Stock Assessment Form
Demersal species

Reference year: 2016

Reporting year: 2017

Following the request of GFCM WGSAD 2016, a first attempt of a joint assessment for red mullet in GSAs 17 and 18 is here presented. For the assessment different sources of data (fishery dependent and fishery independent) have been used. The model implemented allows time-varying length selectivity for survey data, in order to take into account the change in availability and vulnerability of the stock along the years due to the change in the actual survey time. Given the results from this analysis, based on the whole information from the area, the stock is sustainably exploited (F0.1=0.55; Fcurrent=0.2) and it is recommended to maintain the fishing mortality in line (equal or less) with the agreed reference point. The abundance indices are in agreement with the stock assessment results, indicating an increase both in recruitment and in SSB and the subsequent increase in recent catch. The total F estimated by SS3 in GSA 18 in 2016 is split in 19 % exerted by Italian trawlers GSA 18, 1% by Italian netters, 1% by Montenegrin fleet, 2% by Albanian trawler, 55% by Italian trawlers in GSA 17 and 22% by Croatian trawlers.

Stock Assessment Form version 1.0 (January 2014)

Uploader:

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	GSA 17	
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**
Croatia		
Stock assessment method: (direct, indirect, combined, none)		
Combined (Trawl survey, SS3)		
Authors:		
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Affiliation:		
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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

2.1 Stock unit

During the last GFCM Working Group on Demersal Species (WGSAD) in 2016, the experts were required to explore the possibility of a joint stock assessment on the basis of STOCKMED (MAREA framework) results.

After the analysis of the survey indices showing a very similar increasing trend in both areas in the recent years and considering that the Western side of both GSAs was characterized by a decrease in effort from 2004 to 2016, the experts working in the data collection in GSA 17 and GSA 18, under Adriamed umbrella, carried out a first attempt, here presented, assuming that the stock was in the boundaries of Adriatic Sea (GSA 17 and GSA 18).

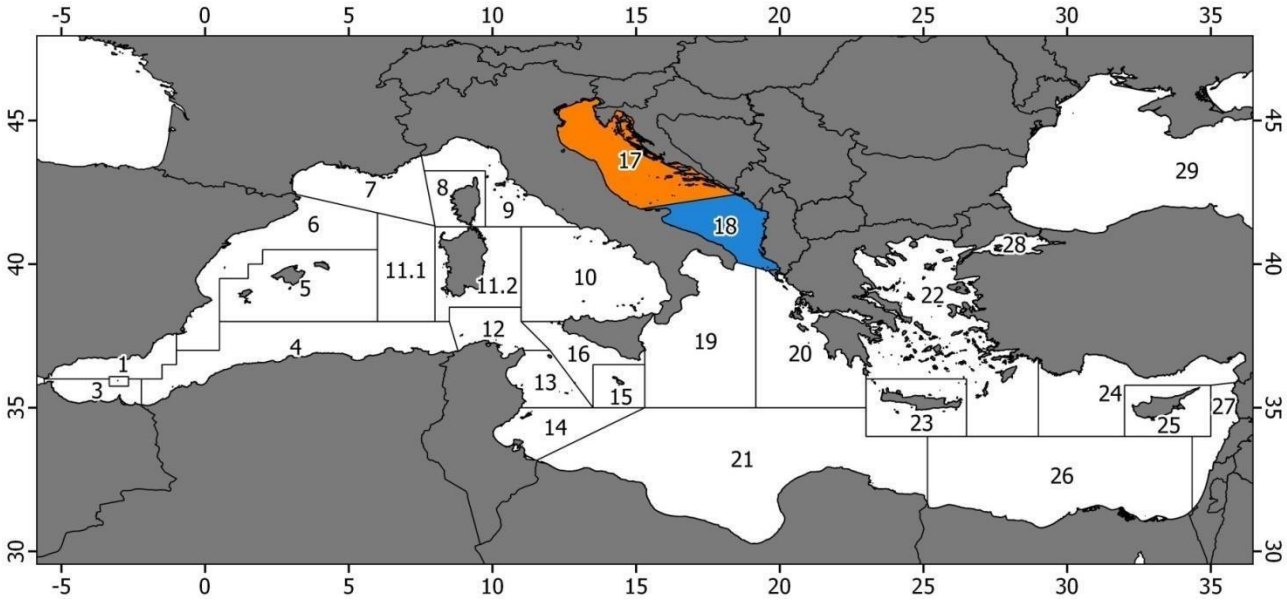


Figure 2.1-2-1 Study area in the GFCM Geographical Sub-Areas map.

2.2 Growth and maturity

The von Bertalanffy growth parameters have been estimated in GSA 18 for sex combined, using the mean lengths from Age- Length key from commercial sampling (discard and landing) and survey from 2011 to 2016. A constraint has been included in the VBF fitting to take into account the exceptional finding of 4 cmsized metamorphosed individuals during MEDITS trawl survey.

This set of growth parameters was used for the assessment.

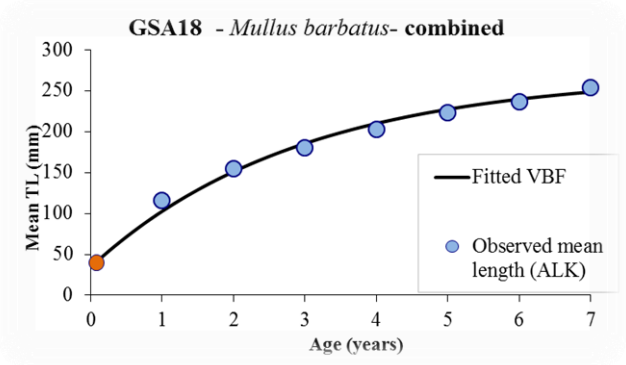


Figure 2.2-1 Von Bertalanffy curve fitted for M. barbatus in GSA 18 used for the joint assessment GSA 17 and 18.

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**	late spring-early summer with a peak in June-July
Maximum size observed			28	**Recruitment season**	Late summer with a peak in August
Size at first maturity	11			**Spawning area**	along the Albanian coasts at the latitude of Durrës; north of Vlora and along the coasts of Otranto; along Croatian coast in GSA 17.
Recruitment size to the fishery			9.5	**Nursery area**	offshore Gargano promontory; in front of Bari; along Italian coast in GSA 17.

The natural mortality vector has been estimated as average between the vector used in GSA 18 (according to Chen and Watanabe method) and the vector used in GDS 17 to be consistent with the benchmark assessments of GFCM WGSAD 2016. The vector of proportion of mature individuals by age has been derived associating the proportion of matures of the length derived by von Bertalanffy calculated in the middle of age class. However, the assessment was carried out using the maturity at length estimated in GSA 18 from DCF data in 2016 (Figure 2.2 2).

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

Size/Age	Natural mortality	Proportion of matures
0	*1.32*	*0*
1	*0.73*	*1*
2	*0.55*	*1*
3	*0.47*	*1*
4	*0.42*	1
5	*0.42*	1
6	*0.42*	1

Table 2.2-3 M vector and proportion of matures by size or age (Females)

Size/Age	Natural mortality	Proportion of matures
Size/Age	Natural mortality	Proportion of matures
0	*1.32*	*0*
1	*0.73*	*1*
2	*0.55*	*1*
3	*0.47*	*1*
4	*0.42*	1
5	*0.42*	1
6	*0.42*	1

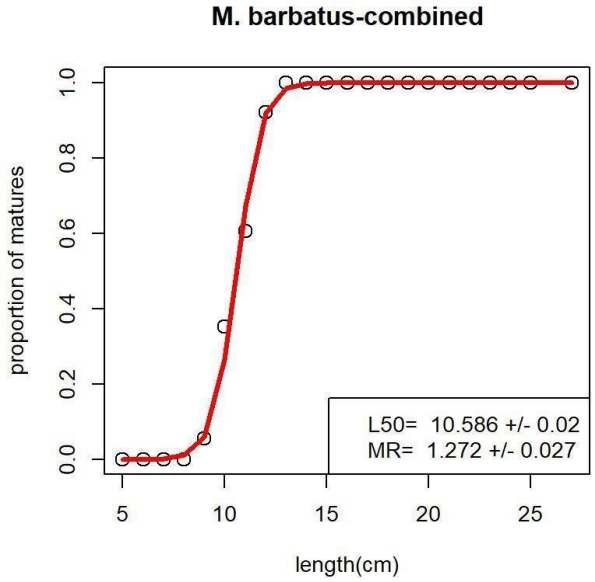


Figure 2.2-2 Maturity at length (sex combined) from DCF 2016.

Table 2.2-3 Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	**L_∞**	cm			30	2002-2016
	K	year^{-1}			0.24	2002-2016
	t_0	year			−0.61	2002-2016
	Data source	DCF GSA 18 (update to 2017)				
Length weight relationship	**a**				0.0088	
	b				3.085	

	M (scalar)					
	sex ratio (% females/total)	0.5				

3 Fisheries information

3.1 Description of the fleet

Red mullet in the area is mainly fished by bottom trawl nets. Smaller quantities are also caught with trammel-nets and gill nets.

The fleet data are referred to the whole GSA and are from the Fisheries and Maritime Affairs' Fleet Register

(2017) for Italian fleet, Ministry of Agriculture of Albania for Albanian Fleet and Fisheries Information System, Ministry of Agriculture and Rural Development (FIS-MARD) Montenegro (Table 3.1.1). Catch data in the table 3.1.2 below reported are referred to the year 2016 (DCF data for Italy, and data from ADRIAMED pilot study and National Statistics for Albania and Montenegro). The Italian fleet segments include also demersal slope fishing (mixed demersal according to DCF classification).

Table 3.1-1 Composition of the fleet exploiting the stock according GFCM Fleet Segmentation http://www.fao.org/gfcm/activities/fisheries/fleet/segmentation/en/

Area	Country	Trawlers < 6 m (T-09)	Trawlers 6 - 12 m (T-10)	Trawlers 12 - 24 m (T-11)	Trawlers > 24 m (T-12)	Small scale vessel with engine using passive gears < 6 m (P-05)	all scale vessel with engine ing passive gears 6 - 12 m (P-06)	Total
GSA 17	Italy[1]	-	135	512	100	-	-	747
	Croatia[2]	-	156	254	21	-	-	431
GSA 18	Italy[1]	-	37	360	31	84	150	662
	Albania[3]	-	2	122	33	-	-	157
	Montenegro[4]	-	4	14	5	62	36	121

[1] Fisheries and Maritime Affairs' Fleet Register, 2017

[2] Fisheries Directorate of Republic of Croatia

[3] Ministry of Agriculture of Albania [4]

Fisheries Information System, Ministry of Agriculture and Rural Development (FIS-MARD)

Montenegro *Table 3.1-3 Catch, bycatch, discards and effort by operational unit in the reference year (2016)*

Operational Units*	Fleet (n° of boats)**	Catch (T or kg of the species assessed)	her species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
ITA 18 T10-T11-T12	428	1398 T		87.4 T		
ITA P05-P06	234	50 T		NA		
ALB T10-T11-T12	157	171 T *		NA		
MNE	23	37 T				
ITA 17 T10-T11- T12	747	2947 T		499 T		
HRV T10-T11-T12	431	1110 T		158 T		
Total	1997	5713 T		744.4 T		

*The Albanian landing is related to 2015.

**For Italian fleet: Fisheries and Maritime Affairs' Fleet Register, 2017; for Albanian fleet Ministry of Agriculture of Albania; for

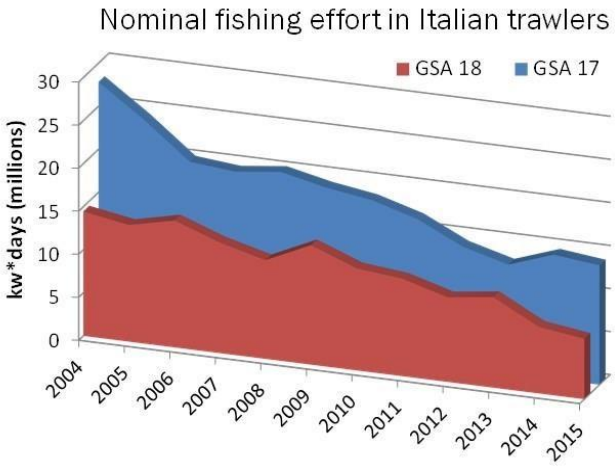


Figure 3.1-2 Effort data (nominal effort) for western side of Adriatic Sea by GSA (DCF data reported in STECF, 2016).

