Stock Assessment Form

Demersal species

Reference year: 2012

Reporting year:2014

STOCK ASSESSMENT OF RED MULLET IN GSA19

Red mullet is one of the most commercially valuable species in the GSA19 and is an important component in the demersal assemblage targeted by the bottom trawling fleets operating near shore. Biomass and density index values derived by trawl surveys highly fluctuated throughout 1994-2012 but indicating a significant increasing trend. The analysis on Biomass index by survey throughout the time series indicated that B_{curr} is falling within the 66^{th} limit percentile showing an empirical relative intermediate condition in the stock biomass. However, the majority of the sampled specimens in both the experimental surveys as well in landing catches monitored by DCF in GSA19, belonged to the 0 and 1 age classes showing sizes < 15.0 cm TL, providing thus elements to consider the current assessment of a certain concern (Sion et al., 2012).

Data used for the assessment of red mullet in GSA19 were catch (landings and discards) at age data per gear in numbers by DCF from 2006 to 2012. As observed for the catches in the experimental surveys, the 0 and 1 age classes represent the bulk of the exploited population, whilst the age classes 2, 3 and 4 provided a progressive reduced contribution. The highest catches were generally provided by the bottom otter trawl (OTB) followed by the gillnet (GNS), whilst the trammel net (GTR) mostly provided negligible contributions. The assessment carried out using a VPA steady state approach (VIT-model) put in evidence a condition of high overexploitation for the stock in GSA19. The objectives of a more sustainable harvest strategy could be achieved with a multiannual plan based on a reduction of the fishing mortality through fishing activity limitations and possibly fishing capacity decreasing.

Stock Assessment Form version 1.0 (January 2014)

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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:**
19		
1st Country	**2nd Country**	**3rd Country**
Italy		
Stock assessment method: (direct, indirect, combined, none)		
Trawl survey, steady state VPA		
Authors:		
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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

2 Stock identification and biological information

The GSA19 (North-Western Ionian Sea) is located between Cape Otranto and Cape Passero. This area covers a surface of about 16,500 km^2 in the depth range from 10 to 800 m and has a coast line of about 1,000 km along the Apulia, Basilicata, Calabria and Sicily regions, where 8 maritime compartments are located. The North-Western Ionian Sea is geo-morphologically divided in 2 sectors by the Taranto Valley (NW-SE canyon exceeding 2200 m in depth). Along the Calabria and Sicily, the shelf is generally very limited with the shelf break located at a depth varying between 30 and 100 m. Different biocenosis are distributed along the very long Ionian arc from the coastal to the bathyal grounds. Along the Apulia coast the shelf is generally wider and the biocenosis of coralligenous is widespread from 40 to 80 m in depth.

In both sectors of the North-Western Ionian Sea, some shallower ground sites are characterized by the biocenosis of coarse-grained sands and fine gravels under bottom currents (SGCF) and superficial muddy sands in sheltered areas (SVMC). On the shelf edge, there are some areas with the biocenosis of the shelf-edge detritic often characterized by the dominance of the sea-lily *Leptometra phalangium*, while over the continental slope the biocenosis of the bathyal mud extends in the whole Ionian Sea.

As well as in the rest of the Mediterranean, the red mullet is distributed in the GSA19 on the shelf, resulting mainly concentrated down to100 m. No definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on morphometrics is currently available for the species. Those information could desirably be derived as the main outcomes of the EU StockMed project carried out in MAREA framework. Up to date, the hypothesis of a single stock of red mullet in GSA19 seems almost unlikely, mainly due to geo-morphological and hydrographic features in the North-Western Ionian Sea. However, under a management point of view, when the lack of any experimental evidence does not allow any alternative hypothesis, it is assumed that inside each of the GSAs boundaries inhabits a single, homogeneous stock that behaves as an unique well-mixed and self-perpetuating population. As matter of fact, the GSA boundaries are arbitrary and do not take under consideration neither the existence of local biological features nor differences in the spatial allocation of fishing pressure. Thus, the inability to take into account for spatial structure might lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions, and to a worse utilization of the potential productivity of the resources.

In the framework of the experimental trawl survey carried out in the GSA19 (MEDITS time series 1994-2010 and GRUND time series 2000-2006), *M. barbatus* was caught at depth ranging from 14 to 342 m (Maiorano et al., 2010). The timing of the MEDITS survey did not perfectly allow the sampling of recruits as juveniles of red mullet mostly appear in late summer. Thus, at the state, no persistent nursery areas were detected for the species in the GSA19. However, an area with high density of recruits was frequently detected for *M. barbatus* on the shelf off Punta Stilo (163525 recruits/km^2 were estimated during autumn 1997) (Carlucci et al., 2009). Moreover, additional areas were also detected within 200 m on bottoms off Otranto, Corigliano, Crotone and Cape Spartivento. The main spawning areas detected for *M. barbatus* in the GSA19 were observed on the shelf bottoms down to 100-150 m, offshore Policoro, Cape Trionto and Cirò as

well as in the very narrow coastal area from Punta Stilo to Cape Spartivento, offshore Catania and southern Siracusa. However the more persistent spawning areas were located from Punta Stilo to Caulonia and offshore Cape Bruzzano on the shelf grounds down to 165 m.

2.1 Stock unit

2.2 Growth and maturity

The minimum and maximum sizes for *M. barbatus* in GSA19 during the MEDITS and GRUND surveys were 4.5 and 30.0 cm TL, respectively. The vectorial sex ratio showed a higher fraction of males in the size range 9.0-12.0 cm TL and an increase of females from 12.0 cm TL. The species is considered fast growing reaching half of its maximum size at the age 1 and females showing higher sizes. Generally, the majority of the sampled specimens in both the experimental surveys as well in landing catches monitored by DCF in GSA19, belonged to the 0 and 1 age classes showing sizes < 15.0 cm TL, providing thus elements to consider the current assessment of a certain concern (Sion et al., 2012). The growth parameters as well as the estimated length-weight relationship were adopted for sex combined (L_∞ = 27.0 cm TL, k = 0.697 and t_0 = -0.39; a = 0.0084, b = 3.09), being derived from the otoliths readings (Voliani et al., 1998) and lengths measurements in specimens collected in the framework of the MEDITS and GRUND surveys (Tursi et al., 2010).

The red mullet is an iteroparous and a total spawner. Reproduction occurred from May to August and recruits were mostly found in the GSA19 during late summer-autumn. The smallest mature female and male were 9.5 and 9.0 cm TL, respectively. The estimated length at first maturity in females was 11.7 cm TL, and the bulk of mature females corresponds to the age class 1.

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

Somatic magnitude measured (LT, LC, etc)				**Units**	TL cm
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	May to August
Maximum size observed	30			**Recruitment season**	
Size at first maturity	11.7			**Spawning area**	
Recruitment size to the fishery			6	**Nursery area**	

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

Size/Age	Natural mortality	Proportion of matures
…	…	…

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

Size/Age	Natural mortality	Proportion of matures
0	*0.92*	*0.5*
1	*0.40*	*1*
2	*0.30*	*1*
3	*0.26*	*1*
4	*0.23*	*1*

The vector of natural mortality M was estimated using ProdBiom model (Abella et al., 1998).

