Stock Assessment Form

Demersal species

The assessment of the stock of Deep water rose shrimp, *Parapenaeus longirostris*, in the Ligurian and northern Tyrrhenian Sea (FAO-GFCM Geographical Sub-Area 9, GSA 09) was carried out by means of an Extended Survivor Analysis (XSA) run using FLR libraries. The assessment was carried out using as input data the period 2006-2014 for the catch data and 2006-2014 for the tuning file (Medits indices). The results of the assessment show an increasing trend in the catches, fluctuation in recruitment and SSB, and an estimated $F_{curr} = 0.67$. F_{curr} shows the same value of $F_{0.1}$ (0.67), chosen as proxy of F_{MSY}, which indicates that Deep-water rose shrimp stock in GSA 09 is exploited sustainably.

Stock Assessment Form version 1.0 (January 2014)

Uploader: Mario Sbrana

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 09		
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)
XSA
Authors:
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The ISSCAAP code is assigned according to the FAO 'International Standard Statistical Classification for Aquatic Animals and Plants' (ISSCAAP) which divides commercial species into 50 groups on the basis of their taxonomic, ecological and economic characteristics. This can be provided by the GFCM secretariat if needed. A list of groups can be found here:

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

2 Stock identification and biological information

Due to a lack of information about the structure of Deep-water rose shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.
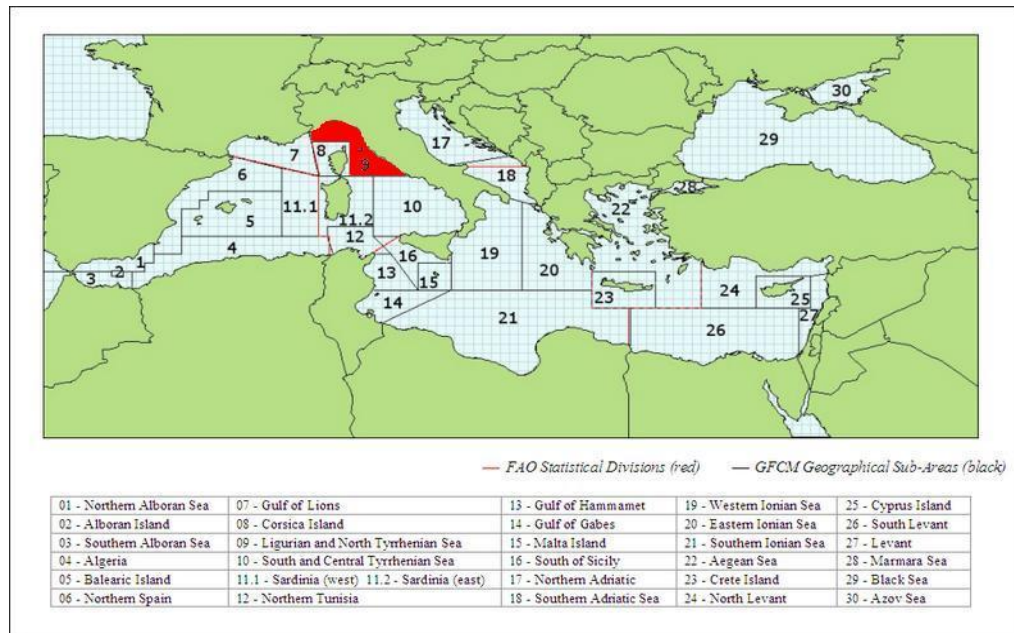

01 - Northern Alboran Sea	07 - Gulf of Lions	13 - Gulf of Hammamet	19 - Western Ionian Sea	25 - Cyprus Island
02 - Alboran Island	08 - Corsica Island	14 - Gulf of Gabes	20 - Eastern Ionian Sea	26 - South Levant
03 - Southern Alboran Sea	09 - Ligurian and North Tyrrhenian Sea	15 - Malta Island	21 - Southern Ionian Sea	27 - Levant
04 - Algeria	10 - South and Central Tyrrhenian Sea	16 - South of Sicily	22 - Aegean Sea	28 - Marmara Sea
05 - Balearic Island	11.1 - Sardinia (west) 11.2 - Sardinia (east)	17 - Northern Adriatic	23 - Crete Island	29 - Black Sea
06 - Northern Spain	12 - Northern Tunisia	18 - Southern Adriatic Sea	24 - North Levant	30 - Azov Sea

Figure 2-1: Geographical location of GSA 09.

The species shows a wide bathymetric distribution in GSA 09, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms. The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).

2.1 Stock unit

The stock unit is represented by the GSA 09.

2.2 Growth and maturity

The growth of *P. longirostris* has been studied in the southern part of the GSA 09 (central Tyrrhenian Sea) using modal progression analysis. The following sets of Von Bertalanffy growth parameters were estimated: Females: L∞ = 43.5, K=0.74, t0=-0.13; Males: L∞ = 33.1, K=0.93, t0=-0.05. The life cycle is of 3-4 years. Females grow faster than males attaining larger size-at-age.

In the northern Tyrrhenian Sea, the reproduction area of *P. longirostris* is located from 150 to 350 m; mature females are present all year round, even though the species shows two peaks in reproductive activity, one in spring and another at the beginning of autumn. In the central Tyrrhenian Sea, the southern part of GSA 09, a main winter spawning was hypothesized. The size at onset of sexual maturity estimated for different years in northern Tyrrhenian Sea is about 24 mm CL. The number of oocytes in the ovary was related to the size of the females and ranged from 23,000 oocytes at 26 mm CL to 204,000 at 43 mm CL. An exponential relationship was observed between

fecundity and carapace length: Fecundity = $0.0569*CL^{4.0177}$ (r = 0.829).
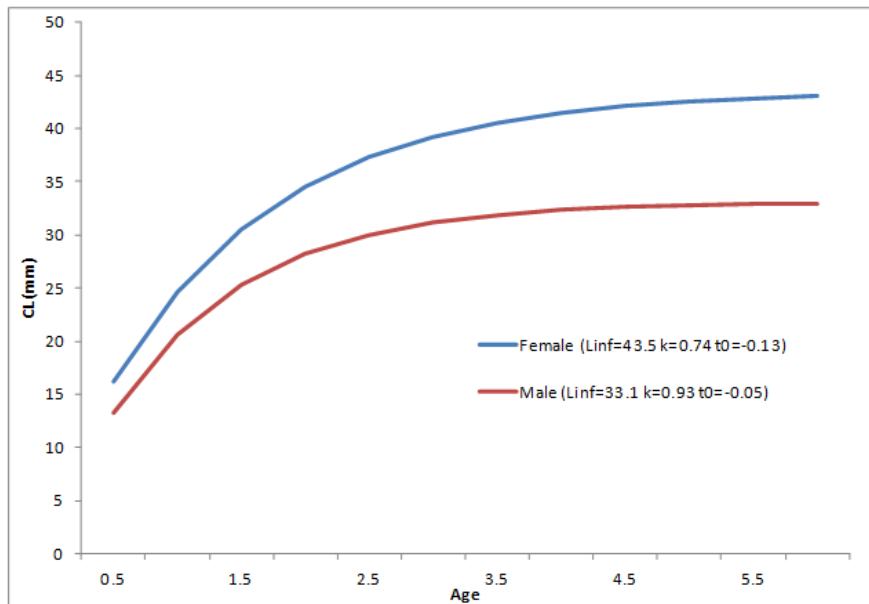
Figure 2.2-1: Deep-water rose shrimp in GSA 09. Von Bertalanffy curves used in the analysis.

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

Somatic magnitude measured CL (mm)				Units	
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	All year round
Maximum size observed	49	40		**Recruitment season**	All year round with peaks from July to October
Size at first maturity	24			**Spawning area**	Main areas between 150 and 350 m depth to the south of Elba Island
Recruitment size to the fishery				**Nursery area**	Main nurseries between 60 and 220 m depth to the south of Elba Island

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

Size/Age	Natural mortality	Proportion of matures
0	1.66	0.0
1	0.68	0.8
2	0.48	1.0
3+	0.38	1.0

Table 2.2-3: Growth and length weight model parameters.

