



**MARE/2014/27**



**Study on the evaluation of specific management scenarios for the preparation of multiannual management plans in the Mediterranean and the Black Sea**  
(tender MARE /2014/27)

## **Management scenarios for the preparation of multi-annual management plans of demersal and small pelagic stocks in GSAs 9-11**

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**Seminar on the results of the "Assessment of management scenarios for the preparation of long-term plans in the Mediterranean"**

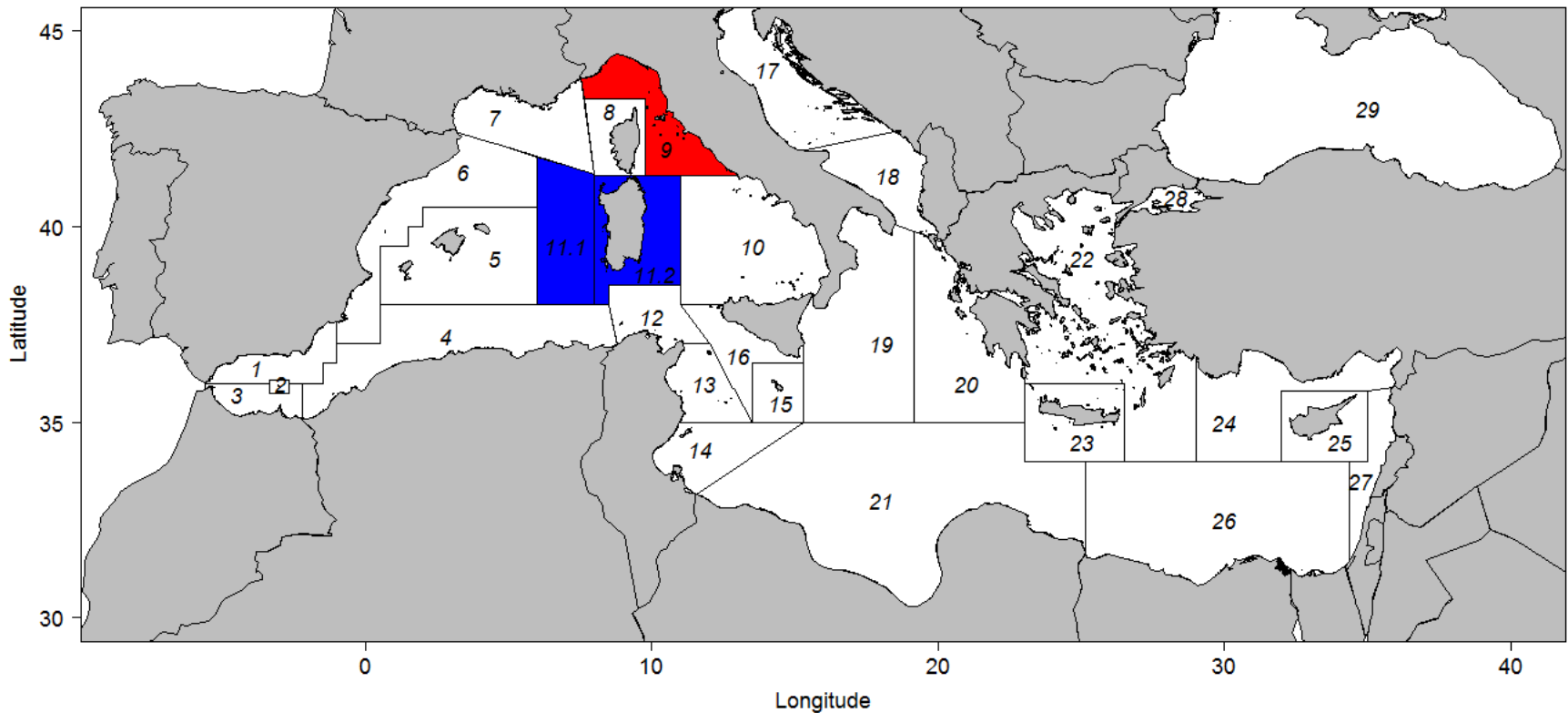
Malta, November 10<sup>th</sup> 2015



## Investigated areas

**FAO-GFCM Geographical Sub-Area 9 (GSA 9, Ligurian Sea and northern Tyrrhenian Sea)**

**FAO-GFCM Geographical Sub-Area 11 (GSA 11, Sardinia east and west)**





**Case Studies:**

GSA 9

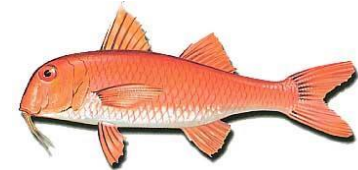
Small pelagics: Anchovy, Sardine



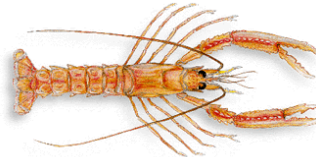
Demersal species: European hake



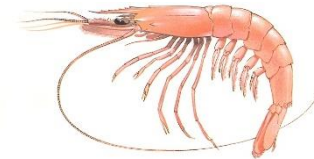
Red mullet



Norway lobster



Deep-water rose shrimp



GSA 11

Demersal species: European hake

Red mullet

Giant red shrimp



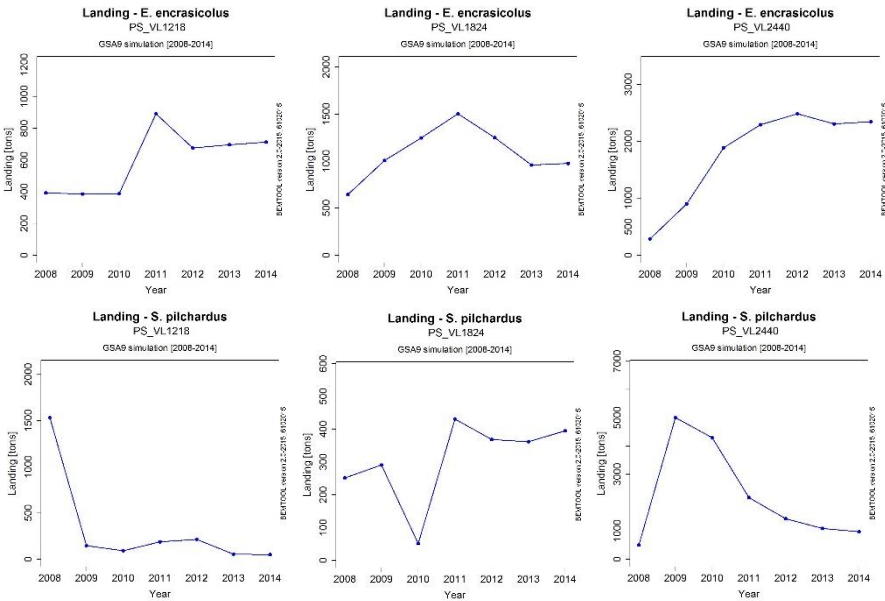


### GSA 9 – Small pelagics, Fleets involved

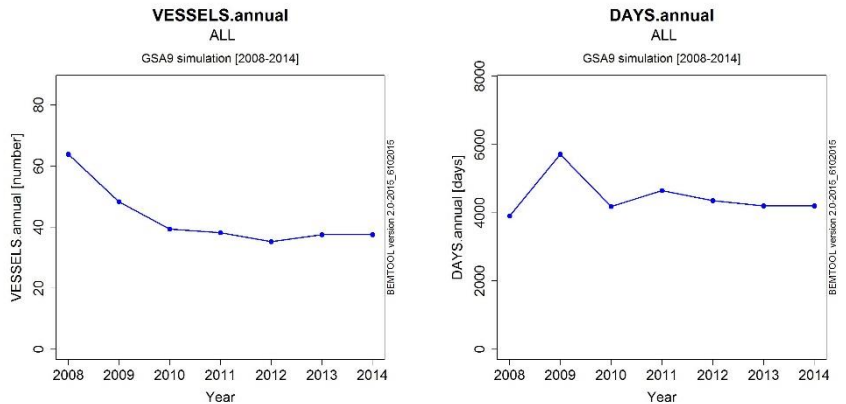
Three main fleet segments operating in the Ligurian and northern Tyrrhenian Seas have been identified. Small pelagics fishery is a mixed fishery with a higher catch of anchovy, whilst sardine is mainly caught as a by-catch and/or in periods when anchovy are available in low quantity.

Fleet name	Fleet code
Italian GSA09 purse-seiners with vessel length 12-18 m	PS_VL1218
Italian GSA09 purse-seiners with vessel length 18-24 m	PS_VL1824
Italian GSA09 purse-seiners with vessel length 24-40 m	PS_VL2440

Stock	Percentage (%) (average 2010-2013)
Anchovy	66
Sardine	25



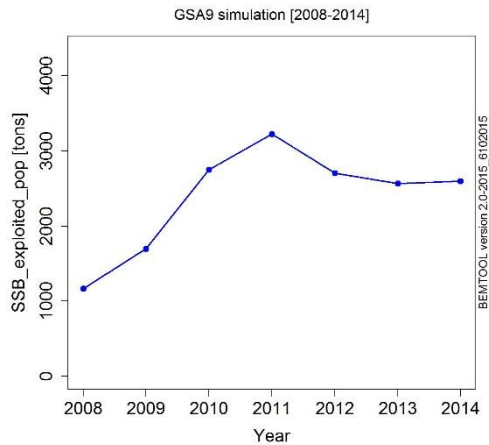
Fishing capacity (n. of vessels) and fishing activity (fishing days per year) by the purse seine fleet in GSA 9 (all segments combined).



