Stock Assessment Form

Demersal species

Reference year: 2012

Reporting year: 2013

P. longirostris represents one of the most important resources of the demersal assemblage in the Ionian sea where it is distributed between 100 and 500 m depth and targeted mainly by trawlers. A first stock assessment of this species in the area has been performed in 2013, during the EWG 13-09, using different sources of data (fishery dependent and fishery independent). Given the results from this analysis, the stock is in overfishing and it is necessary to consider a reduction of the fishing mortality. Here the evaluation is expanded to an exercise using the ALADYM simulation model to explore effects of possible different management scenarios.

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:**
GSA19		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
ITALY		
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
Combined (XSA, ALADYM)		
Authors:		
Bitetto I.[1], Recasens L.[2], Carbonara P.[1], Casciaro L.[1], Facchini M. T.[1], Lembo G.[1], Spedicato M. T.[1]		
Affiliation:		
[1] COISPA Tecnologia & ricerca, Bari – Italy; [2]Institut Ciències Mar Barcelona (ICM-CSIC) – Spain		

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)

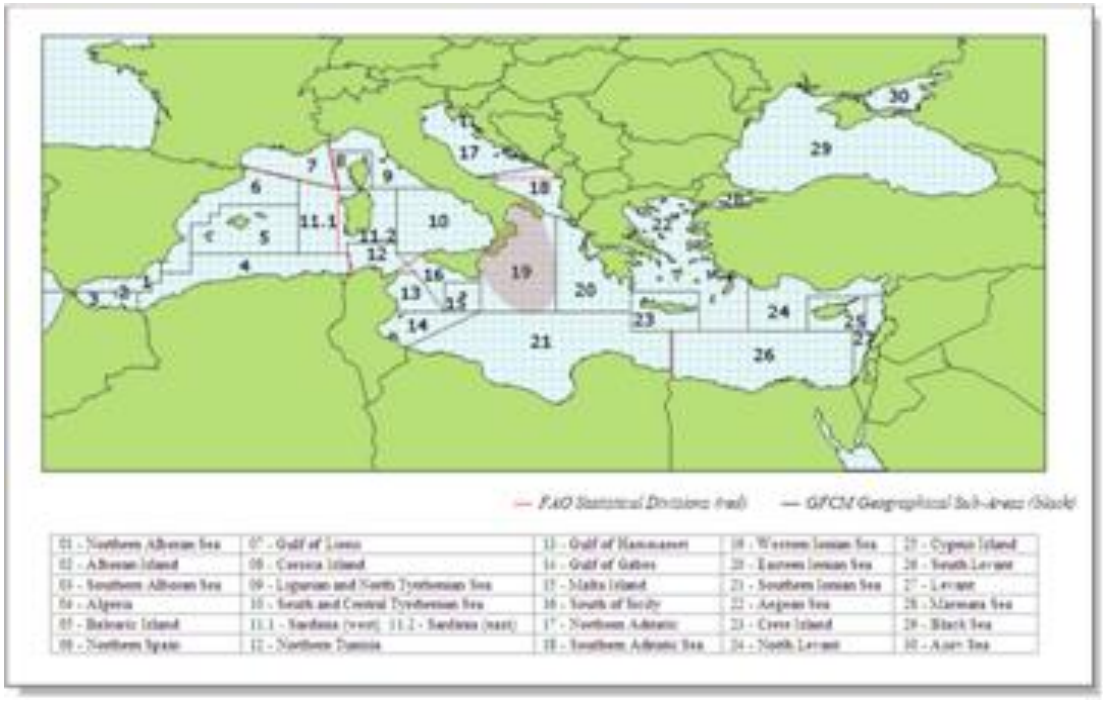
Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify).

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

The North-Western Ionian Sea is geo-morphologically divided in two sectors by the Taranto Valley (NW-SE canyon exceeding 2200 m in depth): an Eastern sector and a South-Western one. Along the Calabria and Sicily, the shelf is limited with the shelf break at a depth varying between 30 and 100 m. Many submarine canyons are located along these coasts. The general cyclonic circulation in the Ionian Sea is markedly influenced by the cold dense deep-water masses of the Adriatic Sea inflowing through the Otranto Channel and by the LIW. The north-western Ionian Sea, like most of the Mediterranean Sea, has oligotrophic conditions.

Due to a lack of information about the structure of deepwater pink shrimp population, this stock was assumed to be confined within the boundaries of the GSA19.



2.1 Growth and maturity

Growth parameters (Linf= 46.0, k= 0.6; to= -0.2, sex combined) and length- weight relationship parameters (a=0.94 and b=2.45, length in cm and weight in g) used in the assessment were from DCF and are very similar to Maiorano et al. (2010).

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**	Between late spring and autumn
Maximum size			46	**Recruitment**	All year

observed				**season**	
Size at first maturity	19.3			**Spawning area**	Aggregation areas for adults specimens were detected offshore Gallipoli and Roccella Ionica.
Recruitment size to the fishery				**Nursery area**	Persistent nursery areas on the shelf between Otranto and Santa Maria di Leuca in the Gulf of Squillace and between Siracusa and Cape Passero.

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

Age	Natural mortality	Proportion of matures
0	*1.41*	*0.47*
1	*0.81*	*0.98*
2	*0.7*	*1*
3+	*0.7*	*1*

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

Age	Natural mortality	Proportion of matures

0	*1.41*	*0.47*
1	*0.81*	*0.98*
2	*0.7*	*1*
3+	*0.7*	*1*

In GSA 19 the deep-water pink shrimp showed an extended reproductive period between late spring and autumn. The highest percentage of mature females was recorded during autumn.

The maturity ogive Fig. 2.2-1 was obtained in DCF 2008 framework from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b-2e (according to the Medits maturity scale).