			Sex			
		Units	female	male	Combined	Years
Growth model	L_∞	Mm	43.5	33.1		
	K	years^{-1}	0.74	0.93		
	t_0	years	-0.13	-0.05		
	Data source					
Length weight relationship	a	g	0.0044	2.359		
	b	g	0.0045	2.377		
	M (scalar)					
	sex ratio (% females/total)	52				

3   Fisheries information

3.1   Description of the fleet

In GSA 09, Deep-water rose shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope. The species is exclusively exploited with otter bottom trawling.

The trawl fleet of GSA 09 accounted for 197 vessels in 2014 based in several ports: Viareggio, Livorno, Porto Santo Stefano, Civitavecchia, Fiumicino, Anzio, Terracina, Gaeta, Formia. The majority of bottom trawlers of GSA 09 operate daily fishing trips with some vessels (especially those of Porto Santo Stefano) staying out for two-three days and mainly in the summer. The mean number of fishing days/year per vessel carried out by the GSA 09 trawlers varied from 187 in 2004 to 177 in 2006. Due to the distance of the fishing grounds to the main harbors, fishing activity targeting *P. longirostris* shows some seasonal variations, with maxima from mid spring to mid autumn.

The main fishing grounds are located in the southern part of the GSA 09, to the south of Elba Island (northern and central Tyrrhenian Seas); they are mainly exploited by several trawlers of Porto Santo Stefano, Porto Ercole, Fiumicino, Terracina and Gaeta. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are European hake, *Merluccius merluccius*, Horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths.

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*	ITALY	GSA9	[Fleet Segment1]	OTB	34-47-58	

Table 3.1-2: Catch, bycatch, discards and effort by operational unit in 2014.

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)		Discards (T of the species assessed)	Discards (other species caught)		Effort (units)
1	197	606 (including discard)	HKE MUT EOI MTS PAC SQR SQM HMM CTC OCC GFB WHB	1296 1204 655 593 434 291 290 268 218 201 187 126	45	MTS HKE HMM PAC GFB MUT DPS SBA CIL EOI SQM POD	314 286 200 198 135 106 45 29 29 17 17 12	
Total	197	606			45			

3.2   Historical trends

Total landings of Deep-water rose shrimp fluctuated from 161 tons in 2002 to 576 tons in 2013; fluctuations have been observed with a peak in 2006 corresponding to 462 tons and very high values in the last three years. The landings were mainly taken by demersal otter trawlers.
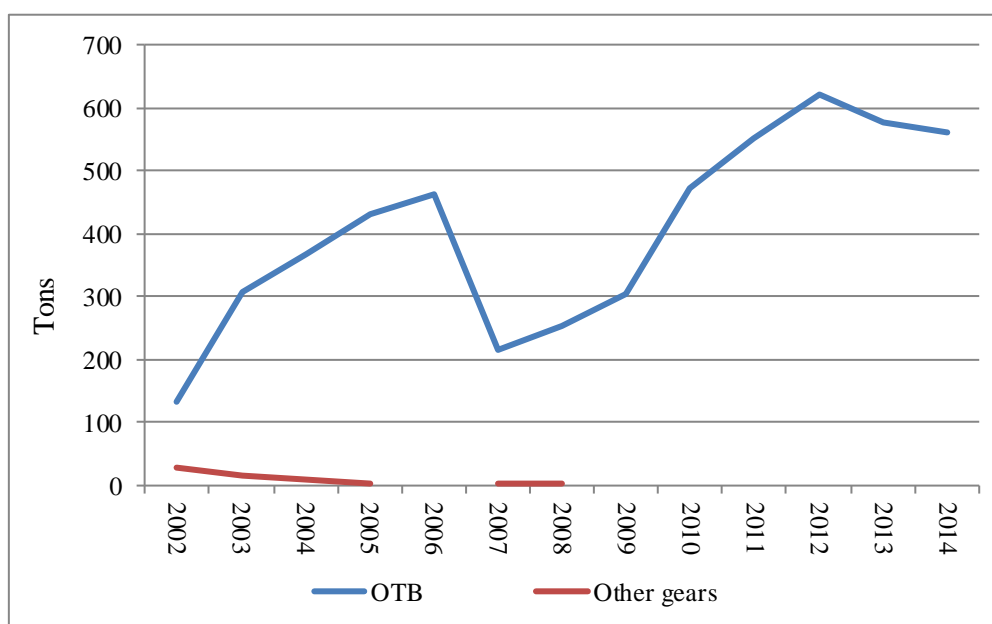

Figure 3.2-1: Total landings of Deep-water rose shrimp in GSA 09.

Table 3.2-1: Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF (EU).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
OTB	133	308	367	430	462	215	253	303	473	551	621	576	561
Other gears	28	15	9	1		2	1						
Total	161	323	376	431	462	217	254	303	473	551	621	576	561

Discards of *P. longirostris* are generally low. They mainly occur on the fishing grounds located at depths of less than 200 m, where juvenile specimens are more abundant. In the period considered (2006-2014), discard represented about 9% of the annual total catch. The discarded biomass *of P. Longirostris* ranged from a minimum of 8 tons in 2012 to a maximum of 63 tons in 2011.

Table 3.2-2: Annual discard (t) for OTB in GSA 09 as provided through the official DCF (EU).

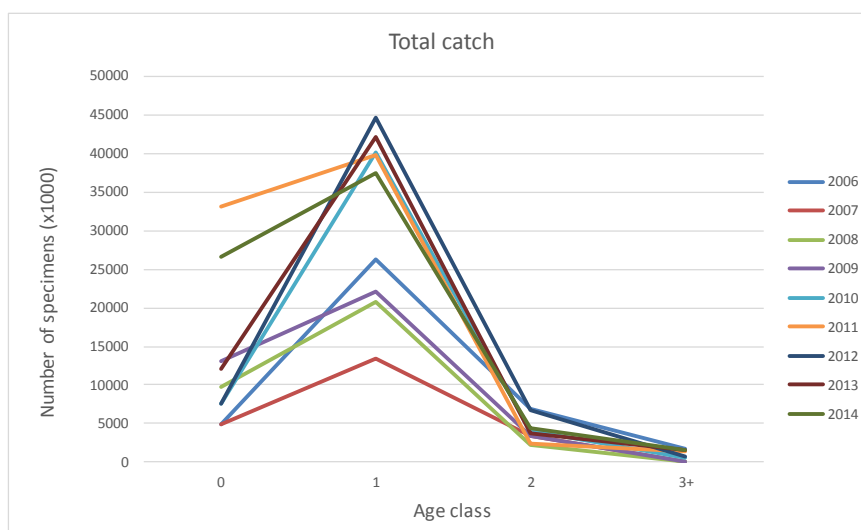|	2006	2007	2008	2009	2010	2011	2012	2013	2014
OTB	34	35	41	49	27	63	8	30	45

Figure 3.2-2: Deep-water rose shrimp in GSA 09. Age frequency distribution of the total catch (landings + discard) from 2006 to 2014 as obtained from EU DCF data.

The total fishing effort of the GSA 9 trawl fleet, expressed as kw*days at sea, has shown a progressive decrease in the last 10 years. It varied from about 14,800,000 in 2004 to 10,000,000 in 2012. Anyway, there is no information on the specific effort directed to *P. longirostris* in GSA 09.
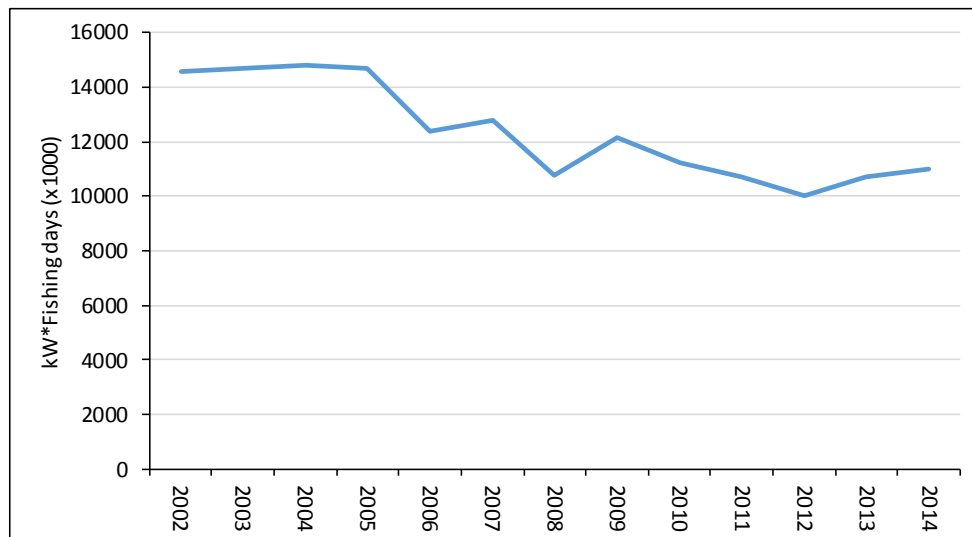
*Figure 3.2-3: Fishing effort of OTB in GSA 09 expressed as kW*fishing days (EU DCF data).*

3.3 Management regulations

• Minimum conservation size: 20 mm CL.

