Stock Assessment Form

Demersal species

Reference year: 2012

Reporting year: 2013

In the southern Adriatic, deep water pink shrimp is distributed mostly between 30 and 600 m depth although it is more abundant between 200 and 400 m depth. It is targeted by trawlers operating up to 500 m depth. For the assessment of the stock status in the GSA 18 different sources of data (fishery dependent and fishery independent) have been used. Given the results from this analysis, based on the whole information from the area, the stock is in overfishing (F0.1=0.75 ; Fcurrent=1.36) and it is necessary to consider that a reduction of the fishing mortality. The reference point F0.1 can be gradually achieved by multiannual management plans. The contribute of each country to the total production of *P. longirostris* in the GSA18 is: Italy 60 %; Albania 38%; Montenegro 2%.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Isabella Bitetto*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Parapenaeus longirostris	Deep-water pink shrimp	45
1st Geographical sub-area:	2nd Geographical sub-area:	3rd Geographical sub-area:
GSA 18		
4th Geographical sub-area:		
1st Country	2nd Country	3rd Country
Italy	Albania	Montenegro
4th Country	5th Country	6th Country
Stock assessment method: (direct, indirect, combined, none)		
Combined (Trawl survey, XSA, ALADYM)		
Authors:		
Bitetto I.[1], Carbonara P.[1], Casciaro L.[1], Ceriola L.[2], Đuroviæ M.[3], Facchini M. T.[1], Hoxha A.[4], Ikica Z.[3], Joksimoviæ A.[3], Kolitari J.[4], Kroqi G.[4], Lembo G.[1], Markoviæ O.[3], Milone N.[2], Spedicato M. T.[1]		
Affiliation:		
[1] COISPA Tecnologia & ricerca, Bari – Italy; [2] AdriaMed, FAO, Rome – Italy; [3] Institute of Marine Biology, Kotor – Montenegro; [4] University of Tirana – Albania		

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

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

Direct methods (you can choose more than one):

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

Indirect method (you can choose more than one):

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

Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify)

We have applied the direct method using trawl survey data for the estimation of indicators and for tuning. The XSA among the indirect methods and Aladym as simulation model.

2 Stock identification and biological information

2.1 Stock unit

The Southern Adriatic Sea extends from the line between Gargano and Lastovo to the boundary with the Ionian Sea at the latitude of Otranto (Artegiani et al., 1997). This southern section of the entire Adriatic Sea is characterised by the presence of a deep central depression known as the “South Adriatic Pit” (or Bari Pit). The seabed reaches a depth of 1,233 m in this area. The northern and southern portions of the Southern Adriatic Sea feature substantial differences; the first contains a wide continental shelf (the distance between the coastline and a depth of 200 m is around 45 nautical miles) and a very gradual slope; in the second, the isobathic contours are very close, with a depth of 200 m already found at around 8 miles from the Cape of Otranto. The continental shelf break is at a depth of around 160-200 m and is furrowed by the heads of canyons running perpendicular to the line of the shelf. The Adriatic Sea, together with the Levant basin, is one of three areas in the Mediterranean where down-welling processes produced by surface cooling lead to the formation of so-called “dense waters”, rich in oxygen, which supply the lower levels (Cataudella S. & Spagnolo M., 2011).

The stock of the deep-water rose shrimp was assumed in the boundaries of the whole GSA18, lacking specific information on stock identification.

The deep-water pink shrimp, is one of the target species of the central and southern Adriatic multispecies trawl catches and is an epibenthic short-lived species, inhabiting preferably muddy sediments (Karlovac, 1949). In the southern Adriatic it is distributed mostly between 30 and 600 m depth although it is more abundant between 200 and 400 m depth (Pastorelli et al., 1996). Larger specimens are caught mainly in deeper waters.

According to previous studies (Abellò et al., 2002; Mannini et al., 2004), the eastern part the south Adriatic is characterised by high occurrence and abundance of the species, given the characteristics of the water masses (warmer and saltier) and the lower fishing pressure; in particular an higher abundance of the juvenile component of the population was reported (Ungaro et al., 2006). However according to MEDITS time series the abundance of the species was growing even on the western side since 2002.

Spawning time is considered extended almost all the year around, as for other Mediterranean areas (Relini, 1999) and sex ratio, as estimated from trawl-survey data, is approximately 0.5. The abundance of this shrimp was steadily growing from 1996 to 2005 (Ungaro *et al.*, 2006).

2.2 Growth and maturity

According to historical information on growth in the Adriatic area, *P. longirostris* can grow up to 16 cm (males) and 19 cm (females) total length. However, males are usually 8 to 14 cm and females from 12 to 16 cm total length. During the expedition “Hvar”, the largest specimen caught was a female 17 cm in length (Karlovac, 1949). The growth rate of *P. longirostris* is high, but differs between sexes. Size distribution and growth parameters indicate a life cycle of 3-4 years (Froglia, 1982). Historical parameters of the length-weight relationship reported in the literature for carapace length expressed in mm and both sexes combined (Marano *et al.*, 1998) are a=0.0034, b=2.4364.

Estimates of growth parameters estimated within the DCF framework using the length frequency distribution analysis and von Bertalanffy model gave the following parameters : CL_{∞}=45.0 mm; K=0.6; t_0= -0.20.

The parameters of the length-weight relationship estimated within the DCF for sexes combined and carapace length expressed in mm were: *a*=0.0043, *b*=2.376.

In the Mediterranean Sea, both sexes of *P. longirostris* reaches maturity in the first year of life (Froglia, 1982).

According to the data obtained in the Data Collection Framework (DCF), the maturity ogive (mature females were specimens belonging to the maturity stage 2 onwards) estimated by a maximum likelihood procedure indicates a $L_{m50\%}$ of about 18.3 mm (±0.1 mm) and a maturity range (MR; $L_{m75\%}$-$L_{m25\%}$) equal to 24 mm (±0.13 mm) of carapace length.

Information about maximum observed length, size at first maturity and recruitment size are reported in Table 2.2-1 and in Fig. 2.2-1.

The sex ratio of commercial catches evidenced the prevalence of males in the size class from 16 to 18 mm and from 23 to 25 mm, while from 27 mm onwards the proportion of females was dominant.

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

Somatic magnitude measured (LT, LC, etc)			**LC**	**Units**	mm
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	
Maximum size observed	45	40		**Recruitment season**	**March – December**
Size at first maturity			18.3	**Spawning area**	Offshore of eastern and western coast of the entire GSA 18
Recruitment size to the fishery			< 14 mm	**Nursery area**	Nuclei of recruit aggregations on both sides, but more relevant along the eastern side

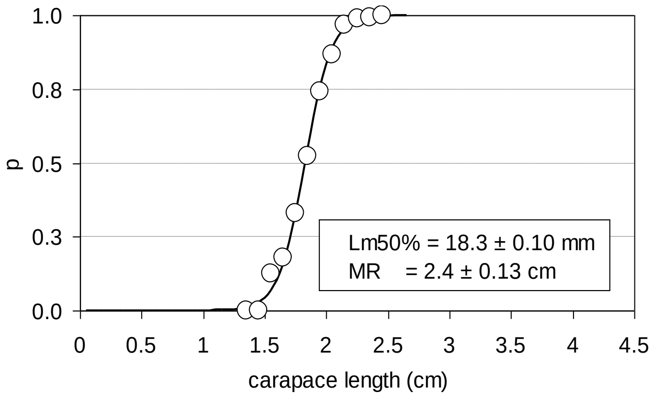


Fig. 2.2-1. Maturity ogive for *P. longirostris* females.

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

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

Size/Age	Natural mortality	Proportion of matures
0	1.41	0.47
1	0.81	0.98
2	0.7	1.00
3+	0.65	1.00

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

Size/Age	Natural mortality	Proportion of matures
0	1.41	0.47
1	0.81	0.98
2	0.7	1.00
3+	0.65	1.00

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	mm	45			
	K	Year^{-1}	0.6			
	t_0	Year	−0.2			
	Data source					
Length weight relationship	**a**	mm; g	0.0043			
	b	mm; g	2.376			
	M (scalar)					
	sex ratio (% females/total)	0.5				

3 Fisheries information

3.1 Description of the fleet

The Southern Adriatic sea makes a substantial contribution to national fishery production, with an input comparable to that of the Strait of Sicily, accounting for about 13% (Cataudella S. & Spagnolo M., 2011). The fleet data are referred to the whole GSA and are from the GFCM Task 1 Statistical Bulletin 2010. Catch data in the table 3.1.2 below reported are referred to the year 2012(DCF data for Italy, and data from ADRIAMED pilot study and National Statistics for Albania and Montenegro). The operational units ITA18E0333-DPS, ITA18F0333-DPS, ALB 18 E 03 33-DPS and ALB 18 F 03 33-DPS include also demersal slope fishing (mixed demersal according to DCF classification).