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	**L_∞**	cm	27.0	20.6		
	K	y^{-1}	0.697	0.696		
	t_0	y	-0.39	-0.60		
	Data source	Voliani et al. (1998)				
Length weight relationship	**a**				0.0084	
	b				3.09	
	M (scalar)					
	sex ratio (% females/total)					

3 Fisheries information

3.1 Description of the fleet

Red mullet is one of the most commercially valuable species in the GSA19 and is an important component in the demersal assemblage targeted by the bottom trawling fleets operating near shore. The highest trawl fishing pressure occurs along the Calabrian coast while the presence of rocky bottoms on the shelf along the Apulian coast prevents the fishing by trawling in this sector. The maritime compartments where trawling is highly representative were Gallipoli, Taranto, Crotone e Reggio Calabria, however different dimensional classes were observed in fishing effort (LFT, GT) and engine power (kW) (Maiorano et al., 2010) (Tab. 3.1). National official statistics (IREPA, 2009) indicated as the highest percentage of vessel with higher LFT (≥ 10 GT) is mostly concentrated in the maritime compartments of Crotone (44%) and Reggio Calabria (21%), whilst a reduced percentage was recorded in Gallipoli (24%) and Taranto (11%), where vessels are generally smaller with LFT < 10 GT (Tursi et al., 2011). On the structural point of view, the trawling fleet along the Calabrian and Apulian coasts counted 225 vessels for a total amount of 4000 GT and 30000 kW. Generally, trawling occurred with daily trip (Gallipoli, Taranto, Crotone), with the exception of the fleet working around Roccella Ionica (Reggio Calabria), where fishing trip lasted 2-3 days (Tursi *et al.,* 2011). During spring and summer months a higher number of working days were recorded for trawling in GSA19, whilst during autumn and winter the bad sea-weather conditions could influence the displacement of the fishing effort on very coastal areas rather than on deep water grounds.

Tab. 3.1 - Number of vessels and mean GT by fishing activity in different maritime compartments in the GSA19.

	Trawling		**Long-line**		**Gill net**		**Purse seine**	
Maritime compartments	*N. vessels*	*mean GT*	*N. vessels*	*mean GT*	*N. vessels*	*mean GT*	*N. vessels*	*mean GT*
Gallipoli	75	11.61	16	8.22	313	3.58	-	-
Taranto	53	9.27	2	9.43	118	2.65	6	8.92
Crotone	95	18.55	16	9.31	262	2.71	-	-
Reggio Calabria	1	19.55	4	15.40	121	2.15	-	-

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	19	E - Trawl (12-24 metres)	Otter trawl	34 - Demersal shelf species	
Operational Unit 2	ITA	19	C - Minor gear with engine (6-12 metres)	07 - Gillnets and Trammel Nets	34 - Demersal shelf species	

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)
[Operational Unit1]						
[Operational Unit2]						
[Operational Unit3]						
[Operational Unit4]						
[Operational Unit5]						
Total						

3.2 Historical trends

During the 2004-2011 period the monthly fishing effort in GSA19 fluctuated between 17172 GT*days (September 2004) and 757801 GT*days (June 2006), with a mean value of 482470±217862 GT*days (Tab. 3.2.1). The mean annual values fluctuated between 63167±21505 GT*days (2004) and 582576±198435 GT*days (2006), without indicating any temporal trend. Similarly, the monthly engine power *number of working days fluctuated between 133961 kW*days (September 2004) and 2317683 kW*days (May 2006), with a mean value of 1481187±497910 kW*days (Tab. 3.2.2). The mean annual values fluctuated between 476270±163906 kW*days (2004) and 1892829±305992 kW*days (2005), without indicating any temporal trend. Lastly, during September a reduction of both this effort indicators was observed as consequence of the annual 45 days of fishing closure occurring in the GSA19.

Tab. 3.2.1 - Trawl fishing effort as gross tonnage*working days (GT*days) recorded in the GSA19 in the time period 2004-2011.

Fishing effort (GT*days)

GSA19	2004	2005	2006	2007	2008	2009	2010	2011
January	45616	451620	432269	506783	497995	485588	453175	557922
February	58660	441384	320192	430496	505330	481786	495726	542303
March	75711	557734	558850	389428	553589	582969	626851	635154
April	73525	559990	539354	448900	552510	626267	638159	547199
May	84230	709284	750215	593845	581577	624061	623724	682586
June	84649	684944	757801	576290	395736	671967	498881	723172
July	82859	664696	744874	676087	746894	745627	666130	678380
August	85688	713984	687139	656130	634938	653315	676659	735179
September	17172	321827	138423	257703	71797	94377	32284	470751
October	54177	568132	747398	640168	465235	519665	564280	118472
November	44065	529803	718915	557619	489940	607597	633290	579686
December	51646	315500	595486	543829	489515	508428	545396	459971
Annual mean	63167	543242	582576	523107	498755	550137	537880	560898
Standard dev.	21505	138991	198435	123183	161558	164750	175034	166728

Tab. 3.2.2 -Trawl fishing effort as engine power*working days (kW*days) recorded in the GSA19 in the time period 2004-2011.

Fishing effort (kW*days)

GSA19	2004	2005	2006	2007	2008	2009	2010	2011
January	325484	1743710	1592078	1869174	1600128	1390762	1442068	1569399
February	441554	1756854	1681642	1744965	1619009	1472529	1469620	1383964
March	553998	2200535	2091578	1835598	1490445	1824903	1747775	1653357
April	556031	2098433	1921292	1777005	1699747	1657035	1686457	1445578
May	645799	2302659	2317683	1991433	1557674	1843186	1732021	1698183
June	642611	2210272	2209170	1896055	1052210	1736020	1711445	1727007
July	625907	2070729	2221678	2010352	1937517	1899379	1782085	1532023
August	654885	1346294	1160483	1228483	1018410	1065114	1064892	934880
September	133961	1560526	1473395	1402280	1075353	1160005	959509	834834
October	413324	2027875	1840984	1908833	1709162	1462056	1442444	935541
November	342347	1853954	1942359	1646087	1623750	1654061	1594570	1411624
December	379337	1542106	1660763	1413737	1523887	1394787	1393623	1307655
Annual mean	476270	1892829	1842759	1727000	1492274	1546653	1502209	1369504
Standard dev.	163906	305992	344468	253221	290863	268115	266887	310054

In the contest of the Data Collection Framework (DCF), the landings and discards of the red mullet from the otter bottom trawl (OTB) and on lesser extent gillnet (GNS) and trammel net (GTR) recorded in the GSA19 from 2006 to 2012 were analysed showing abundance fluctuations from a minimum of 446 t (2008) to a maximum of 872 t (2006) (Fig. 3.2.1 and Tab. 3.2.3). However, the observed decreasing trend not resulted statistical significant. Generally the discard was almost negligible as reported for 2011 (Tab. 3.2.4).