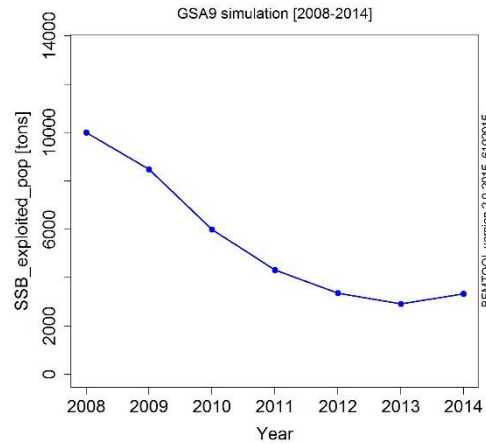
Landings of anchovy (*E. encrasicolus*) and sardine (*S. pilchardus*) in the GSA 9 by fleet segment.



SSB\_exploited\_pop - *E. encrasicolus*

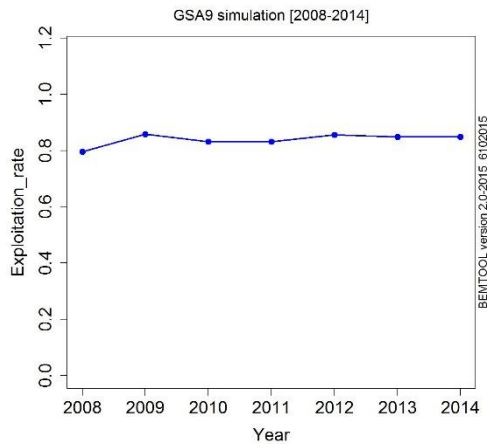


SSB\_exploited\_pop - *S. pilchardus*

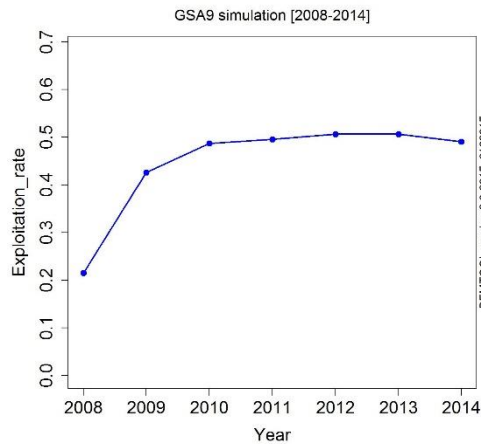


Spawning Stock Biomass (SSB) of anchovy (*E. encrasicolus*) and sardine (*S. pilchardus*) in GSA 9.

Exploitation\_rate - *E. encrasicolus*



Exploitation\_rate - *S. pilchardus*



Exploitation rate (Fishing mortality/Total mortality,  $E=F/Z$ ) of anchovy (*E. encrasicolus*) and sardine (*S. pilchardus*) in GSA 9.



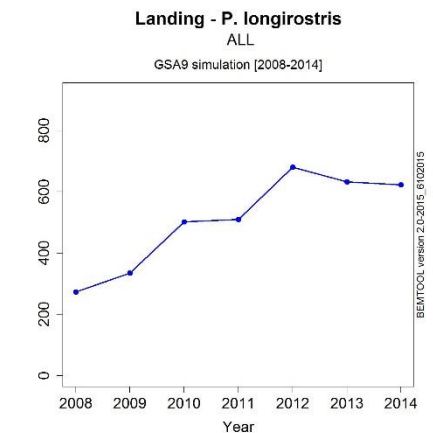
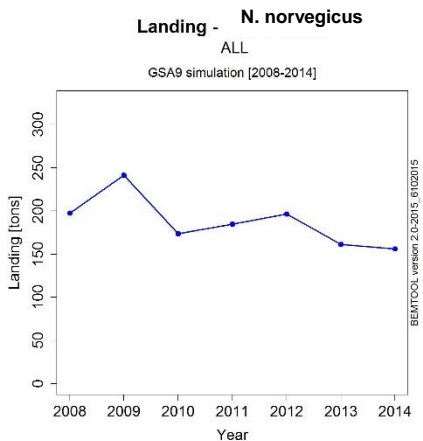
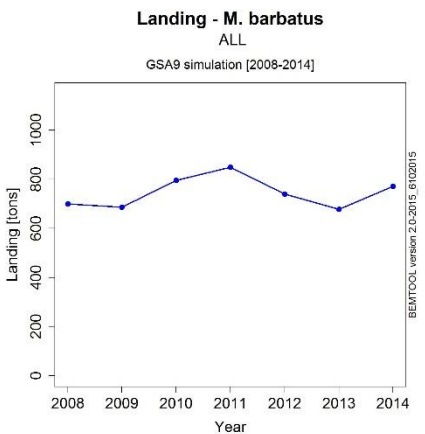
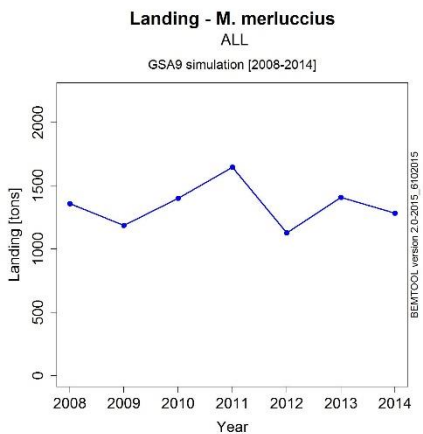
### GSA 9 – Demersal species, Fleets involved

Five main fleet segments operating in GSA 09 carrying out demersal fisheries have been 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 and the largest PGP segment (mostly using gill nets targeting European hake).

	<b>Fleet name</b>	<b>Fleet code</b>
1	Bottom trawlers with vessel length 12-18 m	DTS_VL1218
2	Bottom trawlers with vessel length 18-24 m	DTS_VL1824
3	Bottom trawlers with vessel length 24-40 m	DTS_VL2440
4	Vessels using polyvalent passive gears length 00-12 m	PGP_VL0012
5	Vessels using polyvalent passive gears length 12-18 m	PGP_VL1218

	DTS	DTS	DTS	PGP	PGP
	VL1218	VL1824	VL2440	VL0012	VL1218
<b>NEP (kg)</b>	2.03%	2.75%	3.91%	0.00%	0.00%
<b>DPS (kg)</b>	6.42%	6.50%	13.50%	0.00%	0.00%
<b>HKE (kg)</b>	9.23%	13.70%	14.78%	6.69%	29.98%
<b>MUT (kg)</b>	12.70%	8.84%	6.34%	1.80%	0.13%
<b>Total assessed</b>	30.38%	31.79%	38.53%	8.49%	30.11%

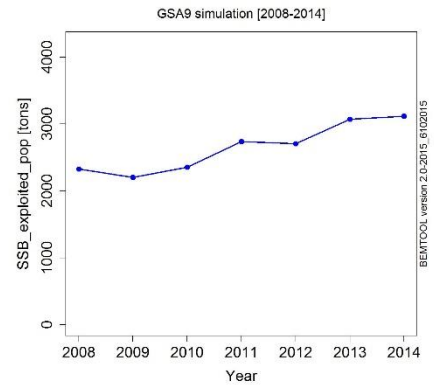
NEP = Norway lobster; DPS = deep-water pink shrimp; HKE = European hake; MUT = red mullet



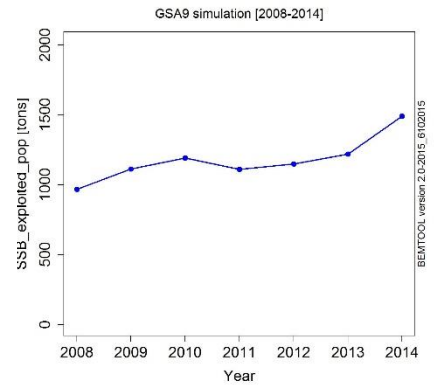
Total landings of European hake (*M. merluccius*), red mullet (*M. barbatus*), Norway lobster (*N. norvegicus*), and deep-water pink shrimp (*P. longirostris*) in GSA 9.



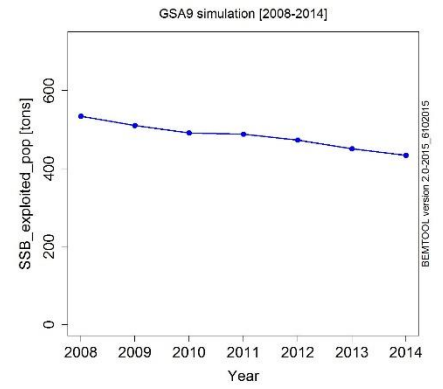
### SSB\_exploited\_pop - M. merluccius



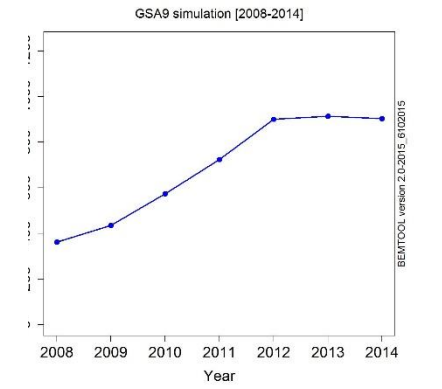
### SSB\_exploited\_pop - M. barbatus



### SSB\_exploited\_pop - N. norvegicus

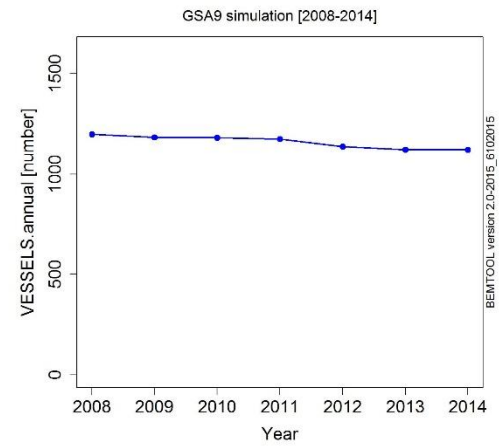


### SSB\_exploited\_pop - P. longirostris

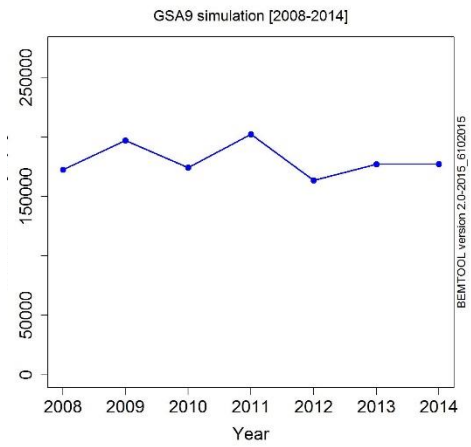


SSB of European hake (*M. merluccius*), red mullet (*M. barbatus*), Norway lobster (*N. norvegicus*), and deep-water pink shrimp (*P. longirostris*) in GSA 9.