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

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

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1	ITA	18	D – Trawls (6-12 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 2	ITA	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 3	ITA	18	F – Trawls (>24 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 4	MNE	18	D – Trawls (6-12 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 5	MNE	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 6	ALB	18	D – Trawls (6-12 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 7	ALB	18	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 8	ALB	18	F – Trawls (>24 m)	03 – Trawls	33 – Demersal shelf species	DPS

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

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
ITA Operational Units 1+2+3	455	522.8 T				
ALB Operational Units 6+7+8	199	334.6[3] T				
MNE Operational Units 4+3	20	21.9 T				
Total	674					

Table 3.1-3. Catch values used in the assessments

Classification	Catch (t)
2007 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	863.0
2007 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	309.4[1]
2007 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	39.0[1]
2007 Total	**1211.4**
2008 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	897.7
2008 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	309.4[2]
2008 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	39.0
2008 Total	**1246.1**
2009 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	934.0
2009 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	275.0[2]
2009 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	35.7
2009 Total	**1244.6**
2010 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	880.8
2010 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	409.4[2]
2010 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	32.3
2010 Total	**1322.4**
2011 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	862.5
2011 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	328.1[2]
2011 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	26.7
2011 Total	**1217.3**
2012 ITA 18 D 03 33 – ITA 18 E 03 33 – ITA 18 F 03 33	522.8
2012 ALB 18 D 03 33 – ALB 18 E 03 33 – ALB 18 F 03 33	334.6[3]
2012 MNE 18 03 33 – MNE 18 E 03 33 – MNE 18 F 03 33	21.9
2012 Total	**879.3**

[1] Due to the lack of data, the 2007 catch for Albania and Montenegro was assumed to be identical to the catch of 2008

[2] Catches in Albania were based on export data, which was assumed to equal 64% of the total catch (FAO Yearbook of

Fishery Statistics)
[3] Preliminary data of Ministry of Environment, forests and Water Management of Albania for 2012.

3.2 Historical trends

Available time series for the deep-water pink shrimp landings in GSA 18 is relatively short (Table 3.2-1), consisting of only six years (2007-2012), and not complete for all countries in question. However, several assumptions have been made in order to overcome these limits. The reduction of landings observed in 2011 continued, and was even more pronounced in 2012, marking the lowest point in the time series.

Landing values in Italy seem to be closely correlated with the nominal fishing effort (kW×days) values (Fig. 3.2-1).

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

Year	Montenegro	Albania	Italy	Total
2007	39.0	309.4	863.0	1211.4
2008	39.0	309.4	897.7	1246.1
2009	35.7	275	934.0	1244.6
2010	32.3	409.4	880.8	1322.4
2011	26.7	328.1	862.5	1217.3
2012	21.9	334.6	522.8	879.3

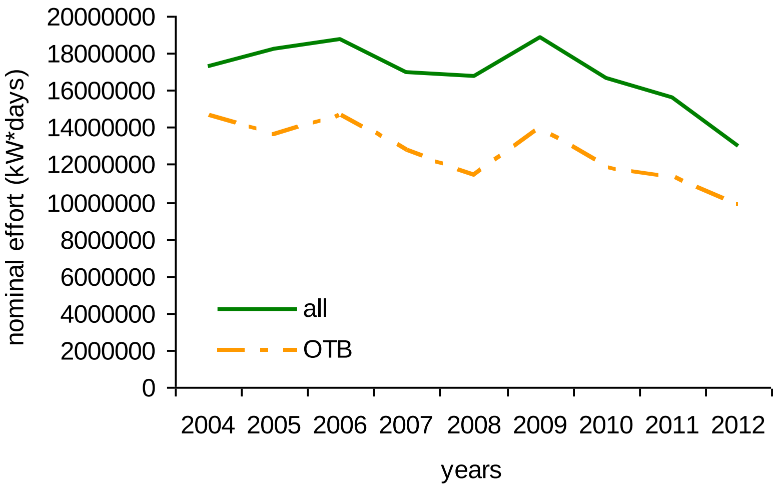


Fig. 3.2-1. Nominal fishing effort in kW×days by fishing technique for the western side (Italian coast) of GSA 18 from DCF.

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.

In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km^2, between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km^2 along the bathymetry of 100 m) on the northern border of the GSA where a marine protected area (MPA) had been established in 1989. In the former only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30th, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Recreational fishery using no more than 5 hooks is allowed in both the areas. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

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

In Albania, a new law “On fishery” has now been approved, repealing the Law n. 7908. The new law is based on the main principles of the CFP, it reflects Reg. 1224/2009 CE ; Reg.1005/2008 CE; Reg. 2371/2002 CE; Reg. 1198/2006 CE; Reg. 1967/2006 CE; Reg. 104/2000; Reg. 1543/2000 as well as the GFCM recommendations. The legal regime governing access to marine resources is being regulated by a licensing system. Regarding conservation and management measures, minimum legal sizes and minimum mesh sizes is those reflected in the CE Regulations. Albania has already an operational vessel register system. It is forbidden to trawl at less than 3 nautical miles (nm) from the coast or inside the 50m isobath when this distance is reached at a smaller distance from the shore.

3.4 Reference points

Table 3.4-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B					
SSB					
F			F0.1	0.68	F0.1 (proxy of F_{MSY}) was calculated on the basis of VIT assessment presented in 2012.
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 MEDITS trawl survey

4.1.1 Brief description of the direct method used

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 4.1.1-1: Trawl survey basic information

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

Table 4.1.1-2: Trawl survey sampling area and number of hauls

Stratum	**Total surface (km²)**	**Trawlable surface (km²)**	**Swept area (km²)**	**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

The haul positions are represented in the map below.

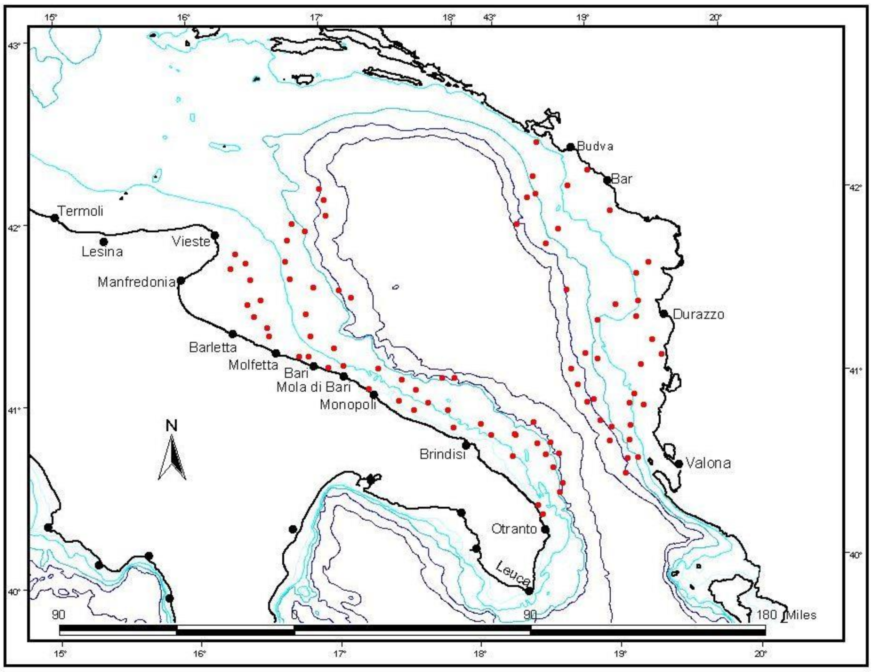


Fig. 4.1.1-1. Map of MEDITS haul positions in the GSA 18.

The abundance indices and the associated coefficient of variation for 2012 are reported in the table below.

