Stock Assessment Form Demersal species

Deep-water pink shrimp

Reference year: 2001 - 2016

Reporting year: 2017

Assessment of Deep-water pink shrimp *Parapenaeus longirostris* from the trawl fishery off the geographical sub-area Northern Spain GSA 6

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Deep-water pink shrimp (*Parapenaeus longirostris*) is one of the main crustacean species for trawl fisheries in the GFCM geographical sub-area Northern Spain (GSA 6). It is an important component of landings in some ports and occasionally a target species of the trawl fleet composed of approximately 260 vessels that operates on the upper slope. The annual landings (Y) showed a very sharp decrease at the beginning of the times series, from (331 t) in 2001 to the minimum observed in 2004 (76 t). Landings remained relatively stable during the period 2005-2015, fluctuating between 100 and 150 t, and increased notably in 2016 reaching up 432 t, 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 2016. Fishing mortality (F_{bar0-2}) showed a decreasing trend from 2001 to 2004, remained stable in the coming years, oscillating around 1.5.

Y/R analysis shows that the $F_{ref} = F_{current}$ (1.6) exceeds the Y/R $F_{0.1}$ reference point (0.7).

Based on this assessment results, the *Parapenaeus longirostris* stock in GSA 6 is subjected to over-fishing. From a precautionary approach and taking into account the estimated reference point $FMSY_{proxy}$ $F_{0.1}$, a reduction of the fishing mortality is recommended.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *José Luis Pérez Gil**

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Stock assessment form

Contents

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_6		
1st Country	**2nd Country**	**3rd Country**
Spain		
4th Country	**5th Country**	**6th Country**

Stock assessment method: (direct, indirect, combined, none)
XSA (tuning with MEDITS indices) and Y/R
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2 Stock identification and biological information

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

2.1 Stock unit

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**	mm
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	All year long, with a peak in summer
Maximum size observed	44	34	44	**Recruitment season**	
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 (Combined)

Size/Age	Natural mortality	Proportion of matures
0	*1.42*	*0.53*
1	*0.83*	*0.99*
2	*0.71*	*1*
3+	*0.64*	*1*
scalar	*0.76*	*-*

Table 2.2-3: Growth and length weight model parameters

		Units	Sex			
			female	male	Combined	Years
Growth model*	L_∞				47	
	K				0.8	
	t_0				-0,04	
	Data source	*Spain Data Collection Framework (DCF_EU)_2012				
Length weight relationship*	a		0.0051863	0.003417	0.003055	
	b		2.341197	2.446339	2.490608	
	M (scalar)		0.363	0.517	0.46	
	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 439 boats averaging 47 TRB, 58 GT and 297 HP. Around 315 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.

Identification of Operational Units exploiting this stock. Use as many rows as needed

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*	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 (days)
Trawl	160 (average 20142016)	246 (average 2014-2016); 432 (2016)		No		24796 days (average 2014-2016)
Total						

3.2 Historical trends

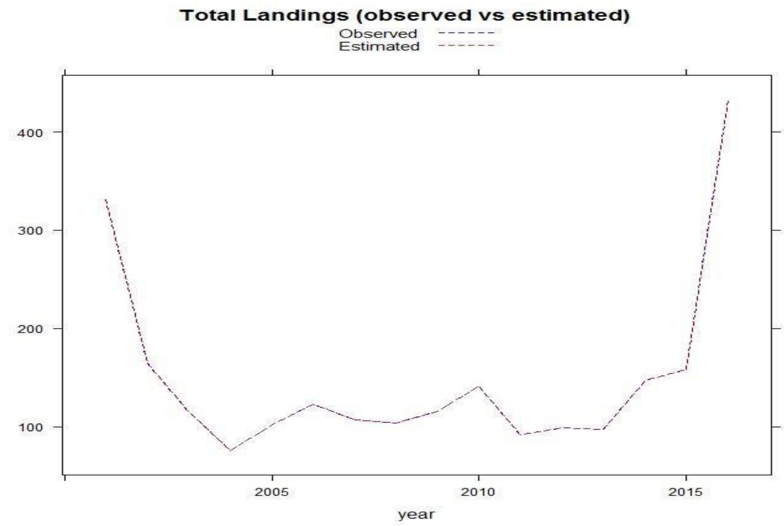
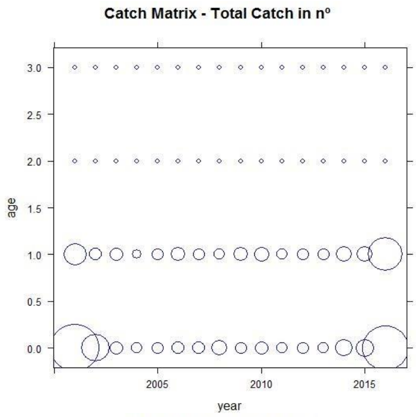


Figure 1. Estimated landings of Parapenaeus longirostris. Red shrimp landings reached a peak in 2001 and strongly decreased 45 tons in 2004. Landings have remained stable for the 2005-2015 period at about 110 tons annually reaching a peak (the maximum in the series) in 2016 (432 t).



