BLUE AND RED SHRIMP IN GSA 5
STECF EWG 25-09

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1. BLUE AND RED SHRIMP IN GSA 5

1.1. DATA CHECK

1.1.1. CATCH (LANDINGS AND DISCARDS)

Landings for GSA 5 were reported to STECF EWG 25-09 through the Data Call. Data are available for the period 2002-2024 and were exclusively reported by OTB fishing operations. Small differences have been observed in the landings reported in the STECF EWG 24-10 and STECF EWG 25-09 in the years 2019, 2021 and 2023, but these are negligible (Table 1.1.1.1 and Figure 1.1.1.1). The percentage of the discards for the blue and red shrimp in GSA 5 is very low, between zero and 0.5% of the total catches, except in 2012 when it was 1.2% (Table 1.1.1.2 and Figure 1.1.1.2), so they were considered negligible and were not included in the assessment.

Table 1.1.1.1. Blue and red shrimp in GSA 5. Reported landings (t) from the DCF Data by all OTB metiers (2002-2024) in EWG 24-10 and EWG 25-09.

Year	Landings EWG 24-10	Landings EWG 25-09	Differences
2002	141.45	141.45	0
2003	122.01	122.01	0
2004	193.58	193.58	0
2005	191.48	191.48	0
2006	213.89	213.89	0
2007	239.12	239.12	0
2008	232.85	232.85	0
2009	126.16	126.16	0
2010	153.24	153.24	0
2011	111.24	111.24	0
2012	201.14	201.14	0
2013	188.6	188.6	0
2014	141.28	141.28	0
2015	160.15	160.15	0
2016	138.1	138.1	0
2017	171.35	171.35	0
2018	249.68	249.68	0
2019	205.90423	206.46623	0.562
2020	130.705	130.705	0
2021	120.11471	121.31371	1.199
2022	166.69022	166.69022	0
2023	162.6203	162.7053	0.085
2024		174.41922	

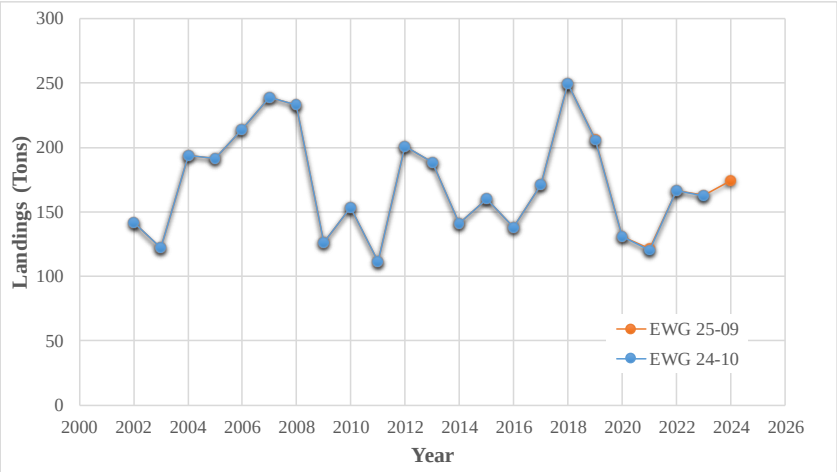


Figure 1.1.1.1. Blue and red shrimp in GSA 5. Reported landings (t)) from the DCF Data by all OTB metiers (2002-2024) in EWG 24-10 and EWG 25-09.

Table 1.1.1.2. Blue and red shrimp in GSA 5. Reported landings (t) and discards from the DCF Data by all OTB metiers (2002-2024) in EWG 25-09.

EWG 25-09			
Year	**Landings**	**Discards**	**% Discards**
2002	141.45	0	0
2003	122.01	0	0
2004	193.58	0	0
2005	191.48	0	0
2006	213.89	0	0
2007	239.12	0	0
2008	232.85	0	0
2009	126.16	0.03	0.024
2010	153.24	0	0.000
2011	111.24	0.41	0.367
2012	201.14	2.5	1.228
2013	188.6	0.17	0.090
2014	141.28	0.23	0.163
2015	160.15	0.1	0.062
2016	138.1	0.04	0.029
2017	171.35	0.14	0.082
2018	249.68	0.23	0.092
2019	206.46623	0	0.000
2020	130.705	0.02	0.015
2021	121.31371	0.55397	0.455
2022	166.69022	0.04001	0.024
2023	162.7053	0.00999	0.006
2024	174.41922	0	0.000

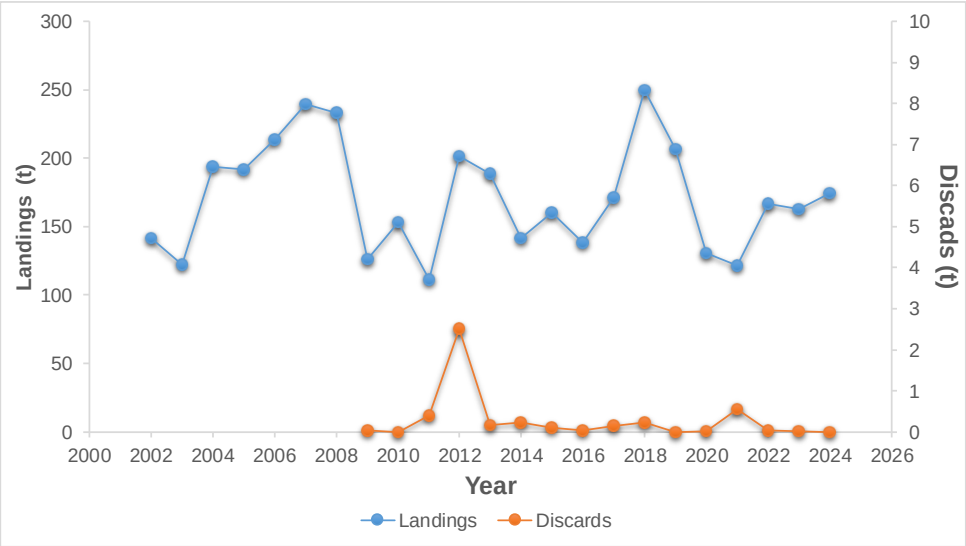


Figure 1.1.1.2. Blue and red shrimp in GSA 5. Reported landings (t) and discards (t) from the DCF Data by all OTB metiers (2002-2024).

Length frequency distributions per gear, metier and year of landings from the DCF database (2002-2024) before reconstructions are presented in Figure 1.1.1.3. Length structure by gear, fishery and year (2002-2024) after reconstruction is shown in Figure 1.1.1.4. The percentage of total landings that were reconstructed applying the SOP correction to LFDs (only in OTB_DEF for this stock) is shown in Figure 6.16.2.2.4.

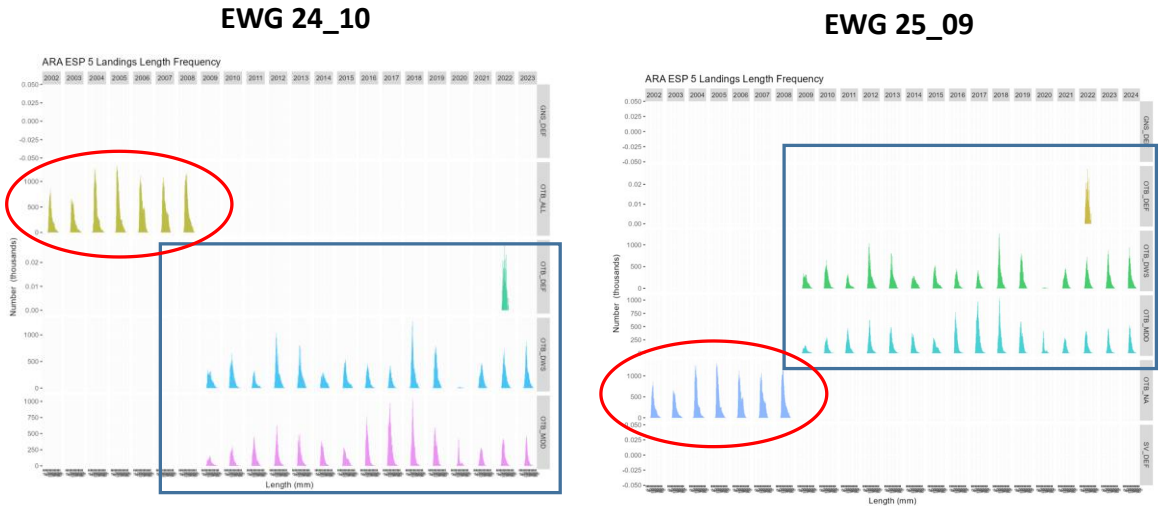


Figure 1.1.1.3. Blue and red shrimp in GSA 5. Original length frequency distribution before reconstruction by fishing gear and fishery (2002-2024).

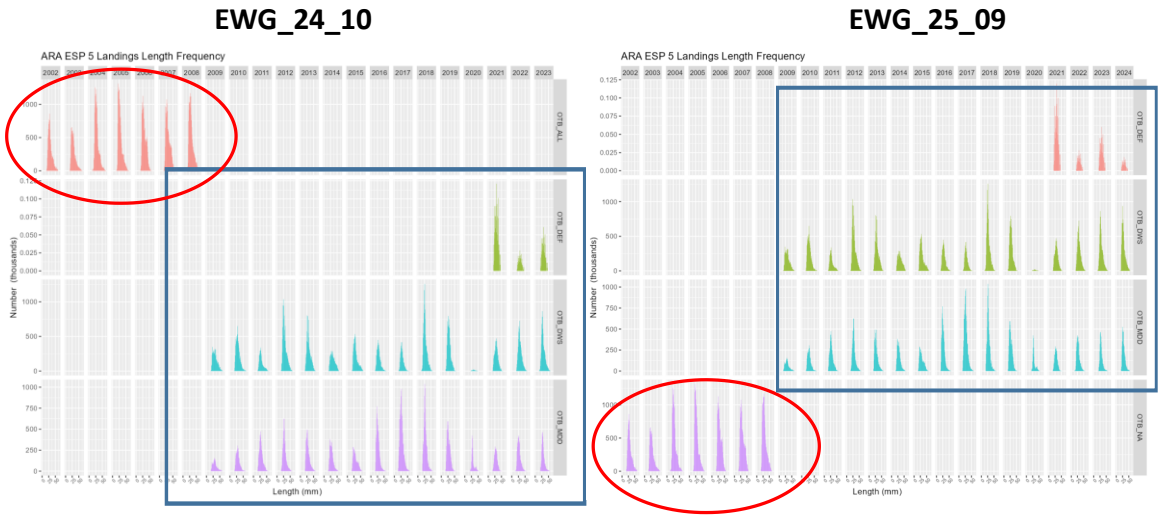


Figure 1.1.1.4. Blue and red shrimp in GSA 5. Length frequency distribution after reconstruction by fishing gear and fishery (2002-2024).