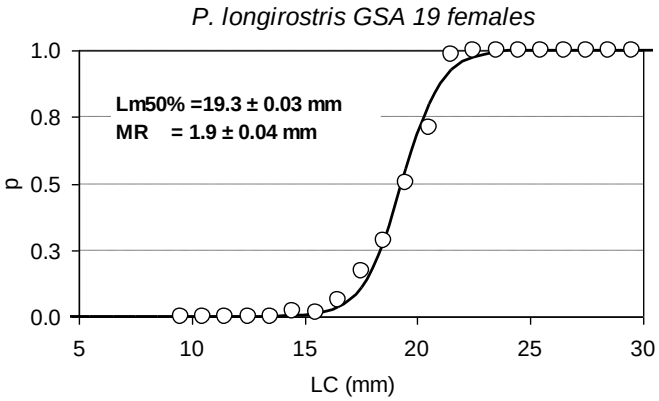


Figure 2.2-1 Maturity ogive of pink shrimp in the GSA19 (MR indicates the difference Lm75%-Lm25%) from DCF 2008.

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

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	mm			46	2006-2012
	K	year^-1			0.6	2006-2012
	t_0	year			-0.2	2006-2012

	Data source		DCF	
Length weight relationship	**a**		0.0033	2006-2012
	b		2.45	2006-2012
	M (scalar)			
	sex ratio (% females/total)	0.5		

3 Fisheries information

3.1 Description of the fleet

In the north-western Ionian Sea, fishing of *P. longirostris* occurs from coastal waters (70-80 m depth) to 700–750 m. The most important demersal resources are represented by the red mullet (*Mullus barbatus*) on the continental shelf, hake (*Merluccius merluccius*), rose shrimp (*Parapenaeus longirostris*) and Norway lobster (*Nephrops norvegicus*) over a wide bathymetric range and the deep-water red shrimps (*Aristeus antennatus* and *Aristaeomorpha foliacea*) on the lower slope/bathyal bottoms. Pink shrimp is only targeted by trawlers in this area. Gallipoli, Taranto, Crotone, Reggio Calabria and Catania represent the most important fisheries in the north-west Ionian Sea, although with a different distribution of the fishing effort. The most important metier is mixed demersal deep water species which represent about 40% of trawlers.

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

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1	ITA	19	D – Trawls (6-12 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 2	ITA	19	E – Trawls (12-24 m)	03 – Trawls	33 – Demersal shelf species	DPS
Operational Unit 3	ITA	19	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)
Operational Units 1+2+3	225	488 T				
Total	225	488 T				

* Catch values used in the assessments and are related to 2012.The catch data are from DCF. The number of vessels is from Fisheries and Maritime Affairs' Fleet Register, 2012.

3.2 Historical trends

Available time series for the deep-water pink shrimp landings in GSA 19 is relatively short (Table 3.2-1), consisting of seven years (2006-2012). For the assessment commercial and MEDITS survey LFDs have been used.

Table 3.2-1. Landing data for GSA 19 by year

Year	Landing
2006	1245
2007	608
2008	785
2009	767
2010	716
2011	593
2012	488

3.3 Management regulations

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. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

In the GSA 19 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers, whilst in the last years it was mandatory.

Porto Cesareo MPA was permanently established in 1997 (Decree of Ministry of Environment of 12.12.1997; G.U. n. 45 del 24/02/1998). Porto Cesareo MPA is delimited by Punta Prosciutto and Torre dell'Inserraglio and its surface is 16.654 hectares. The MPA is divided in three zones with different level of protection, from total to partial.

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.

3.4 Reference points

Table 3.3-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B					
SSB					
F			F0.1	0.67	Based on the assessment performed during STECF EWG 13-09 (STECF, 2013).
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 area.
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 (Souplet, 1996).

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information - GSA19

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

Table 4.1-2.1: Trawl survey sampling area and number of hauls GSA 19

Stratum	**Total surface (km^2)**	**Trawlable surface (km^2)**	**Swept area (km^2)**	**Number of hauls**
[GSA 19] 10 – 50 m	1697			9
[GSA 19] 50 – 100 m	1331			8
[GSA 19] 100 – 200 m	2208			10
[GSA 19] 200 – 500 m	3830			14

[GSA 19] 500 – 800 m	4454			29
[GSA 19] Total (10 – 800 m)	13520			70

Table 4.1-3.1: Trawl survey abundance and biomass results GSA 19

Depth Stratum	Years	kg per km^2	CV or other	N per km^2	CV or other
Total (10–800 m)	2006	7.1	18.9	1455	25.7
Total (10–800 m)	2007	4.4	15.5	942	16.4
Total (10–800 m)	2008	8.7	17.6	1710	25.1
Total (10–800 m)	2009	12.2	13.1	2313	20.5
Total (10–800 m)	2010	10.9	15.0	2099	16.4
Total (10–800 m)	2011	6.9	22.6	1342	25.3
Total (10–800 m)	2012	8.8	14.9	1569	19.4

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 4.1-4: Trawl survey results by age class for GSA 19 used for tuning.

N (Total or sex combined) by Age class	Year						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
0	1005.2	737.2	1195.1	1553.2	1298.9	903.9	950.0
1	429.5	192.1	496.1	714.7	765.5	420.4	597.2
2	19.9	11.7	17.5	44.3	34.2	17.3	21.2
3+	0.5	0.5	1.0	0.4	0.8	0.3	0.9
Total	1455.1	941.7	1709.8	2312.7	2099.4	1341.9	1569.3

Sex ratio by Length or Age class	Year
	2006-2012
Total	0.5

Direct methods: trawl based Recruitment analysis

Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey	**MEDITS**	**Trawler/RV**	**PAC**
Survey season		Spring	
Cod –end mesh size as opening in mm		20	

Investigated depth range (m)	10-800
Recruitment season and peak (months)	peaks in autumn and spring
Age at fishing-grounds recruitment	0
Length at fishing-grounds recruitment	5 mm carapace length

Table 4.1-6.1: Trawl surveys; recruitment analysis results GSA 19 (age 0 individuals).

