Stock Assessment Form
Demersal species

Reference year: 2014

Reporting year: 2015

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Zdravko Ikica*

Stock assessment form

1 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 18		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
Italy	Albania	Montenegro
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
Combined (Trawl survey, XSA, a4aSCA, ALADYM)		
Authors:		
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Affiliation:		
[1] COISPA Tecnologia & ricerca, Bari – Italy; [2] AdriaMed, FAO, Rome – Italy; [3] Institute of Marine Biology, University of Montenegro, Kotor – Montenegro; [4] University of Tirana – Albania		

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):

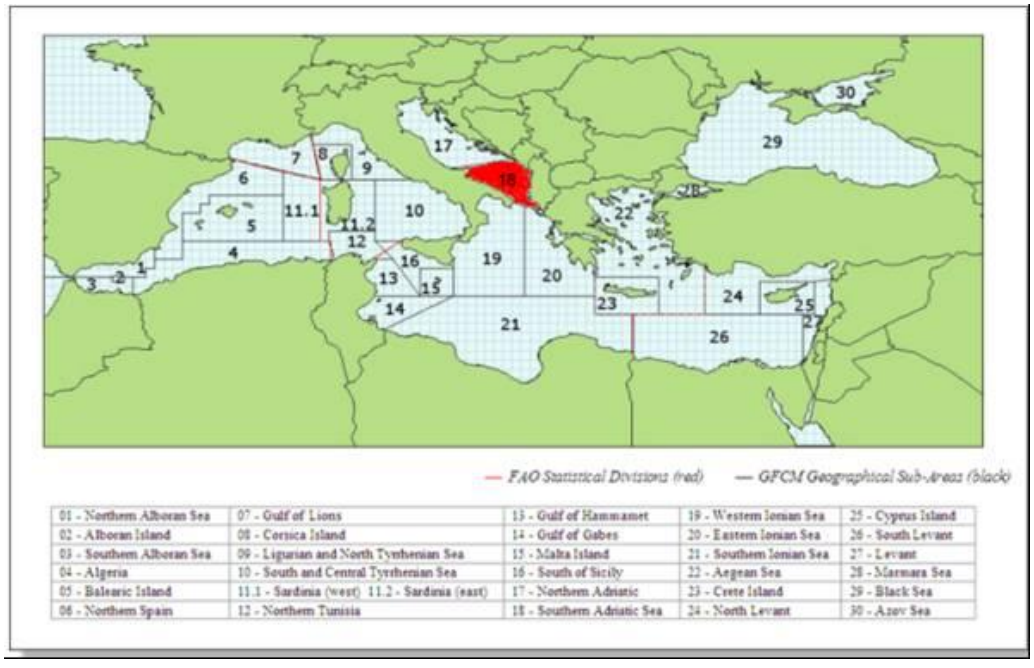
- ICA
- VPA
- LCA
- AMCI
- XSA
- Biomass models
- Length based models
- Other (please specify)

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

2.1 Stock unit

The Southern Adriatic Sea is characterised by the presence of a deep central depression known as the "South Adriatic Pit" (or Bari Pit) where the seabed reaches a depth of 1,233 m.
The northern and southern portions of the Southern Adriatic Sea feature substantial differences; the first contains a wide continental shelf (the distance between the coastline and a depth of 200 m is around 45 nautical miles) and a very gradual slope; in the second, the isobathic contours
are very close, with a depth of 200 m already found at around 8 miles from the Cape of Otranto.
The continental shelf break is at a depth of around 160-200 m and is furrowed by the heads of canyons running perpendicular to the line of the shelf.
The Adriatic Sea, together with the Levant basin, is one of three areas in the Mediterranean where down-welling processes produced by surface cooling lead to the formation of so-called "dense waters", rich in oxygen, which supply the lower levels.



2.2 Growth and maturity

Incorporate different tables if there are different maturity ogives (e.g. catch and survey). Also incorporate figures with the ogives if appropriate. Modify the table caption to identify the origin of the data (catches, survey). Incorporate names of spawning and nursery areas and maps if available.

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**	
Maximum size observed	33.5	30		**Recruitment season**	
Size at first maturity	11.9			**Spawning area**	
Recruitment size to the fishery			9	**Nursery area**	

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

Size/Age	Natural mortality	Proportion of matures
0	*1.03*	*0.16*
1	*0.71*	*0.92*
2	*0.65*	*1*
3+	*0.62*	*1*

Table 2-2.3: M vector and proportion of matures by size or age (Females)

Size/Age	Natural mortality	Proportion of matures
0	*1.03*	*0.16*
1	*0.71*	*0.92*
2	*0.65*	*1*
3+	*0.62*	*1*

For the assessment a vector natural mortality estimated by PRODBIOM method (Abella et al., 1997) for sex combined. The vector of proportion of mature individuals by age has been derived slicing the maturity ogive by length with the von Bertalanffy coefficients for sex combined reported above. LFDA (FAO package) algorithm has been used for the age slicing.

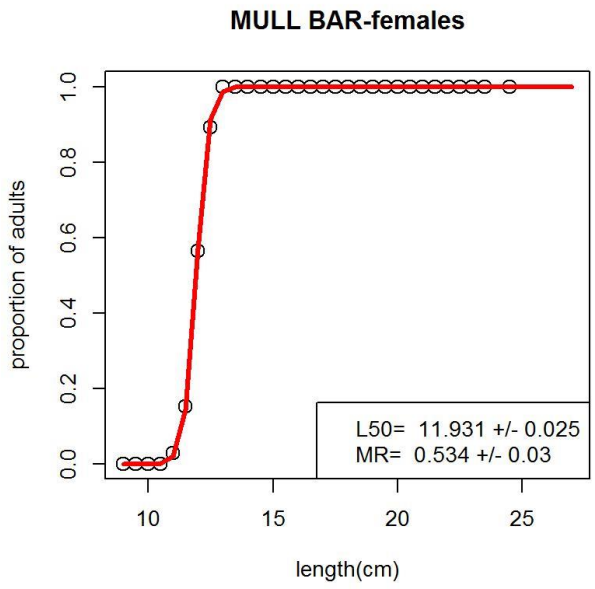


Table 2-3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	cm			30	
	K	$year^{-1}$			0.4	
	t_0	year			−0.3	
	Data source					
Length weight relationship	**a**					
	b					
	M (scalar)					
	sex ratio (% females/total)	0.5				

3 Fisheries information

3.1 Description of the fleet

The fleet data are referred to the whole GSA and are from the GFCM Task 1 Statistical Bulletin 2010. Catch data in the table 3.1.2 below reported are referred to the year 2014 (DCF data for Italy, and data from ADRIAMED pilot study and National Statistics for Albania and Montenegro). The operational units ITA18E0333-MUT, ITA18F0333- MUT, ALB 18 E 03 33- MUTand ALB 18 F 03 33- MUT include also demersal slope fishing (mixed demersal according to DCF classification).