• Fishing closure for trawling: 30-45 days in late summer – beginning of autumn (not every year have been enforced).

• Cod end mesh size of trawl nets: 40 mm square meshes or, under certain conditions, 50 mm (stretched) diamond meshes.

• Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coast with the exception of some areas of the Ligurian Sea that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.

• Two small No Take Zones ("Zone di Tutela Biologica", ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTBs. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

3.4   Reference points

Table 3.4-1: List of reference points and empirical reference values previously agreed.

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B					
SSB					
F			$F_{0.1}$	0.71	STECF EWG 14-19 (Proxy of F_{msy})
Y					
CPUE					
Index of Biomass at sea					

4   Fisheries independent information

4.1   *Mediterranean International Bottom Trawl Survey (MEDITS)*

The Mediterranean International Bottom Trawl Survey MEDITS has been carried in the Ligurian and northern Tyrrhenian Seas since 1994.

4.1.1 Brief description of the direct method used

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means. This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial.

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information.

Survey	Mediterranean International Bottom Trawl Survey (MEDITS)	Trawler/RV	FV Libera
Sampling season	Spring-Summer		
Sampling design	Random Stratified		
Sampler (gear used)	Ifremer GOC73 bottom trawl net		
Cod –end mesh size as opening in mm	20 mm		
Investigated depth range (m)	10-800 m		

Table 4.1-2: Trawl survey sampling area and number of hauls.

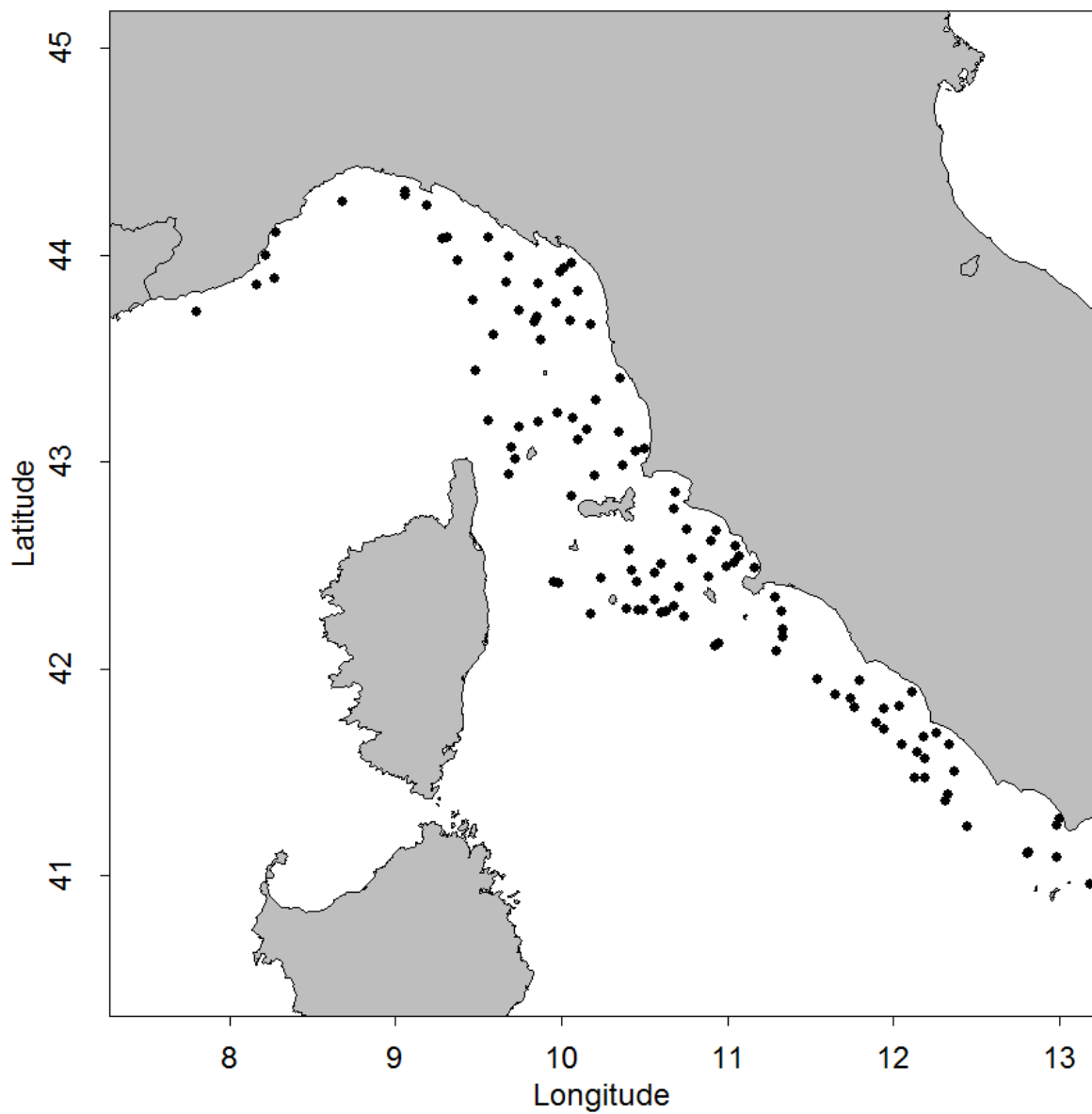| Stratum	Total surface (km²)	Trawlable surface (km²)	Swept area (km²)	Number of hauls
10 – 50 m	5762	5762	0.75	15
50 – 100 m	5992	5992	0.95	19
100 – 200 m	10878	10878	1.45	29
200 – 500 m	10587	10587	3.60	36
500 – 800 m	9191	9191	2.10	21
Total (10 – 800 m)	42410	42410	8.85	120

Figure 4.1-1: Map of the position of MEDITS survey hauls in GSA 09.

Table 4.1-3: Trawl survey abundance and biomass results.

Depth Stratum	Years	kg per km²	CV	N per km²	CV
10-800 m	2006	3.8	13.02	291.7	12.81
10-800 m	2007	1.7	10.16	170.5	9.35
10-800 m	2008	3.7	10.93	380.9	11.64
10-800 m	2009	3.4	10.44	406.7	12.56
10-800 m	2010	10.3	9.85	1278.7	10.18
10-800 m	2011	7.5	10.44	1014.7	12.00
10-800 m	2012	7.5	9.43	769.5	9.91
10-800 m	2013	8.1	9.59	978.6	12.23
10-800 m	2014	5.1	11.23	774.1	17.72

*

Comments

- Specify CV or other index of variability of mean
- Specify sampling design (for example random stratified with number of haul by stratum proportional to stratum surface; or systematic on transect;…)
- Specify if catchability coefficient is assumed =1 or other

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

Slicing method

The length frequency distributions have been transformed in age data applying the length-to-age slicing method.

Table 4.1-4: Trawl survey results by age class. Number of specimens/km².