Table 4.1.1-3: Trawl survey abundance and biomass results

Depth Stratum	Years	kg per km²	CV or other	N per km²	CV or other
10 – 50 m	2012	0	100	28	100
50 – 100 m	2012	1	34	291	31
100 – 200 m	2012	7	30	1082	30
200 – 500 m	2012	15	29	1978	30
500 – 800 m	2012	2	69	202	67
Total (10 – 800 m)	2012	5	19	786	19

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

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

Slicing method

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

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

Table 4.1.1-4: Trawl survey results by length or age class

N (Total or sex combined) by Length or Age class	Year					
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
0	106.46	178.37	712.09	476.10	461.56	455.21
1	156.08	498.33	335.88	302.41	225.85	321.79
2	39.24	168.42	25.35	24.61	15.66	8.93
3+	17.69	47.54	2.47	4.95	0.64	0.07
Total	319.47	892.66	1075.79	808.06	703.71	786.00

Sex ratio by Length or Age class	Year		
	2007-2012	**....**	**.....**
Total	0.5		

Comments

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

Direct methods: trawl based Recruitment analysis

Table 4.1.1-5: Trawl surveys; recruitment analysis summary

Survey	MEDITS	Trawler/RV	PEC
Survey season		summer	
Cod –end mesh size as opening in mm		20	
Investigated depth range (m)		10-800	
Recruitment season and peak (months)		All year round (autumn-spring)	
Age at fishing-grounds recruitment		0	
Length at fishing-grounds recruitment		~7 mm CL	

Table 4.1.1-6: Trawl surveys; recruitment analysis results (<=14 mm)

Years	Area in km^2	N of recruit per km^2	CV or other
1996	29008	63	33.4
1997	29008	13	35.3
1998	29008	45	67.1
1999	29008	6	28.1
2000	29008	34	25.3
2001	29008	85	16.3
2002	29008	39	24.4
2003	29008	97	28.2
2004	29008	40	21.5
2005	29008	88	18.5
2006	29008	14	31.5
2007	29008	3	38.0
2008	29008	8	40.6
2009	29008	170	38.2

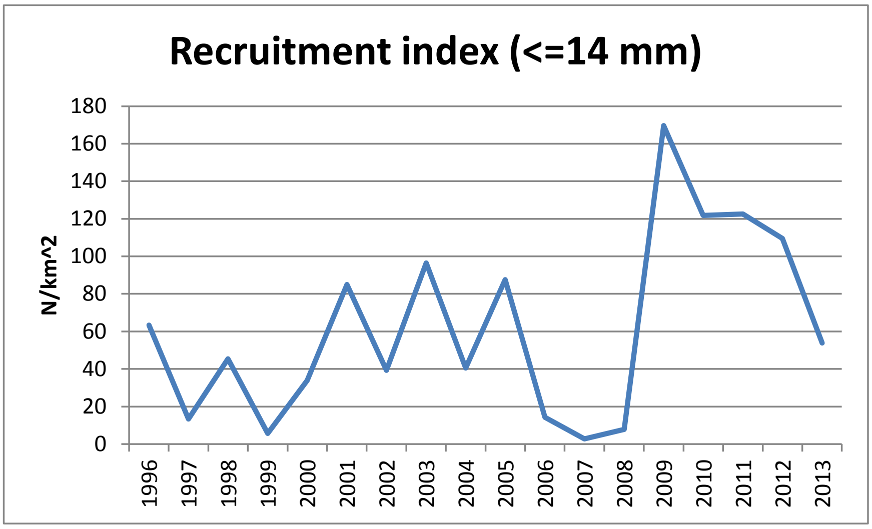
2010	29008	122	26.7
2011	29008	123	25.3
2012	29008	109	23.7

Comments

Recruitment follows a quasi-continuous pattern with main peaks in spring and autumn. Recruits mainly occur between 100 and 200 m depth. Size of recruits ranged between 14 mm and 19 mm CL.

The threshold size (14.5 mm) to extract recruitment indices has been derived by the separation of length frequency distribution (Batthacharya method) applied to the years when the first mode was well detectable. The abundance indices of individuals <=14 mm has been considered has recruitment index.

Indices are related to the total area (N/Km^2, not raised to the total area).



Direct methods: trawl based Spawner analysis

Table 4.1.1-7: Trawl surveys; spawners analysis summary

Survey	**MEDITS**	**Trawler/RV**	**PEC**
Survey season			summer
Investigated depth range (m)			10-800
Spawning season and peak (months)			All year round (April-May; September-October)

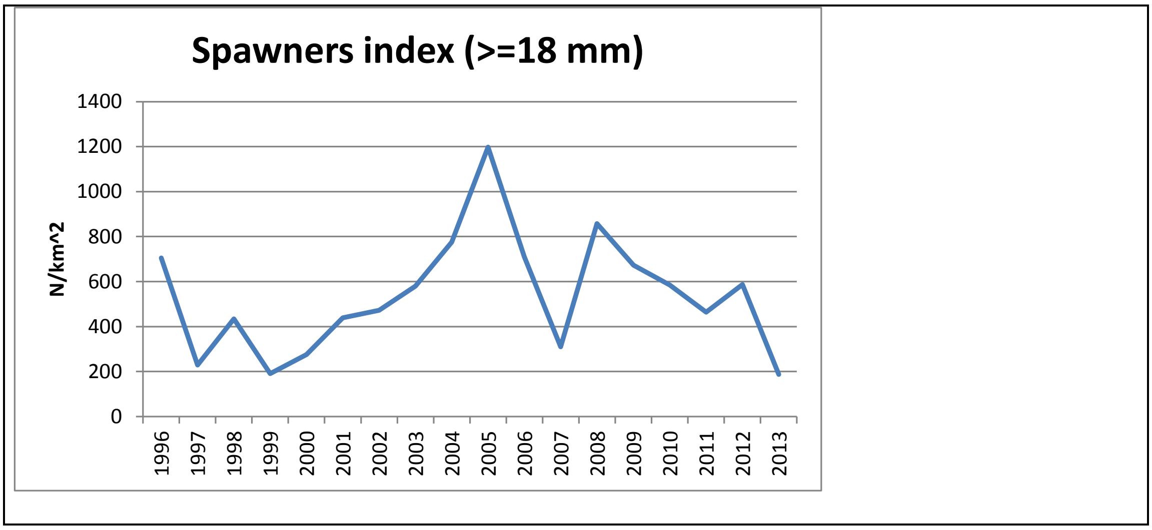
Table 4.1.1-8: Trawl surveys; spawners analysis results (>= 18 mm)

Years	Area in km^2	N of spawners per km^2	CV or other
1996	29008	705	23.5
1997	29008	229	18.8
1998	29008	434	19.5
1999	29008	191	15.4
2000	29008	276	18.6
2001	29008	439	15.6
2002	29008	472	12.6
2003	29008	580	18.1
2004	29008	776	21.7
2005	29008	1198	15.7
2006	29008	710	15.3
2007	29008	311	22.9
2008	29008	858	21.4
2009	29008	672	18.3
2010	29008	584	18.9
2011	29008	464	18.9
2012	29008	588	21.1

Comments

P. longirostris is a sequential spawners, spawning all year round with peaks in April-May and September-October. Adult aggregations of females are mainly located in the eastern part of the GSA18, along the Albania coast.

Indices are related to the total area (N/km^2, not raised to the total area).



4.1.2 Spatial distribution of the resources

The geographical distribution pattern of pink shrimp in the GSA 18 has been studied using trawl-survey data and geostatistical methods. In these studies the abundance indices of recruits were analysed. Results highlighted that areas located in the Gulf of Manfredonia and between Monopoli and Brindisi coasts within 200 m depth are characterised by high concentration of pink shrimp recruits reaching 2000 individuals/km2 in 2000-2001. A peak of 5000 individuals/km2 was observed in the southernmost location (border between GSA 18 and 19) off Capo S. Maria di Leuca (e.g. Carlucci et al., 2009).

Pink shrimp nursery areas obtained applying the indicator kriging techniques are reported below (Fig. 4.1.2-1).

