Stock Assessment Form

Demersal species

Reference year: 2012

Reporting year: 2014

Red mullet (*Mullus barbatus*) is a by-catch species in the trawl fishery developed by around 32 vessels off Mallorca (Balearic Islands, GFCM-GSA05), whose annual landings have oscillated between 10-28 tons. This stock has been assessed using data from the trawl fishery on a time series covering 13 years (2000-2012). The assessment has been carried out applying tuned virtual population analysis (Extended Survivor Analysis, XSA) on the cohorts present during 2000-2012 and a Y/R analysis based on the exploitation pattern resulting from the XSA model and population parameters for the period 2009-2012. These approaches were performed using monthly size composition of catches, official landings and the biological parameters estimated within the framework of the Data Collection Programme. The VPA was tuned with bottom trawl surveys (2001–2012). The vector of natural mortality by age was calculated from Caddy´s formula, using the PROBIOM Excel spreadsheet. The software used was FLR in R.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Beatriz Guijarro*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Mullus barbatus	Red mullet	34
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
GSA 05		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
Spain		
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
Trawl survey, XSA and Y/R		
Authors:		
Beatriz Guijarro, Vanessa Rubio, Francesc Ordines and Antoni Quetglas		
Affiliation:		
Instituto Español de Oceanografía_ Centre Oceanogràfic de Balears; Moll de Ponent s/n; 07015; Palma de Mallorca; Illes Balears		

The ISSCAAP code is assigned according to the FAO 'International Standard Statistical Classification for Aquatic Animals and Plants' (ISSCAAP) which divides commercial species into 50 groups on the basis of their taxonomic, ecological and economic characteristics. This can be provided by the GFCM secretariat if needed. A list of groups can be found here:

http://www.fao.org/fishery/collection/asfis/en

Direct methods (you can choose more than one):

- Trawl survey

Indirect method (you can choose more than one):

- XSA
- Y/R

2 Stock identification and biological information

GSA05 has been pointed as an individualized area for assessment and management purposes in the western Mediterranean (Quetglas *et al.*, 2012) due to its main specificities. These include: 1) Geomorphologically, the Balearic Islands (GSA05) are clearly separated from the Iberian Peninsula (GSA06) by depths between 800 and 2000 m, which would constitute a natural barrier to the interchange of adult stages of demersal resources; 2) Physical geographically-related characteristics, such as the lack of terrigenous inputs from rivers and submarine canyons in GSA05 compared to GSA06, give rise to differences in the structure and composition of the trawling grounds and hence in the benthic assemblages; 3) Owing to these physical differences, the faunistic assemblages exploited by trawl fisheries differ between GSA05 and GSA06, resulting in large differences in the relative importance of the main commercial species; 4) There are no important or general interactions between the demersal fishing fleets in the two areas, with only local cases of vessels targeting red shrimp in GSA05 but landing their catches in GSA06; 5) Trawl fishing exploitation in GSA05 is much lower than in GSA06; the density of trawlers around the Balearic Islands is one order of magnitude lower than in adjacent waters; and 6) Due to this lower fishing exploitation, the demersal resources and ecosystems in GSA05 are in a healthier state than in GSA06, which is reflected in the population structure of the main commercial species (populations from the Balearic Islands have larger modal sizes and lower percentages of small-sized individuals), and in the higher abundance and diversity of elasmobranch assemblages.

2.1 Stock unit

2.2 Growth and maturity

Table 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**	May-July
Maximum size observed				**Recruitment season**	
Size at first maturity				**Spawning area**	
Recruitment size to the fishery				**Nursery area**	

Table 2-2.2: M vector and proportion of matures by size or age (Combined)

Size/Age	Natural mortality	Proportion of matures
0	*0.8*	*0.02*
1	*0.38*	*0.94*
2	*0.29*	*1*
3	*0.26*	*1*
4	*0.24*	*1*
5+	*0.23*	*1*

Table 2-3: Growth and length weight model parameters

		Sex				
		Units	female	male	Combined	Years
Growth model	**L_∞**				26	
	K				0.41	
	t_0				-0.4	
	Data source	SGMED-08-03				
Length weight relationship	**a**				0.00624	
	b				3.1597	
	M (scalar)					
	sex ratio (% females/total)					

The growth parameters used during the EWG 13-19 were those agreed during the SGMED-08-03. During that meeting, two sets of parameters were agreed (Table 2-4), one related to fast and one to slow growth. Although this, the slicing is not very different for the first age classes (Table 2-4). Trial runs with both set of parameters were carried out, considering ages 0-5 and 0-3+ for the fast growth and ages 0-5+ for the slow growth. Results from slow growth trial were considered more realistic and robust, so this assessment was used as the final one.