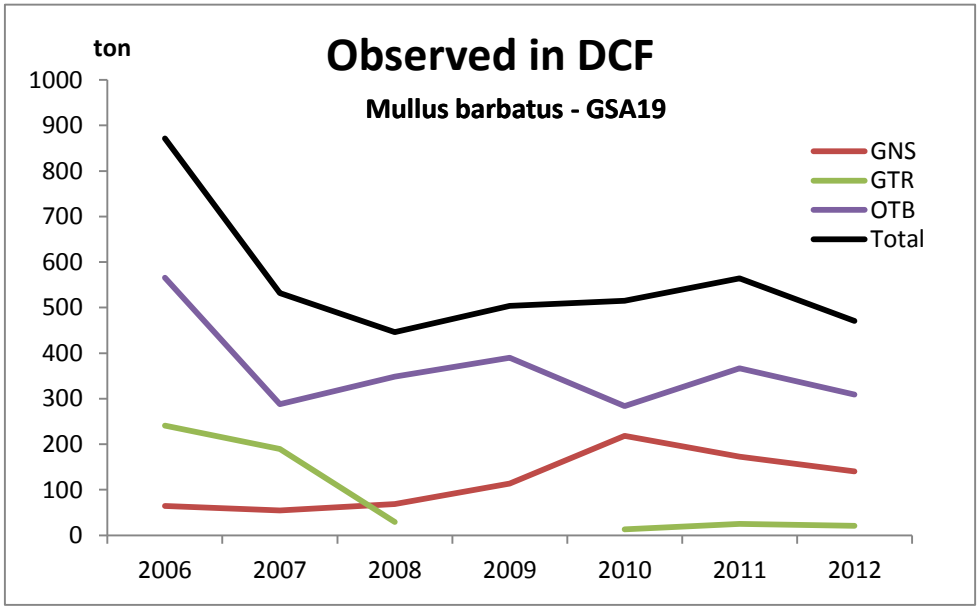

Fig. 3.2.1 - Changes in the production of *M. barbatus* by fishing segments and total landing in the GSA19 as observed by DCF in the time period 2006-2012.

Tab. 3.2.3 - Production of *M. barbatus* by fishing segments and total landing in the GSA19 as observed by DCF in the time period 2006-2012.

	GNS	GTR	OTB	Total
2006	64.69	240.93	566.00	871.62
2007	54.63	189.52	287.76	531.91
2008	68.53	29.26	348.32	446.12
2009	113.83		389.81	503.64
2010	218.17	13.13	283.53	514.84
2011	172.77	25.01	366.58	564.36
2012	140.33	20.77	309.32	470.42

Tab. 3.2.4 - Discard rate of *M. barbatus* by fishing segments as observed in the GSA19 by DCF during 2011.

Discard rate 2011

OTB	GNS	GTR
0.0039	0.0389	0.0144

3.3 Management regulations

- ✓ Minimum landing sizes: 11 cm TL (EC regulation 1967/2006)
- ✓ Fishing closure for trawling: 45 days in late summer early autumn (not every year the same).
- ✓ Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have been replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes. It was not observed a noticeable increase in the size of entering to the fishery with the new introduced changes because the exploitation pattern is only partially conditioned by the gear selectivity but mainly due to a reduced availability of juveniles considering their spatial distribution.
- ✓ Towed gears are not allowed within 3 nm from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.
- ✓ Minimum mesh size for gill net (16 mm stretched).
- ✓ Maximum length of nets x vessel x day (5,000 m).

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					
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 Medits survey

4.1.1 Brief description of the direct method used

In GSA 19 the following number of hauls was reported per depth stratum.

STRATUM	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
10-50	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9
50-100	8	8	8	8	8	8	8	8	8	8	8	9	8	8	8	8	8
100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
200-500	15	15	15	15	15	15	14	14	14	15	14	14	14	14	14	14	14
500-800	32	32	32	32	32	32	29	29	29	28	29	29	29	29	29	29	29
10-800	74	74	74	74	74	74	70	70	70	70	70	70	70	70	70	70	70

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). The density and biomass indices of *M. barbatus* in GSA19 were estimated on the depth strata 10-200 m and standardized to km^2.

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	Medits	**Trawler/RV**	Pasquale e Cristina
Sampling season	Late spring-early summer		
Sampling design	Random stratified		
Sampler (gear used)	Otter trawl (GOC 73)		
Cod –end mesh size as opening in mm	20		
Investigated depth range (m)	10-800		

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

Stratum	Total surface (km2)	Trawlable surface (km2)	Swept area (km2)	Number of hauls
1 (10 - 50 m)	**2124**	1148		**9**
2 (50 – 100 m)	**1701**	1065		**8**
3 (100 – 200 m)	**2663**	2529		**10**
4 (200 – 500 m)	**4356**	3959		**14**
5 (500 – 800 m)	**5503**	5104		**29**
Total	**16347**	13805		**70**

Map of hauls positions (Medits trawl survey)

Table 4.1-3: Trawl survey abundance and biomass results

Stratum (10-200m)	Years	kg per km^2	CV	Relative * biomass All age groups	CV or other	N per km^2	CV	Relative * abundance All age groups	CV or other
Total	1994	19.99	0.33			589.4	0.40		
Total	1995	45.04	0.66			1750.1	0.66		
Total	1996	19.82	0.40			709.1	0.47		
Total	1997	9.11	0.33			268.5	0.32		
Total	1998	17.54	0.28			654.3	0.33		
Total	1999	6.14	0.36			152.3	0.34		
Total	2000	14.79	0.54			368.8	0.59		
Total	2001	29.13	0.30			762.6	0.31		
Total	2002	35.86	0.36			1089.6	0.41		
Total	2003	20.58	0.34			657.0	0.47		
Total	2004	36.51	0.26			1533.3	0.30		
Total	2005	34.25	0.38			1079.5	0.41		
Total	2006	34.80	0.37			1147.7	0.46		
Total	2007	81.21	0.27			12272.3	0.31		
Total	2008	190.5	0.87			6744.3	0.89		
Total	2009	24.70	0.36			850.5	0.42		
Total	2010	56.10	0.44			2506.0	0.49		
Total	2011	35.45	0.35			1207.3	0.37		
Total	2012	33.87	0.24			1308.1	0.26		

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

Slicing method

Report the maturity scale and age slicing method used

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

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

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

Comments

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

Direct methods: trawl based Recruitment analysis

Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey		**Trawler/RV**	**Pasquale e Cristina**
Survey season		Late spring-early summer	
Cod –end mesh size as opening in mm		20	
Investigated depth range (m)		10-800	
Recruitment season and peak (months)		Late summer –autumn (September)	
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-6: Trawl surveys; recruitment analysis results

Years	**Area in km²**	**N of recruit per km²**	**CV or other**

Comments

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

Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey		**Trawler/RV**	**Pasquale e Cristina**
Survey season			Late spring-early summer
Investigated depth range (m)			10-800
Spawning season and peak (months)			May to August