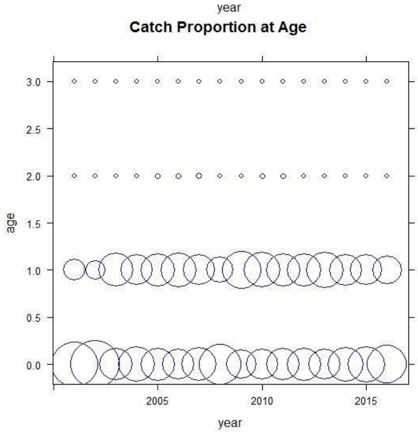
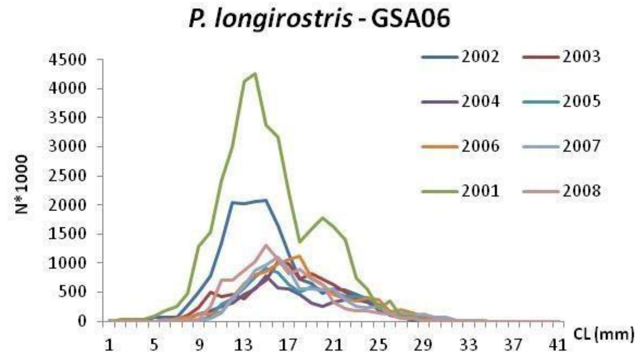


Figure 2. Catch matrix in nº (left) and catch proportion at age (right) for Parapenaeus longirostris of trawl catches in the geographical sub-area 6 (Northern Spain) for the period 2001-2016.



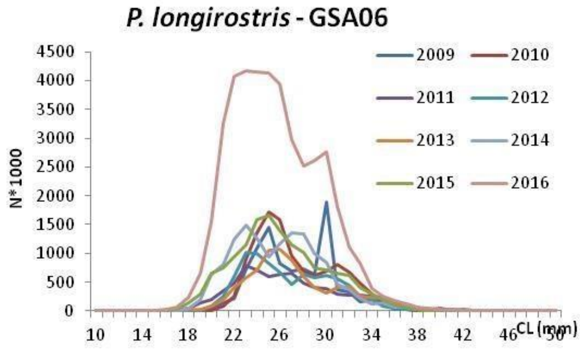


Figure 3. Length frequency distribution (Carapace Length) of trawl catches in the geographical subarea 6 (Northern Spain) for the period 2001-2016. Size composition has been obtained from monthly onboard and port sampling (stratified random method).

3.3 Management regulations

- Fishing license: fully observed

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

- Mesh size in the codend (40 mm square or 50 mm rhomboidal): fully observed (In force since June 2010)

- Fishing forbidden within upper 50 m depth: fully observed

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

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

4 Fisheries independent information

4.1 MEDITS_ES

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.

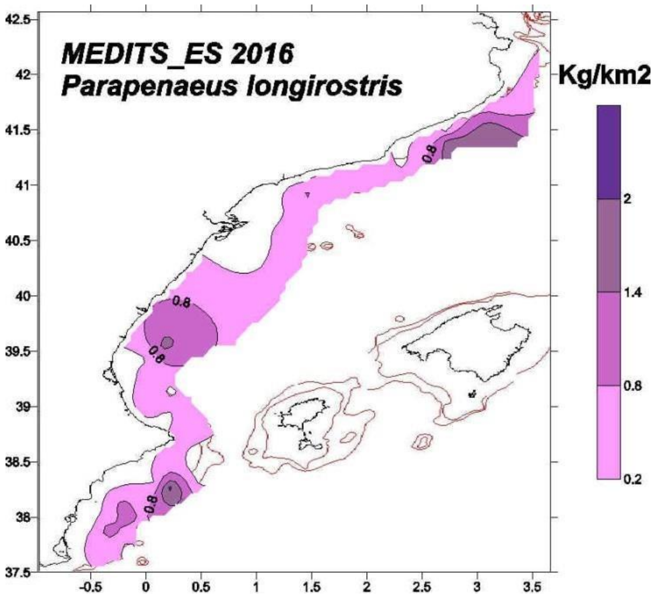
Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	MEDITS_ES	**Trawler/RV**	Trawler
Sampling season	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)	40-750		

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
Total (… – … m)				



