Stock Assessment Form

Demersal species

Reference year: 2019

Reporting year: 2020

Trawl fishery data for the period 2001-2019 have been used to assess the *Parapenaeus longirostris* stock in the GSA06. The assessment has been carried out applying Extended Survivor Analysis model (XSA) and Y/R analysis. To this aim, FLR libraries under R language were used. The annual landings (Y) remained relatively stable during the period 2003-2013, fluctuating between 100 and 150 tons, and increased notably from 2014, reaching up 914 tons in 2018, the maximum observed in the assessed period. Since 2002, main population indicators (SSB and R) remain stables at low levels, increasing from 2014 and reach the maximum values observed in the assessed period in 2018. Fishing mortality (F_{bar0-2}) showed a decreasing trend from 2001 to 2004, remained stable in the coming years, oscillating around 0.7, but increasing the last three years. Y/R analysis showed that the $F_{ref} = F_{current}$ (1.02) exceeds the Y/R $F_{0.1}$ reference point (0.75).
Based on this assessment results, the *Parapenaeus longirostris* stock in GSA06 is subjected to intermediate overfishing with relative high biomass. From a precautionary approach, a reduction of the fishing mortality is recommended.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Miguel Vivas Salvador*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Parapenaeus longirostris	Deep-water rose shrimp	45
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
[GSA_6]		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
Spain		
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
Extended Survivor Analysis (XSA) and Y/R		
Authors:		
Vivas, M. (1); Pérez-Gil, J.L. (2); García-Rodríguez, E. (1); Esteban, A. (1)		
Affiliation:		
(1)Instituto Español de Oceanografía (IEO). Murcia. Spain. (2) Instituto Español de Oceanografía (IEO). Málaga. Spain.		

2 Stock identification and biological information

The assessment cover the complete stock unit in the GSA06 (Northern Spain).

2.1 Stock unit

Due to the lack of information about the structure of the population in the Western Mediterranean, it is considered that the stock limits of the assessed *Parapenaeus longirostris* are in agreement with the limits of GSA 06.

2.2 Growth and maturity

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

Somatic magnitude measured (LT, LC, etc)			**CL length**	**Units**	
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	All year long, with a peak in summer
Maximum size observed	39	34	39	**Recruitment season**	All year long
Size at first maturity			25.6	**Spawning area**	Continental shelf
Recruitment size to the fishery			10	**Nursery area**	Continental shelf

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

Size/Age	Natural mortality	Proportion of matures
Age 0	*1.42*	*0.11*
Age 1	*0.83*	*0.62*
Age 2	*0.71*	*0.96*
Age 3+	*0.64*	*1.00*

Table 2-2.3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	mm			44	
	K				0.67	
	t_0				-0.21	
	Data source	*Guijarro et al. 2009				
Length weight relationship	**a**		0.0022	0.0024	0.0021	
	b		2.56	2.53	2.594	
	M (scalar)				0.76	
	sex ratio (% females/total)	0.56 (2014-2016) DCF_GSA6				

3 Fisheries information

3.1 Description of the fleet

According to official data (2016), the total trawl fleet of the whole geographical sub-area 06 (Northern Spain) is composed by 437 boats averaging 47 TRB, 58 GT and 297 HP. Around 354 boats capture deep pink shrimp.

Some units (smaller vessels) operate almost exclusively on the shallow and deep continental shelf (targeted at red mullet, octopus, hake and sea breams). Bigger vessels operate almost exclusively on the upper and middle slope (targeted at decapod crustaceans). The rest can operate indistinctly on the continental shelf and slope fishing grounds, depending on the season, the weather conditions and also economic factors (e.g. landings price). The percentage of these trawl fleet segments have been estimated* around 30, 40 and 30% of the boats, respectively.
The pink shrimp is caught as a by-catch in the deep continental shelf and the upper slope.

Table 3.1-1: Description of operational units exploiting the stock

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	ESP	06	E – Trawl (12-24 m)	03 - Trawl	34-Demersal slope 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 Unit1]	354	704 tons (2019)		No		33.4 (Fishing days *1000)
Total						

3.2 Historical trends

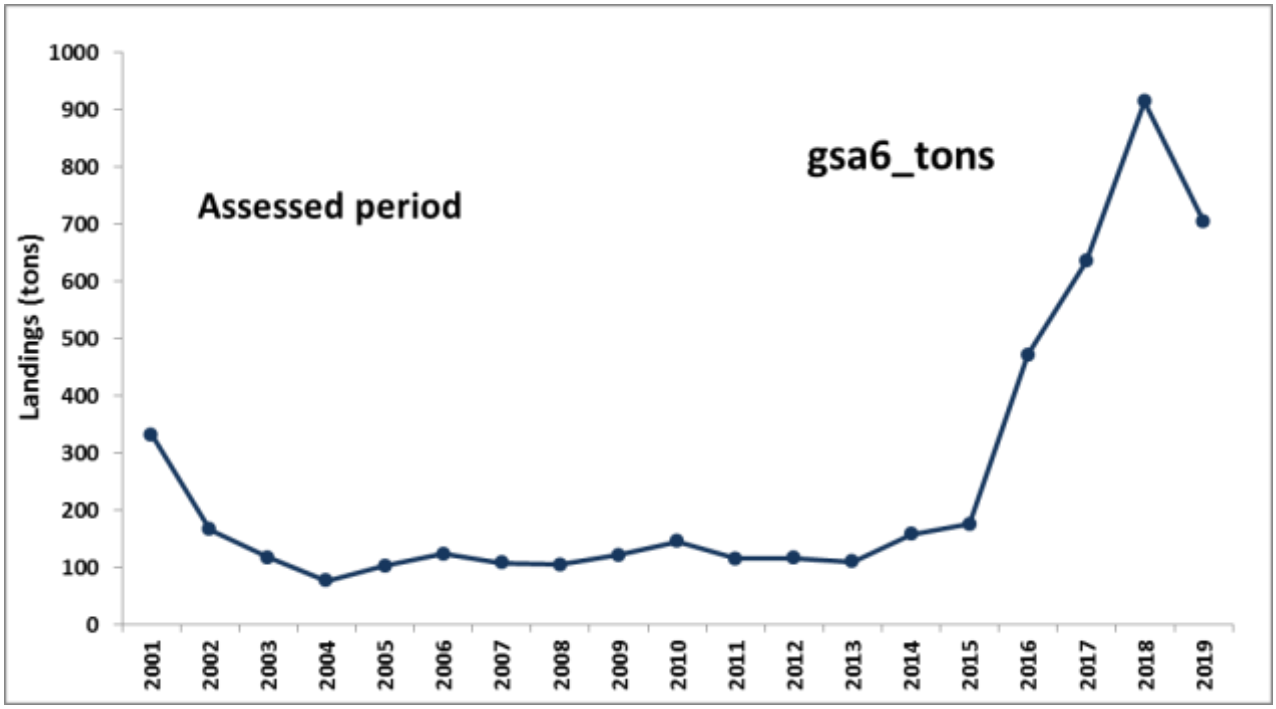


Figure 3.2-1: Estimated landings of *Parapenaeus longirostris*. Deep water rose shrimp landings reached a peak in 2001 and strongly decreased to 76 tons in 2004. Landings have remained stable for the 2005-2015 period at about 120 tons annually reaching a peak (the maximum in the series) in 2018 (914 tons).