N (Total) by Age class	Year								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
0	3.8	90.3	29.3	133.7	240.8	342.7	77.7	301.2	332.4
1	208.0	23.0	340.8	263.7	1015.9	652.0	656.4	648.3	427.9
2	79.5	56.9	10.5	8.4	22.0	19.6	35.4	28.8	13.8
3+	0.4	0.3	0.3	0.9	0.0	0.4	0.0	0.3	0.0
Total	291.7	170.5	380.9	406.7	1278.7	1014.7	769.5	978.6	774.1

Table 4.1-5: Sex ratio by age class.

Sex ratio by Age class	Year								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
0	0.89	0.59	0.75	0.62	0.69	0.68	0.76	0.64	0.61
1	0.65	0.49	0.38	0.51	0.35	0.40	0.41	0.49	0.39
2	0.55	0.74	0.30	0.42	0.30	0.28	0.27	0.35	0.30
3+	0.32	0.32	0.34	0.07	0.15	0.05	0.14	0.06	0.14
Total	0.63	0.57	0.45	0.54	0.47	0.52	0.47	0.53	0.50

Comments

- Specify if numbers are per km² or raised to the area, assuming the same catchability .
- In case maturity ogive has not been estimated by year, report information for groups of years.
- Possibility to insert graphs and trends

Direct methods: trawl based Recruitment analysis

Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey		Trawler/RV	
Survey season			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-6: Trawl surveys; recruitment analysis results

Years	Area in km²	N of recruit per km²	CV or other

Comments

- Specify type of recruitment:
  - continuous and diffuse
  - discrete and diffuse
  - discrete and localised
  - continuous and localised.
- Specify the method used to estimate recruit indices
- Specify if the area is the total or the swept one
- Possibility to insert graphs and trends

Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey		Trawler/RV	
Survey season			
Investigated depth range (m)			
Spawning season and peak (months)			

Table 4.1-8: Trawl surveys; spawners analysis results

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

Comments

- Specify type of spawner:
  - total spawner
  - sequential spawner
  - presence of spawner aggregations
- Specify if the area is the total or the swept one
- Possibility to insert graphs e trends

4.1.2 Spatial distribution of the resources

P. longirostris shows a wide bathymetric distribution in GSA 09, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms.

The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).
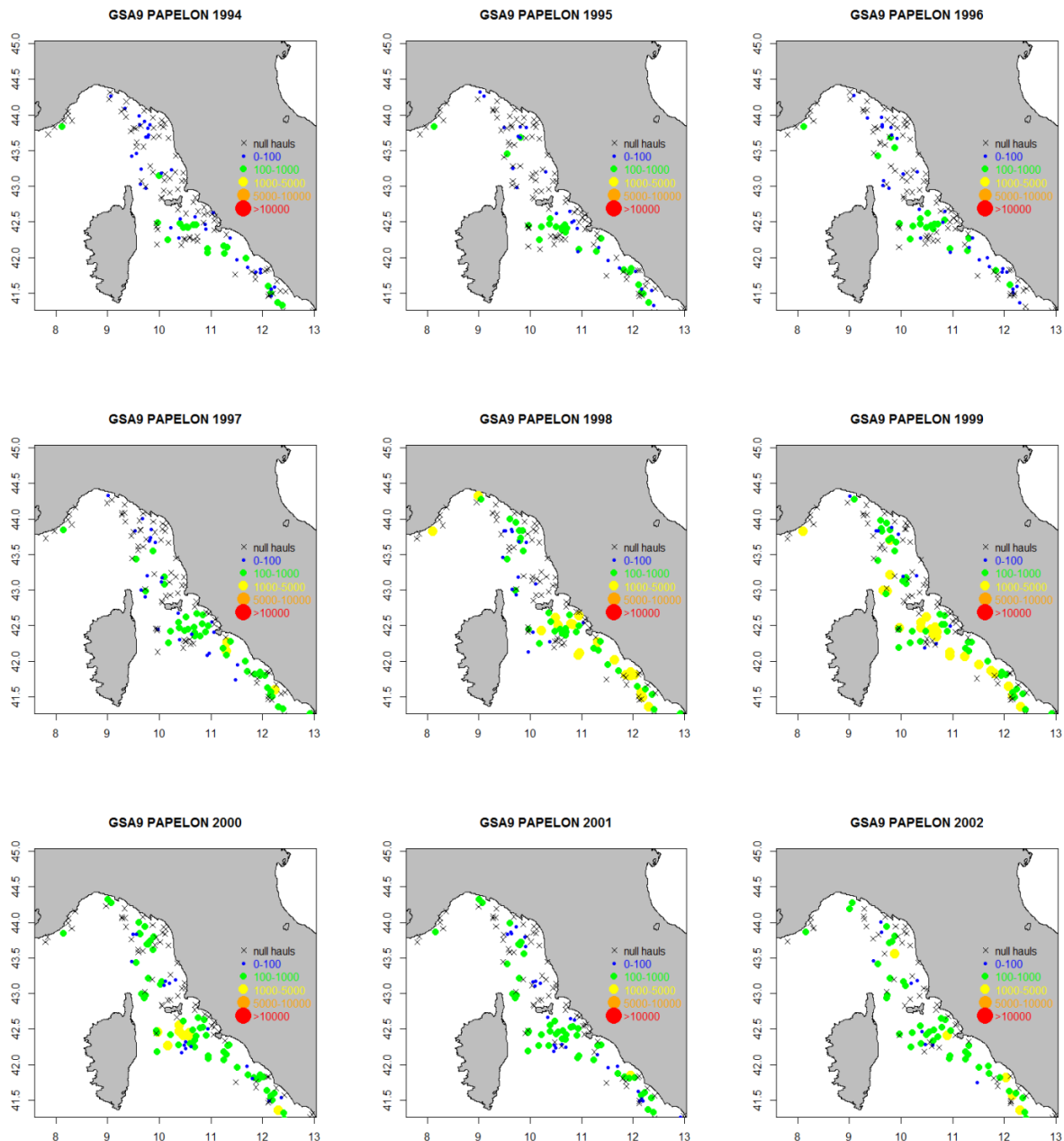

Figure 4.1.2-1: Deep-water rose shrimp distribution pattern in GSA 09 in the period 1994-2002 (MEDITS survey).
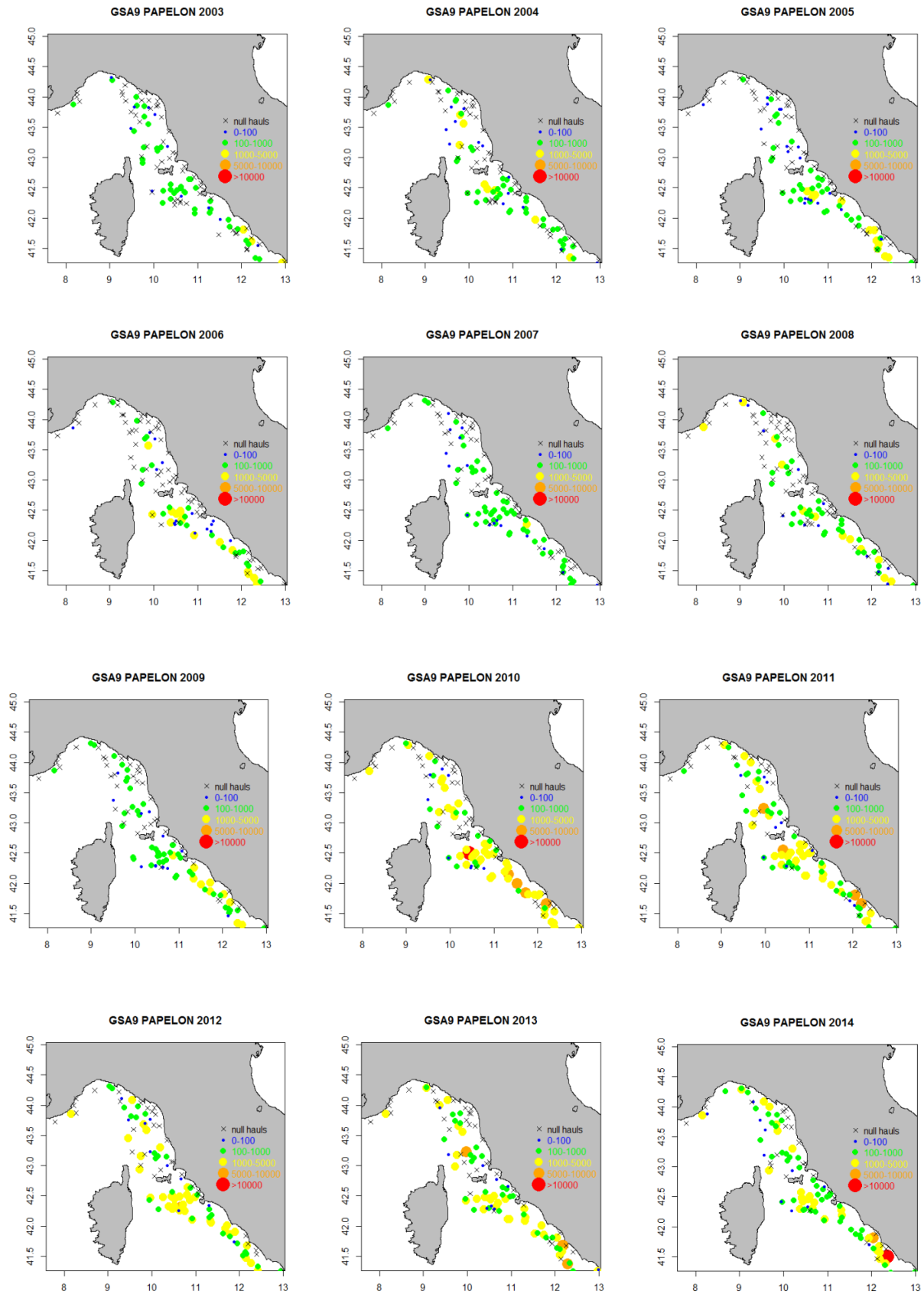
Figure 4.1.2-2: Deep-water rose shrimp distribution pattern in GSA 09 in the period 2003-2014 (MEDITS survey).

