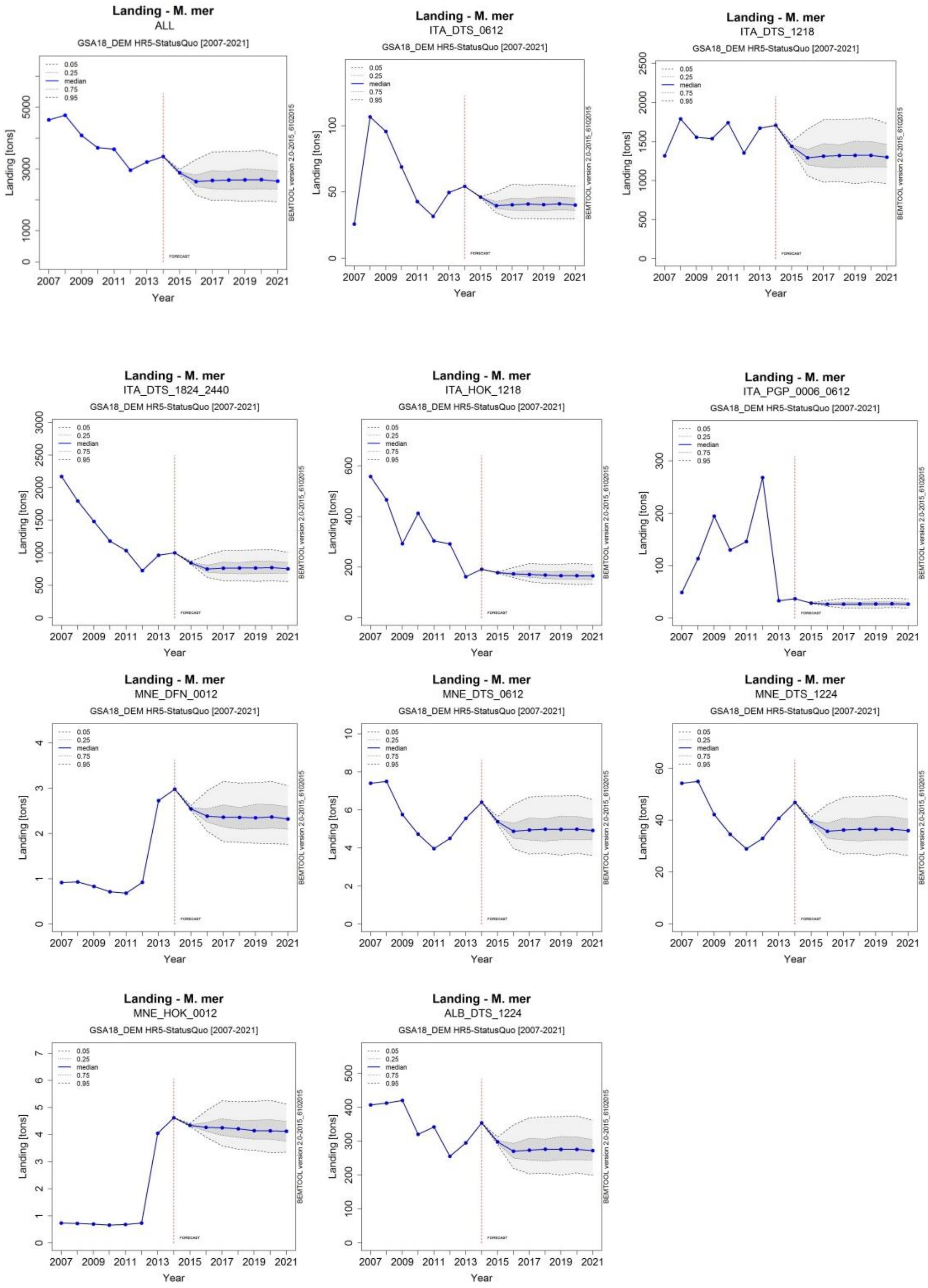


Figure 2.9.8.1.2 Landing for European hake in the status quo scenario with confidence intervals.

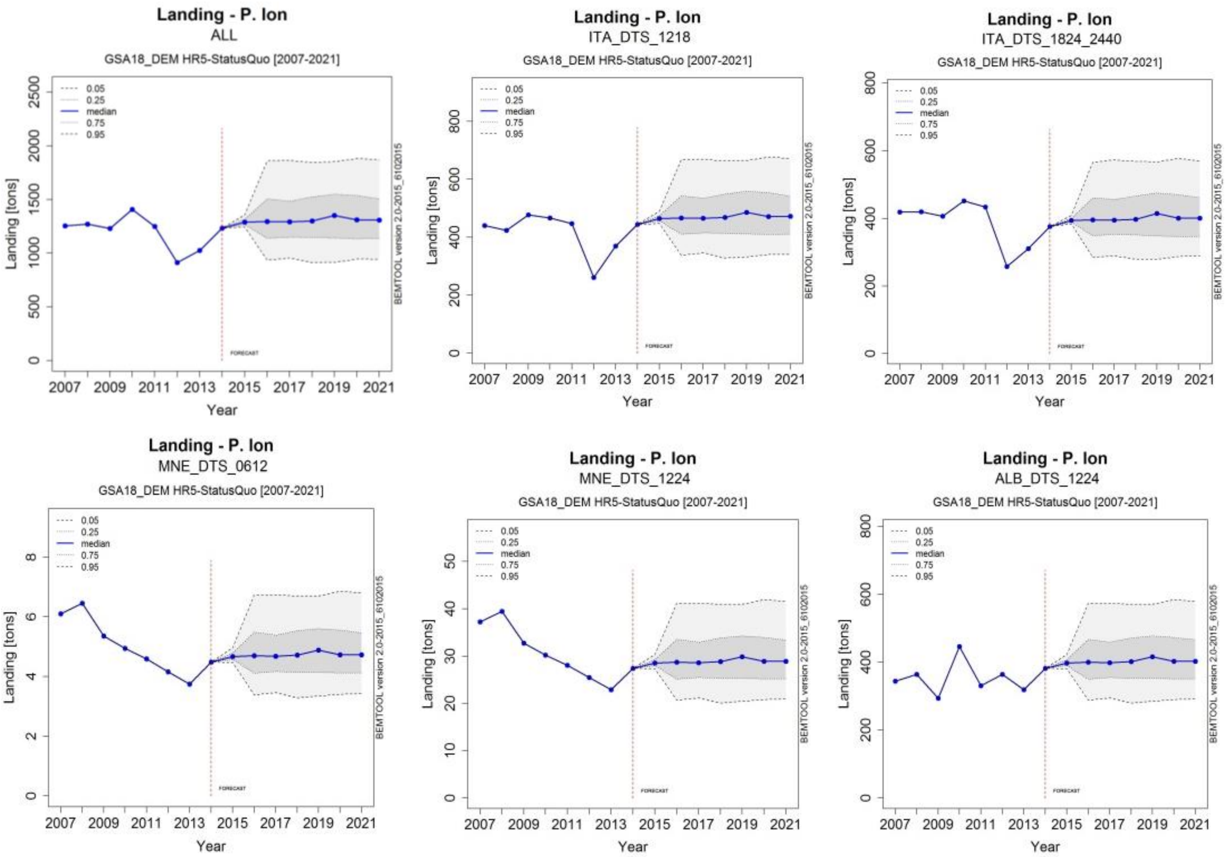


Figure 2.9.8.1.3 Landing for deep water pink shrimp in the status quo scenario with confidence intervals.

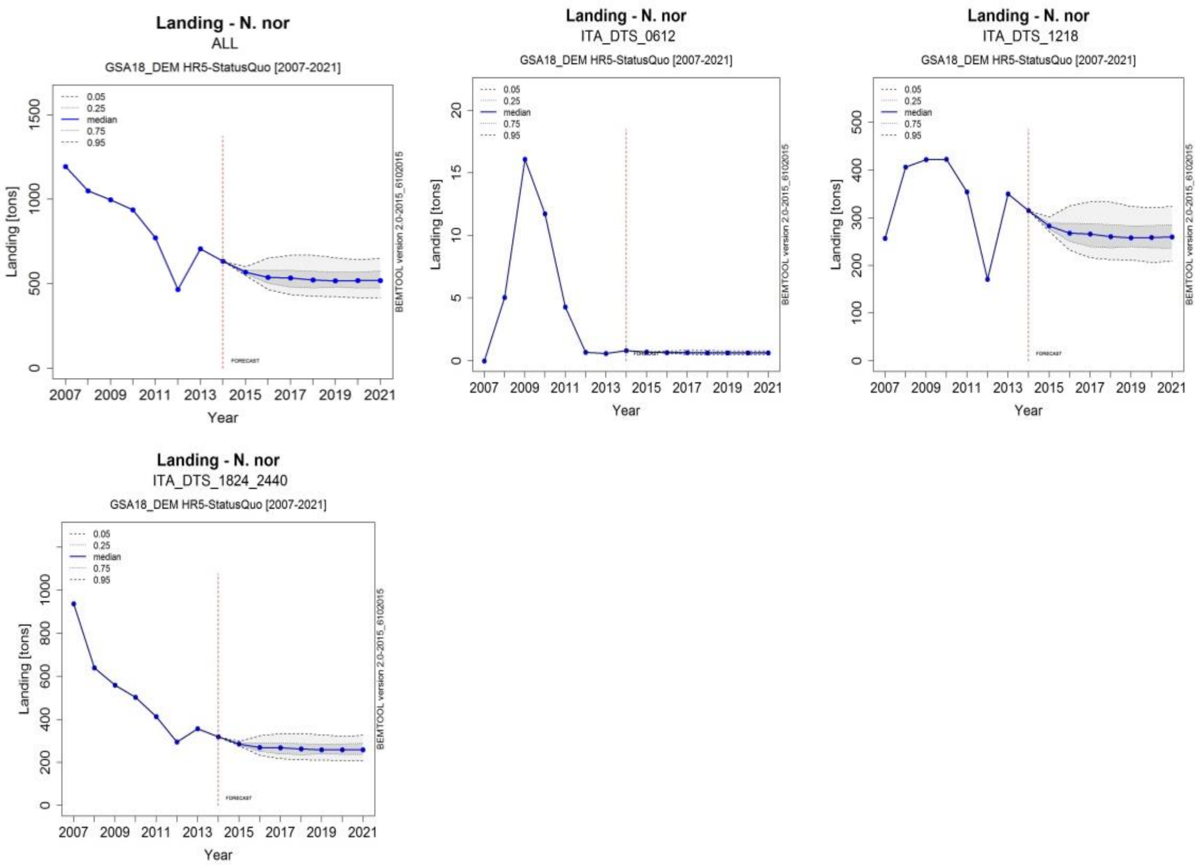
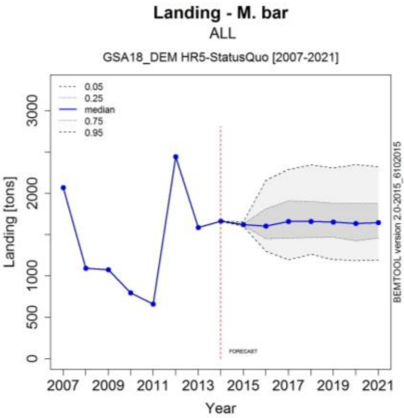
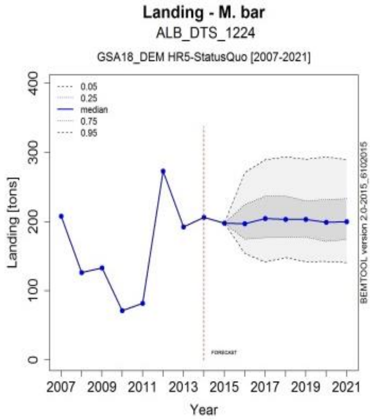
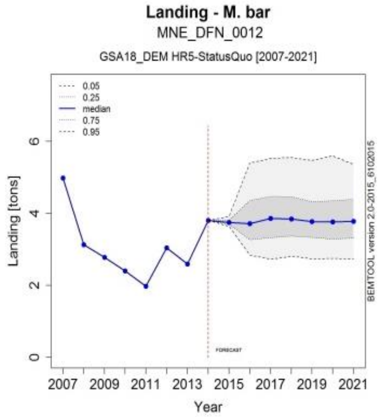


Figure2.9.8.1.4 Landing for Norway lobster in the status quo scenario with confidence intervals.


Landing - M. bar
ALL
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
ALB_DTS_1224
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
MNE_DFN_0012
GSA18_DEM HR5-StatusQuo [2007-2021]
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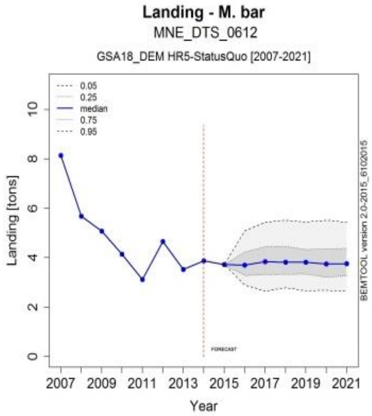
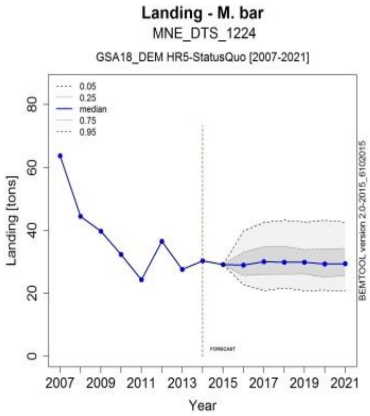
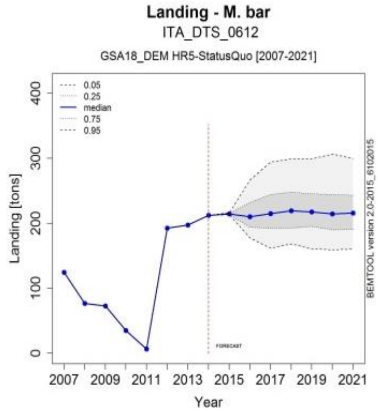
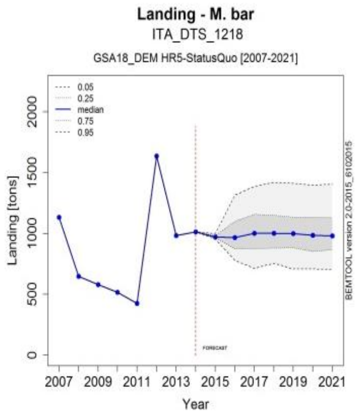
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
MNE_DTS_0612
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
MNE_DTS_1224
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
ITA_DTS_0612
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
ITA_DTS_1218
GSA18_DEM HR5-StatusQuo [2007-2021]
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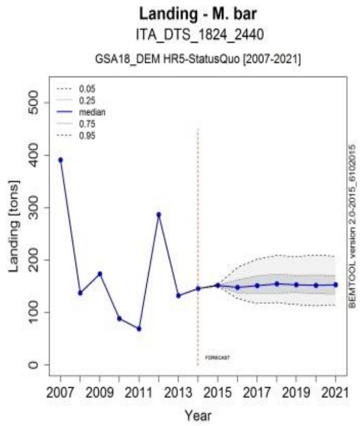
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
ITA_DTS_1824_2440
GSA18_DEM HR5-StatusQuo [2007-2021]
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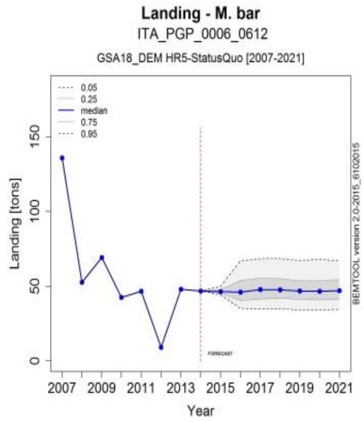
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015


Landing - M. bar
ITA_PGP_0006_0612
GSA18_DEM HR5-StatusQuo [2007-2021]
0.05
0.25
median
0.75
0.95
Landing [tons]
Year
FORECAST
BEMTOOL version 2.0-2015_6102015

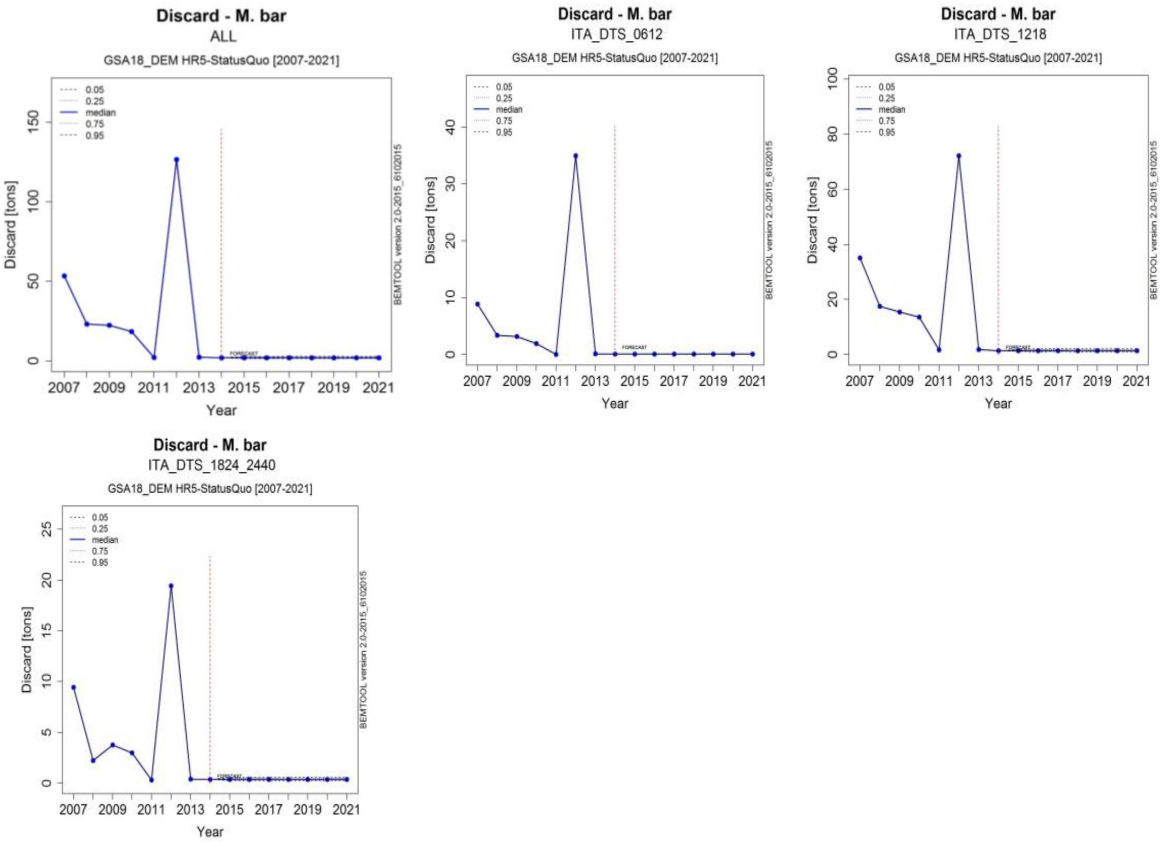


Figure 2.9.8.1.5 Landing and discard for red mullet in the status quo scenario with confidence intervals.

2.9.8.2 RESULTS OF THE SOCIO-ECONOMIC INDICATORS IN THE STATUS QUO SCENARIO

In 2013 the fleets considered in the case study produced 20.5 thousand tons of total production generating 135 million euro, an increase by 38% in quantity and 41% in value compared to 2012. The most important fleet segment is the Italian demersal trawlers VL1218, accounting for almost half of total revenues. Other relevant fleet segments are the Italian demersal trawlers VL1824_VL2440, which account for around 20% of total revenues, and the Italian small scale fleet lower than 12m with 13% of total revenues. In 2013 the Italian fleet produced around 90% of total landings, while the Albanian fleet produced less than 10% and the Montenegrin fleet less than 2%.

As reported in the Figure 2.9.8.2.1., total revenues of demersal fleets operating in GSA 18 show a negative trend in the period 2010-2012 with a fast recovery in 2013. Comparing 2013 to 2007, revenues results in a very small increase by around 2%. The main fleet segments show opposite trends: strong increases for the Italian demersal trawlers VL0612 and VL1218 are counterbalanced by strong decreases for the Italian demersal trawlers VL1824_2440 and vessels using hooks VL1218. Landings in weight show a dynamic similar to revenues with an increase from 2007 to 2013 for the whole fleet by 6%.

In the forecast period, total revenues for the overall fishing sector show a decreasing trend with a reduction by 10% in value and 9% in weight in 2021 compared to 2013. Among the main fleet segments, the strongest reduction is registered for the Italian demersal trawlers VL1824_2440 (-20% in value and -30% in weight) and the Italian small scale fleet lower than 12m (-11% in value and in weight). On the contrary, the Italian vessels using hooks VL1218 and the demersal trawlers VL0612 show an increase respectively by 8% and 24% in value (equivalent to +9% and +27% in weight respectively). The other fleet segments, Albanian and Montenegrin fleets, show stable trend in weight and value with the exception of an increasing trend for the Montenegrin vessels using hooks VL0012 and DFN_0012 (both for about +8% in value and weight).

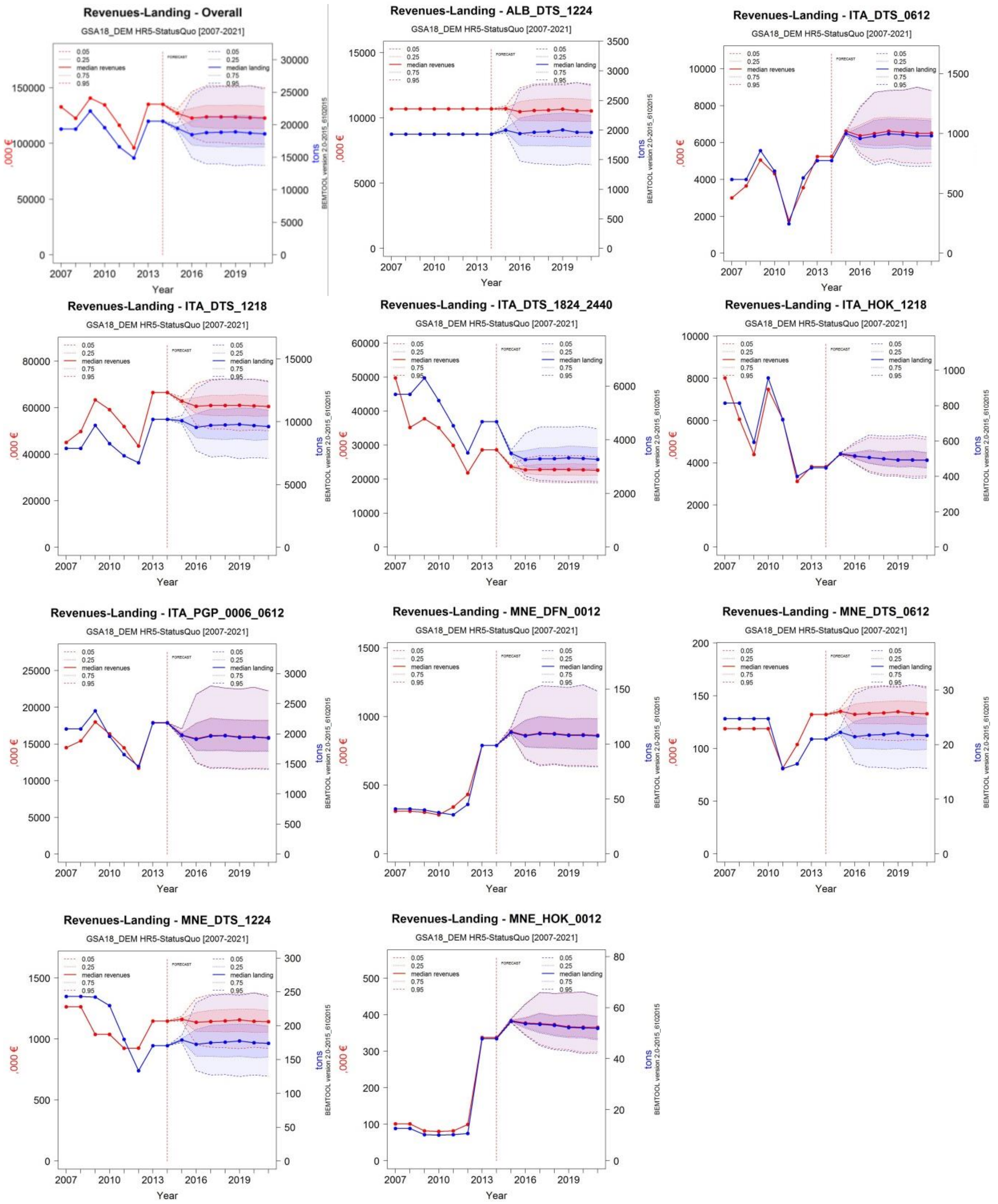


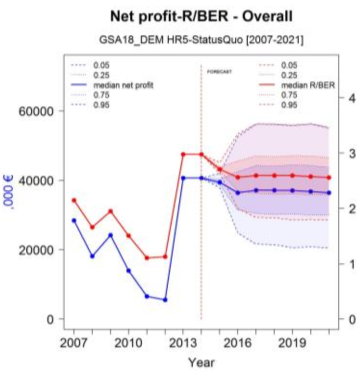
Figure 2.9.8.2.1 Landings weight and value by fleet segment and quantile.

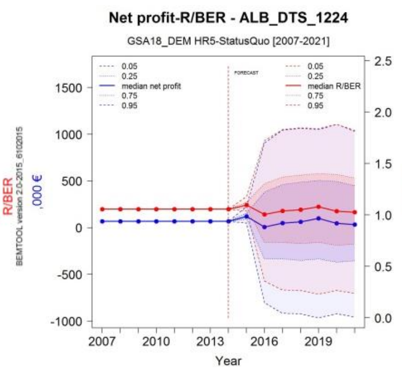
In 2013 the economic efficiency of the fishing sector, calculated in terms of net profit, is positive. The whole demersal fleet operating in GSA 18 shows positive values for net profit in the period 2007-2013. Negative values are registered mainly in the period 2010-2012 for some Italian and Montenegrin fleet segments. The Italian demersal trawlers VL1824_2440 and small scale fleet under 12m lengthshow the worst performance in that period. The Montenegrin demersal trawlers VL1224 and vessels using hooks VL0012 registered negative values also in the period 2007-2009. Nevertheless, in 2013 all fleet segments included in the case study had positive values for net profits.

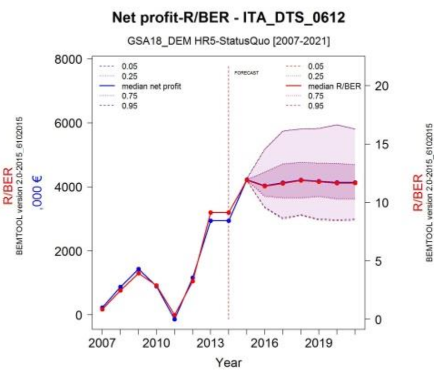
In the forecast period, net profit for the overall fishing sector show a negative trend. Compared with 2013, net profit is expected to reduce by 10% in 2021. With the exceptions of the Italian demersal trawlers VL0612 (+40%), the Italian vessels using hooks VL1218 (+22%), the Montenegrin vessels using hooks VL0012 (+23%) and the Montenegrin DFN_0012 (+11%), all fleet segments are expected to register a declining net profit.

In 2013 the ratio between current and break-even revenues (CR/BER), which shows how current revenues are sufficient to cover variable and fixed costs, is greater than 1 for all fleet segments. Values lower than 1 are registered in the period 2010-2012 for the Italian demersal trawlers VL1824_2440 and small scale fleet under 12m length. The worst performance with values lower than 1 or negative is registered for the Montenegrin demersal trawlers VL1224 in the period 2007-2011 and for the Montenegrin vessels using hooks VL0012 in the period 2007-2012.

The ratio between current and break-even revenues (CR/BER) in the forecast period shows a negative trend for all fleet segments with the exceptions of the Montenegrin vessels using hooks VL0012, the Italian demersal trawlers VL0612 and the Italian vessels using hooks VL1218. The worst performance is expected for the Italian trawlers greater than 18 m.







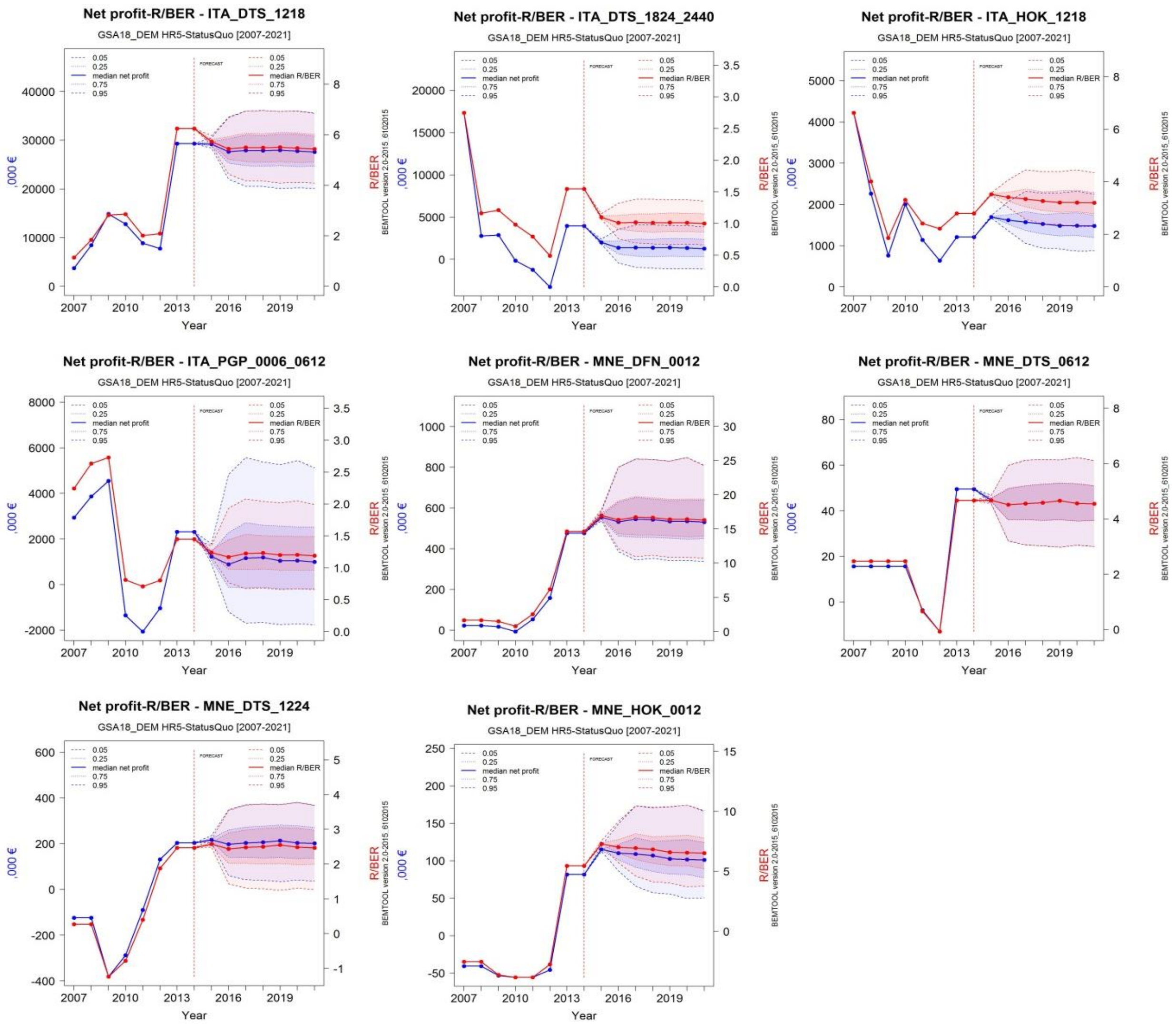


Figure2.9.8.2.2 Net profit and Current Revenue to the Break-Even Revenue ratio by fleet segment and quantile.

2.9.9 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

According to the state of exploitation of the four demersal stocks in GSA 18 case study, 5 forecast scenarios alternative to status quo have been performed to evaluate the consequences of several management strategies in terms of costs and benefits for the renewal of stocks, fishery sustainability and productive and economic performances of different fleet segments.

2.9.9.1 BIOLOGICAL AND PRESSURE INDICATORS

SSB shows the highest rebuilding in the Scenario 2, for both Norway lobster and red mullet, while for European hake scenarios 2 and 3 are almost equivalent. For deep-water rose shrimp, instead, Scenario 3 gives the best results. The success of scenarios 2 and 3 seems consistent with the greater benefit that generally the reduction of fishing mortality produce on indicators if applied in a short timeframe. The better result for the SSB of deep water pink shrimp under scenario 3 is probably a consequence of how the management measures are implemented. In the case of Fupper of Norway lobster as a basis for management, the fleets more impacted are the Italian ones, but the deep water pink shrimp is also impacted by the Albania fleet, at relatively larger extent than European hake. Thus the F_{MSY} combined as a basis for management is more effective for this stock.

Scenario 2 and 3 allow to obtain immediately the highest benefit in SSB. Scenario 6 (selectivity) gives better results for deep water rose shrimp and red mullet, compared with Norway lobster and European hake. The worst result for all the stocks is in the status quo scenario (Figure 2.9.9.1.1).

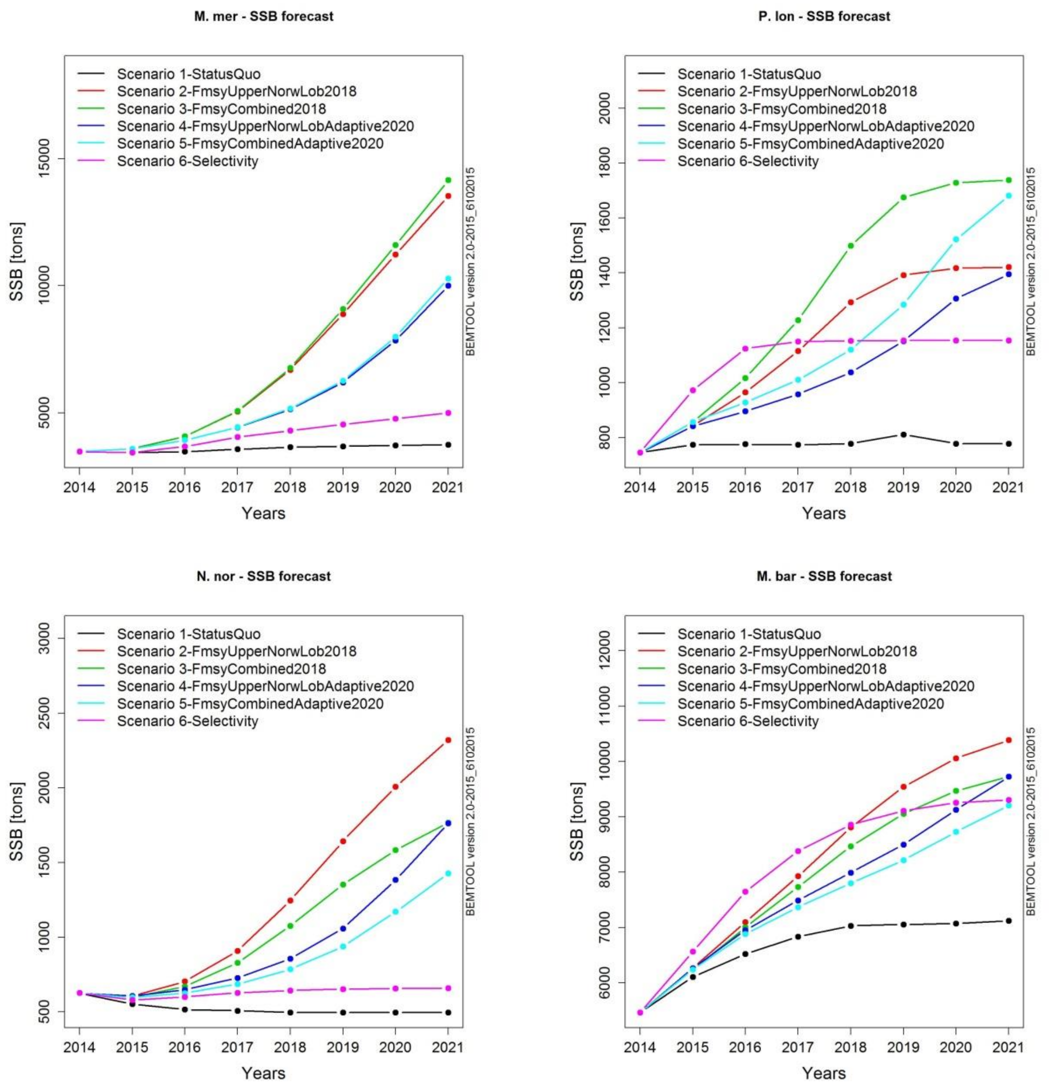


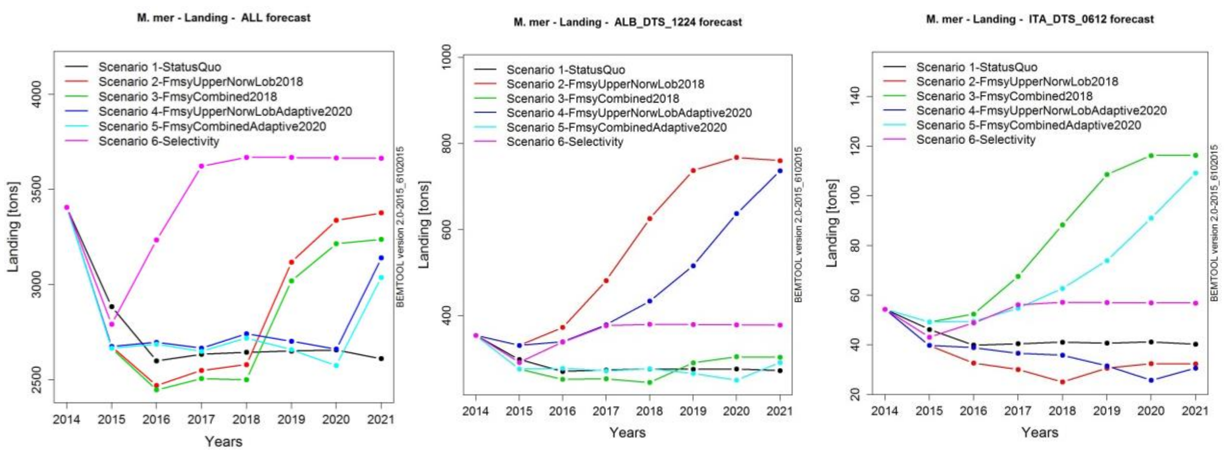
Figure 2.9.9.1.1 - SSB of the 4 selected stock in GSA 18: comparison among the management scenarios.

As regards the overall catches of hake, Scenario 6 is the best one, with an increase of 40%. This is due to the positive effect on the fleet segment ITA_DTS_1218 and ITA_DTS_1840 of this management measure. Instead catches of hake are severely reduced for the Italian trawlers larger than 12 m length under Scenario 2 and 4, as these fleets are the only ones reduced. Italian DTS_0612 shows the best performances under Scenarios 3 and 5, since in this case it is not affected by the management measure, that are based on F_{MSY} combined. As regards Albania, the best performance is shown in Scenarios 2 and 4 (reduction towards Fupper of Norway lobster by 2018 and 2020), as these management options do not affect Albania fleet, because not targeting Norway lobster. Montenegrin fleets would benefit more from reduction both towards F_{MSY} combined and F upper, as they are not reduced in both cases.
Generally the best performance of management measures reducing fishing effort is in the shorter time frame.

For Italian trawlers, catches of deep water rose shrimp are severely reduced in all the scenario, except in scenario 6, which effects are comparable with the trend of the status quo. Albania fleet sees a remarkable increases of catches in the scenarios 2 and 4, because these are based on Fupper of Norway lobster that is not targeted by this fleet. Conversely catches are lower in the scenario based on Fmsy combined, since the Albania fleet is impacted by these scenarios. The Montenegrin fleets would have the highest catches in all the scenarios, except the status quo, and especially when the management measures are applied in a shorter timeframe.

Catches of Norway lobster will be severely reduced in the short term under all the scenarios, except selectivity. This reduction will affect mainly the two Italian fleet segments ITA_DTS_1818 and ITA_DTS_1824_2440. The fleet segment ITA_DTS_0612 will be instead positively impacted by the scenarios 3 and 5 that are based on F_{MSY} combined, given that this fleet would not be impacted by these management options. However, given a fast rebuilding of the stock, the catches will be higher than the status quo in 2021 at least in the scenarios that apply the management measures in the short timeframe.