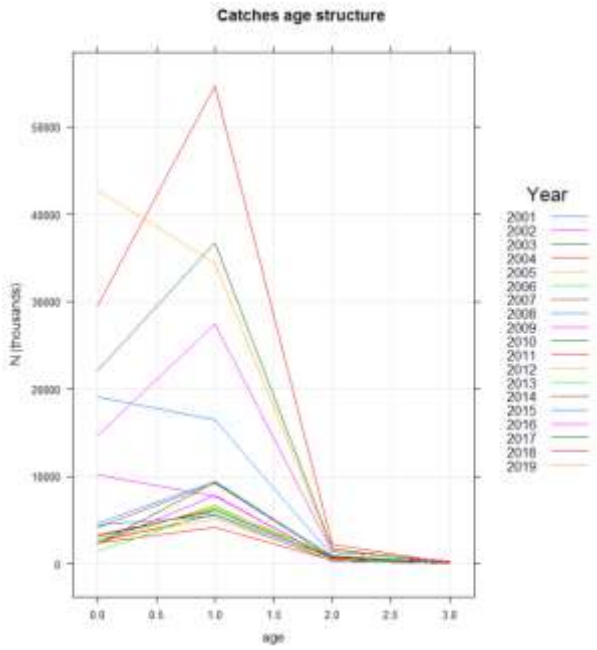


Figure3.2-2: Length frequency distribution of trawl catches in the geographical subarea GSA6 (Northern Spain) for the period 2004-2019. Size composition has been obtained from monthly onboard and port sampling (stratified random method).

3.3 Management regulations

- Engine power limited to 316 KW or 500 CV: not fully observed

- Fishing license: fully observed

- Mesh size in the cod-end (50 mm diamond or 40 mm square). In force since June 2010: fully observed

- Fishing ban of trawl fishing in areas less than 50 m depth: fully observed

- Time at sea (12 hours per day and 5 days per week): fully observed

- Spatial and temporal closures of trawl fishing.

- Minimum legal size: 20 mm CL: mostly fully observed (EC regulation 1967/2006)

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		2767		1269	B mean as a referent point (B low = 514)
SSB		202		124.7	SSB mean as a referent point (SSB low = 57)
F		1.27		0.79	F0.1 as a referent point
Y		704		252	Y mean as a referent point (Y low = 76)
CPUE		19.14		6.70	CPUE mean as a referent point (CPUE low = 1.89)

4 Fisheries independent information

4.1 MEDITS Survey (2001-2018)

The Mediterranean International Bottom Trawl Survey MEDITS has been carried in the GSA 6 since 1994.

4.1.1 Brief description of the direct method used

The Spanish Institute of Oceanography carries out two scientific surveys under the Data Collection Regulation: MEDITS and MEDIAS. Both are international coordinated surveys.

The IEO is involved in the international bottom trawl survey MEDITS since 1994. The survey takes place in all European Mediterranean countries and the main target species are demersal species. The Spanish MEDITS survey carries out about 170 – 180 hauls in spring. It samples 4 GSAs, including Balearic Islands, and the sampling procedure is based on the common methodology included in the MEDITS instruction manual. The GSAs sampled are: GSA1, GSA2, GSA5 and GSA6.

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	Mediterranean International Bottom Trawl Survey (MEDITS_ES)	**Trawler/RV**	Miguel Oliver
Sampling season	SPRING (MAY-JUN)		
Sampling design	random stratified with number of haul by stratum proportional to stratum surface		
Sampler (gear used)	GOC-73		
Cod –end mesh size as opening in mm	20		
Investigated depth range (m)	40-800		

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
A (-50m)	3026	3026	0.4689	8
B (50-100m)	11314	11314	1.7507	39
C (100-200m)	6889	6889	1.3371	25
D (200-500 m)	6719	6719	2.3469	21
E (+500m)	4558	4558	1.2012	9
Total (km^2)	32506	32506	7.1047	102