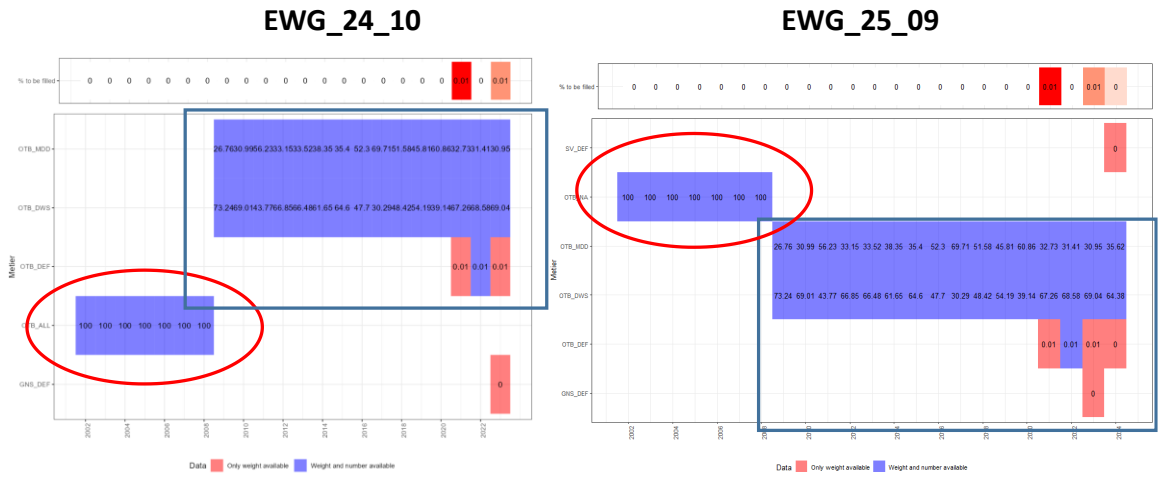


Figure 1.1.1.5. **Blue and red shrimp in GSA 5**. Percentages of total landings LFDs that were reconstructed by year and gear and SOP applied to LFD.

1.1.2. SURVEY DATA

The MEDITS (MEDiterranean International Trawl Survey) survey is an extensive trawls survey occurring in all European countries and included in the Data Collection Framework. According to the MEDITS protocol (Bertrand et al., 2002), it takes places every year during springtime following a random stratified sampling by depth (5 strata: 0-50 m, 50-100 m, 100-200 m, 200-500m and over 500 m). The number of hauls in each stratum is proportional to the surface of the stratum and their positions were randomly selected and maintain fixed throughout the time. Same sampling gear (GOC73), characterized by a 20 mm stretched mesh size cod-end, is used throughout GSAs and years.

The survey area around the Balearic Islands (GSA5) was only very partially covered by the MEDITS survey during 1994-2006, with a very low number of surveys by year, covering only a small part of the area (Ibiza channel). Thus, survey data prior to 2007 was excluded from the stock assessment analysis. Since 2007, the survey has taken place between May and June (Figure 1.1.2.1).

EWG_24_10 **EWG_25_09**

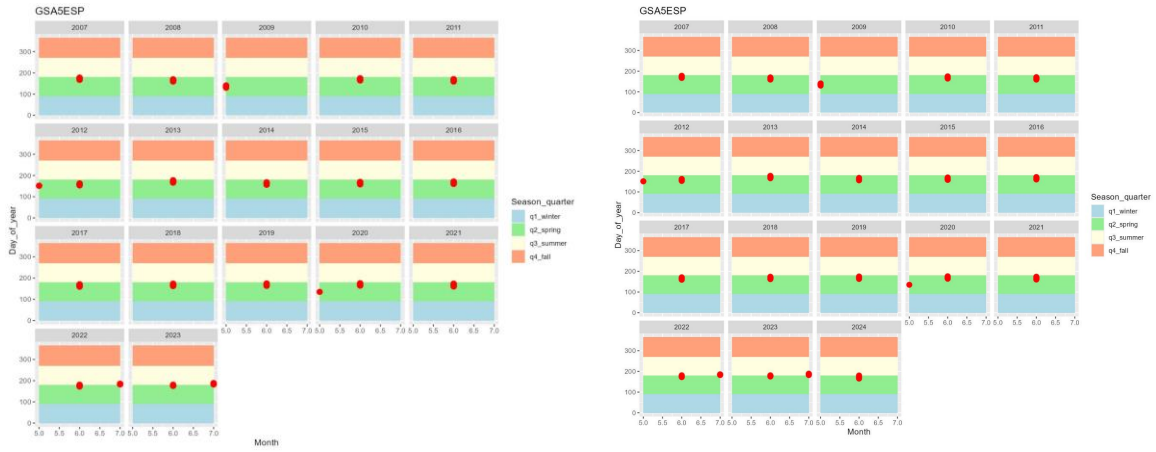


Figure 1.1.2.1 Year period when the hauls of MEDITS survey are being conducted in GSA 5.

The time series of abundance and biomass indices of blue and red shrimp from MEDITS bottom trawl survey in GSA5 are shown in Figure 1.1.2.2 and 1.1.2.3. Large variations and no clearly discernible trends over the available period can be observed. Both estimated abundance and biomass indices show similar variation along the time series, excepting for 2020 and 2022 where the pattern between both variables were oposite, suggesting a shift in size. However, an increase in abundance and biomass is observed in 2023.

EWG_24_10 **EWG_25_09**

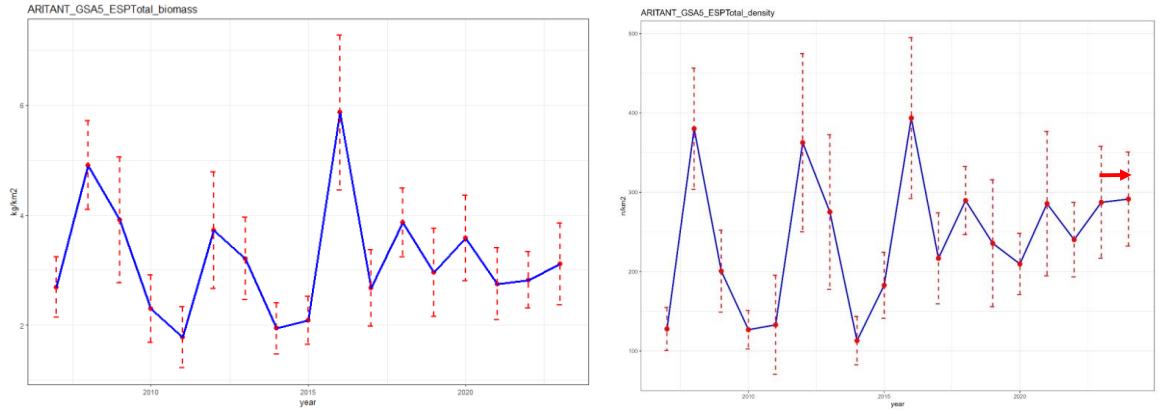


Figure 1.1.2.2. Blue and red shrimp in GSA 5. MEDITS survey abundance index (n/km^2) as reported by DCF (2007-2024).

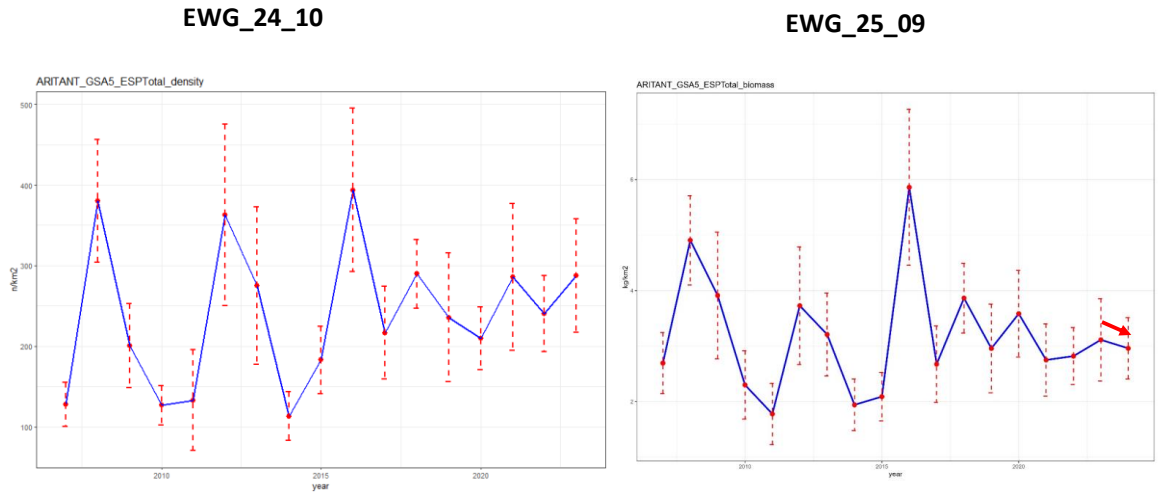


Figure 1.1.2.3. Blue and red shrimp in GSA 5. MEDITS survey biomass index (kg/km^2) as reported by DCF (2007-2024).

The observed length frequency distributions from MEDITS survey in GSA 5 are illustrated in Figure 1.1.2.4.

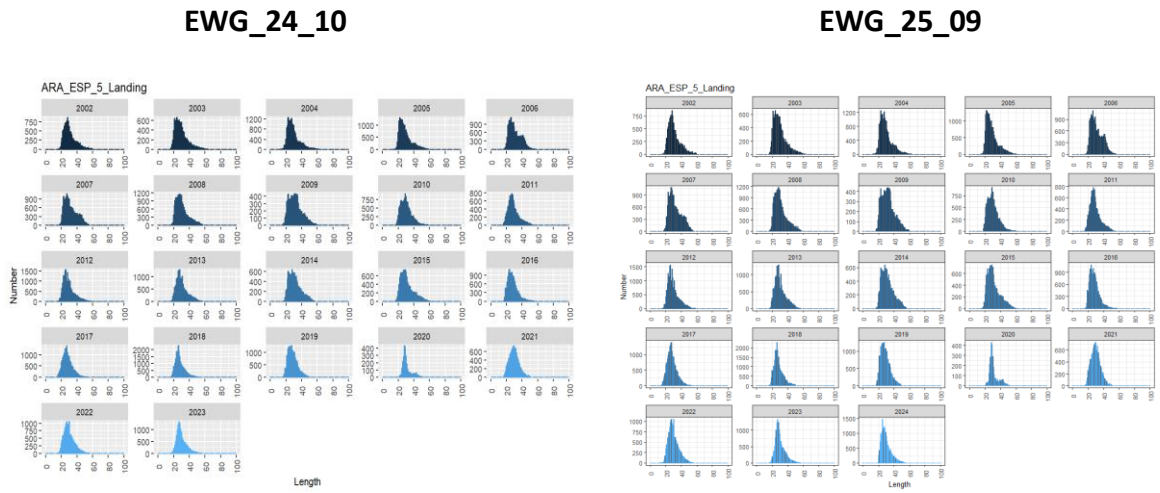


Figure1.1.2.4. Blue and red shrimp in GSA 5. Length frequency distribution of the MEDITS survey data (n/km^2).