Catches of red mullet would severely decrease for the Italian fleet segments ITA_DTS_1818 and ITA_DTS_1824_2440 in all the scenarios, excluded selectivity and status quo. The catches would remain low also in 2021. As expected selectivity scenario is the best one for fleets different from trawlers, Italian i.e. small scale PGP and Montenegrin DFN with the higher values of catches. However these fleets take advantage from all the scenarios, except the status quo. Instead, Montenegrin trawlers take advantage by all scenarios except the Selectivity, given that are impacted by such measure. Catches from Albania trawlers would perform better under scenarios based on Fupper of Norway lobster, since they are not impacted by such management measures.



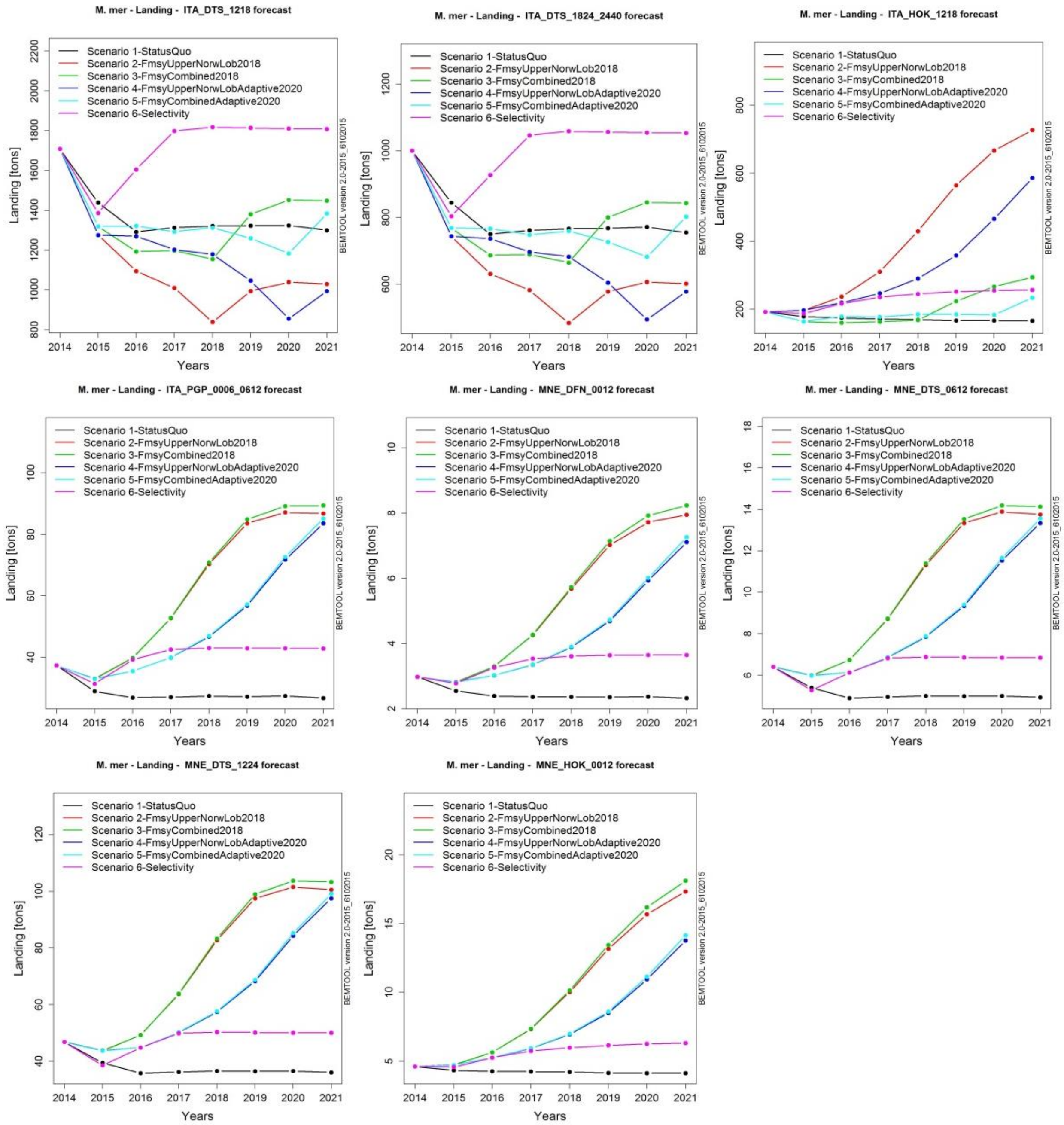


Figure 2.9.9.1.2 Landings of hake in GSA 18 by fleet segment: comparison among the management scenarios.

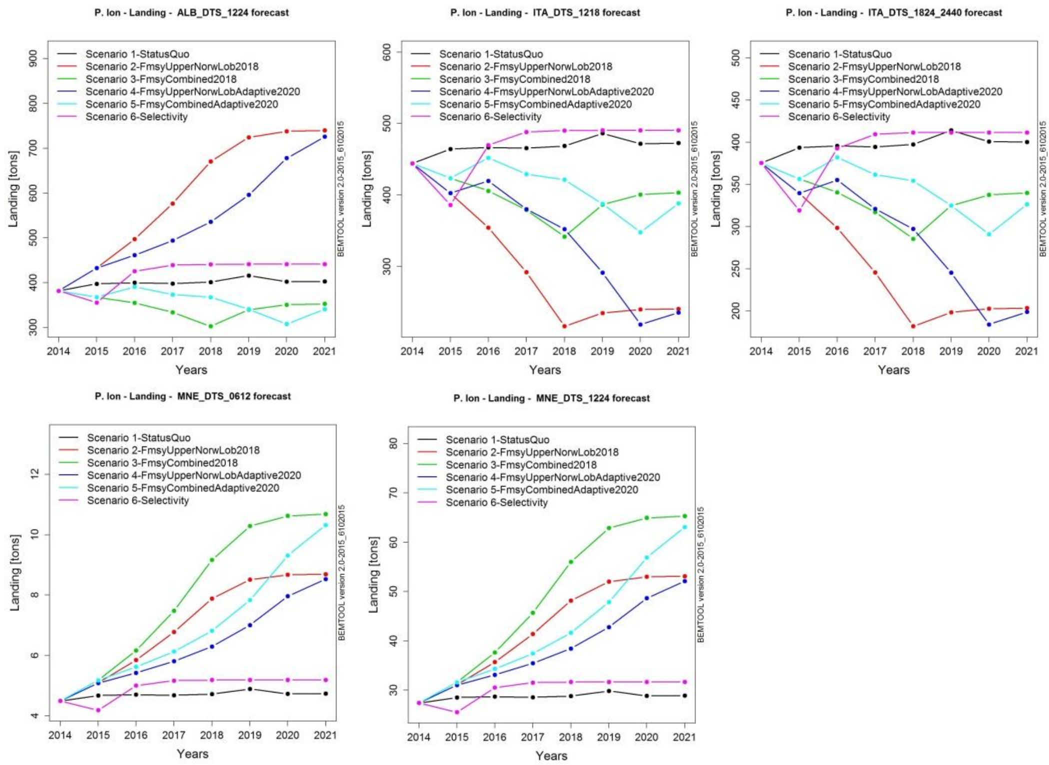


Figure 2.9.9.1.3 Landings of deep water pink shrimp in GSA 18 by fleet segment: comparison among the management scenarios.

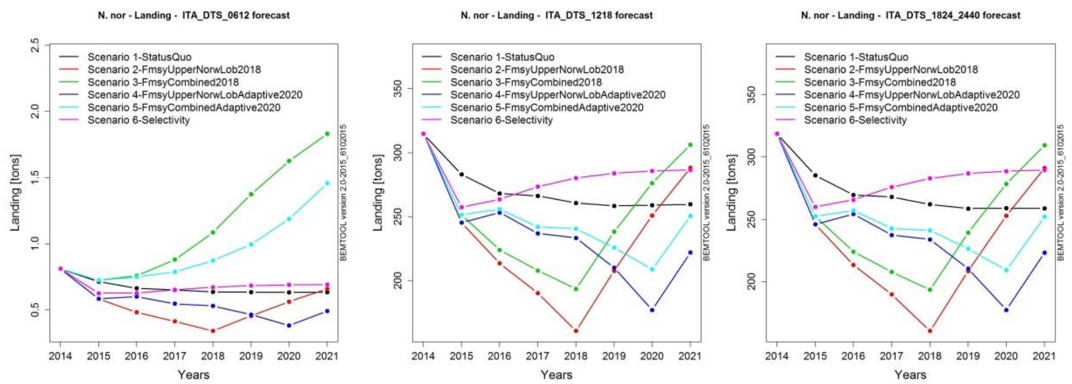
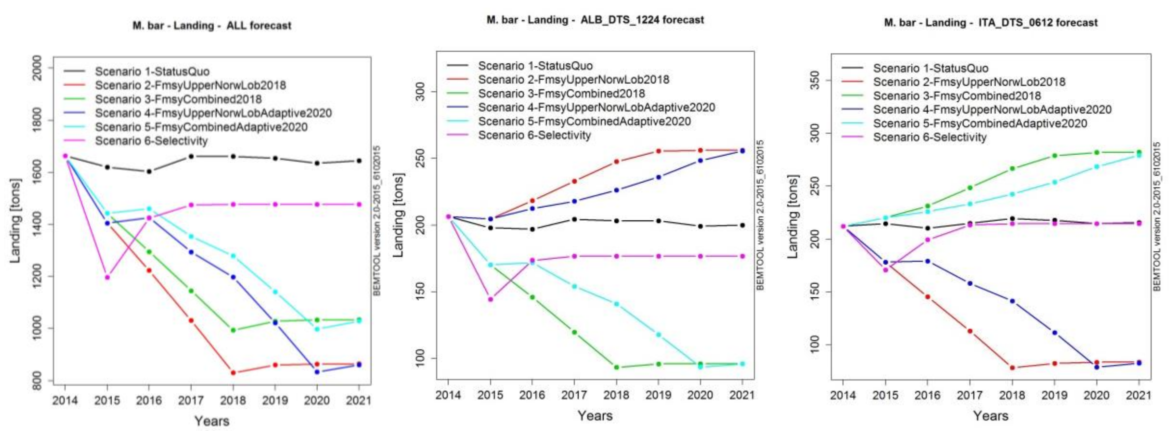


Figure 2.9.9.1.4 Landings of Norway lobster in GSA 18 by fleet segment: comparison among the management scenarios.



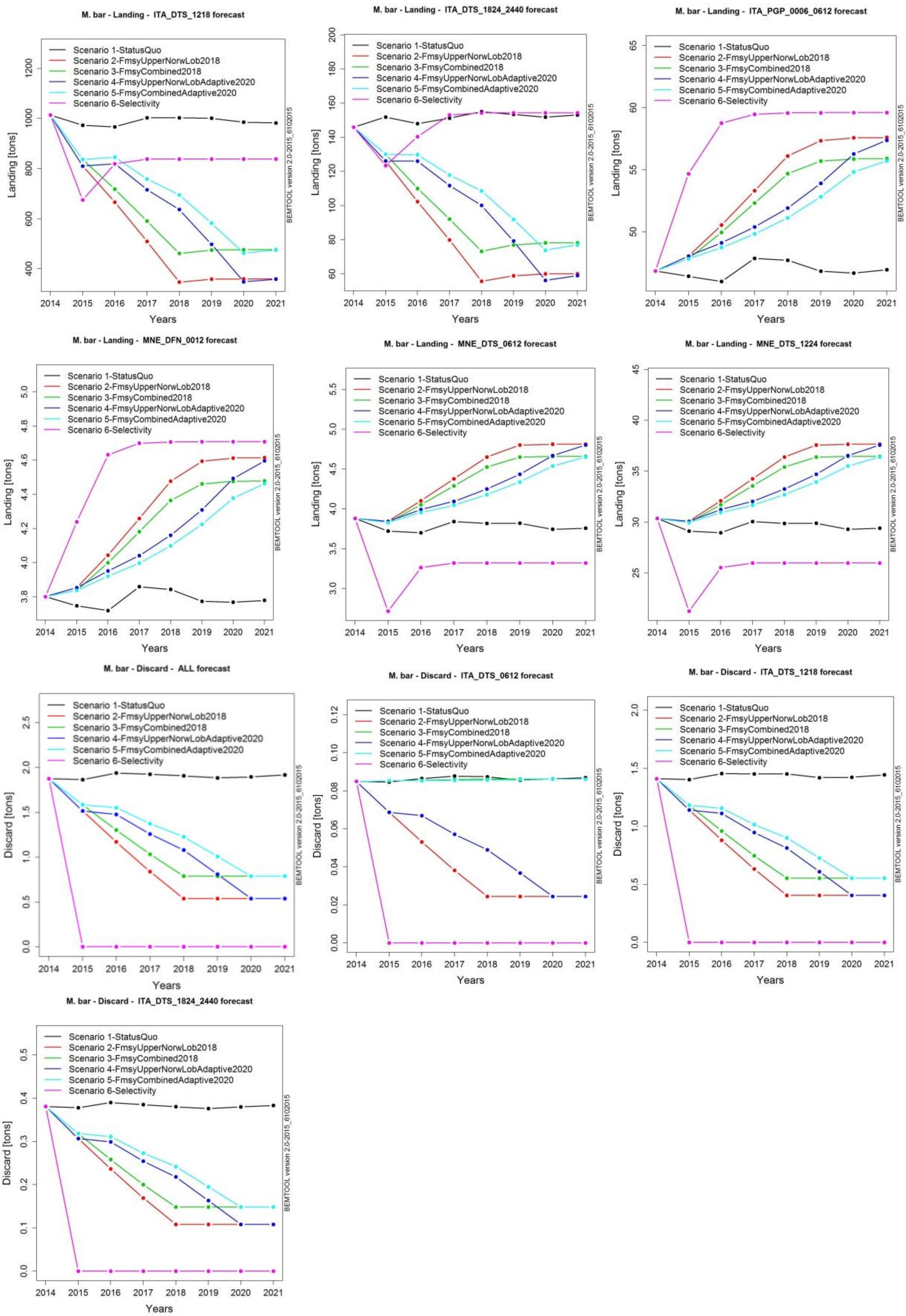


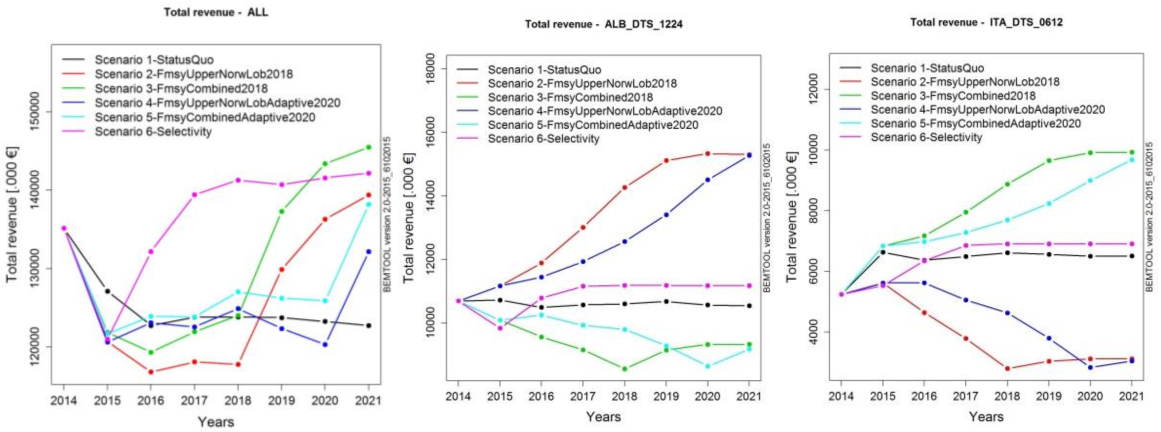
Figure 2.9.9.1.5 Landings and discards of red mullet in GSA 18 by fleet segment: comparison among the management scenarios.

2.9.9.2 FORECAST OF SOCIO-ECONOMIC INDICATORS

Figure 2.9.8.2.1 shows the expected impacts on total revenues deriving from each of the five alternative scenarios. The simulation outcomes are compared with the status quo scenario.

In 2021 total revenues of the overall fishing fleet is expected to increase under all the scenario with best performance in Scenario 3 (+16%). Scenario 4 shows the minor impact on total revenues with an increase of only 5% compared with the Status Quo.

The highest negative impact on revenues under scenarios from 2 to 5 is expected for the Italian demersal trawlers VL1218 and VL1824_2440 (with lowest revenues in Scenario 4), while for the same fleet segments the best performance in revenues is Selectivity (Scenario 6).. This Scenario shows always positive effects respect to the status quo. Total revenues for Albania fleet would have the highest performance respectively in Scenario 2 and 4 (in which Albania is not affected by the management measures, given that these are based on the Fupper of Norway lobster). Analogous pattern is seen for the fleet ITA_HOK_1218, while the fleet segment ITA PGP_0006_0612 takes advantage by all the management measures since it is not affected by any of these. Same considerations hold for the Montenegrin fleets.



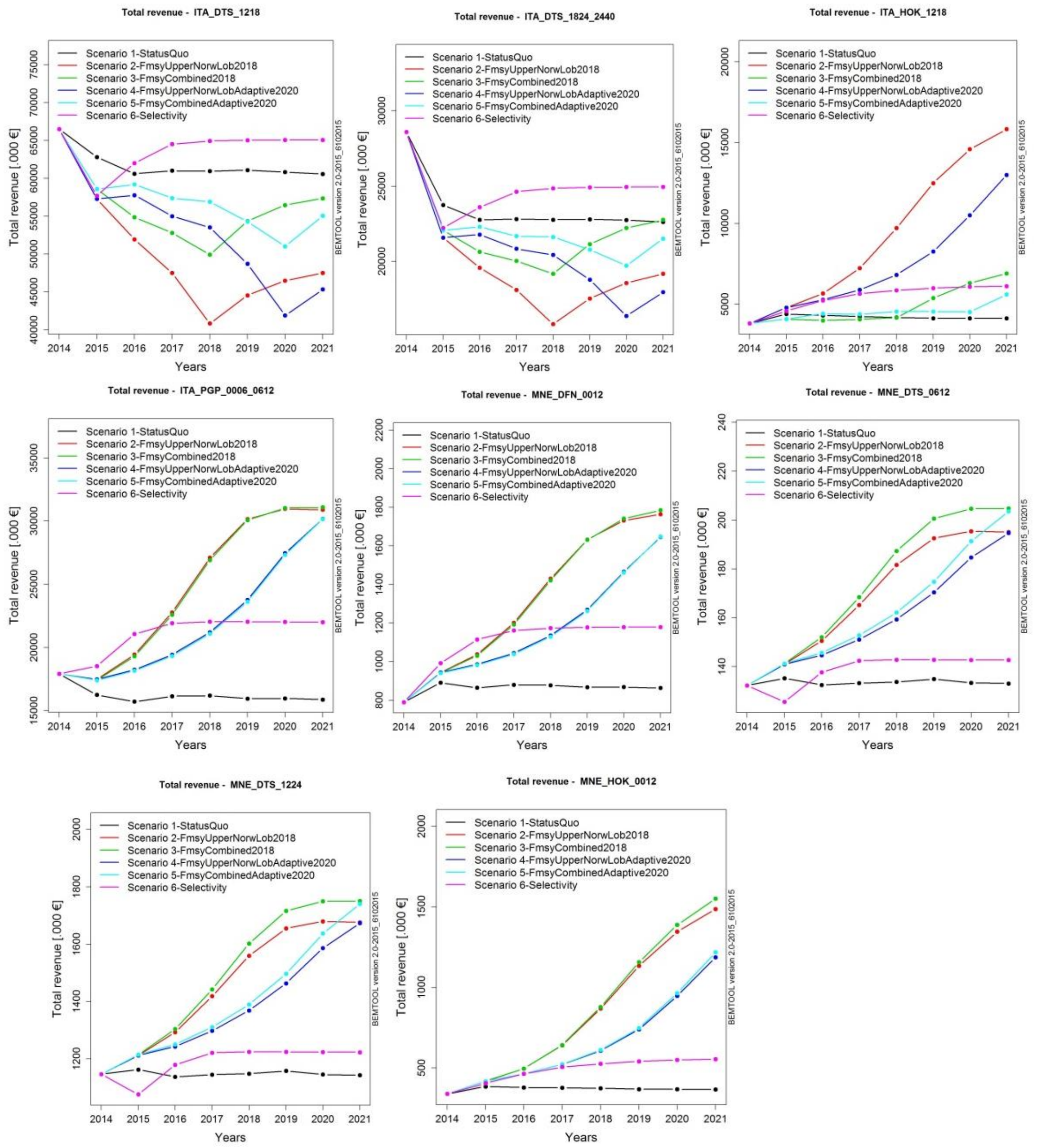


Figure2.9.9.2.1 Revenues by fleet segment and scenario.

In 2021, the CR/BER ratio under the Status Quo scenario shows values higher than 1 for all fleet segments. In all the scenarios the CR/BER shows values higher than the status quo for all the fleet segments, except for Italian and DTS_1218 and DTS_0612 (in Scenario 2, 4 and 6). The best performance for this indicator is expected under Scenario 2 and 3, i.e. those acting in the shorter timeframe.

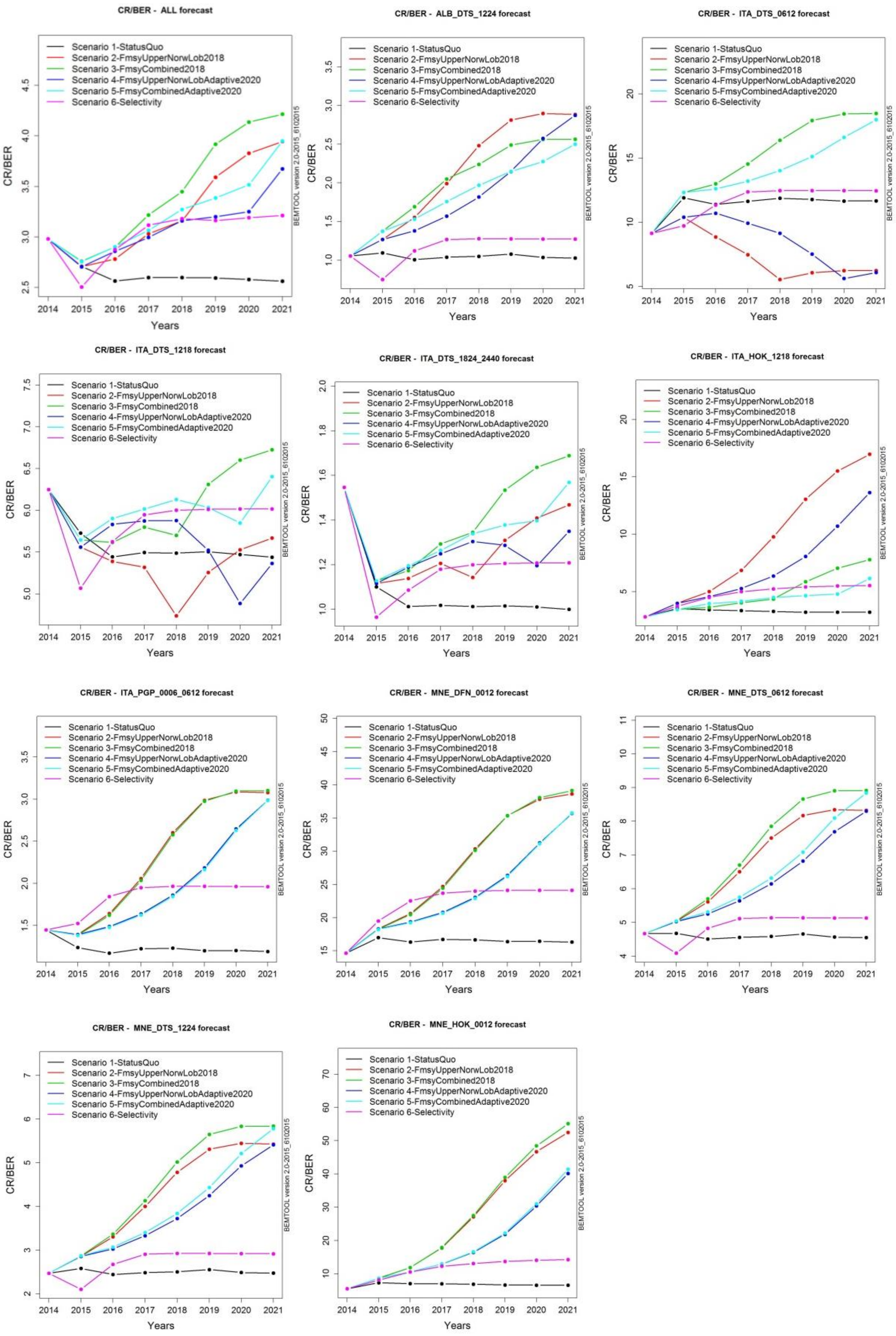
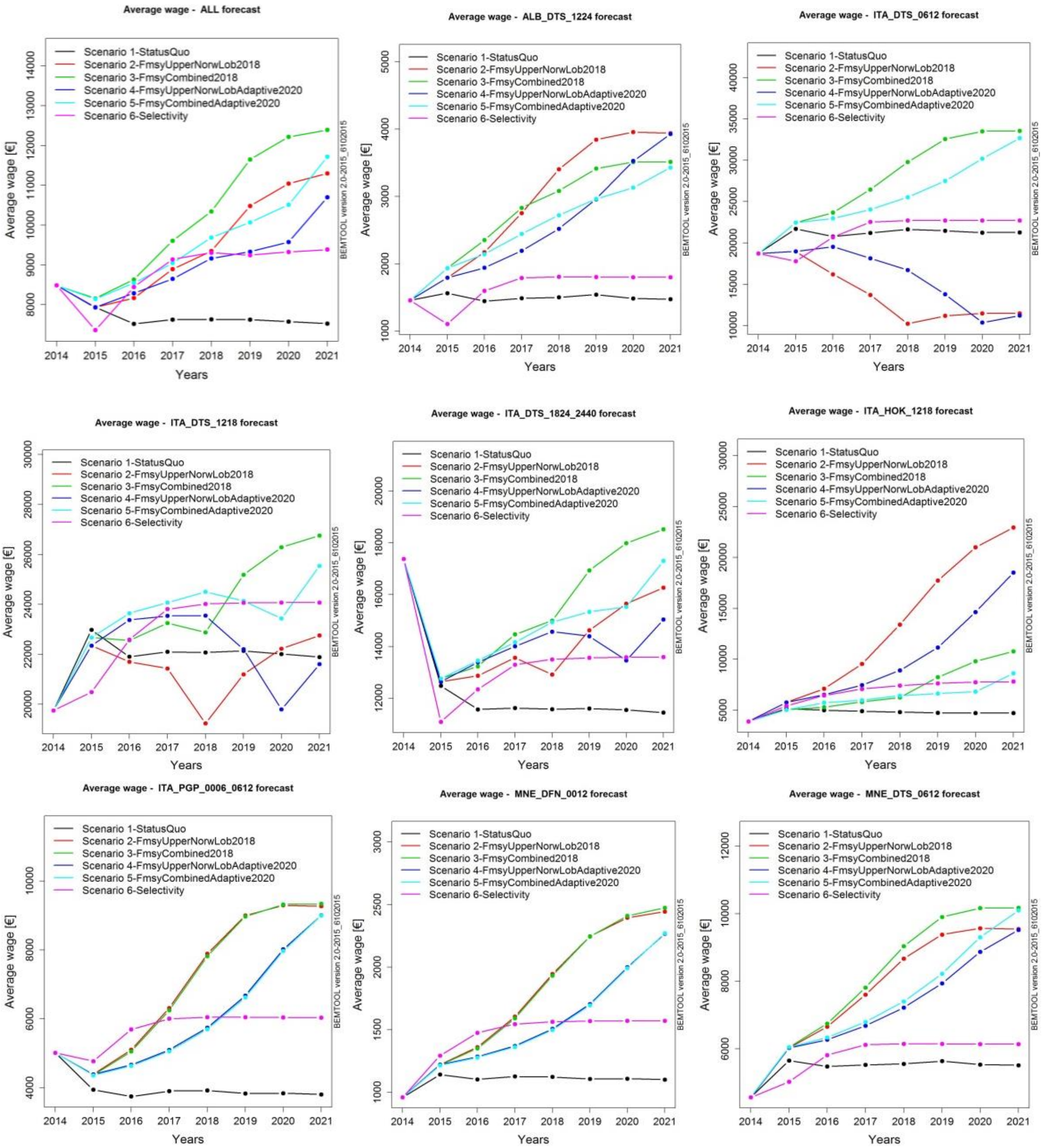


Figure2.9.9.2.2 Current Revenue to the Break-Even Revenue ratio (CR/BER) by fleet segment and scenario

Figure 2.9.8.2.3shows the effects simulated by the different scenarios on average salary per man employed.

With the exception of Scenario 2 and 4 for Italian DTS_1218 and DTS_0612, all alternative scenarios are expected to have a better impact on the average salary for all the fishing fleets rather than the Status Quo scenario.



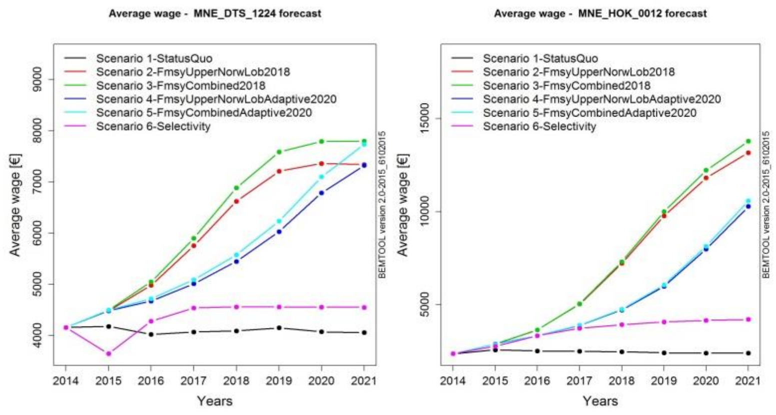


Figure 2.9.9.2.3 Average salary by fleet segment and scenario

2.9.10 REPORT OF THE RESULTS IN TERMS OF TRAFFIC LIGHT AND MULTI-CRITERIA DECISION ANALYSIS APPROACHES

According to the traffic light approach, all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect to the status quo. The SSB would have remarkable rebuilding especially for Norway lobster and European hake. Better values are observed for Norway lobster and red mullet in Scenario 2, while for hake and deep water pink shrimp in Scenario 3, i.e. the scenario based on a F_{MSY} combined. This better performance of the scenario is explained by the fact that deep water pink shrimp and hake are affected by all the fleets. Adaptive scenarios (Scenario 4 and 5) show a reduced short term benefit for SSB compared to the other scenarios (respectively 2 and 3). These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on this indicators if applied in a short time range.

Considering all the fleets, the best results in terms of catches is produced by Scenario 6, with respectively an increasing of 40%, 6% and 11% for hake, deep water pink shrimp and Norway lobster and a decrease of 10% for red mullet compared to the status quo (the lower decrease if compared to the other scenarios). This is quite reasonable, as change of selectivity affects the harvest pattern, but the effort is unchanged. Considering the other scenarios, there is a worse result for catches of the 4 stocks in Scenarios 4 and 5, that apply the reduction in a wider time frame. The worst result is however observed in the status quo.

Under the economic viewpoint, the revenues are highest for Scenario 3 (16% higher than the status quo), this is mainly due to the rebuilding of the stocks of hake and Norway lobster, but also to a less decrease of red mullet catches. The lowest revenues are expected in the Scenario 4 (about 5.5%). Scenarios 2 and 5 are almost equivalent in terms of change of revenues. The economic performance is improving if salary and the indicators CR/BER and ROI are considered. The reduction of employees is limited, given the low amount of scraping. The best performance of such indicators is under scenarios 3 and 5.

On an overall basis, the best performing scenarios is Scenario 2 followed by scenario 3, that allows to obtain a quite stable trade off among the different indicators, when considered having all the same weight. These results seems to confirm the higher efficiency when the management measure is applied in a short timeframe.

At fleet segment level, Montenegrin fleets have in all the scenarios performances better than status quo under biological and socio-economic viewpoint, benefitting more from Scenario 3, as the reduction is applied also to Albania fleet; this benefit is more evident for trawlers than for DFN fleet. As expected, Albania fleet shows the best performance in Scenario 2 and Scenario 4, as in these scenarios the reduction is applied only to Italian trawlers, on the basis of Fupper of Norway lobster as target. Also for Italian longliners and small scale fishery Scenario 2 would perform better, as especially longliners are not impacted by such scenarios.

Italian trawlers have performance worse than status quo in Scenario 2 and 4, in particular all these fleet segments will have a severe reduction of revenues, till -50% for the fleet ITA_DTS_0612, because its catches are probably less compensated by the rebuilding of hake and Norway lobster stocks, compared to the losses of catches for red mullet and pink water deep shrimp. The losses of revenues for the fleets ITA_DTS_1218 and ITA_DTS_1824_2440 will be more limited compared to the fleet ITA_DTS_0612, but however in the order of -20%. Only the fleet ITA_DTS_1824_2440 is expected to see an improvement of salary and CR/BER, given the likely compensation due to the improvement of catches deriving from the rebuilding of stocks as hake and Norway lobster.

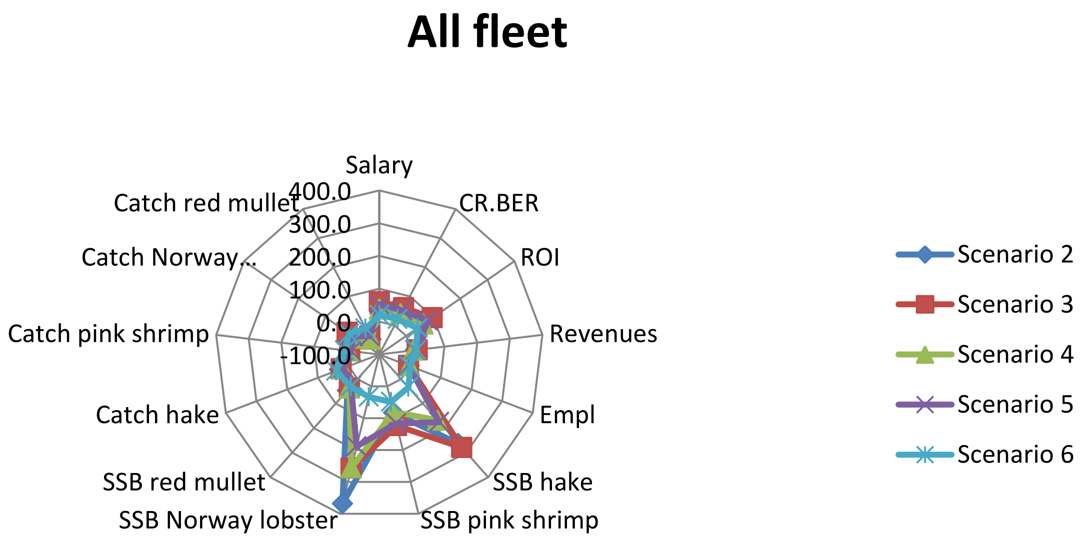


Figure 2.9.10.1 Radar plot for all the fleet. Each line represents a scenario and each point the corresponding percentage of each indicators respect to status quo.

Table 2.9.10.1 - Performances of the simulated management scenarios (% respect to status quo) in terms of SSB and overall catches of European hake, deep water rose shrimp, red mullet and Norway lobster, salary, CR/BER, employment and revenues. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment. The baseline of 2014 is also reported. The values of the fishing mortality F by target stock are reported by scenario and by target year; in case the target year is 2020 also the value of 2018 is reported in parenthesis. For the baseline F is reported. SQ= Status quo. GSA18.

Demersal species in GSA 18	**ALL fleets**																
Scenario, year 2021	Salary (euros)	CR.BER (ratio)	ROI	Rev. (Keuros)	Emp. (units)	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Catch European hake (tons)	Catch deep water rose shrimp (tons)	Catch Norway lobster (tons)	Catch red mullet (tons)	F European hake	F deep water rose shrimp	F Norway lobster	F red mullet
SQ (values in 2014 – baseline year)	8487	2.98	0.575	135151	3350	3470	745	627	5460	3407	1233	634	1665	0.72	1.31	0.8	0.32
Scenario 1 (values in 2021)	7530	2.561	0.453	122767	3276	3742	778	496	7120	2612	1307	518	1646	0.72	1.31	0.8	0.32
Scenario 2	47.0	50.7	79.3	11.6	-2.4	262	83	368	46	29.3	-4.7	11.9	-47.5	0.34	0.74	0.23	0.13
Scenario 3	60.9	60.7	96.3	16.2	-4.1	278	124	256	37	24.0	-10.3	19.1	-37.1	0.31	0.53	0.31	0.16
Scenario 4	38.6	39.7	62.7	5.5	-2.4	167	79	256	37	20.3	-6.6	-14.0	-47.7	0.33 (2018) 0.48	0.74 (2018) 0.97	0.23 (2018) 0.45	0.13 (2018) 0.21
Scenario 5	52.8	51.2	80.1	10.8	-4.1	175	116	188	29	16.3	-13.6	-2.7	-37.5	0.31 (2018) 0.47	0.53 (2018) 0.85	0.31 (2018) 0.5	0.16 (2018) 0.23
Scenario 6	21.0	21.6	41.7	13.5	0.0	33	48	33	31	40.3	5.6	11.3	-10.3	0.73	1.16	0.75	0.21

Table 2.9.10.2 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of European hake, deep water rose shrimp, red mullet and Norway lobster, salary, CR/BER, employment and revenues by fleet segment (ITA_DTS_0612, ITA_DTS_1218, ITA_DTS_1840, ITA_HOK_1218 fleet segments). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment.

Fleet segment	ITA_DTS_0612								ITA_DTS_1218							
	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)
SQ (values in 2014 – baseline year)	18720	9.14	5242	70	45	0	1	156	19750	6.25	66490	708	1475	401	407	911
Scenario 1 (values in 2021)	21276	11.67	6504	78	40	0	1	216	21888	5.44	60576	574	1300	473	260	982
Scenario 2	-46.0	-46.5	-52.0	-7.7	-19.9		3.8	-61.2	4.0	4.2	-21.6	-7.7	-20.8	-49.1	11.0	-63.4
Scenario 3	57.7	58.4	52.6	0.0	188.6		188.8	30.8	22.2	23.6	-5.3	-6.5	11.4	-14.7	17.9	-51.5
Scenario 4	-47.2	-47.8	-53.1	-7.7	-24.1		-22.5	-61.7	-1.3	-1.4	-25.2	-7.7	-23.5	-50.2	-14.5	-63.5
Scenario 5	53.6	54.2	48.8	0.0	170.9		129.9	29.4	16.7	17.7	-9.1	-6.5	6.4	-17.8	-3.5	-51.6
Scenario 6	6.7	6.8	6.1	0.0	41.1		9.2	-0.6	10.0	10.6	7.4	0.0	39.1	3.8	10.3	-14.8
Fleet segment	ITA_DTS_1824_2440								ITA_HOK_1218							
	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)
SQ (values in 2014 – baseline year)	17377	1.55	28586	368	859	332	426	136	3891	2.80	3813	147	151			
Scenario 1 (values in 2021)	11444	1.00	22621	380	755	400	259	153	4729	3.20	4131	135	166			
Scenario 2	42.1	46.8	-15.2	-7.7	-20.4	-49.2	12.6	-60.8	385.0	430.1	283.4	0.0	338.1			
Scenario 3	61.8	68.8	0.6	-6.5	11.7	-15.1	19.6	-49.0	128.1	143.1	67.2	-6.5	77.2			
Scenario 4	31.4	35.0	-20.6	-7.7	-23.5	-50.4	-13.7	-61.5	291.9	326.0	214.8	0.0	253.3			
Scenario 5	51.1	56.9	-4.9	-6.5	6.3	-18.5	-2.6	-49.7	82.3	91.9	35.7	-6.5	40.5			
Scenario 6	18.7	20.9	10.3	0.0	39.6	2.8	11.9	0.5	65.3	73.0	48.1	0.0	54.6			

Table 2.9.10.3 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of European hake, deep water rose shrimp, red mullet and Norway lobster, salary, CR/BER, employment and revenues by fleet segment (ITA_PGP_0006_0612, ALB_DTS_1224, MNE_DFN_0012, MNE_DTS_0612 fleet segments). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment.

