



Stock Assessment Form

Demersal species

Red mullet – GSA7

Reference year: 2004-2016

Reporting year: 2017

[A brief abstract may be added here]

Stock Assessment Form version 1.0 (January 2014)

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Stock assessment form

1	Basic Identification Data	3
2	Stock identification and biological information	4
2.1	Stock unit.....	4
2.2	Growth and maturity	4
3	Fisheries information	7
3.1	Description of the fleet.....	7
3.2	Historical trends	9
3.3	Management regulations	10
3.4	Reference points.....	11
4	Fisheries independent information	11
4.1	MEDITS.....	11
4.1.1	Brief description of the direct method used.....	11
4.1.2	Spatial distribution of the resources	12
4.1.3	Historical trends	13
5	Ecological information	14
5.1	Protected species potentially affected by the fisheries.....	14
5.2	Environmental indexes.....	14
6	Stock Assessment.....	15
6.1	Extended Survivor Analysis (XSA)	15
6.1.1	Model assumptions	15
6.1.2	Scripts	15
6.1.3	Input data and Parameters	15
6.1.4	Tuning data.....	16
6.1.5	Results.....	17
6.1.6	Robustness analysis	20
6.1.7	Retrospective analysis, comparison between model runs, sensitivity analysis. etc.....	20
6.1.7.1	Sensitivity analysis	20
6.1.7.2	Retrospective analysis	21
6.1.8	Assessment quality.....	21
7	Stock predictions.....	21
7.1	Short term predictions	21
7.1.1	Short term predictions 2015-2017 by fleet.....	23
7.1.1.1	Method.....	23
7.1.1.2	Input parameters	23
7.1.1.3	Results	24
7.2	Medium term predictions	24
7.3	Long term predictions	24
8	Draft scientific advice:.....	25

9 Explanation of codes.....26

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
<i>Mullus barbatus</i>	Red mullet	33 MUT
1 st Geographical sub-area:	2 nd Geographical sub-area:	3 rd Geographical sub-area:
GSA 07		
1 st Country	2 nd Country	3 rd Country
France	Spain	
Stock assessment method: (direct, indirect, combined, none)		
Indirect (XSA and Yield per Recruit)		
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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):

- Acoustics survey
- Egg production survey
- Trawl survey
- SURBA
- Other (please specify)

Indirect method (you can choose more than one):

- ICA
- VPA
- LCA
- AMCI
- XSA
- Biomass models
- Length based models
- Other (please specify). Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify)

2 Stock identification and biological information

Red mullet (*Mullus barbatus*) in the Gulf of Lions (GSA 7) is a shared stock exploited by both Spanish and French trawlers, also since very recent years by French gillnetters (2011, 2013-2016). The Gulf of Lions (GSA 7) is used as an individualized area for the assessment and management of red mullet in the western Mediterranean. However, recent studies stated that the red mullet of the Gulf of Lions could not be isolated from concomitant areas, for instance from GSAs 5 and 6 (STOCKMED, MAREA project, 2014).

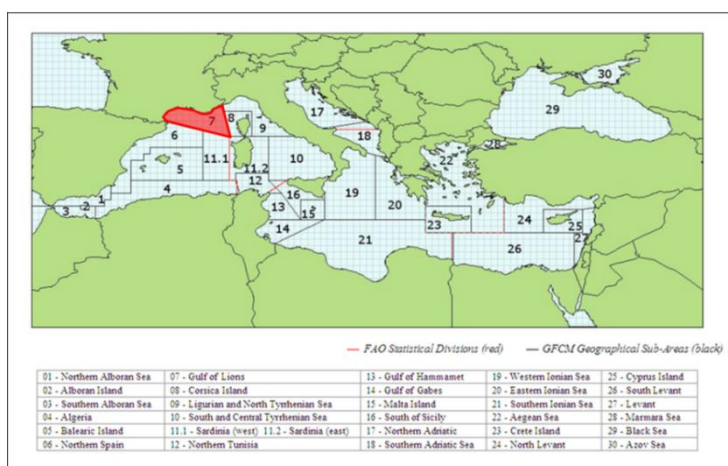


Figure 2-1: Geographical location of GSA 7 – Gulf of Lions

2.1 Stock unit

2.2 Growth and maturity

The growth parameters used are **fast growth parameters** from GSAs 1, 5 and 6 (Demestre et al., 1997 ; adopted by SGMed 08-03 - fast growth ; Source: length data), as agreed during last year WGSADS, after presentation of sensitivity analysis on 3 growth options.

Maturity (table 2.2-3) and **sex-ratio** (table 2.2-5) were calculated using data collected within the DCF in GSA 7 over the period 2004-2016, computed with inbio R scripts developed by IEO.

Natural mortality (table 2.2-2) was obtained from PRODBIOM (Abella et al., 1997).

Table 2.2-1: Maximum size, size at first maturity and size at recruitment.

Somatic magnitude measured (LT, LC, etc)			LT	Units	cm
Sex	Fem	Mal	Combined	Reproduction season	End of spring and summer
Maximum size observed			31	Recruitment season	End of summer, beginning of autumn
Size at first maturity			8.6	Spawning area	Shelf
Recruitment size to the fishery			5	Nursery area	Shelf

Table 2.2-2: Red mullet in GSA 7. Vector of natural Mortality (M) at age estimated using PRODBIOM (combined)

Years/Ages	0	1	2	3
2004-2015	1.19	0.52	0.29	0.21

Table 2.2-3: Red mullet in GSA 7. Proportion of matures by size or age (both sexes)

Years/Ages	0	1	2	3
2004	0,75	0,96	0,99	1,00
2005	0,76	0,96	0,99	1,00
2006	0,77	0,96	0,99	1,00
2007	0,79	0,97	0,99	1,00
2008	0,80	0,96	0,99	1,00
2009	0,73	0,96	0,99	1,00
2010	0,71	0,96	0,99	1,00
2011	0,73	0,96	0,99	1,00
2012	0,72	0,96	0,99	1,00
2013	0,43	0,97	1,00	1,00
2014	0,69	0,93	0,98	1,00
2015	0,57	0,88	0,96	1,00
2016	0,75	0,95	0,98	1,00

Table 2.2-4: Growth and length weight model parameters

		Sex			
		Units	female	male	Combined
					FAST (GSAs 1, 5, 6 ²)
Growth model	L _∞				34.5
	K				0.34
	t ₀				-0.143
	Data source				Demestre et al., 1997 (adopted by SGMed 08-03 - fast growth). Source: length data
Length weight relationship	a				0.006419
	b				3.178318
	sex ratio (% females/total)	(*)			

Table 2.2-5: Sex-ratio (*) at length from data collected in GSA 7 (2004-2014) by IFREMER (DCF).