3.2 *Historical trends*

Available time series for red mullet landings in GSA 18 consists of only 14 years (2003-2016), but is not complete for all countries in question.

An attempt to retrieve landing from FishStat database (FAO, 2013) for the years before 2003 has been made, but the species is considered pulled with other mullets in a unique category (Mullets spp). Thus, it was decided to use only DCF data.

Table 3.2-1. Landing data for GSAs 17 and 18 by year and country

Year	Italy 18 OTB	Italy 18 GEN	Montenegro OTB	Montenegro Nets	Albania	Croatia OTB	Italy 17 OTB
2003	1750	312	NA	NA	NA	NA	NA
2004	1981	82	NA	NA	NA	NA	NA
2005	1350	99	NA	NA	NA	NA	NA
2006	1803	130	NA	NA	NA	NA	3101
2007	1680	123	NA	NA	NA	NA	3298
2008	914	47	38	3.7	149	767	3158
2009	955	77	36	3.6	154	818	2433
2010	601	45	35	3.4	90	763	1796
2011	494	38	32	3.2	110	1086	1823
2012	2089	8	35	3.5	280	1248	1464
2013	1203	47	32	3.1	247	1086	1946
2014	1250	23	41	4	147	1158	2324
2015	1572	15	36	3.6	171	1127	2143
2016	1398	50	37	3.7	171[1]	951	2037

[1] The same landing of 2015 was assumed in 2016.

Table 3.2-2. Discard data for GSAs 17 and 18 by year and country (DCF update to 2017). In bold the discard data reconstructed on the basis of the first three years available.

Year	Italy 18 OTB	Italy 18 GEN	Montenegro OTB	Montenegro Nets	Albania	Croatia OTB	Italy 17 OTB
2003	**57**	0	NA	0	NA	NA	NA
2004	**64**	0	NA	0	NA	NA	NA
2005	**44**	0	NA	0	NA	NA	NA
2006	58	0	NA	0	NA	NA	**786**
2007	**54**	0	NA	0	NA	NA	**836**
2008	**30**	0	NA	0	NA	**207**	**800**
2009	14	0	NA	0	NA	**220**	**617**
2010	34	0	NA	0	NA	**206**	183
2011	13	0	NA	0	NA	**293**	803
2012	434	0	NA	0	NA	**336**	325
2013	18	0	NA	0	NA	162	291
2014	120	0	NA	0	NA	453	446
2015	89	0	NA	0	NA	300	910
2016	87	0	NA	0	NA	158	499

Due to the lack of data, the 2003-2007 catch for Albania and Montenegro was assumed to be identical to the catch of 2008; catches in Albania for period from 2008 to 2013 were obtained from within the SEDAF project (MAREA Specific Project No. 10). Due to the lack of data, the total production of fleet segments P– 05 and P– 06 for period 2008–2012 and 2014–2016 was estimated based on the data from 2013. Nevertheless, in the assessment, the whole Montenegrin fleet was considered (not separated).

The landing data for Montenegro are estimated based on collecting data from a small number of vessels, and then raised to the total fleet in order to obtain the yearly estimate. Current national data collection in Montenegro is based on different methods (used by different agencies, namely, Statistical office of Montenegro – MONSTAT and the Ministry of agriculture and rural development, Department for agriculture statistics) which are not fully compliant with the requirements of the EU DCF, and are considered incomplete and not suitable for realistic analyses.

Due to the lack of data in 2003-2007 for Croatia the landing of 2008 was assumed; similarly for Italy GSA 17.

The lacking years in the discard time series were reconstructed on the basis of the ratio discard/landing in weight observed in the first three available years (in bold in table 3.2-2).

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.

Since the accession of Croatia to the EU the 1st of July 2013, the same regulations as in the Italy are implemented. Furthermore the following regulations are applied:

Bottom trawl fisheries is closed one and half NM from the coast and island in inner sea, 2 NM around island on the open sea, and 3 NM about several island in the central Adriatic. For vessel smaller than 15 meters, according derogation in sea deeper than 50 meters bottom trawl fisheries is forbidden till 1NM of the coast. Bottom trawl fishery is closed also in the majority of channel area and bays. About 1/3 of the territorial waters is closed for bottom trawl fisheries over whole year and additionally 10% is closed from 100-300 days per years. Minimum mesh size on the bottom trawl net was 20 mm ("knot to knot") in the open sea, and 24 mm ("knot to knot") in the inner sea. Recently, mesh site regulation is according EC 1967/2006 (ie. 40 mm square or 50 mm diamond).

In 2015 the no-take zone was established in Jabuka Pit. The establishment of Marine managed area (MMA) was based on long-time assessment of biological resources and analysis carried out by working group through FAO AdriaMed project that showed a decline in biomass of these commercial species. The proposed MMA covers the waters closed to trawling through a bilateral agreement between Republic of Italy and Republic of Croatia. The Pit was re-opened to trawling in 2016. Recently, following the growing support for a MMA in the Jabuka/Pomo Pit, Croatia and Italy agreed to reintroduce a fishing closure from the 1st of September 2017 to 31st of August 2020.

Other interventional fisheries regulation measures were introduced in Croatia such as temporal ban of trawl fisheries in open part of central Adriatic and in channel area of northern Adriatic. The aim of those measures were protection of commercially important species (e.g. European hake and Norway lobster) in critical period (spawning or recruitment period).

3.4 Reference points

Table 3.4-1: List of reference points and empirical reference values previously agreed (if any) No reference value was previously agreed.

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 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 GSA 18**	**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. Fishtrawl scientific survey web platform.

Table 4.1-3: Trawl survey abundance and biomass results (MEDITS 2016)

Depth Stratum	Years	kg per km²	CV (%)	N per km²	CV (%)
10 – 50 m	2016	151.5	28.2	24947	31.5
50 – 100 m	2016	18.9	46.5	794	52.3
100 – 200 m	2016	20.6	27.5	587	34.7
200 – 500 m	2016	1.54	54.8	31.6	58.5
500 – 800 m	2016	0	0	0	0
Total (10 – 800 m)	2016	29.2	19.6	3327	28.2

Table 4.1-4: Trawl survey basic information

Survey	**MEDITS GSA 17 Western side**	**Trawler/RV**	AND
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	10 – 500 m		
range (m)			

Table 4.1-5: 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	22000			69
50 – 100 m	18550			54
100 – 200 m	14950			45
200 – 500 m	3900			12
500 – 800 m	0			0
Total (10 – 800 m)	59400			180

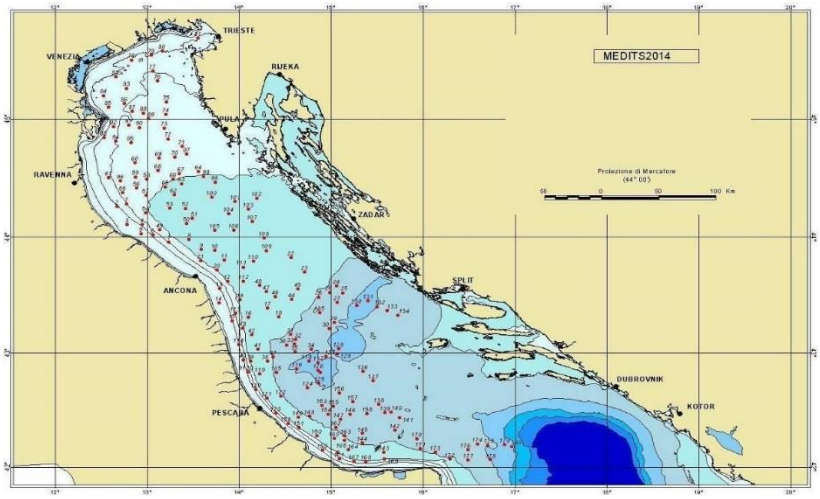


Fig. 4.1-2. Map of MEDITS haul positions in the GSA 17 Western side.

Table 4.1-6: Trawl survey abundance and biomass results

(MEDITS 2016)

Depth Stratum	Years	kg per km²	CV (%)	N per km²	CV (%)
10 – 50 m	2016	1363.6	19.7	15597.5	20.5
50 – 100 m	2016	204.3	18.1	2234.8	18.2
100 – 200 m	2016	14.8	26.5	653.7	32.7
200 – 500 m	2016	0.2	60.6	2.6	52.4
Total (10 – 500 m)	2016	78.56	14.64	6639.44	17.91

Table 4.1-7: Trawl survey basic information

Survey	**MEDITS GSA 17 Eastern side**	**Trawler/RV**	BIO
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 – 500 m		

Table 4.1-8: 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	7308			6
50 – 100 m	14785			21
100 – 200 m	7225			24
200 – 500 m	2409			5
500 – 800 m				
Total (10 – 500 m)	31727			56

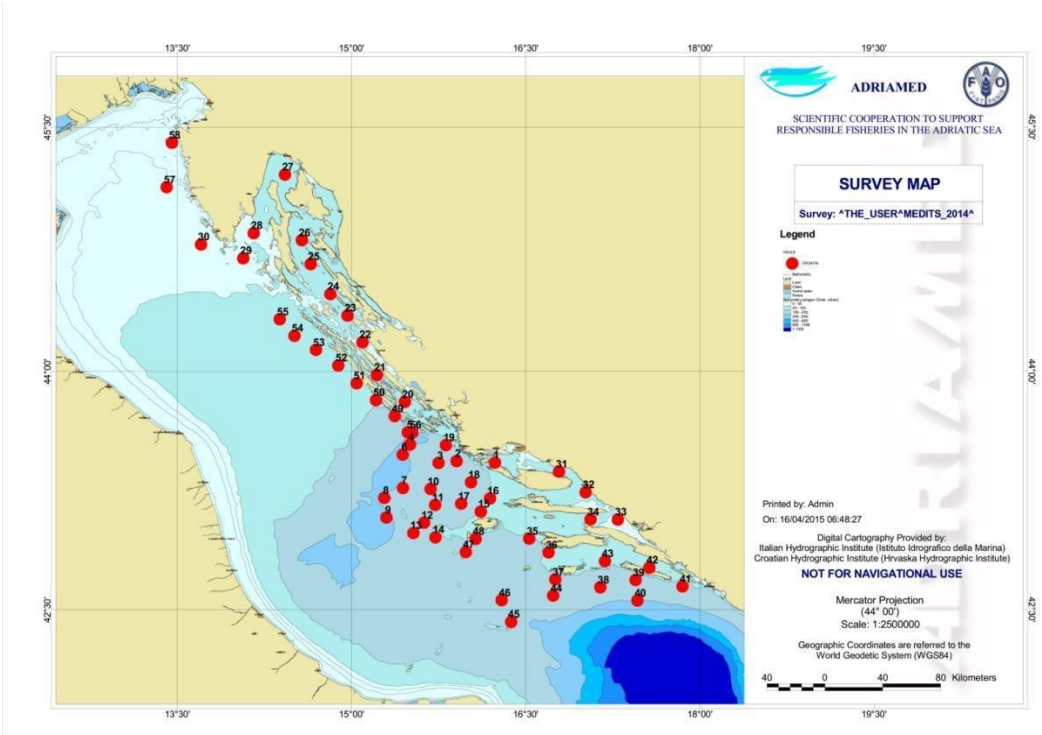


Fig. 4.1-3. Map of MEDITS haul positions in the GSA 17 Eastern side.

Table 4.1-9: Trawl survey abundance and biomass results (MEDITS 2016)

Depth Stratum	Years	kg per km^2	CV (%)	N per km^2	CV (%)
10 – 50 m	2016	93.02	35.02	2829	30.52
50 – 100 m	2016	120.51	19.59	3971	21.46
100 – 200 m	2016	89.15	14.59	3155	17.58
200 – 500 m	2016	4.25	71.19	101	68.86
500 – 800 m					
Total (10 – 500 m)	2016	98.21	13.89	3228	14.30

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 2017, version 9).

Table 4.1 9 Trawl survey results by length class. MEDITS GSA 18.