Recruits (CL 15 mm) occur all year round, with a main peak from July to October. The main nurseries revealed a high spatio-temporal persistency between 60 and 220 m depth.
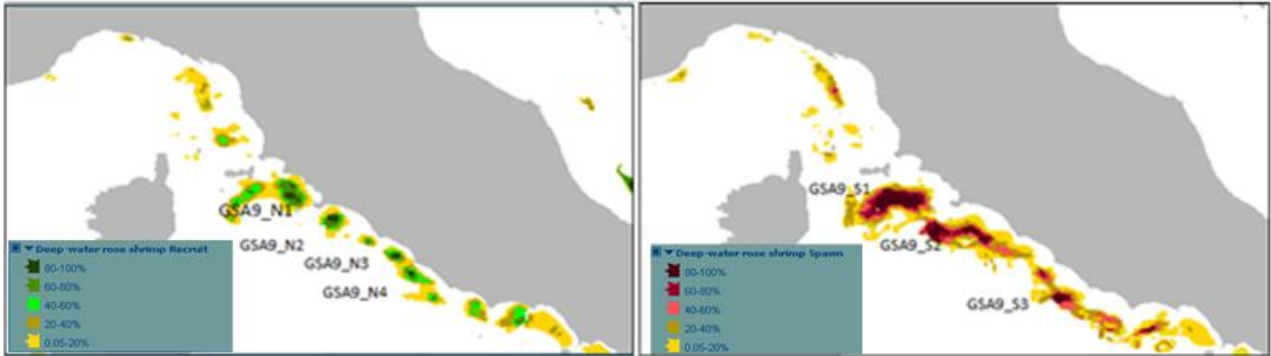

Figure 4.1.2-3: Temporal persistence of deep-water rose shrimp nurseries (left) and adults distribution (right) calculated from MEDITS time-series density maps (1994-2012). The figure is taken from the MEDISEH project.

4.1.3 Historical trends

Since 1994, Medits trawl survey was regularly carried out each year. The survey showed a temporal increasing trend in density and biomass of Deep-water rose shrimp, with maximum value in 2010.
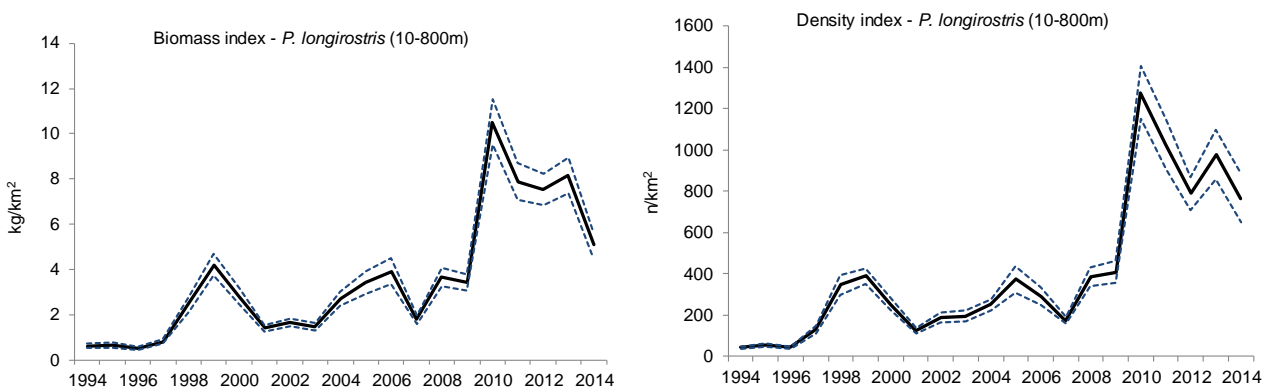

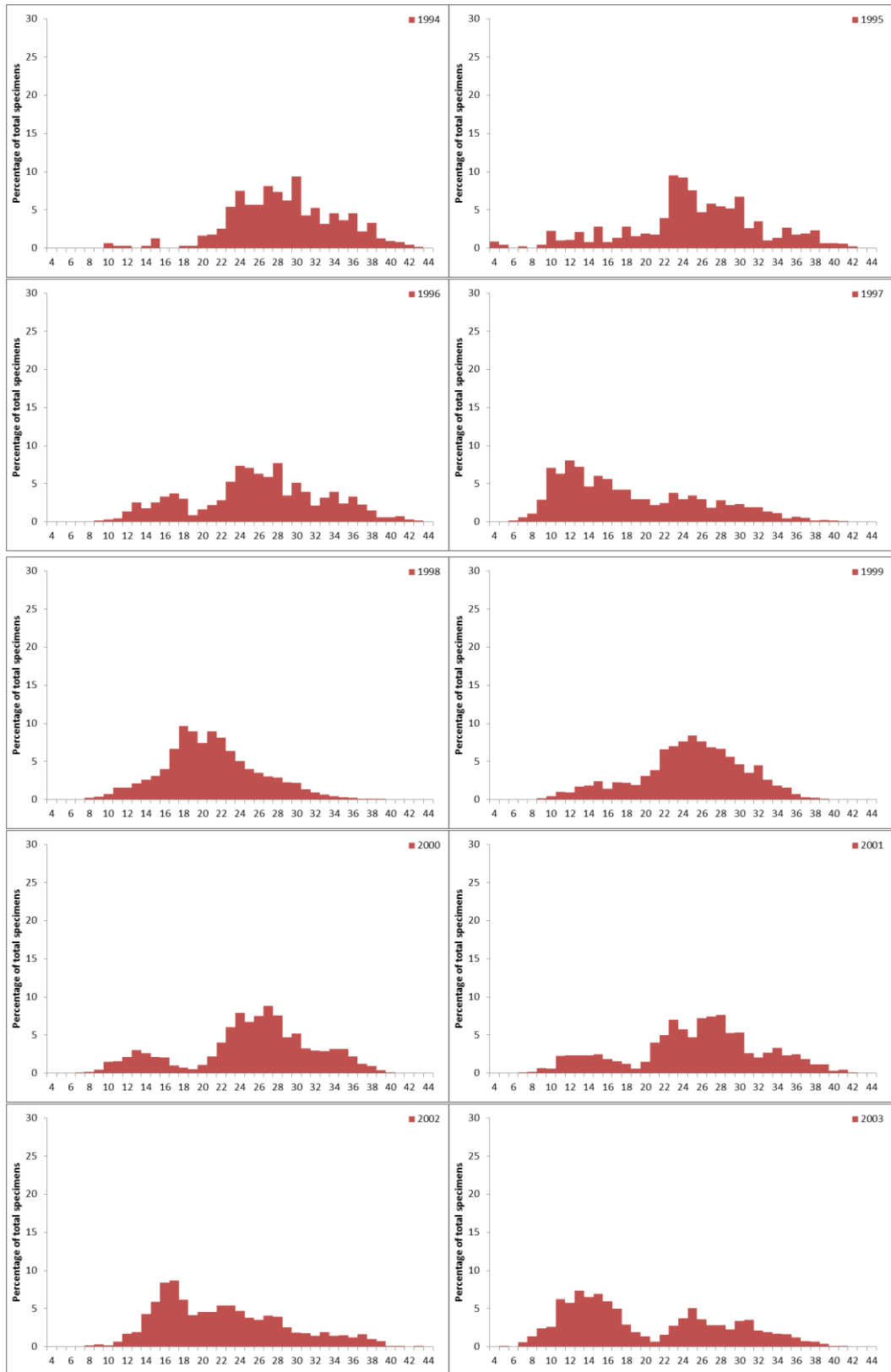*Figure 4.1.3-1: MEDITS survey. Trend of biomass and density index of* P. longirostris *in GSA 09.*