Size (cm)	Prop. Of Fem
9	0,27
10	0,26
11	0,30
12	0,42
13	0,45
14	0,53
15	0,45
16	0,48
17	0,55
18	0,74
19	0,78
20	0,92
21	0,91
22	0,96
23-29	1,00

3 Fisheries information

3.1 Description of the fleet

In the Gulf of Lions (GSA 7), red mullet is exploited by both French and Spanish trawlers. Information on French gillnetters is only available for 2011 and 2013-2016, but although it is suspected that they have been fishing red mullet in the past, no data is available to quantify their catches. According to official statistics, during the first part of this period (2004-2012), the total annual landings have oscillated around an average value of 190 tons; since 2012, landings have shown a clear increasing trend. French trawlers dominate the fishery, as they represent 88% of the catches (average 201 tons) for the entire period. After 2009, because of the large decline of small pelagic fish species in the area, the trawlers fishing small pelagic have diverted their effort on demersal species, which may partially explain the high levels of catches since 2010. Between 2004 and 2014, the number of French trawlers operating in the GSA 07 has decreased by 50%: From a maximum number of 121 trawlers in 2004, the French fleet catching red mullet is nowadays composed by 57 units. This follows management measures to reduce the number of boats. The mean modal lengths in the catches of the French and Spanish trawlers are 14 and 15 cm, respectively and the length at first capture is about 5 cm. Catch is mainly composed by individuals of age 0, 1 and 2 (Figure 6.1.3-2), while the oldest age class (3+ group) is poorly represented. In GSA 07, the trawl fishery is a multi-specific fishery. In addition to *M. barbatus*, the following species can represent important catches: *Merluccius merluccius*, *Lophius* sp., *Pagellus* sp., *Trachurus* sp., *Mullus surmuletus*, *Octopus vulgaris*, *Eledone* sp., *Scyliorhinus canicula*, *G. melastomus*, *Trachinus* sp., *Triglidae*, *Scorpaena* sp. and *Raja* sp.

Table 3.1-1: Description of operational units exploiting the stock

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	France	GSA 07	E – trawl (12-24m)	03 - Trawls	33 – Demersal shelf species	MUT
Operational Unit 2	Spain	GSA 07	E – trawl (12-24m)	03 - Trawls	33 – Demersal shelf species	MUT
Operational Unit 3	FRA	07	C - Minor gear with engine (6-12 metres)	07 - Gillnets and Entangling Nets	33 - Demersal shelf species	MUT

Table 3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year (2016)

Operational Units*	Fleet (n° of boats) *	Landings (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
FRA 07 I 03 33 - MUT	57	345 tons	<i>M. merluccius</i> , <i>M. surmuletus</i> , <i>Solea spp.</i> , <i>Lophius spp.</i> , <i>S. aurata</i> , <i>D. labrax</i> , <i>Pagellus spp.</i> , <i>M. poutassou</i> , <i>T. m. capelanus</i> , <i>Elasmobranchs</i> , <i>O. vulgaris</i> and <i>Eledone spp.</i>	1.35	unknown	unknown
ESP 07 I 03 33 - MUT	19	43 tons	<i>M. merluccius</i> , <i>M. surmuletus</i> , <i>Solea spp.</i> , <i>Lophius spp.</i> , <i>Pagellus spp.</i> , <i>M. poutassou</i> , <i>T. m. capelanus</i> , <i>O. vulgaris</i> and <i>E. cirrhosa</i>	No	unknown	unknown
FRA 07 C 07 33 - MUT	76	48 tons	<i>Mullus surmuletus</i>	No	unknown	unknown
Total	152	436 tons		1.35 tons		

Table 3.1-3: Red mullet in GSA 7. Annual catches (t) by gear (DCF data).

Gears/Years	OTB-French	OTB-Spanish	GNS-French
2004	151	26	-
2005	148	28	-
2006	183	33	-
2007	172	37	-
2008	111	21	-
2009	120	26	-
2010	219	25	-
2011	170	28	30
2012	150	29	-
2013	227	38	33
2014	294	41	39
2015	317	33	1
2016	346	43	48

Table 3.1-4: Red mullet in GSA 7. Annual landings (t) by gear (DCF data).

Gears/Years	OTB-French	OTB-Spanish	GNS-French
2004	151	26	-
2005	148	28	-
2006	183	33	-
2007	172	37	-
2008	111	21	-
2009	120	26	-
2010	219	25	-

2011	170	28	30
2012	135.3	29	-
2013	210.5	38	33
2014	294	41	39
2015	279.7	33	1.2
2016	345	43	48

Considering Spain, landings are almost equal to catches, no discards observed before 2011 in France.

Table 3.1-5: Red mullet in GSA 7. Annual discards (t) by gear (DCF data)

Gears/Years	OTB-French	OTB-Spanish	GNS-French
2004	-	-	-
2005	-	-	-
2006	-	-	-
2007	-	-	-
2008	-	-	-
2009	-	-	-
2010	-	-	-
2011	-	-	-
2012	14.8	-	-
2013	16.3	-	-
2014	11.9	-	-
2015	37.3	-	-
2016	1.3	-	-

3.2 Historical trends

Total catch have increased during the period analyzed, with the higher levels of catch in the most recent years (Figure 3.2.1.). The total catch has been driven by the French trawlers, whose catch accounted for 88% over the period 2004-2016. Information on French gillnetters is available for 2011 and 2013-2016, although it is suspected that they have been fishing red mullet in the past, but no data is available to quantify their catches. Catch at age structure is stable over time, with mostly ages 0-2 targeted.

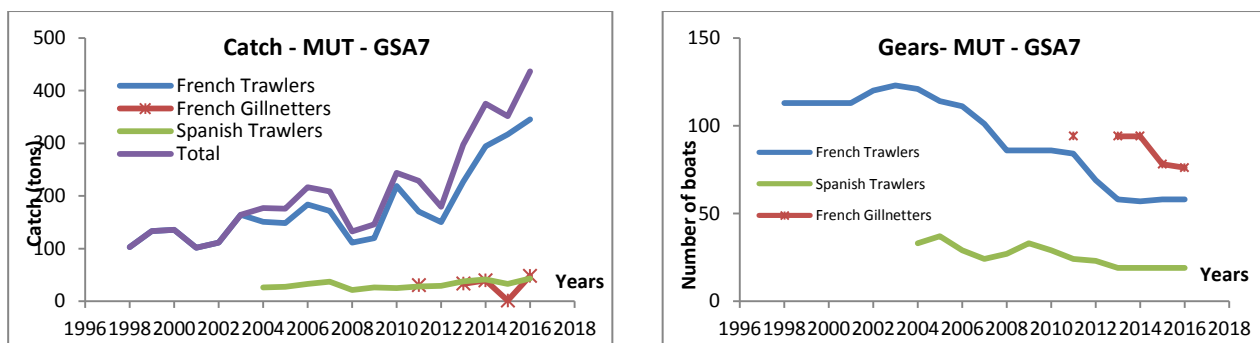


Figure 3.2-1. Left panel: catch of red mullet in the GSA 07 for French gillnetters and French and Spanish trawlers (1998-2016). Right panel: time series of the number of French and Spanish boats