### VESELS.annual ALL

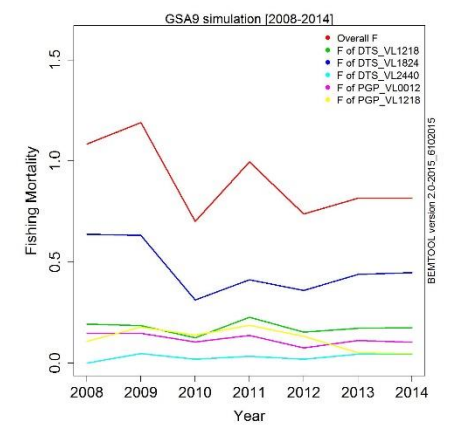


### DAYS.annual ALL



Fishing capacity (n. of vessels) and fishing activity (fishing days per year) by the demersal fleets in GSA 9 (all segments combined).

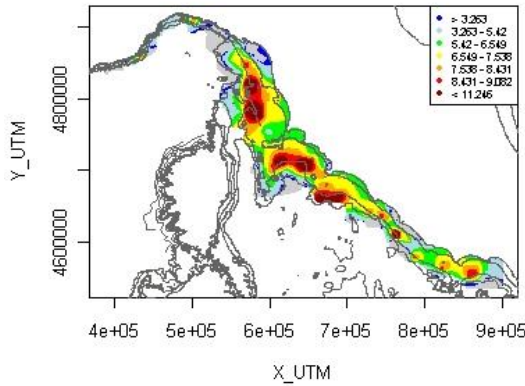
### Fishing Mortality - M. merluccius



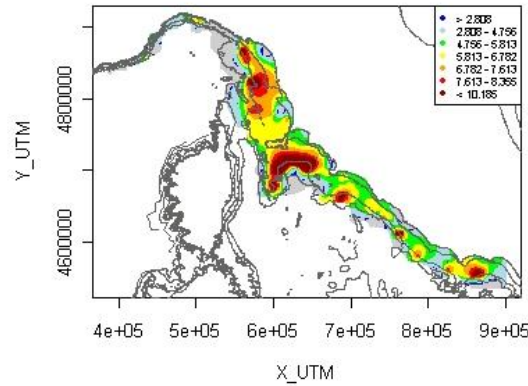
Fishing mortality F of European hake (*M. Merluccius*) in GSA 9 (total and by fleet segment).



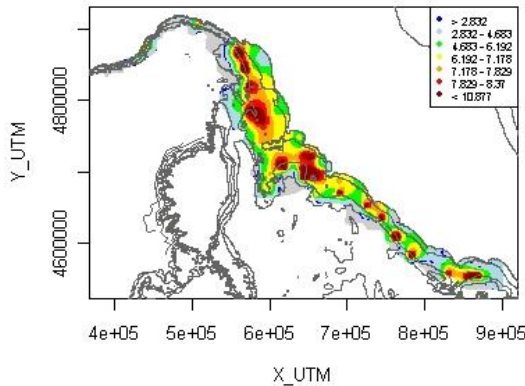
st2002



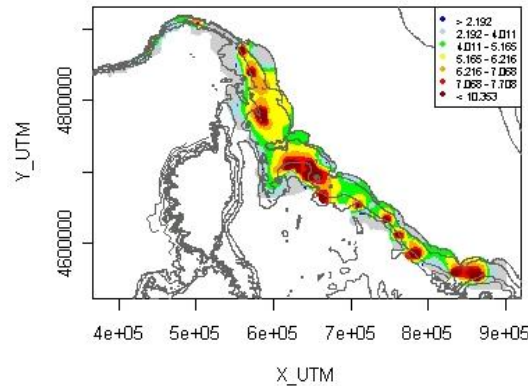
st2003



st2004



st2005



According to several studies, the density of hake recruits concentrations in the nursery areas of GSA 9 is by far higher than that of the other GSAs of the western Mediterranean and, probably, also of the other Mediterranean GSAs

Maps of the nursery areas of European hake in GSA 9 (MEDITS Survey data, 2002-2005).





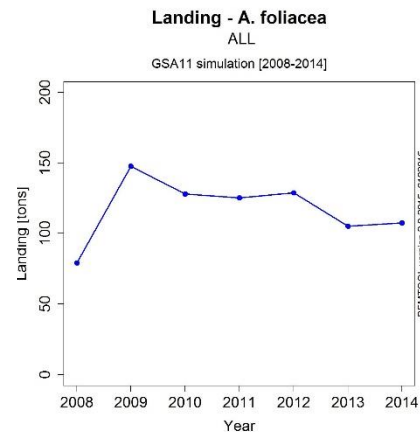
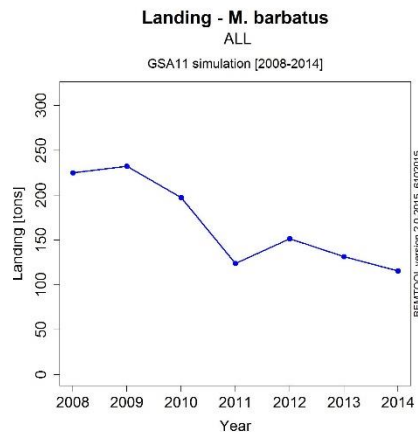
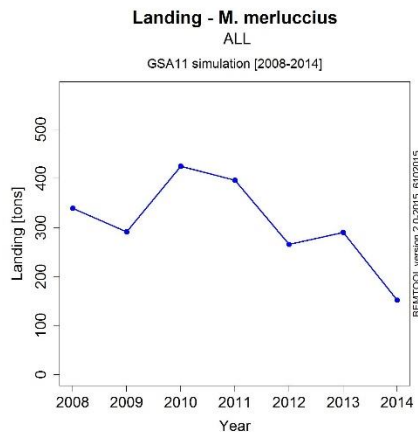
### GSA 11 – Demersal species, Fleets involved

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.

	<i>Fleet name</i>	<i>Fleet code</i>
1	Bottom trawlers with vessel length 12-18 m	DTS_VL1218
2	Bottom trawlers with vessel length 18-24 m	DTS_VL1824
3	Bottom trawlers with vessel length 24-40 m	DTS_VL2440
4	Vessels using polyvalent passive gears length 00-12 m	PGP_VL0012
5	Vessels using polyvalent passive gears length 12-18 m	PGP_VL1218

	DTS	DTS	DTS	PGP	PGP
	VL1218	VL1824	VL2440	VL0012	VL1218
<b>ARS (kg)</b>	1.2%	2.4%	11.3%		
<b>HKE (kg)</b>	7.2%	6.9%	12.6%	1.6%	1.5%
<b>MUT (kg)</b>	5.7%	7.8%	2.9%	0.3%	0.2%
<b>Total assessed</b>	14.1%	17.1%	26.8%	1.9%	1.7%

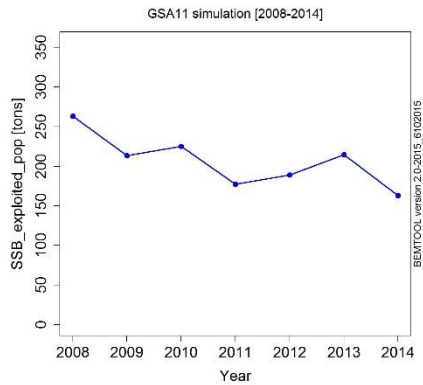
ARS = giant red shrimp; HKE = European hake; MUT = red mullet



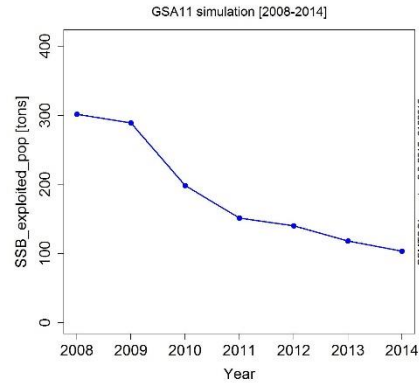
Total landings of European hake (M. merluccius), red mullet (M. barbatus), and giant red shrimp (A. foliacea) in GSA 11.