Table 4.1-8: Trawl surveys; spawners analysis results

Surveys	**Area in km²**	**N (N of individuals) of spawners per km²**	**CV or other**	**SSB per km²**	**CV or other**

Comments

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

4.1.2 Spatial distribution of the resources

Some analysis and output for both recruits and spawners were available in the contest of the EU StockMed project carried out in MAREA framework. No persistent nursery areas were detected for the species in the GSA19. However, an area with high density of recruits was frequently detected for *M. barbatus* on the shelf off Punta Stilo (163525 recruits/km^2 were estimated during autumn 1997) (Carlucci et al., 2009). Moreover, additional areas were also detected within 200 m on bottoms off Otranto, Corigliano, Crotone and Cape Spartivento. The main spawning areas detected for *M. barbatus* in the GSA19 were observed on the shelf bottoms down to 100-150 m, offshore Policoro, Cape Trionto and Cirò as well as in the very narrow coastal area from Punta Stilo to Cape Spartivento, offshore Catania and southern Siracusa. However the more persistent spawning areas were located from Punta Stilo to Caulonia and offshore Cape Bruzzano on the shelf grounds down to 165 m (Fig. 4.1.2.1).

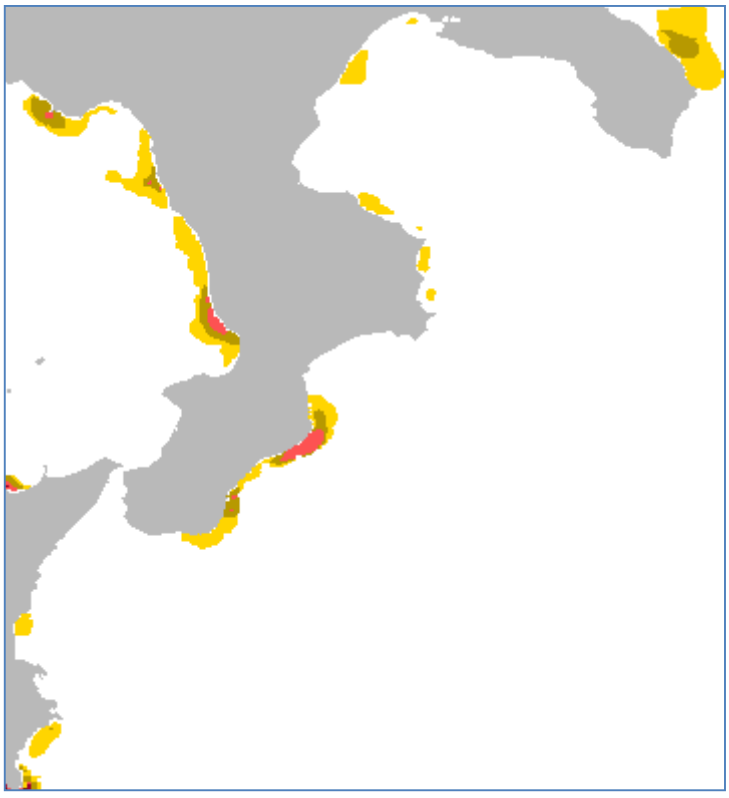

Fig. 4.1.2.1 - Distribution map of the more persistent area for spawners of *M. barbatus* in GSA19 from trawl survey data Medits 1994-2012.

4.1.3 Historical trends

Biomass index values fluctuated between 6.14 kg/km^2 (1999) and 190.45 kg/km^2 (2008), whilst density index values between 152 N/km^2 (1999) and 12272 N/km^2 (2007) (Fig. 4.1.3.1). In both indices a significant increasing trend was observed. The analysis on Biomass index by survey throughout the time series was approached and $B_{33th} < B_{curr} < B_{66th}$ resulting in an intermediate condition.

The recruitment index was generally negligible due to the mismatch between the recruitment and survey period (Fig. 4.1.3.1). Some exception were observed when surveys were carried out a little bit later than usual. The length structure showed as the sampled population was mainly constituted by specimens with size < 15 cm TL (Fig. 4.1.3.2). In particular, during 2007 the presence of specimens with size of 6 and 8 cm TL was observed, due to the sampling shifted towards July and August, when the initial recruitment of the species could be matched on the coastal grounds of the GSA19. No significant reduction in the sizes was observed for the species in the area.