Years	Area in km^2	N of recruit per km^2	CV (%)
1994		39	37.5
1995		81	29.9
1996		260	36.1
1997		58	37.1
1998		161	43.7
1999		164	53.6
2000		54	35.7
2001		122	48.9
2002		87	30.8
2003		164	23.5
2004		102	63.3
2005		138	43.7
2006		323	41.1
2007		180	33.7
2008		274	54.3
2009		487	31.4
2010		516	34.0
2011		199	26.7

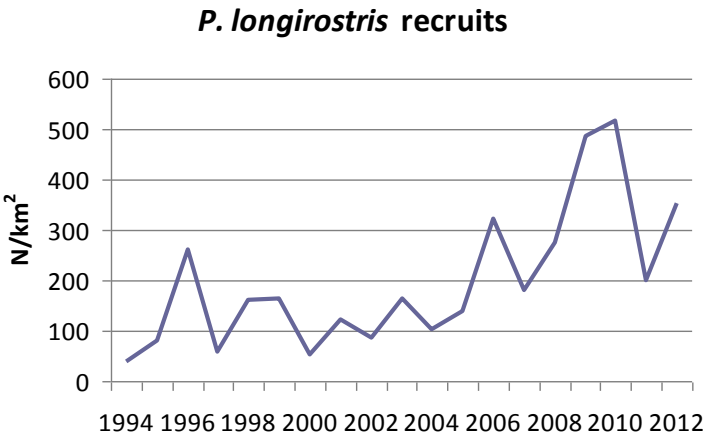
2012		354	34.2

Comments

Recruits index has been estimated analysing the LFDs and setting a cut-off in correspondence of the upper limit of the first mode. Then this value has been standardised to the swept area.

Recruitment follows a quasi-continuous pattern with main peaks in spring and autumn. The abundance indices of individuals of age 0 has been considered has recruitment index.

Indices are related to the total area.



Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey	**MEDITS**	**Trawler/RV**	**PAC**
Survey season			Spring and autumn
Investigated depth range (m)			10-800
Spawning season and peak (months)			April-May; September-October

Table 4.1-8: Trawl surveys; spawners analysis results

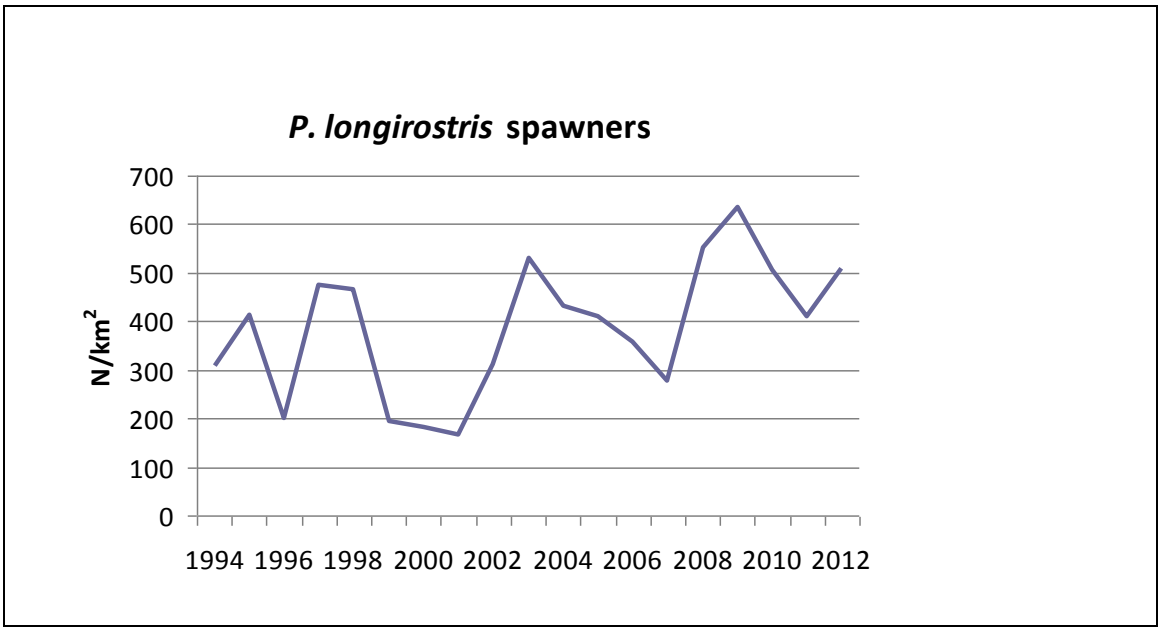
Surveys	**Area in km²**	**N (N of individuals) of spawners**	**CV or other**	**SSB per km²**	**CV or other**

		per km^2			
MEDITS					
1994		308	27.1		
1995		412	26.9		
1996		200	20.7		
1997		476	26.3		
1998		465	28.4		
1999		194	31.7		
2000		182	43.1		
2001		165	24.4		
2002		312	18.1		
2003		531	26.7		
2004		432	22.8		
2005		410	24.1		
2006		357	23.0		
2007		279	16.6		
2008		552	18.3		
2009		634	14.9		
2010		505	16.0		
2011		409	22.8		
2012		509	21.2		

Comments

P. longirostris is a sequential spawners, spawning all year round with peaks in April-May and September-October. Aggregation areas for adults specimens were detected offshore Gallipoli and Roccella Ionica. in the Gulf of Squillace and between Siracusa and Cape Passero.

Indices are related to the total area.


P. longirostris spawners
N/km2
700
600
500
400
300
200
100
0
1994 1996 1998 2000 2002 2004 2006 2008 2010 2012

4.1.2 Spatial distribution of the resources

In the MEDISEH project (DG MARE Specific Contract SI2.600741, call for tenders MARE/2009/05), in GSA19 the nursery areas of P. longirostris were mainly observed on the shelf and shelf break in the Gulf of Squillace and from Catania to Cape Passero (Fig. 4.1.2.1). The more persistent nursery areas were distributed on the shelf offshore Catanzaro, the shelf break-upper slope between Siracusa and Cape Passero. The spawning areas were distributed on deeper grounds compared to the nursery areas. In fact, the highest levels of persistency were detected for on the shelf break-upper slope south-eastern Santa Maria di Leuca, as well as offshore Gallipoli and Torre Ovo, eastern the Amendolara Bank, in the Gulf of Squillace and between Siracusa and Cape Passero.