Fleet segment	ITA_PGP_0006_0612								ALB_DTS_1224							
	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)
SQ (values in 2014 – baseline year)	5012	1.45	17923	866	36			47	1460	1.06	10692	1026	280	335	0	247
Scenario 1 (values in 2021)	3805	1.19	15887	962	27			47	1474	1.03	10544	984	272	403	0	200
Scenario 2	143.5	158.2	94.5	0.0	225.5			22.7	167.3	180.5	45.1	0.0	179.3	83.8		
Scenario 3	145.4	160.2	95.7	0.0	235.4			19.1	138.3	149.3	-11.5	-6.5	11.4	-12.4		
Scenario 4	136.7	150.7	90.0	0.0	213.6			22.2	166.4	179.6	44.9	0.0	170.8	80.3		
Scenario 5	136.5	150.5	89.9	0.0	219.4			18.7	132.7	143.2	-13.0	-6.5	6.9	-15.3		
Scenario 6	58.6	64.6	38.6	0.0	60.6			26.9	22.1	23.8	6.0	0.0	38.9	9.6		
Fleet segment	MNE_DFN_0012								MNE_DTS_0612							
	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Salary	CR.BER	Rev.	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)
SQ (values in 2014 – baseline year)	959	14.63	789	97	3			4	4564	4.67	132	5	5	4		5
Scenario 1 (values in 2021)	1102	16.31	864	94	2			4	5518	4.55	133	4	5	5		4
Scenario 2	121.8	137.0	104.3	0.0	242.7			22.1	73.0	83.1	46.6	0.0	179.3	83.8		

Scenario 3	124.5	140.0	106.6	0.0	254.9			18.5	84.4	96.0	53.8	0.0	187.0	125.8		
Scenario 4	105.8	118.9	90.6	0.0	206.6			21.6	72.6	82.6	46.3	0.0	170.8	80.3		
Scenario 5	106.1	119.4	90.9	0.0	213.2			18.1	83.0	94.5	53.0	0.0	175.5	118.3		
Scenario 6	42.6	47.9	36.5	0.0	57.2			24.6	11.3	12.8	7.2	0.0	38.9	9.6		

Table 2.9.10.4 Performances of the management scenarios (% respect to status quo) simulated in terms of catches of European hake, deep water rose shrimp, red mullet and Norway lobster, salary, CR/BER, employment and revenues by fleet segment MNE_DTS_1224 and MNE_HOK_0012). The green values are higher than +5%, the red ones are the smaller than -5% and the yellow ones are between -5% and +5%. Rev=Revenues; Emp=Employment.

Fleet segment	MNE_DTS_1224								MNE_HOK_0012							
	Salary	CR.BER	Revenues	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)	Salary	CR.BER	Revenues	Empl	SSB European hake (tons)	SSB deep water rose shrimp (tons)	SSB Norway lobster (tons)	SSB red mullet (tons)
SQ (values in 2014 – baseline year)	4157	2.47	1147	39	37	24		36	2361	5.46	338	24	4			
Scenario 1 (values in 2021)	4054	2.47	1143	39	36	29		29	2393	6.53	366	26	4			
Scenario 2	81.0	119.5	46.7	0.0	179.3	83.8		28.0	450.2	703.9	306.5	0.0	320.1			
Scenario 3	92.2	136.1	53.2	0.0	187.0	125.8		24.0	476.2	744.5	324.2	0.0	338.7			
Scenario 4	80.5	118.9	46.4	0.0	170.8	80.3		27.8	329.6	515.4	224.4	0.0	233.7			
Scenario 5	90.8	134.0	52.3	0.0	175.5	118.3		23.8	342.3	535.2	233.0	0.0	242.8			
Scenario 6	12.2	18.0	7.0	0.0	38.9	9.6		-11.6	75.8	118.4	51.6	0.0	53.3			

The BEMTOOL option aimed at comparing the outputs of the different scenarios, i.e. the Multi-Criteria Decision Analysis that combines Multi-Attribute Utility Theory (MAUT) and the Analytic Hierarchy Process(AHP), has been used to assess the performances of the alternative fisheries management policies (Rossetto et al., 2015).

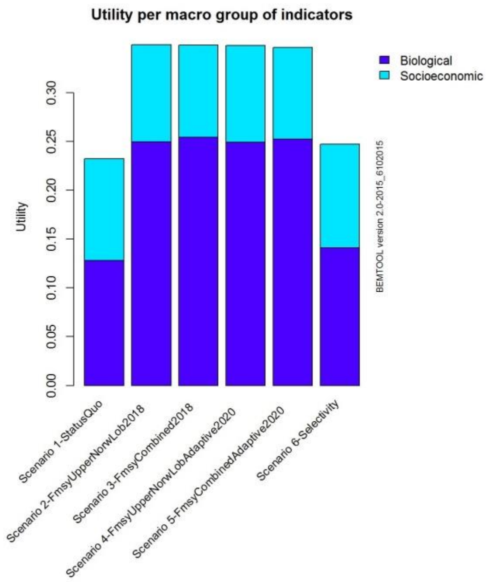
The eight indicators used in the analysis are listed in table 2.9.10.5, along with the weighting set used to calculate the overall utility associated to each scenario. The value of the indicators in the last year of simulation (2014) is referred to as the 'current condition'. The performance of a scenario with respect to a specific objective is calculated as the value of the relevant indicator in 2021.

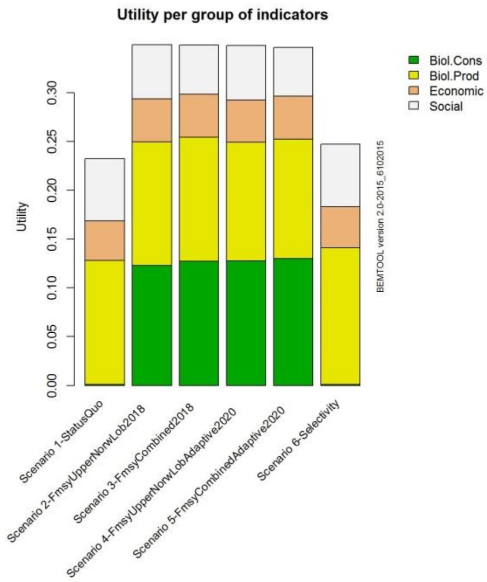
Table 2.9.10.5 Summary of the indicators used in the MCDA

Top level hierarchy	Low level hierarchy	Indicator*	Weight
Socioeconomic	Economic	GVA, ROI or Profit	0.0080
Socioeconomic	Economic	CR.BER	0.0421
Socioeconomic	Social	EMP.	0.1914
Socioeconomic	Social	Salary	0.0641
Biological	Biological conservation	SSB	0.2605
Biological	Biological conservation	F	0.2605
Biological	Biological production	Landing	0.1373
Biological	Biological production	D	0.0361

* GVA: Gross Value Added; ROI: Return On Investment; CR.BER: Ratio of Revenues to Break-even revenues; Salary: Average wage; EMP: Employment; SSB: Spawning Stock Biomass; F: Fishing mortality; Y: Landing; D: Discard rate.

According to MCDA (Fig. 2.9.10.5), all the scenarios allow to reach the same overall utility (overall utility about 0.34), except for Scenario 6 with the lowest utility (0.25), as the status quo (0.25).





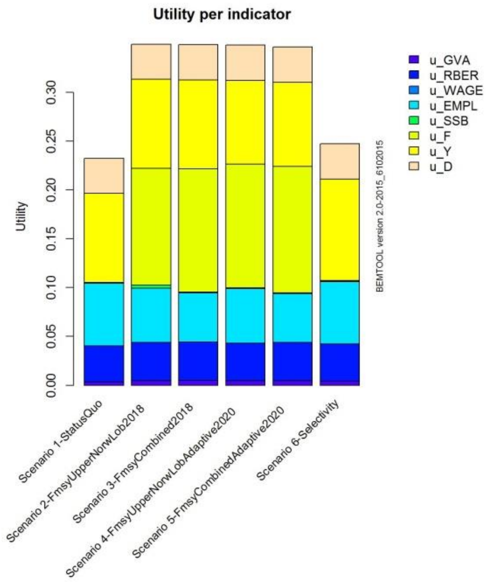


Figure 2.9.10.5 MCDA results: evaluation of the overall utility associated to each management scenario.

2.9.11 DISCUSSION AND CONCLUSION ON DEMERSAL CASE STUDY IN GSA18

The projections performed with BEMTOOL model showed that all the performed scenarios allow to obtain a benefit on the SSB for the 4 stocks under consideration respect to the status quo; on an overall basis, the best performing scenarios are the ones characterized by the strongest reduction in the shortest timeframe. In addition, the rebuilding of stocks such as European hake and Norway lobster would mitigate the situation of losses of stocks such as deep water pink shrimp and red mullet that will be underutilized.

Under the economic viewpoint and considering the overall fleet, revenues are highest for Scenario 3, while the lowest value is given by the Scenario 4. The overall economic performance is improving if salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping.

On an overall basis, the scenarios better performing seem Scenario 2, followed by Scenario 3, that allows to obtain a quite stable trade off among the different indicators, when considered having all the same weight. A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that all the scenarios allow to reach the same overall utility (overall utility about 0.34), except for Scenario 6 with the lowest utility (0.25), as the status quo. These results seems to confirm the higher efficiency when the management measure is applied in a shortest timeframe.

However it should be considered that Italian trawlers are expected to have a performance worse than status quo in Scenario 2 and 4, in particular all these fleet segments will have a severe reduction of revenues, till -50% for the fleet ITA_DTS_0612, because its catches are probably less compensated by the rebuilding of hake and Norway lobster stocks, compared to the losses of catches for red mullet and pink water deep shrimp. The losses of revenues for the fleets ITA_DTS_1218 and ITA_DTS_1824_2440 will be more limited compared to the fleet ITA_DTS_0612, but however in the order of -20%. Only the fleet ITA_DTS_1824_2440 is expected to see an improvement of salary and CR/BER, given the likely compensation due to the improvement of catches deriving from the rebuilding of stocks as hake and Norway lobster.

ANNEX H –INPUTS FOR MODELLING DEMERSAL FISHERIES IN GSA18

H.1 INPUT OF THE BIOLOGICAL MODULE OF DEMERSAL FISHERIES IN GSA18

The data used for the parameterization of the biological and the pressure module *P. longirostris* come from the stock assessment carried out during the Working Group on Stock Assessment of Demersal Species (GFCM-WGSADS report) held in November 2014. The input for biological and pressure modules for *N. norvegicus* are from the STECF Expert Working Group EWG 14-19 held in January 2015. For *M. merluccius* the stock assessment developed with ADRIAMED demersal working group held in 2015 has been used, while for M. barbatus the stock assessment performed on the GFCM ADRIAMED 2015 working group and presented at GFCM WGSAD in November 2015 has been used.

The methodologies used for the assessment are Extended Survivor Analyses (XSA, Darby and Flatman, 1994) for all the stocks.

The assessments of *M. merluccius*,*P. longirostris* and *M. barbatus* cover the whole GSA18, combining data from Italy, Albania and Montenegro.

GROWTH PARAMETERS OF DEMERSAL IN GSA18

The growth parameters and the length-weight relationship coefficients for the four species are listed in tables.

The life span has been set equal to 15 years for European hake and Norway lobster, to 4 years for deep-water pink shrimp and 7 for red mullet.

Table H.1.1 - Growth parameters for European hake in GSA 18.

Parameter	European hake Sex combined	Red mullet Sex combined	deep-water pink shrimp Sex combined	Norway lobster Females	Norway lobster Males
Linf (mm)	1040	300	45	61	80
K	0.2	0.4	0.6	0.17	0.18
t_0	-0.1	-0.3	-0.2	-0.5	-0.5
a (mm/g)	0.00000301	0.00000638	0.003409	0.0006	0.0004
b (mm/g)	3.1553	3.1134	2.434	3.0576	3.1323

RECRUITMENT OF DEMERSAL IN GSA18

For all the stocks a reliable stock recruitment relationship is not available, given also the shortness of the time series. For this reason a recruitment vector has been used for the simulation (past and present time) and a constant value for the projections.

M. merluccius

The recruitment figures of European hake from the stock assessment results were related to age 0 and are from XSA results. The age of recruitment has been set equal to 2 months.

The recruitment figures of red mullet from the stock assessment results were related to age 0 and were from XSA results. A process of calibration has been applied to the recruitment from XSA on the basis of observed landing. The age of recruitment has been set equal to 3 months.

The recruitment figures of deep water rose shrimp from the stock assessment results were related to age 0 and are from XSA results. The age of recruitment has been set equal to 0 months.

The recruitment figures of Norway lobster from the stock assessment results were related to age 1 (being not much representative the individuals of age 0 in the catches) and from XSA results. The recruitment of 2011 has been rescaled with a factor 0.85 as it was more consistent with the shape of production trend. The age of recruitment has been set equal to 16 months.

Table H.1.2 - Recruitment by year by year used in simulation phase European hake in GSA 18.

Year	R (thousands)			
	European hake	Red mullet	pink shrimp	Norway lobster
2007	238060	155965	730 047	97 020
2008	183211	112920	748 124	66 445
2009	171632	109665	806 637	66 963
2010	174251	149919	714 594	49 477
2011	115997	216661	481 417	42 941
2012	173821	280816	555 999	33 924
2013	90732	235205	714 582	36 058
2014	90732*	235205*	714 582*	36 058*

* This value has been assumed equal to 2013

The number of recruits of European hake entering in the population has been monthly split in order to take into account the seasonal recruitment, according to the characteristics of this species recruiting more in spring and autumn (Tab. H.I.3).

The number of recruits of red mullet entering in the population has been monthly split in order to take into account the seasonal recruitment, according to the characteristics of this species to recruit more from May to September.

The number of recruits of deep water rose shrimp entering in the population has been monthly split in order to take into account the seasonal recruitment, according to the characteristics of this species recruiting more from April to October.

The number of recruits of Norway lobster entering in the population has been monthly split in order to take into account the seasonal recruitment, according to the characteristics of this species to recruit more from May to August.

Table H.1.3 - Proportions of recruits of the assessed species entering by year and month in the simulated population in GSA 18.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
European hake	0.05	0.05	0.15	0.15	0.05	0.05	0	0	0.15	0.15	0.1	0.1
Red mullet	0	0	0	0	0.05	0.3	0.3	0.3	0.05	0	0	0
Deep water rose shrimp	0	0	0	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0	0
Norway lobster	0	0	0	0	0.1	0.4	0.4	0.1	0	0	0	0

MATURITY AND SEX RATIO OF DEMERSAL IN GSA18

The size at first maturity (Lm50%) and maturity range by species are reported in the table below. These parameters have been estimated within DCF on biological sampling data.

Table H.1.4 - Maturity parameters for the 4 stocks in demersal fisheries GSA 18 case study

Length in mm	**Lm50%**			**MR =Lm75%-Lm25%**		
Species	**Males**	**Females**	**Combined**	**Males**	**Females**	**Combined**
M. merluccius			333			36
N. norvegicus	29.4	23.8		1	2	
P. longirostris			17			2.4
M. barbatus			110			7.5

NATURAL MORTALITY OF DEMERSAL IN GSA18

The natural mortality at age was estimated using the Prodbiom method (Abella et al., 1997). In the following tables the natural mortality rates by age class for the 4 stocks are reported.

Table H.1.5 - Natural mortality for hake in GSA 18.

Age	M			
	European hake	Red mullet	Norway lobster	Deep water rose shrimp
0	1.25	1.03	0.24	1.41
1	0.53	0.71	0.2	0.81
2	0.40	0.65	0.19	0.7
3	0.35	0.62	0.18	0.65
4	0.32	0.62	0.17	0.65
5	0.30	0.62	0.16	
6	0.29	0.62	0.16	
7	0.28		0.16	
8	0.27		0.16	
From 9 to 15	0.26		0.16	

TOTAL MORTALITY OF DEMERSAL IN GSA18

The total mortality for the 4 stocks has been derived from the overall fishing mortality reported in the next paragraph (INPUT OF THE PRESSURE MODULE).

Table H.1.6 - Total mortality for hake in GSA 18.

Stock	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
M. merluccius	1.97	2.03	2	2.06	2.26	1.87	1.72
P. longirostris	2.14	2.17	2.1	2.29	2.59	2.39	2.59

N. norvegicus	1.12	1	1.02	1.07	1.02	0.67	1.02
M. barbatus	1.43	1.1	1.2	1.03	0.92	1.5	1.2

For 2014 the same total mortality of 2013 has been assumed.

H.2 INPUT OF THE PRESSURE MODULE OF DEMERSAL FISHERIES IN GSA18

The Z-mode of ALADYM model has been used in BEMTOOL for all the stocks

FISHING MORTALITY OF DEMERSAL IN GSA18

M. merluccius

The overall fishing mortality by year and age from XSA model for hake have been split according to the proportions in weight in the landing of the different fleet segments. For 2014 the same fishing mortality as 2013 has been assumed. The age range used for calculation of average F for hake was 0-5.

Table H.2.1 - Overall fishing mortality for hake in GSA 18 (XSA model).

age	2007	2008	2009	2010	2011	2012	2013
0	0.43	0.29	0.34	0.35	0.41	0.58	0.46
1	2.66	2.64	2.52	2.45	2.78	2.15	2.23
2	0.56	0.71	0.76	0.95	1.02	0.86	0.48
3	0.30	0.60	0.44	0.64	0.59	0.86	0.22
4	0.92	0.63	0.35	0.70	0.39	0.22	0.29
5	0.21	0.62	0.73	0.35	1.57	0.34	0.14
6+	0.21	0.62	0.73	0.35	1.57	0.34	0.14

P. longirostris

The overall fishing mortality for pink shrimp by year and age from XSA model have been split according to the proportions in weight in the landing of the different fleet segments. For 2014 the same fishing mortality as 2013 has been assumed. The age range used for calculation of average F for deep-water pink shrimp was 0-2.

Table H.2.2 - Overall fishing mortality for deep water rose shrimp in GSA 18 (XSA model).

Age	2007	2008	2009	2010	2011	2012	2013
0	0.252	0.255	0.229	0.255	0.301	0.298	0.323
1	2.177	2.335	2.122	2.463	2.997	2.616	3.005
2	1.282	1.230	1.246	1.460	1.768	1.566	1.749
3+	1.282	1.230	1.246	1.460	1.768	1.566	1.749

N. norvegicus

The overall fishing mortality for Norway lobster by year and age from XSA model have been split according to the proportions in weight in the landing of the different fleet segments. For 2014 the same fishing mortality as 2013 has been assumed. The age range used for calculation of average F for Norway lobster was 1-6.

Table H.2.3 - Overall fishing mortality for Norway lobster in GSA 18 (XSA model).

age	2007	2008	2009	2010	2011	2012	2013
1	0.401	0.182	0.289	0.223	0.202	0.238	0.137
2	1.110	0.887	0.860	0.873	0.826	0.489	0.850
3	1.166	1.052	1.183	1.122	1.152	0.611	1.108
4	1.195	0.931	1.118	1.165	1.119	0.614	1.118
5	0.877	1.161	0.872	1.129	0.928	0.550	1.001
6+	0.923	0.774	0.807	0.871	0.845	0.491	0.891

M. barbatus

The overall fishing mortality for red mullet by year and age from XSA model have been split according to the proportions in weight in the landing of the different fleet segments, assuming that the selectivity of the Eastern side of GSA 18 is the same as Western side. For 2014 the same fishing mortality of 2013 has been assumed. The age range used for the calculation of average F for red mullet was 0-2.

Table H.2.4 - Overall fishing mortality for red mullet in GSA 18 (XSA model).

Age	2007	2008	2009	2010	2011	2012	2013
0	0.29	0.12	0.20	0.14	0.04	0.63	0.18
1	0.55	0.60	0.81	0.56	0.22	0.71	0.62
2	1.38	0.51	0.51	0.32	0.43	0.81	0.36
3+	1.38	0.51	0.51	0.32	0.43	0.81	0.36

SELECTIVITY TABLE OF DEMERSAL IN GSA 18

In the following tables for each fleet segment the selectivity used for the modelization of the past/present and future are reported and in case of trawlers the parameters of the different forecast scenarios are specified.

Table H.2.5 – Selectivity for hake in GSA 18 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
ITA18_DTS_0612	2007-2010	Ogive with deselection	89.1	8	500
	2011-2014	Ogive with deselection	117.4	10	500
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500
	2015-2021 (Selectivity)	Ogive with deselection	182.2	10	500
ITA18_DTS_1218	2007-2010	Ogive with deselection	89.1	8	500
	2011-2014	Ogive with deselection	117.4	10	500
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500
	2015-2021 (Selectivity)	Ogive with deselection	182.2	10	500
ITA18_DTS_1824_2440	2007-2010	Ogive with deselection	89.1	8	500
	2011-2014	Ogive with deselection	117.4	10	500
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation2
	2015-2021 (Selectivity)	Ogive with deselection	182.2	10	500
ITA18_HOK_1218 *	2007-2014	Normal	469	165	
	2015-2021	Normal	445	165	
ITA18_PGP_0006_061	2007-2021	Normal	350	150	
ALB18_DTS_1224	2007-2010	Ogive with deselection	89.1	8	500
	2011-2014	Ogive with deselection	117.4	10	470
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500
	2015-2021 (Selectivity)	Ogive with deselection	182.2	10	500
MNE18_DFN_0012	2007-2021	Normal	350	150	
MNE18_DTS_0612	2007-2012	Ogive with deselection	89.1	8	500
	2013-2014	Ogive with deselection	117.4	9	450
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500
	2015-2021 (selectivity)	Ogive with deselection	182.2	10	500
MNE18_DTS_1224	2007-2012	Ogive with deselection	89.1	8	500
	2013-2014	Ogive with deselection	117.4	9	450
	2015-2021 (StatusQuo)	Ogive with deselection	117.4	10	500
	2015-2021 (selectivity)	Ogive with deselection	182.2	10	500
MNE18_HOK_0012 *	2007-2014	Normal	469	185	
	2015-2021	Normal	445	185	

*In the selectivity function used for Italian hook, the Mean varies in the years according the mean size in the observed data: in the table is reported the average (on the values between 445 and 515 mm). The same selectivity has been assumed for the Montenegrin hook.

Table H.2.6 – Selectivity for deep water pink shrimp in GSA 18 (length in mm).

Fleet segment	Period	Model	L50	SR
ITA18_DTS_0612, ITA18_DTS_1218, ITA18_DTS_1824_2440, ALB18_DTS_1224	2007-2010	Classical ogive	12.1	4
	2011-2014	Classical ogive	16	5
	2015-2021 (Status Quo)	Classical ogive	16	5
	2015-2021 (selectivity)	Classical ogive	20.5	4.2
MNE18_DTS_0612, MNE18_DTS_1224	2007-2012	Classical ogive	12.1	4
	2013-2014	Classical ogive	16	5
	2015-2021 (StatusQuo)	Classical ogive	16	5
	2015-2021 (selectivity)	Classical ogive	20.5	4.2

Table H.2.7 – Selectivity for Norway lobster in GSA 18 (length in mm).

Fleet segment	Period	Model	L50	SR
ITA18_DTS_0612	2007-2010	Classical ogive	14.87	5
	2011-2014	Classical ogive	17.94	6
	2015-2021 (StatusQuo)	Classical ogive	17.94	6
	2015-2021 (Selectivity)	Classical ogive	23.7	8
ITA18_DTS_1218	2007-2010	Classical ogive	14.87	5
	2011-2014	Classical ogive	18.72	6
	2015-2021 (StatusQuo - DM50)	Classical ogive	18.72	6
	2015-2021 (Selectivity)	Classical ogive	23.7	8

Fleet segment	Period	Model	L50	SR
ITA18_DTS_1824_2440	2007-2010	Classical ogive	14.87	5
	2011-2014	Classical ogive	18.72	6
	2015-2021 (StatusQuo)	Classical ogive	18.72	6
	2015-2021 (Selectivity)	Classical ogive	23.7	8

Table H.2.8 – Selectivity for red mullet in GSA 18 (length in mm).

Fleet segment	Period	Model	L50 or Mean	SR or Standard Deviation	DSL50% or Standard deviation 2
ITA18_DTS_0612	2007-2010	Ogive with deselection	73	4	258
	2011-2014	Ogive with deselection	88	3	238
	2015-2021 (StatusQuo)	Ogive with deselection	93*	1	220
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	220
ITA18_DTS_1218	2007-2010	Ogive with deselection	74	3	240
	2011-2014	Ogive with deselection	89	2	225
	2015-2021 (StatusQuo)	Ogive with deselection	90*	1	200
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	200
ITA18_DTS_1824_2440	2007-2010	Ogive with deselection	74	3	230
	2011-2014	Ogive with deselection	87	4	238
	2015-2021 (StatusQuo)	Ogive with deselection	88*	54	230
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	230
ITA18_PGP_0006_0612	2007-2014	Normal	110	45	
	2015-2021	Normal	110	45	
ALB18_DTS_1224	2007-2010	Ogive with deselection	98	4	186
	2011-2014	Ogive with deselection	117	3	180
	2015-2021 (StatusQuo)	Ogive with deselection	117	3	180
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	180
MNE18_DTS_0612	2007-2010	Ogive with deselection	98	4	186
	2011-2014	Ogive with deselection	117	3	180
	2015-2021 (StatusQuo)	Ogive with deselection	117	3	180
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	180
MNE18_DTS_1224	2007-2010	Ogive with deselection	98	4	186
	2011-2014	Ogive with deselection	117	3	180
	2015-2021 (StatusQuo)	Ogive with deselection	117	3	180
	2015-2021 (Selectivity)	Ogive with deselection	141.5	3.7	180
MNE18_DFN_0012	2007-2014	Normal	120	40	
	2015-2021	Normal	120	40	

* the parameters used for the projections are those used in 2014, while the values reported for 2011-2014 are mean values on the years.

EFFORT OF DEMERSAL FISHERIES IN GSA18

The monthly effort variables used to simulate the past and current years by fleet segment are listed in the following table H.2.9. For 2014 the same effort as 2013 has been assumed.

Table H.2.9 - Effort for the selected fleet segment in GSA 18.

Effort Variable	ITA18_DTS_0612							ITA_18DTS_1218						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	7	7	6	7	6	7	6	18	18	18	19	19	19	19
average monthly KW	58	58	57	57	57	56	56	129	129	130	130	130	131	131
number of vessels	35	35	35	38	38	39	39	325	325	324	299	302	287	287
mean annual fishing	135	135	165	136	100	106	141	140	140	184	162	156	156	171
Effort Variable	**ITA18_DTS_1824_2440**							**ITA18_HOK_1218**						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	62	62	63	64	62	62	62	17	17	18	17	18	19	19
average monthly KW	296	296	297	295	294	290	290	168	168	174	161	173	184	184
number of vessels	117	117	118	120	114	95	95	34	34	33	44	43	27	27
mean annual fishing	163	163	174	161	146	146	156	97	97	98	110	112	96	102
Effort Variable	**ITA18_PGP_0006_0612**							**ALB18_DTS_1224**						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	2	2	2	2	2	2	2	37	37	37	37	37	37	37
average monthly KW	17	17	16	17	17	17	17	232	232	232	232	232	232	232
number of vessels	489	489	486	490	485	477	481	164	164	164	164	164	164	164
mean annual fishing	156	156	167	172	172	151	159	144	144	144	144	144	144	144
Effort Variable	**MNE18_DFN_0012**							**MNE18_DTS_0612**						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	2	2	2	2	2	2	2	13	13	13	13	13	11	11
average monthly KW	29	29	29	29	28	27	23	147	147	147	147	147	130	130
number of vessels	37	37	37	37	38	37	47	3	3	3	3	3	4	4
mean annual fishing	144	144	144	144	144	144	132	60	60	60	60	36	48	48
Effort Variable	**MNE18_DTS_1224**							**MNE18_HOK_0012**						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
average monthly GT	30	30	30	29	27	27	27	2	2	2	2	2	2	3
average monthly KW	167	167	167	187	205	205	205	46	46	46	46	46	43	61
number of vessels	15	15	15	15	13	13	13	10	10	10	10	10	11	13
mean annual fishing	132	132	120	120	96	60	84	48	48	48	48	48	36	132

LANDINGS AND DISCARDS OF DEMERSAL FISHERIES IN GSA 18

Landings were obtained from the data collected and reviewed by the SEDAF project and presented in the *WP2-Collation and review on the main socio-economic information on the main fisheries* deliverable. Also GFCM stock assessment forms have been used as source of information for landings, in particular for Albanian fleet segment. Landing data of 2007 for Italy were obtained from the National Programs of the EU Data Collection Framework.

M. merluccius

The landing data for hake by fleet segment used to parameterize the model are listed in the following table. For 2014 the same landing as 2013 has been assumed.

Table H.2.10 - Landings for hake by fleet segment in GSA 18 (tons).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	26	100	97	84	41	34	45
ITA18_DTS_1218	1326	1782	1774	1902	2120	1631	1475
ITA18_DTS_1824_2440	2145	1761	1677	1411	1152	847	859
ITA18_HOK_1218	607	491	335	463	363	297	151
ITA18_PGP_0006_0612	51	118	223	160	175	295	36
ALB18_DTS_1224	390	390	456	375	402	280	280
MNE18_DFN_0012	1.1	1.1	1.1	1.0	0.9	1.2	3
MNE18_DTS_0612	7	7	6	6	4	5	5
MNE18_DTS_1224	52	52	46	40	33	34	37
MNE18_HOK_0012	0.8	0.8	0.8	0.8	0.8	0.9	4
Total	**4605**	**4702**	**4616**	**4443**	**4290**	**3427**	**2895**

P. longirostris

The landing data for pink shrimp by fleet segment used to parameterize the model are listed in the following table. For 2014 the same landing as 2013 has been assumed.

Table H.2.11 - Landings for pink shrimp by fleet segment in GSA 18 (tons).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	7	14	12	7	6	0	0
ITA18_DTS_1218	439	374	486	439	463	264	401
ITA18_DTS_1824_2440	417	378	441	441	401	259	332
ALB18_DTS_1224	309	309	275	409	328	335	335
MNE18_DTS_0612	5	5	5	5	4	3	4
MNE18_DTS_1224	34	34	31	28	23	19	24
Total	**1211**	**1114**	**1250**	**1329**	**1224**	**880**	**1097**

N. norvegicus

The landing data for Norway lobster by fleet segment used to parameterize the model are listed in table below. For 2014 the same landing as 2013 has been assumed.

Table H.2.12 - Landings for Norway lobster by fleet segment in GSA 18 (tons).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	0	6	16	12	4	0.848	0.85
ITA18_DTS_1218	276	390	464	458	342	186	407
ITA18_DTS_1824_2440	1024	609	613	553	413	271	426
Total	**1300**	**1005**	**1093**	**1023**	**759**	**458**	**834**

M. barbatus

The landing data for red mullet by fleet segment used to parameterize the model are listed in table below. The discard data from DCF have been split according to the proportions of landing by fleet. For 2014 the same landing and discard as 2013 has been assumed.

Table H.2.13 - Landings for red mullet by fleet segment in GSA 18 (tons).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	187	98	92	37	8	356	156
ITA18_DTS_1218	1139	686	655	472	417	1423	911
ITA18_DTS_1824_2440	354	130	208	92	70	308	136
ITA18_PGP_0006_0612	123	47	77	45	38	9	47
ALB18_DTS_1224	171	149	154	90	110	280	247
MNE18_DFN_0012	4	4	4	3	2	3	3
MNE18_DTS _0612	7	7	6	5	4	4	5
MNE18_DTS_1224	52	52	46	41	33	35	35
Total	**2037**	**1173**	**1242**	**785**	**682**	**2418**	**1540**

Total landing

The total landing data by fleet segment used to parameterize the model are listed in the table below. For 2014 the same landings as 2013 has been assumed.

Table H.2.14 - Total landing by fleet segment in GSA 18 (tons).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	615744	615744	857447	686929	246769	629184	773321
ITA18_DTS_1218	7885629	7885629	9723540	8270698	7301481	6747679	10195643
ITA18_DTS_1824_24	5696367	5696367	6308621	5463875	4524591	3516813	4678231
ITA18_HOK_1218	814490	814490	592481	956996	720657	399728	448921
ITA18_PGP_0006_06	2082431	2082431	2382681	1959768	1655646	1460856	2178870
ALB18_DTS_1224	1931100	1931100	1931100	1931100	1931100	1931100	1931100
MNE18_DFN_0012	40900	40900	39966	37620	35641	45112	98661

Fleet segment	2007	2008	2009	2010	2011	2012	2013
MNE18_DTS_0612	24756	24756	24756	24756	15625	16485	21000
MNE18_DTS_1224	243386	243386	242273	229673	179910	133676	170490
MNE18_HOK_0012	12652	12652	10266	10067	10246	10717	47889
Total	19347455	19347455	22113131	19571482	16621666	14891350	20544126

H.3 INPUT OF THE ECONOMIC MODULE DEMERSAL FISHERIES IN GSA 18

Data for the estimation of the socio-economic parameters were obtained from the data collected and reviewed by the SEDAF project and presented in the WP2-*Collation and review on the main socio-economic information on the main fisheries*. Data of 2007 for Italy were obtained from the National Programs of the EU Data Collection Framework.

REVENUES OF DEMERSAL FISHERY IN GSA18

The revenues by fleet segment for hake, deep water pink shrimp, Norway lobster, red mullet and the total revenues are reported in the tables below. In the projections the prices have been modelled according to the revenues and the landings by fleet segment.

M. merluccius

Table H.3.1- Revenues of hake by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	153747	661950	683816	538520	319520	207173	239591
ITA18_DTS_1218	9719703	12899611	12860962	12596042	15532568	11809150	9088955
ITA18_DTS_1824_2440	12768786	10498047	10267345	9582396	8240404	5593675	5449324
ITA18_HOK_1218	4829178	3758971	2463968	3319797	2654494	2177049	965633
ITA18_PGP_0006_0612	350879	854021	1595260	1108433	1219651	2028464	241968
ALB18_DTS_1224			2551966	2006421	2342480	1699976	1566644
MNE18_DFN_0012	6467	6467	6319	5948	5635	7133	15600
MNE18_DTS_0612	28360	28360	25000	22120	22250	23450	30360
MNE18_DTS_1224	207640	207640	183000	161880	162800	171550	222180
MNE18_HOK_0012	6024	6024	4888	4793	4878	5102	22800
Total	**28070784**	**28921091**	**30642524**	**29346350**	**30504680**	**23722722**	**17843055**

P. longirostris

Table H.3.2 - Revenues of deep water pink shrimp by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	45327	123397	116603	59464	44888		
ITA18_DTS_1218	3419357	3111109	4116866	3992087	4357451	2162511	3150100
ITA18_DTS_1824_2440	3170473	2575118	2712769	2576203	2230997	1459994	2189339
ALB18_DTS_1224	1103571	1103571	982157	1314630	1171414	1196443	1435731
MNE18_DTS_0612	38360	38360	35070	31780	30000	27630	35370
MNE18_DTS_1224	234640	234640	214760	194320	183600	169470	216540
Total	**8011728**	**7186195**	**8178225**	**8168484**	**8018350**	**5016048**	**7027080**

N. norvegicus

Table H.3.3 - Revenues of Norway lobster by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612		84250	351617	240113	84430	13147	21499
ITA18_DTS_1218	3887578	5856320	8111656	7937126	5678787	3065829	7092458
ITA18_DTS_1824_2440	14854608	9793585	10569459	9353280	6975577	4565471	7081325
Total	**18742186**	**15734155**	**19032732**	**17530519**	**12738794**	**7644447**	**14195282**

M. barbatus

Table H.3.4 Revenues of red mullet by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	577136	365473	364903	228476	54759	1905951	588059
ITA18_DTS_1218	4782188	3272793	3253069	3448661	3153548	7295214	3864743
ITA18_DTS_1824_2440	1673256	687724	876440	621392	483639	1127748	657021
ITA18_PGP_0006_0612	495230	319969	468141	437355	412881	60706	297872

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ALB18_DTS_1224	955643	831392	864113	482313	642547	1698749	1382927
MNE18_DFN_VL0012	6218	6218	6076	5720	5419	6859	15000
MNE18_DTS _VL0612	17240	17240	16520	15800	14640	20000	20000
MNE18_DTS_VL1224	134760	129080	123400	114560	156500	156500	134760
Total	**8641671**	**5629889**	**5972662**	**5354277**	**4923933**	**12271727**	**6960382**

Total revenues

Table H.3.5 - Total revenues by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	3001552	3648726	5052209	4315292	1776503	3550741	5241690
ITA18_DTS_1218	45109083	49820026	63335208	59143739	51941289	43548673	66490023
ITA18_DTS_1824_2440	49773660	35206146	37796485	35143062	29909888	21833166	28585849
ITA18_HOK_1218	8023505	6062132	4391556	7483942	6061471	3119017	3812736
ITA18_PGP_0006_0612	14512222	15434210	17997073	16365904	14497744	11731366	17922828
ALB18_DTS_1224	10691833	10691833	10691833	10691833	10691833	10691833	10691833
MNE18_DFN_0012	310840	310840	303741	285912	342153	433005	789288
MNE18_DTS_0612	118828	118828	118828	118828	81562	103855	132300
MNE18_DTS_1224	1263876	1263876	1038234	1038234	924003	926284	1146626
MNE18_HOK_0012	101216	101216	82130	80537	81971	99377	337800
Total	**132906615**	**122657833**	**140807297**	**134667283**	**116308417**	**96037317**	**135150973**

PROFIT OF DEMERSAL FISHERIES IN GSA18

In the following table H.3.6 the profit of demersal fishery in GSA17 are preported by fleet segment. These metrics are used for the calculation of the indicator ROI.

Table H.3.6 - Profit by fleet segment in GSA 18 (€).

Fleet segment	2008	2009	2010	2011	2012	2013
ITA_DTS_0612	590759	1347773	893793	-285571	1029771	2941617
ITA18_DTS_1218	5631007	13798829	12809600	6533977	5939172	29321865
ITA18_DTS_1824_2440	1500197	2222336	-157069	-2323750	-4130675	3964434
ITA18_HOK_1218	2260507	760860	2000190	1131030	638907	1208519
ITA18_PGP_0006_0612	3864240	4549155	-1363134	-2082074	-1049071	2314361
ALB18_DTS_1224	68876	68876	68876	68876	68876	68876
MNE18_DFN_0012	22926	16806	-7286	53020	158555	473093
MNE18_DTS_0612	15556	15556	15556	-3610	-13055	44495
MNE18_DTS_1224	-124375	-381628	-287377	-89800	132007	202026
MNE18_HOK_0012	-40642	-53444	-55776	-55789	-45600	81559
Total	13789051	22345119	13917373	2946309	2728887	40620845

COSTS OF DEMERSAL FISHERIES IN GSA18

In the following tables all the data of costs by fleet segment as taken into account in the simulation phase of the case study (past and present years) are reported.