The catch data from the whole GSA18 including the east side are below reported:

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*	ITA	18	D – Trawls (5-12 m)	03 – Trawls	33 – Demersal shelf species	MUT
Operational Unit 2	ITA	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	MUT
Operational Unit 3	ITA	18	F – Trawls (>24 m)	03 – Trawls	33 – Demersal shelf species	MUT
Operational Unit 4	ITA	18	B – Minor gear with engine (<6 m)	07 – Gillnets and entangling nets	33 – Demersal shelf species	MUT
Operational Unit 5	ITA	18	C – Minor gear with engine (6-12 m)	07 – Gillnets and entangling nets	33 – Demersal shelf species	MUT
Operational Unit 6	MNE	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	MUT
Operational Unit 7	MNE	18	B – Minor gear with engine (<6 m)	07 – Gillnets and entangling nets	33 – Demersal shelf species	MUT
Operational Unit 8	MNE	18	C – Minor gear with engine (6-12 m)	07 – Gillnets and entangling nets	33 – Demersal shelf species	MUT
Operational Unit 9	ALB	18	D – Trawls (5-12 m)	03 – Trawls	33 – Demersal shelf species	MUT

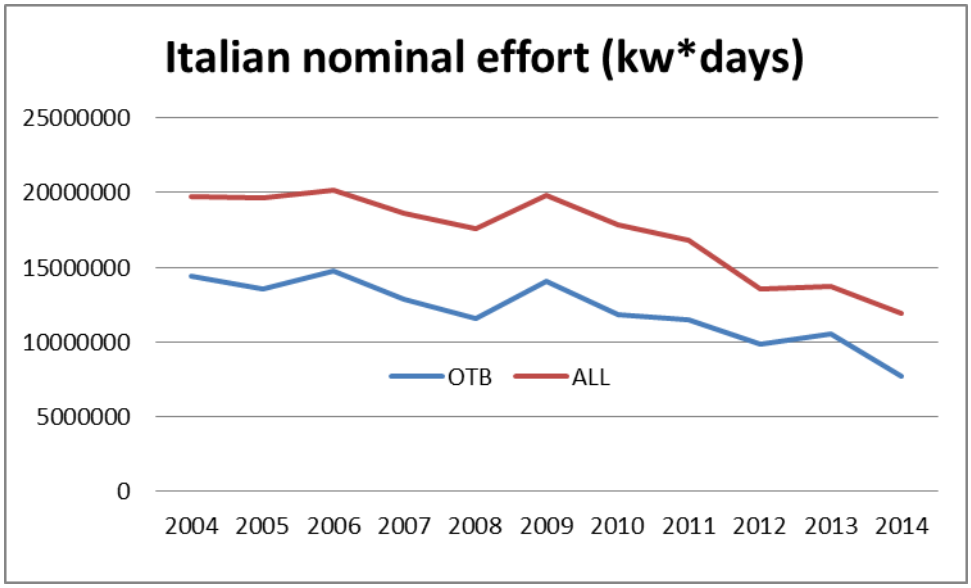
Operational Unit 10	ALB	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	MUT
Operational Unit 11	ALB	18	F – Trawls (>24 m)	03 – Trawls	33 – Demersal shelf species	MUT

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)
ITA Operational Units 1+2+3	400	1249.6 T		119.6		
ITA Operational Unit 4+5	355	22.6 T				
MNE Operational Units 6	20	41 T				
MNE Operational Units 7+8	90	4 T				
ALB Operational Units 9+10+11	199	147 T				
Total		1684 T				

Classification	Catch (t)
2007 ITA 18 B 03 33 – ITA 18 C 03 33	22.3[5]
2007 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	1741.5
2007 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	171[1]
2007 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	38[1]
2007 MNE 18 B 03 33 – MNE 18 C 03 33	3.7[1]
2007 Total	**1976**
2008 ITA 18 B 03 33 – ITA 18 C 03 33	22.3[1]
2008 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	947.9
2008 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	149[2]
2008 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	38
2008 MNE 18 B 03 33 – MNE 18 C 03 33	3.7[4]
2008 Total	**1161**
2009 ITA 18 B 03 33 – ITA 18 C 03 33	22.3[1]
2009 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	969
2009 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	154[2]
2009 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	36
2009 MNE 18 B 03 33 – MNE 18 C 03 33	3.6[4]
2009 Total	**1186**
2010 ITA 18 B 03 33 – ITA 18 C 03 33	22.3[1]
2010 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	635.7
2010 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	90[2]
2010 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	35
2010 MNE 18 B 03 33 – MNE 18 C 03 33	3.4[4]
2010 Total	**786**
2011 ITA 18 B 03 33 – ITA 18 C 03 33	37.5
2011 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	508.1
2011 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	110[2]
2011 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	32
2011 MNE 18 B 03 33 – MNE 18 C 03 33	3.2[4]
2011 Total	**691**
2012 ITA 18 B 03 33 – ITA 18 C 03 33	7.1
2012 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	2522.7
2012 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	280[2]
2012 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	35
2012 MNE 18 B 03 33 – MNE 18 C 03 33	3.5[4]
2012 Total	**2848**
2013 ITA 18 B 03 33 – ITA 18 C 03 33	47
2013 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	1220.8
2013 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	247[2]
2013 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	32
2013 MNE 18 B 03 33 – MNE 18 C 03 33	3.1
2013 Total	**1550**
2014 ITA 18 B 03 33 – ITA 18 C 03 33	22.6
2014 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	1369.2
2014 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	147[3]
2014 MNE 18 D 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	41
2014 MNE 18 B 03 33 – MNE 18 C 03 33	4.0
2014 Total	**1684**

[1] Due to the lack of data, the 2007 catch for Albania and Montenegro was assumed to be identical to the catch of 2008
[2] Catches in Albania for period from 2008 to 2013 were obtained from within the SEDAF project (MAREA Specific Project No. 10)
[3] Preliminary data of Ministry of Environment, forests and Water Management of Albania for 2012.
[4] Due to the lack of data, the total production of fleet segments MNE 18 B 03 33 and MNE 18 C 03 33 for period 2008–2012 and 2014 was estimated based on the data from 2013
[5] From 2007 to 2010 catch for Italian gillnets and entangling nets was assumed to be equal to the average of catches in 2011-2014.



