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Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines This report documents the outcomes of STECF Expert Working Group 24-10: 2024 stock assessments of demersal stocks in the Western Mediterranean Sea from the meeting held in hybrid mode from 2nd to 8th September 2024. A total of 20 fish stocks have been considered as 15 stocks were evaluated by means of a statistical catch at age using as a4a, 1 stock (NEP11) as production model using SPICT, 1 stock (NEP5) as index-based advice and, finally advices for 3 stocks (ARA8-9-10-11, NEP9 and MUT10) have been provided as catch only advice (20% of reduction) (ICES Category 5). The content of the report gives the STECF terms of reference; the basis of the evaluations; assessments, reference point calculations; summaries of state of stock and advised catch or F based on either the MSY approach for assessed stocks and category 3 and 5 based advices for those without assessments. The report contains the full stock assessment reports, the exploration of assessments and category 3 and 5 evaluations for the remaining stocks. The report also contains the STECF observations and conclusions on the assessment report. These conclusions come from the STECF mini plenary meeting 17-18 October 2024.

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) - Stock assessments in the Western Mediterranean Sea (STECF-24-10).

Request to STECF

STECF is requested to review the report of the STECF Expert Working Group meeting (EWG 24-10), evaluate the findings and make any appropriate comments and recommendations.

Summary of EWG 24-10

The working group was held in hybrid form in Ispra (Italy, JRC premises), 2-6 September 2024 and remotely during the last two days (7-8 September). The meeting was attended by 23 experts in total, including four STECF members and three JRC experts. Three observers participated online. The objective of the EWG was to carry out demersal stock assessments and provide reference points and short-term forecast advice for stocks in the Western Mediterranean as defined in the ToRs.

A total of 20 stocks (area/species combinations) were evaluated (Table 1). Fifteen stocks were evaluated by means of a statistical catch at age model (a4a, assessment for all), while one stock was evaluated by means of a surplus production model (SPiCT). For the rest, index-based advice (ICES Category 3) was provided for one stock and catch-only advice (ICES Category 5) was provided for three stocks.

Last year the lack of MEDITS survey information in Italian areas for 2022 impeded running analytical assessments for five stocks in EMU2 and the advice was provided projecting two years ahead from the assessments carried by EWG 22-09 (with data up to 2021) conditioned on the reported catches in weight for 2022. This year the MEDITS tuning index for 2023 was available and the index for 2022 was included as NA (Not Available), so that the lack of MEDITS survey information in Italian areas for 2022 did not hamper the update of a4a models for stocks in EMU2. Advice for four of these five stocks (European hake in GSAs 8_9_10_11, Deep-water rose shrimp in GSAs 8_9_10_11, Red mullet in GSA 9 and Giant red shrimp in GSAs 8_9_10_11) was again based on a4a models. The only exception was Norway lobster in GSA 9, for which the update of the age-based assessment with a4a did not produce robust results (residuals and retrospective patterns). Alternative methods were tested (e.g., SS3, SPiCT, LBB), resulting in different patterns in F in the most recent years. EWG 24-10 noted that different assumptions (e.g., down-

weighting the survey information in SS3, scaling recruitment to 2019, etc.) led to contrasting results in recent years. The general instability of the results of the models tested led EWG 24-10 to not validate any of the models tested. Due to the lack of MEDITS survey in 2022, the ICES Category 3 advice rules could not be applied and EWG 24-10 agreed to downgrade this stock to ICES Category 5 (catch only advice). Further work is needed to better investigate the dynamics of this stock and incorporate them into an assessment model.

In 2023, EWG 23-09 agreed on the index-based two-year advice provided in 2022 for Blue and red shrimp in GSAs 8-9-10-11 and Norway lobster in GSA 11. EWG 24-10 succeeded in fitting a surplus production model with SPiCT for Norway lobster in GSA 11 that was considered suitable to provide advice (other attempts were made with SS3, LBB and LBSPR, supporting the SPiCT results). However, the attempts made with Blue and red shrimp in GSAs 8-9-10-11 (updating the last a4a model available; including more recent data and trying also different runs with alternative approaches, such as assessing females only) did not provide reliable results. The missing index information for 2022, and problems with the timing of the MEDITS survey in 2023 (summer period in GSA 11, autumn in GSAs 9 and 10) led to downgrading the advice from an index-based one (ICES Category 3) to a catch only approach (ICES Category 5). In addition, the characteristics of the species with i) sexual dimorphism, where the majority of catches of larger individuals are females while the proportion of males increases in the lower commercial category landed, ii) the difficulty in ageing and iii) the stock identities, suggested that a benchmark is needed for this stock in the near future.

For Striped red mullet in GSA 5, Norway lobster in GSA 5 and Blue and red shrimp in GSAs 1-2, the index-based advices provided in 2023 (two years advice) were evaluated again looking for a plausible fully analytical assessment. For Norway lobster in GSA 5, none of the a4a model settings tried was able to provide acceptable results, therefore a biomass index-based advice is given as previously. For Stripped red mullet in GSA 5, an age-based assessment with a4a was considered by EWG 24-10 as suitable to provide advice (a surplus production model with a longer time-series of landings was also presented to the group). For Blue and red shrimp in GSAs 1_2, the new data point added (2023) increased slightly the stability of the a4a model (in combination with an update in the biological parameters used to produce the stock object and index), and the advice is provided based on the age-based assessment. However, EWG 24-10 agreed in not estimating biological reference points for this stock, waiting for further evaluation over time. Also, for this stock as for Blue and red shrimp in EMU2 (ARA in GSAs 8_9_10_11) a revaluation of the life history traits and stock boundaries should be considered (i.e., benchmark process).