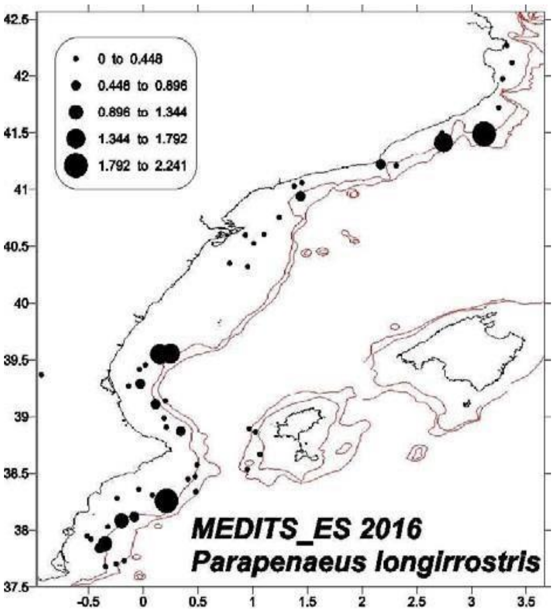


Figure 4. Trawl survey sampling area and Parapenaeus longirostris spatial distribution of estimated abundances indices (N/Km²) for the 2016 MEDITS_ES trawl surveys. (GSA 6, Northern Spain)

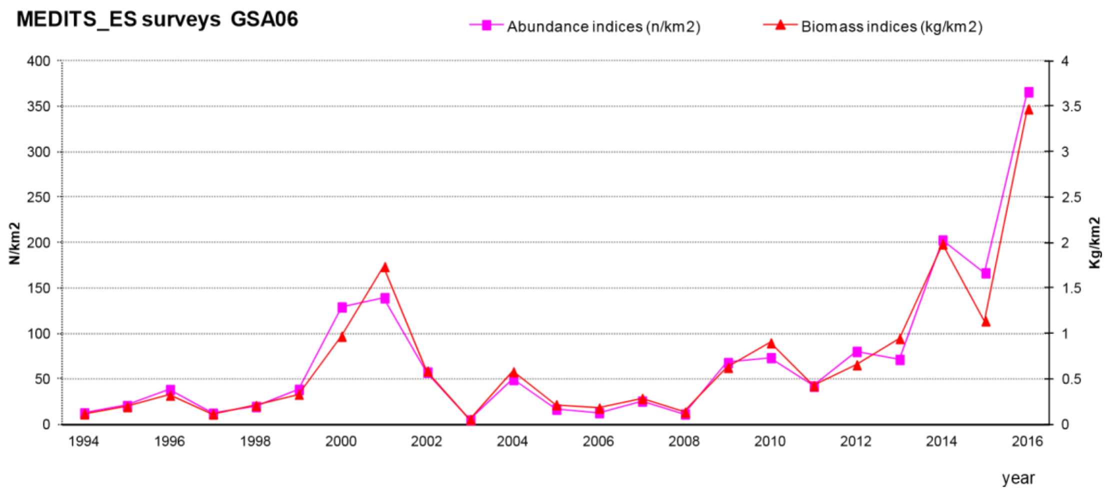
Table 4.1-3: Trawl survey abundance and biomass results. MEDITS-ES 2014 survey. GSA01 and GSA06 south region.

Depth Stratum	Years	kg per km^2	N per km^2
	2001	1.7349	139.2543
	2002	0.5866	57.3872
	2003	0.0541	4.7745
	2004	0.5778	49.2590
	2005	0.2155	16.6395
	2006	0.1787	12.9037
	2007	0.2844	25.5737
	2008	0.1332	11.3345
	2009	0.6262	67.9532
	2010	0.8962	73.2971
	2011	0.4256	41.8975
	2012	0.6542	286.4629
	2013	0.9436	71.3586
	2014	1.9848	202.8465
	2015	1.1378	166.7131
	2016	3.4705	365.8861

4.1.1 Spatial distribution of the resources

4.1.2 Historical trends

Time series analysis (if available) and graph of the observed trends in abundance, abundance by age class, etc. for each of the directed methods used.



