Stock Assessment Form

Demersal species

Reference year: 2014

Reporting year: 2015

ABSTRACT

The current Assessment Form corresponds to an assessment of *M. barbatus* produced during the meeting held form 3-6 November 2015 in Málaga organized by **CopeMed II** project. The sub-regional working groups among Algeria, Morocco and Spain were created by the **CopeMed II** to reinforce the cooperation and prepare solid assessments of the stocks that are shared between different fisheries and countries in the Alborán sea area. The Study Group on demersal species met for the 4th time after one year and progressed on the assessment of *M. barbatus*, *M. merluccius* and *P. longirostris*. The status of red mullet in GSA01 and GSA03 combined, resulted in overxploitation status with intermediate level of biomass. The quality of the data used and reliability of the model assumptions can be considered good according to the fitting results.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *CopeMed II WG*

Stock assessment form

Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Mullus barbatus	[Red mullet]	33
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
[GSA_1]	[GSA_3]	[GSA_4]
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
[Spain]	[Morocco]	[Algeria]
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
(LCA, XSA, Production, trawl surveys)		
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1. Stock identification and biological information

1.1. Stock unit

1.2. Growth and maturity

Table 1.2.2-1: Maximum size, size at first maturity and size at recruitment.

Somatic magnitude measured (LT, LC, etc)				Units	
Sex	Fem	Mal	Combined	Reproduction season	October-December
Maximum size observed			35(1)	Recruitment season	
Size at first maturity			11.2 (2)	Spawning area	Continental shelf
Recruitment size			7.8 (3)	Nursery area	Coastal areas

2. (1) Size composition of trawl catches in GSA01 and 03.
3. (2) From the Spanish EU-DCF National Programme (2011)
4. (3) García-Rodriguez, M. and Fernández, A.M .2005.

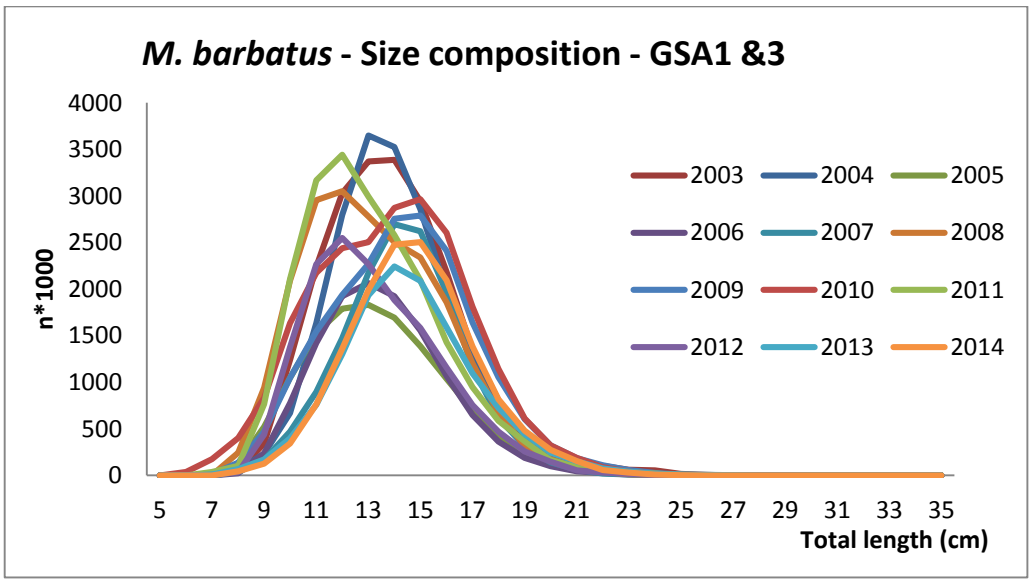

Fig. 1 *Mullus barbatus*. Length distributions for trawl fleet in GSA1 and GSA3 combined.

Table 1.2-2.2: M vector and proportion of matures by size or age (combined)

Size/Age	Natural mortality	Proportion of matures
0	0.9	0.16
1	0.72	0.92
2	0.65	1
3	0.62	1
4+	0.6	1

Table 1.2-3: Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	**L_∞**				34.5	
	K				0.34	
	t_0				-0.143	
	Data source	Demestre et al., 1997 (adopted by SGMED-08-03)				
Length weight relationship	**a**				0.0062	
	b				3.159	
	M (scalar)				0.25	

L/W relationship from DCF 2011 (Spain); M from PRODBIOM Fisheries information

3. Fisheries information

3.1. Description of the fleet

***Mullus* spp fishery in Spain GSA01**

Both species of mullets, *Mullus surmuletus* and *M. barbatus*, are exploited by trawl and artisanal fleets in GSA 01. Small gears (trammel nets and gillnets) account for 13% and 32% of the total landings of *M. Barbatus* and *M. Surmuletus* respectively (average 2003-2014 period). Trawl fleet account 104 and 99 tonnes for *M. Barbatus* and *M. Surmuletus* respectively (average 2003-2014 period).

From official data, the total trawl fleet of the geographical sub-area 01 catching Mullus spp is composed almost exclusively by 141 trawlers and 206 trammel net (average 2009-2014 period).

Official landings data for both species in the GSA01 are available as *Mullus* spp. and for the whole fishing fleet. The percentage of *Mullus barbatus* vs *Mullus surmuletus* in the landings (around 52% for the 2003-2014 period) have been estimated from sampling developed by IEO at Almería and Fuengirola, two of the most important ports for the trawl fishery along the GSA01 area.