SGMED-08-03	Fast	Slow
Origen	Length	Otholits
L_{inf} (cm)	34.5	26.0
k	0.34	0.41
t_0	-0.143	-0.4
Age slicing		
1	11.1	11.4
2	17.9	16.3
3	22.6	19.5
4	26.1	21.7
5+	28.5	23.2

Table 2-4. Mullus barbatus GSA5: 'Upper' and 'lower' growth parameter estimates agreed during the SGMED-08-03. The table also shows the length (in cm) limits for the age slicing for each model.

3 Fisheries information

3.1 Description of the fleet

In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (Guijarro and Massutí 2006; Ordines et al. 2006), mainly targeted to: (i) *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The red mullet, *M. barbatus*, is a by-catch species in the shallow and deep shelf.

Table 3-1: Description of operational units exploiting the stock

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	ESP	05	E-Trawl (12-24 meters)	03- Trawls	33- Demersal inshore species	MUT

Table 3.1-2: 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)
Trawl	32 (1)	16.92 (2)	No	No (3)		Fishing trips
Total	32 (1)	16.92 (2)	No	No (3)		Fishing trips

(1) Number of boats refer to Trawl fishery: mean values 2000-2012.
(2) Catch (tonnes): mean values from 2000- 2012.
(3) Discard of red mullet in GSA 05 can be considered as negligible (the mean values 2002-2012 represent less than 1% in OTB and less than 0.5% in GTR, in weight.

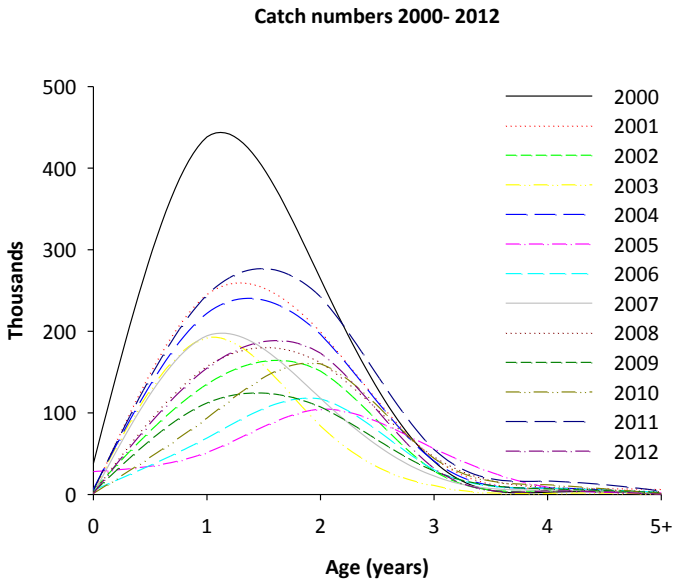


Figure 3.1-1: M. barbatus GSA 5: Catch numbers (in thousands) by year. Most of the catches correspond to age 1-2

3.2 Historical trends

Historical data landings showed important oscillations between 10 and 30 t, without a clear trend (Figure 3.2-1).

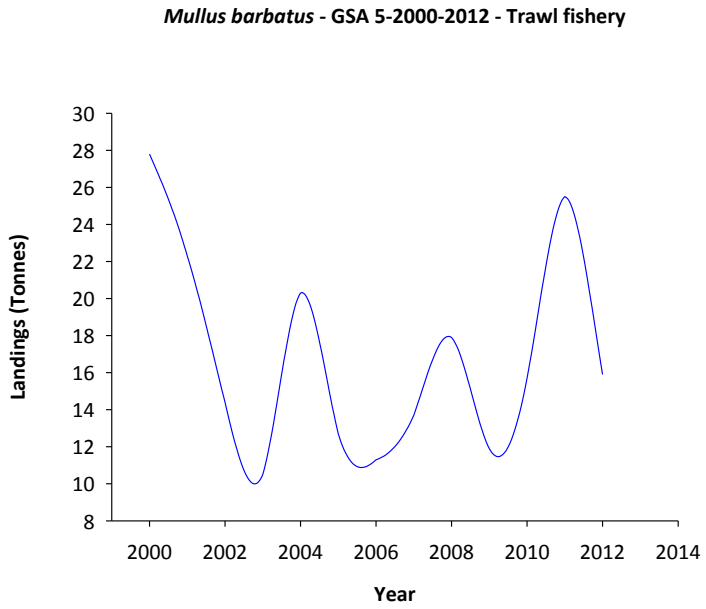


Figure 3.2-1. Mullus barbatus GSA 5: Historical data landings.