Finally, for Red mullet in GSA 10, due to the lack of the survey index in 2022 and a late survey in 2023 (with partial coverage in terms of hauls), EWG 24-10 confirmed the catch only advice (ICES Category 5) provided by EWG 23-09, which was valid for 2024, 2025 and 2026.

Due to changes in the input data, the conservation reference points (Blim and Bpa) were re-evaluated for most of the stocks according to the procedure described in STECF EWG

22-03. For five stocks (Blue and red shrimp in GSAs 1_2, Red mullet in GSA 1, Striped red mullet in GSA 5, Deep-water rose shrimp in GSA 1 and Deep-water rose shrimp in GSAs 5_6_7) further evaluation of model stability over time is needed before biological reference points can be calculated. Alternatively, FMSY was calculated for the sixteen stocks with analytical assessments. The surplus production model provides direct estimates of FMSY and BMSY. For the stocks assessed with a4a, the methodology described in STECF 24-02 was followed: FMSY was calculated as Fmax for Type 1 stocks (European hake in GSAs 1_5_6_7 and in GSAs 8_9_10_11 and Norway lobster in GSA 6), whereas F0.1 was used as a proxy of FMSY for the other stocks. Accordingly, BMSY was equal to the biomass at each respective FMSY in equilibrium. “

The EWG carried out short term forecasts for the sixteen accepted age-based and production assessments. The primary catch advice was based on reaching FMSY in 2025. However, when SSB was projected to be below Bpa in 2025, the target fishing mortality was further linearly reduced below FMSY, following ICES advice rule (F reduced).

Table 1 Summary of the work attempted and basis for advice in 2023 and 2024 assessments. A4a: an age-based assessment method; Index refers to the ICES Category 3 approach to provide advice for stocks without analytic assessment; "Catch only" option refers to the ICES Category 5 approach. Catch projection means that the stock was projected one year assuming the 2022 observed catches.

Area (GSA)	Species	Code	Basis 2023	Basis 2024	Changes
1_5_6_7	Hake	HKE	a4a	a4a	
1	Deep-water rose shrimp	DPS	a4a	a4a	
5_6_7	Deep-water rose shrimp	DPS	a4a	a4a	
1	Red Mullet	MUT	a4a	a4a	
5	Striped red Mullet	MUR	Index 2023	a4a	Upgrade
6	Red Mullet	MUT	a4a	a4a	
7	Red Mullet	MUT	a4a	a4a	
5	Norway lobster	NEP	Index 2023	Index 2023	
6	Norway lobster	NEP	a4a	a4a	
8_9_10_11	Hake	HKE	Catch projection, STF	a4a	Upgrade
8_9_10_11	Deep-water rose shrimp	DPS	Catch projection, STF	a4a	Upgrade
9	Red Mullet	MUT	Catch projection, STF	a4a	Upgrade
10	Red Mullet	MUT	ICES Category 5	ICES Category 5	
9	Norway lobster	NEP	Catch projection, STF	ICES Category 5	Downgrade
11	Norway lobster	NEP	Index 2022	SPiCT	Upgrade
1_2	Blue and red shrimp	ARA	Index 2023	a4a	Upgrade
5	Blue and red shrimp	ARA	a4a	a4a	
6_7	Blue and red shrimp	ARA	a4a	a4a	
8_9_10_11	Blue and red shrimp	ARA	Index 2022	ICES Category 5	Downgrade
8_9_10_11	Giant red shrimp	ARS	Catch projection, STF	a4a	Upgrade

Source: Own elaborations

The main results of the EWG are summarized in the bullet point list below and in Table 2. Overall, the assessments indicate that for 12 out of 16 stocks with analytical assessment overfishing is occurring, while four stocks are being fished below FMSY (Table 2).

- European hake in GSA 1_5_6_7: the biomass is not showing any sign of recovery, and F is almost stable at high levels well above FMSY. Biomass reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and below Blim. Catches should be reduced by at least 55% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 91 % with respect to 2023 (Freduced).

- Deep-water rose shrimp in GSA 1: the biomass is increasing. F is below F_{MSY}. When MSY considerations are applied, catches in 2025 should be reduced by at least 41% (this reduction is mainly due to a decline in recruitment). F in 2023 is below FMSY. Biomass reference points were not estimated by EWG 24-10.

- Deep-water rose shrimp in GSA 5_6_7: the biomass is increasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 56%. F in 2023 is below F_{MSY}. Biomass reference points were not estimated by EWG 24-10.

- Red Mullet in GSA 1: the biomass is decreasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 49%. The assessment has been significantly revised, and EWG 24-10 agreed in not estimating biomass reference points for this year.

- Striped red Mullet in GSA 5: the biomass is increasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 32%. This is a new assessment, and EWG 24-10 agreed in not estimating reference points for this year.

- Red Mullet in GSA 6: the biomass is increasing. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and above Blim. Catches should be reduced by at least 61% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 74% with respect to 2023 (Freduced).

- Red Mullet in GSA 7: the biomass is increasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 54%. F in 2023 is below FMSY. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be above BMSY(BF0.1), above Bpa and above Blim.

- Norway lobster in GSA 5: the biomass is fluctuating. When MSY considerations are applied, catches in 2025 may be increased by no more than 11%. Reference points are not available.