3.3 Management regulations

French trawlers

- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: Not full compliance
- Cod-end mesh size (bottom trawl: square 40 mm or 50 mm diamond, by derogation): not fully observed
- Fishing forbidden within 3 miles (France): not fully observed
- Time at sea: fully observed
- Temporal bans depending on years (2011 and 2012, 1 month/year; 2017: 30 days/trawler between March and July): fully observed

Spanish trawlers

- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: Not full compliance
- 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
- Fishing forbidden <50 m depth: fully observed
- Time at sea: fully observed
- Temporal bans depending on years (for instance, 2015 and 2016, 1 month): fully observed

French gillnetters:

- Fishing license: fully observed
- Maximum length of net: not fully observed

Fishery Restricted Area: In 2009, the GFCM proposed to create a High Sea Fishery Restricted Area (FRA, GFCM/33/2009/1) in which the fishing effort for demersal stocks of vessels using towed nets, bottom and mid-water longliners, bottom-set nets shall not exceed the level of fishing effort applied in 2008 in the fisheries restricted area of the eastern Gulf of Lions. The FRA area is bounded by lines joining the following geographic coordinates: 42°40'N, 4°20' E; 42°40'N, 5°00' E; 43°00'N, 4°20' E; 43°00'N, 5°00' E. This fisheries restricted area was established in article 4 from the EU Regulation No. 1343/2011 of the European Parliament and of the Council of 13 December 2011. In 2012 both French (Arrêté du 28 décembre 2012, NOR: TRAM1240493A) and Spanish (Orden AAA/1857/2012 de 22 de agosto) governments published their own laws regulating the FRA.

Important decrease in capacity of French trawler fleet since 2011, reducing the number of boats by 50% since the beginning of the series (2004).

Management plan: A management plan for GSA 7 is still in progress considering protection of demersal species, mainly nurseries and spawning zones and periods.

Other measures: Additional Spanish national measures are in discussion considering the protection of spawning period and zone for hake, but they may marginally affect fishing grounds where red mullet can be caught. The proposal is an annual spatio-temporal closure between 12th of October and 12th of December and between 150 and 275 meters, considering longliners, bottom trawlers and gillnetters.

3.4 Reference points

Table 3.4-1: 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	$F_{0.1}$	0.35 (estimated in 2016)			
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 MEDITS

4.1.1 Brief description of the direct method used

Fishery independent information regarding the state of the red mullet in GSA 07 was derived from the international survey MEDITS. MEDITS surveys have been carried out from late spring to middle summer, between 1994 and 2016, following random depth-stratified sampling design. Five depth strata were considered: 10-49 m, 50-99 m, 100-199 m, 200-499 m and 500-800 m. The gear used was a GOC 73, an experimental bottom trawl gear, with a cod-end mesh size of 20 mm. Sampling duration depended on the depth of the sampling station: 30 minutes for the samples on the shelf (10-199 m) and 60 minutes for those in the slope (200-800 m). See Bertrand et al. (2002) for further details.

The data was assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This involves weighting the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where: A=total survey area

A_i =area of the i-th stratum

s_i =standard deviation of the i-th stratum

n_i =number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i =mean of the i-th stratum

Y_{st} =stratified mean abundance

$V(Y_{st})$ =variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

$$\text{Confidence interval} = Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

Length distributions were obtained by the sum of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the GSA strata

4.1.2 Spatial distribution of the resources

In the Gulf of Lions, reproduction of red mullets takes place at the end of spring and in summer (May-July). The period of MEDITS survey (May-June) precedes then the recruitment of this species that occurs massively in the second part of the summer on sandy bottoms close to the coast. This recruitment on the bottom is followed by a gradual dispersion to deeper depths. The graphical representation of demographic structures of red mullet fished during MEDITS (fig.4.1.3.2.) shows clearly the abundance of spawners (≥ 12 cm) and the absence of small individuals. The size range on the 1998-2016 series is distributed between 9 and 30 cm, with higher abundance from 12 cm (93% of total abundance, average 1998-2016). So the results of this survey cannot be used to estimate the spatial distribution of red mullet juveniles.

In the MEDISEH project (2014), spawners have been mapped using a generalized additive Model (GAM) (fig.4.1.2.1.) The maturity stage 3 of the MEDITS scale had been chosen for identifying spawners.

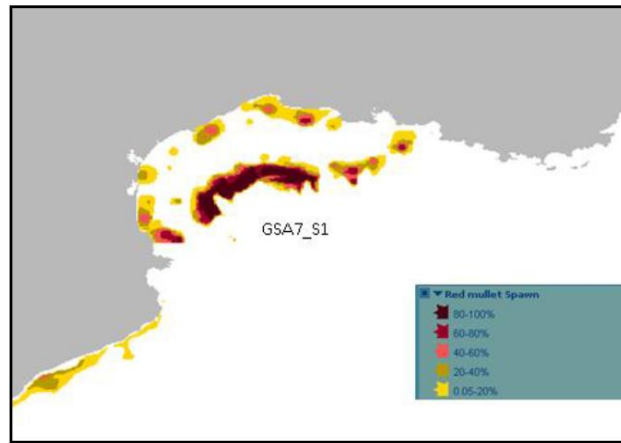


Figure 4.1.2.1. Spawning aggregations of red mullet in the Gulf of Lions (mean 1994-2010) (MEDISEH, 2014)

The results show that the adults of red mullet concentrate in the Gulf of Lions on a wide zone located in the western-center of the continental shelf: GSA7_S1 (tab. 4.1.2.1.), at depths from 90 to 130 m. Little patches of spawners aggregation appears also at different places along the coast, between 20 and 40 m depth (fig. 4.1.2.1.).

Table 4.1.2.1. Spawning zones in the Gulf of Lions, identified with MEDITS data

Zone	Code	Depth(m)	Description
Spawners aggregation	GSA7_S1	90-130	Wide zone of muddy terrigenous sediments, on the deeper part western-center of the continental shelf of the Gulf of Lions.

4.1.3 Historical trends

Fishery independent information regarding the state of the red mullet in GSA 07 was derived from MEDITS international survey. Figures below display the estimated trend in red mullet abundance in GSA 07 (Figure 4.1.3-1) and the length (Figure 4.1.3-2) and age (Figure 4.1.3-3) frequency distributions. The estimated abundance index shows several fluctuations, but with a clear increasing trend since 2006, with the highest values in the most recent year (2016).