N/km^2 (sex combined) by Length class	Year													
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	3	0	0	1	0
4	0	0	25	0	0	0	0	0	21	588	132	178	22	192
5	1	0	57	0	0	0	0	0	62	2133	503	1990	98	1039
6	1	0	63	0	1	0	0	0	52	720	276	932	214	913
7	0	1	79	0	7	0	0	0	21	97	233	596	232	705
8	0	1	62	0	22	0	0	0	5	23	141	401	110	675
9	0	1	18	0	43	0	5	5	1	4	91	284	39	331
10	0	2	24	1	47	5	27	32	8	32	95	126	27	162
11	1	10	25	7	51	14	29	47	93	121	153	68	121	189
12	18	10	25	14	50	23	29	44	118	154	250	129	166	174
13	12	15	24	20	44	19	43	31	65	156	218	138	171	169
14	12	15	25	11	33	20	44	32	53	148	153	106	133	141
15	10	8	21	16	20	23	35	27	38	128	102	69	102	96
16	5	8	17	11	12	25	24	20	21	90	66	50	80	73
17	9	5	18	12	9	31	20	19	17	47	40	26	37	38
18	6	4	11	9	8	22	14	14	9	24	28	16	19	19
19	5	3	4	4	7	13	9	5	6	11	14	10	8	10
20	5	3	5	5	6	14	5	2	4	6	8	9	4	4

21	2	1	2	2	2	5	5	3	2	3	4	3	2	2
22	0	0	2	2	0	4	4	3	2	2	2	0	1	1
23	0	2	1	1	1	5	2	1	1	1	1	1	0	1
24	1	0	1	1	0	0	1	0	0	0	0	0	0	0
25	0	0	0	0	0	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	89	89	510	116	362	225	295	286	598	4491	2512	5133	1589	4934

Table 4.1 10 Trawl survey results by length class. MEDITS GSA 17 Western side.

N/km^2 (sex combined) by Length class	Year													
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	5	3	4	4	15	0	0	0	15	0	0	0	10	4
5	76	2	12	7	45	0	0	0	133	2	1	29	26	143
6	9	10	11	1	18	0	0	0	61	0	0	58	133	569
7	0	11	0	3	3	0	0	0	63	0	0	114	305	825
8	0	5	1	14	0	0	0	0	55	4	23	259	160	1054
9	0	6	1	39	0	1	0	1	7	67	154	404	79	926
10	1	47	15	140	7	8	5	15	44	215	320	589	208	872
11	11	77	65	152	34	49	35	62	139	352	532	798	270	798

12	39	58	66	152	49	74	70	89	117	255	455	804	298	679
13	46	41	44	156	46	76	60	76	110	141	285	464	236	440
14	38	24	33	44	24	56	49	45	60	78	171	267	101	203
15	25	16	18	21	15	34	30	32	36	44	87	153	63	63
16	20	9	11	10	14	26	23	17	19	21	64	68	36	33
17	14	5	10	5	6	15	15	8	9	11	27	39	19	21
18	7	2	5	3	4	9	6	7	6	6	12	21	8	6
19	4	1	3	2	1	2	4	2	3	2	8	9	3	2
20	2	1	1	2	1	2	2	2	2	1	1	2	1	1
21	1	1	0	1	1	1	0	0	0	0	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	298	320	300	758	285	353	300	356	879	1200	2141	4079	1957	6639

Table 4.1 11 Trawl survey results by length class. MEDITS GSA 17 Eastern side.

N/km^2 (sex combined) by Length class	Year													
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	1	0	1	0	5	1	0	0	0	2	27	0	1
6	0	8	0	0	0	3	1	0	0	0	0	34	4	0
7	0	10	1	0	0	1	1	0	0	1	0	0	0	0
8	0	7	0	0	0	1	0	0	0	0	106	0	71	2
9	1	7	2	2	0	1	1	0	2	9	408	44	202	21
10	9	22	16	51	3	15	5	5	23	112	472	369	231	193
11	44	102	43	95	22	41	33	26	117	436	423	880	516	410
12	120	232	135	116	70	132	136	136	186	682	683	851	801	483
13	178	255	255	247	169	326	229	350	226	751	670	1025	798	502
14	214	211	222	262	196	415	286	407	238	495	493	781	585	450
15	166	160	148	203	132	387	230	316	177	357	354	526	416	427
16	97	111	118	166	104	301	175	220	97	204	241	381	284	253
17	61	59	81	131	85	198	126	156	73	132	153	226	216	181
18	39	38	46	66	41	83	94	97	53	60	113	148	108	147
19	19	26	30	50	29	55	69	52	48	25	73	95	81	77
20	9	15	21	21	12	19	18	30	16	13	17	53	32	30
21	7	17	23	13	12	14	13	14	4	4	14	25	24	23

22	1	6	9	2	3	4	2	4	3	2	4	15	14	13
23	2	5	4	2	1	2	1	1	1	3	0	1	10	9
24	1	2	2	0	0	0	0	1	0	0	1	5	2	1
25	0	2	2	1	1	0	0	0	0	0	0	0	2	2
26	0	0	0	0	0	0	0	0	0	0	0	5	2	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	968	1296	1159	1429	880	2002	1420	1816	1263	3288	4226	5491	4398	3228

Sex ratio by Length or Age class	**Year**		
	2003-2016	**….**	**…..**
Total	0.5		

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

Direct methods: trawl based Recruitment analysis

Table 4.1-12: Trawl surveys; recruitment analysis summary

Survey	**MEDITS GSA 18**	**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 4.1-13: Trawl surveys; recruitment analysis results (<=9 cm)

Years	Area in km^2	N of recruit per km^2	CV
1996	29008	67	102.1
1997	29008	1	67.2
1998	29008	0	0.0
1999	29008	249	34.8
2000	29008	0	0.0
2001	29008	0	81.9
2002	29008	1	66.1
2003	29008	1	86.1
2004	29008	3	102.8
2005	29008	248	81.9
2006	29008	0	0.0
2007	29008	14	27.3
2008	29008	0	100.0
2009	29008	1	62.0
2010	29008	1	73.7
2011	29008	159	99.1
2012	29008	2667	74.8
2013	29008	992	74.6
2014	29008	2585	60.8
2015	29008	463	65.9
2016	29008	860	34.2

The recruitment index from MEDITS survey shows a sharp increase in the recent years. This signal is magnified by a shift in the survey timing in the late summer, when this species recruits to the fishing grounds.

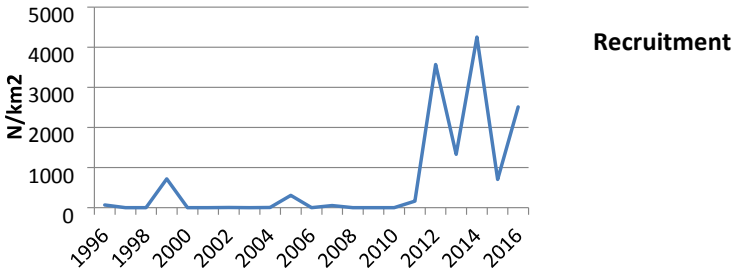


Fig. 4.1-4. MEDITS GSA 18 recruitment index (<=9 cm)

Table 4.1-14: Trawl surveys; recruitment analysis summary

Survey	**MEDITS GSA 17 Western side**	**Trawler/RV**	**AND**
Survey season		summer	
Cod –end mesh size as opening in mm		20	
Investigated depth range (m)		10-500	
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-15: Trawl surveys; recruitment analysis results (<=9 cm)

Years	Area in km^2	N of recruit per km^2	CV
2002	59400	141.43	57.23
2003	59400	98.30	97.93
2004	59400	33.41	80.78
2005	59400	27.99	79.98
2006	59400	31.13	60.03
2007	59400	81.31	94.83
2008	59400	0.35	69.24
2009	59400	0.17	98.29
2010	59400	0.17	98.77
2011	59400	332.33	103.83
2012	59400	9.99	31.97
2013	59400	33.78	32.57
2014	59400	500.22	38.86
2015	59400	660.47	92.80
2016	59400	2671.30	27.07

The recruitment index from MEDITS survey shows a sharp increase in the last three years especially in 2016 when the end of the survey shift in late summer , when this species recruits to the fishing grounds.

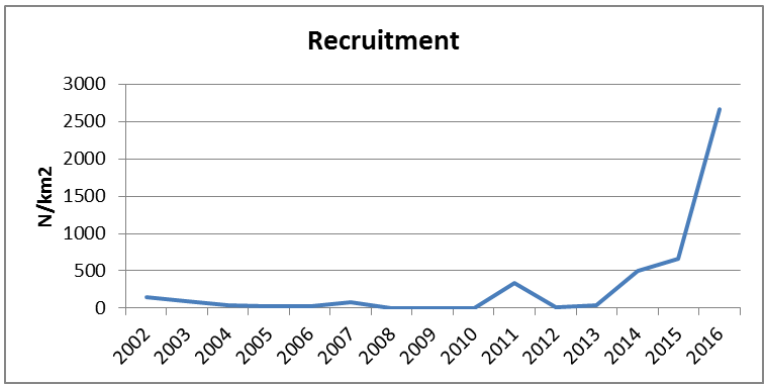


Fig. 4.1-4. MEDITS GSA 17 Western side recruitment index (<=9 cm)

Survey	**MEDITS GSA 17 Eastern side**	**Trawler/RV**	**BIO**
Survey season		summer	
Cod –end mesh size as opening in mm		20	
Investigated depth range (m)		10-500	
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-17: Trawl surveys; recruitment analysis results (<=9 cm)

Years	Area in km^2	N of recruit per km^2	CV
1996	31727	1	99.35
1997	31727	12	90.88
1998	31727	0	0
1999			
2000	31727	1	97.1
2001	31727	0	0
2002	31727	0	98.24
2003	31727	1	99.91
2004	31727	31	75.54
2005	31727	1	82.66
2006	31727	1	71.76
2007	31727	0	98.67
2008	31727	10	100.9
2009	31727	2	75.02
2010	31727	0	0
2011	31727	0	0
2012	31727	1	92.96
2013	31727	109	76.77
2014	31727	62	95.45
2015	31727	74	84.93
2016	31727	3	69.12

The recruitment index from MEDITS survey …..

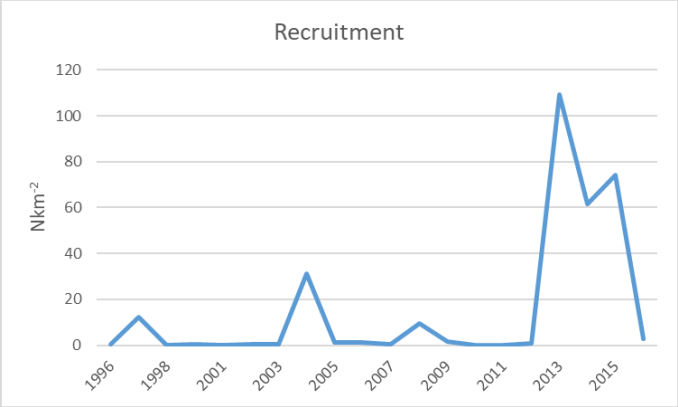


Fig. 4.1-4. MEDITS GSA 17 Eastern side recruitment index (<=9 cm)

Direct methods: trawl based Spawner analysis

Table 4.1-18: Trawl surveys; spawners analysis summary

Survey	**MEDITS GSA 18**	**Trawler/RV**	**PEC**
Survey season			summer
Investigated depth range (m)			10-800
Spawning season and peak (months)			spring-early summer with peak June-July

Table 4.1-19: Trawl surveys; spawners analysis results (>= 12 cm)

Years	Area in km²	N of spawners per km²	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
2015	29008	725	29.6
2016	29008	494	22.5

The spawners index from MEDITS survey shows a sharp increase in the recent years. This trend is probably influenced the shift in the survey timing.