- Norway lobster in GSA 6: the biomass is stable in recent years. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and below Blim. For this stock the target fishing mortality is reduced below FMSY. Catches in 2025 should be reduced to at least 50% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 78% with respect to 2023 (Freduced)

- European Hake in GSA 8_9_10_11: the biomass increased in 2023. . Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and below Blim. For this stock the target fishing mortality is reduced below FMSY and catches should be reduced by at least 10% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 47 % with respect to 2023 (Freduced).

- Deep-water rose shrimp in GSA 8_9_10_11: the biomass is decreasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 11%. F in 2023 is below FMSY. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be above BMSY, and above Bpa and Blim.

- Red Mullet in GSA 9: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 7%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, above Bpa and above Blim.

- Red Mullet in GSA 10: When precautionary considerations are applied, catches in 2025 should be reduced by at least 5%. Reference points are not available.

- Norway lobster in GSA 9: When precautionary considerations are applied, catches in 2025 should be reduced by at least 20%. Reference points are not available.

- Norway lobster in GSA 11: the biomass is decreasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 27%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}.

- Blue and red shrimp in GSA 1_2: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 25%. The assessment has been significantly revised, and EWG 24-10 agreed in not estimating biomass reference points for this year.

- Blue and red shrimp in GSA 5: the biomass is increasing since 2021. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and above Blim. For this stock the target fishing mortality is reduced below FMSY and catches should be reduced by at least 64% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 76 % with respect to 2023 (Freduced).

- Blue and red shrimp in GSA 6_7: the biomass is fluctuating. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below BMSY, below Bpa and above Blim. For this stock the target fishing mortality is reduced below FMSY and catches should be reduced by at least 62% to reach FMSY in 2025. As SSB is projected below Bpa in 2025 it is advised that catches are further reduced, leading to a reduction in advised catches of 68 % with respect to 2023 (Freduced).

- Blue and red shrimp in GSA 8_9_10_11: When precautionary considerations are applied, catches in 2025 should be reduced by at least 20%. Reference points are not available.

- Giant red shrimp in GSA 8_9_10_11: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 29%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be above BMSY, above Bpa and above Blim.

Table 2 Summary of advice and stock status from EWG 24-10 by area (GSA) and species based on FMSY target for F2025. Stock status is provided as change in Biomass and F from 2021 to 2023 and where reference points are available status above or below Bmsy, Bpa and Blim. (Reference point definitions and calculations are reported in Sections 4 and 6 of the EWG report respectively) Fishing mortality (F) 2023 is estimated F in the assessment. Where SSB at the start of 2025 is estimated to be below Bpa an additional option based on reduced F is also provided (Section 4 of the EWG report). Catch in 2025 is based on FMSY and reduced F when relevant. Change in F is the difference (%) between target F (FMSY or Freduced) in 2025 and the estimated F for 2023. Change in catch is the difference (%) between model estimated catch in 2023 and forecasted catch in 2025. For catch only and index based methods the catch in 2023 are the observed catch. Biomass and catch 2021-2023 are given as an indication of trends over the last 3 years for stocks with time series analytical assessments or biomass indices.

Area (GSA)	Species	Method/Basis	Age Fbar	Biomass 2021-2023	Catch 2021-2023	B / Bmsy 2023	B / Bpa 2023	B / Blim 2023	F 2023	F 2025 (F MSY and F reduced ^)	Change in F**	Catch 2023*	Catch 2025	Change in catch**
1_5_6_7	European ~~H~~ake	a4a	1-3	stable	stable	below	below	below	1.68	0.57	-66%	2651.3	1189.9	-55%
										0.09^	-94%		236.1	-91%
1	Deep-water rose shrimp	a4a	1-2	increasing	increasing				0.99	1.02	3%	960.0	-	-
5_6_7	Deep-water rose shrimp	a4a	1-2	increasing	increasing				0.88	1.49	69%	1552.1	-	-
1	Red Mullet	a4a	1-2	decreasing	increasing				1.24	0.63	-49%	217.3	110.1	-49%
5	Striped Red Mullet	a4a	1-3	increasing	decreasing				0.57	0.46	-19%	55.8	73.4	32%
6	Red Mullet	a4a	1-3	decreasing	decreasing	below	below	above	1.40	0.44	-69%	1164.0	455.4	-61%
										0.27^	-81%		299.2	-74%
7	Red Mullet	a4a	0-3	increasing	increasing	above	above	above	0.32	0.45	42%	438.8	-	-
5	Norway lobster	Index 2023		fluctuating	decreasing							23.2	25.7	11%
6	Norway lobster	a4a	3-6	stable	decreasing	below	below	below	0.68	0.29	-57%	147.6	74.3	-50%
										0.11^	-84%		31.8	-78%
8_9_10_11	European ~~H~~ake	a4a	1-3	increasing	decreasing	below	below	below	0.40	0.25	-38%	1476.7	1326.7	-10%
										0.14^	-65%		777.0	-47%
8_9_10_11	Deep-water rose shrimp	a4a	1-2	decreasing	decreasing	above	above	above	1.15	1.39	20%	1575.5	1741.7	11%