Figure 4.1.3-2: MEDITS survey. Length frequency distribution of Deep-water rose shrimp in GSA 09 for the period 1994-2003.
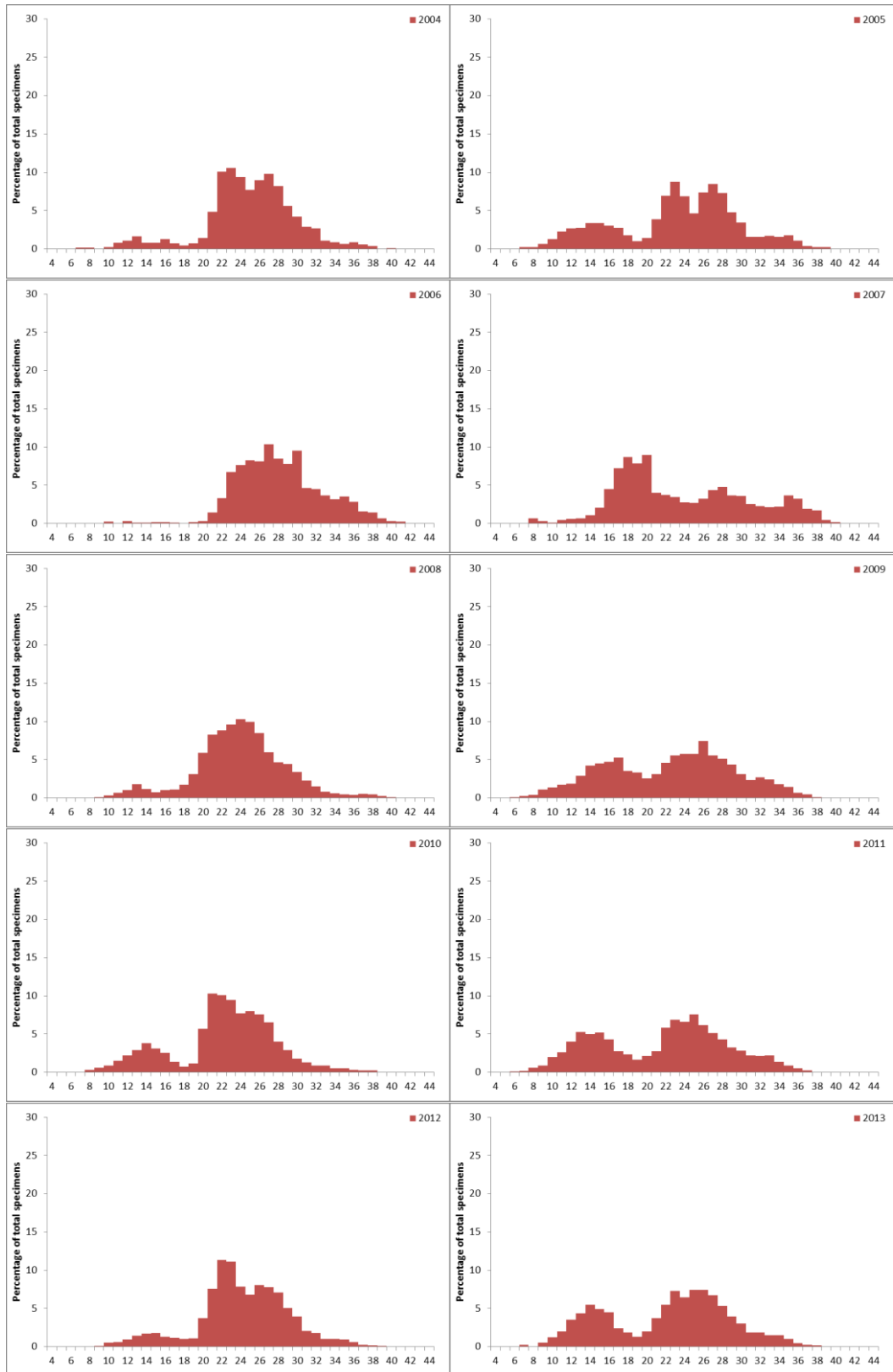
Figure 4.1.3-3: MEDITS survey. Length frequency distribution of Deep-water rose shrimp in GSA 09 for the period 2004-2013.
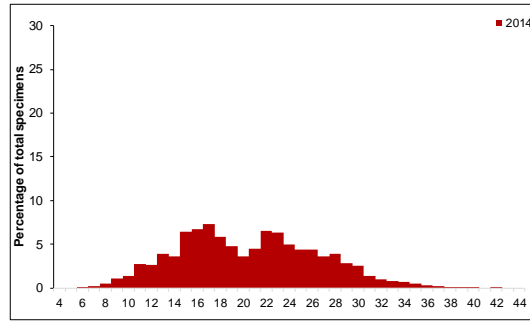
Figure 4.1.3-4: MEDITS survey. Length frequency distribution of Deep-water rose shrimp in GSA 09 for the year 2014.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

In GSA 09 the fisheries fishing for Deep-water rose shrimp do not significantly affect protected species.

5.2 Environmental indexes

No environmental indices were used to perform the stock assessment of Deep-water rose shrimp in GSA 09.

6 Stock Assessment

FLR libraries were employed in order to carry out an Extended Survivor Analysis (XSA) assessment.

6.1 Extended Survival Analysis (XSA)

6.1.1 Model assumptions

6.1.2 Scripts

The model settings that minimized the residuals and showed the best diagnostics outputs were used for the final assessment, and are the following:

FLXSA.control.aafin <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.5, rage=0, qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)

6.1.3 Input data and Parameters

The assessment by means of XSA was carried out using as input data the period 2006-2014 for the catch data and 2006-2014 for the tuning file (MEDITS indices).
A natural mortality vector computed using ProdBiom software was used. Length frequency distributions of commercial catches and surveys were split by sex and then transformed in age classes (plus group was set at age 3) using length-to-age slicing with different growth parameters. The number of individuals by age was SOP corrected [SOP = Landings / Σa (total catch numbers at

age a x catch weight-at-age a)]. However, the correction factor resulted low.

XSA analysis was performed by sex combined. Given that the landings were composed mainly of individuals between 0 and 2 years, these ages were selected as the Fbar.

Table 6.1.3-1: Catch at age matrix (including discard).

Catch-at-age (thousands)									
Age class	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	4924.3	4872.0	9717.7	13071.0	7504.3	33199.1	7619.9	12103.8	26557.9
1	26312.2	13339.6	20689.9	22068.3	40079.0	39825.8	44708.5	42176.3	37542.9
2	6957.2	3390.2	2271.0	3395.0	4044.3	2322.1	6787.7	3801.0	4422.8
3+	1760.7	0.02	0.01	0.05	622.8	1391.8	693.9	1595.7	1511.7

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

Catch-at-age (Number/Km^2)									
Age class	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	3.8	90.3	29.3	133.7	240.8	342.7	77.7	301.2	332.4
1	208.0	23.0	340.8	263.7	1015.9	652.0	656.4	648.3	427.9
2	79.5	56.9	10.5	8.4	22.0	19.6	35.4	28.8	13.8
3+	0.4	0.3	0.3	0.9	0.0	0.4	0.0	0.3	0.0

Table 6.1.3-3: Catch (tons, including discards).