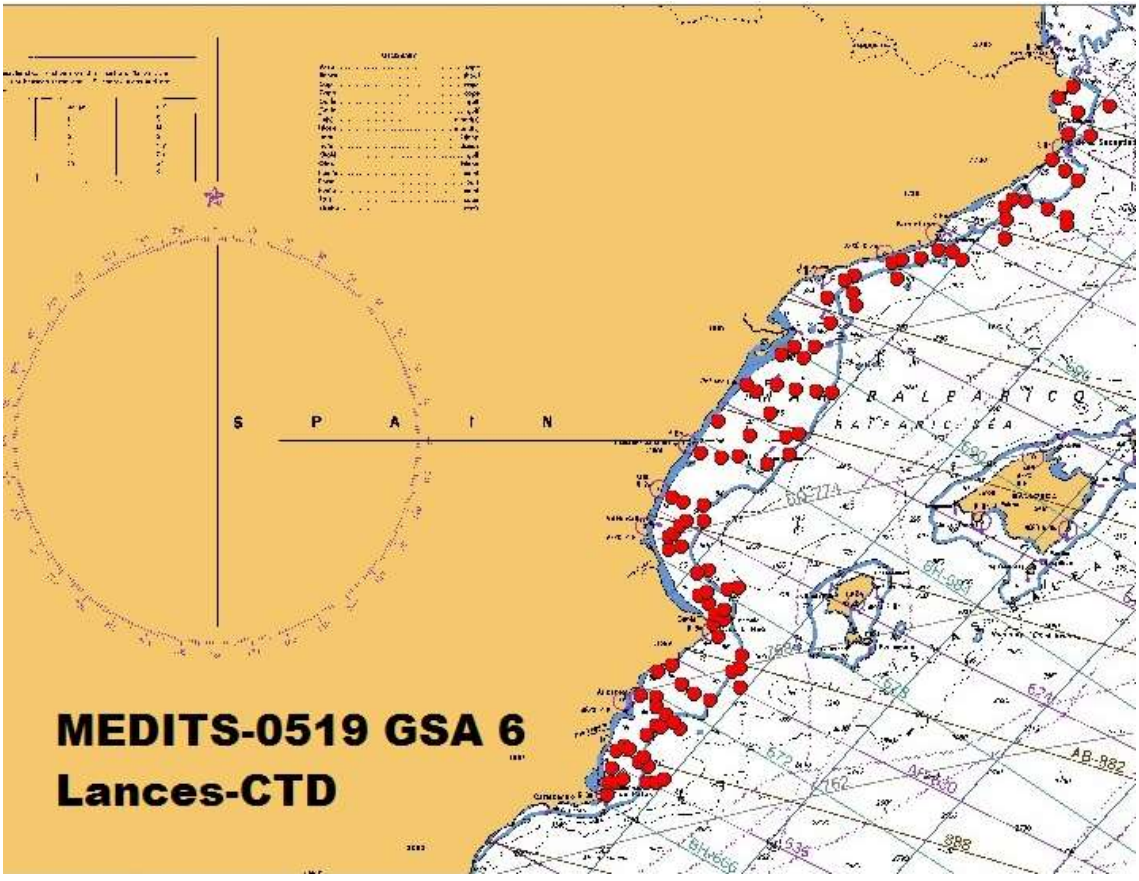
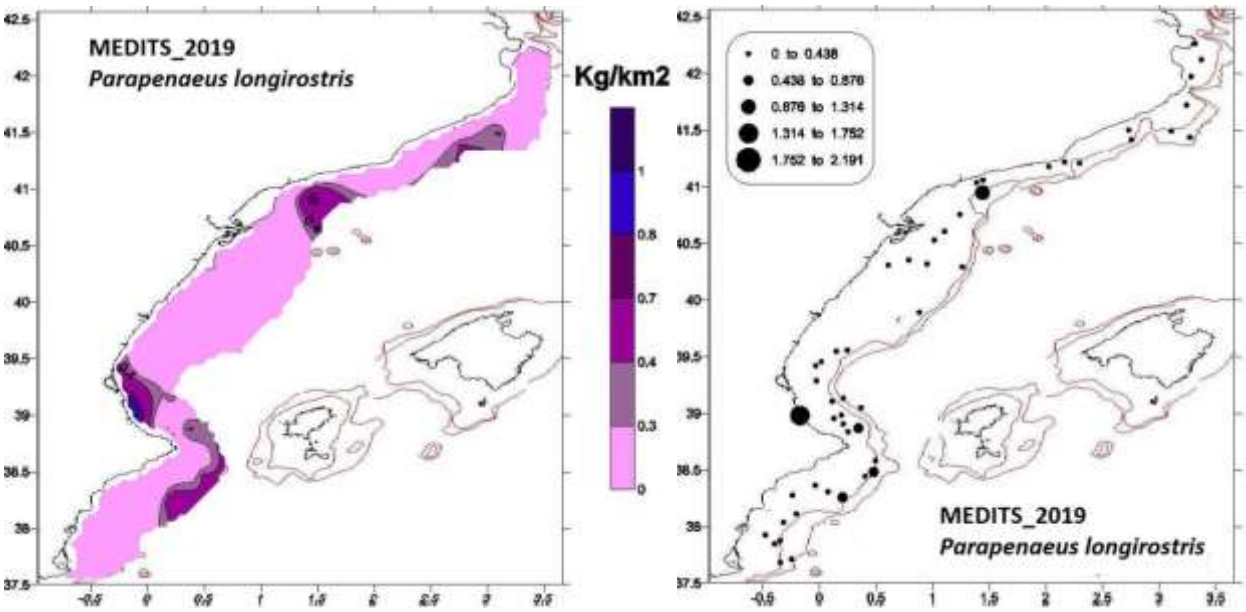


Figure 4.1-1: Map of the position of MEDITS survey hauls in GSA 06.

Depth Stratum	Years	kg per km^2	N per km^2
40-800 m	2001	1.82	173.6
40-800 m	2002	0.71	67.4
40-800 m	2003	0.06	6.2
40-800 m	2004	0.54	48.2
40-800 m	2005	0.22	16.8
40-800 m	2006	0.17	12.4
40-800 m	2007	0.25	20.5
40-800 m	2008	0.13	11.1
40-800 m	2009	0.63	65.1
40-800 m	2010	0.93	73.1
40-800 m	2011	0.45	41.3
40-800 m	2012	0.33	25.0
40-800 m	2013	0.97	71.3
40-800 m	2014	2.05	201.1
40-800 m	2015	1.31	170.6
40-800 m	2016	3.80	361.2
40-800 m	2017	2.40	230.2
40-800 m	2018	6.09	533.8

4.1.2 Spatial distribution of the resources



Figures 4.1.2-1 and 2: Trawl survey sampling area and *Parapenaeus longirostris* spatial distribution of estimated abundances indices (Kg(km2) left, and (N/Km2) right, for the 2019 MEDITS_ES trawl surveys. (GSA 6, Northern Spain)

4.1.3 Historical trends

MEDITS surveys data show an increasing trend in abundance along the period.