3.2 Historical trends

Available time series for

Red mullet landings in GSA 18 is relatively short (Table 3.2-1), consisting of only eight years (2007-2014), and even not complete for all countries in question.

Table 3.2-1. Landing data for GSA 18 by year and country

Year	Italy-OTB	Italy-GEN	Montenegro-OTB	Montenegro-GEN	Albania	Total Landings
2007	1679.6	22.3	38	3.7	171	1914
2008	914.2	22.3	38	3.7	149	1127
2009	954.3	22.3	36	3.6	154	1171
2010	600.7	22.3	35	3.4	90	751
2011	494.2	37.5	32	3.2	110	677
2012	2088.6	7.1	35	3.5	280	2414
2013	1202.8	47.0	32	3.1	247	1532
2014	1249.6	22.6	41	4.0	147	1464

Table 3.2-2. Discard data available for GSA 18 by year and country

Year	Italy-OTB
2007	62
2008	34
2009	15
2010	35
2011	14
2012	434
2013	18
2014	120

3.3 Management regulations

In Italy management regulations are based on technical measures, closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban, that in southern Adriatic has been mandatory since the late eighties. Regarding long-lines the management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences. Regarding small scale fishery management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet. In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km^2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km^2 along the bathymetry of 100 m) on the northern border of the GSA where a marine protected area (MPA) had been established in 1989. In the former only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30th, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Recreational fishery using no more than 5 hooks is allowed in both the areas. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

In Montenegro, management regulations are based on technical regulations, such as mesh size (Official Gazette of Montenegro, 8/2011), including the minimum landing sizes (Official Gazette of Montenegro, 8/2011), and a regulated number of fishing licenses and area limitation (no–fishing zone up to 3 NM from the coastline or 8 NM for trawlers of 24+ m LOA). Currently there are no MPAs or fishing bans in Montenegrin waters.

In Albania, a new law “On fishery” has now been approved, repealing the Law n. 7908. The new law is based on the main principles of the CFP, it reflects Reg. 1224/2009 CE ; Reg.1005/2008 CE; Reg. 2371/2002 CE; Reg. 1198/2006 CE; Reg. 1967/2006 CE; Reg. 104/2000; Reg. 1543/2000 as well as the GFCM recommendations. The legal regime governing access to marine resources is being regulated by a licensing system. Regarding conservation and management measures, minimum legal sizes and minimum mesh sizes

is those reflected in the CE Regulations. Albania has already an operational vessel register system. It is forbidden to trawl at less than 3 nautical miles (nm) from the coast or inside the 50m isobath when this distance is reached at a smaller distance from the shore.

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			$F_{0.1}$	0.42	
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 MEDITS Trawl Survey

The sampling design is random stratified with number of haul by stratum proportional to stratum surface. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Hauls noted as valid were used only, including stations with no catches (zero catches are included).
The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). The variation of the stratified mean is then expressed as coefficient of variation respect to the mean.

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	**MEDITS**	**Trawler/RV**	PEC
Sampling season	Summer		
Sampling design	Stratified sampling design with the number of hauls proportionate to the strata surface		
Sampler (gear used)	GOC 73		
Cod –end mesh size as opening in mm	20 mm		
Investigated depth range (m)	10 – 800 m		

Table 4.1-2: Trawl survey sampling area and number of hauls

Stratum	**Total surface (km^2)**	**Trawlable surface (km^2)**	**Swept area (km^2)**	**Number of hauls**
10 – 50 m	3430			12
50 – 100 m	6435			20
100 – 200 m	9664			31
200 – 500 m	4761			13
500 – 800 m	4718			14
Total (10 – 800 m)	29008			90

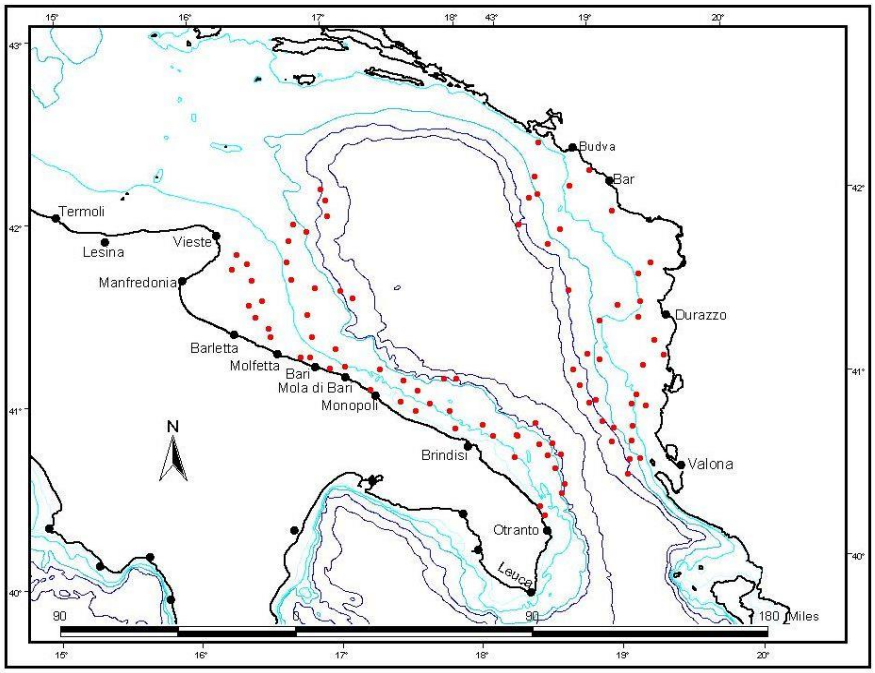


Fig. 4.1-1. Map of MEDITS haul positions in the GSA 18

Table 4.1-3: Trawl survey abundance and biomass results (MEDITS 2014)