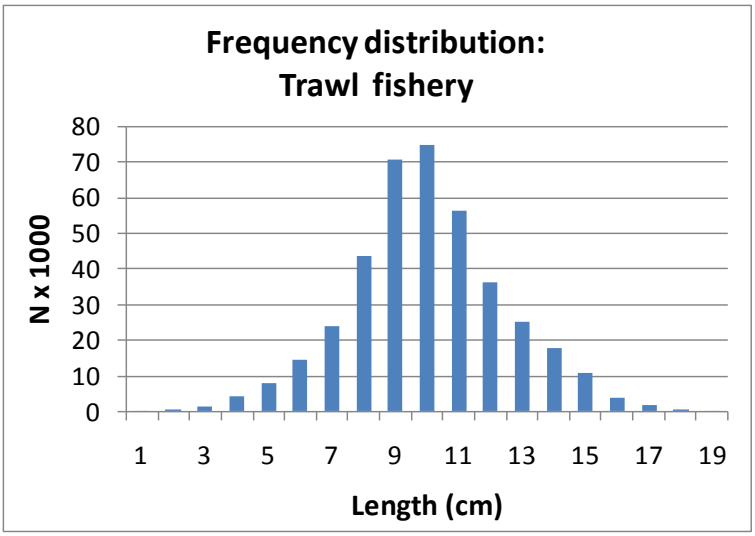


Figure 3.2-3. Size composition from the trawl fishery. Mean values 2000-2012.

3.3 Management regulations

- Fishing license: number of licenses observed
- Engine power limited to 316 KW or 500 HP: not fully observed.

- Mesh size in the codend (before Jun 1st 2010: 40 mm diamond: after Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-): fully observed.
- Time at sea (12 hours per day and 5 days per week): fully observed.
- Minimum landing size (EC regulation 1967/2006, 11 cm TL): mostly fully observed.

3.4 Reference points

Table 3.3-1: 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					
SSB					
F	F_{ref}	0.93º	$F_{0.1}$	0.15	
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 BALAR- MEDITS bottom trawl surveys

From 2001, the Spanish Institute of Oceanography has performed annual bottom trawl surveys following the same methodology and sampling gear described in the MEDITS protocol (BALAR surveys, Massutí and Reñones, 2005). Since 2007, this survey has been included in the MEDITS program (Bertrand *et al*., 2002).

4.1.1 Brief description of the direct method used

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	BALAR- MEDITS bottom trawl surveys	**Trawler/RV**	Francisco Paula Navarro (2001-2006); Cornide de Saavedra (2007-2012)
Sampling season	Spring - Summer		
Sampling design			
Sampler (gear used)	GOC - 73		
Cod –end mesh size as opening in mm	20mm		
Investigated depth range (m)	50- 800m		

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

Slicing method

Report the maturity scale and age slicing method used

Table 4.1-2: Trawl survey results by length or age class

N (Total) by Length class	Year											
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
0	24	3	3	1	0	47	14	2	42	1	0	3
1	885	167	291	111	16	526	632	229	187	92	56	43
2	273	198	147	154	35	144	302	219	198	160	82	55
3	54	39	41	43	19	50	85	51	35	40	35	14
4	11	3	8	6	3	15	15	7	6	8	8	3
+5	0	2	4	1	0	1	1	1	2	1	1	1
Total	1247	412	494	316	73	783	1049	509	470	302	182	119

4.1.2 Spatial distribution of the resources

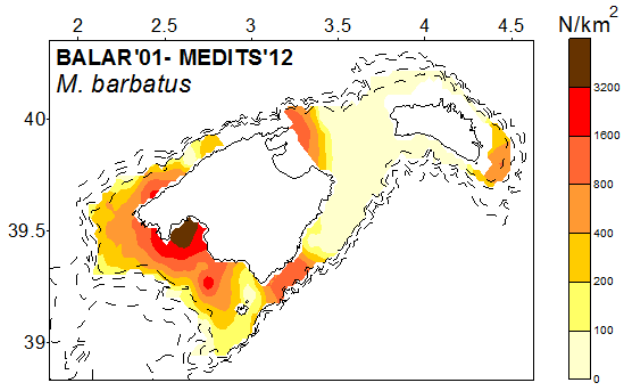


Fig 4.1.2-1. Red mullet in GSA 5: Geographical distribution based on bottom trawl surveys (2001-2012).