Spawners

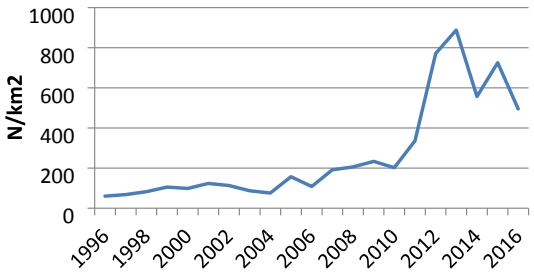


Fig. 4.1-5. MEDIT spawners index (>=12 cm)

Table 4.1-20: Trawl surveys; spawners analysis summary

Survey	**MEDITS GSA 17 Western side**	**Trawler/RV**	**AND**
Survey season			summer
Investigated depth range (m)			10-500
Spawning season and peak (months)			spring-early summer with peak June-July

21: Trawl surveys; spawners analysis results (>= 12 cm)

Years	Area in km²	N of spawners per km²	CV
2002	59400	312.56	39.23
2003	59400	195.98	15.48
2004	59400	158.82	18.80
2005	59400	190.97	21.29
2006	59400	402.56	48.88
2007	59400	161.27	16.88
2008	59400	294.81	17.60
2009	59400	259.98	19.19
2010	59400	277.92	22.56
2011	59400	363.51	26.48
2012	59400	559.52	25.69
2013	59400	1112.27	17.27
2014	59400	1828.04	11.85
2015	59400	775.03	22.08
2016	59400	1448.32	15.10

The spawners index from MEDITS survey shows a sharp increase in the recent years.

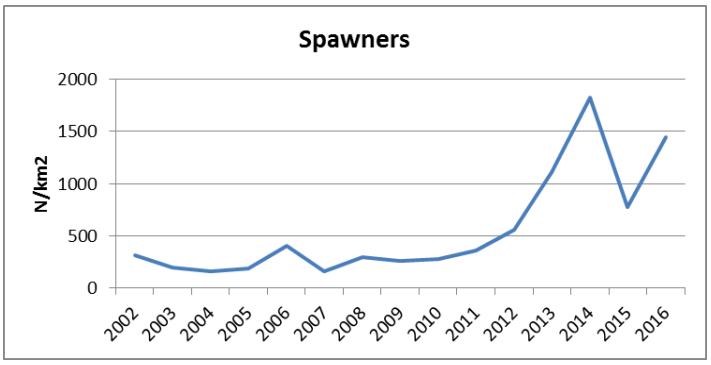


Fig. 4.1-6. MEDITS GSA 17 Western side spawners index (>=12 cm)

Table 4.1-22: Trawl surveys; spawners analysis summary

Survey	**MEDITS GSA 17 Eastern side**	**Trawler/RV**	
Survey season			summer
Investigated depth range (m)			10-500
Spawning season and peak (months)			spring-early summer with peak June-July

Table 4.1-21: Trawl surveys; spawners analysis results (>= 12 cm)

Years	Area in km²	N of spawners per km²	CV
1996	31727	670	19.01
1997	31727	1114	19.58
1998	31727	571	22.02
1999			
2000	31727	1035	22.34
2001	31727	1235	16.83
2002	31727	570	19.49
2003	31727	941	18.01
2004	31727	1358	31.85
2005	31727	1191	19.86
2006	31727	1280	23.73
2007	31727	861	14.78
2008	31727	1935	15.67
2009	31727	1381	17.39
2010	31727	1784	15.67
2011	31727	1121	13.2
2012	31727	2730	14
2013	31727	2833	22.07
2014	31727	4196	17.78
2015	31727	3398	17.04
2016	31727	2601	12.82

The spawners index from MEDITS survey shows ...

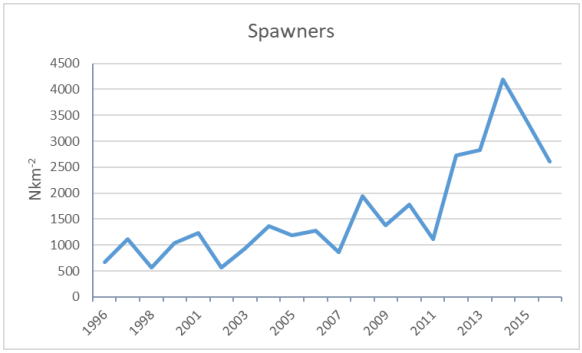


Fig. 4.1-6. MEDITS GSA 17 Eastern side spawners index (>=12 cm)

4.1.1 Spatial distribution of the resources

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. In GSA 17 recruitment areas are mainly distributed along Italian coast, while spawning areas are located along Croatian coast.

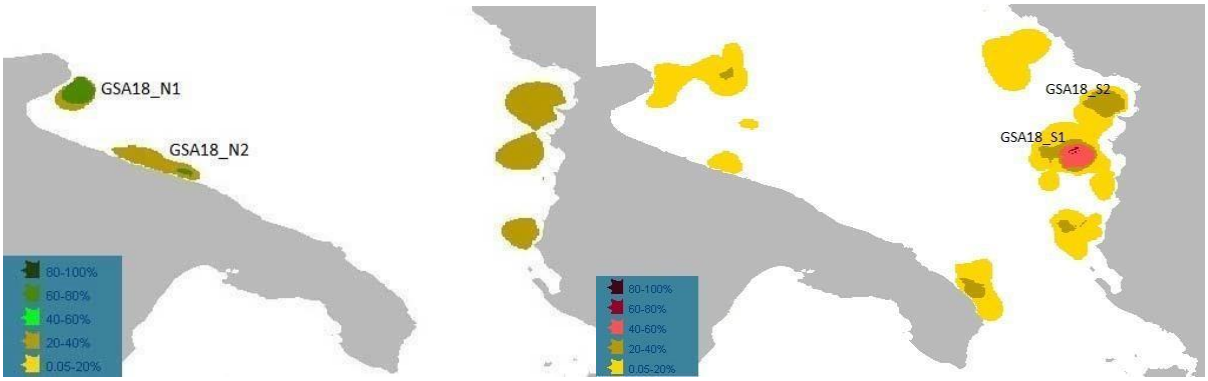


Fig. 4.1.1-1. Position of persistent nursery (left) and spawning (right) areas of red mullet in the GSA18

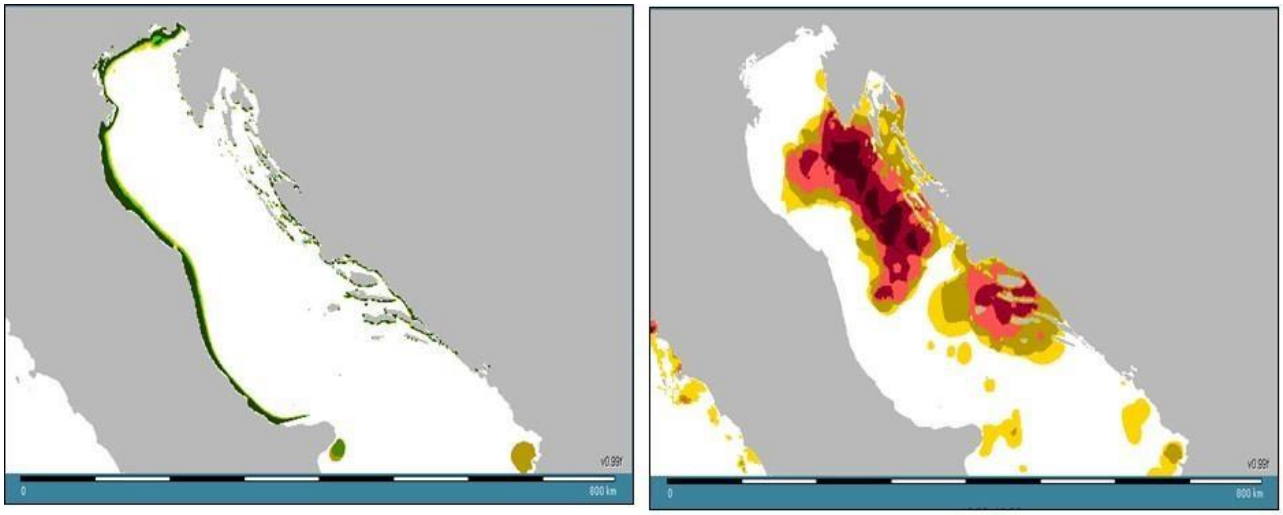


Fig. 4.1.1-2. Position of persistent nursery (left) and spawning (right) areas of red mullet in the GSA17

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.

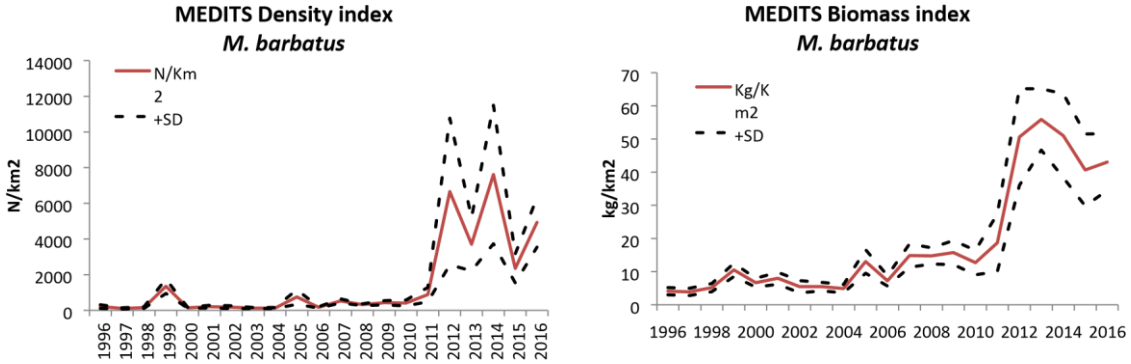


Fig. 4.1.2-1. Density and biomass MEDITS indices GSA 18 (1996-2016).

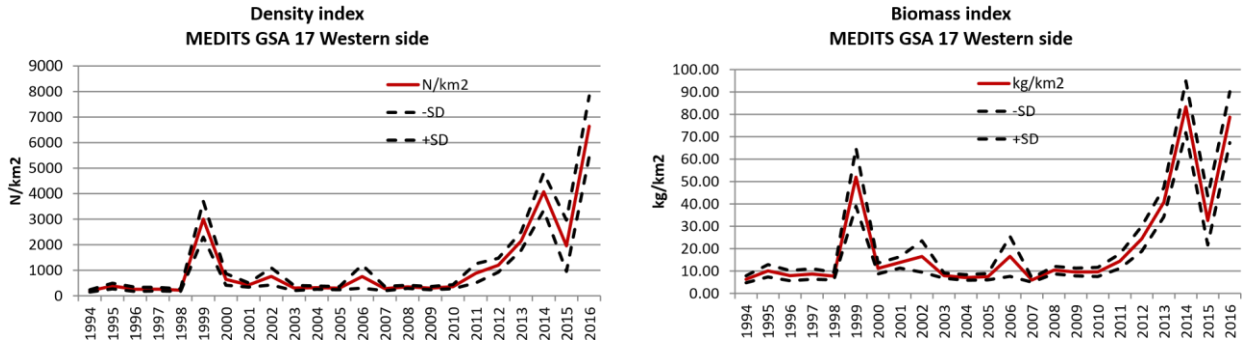


Fig. 4.1.2-2. Density and biomass MEDITS indices GSA 17 Western side (1994-2016).

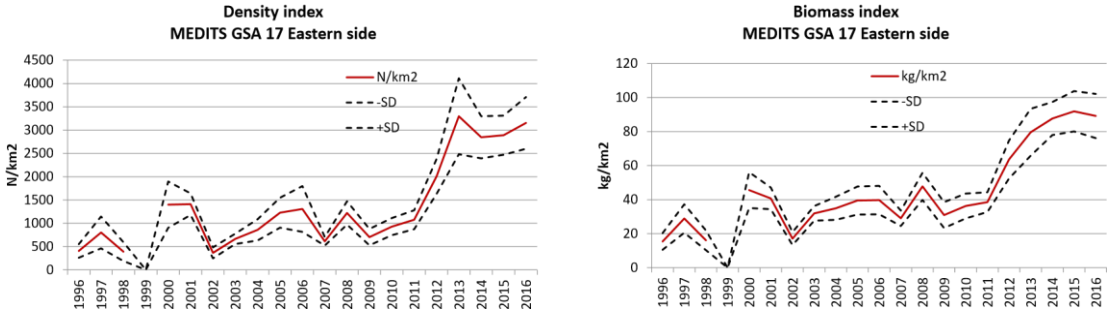


Fig. 4.1.2-3. Density and biomass MEDITS indices GSA 17 Eastern side (1996-2016).