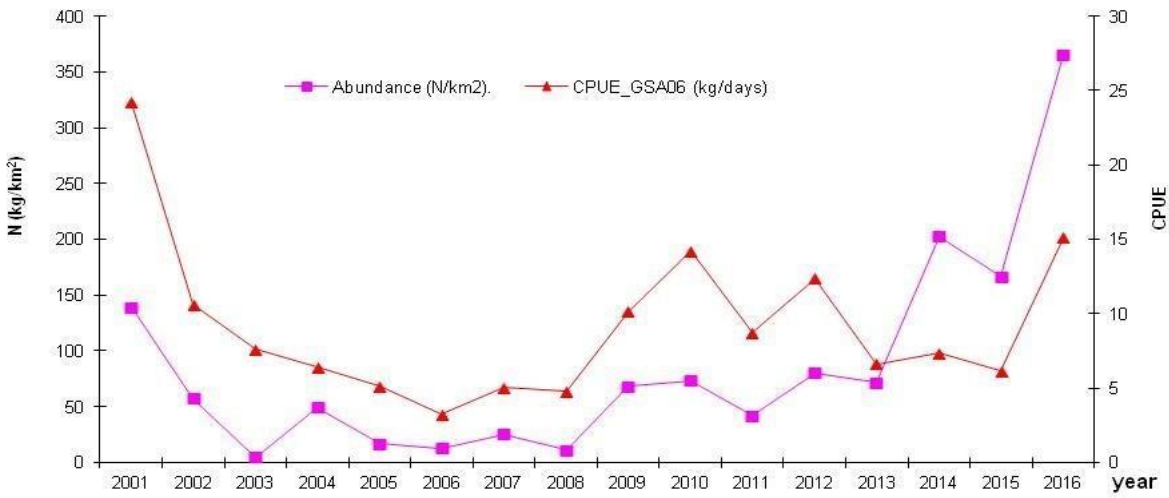


Figure 5. *Parapenaeus longirostris*. MEDITS_ES_GSA6 (1995-2017). Above/Trends in abundance indices (n/km^2) and biomass indices (kg/day). Below/ Trends in abundance indices (n/km^2) and CPUE (fishing days).

5 Ecological information

5.1 Protected species potentially affected by the fisheries

5.2 Environmental indexes

If any environmental index is used as i) a proxy for recruitment strength, ii) a proxy for carrying capacity, or any other index that is incorporated in the assessment, then it should be included here.

Other environmental indexes that are considered important for the fishery (e.g. Chl a or other that may affect catchability, etc.) can be reported here.

6 Stock Assessment

6.1 Extended Survivor Analysis - XSA

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) (Kett *et 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 catchatage 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 (GSA01, Northern Alborán Sea) and (GSA 6, Southern area, Alicante Gulf) and CPUEs from commercial fleet

- ✓ *Imput Parameters*
  - Landings time series 2001-2016 (official landings).
  - Length distributions 2001-2016 (monthly onboard and port sampling).
  - Catch-at-Length data converted to Catch-at-Age data using cohort slicing.
  - Growth Parameters from DCF_EU 2012 in the Spanish Mediterranean.
  - Biological sampling 2001-2016 for Maturity and Length-Weight relationships.
  - M vector by age using PROBION spreadsheet (*Abella et al, 1997*).
  - Tuning data 1995-2016 from MEDITS survey and commercial fleet.
- ✓ *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 2
  - 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 = 1.5.
  - Minimum standard error for population estimates derived from each fleet = 0.3.

Following the recommendations of previous demersal working group, several previous tentative assessment 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 Results

Tables and graphs of Total biomass, SSB, Recruitment, F or other outcomes of the stock assessment model with comments on trends in stock size, recruitment and exploitation.

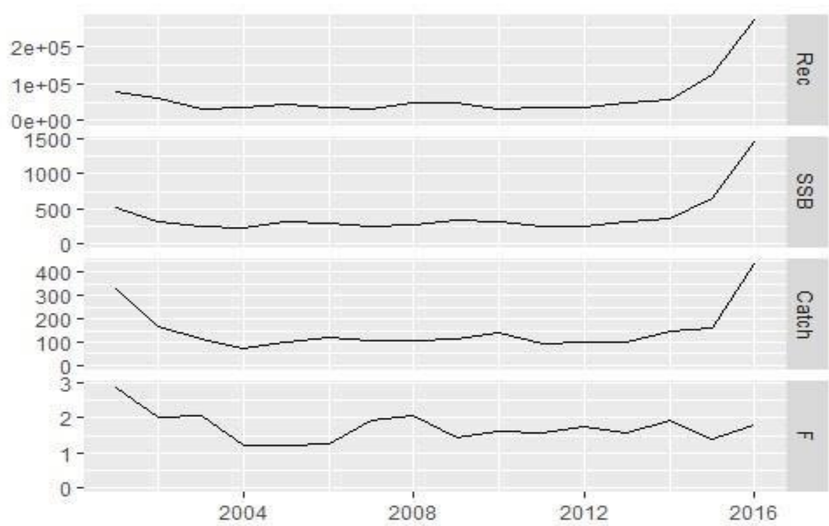


Figure 6. XSA results for P. longirostris in GSA 6.

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), followed a increasing trend from 2014 to 2016 with a sharp increase in three years.

Fishing mortality (F_{bar0-2}) showed a decreasing trend from 2001 to 2004, remained stable in the coming years, oscillating around 1.5.