2006	2007	2008	2009	2010	2011	2012	2013	2014
496.1	249.8	294.2	351.9	500.4	614.3	628.7	605.7	606.4

Table 6.1.3-4: Weight-at-age matrix (kg).

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	0.004694	0.004625	0.005106	0.003364	0.004012	0.002869	0.004344	0.002962	0.002962
1	0.011581	0.012443	0.009769	0.011244	0.009552	0.011193	0.010244	0.011035	0.011035
2	0.018159	0.018064	0.018708	0.017608	0.018059	0.017724	0.017806	0.017717	0.017717
3+	0.023792	0.023606	0.023772	0.023232	0.023156	0.023076	0.024052	0.023251	0.023251

Table 6.1.3-5: Maturity and natural mortality vectors.

Age	0	1	2	3+
Maturity	0.0	0.8	1.0	1.0
M	1.66	0.68	0.48	0.38

6.1.4 Result

The results of the assessment run using XSA are shown in Figure 6.1.4-1, and Tables 6.1.4-1 – 6.1.4-3. The XSA results show an increasing trend in the catches, recruitment and SSB till 2011. Then, the values slightly decreased. In 2014, F_{curr} was 0.69.
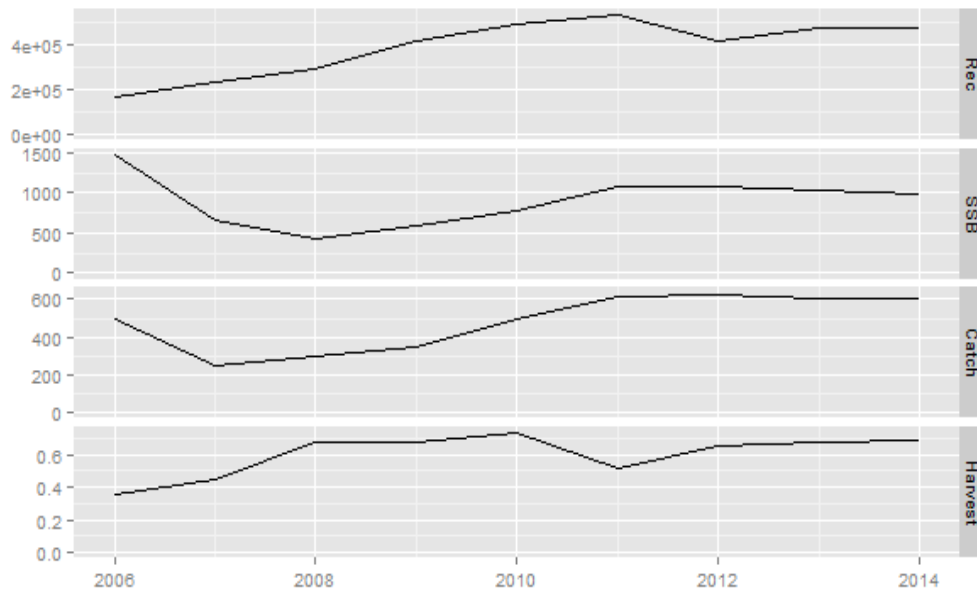

Figure 6.1.4-1: Deep-water rose shrimp in GSA 09. XSA results: fishing mortality (Harvest), recruitment, SSB, and yield.

Table 6.1.4-1: Deep-water rose shrimp in GSA 09. Stock numbers-at-age (thousands) as estimated by XSA.

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	164573	234194	293737	414530	495927	537733	422165	479798	479736
1	76403	29145	42405	51613	73119	91023	87768	76947	85951
2	32079	19979	5270	6757	10441	8516	17767	12642	8963
3+	7939	0	0	0	1551	4972	1753	5158	2920

Table 6.1.4-2: Deep-water rose shrimp in GSA 09. XSA summary results.

	F_{bar0-2}	Recruitment (thousands)	SSB (t)	TB (t)
2006	0.352	164573	1479.3	2429.7
2007	0.441	234194	651.0	1807.8
2008	0.676	293737	430.0	2013.7
2009	0.670	414530	583.2	2094.0

2010	0.728	495927	783.2	2912.5
2011	0.511	537733	1080.7	2827.4
2012	0.655	422165	1077.8	3092.5
2013	0.670	479798	1023.2	2614.0
2014	0.691	479736	985.5	2596.0

Table 6.1.4-3: Deep-water rose shrimp in GSA 09. XSA summary results: F-at-age matrix.

	F-at-age			
	0	1	2	3+
2006	0.071	0.661	0.323	0.323
2007	0.049	1.030	0.243	0.243
2008	0.079	1.157	0.794	0.794
2009	0.075	0.918	1.018	1.018
2010	0.035	1.470	0.678	0.678
2011	0.153	0.954	0.426	0.426
2012	0.042	1.258	0.665	0.665
2013	0.060	1.470	0.482	0.482
2014	0.136	0.951	0.987	0.987

6.1.5 Robustness analysis

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

XSA was run setting shrinkage at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0. As showed by Figure 6.1.6-1, the six

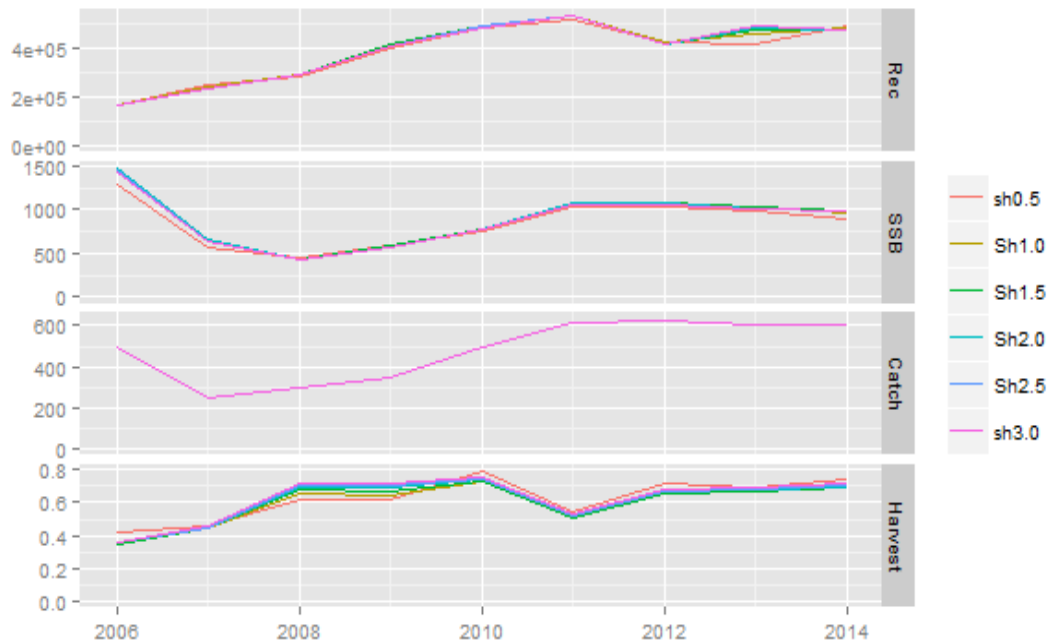different settings produced similar estimates of recruitment and SSB.

Figure 6.1.6-1: Deep-water rose shrimp in GSA 09. XSA outputs for different shrinkage scenario and log residuals for the tuning fleet.