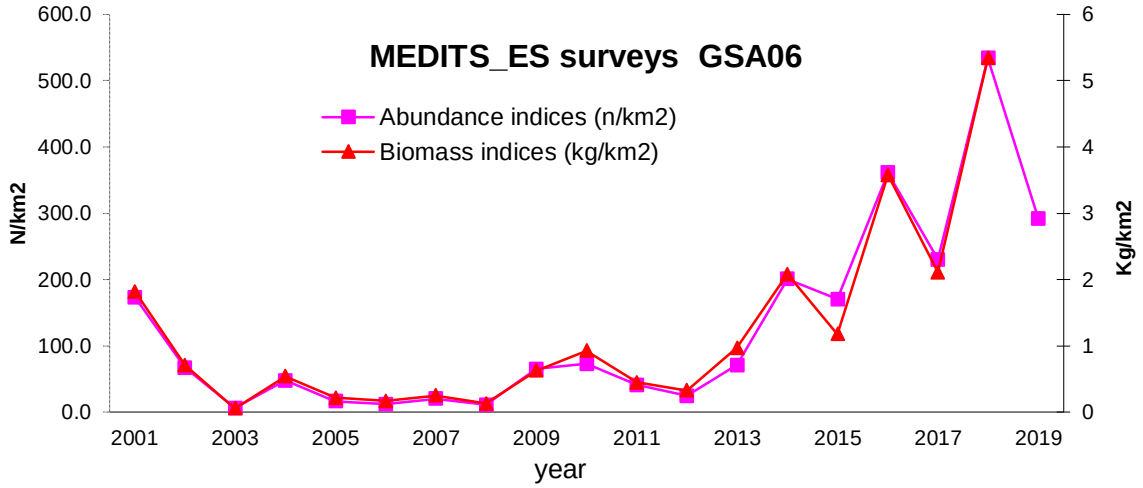


Figure 4.1.3-1: Historical Medits abundance index along the time series assessed

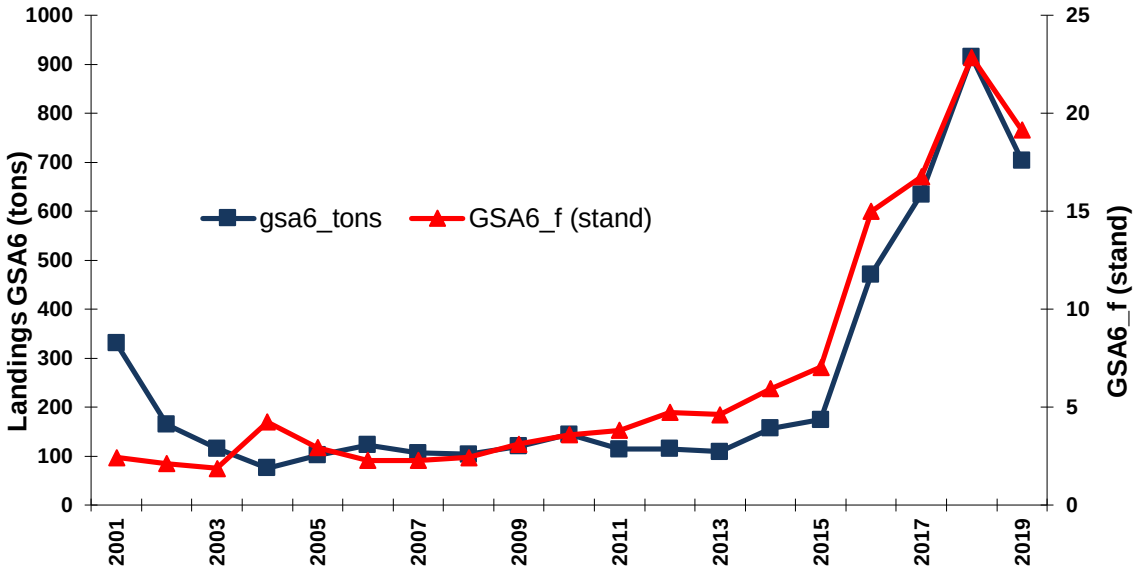


Figure 4.1.3-2: Parapenaeus longirostris. MEDITS_ES_GSA6 (2001-2019). Trends in abundance indices (n/km2) and standardized effort (fishing days)

5 Ecological information

5.1 Protected species potentially affected by the fisheries

5.2 Environmental indexes

6 Stock Assessment

6.1 Extended Survivor Analysis implemented with FLR libraries.

Ad hoc methods for tuning single species VPA's to fleet catch per unit effort (CPUE) data are sensitive to observation errors in the final year because they make the assumption that the data for that year are exact. In addition, the methods fail to utilize all of the year class strength information contained within the catches taken from a cohort by the tuning fleets.

Extended Survivors Analysis (XSA), (Shepherd, 1992,1999), an extension of Survivors Analysis (Doubleday, 1981), is an alternative approach which overcomes these deficiencies. In general, the algorithms used within the ad hoc tuning procedures, exploit the relationship between fishing effort and fishing mortality.

XSA focuses on the relationship between catch per unit effort and population abundance, allowing the use of a more complicated model for the relationship between CPUE and year class strength at the youngest ages. (Darby and Flatman, 1994).

The XSA assessments were performed using the Lowestoft VPA Suite stock assessment software package (Darby and Flatman, 1994) and the open-source framework FLR (Fisheries Library for R) (Kettet al, 2007). Their results were analyzed and compared. FLR packages were also used to perform Exploratory Data Analysis, Sensitivity Analysis, Retrospective Analysis, Reference Points Estimation and Short Term Projections.

Shepherd J. G., 1999. Extended survivors analysis: An improved method for the analysis of catch-atage data and abundance indices. ICES J. Mar. Sci 56: 584–591.

Darby, C. D., and S. Flatman. "1994. Virtual population analysis: version 3.1 (Windows/DOS) user guide." Info.Tech. Ser. MAFF Direct.Fish. Res., Lowestoft 1: 85.

Kell L.T., Mosqueira I., Grosjean P., Fromentin J-M., Garcia D., Hillary R., Jardim E., Pastoors M., Poos J.J., Scott F. & Scott R.D. 2007. FLR: an open-source framework for the evaluation and development of management strategies. ICES J. of Mar. Sci. 20: 289-290.

6.1.1 Model assumptions

The XSA tuning was performed using abundance index series from MEDITS trawl surveys (GSA 6, Northern Spain)

• Imput Parameters

- Landings time series 2001-2018 (official landings).
- Length distributions 2001-2018 (monthly onboard and port sampling).
- Catch-at-Length data converted to Catch-at-Age data using cohort slicing.

- Growth Parameters from Guijarro et al. in Western Mediterranean.
- Biological sampling 2001-2018 for Maturity and Length-Weight relationships.
- M vector by age using PRODBIOM spreadsheet (Abella et al, 1997).
- Tuning data 2001-2018 from MEDITS survey.

• Main Settings

- Ages 0 to 3+ (Age 3 is a Plus Group)
- Fbar 0-2.
- Catchability dependent on stock size for ages >0
- Catchability independent of ages for ages>= than 1
- Survivor estimates shrunk towards the mean F of the final 2 yrs or the 2 oldest ages.
- 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.

Following the recommendations of previous demersal working group, several previous tentative assessments for male, female and unsexed data was carried out, in order to compare the results by sex and for male and female together. XSA assessment results (landings, recruitment, spawning stock biomass, total biomass and fishing mortalities) obtained for (male and female) and unsexed, showed no significant differences.

6.1.2 Scripts

FLR (Fisheries Libraries in R)

FLR Project -http://flr-project.org/

6.1.3 Input data and Parameters

The assessment by means of XSA was carried out using as input data the period 2001-2018 for the catch data and 2001-2018 for the tuning file (MEDITS indices).
A natural mortality vector computed using ProdBiom software was used (after the benchmark performed at WGSAD 2016, ProdBiom was accepted as most appropriate method to estimate M vector for this stock). Length-frequency distributions of commercial catches and surveys transformed in age classes (plus group was set at age 3) using length-to-age slicing.

Table 6.1.3-1: Catch at age matrix (No discards, as considered negligible).

age	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	19116	10160	3079	2328	2718	2780	2508	4452	2262
1	16407	7701	6203	4159	5130	6474	5633	5446	7831
2	853	501	719	416	632	960	694	290	457
3+	22	20	36	21	79	126	197	36	28

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2245	3317	2277	1404	4169	4661	14692	22087	29495	42720
9312	6070	6700	6048	9193	9382	27443	36726	54665	34398
650	788	485	890	676	851	1374	1751	2154	1510
19	27	43	46	59	43	278	29	159	56

Table 6.1.3-2: Tuning data (MEDITS survey).