9	Red Mullet	a4a	1-3	increasing	increasing	below	above	above	0.58	0.48	-17%	801.4	743.1	-7%
10	Red Mullet	Catch only			decreasing							274.0	261.0	-5%
9	Norway lobster	Catch only			increasing							150.6	120.4	-20%
11	Norway lobster	SPICT		decreasing	decreasing	below			0.46	0.24	-48%	26.1	19.1	-27%
1_2	Blue and red shrimp	a4a	1-2	increasing	increasing				0.42	0.29	-31%	204.9	154.5	-25%
5	Blue and red shrimp	a4a	1-3	increasing	increasing	below	below	above	1.46	0.33	-77%	145.8	52.6	-64%
										0.21^	-86%		34.4	-76%
6_7	Blue and red shrimp	a4a	1-2	fluctuating	fluctuating	below	below	above	1.08	0.25	-77%	547.4	207.9	-62%
										0.21^	-81%		174.5	-68%
8_9_10_11	Blue and red shrimp	Catch only			stable							210.0	171.9	-18%
8_9_10_11	Giant red shrimp	a4a	1-3	increasing	increasing	above	above	above	0.62	0.48	-23%	441.5	312.0	-29%

* Estimated Catch from 2024 Assessments STECF EWG 24-10 or observed catch for the Index based advice or catch only methods.
**Change in F is % change in F 2025 relative to 2023; change in catch % change forecasted catch in 2025 relative to estimated catch in 2023.
^ Freduced = Fmsy proxy * B/Bpa (ICES advice rule)

Source: Own elaborations

Table 3 Summary of stock and fishery status by area (GSA) and species, based on FMSY Transition target for F2025. Recent change gives general change in F and catch over the last three years. F2019 and F2023 are both estimated F in the 2024 assessment. F 2025 is FMSY the target for the end of transition, F2019 is the starting point of the MAP. The estimate of progress so far is shown as the F change % 2021 to 2023 and the F status relative to transition with FMSY Transition 2023. Advice for 2025 is based on the FMSY Transition for the next advice year (2025) which is set at a level to reach FMSY in 2025, the change in F and implied by the MAP is the difference (as a fraction) between FMSY Transition in 2025 and the F in 2019 and the most recent year for which we have estimates, F in 2023. Change in catch is from model estimated catch in 2023 and forecasted catch in 2025. Shaded cells are index based for which catch in 2023 are actually the observed ones.

Area	Species	F change 2021-2023	Catch Change 2021-2023	F 2019	F 2023	Fmsy Transition 2023	Target F 2025 F MSY	F Change % 2019-2023	F Status 2023 Rel to FMSY transition 2023	F Change % 2019-2025	F Change % 2023-2025	Catch 2023	Catch 2025 Fmsy Transition	Catch Change 2023-2025
1_5_6_7	European hake	stable	stable	1.78	1.68	0.97	0.57	-6%	behind transition	-68%	-66%	2651.3	1189.9	-55%
1	Deep-water rose shrimp	stable	increasing	0.91	0.99	0.98	1.02	9%	F below FMSY	12%	3%	960.0	-	-
5_6_7	Deep-water rose shrimp	decreasing	increasing	1.41	0.88	1.46	1.49	-38%	F below FMSY	6%	69%	1552.1	-	-
1	Red Mullet	increasing	increasing	1.59	1.24	0.95	0.63	-22%	behind transition	-60%	-49%	217.3	110.1	-49%
5	Striped Red Mullet	decreasing	decreasing	1.47	0.57	0.80	0.46	-61%	ahead of transition	-69%	-19%	55.8	73.4	32%
6	Red Mullet	increasing	decreasing	1.33	1.40	0.74	0.44	5%	behind transition	-67%	-69%	1164.0	455.4	-61%
7	Red Mullet	decreasing	increasing	0.51	0.32	0.47	0.45	-38%	F below FMSY	-11%	42%	438.8	-	-
5	Norway lobster		decreasing									23.2	25.7	11%
6	Norway lobster	decreasing	decreasing	1.12	0.68	0.57	0.29	-39%	behind transition	-74%	-57%	147.6	74.3	-50%
8-9-10-11	European hake	decreasing	decreasing	0.74	0.40	0.41	0.25	-46%	ahead of transition	-66%	-38%	1476.7	1326.7	-10%
8_9_10_11	Deep-water rose shrimp	decreasing	decreasing	1.11	1.15	1.29	1.39	4%	F below FMSY	25%	20%	1575.5	1741.7	11%
9	Red Mullet	decreasing	increasing	1.24	0.58	0.73	0.48	-53%	ahead of transition	-61%	-17%	801.4	743.1	-7%
10	Red Mullet		decreasing									274.0	261.0	-5%

9	Norway lobster		increasing									150.6	120.4	-20%
11	Norway lobster	decreasing	decreasing	0.51	0.46		0.24	-10%		-53%	-48%	26.1	19.1	-27%
1_2	Blue and red shrimp	stable	increasing	0.64	0.42	0.41	0.29	-34%	behind transition	-55%	-31%	204.9	154.5	-25%
5	Blue and red shrimp	decreasing	increasing	2.14	1.46	0.93	0.33	-32%	behind transition	-84%	-77%	145.8	52.6	-64%
6_7	Blue and red shrimp	decreasing	fluctuating	1.16	1.08	0.55	0.25	-7%	behind transition	-78%	-77%	547.4	207.9	-62%
8_9_10_11	Blue and red shrimp		stable									210.0	171.9	-18%
8_9_10_11	Giant red shrimp	decreasing	increasing	0.70	0.62	0.55	0.48	-12%	behind transition	-32%	-23%	441.5	312.0	-29%

Source: Own elaborations

STECF observations

STECF acknowledges that the EWG has addressed all ToRs adequately and has carefully reviewed the quality of the assessments produced.