Depth Stratum	Years	kg per km²	CV (%)	N per km²	CV (%)
10 – 50 m	2014	170.0	37.3	39538	55.9
50 – 100 m	2014	29.2	53.7	1149	60.1
100 – 200 m	2014	23.2	27.5	596	26.8
200 – 500 m	2014	1.4	74.8	25	79.2
500 – 800 m	2014	0	0	0	0
Total (10 – 800 m)	2014	34.6	24.7	5133	51

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

Slicing method

The maturity scale used for the maturity stages of this species is MEDITS scale (Medits Handbook 2013, version 7).

The age slicing method used for this stock is the LFDA (FAO package) algorithm implemented by means of a routine in R.

Table 4.1-4: Trawl survey results by length or age class

N/km² (Total or sex combined) by Length or Age class	Year							
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
0	271.3	38.7	97.6	135.9	422.3	5562.9	2474.2	6827.5
1	231.5	198.7	277.5	239.9	429.9	1034.5	1153.3	734.7
2	27.4	71.4	43.7	32.3	31.4	60.2	75.9	54.2
3+	0.7	7.6	8.6	5.7	3.4	3.9	5.4	1.6

Total	530.9	316.5	427.4	413.8	887.0	6661.6	3708.9	7618.0

Sex ratio by Length or Age class	**Year**		
	2007-2013	**….**	**…..**
Total	0.5		

The number are standardised to the square km but not raised to the overall area assuming the same catchability (=1).

Direct methods: trawl based Recruitment analysis

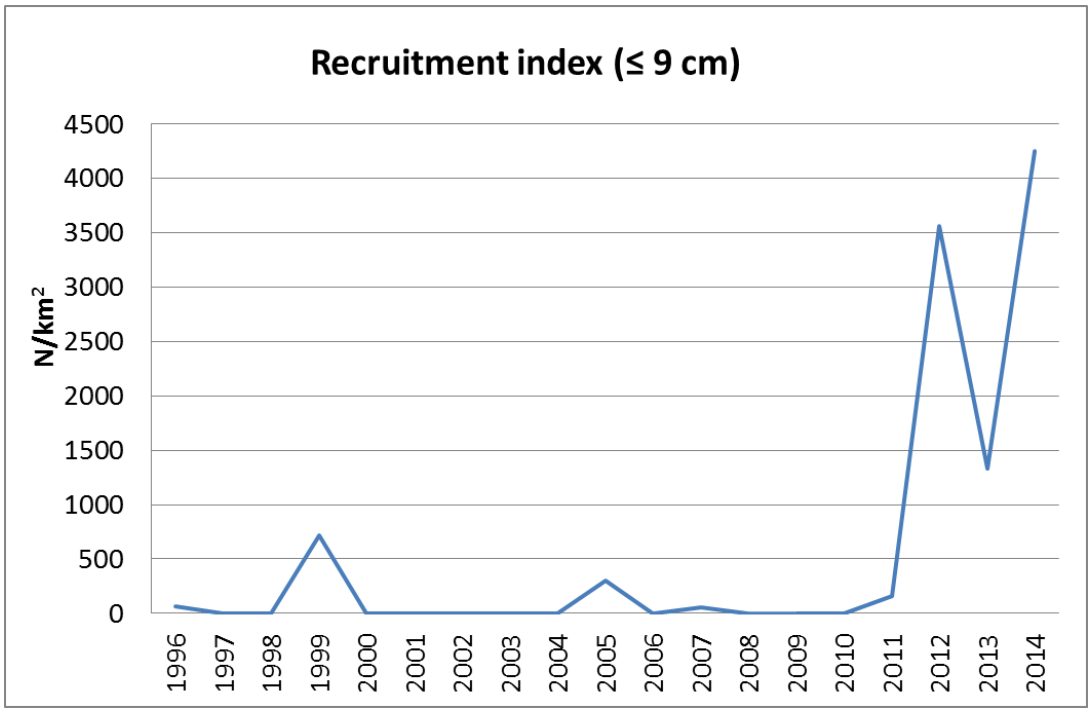
Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey	**MEDITS**	**Trawler/RV**	**PEC**
Survey season		summer	
Cod –end mesh size as opening in mm		20	
Investigated depth range (m)		10-800	
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-6: Trawl surveys; recruitment analysis results (<=9 cm)

Years	**Area in km²**	**N of recruit per km²**	**CV**
1996	29008	65	102.1
1997	29008	1	67.2
1998	29008	0	0.0
1999	29008	718	34.8

2000	29008	0	0.0
2001	29008	0.3	81.9
2002	29008	2	66.1
2003	29008	1	86.1
2004	29008	3	102.8
2005	29008	303	81.9
2006	29008	0	0.0
2007	29008	52	27.3
2008	29008	0.4	100.0
2009	29008	1	62.0
2010	29008	1	73.7
2011	29008	161	99.1
2012	29008	3566	74.8
2013	29008	1330	74.6
2014	29008	4252	60.8