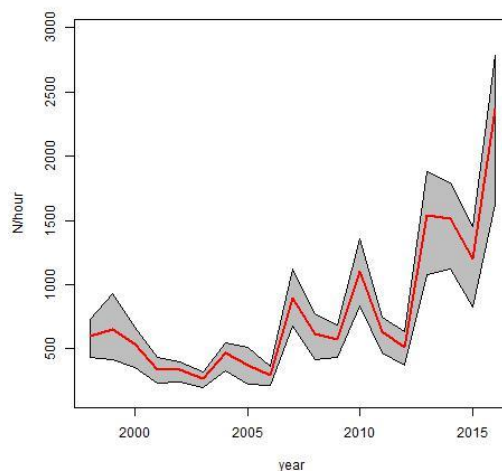


Figure 4.1.3-1: Red mullet in GSA 7. MEDITS abundance index 1994-2016 (n/hour).

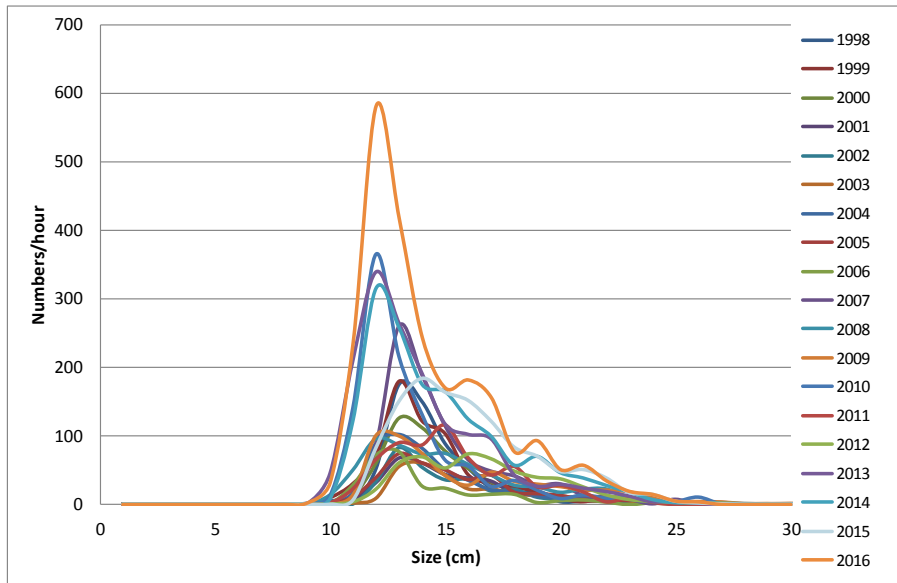


Figure 4.1.3-2: Red mullet in GSA 7. Length frequency distribution obtained from MEDITS survey.

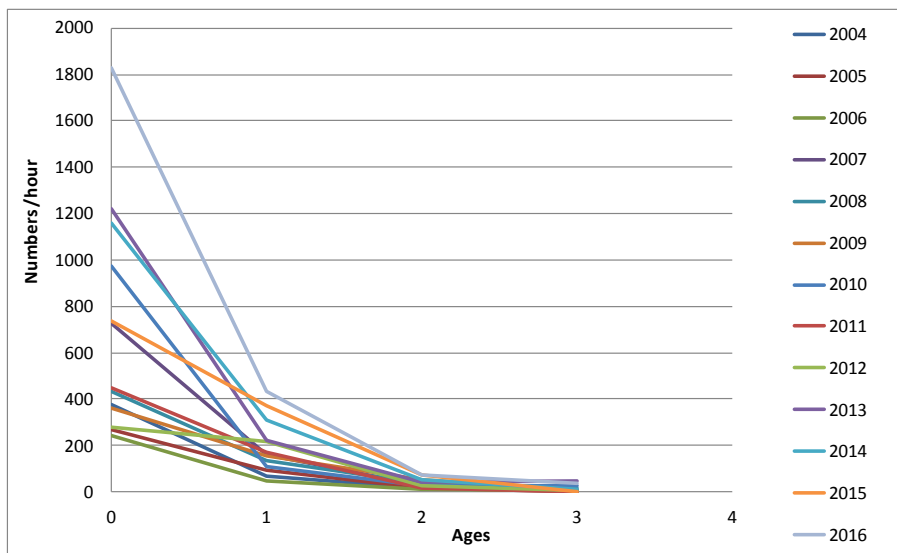


Figure 4.1.3-3 Red mullet in GSA 7. Age structure of MEDITS abundance index (n/hour)

5 Ecological information

5.1 Protected species potentially affected by the fisheries

No list of protected species that can be potentially affected by the fishery is currently available.

5.2 Environmental indexes

There is currently no evidence for any environmental index to be relevant for the fishery.

6 Stock Assessment

6.1 Extended Survivor Analysis (XSA)

6.1.1 Model assumptions

The stock assessment was performed over the period 2004-2016 using an XSA model over age classes ranging from 0 to 3+ and with MEDITS index, as tuning fleet (ages 0-2). The selection of suitable parameters for the final XSA run was made after performing four sensitivity analyses (section 6.1.7.1.).

6.1.2 Scripts

The R script and the data used to perform the final XSA run have been provided to the GFCM.

6.1.3 Input data and Parameters

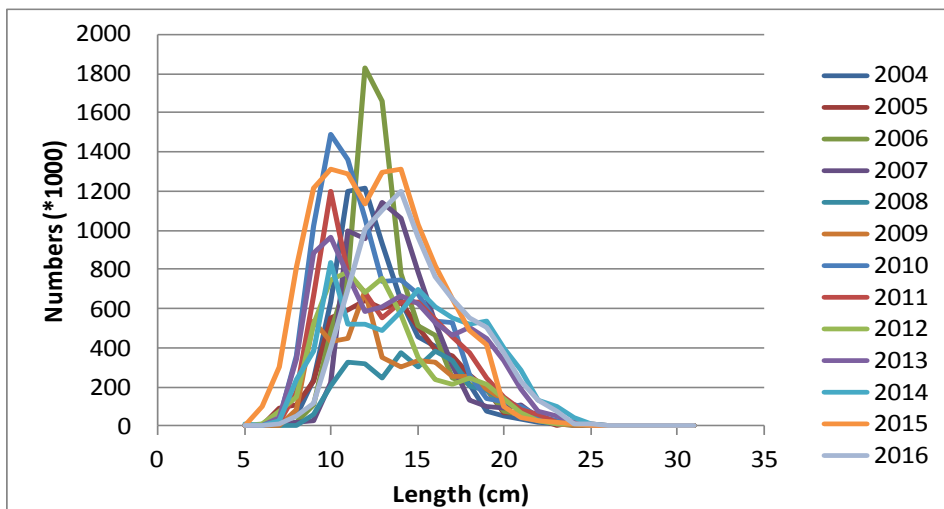


Figure 6.1.3-1: Red mullet in GSA 7. Length structure of the total catches (2004-2016)