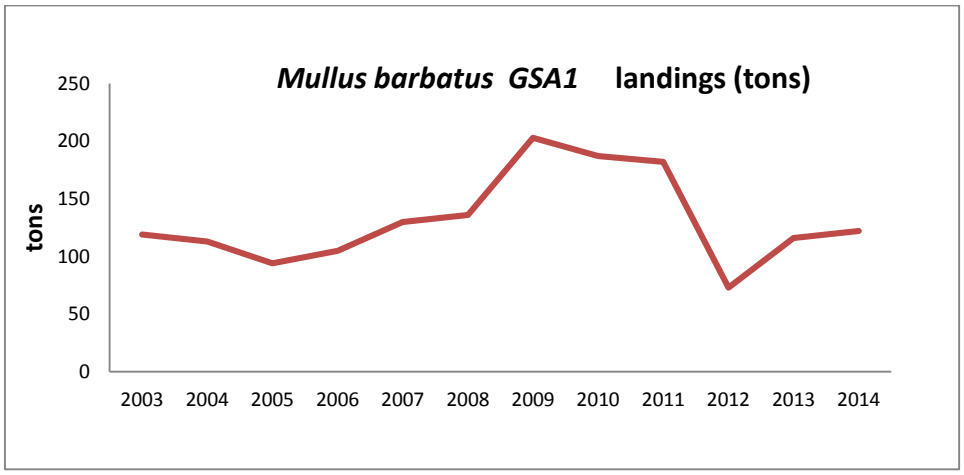

Fig.2: Evolution of *Mullus barbatus* annual catch in GSA01

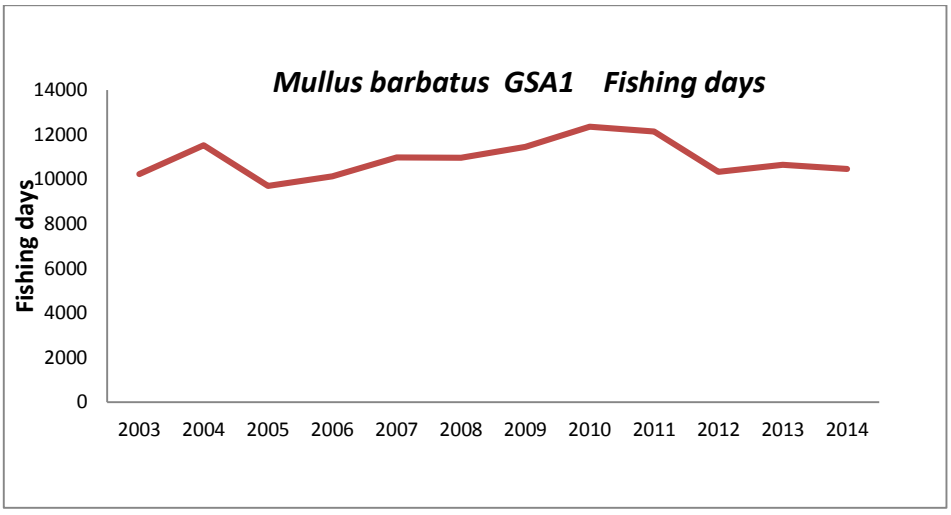

Fig.3: Evolution of annual fishing effort on *Mullus barbatus* GSA01

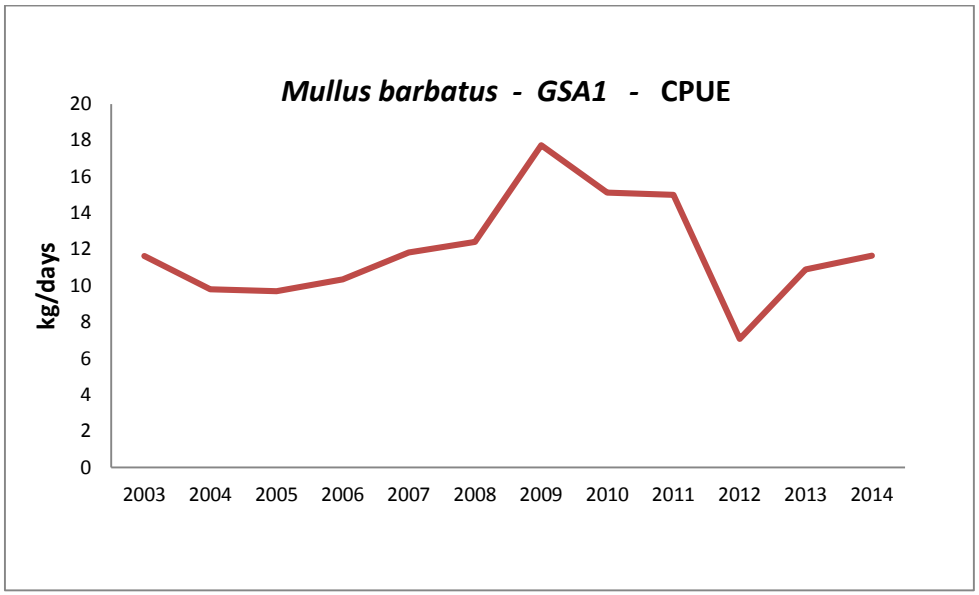

Fig.4: Evolution of the CPUE of *Mullus barbatus* in GSA01

Mullus barbatus fishery in Morocco GSA03

Fishing demersal species in Moroccan Mediterranean coast is practiced mainly by a trawler fleet consisting of 114 units, but also by artisanal fishing fleet albeit in a much smaller way. The engine power of trawlers is highly variable, ranging from a minimum of 80 hp and a maximum of 500 hp with an average of 356 CV in 2014. Also, the GRT is very variable oscillating between 15.23 and 116.2 tons. The average value of GRT in 2014 is 53.06 tons.

In general, Mullus barbatus landings showed fluctuations over the years with two major peaks recorded in 2004 and 2010 on the order of 417 tones and 367 tons respectively. The average annual value of the catch is in the order of 313 tons (fig.5). Fishing depths of this species are understood, essentially, between the coast up to 100 meters.

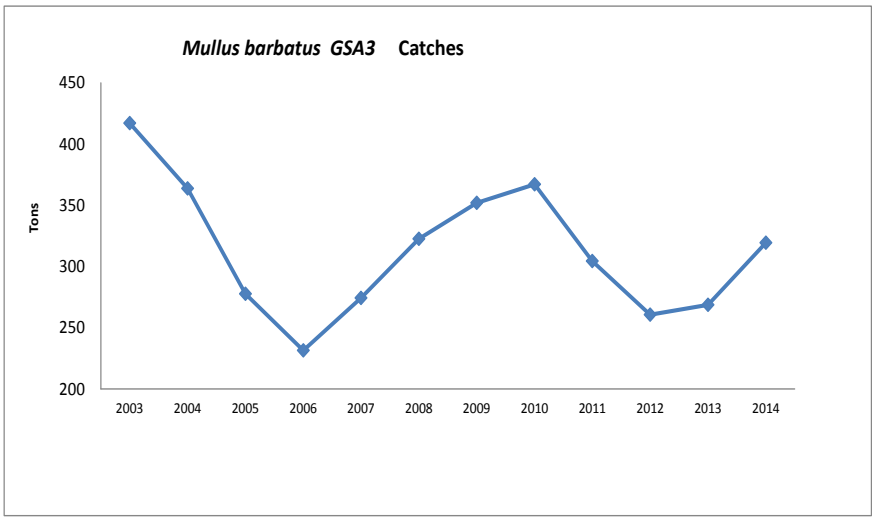

Fig.5: Evolution of *Mullus barbatus* annual catch in GSA03

The evolution of fishing effort in fishing days on the red mullet since 2004 shows a succession of periods of decrease and increase. Indeed, after a decrease from 2004 to 2006, the fishing effort has increased again, reaching a maximum in 2009 of around 15540 fishing days. A decrease phase was recorded again until 2013 (fig.6)

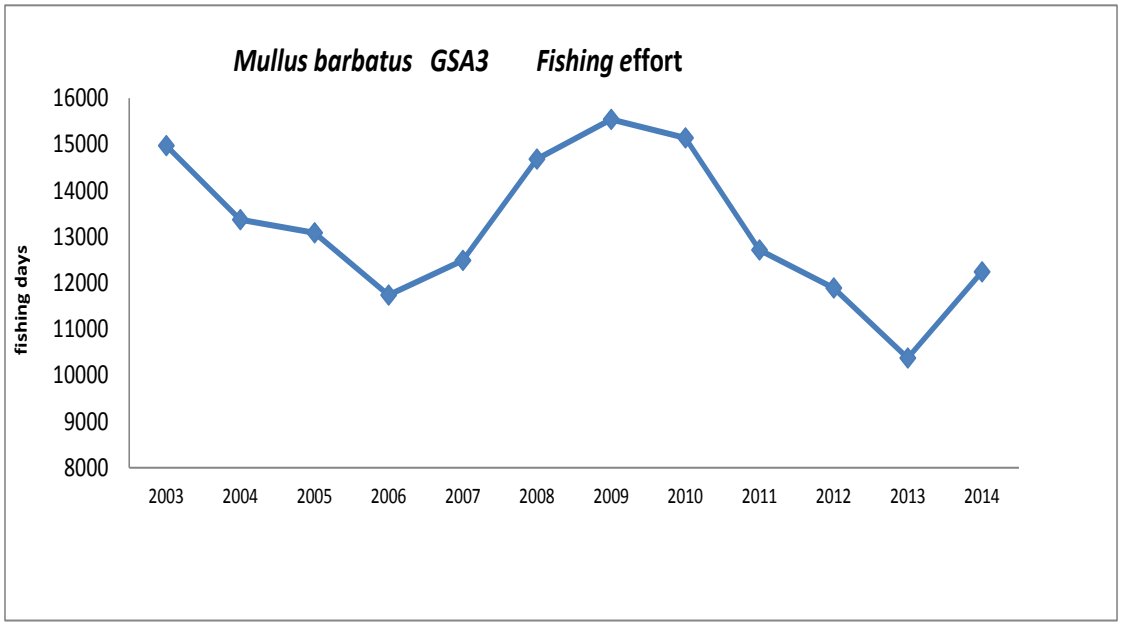

Fig.6: Evolution of annual fishing effort on *Mullus barbatus* in GSA03

After a major drop in CPUE from 2004 to 2006 when a minimum value was recorded, a rapid recovery was reported in 2007 and 2008. Between 2009 and 2011, CPUE has fluctuated around 23,62kg / fishing day. A gradual increase is observed during 2013 following by a stabilization in 2014 (fig.7).

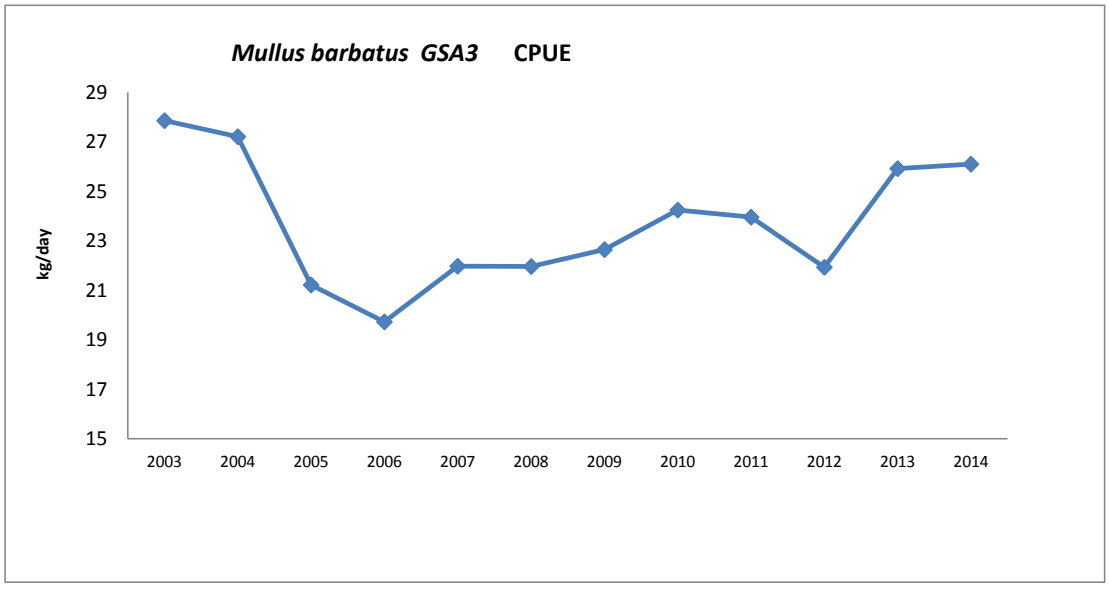

Fig.7: Evolution of the CPUE of *Mullus barbatus* in GSA03

***Mullus barbatus* fishery in Algeria GSA04**

In GSA 4, the demersal fishing fleet is composed of 3322 vessels (between 2.5 and 19.2 m length overall and 39 – 430 HP engine power) which can be divided in two main categories according to the fishing gear and zone: trawlers targeting species generally between 100m to 500m and the "small scale" vessels working mostly in shallow water of the continental shelf using gillnets. Although, landings from trawlers account for 80% of the total production and are mainly composed by fish (locally named "white fish"), crustaceans decapods and cephalopods. The most important species are: deep shrimps *Aristeus antennatus* and *Parapenaeus longirostris, red Mullet Mullus barbatus, Merluccius merluccius, Pagellus acarne , Boops boops and Pagellus erythrinus*. Regarding cephalopods the main target species is *Sepia officinalis* both in terms of quantities landed and economic value.