6.1.4 Robustness analysis

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

6.1.5.1 Retrospective analysis.

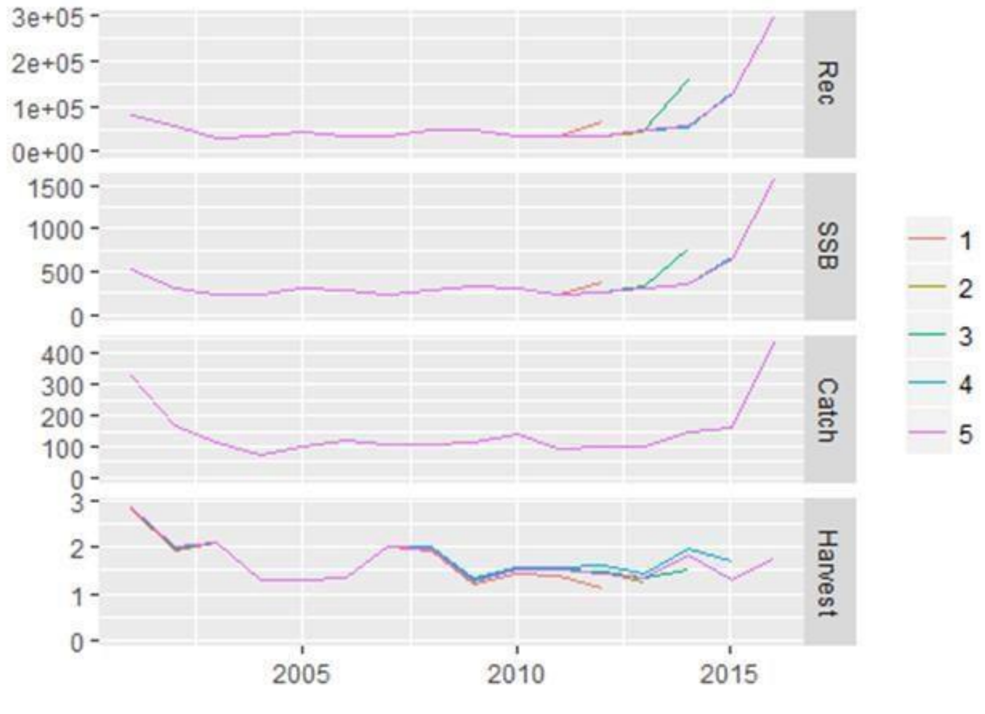


Figure 7. The retrospective time series of XSA estimates of Parapenaeus longirostris average fishing mortality (FBAR0-2), recruitment-at-age 0, and spawning stock biomass. The retrospective analysis indicates good agreement between years in the assessment results. No systematic bias were detected.