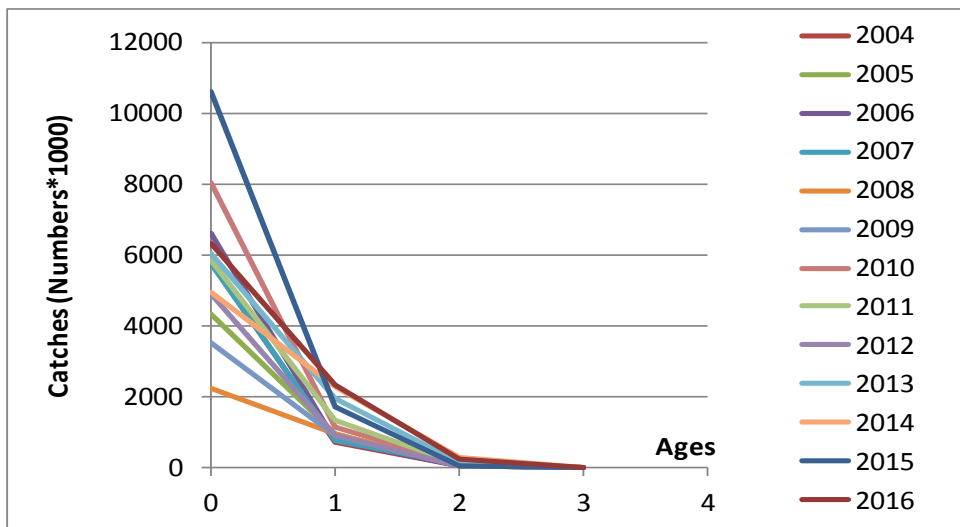


Figure 6.1.3-2: Red mullet in GSA 7. Age structure of the total catches (2004-2016)

Table 6.1.3-1 Catch-at-age (thousands) - Discards not included before 2012

Years/Ages	0	1	2	3
2004	5791	719	46	0
2005	4346	950	67	15
2006	6623	783	64	2
2007	5743	749	75	0
2008	2225	943	52	1
2009	3515	911	68	0
2010	8025	1153	91	4
2011	5874	1308	96	9
2012	4886	884	49	8
2013	6021	1936	147	11
2014	4941	2306	286	15
2015	10624	1706	63	1
2016	6305	2319	234	4

Table 6.1.3-2 Weight-at-age in the catch and in the stock (kg)

Years/Ages	0	1	2	3
2004	0.021	0.070	0.139	0.233
2005	0.022	0.070	0.145	0.230
2006	0.022	0.075	0.141	0.241
2007	0.024	0.079	0.131	0.236
2008	0.026	0.072	0.132	0.227
2009	0.020	0.072	0.133	0.230
2010	0.018	0.072	0.136	0.226
2011	0.020	0.071	0.141	0.230
2012	0.020	0.079	0.158	0.254
2013	0.021	0.077	0.145	0.252
2014	0.026	0.086	0.155	0.276
2015	0.021	0.071	0.141	0.262
2016	0.030	0.089	0.164	0.288

6.1.4 Tuning data

Table 6.1.4-1 Tuning data: MEDITS index at age (thousands), ages 0-2

Years/Ages	0	1	2
2004	374.4	69.6	15.2
2005	268.8	92.3	14.1
2006	241.3	45.2	11.3
2007	725.7	162.3	28.1
2008	435.0	133.3	37.3
2009	358.8	155.6	52.3
2010	973.9	106.3	26.7
2011	449.4	171.2	17.2
2012	279.6	215.0	27.4
2013	1222.7	219.3	40.5

2014	1157.9	309.3	53.1
2015	736.6	372.8	74.7
2016	1827.0	432.8	73.0

6.1.5 Results

An XSA model was achieved after having performed a sensitivity analysis (section 6.1.7.1). The results of the assessment (Fig. 6.1.5-1.) show the highest recruitments in the very recent years. The spawning stock biomass (SSB) showed the highest values of the series in the last year. Fishing mortalities showed certain oscillations, with a certain decreasing trend for the last years. MEDITS log residuals (fig. 6.1.5-2.) showed low values without any trend.

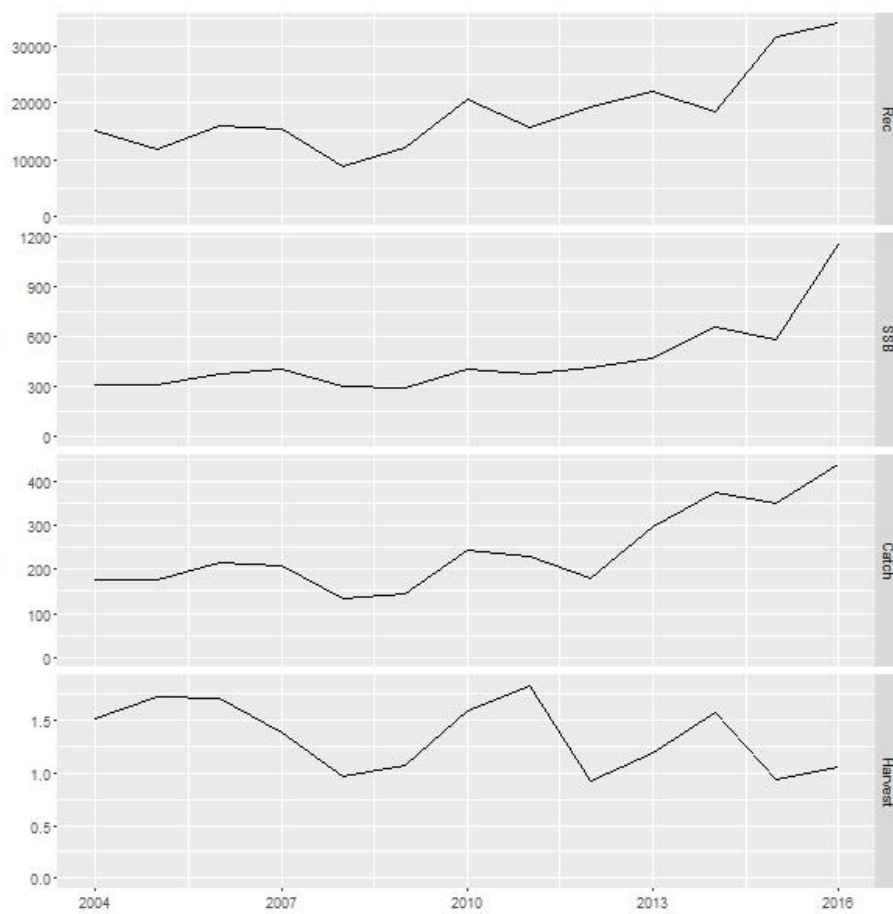


Figure 6.1.5-1: Red mullet in GSA 7. XSA results: recruitment (numbers in thousands), SSB and catch (tons), fishing mortality