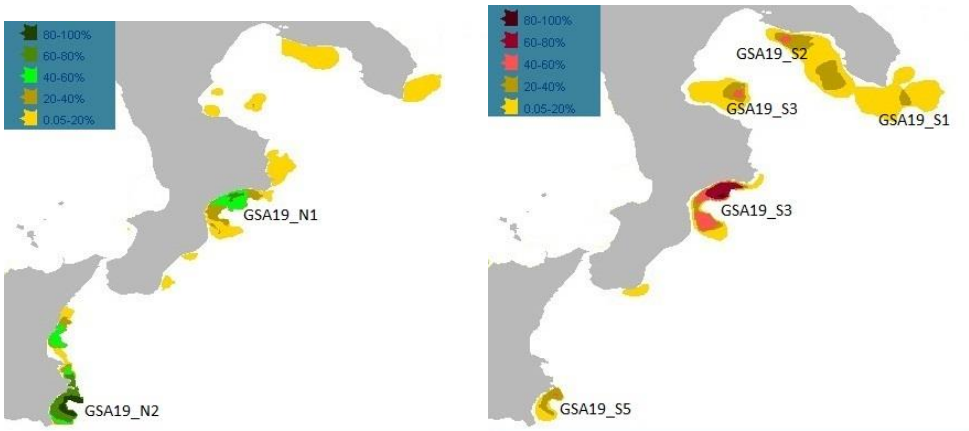


Fig. 4.1.2.1 Position of persistent nursery (left) and spawning areas (right) of deep-sea pink shrimp in GSA 19 (MEDISEH project).

4.1.3 Historical trends

Abundance indices show a global increase with a highest value in 2009. The last value of the time series is one of the higher in the whole time series both for density and biomass indices.

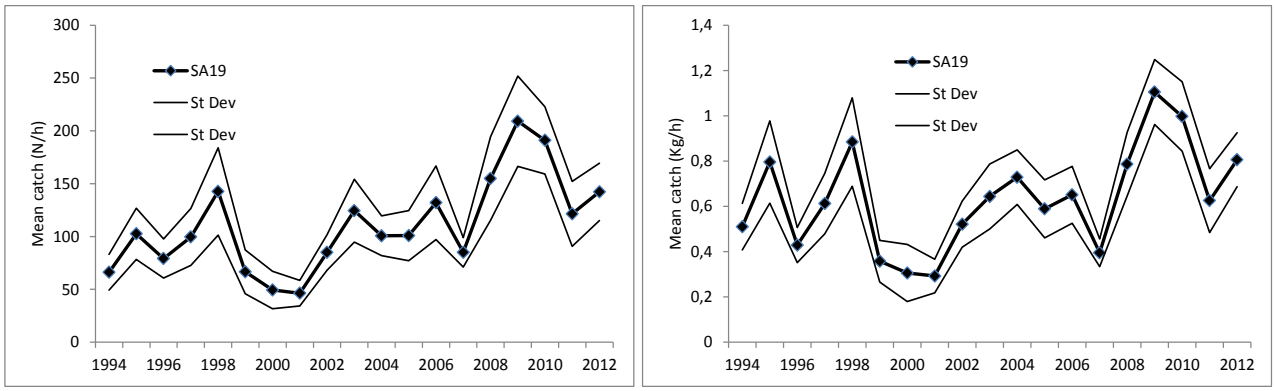


Fig.4.1-1. Abundance and biomass indices of pink shrimp in SA19 (STECF EWG 13-09 report).

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

XSA assessment has been performed for the first time within STECF EWG 13-09 (STECF, 2013 with DCF survey and commercial landing data from 2006 to 2012.

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 landings and survey data.

6.1.2 Scripts

```
library(FLCore)
library(FLEDA)
library(FLXSA)
library(FLAssess)
library(FLash)
library(ggplotFL)
library(plyr)
#read stock file
dps.stk <- readFLStock("DPS19.IND", no.discards=TRUE)
units(harvest(dps.stk))<-"f"
range(dps.stk)["minfbar"] <- 0
range(dps.stk)["maxfbar"] <- 2     # non consideriamo il plus group

#Set the plus group
dps.stk <- setPlusGroup(dps.stk, 3)
#read index (tuning file)
dps.idx <- readFLIndices("DPS19TUN.DAT")

FLXSA.control.dps1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1,
rage=-1, qage=1, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
window=100, tsrange=20, tspower=3, vpa=FALSE)
dps.xsa_1 <- FLXSA(dps.stk, dps.idx, FLXSA.control.dps1)
dps.stk_1 <- dps.stk+dps.xsa_1
plot(dps.stk_1,main="Shrinkage 1")

# diagnostics and residuals
diagnostics(dps.xsa_1)
res1<-as.data.frame(index.res(dps.xsa_1))
ggplot(data = res1)+geom_point(aes(x=year, y = age,size=abs(data),
```

```
colour=sign),shape=16)+    scale_colour_manual(values = c("positive" = "red", "negative"
= "darkblue"))+scale_size_continuous(breaks= seq(-2, 2, by = 0.2))+ggtitle("Log
catchability residuals at age by year Sh2")

#retrospective analysis

dps.stk.retro_1 <- retro(dps.stk, dps.idx, FLXSA.control.dps1, 3)

plot(dps.stk.retro_1)
```

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 (no discard is included, because <10%) for GSA 19

	Catch-at-age (thousands)						
Age class	2006	2007	2008	2009	2010	2011	2012
0	97034	67395	94337	102563	74717	73810	58313
1	70538	30102	37695	33765	37263	26468	19523
2	3587	230	735	718	1495	1546	562
3+	155	0	13	2	46	1	22

Table 6.1.3-2. Tuning data used in the assessment for GSA 19

	Catch-at-age (N/km^2)						
Age class	2006	2007	2008	2009	2010	2011	2012
0	1005	737	1195	1553	1299	904	950
1	430	192	496	715	765	420	597
2	20	12	17	44	34	17	21
3+	1	1	1	0	1	0	1

Natural mortality and maturity vectors are reported in section 2.2.