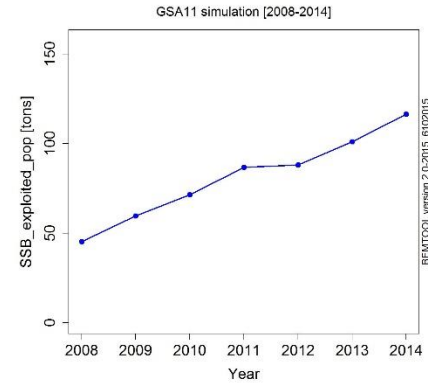
SSB\_exploited\_pop - M. merluccius



SSB\_exploited\_pop - M. barbatus

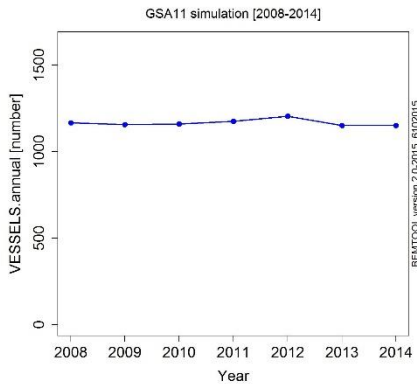


SSB\_exploited\_pop - A. foliacea

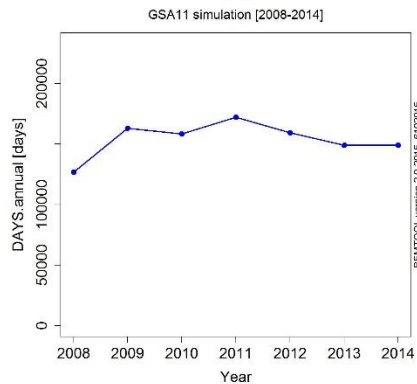


SSB of European hake (*M. merluccius*), red mullet (*M. barbatus*), and giant red shrimp (*A. foliacea*) in GSA 11.

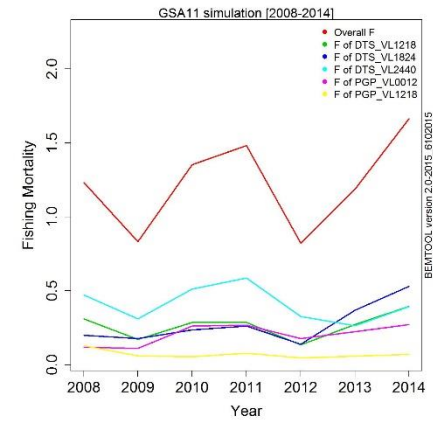
VESSELS.annual  
ALL



DAYS.annual  
ALL



Fishing Mortality - M. merluccius



Fishing capacity (n. of vessels) and fishing activity (fishing days per year) by the demersal fleets in GSA 11 (all segments combined).

Fishing mortality F of European hake (*M. Merluccius*) in GSA 11 (total, and by fleet segment).



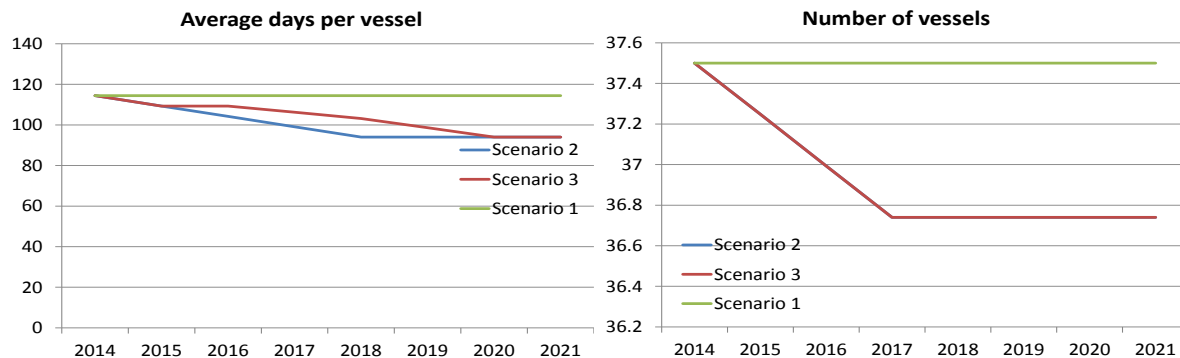
## DEFINITION OF THE DIFFERENT MANAGEMENT SCENARIOS

### Small pelagics in GSA 9

Based on F levels, anchovy is the most heavily exploited stock in the mix; however, sardine is the stock that was assessed more recently, therefore it was decided to use sardine as a benchmark.

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).

<b>Scenario 1</b>	Status quo
<b>Scenario 2</b>	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.
<b>Scenario 3</b>	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.





## Demersal species in GSA 9 and 11

The scenarios were implemented according to 2 main objectives:

- to reduce the fishing mortality of hake (the most overexploited stock) to its reference point ( $F_{msy}$  upper);
- to reduce the overall combined fishing mortality towards a combined reference point.

The scenarios implemented are:

**Scenario 1:** status quo;

**Scenario 2:** Linear reduction towards upper  $F_{msy}$  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 differentiated by fleet;

**Scenario 3:** Linear reduction towards a weighted average  $F_{msy}$  for a mix of species (using landings for weighing) in 2018 applied on both activity and capacity, up to 2017 included. Application be differentiated by fleet;

**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 differentiated by fleet;

**Scenario 5:** Adaptive reduction towards a weighted average  $F_{msy}$  for a mix of species (using landings for weighing) in 2020 applied only on activity from 2018 to 2020. Application differentiated by fleet;

**Scenario 6:** Improving selectivity delaying the size at first capture.



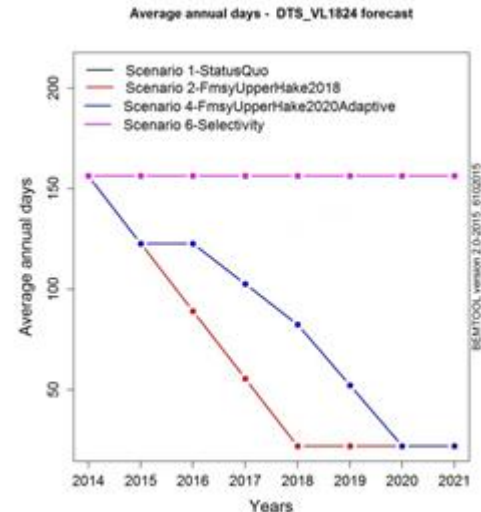
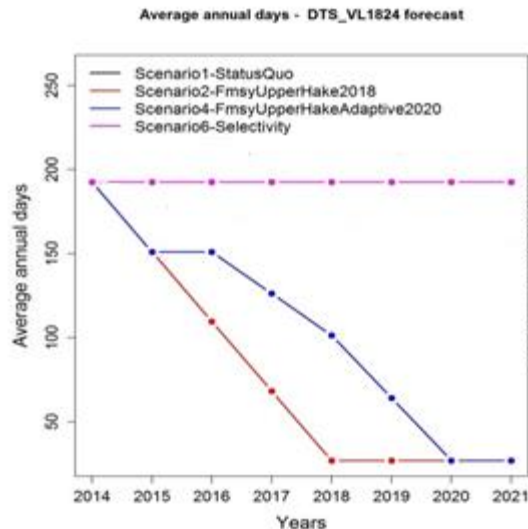
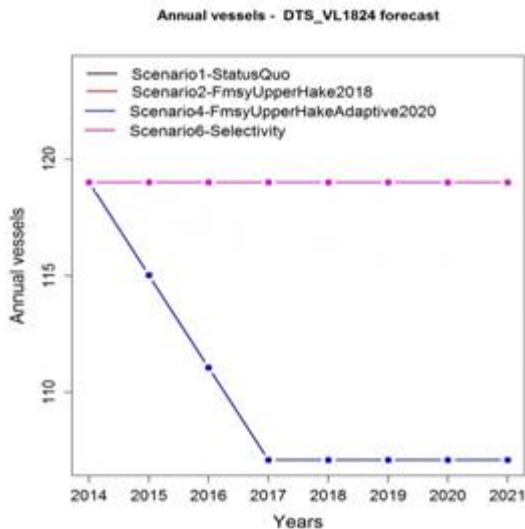
In **GSA 9**, according to the state of exploitation of European hake, a reduction of F by 66% is needed to reach  $F_{msy}$  upper.

A reduction of 48% on the overall fishing mortality would be needed to reach the  $F_{msy}$  combined.

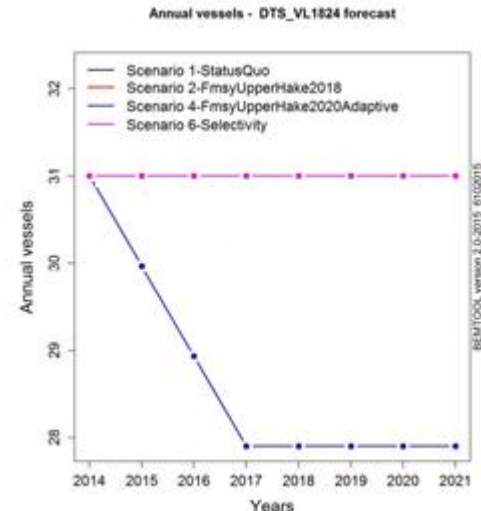
In **GSA 11**, according to the state of exploitation of European hake, a reduction of F by 86% is needed to reach  $F_{msy}$  upper.

A reduction of 73% on the overall fishing mortality would be needed to reach the  $F_{msy}$  combined.