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

6.1 Stock Synthesis 3 (SS3)

A first attempt to take into account the hypothesis of a selectivity different among the fleets by means of SS3 model is here presented.

The Stock Synthesis (SS3, Methot and Wetzel, 2013) assessment program provides a statistical framework for calibration of a population dynamics model using a multi-fleet approach. It is designed to include different information from fishery and survey data, as well as to consider different subareas within the same stock. The model allows to work by length or by age and to assume different selectivity patterns for the different fleet exploiting the stock. In the model the selectivity is a combination of availability and vulnerability.

SS3 is based on ADMB C++ software, allowing to easily work with large databases, as well as to simultaneously estimate a number of parameters. A wide number of options are available for modelling the selectivity patterns of the different fishing gears. Moreover, time varying selectivity can be defined in order to take into account annual changes in vulnerability and availability of the stock.

6.1.1 Model assumptions

The model built in SS3 for this stock has the following features:

- Length based;
- Discard included in catch data;
- sex combined;
- 1 area;
- annual time step;
- 6 commercial fleets (Italian trawlers GSA 18 , Italian gill and trammel netters GSA 18, Albanian trawlers, Montenegrin trawlers and gill and trammel netters, Italian trawlers GSA 17 and Croatian trawlers GSA 17)
- 3 survey fleets (MEDITS whole GSA 18 (ITA, ALB, MON), MEDITS GSA 17 Western side, MEDITS GSA 17 Eastern side)
- logistic selectivity for the survey and all commercial fleet except the Italian gill and trammel netters

  GSA 18, Montenegrin fleet, Italian trawlers GSA 17* and MEDITS Western side GSA 17* (doublenormal function);
- Albanian trawlers with the same selectivity of Italian trawlers; no stock-recruitment relationship (annual scalar recruitment).

*on the basis of spawners (East) and recruits (West) distribution.

The number of parameters estimated by the model is 74.

Blocks defined for MEDITS according to the survey time, in order to inform the model about a different sizes availability according to the actual time of the survey (if recruitment is detected or not).

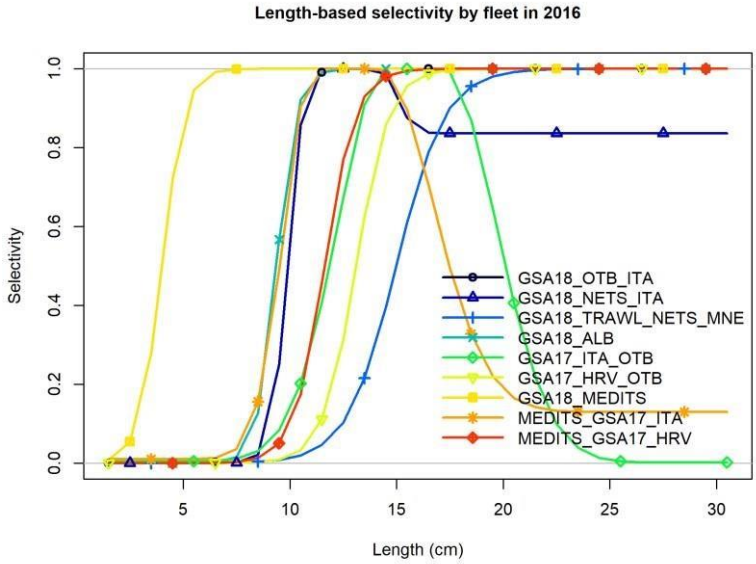


Fig. 6.1.1-1 Length selectivity estimated by SS3 in 2016.

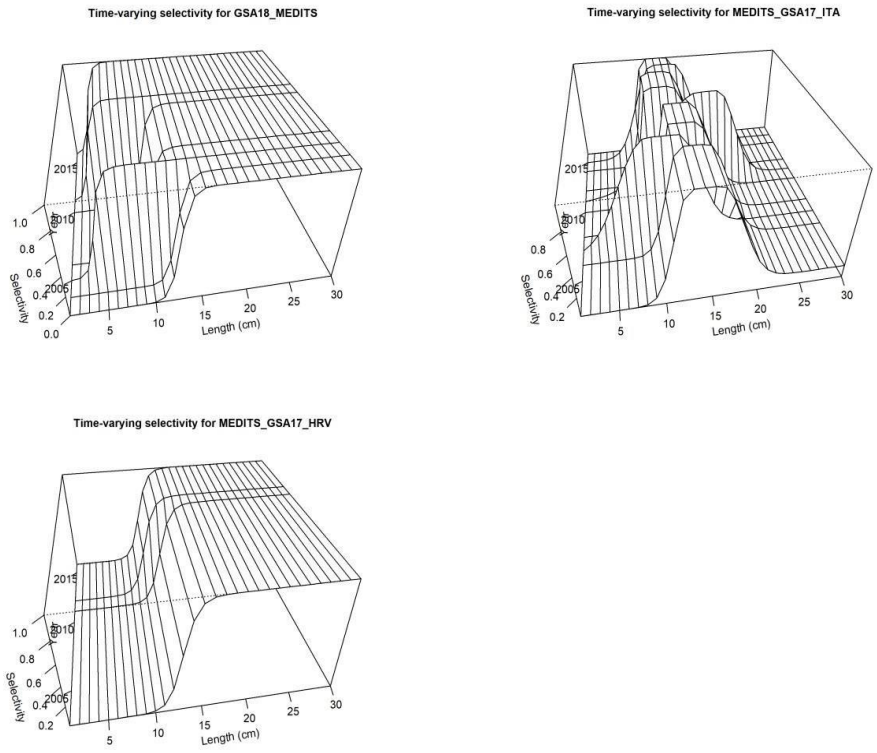


Fig. 6.1.1-2 Time varying length selectivity estimated by SS3 by fleet.

For MEDITS in GSA 18 the size at first capture ranges between 4 and 13 cm along the years, depending on the presence or absence of the recruitment; for MEDITS GSA 17 Eastern side between 12 and 13 cm, while for MEDITS GSA 17 Western side the size at which the selectivity is 1 ranges between 10 and 13 cm.

6.1.2 Scripts

The version 3 of Stock Synthesis has been used to carry out the assessment (SS3safe_Win64.exe). The input and files of the final run have been uploaded on the GFCM Extranet.

6.1.3 Input data and Parameters

The proportion of the discards of red mullet in the whole area (GSA 17 and 18)was around 15% in 2016. Discard data not available have been estimated on the basis of the average discard ratio in the first three available years for all the fleet except Montenegro and Albania, where no discard data was available.

The LFDs of Italian trawlers in GSA 18 were available from 2003, the LFDs of Italian nets from 2011 and for Montenegrin fleet from 2008. No LFDs were provided for Albanian fleet and the same selectivity of Italian fleet was assumed in the model. The LFDs of Italian trawlers in GSA 17 were available from 2006 to 2016, while for Croatian fleet from 2013 to 2016.

The MEDITS data as aggregated indices (N/km^2) and LFDs were available for the whole period (2003-2016) for the three surveys.

The natural mortality vector used was an average between the M used for the GSA 18 assessment and the M of GSA 17.

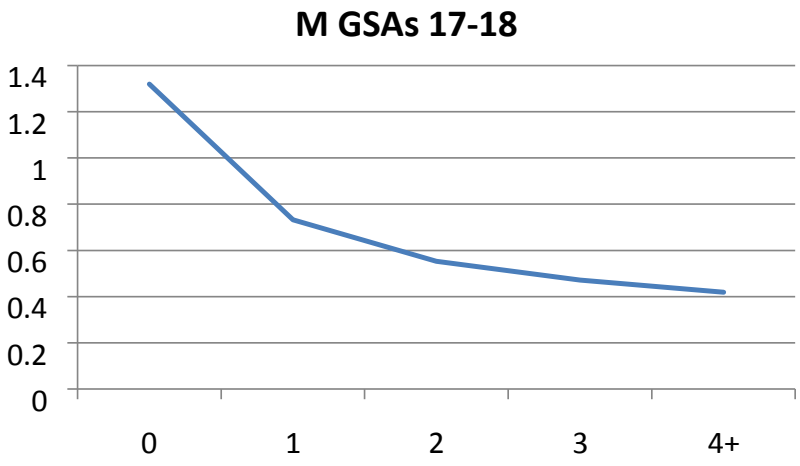


Fig. 6.1.3-1 Natural mortality by age.

Tab. 6.1.3-1 Italian trawlers GSA 18 LFDs

TL (cm)	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	8	0
5	12	14	9	12	6	18	7	5	960	5	0	967	12
6	145	191	223	154	76	57	176	21	3850	17	211	2876	122
7	491	1170	2831	956	203	457	657	241	5143	201	2137	3327	368
8	1668	2990	5142	5399	835	2365	1651	1080	28352	2161	7177	4022	1102
9	2950	3367	5191	8550	1940	4542	3827	1997	42275	9242	19211	14274	3127
10	5226	5798	4730	11392	4045	5313	6795	2021	24057	14875	23581	15859	7587
11	4403	7002	5159	10215	4561	6741	6148	2629	18818	9483	14938	10214	8349
12	5234	5779	7853	8240	4377	5971	4939	2474	13840	8254	10041	7955	7435
13	8546	8240	5738	7497	6043	5493	3764	2144	10295	6279	6388	7787	6665
14	8103	7105	5888	6595	5398	4260	2251	1540	7874	4649	3431	7127	5758
15	7158	6607	4584	6248	4005	2301	1200	1121	5476	2833	1686	5074	4598
16	4940	4149	3462	4348	2230	1382	614	987	4014	1511	580	2874	3281
17	2703	3340	2601	2484	1041	885	270	939	1820	875	365	1552	1702
18	2261	2263	1005	932	310	489	128	559	1002	476	259	489	947
19	1155	1643	495	287	64	292	74	247	306	119	169	327	463
20	418	808	144	136	13	119	49	213	123	106	55	73	151
21	172	323	48	20	24	79	16	121	33	14	27	41	87
22	123	242	0	5	10	18	15	19	5	5	16	8	18
23	74	135	0	45	8	2	9	3	4	2	1	4	13
24	0	162	0	0	7	0	1	1	1	0	1	0	1
25	0	0	0	0	1	0	0	1	0	1	0	0	0
26	0	0	0	0	3	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	1	0	0
28	0	54	0	0	0	0	0	0	0	0	0	0	0

Tab. 6.1.3-2 Italian gill and trammel netters GSA 18 LFDs(Landing+Discard)

TL (cm)	2011	2012	2013	2014	2015	2016
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	10	0
5	0	0	0	0	48	0
6	0	0	0	0	291	0
7	0	0	0	0	831	0
8	0	14	23	11	556	8
9	1	94	506	82	335	147
10	37	123	944	206	146	407
11	234	77	602	242	35	629
12	338	28	280	255	10	196
13	339	26	119	133	8	151
14	143	19	121	83	5	83
15	77	11	56	36	6	60
16	51	8	54	25	6	60
17	68	5	24	13	5	136
18	21	4	10	4	2	72
19	7	0	5	1	0	34
20	0	0	2	1	1	11
21	0	0	3	0	0	0
22	0	0	0	0	0	0

23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	0	0	0	0	0	0

Tab. 6.1.3-3 Montenegrin fleet (gill and trammel netters and trawlers) LFDs

TL (cm)	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	35	17	0	70	0	0	3	0	0
11	89	58	27	178	13	11	3	23	17
12	111	103	96	118	32	24	45	77	45
13	170	138	107	150	75	56	79	129	89
14	143	154	166	83	120	79	88	244	146
15	106	118	131	42	134	118	154	243	177

16	60	62	65	31	129	114	147	143	141
17	37	38	39	5	140	136	132	93	145
18	17	18	19	5	71	84	84	62	93
19	9	17	25	1	40	27	54	35	43
20	1	3	4	0	22	19	28	14	27
21	1	2	3	0	7	11	12	13	20
22	0	0	0	0	7	1	5	7	6
23	0	0	0	0	3	1	3	0	1
24	2	3	4	0	3	0	4	0	1
25	0	0	0	0	0	0	5	0	0
26	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0

Tab. 6.1.3-4 Italian trawlers GSA 17 LFDs (Landing+Discard)