According to recent statistics of the Ministry of Agriculture, Rural developpement and Fishery Algerian (MADRP), the total catch of *Mullus barbatus* in 2013 is about 382 Tons which represent (11%) from total demersal landings, *P. longirostris* is 15,5 % and *M. merluccius* is considering 15 %.

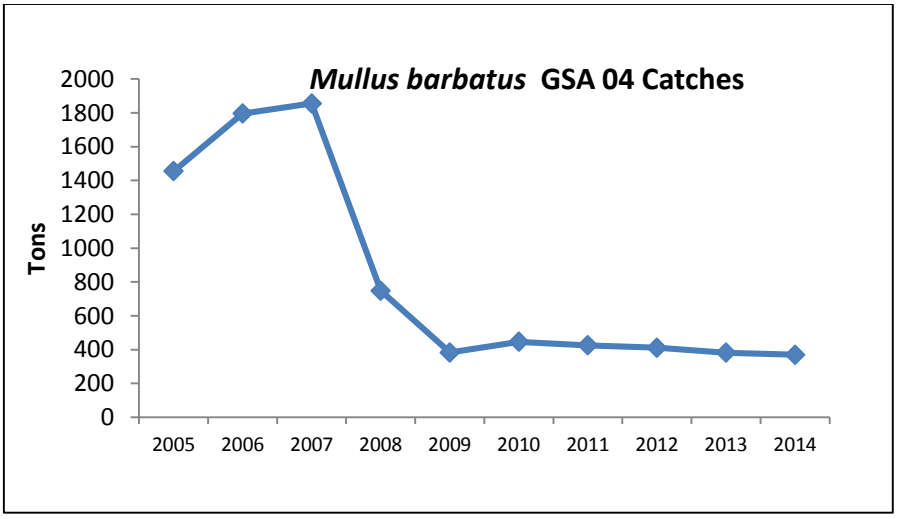

Fig.8: Evolution of *Mullus barbatus* annual catch in GSA04

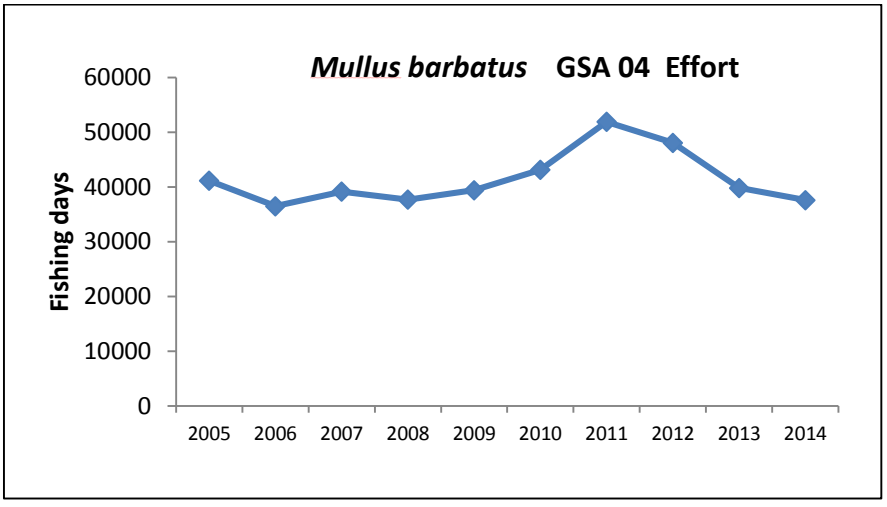

Fig.9: Evolution of annual fishing effort on *Mullus barbatus* in GSA04

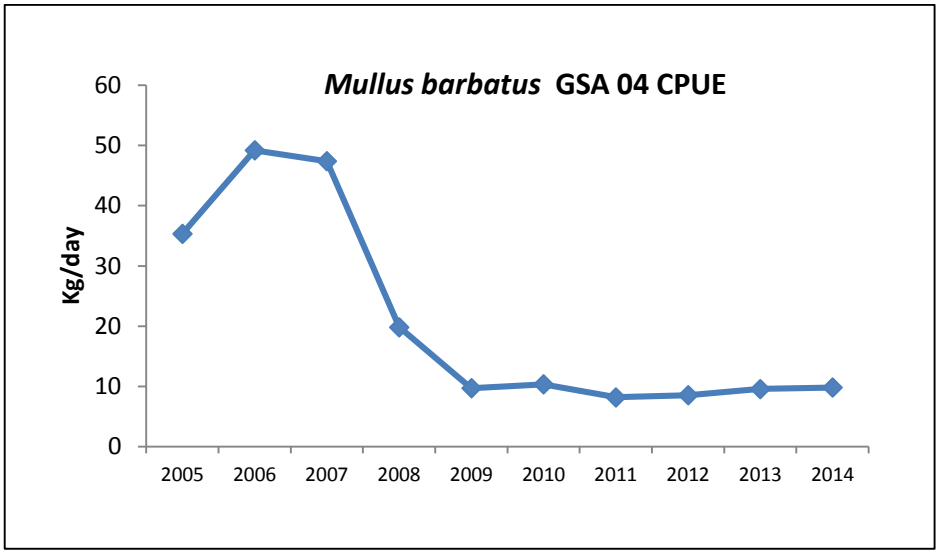

Fig.10: Evolution of the CPUE of *Mullus barbatus* in GSA04

Table 3.1-1: Description of operational units exploiting the stock in GSAs 01, 03 and 04

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	[Spain]	[GSA1]	E – Trawl (12-24 m)	03 - Trawl	33-Demersal shelf species	*Pagellus acarne Pagellus erythrinus Merluccius Octopus vulgaris Sepia officinalis Eledone cirrhosa*
Operational Unit 2	[Morocco]	[GSA3]	[Trawlers]	[Trawl]	33-Demersal shelf species	*Mullus spp White hake Parapenaeus longirostris and other shrimps Pagellus acarne Boops bops Octopus vulgaris etc.*
Operational Unit 3	[Algeria]	[GSA4]	Trawlers	trawl	demersal shelf species	

Table 3.1.1-2: Catch, bycatch, discards and effort by operational unit in the reference year

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
[Operational Unit1]	120	103 tons (average 2012-2014)		No		10460 days (2014)
[Operational Unit2]	114	283 tons (Average 2012-2014)	*White hake Parapenaeus longirostris and other shrimps Pagellus acarne Boops bops Octopus vulgaris etc.*	No	Low discards (not assessed)	12240 Fishing days (in 2014)
[Operational Unit3]						
[Operational Unit4]						
[Operational Unit5]						
Total						

Historical trends

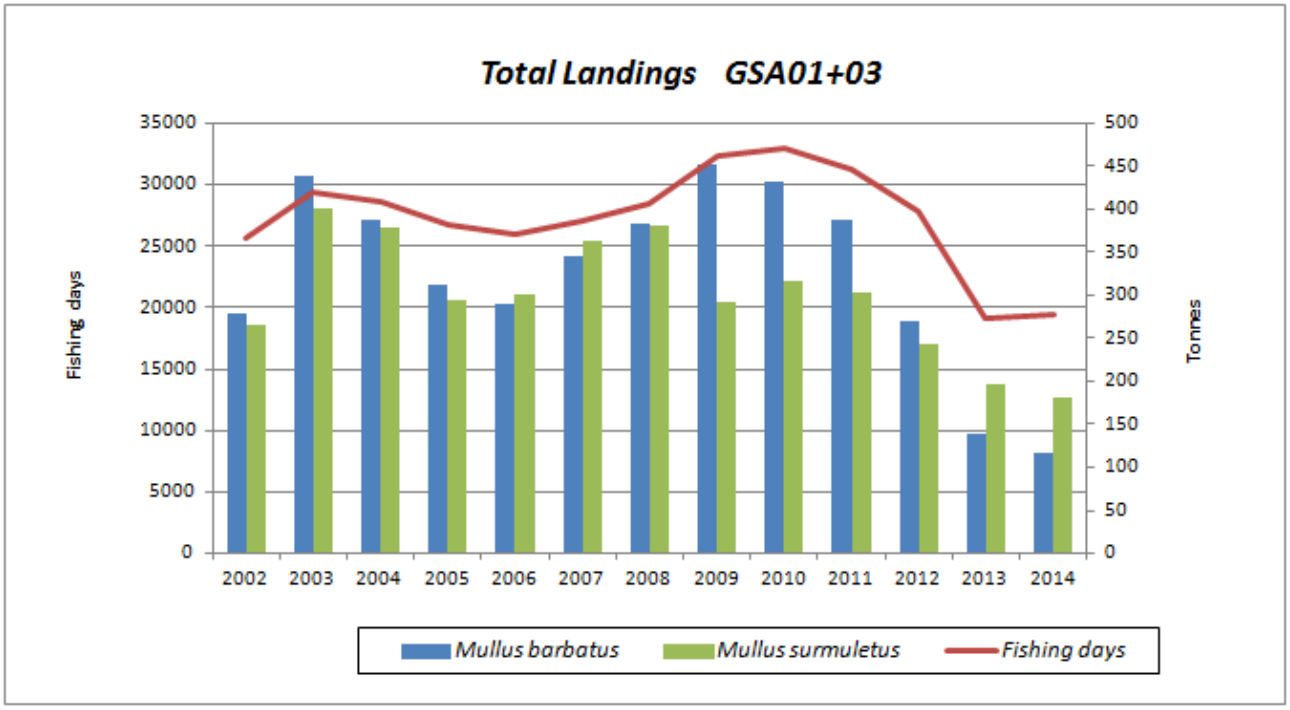

Fig.11. Total landings of Mullus barbatus and Mullus surmuletus and fishing effort in GSAs 1 & 3

3.2. Management regulations

In Spain GSA01

- Engine power limited to 316 KW or 500 CV.
- Mesh size in the cod-end (50 mm diamond or 40 mm square).
- Fishing ban of trawl fishing in areas less than 50 m depth.
- Time at sea (12 hours per day and 5 days per week).
- Spatial and temporal closures of trawl fishing.