Table H.3.6 - Total variable costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	1678005	1678005	1585531	1625206	1311031	643151	578178
ITA18_DTS_1218	24508782	24508782	20637367	19709251	25366455	22726120	15666826
ITA18_DTS_1824_2440	15013922	15013922	13936511	15346519	13048105	13361661	10154205
ITA18_HOK_1218	1480476	1480476	1075483	1869986	2141063	1084605	1108913
ITA18_PGP_0006_0612	4190678	4190678	3419332	3940417	4513157	3826029	5463445
ALB18_DTS_1224	7760446	7760446	7760446	7760446	7760446	7760446	7760446
MNE18_DFN_0012	117050	117050	116071	122334	116770	115120	117903
MNE18_DTS_0612	49524	49524	49524	49524	31424	51535	45250
MNE18_DTS_1224	824017	824017	855628	804807	533116	313590	483804
MNE18_HOK_0012	37530	37530	31246	31985	33432	32200	113992
Total	55660430	55660430	49467139	51260475	54854999	49914457	41492962

Table H.3.7 - Other variable costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	456323	456323	601279	527753	284646	427450	120216
ITA18_DTS_1218	6462418	6462418	8170908	7177311	6494454	4269565	2249456
ITA18_DTS_1824_2440	3562159	3562159	3795119	3572177	2963867	2344191	846810
ITA18_HOK_1218	592216	592216	517495	813276	800883	435233	351995
ITA18_PGP_0006_0612	1523219	1523219	1577160	1561324	1398982	1241341	1306945
ALB18_DTS_1224	41565	41565	41565	41565	41565	41565	41565
MNE18_DFN_0012	30895	30895	30592	32533	30315	30055	28775
MNE18_DTS_0612	8701	8701	8701	8701	5521	9054	7950
MNE18_DTS_1224	102749	102749	114479	106550	65125	38717	61984
MNE18_HOK_0012	19062	19062	15899	16267	16997	16389	58085
Total	**12799307**	**12799307**	**14873197**	**13857457**	**12102355**	**8853560**	**5073781**

Table H.3.8 - Fuel costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	1221682	1221682	984252	1097453	1026385	215701	457962
ITA18_DTS_1218	18046364	18046364	12466459	12531940	18872001	18456555	13417370
ITA18_DTS_1824_2440	11451763	11451763	10141392	11774342	10084238	11017470	9307395
ITA18_HOK_1218	888260	888260	557988	1056710	1340180	649372	756918
ITA18_PGP_0006_0612	2667459	2667459	1842172	2379093	3114175	2584688	4156500
ALB18_DTS_1224	7718881	7718881	7718881	7718881	7718881	7718881	7718881
MNE18_DFN_0012	86155	86155	85479	89801	86455	85065	89128
MNE18_DTS_0612	40823	40823	40823	40823	25903	42481	37300
MNE18_DTS_1224	721268	721268	741149	698257	467991	274873	421820
MNE18_HOK_0012	18468	18468	15347	15718	16435	15811	55907

Fleet segment	2007	2008	2009	2010	2011	2012	2013
Total	**42861123**	**42861123**	**34593942**	**37403018**	**42752644**	**41060897**	**36419181**

Table H.3.9 - Maintenance costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	115013	115013	114943	123963	113225	124795	49926
ITA18_DTS_1218	1521050	1521050	1513415	1402304	1334177	1263096	1933308
ITA18_DTS_1824_2440	1195323	1195323	1194835	1211051	1161732	972031	814274
ITA18_HOK_1218	252649	252649	252088	336200	337170	156281	251269
ITA18_PGP_0006_0612	869942	869942	869711	875075	800313	698906	630335
ALB18_DTS_1224	106000	106000	106000	106000	106000	106000	106000
MNE18_DFN_0012	67749	67749	67749	67749	68803	61784	70536
MNE18_DTS_0612	6638	6638	6638	6638	6638	7600	7600
MNE18_DTS_1224	202900	202900	202900	193655	170493	170493	161317
MNE18_HOK_0012	45596	45596	45596	45596	45596	49477	67290
Total	**4382860**	**4382860**	**4373875**	**4368231**	**4144147**	**3610463**	**4091855**

Table H.3.10 - Total fixed costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	137945	137945	137595	148393	142725	149389	74896
ITA18_DTS_1218	1902281	1902281	1892330	1753400	1698764	1093381	1207736
ITA18_DTS_1824_2440	1533762	1533762	1534018	1554859	1419262	1248194	687032
ITA18_HOK_1218	169925	169925	170387	227239	231363	84173	222317
ITA18_PGP_0006_0612	661990	661990	666158	670315	656124	406633	729973
ALB18_DTS_1224	28000	28000	28000	28000	28000	28000	28000
MNE18_DFN_0012	17146	17146	17146	17146	17290	15293	17042
MNE18_DTS_0612	3459	3459	3459	3459	3459	3961	3961
MNE18_DTS_1224	71271	71271	71271	66777	65859	65859	58384
MNE18_HOK_0012	5027	5027	5027	5027	5027	5156	8535
Total	**4530806**	**4530806**	**4525391**	**4474615**	**4267873**	**3100039**	**3037876**

Table H.3.11 - Labour costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	863851	863851	1545958	1199638	180961	1296634	1310422
ITA18_DTS_1218	11450780	11450780	19817848	18308466	12229739	8184645	13982843
ITA18_DTS_1824_2440	8303330	8303330	9905317	8186396	6779967	3465103	6394780
ITA18_HOK_1218	1318147	1318147	1424643	2411854	1653157	715997	571910
ITA18_PGP_0006_0612	4145822	4145822	6528796	5703888	4132561	2901013	4340713
ALB18_DTS_1224	1497506	1497506	1497506	1497506	1497506	1497506	1497506
MNE18_DFN_0012	69261	69261	69261	69261	69261	66902	93051
MNE18_DTS_0612	36512	36512	36512	36512	36512	45640	22820
MNE18_DTS_1224	190748	190748	190748	165586	160866	160866	162129
MNE18_HOK_0012	47198	47198	47198	47198	47198	51128	56653
Total	**27923155**	**27923155**	**41063787**	**37626305**	**26787728**	**18385434**	**28432827**

Table H.3.12 - Depreciation costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	252082	252082	283322	297522	286999	283059	245920
ITA18_DTS_1218	4560996	4560996	4872362	4633501	4275580	3919414	3624218
ITA18_DTS_1824_2440	7285371	7285371	7785318	8131889	8879613	6301739	5500316
ITA18_HOK_1218	553440	553440	621428	581475	515835	401831	382866
ITA18_PGP_0006_0612	1628783	1628783	1727541	5939100	5872477	4498694	3686756
ALB18_DTS_1224	1021800	1021800	1021800	1021800	1021800	1021800	1021800
MNE18_DFN_0012	7784	7784	7784	7784	7946	7213	8374
MNE18_DTS_0612	3766	3766	3766	3766	3766	4312	4312
MNE18_DTS_1224	45164	45164	45164	43705	35082	35082	35082
MNE18_HOK_0012	2324	2324	2324	2324	2324	2464	3645
Total	**15361510**	**15361510**	**16370809**	**20662866**	**20901422**	**16475608**	**14513289**

Table H.3.13 - Opportunity costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	11072	11072	37086	26778	27132	23942	40732
ITA18_DTS_1218	245130	245130	803057	527217	502597	422845	753227
ITA18_DTS_1824_2440	374241	374241	1218150	869417	944959	615113	1070808
ITA18_HOK_1218	26988	26988	86667	56998	51853	37223	66942
ITA18_PGP_0006_0612	72755	72755	236380	600243	605186	449162	757245
ALB18_DTS_1224	209205	209205	209205	209205	209205	209205	209205
MNE18_DFN_0012	8924	8924	8924	8924	9063	8138	9289
MNE18_DTS_0612	3373	3373	3373	3373	3373	3862	3862
MNE18_DTS_1224	54151	54151	54151	51081	48387	48387	43884
MNE18_HOK_0012	4183	4183	4183	4183	4183	4552	6126
Total	**1010022**	**1010022**	**2661176**	**2357419**	**2405938**	**1822429**	**2961320**

Table H.3.14 - Total capital costs by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	263153	263153	320409	324299	314132	307001	286651
ITA18_DTS_1218	4806126	4806126	5675419	5160718	4778177	4342259	4377445
ITA18_DTS_1824_2440	7659612	7659612	9003468	9001306	9824572	6916852	6571124
ITA18_HOK_1218	580428	580428	708095	638473	567688	439054	449808
ITA18_PGP_0006_0612	1701538	1701538	1963921	6539343	6477663	4947856	4444001
ALB18_DTS_1224	1231005	1231005	1231005	1231005	1231005	1231005	1231005
MNE18_DFN_0012	16708	16708	16708	16708	17009	15351	17663
MNE18_DTS_0612	7139	7139	7139	7139	7139	8174	8174
MNE18_DTS_1224	99315	99315	99315	94786	83469	83469	78966
MNE18_HOK_0012	6507	6507	6507	6507	6507	7016	9771
Total	**16371531**	**16371531**	**19031986**	**23020284**	**23307361**	**18298037**	**17474608**

Table H.3.15 - Other income by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	283089	283089	85422		146456	130659	
ITA18_DTS_1218	2813976	2813976	1073439		2321762	1812217	
ITA18_DTS_1824_2440	1278598	1278598	647827		1094093	870573	
ITA18_HOK_1218					10309		
ITA18_PGP_0006_0612				18678	19903	11828	
ALB18_DTS_1224							
MNE18_DFN_0012							3200
MNE18_DTS_0612							5000
MNE18_DTS_1224							2000
MNE18_HOK_0012							
Total	**4375663**	**4375663**	**1806688**	**18678**	**3592523**	**2825277**	**10200**

Table H.3.16 - Number of employees by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	74	74	74	73	81	77	70
ITA18_DTS_1218	795	795	853	857	785	708	708
ITA18_DTS_1824_2440	467	467	479	484	422	354	368
ITA18_HOK_1218	150	150	72	73	171	144	147
ITA18_PGP_0006_0612	887	887	879	891	878	844	866
ALB18_DTS_1224	1026	1026	1026	1026	1026	1026	1026
MNE18_DFN_0012	70	70	70	70	70	68	97
MNE18_DTS_0612	8	8	8	8	8	10	5
MNE18_DTS_1224	46	46	46	40	39	39	39
MNE18_HOK_0012	18	18	18	18	18	19	24
Total	**3541**	**3541**	**3525**	**3540**	**3498**	**3289**	**3350**

Table H.3.17 - Capital value by fleet segment in GSA 18 (€).

Fleet segment	2007	2008	2009	2010	2011	2012	2013
ITA18_DTS_0612	971109	971109	1065045	1115014	1107897	1084753	942865
ITA18_DTS_1218	21500849	21500849	23062152	21952973	20522723	19157855	17435809
ITA18_DTS_1824_2440	32825382	32825382	34982768	36201947	38585814	27868937	24787234
ITA18_HOK_1218	2367179	2367179	2488891	2373348	2117330	1686455	1549577
ITA18_PGP_0006_0612	6381493	6381493	6788342	24993712	24711749	20350213	17528820
ALB18_DTS_1224	6640000	6640000	6640000	6640000	6640000	6640000	6640000
MNE18_DFN_0012	230084	230084	230084	230084	232820	222925	264600
MNE18_DTS_0612	82500	82500	82500	82500	82500	110000	110000
MNE18_DTS_1224	1445833	1445833	1445833	1445833	1240833	1240833	1250000
MNE18_HOK_0012	127476	127476	127476	127476	127476	135833	174500
Total	**72571905**	**72571905**	**76913091**	**95162887**	**95369142**	**78497804**	**70683405**

H.4 FITTING OF OBSERVED LANDING DATA AND COMPARISON WITH ASSESSMENT RESULTS

The fitting of the model is quite satisfactory for all the stocks, with an average difference of about 4% by year for hake and for pink shrimp, -7% for Norway lobster and of -1% for red mullet. The differences between simulated and observed data by fleet segment and year in percentage are reported in the figures H.4.1-H.4.4.

The observed landing for 2014 has been assumed equal to 2013.

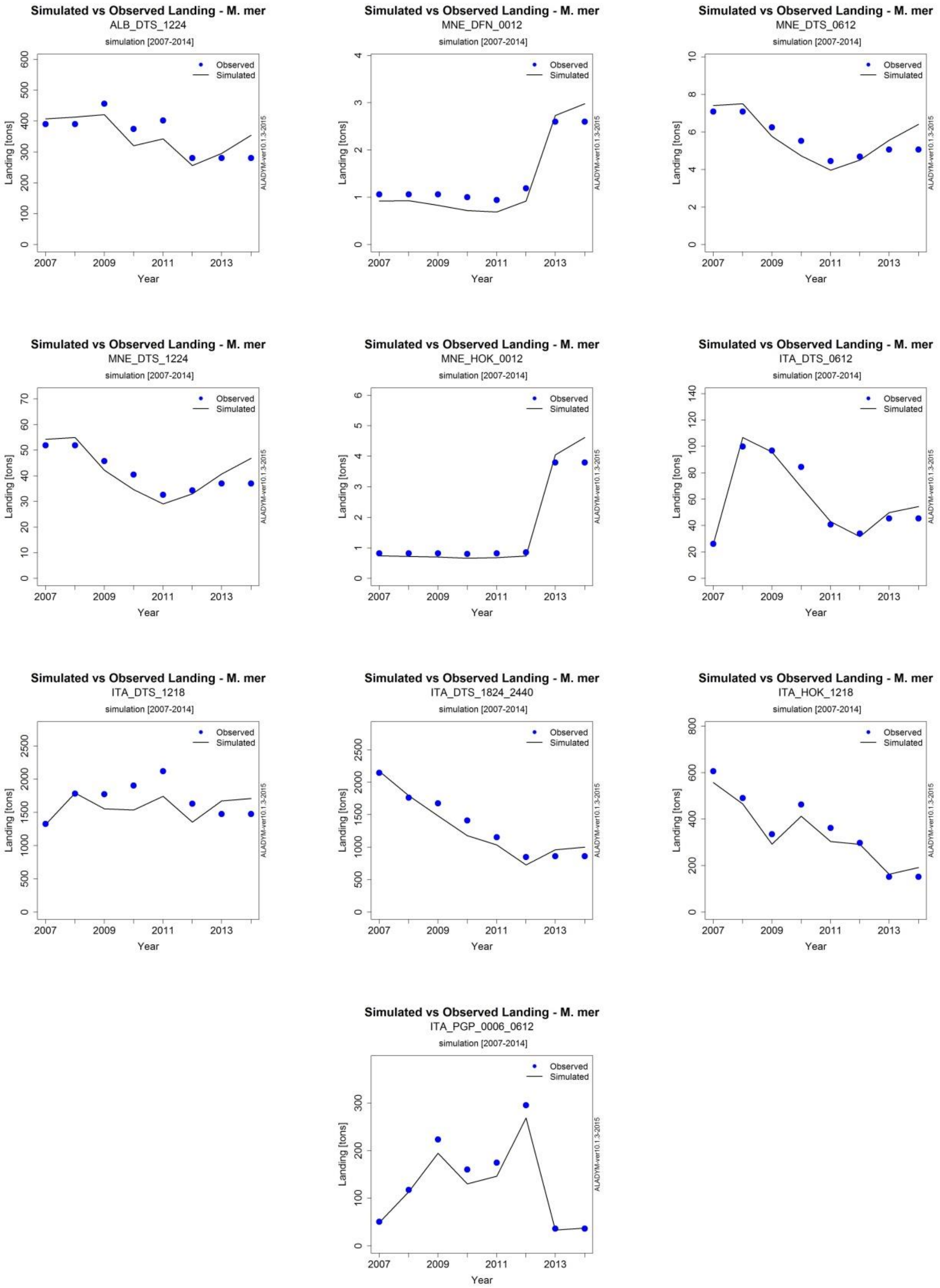


Figure H.4.1 - Comparison between simulated and observed landings by fleet segment for hake in GSA 18. The observed landing for 2014 has been assumed equal to 2013.

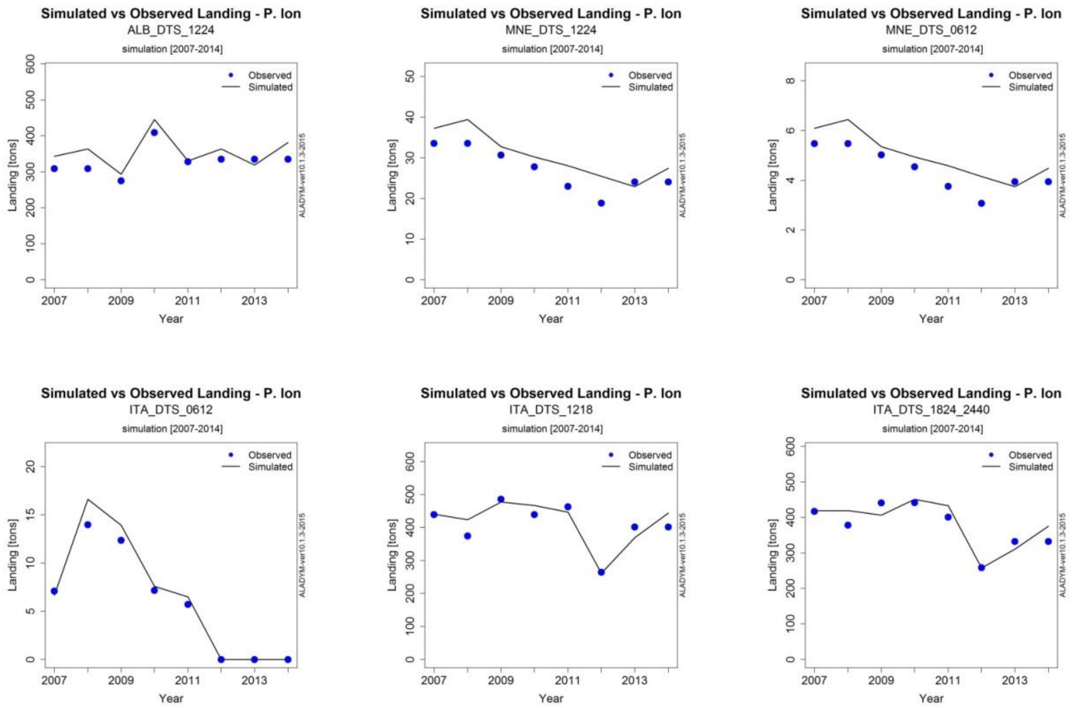


Figure H.4.2 - Comparison between simulated and observed landings by fleet segment for pink shrimp in GSA 18. The observed landing for 2014 has been assumed equal to 2013.

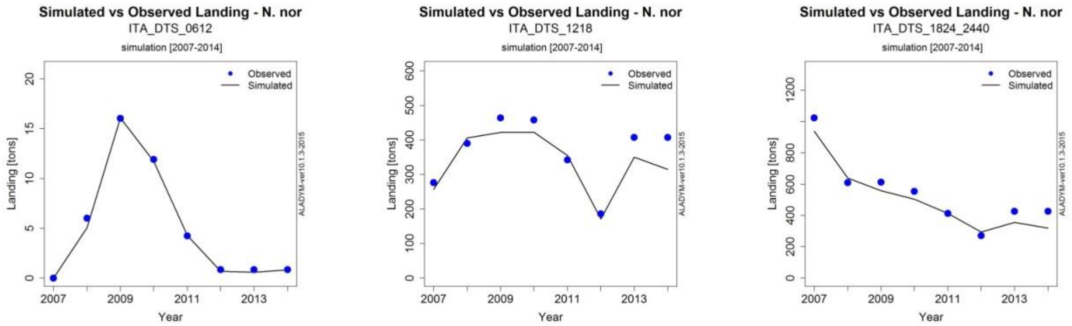


Figure H.4.3 - Comparison between simulated and observed landings by fleet segment for Norway lobster in GSA 18. The observed landing for 2014 has been assumed equal to 2013.

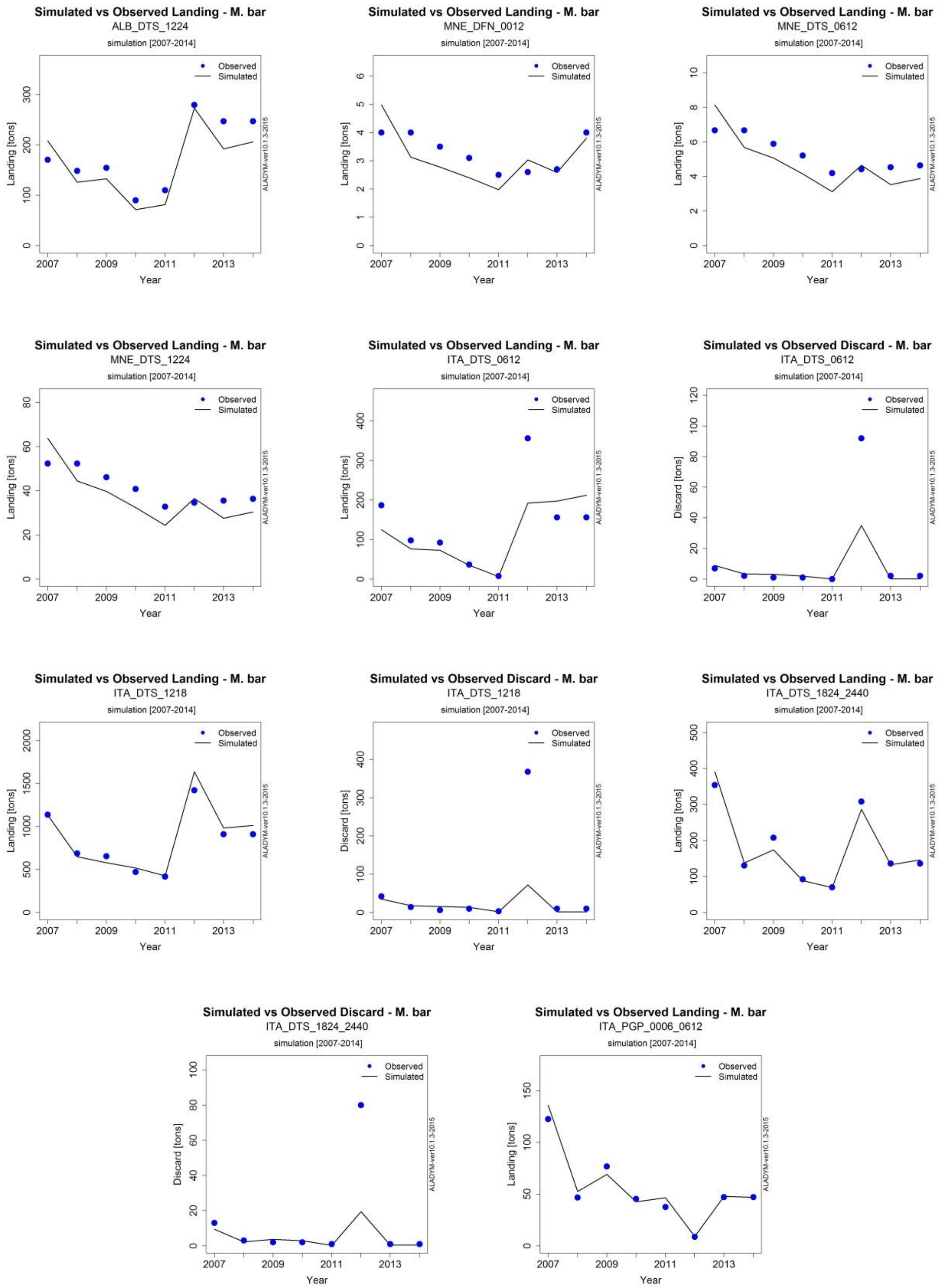


Figure H.4.4 - Comparison between simulated and observed landings and discard by fleet segment for red mullet in GSA 18. The observed landing and discard for 2014 has been assumed equal to 2013.

The comparison between the Spawning Stock Biomass (SSB) from the assessment model and the BEMTOOL simulations are shown in Figure H.4.5.

The simulated SSB of hake in quite close to the one estimated by XSA; as regards deep water pink shrimp, BEMTOOL estimates an SSB much lower than the SSB estimated by XSA (around 1/3): this is due to different time scale of the 2 models (XSA has yearly time scale while BEMTOOL works by month).

Indeed the individual weight of pink shrimp varies considerably especially in the first year of life (from 0.2 g to 7.5 g according to the selected growth parameters), making the approximation of the individual weight at year time scale age class and thus the estimation of SSB in XSA less accurate respect to BEMTOOL. Nevertheless, the general trend is common between the two models.

For Norway lobster and red mullet, the fitting of the SSB is quite satisfactory showing a good level of agreement for estimated SSB between BEMTOOL and XSA.

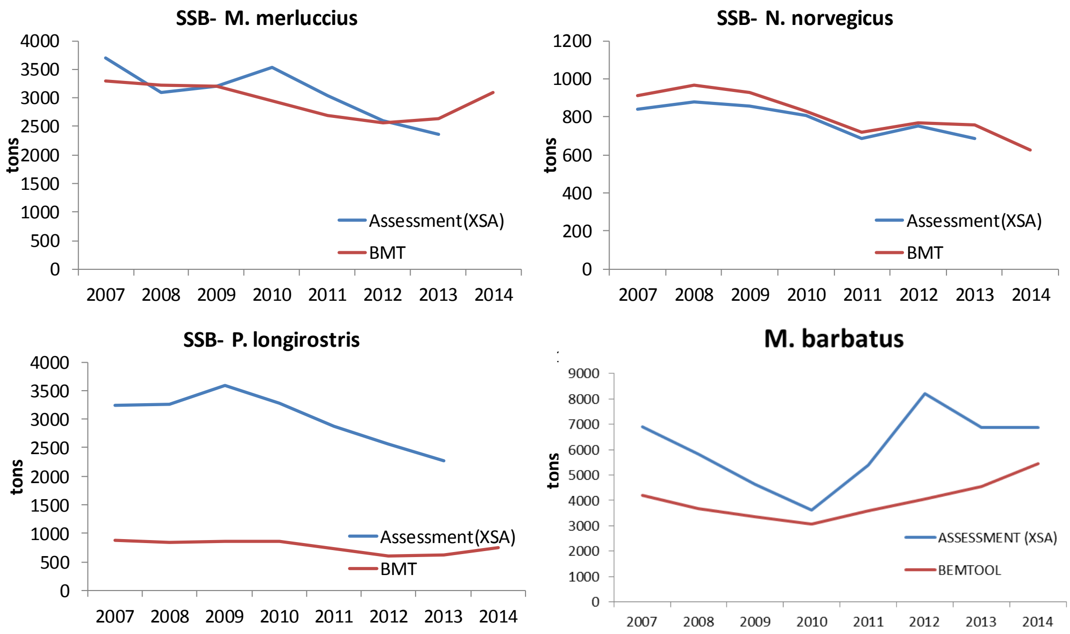


Figure H.4.5 - Comparison between BEMTOOL and stock assessment SSB by fleet segment for the 4 stocks under consideration

H.5 PROJECTIONS OF STATUS QUO WITH UNCERTAINTY ON RECRUITMENT

H.5.1 INPUT OF THE BIOLOGICAL AND PRESSURE MODULES

In order to perform the projections of the stock in the future, the recruitment of all the stocks has been assumed constantly equal to the last year. A multiplicative log-normal error with mean 0 and standard deviation 0.3 has been applied to the geometric mean of recruitment in order to take into account the uncertainty due to the process error that is propagated to all the indicators produced by BEMTOOL. shows the recruitment of the four stocks with confidence interval used in all the performed scenarios.

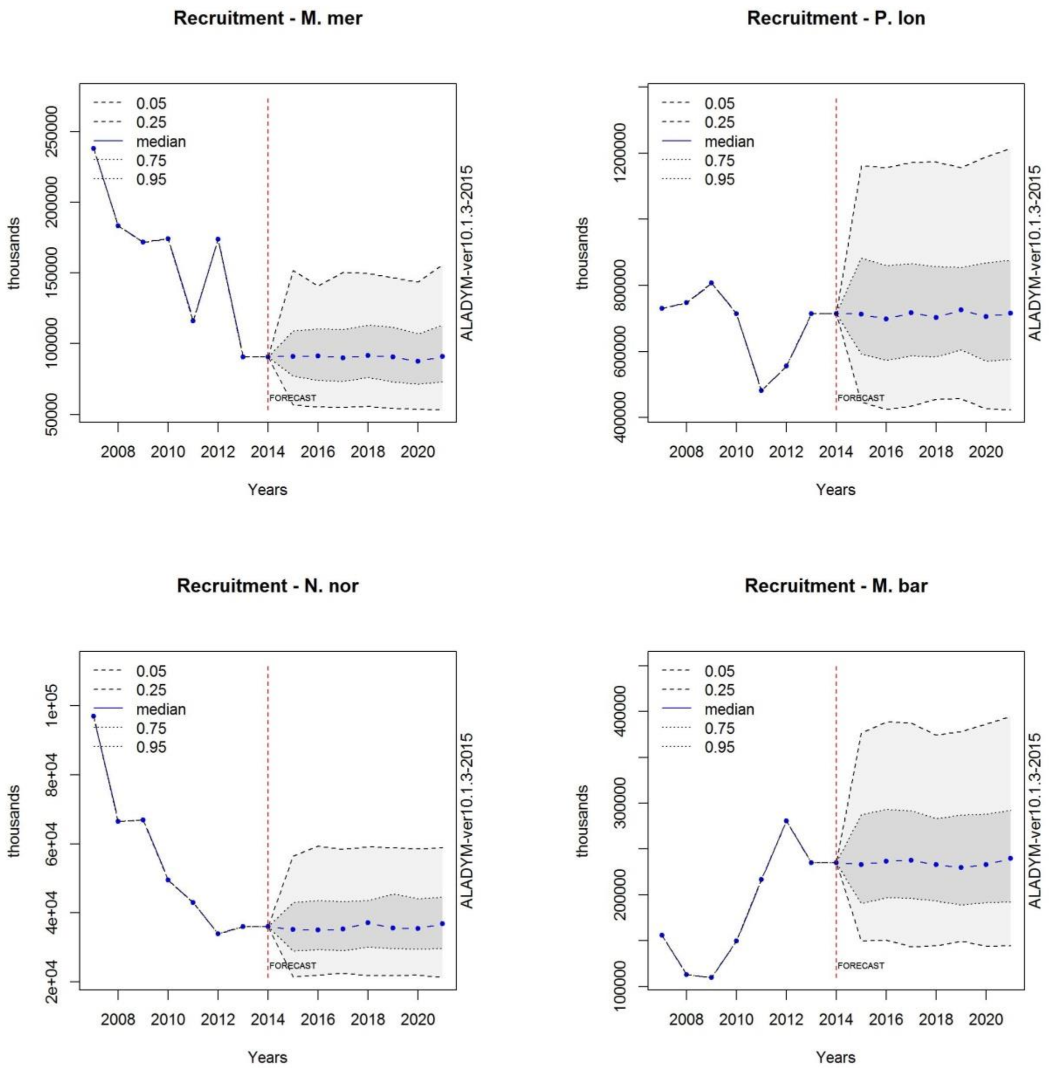


Figure H.5.1.1 - Recruitment with confidence intervals used for hake, deep water pink shrimp, Norway lobster and red mullet in the forecast scenarios.

All the other biological inputs have been maintained unchanged in the projections.

For all the scenarios the effort has been maintained constant for all the years (until 2021) and equal to 2013.

H.5.2 INPUT OF THE ECONOMIC MODULE

The main equations in the socio-economic model are related to the dynamics of prices and costs. Each equation has been tested on the basis of available historical series of data in order to check that the functional relationships are correctly specified. Economic parameters for each fleet segments and model equations are described below.

Given the presence of relevant fluctuations in the time series of most fleet segments, the socio economic parameters have been estimated on the basis of the most recent economic data, 2012 or 2013.

Socio-economic parameters of the Albanian demersal trawl segment 1224 m were available only for 2012 from SEDAF project. Therefore, socio-economic parameters of the other years were estimated on the basis of 2012.

For all fleets included in the case study, 2014 data were assumed equal to 2013.

PRICES DYNAMICS

The price of European hake, red mullet, deep water rose shrimp and Norway lobster are estimated by using the inverse of the price elasticity of supply ("supply elasticity of price" or "price flexibility"). Elasticity is the measurement of how responsive an economic variable is to a change in another. The elasticity coefficient used to simulate price dynamics gives the percentage change in price due to a one percent change in landings:

$$\varepsilon_{s,f} = \frac{\Delta p_{s,f,t}}{\Delta L_{s,f,t}} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}} \Bigg/ \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}} .$$

This elasticity coefficient is negative because an increase in landings would result in an increase in the quantity of product on the market, which is expected to affect negatively the price. A value equal to -0.2 for the elasticity coefficient $\varepsilon_{s,f}$ means that a percentage increase (decrease) by 1% in landings would produce a percentage decrease (increase) in price by 0.2%.

In order to model this type of relationship, option one of BEMTOOL software has been selected. Given a value for the elasticity coefficient, which can be estimated on time series or based on existing literature, the estimation process for the price of the target species s landed by the fleet segment f at time t can be split in the following steps:

4) the percentage change in landings of species s by fleet segment f from time t-1 to time t is given by the equation $\Delta L_{s,f,t} = \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
5) the percentage change in price of species s by fleet segment f from time t-1 to time t, $\Delta p_{s,f,t} = \frac{p_{s,f,t} - p_{s,f,t-1}}{p_{s,f,t-1}}$, is calculated by multiplying the supply elasticity of price, $\varepsilon_{s,f}$, by the percentage change in landings, $\Delta L_{s,f,t}$, $\Delta p_{s,f,t} = \varepsilon_{s,f} \Delta L_{s,f,t} = \varepsilon_{s,f} \frac{L_{s,f,t} - L_{s,f,t-1}}{L_{s,f,t-1}}$;
6) given the percentage change in price $\Delta p_{s,f,t}$, the price of species s by fleet segment f at time t is calculated as $p_{s,f,t} = p_{s,f,t-1} + \Delta p_{s,f,t} * p_{s,f,t-1} = p_{s,f,t-1}(1 + \Delta p_{s,f,t})$.

The three steps described above can be summarised by the following equation:

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

where:

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

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

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

$\Delta L_{s,f,t}$ is the percentage change in landings of species s by fleet segment f from time t-1 to time t;

$\Delta p_{s,f,t}$ the percentage change in price of species s by fleet segment f from time t-1 to time t.

According to this option the ex-vessel mean price of stock *s* landed by fleet segment *f* at time *t* is a function of the same price at time *t-1* and the relative increase of landings (at the same level of aggregation than price) from time *t-1* to time *t,* given an elasticity coefficient $\varepsilon_{s,f}$ estimated for that stock and fleet segment, which represents the parameter to be estimated.Due to the lack of reliable estimations based on available data, the flexibility coefficient was computed exogenously. Sector studies (Nielsen, 2000 and Camanzi *et al.* 2010) confirm that the flexibility coefficient normally ranges between -0.1 and -0.4 (Table H.5.2.1). In this case study flexibility coefficients estimated for the Italian management plans have been applied, which estimated an average coefficient of -0.4 for all target species.

Table H.5.2.1 - Price parameterization by fleet segment and stock in GSA 18 demersal case study.

Fleet segment	coeff. price-landings M. merluccius	coeff. price-landings P. longirostris	coeff. price-landings N. norvegicus	coeff. price-landings M. barbatus
ITA18_DTS_0612	-0.4	-0.4	-0.4	-0.4
ITA18_DTS_1218	-0.4	-0.4	-0.4	-0.4
ITA18_DTS_1824_2440	-0.4	-0.4	-0.4	-0.4
ITA18_HOK_1218	-0.4	-0.4	-0.4	-0.4
ITA18_PGP_0006_0612	-0.4	-0.4	-0.4	-0.4
ALB18_DTS_1224	-0.4	-0.4	-0.4	-0.4
MNE18_DFN_0012	-0.4	-0.4	-0.4	-0.4
MNE18_DTS_0612	-0.4	-0.4	-0.4	-0.4
MNE18_DTS_1224	-0.4	-0.4	-0.4	-0.4
MNE18_HOK_0012	-0.4	-0.4	-0.4	-0.4

The flexibility coefficient price-landings was assumed equal to -0.4 for all target species, which means that given a 1% fall in the production of a given species, it is assumed an increase in price of 0.4%.

COSTS DYNAMICS

Variable costs

Variable costs were modelled as a single item, which is the sum of fuel costs and other variable costs. Total variable costs are a function of the fishing effort (expressed in terms of days at sea):

$$TVC_{f,t} = \beta_f E_{f,t}$$

where:

$TVC_{f,t}$ are total variable costs for fleet segment *f* at time *t* (€);

$E_{f,t}$ is the effort (in terms of total annual days at sea) of fleet segment *f* at time *t*;

β_f is the total variable costs per unit of effort at time *t*

Maintenance costs and fixed costs

Maintenance costs (MC) and other fixed costs (OFC) are assumed to be proportional to the gross tonnage (GT) of the fleet segment, corresponding to option 1 of the BEMTOOL software.

$$MC_{f,t} = \alpha''_f GT_{f,t}$$

$$OFC_{f,t} = \alpha'_f GT_{f,t}$$

Capital costs

Capital costs are function of the estimated fleet capacity, expressed in terms of capital value and gross tonnage.

Depreciation costs DC are estimated by a linear function of the annual gross tonnage GT as well.

$$DC_{f,t} = \beta'_f GT_{f,t}$$

Following the approach of "The 2014 Annual Economic Report on the EU Fishing Fleet "(STECF-14-16), opportunity costs of capital (OC) are calculated by taking into account the fixed tangible asset value (*K*) and multiplying it by the real interest (*r*).

$$OC_{f,t} = r_{f,t} K_{f,t}$$

Capital costs include annual depreciation and the opportunity costs of capital.

Labour costs

Labour cost are directly related to total revenues and variable cost.

According to the prevalent income sharing system between the ship-owner and the crew, the labour cost is assumed to be proportional to revenues and total variable costs:

$$LC_{f,t} = cs_f \left(R_{f,t} - TVC_{f,t}\right)$$

where:

$LC_{f,t}$ is the labour cost of the fleet segment *f* at *t* (€);

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

$TVC_{f,t}$ are the total variable costs for the fleet segment *f* at time *t* (€);

cs_f is crew share for the fleet segment *f*.

On average the crew share is around 0.30 for most fleets included in the case study. The maximum crew share is estimated for the Albanian demersal trawlers VL1224, which is equal to 0.51.

Revenues and total landings

Total revenues (total landings) are calculated as a function of the sum of the estimated landings value (landings weight) of the target assessed species for most of the fleet segments. According to option 1 of this model component, total revenues and landings are proportional to the sum of the revenues and landings of target stock of the fleet segment *f* through a correction factor (rr_f and ll_f).

Option 1 :

$$R_{f,t} = rr_f \sum_{s=1:n} R_{f,s,t}$$

$$L_{f,t} = ll_f \sum_{i=1:n} L_{f,i,t}$$

where:

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

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

rr_f is correction factor to estimate the total revenues of the fleet segment *f* from the revenues of assessed species;

$L_{f,t}$ is the total landings weight (target species+ other species) of the fleet segment *f* at time *t* (€);

$L_{f,s,t}$ is the landings weight of target species s of the fleet segment *f* at time *t* (€);

ll_f is correction factor to estimte the total landings of the fleet segment *f* from the landings of assessed species.

For Italian DTS_0612, small scale and longliners and Montenegrin DFN_VL0012 and HOK 0012, where the target species consists of a minor part of the total landings and revenues, total landings are calculated as a sum of landings of not assessed species, estimated as a function of the assessed species, and the landings of the assessed species. In this case, according to option 2 of the model component, total revenues are estimated as a sum of the revenues of target assessed specie and the revenues of non-assessed species. The latter amount is calculated applying the average price in the last year of available data to the landings estimated as described above.

Option 2:

$$L_{other\_species,f,t} = u_f + v_f \sum_{s=1:n} L_{s,f,t}$$

where:

$L_{other\_species,f,t}$ is the landing of the other species of the fleet segment *f* at time *t*;

$L_{s,f,t}$ is the landing of the species s of the fleet segment *f* at time *t*;

u_f the amount of landings of non-target species independent on the landings of the target species;

v_f the quota of landings of non-target species dependent on the landings of the target species.

The following formulas are used to estimate total landings and total revenues:

$$L_{f,t} = L_{other\_species,f,t} + \sum_{s=1:n} L_{s,f,t}$$

$$p_{other\_species,f} = \frac{R_{f,t=last} - \sum_{s=1:n} R_{s,f,t=last}}{L_{f,t=last} - \sum_{s=1:n} L_{s,f,t=last}}$$

$$R_{f,t} = L_{other\_species,f,t} * p_{other\_speies,f} + \sum_{s=1:n} (p_{s,f,t} * L_{s,f,t})$$

where:

$L_{f,t}$ is the total landing of the fleet segment *f* at time *t*;

$p_{other\_species,f}$ is the average price of the non-target species in the last year of simulation;

$R_{f,t=last}$ is the total revenues of the fleet segment *f* in the last year;

$R_{s,f,t=last}$ is the revenues of the target species s for the fleet segment *f* in the last year;

$L_{f,t=last}$ is the total landing of the fleet segment *f* in the last year;

$L_{s,f,t=last}$ is the landing of the target species s for the fleet segment *f* in the last year.

$p_{s,f,t}$ is the price of the target species s for the fleet segment *f* at time *t*.

Average employees per vessel

Employment was estimated by average number of employees per vessel in the fleet segment *f* (em_f) multiplied by the number of vessels for each fleet segment ($N_{f,t}$):

$$EM_{f,t} = em_f N_{f,t}$$

Capital Value

Capital value was estimated by the average value of a vessel for the fleet segment *f* at time *t*. Discount rates used are the harmonized long-term interest rates for convergence assessment calculated by the European Central Bank, available at http://www.ecb.int/stats/money/long/html/index.en.html.

Table H.5.2.2 - Cost parameterization by fleet segment in GSA 18 demersal case study

Fleet segment	Total variable costs per unit of effort (sea days)	crew share	maintenance costs per unit of GT	other fixed costs per unit of GT	depreciation costs per unit of GT	interest costs per unit of GT
ITA18_DTS_0612	105	0.28	213	320	1051	174
ITA18_DTS_1218	320	0.28	355	221	665	138
ITA18_DTS_1824_2440	688	0.35	138	117	934	182
ITA18_HOK_1218	396	0.21	490	433	746	130
ITA18_PGP_0006_0612	71	0.35	655	759	3832	787
ALB18_DTS_1224	326	0.51	17	5	168	34
MNE18_DFN_0012	20	0.14	750	181	89	99
MNE18_DTS_0612	251	0.26	173	90	98	88
MNE18_DTS_1224	443	0.24	460	166	100	125
MNE18_HOK_0012	68	0.25	1725	219	93	157

Table H.5.2.3 - Socio-economic indicators parameterization by fleet segment in GSA 18 demersal case study.

Fleet segment	correction	correction	coefficient	coefficient	value of a	average	discou
ITA18_DTS_0612				2.83	24176	2	0.043
ITA18_DTS_1218	3.19	2.87			60752	2	0.043
ITA18_DTS_1824_244	2.09	1.71			260918	4	0.043
ITA18_HOK_1218				1.96	57392	5	0.043
ITA18_PGP_0006_061				25.21	36442	2	0.043
ALB18_DTS_1224	2.24	2.44			40488	6	0.032
MNE18_DFN_0012			0	16.61	5630	2	0.035
MNE18_DTS_0612	1.62	1.54			27500	1	0.035
MNE18_DTS_1224	1.85	1.93			96154	3	0.035
MNE18_HOK_0012			0	11.59	13423	2	0.035

H.5.3 INPUTS AND DYNAMICS OF EFFORT REDUCTION

The table H.5.3.1 reports the dynamics of effort reduction to reach the reference point by fleet, year and scenario. In the status quo scenario the absolute values of the average number of annual fishing days per vessel and the number of active vessels are reported.

Table H. 5.3.1 – Dynamics of effort reduction in comparison to the status quo (Scenario 1). For the status quo absolute number are reported, while for the other scenarios percentage to the status quo are reported.