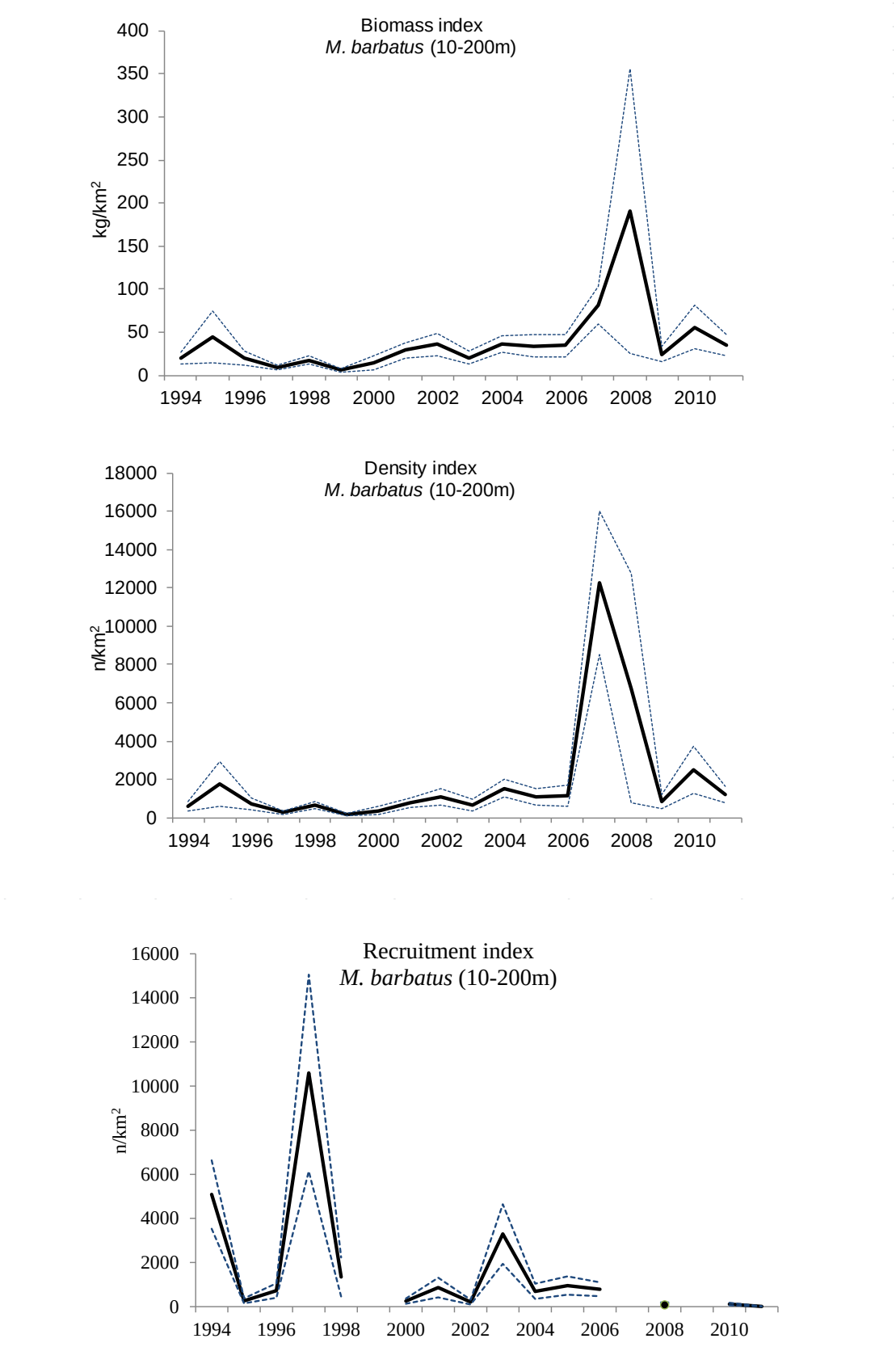

Fig. 4.1.3.1 - Trends of the biomass, density and recruitment indices estimated (Depth strata 10-200 m; grey lines: ± standard deviation).

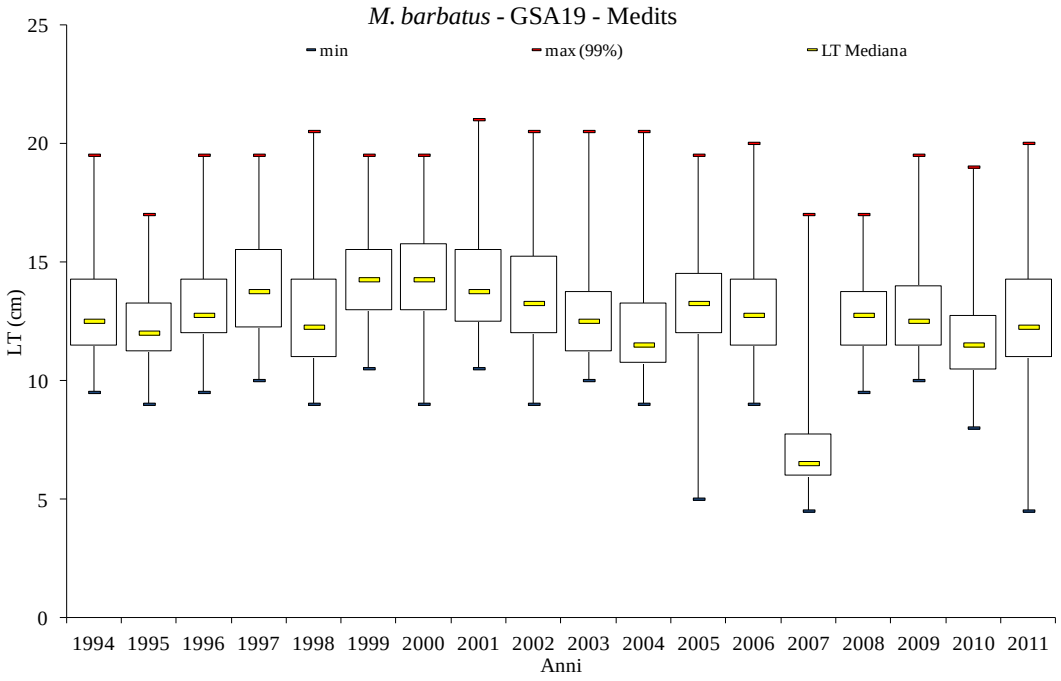

Fig. 4.1.3.2 - Changes in size indicators for *Mullus barbatus* sampled in the GSA19.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

5.2 Environmental indexes

6 Stock Assessment

6.1 Steady state VPA (VIT model)

6.1.1 Model assumptions

The program VIT was designed to analyze exploited marine populations based on catch data, structured by ages or sizes, from one or several gears. The main assumption is that of steady state because the program works with pseudo-cohorts, therefore it is not suitable for historic series. From the catch data with some auxiliary parameters and using Virtual Population Analysis (VPA) the program rebuilds the population and mortality vectors.

6.1.2 Scripts

6.1.3 Input data and Parameters

Data used for the analyses of red mullet in GSA19 were catch (landings and discards) at age data per gear in numbers by DCF from 2006 to 2012. The contribution of each age class to the production by gear in the landings was reported (Fig. 6.1.3.1). As observed for the catches in the experimental surveys, the 0 and 1 age classes represent the bulk of the exploited population, whilst the age classes 2, 3 and 4 provided a progressive reduced contribution. The highest catches were generally provided by the bottom otter trawl (OTB) followed by the gillnet (GNS), whilst the trammel net (GTR), with the exception of 2006 and 2007, mostly provided negligible contributions. The set gill net (GNS) provided quite stable catches throughout the investigated period with the highest production in 2010. The vector of natural mortality M was estimated using ProdBiom model (Abello et al., 1998) assuming values equal to M in age 0=0.92, M in age 1=0. 40, M in age 2=0.30, M in age 3=0.26, M in age 4=0.23. The F terminal (0.23) was set equal to M at age 4. Due to the length at maturity equal to 11.7 cm TL and the adopted growth parameters for sex combined (L_∞ = 27.0 cm TL, k = 0.697 and t_0 = -0.39), the proportion of mature was set as equal to 0.5 in age 0 and 1 in the other age classes. As an example the catches in numbers at ages by gear was provided for current year, but of course available for the time series 2006-2012 (Tab. 6.1.3.1).