4.1.3 Historical trends

Abundance and biomass indices from the surveys showed a similar trend, with clear oscillations, a maximum in 2007 and a clear decreasing trend since then. Minimum values were found in 2005 and 2012. (Figure 4.1.3-1)

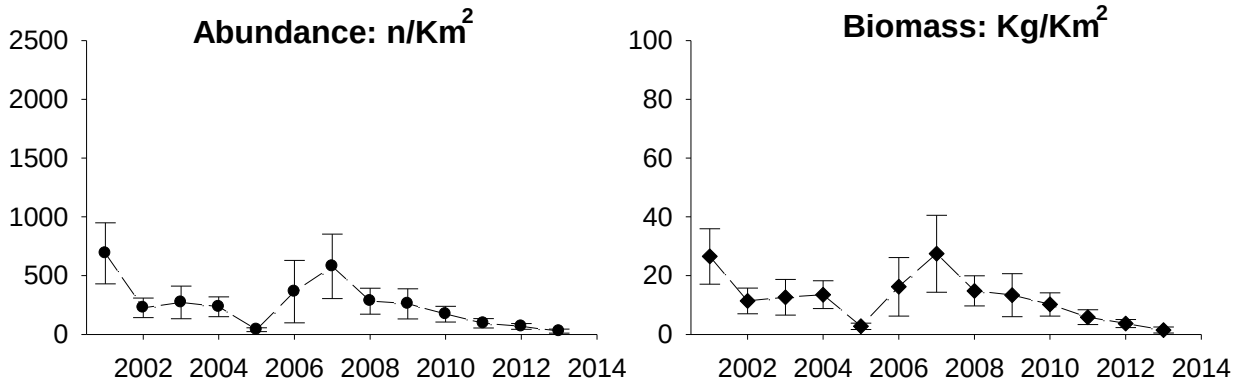


Figure 4.1.3-1. Red mullet in GSA 5: Abundance and biomass indices from the bottom trawl surveys.

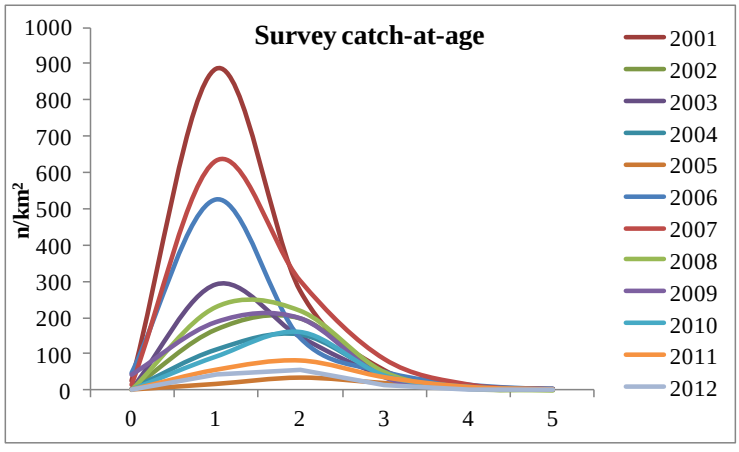


Figure 4.1.3-2. Red mullet. GSA 5. Age distribution by year for survey data.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

A list of protected species that can be potentially affected by the fishery should be incorporated here. This should also be completed with the potential effect and if available an associated value (e.g. bycatch of these species in T)

5.2 Environmental indexes

6 Stock Assessment

6.1 Extended survivor analysis (XSA)

6.1.1 Model assumptions

6.1.2 Scripts

6.1.3 Input data and Parameters

Age/Length class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	27.9	3.2	3.5	5	5.7	25.5	3.5	0.3	2.7	2.1	0.6	2.6	1.1
1	617.9	374.1	229.3	245.3	349.1	93.7	137.6	280.4	262.6	182.5	191	422	277.1
2	137.6	123.3	91.1	43.6	117.1	128.3	86.5	59.5	111.3	71.3	117.2	134.7	87
3	0.2	8.3	2.5	0.6	2.4	3.7	4.3	2.1	5.9	3.8	2.8	8	0.3
4	0	0.3	0	0	0	0	0	0.1	0.1	0.1	0	0	0
5+	0	0	0	0	0	0	0	0.1	0	0	0	0	0