The 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 = 1
- Minimum standard error for population estimates derived from each fleet = 0.3.

6.1.4 Results

The results obtained with XSA method showed a decreasing pattern in SSB (from 2142 in 2006 to 984 tons in 2011) except for 2012 where SSB shows a very small increase to 1006 tons. Recruitment shows a global decrease until 2012 and a pick in 2009.

The F shows a decrease in time from 2.81 in 2006 to 1.6 in 2012.

The $F_{0.1}$ value estimated on the basis of the XSA was 0.67 by FLBRP package (FLR library).

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

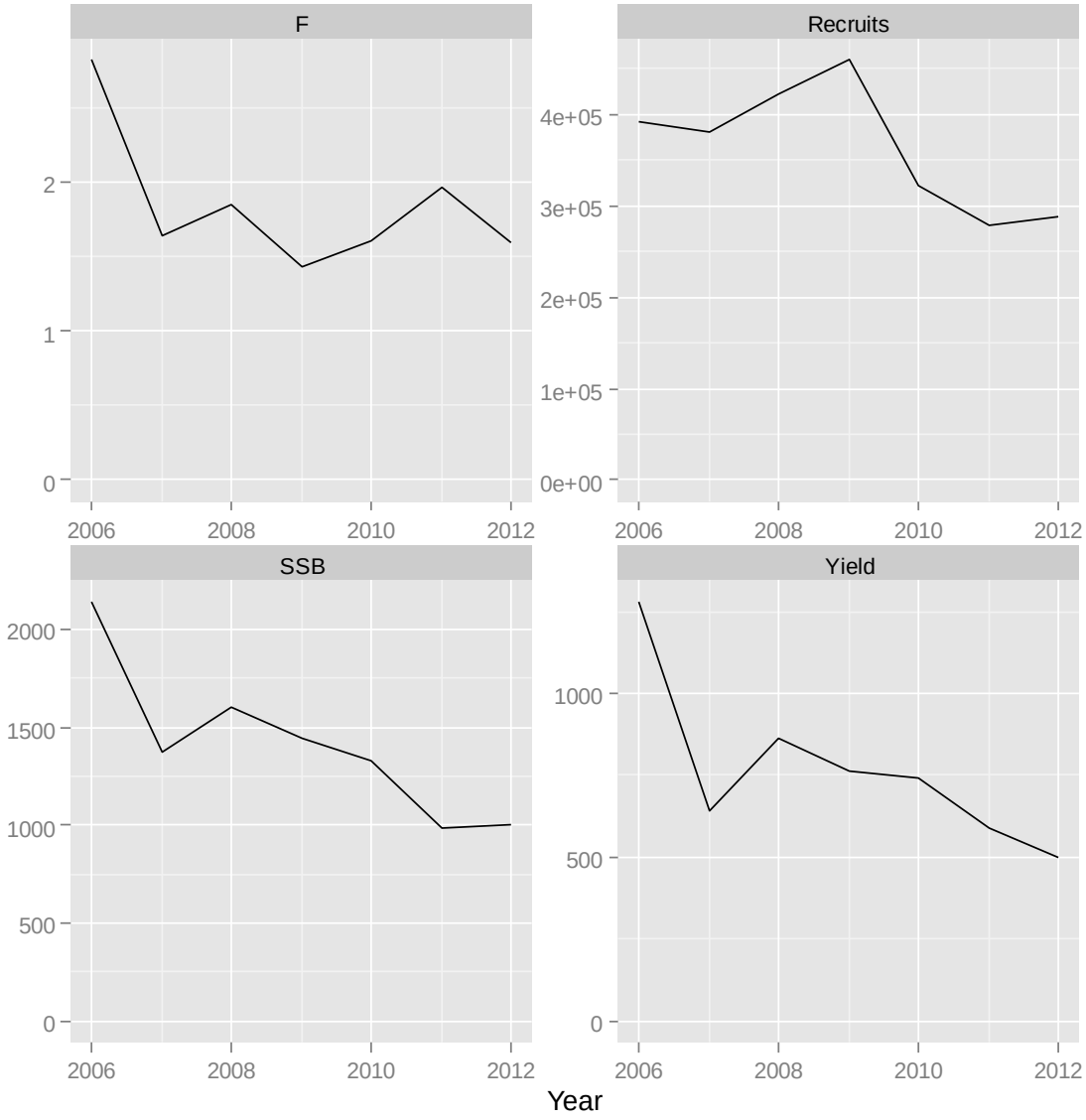


Fig. 6.1.5-1. Summary XSA results for *P. longirostris* in GSA 19.

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 1 (Fig. 6.1.6-1) was chosen as the best one.