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	35.8	21.4	2.8	11.8	5.2	2.4	5.8	2.7	30.3
1	122.8	44.2	3.2	35.5	9.8	8.1	12.4	7.7	32.5
2	13.4	1.3	0.3	0.9	1.6	1.1	2.1	0.7	1.9
3	1.6	0.6	0	0	0.2	0.7	0.3	0	0.5

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
16	17.7	2.5	12	86.7	109.2	117	97.7	167.1	110.9
48.9	19.8	19.9	47.8	108.4	50.7	239.5	123.1	345.5	167.7
6.7	3.3	2.1	10.6	5.3	10	4	8.8	19.6	13
1.4	0.5	0.4	0.9	0.7	0.6	0.7	0.7	1.6	0.4

Table 6.1.3-3: Input parameters and model settings

Age group	M (Prodbiom)	Maturity (DCF)
0	1.42	0.11
1	0.83	0.62
2	0.71	0.96
+gp	0.64	1.00

6.1.4 Results

The results of the assessment run using XSA show an increasing trend in catches, recruitment and SSB, but not trend in fishing mortality (F).

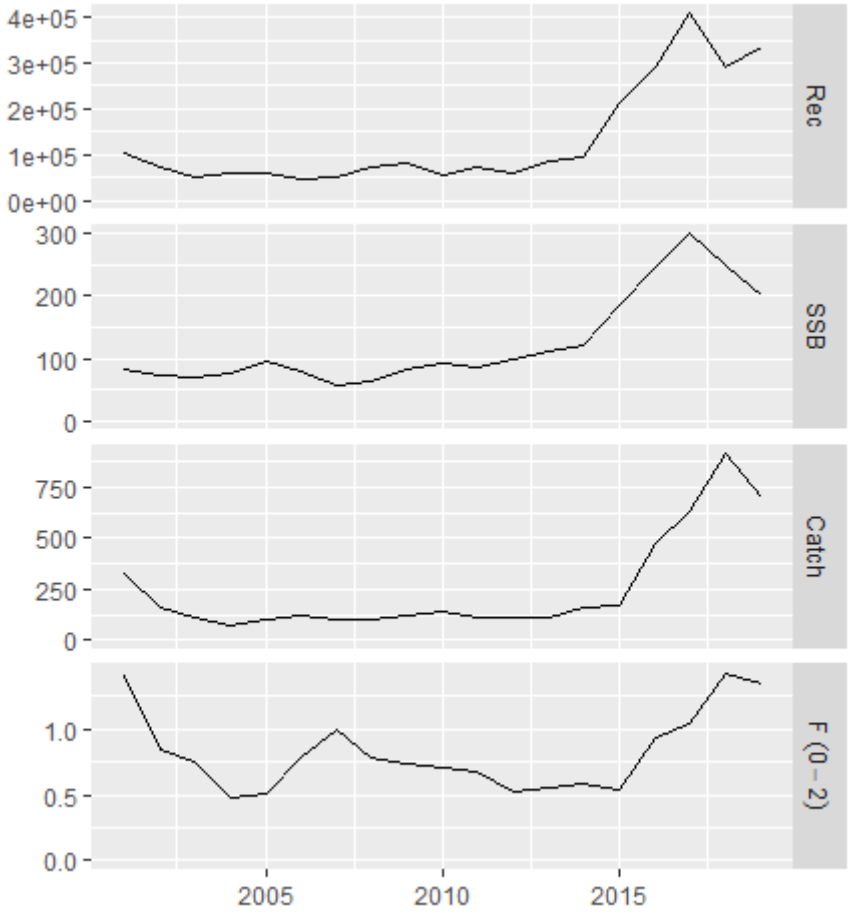


Figure 6.1.4-1: XSA results for *P. longirostris* in GSA 6*; fishing mortality (Harvest), recruitment, SSB, and catch.*

XSA results showed that total biomass (B), spawning biomass (SSB), yield (Y) and recruitment (R), remained quite stable for most of the historical series (2004-2015 period), trend from 2015 to 2018 with a sharp increase in the last three years. Fishing mortality (F_{bar0-2}) showed a decreasing trend from 2001 to 2004, remained stable in the coming years, oscillating around 0.7.

Table 6.1.4-1: Fishing mortality at age

age	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.47	0.33	0.13	0.08	0.10	0.13	0.11	0.13	0.06
1	2.30	1.32	1.33	0.82	0.89	1.35	1.83	1.39	1.36
2	1.45	0.87	0.79	0.51	0.53	0.85	1.05	0.84	0.78
3+	1.45	0.87	0.79	0.51	0.53	0.85	1.05	0.84	0.78

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0.08	0.09	0.08	0.03	0.09	0.05	0.11	0.12	0.23	0.30
1.34	1.25	0.92	1.05	1.09	1.09	1.75	1.96	2.61	2.40
0.71	0.70	0.55	0.56	0.58	0.49	0.96	1.05	1.43	1.34
0.71	0.70	0.55	0.56	0.58	0.49	0.96	1.05	1.43	1.34

Table 6.1.4-2: Recruitment, Spawning stock biomass and F_{bar} 0-2

Year	Recruits	SSB	F bar 0-2
2001	103158	81.404	1.41
2002	72321	72.708	0.84
2003	51708	70.688	0.75
2004	58122	76.041	0.47
2005	59186	95.278	0.51
2006	46866	78.185	0.78
2007	49544	56.900	1.00
2008	73792	61.400	0.79
2009	82157	83.287	0.73
2010	56720	91.555	0.71
2011	74958	85.284	0.68
2012	61720	99.552	0.52
2013	87943	112.696	0.55
2014	95126	122.459	0.59
2015	213234	183.969	0.54
2016	292284	245.683	0.94
2017	407087	300.089	1.04
2018	291956	250.343	1.42
2019	336688	202.415	1.35

6.1.5 *Robustness analysis*:

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

A retrospective analysis was conducted to ensure the robustness of the final estimates. The retrospective series indicate good agreement between years.