6.1.4 Tuning data

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	18.1	1.8	0.9	0.7	0	23	6.9	1	28.3	0.2	0	2.1
1	1076	283.4	379.4	199.6	34.4	631	817.4	367.9	328.4	197.7	103.9	76.8
2	150.6	125.2	108.1	113.8	37.6	124.5	219.4	137.7	109.7	100.7	74.6	38.5
3	2.5	1.7	3.6	2.1	0.2	4.9	5	2.2	3.5	2.5	2	1.1
4	0	0	1.2	0	0	0	0	0	0	0	0	0
5+	0	1	1.3	0	0	0	0	0	0	0	0	0

6.1.5 Results

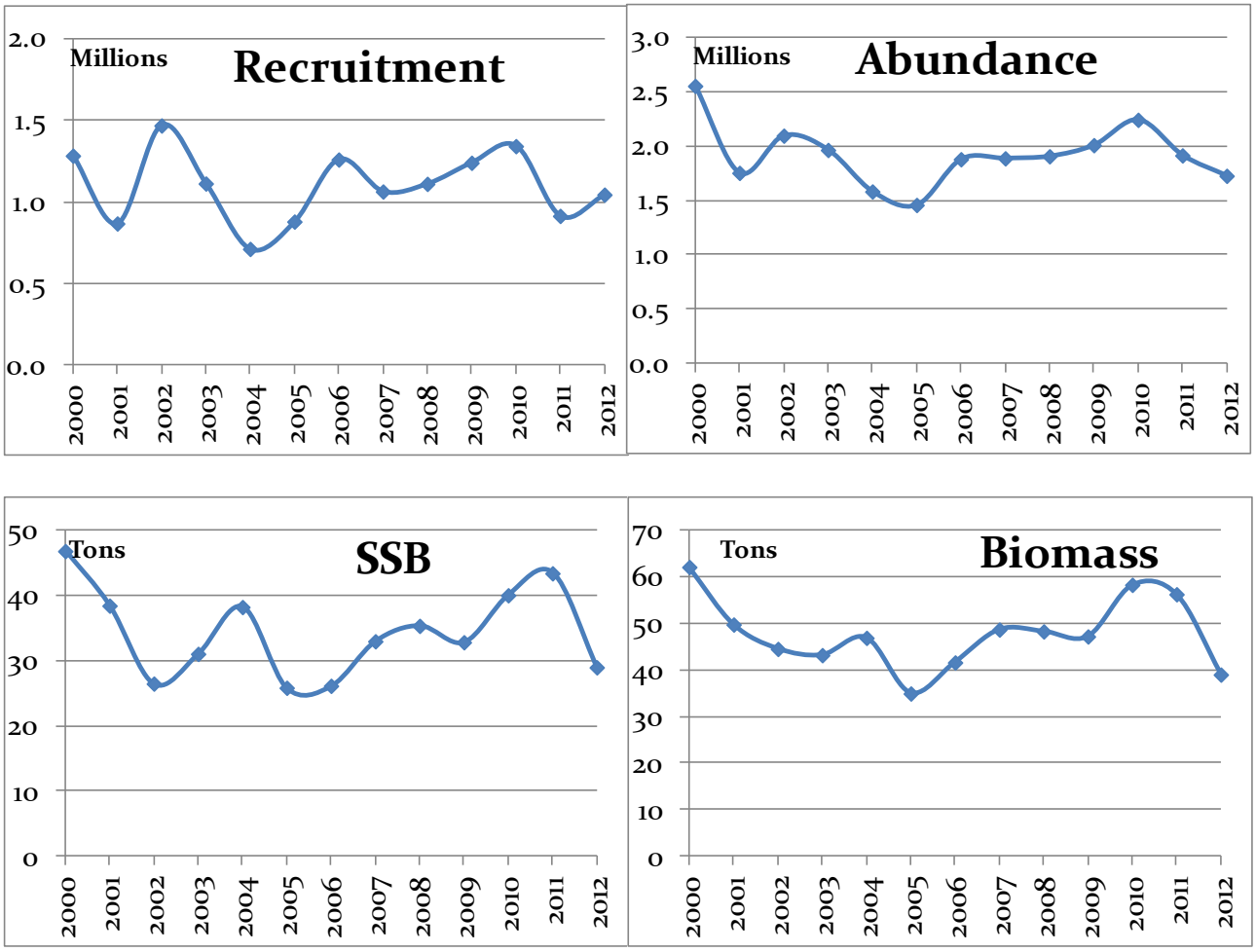


Fig. 6.1.5.-1. Mullus barbatus GSA 5: XSA results.