STECF observes that the number of stocks whose advice is based on analytical assessments (age-structured or surplus production models) has increased considerably from last year (from nine to 16 out of 20 stocks), thanks to two different factors:

On the one hand, last year the number of analytical assessments was hindered by the lack of fishery-independent information collected by the MEDITS surveys in Italian areas for 2022. For five stocks in EMU2 (Italian and Corsica Island GSAs), analytical assessments could not be conducted and the advice was provided projecting two years ahead from the assessments carried out in 2022 conditioned on the reported catches in weight for 2022. This year the data was available for the year 2023, allowing the continuation of the time series; the lack of 2022 MEDITS was overcome by including it as missing data. Advice for 2025 for four of these stocks (European hake in GSAs 8_9_10_11, Deep-water rose shrimp in GSAs 8_9_10_11, Red mullet in GSA 9 and Giant red shrimp in GSAs 8_9_10_11) was again based on age-structured models. STECF notes that the potential impacts of missing survey data, and methods used to deal with such a situation, should be reviewed by the proposed methodological EWG and approved by the stock assessment EWG, to ensure that potential impacts and/or bias is not introduced to the index, and consequently the stock assessment. STECF notes that despite the addition of 2023 data, it was not possible to obtain robust results for Norway lobster in GSA 9 neither from the age-structured model nor from the other alternative methods attempted. Given that the lack of MEDITS in 2022 prevented the application of index-based methods (ICES category 3), the stock was downgraded to catch-only advice (ICES Category 5).

On the other hand, STECF notes that the EWG attempted to obtain fully analytical assessments for the six stocks for which last year the advice was index-based (either from 2022 or 2023) or catch-only. Advice for Striped red mullet in GSA 5 and Blue and red shrimp in GSAs 1_2 were upgraded to a4a stock assessment models, while Norway lobster in GSA 11 was moved to a SPiCT assessment. The trials to obtain an analytical assessment for Blue and red shrimp in GSAs 8_9_10_11 were unsuccessful and the advice was downgraded to catch-only (ICES Category 5). STECF agrees with the suggestion of the EWG that given the stock characteristics (sexual dimorphism, ageing difficulties and stock boundaries) a benchmark for this stock is needed. Finally, the advice basis remained the same for Norway lobster in GSA 5 (index-based) and Red mullet in GSA 10 (catch-only).

Stock status

STECF notes that the primary catch advice is based on the target of FMSY in 2025 (Table 2). If the stock is forecasted to be below Bpa at the start of 2025, an additional catch option in which, in line with the ICES advice rule, the catches are advised to be reduced below catch at FMSY (F reduced) is also given. The values in Table 2 include both of these reductions.

STECF observes that additional advice associated with the Western Med MAP transition to FMSY in 2025 was provided by the EWG (Table 3). The transition to FMSY consists of a gradual change of fishing mortality of equal steps between 2019 to 2025 to reach FMSY in 2025. Since this year represents the last step of that transition period, STECF notes that the catch options based on FMSY transition for 2025 are the same as FMSY, therefore this year no additional catch options were provided for FMSY transition. However, the status of the most recent year for which F estimates are available (2023) can be compared with respect to the FMSY transition in that year.

STECF notes that for 12 out of the 16 stocks with analytical assessments overfishing is occurring (F2023 > FMSY), while four stocks are being fished below FMSY. From the 15 stocks with age-structured assessment models, four stocks are below FMSY, eight stocks are behind transition and three stocks are ahead of transition in 2023.

STECF further notes that of the 10 stocks for which biological reference points (Blim and Bpa) are available, six are estimated to be below Bpa in 2023 and three are estimated to be also below Blim.

STECF notes that the three stocks that remain below Blim are European hake stocks in GSAs 1_5_6_7 and in GSAs 8_9_10_11 and Norway lobster in GSA 6. The catch advice to reach FMSY in 2025 would imply a reduction in catches of 55%, 10% and 28% respectively for these stocks. However, given that these stocks are projected to be below Bpa in 2025, the target fishing mortality rate could be further reduced, leading to a reduction in advised catches for 2025 of 91%, 47% and 78% with respect to 2023 (see table 2, F reduced). STECF notes that the effect of applying both Freduced and FMSY proxy scenarios will be tested in EWG 24-12.

STECF notes that the update of stock assessments with 2023 data did not change the conclusions from STECF PLEN 24-01 stating that there is still a substantial level of overfishing of the stocks across the two EMUs and that there is only one stock (among the accepted advices) with $F/F_{MSY} <= 1$ (which also has $B/B_{MSY}>=1$).

STECF notes that three stocks; deep-water rose shrimp in GSA 1, deep-water rose shrimp in GSAs 5_6_7, red mullet in GSA 7, show increasing patterns in recent years. These dynamics might be related to environmental factors (Sbrana et al., 2019; Tserpes et al., 2019). STECF therefore notes that productivity is not stable and well understood for these stocks, and assessments need to be carried out for a large number of years to assess their stability. STECF further notes that for such fast-moving stocks, F and biomass reference points should be considered as not fully robust for providing advice. Consequently, short-term forecasts should not be taken into account for these three stocks.