Model with 1.5 shrinkage was adopted as final model based on the analysis of residual distributions (Figure 6.1.6-2). Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 2 to - 2, and did not show any trend with time.
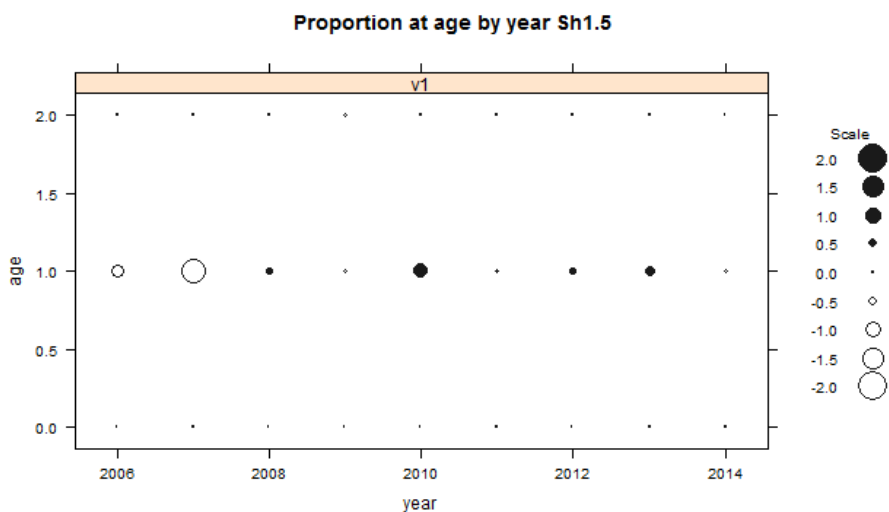

Figure 6.1.6-2: Deep-water rose shrimp in GSA 09. Residuals at age for the MEDITS survey from 2006 to 2014 obtained with shrinkage set at 1.5.

Moreover, a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 6.1.6-3) to ensure the robustness of the final estimates. The retrospective series indicate good agreement

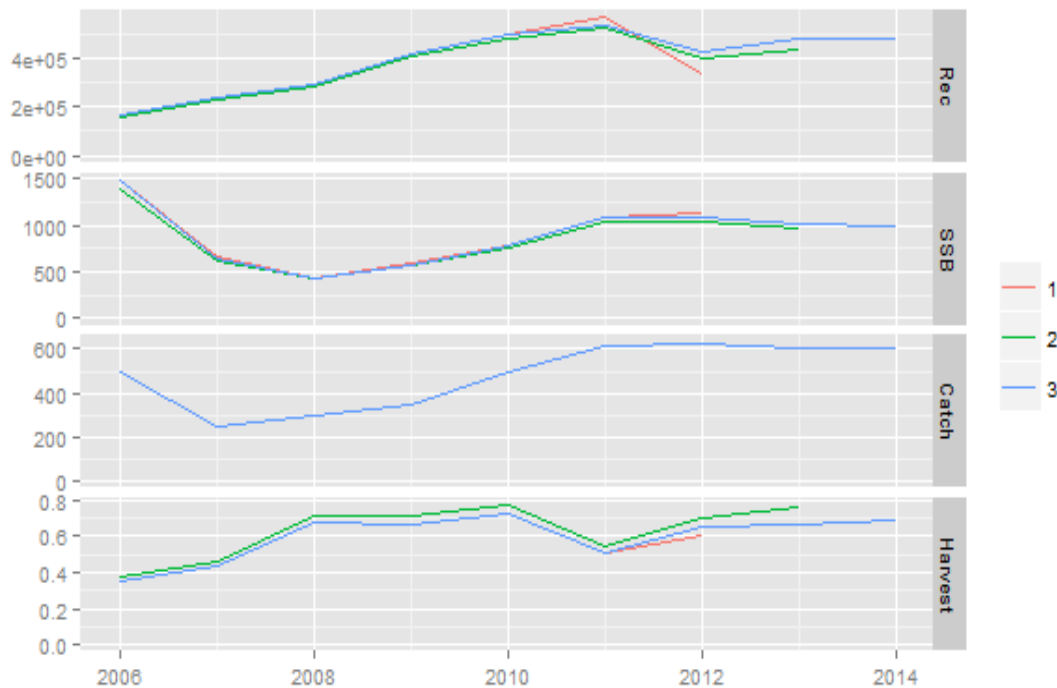between years in the assessment results, with no systematic bias.

Figure 6.1.6-3: Deep-water rose shrimp in GSA 09. XSA retrospective analysis with shrinkage set at 1.5.

6.1.7 Assessment quality

Data from EU DCF as submitted through the Official data call in 2015 were used. Length- frequencies distributions (LFD) were missing for the "métier" OTB_DWS. Missing LFD were borrowed from other OTB segments. EU DCF data prior to 2006 were considered incomplete; therefore, they were not used for the stock assessment.
Discards data were missing for 2007 and 2008. Discards for OTB in 2007 and 2008 were estimated as the mean discard % of the entire time-series. The LFD of OTB discards of 2009 were used to raise the discards.

7   Stock predictions

A deterministic short term prediction for the period 2015 to 2017 was performed using the FLR routines and based on the results of the XSA stock assessment.

7.1   Short term predictions

The input parameters for the deterministic short-term predictions for the period 2015 to 2017 were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (460566 thousand individuals).

Table 7.1-1: Deep water rose shrimp in GSA 09. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch 2014	Catch 2015	Catch 2016	Catch 2017	SSB 2016	SSB 2017	Change SSB 2016-2017(%)	Change Catch 2014-2016(%)
Zero catch	0	0	606	681	0	0	1048	1749	66.82	-100
High long term yield (F0.1)	0.997	0.67	606	681	683	681	1048	1043	-0.55	12.63
Status quo	1	0.672	606	681	684	681	1048	1041	-0.67	12.85
Different Scenarios	0.2	0.134	606	681	189	246	1048	1544	47.22	-68.79
	0.3	0.202	606	681	272	340	1048	1456	38.88	-55.22
	0.4	0.269	606	681	347	418	1048	1377	31.37	-42.81
	0.5	0.336	606	681	416	484	1048	1306	24.6	-31.46
	0.6	0.403	606	681	479	538	1048	1242	18.49	-21.05
	0.7	0.47	606	681	537	584	1048	1184	12.97	-11.5
	0.8	0.538	606	681	590	622	1048	1132	7.97	-2.71
	0.9	0.605	606	681	639	654	1048	1085	3.44	5.38
	1.1	0.739	606	681	726	704	1048	1002	-4.4	19.75
	1.2	0.806	606	681	765	723	1048	967	-7.81	26.15
	1.3	0.874	606	681	801	739	1048	934	-10.91	32.08
	1.4	0.941	606	681	834	752	1048	904	-13.74	37.59
	1.5	1.008	606	681	866	764	1048	877	-16.34	42.73
	1.6	1.075	606	681	895	773	1048	852	-18.72	47.52
	1.7	1.142	606	681	922	781	1048	829	-20.91	52
	1.8	1.21	606	681	947	788	1048	808	-22.93	56.2
	1.9	1.277	606	681	971	794	1048	789	-24.79	60.14
	2	1.344	606	681	994	799	1048	771	-26.51	63.84

7.2   Medium term predictions

No medium term predictions were carried out for this stock.

7.3   Long term predictions

No long term predictions were carried out for this stock.

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	$F_{0.1} = 0.673$	$F_{curr} = 0.672$ (as $F_{bar}0\text{-}2$ and average of the last three years)		N	S
	Fishing effort				D	
	Catch					
Stock abundance	Biomass					
	SSB		1028,8 t (average of the last three years)	$SSB_{33p}=735,6$ t $SSB_{66p}=1038,5$ t	N	S
Recruitment						
Final Diagnosis		Fully exploited with high level of biomass				

The stock of Deep-water rose shrimp in GSA 09 was assessed applying an Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS in GSA 09). Input data on landings, discards and length frequencies were taken from EU DCF. Von Bertalanffy growth parameters and length-weight relationship were taken from parameters agreed and used in previous working groups.

SSB is fluctuating along the time series 2006-2014 with an average of 899 t. Recruitment estimated for 2014 is 479736 thousand individuals, higher compared to the series average (391377 thousand, period 2006-2014). Current F (0.672, average of the last three years) shows the same value of $F_{0.1}$ (0.67), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long-term yields, which indicates that Deep-water rose shrimp stock in GSA 09 is exploited sustainably. The final recommendation is to not increasing the current level of fishing effort.

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)