Both recruitment and SSB showed some oscillations along the data series, without a clear trend, similarly than F.

6.1.6 Robustness analysis

Residuals from the BALAR-MEDITS tuning fleet show low values for all the ages and years considered. After some trials, in the last run only ages 1-4 were considered.

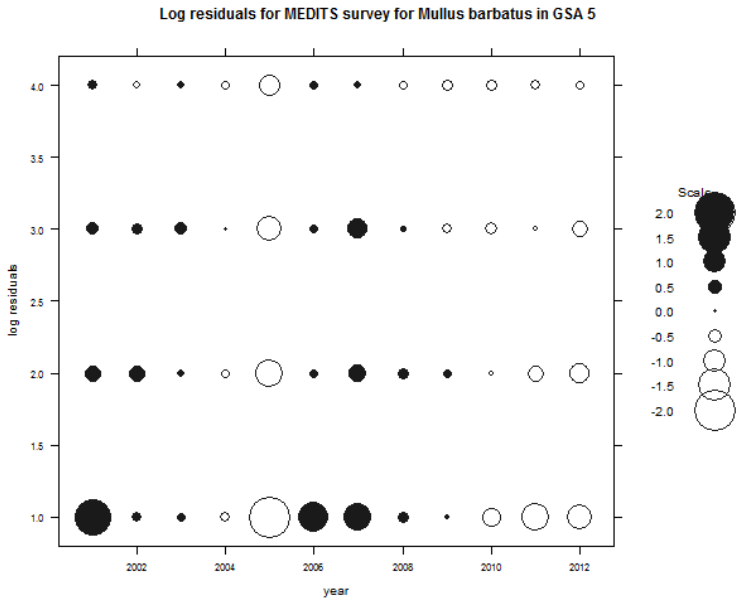


Fig 6.1.6-1.Log catchability residual plots (XSA) for BALAR -MEDITS surveys

6.1.7 Retrospective analysis

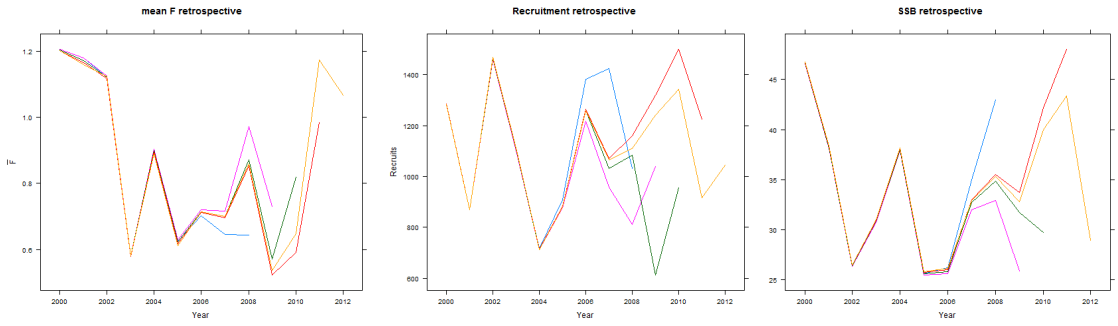


Figure 6.1.7-1. *Mullus barbatus* GSA 5: Restrospective analysis for F, recruitment and SSB.

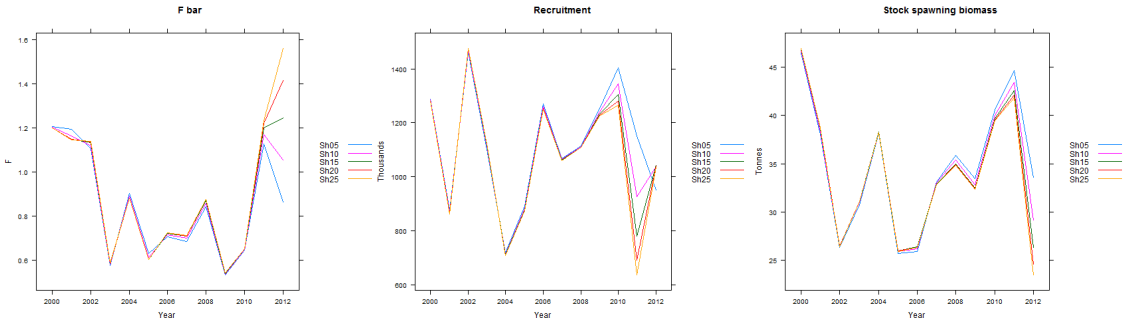


Figure 6.1.7-2. Sensitivity analysis considering different weights for shrinkage for F, R and SSB.