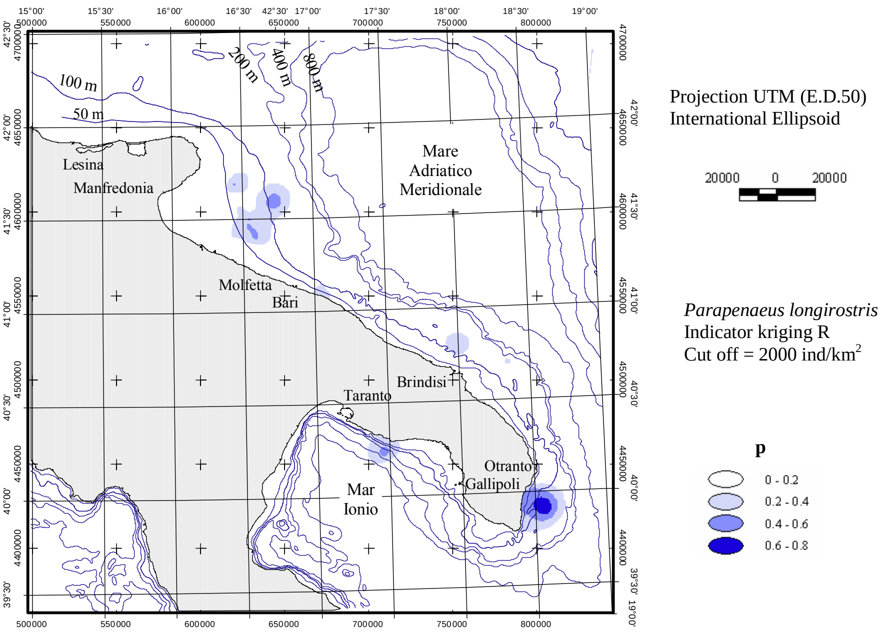


Fig. 4.1.2-1. Geographical distribution patters of pink shrimp nursery areas as estimated from MEDITS

In the MEDISEH project (DG MARE Specific Contract SI2.600741, call for tenders MARE/2009/05), nursery areas and spawner aggregations have been detected, mainly in the eastern part of the GSA18, along the Albania coasts, where a persistent spawning ground is localized.

Warmer and saltier waters flowing in the eastern side are a favourable environmental condition for the preferential distribution of this species.

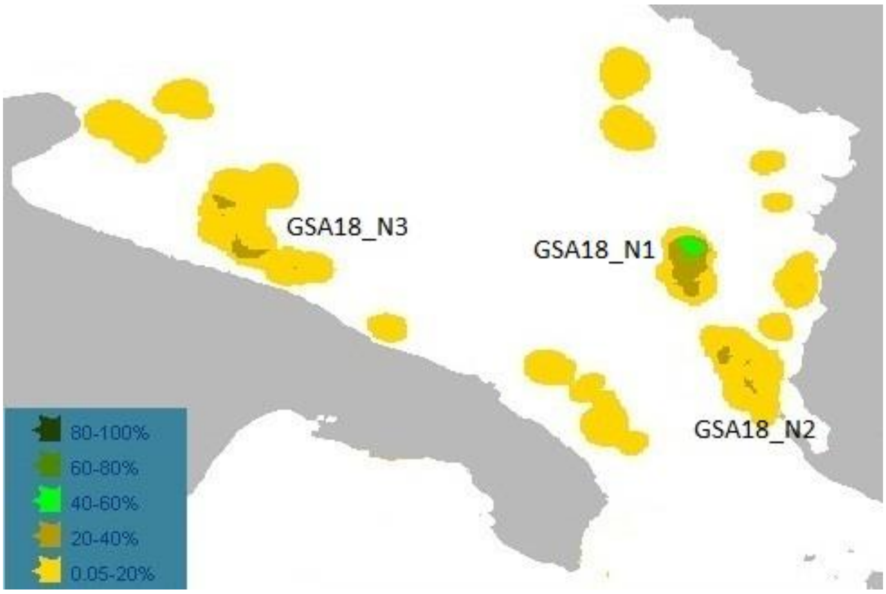


Fig. 4.1.2-2. Locations of persistent nurseries of *P. longirostris* in GSA 18

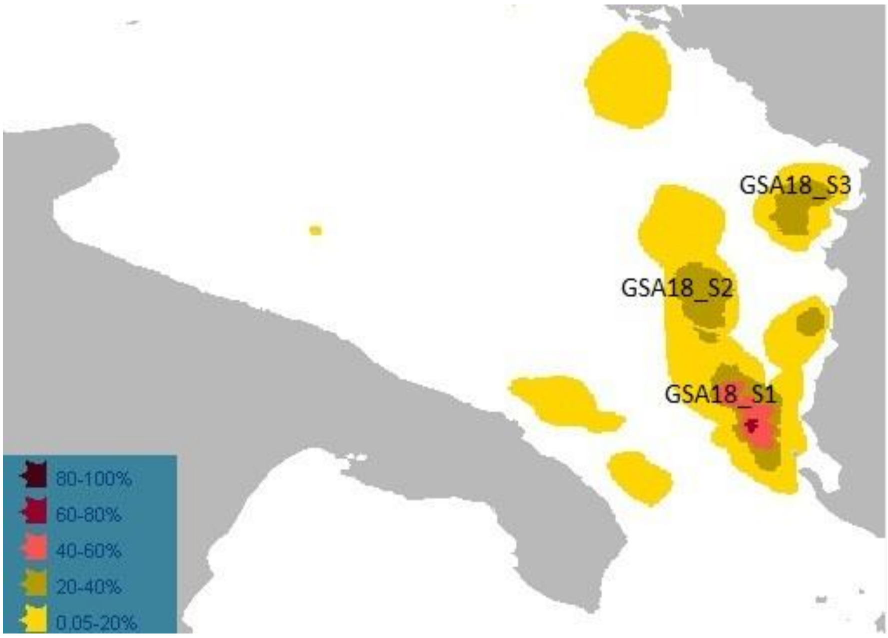


Fig. 4.1.2-3. Locations of persistent spawning areas of *P. longirostris* in GSA 18

4.1.3 Historical trends

Observed abundance and biomass indices of *P. longirostris* are given on the figures below (Fig. 4.1.3-1, 4.1.3-2).

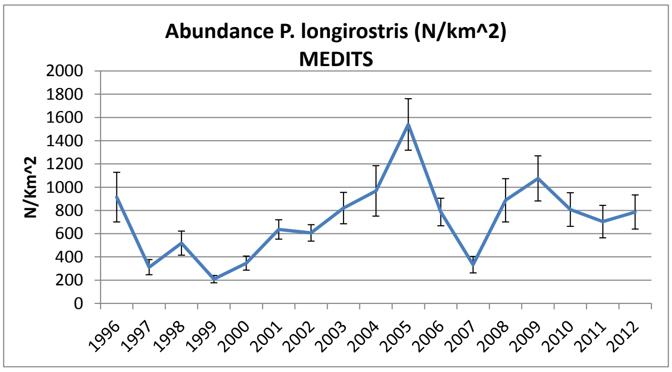


Fig. 4.1.3-1. Estimated abundance indices (N/km^2) of *P. longirostris* in GSA 18, 1996–2012

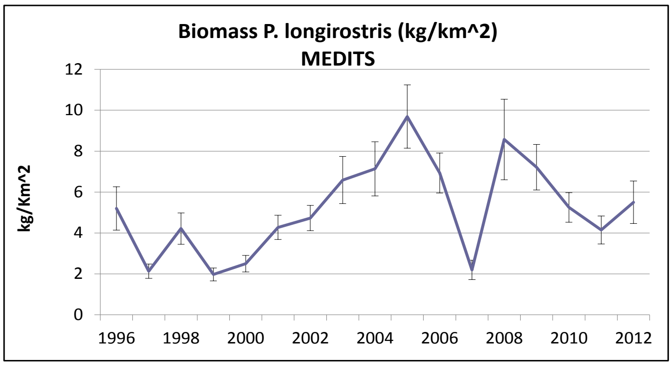


Fig. 4.1.3-2. Estimated biomass indices (kg/km^2) of *P. longirostris* in GSA 18, 1996-2012

Both estimated abundance and biomass indices show similar trends, with a sharp drop in values in 2005-2007, a recovery until 2009 followed by a gradual drop until 2011 and a slight recovery in 2012.

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 XSA

Standardized LFD abundance indices (N/km2) for the whole GSA18 from MEDITS trawl survey data from 1996 to 2012 have been used for the analysis. The length structure of landings and production by fishing segment from DCF has been used for west side, while for the east side data collected within a pilot study in the framework of Adriamed project (Montenegro) and from National Statistics (Albania).

All the LFDs have been transformed in age distributions by age slicing procedure to be used as XSA input.

6.1.1 Model assumptions

The major assumption of the method is the flat selectivity for the oldest ages (selectivity as classical ogive). The method performs a tuning by survey index by age. The method was applied using the age data obtained by the slicing of the length frequency distributions of the landing and survey data.

6.1.2 Scripts

The rows related to the best run (shrinkage 0.5) are reported.