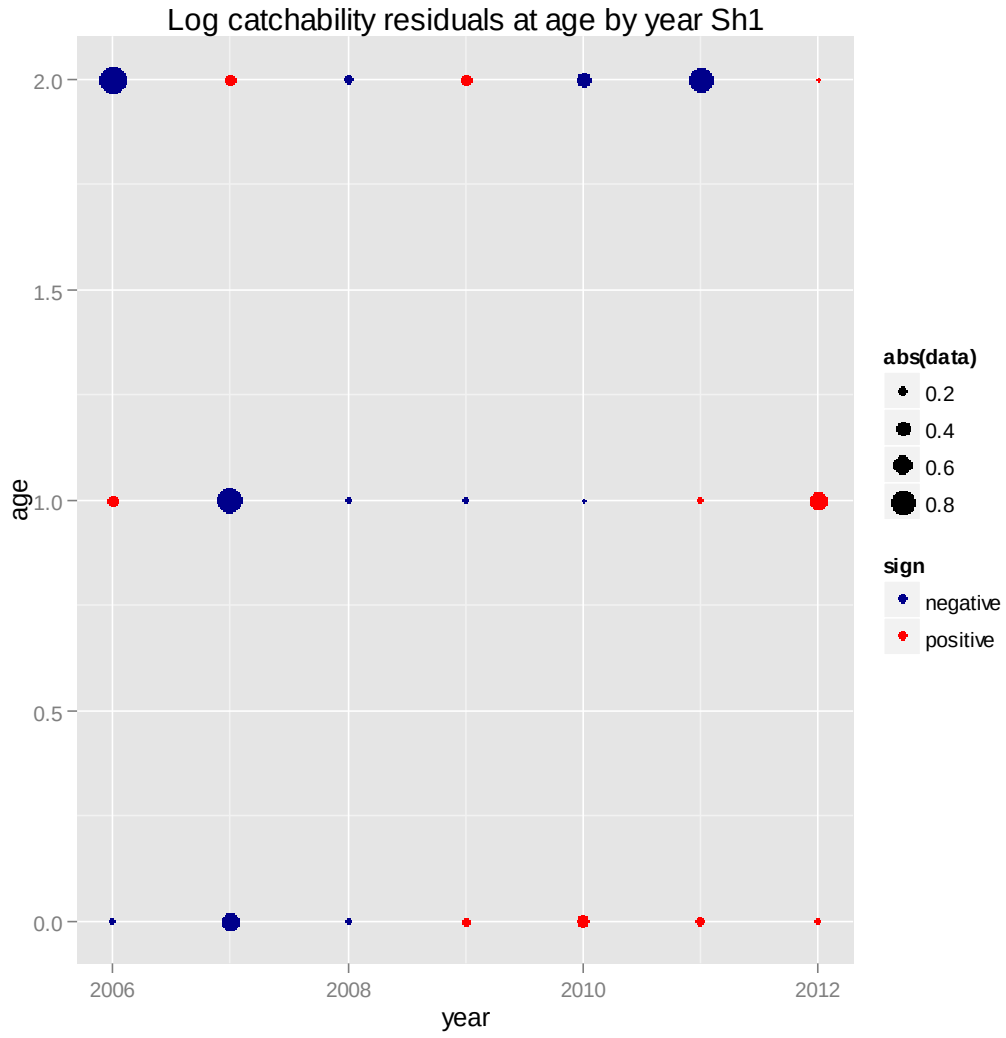


Fig. 6.1.6-1. Log catchability residuals at shrinkage 1.

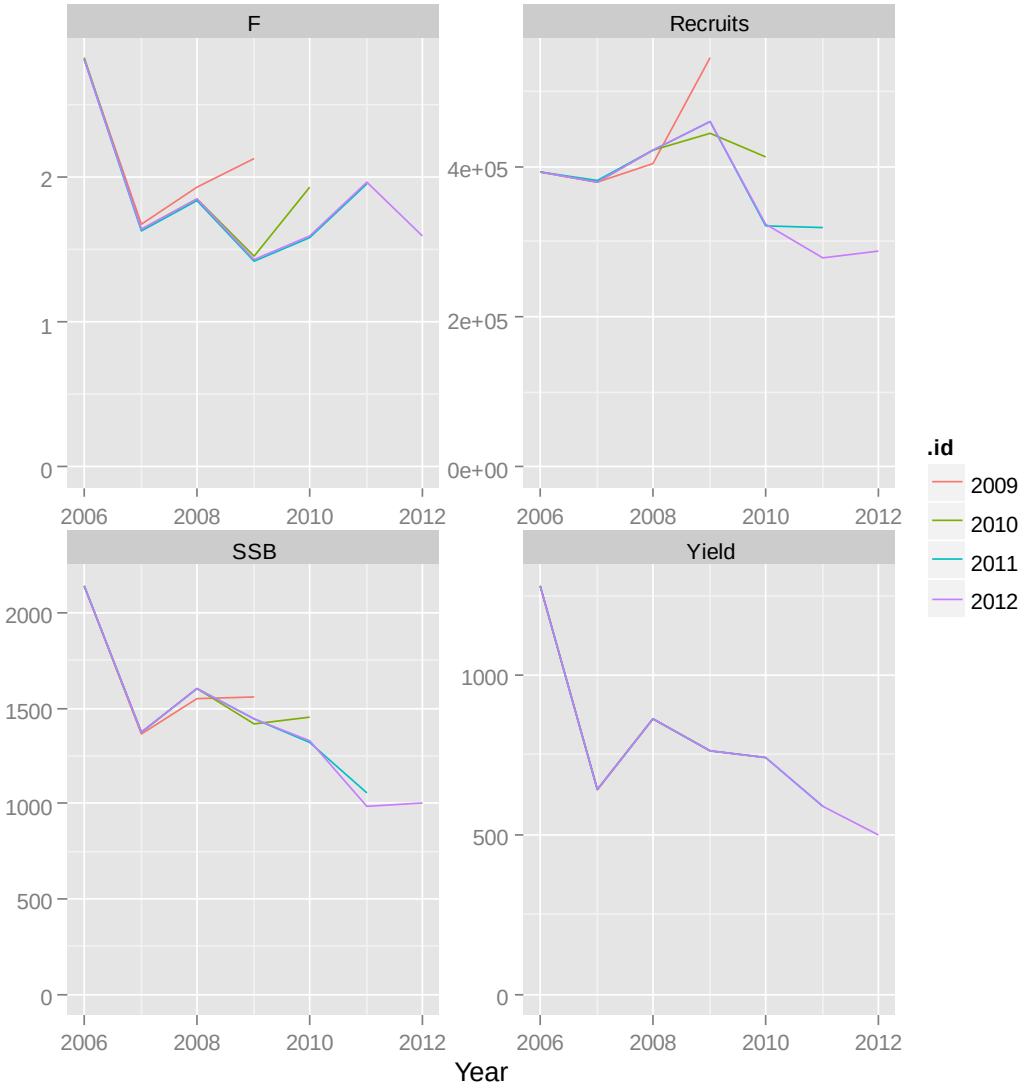


Fig. 6.1.6-2. Retrospective analysis results.

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

In addition, the pattern of the MEDITS abundance indices (Fig. 6.1.6-3) with the stock in numbers and of the MEDITS biomass indices with the SSB from XSA (Fig. 6.1.6-4).