In Morocco GSA03

- Freezing number of fishing licenses: Fully observed
- Trawl mesh size: ≥ 50mm (streched mesh size)
- Minimal landing size : 15 cm (total length)
- Interdiction of fishing under 1,5 miles between Tangier and Al Hoceima, under 2 miles between Al Hoceima and Cap de trois fourches and under 3 miles between Cap de trois fourches and Saidia.

In Algeria GSA 04

- Trawl mesh size : 40 mm diamond
- Mesh size in the cod-end (40 mm diamond).
- Interdiction of fishing for trawlers in area less than 50 m depth.

- Spatial and temporal closures of trawl fishing beyond 03miles from Mayst to 31 of August.
- Minimal commercial authorized length is 15cm (total length).

Reference points

Table 0.1-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B	B/BMSY	See Results of the BioDyn model	B/B0,1	See Results of the BioDyn model	
SSB					
F					
Y					
CPUE					
Index of Biomass at sea					

4. Fisheries independent information

4.1. {MEDITS_ES Surveys}

4.1.1. Brief description of the direct method used

The Spanish Institute of Oceanography carries out two scientific surveys under the Data Collection Regulation: MEDITS and MEDIAS. Both are international coordinated surveys.

MEDITS is an international bottom trawl survey, the IEO is involved in it from 1994. The survey takes place in all european mediterranean countries and the main target species are the demersal species.

The Spanish Medits survey carries out about 170 – 180 hauls in spring. It samples 4 GSAs, including Balearic Islands, and the sampling procedure is based on the common methodology included in the MEDITS instruction manual. The GSAs sampled are: GSA1, GSA2, GSA5 and GSA6.

Table 4.0-1: Trawl survey basic information

Survey	MEDITS	**Trawler/RV**	Miguel Oliver
Sampling season	Spring		
Sampling design	Depth stratified sampling with random drawing of the positions within each stratum. The number of position in each stratum is proportional to the area of this strata		
Sampler (gear used)	GOC73		
Cod –end mesh size as opening in mm	20 mm of mesh opening		
Investigated depth range (m)	10-800		

Table4.0-2: Trawl survey sampling area and number of hauls

Stratum	**Total surface (km^2)**	**Trawlable surface (km^2)**	**Swept area (km^2)**	**Number of hauls**
11101 (30-50 m)		510	0.167852908	4
11102 (50-100)		1951	0.588512448	13
11103 (100-200)		1086	0.265784576	7
11104 (200-500)		3461	1.411562073	14
11105 (500-800)		4912	1.450589446	14

Total (30-800m)		11929	3.884301451	52

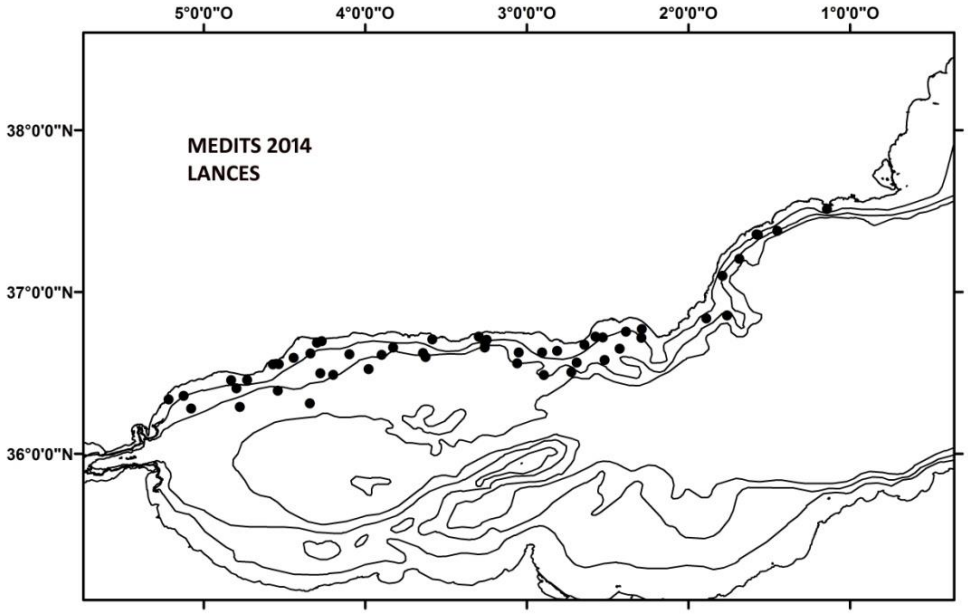

Fig 12: Map of hauls positions in MEDITS 2014

Table4.0-3: Trawl survey abundance and biomass results for *M. barbatus*

Depth Stratum	Years	kg per km²	SE or other	N per km²	SE or other
11101 (30-50 m)	2014	9.18	2.17	210.37	87.4
11102 (50-100)	2014	49.19	23.02	1173.88	555.44
11103 (100-200)	2014	3.72	2.42	51.04	31.26
11104 (200-500)	2014	---	---	---	---
11105 (500-800)	2014	---	---	---	---
Total (30-800m)	2014	6.13	3.04	100.30	54.07

Table4. 0-4: Trawl survey abundance and biomass results

Depth Stratum	**Years**	**kg per km^2**	**CV or other**	**N per km^2**	**CV or other**
	……				
	……				
	……				
	……				
	……				
Total (… – … m)	……				

Comments

- Specify CV or other index of variability of mean
- Specify sampling design (for example random stratified with number of haul by stratum proportional to stratum surface; or systematic on transect;…)
- Specify if catchability coefficient is assumed =1 or other

Direct methods: trawl based length/age structure of population at sea

Slicing method

Report the maturity scale and age slicing method used

Table4.0-5: Trawl survey results number of individuals by length or age class

N (Total or sex combined) by Length or Age class	Year		
	….	….	…..
Total			

Sex ratio by Length or Age class	Year		
	….	….	…..
Total			

Comments

- Specify if numbers are per km^2 or raised to the area, assuming the same catchability .
- In case maturity ogive has not been estimated by year, report information for groups of years.
- Possibility to insert graphs and trends

Direct methods: trawl based Recruitment analysis

Table4.0-6: Trawl surveys; recruitment analysis summary

Survey		**Trawler/RV**	
Survey season			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table4.0-7: Trawl surveys; recruitment analysis results

Years	**Area in km^2**	**N of recruit per km^2**	**CV or other**

Comments

- Specify type of recruitment:
  - continuous and diffuse
  - discrete and diffuse
  - discrete and localised
  - continuous and localised.
- Specify the method used to estimate recruit indices
- Specify if the area is the total or the swept one
- Possibility to insert graphs and trends

Direct methods: trawl based Spawner analysis

Table4.0-8: Trawl surveys; spawners analysis summary

Survey		**Trawler/RV**	
Survey season			
Investigated depth range (m)			
Spawning season and peak (months)			

Table4.0-9: Trawl surveys; spawners analysis results

Surveys	**Area in km^2**	**N (N of individuals) of spawners per km^2**	**CV or other**	**SSB per km^2**	**CV or other**

Comments

- Specify type of spawner:
  - total spawner
  - sequential spawner
  - presence of spawner aggregations
- Specify if the area is the total or the swept one
- Possibility to insert graphs e trends