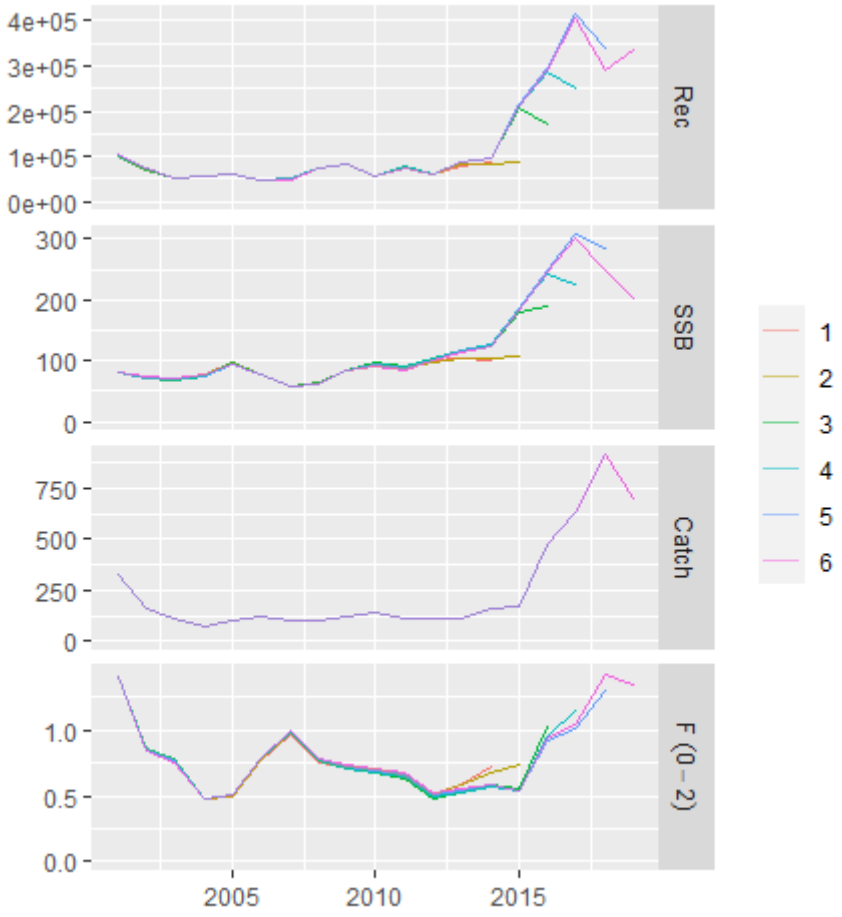


Figure 6.1.6-1: The retrospective time series of XSA estimates of *Parapenaeus longirostris* average fishing mortality F_{BAR} 0-2, recruitment-at-age 0, and spawning stock biomass. The retrospective analysis indicates good agreement between years in the assessment results. No systematic bias was detected.

6.1.7 Assessment quality

Discards were not used in the assessment as they are considered negligible for this species. Figure 6.1.7-1 shows the internal consistency of the Medits survey used as tuning fleet in the XSA model, while Figure 6.1.7-2 shows the internal consistency of catch-at-age matrix.

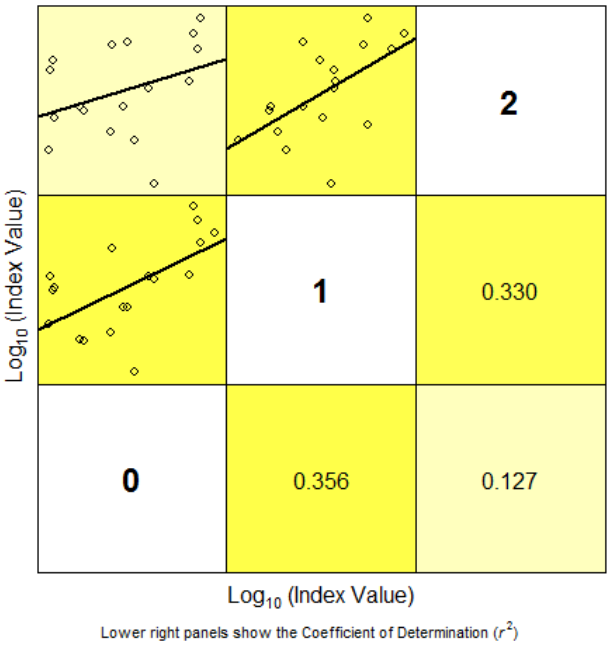


Figure 6.1.7-1: Deep warter rose shrimp in GSA 06. Internal consistency of the tuning Medits Survey

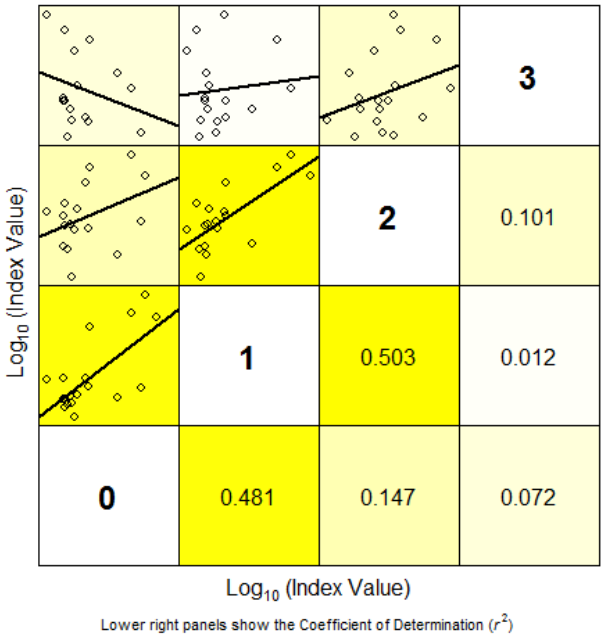


Figure 6.1.7-2: Deep warter rose shrimp in GSA 06. Internal consistency of the catch at age matrix.

6.1.7.2 Sensitivity analysis

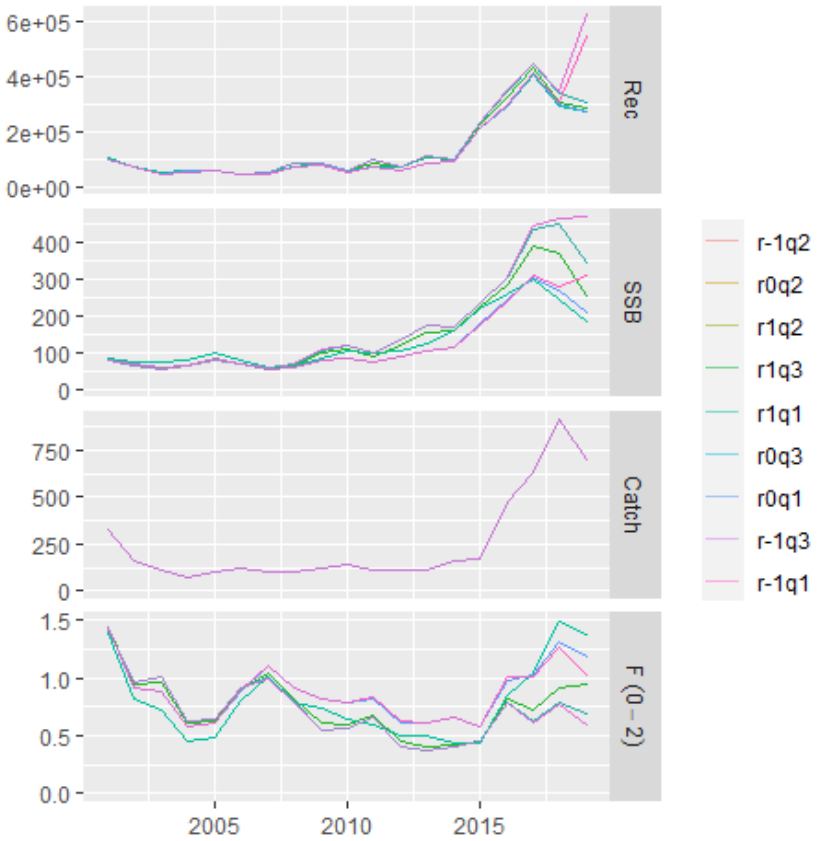


Figure 6.1.7.2_1: Sensitivity analysis on different catchability independent of *"rage" and "qage"*.