TL (cm)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	75	80	76	59	0	124	0	0	0	0	38
5	1820	1936	1854	1428	0	3019	7	1	0	0	595
6	683	726	695	536	0	1131	8	2	0	0	5270
7	316	336	322	248	7	515	10	26	14	86	9069
8	3571	3799	3638	2803	58	5859	424	400	255	2656	5927
9	4242	3913	3791	2886	1140	5677	2890	3034	3230	8641	9623
10	10342	8559	8556	7283	3670	12700	3915	8466	9008	11421	14934
11	14789	16858	14223	14811	10262	18440	6343	10892	11096	16708	16265
12	13194	16386	14228	21555	11025	17372	11260	12544	14969	19026	18562
13	16526	21848	27743	21655	14266	13691	13250	13290	16241	18085	15515
14	23050	29722	29866	16344	9226	12165	10730	10810	15282	15134	10231
15	20312	19585	13259	11187	8330	7863	7805	8200	12339	12078	7523
16	10613	9326	8503	6836	5793	6976	4040	5331	7166	7613	4889
17	3869	3196	3773	2674	2481	2751	1236	2306	3254	2439	2215
18	1322	1986	1325	1487	1045	493	373	1019	977	815	635
19	487	688	361	265	426	235	109	442	405	546	210
20	235	24	92	133	57	55	17	94	145	92	69
21	147	39	19	37	0	9	4	2	23	63	5
22	0	43	0	0	14	1	6	17	3	0	0

23	0	0	0	0	0	0	4	0	2	3	0
24	0	0	0	0	0	0	2	0	0	0	0
25	0	0	0	0	0	0	6	0	0	0	0
26	0	0	0	0	0	0	0	0	0	3	0
27	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	2	0	0	0

Tab. 6.1.3-5 Croatian trawlers LFDs (Landing+Discard)

TL (cm)	2013	2014	2015	2016
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	152	168	11	0
7	76	375	0	0
8	26	0	0	0
9	160	586	81	241
10	1132	2015	370	1004
11	2861	7198	1433	1927
12	5776	11591	4637	2585
13	7935	13242	7569	4271
14	7995	10073	7209	5225

15	5518	6428	6739	5077
16	3125	3936	6159	3779
17	2032	2044	4366	2719
18	1240	1346	2708	1866
19	669	596	1255	1175
20	265	301	587	695
21	104	108	322	389
22	29	36	92	185
23	13	4	60	34
24	1	6	22	6
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0

6.1.4 Tuning data

The survey LFDs used in SS3 are the ones reported in section 4.1.

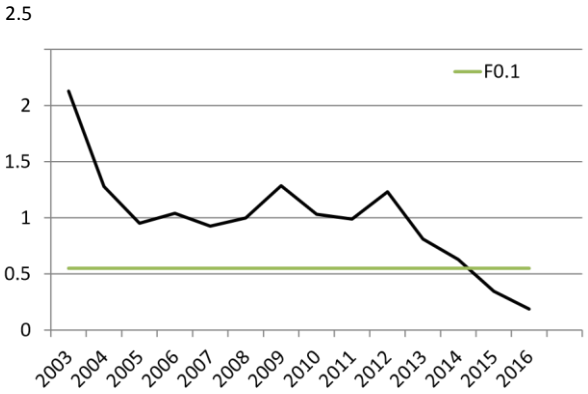
6.1.5 Results

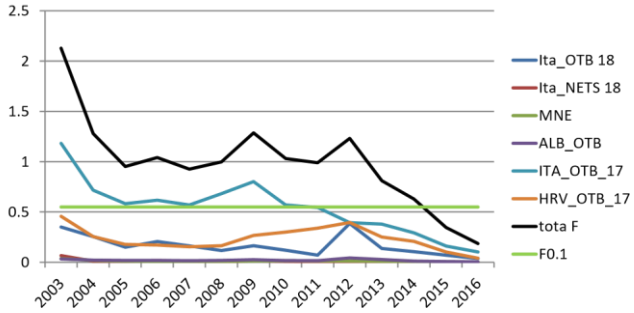
Fishing mortality (F) shows the minimum value of 0.2 ($\bar{F}$ or F_{bar}) in 2016, and a maximum of 2.12 in 2003. Average F for the period of last three years (2014-2016) was 0.38.

The $F_{0.1}$ value was estimated on the basis of the F at age estimated by the model by means of fishmethods R package (yield per recruit model) and was equal to 0.55.

The summary of the final run, chosen for the advice is reported below in Fig. 6.1.5-1.

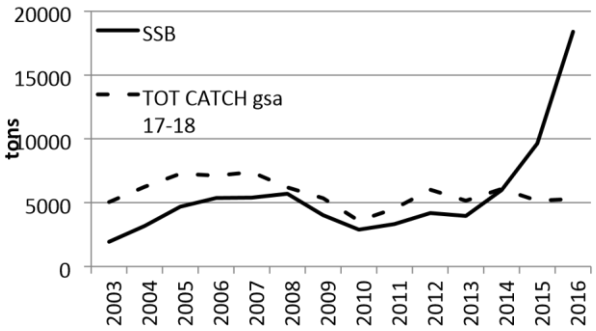
Fbar(1-3)





Fbar(1-3) by fleet

SSB



Recruitment

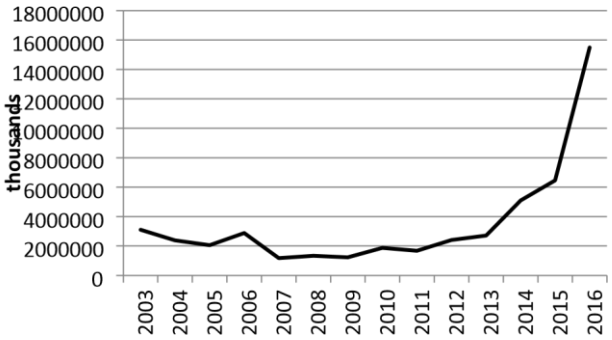


Figure. 6.1.5-1 Results of the final run.

6.1.6 *Robustness analysis*

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

The retrospective analysis shows some signal of instability. Higher residuals are observed for the Italian trawlers (GSA 17s and 18) and MEDITS 18 and 17 Western side LFDs. Generally, it happened when the model was not able to completely explain the unusually strong peaks in recruitment (Fig. 6.1.7-1 and Fig.

6.1.7-2).

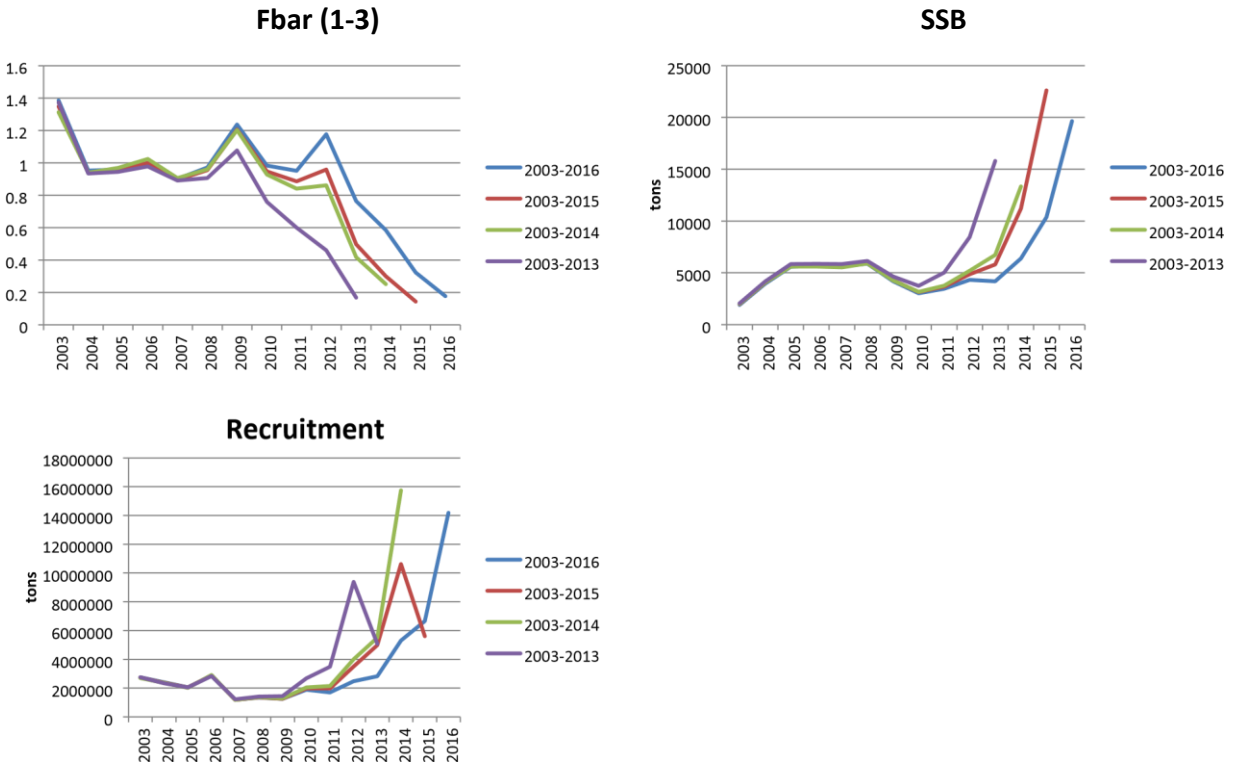


Fig. 6.1.7-1. Retrospective analysis results.

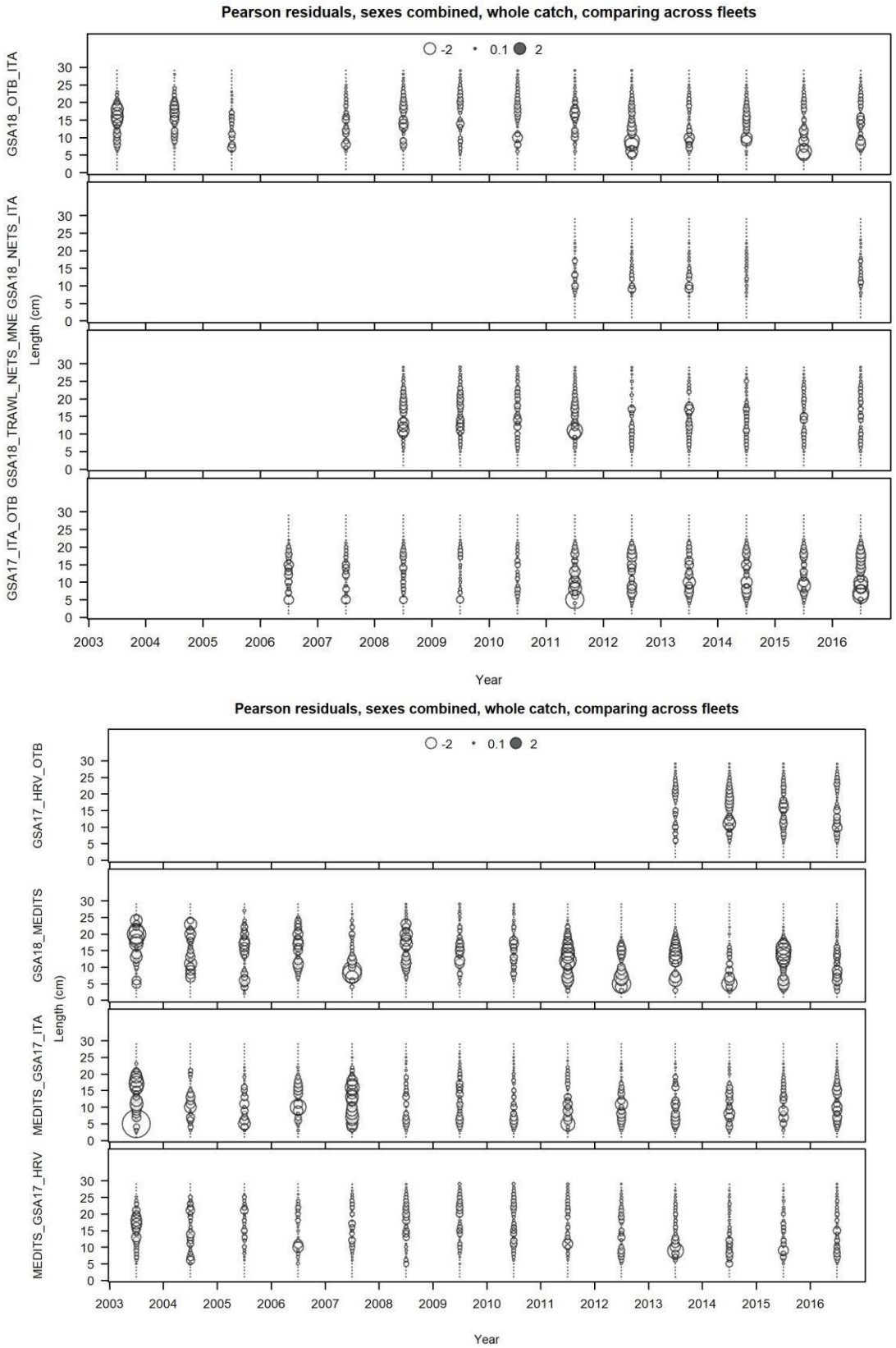


Fig. 6.1.7-2. Pearson residuals by fleet.