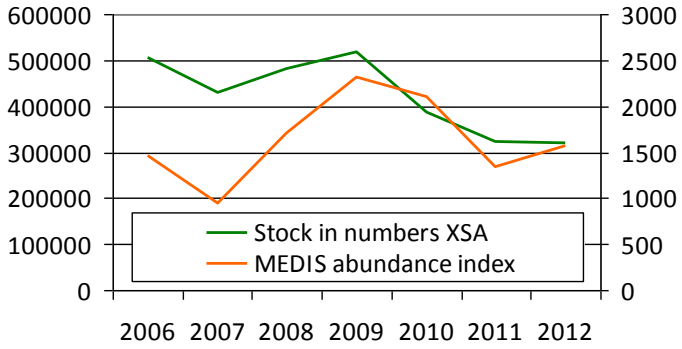


Fig. 6.1.6-3. Comparison of XSA outputs of stock in numbers and abundance indices from MEDITS.

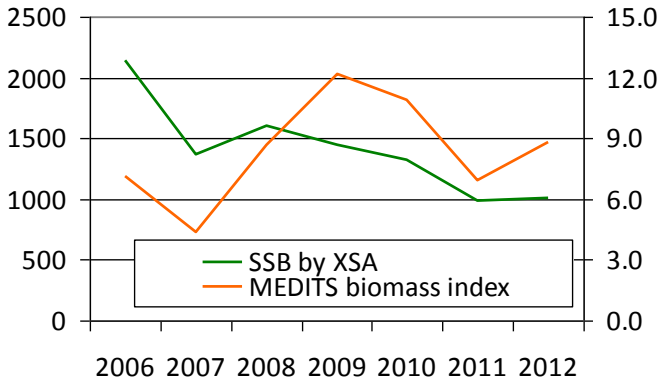


Fig. 6.1.6-4. Comparison of XSA outputs of SSB and biomass indices from MEDITS..

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, uses a monthly time scale and a multi-fleet/gear approach. For this assessment classical ogive selectivity function has been assumed with different parameters according to the mesh size used along the time.

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

XSA results, in particular, recruitment and fishing mortality, have been used as proxy to parameterize ALADYM.

The hind-casting approach has been used for this assessment for comparison with XSA results and in order 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, one fleet segment has been assumed (Trawlers 6-24 m). Until 2010, selectivity was assumed to correspond to the classical ogive with $SL_{50\%}$=14.2 mm and selectivity range (SR) of 2.9 mm. From 2011, trawlers are assumed to use diamond mesh size of 50 mm and corresponding values of $SL_{50\%}$=17 mm and SR=2.9 mm. DCF data are used for production and effort (DCF).

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).

The annual recruitment has been split in the month of each year, according to the following proportions, which simulates the recruitment pulses:

Table 6.2.3-1. Monthly proportions of recruits entering in the population each year.

Jan	Feb	Mar	Apr	May	Jun
0	0	0	0.1	0.1	0.2
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
0.2	0.1	0.1	0.2	0	0

Information on fishing bans has been included in the hindcasting parameterization.

6.2.4 Results

A satisfactory fit has been obtained with ALADYM simulation model for all the fleet segments with a mean of 4% of percentage difference between simulated and observed landing.

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

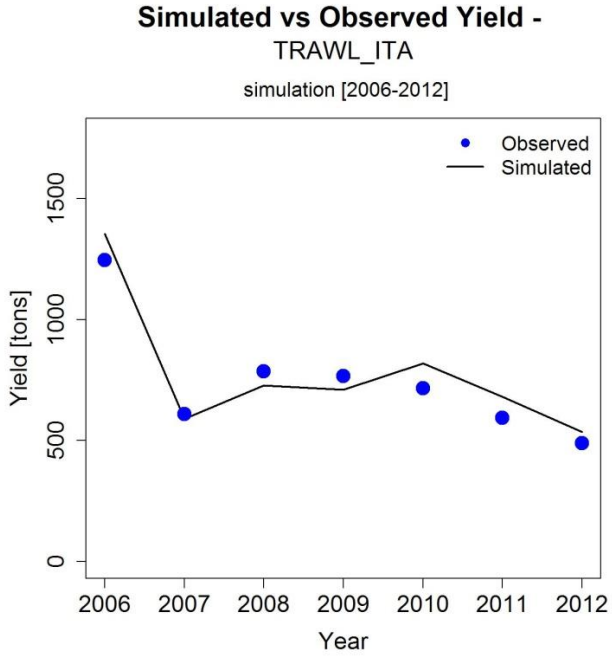


Fig. 6.2.4-1. Simulated vs. observed yield trawlers fleet segment.

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 seemed quite plausible and coherent with the obtained results. The hind-casting approach used for this assessment was accomplished for supporting the combined assessment.

7 Stock predictions

The recruitment has been assumed constant (average of the last three years) in the projections, being lacking a reliable stock recruitment relationship.

The recruitment for the projections is around 285 millions of individuals (average of last three years (279, 287 and 287 millions).

Three different scenarios were simulated:

- Scenario 1 – “status quo” or no changes until 2021;
- Scenario 2 – Gradual reduction of F to estimated $F_{0.1}$ level by 2021;
- Scenario 3 – Increase in mesh size (60 mm diamond mesh size) since 2014;

7.1 Short term predictions

7.2 Medium term predictions

In terms of landing, Change in mesh size scenario shows a decrease in 2014 (due to the new increase in mesh size) and an increase in 2015, followed by another one smaller in 2016 (Fig. 7.2.2). After 2015 the change mesh size scenario gives increasing landings and a structure of landing characterised by larger mean size (Fig. 7.2.3). The F reduction toward F0.1 in 2020 scenario, shows a decrease in landing since 2014. until 2020. In 2021 the landing shows again an increase, as a result of the recovery in productivity of the stock. Furthermore, the SSB increase resulting by the reduction towards F0.1 scenario is the highest (Fig. 7.2.1).