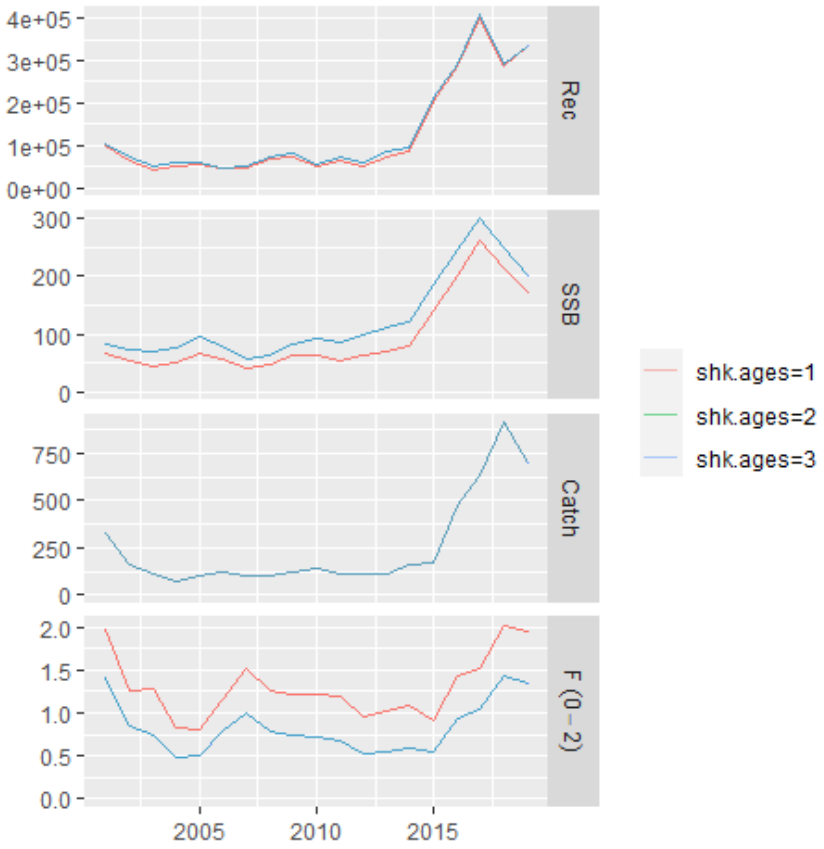


Figure 6.1.7.2_2: Sensitivity analysis on different shrinkage age "shk.ages" values.

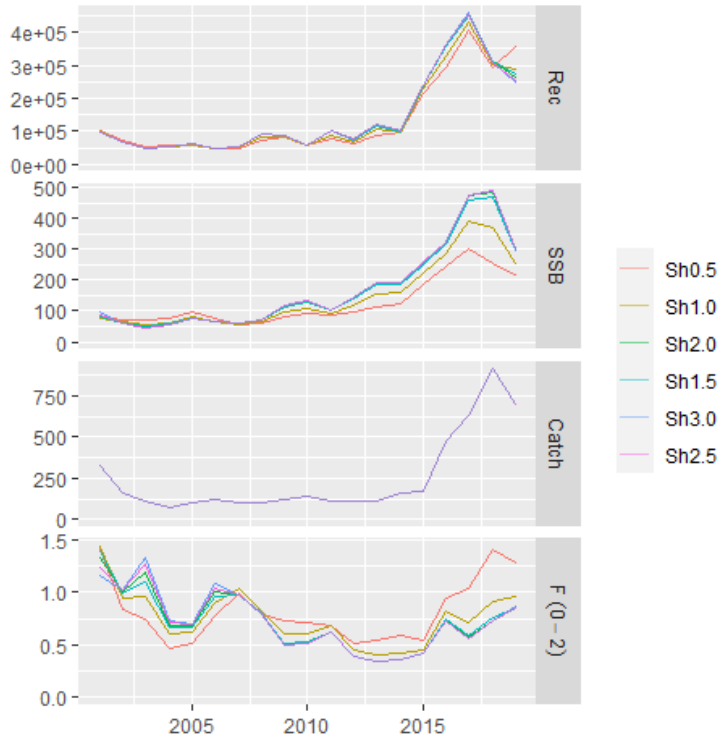


Figure 6.1.7.2_3: Sensitivity analysis on different *shrinkage weight "fse".*

On the basis of the sensitivity analisys, residuals distributions and of the retrospective analysis, the model with rage=1(0), qage=2 ,fse= 0.5, shk.yrs=3 and shk.ages=2 was adopted as final model.