4.1.2. Spatial distribution of the resources

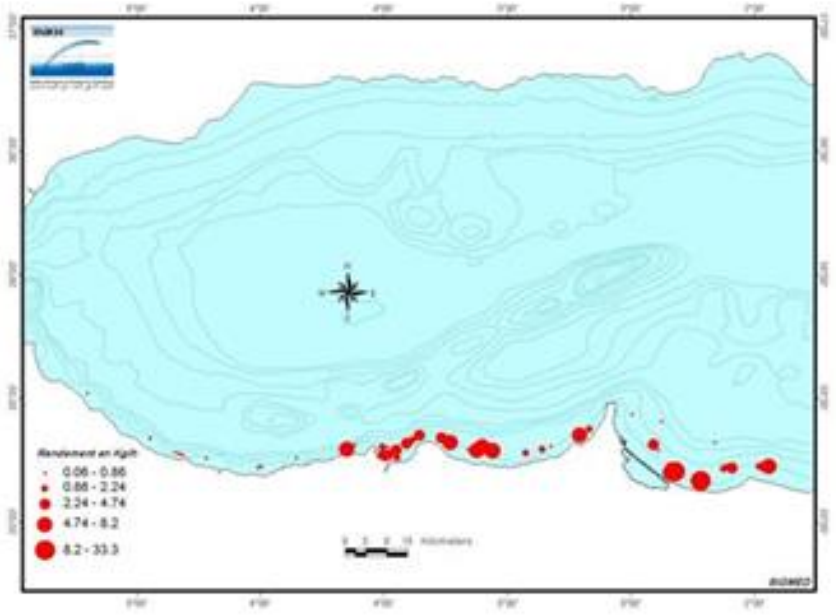

Fig 13 Map of spatial distribution of *Mullus barbatus* in GSA03. Biomass (Kg/h) in 2012

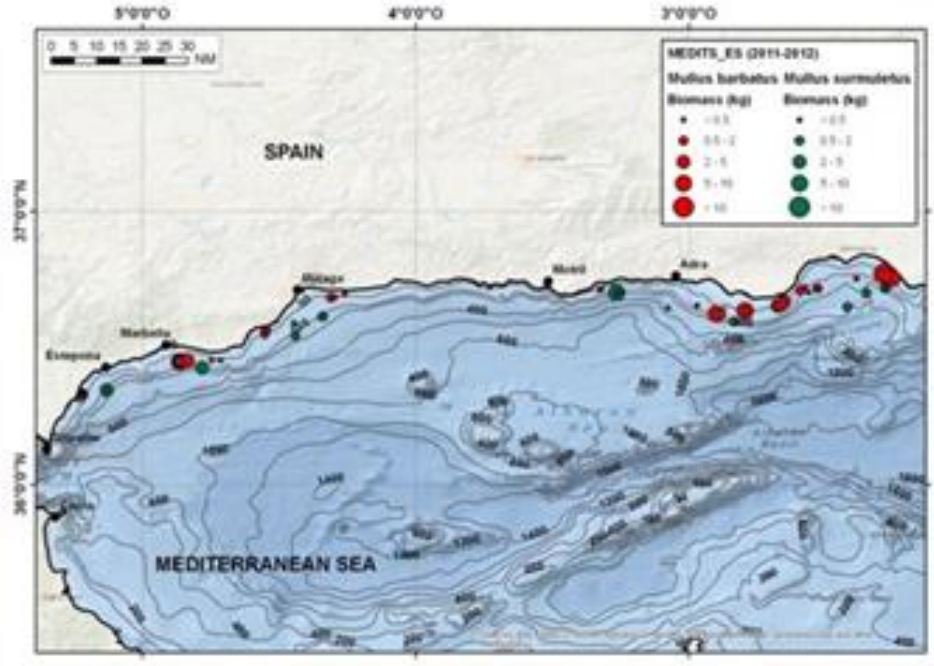

Fig.14. Map of spatial distribution of *Mullus barbatus* and *Mullus surmuletus* in GSA01. Biomass (Kg/Km^2). Medits surveys (2011-2014).

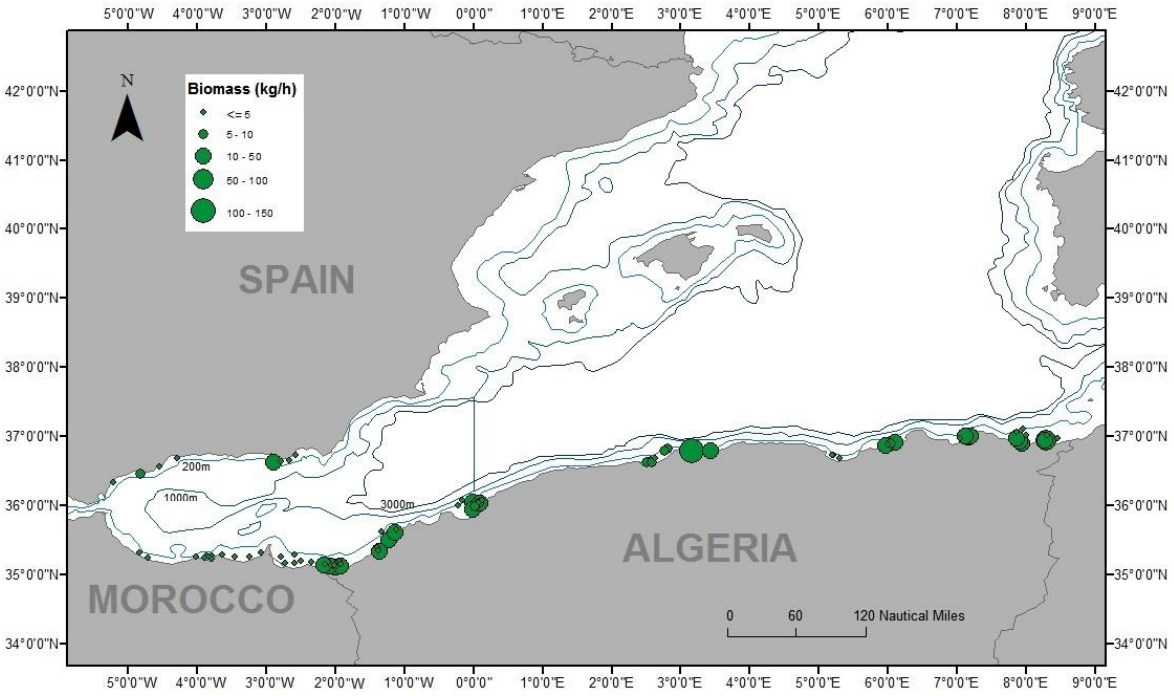

Fig 15 . Map of spatial distribution of *Mullus barbatus* in GSA01, 03 and 04. Biomass (Kg/h) in 2012.

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4.1.3. Historical trends

5. Ecological information

5.1. Protected species potentially affected by the fisheries

5.2. Environmental indexes

6. Stock Assessment

6.1. {Extended Survivor analysis (XSA)}

Ad hoc methods for tuning single species VPA's to fleet catch per unit effort (CPUE) data are sensitive to observation errors in the final year because they make the assumption that the data for that year are exact. In addition, the methods fail to utilize all of the year class strength information contained within the catches taken from a cohort by the tuning fleets.

Extended Survivors Analysis (XSA), (Shepherd, 1992,1999), an extension of Survivors Analysis (Doubleday, 1981), is an alternative approach which overcomes these deficiencies. In general, the algorithms used within the *ad hoc* tuning procedures, exploit the relationship between fishing effort and fishing mortality.

XSA focuses on the relationship between catch per unit effort and population abundance, allowing the use of a more complicated model for the relationship between CPUE and year class strength at the youngest ages. (Darby and Flatman, 1994).

6.1.1. Model assumptions

Input Parameters

- Landings time series 2003-2014 (official landings, Spain & Morocco; GSAs 1&3).
- Length distributions 2003-2014 (monthly onboard and port sampling).
- Catch-at-Length data converted to Catch-at-Age data using cohort slicing.
- Growth Parameters, Demestre *et al*., 1997 .
- M vector by age using PROBIOM spreadsheet *(Abella et al, 1998*).
- Tuning data 2005-2014 from MEDITS survey GSA01 and commercial fleet from GSA1 & GSA3.

Main Settings

- Ages 0 to 3+ (Ag 3 is a Plus Group)
- Fbar 1-2.
- Catchability independent of size and age for ages older than 1 and 2 respectively.
- Survivor estimates shrunk towards the mean F of the final 3yrs or the 2 oldest ages.
- S.E. of the mean to which the estimates are shrunk = 0.5.
- Minimum standard error for population estimates derived from each fleet = 0.3.

6.1.2. Scripts

If a script is available which incorporates the stock assessment run (e.g. if using FLR in R) it should be provided here in order to create a library of scripts.

6.1.3. Input data and Parameters

For analytical models: **catch matrix** in lengths or ages (see the example below for age). Specify if catch includes discards.