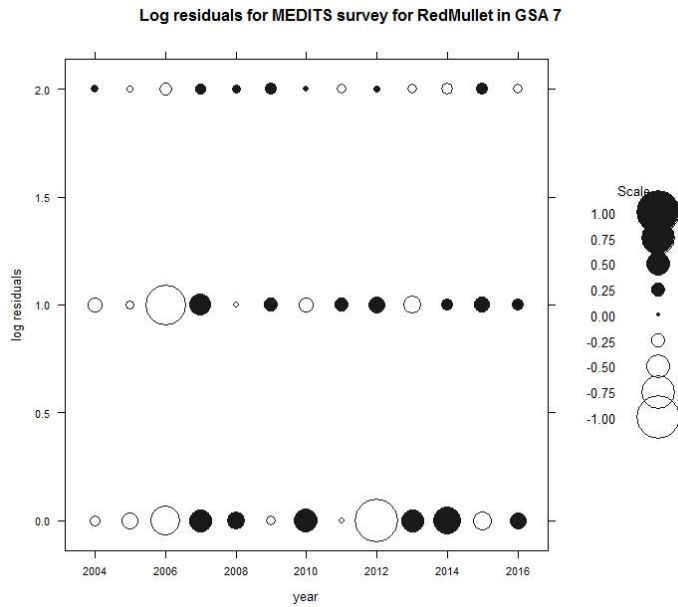


Figure 6.1.5-2 Red mullet in GSA 7. Log-residuals of MEDITS survey

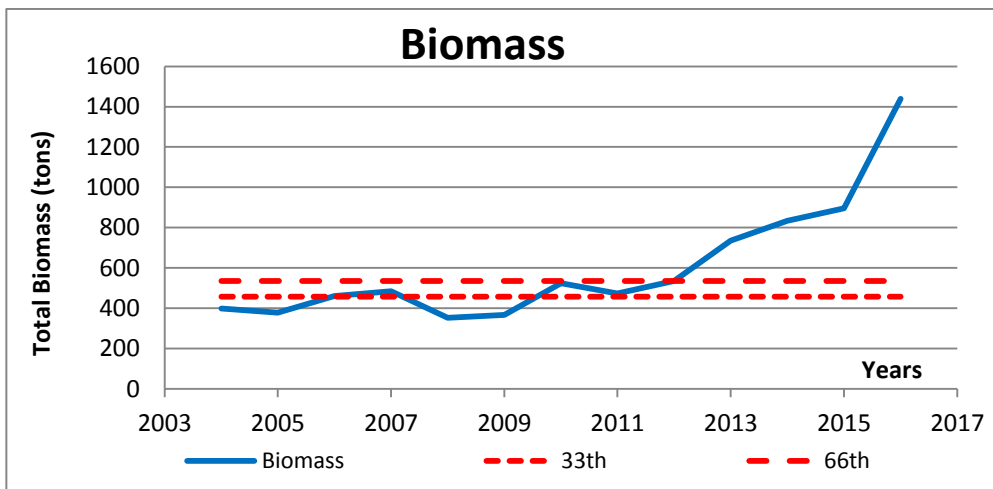


Figure 6.1.5-3 Red mullet in GSA 7. XSA results: Biomass (tons), 33rd and 66th

Table 6.1.5-1 Estimated fishing mortality at age

Years/Ages	0	1	2	3
2004	1.20	1.95	1.39	1.39
2005	1.09	2.25	1.84	1.84
2006	1.40	1.80	1.92	1.92
2007	1.13	1.70	1.30	1.30
2008	0.63	1.67	0.63	0.63
2009	0.76	1.82	0.63	0.63
2010	1.21	2.07	1.49	1.49
2011	1.13	2.35	2.00	2.00
2012	0.62	1.37	0.77	0.77

2013	0.69	1.57	1.32	1.32
2014	0.67	2.20	1.85	1.85
2015	0.94	1.47	0.40	0.40
2016	0.41	1.58	1.16	1.16

Table 6.1.5-2 Estimated abundance at age (thousands)

Years/Ages	0	1	2	3
2004	15028	1087	71	0
2005	11876	1378	92	20
2006	15915	1216	87	3
2007	15367	1189	119	0
2008	8668	1507	129	2
2009	11998	1410	169	0
2010	20711	1711	136	6
2011	15702	1874	128	11
2012	19281	1537	106	17
2013	21971	3171	232	17
2014	18411	3363	392	20
2015	31706	2876	221	3
2016	34061	3786	394	7

Table 6.1.5-3c: Summary table

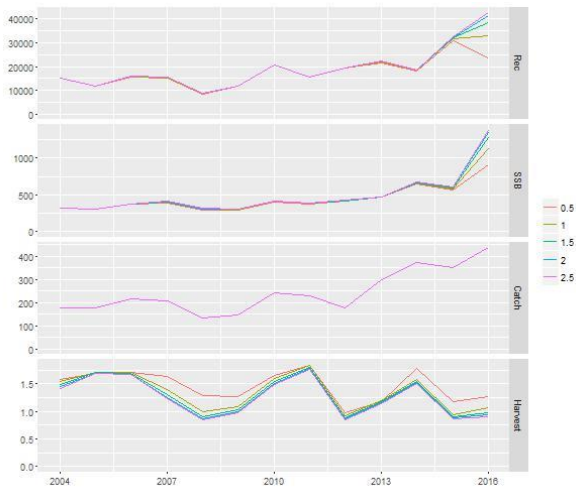
Years/Ages	SSB (t)	Recruitment (thousands)	Fbar (0-2)
2004	317.3	15028.2	1.51
2005	309.1	11876.4	1.73
2006	375.0	15915.2	1.71
2007	403.0	15367.1	1.38
2008	303.6	8667.8	0.97
2009	297.7	11998.1	1.07
2010	410.1	20711.0	1.59
2011	382.1	15701.6	1.83
2012	419.8	19280.7	0.92
2013	468.1	21970.8	1.19
2014	661.7	18410.8	1.57
2015	587.8	31706.1	0.93
2016	1160.3	34060.7	1.05

6.1.6 Robustness analysis

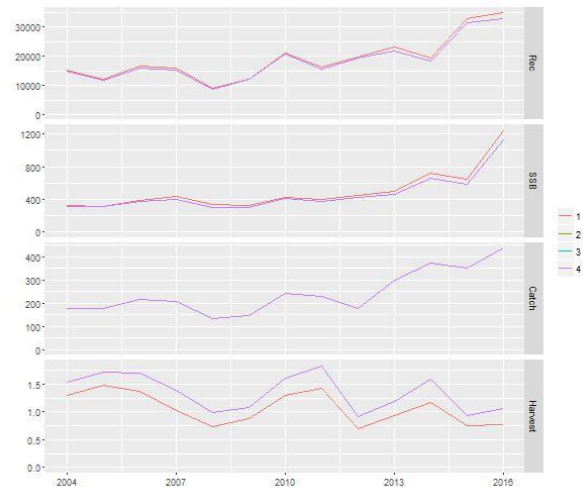
6.1.7 Retrospective analysis, comparison between model runs, sensitivity analysis. etc.