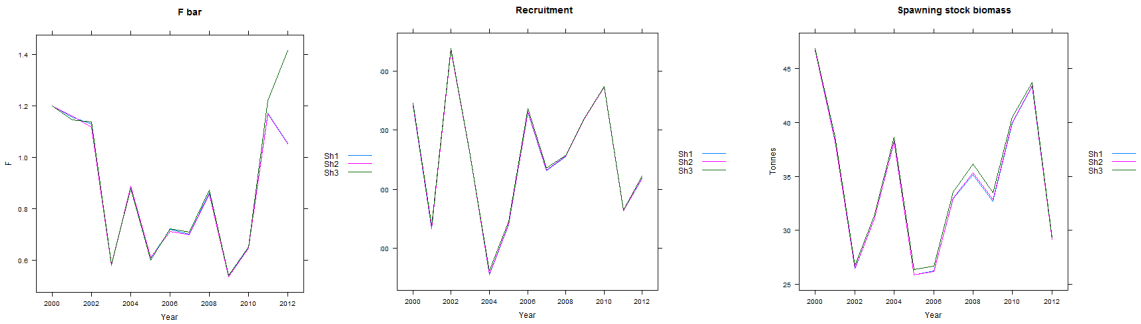


Figure 6.1.7-3. Sensitivity analysis considering different ages for shrinkage for F, R and SSB.

6.1.8 Assessment quality

7 Stock predictions

7.1 Short term predictions

A deterministic short term prediction for the period 2013 to 2015 was performed using the FLR routines provided by JRC (Finlay Scott), which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the XSA stock assessments performed during EWG13-09 for the years 2003–2012.

A short term projection (Table 7.1.1), assuming an Fstq of 0.93 in 2013 and a recruitment of 1087 thousands individuals, shows that: (i) Fishing at the Fstq (0.93) generates a decrease of the catch of 8% from 2012 to 2014 along with an increase of the spawning stock biomass of 3% from 2014 to 2015 and (ii) Fishing at F0.1 (0.15) generates a decrease of the catch of 78% from 2012 to 2014 and an increase of the spawning stock biomass of 52% from 2014 to 2015.

Outlook until 2013

Basis: F(2013) = mean(F_{bar}1-2 2010-2012)= 0.93; R(2012) = geometric mean of the recruitment of the last 3 years; R = 1087 (thousands); SSB(2012) = 28.9 t, Catch (2012)= 15.9 t.

Rationale	Ffactor	fbar	Catch 2014	Catch 2015	SSB 2015	Change SSB 2014-2015 (%)	Change Catch 2012-2014 (%)
zero catch	0.00	0.00	0.0	0.0	49.9	67.8	-100.0
High long-term yield ($F_{0.1}$)	0.15	0.14	3.4	6.3	45.4	52.4	-78.5
Status quo	1.00	0.93	14.7	15.4	30.8	3.5	-7.8
Different scenarios	0.10	0.09	2.3	4.4	46.9	57.5	-85.7
	0.20	0.19	4.3	7.7	44.2	48.5	-72.9
	0.30	0.28	6.1	10.0	41.8	40.4	-61.5
	0.40	0.37	7.8	11.7	39.6	33.2	-51.2
	0.50	0.47	9.2	13.0	37.7	26.8	-42.0
	0.60	0.56	10.5	13.9	36.0	21.1	-33.8
	0.70	0.65	11.7	14.5	34.5	16.0	-26.3
	0.80	0.75	12.8	14.9	33.1	11.4	-19.5
	0.90	0.84	13.8	15.2	31.9	7.2	-13.4
	1.00	0.93	14.7	15.4	30.8	3.5	-7.8
	1.10	1.03	15.5	15.5	29.8	0.1	-2.6
	1.20	1.12	16.2	15.6	28.9	-3.0	2.0
	1.30	1.21	16.9	15.6	28.0	-5.8	6.4
	1.40	1.31	17.5	15.6	27.3	-8.4	10.3
	1.50	1.40	18.1	15.5	26.5	-10.8	14.0
	1.60	1.49	18.7	15.5	25.9	-12.9	17.4
	1.70	1.59	19.2	15.5	25.3	-14.9	20.5
	1.80	1.68	19.6	15.4	24.8	-16.8	23.5
	1.90	1.77	20.1	15.4	24.2	-18.5	26.2
	2.00	1.87	20.5	15.3	23.8	-20.1	28.8

Table 7.1-1. Mullus barbatus GSA 5: Short term forecast in different F scenarios.