Catch numbers at age

AGE	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	1867	1138	1877	1191	771	3599	1837	3309	3357	2104	734	600
1	18057	17324	9699	10361	12716	16192	14939	16859	16173	12105	10768	12282
2	1843	1450	1039	811	1323	1453	2492	2599	1397	1064	1779	1978
+gp	179	45	30	35	19	48	138	102	102	37	107	67

6.1.4. Tuning data

Abundance (Number/Km^2)

age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.5	29.2	0.5	25.3	3.5	2	21.4	0.1	1	0.1	0.9	1.1
1	64.7	344.8	27.9	630.5	589.6	358.2	426.8	39.6	220.6	39.6	141.5	157.3
2	14.9	24.4	12.1	89.5	46.6	31.7	45	19.3	27.9	19.3	12	19.1
g+	1.7	0.6	2.2	3.3	7.2	5.3	5.6	3.5	2.1	3.5	1.2	3.5

6.1.5. Results

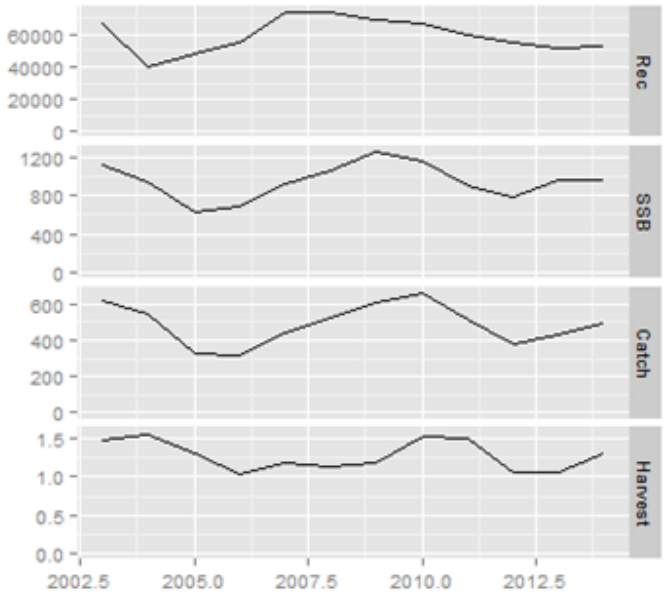


Fig.16: main results obtained by XSA model

Recruitment shows decrease trend since 2007. Biomass (B) and Spawning Stock Biomass (SSB) show quite stable values around 1500 y 1000 respectively in the last years. Average fishing mortality in ages 1-2, (Fbar 1-2), fluctuates between 1 and 1,5 and decrease after 2010.

Yield per recruit analysis.

Yield per recruit analyses was conducted based on the exploitation pattern resulting from the XSA model and population parameters. Minimum and maximum ages for the analysis were considered to be age group 0 and 3. Stock weight at age, catch weight at age and maturity ogive was estimated as mean values between 2003 and 2014 for GSA01 and 03 combined. Natural mortality vector values were applied per age group using ProBiom (Abella et al., 1998). Fishing mortalities were the mean exploitation pattern F between 2012 and 2014. Reference F was considered to be mean F for ages 1 to 2 during the last 3 years (2012-2014).

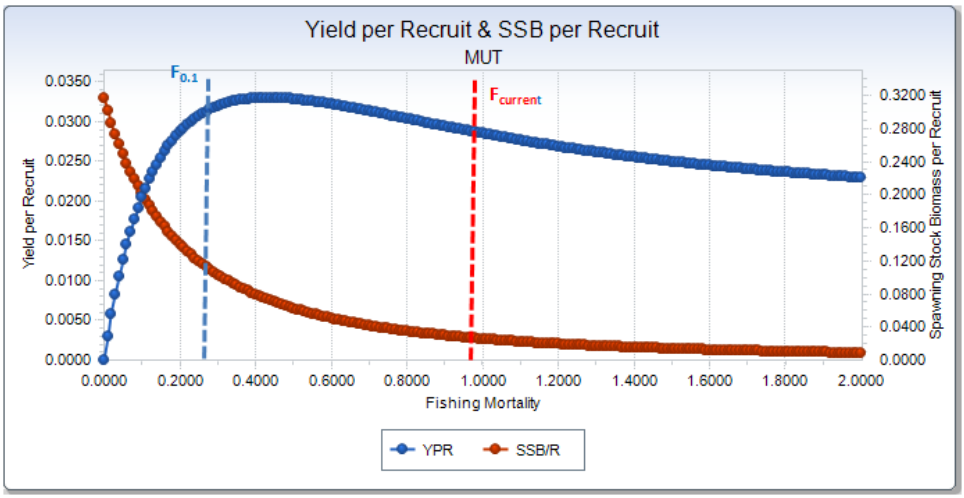
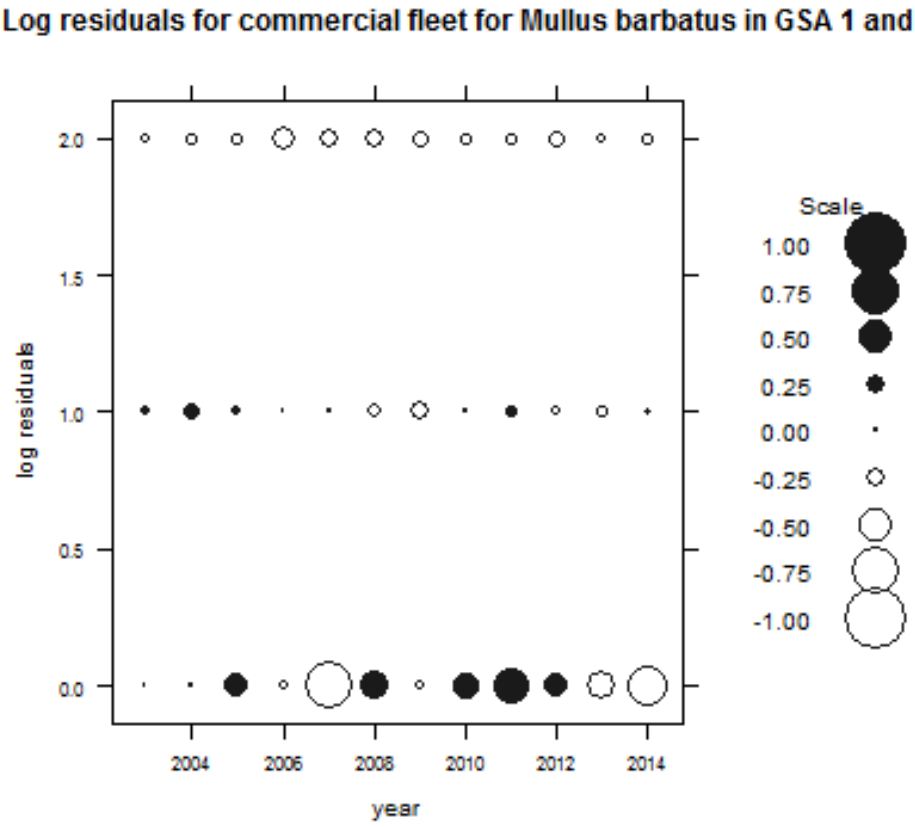


Fig.17: Curve of Yield per recruit and SSB per recruit

	F	YPR (gr)	SSBR (gr)
F current	0.89	29.506	30.197
F 0.1	0.26	31.005	116.335
F max	0.43	32.987	73.746

6.1.6. Robustness analysis



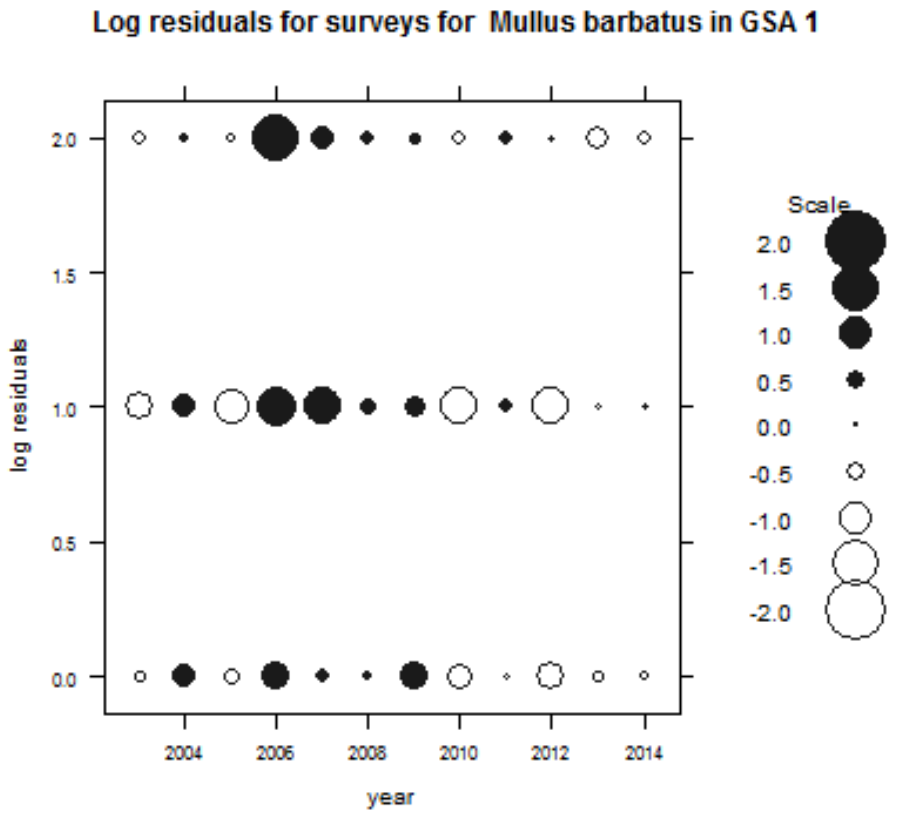


Fig.18: Log catchability residuals for commercial fleet and surveys for Mullus barbatus in GSAs 1 & 3