	Reduction on days							Reduction on vessels						
Scenario 1 - StatusQuo	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ALB18_DTS_1224	144	144	144	144	144	144	144	164	164	164	164	164	164	164
ITA18_DTS_0612	141	141	141	141	141	141	141	39	39	39	39	39	39	39
ITA18_DTS_1218	171	171	171	171	171	171	171	287	287	287	287	287	287	287
ITA18_DTS_1824_2440	156	156	156	156	156	156	156	95	95	95	95	95	95	95
ITA18_HOK_1218	102	102	102	102	102	102	102	27	27	27	27	27	27	27
ITA18_PGP_0006_0612	159	159	159	159	159	159	159	481	481	481	481	481	481	481
MNE18_DFN_0012	132	132	132	132	132	132	132	47	47	47	47	47	47	47
MNE18_DTS_0612	48	48	48	48	48	48	48	4	4	4	4	4	4	4
MNE18_DTS_1224	84	84	84	84	84	84	84	13	13	13	13	13	13	13
MNE18_HOK_0012	132	132	132	132	132	132	132	13	13	13	13	13	13	13

	Reduction on days							Reduction on vessels						
Scenario 2 - FmsyUpperNorwLob2018	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ALB18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA18_DTS_0612	-17%	-35%	-52%	-69%	-69%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_DTS_1218	-17%	-35%	-52%	-69%	-69%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_DTS_1824_2440	-17%	-35%	-52%	-69%	-69%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_HOK_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA18_PGP_0006_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DFN_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_HOK_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days	Reduction on vessels

Scenario 3 - FmsyCombined2018	2015	2016	2017	2018	2019	2020	2021	2015	2016	2017	2018	2019	2020	2021
ALB18_DTS_1224	-15%	-29%	-44%	-59%	-59%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA18_DTS_1218	-15%	-29%	-44%	-59%	-59%	-59%	-59%	-2%	-4%	-6%	-6%	-6%	-6%	-6%
ITA18_DTS_1824_2440	-15%	-29%	-44%	-59%	-59%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_HOK_1218	-15%	-29%	-44%	-59%	-59%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_PGP_0006_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DFN_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_HOK_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days							Reduction on vessels						
Scenario 4 - FmsyUpperNorwLobAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ALB18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA18_DTS_0612	-17%	-17%	-28%	-38%	-54%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_DTS_1218	-17%	-17%	-28%	-38%	-54%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_DTS_1824_2440	-17%	-17%	-28%	-38%	-54%	-69%	-69%	-3%	-5%	-8%	-8%	-8%	-8%	-8%
ITA18_HOK_1218	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ITA18_PGP_0006_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DFN_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_HOK_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Reduction on days							Reduction on vessels						
Scenario 5 - FmsyCombinedAdaptive2020	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
ALB18_DTS_1224	-15%	-15%	-23%	-32%	-45%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

ITA18_DTS_1218	-15%	-15%	-23%	-32%	-45%	-59%	-59%	-2%	-4%	-6%	-6%	-6%	-6%	-6%
ITA18_DTS_1824_2440	-15%	-15%	-23%	-32%	-45%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_HOK_1218	-15%	-15%	-23%	-32%	-45%	-59%	-59%	-2%	-4%	-7%	-7%	-7%	-7%	-7%
ITA18_PGP_0006_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DFN_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_0612	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_DTS_1224	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MNE18_HOK_0012	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

2.10 CASE STUDY ON GSA 29

2.10.1 IDENTIFICATION OF MAIN ELEMENTS THAT CONTRIBUTE TO DEFINE MSY (SINGLE SPECIES, MULTISPECIES, FLEETS, TECHNICAL FEATURES, ETC..)

GSA, Fisheries, Stock assessed

The main fishing gears in the area are midwater otter trawl (OTM), bottom trawls, and demersal gillnets (GNS). Fleet segments including boats with length between 12-18 m operates with mid-otter trawls, long lines and gillnets for fishing of small pelagic fish (sprat, horse mackerel) and for demersals – turbot, red mullet and spiny dogfish. These fleets have taken about 50 % of the total catches in Bulgarian and Romanian Black Sea waters on average.

Despite of the limitations in the past (in the 1990s catch was banned or severely restricted in the north and western Black Sea (Shlyakhov and Daskalov 2008) and those imposed recently (annual TAC in EU waters, Ukraine and Russia, closed season in Turkey) turbot biomass and catches continue to decrease and are at the moment well below the limit reference point (STECF, 2014).

A real problem of the turbot fishery is the IUU fishing. For the period after 2002, the misreporting of actual catches (IUU catch) is assumed to be around 4.7 the official catches of Bulgaria, Romania and Ukraine, but this value may be underestimated (STECF, 2014).

Turbot is also known to be caugth as bycatch by several fisheries, but some limited information of the amount of this bycatch exist only for the sprat fishery.

Contribution of the stocks assessed to the production of the specific fisheries

6 fleets are defined based on catch, gear information and the goals of the present study. The IUU (Illegal, Unregulated and Unreported) fishing of turbot was explicitly presented as a separate fleet as it is assumed to represent about 65 % of the total catch (2011-2013 average).

The main fleet segments involved in the turbot fishery in GSA29 are reported in the table 2.10.1.1.

Table 2.10.1.1 - Main fleet segments involved in the turbot fishery in GSA29.

	Fleet name	Fleet code	% of catch
1	Bulgarian GNS fisheries	Bul_GNS	2.34%
2	Romanian GNS fisheries	Rom_GNS	2.66%
3	Ukraine, Russia, and Georgia GNS fisheries	URG_GNS	15.34%
4	Turkish OTB fisheries	Tur_OTB	10.51%
5	Sprat OTM fisheries from all countries (turbot bycatch)	SPR_OTM	4.22%
6	IUU fishing	IUU	64.93%

2.10.2 DEVELOPMENT OF STOCKS OVER TIME AND DIAGNOSIS OF THE STOCKS

Several consecutive stock assessment working groups have classified the stock of turbot in the Black Sea as being exploited unsustainably and at risk of collapse (e.g. Daskalov et al. 2012, Sampson et al. 2013, STECF 2014). To achieve a recovery of the stock these fora advised to stop the fisheries for turbot.

Due mainly to the low level of the stock biomass and excessive (including illegal) fishing, the present fishing mortality (Fcurr) is more than 4 times higher than Fmsy.

Stock assessment of turbot was performed by the STECF-EWG 14-14. This assessment used DCF data together with the historical time series available for Black Sea from 1950 to 2013.

Turbot has attained higher abundance in 1977 – 1982 and very low values after 2009. Fishing mortality reached its peak (F = 1.33) during recent years (2012 – 2013). Fcurrent is estimated as average fishing mortality over 2011-2013 (Figure 2.10.2.1).

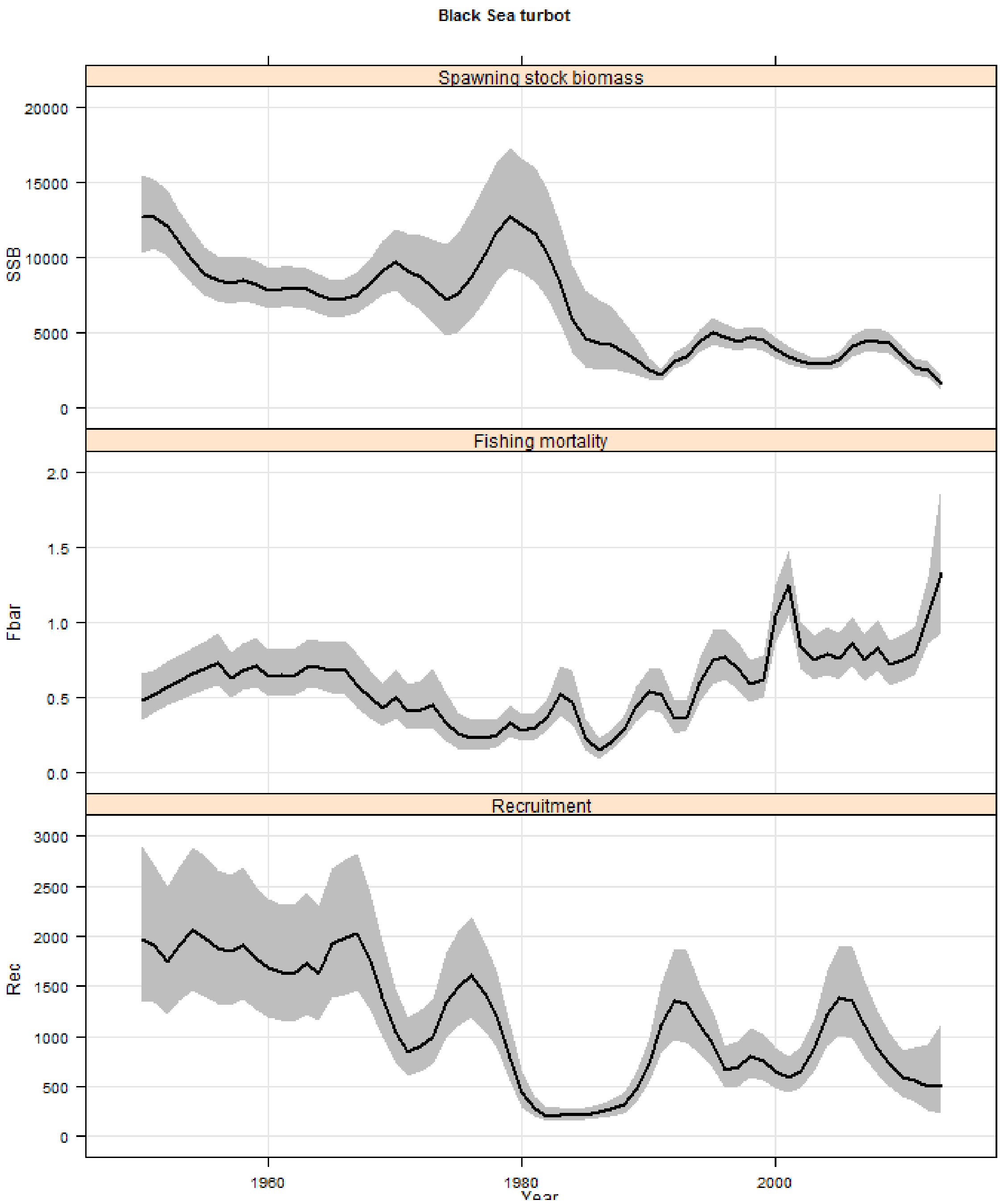


Figure 2.10.2.1. Turbot in GSA 29. SSB and catch are in tons, recruitment in 1000s individuals (STECF 2014).

Stock advice, Reference points, and their technical basis

Stock estimates are summarised in the table 2.10.2.1

Table 2.10.2.1 Current stock estimates of turbot in GSA 29 (STECF 2014)

Stock	Fishing mortality* (Fcurrent)	Spawning Stock Biomass* (tons)	Catch* (tons)	Landings* (tons)	Recruitment* (in thousands)
Turbot	$F_{bar\ (4\text{-}8)}$= 1.058	1634	1522	1522	504

*estimates refer to assessment STECF-EWG 14-14

The framework used for the reference points is summarised in Table 2.10.2.2

The STECF EWG 14-14 (STECF 2014) the program Eqsim was used to estimate stock recruitment relationship and F_{MSY} and F_{MSY} ranges. On the basis of median simulated catches for turbot the following ranges were obtained: F_{MSY} = 0.26; F_{lower} = 0.23, F_{upper} = 0.364

Table 2.10.2.2 Reference points of turbot in GSA 29 (STECF 2014)

	Framework					
	MSY approach				Precautionary approach	
Reference point	F_{MSY}	F_{MSY} upper range	F_{curr}/F_{MSY} ratio	Bmsy	$B_{lim\ (tons)}$	$B_{pa\ (tons)}$
Technical basis for turbot	Fmsy from the stock-recruit function				Defined as Blim = Bpa/1.4	Defined as 0.39*Bmax
Values for turbot	0.26	0.364	4.07		3535	4949

The recent stock assessment indicates that the spawning stock biomass is at very low level (around 1634 t) and it is estimated to be around half of Blim (3535 t). Fcurrent is about four times higher than Fmsy (0.26). The STECF EWG 14 14 has classified the stock of turbot in the Black Sea as being exploited unsustainably and at risk of collapse. The STECF EWG has advised that on the basis of precautionary considerations, there should be no directed fisheries for turbot and bycatch should be minimised (STECF 2014)

Development of economic indicators over time and current status

Although some general information about economic performance of fisheries for the EU member states – Bulgaria and Romania can be found, there is no specific data on economic variables and indicator relevant to the turbot fisheries and associate fleets.

The only reliable economic information is the average value of the turbot catch, which is reported to be 15.12 euros per kg (Goulding et al., 2014). Value of the total catches of turbot is presented in Table 2.10.2.3. It decreases about twice since 2000 following the trend in the catches.

Table 2.10.2.3. Catches (t) of turbot fleet and their value (euros)

Fleets	Bul_GNS	Rom_GNS	URG_GNS	Tur_OTB	SPR_OTM	IUU	Total	Value
2000	55	2	93	2639	122	0	2911	44012
2001	57	13	164	2323	193	0	2749	41568
2002	136	17	130	335	196	754	1567	23697
2003	41	24	140	219	117	581	1122	16960
2004	16	42	142	234	110	598	1142	17270
2005	13	37	144	548	126	533	1400	21170
2006	15	35	170	747	107	677	1751	26469
2007	67	48	221	699	76	1147	2259	34156
2008	55	47	256	458	94	1213	2122	32088
2009	52	49	287	342	106	1241	2078	31423
2010	46	48	232	295	97	1019	1738	26278
2011	38	43	260	145	94	1079	1659	25080
2012	36	43	267	172	64	1122	1704	25770
2013	40	43	223	194	49	973	1522	23006

2.10.3 SPECIFY THE CRITERIA THAT COULD BE USED TO SELECT THE MOST SUITABLE APPROACH TO ATTAIN THE MSY OBJECTIVES (IMPLEMENT DIFFERENT TRAJECTORIES AND STRATEGIES)

Fmsy objectives can be achieved by reducing fishing mortality of the fleets in order to avoid the catch of juvenile fish. Unselective demersal gears such as bottom trawls, beam trawls and dredges, are known to cause highest fishing mortality of juveniles. However, these gears are operated either illegally (EU countries Bulgaria and Romania as well as well as Ukraine and Russia have strong restrictions on the operation of demersal gears) or out of the jurisdiction of the EU e.g. in Turkey. Because of the lack of information about the selection pattern in illegal fisheries and the lack of possibility to apply management actions in Turkey (a non EU country), scenarios toward MSY and turbot stock recovery have been developed based on the reduction of the fishing mortality only, and keeping constant exploitation pattern.

2.10.4 EXPLORE THE DIFFERENT MANAGEMENT POSSIBILITIES TO ACHIEVE MSY OR ITS PROXIES: SETTING SCENARIOS

Proposed scenarios for the management of turbot stock are reported in the table 2.10.4.1.

In the Scenario 1 the current situation is projected to 2018 and 2020 under status quo condition.

In Scenario 2 a gradual linear reduction to 2018 is applied, afterward fishing continues at Fmsy.

In Scenario 3 an adaptive strategy is applied which implies, a lower reduction in the short term and a sharp reduction thereinafter, in order to achieve MSY in 2020.

Given the specifics characteristics of the turbot fisheries and mainly the fact that about 65 % of the catch is IUU, four versions of each scenario were formulated:

- Version 1, the condition of each scenario are applied to all fleets;
- Version 2 the scenarios are applied, but IUU is assumed to be completely eliminated (IUU catch=0);

- Version 3, the bycatch is assumed to be completely eliminated (bycatch=0);
- Version 4 simulates effects of a reduction or ban of the fisheries where the IUU is not controlled and stays at the status quo level.

Under these assumptions, the scenarios are thus summarized in the table 2.10.4.1.

Table 2.10.4.1 Scenarios of turbot fishing projected simulations 2015 - 2020

Scenario 1	**Status quo to 2020**
SQ_version1	Status quo fishing applied to all fleets
SQ_version2	Status quo fishing applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
SQ_version3	Status quo fishing applied to all fleets and, but no bycatch is allowed (bycatch =0)
SQ_version4	Ban on legal fishing, but IUU is allowed (IUU catch at status quo level)
Scenario 2	**Linear reduction towards upper F_{MSY} of turbot in 2018,**
Lin_ version1	Linear reduction applied to all fleets
Lin_ version2	Linear reduction applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
Lin_ version3	Linear reduction applied to all fleets, but no bycatch is allowed (bycatch =0)
Lin_ version4	Linear reduction applied to all fleets, but IUU is allowed (IUU at status quo level)
Scenario 3	**Adaptive reduction towards upper F_{MSY} of turbot from 2018 to 2020**
Adapt_ version1	Adaptive reduction applied to all fleets
Adapt_ version2	Adaptive reduction applied to all fleets, but no IUU fishing is allowed (IUU catch =0)
Adapt_ version3	Adaptive reduction applied to all fleets, but no bycatch is allowed (bycatch =0)
Adapt_ version4	Adaptive reduction applied to all fleets, but IUU is allowed(IUU at status quo level)

Linear reduction toward Fmsy $_{upper}$ = 0.364 was applied in 2014-2018 (Table 2.10.4.2). In Lin_ version 2, staring value of F=0.382 in 2014 is lower than F in 2013 by about 65%, because of substituting of the IUU catch from the total catch. Conversely in Lin_ version 4, Fmsy is not achieved because IUU catch is allowed.

Table 2.10.4.2. Reduction of F in management scenarios for turbot in GSA29

Year	Lin_ version1	Lin_ version2	Lin_ version3	Lin_ version4
2013	1.058	1.058	1.058	1.058
2014	1.058	0.382	1.024	1.058
2015	0.885	0.378	0.859	0.962
2016	0.712	0.374	0.695	0.867
2017	0.539	0.370	0.530	0.771
2018	0.364	0.364	0.364	0.676
2019	0.364	0.364	0.364	0.676
2020	0.364	0.364	0.364	0.676

All scenarios are based on reductions in in fishing mortality (F) that are only hypothetically related to actual fishing effort - representative data for which are not available. Turkish and former Soviet fisheries are taking most of the legal catch, and only about 5% of the total catch is taken by specialised legal fisheries in EU waters (Table 2.10.1.1). The IUU fishing, which is a dominant part of the catch (65%), partly take place in EU waters, the other part of it is situated in the waters of the former Soviet countries (Georgia, Russia and

Ukraine). Under these circumstances we have based our simulations on catch proportions only (Table 2.10.1.1) and cannot advise on specific fleet effort scenarios.

2.10.5 IDENTIFY TOOLS TO BE USED FOR SCENARIO MODELLING AND DESCRIBE METHOD APPLIED

As economic information relevant to the turbot fisheries is generally missing, we found that using bieconomic modeling is not necessary in this case study. We used a mid-term forecasting model of turbot based on the output from analytical stock assessment (SAM model, STECF 2014) applied with spreadsheets (MS Excel).

The model applied the VPA equations in a forecast mode starting from generalised information from the last assessment year (Table L.1 in the ANNEX L). Recruitment is deterministicaly forecasted based on the stock-recruitment relationship. Maturity ogive and weight at age are kept constant.

The fishing mortality was predicted by multiplying a constant selection pattern based on the current fishing mortality vector by an yearly multiplier according to the predefined scenarios (details of inputs in the ANNEX L)

2.10.6. REPORT OF INPUTS FOR MODELLING TURBOT FISHERY IN GSA29

Inputs for modelling are reported in the Annex L.

2.10.7 EVALUATE THE RESULTS OF MODELLING WHEN ESTABLISHING MSY TARGET IN 2018 AND 2020

2.10.7.1 PROJECTIONS OF STATUS QUO FISHING WITH DETERMINISTIC RECRUITMENT

The projection of the turbot fishery under current conditions until 2014 is shown in Fig. 2.10.7.1. Recruitment is estimated according to the stock-recruitment model (ANNEX L). Standard population dynamics parameters are depicted: the average fishing mortality (Fbar between ages 4 and 8 year, year^{-1}), spawning stock biomass (SSB, tons) and catches (in tons). In the right low panel of Figure 2.10.7.1 the total value of the catch is shown (in euros).

We can see from the Fig. 2.10.7.1A that lowest F is achieved when all IUU is eliminated (SQ_version 2, Table 2.10.4.1). In the case of a ban of the official catch but no control of the IUU, the fishing mortality is almost twice high (SQ_version 4, Fig. 2.10.7.1A), that corresponds to the share of its catch 35% official catch against 65% IUU. The least effect on the fishing mortality has the elimination of the bycatch (SQ_version 3, Fig. 2.10.7.1A). In accordance to the 4 scenario versions, the SSB, catches and value keep decreasing when fishing is kept at status quo or only bycatch is eliminated (SQ_version 1, SQ_version 3, Fig. 2.10.7.1B, C and D). SSB, catches and value stabilise about at the level of 2012-2013, when legal fishing is stopped, but IUU is allowed (SQ_version 4, Fig. 2.10.7.1B, C and D). Catches show an increasing trend when fishing is allowed at the current level, but the IUU is totally eliminated (SQ_version 2, Fig. 2.10.7.1B, C and D). A quick recovery of the SSB is to be expected if all catch (legal + IUU) can be stopped for a few years. We can see from Fig. 2.10.7.1B, that the SSB would top the estimated B_{pa} 4949 tons (Table 2.10.5.2) by 2019.

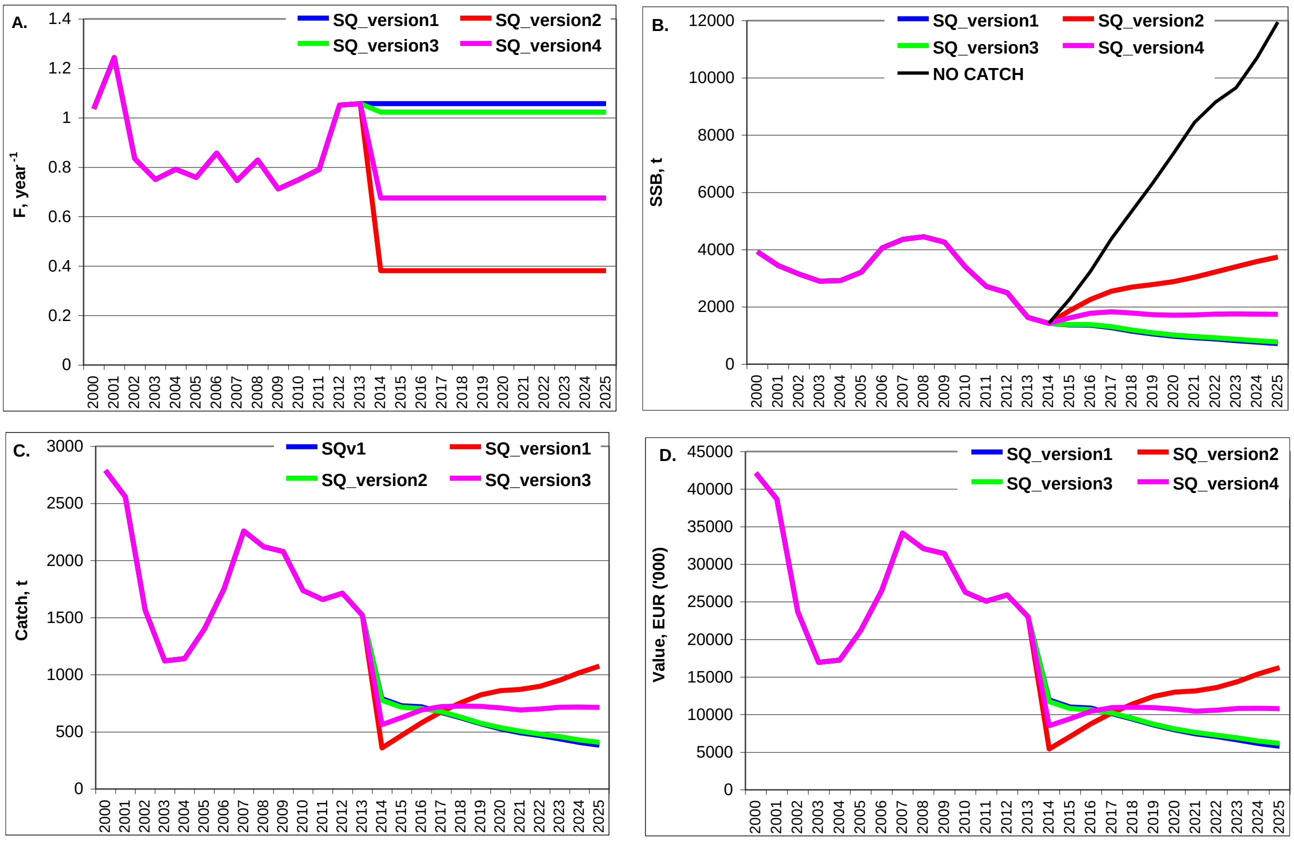


Figure 2.10.7.1 Turbot stock historic parameters (2000-2014) and projections (2015-2025) according to the status quo scenarios: A. Average fishing mortality (Fbar between ages 4 and 8 year, year^{-1}), B. Spawning Stock Biomass (SSB, tons), C. Catches (in tons), D. Value of the catch is shown (in euros).

2.10.8 COMPARISON OF THE DIFFERENT MANAGEMENT SCENARIOS

2.10.8.1 SCENARIO 2 LINEAR REDUCTION TOWARDS UPPER FMSY IN 2018

The second type of scenarios were to sharply reduce the fishing mortality down to the upper range of Fmsy = 0.364 (Table 2.10.5.2). Results from the scenarios Lin_version1 and Lin_version3 (no bycatch) are again rather similar (Figure 2.10.8.1). SSB, catches and value show increasing trends, but the SSB cannot attain Blim by 2025 (Lin_version1 and Lin_version3, Figure 2.10.8.1B). The best scenario, that most clearly improve SSB and catches, is Lin_version 2 (no IUU allowed) which, due to the cut edge elimination of the IUU in 2014, allows a stock rebuilding and consequently the growth of catches in condition that fishing is kept at the upper Fmsy level (Figure 2.10.8.1).

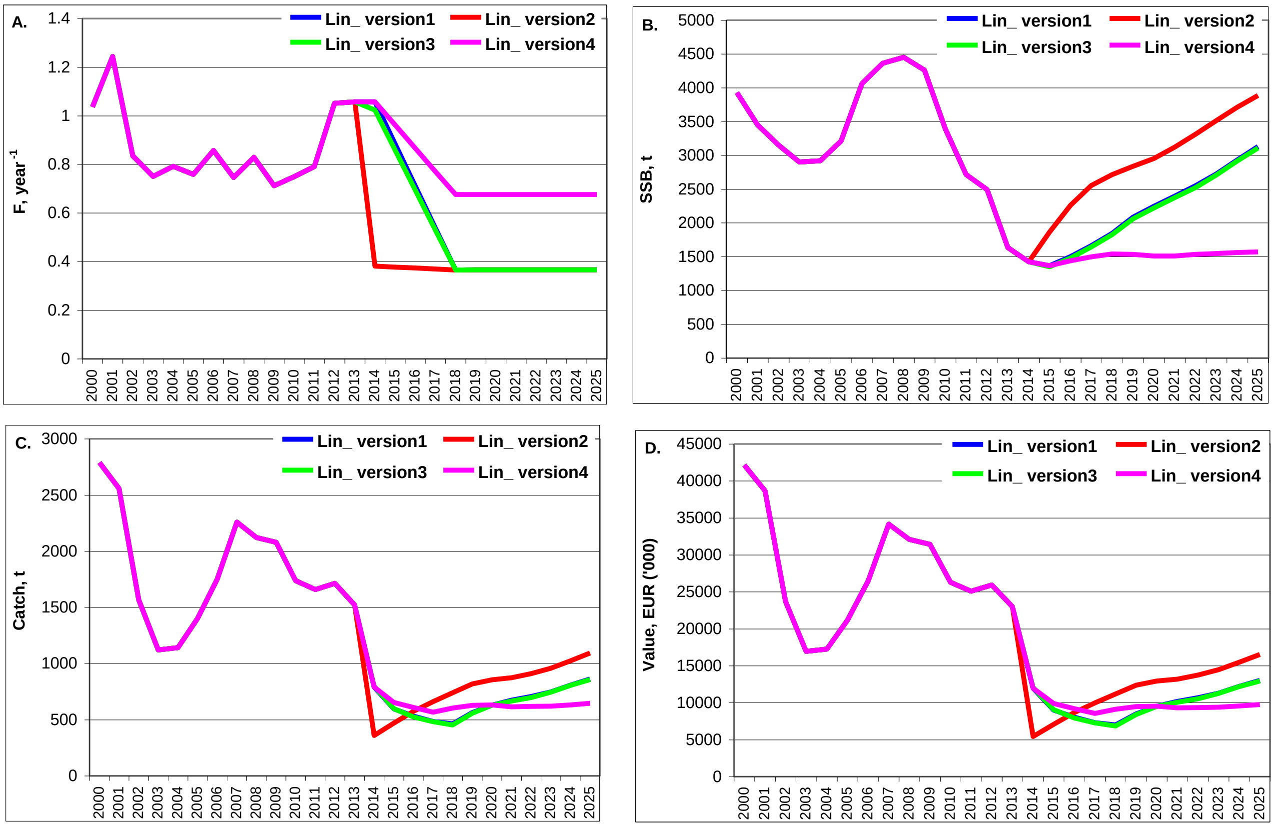


Figure 2.10.8.1 Turbot stock historic parameters (2000-2014) and projections (2015-2025) according to the linear reduction scenarios: A. Average fishing mortality (Fbar between ages 4 and 8 year, year^{-1}), B. Spawning Stock Biomass (SSB, tons), C. Catches (in tons), D. Value of the catch is shown (in euros).

2.10.8.2 SCENARIO 3. ADAPTIVE REDUCTION TOWARDS UPPER FMSY IN 2020

The projections of the scenarios with adaptive reduction (Figure 2.10.8.2) behave somewhere between those of the status quo and the linear reduction. In the versions 1, 3, 4 (Adapt_version 1, Adapt_version 3, Adapt_version 4, Figure 2.10.8.2) the improvement in SSB and catches appear after 2020, when fishing attains the upper Fmsy = 0.364. Prior to 2020, versions 1, 3, 4 tend to keep SSB and catches at low levels, and version 2 (Adapt_version 2) is similar to the versions 2 in the status quo and also to linear scenarios (SQ_version 2, Lin_version 2), as most of the reduction of the catch is achieved with the immediate elimination of IUU in 2015.

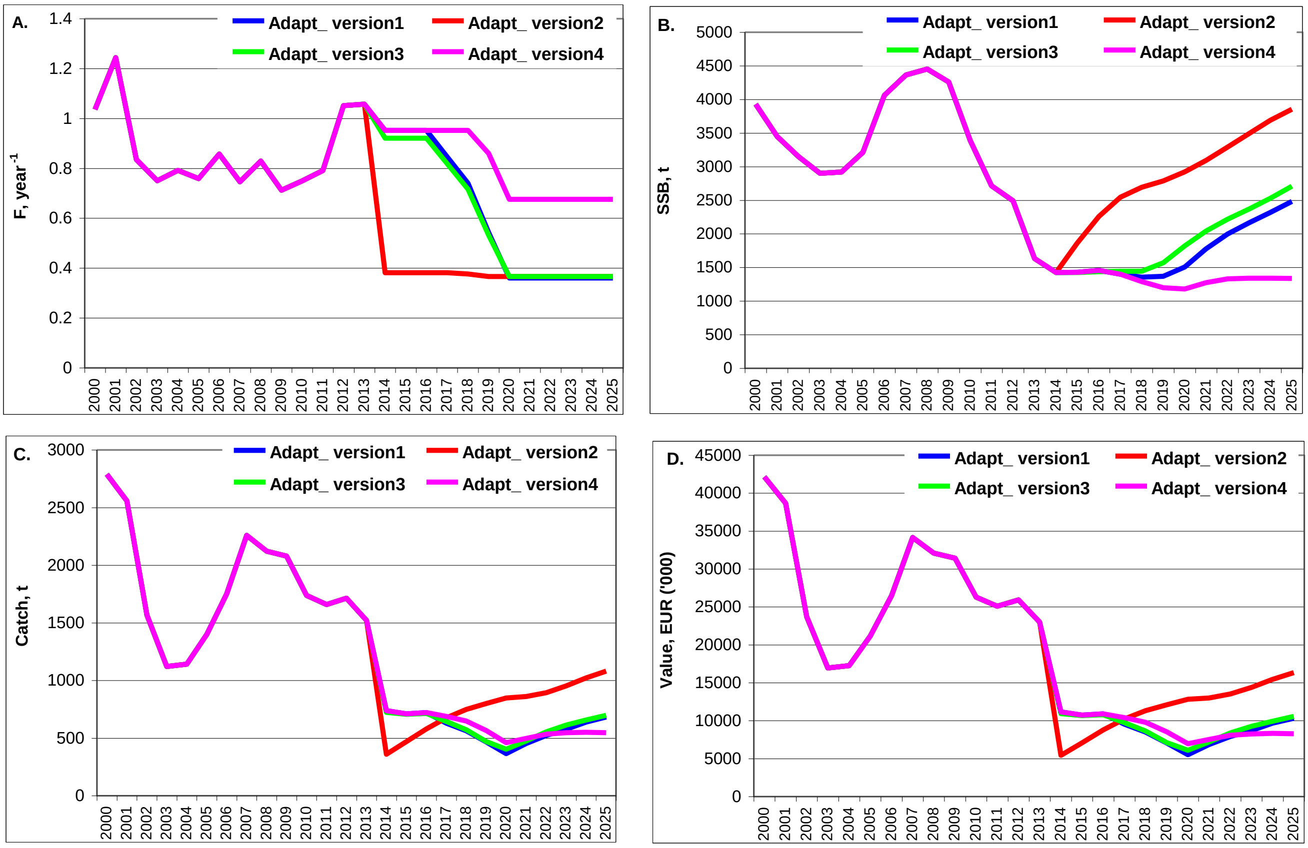


Figure 2.10.8.2 Turbot stock historic parameters (2000-2014) and projections (2015-2025) according to the adaptive reduction scenarios: A. Average fishing mortality (Fbar between ages 4 and 8 year, year^{-1}), B. Spawning Stock Biomass (SSB, tons), C. Catches (in tons), D. Value of the catch is shown (in euros).

2.10.9. REPORT THE RESULTS IN TERMS OF TRAFFIC LIGHT AND DECISION ANALYSIS

As shown in the traffic light summary (Table 2.10.9.1), the total control of IUU (version 2, no IUU catch) allows the SSB to double and the catch to increase by about 10% by 2021 in all 3 scenarios. In all other versions the catches decrease form 12% to 43%.

In a case of a total ban on the fishery (as suggested by the STECF 2014 and 2015b) and complete control over IUU, the SSB is expected to increase by the 2021 by about 5 times and to reach 8450 t, that is more than two times the Blim. If only "legal" fisheries are stopped, but IUU fishing is allowed at the status quo level (Scenario 1, Status quo, version 4), SSB is expected to increase by only 20% to 1723 t, that is less then a half of the Blim, and therefore recovery of the stock is not going to happen. If linear or adaptive strategies toward Fmsy are applied, but IUU fishing is allowed at the status quo level (Scenarios 2 and 3, version 4), SSB be would increase by 6% only, or decrease by 11%, respectively.

Table 2.10.9.1 Performances of the simulated management scenarios in 2021 (% with respect to status quo) in terms of SSB and overall catches of turbot

Scenarios		Catch			SSB		
		Status quo	Linear	Adaptive	Status quo	Linear	Adaptive
All fisheries	version 1	-37.8%	-14.9%	-42.7%	-35.4%	68.1%	24.7%
No IUU	version 2	10.1%	10.4%	8.7%	113.1%	118.9%	117.0%
No Bycatch	version 3	-36.0%	-15.8%	-39.8%	-32.1%	66.6%	43.2%

Ban on legal fishing	**version 4**	-12.5%	-22.3%	-37.0%	20.9%	6.0%	-10.7%
	no catch				493.0%		

If all scenarios and versions are ranked using an expert system accounting for both effects on SSB and catches by 2021 (Table 2.10.9.2), it can be seen that the versions 2 of all 3 scenarios (no IUU fishing) bring highest SBBs and catches and acquire the highest ranks. Versions with linear reduction, that produces a sharper decreases than the adaptive strategies during early years of simulations are ranked next with higher increase in biomass and less decreases in catches (Tables 2.10.9.1 and 2.10.9.2).

The 3 best scenarios (SQ_version 2, Adapt_ version 2, Lin_ version 2) approach, but not achieve Blim by the 2021 (Table. 2.10.9.1).

Table. 2.10.9.2 Scenarios versions and respective SSB and catches in 2021, ranked using a two factors expert system.

Rank	Scenario	SSB, t	Catch, t
1	SQ_version 1	921	492
2	SQ_version 3	967	506
3	Adapt_ version 4	1273	498
4	Adapt_ version 1	1777	453
5	Adapt_ version 3	2041	476
6	Lin_ version 4	1510	615
7	SQ_version 4	1723	692
8	Lin_ version 3	2374	666
9	Lin_ version 1	2396	673
10	SQ_version 2	3036	871
11	Adapt_ version 2	3092	860
12	Lin_ version 2	3120	873

2.10.10 DISCUSSION AND CONCLUSIONS

The simulation studies of the turbot fisheries in GSA 29 bring us to the following conclusions:

- Fishing at the upper Fmsy = 0.364 brings a clear improvement, but given the biological characreristics of the stock is not enough to reach Blim or Bpa by 2021.
- Sharper reduction brings a quicker positive response of the stock toward recovery i.e. immediate or linear reduction by 2018 gives better results than adaprive reduction by 2020.
- Total closure of the fishery and control over the IUU would allow the SSB to recover to level of Bpa by 2019.
- Ellimination of the IUU catch is crucial for the recovery, given that under the present assumption IUU catch is about 65% of the total catch.

The case study encompassed that the most important management action would be to establish an effective control on the illegal fishing. If this is done, than a total ban on the fishery would bring the SSB above Blim and Bpa, by 2018 and 2020, respectively. On the other hand, successful recovery by 2020 is impossible, if IUU fishing is not controlled (continue fishing at its status quo level) by any option applied only to the "legal" fisheries, including their ban (but not stopping the IUU). Scenario versions with immediate or fast restrictive effects (e.g. linear reduction until 2018) are more efficient in achieving recovery, than delaying action (adaptive) scenarios, because of the heavily overfished state of the stock.

It should be noted that the estimate of IUU catch used in recent stock assessment as well as in this study, is rather conservative (Interim report, STECF 2014). It is quite possible that real IUU catch is higher. The recent studies (including this one) also do not account for the age composion (selection pattern) of the IUU catch, which is known to include a large portion of immature individuals. Thus, it is rather possible that the effects of the IUU fishing are more severe than accounted by this study and recent stock assessments.

Given that turbot stock is at its historical minimum the STECF EWGs have repetedly advised the closure of the fishery as the most appropriate management action that should be taken to assure the recovery (e.g. Daskalov et al. 2012, Sampson et al. 2013, STECF 2014). Our study demonstrate, that given the biological characteristics of the stock, a relatively fast recovery (in 5 years) can be achieved, by completely closing the fishery and not allowing any IUU fishing.

In fact, such scenario is not unprecedented. In the late 1980s - early 1990s when the stock was at historical minimum, moratoria were established in Bulgaria, Romania and the former USSR. It can be seen that shortly after this came strong recruitment and the SSB had recovered at level of Bpa.

ANNEX L - INPUTS FOR MODELLING IN GSA29

BIOLOGICAL INPUTS

Recruitment in numbers at age 2 were plotted against SSB over the period 1950-2011 (STECF 2014) in order to estimate the parameters of the Ricker model (Fig. L.1):

Recruits = 394.28 SSB e $^{(-0.00014\ SSB)}$

The stock recruit model was then used to deterministically predict the recruitment (at age 2 year) with the mid-term forecasting model (Table L.1) during the projection period (2015-2020).

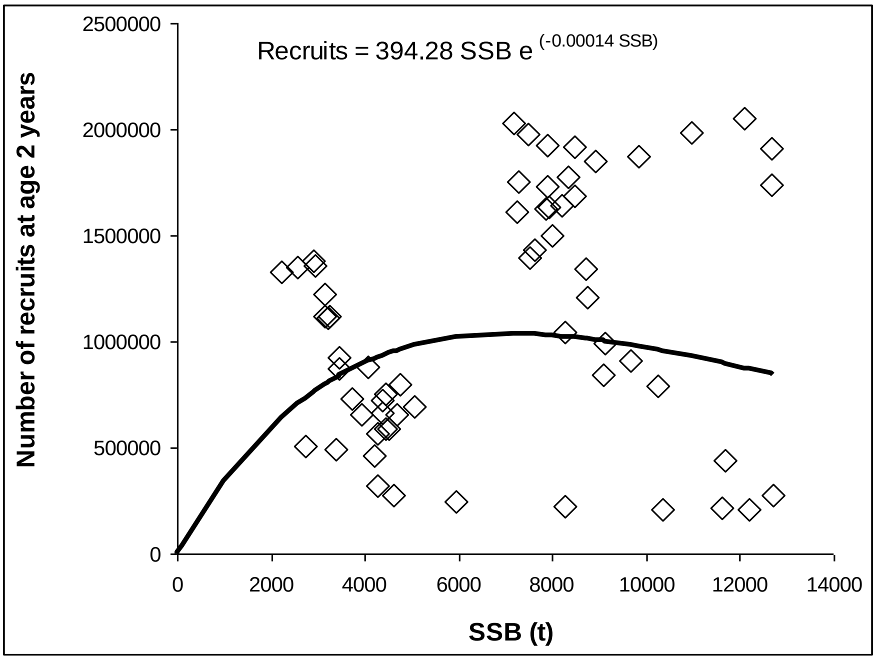


Figure L.1 Ricker stock-recruitment relationship fitted to data for 1950-2011 (STECF 2014).