1.2. CHECK STOCK OBJECT

The present assessment was carried out using a statistical catch-at-age analysis (a4a). A4a is a statistical catch-at-age method that utilizes catch-at-age data to derive estimates of historical population size and fishing mortality (Jardim et al., 2015). Model parameters estimated using catch-at-age analysis are done so by working forward in time and analyses do not require the assumption that removals from the fishery are known without error. Data typically used are: catch, statistical sample of age composition of catch and abundance index.

Input data

Data used were landings and length frequency distribution before and after reconstruction of the commercial landings, as well as the abundance and biomass index and length frequency distributions of the MEDITS survey. The used biological parameters:

Table 1.2.1. Blue and red shrimp in GSA 5. Growth parameters (L_{inf}, K, t_0) and parameters of the Length-Weight relationship (a, b) used for the assessment.

	Growth parameters			Length-weigth	
Parameter	**L_{inf}**	**k**	**t_0**	**a**	**b**
Value	75	0.38	0.05	0.002	2.515

Table 1.2.2. Blue and red shrimp in GSA 5. Proportion of mature specimens and natural mortality at age.

Age	0	1	2	3	4	5
Maturity	0.477	0.611	0.747	0.974	1	1
Mortality	2.418	0.897	0.627	0.520	0.466	0.435

No differences are observed with the stock object generated last year (Figure 1.1.2.4)

Figure 1.2.1. Blue and red shrimp in GSA 5. Comparison of STECF EWG 24-10 and STECF EWG 25-09 stock object.

Regarding the comparison with the data from last year's assessment, no differences were observed in the stock object generated this year compared with the one produced previously, ensuring consistency in the time series. Since no substantial changes were identified with respect to last year, the assessment has been updated by incorporating the most recent data. The same types of input data were used, namely landings and length frequency distributions (before and after reconstruction) from commercial catches, as well as abundance, biomass indices, and length frequency distributions from the MEDITS survey. T0 correction is applied from length distribution from catches and survey and thus age0 was removed from the data to run the assessment.

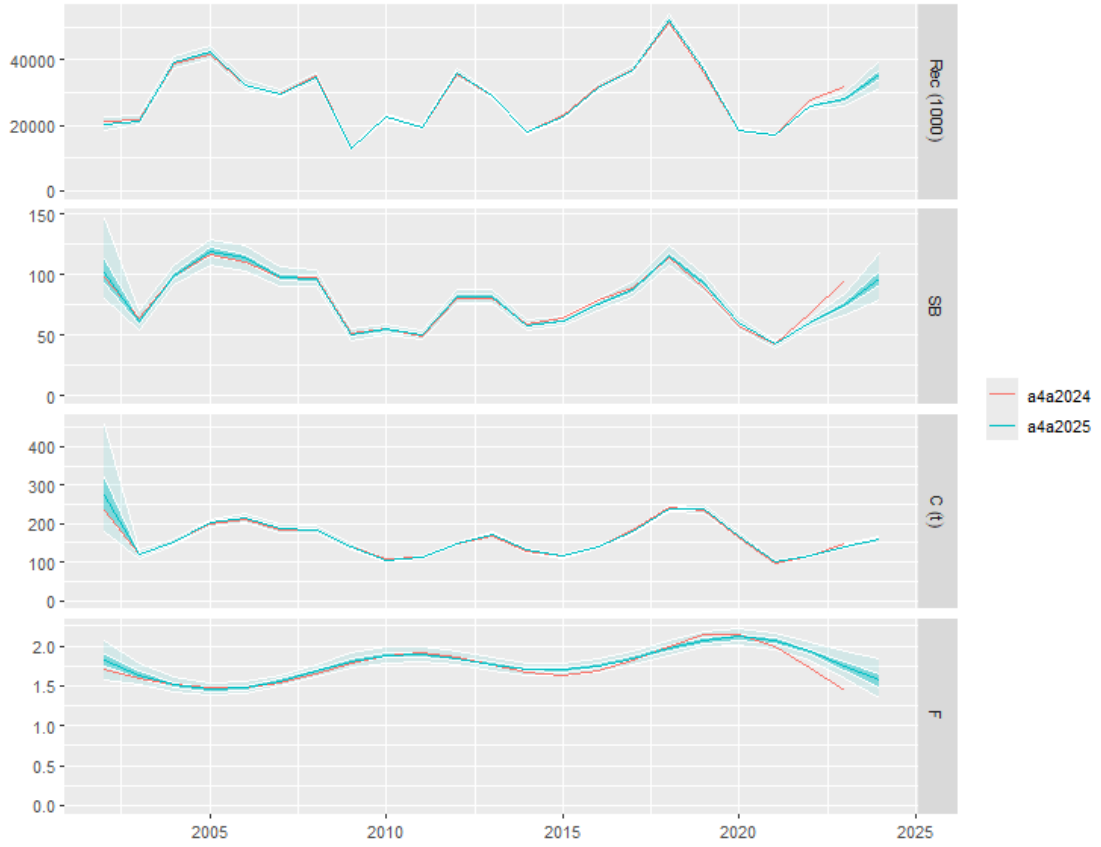
The model specifications are the following:

- fmodel <- ~ factor(replace(age, age>2,2)) + s(year, k=7)

- qmodel <- list(~ s(replace(age, age>3,3), k=3))

- srmodel <- ~geomean(CV=0.35)

Assessment results compared with last year



	F0.1	Fbar	Fbar/F0.1
EWG 24-10	0.332	1.4609	4.406
EWG 25-09	0.333	1.5727	4.726

Figure 1.2.2. Blue and red shrimp in GSA 5. Stock summary of the final a4a model for Rec, SSB, Catch and F obtained in STECF EWG 24-10 and STECF EWG 25-09

The following section presents the updated report incorporating all the most recent data; it is still subject to review of the assessment in STECF EWG 25-09.

6.16 BLUE AND RED SHRIMP IN GSA 5

6.16.1 STOCK IDENTITY AND BIOLOGY

GSA 5 (Figure 6.16.1.1) has been selected as an separate area for assessment and management purposes in the western Mediterranean (Quetglas et al., 2012) due to its main specificities. These include: 1) Geomorphologically, the Balearic Islands (GSA 5) are clearly separated from the Iberian Peninsula (GSA 6) by depths between 800 and 2000 m, which would constitute a natural barrier to the interchange of adult stages of demersal resources; 2) Physical geographically-related characteristics, such as the lack of terrigenous inputs from rivers and submarine canyons in GSA 5 compared to GSA 6, give rise to differences in the structure and composition of the trawling grounds and hence in the benthic assemblages; 3) Owing to these physical differences, the faunistic assemblages exploited by trawl fisheries differ between GSA 5 and GSA 6, resulting in large differences in the relative importance of the main commercial species; 4) There are no important or general interactions between the demersal fishing fleets in the two areas, with only local cases of vessels targeting red shrimp in GSA 5 but landing their catches in GSA 6) Trawl fishing exploitation in GSA 5 is much lower than in GSA 6; the density of trawlers around the Balearic Islands is one order of magnitude lower than in adjacent waters; and GSA 6. Due to this lower fishing exploitation, the demersal resources and ecosystems in GSA 5 are in a healthier state than in GSA 6, which is reflected in the population structure of the main commercial species (populations from the Balearic Islands have larger modal sizes and lower percentages of small-sized individuals), and in the higher abundance and diversity of elasmobranch assemblages.

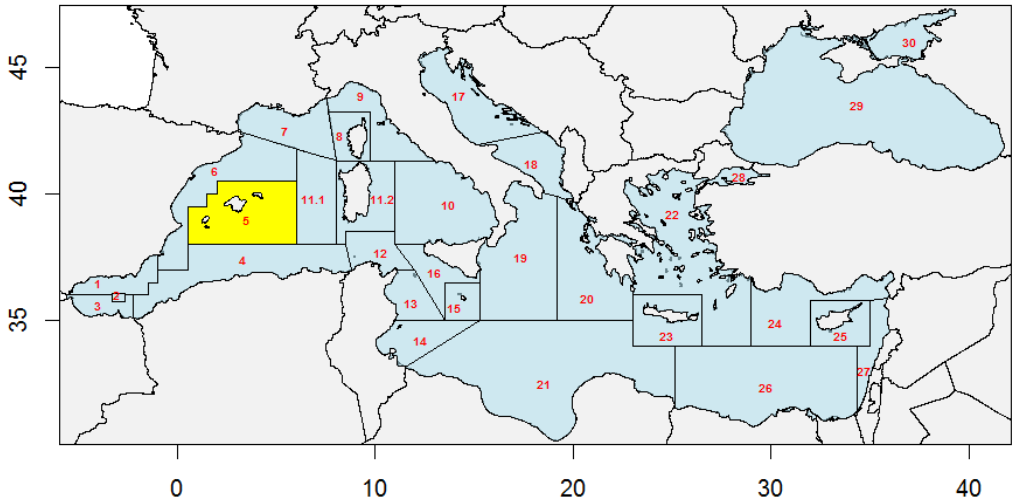


Figure 6.16.1.1. Geographical localization of GSA 5.

The reproductive period for the blue and red shrimp in GSA 5 began in May and ended in September. Two main peaks were detected as an entry of juveniles (recruits) to the fishery: one in February-March and the other in September-October, for both females and males (Carbonell et al., 1999). For females, condition index, hepatosomatic index and the content of lipids in the hepatopancreas showed the minimum values at the end of the spawning period (Guijarro et al., 2008).

In the absence on new information on somatic growth, the same growth function and length-weight relationship parameters presented in the 2018 assessment for GSA 5 (STECF 15-18) were used (Table 6.16.1.1). Although females reach notable larger maximum sizes than males, it was decided

to combine sexes for consistency with both previous assessments and the approaches used for the adjacent areas GSA 1 and GSA 6 and 7. Similarly, sex-aggregated estimates for maturity-at-age and mortality-age vectors presented in the 2018 (STECF 15-18) were considered as input for the stock assessment model (Table 6.16.1.2), where age-dependent M estimates were computed based on the Chen Watanabe (1989) model.

Table 6.16.1.1. Blue and red shrimp in GSA 5. Growth parameters (L_{inf}, K, t_0) and parameters of the Length-Weight relationship (a, b) used for the assessment.

	Growth parameters			Length-weigth	
Parameter	**L_{inf}**	**k**	**t_0**	**a**	**b**
Value	75	0.38	0.05	0.002	2.515

Table 6.16.1.2. Blue and red shrimp in GSA 5. Proportion of mature specimens and natural mortality at age.

Age	0	1	2	3	4	5
Maturity	0.477	0.611	0.747	0.974	1	1
Mortality	2.418	0.897	0.627	0.520	0.466	0.435

6.16.2 DATA

General description of the fisheries

In the Balearic Islands, commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf (SS), deep shelf (DS), upper slope (US) and middle slope (MS) (Guijarro and Massutí 2006; Ordines et al. 2006), mainly targeted to: (i) *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the SS (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the DS (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the US (350-600 m) and (iv) *Aristeus antennatus* on the MS (600-750 m). The MS fishing tactics coincides with the metier OTB_DWSP; OTB_DEMSP corresponds to those days in one of the other fishing tactics is present (SS, DS and/or US) and OTB_MDDWSP corresponds to those days in which one haul is MS and at least one of the other fishing tactics is performed.