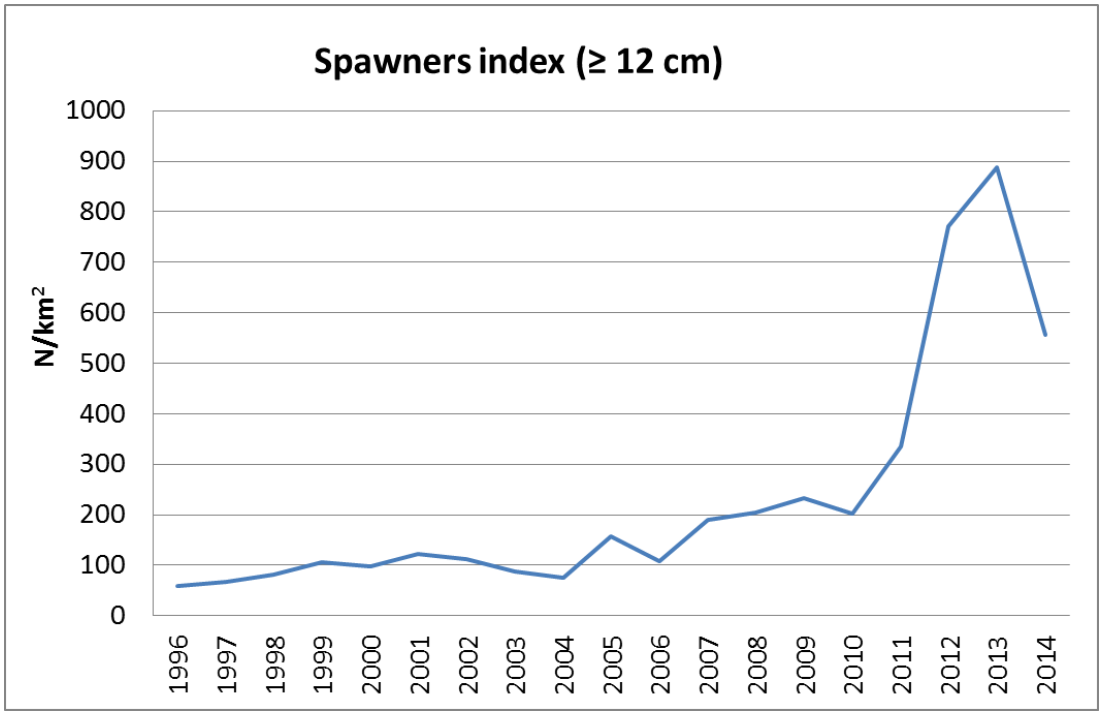
Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey	**MEDITS**	**Trawler/RV**	**PEC**
Survey season			summer
Investigated depth range (m)			10-800
Spawning season and peak (months)			

Table 4.1-8: Trawl surveys; spawners analysis results (>= 12 cm)

Years	Area in km^2	N of spawners per km^2	CV
1996	29008	60	30.8
1997	29008	68	32.1
1998	29008	82	23.7
1999	29008	106	22.4
2000	29008	98	19.4
2001	29008	123	25.1
2002	29008	113	45.1
2003	29008	87	24.9
2004	29008	75	24.3
2005	29008	157	27.6
2006	29008	108	22.8
2007	29008	191	20.6
2008	29008	205	16.1
2009	29008	233	26.7
2010	29008	202	28.5
2011	29008	336	51.5
2012	29008	771	25.5
2013	29008	888	20.6
2014	29008	557	31.7


Spawners index (≥ 12 cm)
N/km2
1000
900
800
700
600
500
400
300
200
100
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

4.1.1 Spatial distribution of the resources

Include maps with distribution of total abundance, spawners and recruits (if available)

In the GSA18 nursery areas of red mullet were localized using few years and the main place was offshore Gargano promontory, while a smaller nursery was localised in fron of Bari. Persistent spawning grounds were mainly identified in the eastern side, along the Albanian coasts at the latitude of Durrës (Fig. 4.1.1-1), on muddy bottom with coastal terrigenous muds biocoenosis (VTC). The main current is from south to north. Other nuclei were identified north of Vlora and along the coasts of Otranto on the west side.

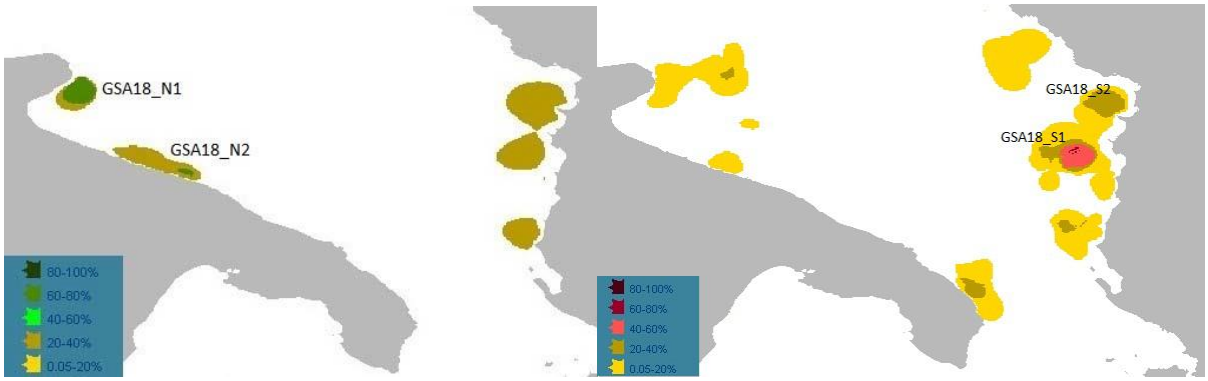
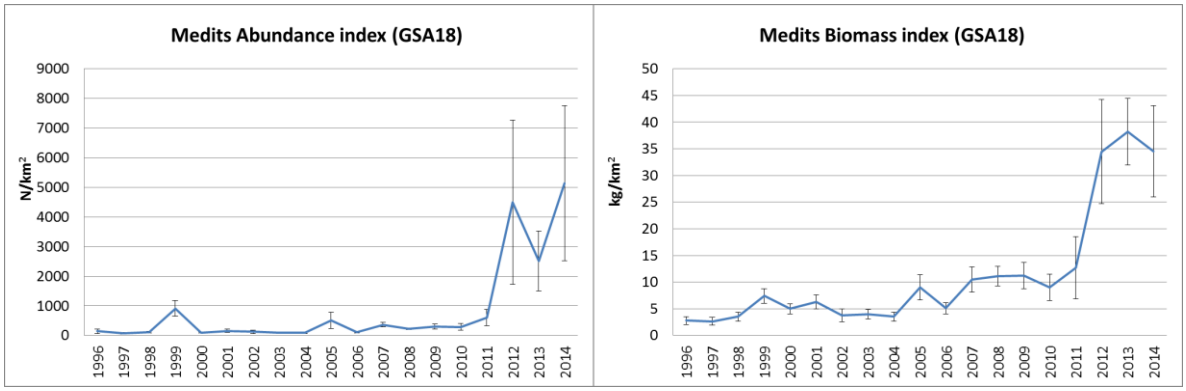


Fig. 4.1.1-1. Position of persistent nursery (left) and spawning (right) areas of red mullet in the GSA18

4.1.2 Historical trends

Time series analysis (if available) and graph of the observed trends in abundance, abundance by age class, etc. for each of the directed methods used.