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

dps.stk <- readFLStock("DPS18.IND", no.discards=TRUE)

units(harvest(dps.stk))<-"f"
range(dps.stk)["minfbar"] <- 0
range(dps.stk)["maxfbar"] <- 2

dps.stk <- setPlusGroup(dps.stk, 3)

dps.idx <- readFLIndices("DPS18TUN.DAT")

# settings of XSA
FLXSA.control.dps_05 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,
rage=-1,  qage=1,  shk.n=TRUE,  shk.f=TRUE,  shk.yrs=2,shk.ages=2,window=100,  tsrange=20,
tspower=3, vpa=FALSE)

dps.xsa_05 <- FLXSA(dps.stk, dps.idx, FLXSA.control.dps_05)
dps.stk_05 <- dps.stk+dps.xsa_05

#summary plot
plot(dps.stk_05,main="Shrinkage 0.5")

#diagnostic and residuals
diagnostics(dps.xsa_05)
res05<-as.data.frame(index.res(dps.xsa_05))

#plot of residuals
res05[["sign"]] = ifelse(res05[["data"]] >= 0, "positive", "negative")
ggplot(data=res05)+geom_point(aes(x=year, y=age, size=abs(data), colour=sign), shape=16)+
scale_colour_manual(values=c("positive"="red","negative"=darkblue"))
```

```
+scale_size_continuous(breaks = seq(-2, 2, by = 0.2))+ggtitle("Log catchability residuals at age by year Sh05")