6.16.2.1 CATCH (LANDINGS AND DISCARDS)

Landings for GSA 5 were reported to STECF EWG 25-09 through the Data Call. Data are available for the period 2002-2024 and were exclusively reported by OTB fishing operations (Table 6.16.2.2.1 and Figure 6.16.2.2.1). The percentage of the discards for the blue and red shrimp in GSA 5 is very low, between zero and 0.5% of the total catches, except in 2012 when it was 1.2%, so they were considered negligible and were not included in the assessment.

Table 6.16.2.2.1. Blue and red shrimp in GSA 5. Reported landings (t) and discards (t) from the DCF Data by all OTB metiers (2002-2024).

Year	SPAIN GSA5	Total landings	Total Effort * (Fishing Days)
2002	141.5	141.5	
2003	122	122	
2004	193.6	193.6	12012
2005	191.5	191.5	11497
2006	213.9	213.9	10507
2007	239.1	239.1	11907
2008	232.9	232.9	12226
2009	126.2	126.2	10934
2010	153.2	153.2	11239
2011	111.2	111.2	10498
2012	201.1	201.1	10568
2013	188.6	188.6	9942
2014	141.3	141.3	11817
2015	160.2	160.2	11965
2016	138.1	138.1	10490
2017	171.4	171.4	10176
2018	249.7	249.7	8715
2019	205.9	205.9	8202
2020	130.7	130.7	7306
2021	121.3	121.3	6439
2022	166.7	166.7	
2023	162.6	162.6	
2024	174.4	174.4	

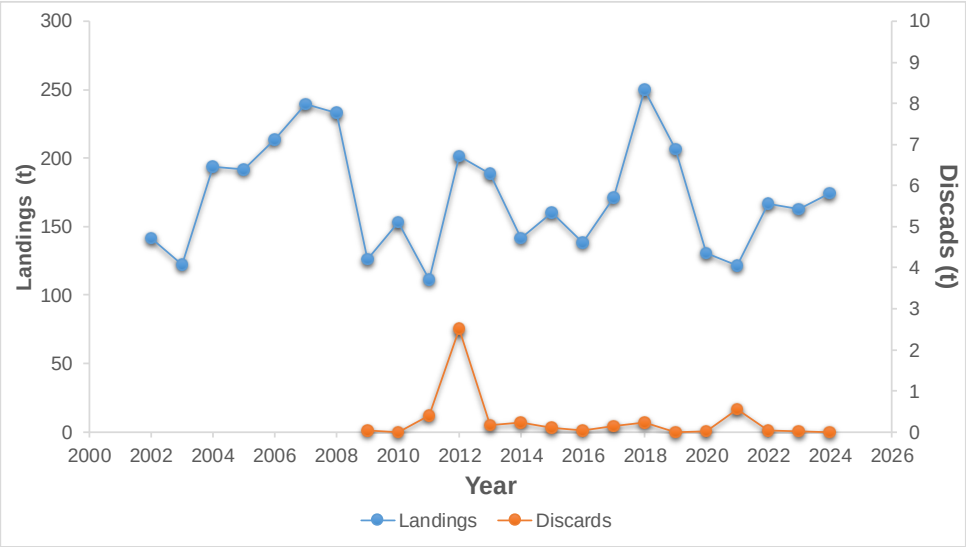


Figure 6.16.2.2.1. Blue and red shrimp in GSA 5. Reported landings (t) and discards (t) from the DCF Data by all OTB metiers (2002-2024).

Length frequency distributions per gear, metier and year of landings from the DCF database (2002-2024) before reconstructions are presented in Figure 6.16.2.2.2. Length structure by gear, fishery and year (2002-2024) after reconstruction is shown in Figure 6.16.2.2.3. The percentage of total landings that were reconstructed applying the SOP correction to LFDs (only in OTB_DEF for this stock) is shown in Figure 6.16.2.2.4.

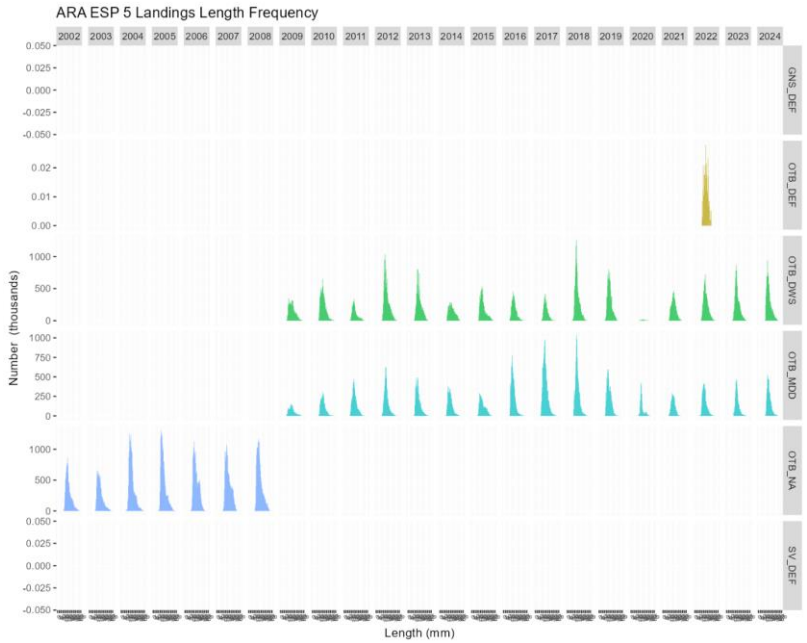


Figure 6.16.2.2.2. Blue and red shrimp in GSA 5. Original length frequency distribution before reconstruction by fishing gear and fishery (2002-2024).

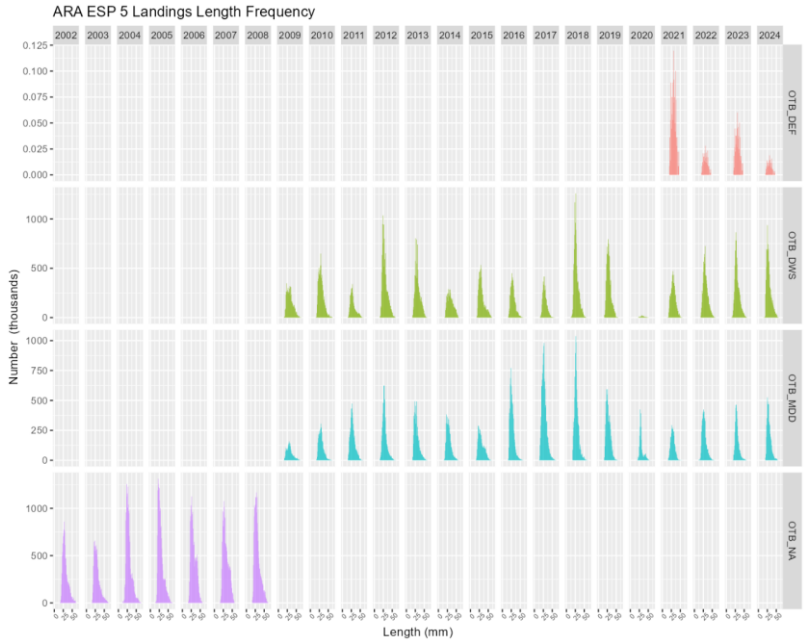


Figure 6.16.2.2.3. Blue and red shrimp in GSA 5. Length frequency distribution after reconstruction by fishing gear and fishery (2002-2024).

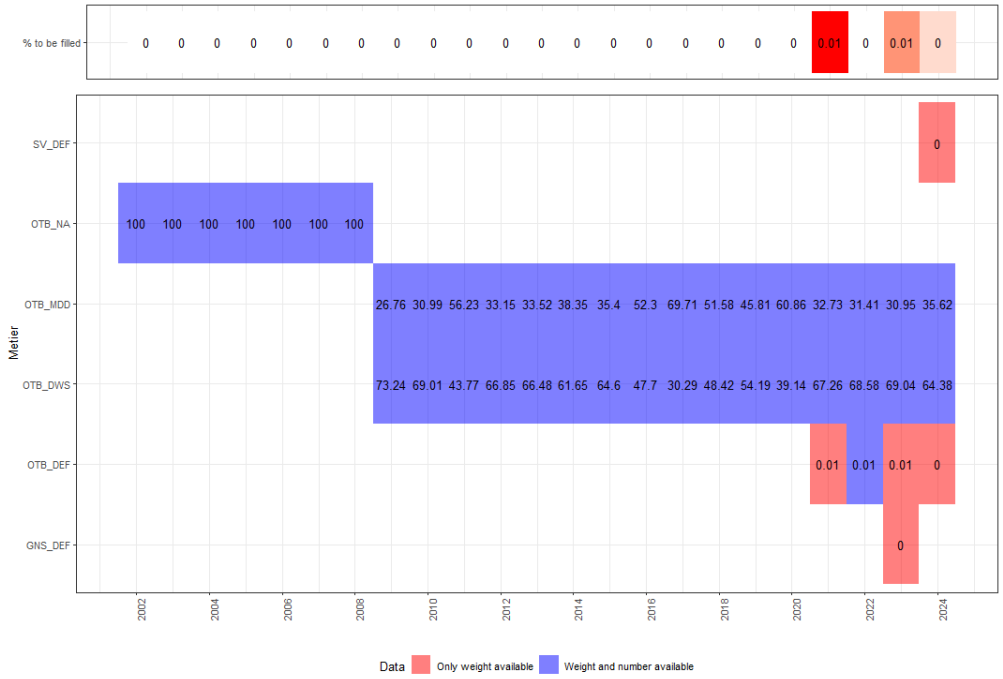


Figure 6.16.2.2.4. **Blue and red shrimp in GSA 5**. Percentages of total landings LFDs that were reconstructed by year and gear and SOP applied to LFD.

6.12.2.2 EFFORT

6.16.2.3 SURVEY DATA

The MEDITS (MEDiterranean International Trawl Survey) survey is an extensive trawls survey occurring in all European countries and included in the Data Collection Framework. According to the MEDITS protocol (Bertrand et al., 2002), it takes places every year during springtime following a random stratified sampling by depth (5 strata: 0-50 m, 50-100 m, 100-200 m, 200-500m and over 500 m). The number of hauls in each stratum is proportional to the surface of the stratum and their positions were randomly selected and maintain fixed throughout the time. Same sampling gear (GOC73), characterized by a 20 mm stretched mesh size cod-end, is used throughout GSAs and years.

The survey area around the Balearic Islands (GSA5) was only very partially covered by the MEDITS survey during 1994-2006, with a very low number of surveys by year, covering only a small part of the area (Ibiza channel). Thus, survey data prior to 2007 was excluded from the stock assessment analysis. Since 2007, the survey has taken place between May and June (Figure 6.16.2.3.1).

Figure 6.16.2.3.1 Year period when the hauls of MEDITS survey are being conducted in GSA 5.