6.1.7.1 Sensitivity analysis

The selection of the suitable parameters for the final XSA run was possible by performing four sensitivity analysis, for the SSB, fishing mortality and recruitment (Figure 6.1.7.1.1.a-d). The first sensitivity analysis (a) was conducted using 5 different shrinkage weight assumptions (i.e. fse 0.5, 1, 1.5, 2 and 2.5). The final setting selected is an intermediate value (1). The second analysis (b) was conducted to assess the effect of the age after which catchability is no longer estimated (i.e. qage assigning values ranging from 0 to 3). The final setting selected is a constant catchability for all ages, as in last year assessment. The third analysis (c) was conducted to assess the effect of shrinkage on the last ages (i.e. ranging from 1 to 4). The final setting selected is shrinkage on the last 2 ages. The fourth analysis (d) was conducted to assess the effect of shrinkage on the last years (i.e. ranging from 1 to 5). The final setting selected is shrinkage on the last 4 years. The summary of parameters finally retained for the final XSA run is in Table 6.1.7.1.1.



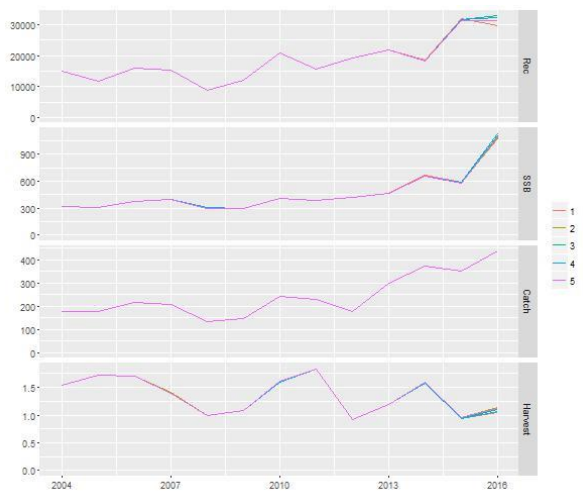
(a) Shrinkage weight (fse 0.5, 1, 1.5, 2 and 2.5)



(b) Catchability (qage values ranging from 0 to 4)



(c) Shrinkage on the last ages (i.e. ranging 1-4)



(d) Shrinkage on the last years (i.e. ranging 1-5)

Figure 6.1.7.1.1: Red mullet in GSA 7. Sensitivity analysis on weight of the shrinkage (a), catchability at age (b), shrinkage on the last ages (c) and last years (d).

Table 6.1.7.1.1: Red mullet in GSA 7. XSA settings.

Fse	shk.yrs	shk.ages	rage	qage
1	4	2	-1	4

6.1.7.2 Retrospective analysis

A retrospective analysis was conducted on recruitment, mean F and SSB (Figure 6.1.7.2.1) to ensure the robustness of final estimates.

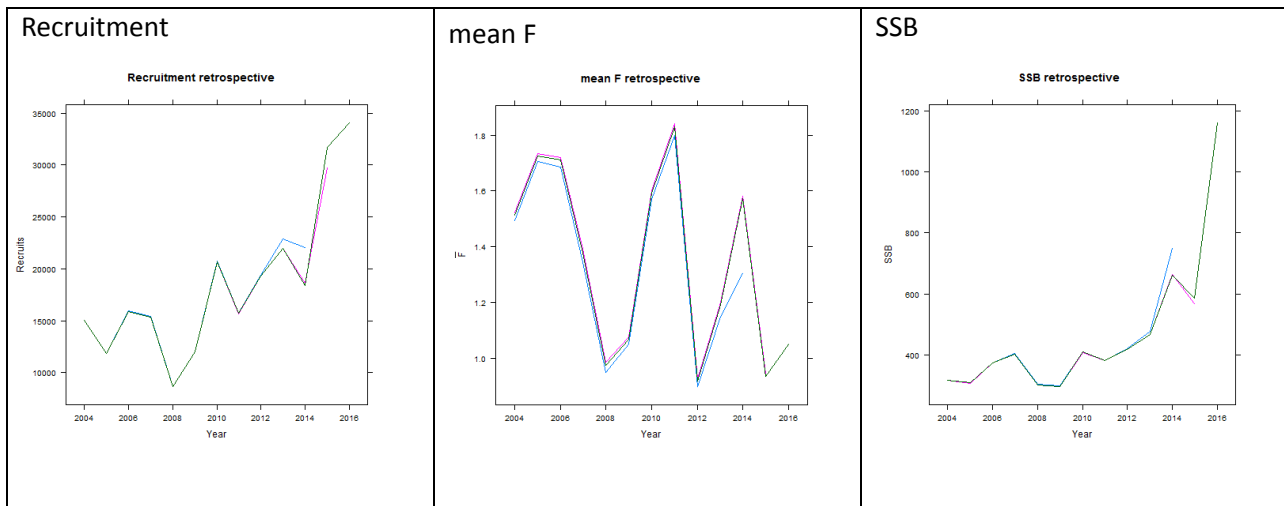


Figure 6.1.7.2.1: Red mullet in GSA 7. Retrospective analysis performed with XSA: Recruitment, mean F and SSB.

6.1.8 Assessment quality

Stability of the assessment, evaluation of quality of the data and reliability of model assumptions are described in the 6.1.5-7, sections.

7 Stock predictions

7.1 Short term predictions

A deterministic short term prediction for the period 2017 to 2019 was performed using the FLR routines (<http://www.flr-project.org>) by JRC and based on the results of the XSA stock assessments.

The input parameters were the same parameters used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age and maturity at age. Recruitment (age 0) has been estimated from the population results as geometric mean of the last 3 years. As the values of F showed a decreasing trend for the last two years, two different analysis were carried out, considering F at age as i) the average of last three years and ii) the average of last two years.

Table 7.1.1: Red mullet in GSA 7. F status quo (two different analysis), recruitment and catch used for short-term forecast.