#retrospective analysis
dps.stk.retro_05 <- retro(dps.stk, dps.idx, FLXSA.control.dps_05, 3)
plot(dps.stk.retro_05)
```

6.1.3 Input data and Parameters

XSA uses catch-at-age, mean weight at age, landing, proportion of mature individuals by age, natural mortality by age and mean weight at age in stock to perform the analysis, which is tuned by survey data (MEDITS) by age. Catch-at-age and tuning data are presented in tables 6.1.3-1 and 6.1.3-2, respectively.

Table 6.1.3-1. Catch-at-age data used in the assessment

	Catch-at-age (thousands)					
Age class	2007	2008	2009	2010	2011	2012
0	61810.1	64793.7	65538.8	49196.1	34414.4	54163.9
1	83758.8	85161.5	84408.2	100917.1	89200.1	52509.7
2	5348.4	4570.0	3766.1	5777.4	4703.4	2591.1
3+	175.6	143.6	109.0	231.9	251.5	64.4

Table 6.1.3-2. Tuning data used in the assessment

	Catch-at-age (N/km^2)					
Age class	2006	2007	2008	2009	2010	2011
0	106.46	178.37	712.09	476.1	461.56	455.21
1	156.08	498.33	335.88	302.41	225.85	321.79
2	39.24	168.42	25.35	24.61	15.66	8.93
3	17.69	47.54	2.47	4.95	0.64	0.07

Discards data of 2009, 2010, 2011 and 2012 were available for the western side. The proportion of the discards of hake in the GSA 18 was generally less than 10%. Considering the amount of discards and the fact that the collection of discard data was not foreseen in DCF in 2007 and 2008 and discards data are not available for the east side these data were not used in the analyses.

Additional settings for XSA are listed below:

- Catchability independent of size for all ages
- Catchability independent of age for ages > 1
- S.E. of the mean to which the estimates are shrunk = 0.5
- Minimum standard error for population estimates derived from each fleet = 0.3

6.1.4 Results

Fishing mortality (F) shows the minimum value of 1 ($\bar{F}$ or F_{bar}) in 2009, and a maximum of 1.42 in

2011. Average F for the period of last three years was 1.33, while in 2012 it was 1.36 (Fig. 6.1.5-1).

The increase of F in the last years seems consistent with the decrease in landing associated to the decrease in abundance indices.

The $F_{0.1}$ value estimated on the basis of the XSA was 0.77 by FLBRP package (FLR library).

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

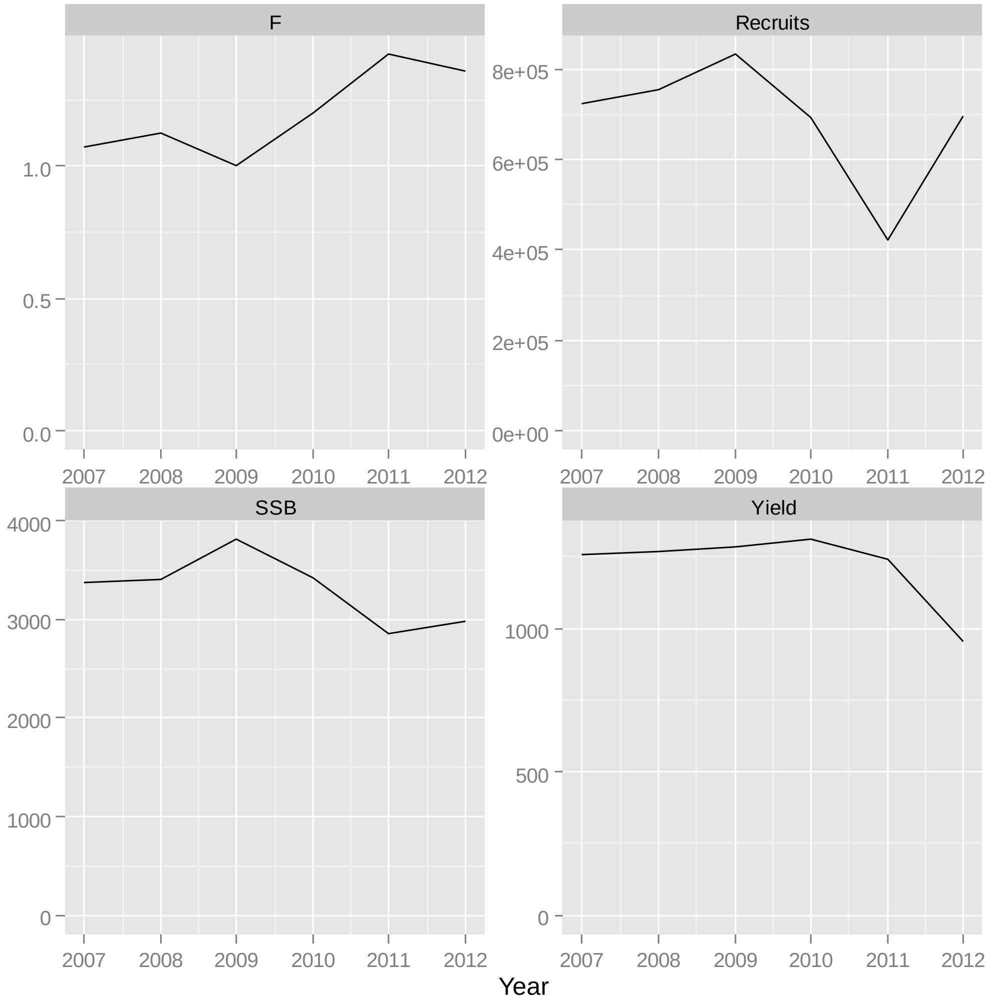


Fig. 6.1.5-1. Summary XSA results for *P. longirostris* in GSA 18.

6.1.5 Robustness analysis

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

Sensitivity analysis with shrinkage values of 0.5, 1.0, 1.5 and 2.0 was performed on the results, and on the basis of the residuals and of the retrospective analyses, shrinkage of 0.5 (Fig. 6.1.6-1) was chosen as the best one.

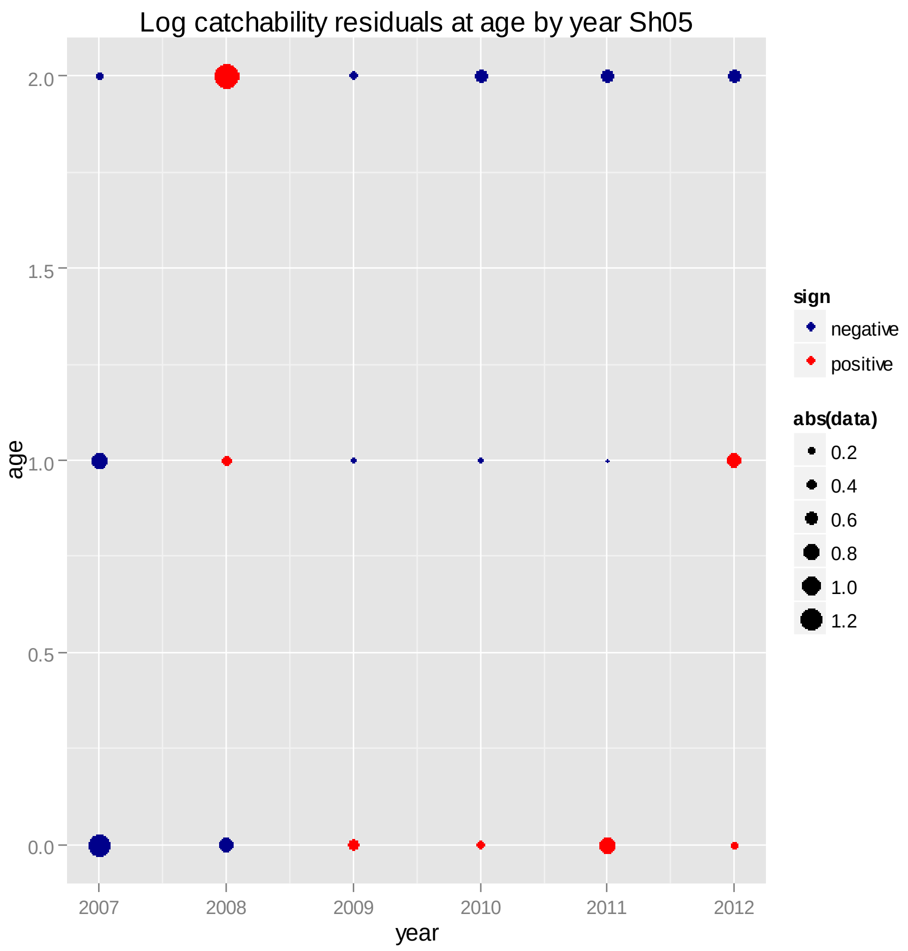


Fig. 6.1.6-1. Log catchability residuals at shrinkage 0.5

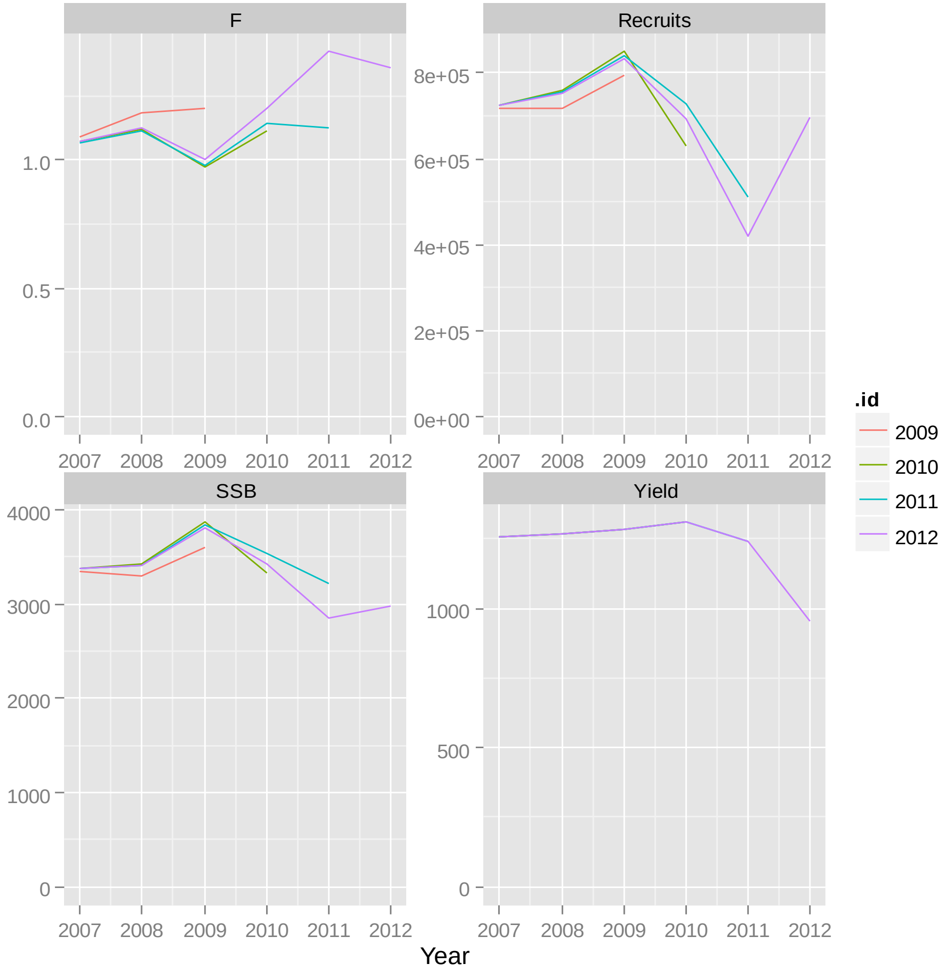


Fig. 6.1.6-2. Retrospective analysis results

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

6.1.7 Assessment quality

The assumption of ogive selectivity for this species seems consistent. The length of the time series is consistent with the lifespan of the species, allowing to obtain plausible results.

6.2 ALADYM

6.2.1 Model assumptions

An exercise was accomplished using ALADYM (Lembo et al., 2009) simulation model, to figure out effects of possible management measures. The model is belonging to the family of pool-dynamic models. ALADYM uses a monthly time scale and a multi-fleet/gear approach. For this assessment classical ogive selectivity function has been assumed for all the fleet segments, with different parameters according to the mesh size used by each fleet segments.

The recruitment is assumed constant (average of the last three years) in the projections.