The time series of abundance and biomass indices of blue and red shrimp from MEDITS bottom trawl survey in GSA5 are shown in Figure 6.16.2.3.2 and 6.16.2.3.3. Large variations and no clearly discernible trends over the available period can be observed. Both estimated abundance and biomass indices show similar variation along the time series, excepting for 2020 and 2022 where the pattern between both variables were oposite, suggesting a shift in size. However, an increase in abundance and biomass is observed in 2023.

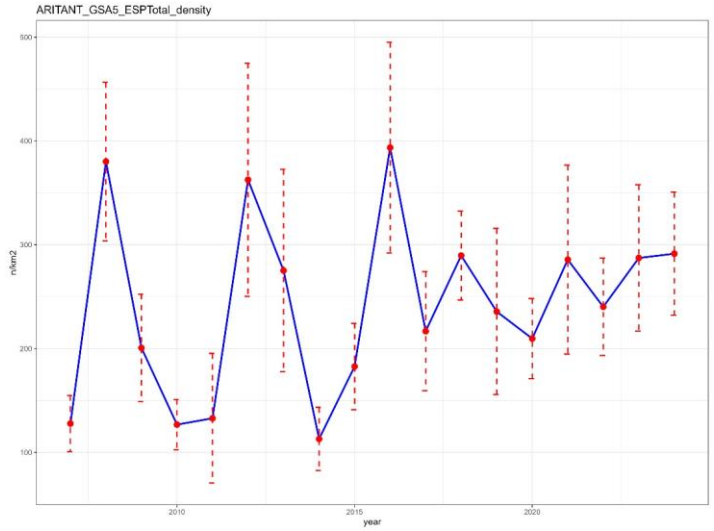


Figure 6.16.2.3.2 Blue and red shrimp in GSA 5. MEDITS survey abundance index (n/km^2) as reported by DCF (2007-2023).

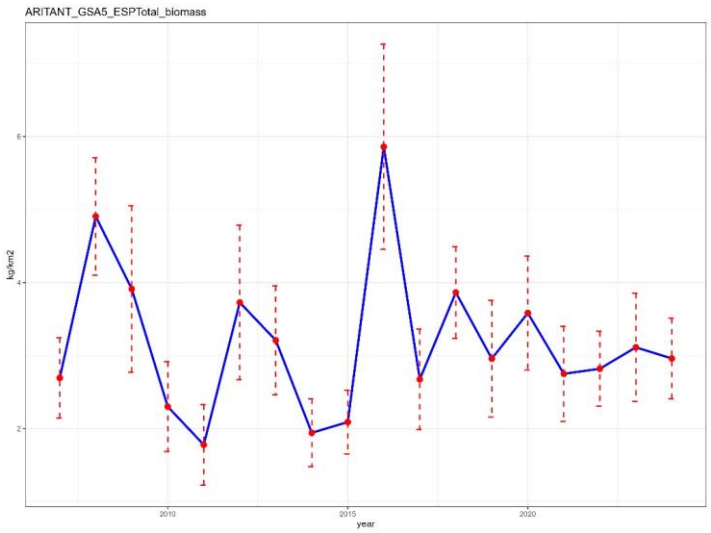


Figure 6.16.2.3.3 Blue and red shrimp in GSA 5. MEDITS survey biomass index (kg/km^2) as reported by DCF (2007-2023).

The observed length frequency distributions from MEDITS survey in GSA 5 are illustrated in Figure 6.16.2.3.4.

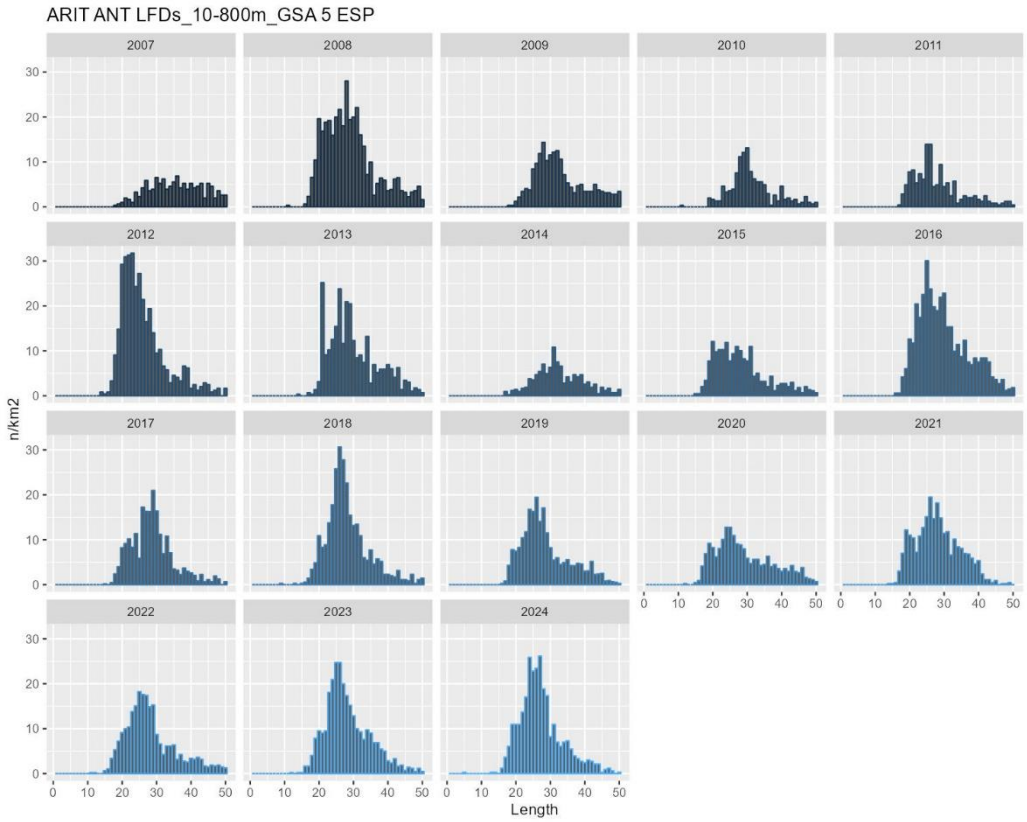


Figure 6.16.2.3.4. Blue and red shrimp in GSA 5. Length frequency distribution of the MEDITS survey data (n/km^2).

6.16.3 STOCK ASSESSMENT

The present assessment was carried out using a statistical catch-at-age analysis (a4a). A4a is a statistical catch-at-age method that utilizes catch-at-age data to derive estimates of historical population size and fishing mortality (Jardim et al., 2015). Model parameters estimated using catch-at-age analysis are done so by working forward in time and analyses do not require the assumption that removals from the fishery are known without error. Data typically used are: catch, statistical sample of age composition of catch and abundance index.

Input data

Data used were landings (Table 6.16.2.2.1) and length frequency distribution before and after reconstruction of the commercial landings (Figure 6.16.2.2.2 and 6.16.2.2.3, respectively), as well as the abundance and biomass index and length frequency distributions of the MEDITS survey (Figures 6.16.2.3.2, 6.16.2.3.3 and 6.16.2.3.4, respectively). The used biological parameters were those included in section 6.16.1. The catch at age structure for the commercial data and of the MEDITS survey and their internal consistency was checked. Age composition is mainly composed by age 1 individuals both for commercial and MEDITS survey data, although age 2 are also frequent in the catches (Figures 6.16.3.1 and 6.16.3.3). The internal consistency was quite good for the commercial data (Figure 6.16.3.2), but for the MEDITS it was in general poorer, especially for ages 2-3 and 4-5 (Figure 6.16.3.4).

Table 6.16.3.1. Blue and red shrimp in GSA 5: Catch-at-age number (thousands) from the commercial fleet per year used in the assessment.

Year	1	2	3	4	5
2002	7283.5	3295	645.9	111.7	2.6
2003	7135	2623.3	562.3	127.3	12.1
2004	12279	4113.7	719.9	158.2	18
2005	12844	3933.6	908	76.2	5.5
2006	9977.1	6070.5	831.8	17.8	2.7
2007	9518.3	6006.7	1686.2	27.4	2.4
2008	11791	5246	1358	138.7	4.8
2009	4613.4	3417.9	785.3	100.4	9.1
2010	8342.4	4196.4	468.2	68.1	5.6
2011	7187.1	2528.7	471.3	16.6	0.4
2012	13019	4494.3	785	49.6	0.1
2013	10214	4735.7	849	27.6	0.1
2014	6135.4	3717.3	874.6	24.3	1
2015	7662.8	3591	970.2	108.9	0.1
2016	10967	3035.7	314	25.2	2.4
2017	13410	4015.2	335.8	31.8	0.5
2018	19872	5530.5	574.3	15.3	1.9
2019	14682	5346.4	374.8	7.9	0.1
2020	7463.6	2775.9	444.9	8.6	0.5
2021	6688.1	3837	201.3	4.2	0.1
2022	9692.9	4461.3	522.5	18.5	0.3
2023	9787.3	4030.9	506	20.6	0.1
2024	11442	4159.6	528.5	10.1	0.1

Table 6.16.3.2. Blue and red shrimp in GSA 5: Catch-at-age weights (kg) per year from the commercial fleet used in the assessment.

Year	1	2	3	4	5
2002	0.007	0.018	0.035	0.052	0.062
2003	0.007	0.017	0.036	0.052	0.065
2004	0.007	0.018	0.035	0.051	0.065
2005	0.007	0.018	0.035	0.051	0.063
2006	0.007	0.019	0.033	0.05	0.064
2007	0.007	0.018	0.033	0.049	0.07
2008	0.007	0.017	0.035	0.051	0.063
2009	0.007	0.017	0.035	0.052	0.066
2010	0.007	0.017	0.035	0.053	0.064
2011	0.007	0.017	0.034	0.051	0.064
2012	0.007	0.017	0.034	0.051	0.065
2013	0.007	0.017	0.034	0.051	0.065
2014	0.007	0.017	0.034	0.049	0.065
2015	0.007	0.018	0.035	0.051	0.065
2016	0.007	0.016	0.034	0.051	0.066
2017	0.007	0.017	0.034	0.051	0.062
2018	0.007	0.017	0.033	0.05	0.062
2019	0.007	0.016	0.032	0.052	0.065
2020	0.009	0.018	0.032	0.049	0.065
2021	0.008	0.016	0.033	0.049	0.065
2022	0.007	0.017	0.034	0.051	0.067
2023	0.008	0.017	0.034	0.049	0.065
2024	0.007	0.017	0.034	0.048	0.065