For Italian trawlers in the years of DCR (2003-2007) the model estimates a higher level of uncertainty; moreover, the model reveals some difficulty in the detection of the peculiar occurrence of recruits in the trawlers GSA 18 catch in 2012-2014. Finally, the trend in the mean lengths by year are globally correctly estimated. The double-normal function seems to fairly well represent the selectivity of Italian gill-nets , Montenegrin fleet, Italian trawlers of GSA 17 and MEDITS GSA 17 Western side. Indeed, the trends of the mean lengths by year are in general correctly estimated(Fig. 6.1.7-6).

The MEDITS abundance indices and the annual mean lengths are estimated in a satisfactory way by the model (Fig. 6.1.7-3, 6.1.7-4 and 6.1.7-5).

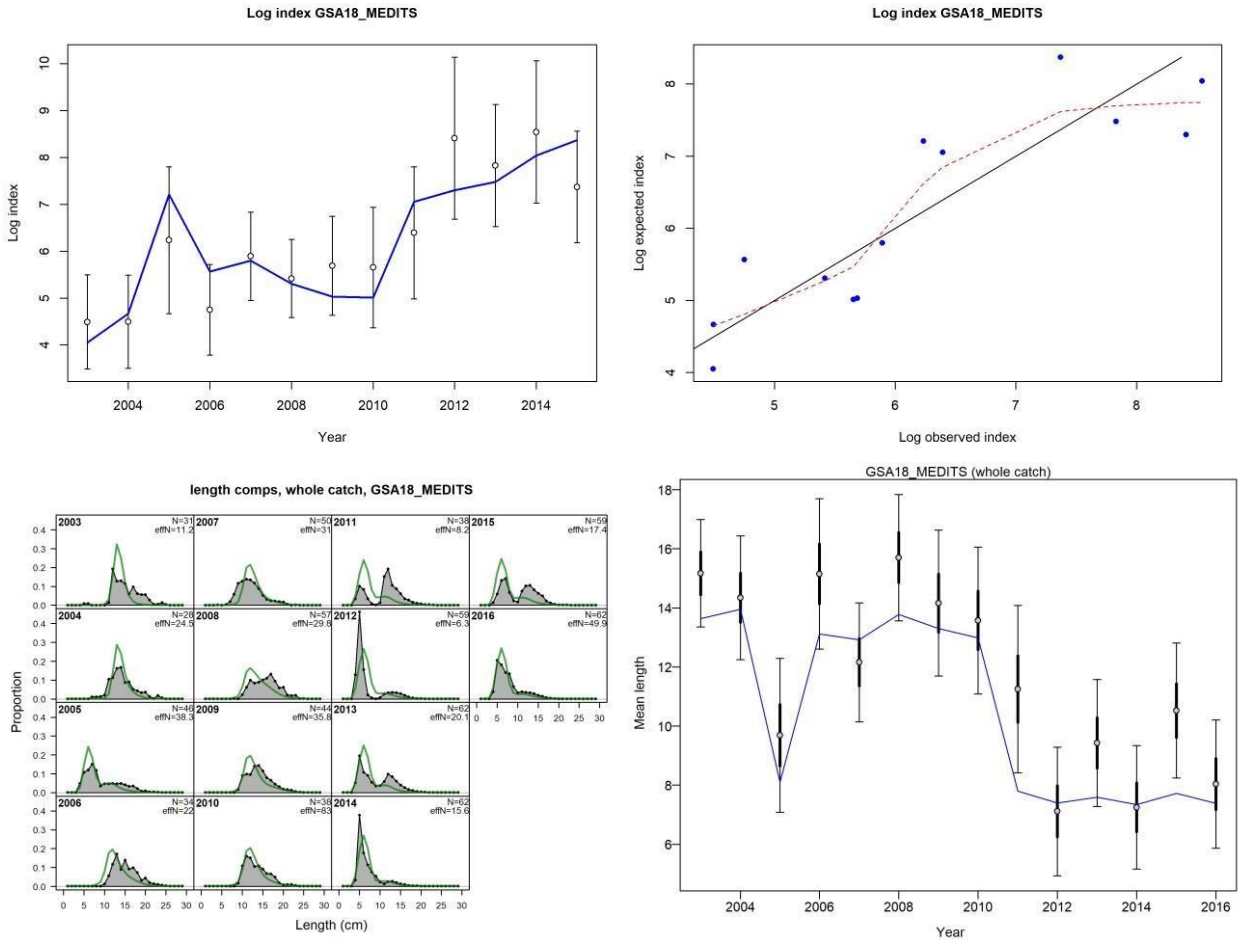
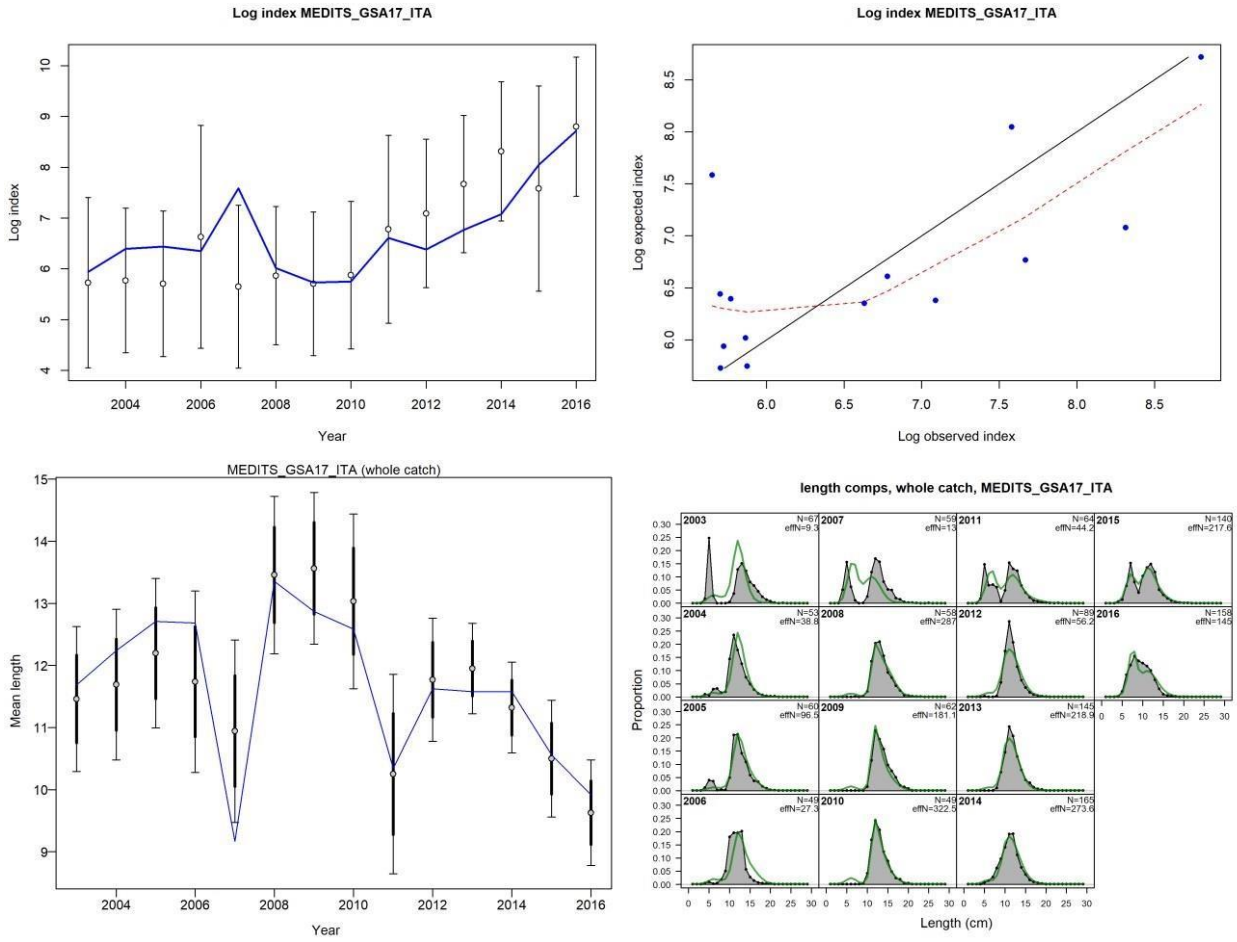
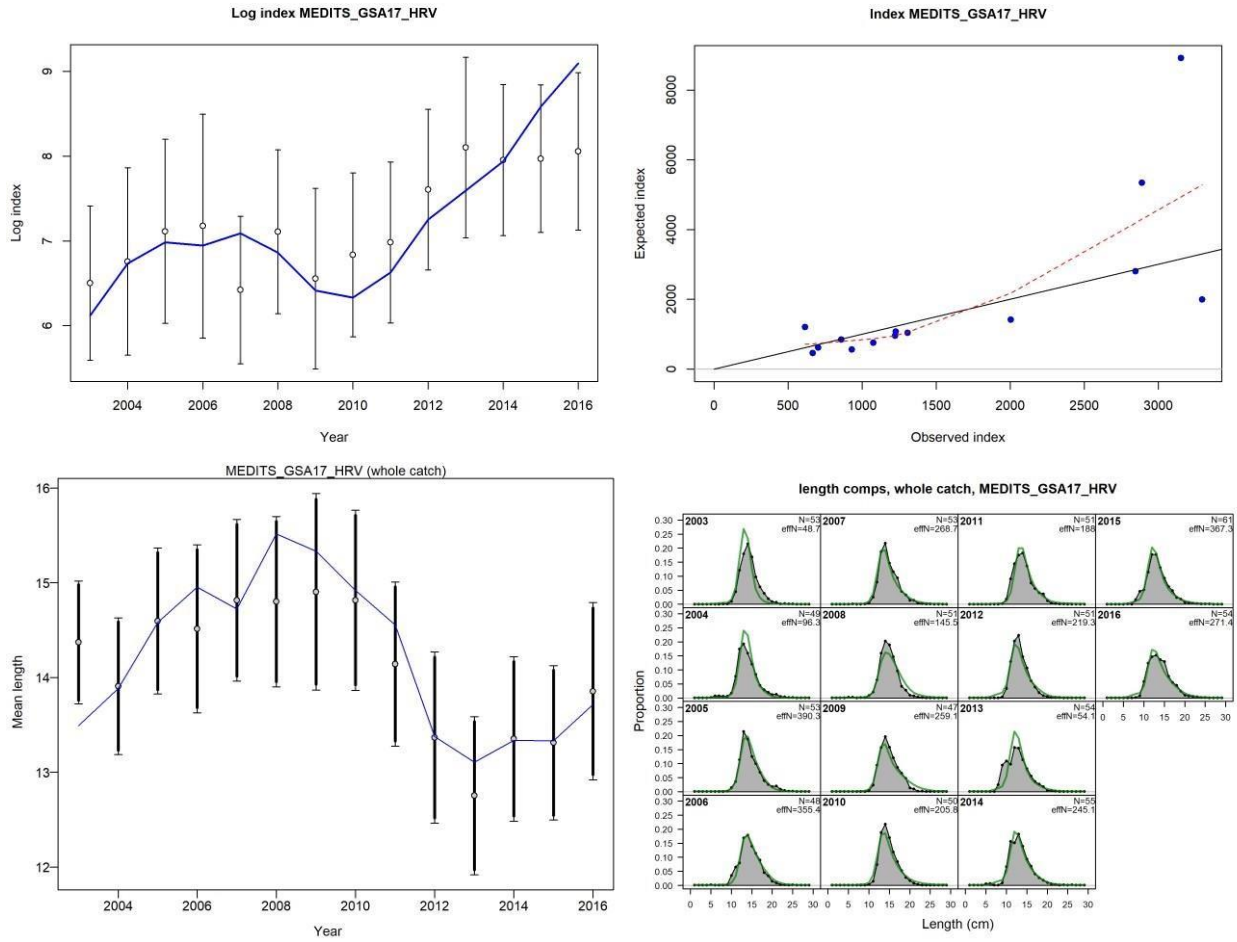