The maturity parameters used for the analysis are shown in Table L.2 The maturity ogive is used in the annual stock assessments (e.g. Daskalov et al. 2012, Sampson et al. 2013, STECF 2014).

Table L.2 Maturity parameters of turbot in GSA 29 (STECF 2014)

age	2	3	4	5	6	7	8	9	10	source
Maturity	0	0.432	0.678	1	1	1	1	1	1	EWG 14-14

The natural mortality at age (Table L.3) was estimated using the ProdBioM model (Abella et al. 1997). These estimates have been used in the last annual stock assessments (e.g. Daskalov et al. 2012, Sampson et al. 2013, STECF 2014).

Table L.3 Natural mortality of turbot in GSA 29 (STECF 2014)

age	2	3	4	5	6	7	8	9	10	source
M	0.146	0.139	0.136	0.134	0.133	0.132	0.131	0.13	0.13	EWG 14-14

Finally, predicted biomasses and catches were estimated by multiplying predicted abundance numbers by the weight-at-age in the catch, which is assumed the same as the weight-at-age in the stock according to STECF (2014) (Table L.4).

Table L.4 Weight-at-age in the catch and the stock of turbot in GSA 29 (STECF 2014)

age	2	3	4	5	6	7	8	9	10	source
weight (kg)	0.454	1.227	1.592	2.257	3.087	3.93	4.662	5.946	7	EWG 14-14

INPUT OF THE PRESSURE COMPONENT

The fishing mortality vector was estimated as an average over 2011 - 2013 and propagated to 2014. The fishing mortality vector applied over the projection period (2015-2020) resulted from multiplying the exploitation pattern (the vector in Table L.5 divided by reference F (Fbar, 4-8 years), by an yearly multiplier according to the predefined scenarios in Table 6.0.4. Current fishing mortality vector is reported in the table L.5. Fbar graphs corresponding to different scenarios are presented on the Figures 2.10.7.1, 2.10.8.1, 2.10.8.2.

Inputs for the mid-term forecasting model are reported in Table L.6

Table L.5 Current fishing mortality vector estimated as an average over 2011 – 2013 from the 2014 stock assessment (STECF 2014)

age	2	3	4	5	6	7	8	9	10	source
F	0.273	0.182	0.382	0.763	0.694	1.265	2.186	2.186	2.186	EWG 14-14

Table L.6 Input data for the mid-term forecasting model

age	stock size (000)	M	maturity	weight in stock (kg)	Fishing mortality	weight in catch (kg)
2	732	0.146	0	0.454	0.272987967	0.454
3	347	0.139	0.4317	1.227	0.181839667	1.227
4	260	0.136	0.6783	1.592	0.3818322	1.592
5	215	0.134	1	2.257	0.7625845	2.257
6	115	0.133	1	3.087	0.693623333	3.087
7	53	0.132	1	3.93	1.264915467	3.93
8	16	0.131	1	4.662	2.185562967	4.662
9	5	0.13	1	5.946	2.185562967	5.946
10	2	0.13	1	7	2.185562967	7

6 fleets were defined based on catch and gear information and the goals of the present study. Catches of the first 3 fleets (Bul_GNS, Rom_GNS, URG_GNS) are taken mainly by using bottom gillnets which the legally allowed specialised gear in Bulgaria, Romania, Ukraine and Russia (Table L.7). The forth fleet (Tur_OTB) is defined as catching turbot by bottom trawl, which is the dominant tubot fishery in Turkish waters.

Catches of the first 4 fleets (Bul_GNS, Rom_GNS, URG_GNS, Tur_OTB) correspond to the official landings by the countries as reported by the STECF EWG 14-14 (STECF 2014).

In Table L.7:

- catches of the Bul_GNS fleet correspond to total landings by Bulgaria,
- catches of the Rom_GNS fleet correspond to total landings by Romania,
- catches of the URG_GNS correspond to total landings by Ukraine, Russia, and Georgia,
- catches of the Tur_OTB fleet correspond to total landings by Turkey.

It should be noted that catches by the fleets in Table L.7 are only assumed (because we miss information of the exact catches by gears, cfr. Interim report) to be caught using the main gears: gill nets (GNS) used in Bulgaria, Romania, Ukraine, Russia, Georgia, and bottom trawls (OTB) in Turkey, respectively. The actual official landings contain catches by all gears, not only by the dominant ones.

The bycatch of turbot by the sprat trawl fisheries (SPR_OTM, Table L.7) has been estimated based on a limited sampling (from Bulgarian and Romanian sprat fisheries), where the percentage of turbot is estimated to 0.8% in the third quarter (when 35% of the catch is taken). These figures were then applied to the total sprat catch from all countries and resulting amount was assumed to form the bycatch of turbot by the SPR_OTM (Table L.6).

The IUU (Illegal, Unregulated and Unreported) fishing of turbot was explicitly presented as a separate fleet (IUU) as it is assumed to represent about 65 % of the total catch (2011-2013 average).

The method of estimating the IUU catch has been explicitly presented in the Interim report and the STECF (2014). As the age composition of the IUU catch is unknown, the age composition of the total reported catches has been used to distribute the estimated IUU catch by age groups for the purpose of stock assessment (STECF 2014).

Finally, the only reliable economic information is the average value of the turbot catch, which is reported to be 15.12 euros per kg (Goulding et al. 2014). Value of the total catches of turbot is presented in Table L.7. It decreases about twice since 2000 following the trend in the catches.

Table L.7. Catches (t) of turbot fleet and their value (euros)

Fleets	Bul_GNS	Rom_GNS	URG_GNS	Tur_OTB	SPR_OTM	IUU	Total	Value
2000	55	2	93	2639	122	0	2911	44012
2001	57	13	164	2323	193	0	2749	41568
2002	136	17	130	335	196	754	1567	23697
2003	41	24	140	219	117	581	1122	16960
2004	16	42	142	234	110	598	1142	17270
2005	13	37	144	548	126	533	1400	21170
2006	15	35	170	747	107	677	1751	26469
2007	67	48	221	699	76	1147	2259	34156
2008	55	47	256	458	94	1213	2122	32088
2009	52	49	287	342	106	1241	2078	31423
2010	46	48	232	295	97	1019	1738	26278
2011	38	43	260	145	94	1079	1659	25080
2012	36	43	267	172	64	1122	1704	25770
2013	40	43	223	194	49	973	1522	23006

SECTION 3 - DELAY THE SIZE AT FIRST CAPTURE BY AREA CLOSURE

There are at least two possible ways to deal with the undesired catch of small-sized individuals. One is to modify gear characteristics so as to allow more small fish to escape (e.g., increase mesh size). In mixed fisheries such as those occurring in the Mediterranean, where the catch is composed by many species and many of them are small-sized even when they are adult, the increase of mesh size aimed at a better exploitation pattern and reduction of discards of undersized individuals of certain species may result in considerable escapement of individuals of other species with consequent important economic losses. Gear modifications other than increasing mesh size can be done (e.g. escapement windows), but effectiveness may be variable and species-specific as it mainly depends on the behavior of each species. The utilization of gears characterized by different selection ability at different depths, different grounds or when targeting different stocks can be effective, but such measures work better when a single species dominates the catch. However, that is not a common case in Mediterranean fisheries, especially in fisheries operating over the continental shelf.

Alternative ways to avoid the capture of undersized individuals could be to restrict operations in specific grounds where nurseries occur (i.e. at certain depths, areas and/or over specific types of substrate) or to restrict fishing in certain periods of the year that coincide with the recruitment of exploited species. However, this strategy may not be equally efficient for all exploited species as different species may exhibit different recruitment time schedules and juveniles may exhibit different levels of aggregation. In any case, many demersal species are known to recruit at the littoral zone, especially in early summer. In some countries, seasonal fishing bans have been enforced in coincidence with this process. A prohibition to operate in the 3 miles stripe or under 50m of depth is already enforced for trawlers (EU Reg. 1967/2006) but further measures can be enforced for those species that recruit in deeper waters, such as hake.

It is difficult to provide quantitative estimates of the potential impacts associated with improvements in the selectivity of fishing gears. The same difficulties apply for the evaluation of the likely consequences of the enforcement of any alternative technical measure (when and where to fish). While short-term losses can be expected, at a medium- and long-term a better exploitation pattern should have positive consequences on the age structure of the stock at sea and in productivity (Maravelias et al. 2014).

MEDITS time-series can provide some useful information to estimate local abundance indices of the population fraction below the MLS for those species appearing both in the list of the Annex III of the EU Reg. 1967/2006 and in the MEDITS reference list. This can be achieved by analyzing the distribution of such indices in different MEDITS depth strata and geographical sub-areas. This information can help to give insight on the potential availability of such population fraction to the towed gears and possibly identify depth strata/areas where risk of catching population fractions below the MCRS of some important demersal species is higher.

MLSs as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. Abundance indices by year and depth stratum were computed according to the MEDITS protocol (Fig. 9.1-9.6). More recent data, i.e. those related to the last 5 years were used.

From the figures from 3.1 to 3.6 it can be seen that individuals at length below the MCRS of species living more inshore, that are target of the fisheries (as Mullus sp. Pagellus sp.) or frequent by catch (Trachurus sp.) are also present in waters deeper than 50 m, although to a lesser extent compared to the depth range from 10 to 50 m. Thus, there is a fraction of the population that is not under protection of the Reg. 1967/2006. Such fraction could be protected extending the area to be forbidden to trawlers also offshore 50 m and, for example, to 80-100 m depth, at least in some seasons (i.e. late spring-summer), when the young of the year of some key species are still present in more coastal waters. This will not however protect those species as hake, which young of the year concentrate in deeper waters (100-200 m depth). In this case measure for protecting nursery areas can be introduced.

In Colloca et al. (2015), the distribution of nursery areas of 11 important commercial species of demersal fish and shellfish was analysed in the European Union Mediterranean waters using time series of bottom trawl survey data with the aim of identifying the most persistent recruitment areas.
A high interspecific spatial overlap between nursery areas was mainly found along the shelf break of many different sectors of the Northern Mediterranean indicating a high potential for the implementation of conservation measures. Several patches of co-occurrence of nursery areas of multiple species were identified along the coast of the Ligurian and North Tyrrhenian Sea, Northern Adriatic Sea, South Adriatic Sea.
The localization of the more persistent nursery areas was reported in the Interim Report of this study. Area of concentration and overlap were identified in the Pomo pit in the north-central Adriatic sea , in the south Adriatic sea along the border of the Bari pit, in the Northern Tyrrhenian sea, south of Elba Island, and in the Gulf of Lion (Morfin et al., 2012) if the case studies encompassed by this project are considered.

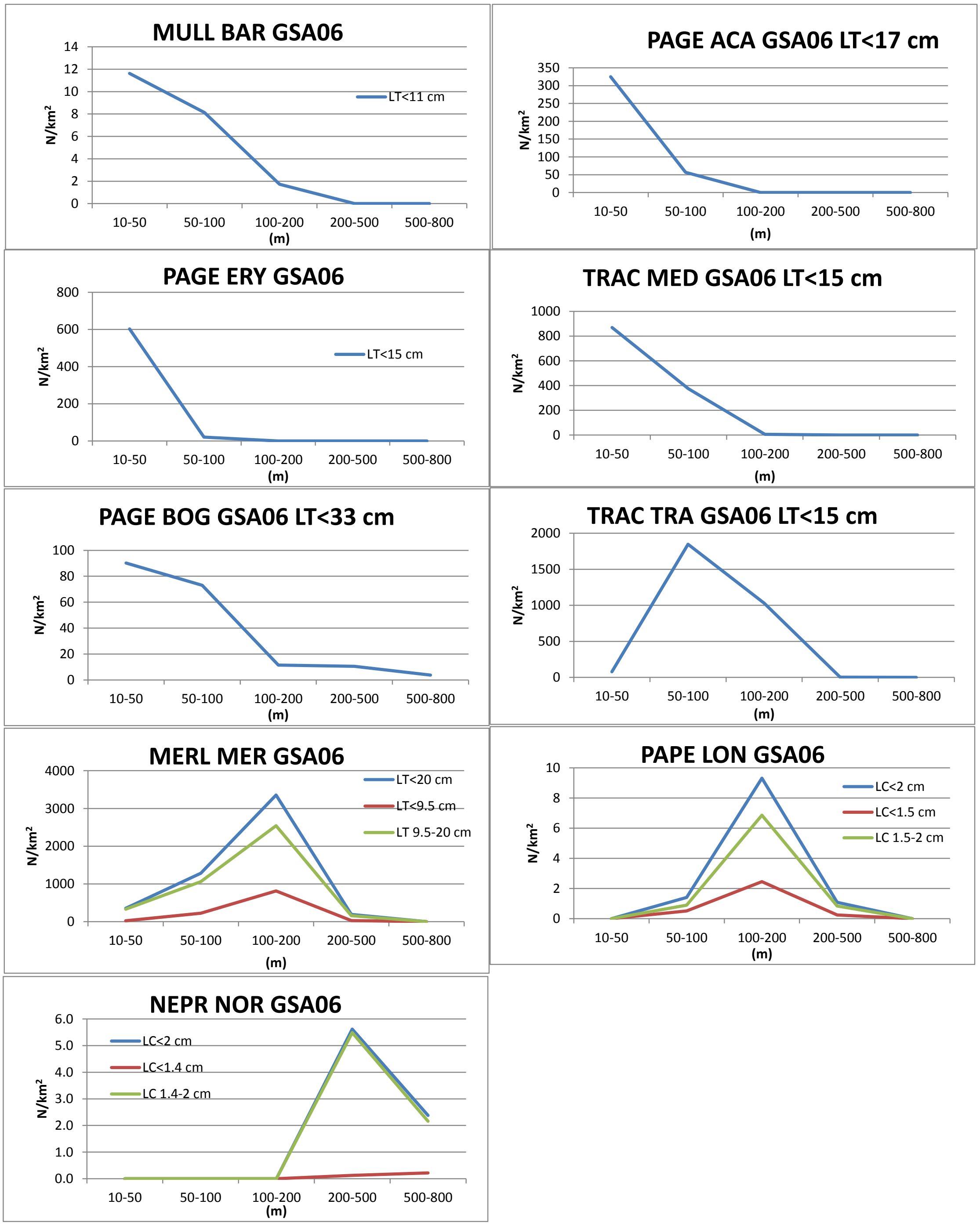


Fig. 3.1 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA6.

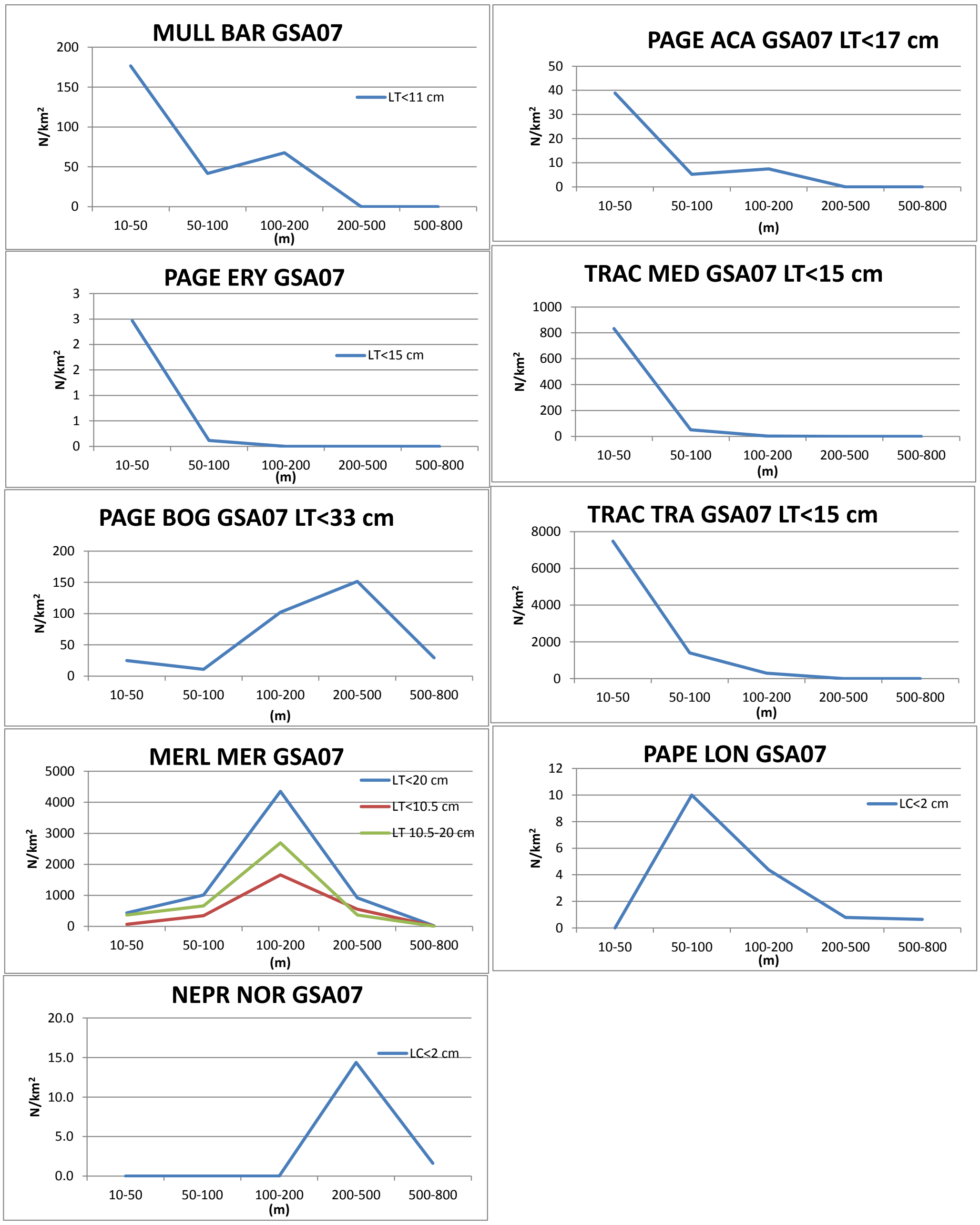


Fig. 3.2 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA7.

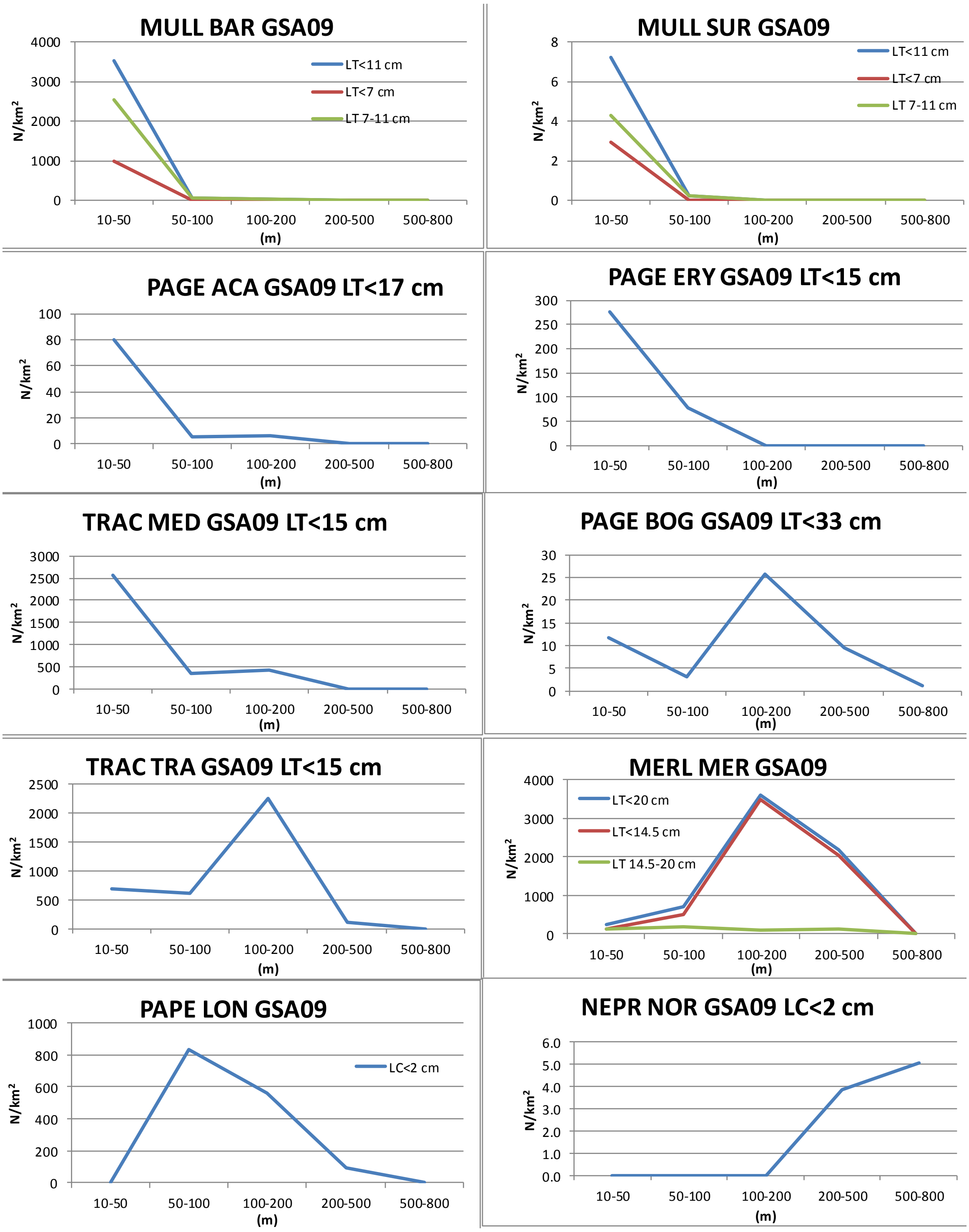


Fig. 3.3 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA9.

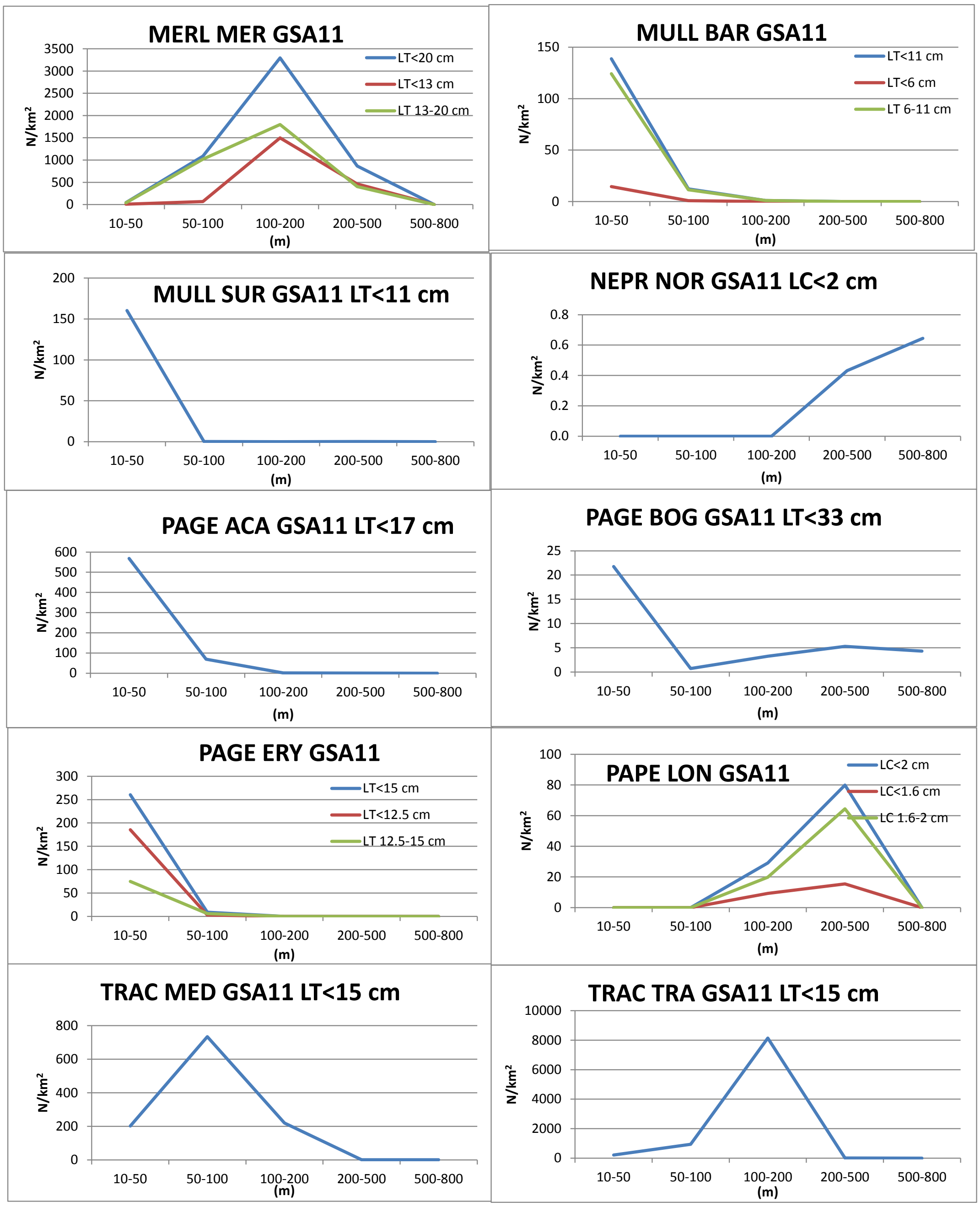


Fig. 3.4 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA11.

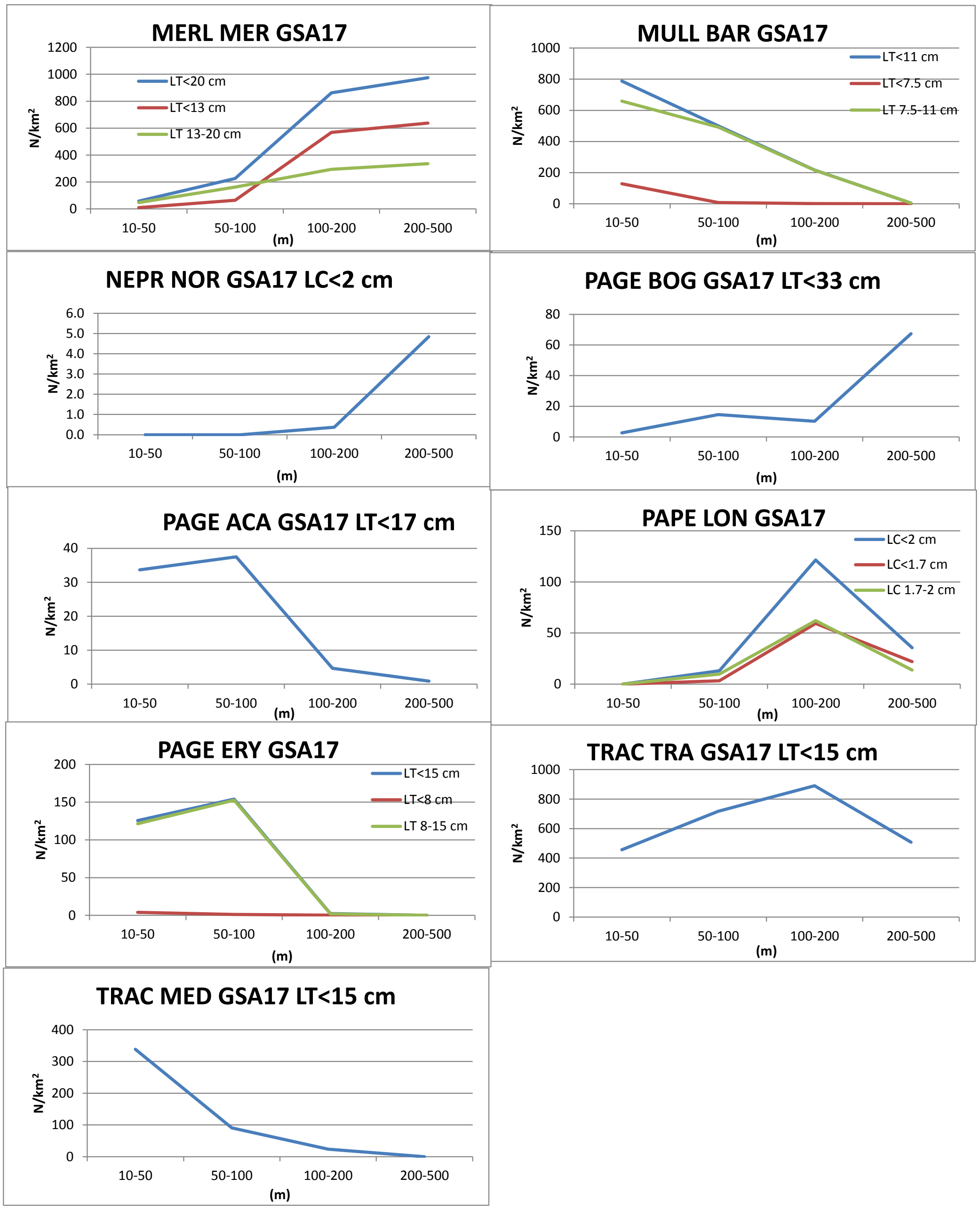


Fig. 3.5 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA17.

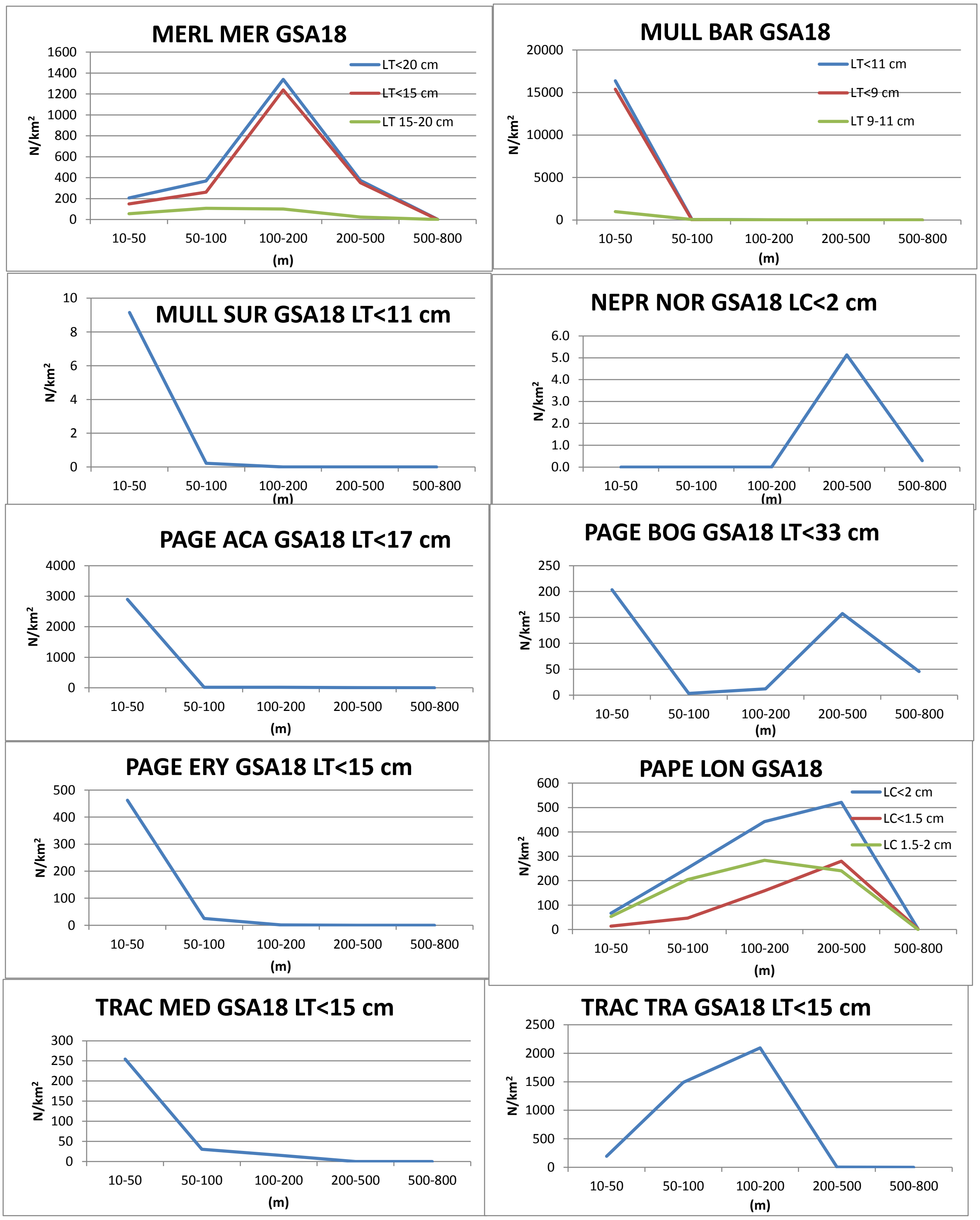


Fig. 3.6 Abundance indices by year and depth stratum computed according to the MEDITS protocol (last 5 years used). Minimum Conservation Reference size as well as the thresholds based on recruitment size as used in MEDISEH project were taken into account. GSA18.

SECTION 4 – REGIONAL COOPERATION

4.1 OVERALL GOVERNANCE AND POTENTIAL INVOLVEMENT OF STAKEHOLDERS

The preparation of multi-annual management plans require the definition of the following elements: the general scope, quantifiable targets, conservation reference points, technical measures to be taken in order to achieve the targets set and avoid/reduce unwanted catches.

The principal aim of the Common Fisheries Policy (CFP) is to achieve maximum sustainable yields (MSY) for all stocks at the latest by 2020. Setting MSY objectives (or its proxies), in the Mediterranean multispecies and multiple fishing techniques context, also implies to explore different management scenarios and how technical measures can affect the exploitation pattern towards MSY objective.

Ultimately, EU multi-annual plans should define trajectories balancing ecological and economic aspects, while considering the overall governance framework.

An adequate preparation of multi annual management plans includes different management measures, various regulatory objectives and rely on adaptive/participative co-management, whereas a limited approach would consist in a short time consultation of stakeholders by managers. However, a key to the success of the EU multi-annual plans (their preparation and implementation) mostly depends by the methodology that time to time will be used.

According to the reformed Common Fisheries Policy, support and participation from managers, at EU and national level, shall be constant and open dialog shall be promoted between managers, scientists and administrations. The pyramidal institutional set-up, where managers keep the information and alternatively manage advisory channels (scientific advice and stakeholder advice) shall disappear in favour of common work. Such methodology does not hinder final decision to remain within the competent authorities according to arrangement proposed in the EU Reg. 1380/2013.

All fishing interests should be represented in the process, either from the fishing sector or from other interested groups. Within the fishing sector the various existing interests are often diluted into the umbrella organization, where the internal balance of powers sometime lead to position more linked to the large scale sector. Particular attention should therefore be paid to the legitimate representation of the small-scale sector interests.

The participatory process of the fishing sector should also include to direct consultation (e.g. interviews) of fishermen who do have empirical knowledge about essential fish habitat, species behaviour and migratory routes. Their feedback/perspective should also be gathered regarding management scenarios and technical conservation measures to be taken in order to achieve the target results and reduce unwanted catches. Proposals coming from fishermen should also feed the scientific process.

The principal aim of the EU multi-annual plans primarily focus on reaching MSY, however, fishery is an economic activity and fishermen are constantly adapting their practise in order to guarantee their revenue. Indeed, their income depend on catches, quality of their products, market demand, but also public incentives (subsidies, tax regime, etc.); their costs depend on different factors such as fuel, crew salaries, equipment, etc. This complex reality should be taken into account when the scientific advices are outlined. Therefore, the simulation of alternative management scenarios should consider temporal and spatial measures, as well as thresholds values for parameters such as the minimum resource allocation per vessel, minimum catches per vessel to maintain its profitability, etc.

Focus groups chaired by a facilitator would allow a more effective participatory process. The availability and the ability to understand, at the same time, concerns from managers (regulatory aspects, control issues, time-lines, political dimension, etc.), scientists (data availability, knowledge on species biology, population dynamic, etc.) and fishermen (practices, lifestyle, language issues, etc.) is key factor for a smooth process and a successful preparation and implementation of the multiannual plans.

4.2 A PARTICIPATIVE APPROACH: THE STAKEHOLDERS FEEDBACK

Introduction

A workshop on the implementation of MSY in four case studies (demersals and small pelagics of GSA6 and 7, GSA9 and 11, GSA17 and 18, GSA29) was held in Bari on September 21-25, 2015. The main items in the workshop agenda were: a) explore the different management possibilities to achieve MSY based on single-species, multiple-species, or stratified fleet stratus; b) translate reduction of fishing mortality into effort reduction; c) explore how technical measures (gear specifications, spatial and/or temporal restrictions) could modify the fisheries exploitation pattern; d) run the simulations, discuss the results, evaluate the biological and socio-economic implications. In addition to the researchers involved in the project, actively attended the workshop Mrs Rosa Caggiano and Mrs Erika Monnati from the MEDAC Secretariat, and Mr Xavier Vazquez Alvarez from DG MARE. Their participation allowed to begin an open dialogue with stakeholders and get feedbacks on the scenarios to be tested in the simulations process. Furthermore, it was agreed the venue, the date and the agenda of the final workshop with stakeholders.

The agreed scenarios to be tested with a bio-economic model were: 1) status quo projected to 2020; 2) linear reduction towards upper F_{msy} of the most heavily exploited species in 2018, applied on both activity and capacity; 3) linear reduction towards a weighted average F_{msy} of a mix of species in 2018, applied on both activity and capacity; 4) adaptive reduction towards upper F_{msy} of the most heavily exploited species in 2020, applied on both activity and capacity; 5) adaptive reduction towards a weighted average F_{msy} of a mix of species in 2020, applied on both activity and capacity; 6) improving selectivity accounting for the survivability issue (in case of gear selectivity).

The final workshop with stakeholders was held in Malta on November 10, 2015, back to back with the MEDAC Executive Committee meeting. The main items in the agenda were: a) criteria, trajectories and MSY approach for the preparation of multiannual management plans in the Mediterranean; b) management scenarios for the preparation of multi-annual management plans of demersal and pelagic stocks in selected GSAs (case study presentations); c) general discussion.

34 people attended the workshop on behalf of: 1) Federación Española de Empresarios del Mar; 2) Asociación de Empresarios Marítimos y Pesqueros; 3) Federacion National de Cofradias de Pescadores; 4) Federacio Nacional Catalana De Confraries De Pescadors; 5) General Direction of Fishing and Maritime Affairs of the Catalan Government; 6) Ministerio de Agricultura, Alimentación y Medio Ambiente; 7) Le Comité national des pêches maritimes et des élevages marins; 8) Direction des Pêches Maritimes et de l'Aquaculture; 9) Ghaqda Koperattiva Tas Sajd, Malta; 10) Department of fishery and aquaculture Malta; 11) Alleanza Cooperative Italiane; 12) European Transport Workers Federation; 13) World Wide Fund for Nature; 14) Lega Ambiente; 15) Project Research Institutes 16) MEDAC; 17) EASME.

The President of MEDAC, Mr Giampaolo Buonfiglio, underlined that long term management plans are currently not being developed and noticed that no plan was adopted within the framework of the new Common Fisheries Policy. Therefore, Mediterranean management plans currently in force remain those based on EU Regulation 2006/1967. He expressed the belief that a lot of work should be done to focus on management scenarios.

From the stakeholder point of view, the spatial management is getting more and more importance for the preparation of multiannual management plans. Therefore, the reduction of the fishing effort should be mainly based on the management of sensitive habitat, such as nursery or spawning grounds, through the definition of control policies and criteria for the rotation or temporal closure of such sensitive areas.

The project coordinator, Mrs Maria Teresa Spedicato, introduced the participants to the main objectives of the project MARE/2014/27. It is a 8 months project focusing on 3 tasks : a) characterize stocks, fisheries and current management measures; b) exploring different management options to achieve MSY by 2018 and 2020; c) communicate results, engage stakeholders. The case studies are : turbot fishery in GSA 29, demersal and pelagic fisheries in GSAs 17-18, demersal and pelagic fisheries in GSAs 8-9-11, and demersal and pelagic fisheries in GSAs 6-7.