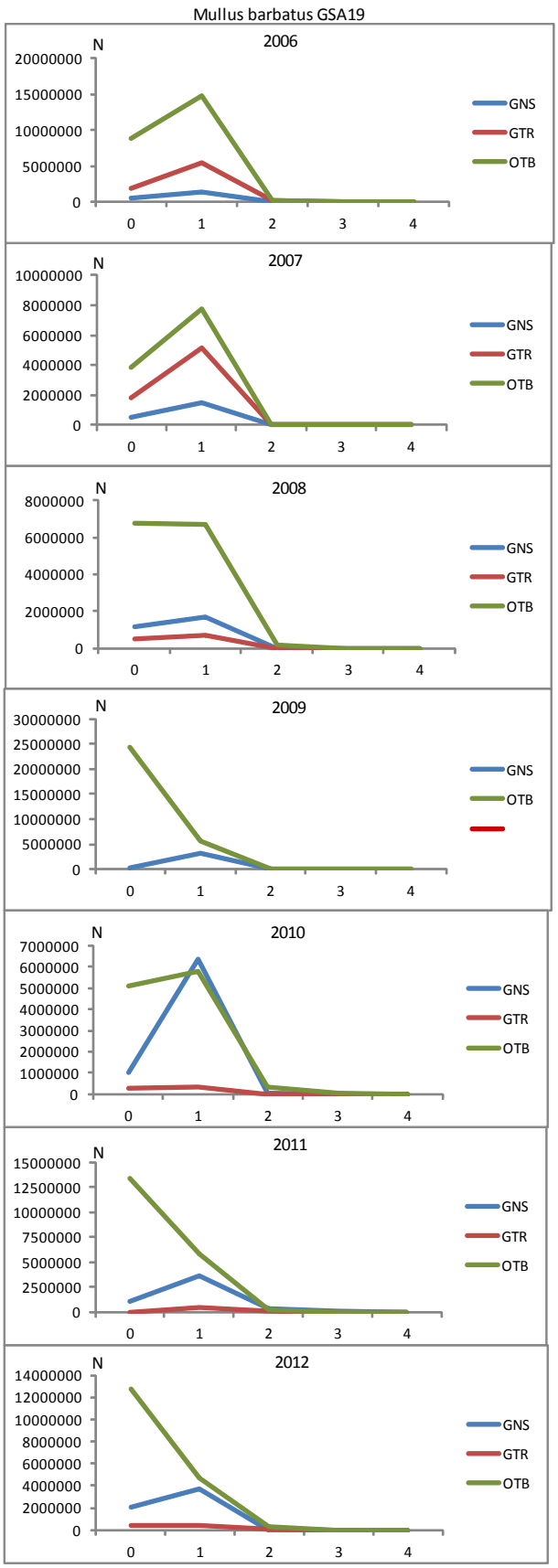

Fig. 6.1.3.1 - Production in number of *Mullus barbatus* by age classes and gears as reported in the DCF data series 2006-2012 for the GSA19.

The following set of parameters was used to perform the VPA:

Growth parameters (von Bertalanffy)
L∞ = 27.0 (cm, TL)
k = 0.697
t0 = -0.39
L*W
a = 0.0084
b = 3.09
Fterminal = 0.23
Natural mortality
M vector Age0=0.92, Age1=0. 40, Age2=0.30, Age3=0.26, Age4=0.23
Length at maturity (L50)
L50 = 11.7 cm TL
Proportion of matures
Age0=0.50, Age1=1.00, Age2=1.00, Age3=1.00, Age4=1.00

The vector of natural mortality M was estimated using ProdBiom model (Abella et al., 1998).

Tab. 6.1.3.1 - Catches in numbers at age by gears for *M. barbatus* as reported in DCF 2012.

2012	0	1	2	3	4
GNS	2020574	3694894	15966	0	0
GTR	402099	406184	39096	2082	0
OTB	12775133	4701123	309234	15289	3810

6.1.4 Results

The VIT outputs for the time series 2006-2012 are available, however the results regarding 2012 were more deeply commented in this report. The VIT analysis confirm as the mean age in the catches is about 1. The critical age and length were 1 and 17 cm TL from 2008 to 2012. Differently, due to a different fishing pattern in 2006 and 2007, the critical age was 2 corresponding to a critical length of 22 cm TL. The catches in weight is mainly on the first two years age classes and mostly on OTB (OTB catches is about 151 and 241 t for the age class 0 and 1 respectively), even if contribution was also provided by GNS on age class 1 (about 62 t) (Fig. 6.1.4.1). Considering 2012, the recruitment was estimated about $14*10^6$ sharply decreasing at the end of the first year of life to $1.7*10^6$. In fact, the mortalities on the age classes 1 (F = 2.48) and 2 (F = 1.93) was higher than in age class 0 (F = 0.73). The mean total F was 1.17 being mostly due to the OTB (F = 1.05).

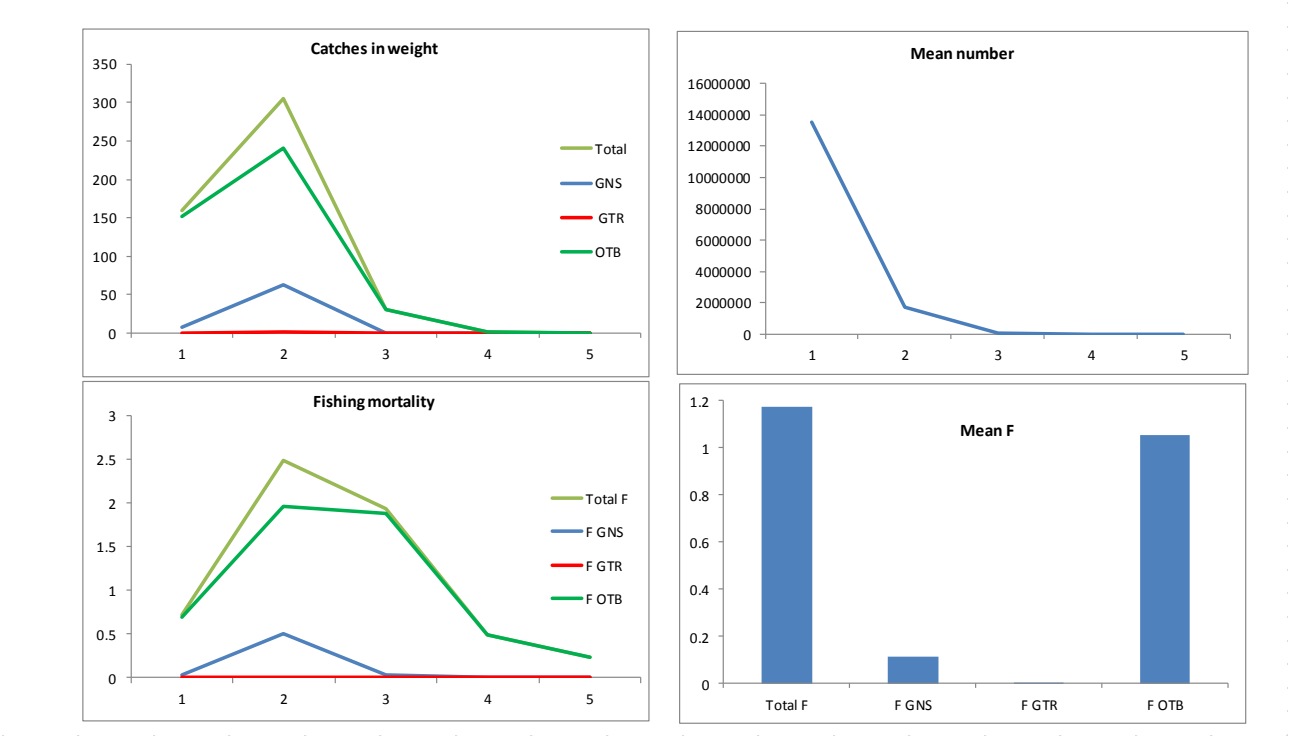

Fig. 6.1.4.1 - VPA outputs: catch in biomass, mean number, fishing mortality at age and mean F of *M. barbatus* in the GSA 19 during 2012.

The recruitment yearly estimated by VIT seems to be quite stable at least from 2008 to 2012 (Fig. 6.1.4.2). The SSB yearly estimated by VIT seems to be quite stable during at least from 2008 to 2012. In particular, SSB was about 256 t during 2012.