Parameter	Method	Value
F status quo	Average over ages 0-2 and years 2014-2016	1.18
Recruitment (*)	Geometric mean of recruitment over 2014-2016	27091 thousands
Catch	2016	438 tons
SSB	Mean 2014-2016	603 tons

A short term projection assuming an F_{stq} of 1.18 in 2016 and a recruitment of 27091 (thousands) individuals (Table 7.1.2a) shows that:

Fishing at the F_{stq} (1.18) generates an increase in the catch of 23% from 2016 to 2018 along with an decrease in the spawning stock biomass of 2% from 2018 to 2019.

Fishing at F_{MSY} (0.35) generates a decrease in the catch of 49% from 2016 to 2018 and an increase in the spawning stock biomass of 43 % from 2018 to 2019.

Catches of red mullet in 2018 consistent with F_{MSY} would not exceed 223 tons.

Table 7.1.2a: Red mullet in GSA 7. Short term forecast in different F scenarios considering Fstq as the average over ages 0-2 and years 2014-2016

Ffactor	Fbar	Catch 2016	Catch 2017	Catch 2018	Catch 2019	SSB 2018	SSB 2019	Change SSB 2018-2019(%)	Change Catch 2016-2018 (%)
0	0	438	660	0	0	930	1641	76	-100
0,1	0,118	438	660	84	151	930	1522	64	-81
0,2	0,236	438	660	159	263	930	1417	52	-64
0,3	0,354	438	660	225	345	930	1324	42	-49
0,4	0,472	438	660	285	405	930	1242	34	-35
0,5	0,59	438	660	339	448	930	1169	26	-23
0,6	0,708	438	660	387	478	930	1105	19	-12
0,7	0,826	438	660	431	499	930	1047	13	-2
0,8	0,944	438	660	471	513	930	996	7	8
0,9	1,062	438	660	507	522	930	950	2	16
1	1,18	438	660	540	527	930	908	-2	23
1,1	1,298	438	660	570	530	930	871	-6	30
1,2	1,416	438	660	598	530	930	837	-10	37
1,3	1,534	438	660	624	530	930	807	-13	42
1,4	1,652	438	660	647	528	930	780	-16	48
1,5	1,77	438	660	669	526	930	755	-19	53
1,6	1,888	438	660	689	524	930	732	-21	57
1,7	2,006	438	660	708	522	930	711	-23	62
1,8	2,124	438	660	725	520	930	693	-25	66
1,9	2,242	438	660	741	518	930	675	-27	69
2	2,36	438	660	756	516	930	660	-29	73
0,3	0,35	438	660	223	343	930	1327	43	-49

7.1.1 Short term predictions 2015-2017 by fleet

7.1.1.1 Method

A deterministic short term prediction by fleet for the period 2017 to 2019 was performed using the FLR routines provided by JRC and based on the results of the XSA stock.

7.1.1.2 Input parameters

The same parameters used in the short term by single fleet were used.

7.1.1.3 Results

Table 7.2.3.1 Red mullet in GSA 7. Short term forecast by fleet.

	F(2014-2016)= 1.18		
fleet	year	catches	partial_F
French trawlers	2017	569	0.93
French gillnetters	2017	23	0.05
Spanish trawlers	2017	69	0.20
French trawlers	2018	181	0.28
French gillnetters	2018	8	0.01
Spanish trawlers	2018	22	0.06
French trawlers	2019	254	0.28
French gillnetters	2019	13	0.01
Spanish trawlers	2019	34	0.06

7.2 Medium term predictions

No medium term forecast has been performed, because of lacking of a reliable stock-recruitment relationship.

7.3 Long term predictions

Yield per recruit analysis was used (FLBRP) to calculate the reference point ($F_{0.1}$ as a proxy of F_{MSY}) and the estimated reference fishing mortality ($F_{current}$). The referent F was estimated using the default assumptions agreed in the meeting, e.g. weights are means of the last 3 years and future recruitment is the geometric mean of the last 3 years.

Table 7.3-1: Red mullet in GSA 7. Reference points

Model - Year	$F_{current(ages\ 0-2)}$	$F_{0.1, estimated\ in\ 2016}$	Ratio ($F_{current}/F_{0.1}$)
XSA - 2017	1.18 (2014-2016)	0.35	3.37
XSA – 2016	1.13 (2013-2015)	0.35	3.23

8 Draft scientific advice:

Based on	Indicator	Analytical 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	$F_{0.1} = 0.35$ (estimated in 2016)	$F_{curr(2014-2016, \text{ages } 0-2)} = 1.18$	$F_{curr}/F_{0.1} = 3.37$	N	IO_H
	Fishing effort					
	Catch					
Stock abundance	Biomass		$B_{curr(\text{mean } 2014-2016)} = 1056$ tons	$B_{33} = 458$ tons $B_{66} = 534$ tons	I	O_H
	SSB		$SSB_{curr(\text{mean } 2014-2016)} = 603$ tons			
Recruitment			$R_{current}$ (geometric mean last 3 years) = 27091 (*1000)		I	
Final Diagnosis		In High overfishing status with a relative high biomass .				

The stock is in a **High overfishing status** with a **relative high biomass** and an increasing trend in the recruitment. The exploitation level is currently above the level estimated to be sustainable since the referent point $F_{0.1}$ is equal to 0.35 and current fishing mortality ($F_{current}$) to 1.18 (average 2014-2016). The current fishing mortality follows fluctuations without clear trend and the spawning stock biomass currently follows an upward trend. The exploitation is mainly concentrated on young individuals (age 0-2). Moreover 75% of the recruitment is mature. The current biomass is above the 66th percentile, however computed over a relatively short time-period (2004-2016).

Management advice and recommendations: Reduce fishing mortality

The current exploitation level is well above the level estimated to be sustainable, despite the important decrease in number of French trawlers since 2011, reducing the number of boats by almost 50%. We should take into account that the French trawl fleet is composed by different gears, bottom trawl (OTB), midwater otter trawl (OTM) and Multi-rig otter trawl (OTT). Catches from OTM represent less than 2% of the French trawl fleet, but the importance of OTT has increased during last years, from 5% in 2015 to 29% in 2016. This may represent a high risk of increasing the fishing effort if the use of this gear is not well regulated and managed.

A management plan for GSA 7 is still in progress considering protection of nurseries and spawning zones and periods.

Some other measures for reducing the effort have been taken at a national level in 2017. Considering France, temporal closure of 25 days/trawler from the 17th of April until the 16th of July, following a biological closure of 5 days by trawler between the 13 of March and the 14th of April 2017. Considering Spain, temporal closures for trawlers between 6th February and 8th of March. Some additional Spanish national measures are in discussion considering the protection of spawning period and zone. For that there is a proposal for annual spatio-temporal closures between 12th of October and 12th of December and between 150 and 275 meters, considering longliners, bottom trawlers and gillnetters.

Other important measures in rules have to be respected such as the minimum legal landing size and legal mesh size and the respect of the freezing of the effort in the Fishery Restricted Area.

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

* F_c 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)