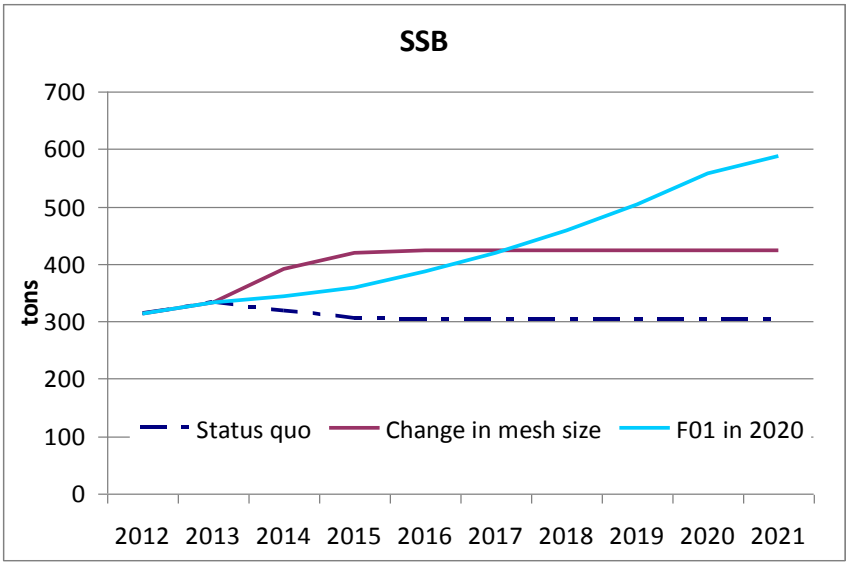


Fig. 7.2.-1. Prediction of the changes of the spawning stock biomass according to the scenarios simulated in ALADYM analyses, 2012-2021.

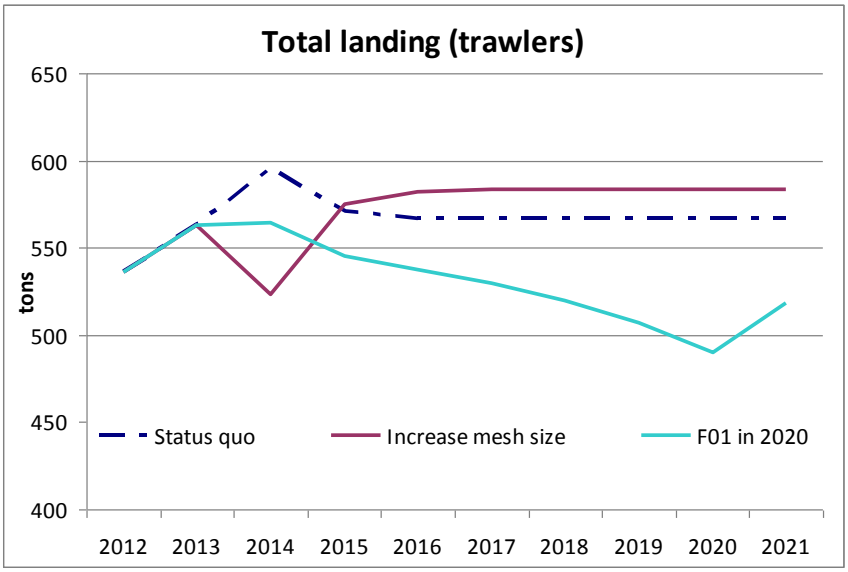


Fig. 7.2. -1. Results of the scenarios analyses, 2012-2021, for total landing (trawlers).

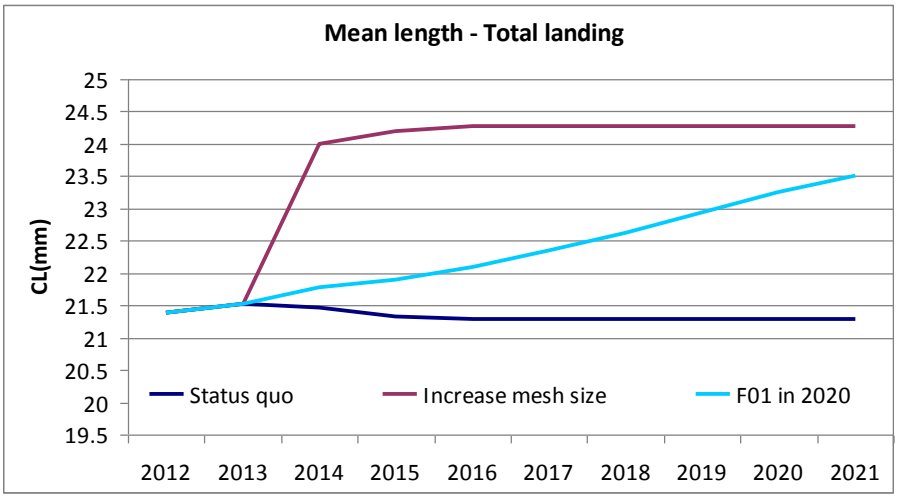


Fig. 7.2.-3. Prediction of the changes in mean length of landing according to the scenarios simulated in ALADYM analyses, 2012-2021.

7.3 Long term predictions

8 Draft scientific advice

Based on	Indicator	Analytical reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Stock Status
Fishing mortality	Fishing mortality	F0.1 = 0.67 (XSA)	Fc = 1.6			OH
	Fishing effort					
	Catch					
Stock abundance	Biomass		Biomass index = 8.8	33 percentile = 6.4 66 percentile = 8.1		

	SSB					
Recruitment					D	
Final Diagnosis		High level of overfishing (Fc/F0.1 = 2.38 (XSA)) high abundance according to the trawl survey (MEDITS) time series				

The stock of European hake in GSA 19 is in high overfishing as current fishing mortality (Fcurr) exceeds the F0.1. levels (1.6 vs. 0.67).

It is necessary to consider a considerable reduction of the fishing mortality in order to achieve the estimated F0.1 levels. Objectives of a more sustainable harvest strategy could be achieved with a multiannual plan that foresees a reduction of fishing mortality through fishing limitations and improving selectivity pattern.

7.4 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)*

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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.

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