### GSA 9



### GSA 11



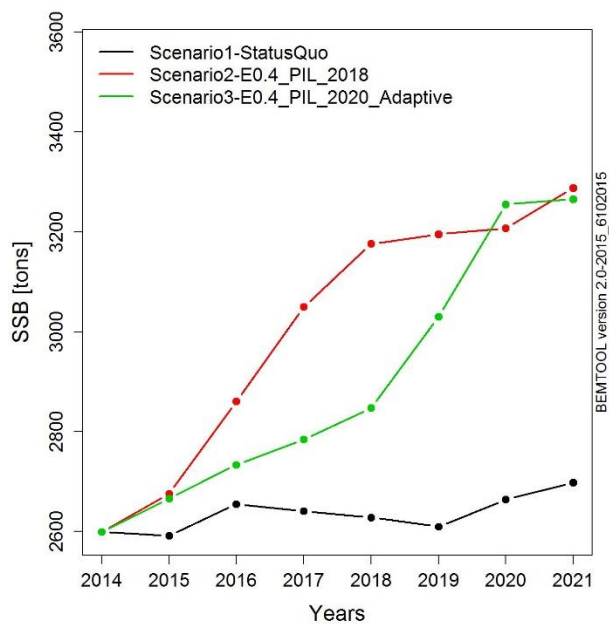


## GSA 9: Small pelagics

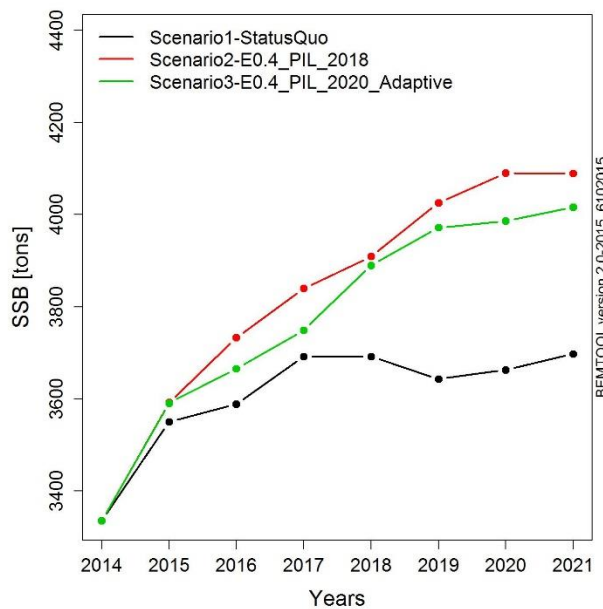
### Forecasts of Spawning Stock Biomass (SSB) under the different scenarios

*E. encrasicolus*: anchovy; *S. pilchardus*: sardine

*E. encrasicolus* - SSB forecast



*S. pilchardus* - SSB forecast



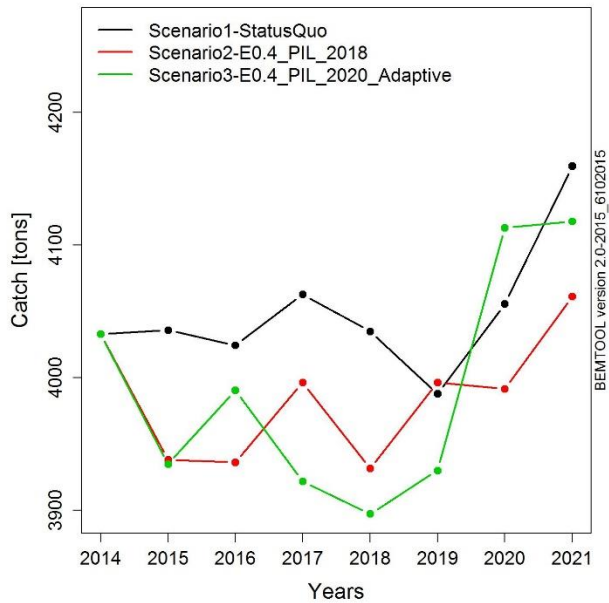


## GSA 9: Small pelagics

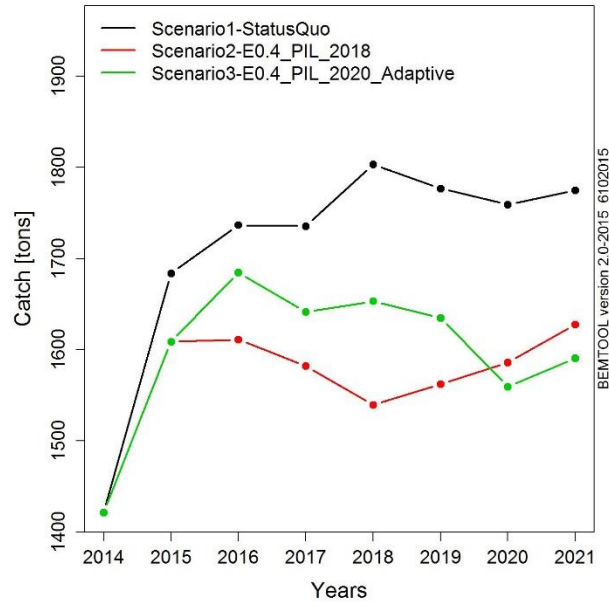
### Forecasts of Catches under the different scenarios

*E. encrasicolus*: anchovy; *S. pilchardus*: sardine

*E. encrasicolus* - Catch - ALL forecast

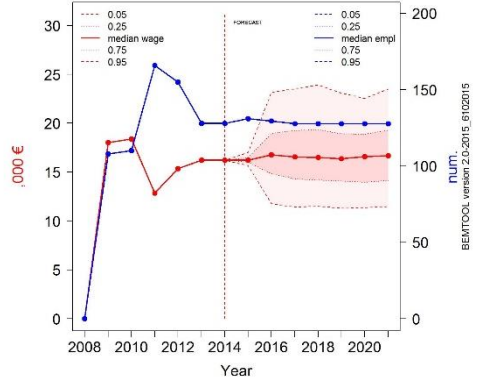
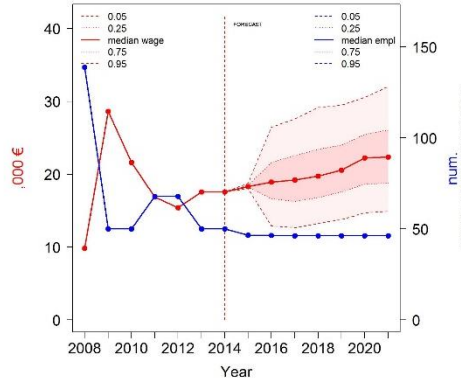


*S. pilchardus* - Catch - ALL forecast

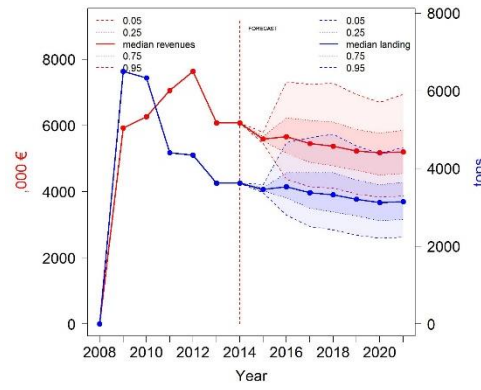
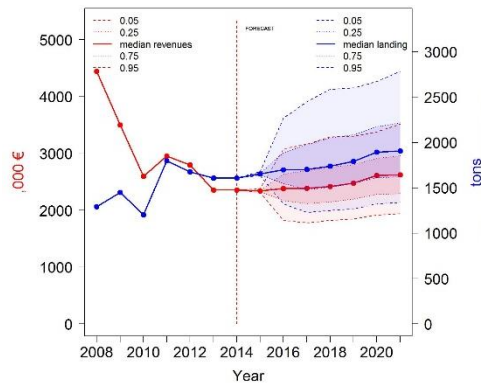




## GSA 9, Small pelagics

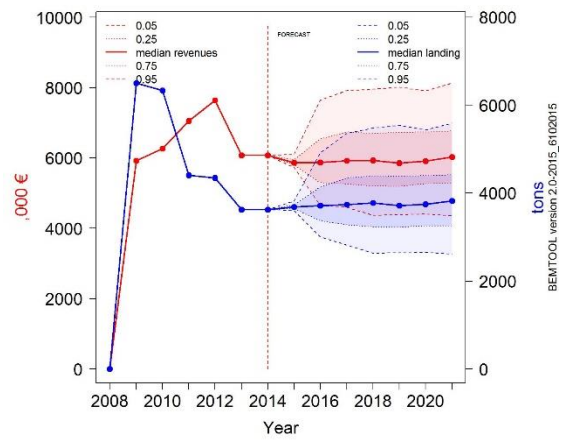


Forecasts of Average salary (red line) and Employment (blue line) in PS\_VL1824 (left panel) and PS\_VL2440 (right panel) under Scenario 3



Forecasts of Total revenues (red line) and Landings (blue line) in PS\_VL1824 (left panel) and PS\_VL2440 (right panel) under Scenario 3

Forecasts of Total revenues (red line) and Landings (blue line) in PS\_VL2440 (right panel) under the Status Quo Scenario



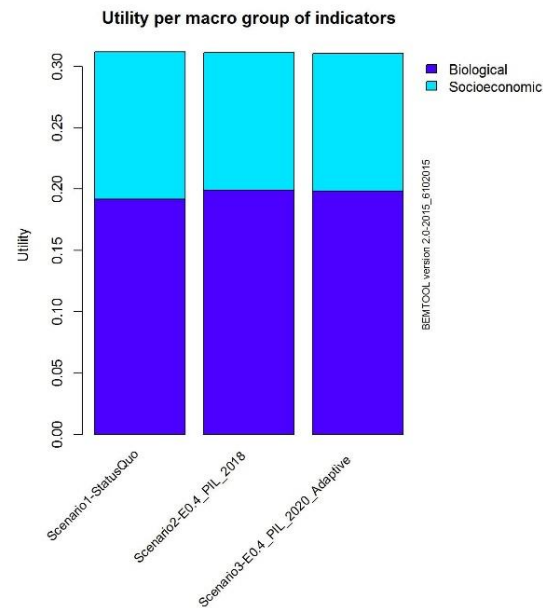




### Small pelagics in GSA 9: Traffic light table (all fleet segments combined)

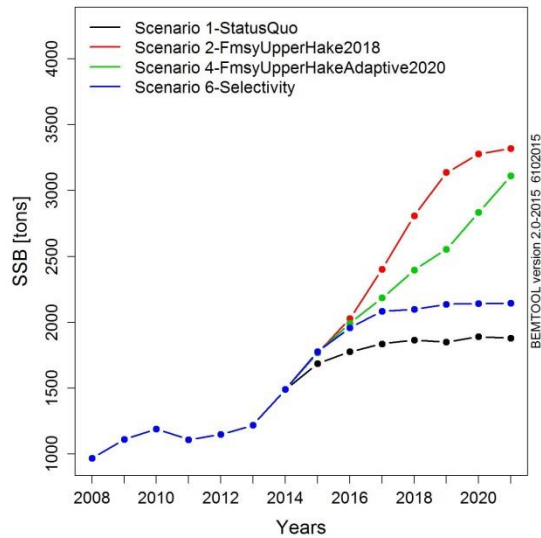
Small pelagics in GSA 09	ALL fleets							
	Salary	CR.BER	Rev.	Employ.	SSB anchovy	SSB sardine	Catch anchovy	Catch sardine
Scenario 2	9.8	16.6	-0.3	-2.2	21.9	21.9	10.6	-2.4
Scenario 3	10.9	17.9	0.5	-2.2	21.1	21.1	8.6	-1.0