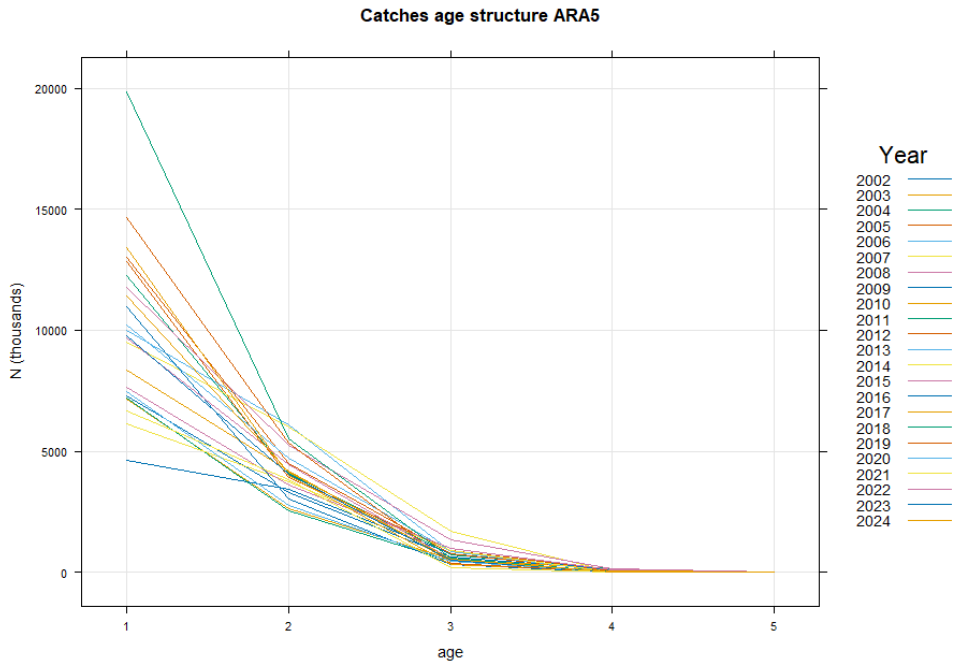


Figure 6.16.3.1. Blue and red shrimp in GSA 5. Catch-at-age data by year from the commercial fleet used in this assessment.

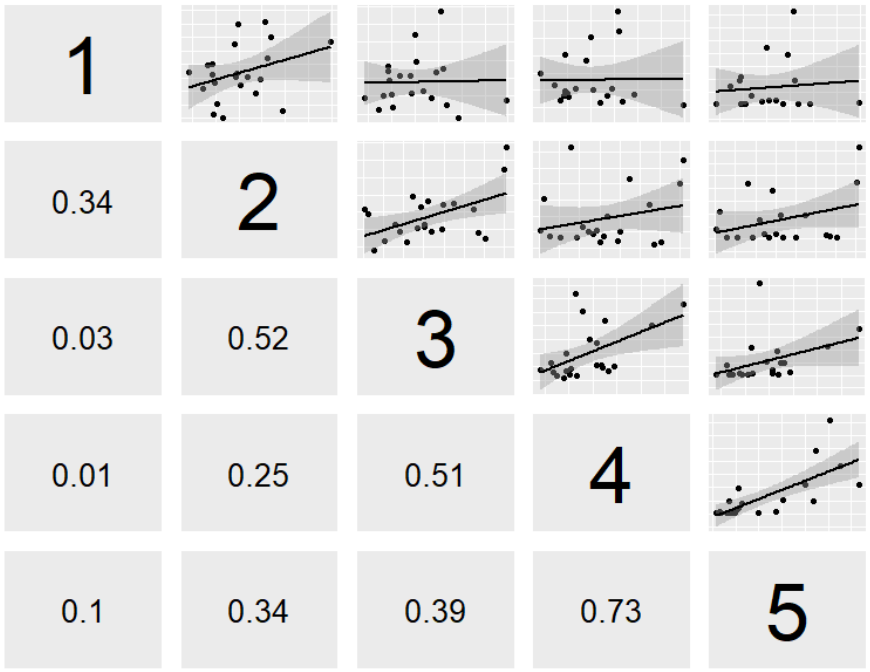


Figure 6.16.3.2 Blue and red shrimp in GSA 5. Internal consistency of the catch- at-age data from used in this assessment.

Table 6.16.3.3. Blue and red shrimp in GSA 5: Catch-at-age number (thousands) per year from MEDITS survey used in the assessment.

Year	1	2	3	4	5
2007	41.4	61.6	24.4	0.3	0.1
2008	93.6	71.8	27.2	5.6	2.5
2009	73.4	40.6	9.5	2.3	0.7
2010	99.4	27	7	0.4	0.1
2011	295.1	50.3	10.7	0.4	0.1
2012	175.9	81.1	14.8	0.1	0.1
2013	54.7	48.4	9.6	0.1	0.2
2014	133.4	37.2	10.3	1.8	0.2
2015	248.8	116.6	23.4	4.8	0.1
2016	158.5	48.7	8	1.5	0.1
2017	219.4	58.2	9.7	1.4	0.6
2018	160.1	54.8	6.3	1	0.1
2019	127.4	55.2	15.7	1.5	0.1
2020	180.8	68	1.8	0.2	0.1
2021	207.9	72.1	7.4	0.1	0.1
2022	229	55.4	6.1	0.6	0.1
2023	41.4	61.6	24.4	0.3	0.1
2024	93.6	71.8	27.2	5.6	2.5

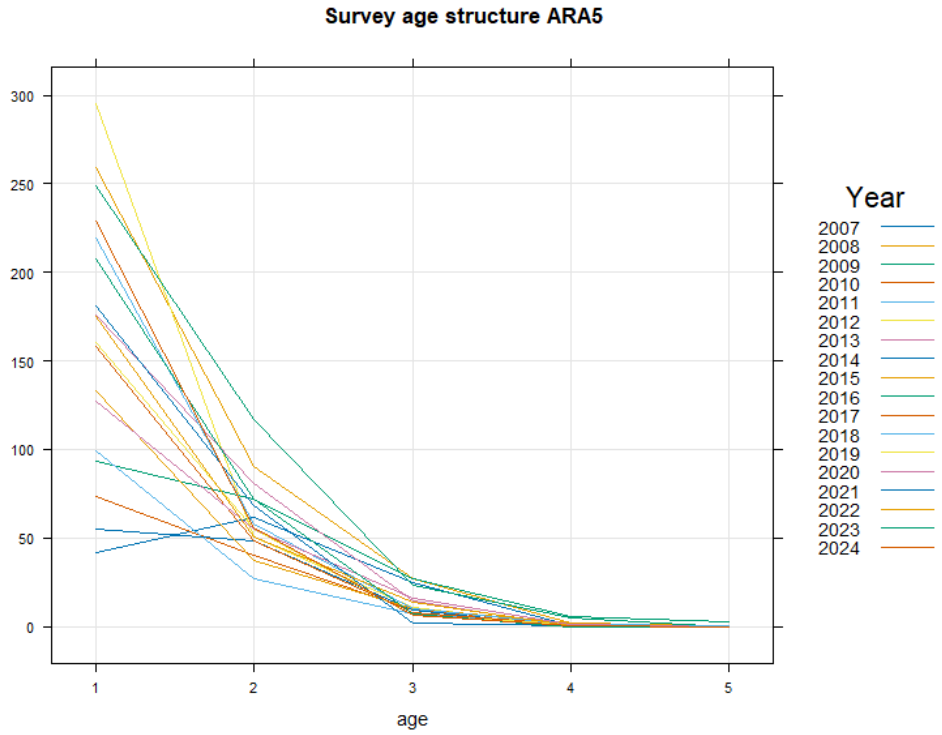


Figure 6.16.3.3. Blue and red shrimp in GSA 5. Catch-at-age data by year from the MEDITS survey used in this assessment.

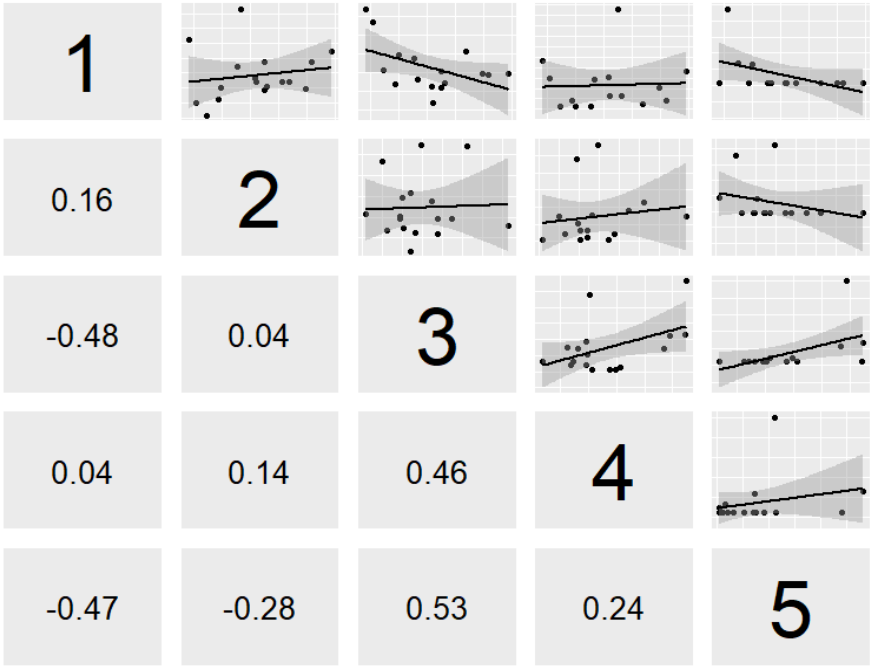


Figure 6.16.3.4. Blue and red shrimp in GSA 5. Internal consistency of the catch- at-age data from the MEDITS survey used in this assessment.

Assessment results

This assessment is an update of the last year assessment. T0 correction is applied from length distribution from catches and survey and thus age0 was removed from the data to run the assessment. The model specifications are the following:

- fmodel <- ~ factor(replace(age, age>2,2)) + s(year, k=7)

- qmodel <- list(~ s(replace(age, age>3,3), k=3))

- srmodel <- ~geomean(CV=0.35)

The general results of the a4a assessment, including the summary of the fitting of the model for all the parameters (Rec, SSB, Catch and F), the estimated fishing mortality and catchability for the survey, the residuals patterns, the fit vs. observed catch-at-age, the retrospective analysis and the performed simulations, are shown in Figures 6.16.3.5 to 6.16.3.11.