7.2 Medium term predictions

Following the agreement reached during the discussions of the EWG-12-19, medium term prediction would only be performed if there is a reliably fit of a stock-recruitment relationship. In the case of the red mullet, no medium term predictions were made, as none reliably the stock-recruitment relationship could be fit (Figure 7.2- 1)

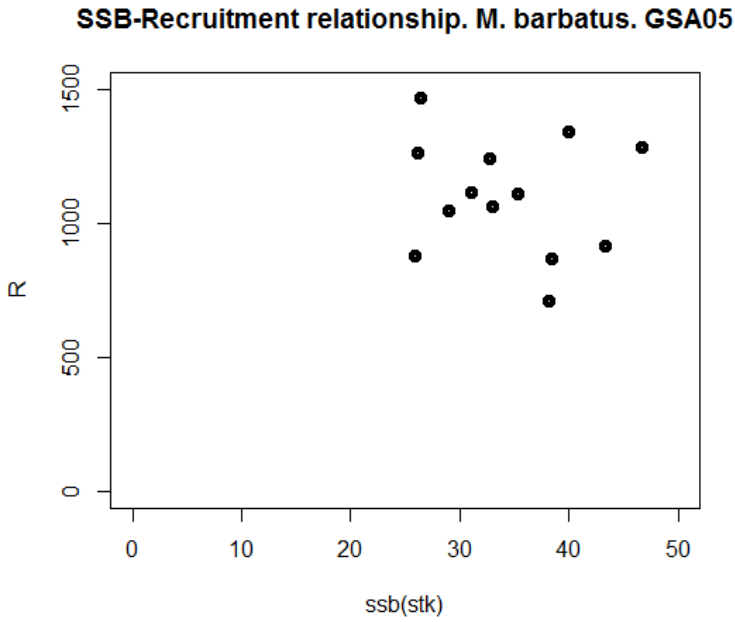
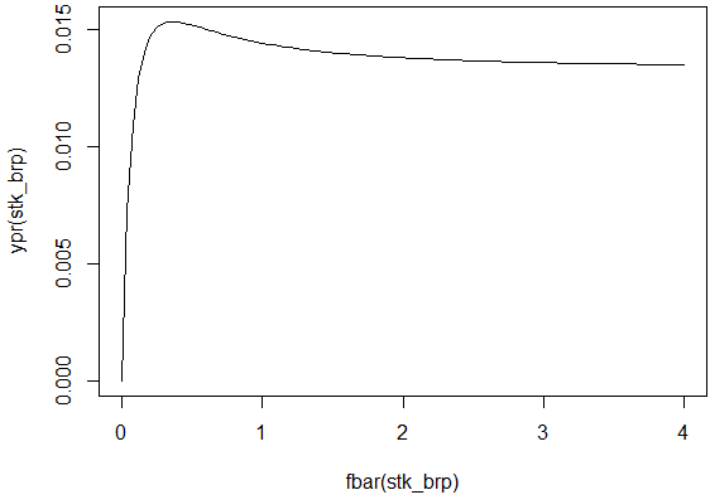


Figure 7.2- 1. Mullus barbatus GSA 5: Stock recruitment relationship.

7.3 Long term predictions

Yield per recruit was calculated using FLR. Figure 7.3- 1 shows the yield per recruit graph.



$F_{ref\ (1\text{-}3,\ 2010\text{-}2012)}$	0.93
$F_{0.1}$	0.15

Figure 7.3- 1. Mullus barbatus GSA 5: Yield per recruit and Reference F and reference point ($F_{0.1}$).

8 Draft scientific advice

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	F0.1=0.14	Fref=0.93		N	O_H
Stock abundance	Total Biomass			33rd perc= 44.4 t 66th perc= 48.6 t Value= 50.3	N	O_H
Final Diagnosis		High overfishing and with relative high biomass				

State the rationale behind that diagnoses, explaining if it is based on analytical or on empirical references

8.1 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)*