5 Ecological information

5.1 Protected species potentially affected by the fisheries

This analysis has not been carried out.

5.2 Environmental indexes

None environmental index used

6 Stock Assessment

In this section there will be one subsection for each different model used, and also different model assumptions runs should be documented when all are presented as alternative assessment options.

6.1 XSA

6.1.1 Model assumptions

The major assumption of the method is the flat selectivity for the oldest ages (selectivity as classical ogive). The method performs a tuning by survey index by age.

The method was applied using the age data obtained by the slicing of the length frequency distributions of the landing and, as tuning indices, MEDITS survey data.

6.1.2 Scripts

The rows related to the best run (shrinkage 2) are reported.

```
library(FLCore)
library(FLEDA)
library(FLXSA)
library(FLAssess)
library(FLash)
require(ggplotFL)
require(plyr)
require(FLBRP)

mul.stk <- readFLStock("MUL18.IND", no.discards=TRUE)
units(harvest(mul.stk))<-"f"
range(mul.stk)["minfbar"] <- 0
range(mul.stk)["maxfbar"] <- 5
mul.stk <- setPlusGroup(mul.stk, 6)
mul.idx <- readFLIndices("MUL18TUN.DAT")

#settings of XSA
FLXSA.control.mul_2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3,
fse=2, rage=0, qage=4, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2,
window=100, tsrange=20, tspower=3, vpa=FALSE)

#plot of the final results
mul.xsa_2 <- FLXSA(mul.stk, mul.idx, FLXSA.control.mul_2)
mul.stk_2 <- mul.stk+mul.xsa_2
plot(mul.stk_2,main="Shrinkage 2")

#diagnostics and residuals
diagnostics(mul.xsa_2)
res2<-as.data.frame(index.res(mul.xsa_2))
res2[["sign"]] = ifelse(res05[["data"]] >= 0, "positive", "negative")
ggplot(data = res2)+geom_point(aes(x=year, y = age,size=abs(data),
colour=sign),shape=16)+    scale_colour_manual(values = c("positive" = "red",
"negative" = "darkblue"))+scale_size_continuous(breaks= seq(-2, 2, by =
0.2))+ggtitle("Log catchability residuals at age by year Sh2")

#retrospective analysis
mul.stk.retro_2 <- retro(mul.stk, mul.idx, FLXSA.control.mul_2, 3)
plot(mul.stk.retro_2)
```

6.1.3 Input data and Parameters

Discards data of 2009, 2010, 2011, 2012, 2013 and 2014 were available for the western side and have been included in the assessment. The proportion of the discards of red mullet in the GSA 18 ranged from about 2% (2013) to about 21% (2012). Discard data not available (in 2007 and 2008) have been estimated on the basis of the average discard ratio in 2009 and 2010.

Catch-at-age (thousands)								
Age class	2007	2008	2009	2010	2011	2012	2013	2014
0	36582	12362	18687	18791	8430	122774	37065	67008
1	29394	20889	21834	15068	10157	41505	27325	25183
2	13060	8158	5132	2451	3585	11515	6223	3435
3+	1825	708	1030	356	1265	1420	723	512

6.1.4 Tuning data

Catch-at-age (N/km^2) MEDITS								
Age class	2007	2008	2009	2010	2011	2012	2013	2014
0	271.32	38.74	97.65	135.91	422.27	5562.94	2474.24	6827.46
1	231.46	198.68	277.50	239.90	429.91	1034.52	1153.31	734.75
2	27.44	71.44	43.66	32.35	31.39	60.24	75.94	54.15
3	0.68	7.63	8.58	5.68	3.44	3.88	5.42	1.60

Additional settings for XSA are listed below:

- Catchability independent of size for ages > 0
- Catchability independent of age for ages > 2
- S.E. of the mean to which the estimates are shrunk = 2
- Minimum standard error for population estimates derived from each fleet = 0.3

6.1.5 Results

Fishing mortality (F) shows the minimum value of 0.23 ($\bar{F}$ or F_{bar}) in 2011, and a maximum of 0.74 in 2007. Average F for the period of last three years (2012-2014) was 0.48.
The $F_{0.1}$ value estimated on the basis of the XSA was 0.42 by FLBRP package (FLR library).
The summary of the best run, chosen for the advice is reported below in Fig. 6.1.5-1.

6.1.6 Robustness analysis

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

Sensitivity analysis with shrinkage values of 0.5, 1.0, 1.5 and 2.0 was performed. A shrinkage of 2.0 (Fig. 6.1.6-1) was taken as the best choice on the basis of both the residuals and the retrospective analysis.