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

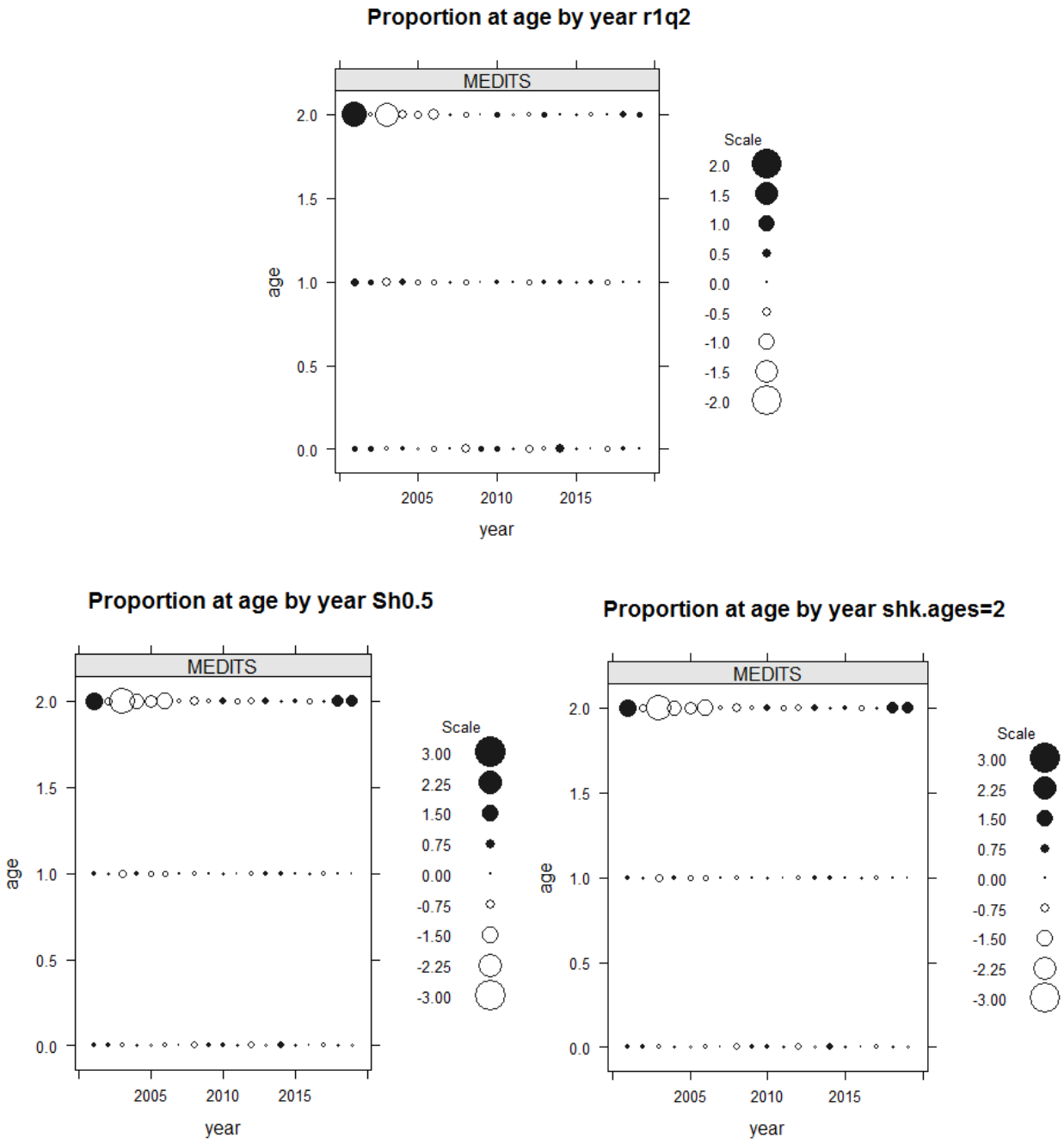


Figure 6.1.7.2_5: Catchability residuals plots with values for MEDITS_ES_GSA6 trawl survey indices and fleet.

6.2 STOCK / RECRUITMENT RELATIONSHIP

7 Stock predictions

7.1 Short term predictions

7.2 Medium term predictions

7.3 Long term predictions

Yield per recruit analyses was conducted based on the exploitation pattern resulting from the XSA model and population parameters.
Minimum and maximum ages for the analysis were considered to be age group 0 and 3+. Stock weight at age, catch weight at age and maturity ogive was estimated as mean values between 2001 and 2017. Natural mortality vector values were applied per age group using ProdBiom (Abella et al., 1998). Fishing mortalities were the mean exploitation pattern F between 2015 and 2017. Reference F was considered to be mean F for ages 0 to 2 during the last 3 years (2016-2018). The assessment results with XSA were used as input data for the Y/R analysis performed in FLR (FLBRP library) in order to calculate the reference point F0.1 (as a proxy of FMSY).

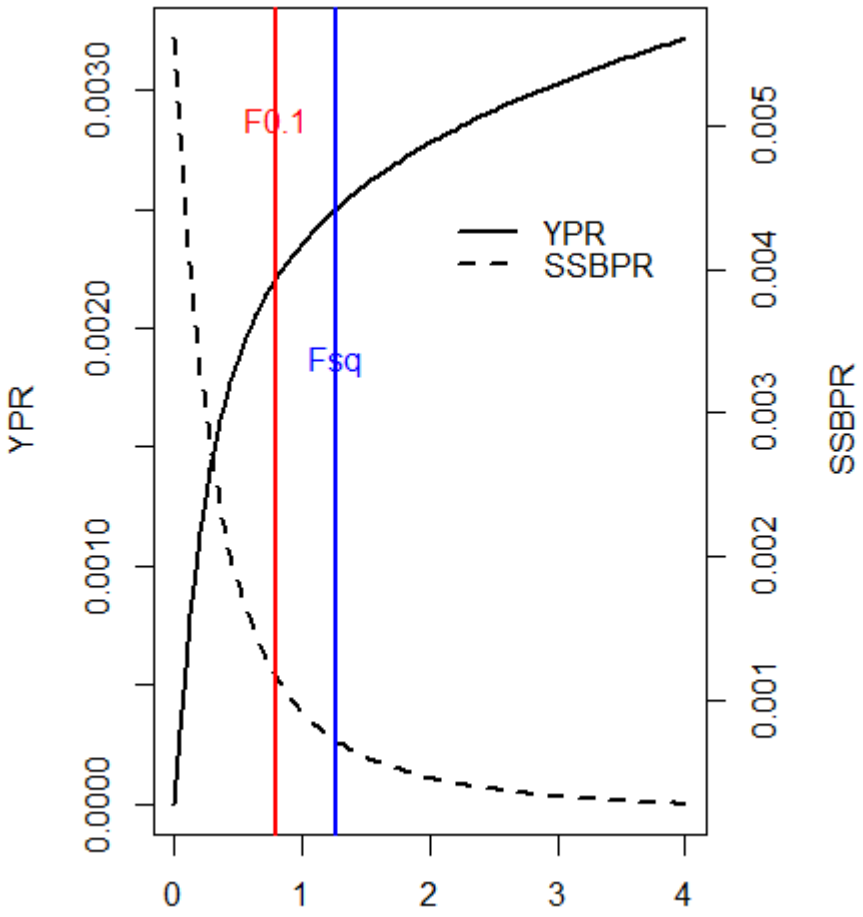


Figure 7.3-1: Equilibrium Yeld (g) per Recruit and SSB (g) per Recruit vs Fishing mortality (F) including yield and spawner reference point proxy MSY (F0.1 =0.79, Fcurrent=1.27).

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	$F_{0.1}$= 0.79	F_c= 1.27		N	IO _ O_I
	Catch				I	
Stock abundance	Total Biomass (t)		3225 (2017-2019)		I	
	SSB (t)		250.9 (2017-2019)	33th percentile = 81.2 66th percentile =106.6	I	O_H
Recruitment			336688 (in 2019)		I	
Final Diagnosis		- In overexploitation($F_{current}$>$F_{0.1}$), Intermediate Overfishing - Relative high biomass; SSB (2019)= 202 (t); Biomass at 66$_{rd}$ percentile = 106.6 (t)				
Scientific advice for management		Reduce $F_{current}$ towards $F_{0.1}$				

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)*