The hind-casting approach has been used for this assessment for comparison with the XSA results in the period 2007-2012 and to perform the projections for the future.

6.2.2 Scripts

Version 10.0 has been used for the assessment. Inputs and parameters are specified in the following paragraphs.

6.2.3 Input data and Parameters

For the ALADYM analysis, four fleet segments have been assumed:

- Italian trawlers <24 m;
- Italian trawlers >24 m;
- Albanian trawlers;
- Montenegrin trawlers.

Until 2010, selectivity of all fleet segments was assumed to correspond to the classical ogive with $SL_{50\%}$ = 14.2 mm and selectivity range (SR) of 2.9 mm. From 2011, all fleet segments apart from Montenegrin trawlers are assumed to use diamond mesh size of 50 mm and corresponding values of $SL_{50\%}$ = 17 mm and SR = 2.9 mm. Montenegro continues to use 40 mm diamond mesh size, with previously mentioned corresponding values.

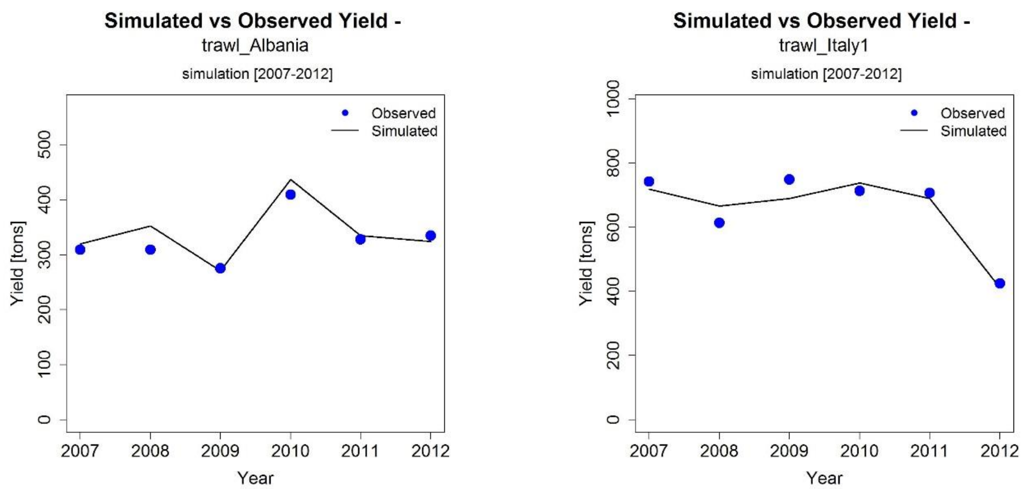
DCF data for Italian trawlers have been used (monthly production and effort). For Albania and Montenegro, annual production data has been split to 12 months equally. For Montenegro, monthly effort data has been used, while data for Albania assumes constant effort.

Natural mortality (M), maturity, and other relevant data used are the same as for the XSA. The recruitment and fishing (F) and total mortality (Z) values used correspond to the results obtained through the XSA (hind-casting).

6.2.4 Results

A satisfactory fit has been obtained with ALADYM simulation model for all the fleet segments with a mean of 5% of percentage difference between simulated and observed landing.

Comparison between observed yield values and values simulated by the ALADYM assessment are provided on Fig. 6.2.7-1.



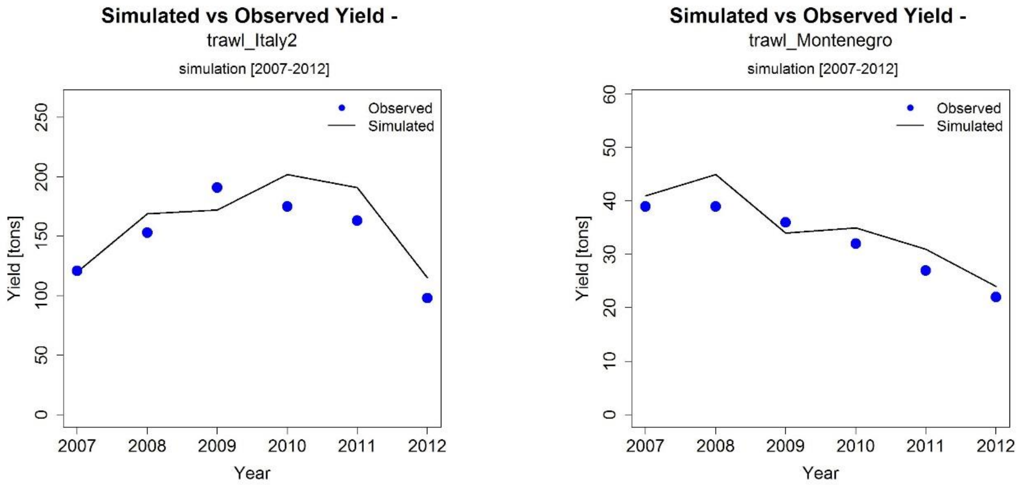


Fig. 6.2.4-1. Simulated vs. observed yield for various fleet segments used in the assessment

6.2.5 Robustness analysis

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

6.2.7 Assessment quality

The assumptions used for the simulations tried to accommodate different selectivity of codend.

Furthermore, the hind-casting approach used for this assessment was accomplished to supporting the validity of the combined assessment.

7 Stock predictions

The recruitment has been assumed equal to the average of the last three years (around 604 millions of individuals) in the projections, being lacking a reliable stock recruitment relationship.

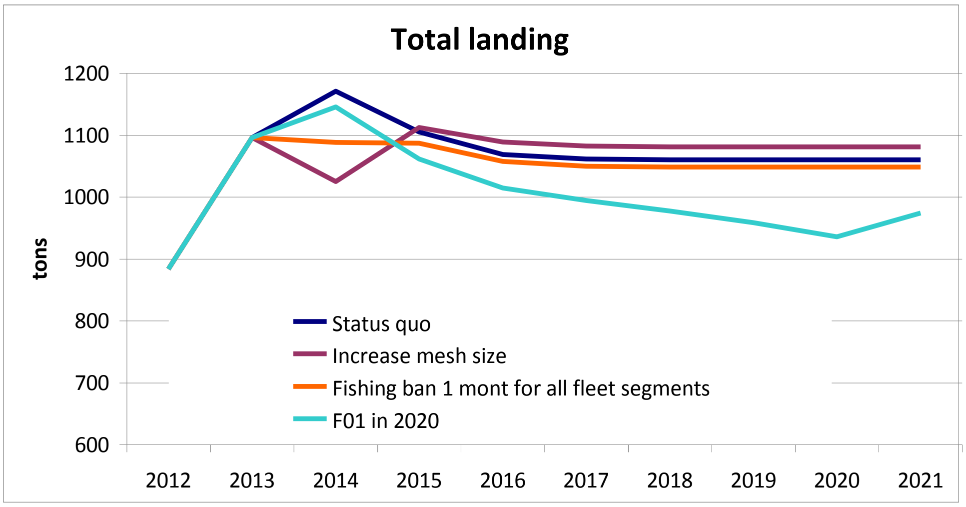
Four different scenarios were assumed:

- Scenario 1 – "status quo" or no changes until 2021;
- Scenario 2 – Gradual reduction of F towards $F_{0.1}$ in 2020;
- Scenario 3 – Increase in mesh size (60 mm diamond mesh size for Italy and Albania, 50 mm for Montenegro);
- Scenario 4 – Introduction of fishing ban in order to have at least one month for the different fleet segments.

All the management measures are applied since 2014; 2013 is assumed equal to 2012 (in recruitment, mortality and proportion of production due the fleet segments).

7.1 Short term predictions

7.2 Medium term predictions



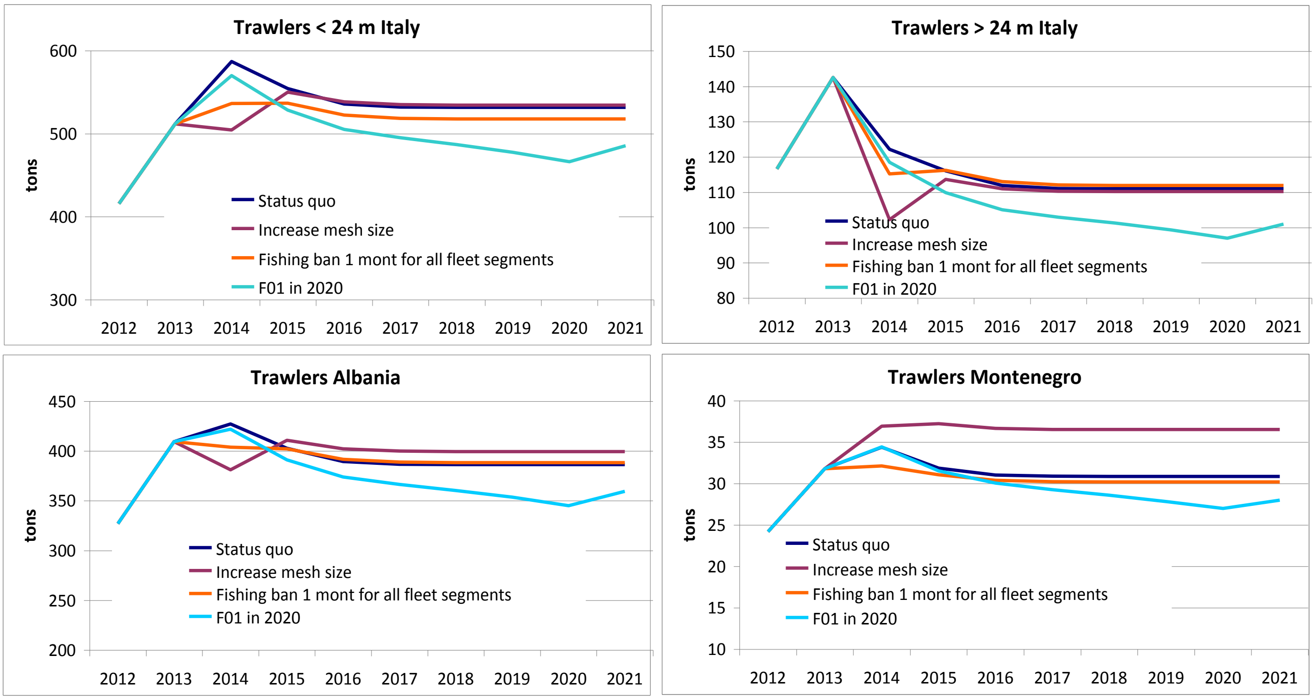


Fig.7.2-1. Simulation of the four scenarios (status quo, increase of mesh size, introduction of the fishing ban and reaching target value of $F_{0.1}$ by 2020) for the entire GSA18, and separately by fleet segments and country. Weights in tons.

For all scenarios except fishing ban and for all the fleet segments considered, the results show that the benefit of the strong recruitment in 2012 (696 millions of individuals) as well as the increase in mesh size of 2011 influences the landing until 2015.