Multi-Criteria Decision Analysis (MCDA): the three scenarios provide similar results in terms of overall utility (values around 0.3)

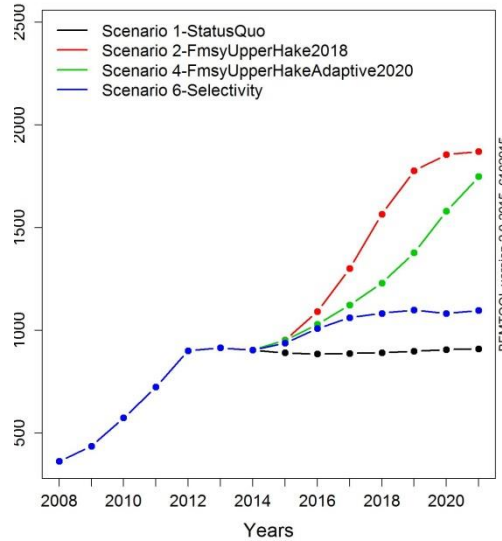




M. barbatus - SSB



P. longirostris - SSB



## GSA 9: Demersal stocks

### Forecasts of Spawning Stock Biomass (SSB) under the different scenarios

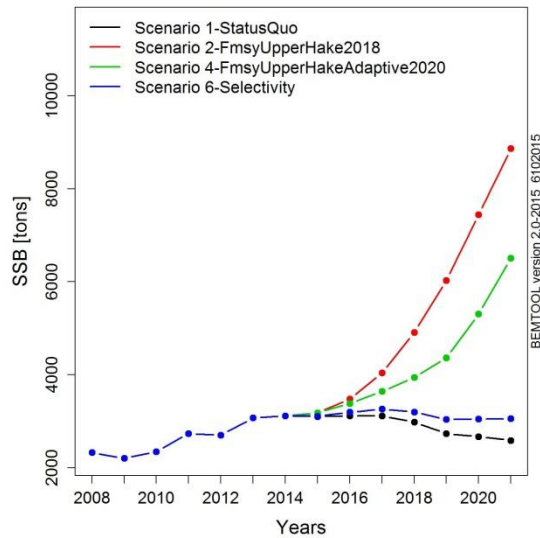
M. merluccius: European hake

M. barbatus: red mullet

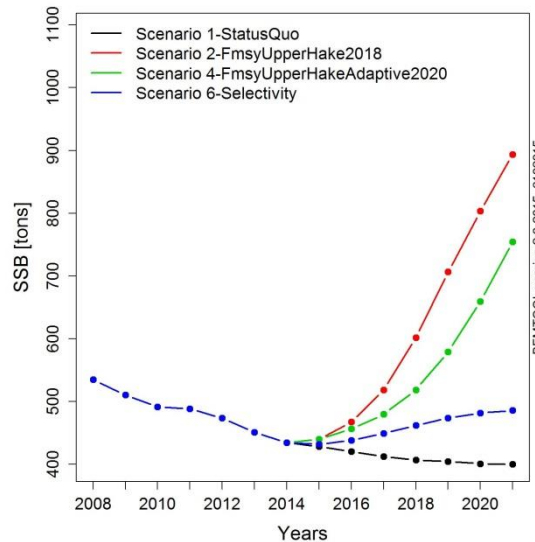
P longirostris: deep-water pink shrimp

N. norvegicus: Norway lobster

M. merluccius - SSB

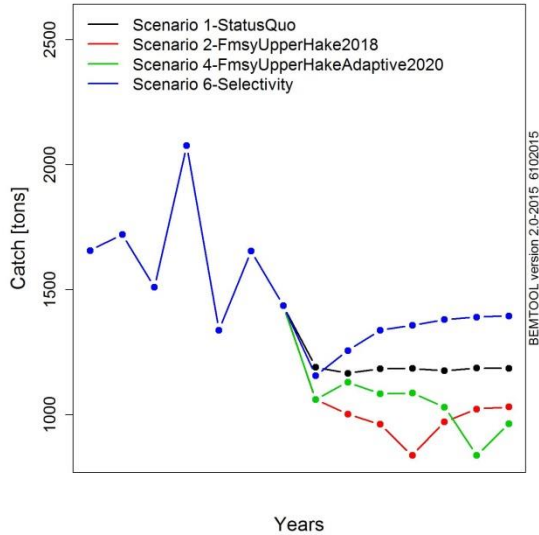


N. norvegicus - SSB

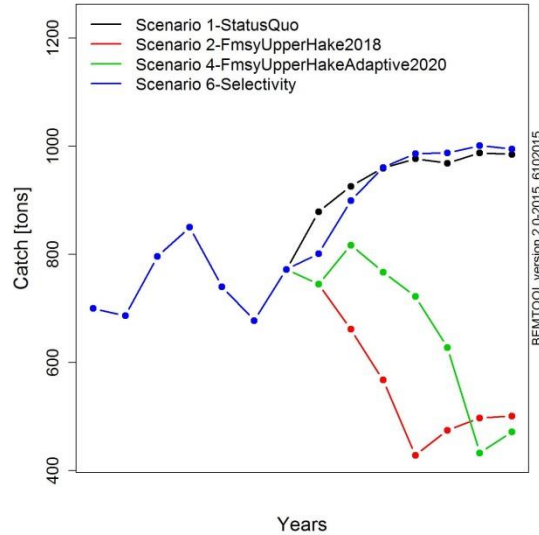




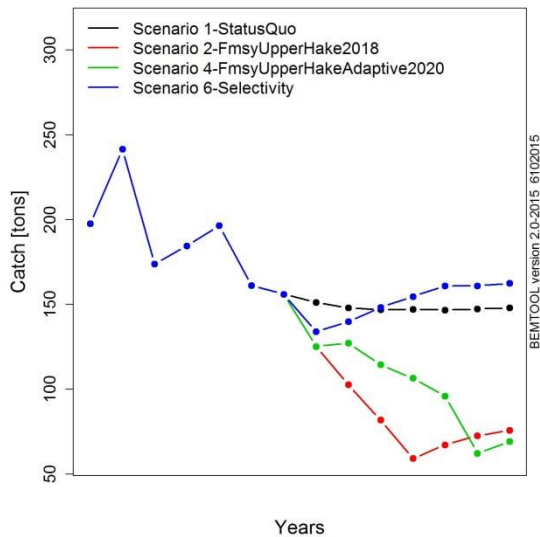
M. merluccius - Catch - ALL



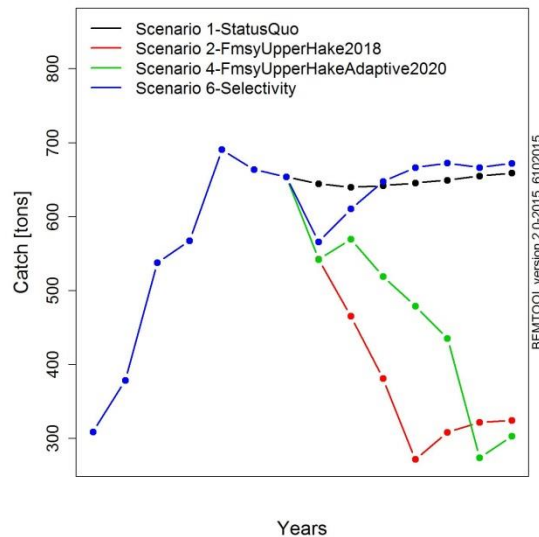
M. barbatus - Catch - ALL



N. norvegicus - Catch - ALL



P. longirostris - Catch - ALL



## GSA 9: Demersal stocks

Forecasts of Catches under the different scenarios

M. merluccius: European hake

M. barbatus: red mullet

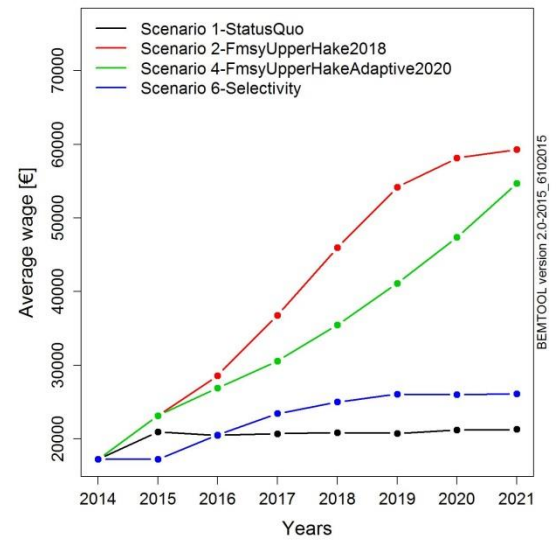
P. longirostris: deep-water pink shrimp

N. norvegicus: Norway lobster

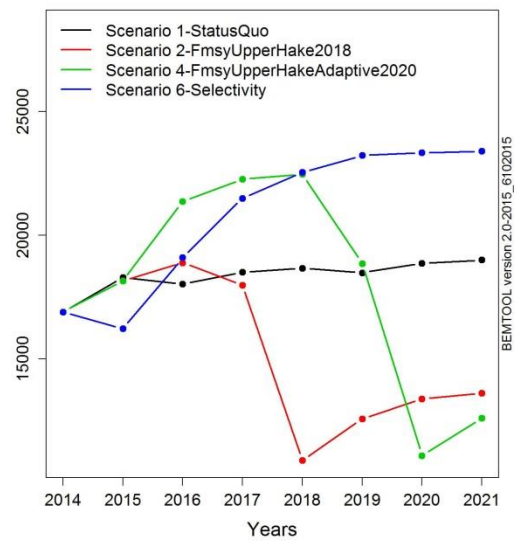


## GSA 9, Demersal stocks

Average wage - DTS\_VL2440 forecast



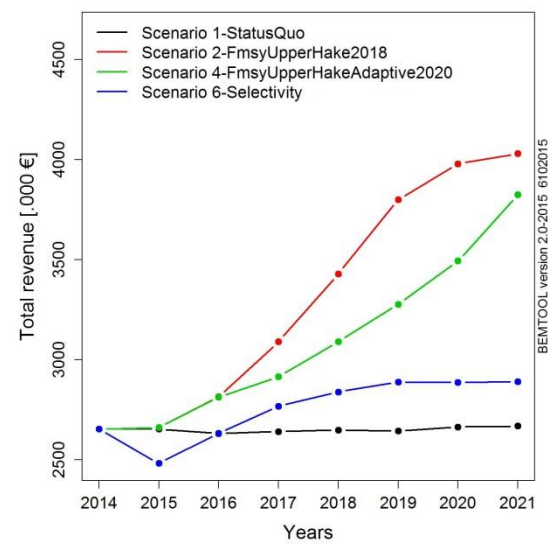
Average wage - DTS\_VL1824 forecast



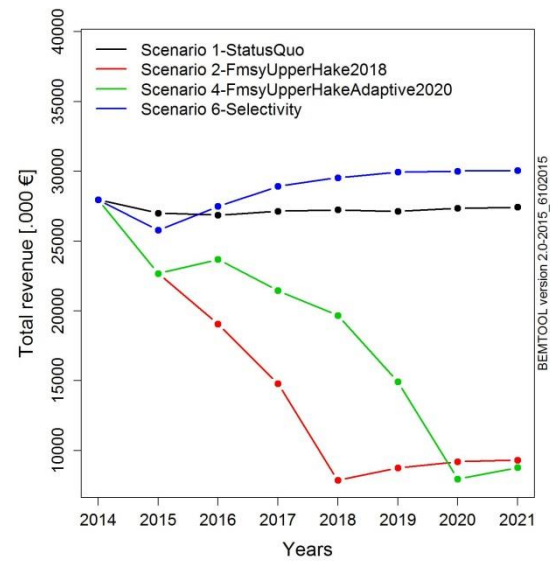