Methodology

Regarding reference points, STECF notes that, following the procedure described in STECF EWG 22-03, the EWG calculated biomass conservation reference points for eleven stocks that had analytical assessments. STECF considers that these reference points are suitable to be used for management purposes. For the remaining five stocks (Blue and red shrimp in GSAs 1_2, Red mullet in GSA 1, Stripped red mullet in GSA 5, Deep-water rose shrimp in GSA 1 and Deep-water rose shrimp in GSAs 5_6_7) STECF notes further evaluation is needed before biological reference points can be calculated.

STECF notes that the methodology to estimate FMSY or proxies, and related ranges, was discussed in EWG 24-02 and STECF PLEN 24-02. Following the proposed approach, the EWG calculated FMSY as Fmax for Type 1 stocks as defined in STECF 24-02 for European hake in GSAs 1_5_6_7, hake in GSAs 8_9_10_11 and Norway lobster in GSA 6 whereas F0.1 was used as a proxy of FMSY for the other stocks. STECF notes that given that the three Type 1 stocks are estimated to be below Bpa, the F ranges cannot be used for management purposes and thus, they were not recalculated. The F ranges provided in the EWG report are based on the empirical equations provided by STECF EWG 15-06.

Data issues/considerations

STECF notes that the EWG conducted extensive data quality checks on commercial data provided through the official Mediterranean and Black Sea Data Call, using the R scripts developed during STECF EWG 21-02 and STECF EWG 22-03. All the data issues found are reported in the EWG report and were transmitted through DTMT.

STECF observes that there has been a deterioration in the data collection in Italian MEDITS surveys (lack of survey in 2022 and late timing in 2020, 2021 and 2023) and that the sampling of commercial landings and discards in GSA 10 has been poor in 2020-2023. This has had a major impact on the assessment of Red mullet in GSA 10, that has been downgraded to a catch-only advice (ICES Category 5). For other stocks in GSA 10, missing commercial catch data has been covered by borrowing data from other areas. However, STECF notes that this hinders the quality of the stock assessments and should be improved as soon as possible.

EWG procedures and STECF process

STECF notes that the ToRs for the EWG are very comprehensive, and in spite of the extended EWG meeting to 6.5 days, the time available remains too short to run both a data preparation and an assessment procedure at the same time. Heavy workload under strong time constraint is a major limiting factor for this EWG, with an increased risk of overlooking data issues or mistakes in the assessment procedure.

STECF considers that a data preparation and a methodological EWG, where clear guidelines are provided for exploring data, assessing data quality, and preparing input stock objects, in advance of the assessment EWG, would allow to better review the available data and the biological parameters of each stock. In addition, a continuation of the plan for capacity building and a possible use of MARE ad-hoc contracts for the preparation of the assessments should be considered. This would improve not only the data preparation process, but also the following assessment process which would focus solely on the technicalities of the modelling procedures, also allowing to test alternative model frameworks, something that is often overlooked due to time constraints. Furthermore, STECF notes that as for any stock

assessment an external revision process should be considered to further improve the assessments and potentially ease the workload of the EWG and the plenary in the future. STECF reiterates its previous suggestion that collective discussions between STECF Bureau, DGMARE and the JRC are crucially required to improve ways to ease the processes and increase capacity for this task.

STECF conclusions

STECF concludes that the 2024 advice for 16 out of 20 stocks is based on analytical assessments.

STECF considers that for 13 out of the 16 analytical assessments presented in the report (taking account of the fact that the understanding of the dynamics of Deep water rose shrimp in GSA 1, Deep water rose shrimp in GSAs 5_6_7 and Red mullet in GSA 7, needs to be improved), the assessments can be used to provide advice on stock status in terms of F relative to FMSY, and therefore provide catch advice for 2025.

STECF concludes that due to the fact that the dynamics of Deep water rose shrimp in GSA1, Deep water rose shrimp in GSAs 5_6_7 and Red mullet in GSA 7 are not fully understood, their estimates of F and biomass reference points are not considered fully robust for providing advice.

STECF concludes that of the 16 stocks with analytical assessments, 12 are in overfishing while four are being fished below F_{MSY}. For the four stocks without analytical assessments there are no reference points to evaluate stock status with regard to F_{MSY}.

STECF concludes that six out of the 15 stocks with conservation reference points are below Bpa and for these stocks the catch advice for 2025 is also based on a reduced F below FMSY. Of these, three stocks (European hake stocks in EMU1 (Spanish waters and Gulf of Lion) and EMU2 (Western Italian waters and Corsica Island) and Norway lobster in GSA6) are below Blim. These stocks will require further reductions in F (91%, 47% and 78% respectively) if F reduced is applied.

STECF concludes that the deterioration of the sampling of commercial catches in GSA10 and in Italian MEDITS survey in 2020-2023 hinders the quality of the stock assessments and improving that situation in the future become acutely necessary and should be addressed as soon as possible.

STECF reiterates its previous conclusion that a collective discussion between STECF Bureau, DGMARE and the JRC is strongly suggested to find ways to build increased capacity available to STECF to conduct the stock assessments as well as consider the structure for future EWGs to allow for robust assessments for the Western Mediterranean stocks going forward.

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STECF members marked with an asterix did not participate to the oline plenary meeting.

Expert Working Group EWG-24-10 report

REPORT TO THE STECF

EXPERT WORKING GROUP ON STOCK ASSESSMENT IN THE WESTERN MEDITERRANEAN SEA (EWG-24-10)

Hybrid meeting, 2-8 September 2024

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1 Introduction

1.1 EWG 24-10 Organisation of the meeting

The working group was held in hybrid form remotely and in person in Ispra, Italy, at the JRC premises, from 2nd to 8th September 2024. The meeting was attended by 23 experts in total, including four STECF members and three JRC experts. Three observers participated online. The objective of the EWG 24-10 was to carry out demersal stock assessments and provide reference points and short-term forecast advice for stocks in the Western Mediterranean as defined in the EWG 24-10 ToRs.