Having a look to the landings of the different fleet segments, the results in medium term is similar to the total landing picture, with the best performances for catches given by the mesh size increase scenario.

On an overall basis, increasing the mesh size (to 60 mm diamond mesh size for Italy and Albania and 50 mm diamond mesh size for Montenegro) could lead to increased landings in the entire GSA (Fig. 7.2-1), under the assumption of total survival of all the escaped individuals from the codend.

The better effect to SSB is given instead by the scenario based on the gradual reduction of F towards F0.1 in 2020 (Fig. 7.2-2).

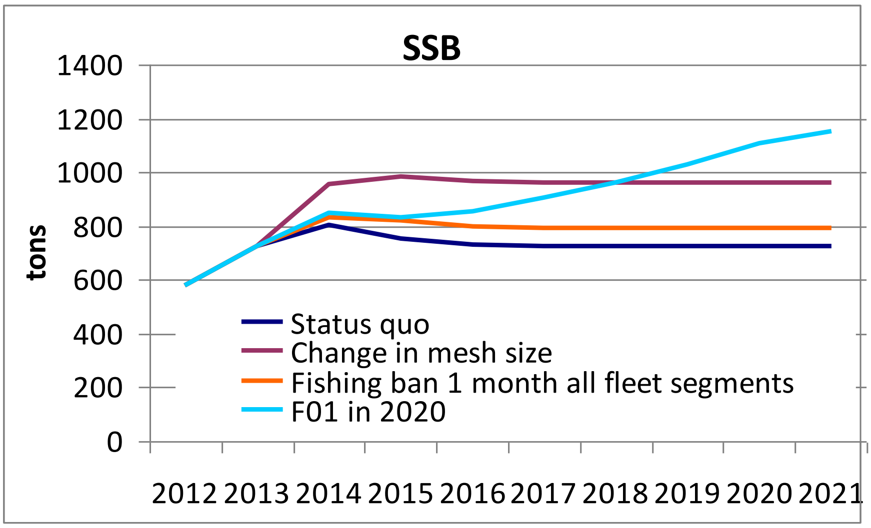


Fig. 7.2-2. Prediction of the changes to the spawning stock biomass according to the four scenarios simulated in ALADYM analyses, 2012-2021. Weights in tons.

Table 7.2-1. Forecast of the percentage variations of the state of the spawning stock biomass in 2021 according to the scenarios analysed, expressed in respect to the “status quo”

Scenario	Variation (%)
Increase mesh size	32
Fishing ban 1 month	9
$F_{0.1}$ in 2020	58

Under the assumption of total survival of all the escaped individuals from the codend, simulations showed that the mean carapax length of pink shrimp in landings would increase most significantly in all segments and in entire GSA 18 (Fig. 7.2-3).

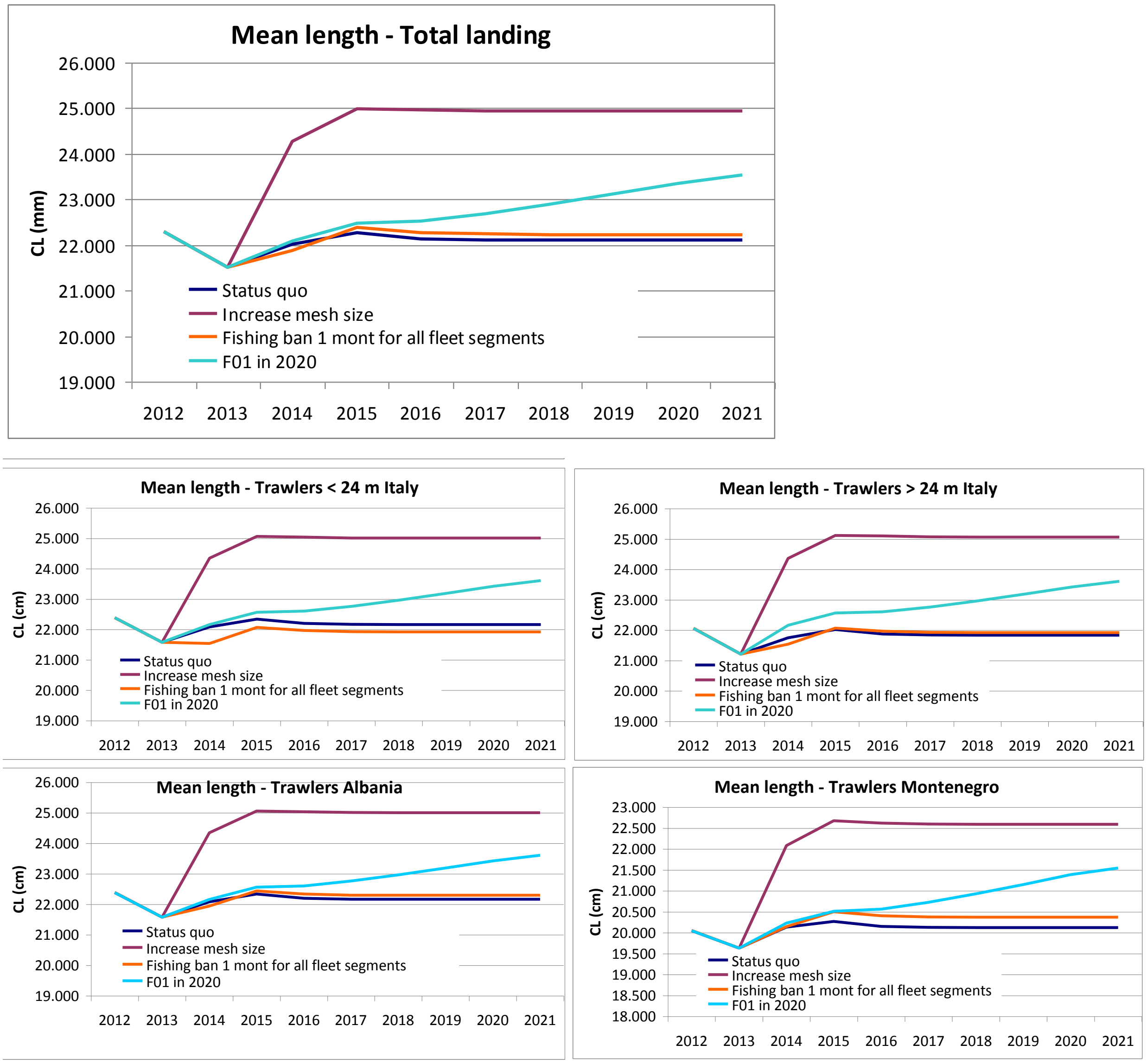


Fig. 7.2-3. Mean carapax length of pink-shrimp (in mm) in landing by country and/or fleet segment according to the four simulated scenarios (status quo, increase of mesh size, introduction of the fishing ban and reaching target value of $F_{0.1}$ by 2020) for GSA 18.

7.3 Long term predictions

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	$F_{0.1}$ = 0.75	F_c = 1.36			O_H
	Fishing effort					
	Catch					
Stock abundance	Biomass			Percentiles MEDITS biomass index (Kg/km^2): 33rd : 4.96 66th : 7.03 Current: 5.5		
	SSB					
Recruitment						
Final Diagnosis		High level of overfishing ($F_{curr}/F_{0.1}$ = 1.81 XSA) with intermediate level of biomass according to MEDITS survey data.				

The stock is in overfishing as current fishing mortality exceed F0.1. levels (1.36 vr. 0.75) and thus it is necessary to consider a considerable reduction of the fishing mortality to allow the achievement of F0.1. The reference point F0.1 can be gradually achieved by multiannual management plans that foresees a reduction of fishing mortality through fishing limitations. As observed in 2012, the contribute of each country to the total production of *P. longirostris* in the GSA18 is: Italy 60 %; Albania 38%; Montenegro 2%.

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).*

9 References

Abella, A., Caddy, J.F., Serena, F., 1997 – Do natural mortality and availability decline with age? An alternative yield paradigm for juvenile fisheries, illustrated by the hake Merluccius merluccius fishery in the Mediterranean. *Aquat. Liv. Res*. 10: 257–269.

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Carlucci R., Lembo G., P. Maiorano, F. Capezzuto, A.M.C. Marano, L. Sion, M.T. Spedicato, N. Ungano, a. Tursi, G. D'Onghia. 2009 Nursery areas of red mullet (*Mullus barbatus*), hake (*Merluccius merluccius*) and deep-water rose shrimp (*Parapenaeus longirostris*) in the Eastern-Central Mediterranean Sea, Estuarine, Coastal and Shelf Science (2009), doi: 10.1016/j.ecss.2009.04.034

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Lembo G., A. Abella, F. Fiorentino, S. Martino and M.-T. Spedicato. 2009 ALADYM: an age and length-based single species simulator for exploring alternative management strategies. Aquat. Living Resour. 22, 233–241.