The first step of the project (state of the art) consisted in the identification of stocks, fishing areas, and current management measures in place. The selected management scenarios are built taking into account the relative impact of the different fleet segments and the multi-specific dimension of Mediterranean fisheries. For each case study, two approaches were explored: a linear reduction and an adaptive reduction (which implies a lower reduction in the short term and a sharp reduction thereinafter, or vice-versa, case by case) towards F_{MSY}, either in 2018 or 2020. The amount of reduction was established on the basis of the results from the assessments endorsed by STCEF or GFCM and the related diagnosis, except in case of selectivity scenarios. One scenario is based on the F_{MSY} range (F_{MSY} upper and lower values) of the most heavily exploited species. F_{upper} should be used in association with a Management Strategy Evaluation (MSE) to test if the upper levels of the range is precautionary (i.e. the risk that SSB falling below B_{lim} is less than 5%). An alternative scenario, instead of using the F_{MSY} range, is based on a weighted average F_{msy} derived from a mix of species (weighted using landings values or quantities). Both the above mentioned scenarios account, to some extent, for mixed fishery considerations. It is worth to highlight that in the second scenario the F_{MSY} of the most heavily exploited species will not be reached in 2020 but, in return, will be avoided waste of productivity for the less exploited species. The conversion of fishing mortality into effort reduction can be applied both on capacity (i.e. number of vessels) and activity (number of fishing days). Scenarios of reduction of activity or capacity are designed taking into account social considerations (feedback from the sector) or management decisions in force. A specific scenario was considered for the selectivity, which consists in delaying the size at first catch (called "improving selectivity"). This objective could be achieved by improving the gear selectivity or by applying spatial measures to protect juveniles, such as rotation or temporal closure of sensitive areas (e.g. nursery areas). For each case study uncertainty margins have been included and all scenario is compared with the *status quo*. Among the objectives of the workshop there is also to solicit stakeholders to express comments and reflections on the project results and governance issues.

Discussion

Questions. A representative of the European Transport Workers Federation asked if socio-economic data have been updated and what the sources are. A representative of the Maltese Administration asked whether it is possible to make comparison between values of MSY.

Answers. All the data, not only the economic data, are collected year by year (Data Collection Framework) according to the Reg.(UE) N. 1380/2013. Comparison can be carried out among scenarios based on F_{MSY} upper on the most heavily exploited species and scenarios based on the F_{msy} derived from a mix of species. Results are also expressed in relation to the different fleet segments.

Case study GSA 17-18 Small pelagics

Selected species (2): Anchovy, Sardine.

Selected fleets (10):GSA17 pelagic trawlers 12/18 m-18/24 m-24/40 m, purse seine 24/40 m, GSA18 pelagic trawlers 24/40 m, purse seine 24/40 m (Italy); GSA17 pelagic trawlers 12/18 m-18/24 m-24/40 m (Croatia); GSA17 pelagic trawlers 12/18 m (Slovenia).

Scenario results: According to a MCDA, the scenarios allowing to reach the highest overall utility are scenarios 4 (linear reduction towards E0.4 of anchovy in 2018) and 5 (adaptive reduction towards E0.4 of anchovy in 2020), while the lowest utility is given by Scenario1 (status quo).

Case study GSA 17 demersal

Selected species (4): Hake, Spottail mantis shrimp, Red mullet, Common sole.

Selected fleets (11): trawlers 6/12m-12/18m-18/24m, beam trawlers 12/18m-18/24m, polyvalent passive gears 06/12m (Italy); Drift/fixed netters 06/12m, trawlers 06/12m-12/18m-18/24m (Croatia); Drift/fixed netters 06/12m, trawlers 12/18m (Slovenia).

Scenario results: According to a Multi-Criteria Decision Analysis approach (MCDA), the scenarios that allows to reach the highest overall utility are scenarios 3 (linear reduction towards a weighted average F_{MSY} for a mix of species, in 2018) and 2 (linear reduction towards upper F_{MSY} of the most heavily exploited species, in 2018), with utility respectively of 0.60 and 0.58. While the lowest utility is given by Scenario 1 (status quo).

Case study GSA 18 demersal

Selected species (4): Hake, Deep-water rose shrimp, Norway lobster, Red mullet.

Selected fleets (10): trawlers 6/12m-12/18m-18/40m, long-liners 12/18m, small scale <12m (Italy); trawlers 12/24m (Albania); trawlers 6/12m-12/24m, long-liners <12m, small scale <12m (Montenegro).

Scenario results: On an overall basis, the best performing scenarios are n° 2 (linear reduction towards upper F_{MSY} of the most heavily exploited species, in 2018) and 3 (linear reduction towards a weighted average F_{MSY} for a mix of species, in 2018). The best results in terms of catches is produced by scenario n° 6 (improving selectivity) although it does not ensure reaching F_{msy}. Strictly enforcing F_{msy} based on the most overexploited species would lead to underutilization of the remaining stocks.

Case study GSA 9 demersal

Selected species (4): Hake, Deep-water rose shrimp, Norway lobster, Red mullet.

Selected demersal fleets (5): trawlers 12/18m-18/24m-24/40m, polyvalent passive gears 00/12m-12/40m (Italy).

Scenario results: According to a MCDA, the scenarios allowing to reach the highest overall utility are scenarios n° 2 (linear reduction towards upper F_{MSY} of the most heavily exploited species, in 2018) and 4 (adaptive reduction towards upper F_{MSY} of the most heavily exploited species, in 2020). The best results in terms of catches is produced by scenario n° 6 (improving selectivity) although it does not ensure reaching F_{msy}. Strictly enforcing F_{msy} based on the most overexploited species would lead to underutilization of the remaining stocks.

Case study GSA 9 Small pelagics

Selected species (2): Anchovy, Sardine.

Selected demersal fleets (3): purse seiners 12/18m-18/24m-24/40m (Italy);.

Scenario results: the two scenario tested based on a linear and an adaptive reduction towards the reference point of sardine gave the same results in terms of utility. SSB of both stocks, anchovy and sardine, improved, while catches were decreasing by a low percentage (around 1-3%), with a limited socio-economic impact.

Case study GSA 11 demersal

Selected species (3): Hake, Giant red shrimp, Red mullet.

Selected demersal fleets (5): trawlers 12/18m-18/24m-24/40m, polyvalent passive gears 00/12m-12/18m (Italy).

Scenario results: the scenarios 2 and 4, based on Fupper of hake, allow to reach a higher overall utility, with value respectively of 0.42 and 0.39; these are followed by scenario 3 based on the target of Fmsy combined to 2018 (0.34), while the lowest utility is reached by the status quo (0.22).

Case study GSA 6 demersal

Selected species (5): Hake, Deep-water rose shrimp, Blue and red shrimp, Red mullet, Blue whiting.

Selected fleets (7): trawlers 12/18 m-18/24 m-24/48 m, long-liners 6/12 m-12/18 m, gillnetters 6/12 m 12/18 m (Spain).

Scenario results: The best performing scenario is n°6 (improving selectivity), although it does not ensure reaching F_{msy}. Strictly enforcing F_{msy} based on the most overexploited species (hake) would lead to underutilization of the remaining stocks.

Case study GSA 7 demersal

Selected species (2): Hake, Red mullet.

Selected fleets (9): trawlers 12/18 m-18/24 m-24/40 m (France); trawlers 12/18 m-18/24 m (Spain), long-liners 12/18 m (Spain); gillnetters 0/6 m-6/12 m-12/18 m (France).

Scenario results: Scenario 6 (improving selectivity) does not allow reaching Fmsy for any of the 2 target species, but the results show a significant increase in spawning stock biomass of both species and keeping landings at high levels.

Discussion

Questions. The Coordinator of MEDAC Working Group on Discards expressed concerns about the consequences for the fishing sector due to the amount of reduction of fishing effort for pelagic trawlers to reach MSY.

The representative of WWF underlined the importance of including spatial considerations in the analysis and asked further specifications about how have been set into the scenarios spatial management measures. In addition she asked whether there are studies on the impact of fishing into nursery areas, because it would be easier to propose management measure knowing the effects and the impact of each measure.

The representative of the Federacio Nacional Catalana De Confraries De Pescadors expressed concerns about the methods to assess the stocking status of small pelagics. Starting from the case of sardine in Catalogna, he argues that the stock status cannot be explained through the level of fishing mortality. Indeed, landings have dropped and sexual maturity size has decreased in spite of the reduction of the fishing effort. Environmental factors, such as temperature increase or pollution could explain this evolution.

The representative of European Transport Workers Federation asked how were decided the timelines for the scenarios and if it is possible to project further forward scenarios.

Answers. At least one scenario based on changes of selectivity has been analysed in each case study. Selectivity improvements could be achieved through spatial management measures (limiting or prohibiting access to zones where juveniles are concentrated) or changing/modifying fishing gears (e.g. increasing mesh size). Specially for demersal species there is a good knowledge on nursery areas (cfr. MAREA-MEDISEH project), which can be a good starting point for further investigate spatial management measures. Also extending the ban on trawling over the isobath of 50 m, in some period of the year, would allow to protect the recruitment of some species (e.g. red mullet). Scenarios where selectivity measures are intermixed with reduction of the fishing effort could achieve MSY in a less traumatic way for fishermen.

Environmental factors, such as temperature increase or pollution, may influence recruitment and/or mortality, particularly in respect of small pelagic. But this influence can play in both senses (positively and negatively), that is why buffers should be set in order to limit the risk on resources. Also because the only manageable factor is fishing mortality and not the climatic events.

The timeline is actually set by the Reg.(UE) N. 1380/2013. All scenarios have been designed to achieve MSY in 2018 or 2020. The bio-economic model used (i.e. BEMTOOL) allows to project further forward scenarios, but this would increase the uncertainty on the results. Mainly because we are working without stock recruitment relationships (reliable SRR would require much longer time series of data). A further element of unpredictability is given by the fact that all simulations are based on a strict compliance of all the management measures in place (e.g. mesh size, closed areas). Obviously the robustness of the results is directly linked to the level of compliance.

Conclusion

The President of MEDAC, Mr Giampaolo Buonfiglio, underlined the utility of the work done for the MEDAC. He highlighted the importance of considering the project results as an input for the internal work of the AC. Indeed, the worst scenario for the AC would be if the European Commission would consider such project results like unilateral emergency measures to be taken. In such case, the Advisory Council (AC) would have lost the opportunity to negotiate the long term management plans. Taking into account the socio-economic impacts of a drastic reduction of the fishing effort (or fishing capacity), he believe that it should be further explored how to achieve MSY by intermix spatial-temporal measures with a less drastic reduction of fishing effort. Moreover, scenarios based on a weighted average F_{msy} derived from a mix of species, instead of using the FMSY range of the most heavily exploited species, are considered a really appropriate alternative. He hopes that this view could be of interest for the European Commission and the Member States. On the other hands, it is duty of MEDAC to advice the Commission on which measures could be more welcomed than others by the fishing sector.

The project coordinator, Mrs Maria Teresa Spedicato, concluded the workshop by saying that these project results can be considered as a starting point for future analyses and, to this purpose, the workshop has been an excellent opportunity to compare and exchange different points of view and feedback on critical issues.

SECTION 5 - CONCLUDING REMARKS

Main findings and conclusions regarding the **scenario modelling and MSY** approach from case studies can be summarized as follows.

a. For small pelagics in GSA17 and GSA18, all the performed scenarios allow to obtain a benefit on the SSB of the 2 stocks in respect of the status quo. The best performance for anchovy and sardine SSB is showed by Scenario 2 (respectively 23 % and 24 % higher than status quo). These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on this indicator if applied in a short time range. For both stocks the catches by fleet segment change according to the percentage of reduction applied and to the impact of the fleet segment on anchovy stock. A Multi-Criteria Decision Analysis approach shows that the scenarios allowing to reach the highest overall utility are scenarios 4 and 5 (overall utility about 0.75) based on the exploitation rate E0.4 as reference point. These scenarios are less impacting the economic and social components and share a comparable level of utility with scenarios 8 and 9, while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.548).

b. For demersal stocks in GSA06 the results of the projections show that, given the high ratio of current fishing mortality to Fmsy, the biomass of all stocks would strongly benefit from the required large reductions in fishing effort (80 to 90%, depending on the scenario). In the case of the more overexploited species (European hake and blue whiting) reducing fishing effort towards Fmsy would imply an increase in landings shortly after 2018 or 2020. However, most of the stocks remained underutilized.

c. Overall for demersal resources in GSA07, considering the results from the traffic lights approach, reducing the present high fishing mortality rates by 2018 (either the linear reduction to Fupper of the more overexploited stock or the F_{MSY} combined among the assessed stocks) would allow increasing in the long term catches and revenues, wages, as well as spawning stock biomass, though at the price of a very significant loss of employment and fishing units. Delaying the reduction of fishing mortality to 2020 would result in worse values of these indicators than at present, except for spawning stock biomass that would be kept at a high level. Improving selectivity allows to obtain from moderate to high increase in all indicators, keeping employment and vessels, at the price of not complying with Fmsy targets.

d. For GSA9 small pelagic stocks both the tested scenarios (reduction to 2018 or 2020) alternative to status quo allow to obtain a benefit in terms of SSB for both anchovy and sardine, and they appear to produce the same effect. Considering all fleet, the catches of anchovy are decreasing by a low percentage (around 1-3%), while those of anchovy are expected to decrease by around 10%. Revenues and employment are expected to decrease similarly in the two scenarios with a percentage around 3%. The reduction of employees is limited, given the limited amount of scraping. Salary and CR/BER (Current Revenues to Break Even Revenues) indicators are expected to improve in both scenarios of around 8-11%.

e. For GSA9 demersal stocks, all the scenarios alternative to the status quo produced an increase in SSB, although the best performance was shown by Scenarios based on Fupper target. In all the scenarios, catches of all stocks showed a decreasing pattern, with the only exception of Scenario 6 (increase selectivity), which produced a slight increase in catches for hake and Norway lobster. However, Scenario 6 was not improving the SSB of the four stocks as the other scenarios. In socio-economic terms, scenarios entail a high decrease in revenues, and a decrease in employment by about 5%.

f. For GSA11 demesal stocks the SSB of all the three demersal stocks remarkably increased, especially that of hake, and the better performing scenarios were those based on Fupper target. For European hake, catches will increase in the long term under all the scenarios alternative to the status quo.

Instead stocks of red mullet and giant red shrimp will remain underutilised. Results showed decrease revenues in the fleet segments more affected by management measures.

g. For GSA17 demersal stocks, all the performed scenarios allow to obtain a benefit on the SSB of the 4 stocks under consideration in respect of the status quo. The best performance for SSB is showed by Scenario applied in a short timeframe (2018), consistently with the greater benefit that generally the reduction of fishing mortality produces on this indicator if applied in a short time range. The worse result is observed in the status quo. According to the strategy by which the management measures have been applied, the Scenario using an F_{MSY} combined is more effective, given that in the specific situation of the local fisheries implies a wider safeguard from an ecological perspective. This because the target stocks of the fleets are different and not all the fleet are targeting the more exploited species (European hake) used as benchmark in the Fupper approach. From a social viewpoint, all alternative scenarios are expected to have a better impact on the average salary, that would improve in all scenarios, as a consequence of reduced costs, determined by the remarkable decrease of activity, except in the scenario 6 (selectivity), which does not implies such cost reduction. As a consequence of this dynamic the CR_BER indicator will fairly improve in all scenarios (between 19 and 28%) except in scenario 6. The indicator ROI (Return of Investments) also will improve.
h. For GSA18 demersal stocks, on an overall basis, the best performing scenarios are the ones characterized by the strongest reduction in the shortest timeframe. The SSB would have remarkable rebuilding especially for Norway lobster and European hake. Considering all the fleets, the best results in terms of catches is produced by Scenario 6 (selectivity) compared to the status quo. This is quite reasonable, as change of selectivity affects the exploitation pattern, but the effort is unchanged. Considering the other scenarios, there is a worse result for catches of the 4 stocks in scenarios, that apply the reduction in a prolonged time frame. The worst result is however observed in the status quo. The rebuilding of stocks such as European hake and Norway lobster would mitigate the situation of losses of stocks such as deep water pink shrimp and red mullet that will be underutilized. It should be considered that Italian trawlers are expected to have a performance worse than status quo in Scenarios based on Fupper. More particularly all these fleet segments will have a severe reduction of revenues, up to -50%. As effect of cost reduction the overall economic performance is improving if salary and the indicator CR/BER are considered. The reduction of employees is limited, given the limited amount of scraping. The indicator ROI will also improve.
i. Regarding case study on GSA29 – Black Sea (the present simulation studies encompassed that of the turbot fisheries in GSA 29), the most important management action would be to establish an effective control on the illegal fishing. If this is done, than a total ban on the fishery would bring the SSB above the reference points Blim and Bpa, by 2018 and 2020, respectively. On the other hand, successful recovery by 2020 is impossible, if IUU fishing is not controlled (continue fishing at its status quo level), by any option applied only to the "legal" fisheries, including their ban (but not stopping the IUU). Scenario versions with immediate or fast restrictive effects (e.g. linear reduction until 2018) are more efficient in achieving recovery, than delaying action (adaptive) scenarios, because of the heavily overfished state of the stock. Given that turbot stock is at its historical minimum (the STECF EWGs have repeatedly advised the closure of the fishery as the most appropriate management action that should be taken to assure the recovery of the stock) action should be taken. Our study demonstrates that given the biological characteristics of the stock, a relatively fast recovery (in 5 years) can be achieved, by completely closing the fishery and not allowing any IUU fishing.

Spatial considerations

An analysis on the possibility of introducing management measures based on spatial consideration has been made using MEDITS (Mediterranean Trawl Survey) time series (chapter 9 of this report) and taking into account the results from MEDISEH project (MAREA Framework). There are parts of the populations of some key demersal species that could be protected extending the area to be forbidden to trawlers for example to 80-100 m depth, at least in some seasons (i.e. late spring-summer), when the young of the year of some key species are still present in more coastal waters. This will not, however, protect those species as

European hake, which young of the year concentrate in deeper waters (100-200 m depth). In this case measures for protecting nursery areas can complement the protection of the young of the year. Such areas were identified in MEDISEH project and were overviewed in this project in task 1.

Remarks, assumptions and limitations regarding the case studies

i. The assessed species are fully representative of the production of small pelagic species, while the situation is differentiated for the demersal fisheries, especially among fleet segments of vessels using polyvalent passive gears and trawlers. In general, for the latter, the assessed species are fairly representative of the demersal production.

ii. The limited number of stocks for which assessments are available, in some cases, can be a factor affecting the bioeconomic analysis. In addition, in some situations, the assessments go back to some years ago (for example 2010 for anchovy in GSA9, or 2011 for spottail mantis in GSA17). This implies to make some assumptions in the scenario modelling related to the fishing mortality for the years following the benchmark time of the assessment.

iii. Stock-recruitment relationships are not available, thus geometric mean was used to project stock. This is considered a conservative approach, nevertheless, because the influence of environmental trends cannot be taken into account, the results of the scenarios should be considered as indicative.

iv. F_{MSY} ranges approach was applied to all case studies (except small pelagics in GSA9 in which E0.4 approch only was used). In some of the case studies this approach was also complemented by a combined F_{MSY}, or E0.4, depending on the stocks. Is some situations, the approach of the F_{MSY} combined was helpful in taking more into account a multispecies component of the fisheries, in particular the underutilization of some stocks, though F_{MSY} of the more exploited stocks was not reached.

v. The methods assume that present bioeconomic conditions (recruitment, stock abundance, cost structure, fish and fuel prices) will not change strongly or will randomly change in the period 2015-2020.

vi. The reduction of fishing mortality is linearly translated into reduction of fishing effort (lacking other specific information), under the assumption of nearly constant or randomly varying catchability. However, even in presence of severe reductions, the effort limitations applied might be not enough to reach the F_{MSY} objectives, or be excessive, given that the effort used for setting the management measures is not, in most of the cases, a specific effort directed to the target species (for the multispecific nature of the Mediterranean fishery).

vii. In the analysis of case study results the Multicriteria Decision Analysis was an helpulf support for making weighed comparisons of the results.

viii. The availability of economic data in the western Mediterranean is limited and the level of aggregation is not in line with the biological one. This implied in the simulations of bioeconomic modelling to making some assumptions or deriving the data at a more fine aggregation level through estimation processes.

ix. The fishing effort is generally decreasing in the western Mediterranean (GSA06, 07, 09, 11), especially the one related to trawlers, and in the Adriatic as well.

x. In many situations the economic and social indicators used to describe the current performance of the sector evidencenced an existing situation of deterioration, revealed by the recent negative trend of the examined indicators: revenues, salary, employement and economic balance indicator.

xi. The review on the Black Sea has revealed some major gaps of information needed for assessment of the turbot fisheries in the Black Sea and to design suitable management measures. Some of the major gaps are: a) Catch data: low quality of official landings statistics by countries; lack of estimates of IUU fishing; lack of data about discards and by-catch rates of turbot in trawl and gillnet fisheries; b) Fishing effort: scarce and not reliable data for some fleets; lack of standardized fishing effort data; c) Fleet structure: lack of information about fleet segments structure from Ukraine, Russia and Georgia; lack of data about fishing capacity in Turkey, d) Fishery-independent data: lack of survey data about turbot abundance from Georgia, Russia and Ukraine since 1997; incomplete datasets from Bulgaria and Turkey; e) Lack of data about balance indicators from non-EU countries; f) Lack of data about economic performance from non-EU countries.

xii. Most of the considered small pelagics and demersal stocks are overexploited, in some situations are chronically overexploited (e.g. European hake in the Gulf of Lion), with the exemption of deep water rose shrimp in GSA9, that is sustainably exploited, and the stock of red mullet in GSA18.

xiii. To bring the stocks for which the ratio between the current fishing mortality and target fishing mortality is high (for example European hake with Fcurrent/F_{MSY} ratios ranging between 4 and 15) in safe conditions, strong reductions of fishing mortality are necessary. Given the multispecies nature of Mediterranean fisheries and the co-occurrence of species with different life history traits and stocks with different productivity, drastic management measures will unavoidably imply an underutilization of some stocks.

xiv. Considering the possible social and economic consequences of reduction of fishing effort, the scenarios to be modelled were projected in two timeframes (2018 and 2020), taking into account two possible different patterns of reduction: linear and adaptive.

xv. Large reductions in fishing mortality for stocks that have been subject to high exploitation rates for decades are difficult to achieve only with the current paradigm of effort control in the Mediterranean. This should be complemented with changes in exploitation patterns (gear selectivity, seasonal and spatial area closures).

xvi. The demersal fleet has legal access to all demersal stocks, hence it is not possible under the current management plan focus on stock-by-stock effort reduction to achieve individual stocks Fmsy (which would help minimize the problem of stock underutilization). Furthermore, the fleet segments are heterogeneous in fishing capacity, costs, and fish selection profile.

Perspectives from the stakeholders

The final workshop with the stakeholders was held in Malta on November 10, 2015, back to back with the MEDAC Executive Committee meeting.

The main items in the agenda were:

a) criteria, trajectories and MSY approach for the preparation of multiannual management plans in the Mediterranean;
b) management scenarios for the preparation of multi-annual management plans of demersal and pelagic stocks in selected GSAs (case study presentations);
c) general discussion.

The stakeholders underlined the utility of the project results for the MEDAC. It was highlighted the importance of considering the project results as an input for the internal work of the AC. Indeed, the worst scenario for the AC would be if the European Commission would consider such project results like unilateral emergency measures to be taken. In such case, the AC would have lost the opportunity to negotiate the long term management plans. Taking into account the socio-economic impacts of a drastic reduction of the fishing effort (or fishing capacity), it was expressed the need to further explore how to achieve MSY by combining spatio-temporal measures with a less drastic reduction of fishing effort. Moreover, scenarios based on a weighted average Fmsy derived from a mix of species, instead of using the FMSY range of the most heavily exploited species, were considered an appropriate alternative. Hopefully this view could be of interest for the European Commission and the Member States. On the other hands, it is duty of MEDAC to advice the Commission on which measures can be more welcomed by the fishing sector.

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ANNEX I - REPORT OF THE KICK-OFF MEETING

Project MARE2014_27 - Evaluation of specific management scenarios for the preparation of multi-annual management plans in the Mediterranean and the Black Sea

Kick-off meeting

Held on May 14, 2015 from 10.00 to 12.30 hours Italian time *via* skype.

Meeting agenda

The following draft agenda was circulated before the meeting and approved at the meeting:

1. discussion on the comments received from the project evaluation;
2. workplan for the first two months
3. preparation of the workshop foreseen at month 3
4. administrative issues

All the partners and expert participated to the meeting, the list of participants is reported in the Annex 1.

Maria Teresa Spedicato introduced the meeting, according to the agenda.

Regarding the comments received to the project the focus of the discussion was in particular to the inconsistency reported by the reviewer on the meeting with stakeholder, that was at month 5 according to the table of the activities in the proposal, while it was foreseen at month 7 in the text. After a short discussion it was clarified that the right statement is in the text, because it was considered unfeasible making the meeting the same month of the draft final report delivery. Benoit Guerin suggested to keep anyhow open the communication channel with stakeholders well before the meeting organization, in order to facilitate the participation process.

Regarding the working methods where there are data gaps it was decided to use all the available information (statistics, DCF economic, transversal and biological data, scientific surveys) and derive the missing information assuming similarities with the adjacent areas.

It was also decided that the coordinator will make a list of data to be asked by a data call. In the meanwhile the group starts to work with the available information in the respective Institutes/areas.

In addition, the group felt useful a presentation letter from the European Commission to facilitate the interactions with the Member States for data which are not mandatory at GSA level, such as some economic data.

As concerns the case studies, the experts highlighted that in the Gulf of Lions the small pelagics fisheries is practically closed, probably just a couple of vessels are still discontinuously working. It was thus decided to describe in details such situations in the reports foreseen for task 1. Regarding the demersal stocks it was highlighted that *Merluccius merluccius, Mullus barbatus, Nephrops norvegicus* and *Aristeus antennatus* are relevant species of most fleet strata in GSA6 while *Merluccius merluccius, Mullus barbatus,* and *Lophius* are relevant for GSA7 were these species were also assessed.

Regarding the case study on GSA8, 9 and 11 Paolo Sartor highlighted that for small pelagics a fishery practically exists only in GSA9, as in GSAs 8 and 11 these species are very scarce. Regarding other demersal species while at level of GSA9 assessments of many species are available, the same is not for GSA8 (none assessment) and 11 (few and not much robust). However all the available information from STECF-EWG meetings and GFCM meetings will be used as well as grey literature on commercial fisheries and especially trawl survey data.

Giuseppe Scarcella and Piera Carpi reported that for both small pelagics and demersals there are assessments available and updated in GSA17. In addition, this area has also been studied within the SEDAF project[10], thus it is necessary to make an update of the information and focus on particular management scenarios. Maria Teresa Spedicato added that the same is for demersal species in GSA18.

For the Black sea Marina Panayotova informed the group that the main species for the area is the turbot, for which also assessment results are available. DCF data (landings, effort, discards and economic data) are available only for Bulgaria and Romania, while for the other countries only catches can be available, although data from Turkey would be important. Time series could be based on 2007-2013 data.

Regarding economic data Paolo Accadia reminded to the group that if the data are available at Member State level they could be estimated at GSA level following the methodology applied at STECF level and even outlined in the BEMTOOL project[11][12]. In addition he informed the group that at the beginning of June JRC should upload the economic data for 2013.

The discussion was then focused on the issue related to Corsica (GSA8), for which the estimation method can be used, provided that some basic variables like number of vessels with kw and GT per fleet segment and time are available, as well as days at sea, landings and revenues. So checks should be made at GSA level to verify the availability of such information. To this purpose Benoit Guerin can try to supplement with infos from the area.

The economic data will be based on the variables as in the annual economic data call and report as from the official data call Ares(2015)421690 - 03/02/2015). These data will be available from the Annual Economic Report and related files: Basic data are also available at the "data dissemination tool" of JRC web site (http://datacollection.jrc.ec.europa.eu/dd/fleet/trans/graphs).

The group agreed to use as proxy of F_{MSY} $F_{0.1}$ if F_{MSY} is not available.

Following some considerations of the time to hold the Workshop foreseen at month 3 in the project and given some difficulties for travelling in south Europe during August the meeting decided to hold the Workshop on the week 21-25 September. This because in the week August 31 September 4 the STECF-EWG meeting is scheduled and the week after (September 7-11) the PGMED and the Regional Coordination Meeting of Mediterranean and Black Sea are scheduled.

Thus, regarding the revision of the project timeframe the group agreed on the re-arrangement reported in the table in Annex 2.

The coordinator took in charge to carry out the following tasks and circulate the relevant documents:

1) outline of the Data call for different type of data (biological and economic data);
2) outline a template to be proposed to the European Commission for a presentation letter;
3) outline a structure for the interim report.

For the administrative matter the coordinator solicited the participants to provide urgently the original of the administrative documentation by courier.

The meeting was closed around 12.30 Italian time.

10Lembo Giuseppe (coord), Giuseppe Scarcella, Evelina Sabatella, Nedo Vrgoč, Isabella Bitetto, Monica Gambino, Aleksandar Joksimovic, Vanja Cikes Kec, Jerina Kolitari, Roland Kristo, Bojan Marčeta, Olivera Marković, Edvard Avdič Mravlje, Ana Pešić, Dario Pinello, Rosaria Sabatella, Alberto Santojanni, Barbara Zorica and Maria Teresa Spedicato. SEDAF Final Report, 2015. pp 146.

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Annex 1

Participants to the kick off meeting:
Maria Teresa Spedicato, project coordinator COISPA, Italy
Giuseppe Lembo, COISPA, Italy
Paolo Sartor, CIBM, Italy
Mario Sbrana, CIBM, Italy
Giuseppe Scarcella, ISMAR CNR, Italy
Piera Carpi, ISMAR CNR, Italy
Georgi Daskalov, IBER BAS, Bulgaria
Marina Panayotova, IBER BAS, Bulgaria
Paolo Accadia, NISEA, Italy
Evelina Sabatella, Italy
Mariano Garcia, IEO, Spain
Francesc Maynou, Spain
Vanja Čikeš Keč, IOF, Croatia
Benoit Guerin, France

Annex 2

Revised table of the activities, milestones and deliverables (interim and final reports and workshops)

	months						
	1	**2**	**3**	**4**	**5**	**6**	**7**
activities and milestones	- preparation of toolbox and guidelines; - data call and collection of information for task 1; - organization of standing alone outputs of task 1	- inputs for task 2 - preparatory work for the implementation of the case studies at own desk by the experts, following the results of task 1	- implementation and running of the case studies at own desk (preparatory activity)	- compilation of the data used in the case studies; - implementation of task 3	-running of the case studies at the Workshop - fine tuning of the work done, - compilation of outputs of the case studies; - preparation of the draft Final Report	- revision process of the draft final Report	- revision process of the draft Final Report- - progress in task 3 and public hearing
Meetings and workshops	**kick off meeting by skype or other web-based communication supports**	skype or other web communication supports	skype or other web communication supports	skype or other web communication supports	**Workshop (one week duration)**	- skype or other web communication supports	**Meeting with stakeholder**
reports			**Interim Report finalization and delivery**		**draft Final Report finalization and delivery**		**Final Report**

ANNEX II - DATA CALL SPECIFICATIONS

Proposal for a Data Call for the project MARE/2014/27

Table with the specifications of data to be requested by an official Data Call for landings, discards, length and age compositions, fishing effort, biological parameters, trawl and hydro acoustic surveys in the Mediterranean and in the Black Sea - MEDITERRANEAN and BLACK SEA

These data will be based on the variables as according to the official data call Ref. Ares(2015)1710784 - 22/04/2015

N.	Survey	Time series	Files	Specifications
1	MEDITS (Mediterranean only)	1994-2014	TA, TB, TC	MEDITS-Handbook. Version n. 7, 2013, MEDITS Working Group: 120 pp.
2	MEDITS (Mediterranean only)	2012-2014	TE	MEDITS-Handbook. Version n. 7, 2013, MEDITS Working Group: 120 pp.
3	SCIENTIFIC SURVEY DATA (non MEDITS) in the Mediterranean and Black Sea	2002-2014 (and before 2002)	Format according to the official Data Call Table ABUND. Ref. Ares (2015)1710784 - 22/04/2015	Annual scientific survey ABUNDANCE by length and sex of pelagic and demersal species (MEDIAS, ECOMED, PELMED, DEPM and all hydro-acoustic surveys, all bottom trawl surveys)
4	SCIENTIFIC SURVEY DATA (non MEDITS) in the Mediterranean and Black Sea	2002-2014 (and before 2002)	Format according to the official Data Call Table BIOMASS. Ref. Ares (2015)1710784 - 22/04/2015	Annual scientific survey BIOMASS by length and sex of pelagic and demersal species (MEDIAS, ECOMED, PELMED, DEPM and all hydro-acoustic surveys, all bottom trawl surveys)
5	SCIENTIFIC SURVEY DATA (non MEDITS) in the Mediterranean and Black Sea	2002-2014 (and before 2002)	Format according to the official Data Call Table ABUND_BIOM. Ref. Ares (2015)1710784 - 22/04/2015	Annual scientific survey ABUND_BIOM. by length and sex of pelagic and demersal species (MEDIAS, ECOMED, PELMED, DEPM and all hydro-acoustic surveys, all bottom trawl surveys)
6	Fisheries catch data (including discards and biological parameters at age)	2002-2014	Format according to the Table A of the official Data Call Ref. Ares (2015)1710784 - 22/04/2015	Fisheries catch data (including discards and biological parameters at age)
7	Fisheries landings	2002-2014	Format according to the Table B of the official Data Call Ref. Ares (2015)1710784 - 22/04/2015	Fisheries landings at length data

8	Fisheries discards	2002-2014	Format according to the Table C of the official Data Call Ref. Ares (2015)1710784 - 22/04/2015	Fisheries discards at length data
9	Fishing effort data	2002-2014	Format according to the Table D of the official Data Call Ref. Ares (2015)1710784 - 22/04/2015	Fishing effort data by metier/fishing technique

Table with the specifications of data to be requested by an official Data Call for **economic and transversal data** - MEDITERRANEAN and BLACK SEA

The economic data will be based on the variables as in the annual economic data call and report as from the official data call Ares(2015)421690 - 03/02/2015)

Variable group	Variable	Years	Aggregation level
Employment	Number of engaged crew FTE national FTE harmonised	2008 -2013 2008 -2013 2008-2013	Yearly, by 1) Fleet segment, Supra-region, 2) National totals
Income	Value of landings Income from fishing rights Direct subsidies Other income Crew wages Value of unpaid labour Energy costs	2008 -2014* 2008 -2013 2008 -2013 2008 -2013 2008-2013 2008-2013 2008 -2013	Yearly, by 1) Fleet segment, Supra-region, 2) National totals
Costs	Repair and maintenance costs Other variable costs Other non-variable costs Rights costs Annual depreciation costs	2008 -2013 2008 -2013 2008-2013 2008 -2013 2008 -2013	Yearly, by 1) Fleet segment, Supra-region, 2) National totals
Capital and Investments	Vessel replacement value In-year investments Number of vessels	2008 -2013 2008 -2013 2008 -2014	Yearly, by 1) Fleet segment, Supra-region, 2) National totals
Capacity	Mean length overall Total GT Total kW Mean age Number of vessels by region	2008 -2014 2008 -2014 2008 -2014 2008 -2014 2008-2013	Yearly, by 1) Fleet segment, Supra-region, 2) National totals Yearly, by 1) Fleet segment, Supra-
Effort	Fishing days	2008 -2014*	Yearly, by 1) National Totals,
	Days at sea	2008 -2014*	Yearly, by 1) Fleet segment, Supra- GFCM-GSA (Mediterranean & Black FAO Area level 3 (All other regions) 2) National Totals
	Energy Consumption	2008 -2013	Yearly, by

			1) Fleet segment, Supra-region, 2) National totals
	Maximum days at sea ***	2008-2013	Yearly, by 1) Fleet segment, Supra-
Landings	Weight of landings per species	2008 -2014*	Yearly, by 1) Fleet segment, Supra-region,
	Value of landings per species	2008 -2014*	

* 2014 data not mandatory but requested from MS wherever possible in order to estimate economic projections for 2014. These data, if provided, will be flagged as preliminary in the 2015 Annual Fleet Economic Report and corresponding data tables.

** Optional

***Non-mandatory under the DCF

ANNEX III - REPORT OF THE WORKSHOP ON THE IMPLEMENTATION OF MSY IN THE DIFFERENT CASE STUDIES WITHIN THE CONTRACT EASME/EMFF/2014/1.3.2.7/SI2.703193 CALL MARE/2014/27 - EVALUATION OF SPECIFIC MANAGEMENT SCENARIOS FOR THE PREPARATION OF MULTI-ANNUAL MANAGEMENT PLANS IN THE MEDITERRANEAN AND THE BLACK SEA

September 21-25, 2015

Hotel Villa Romanazzi Carducci, Bari, Italy.

The project coordinator introduced the meeting thanking Mr. Javier Vazquez Alvarez from DGMARE for the attendance to the workshop that will be very useful for the decision on the scenarios to be implemented for the different case studies. She also thanked the colleagues participating to the meeting.
MT Spedicato recalled that the interim report has been rejected by the Commission and this has a negative impact on the project. A Revision of the report has been done and delivered to DGMARE, although the revision of task 1, particularly the case study on GSA 6-7, will require a second time checking that all the information there is coherent and summarizing as much as possible the different part, putting other tables and figures in annexes.
MT Spedicato presented the structure of the share-point and invited all the colleagues to use this tool in order to share information. She also updated on the documents that were uploaded in the share-point.
MT Spedicato informed the participants to the meeting that Rosa Caggiano and Erika Monnati from MEDAC will join the meeting on Thursday and Friday. Their participation will allow to get preliminary feedbacks on the scenarios to be tested in the simulations from MEDAC and agree on the agenda for the forthcoming meeting with the MEDAC.
The agenda (in Annex 1) was approved by the participants (Annex 2) to the workshop.
Spedicato underlined that the ToRs of the workshop reflect the project proposal.
Then the document in the Annex 3 on the Management possibilities, criteria and planned scenarios to reach F_{MSY} was in deep discussed and approved.

The meeting agreed on proposing the following approach.

- For small pelagics in the Adriatic the F_{MSY} and F_{MSY} range based on the stock-recruitment relationship for anchovy, as estimated at EWG 15-11, will be used, assuming the same reference point and range also for sardine. This because the stock recruitment relationship for sardine and consequently the F_{MSY} approach resulted rather unreliable. Besides this scenario also the one based on E0.4 and an empirical estimation of Blim (Blim equal to the minimum of the time series from which a recovery is observed) will be applied, considering the high uncertainty of the stock recruitment relationships.
- For the case studies on the Adriatic Sea Javier Vasquez suggested to keep as much as possible the same fleet segments adopted in the SEDAF project.
- Regarding the management strategy Javier Vasquez asked to think about the possibility of managing the small pelagic stocks by quota, that could be set on the more productive stock, thus it is important to indicate in the report the level of catches compatible with F_{MSY}.
- Cephalopods will be excluded by the management plan because assessment are not available and management strategy for such stocks should be different from the framework suitable for fish and crustaceans.
- With regard to the specific characteristics of each region of the Mediterranean and Black Sea involved in the project, the partitioning of the reduction of fishing effort by fleet segment or stratum, as well as the proportion of reduction in terms of capacity or activity

will be set case by case. To this purpose, the specific situation/condition of the stocks, the fisheries, the fishing practices of the area and the local framework of rules (for example Spanish management plan in Orden AAA/2808/2012 of 21 December 2012 specifies F_{MSY} of hake, red mullet, blue and red shrimp and deepwater shrimp in GSA 06 as reference points and that 20% of) will be taken in consideration.

- The reduction in terms of capacity will be set up to 2017 included, because afterwards there will be no more the possibility of getting public funds for scraping.
- The discussion highlights that almost all the fisheries under evaluation are mixed fisheries and thus, besides the consideration of the most impacted species in the pool of one fishery or another, it is also important to take into account the mix. This objective can be achieved using F_{MSY} range and also estimating a composite F_{MSY} derived from the mix of the assessed species weighted by landing value, as it applies for the balance indicator. Therefore, the approach to be applied will be the F_{MSY} range of the more impacted stock combined with a Management Strategy Evaluation, if possible, and the composite F_{MSY} weighed for landing value.
- The time frame will be 2018, to represent the consequences of a more severe approach, and 2020 with a more smooth approach (i.e. for example lower reduction at beginning and then increasing), that could be more acceptable by the stakeholders of the fishery sector. The public consultation on multiannual management plans evidenced a preference on adaptive management. The EC is now analyzing these comments in terms of impact assessment. The input of the impact assessment is crucial. The scenarios should be reasonable and have to take into account the social consequences of the management options, measured on different indicators.
- The word selectivity will be used to indicate a delay to the size at first capture due to gear configuration or to the protection of juveniles by closing season and areas. Scenario, in terms of gear selectivity, will be applied for demersal resources. The issue of escape survivability (escape from the gear before it is put on the deck) will be possibly applied (if parameters/data for the model are available).
- Regarding Black sea a pilot configuration will be used including the assessment information, catches, etc… to see how protect turbot. Illegal fishing will be treated as a separate fleet segment with different impacts. The parameterization will be based upon 6 fleet segments and 1 species.
- Javier Vasquez underlined the importance of getting very synthetized, clear (also for no experts) and concise outputs from the project. Thus the reporting should be based on summary sheets summarizing the core of information and an extended report, with an executive summary, where details can be reported, as much as possible in annexes, in order to easily extract the essential information useful to take decisions.
- Paolo Accadia gave a presentation on the results of the SOCIOEC project. Selected indicators were: F, Profit, Profit/revenues; RoFTA (>= long term government bond rate); average crew remuneration; TEI = (F-Fcurr)/(Fmsy-Fcurr) with F that can be different by Fmsy. MT Spedicato thanked P. Accadia and asked to put the presentation in the share-point under the Workshop folder.
- Taking into account the need of preparing an exaustive summary sheet for each case study, the coordinator will make a proposal to be circulated among participants. Such proposal is in the Annex 5 to this report.
- MT Spedicato described the proposal of structure for the Final Report (Annex 4). The Draft Final report, which is due by October 4, should include the results on project task 2 (MSY approach). Then, after the meeting with stakeholders the Final report, which is due by December 4, will be complemented with the outputs of stakeholder meeting, revised and submitted.