The objective of the EWG 24-10 was to carry out assessments and provide draft advice for stocks identified in the ToR supplied by STECF. An initial plenary session commenced at 09:30 on the first day. The ToRs were discussed and examined in detail. Stocks were allocated to participants based on expertise. An ad-hoc workspace repository was created to share documents, data and scripts and prepare the report. The stock assessments were evaluated by all participants.

Over the week plenary sessions were held each day to monitor progress and share results. The overall conclusions for each stock were discussed and finalized in plenary on the Sunday. A review of the assessment quality was completed on Sunday and the meeting closed at 16:30 CEST.

1.2 Organisation of the report

Section 1 provides a meeting overview and ToRs.

Section 2 gives a summary of the report containing all the main conclusions, stock status relative to MSY, MSY Transition and the newly defined biomass reference points and headline fishing mortality and catch values for MSY, reduced MSY and MSY Transition.

Section 3 summaries the areas of work that need additional attention in the future.

Section 4 provides an overview of the methodology used to provide stock status, fishing mortality and catch options consistent with MSY and MSY Transition and the methods used to calculate biomass reference points.

Section 5 gives the summaries by stock relating to ToR 8 by stock, based on the template developed in EWG 18-12. Section 6 documents the data, assessments and short-term forecasts from ToRs 1-5. Section 7 summarises data deficiencies for ToRs 6 and 7.

1.3 Terms of Reference for EWG 24-10

STECF EXPERT WORKING GROUP EWG 24-10

concerning the stock assessments in the Western Mediterranean Sea

2 September – 8 September 2024, ***Ispra, Italy*** */* ***hybrid***

Chairs: Alessandro Ligas – Alessandro Mannini

DG MARE focal points: Anne-Cécile Dragon, Chato Osio

The EWG report would be adopted during a mini-plenary on 17-18 October 2024 for a publication by 23 October if possible and 31 October at the latest.

TERMS OF REFERENCE

For the stocks given in Table 2, the group is requested:

ToR 1. To compile and provide the most updated information on stock identification and boundaries, length and age composition, growth, maturity, feeding, essential fish habitats including spawning grounds and seasonality as well as natural mortality.

ToR 2. To compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2023, including length frequency distribution over time and, where possible, including estimates from recreational fisheries landings.

ToR 3. To assess trends in historic and recent stock parameters on fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate, including retrospective analyses. The selection of the most reliable assessment shall be explained. Assumptions and uncertainties shall be specified. To assist with development of management plans, give preference to models that allow estimation of uncertainty, in line with the recommendations of STECF EWG 17-07. Special attention should be paid to:

- Stocks listed in Table 2 without an analytical assessment to attempt fitting one
- Hake stocks partial fishing mortality estimation in EMU 1 and 2 in order to estimate the partial-F by gear and GSA, in particular if updated length based landings have been made available via the 2024 Med&BS Data Call and these data incorporated into the updated assessments.
- Changes in historical time series of landings for stocks where data was revised to better determine the origin of catches (for example ARS and ARA in GSA 8-11)
- Taking into account the issue of 2022 MEDITS missing data in GSAs 9-10-11 in order to find a standard solution, coherent across assessments from EWG 23-09, EWG 23-11, EWG 24-10 and EWG 24-12 that will allow an estimation of the stocks parameters for 2022 and 2023.

ToR 4. Based on the work developed in STECF EWG 24-02, to compute the conservation reference points (i.e. Bpa and Blim) and the FMSY point value (Fmax for the stocks in Type 1 group (e.g., HKE1567, HKE891011, NEP6) or other appropriate proxy (i.e., F0.1), compared to the ones estimated by previous EWGs. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield. As discussed during PLEN 24-02, in addition to the formal three yearly evaluation of biomass reference points proposed by PLEN 22-03, the EWG should update the F reference points (FMSY and ranges) produced by EWG 24-02, needed for the MAP implementation: Fmax for type 1 stocks and F0.1 for all the others. If the 2024 hake stocks or any other stock show being above Bpa, then ranges of F could be estimated and the EWG could use the FMSY ranges estimated by EWG 24-02.

ToR 5. To provide short and medium term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, including: the status quo fishing mortality and target in line with FMSY ranges identified according to Table 1 or other appropriate proxy for 2025. If the stock is considered to be being fished above FMSY provide an F and catch option consistent with the achievement of MSY in 2025. Also where the

stock is considered to be below B_{LIM} and/ or B_{PA} provide catch options to restore rapidly SSB above B_{PA}, following Art 6 of the West Med MAP and the methodology adopted for other EU sea-basins

- **Table 1 Criteria for the identification of the most vulnerable stock and the use of Fmsy ranges level in line with Art 4 and 6 of the West Med MAP**