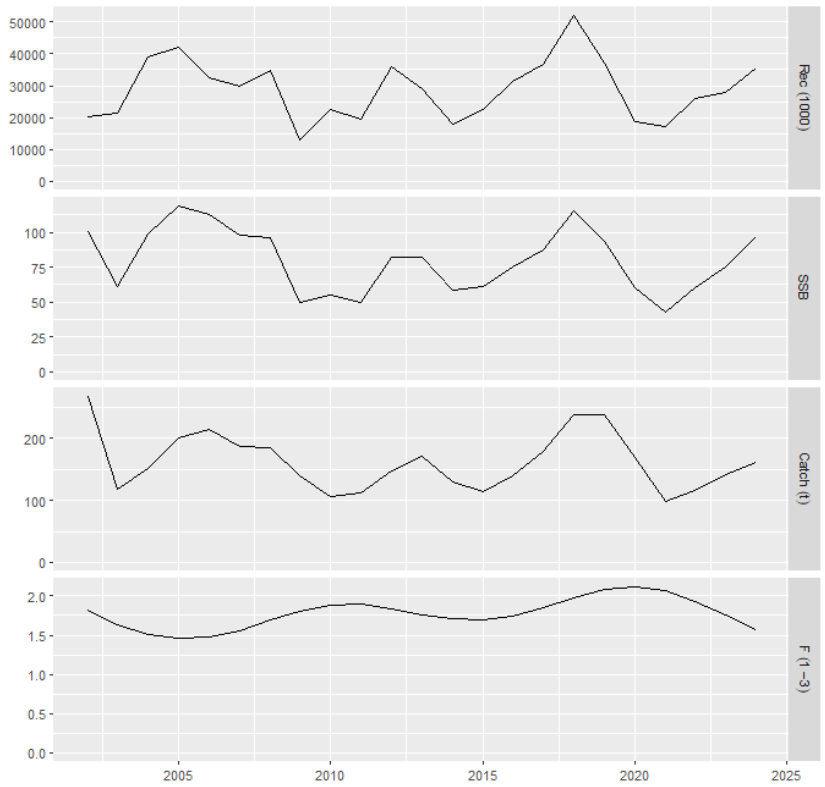


Figure 6.16.3.5. Blue and red shrimp in GSA 5. Stock summary of the final a4a model for Rec, SSB, Catch and F.

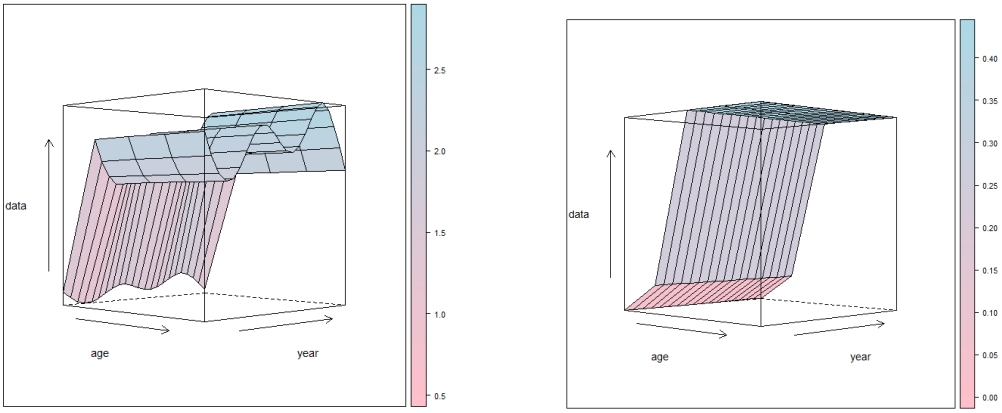


Figure 6.16.3.6. Blue and red shrimp in GSA5. 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated survey catchability (right) at age and year.

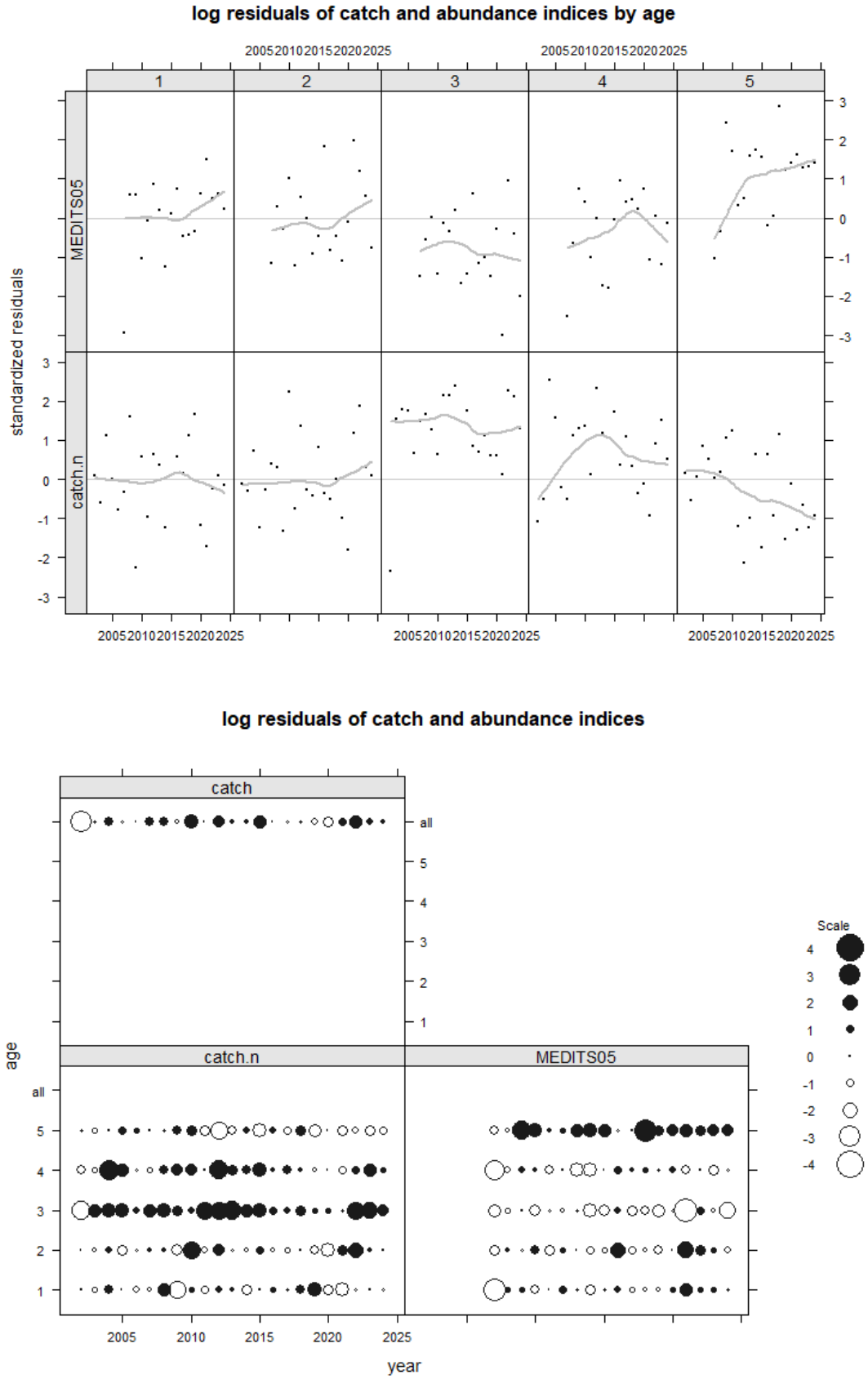


Figure 6.16.3.7. Blue and red shrimp in GSA 5. Standardized residuals for abundance indices and for catch numbers.

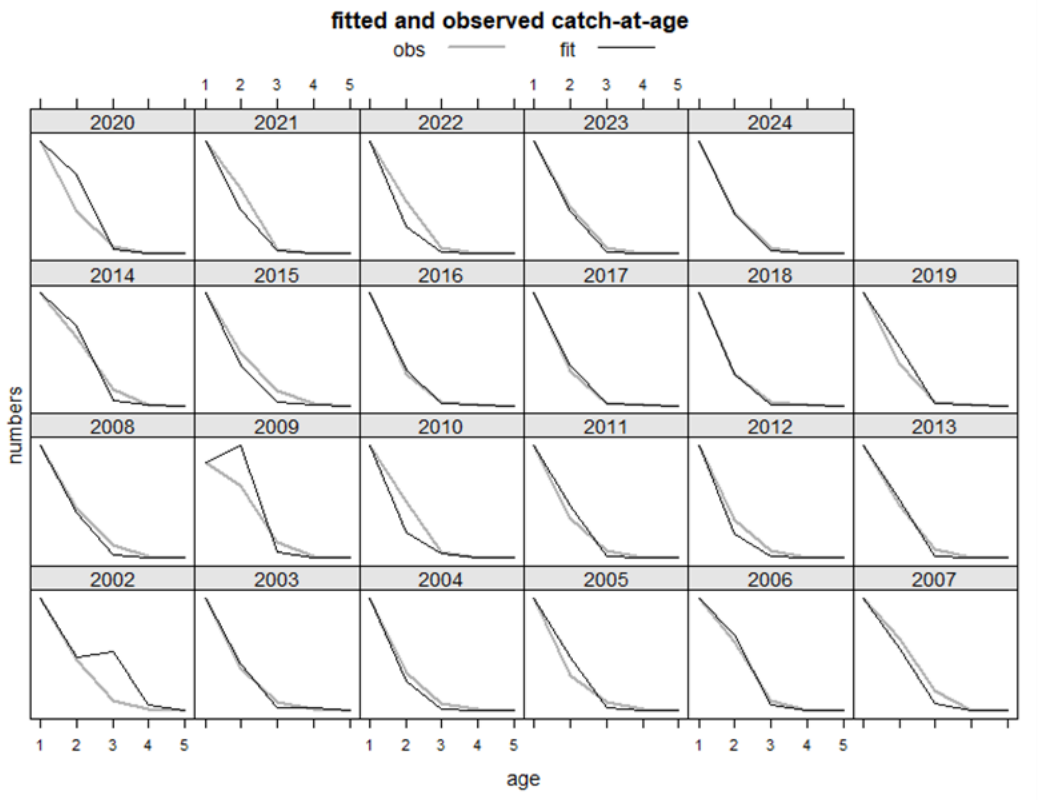


Figure 6.16.3.8. Blue and red shrimp in GSA 5. Fitted and observed catch-at- age.

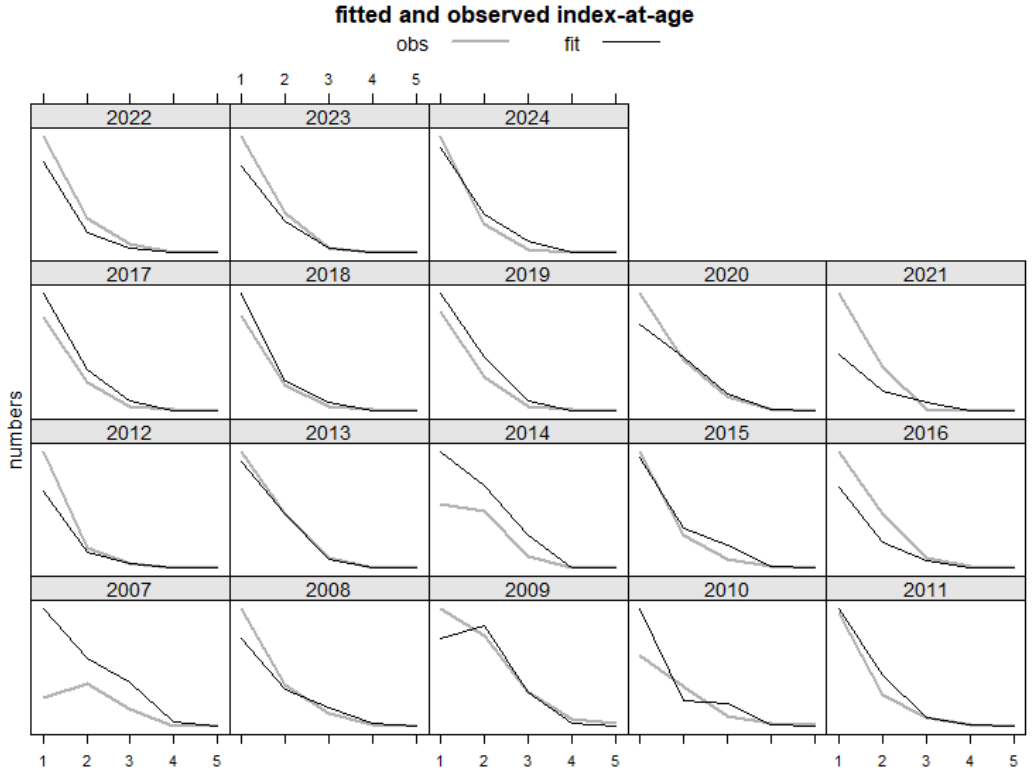


Figure 6.16.3.9. Blue and red shrimp in GSA 5. Fitted and observed index-at-age (MEDITS survey data).