- Considering the complexity of the case studies and the scenarios to be modelled as well as the DGMARE priorities, that were indicated as follows: Small pelagic stocks of Adriatic Sea (GSAs 17 and 18) and Demersal stocks of GSA 6 and 7, it was agreed to ask to DGMARE a modification of the contents of the Draft Final report as follows:
- the phase 1 with the outcomes from the case studies with higher priorities by October 4;
- the phase 2 with the remaining case studies by October 26, (two weeks before the meeting with stakeholders).
- The coordinator informed the group that data from the issued Data Call were received during the meeting. Italia, Slovenian and Bulgarian National correspondents also sent data at national and GSA level to the project coordinator. These are made available through the share-point.
- Finally a draft agenda of the stakeholders meeting was agreed, with the collaboration of the representatives of the MEDAC, who suggested to simplify as much as possible the scientific models to present results in a simple and direct way in order to stimulate the discussion and the stakeholders’involvement. The draft agenda is attached in the Annex 6 to this report. The meeting will take place on November 10, 2015 (morning until lunch time) back to back with the MEDAC and ICCAT meetings in Malta.
- During the meeting the focus was given to the case studies of small pelagics in the Adriatic and of demersals in GSAs 6 and 7, that were almost definitively structured by the end of the meeting. In the meanwhile also case study of demersals in GSA18 and in GSA17 were in an advanced phase, while those of GSA9 and 11 and GSA29 still required some adjustments regarding the final parameterization that will be completed in the forthcoming days.

The meeting was closed on 13.00 hours of Friday 25, September.

ANNEX 1 AGENDA

Contract

EASME/EMFF/2014/1.3.2.7/SI2.703193

Call MARE/2014/27

Evaluation of specific management scenarios for the preparation of multi-annual management plans in the Mediterranean and the Black Sea

Workshop

on the implementation of MSY in the different Case Studies

September 21-25, 2015

Hotel Villa Romanazzi Carducci, Bari, Italy.

Background

Since January 2014, the reformed Common Fisheries Policy (CFP)2 introduces new requirements for the exploitation of living marine biological resources. The principal aim is to achieve maximum sustainable yields (MSY) for all stocks at the latest by 2020. This objective is more effectively achieved through a multiannual approach to fisheries management, establishing as a priority multiannual plans reflecting the specificities of different fisheries. The plans can cover multiple stocks where those stocks are jointly exploited and establish the framework for the sustainable exploitation of stocks and marine ecosystems concerned.

Multiannual plans should define the scope, quantifiable targets,

conservation reference points and technical measures to be taken in order to achieve the targets set, and avoid and reduce unwanted catches.

A specific STECF-EWG was held in June 2015[13] to perform quantitative analyses to support the impact assessment of different management scenarios (e.g., fishery managed through national management plans versus the implementation of a multiannual plan). From the results, the STECF considered multiannual plans as the best tool to achieve the reduction of fishing mortality needed.

Workshop objectives

The aim of the workshop is to analyze, discuss and validate the results of management strategies based on MSY or MSY related reference points (Fmsy, F0.1, etc..) for the different case studies foreseen in the project MARE/2014/27 (demersals and small pelagics of GSA6 and 7, GSA9 and 11, GSA17 and 18, GSA29).

ToRs of the Workshop

In each case study:

1. explore the different management possibilities to achieve MSY (e.g. MSY based on single-species, multiple-species, or stratified fleet stratus). Stocks, fisheries, fleet segments and stock assessment results will be those identified in the task 1 of the project (Interim Report).

2. Specify the criteria that could be used to select the most suitable approach to attain the MSY objectives, taking in to account mixed fisheries interactions and the landing obligation. Agree on the indicators to be selected, considering that besides Fmsy (or MSY), the following will be included: Spawning Stock Biomass, Catches (Landings and Discards), Revenues, Salary, CR.BER).

3. Explore how technical measures (gear specifications, spatial and/or temporal restrictions) could modify the fisheries exploitation pattern to increase selectivity and, therefore, contribute to the MSY objective. Review the results of the implementation of MSY trajectories for the different case studies according to the Table in the Annex1 to this Agenda. It is expected that the workshop will discuss the results of the status quo compared to at least 1 of the planned scenarios for each case study as in the Annex 1. <u>It is thus suggested that the participants bring to the meeting the scenarios based on selectivity simulations.</u>

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[13]Scientific, Technical and Economic Committee for Fisheries (STECF) – Western Mediterranean Multi-annual Plan (STECF-15-09). 2015. Publications Office of the European Union, Luxembourg, EUR XXXX EN, JRC XXXX, 97 pp.

4. Run the simulations related to the other planned scenarios and discuss the results. Evaluate the biological and socio-economic implications of establishing exploitation levels that could bring the maximum sustainable yield while ensuring the economic income of the fleet involved by: i) 2018 and; ii) 2020.

Scenarios should contemplate as far as possible potential intervals above and below F_{MSY}[14]. Such limits ranges will be compatible with ensuring a <5% risk of the stock falling below Blim.

DRAFT AGENDA

Monday, September 21st, 2015

09.00 – 11.00

- Opening of the workshop (Maria Teresa Spedicato).

Adoption of the agenda, discussion on the aim of the workshop and on the expected results,

- Expectations of DGMARE about the Project (DGMARE representative).
- Agree on the scheme of the report for each case study. Agree the scheme of the draft final report.
- Start work on tor1 by case study.

11.00 – 11.15 Coffee break

11.15 – 13.00

- Work on tor1 by case study.
- Discuss results in plenary

13.00 – 14.00 Lunch break

14.00 – 15.30

- Work on tor2 by case study.

15.30 – 15.45 Coffee break

15.45 - 17.30

- Work on tor2 by case study.
- Discuss results in plenary

Tuesday, September 22nd, 2015

[14] ICES. 2015. Report of the Joint ICES-MYFISH Workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 156 pp.

09.00 – 11.00

- Work on tor3 by case study.

11.00 – 11.15 Coffee break

11.15 – 13.00

- Work on tor3 by case study.
- Discuss results in plenary

13.00 – 14.00 Lunch break

14.00 – 15.30

- Work on tor4 by case study.

15.30 – 15.45 Coffee break

15.45 - 17.30

- Work on tor4 by case study.
- Discuss results in plenary

Wednesday, September 23rd, 2015

09.00 – 11.00

- Work on tor4 by case study.

11.00 – 11.15 Coffee break

11.15 – 13.00

- Work on tor4 by case study.

13.00 – 14.00 Lunch break

14.00 – 15.30

- Work on tor4 by case study.

15.30 – 15.45 Coffee break

15.45 - 17.30

- Work on tor4 by case study.
- Discuss results in plenary

Thursday, September 24th, 2015

09.00 – 11.00

- Work on tor4 by case study.
- Discuss and validate results in plenary

11.00 – 11.15 Coffee break

11.15 – 13.00

- Work on tor4 by case study.
- Discuss and validate results in plenary

13.00 – 14.00 Lunch break

14.00 – 15.30

- Work on tor4 by case study.
- Work on the case study reports

15.30 – 15.45 Coffee break

15.45 - 17.30

- Work on the case study report

Friday, September 25th, 2015

09.00 – 11.00

- Work on the case study report

11.00 – 11.15 Coffee break

11.15 – 13.00

- Work on the case study report
- Meeting conclusion, including inputs for the preparation of the Workshop with stakeholders.

ANNEX 2 - LIST OF PARTICIPANTS

N	Surname	Name	Institution
1	Spedicato	Maria Teresa	COISPA
2	Lembo	Giuseppe	COISPA
3	Bitetto	Isabella	COISPA
4	Ligas	Alessandro	CIBM
5	Musumeci	Claudia	CIBM
6	Scarcella	Giuseppe	CNR-ISMAR
7	Carpi	Piera	CNR-ISMAR
8	Maynou	Francesc	External expert
9	Garcia Rodriguez	Mariano	IEO
10	Accadia	Paolo	NISEA
11	Daskalov	Georgi	IBER-Bas
12	Caggiano	Rosa	MEDAC
13	Monnati	Erika	MEDAC
14	Vazquez Alvarez	Francisco Javier	DGMARE

ANNEX 3 - MANAGEMENT POSSIBILITIES, CRITERIA AND PLANNED SCENARIOS TO REACH F_{MSY}.

Reference point	F_{MSY} or related proxies as $F_{0.1}$
Timeframes to reach F_{MSY} or related proxies	2018 and 2020.
Species and fleets	Species are as from the ranking system in task 1 (assessments are available for few species) of the project and fleets according fleet strata as identified in task1 as well.
Strategy to reach the RP in the timeframe	1) gradual linear reduction 2) adaptive strategy which implies for example a lower reduction in the short term and a sharp reduction thereinafter, or viceversa, case by case.
Amount of reduction	Defined on the basis of the results from the assessments and the related diagnosis, except in case of selectivity scenarios.
MSY approach	F_{MSY} range approach is proposed (F_{MSY} upper and lower ranges). These are derived to deliver no more than 5% reduction in long term yield compared with MSY. At first glance the upper and lower boundaries of the FMSY ranges will be used empirically, i.e based on a linear relationship[15] derived for stocks with different life history traits in the ICES area (ICES, 2015). The objective is to get provisional estimates of FMSY ranges for the stocks harvested, thus accounting for mixed fishery considerations. Fupper could be used associated with a Management Strategy Evaluation (MSE) to test if the upper levels of the ranges are precautionary (i.e. the risk of the SSB falling below Blim is less than 5%). The MSE can be applied if the assessment workspaces are available and assessment models applied are in line with such an approach.

[15] FMSY ranges for EWG 15 09 Notes Ernesto Jardim, JRC May 22, 2015

Translate reduction of fishing mortality into effort reduction	The reduction of fishing mortality (F) towards the RP will be applied for the timeframe of 2018 to both activity and capacity as follows, up to 2017: Reduction of F 40% applied by its 90% on activity (i.e. activity reduced of 36%) and its 10% on capacity (i.e. capacity reduced of 4%). Scenarios of reduction of activity or capacity designed taking into account considerations of social/management components based on existing management decisions and feedback from the sector. Reduction of fishing mortality (F) towards the RP will be applied for the timeframe of 2020 only on activity from 2017 to 2020.
Translate reduction of fishing mortality into harvest pattern changes	F_{MSY} ranges are calculated based on current fishery selectivity (using northern stocks for deriving regression parameters) with the possibility of higher yields if selectivity is altered through changes in gear design, fishing area, or season. Changing the current size at first capture based on possible changes to the current gear selectivity, while also considering the effectiveness of such changes (survivability of individuals escaped to the gear, from pertinent literature).
Flexibility	Adapt the approach to the specific characteristics of the areas and fisheries (evaluating which are the main gears/fleet strata and their relative impact) case by case.
Uncertainty	Applying a process error on recruitment to the forecasts. Management Strategy Evaluation (MSE), where possible, on the basis of the available information.

Scenarios

Case Study	**small pelagics in GSAs17-18**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Application to capacity can be differentiated by fleet.
Scenario 3	Adaptive reduction towards upper Fmsy of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet.
Scenario 4	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Application to capacity can be differentiated by fleet.
Scenario 5	Linear reduction towards E0.4 of sardine in 2018 applied both to activity and capacity up to 2017 included, then on the activity only. Application to capacity can be differentiated by fleet.

Scenario 6*	Adaptive reduction towards E0.4 of anchovy in 2020, from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet.
Scenario 7*	Adaptive reduction towards E0.4 of sardine in 2020, from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet.

*this will be not applied if current F of sardine is close to E0.4

Case Study	**demersals in GSAs17, 18, 11, 9, 6, 7**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of the most heavily exploited species (for which we have stock assessment) in 2018 applied on both activity and capacity, up to 2017 included, then on the activity only. Application to capacity can be differentiated by fleet.
Scenario 3	Linear reduction towards a weighted average Fmsy for a mix of species (using landings for weighing) in 2018 applied on both activity and capacity, up to 2017 included. Application to capacity can be differentiated by fleet.
Scenario 4	Adaptive reduction towards upper Fmsy of the most heavily exploited species in 2020 applied only to activity from 2018 to 2020. Application to capacity can be differentiated by fleet.
Scenario 5	Adaptive reduction towards a weighted average Fmsy for a mix of species (using landings for weighing) in 2020 applied only on activity from 2018 to 2020. Application to capacity can be differentiated by fleet
Scenario 6	Improving selectivity accounting for the survivability issue (in case of gear selectivity).

Case Study	**small pelagics in GSA9**
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards E0.4 of sardine in 2018 applied both to activity and capacity up to 2017, then on the activity only. Application to capacity can be differentiated by fleet
Scenario 3	Linear reduction towards E0.4 of sardine in 2020, from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet.

Case Study	GSA29
Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper Fmsy of turbot in 2018
Scenario 3	Adaptive reduction towards upper Fmsy of turbot in 2020

ANNEX 4 PROPOSAL FOR THE STRUCTURE OF THE FINAL REPORT

EXECUTIVE SUMMARY

1.BACKGROUND AND PROJECT OBJECTIVES

2.PROJECT MANAGEMENT AND COORDINATION

Meetings, share-point, data call, workshop, documents

3.PROJECT ACTIVITIES

Refer to project tasks and how these were developed in the case studies

4.ACHIEVED RESULTS

Shortly describe the achieved results by case study

5.CHANGES TO THE ORIGINAL WORK PLAN

6.CASE STUDY OF GSA X X

6.1. State of the art

6.1.1 Brief introduction to the characteristics of the area

6.1.2. Identification and description of the target stocks

6.1.3. Identify and describe the fisheries and quantify in terms of number of vessels, catches, discards and average effort deployed

6.1.4. Identify and describe the economic performance of the identified fisheries

6.1.5. Describe the current management measures at national, European and international level

6.2. Maximum Sustainable Yield

6.2.1 Identification of main elements that contribute to define MSY (single species, multispecies, fleets, technical features, etc..)

6.2.2 Specify the criteria that could be used to select the most suitable approach to attain the MSY objectives (implement different trajectories and strategies)

6.2.3 Explore the different management possibilities to achieve MSY or its proxies: setting scenarios

6.2.4 Identify tools to be used for scenario modelling and describe method applied

6.2.5 Report of inputs for modelling

6.2.6 Evaluate the results of modelling in terms of biological and socio-economic implications of establishing exploitation levels that could bring to MSY in 2018 and 2020

6.2.7 Report the results in terms of traffic light and Multi-Criteria Decision Analysis approaches

6.2.8 Discussion and conclusions

7. REFERENCES

8. LIST OF ACRONYMS

9.REGIONAL COOPERATION

9.1 Regional cooperation: identify and describe the role of the main stakeholders involved in the fisheries

9.2 Report and discuss the results of the meeting with stakeholders

ANNEX 5

SUMMARY SHEET OF CASE STUDY ON SMALL PELAGICS IN GSA 17 AND GSA 18 (ADRIATIC SEA)

Note: Criteria and management possibilities to reach F_{MSY} are in the Annex 1.

1. Fisheries: Small pelagic fisheries in the Adriatic sea

2. GSA: GSA 17 and GSA 18

3. Stocks assessed: anchovy (*Engraulis encrasicolus*); sardine (*Sardina pilchardus*)

4. Modelling tools used: BEMTOOL bioeconomic platform; Management Strategy Evaluation by STECF-EWG 15 11 Working Group.

5. Fleets involved

10 main fleet segments operating in the Adriatic, by country, geographical sub-areas, fisheries and vessel length stratum have been identified….. Small pelagic is a mixed fishery ….

	Fleet name	*Fleet code*
	Pelagic trawlers with vessel length in the range 12-18 m,	ITA17_TM_1218

6. Contribution of the stocks assessed to the production of the specific fisheries

The contribution of the stocks assessed to the production of the specific fisheries (percentage computed on the average production of the last three years) is reported in the table below. These stocks account for percentage comprised between ……

Stock	***Percentage** (%) (average last three years)*
Anchovy GSA17 Italy	48.3
Sardine GSA17 Italy	42.3
…	…
…	…

7. Development of stocks over time and current status

The assessment of anchovy and sardine was presented during the EWG…. This assessment used DCF data …..

Fishing mortality ($F_{bar\ xx\text{-}xx}$) and SSB of (stock 1…) are varying along the time, catch and recruitment are decreasing (or increasing), $F_{bar\ xx\text{-}xx}$ is decreasing…..

Fishing mortality ($F_{barxx\text{-}xx}$) and SSB of (stock 2…) are varying along the time, catch and recruitment are increasing….

Discard in these fisheries is considered …(or is negligible..).

Stock	***Fishing***	***Spawning Stock***	***Catch****	***Landings****	***Recruitment****
Stock 1	$F_{bar\ (xx\text{-}xx)}$=				
Stock 2	$F_{bar\ (xx\text{-}xx)}$=				

*estimates refer to assessment ….

8. Development of economic indicators over time and current status

The economic performance of the whole fleet and of the main fleet segments is evaluated using key social and economic indicators and a traffic light table as below reported (red=recent negative trend; green=recent positive trend; yellow=stable situation or variable but without any trend):

	Salary	CR.BER	Overall	Revenues	Revenues	Revenues	Revenues	Employment
All fleets								
Fleet 1								
Fleet 2								
Fleet 3								
Fleet 4								
Fleet ..								

Add some relevant comment where necessary (for example if last year was better or worse compared to the previous ones).

9. Reference points, their technical basis and Management Strategy Evaluation (MSE)

The framework used for the reference points is summarised in the table below.

Here explain if you have a reliable stock-recruitment relationship, if you adopt F_{MSY} ranges and how these were obtained.

	Framework					
	MSY approach				**Precautionary approach**	
Reference point	F_{MSY}	**F_{MSY} upper range**	**F_{curr}/F_{MSY} ratio**	**Bmsy**	**B_{lim} (tons)**	**B_{pa} (tons)**

Technical basis for anchovy method 1						
Technical basis for anchovy method 2						
Values for anchovy method 1						
Values for anchovy method 2						
Technical basis for sardine method 1						
Technical basis for sardine method 2						
Values for sardine method 1						
Values for sardine method 2						

A Management Strategy Evaluation (MSE) was performed …..

Regarding the stock 1 the findings of the MSE are:

….

For the stock 2 ….

10. Stock advice

Regarding stock 1 Fcurrent was well above the reference point F_{MSY}, thus evidencing unsustainable exploitation levels in the long term…..

Regarding stock 2…

11. Strategy and timeframe to reach the RP

The xxx stocks are components of a mixed fishery, thus management measures should take this aspect into account. Based on F levels, stock xxx that is the most heavily exploited stock in the mix has been used as a benchmark. The percentages of reduction to reach F_{MSY} according to method and stock are reported in the table below ….

Stock	***Fishing mortality reduction***

Anchovy (Reference point method 1)	xxx

The reduction of fishing mortality is linearly translated into reduction of fishing effort, under the assumption of nearly constant or randomly varying catchability.

This reduction is proportionally applied to the different fleet segments, accounting for their relative impact. Below the relative impact of the different fleet segments is expressed in terms of percentage of fishing mortality of stock 1 by fleet segment and year.

Fleet segment/year	2008	2009	2010	2011	2012	2013	2014

Two strategies to reach F_{MSY} were adopted:

1) a gradual linear reduction to 2018, that implies the same reduction in each year until the reference point is reached; this will allow to evaluated a severe approach in a shorter term;

2) an adaptive strategy which implies a lower reduction in the short term and a sharp reduction thereinafter, in order to allow a more gradual implementation and the achievement of MSY in 2020.

12. Proposed scenarios

Proposed scenarios are reported in the table below.

Scenario 1	Status quo to 2020
Scenario 2	Linear reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) in 2018 applied on both activity and capacity, up to 2017, then on the activity only. Application to capacity can be differentiated by fleet.
Scenario 3	Adaptive reduction towards upper F_{MSY} of anchovy (same target applied also for sardine) from 2018 to 2020 applied only on activity. Application to capacity can be differentiated by fleet.
Scenario 4	Linear reduction towards E0.4 of anchovy in 2018 applied both to activity and capacity, up to 2017 included, then on the activity only. Application to capacity can be differentiated by fleet.
Scenario 5	

….	

The choice of achieving the prefixed objectives reducing both activity and capacity, the latter by 2017 (included), and acting only on activity thereinafter relies on the consideration that there will be no more possibility of scraping after 2018.

In all the scenarios the uncertainty on recruitment has been taken into account, applying for both stocks a multiplicative error (on the stock recruitment relationship/geometric mean of recruitment computed for the last three years).

13. Forecast of the effects of proposed scenarios

SSB of stock 1 and stock 2 from xx scenario showed the highest level (xx% and xx% respect to the status quo), whilst the worse result is observed in the status quo …..

These results seem consistent with the greater benefit that generally the reduction in fishing mortality produces on the indicators if applied in a short range of time…..

As regards stock 1 catches, the best scenario is xx for all fleet segments, except for xx fleet segment (decrease xx, for segment yy), that are the fleet segments more penalized by the management strategies (being the more impacting on xx stock).

Regarding stock 2 catches, the best scenarios are xx and yy depending by the fleet segments, except for the fleet segments zz and yy fleet segments, that are the fleet segments again more penalized by the management strategies.

This seems quite consistent with the way the management measures have been implemented, because, …..

In 2018, (excluding status quo) forecast scenarios produce a reduction in total landings weight and value of the whole GSAs fleet lower than xx% compared to the status quo. In 2021, the foreseen reduction is equal to xx% for total landings and to yy% for revenues.

Adaptive scenarios ...in the long term show ….

Among all the scenarios, the ones that change more the status quo situation are the ones involving xxx. The fleet mostly affected from each one of the management measure is the xx fleet segment, the fleets more benefiting are xxx, because …

According to the traffic light summary (table below), all the performed scenarios allow to obtain a benefit on the SSB of the 2 stocks under consideration in respect to the status quo….

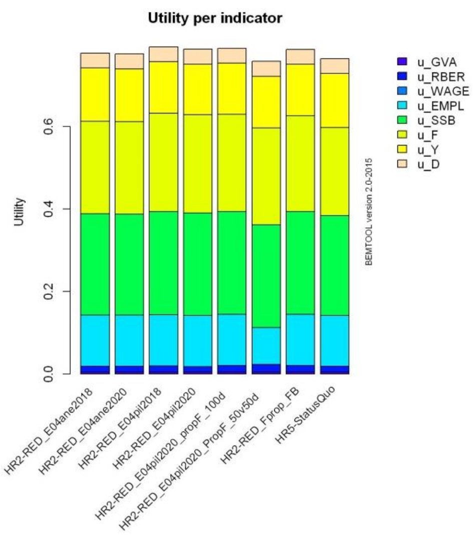
Performances of the management scenarios (% respect to *status quo*) simulated in terms of SSB and overall catches of anchovy and sardine, salary, CR/BER, revenues and employment. The green values are higher than +5%, the red ones are smaller than -5% and the yellow ones are between -5% and +5%.

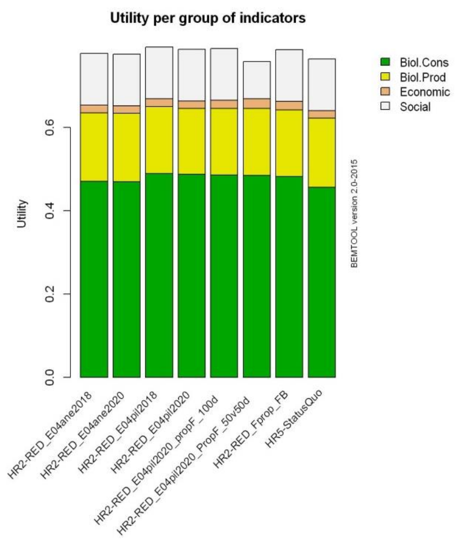
Scenario,	ALL fleets

year 2021	Salary	CR.BER	Rev.	Emp.	Catch stock1	Catch stock2	SSB stock1	SSB stock2	Total
Scenario 1									
Scenario 2									
Scenario 3									
Scenario 4									
Scenario 5									

A Multi-Criteria Decision Analysis approach, combining Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP), thus giving weights and level of utility to the selected biological and economic indicators, shows that the scenario that allows to reach the highest overall utility is xxx (figure 1), while the lowest utility is given by yyy scenario that produces an utility slightly lower than the status quo scenario. This because ….

The scenario that has the second higher utility is …, that is very close to the best scenario in rms of overall utility. ….





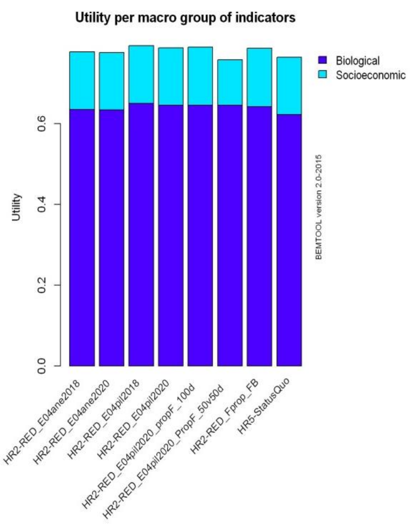


Figure 1. MCDA results: evaluation of the overall utility associated to each management scenario for the case study of xxx in GSAyy

Final comment, for example….

The methodology and the scenarios tested cover a wide range of different options and provide a general and complete overview of the situation of xxx in the xx Sea. The results are consistent with the advices that have been provided so far in different fora and give a more robust evaluation of the efficiency of each of the measures proposed. There are certainly some limitations in the approach used; in particular, one of the main issues is the difficulty in forecasting recruitment and…..

14. Catch option and advice

On the basis of the estimated limit management reference point for sustainable exploitation (F_{upper}=xx for stock1; F_{upper}=xx for stock2…), catches in 2016 should be xxx tons for stock 1 and yyy tons for stock2.

An extended report is available in the case study section of the draft final report.

ANNEX 6 -DRAFT AGENDA OF THE MEETING WITH MEDAC

The meeting will be held on November 10 in Malta, back to back with the MEDAC meeting and ICCAT

9:30 – 9:45 Giampaolo Buonfiglio, Welcome & introduction

9:45 – 10:00 Maria Teresa Spedicato, Criteria, trajectories and MSY approach for the preparation of multi-annual management plans in the Mediterranean and Black Sea

10:00 - 10:10 Giuseppe Scarcella, Management scenarios for the preparation of multi-annual management plans of demersal stocks in GSA 17

10:10 – 10:25 Discussion

10:25 – 10:35 Isabella Bitetto, Management scenarios for the preparation of multi-annual management plans of demersal stocks in GSA 18

10:35 – 10:50 Discussion

10:50 – 11:00 Piera Carpi, Management scenarios for the preparation of multi-annual management plans of small pelagic stocks in GSA 17-18

11:00 – 11:15 Discussion

11:15 – 11:30 Coffee break

11:30 – 11:40 Alessandro Ligas, Management scenarios for the preparation of multi-annual management plans of demersal stocks in GSA 9-11

11:40 – 11:55 Discussion

11:55 – 12:10 Francesc Maynou, Management scenarios for the preparation of multi-annual management plans of demersal stocks in GSA 6-7

12:10 – 12:25 Discussion

12:25 – 12:35 Georgi Daskalov, Management scenarios for the preparation of multi-annual management plans of Turbot in GSA 29 (TBD)

12:35 -13:00 General discussion

13:00 – 13:15 Giampaolo Buonfiglio, MEDAC concluding remarks

13:15 – 13:30 Maria Teresa Spedicato, Project concluding remarks

13:30 Lunch

ANNEX IV - LIST OF ACRONYMS

List of targer species of data Collection Framework by area[16]

3 ALPHA CODE	Scientific name	English name	Species group	Area/Stock
BTH	*Alopias superciliosus*	Bigeye thresher	G1	Mediterranean and Black Sea
ALV	*Alopias vulpinus*	Thresher	G1	Mediterranean and Black Sea
ELE	*Anguilla anguilla*	European eel	G1	Mediterranean and Black Sea
ARS	*Aristaeomorpha foliacea*	Giant red shrimp	G1	Mediterranean and Black Sea
ARA	*Aristeus antennatus*	Blue and red shrimp	G1	Mediterranean and Black Sea
BOG	*Boops boops*	Bogue	G2	1.3 - 2.1 - 2.2 - 3.1 - 3.2
CCP	*Carcharhinus plumbeus*	Sandbar shark	G1	Mediterranean and Black Sea
CCT	*Carcharias taurus*	Sand tiger shark	G1	Mediterranean and Black Sea
GUP	*Centrophorus granulosus*	Gulper shark	G1	Mediterranean and Black Sea
BSK	*Cetorhinus maximus*	Basking shark	G1	Mediterranean and Black Sea
CFW	*Coryphaena equiselis*	Pompano dolphinfish	G2	Mediterranean and Black Sea
DOL	*Coryphaena hippurus*	Common dolphinfish	G2	Mediterranean and Black Sea
SCK	*Dalatias licha*	Kitefin shark	G1	Mediterranean and Black Sea
BSS	*Dicentrarchus labrax*	Sea bass	G2	Mediterranean and Black Sea
RJB	*Dipturus batis*	Blue skate	G1	Mediterranean and Black Sea
RJO	*Dipturus oxyrinchus*	Longnosed skate	G1	Mediterranean and Black Sea
EOI	*Eledone cirrhosa*	Horned octopus	G2	1.1 - 1.3 - 2.1 - 2.2 - 3.1
EDT	*Eledone moschata*	Musky octopus	G2	1.3 - 2.1 - 2.2 - 3.1
ANE	*Engraulis encrasicolus*	Anchovy	G1	Mediterranean and Black Sea
ETX	*Etmopterus spinax*	Velvet belly	G1	Mediterranean and Black Sea
GUG	*Eutrigla gurnardus*	Grey gurnard	G2	2.2 - 3.1
GAG	*Galeorhinus galeus*	Tope shark	G1	Mediterranean and Black Sea
SHO	*Galeus melastomus*	Blackmouth catshark	G1	Mediterranean and Black Sea
RGL	*Gymnura altavela*	Spiny butterfly ray	G1	Mediterranean and Black Sea
HXT	*Heptranchias perlo*	Sharpnose sevengill shark	G1	Mediterranean and Black Sea
SBL	*Hexanchus griseus*	Bluntnose sixgill shark	G1	Mediterranean and Black Sea
SQM	*Illex coindetii*	Broadtail squid	G2	Mediterranean and Black Sea
BIL	*Istiophoridae*	Marlins,sailfishes,etc. nei	G1	Mediterranean and Black Sea
SMA	*Isurus oxyrinchus*	Shortfin mako	G1	Mediterranean and Black Sea
POR	*Lamna nasus*	Porbeagle	G1	Mediterranean and Black Sea

[16]http://datacollection.jrc.ec.europa.eu/c/document_library/get_file?uuid=296dffd3-9c81-4759-b691-9b1654ea66b9&groupId=10213#page=31

RJI	*Leucoraja circularis*	Sandy ray	G1	Mediterranean and Black Sea
JAM	*Leucoraja melitensis*	Maltese ray	G1	Mediterranean and Black Sea
SQR	*Loligo vulgaris*	European squid	G2	Mediterranean and Black Sea
ANK	*Lophius budegassa*	Black-bellied angler	G2	1.1 - 1.2 - 1.3 - 2.2 - 3.1
MON	*Lophius piscatorius*	Anglerfísh	G2	1.1 - 1.2 - 1.3 - 2.2 - 3.1
HKE	*Merluccius merluccius*	European hake	G1	Mediterranean and Black Sea
WHB	*Micromesistius poutassou*	Blue whiting	G2	1.1 - 3.1
MUL	*Mugilidae*	Grey mullets	G2	1.3 - 2.1 - 2.2 - 3.1
MUT	*Mullus barbatas*	Red mullet	G1	Mediterranean and Black Sea
MUR	*Mullus surmuletus*	Striped red mullet	G1	Mediterranean and Black Sea
SDS	*Mustelus asterias*	Starry smooth-hound	G1	Mediterranean and Black Sea
SMD	*Mustelus mustelus*	Smooth-hound	G1	Mediterranean and Black Sea
MPT	*Mustelus punctulatus*	Blackspotted smooth-hound	G1	Mediterranean and Black Sea
MYL	*Myliobatis aquila*	Common eagle ray	G1	Mediterranean and Black Sea
NEP	*Nephrops norvegicus*	Norway lobster	G1	Mediterranean and Black Sea
OCC	*Octopus vulgaris*	Common octopus	G2	Mediterranean and Black Sea
LOO	*Odontaspis ferox*	Smalltooth sand tiger	G1	Mediterranean and Black Sea
OXY	*Oxynotus centrina*	Angular roughshark	G1	Mediterranean and Black Sea
PAC	*Pagellus erythrinus*	Common Pandora	G2	Mediterranean and Black Sea
DPS	*Parapenaeus longirostris*	Deep water rose shrimp	G1	Mediterranean and Black Sea
TGS	*Penaeus kerathurus*	Caramote prawn	G2	3.1
BSH	*Prionace glauca*	Blue shark	G1	Mediterranean and Black Sea
RPP	*Pristis pectinata*	Smalltooth sawfish	G1	Mediterranean and Black Sea
RPR	*Pristis pristis*	Common sawfish	G1	Mediterranean and Black Sea
TUR	*Psetta maxima*	Turbot	G2	Black Sea
PLS	*Pteroplatytrygon violacea*	Pelagic stingray	G1	Mediterranean and Black Sea
JRS	*Raja asterias*	Mediterranean starry ray	G1	Mediterranean and Black Sea
RJC	*Raja clavata*	Thomback ray	G1	1.3 - 2.1 - 2.2 - 3.1
JAI	*Raja miraletus*	Brown ray	G1	1.3 - 2.1 - 2.2 - 3.1
RJU	*Raja undulata*	Undulate ray	G1	Mediterranean and Black Sea
RBC	*Rhinobatos cemiculus*	Blackchin guitarfish	G1	Mediterranean and Black Sea
RBX	*Rhinobatos rhinobatos*	Common guitarfish	G1	Mediterranean and Black Sea
RJA	*Rostroraja alba*	White skate	G1	Mediterranean and Black Sea
BON	*Sarda sarda*	Atlantic Bonito	G2	Mediterranean and Black Sea
MAZ	*Scomber spp.*	Mackerel	G2	Mediterranean and Black Sea
SYC	*Scyliorhinus canicula*	Small-spotted catshark	G1	Mediterranean and Black Sea

SYT	*Scyliorhinus stellaris*	Nursehound	G1	Mediterranean and Black Sea
SKH	*Selachi*	Various sharks nei	G1	Mediterranean and Black Sea
CTC	*Sepia officinalis*	Common cuttlefish	G2	Mediterranean and Black Sea
SOL	*Solea vulgaris*	Common sole	G1	1.2 - 2.1 - 3.1
SBG	*Sparus aurata*	Gilthead seabream	G2	1.2 - 3.1
SPL	*Sphyrna lewini*	Scalloped hammerhead	G1	Mediterranean and Black Sea
SPK	*Sphyrna mokarran*	Great hammerhead	G1	Mediterranean and Black Sea
SPQ	*Sphyrna tudes*	Smalleye hammerhead	G1	Mediterranean and Black Sea
SPZ	*Sphyrna zygaena*	Smooth hammerhead	G1	Mediterranean and Black Sea
SPC	*Spicara smaris*	Picarei	G2	2.1 - 3.1 - 3.2
SPR	*Sprattus sprattus*	Sprat	G1	Black Sea
DGS	*Squalus acanthias*	Piked dogfish	G1	Mediterranean and Black Sea
QUB	*Squalus blainville*	Longnose spurdog	G1	Mediterranean and Black Sea
SUA	*Squatina aculeata*	Sawback angelshark	G1	Mediterranean and Black Sea
SUT	*Squatina oculata*	Smoothback angelshark	G1	Mediterranean and Black Sea
AGN	*Squatina squatina*	Angelshark	G1	Mediterranean and Black Sea
MTS	*Squilla mantis*	Spottail mantis squillids	G2	1.3 - 2.1 - 2.2
ALB	*Thunnus alalunga*	Albacore	G2	Mediterranean and Black Sea
BFT	*Thunnus thynnus*	Atlantic bluefin tuna	G1	Mediterranean and Black Sea
QSX	*Todarodes spp*	Todarodes flying squids nei	G2	Mediterranean and Black Sea
TTR	*Torpedo marmorata*	Marbled electric ray	G1	Mediterranean and Black Sea
HMM	*Trachurus mediterraneus*	Mediterranean horse mackerel	G2	Mediterranean and Black Sea
HOM	*Trachurus trachurus*	Horse mackerel	G2	Mediterranean and Black Sea
GUU	*Trigla lucerna*	Tub gurnard	G2	Mediterranean and Black Sea
CLV	*Veneridae*	Venus clams nei	G2	Mediterranean and Black Sea
SWO	*Xiphias gladius*	Swordfish	G1	Mediterranean and Black Sea

List of FAO subregions

1.1. BALEARIC

1.2. GULF OF LIONS

1.3. SARDINIA

2.1. ADRIATIC

2.2. IONIAN

3.1. AEGEAN

3.2. LEVANT

4.1. MARMARA

4.2. BLACK SEA

4.3. AZOV SEA

List of fishing techniques and codes[17]

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
PG	Vessels using passive gears only for vessels < 12m
PGO	Vessels using other passive gears
PGP	Vessels using polyvalent passive gears only
PMP	Vessels using active and passive gears
PS	Purse seiners
TM	Pelagic trawlers
TBB	Beam trawlers

List and codes of vessel length[18]

VESSEL_LENGTH	
VL0006	Vessel less that 6 meters in length.
VL0612	Vessel between 6 meters and 12 meters in length.
VL1218	Vessel between 12 meters and 18 meters in length.
VL1824	Vessel between 18 meters and 24 meters in length.
VL2440	Vessel between 24 meters and 40 meters in length.

[17] http://datacollection.jrc.ec.europa.eu/wordef/fleet-segment-dcf
[18] http://datacollection.jrc.ec.europa.eu/wordef/fleet-segment-dcf

VL40XX	Vessel greater than 40 meters in length.

List of metier [19]

	Codes	Level 1	**Level 2** (1)	**Level 3**	**Level 4**
Non Active vessels			non active vessels		
Active vessels	MB	Mobile			
	TBB*		Beam trawl		
	DTS*		Demersal trawl and		
	OTB			Bottom trawl	
	STB				Single trawl
	PTB				Paired trawl
	TTB				Twin trawl
	MTB				Other multirig trawl
	FTB				Four-panels trawl
	HTB				High-opening trawl
	DTP			Polyvalent	
	PTS*		Pelagic trawls and		
	OTM			Pelagic trawl	
	STM				Single trawler
	PTM				Paired trawlers
	PEL			Pelagic seiner	
	PELFAD				With FAD
	PELNOFAD				Without FAD
	PPS			Polyvalent	
	DRB*		Dredges		
	DRH			Hydraulic	
	DRO			Other	
	MGP*		Polyvalent mobile		
	MGO*		Other mobile gears		
	PG*(VL0012)	Passive			
	FGL			Fixed gears	
	FGN			Fixed nets	
	FTN				Trammel nets
	FEN				Entangling nets
	GIN				Gill nets
	HOK*		Gears using hooks		

[19] http://datacollection.jrc.ec.europa.eu/wordef/fleet-segment-dcr

	LON			Longlines	
	LONSUR				Surface longlines
	LONBOT				Bottom longlines
	LONMID				Mid-waterlines
	HOO			Other gears using hooks	
	HOT				Troll line
	HOP				Pole line with live bait
	HOW				Pole line without live bait
	DFN*		Drift nets and fixed		
	DNE			Drift nets	
	FPO*		Pots and traps		
	FPT			Fish traps (2)	
	FPC			Crustaceans pots(3)	
	PGP*		Polyvalent passive		
	PGO		Other passive gears		
	PVG	Polyvalent			
	PMP*		Combining mobile &		
	NOL	Vessels			

(1) According to level 2 data should only be reported for the gear codes in **bold***.

(2) Including trap nets and pound nets.

(3) With possible subdivision by target species.

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