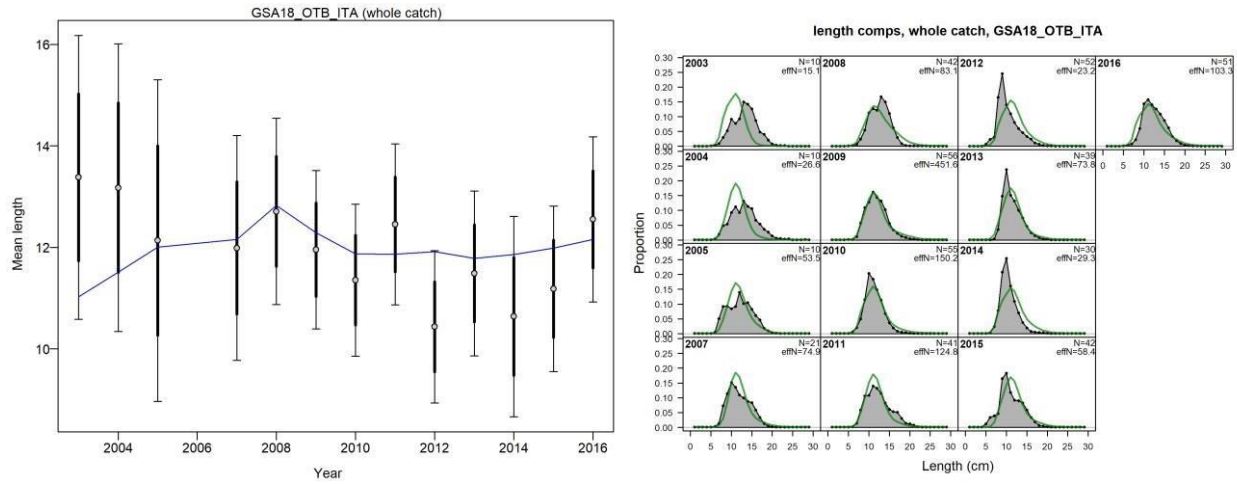
Fig. 6.1.7-3 Comparison between observed and estimated MEDITS GSA 18 log index, mean length, LFDs and between theoretical and empirical quantiles.

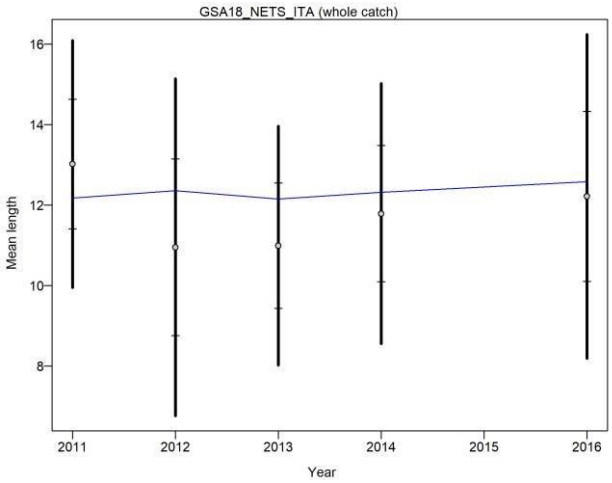


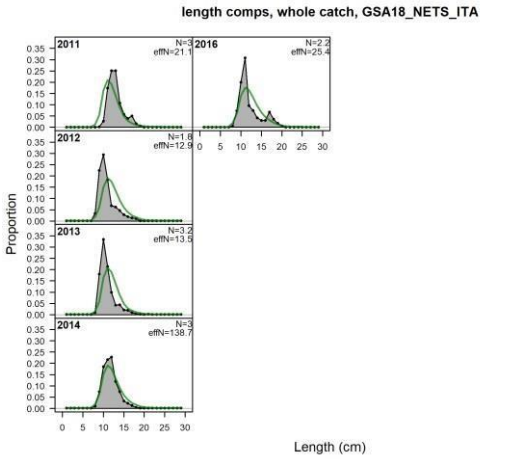
6.1.7-4 Comparison between observed and estimated MEDITS GSA 17 Western side log index, mean length, LFDs and between theoretical and empirical quantiles.

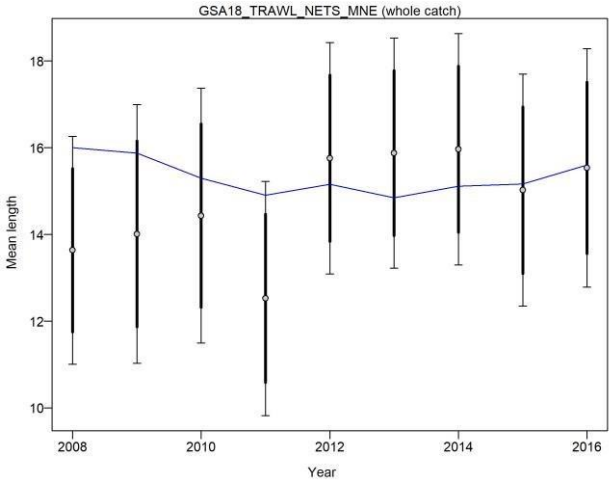


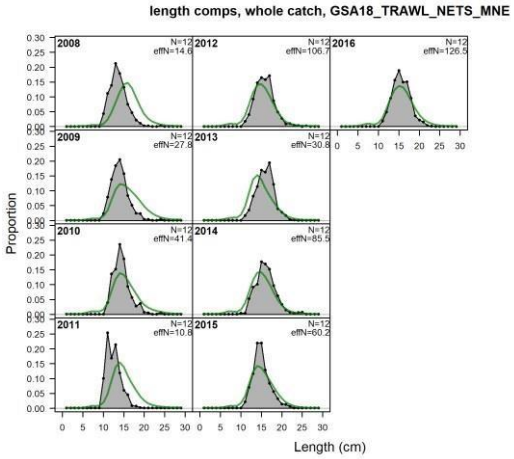
6.1.7-5 Comparison between observed and estimated MEDITS GSA 17 Eastern side log index, mean length, LFDs and between theoretical and empirical quantiles.

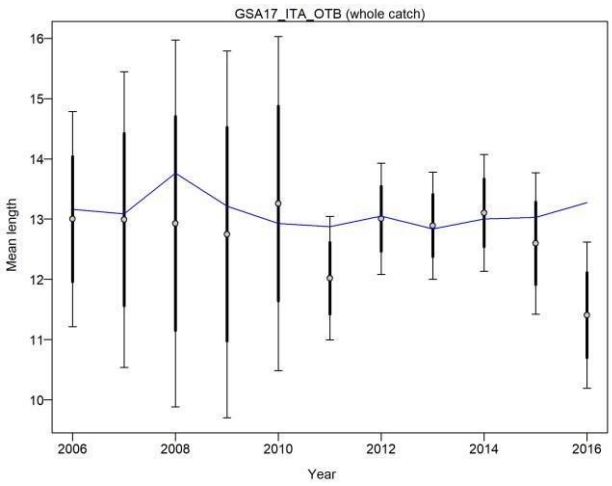


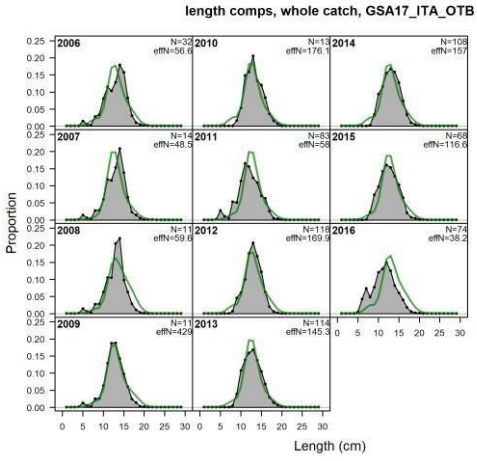

GSA18_NETS_ITA (whole catch)
Mean length
Year


length comps, whole catch, GSA18_NETS_ITA
Proportion
Length (cm)


GSA18_TRAWL_NETS_MNE (whole catch)
Mean length
Year


length comps, whole catch, GSA18_TRAWL_NETS_MNE
Proportion
Length (cm)


GSA17_ITA_OTB (whole catch)
Mean length
Year


length comps, whole catch, GSA17_ITA_OTB
Proportion
Length (cm)

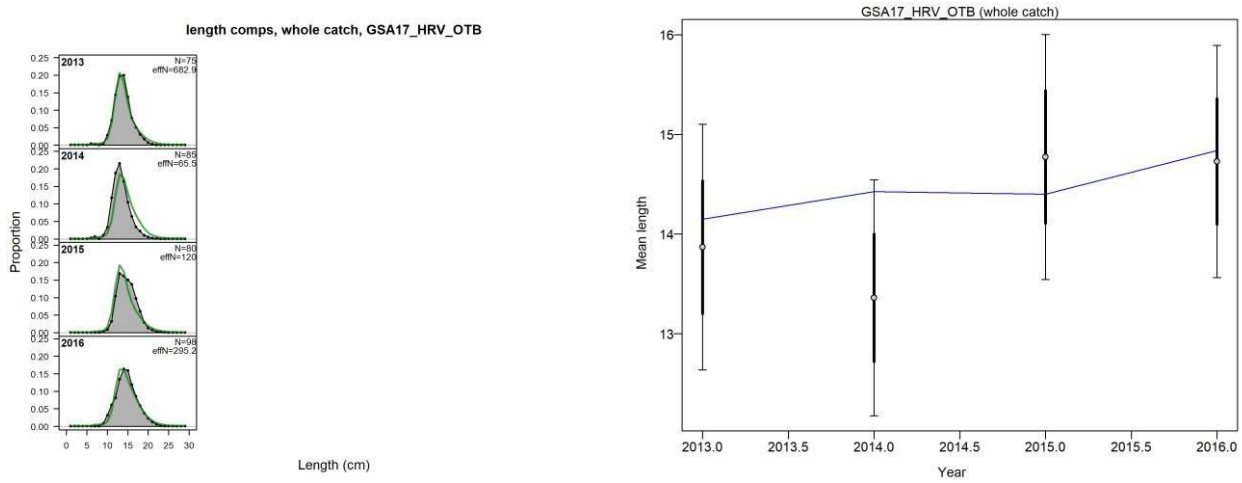


Fig. 6.1.7-6 Comparison between observed and estimated commercial mean length and LFDs.

6.1.8 *Assessment quality*

The residuals do not shows any particular trend. The comparison between observed and estimated commercial LFDs and mean length along the years as well as between observed and estimated MEDITS mean length, log index and LFDs seems quite satisfactory.

6.2 Short term predictions

6.3 Medium term predictions

6.4 Long term predictions

7 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	($F_{0.1}$ = 0.55)	F_{curr} (2016)= 0.2		D	S
	Fishing effort				D	
	Catch					
Stock abundance	Biomass					
	SSB			Percentiles SSB (tons): 33rd : 3977 66th : 5382 Current: 18394		O_H
Recruitment					I	
Final Diagnosis						

The total F estimated by SS3 in GSA 18 in 2016 is split in 19 % exerted by Italian trawlers GSA 18, 1% by Italian netters, 1% by Montenegrin fleet, 2% by Albanian trawler, 55% by Italian trawlers in GSA 17 and 22% by Croatian trawlers.

7.1 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)*

8 References

Cochran W. G., 1953. Sampling techniques. John Wiley & Sons Inc. New York: 1-330.

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