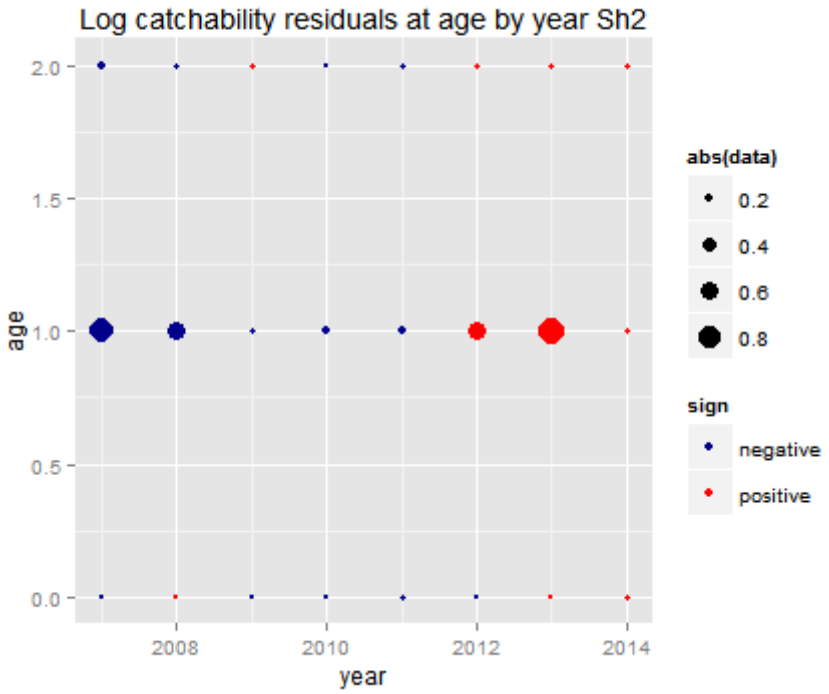


Fig. 6.1.6-1. Log catchability residuals at shrinkage 2.0

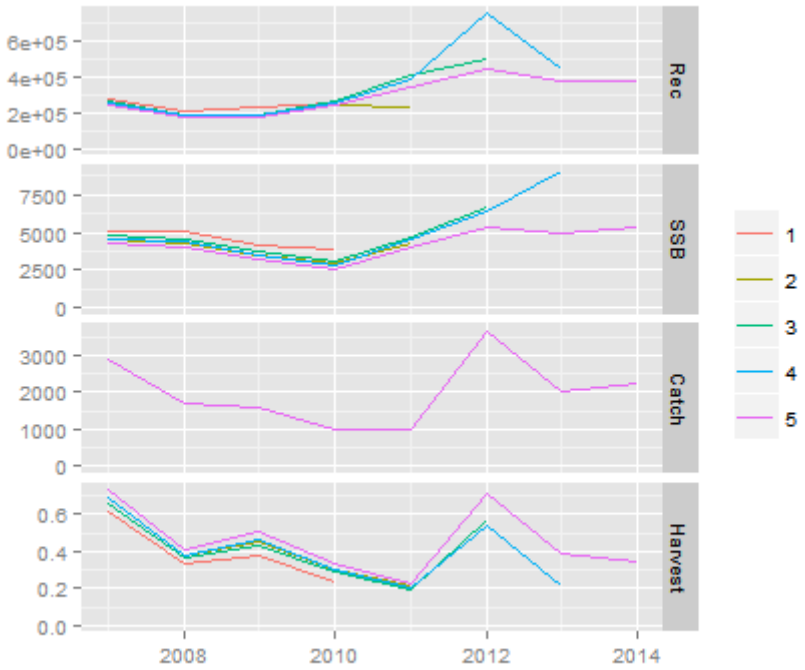


Fig. 6.1.6-2. Retrospective analysis results

The residuals do not shows any particular trend and the retrospective analysis seems to be consistent.

6.1.8 Assessment quality

Stability of the assessment, evaluation of quality of the data and reliability of model assumptions.

6.2 ALADYM

6.2.1 Model assumptions

A simulation was also carried out using ALADYM simulation model to evaluate the possible effects of the delay of the size at first capture for the examined stock. This delay can be represented by changes of technical parameters of the trawl gears as well as by the closure of area and /or fishing season. The model belongs to the family of pool-dynamic models, uses a monthly time scale and multi-fleet/gear approach.

This scenario was carried out under the assumption of stable but randomly varying recruitment in the medium terms. This was accomplished projecting forward the geometric mean of recruitment of the last three years. To take into account the uncertainty due to the process error a multiplicative log-normal error with mean 0 and standard deviation 0.3 was applied to the geometric mean of recruitment. Runs were accepted when observed and simulated catches showed lower residuals.

ALADYM model was parameterised using the same inputs as the assessment model: the total mortality by year, the natural mortality at length, the maturity parameters at length, the growth parameters and a selectivity function among the different options of ALADYM, to simulate the commercial catches (for European hake an ogive with deselection effects at larger size, to mimic the species avoidance to the gear and/or accessibility; for red mullet and deep water rose shrimp a usual ogive). For the present and past time the structure of the catches was used to verify the suitability of the selectivity functions of the model, thus taking into account the current selectivity. The change of selectivity was applied to the trawl fleet segments only and effects were estimated on SSB and catches, under the assumptions of 100% survival of individuals escaped from the codend. The change in selectivity in the forecasts was shaped using the size at first capture that would be determined by a 50 mm square mesh size, on the basis of literature.

6.2.2 Scripts

Version 10.1.3 has been used for the assessment. Inputs and parameters are specified in the following paragraphs.

6.2.3 Input data and Parameters

Input recruitment and change of the SSB and overall catches

The main fleet segments considered in the simulation were:

- ITA_DTS_0612
- ITA_DTS_1218
- ITA_DTS_1824_2440
- ITA_PGP_0006_0612
- ALB_DTS_1224
- MNE_DFN_0012
- MNE_DTS_0612
- MNE_DTS_1224

Among these only to DTS the management measure was applied.

For red mullet selectivity was modelled using an ogive; the set of selectivity parameters in the projection was:

- $L_{50\%}$=141 mm total length
- Selection range 4 mm

6.2.4 Results

Comparison between observed and values simulated by ALADYM model for all the fleet segments are provided on Fig. 6.3.4-1.