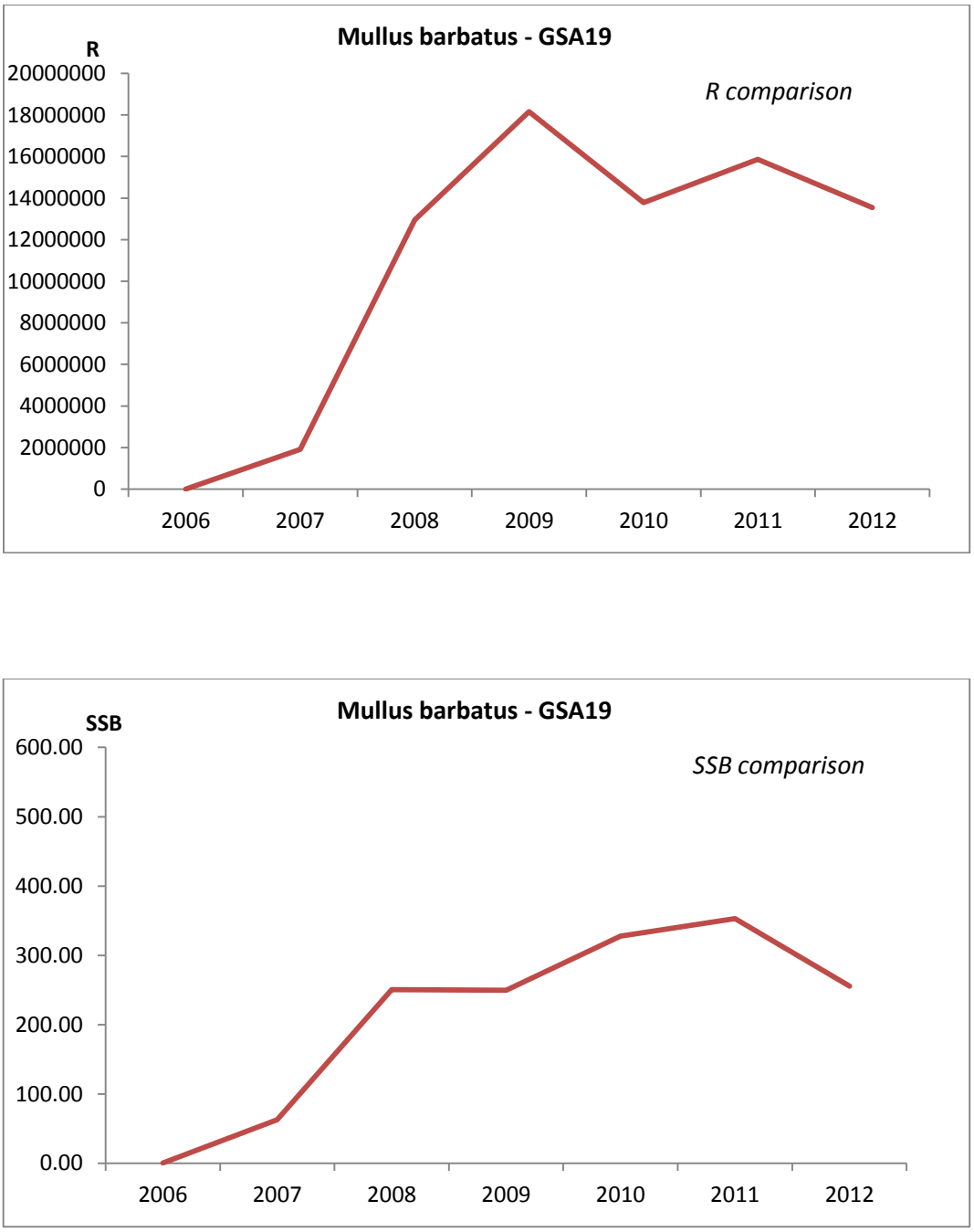

Fig. 6.1.4.2 - Changes in recruitment and SSB as estimated by VIT from 2006 to 2012.

6.1.5 Robustness analysis

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

When the time series of landings is short and tools as VIT are used the application of the model year by year, as performed in this assessment, is preferable. The methods were applied testing different sets of growth parameters and consequent natural mortality values, as estimated by the Prodbiom model.

Consistency between the life history parameters adopted as inputs in the VIT and Y/R models was checked comparing the reconstructing total catches and the landings recorded in the framework of the DCF program from 2006 to 2012 (Fig. 6.1.6.1). The stability in fishing pattern was also tested in order to test the equilibrium condition (Fig. 6.1.6.2).

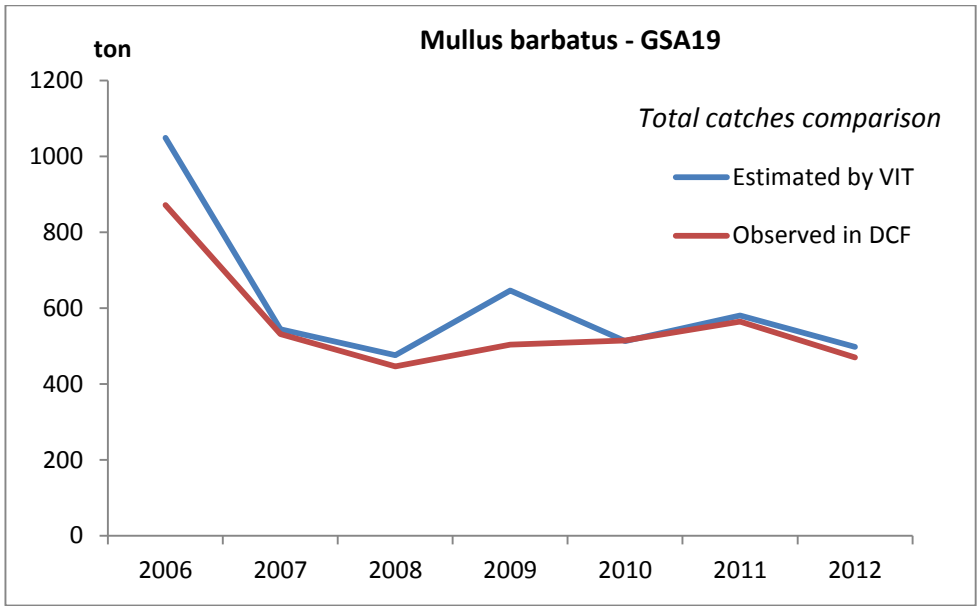

Fig. 6.1.6.1 - Comparison between the total catches of *M. barbatus* as estimated by VIT model and observed in the landings recorded in the GSA19 during the DCF program from 2006 to 2012.