Forecasts of Average wage (salary) in DTS\_VL2440 and DTS\_VL1824 under all the scenarios run

Forecasts of Total revenues in DTS\_VL2440 and DTS\_VL1824 under all the scenarios run

Total revenue - DTS\_VL2440



Total revenue - DTS\_VL1824

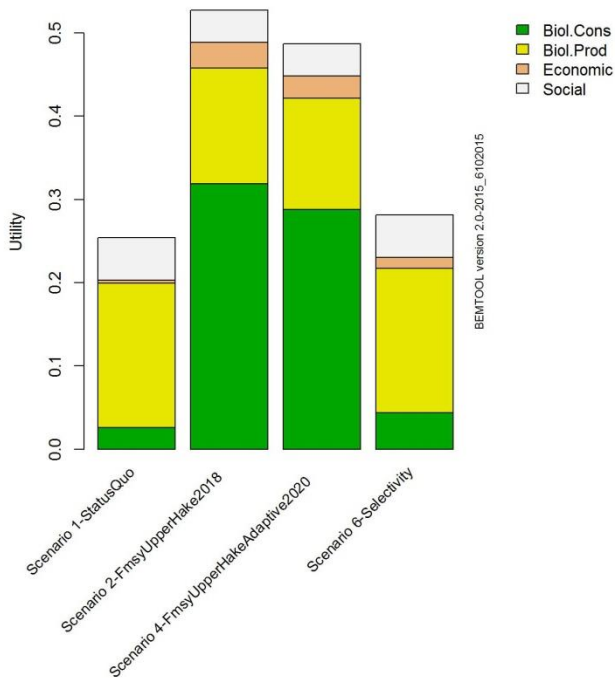




### Demersal stocks in GSA 9: Traffic light table (all fleet segments combined)

Demersals in GSA 09	ALL fleets											
	Salary	CR.BER	Rev.	Employ.	SSB HKE	SSB MUT	SSB DPS	SSB NEP	Catch HKE	Catch MUT	Catch DPS	Catch NEP
Scenario 2	71.6	65.8	-9.7	-4.5	242.2	76.4	105.4	123.3	-13	-49.1	-50.7	-48.8
Scenario 4	59.3	53	-14.2	-4.5	151.2	65.4	92	88.6	-18.7	-52.1	-54	-53.3
Scenario 6	21.5	30.3	11.7	0	18	14.1	20.5	21.5	17.7	1	2	9.8

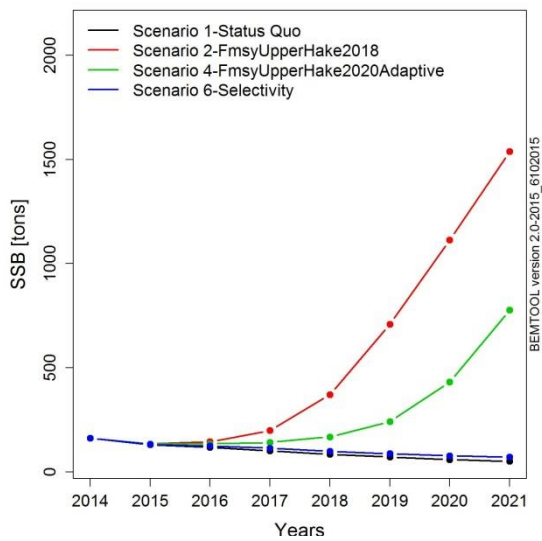
Utility per group of indicators



Multi-Criteria Decision Analysis (MCDA): The scenarios allowing to reach the highest overall utility are scenarios 2 and 4 (overall utility 0.53 and 0.49 respectively), while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.25).



M. merluccius - SSB forecast

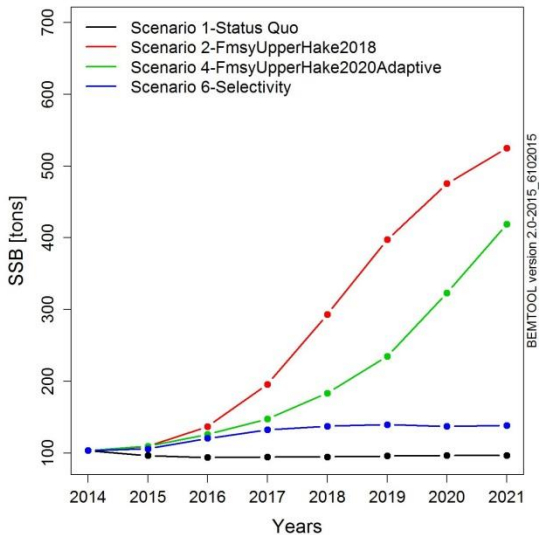


## GSA 11: Demersal stocks

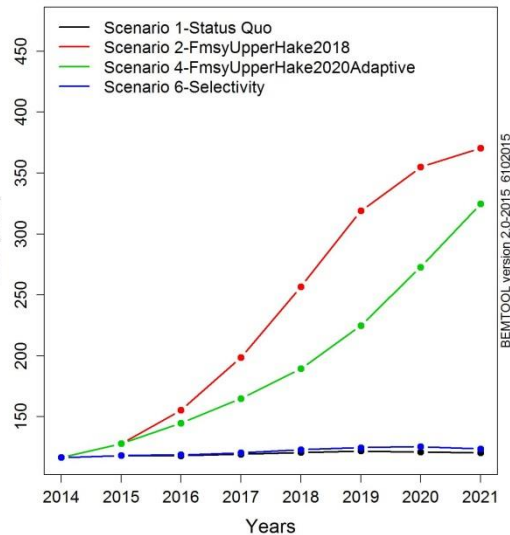
### Forecasts of Spawning Stock Biomass (SSB) under the different scenarios

- M. merluccius: European hake
- M. barbatus: red mullet
- A. foliacea: giant red shrimp