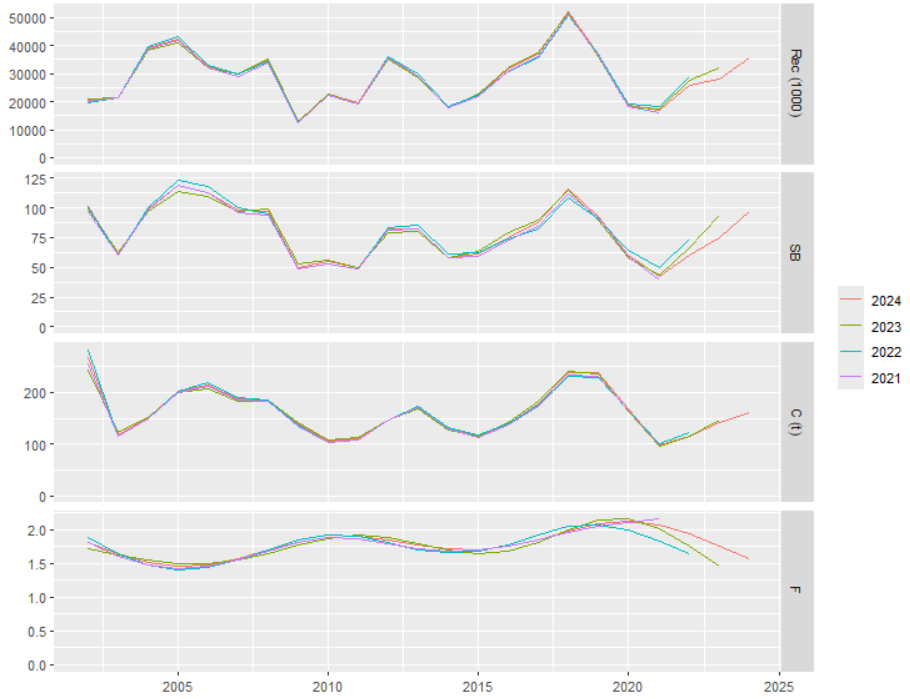


Figure 6.16.3.10. Blue and red shrimp in GSA 5. Results of the retrospective analysis from the a4a analysis.

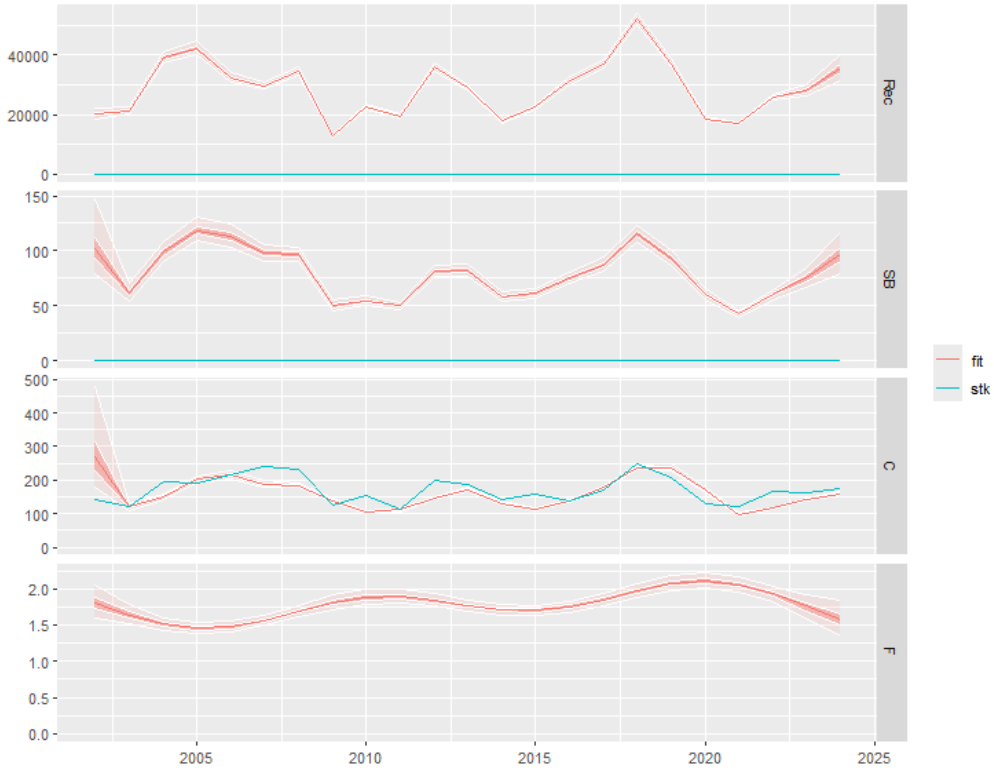


Figure 6.16.3.11. Blue and red shrimp in GSA 5. Simulations over the summary results.

The Mohn'rho test for $Fbar_{1-3}$, SSB and recruitment are also shown below:

fbar	ssb	rec
-0.09193578	0.13167862	0.07107165

In the following tables, the population estimates obtained by the a4a model are provided:

Table 6.16.3.4. Blue and red shrimp in GSA 5. Catch-at-age of number (thousands) as estimated by a4a.

Year	1	2	3	4	5
2002	20307	4568	4978.6	422.9	2.8
2003	21441	4011.1	231.2	280.4	25.3
2004	39199	4540	254.5	16.3	22.9
2005	42216	8725.9	338.9	21.1	3.5
2006	32462	9610.2	700.5	30.3	2.3
2007	29658	7333	752.4	61	3
2008	34653	6474.8	513.8	58.7	5.3
2009	12867	7194.7	385.4	34	4.5
2010	22570	2542.3	364.5	21.7	2.3
2011	19398	4323.5	116.5	18.6	1.3
2012	35879	3706.5	196.4	5.9	1.1
2013	29036	7004.9	180.6	10.7	0.4
2014	17872	5844.6	377	10.8	0.7
2015	22408	3680.6	338.8	24.3	0.8
2016	31387	4631.1	215.8	22.1	1.7
2017	36836	6358.5	254.5	13.2	1.5
2018	52106	7168.1	306.6	13.7	0.8
2019	37139	9650.2	294.3	14	0.7
2020	18645	6600.2	346.5	11.8	0.6
2021	17000	3264	225.6	13.2	0.5
2022	25818	3038.6	119.4	9.2	0.6
2023	27948	4864.4	131.9	5.8	0.5
2024	35471	5649.7	265.4	8	0.4

Table 6.16.3.5. Blue and red shrimp in GSA 5. a4a summary results.

Year	Recruitment age 1 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2002	20307	100.7	267.9	1.81
2003	21441	61.2	117.9	1.64
2004	39199	98.9	150.8	1.51

2005	42216	119	201.8	1.46
2006	32462	113.2	214.4	1.48
2007	29658	97.8	187.5	1.56
2008	34653	96.5	185.0	1.69
2009	12867	50	139.4	1.81
2010	22570	54.7	105.6	1.89
2011	19398	49.8	111.4	1.90
2012	35879	81.9	147.8	1.84
2013	29036	82	171.9	1.77
2014	17872	58.3	130.1	1.71
2015	22408	61.1	114.6	1.70
2016	31387	75.3	139.0	1.75
2017	36836	87.4	178.6	1.85
2018	52106	115.5	238.3	1.97
2019	37139	93.1	237.9	2.08
2020	18645	60.6	169.3	2.11
2021	17000	42.5	98.8	2.06
2022	25818	60.1	115.4	1.93
2023	27948	75.3	140.9	1.76
2024	35471	96.7	160.6	1.57

Table 6.16.3.6. Blue and red shrimp in GSA 5. Fishing mortality at age.

Year	1	2	3	4	5
2002	0.725	2.356	2.356	2.356	2.356
2003	0.655	2.13	2.13	2.13	2.13
2004	0.605	1.968	1.968	1.968	1.968
2005	0.583	1.895	1.895	1.895	1.895
2006	0.591	1.92	1.92	1.92	1.92
2007	0.625	2.031	2.031	2.031	2.031
2008	0.675	2.194	2.194	2.194	2.194
2009	0.725	2.355	2.355	2.355	2.355
2010	0.756	2.456	2.456	2.456	2.456
2011	0.758	2.464	2.464	2.464	2.464
2012	0.737	2.394	2.394	2.394	2.394
2013	0.706	2.295	2.295	2.295	2.295
2014	0.683	2.221	2.221	2.221	2.221
2015	0.68	2.209	2.209	2.209	2.209
2016	0.7	2.274	2.274	2.274	2.274
2017	0.74	2.405	2.405	2.405	2.405
2018	0.789	2.566	2.566	2.566	2.566
2019	0.831	2.7	2.7	2.7	2.7
2020	0.846	2.749	2.749	2.749	2.749
2021	0.825	2.681	2.681	2.681	2.681
2022	0.772	2.51	2.51	2.51	2.51

2023	0.702	2.281	2.281	2.281	2.281
2024	0.629	2.045	2.045	2.045	2.045

The model was fitted assuming flat selectivity from age 2 onwards in the catches and flat catchability (q) from age 3 onwards in the survey. Commercial catches showed greater consistency than the MEDITS survey index. However, the assessment results revealed some instability, particularly regarding the stability of residuals, both in commercial catches (especially at age class 3) and in the MEDITS survey (age classes 3 and 5). The retrospective analysis produced acceptable results, as did all other diagnostics. Therefore, based on the a4a outputs, the main conclusion is that the stock of Blue and Red Shrimp in GSA5 shows a highly variable pattern across all indicators, with no clear trends throughout the time series. After fluctuating from the start of the series until 2014, catches, recruitment (Rec), and spawning stock biomass (SSB) increased progressively between 2014–2015 and 2018, reaching a peak that year. Since then, however, all three dropped sharply until 2021. From 2022 onwards, an increasing trend in catches, Rec, and SSB is again observed. Fbar (ages 1–3) displayed a fluctuating pattern across the series (between 1.57 and 2.11), but with a marked decline from 2020 onwards, reaching 1.57 in 2024.