6.1.5.2 Sensitivity analysis

Sensitivity analysis on different qage,rage,fse and shk.ages values

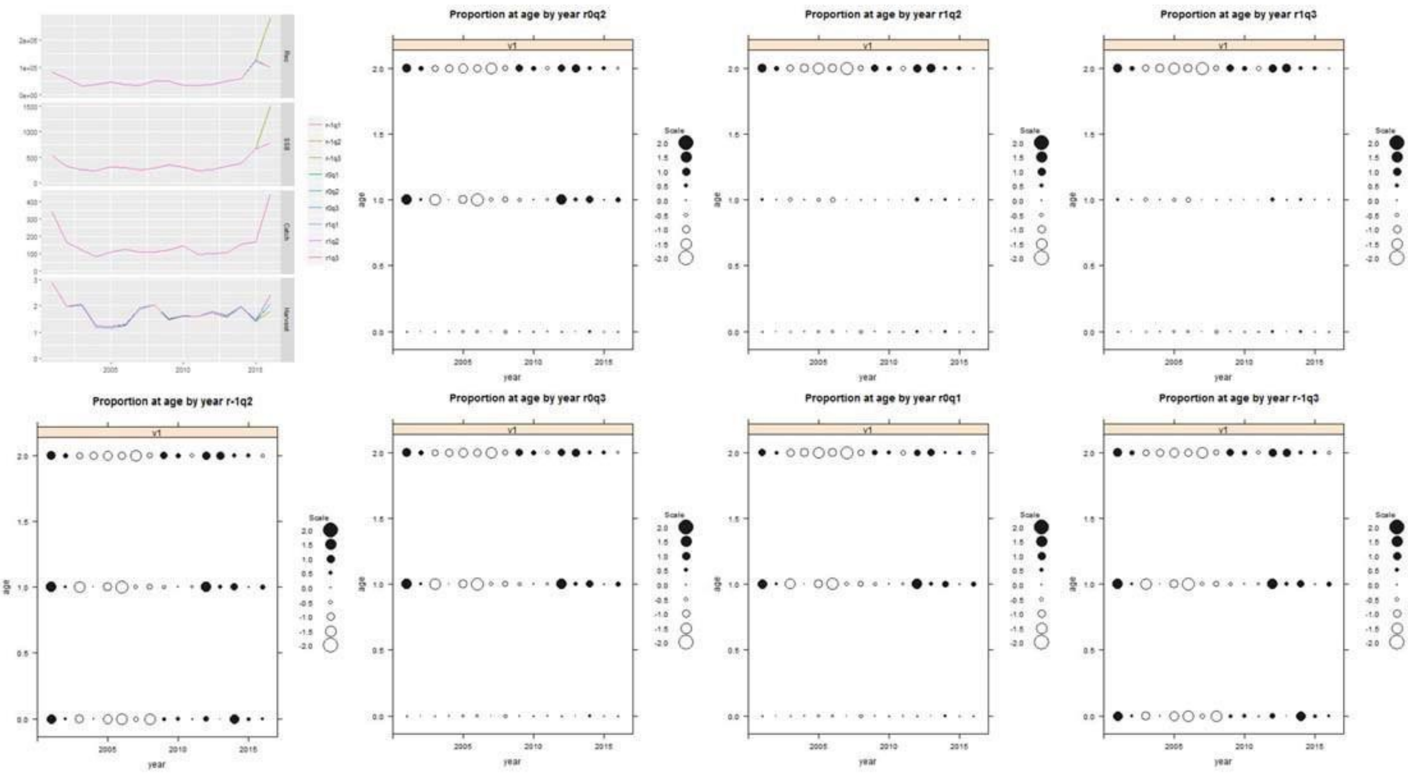


Figure 8. Sensitivity analysis on different catchability independent of “rage” and “qage”.

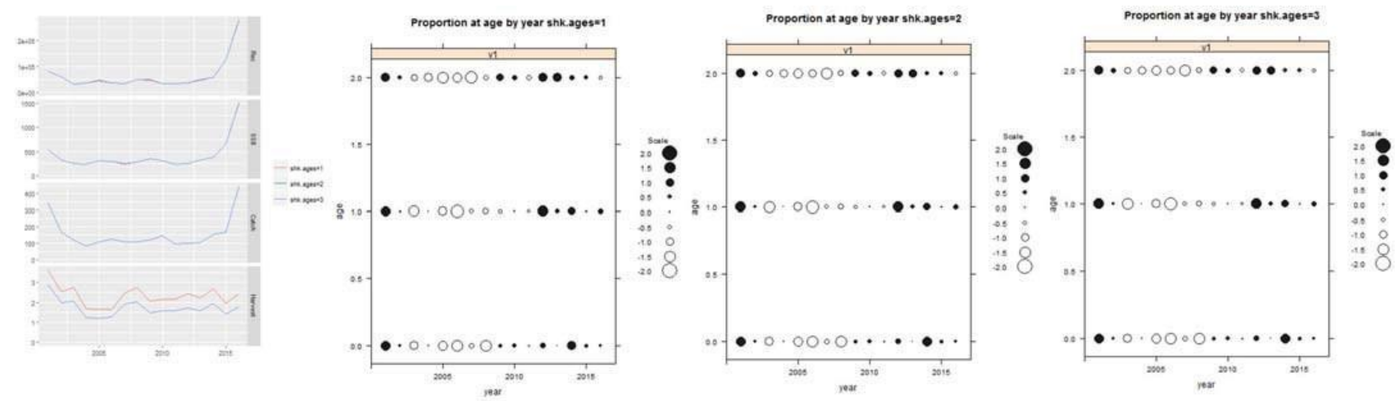


Figure 9. Sensitivity analysis on different shrinkage age “shk.ages” values.

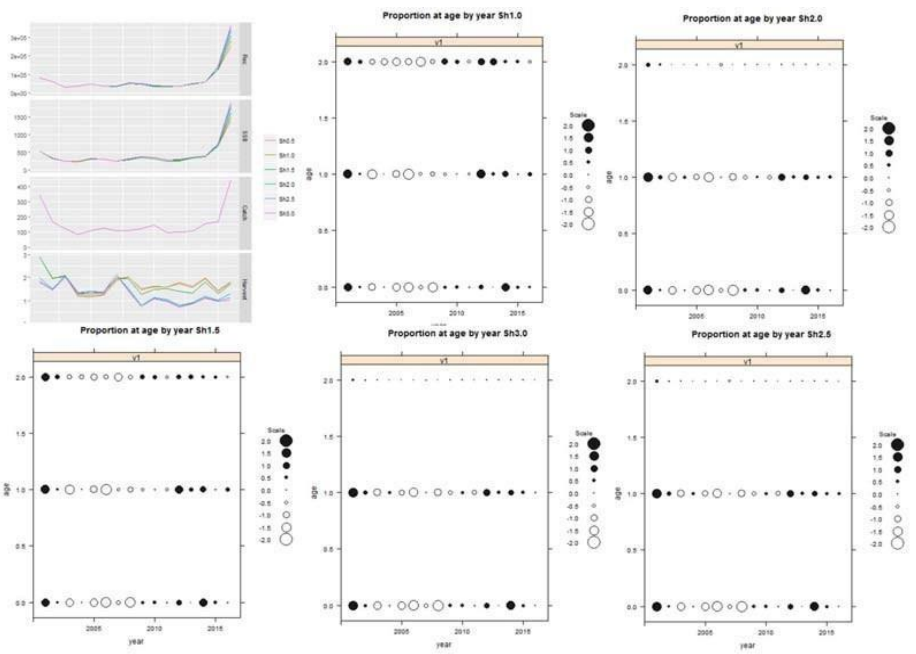


Figure 10. Sensitivity analysis on different shrinkage weight “fse”.