6.1.7. Retrospective analysis, comparison between model runs, sensitivity

Retrospective analysis

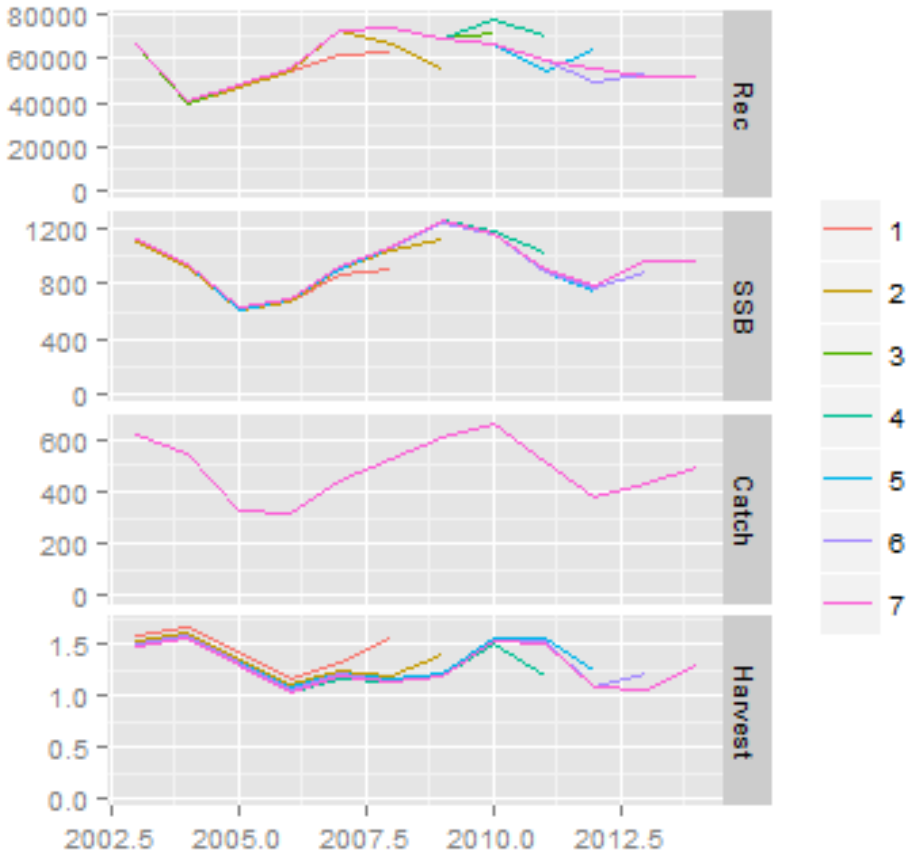


Fig.19: Retrospective *analysis on different stock parameters.*

Sensitivity analysis

Sensitivity analysis on shrinkage weight "fse"

Sensitivity analysis on shrinkage ages "shk.ages"

Sensitivity analysis on catchability independent of age "qage"

Fig.20: *Sensitivity analysis on different qage, fse and shk.ages values.*

Assessment quality

The selection of the suitable parameters for the final XSA run was performed by running sensitivity and retrospective analyses, to ensure the robustness of the final estimates. For instance a value of 1.5 for the shrinkage weight was found inappropriate as it induced large departures from the general pattern.

6.2. Biomass surplus production model (BioDyn)

The BioDyn based on Schaefer model, was used by the Working group to assess the *Mullus barbatus* Status.

The data used are annual total catches of all the fleet targeting *Mullus barbatus* (Morocco and Spain) as well as the CPUE for commercial Moroccan fleet, commercial Spanish fleet, Moroccan surveys abundance index and Spanish surveys abundance index.

The model was also run using the joint data from Algeria, Morocco and Spain (total catches from the three countries and commercial CPUE and surveys abundance index of the three countries). The WG decided to use only the results of the assessment using the joint data from Morocco and Spain to be able to compare these results with those obtained with the XSA and VIT models.

6.2.1. Model assumptions (joint data from Morocco and Spain)

Input data

- Landings time series 2005-2014 (official landings, Spain & Morocco; GSAs 1&3).
- CPUE from Spanish commercial fleet 2005-2014.
- CPUE from Moroccan commercial fleet 2005-2014.
- Abundance index from Spanish surveys 2005-2014.
- Abundance index from Spanish surveys 2005-2014.

Main Settings

- Growth coefficient rate r = 0,4
- Virgin Biomass K = 10000 tons
- Ratio K/B = 30%

6.2.2. Results

The WG adopted the BioDyn assessment results obtained by using Morocco and Spain and the CPUE from Moroccan commercial fleet.

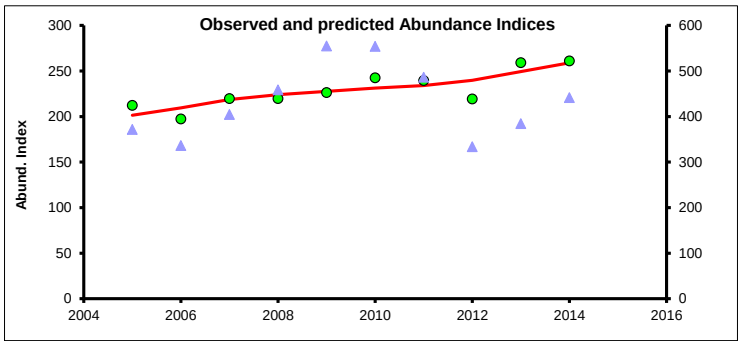


Fig.21: The plot of the fitting model between observed and predicted abundance indices (CPUE of coastal fishery)

The model fitted very well with the data used

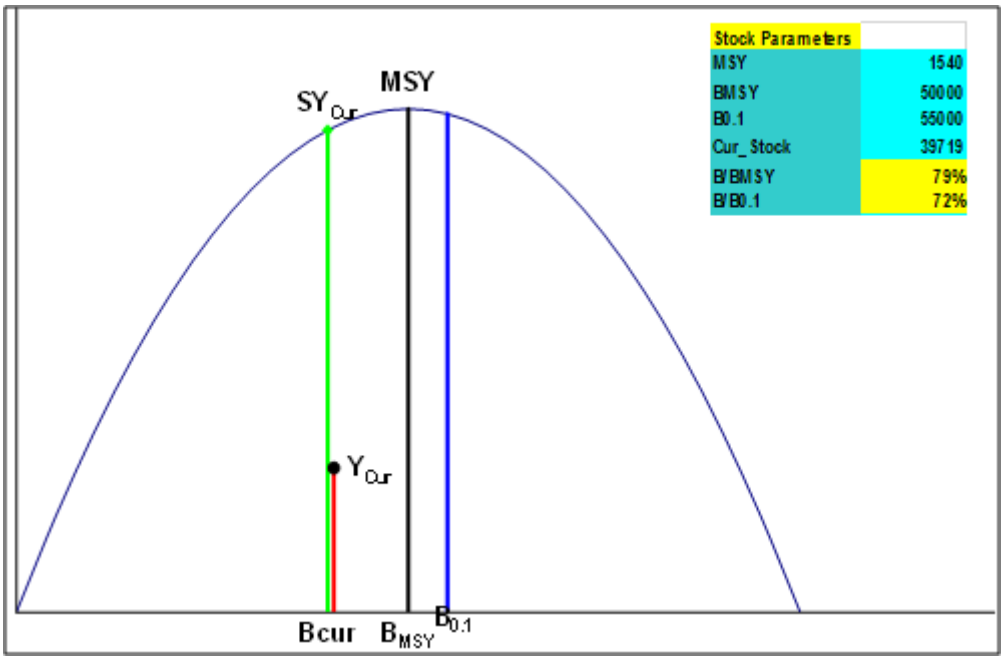


Fig.22: The current situation of the stock of Mullus barbatus in GSAs 1 & 3

The result of the model shows that the current Biomass is low. The stock is in a situation of overexploitation. The current production is lower than the sustainable one showing that the stock will increase next year.

6.2.3. Assessment quality

Relating to the fitting results, the quality of the data used and reliability of the model assumptions can be considered as good. However the WG recommended using a longer data series for the next

WG meeting.

6.3. LCA and Yield per recruit (Excel sheet Pedro De Barros)

The LCA and Yield per Recruit models, prepared by Pedro De Barros in Excel sheets, were also used to assess the Mullus barbatus stock exploitation status.

The data needed to run the LCA are the length frequencies composition extrapolated to the total catches, the growth parameters Linf and K, the natural mortality M and the relationship length-weight's parameters a and b.

The data needed for the yield per recruit model are the same biological parameters (growth parameters Linf and K, natural mortality M, the relationship length-weight's parameters a and b) and the survivals by length.

6.3.1. Model assumptions (joint data from Morocco and Spain)

Input data

- Mean length frequencies extrapolated to the total catches (Morocco+Spain) from 2012 to the 2014.
- Joint catches (Morocco-Spain) for the same period.