M. barbatus - SSB forecast

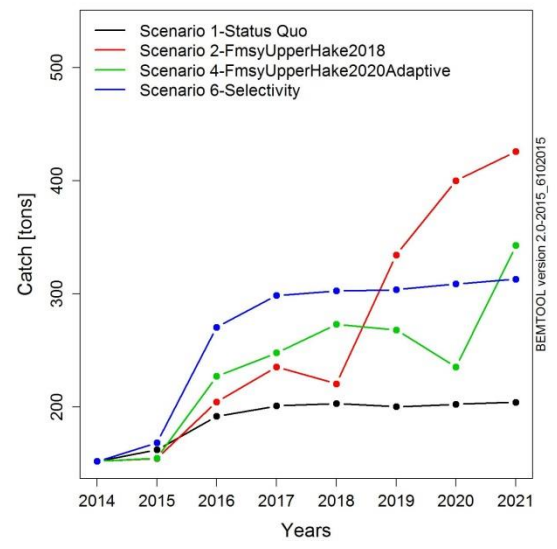


A. foliacea - SSB forecast

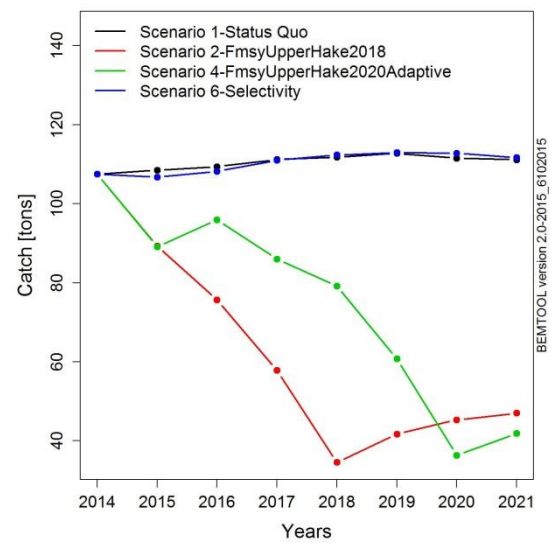




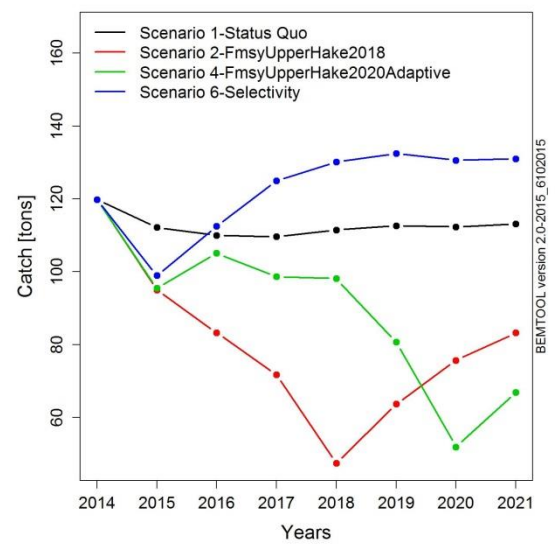
**M. merluccius - Catch - ALL forecast**



**A. foliacea - Catch - ALL forecast**



**M. barbatus - Catch - ALL forecast**



## GSA 11: Demersal stocks

### Forecasts of Catches under the different scenarios

**M. merluccius: European hake**

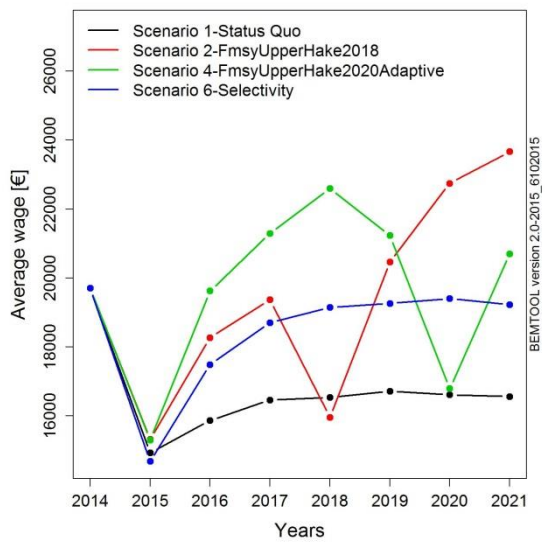
**M. barbatus: red mullet**

**A. foliacea: giant red shrimp**

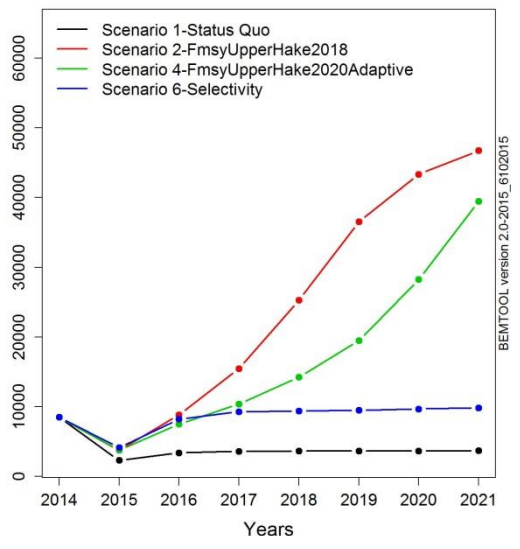


## GSA 11, Demersal stocks

Average wage - DTS\_VL2440 forecast



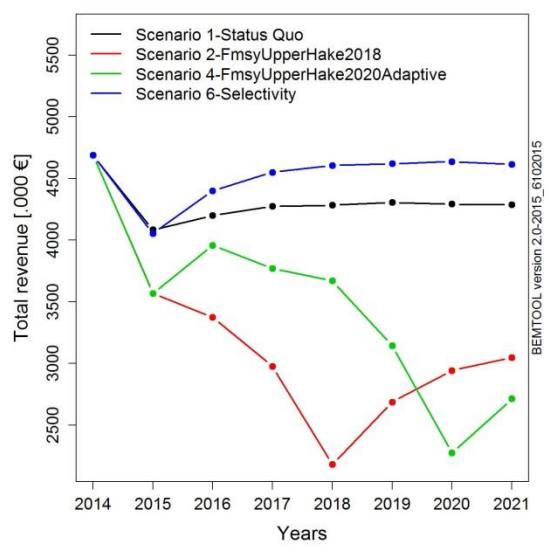
Average wage - PGP\_VL1218 forecast



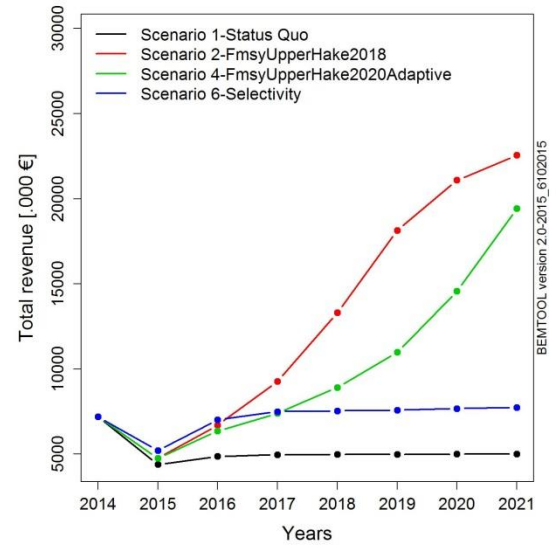
Forecasts of Average wage (salary) in DTS\_VL2440 and PGP\_VL1218 under all the scenarios run

Forecasts of Total revenues in DTS\_VL2440 and PGP\_VL1218 under all the scenarios run

Total revenue - DTS\_VL2440



Total revenue - PGP\_VL1218

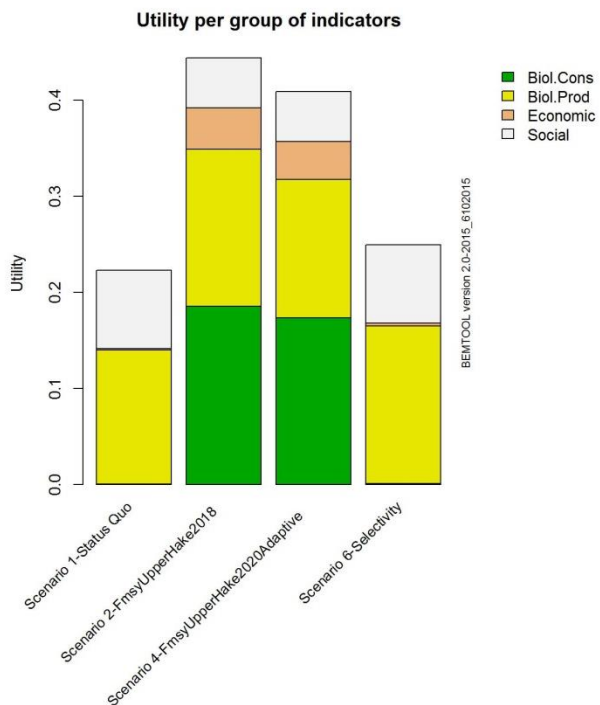






### Demersal stocks in GSA 11: Traffic light table (all fleet segments combined)

Demersals in GSA 11	ALL fleets									
	Salary	CR.BER	Rev.	Employ.	SSB HKE	SSB MUT	SSB ARS	Catch HKE	Catch MUT	Catch ARS
Scenario 2	188.1	586.8	94.9	-7.7	2910.5	442.2	207.8	108.5	-26.4	-57.7
Scenario 4	143.9	463.3	64.8	-7.7	1421.1	332.7	170	67.9	-40.9	-62.3
Scenario 6	44.3	141.8	37.4	0	39.5	43.2	2.8	53.3	15.8	0.5



Multi-Criteria Decision Analysis (MCDA): The scenarios allowing to reach the highest overall utility are scenarios 2 and 4 (overall utility 0.44 and 0.41 respectively), while the lowest utility is given by Scenario1, i.e. status quo (overall utility 0.22).



## General remarks

- 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) and technical measures (Selectivity; only for demersal species);
- As concerns demersal species, all the performed scenarios allow to obtain a benefit on the SSB of the stocks under consideration in respect to the status quo;
- While entailing the lowest decrease in social-economic terms, Scenario 6 does not ensure reaching  $F_{msy}$ ;
- In all cases (GSA 9 and GSA 11), the best performance was shown by Scenario 2 and 4 (hake  $F_{msy}$  upper by 2018 and by 2020, respectively), although they may lead to underutilization of the remaining stocks.