On the basis of the sensitivity analisys, residuals distributions and of the retrospective analysis, the model with rage=-1(0), qage=2 , fse= 1.5 and shk.yrs=2 was adopted as final model.

6.1.6 Assessment quality

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

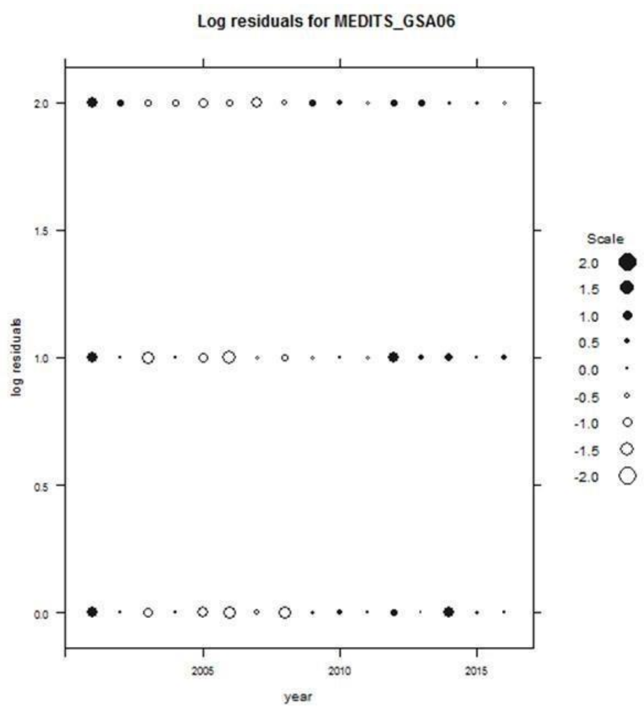


Figure 11. Catchability residuals plots with values for MEDITS_ES_GSA6 trawl survey indices.

7 Stock predictions

7.1 Short term predictions

Deterministic projections for three years (2017-2019) were produced. These projections are based on the arithmetic mean of recruitment, catches and weights at age of the last three years (20142016). F Status Quo is the geometric mean of $Fbar_{0\text{-}2}$ during the last three years (2014-2016).

Table 7-1: Shortterm projection, summary results.

Ffactor	Fbar	Catch				SSB		Change_SSB	Change_Catch
		2016	2017	2018	2019	2018	2019	2018-2019(%)	2016-2018(%)
0	0	432.5	789.24	0	0	949.46	1343.14	41.46	-100
0.1	0.15	432.5	789.24	81.68	116.22	949.46	1247.62	31.4	-81.63
0.2	0.3	432.5	789.24	148.19	197.31	949.46	1173.58	23.61	-66.67
0.3	0.45	432.5	789.24	202.95	254.77	949.46	1115.75	17.51	-54.35
0.4	0.6	432.5	789.24	248.6	296.25	949.46	1070.15	12.71	-44.09
0.49	F0.1=0.75	432.5	789.24	287.12	326.84	949.46	1033.82	8.89	-35.42
0.5	0.75	432.5	789.24	287.14	326.85	949.46	1033.8	8.88	-35.42
0.6	0.9	432.5	789.24	320.1	350	949.46	1004.47	5.79	-28.01
0.7	1.05	432.5	789.24	348.67	367.98	949.46	980.47	3.27	-21.58
0.8	1.2	432.5	789.24	373.75	382.36	949.46	960.52	1.16	-15.94
0.9	1.35	432.5	789.24	396.05	394.17	949.46	943.67	-0.61	-10.92
1	1.5	432.5	789.24	416.11	404.14	949.46	929.21	-2.13	-6.41
1.1	Fc=1.65	432.5	789.24	434.35	412.74	949.46	916.58	-3.46	-2.31
1.2	1.8	432.5	789.24	451.11	420.34	949.46	905.37	-4.64	1.46
1.3	1.95	432.5	789.24	466.64	427.15	949.46	895.27	-5.71	4.95
1.4	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
1.5	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
1.6	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
1.7	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
1.8	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
1.9	2	432.5	789.24	471.24	429.13	949.46	892.33	-6.02	5.99
2	2	432.5	789.24	471.23	429.13	949.46	892.33	-6.01	5.98