Parameters

- Linf = 34,5 cm; K = 0,34; a = 0,0062; b= 3,159 M = 0,4;

6.3.2. Results

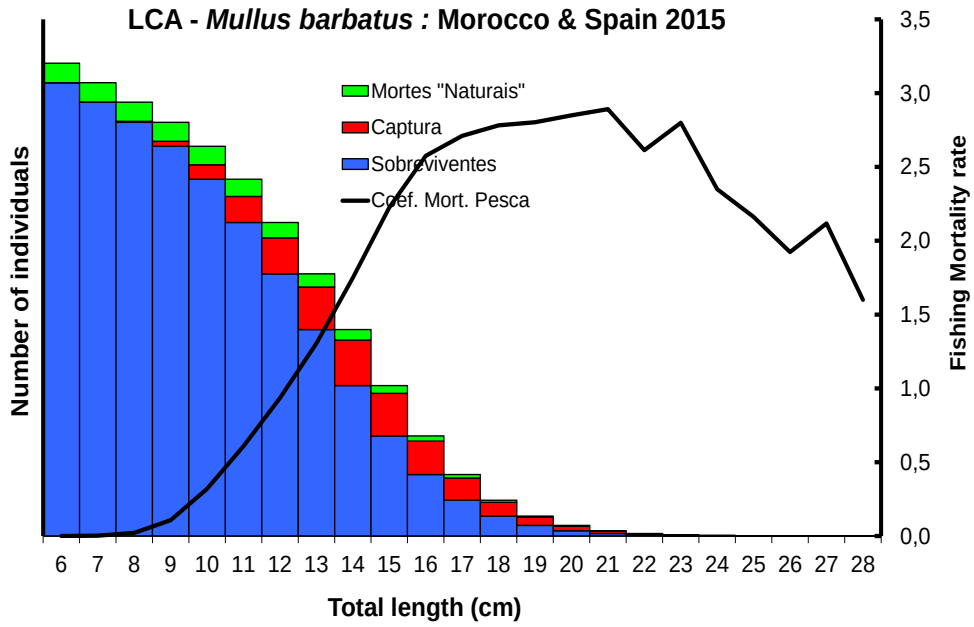


Fig.23: Length Cohort Analysis for M. barbatus in GSAs 1 & 3

The model results showed a high natural mortality for the juveniles and small sizes (6 to 15cm total length), a low survival rate for the medium and big sizes (more than 18cm total length), a high catches and high fishing mortality for the sizes between 13 and 27cm total length.

The fishing mortality rate is high (F = 1,7298).

The Yield per Recruit model gave a following references points:

Fcurr	1,7298
F0,1	0,2941
Fmax	0,5017

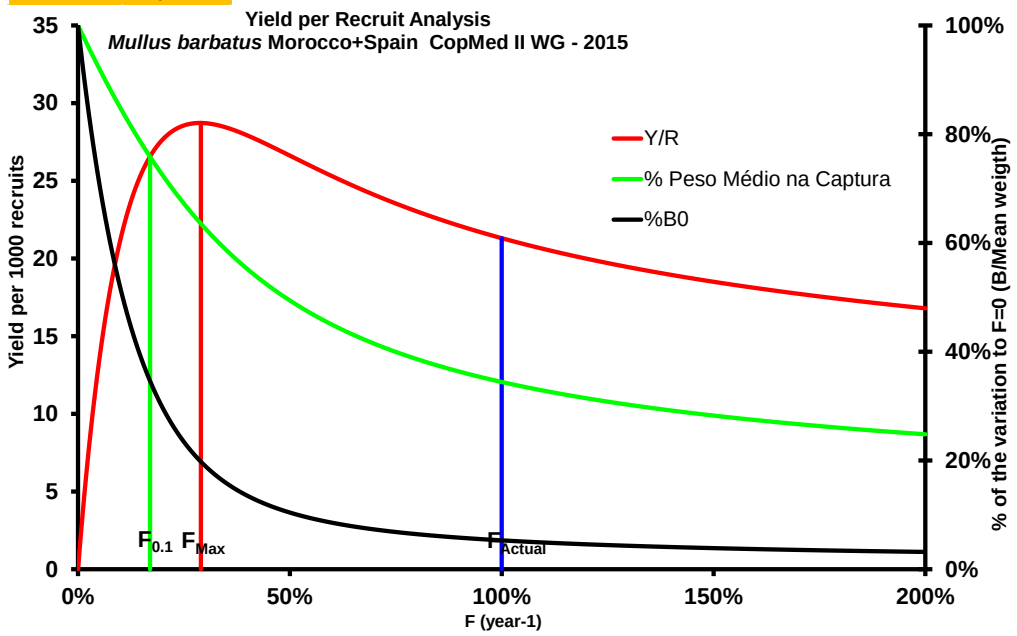


Fig.24: Yield per recruit curve

The Yield per Recruit results showed than the stock is overexploited. The current fishing mortality (Fcurr) is higher than the target one (F0,1).

6.3.3. Assessment quality

Relating to the fitting results, the quality of the data used and reliability of the model assumptions can be considered as good.

7. Stock predictions

Short term predictions

Following the results of the Yield per Recruit model, a prediction for a short term (5 years) were done by reducing the fishing morality by 10, by 20% and by 30%.

A reduction of the fishing mortality by 10 % will increase the catches by 6 %, the Biomass per recruit 9 % and the yield by recruit by 4 %.

A reduction of the fishing mortality by 20 % will increase the catches by 12 %, the Biomass per recruit 21 % and the yield by recruit by 8 %.

A reduction of the fishing mortality by 30 % will increase the catches by 20 %, the Biomass per recruit 38 % and the yield by recruit by 13 %.

The prediction in short term showed that in order to achieve the Yield per recruit at the target fishing mortality (F0,1), the current fishing mortality should be reduced by 5O%. This reduction should be higher than that in order to achieve the sustainable catches and the target Biomass per recruit.

Draft scientific advice from XSA

Based on	Indicator	Analytic al reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Stock Status
Fishing mortality	Fishing mortality	($F_{0.1}$, = 0.26, F_{max}= 0.43) Fcurrent= 0.89)	$Fc/F_{0.1}$=3.4		N	In Overexploitation
	Fishing effort					
	Catch					
Stock abundance	Biomass (t)		1552	33_{th} percentile 1509 66_{th} percentile 1811		Overexploited, intermediate
	SSB (t)		1063	33_{th} percentile 993		Overexploited intermediate
Recruitment						
Final Diagnosis		Stock subjected to overfishing. High overfishing and relative intermediate level of biomass. A reduction of the current fishing mortality is recommended by reducing the fishing effort				

Draft scientific advice from BioDyn

Based on	Indicator	Reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Stock Status
Schaefer production model (improved by Pedro De Barros)	Biomass ratios	B/BMSY and B/ B0,1	B/BMSY = 79% B/ B0,1 = 72%			In Overexploitation

Draft scientific advice from LCA and Yield per Recruit

Based on	Indicator	Analytic al reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Stock Status
Fishing mortality	Fishing mortality	($F_{0.1}$ = 0.29, F_{max}= 0.50) Fcurrent= 1.73)	$Fc/F_{0.1}$=5.97			In Overexploitation

Explanation of codes

Trend categories

1. N - No trend
2. I - Increasing
3. D – Decreasing
4. C - Cyclic

Stock Status

Based on Fishing mortality related indicators

1. **N - Not known or uncertain** – Not much information is available to make a judgment;
2. **U - undeveloped or new fishery** - Believed to have a significant potential for expansion in total production;
3. **S - Sustainable exploitation**- fishing mortality or effort below an agreed fishing mortality or effort based Reference Point;
4. **IO –In Overfishing status**– fishing mortality or effort above the value of the agreed fishing mortality or effort based Reference Point. An agreed range of overfishing levels is provided;

   Range of Overfishing levels based on fishery reference points

   In order to assess the level of overfishing status when $F_{0.1}$ from a Y/R model is used as LRP, the following operational approach is proposed:

   - If $Fc^*/F_{0.1}$ is below or equal to 1.33 the stock is in **(O_L): Low overfishing**
   - If the $Fc/F_{0.1}$ is between 1.33 and 1.66 the stock is in **(O_I): Intermediate overfishing**
   - If the $Fc/F_{0.1}$ is equal or above to 1.66 the stock is in **(O_H): High overfishing**

   *Fc is current level of F

5. **C- Collapsed**- no or very few catches;

Based on Stock related indicators

1. **N - Not known or uncertain:** Not much information is available to make a judgment
2. **S - Sustainably exploited:** Standing stock above an agreed biomass based Reference Point;
3. **O - Overexploited**: Standing stock below the value of the agreed biomass based Reference Point. An agreed range of overexploited status is provided;

   Empirical Reference framework for the relative level of stock biomass index

   - **Relative low biomass:** Values lower than or equal to 33rd percentile of biomass index in the time series **(O_L)**
   - **Relative intermediate biomass:** Values falling within this limit and 66th percentile **(O_I)**
   - **Relative high biomass:** Values higher than the 66th percentile **(O_H)**

4. **D – Depleted**: Standing stock is at lowest historical levels, irrespective of the amount of fishing effort exerted;
5. **R –Recovering:** Biomass are increasing after having been depleted from a previous period;

Agreed definitions as per SAC Glossary

Overfished (or overexploited) *- A stock is considered to be overfished when its abundance is below an agreed biomass based reference target point, like B0.1 or BMSY. To apply this denomination, it should be assumed that the current state of the stock (in biomass) arises from the application of excessive fishing pressure in previous years. This classification is independent of the current level of fishing mortality.*

Stock subjected to overfishing (or overexploitation) *- A stock is subjected to overfishing if the fishing mortality applied to it exceeds the one it can sustainably stand, for a longer period. In other words, the current fishing mortality exceeds the fishing mortality that, if applied during a long period, under stable conditions, would lead the stock abundance to the reference point of the target abundance (either in terms of biomass or numbers)*