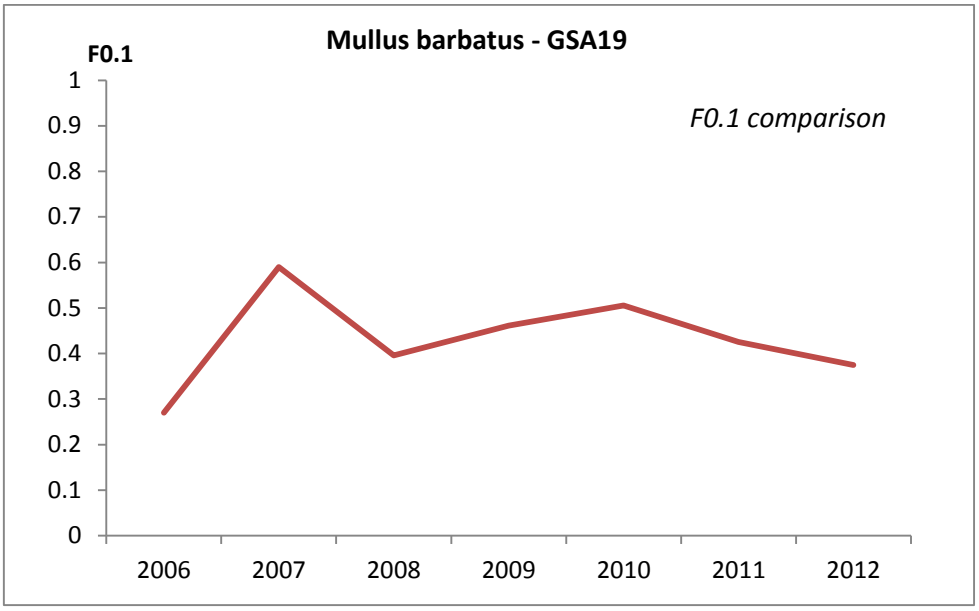

Fig. 6.1.6.2 - Comparison between the $F_{0.1}$ of *M. barbatus* as estimated by VIT model in the GSA19 from 2006 to 2012.

6.1.7 Assessment quality

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

7 Stock predictions

7.1 Short term predictions

7.2 Medium term predictions

7.3 Long term predictions

Yield per recruit analysis was done using the steady state VIT model. The Y/R analysis in 2012 for the complex of the different gears indicated a current level of fishing mortality equal to 1.17 corresponding to a yield of about 18 g/recruit (Fig. 7.3.1). The limit reference point $F_{0.1}$ was estimated to be 0.38 (about 20 g/recruit) (Tab. 7.3.1). According to the $F_{curr}/F_{0.1}$ ratio equal to 3.13 the stock of red mullet in GSA19 is considered to be in high overexploitation indicating that the fishing effort should be reduced in the basin.

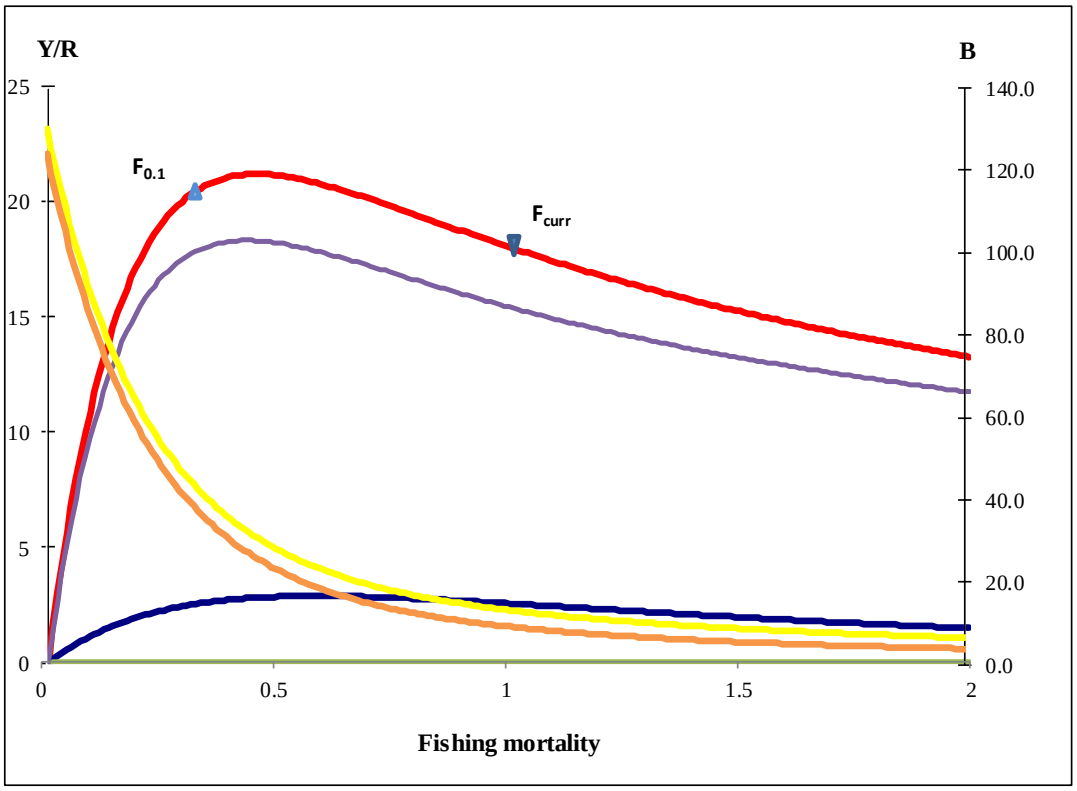

Fig. 7.3.1 - Yield per recruit Y/R, B/R and SSB estimated by different gears for *Mullus barbatus* in the GSA19 during 2012.

Tab. 7.3.1 - Yield and biomass per recruit for *M. barbatus* in GSA19 during 2012.

Yield based RP	**Value (g)**	**F based RP**	**Value**
Y/R_{max}	20.775	F_{max}	0.69
$Y/R_{current}$	17.973	$F_{current}$	1.17
$Y/R_{0.1}$	20.470	$F_{0.1}$	0.38

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	$F_{0.1}$ =0.38	$F_{current}$ = 1.17	$F_{curr}/F_{0.1}$ ratio equal to 3.13	N	O_H
	Fishing effort					
	Catch					
Stock abundance	Biomass		B_{curr} = 33.87	$B33_{th}$ percentile = 20.58; $B66_{th}$ percentile = 35.45		O_I
	SSB					
Recruitment						
Final Diagnosis		High level of overfishing with an intermediate level of stock biomass				

Considering the results of the VIT analyses, the red mullet in GSA 19 is subjected to high overfishing (O_H), being the $F_{curr}/F_{0.1}$ as estimated by means of model ($F_{current}$ = 1.17; $F_{0.1}$ = 0.38) is above to 1.66 ($F_{curr}/F_{0.1}$ = 3.13). In addition, the analysis on biomass index by survey throughout the time series indicated that B_{curr} is falling within the 33th and 66th percentile showing an empirical relative intermediate condition in the stock biomass (O_I).

The objectives of a more sustainable harvest strategy could be achieved with a multiannual plan based on a reduction of the fishing mortality through fishing activity limitations and possibly fishing capacity decreasing, mostly focused on trawling.

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)*