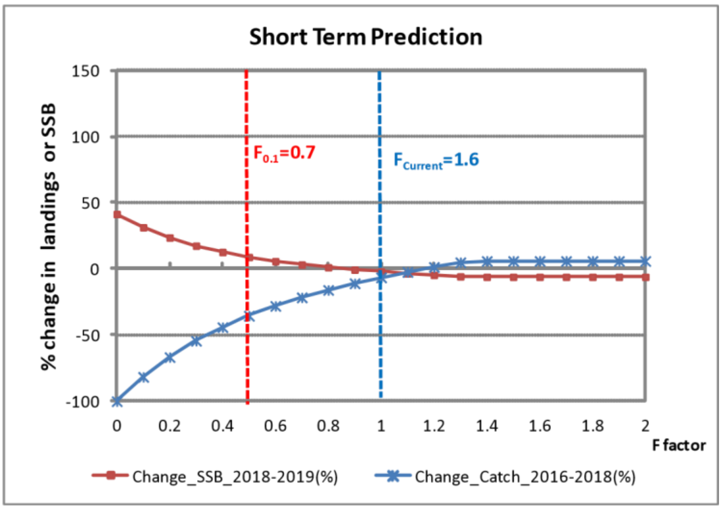


Figure 12. Fishing at $F_{current}$ from 2016 to 2018 would produce a decrease in catches of -2% with a small decrease in SSB for the 2018-2019 period -3%).

Fishing at $F_{0.1}$ from 2016 to 2018 would generate a decrease in catches of 35% and an increase of 9% in SSB for the 2018-2019 period. *Medium term predictions*

No long term prediction was carried out due to the lack of a reliable model fit for the spawning stock biomass-recruitment relationship.

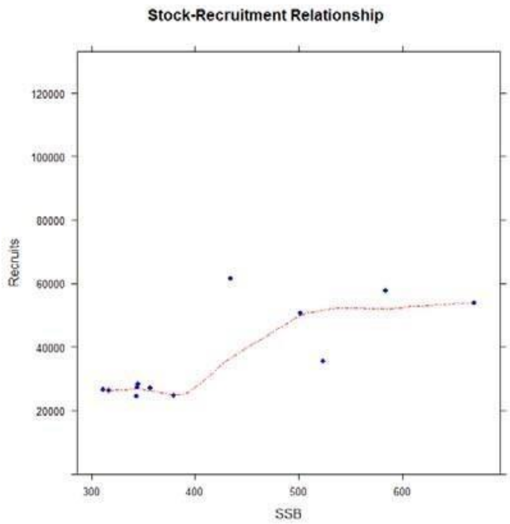


Figure 13. Spawning stock biomass (SSB)-Recruitment (R) relationship.

7.2 Long term predictions

Yield per recruit analysis.

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 2016. Natural mortality vector values were applied per age group using ProBiom (Abella et al., 1998). Fishing mortalities were the mean exploitation pattern F between 2014 and 2016. Reference F was considered to be mean F for ages 0 to 2 during the last 3 years (2014-2016).

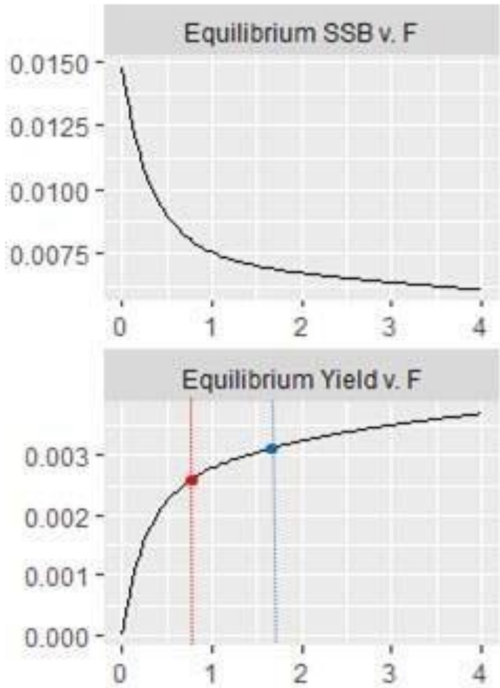


Figure 14. Equilibrium Yeld (g) per Recruit and SSB (g) per Recruit vs Fishing mortality (F) including yield and spawner reference point proxy MSY (F0.1 =0.7, Fcurrent=1.6).

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	($F_{0.1}$ = 0.6) (F_c=1.6)	$F_c/F_{0.1}$=2.2		N 3	IO _O_h
Stock abundance (tons.)	Catch (t)		432.5	33% percentile, 103.9 66% percentile, 139.2	N 17	O_H
$B_{current}$	Biomass (t) (20142016)		1495	33% percentile; 426 66% percentile; 529	N 17	O_H
$SSB_{current}$	SSB (t)(2014-2016)		858	33% percentile; 273 66% percentile; 316	N 17	O_H
Recruitment						
Final Diagnosis		- In overexplotation ($F_{current}$>$F_{0.1}$), High Overfishing - Relative high biomass; $SSB_{current\ (2014-2016)}$= 858 (t); Biomass at 66[rd] percentile = 316(t)				
Scientific advice for management		- Reduce $F_{current}$ towards $F_{0.1}$ - Progressive reduction of the fishing effort				

7.3 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)*