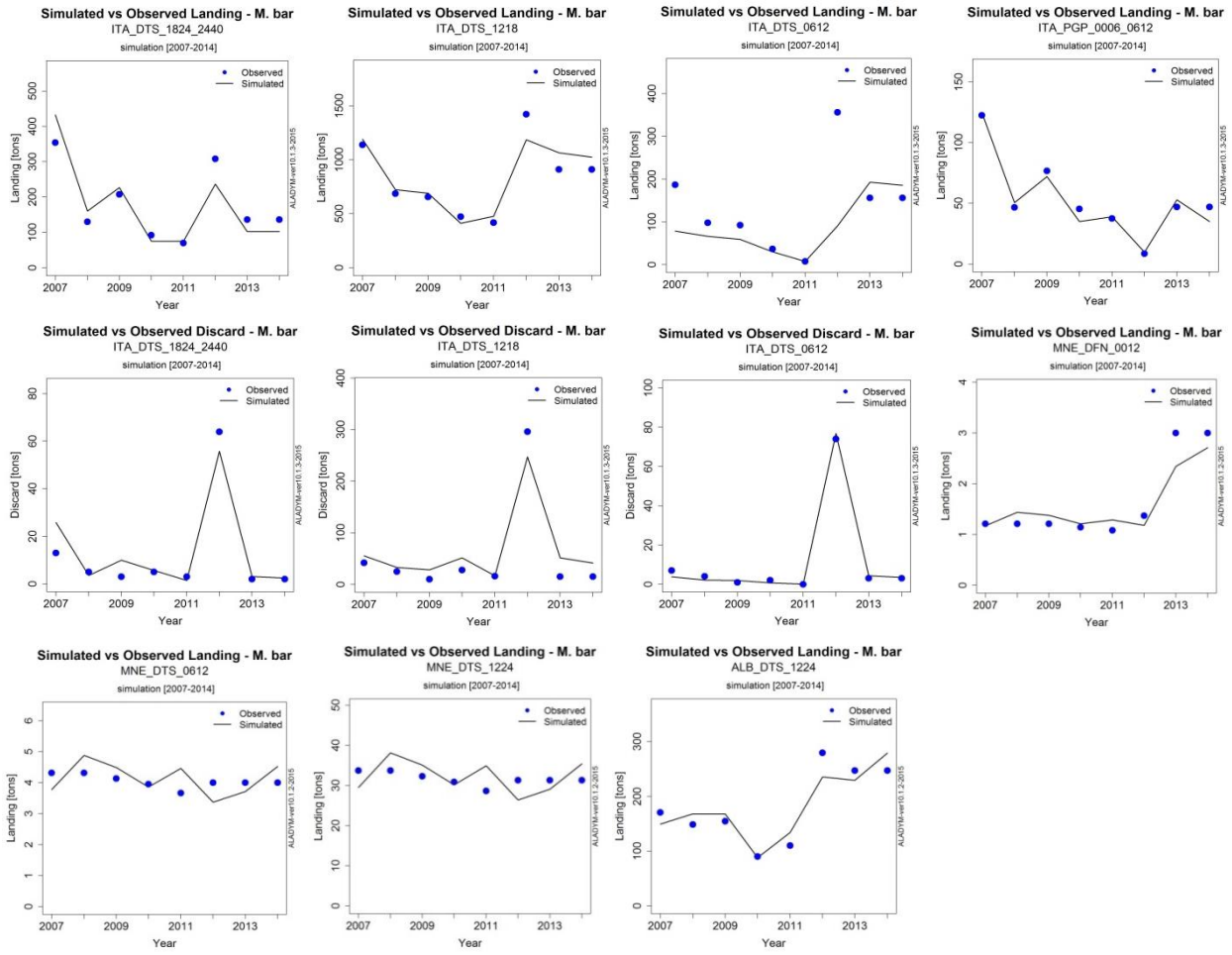


Fig. 6.3.4-1. Simulated vs. observed landing for various fleet segments used in the assessment.

7 Stock predictions

Recruitment was considered stable, but varying randomly. This effect was simulated by forward projections of the geometric mean of the recruitment values of the previous three years. Uncertainty due to the process error was represented by a multiplicative log-normal error with a mean value of 0 and a standard deviation of 0.3.

The scenario focused on applying the 50 mm square mesh size to all trawl fleet segments.

7.1 Short term predictions

7.2 Medium term predictions

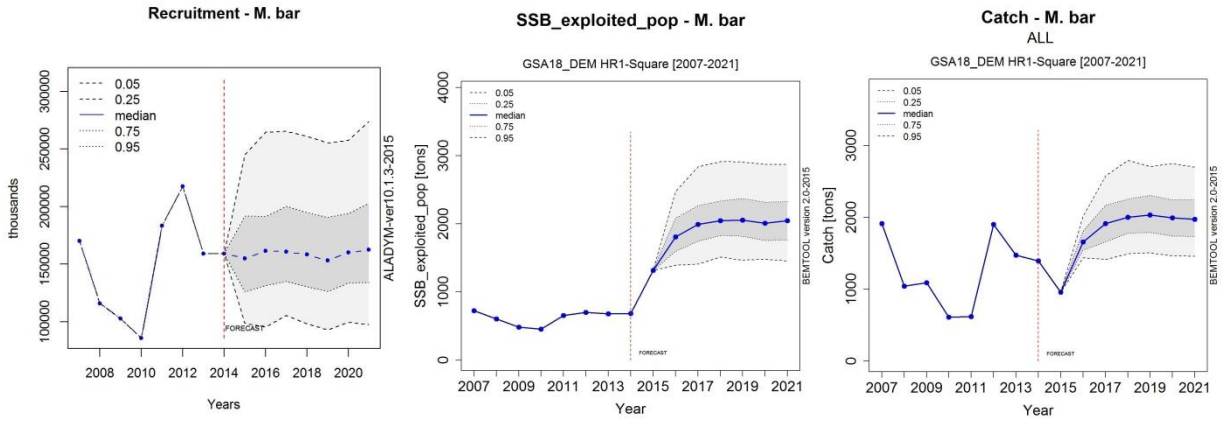


Fig. 7.2-1. Results of the ALADYM simulation

Results showed 200% increase of the spawning stock biomass in 2021, and regarding catches and an increase of the overall catches of 40%, after a slight decrease just after the application of the management measure.

7.3 Long term predictions

8 Draft scientific advice

(Examples in blue)

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	($F_{0.1}$, = 0.42)	F_{curr} = 0.48		N	IO_I
	Fishing effort				D	
	Catch					
Stock abundance	Biomass			Percentiles MEDITS biomass index (Kg/km^2): 33^{rd} : 10.5 66^{th} : 34.5 Current: 34.6		O_L
	SSB					
Recruitment					D	
Final Diagnosis		$\frac{F_{curr}}{F_{0.1}} = 1.13$				

The production of red mullet in GSA 18 is split in 1.4% caught by Italian fixed netters, 86.4% by Italian trawlers, about 2.6% by Montenegrin trawlers, about 0.3% by Montenegrin gillnets and trammel nets and about 9.3% by Albanian trawlers.

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)*