West MED MAP Fmsy ranges provisions	***Points to be checked by EWG***
Which is the most vulnerable stock? Which EMU and effort group does it belong to?	*Most vulnerable stock might change or present spatial mismatch.*
Effort may be set above the Fmsy range if all concerned stocks are above Bpa (Art 4(5))? *-If **NO** Fupper cannot be used* *-If **YES**, conditions a,b,c could apply in particular c ("in order to limit variations in maximum allowable fishing effort between consecutive years to not more than 20%.")*	*Currently in EMU 1 HKE is most depleted but if NEP 6 became most depleted it could conflict with the EMU Fmsy range*
Is the most vulnerable stock below Bpa (Art 6(1))? *Is the most vulnerable stocks below Blim (Art 6(2))?*	*6(1).Where scientific advice shows that the spawning stock biomass of any of the stocks concerned is below BPA, all appropriate remedial measures shall be taken to ensure the rapid return of the stocks concerned to levels above those capable of producing MSY. In particular, notwithstanding Article 4(3), maximum allowable fishing effort shall be set at levels consistent with a fishing mortality that is reduced within the range of FMSY for the most vulnerable stock, taking into account the decrease in biomass.* *6(2).Where scientific advice shows that the spawning stock biomass of any of the stocks concerned is below BLIM, further remedial measures shall be taken to ensure the rapid return of the stocks concerned to levels above those capable of producing MSY. In particular, notwithstanding Article 4(3), such remedial measures may include suspending the targeted fishery for the stocks concerned and the adequate reduction of the maximum allowable fishing effort.*

Source: Own elaborations

ToR 6. To summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched in 2024. Identify further research studies and data collection which would be required for improved fish stock assessments.

ToR 7. To ensure that all unresolved data transmission issues related to the stocks encountered prior to and during the EWG meeting are reported on line via the Data Transmission Monitoring Tool (DTMT) available at https://datacollection.jrc.ec.europa.eu/web/dcf/dtmt. Guidance on precisely what should be inserted in the DTMT, log-on credentials and access rights will be provided separately by the STECF Secretariat focal point for the EWG.

ToR 8. Using the report structure developed in 2018 (EWG 18-12), provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stocks (spawning stock biomass, stock biomass, recruits and exploitation level relative to Fmsy, and by fishing gear, if possible including relevant types of trawlers, longliners and netters); (iii) the source of data and methods and; (iv) the management advice taking into account stock biomass using e.g. the ICES control rule, including FMSY value, range of values and conservation reference points. Provide a summary table showing the progress already made in the transition towards MSY and the F and catch advice for 2025 to reach and maintain Fmsy.

Table 2– List of suggested stocks to be assessed by the EWG 24-10.

Area	Common name	Scientific name
GSA 1-5-6-7	Hake	*Merluccius merluccius*
GSA 1	Deep-water rose shrimp	*Parapenaeus longirostris*
GSA 5-6-7	Deep-water rose shrimp	*Parapenaeus longirostris*
GSA 1	Red mullet	*Mullus barbatus*
GSA 5	Striped red mullet	*Mullus surmuletus*
GSA 6	Red mullet	*Mullus barbatus*
GSA 7	Red mullet	*Mullus barbatus*
GSA 5	Norway lobster	*Nephrops norvegicus*
GSA 6	Norway lobster	*Nephrops norvegicus*
GSA 8-9-10-11	Hake	*Merluccius merluccius*
GSA 8-9-10-11	Deep-water rose shrimp	*Parapenaeus longirostris*
GSA 9	Red mullet	*Mullus barbatus*
GSA 10	Red mullet	*Mullus barbatus*
GSA 9	Norway lobster	*Nephrops norvegicus*
GSA 11	Norway lobster	*Nephrops norvegicus*
GSA 1-2	Blue and red shrimp	*Aristeus antennatus*
GSA 5	Blue and red shrimp	*Aristeus antennatus*
GSA 6-7	Blue and red shrimp	*Aristeus antennatus*
GSA 8-9-10-11	Giant red shrimp*	*Aristaeomorpha foliacea*
GSA 8-9-10-11	Blue and red shrimp*	*Aristeus antennatus*

***EWG to check historical landings against the Med&BS DCF data call from 2024 where the origin of catches has been revised for certain catches/years**

2 Summary of main outcomes

2.1 Stock-Specific Findings & Conclusions

The working group was held in hybrid form remotely and in person in Ispra (Italy, JRC premises), from 2nd to 8th September 2024. The meeting was attended by 23 experts in total, including four STECF members and three JRC experts. Three observers participated online. The objective of the EWG 24-10 was to carry out demersal stock assessments and provide reference points and short-term forecast advice for stocks in the Western Mediterranean as defined in the EWG 24-10 ToRs.

The EWG has addressed all ToRs. The EWG has carefully reviewed the quality of the assessments produced. A total of 20 stocks (area/species combinations) were evaluated this year (Table 1). Fifteen stocks were evaluated by means of a statistical catch at age (SCAA) model (a4a), while one stock was evaluated by means of a surplus production model (SPiCT). The lack of MEDITS survey information in Italian areas for 2022 and the delay in the MEDITS 2023 for GSAs 9 and 10 did not hamper to try the update of a4a stocks in EMU2 as the models attempted were run including NAs in the tuning index for 2022, as agreed by EWG 24-10.

In 2022, index-based advice was given for two stocks (ARA8-9-10-11 and NEP11 on two years basis), and this advice was confirmed by EWG 23-09. While for NEP11, EWG 24-10 succeeded in fitting a surplus production model with SPiCT that was considered as suitable to provide advice (other attempts were made with SS3, LBB and LBSPR, supporting the SPiCT results), the attempts made with ARA891011 (updating the last a4a model available; including more recent data and trying also different runs with alternative approaches, such as assessing females only) did not provide reliable results. The missing index information for 2022, and problems with the timing of the MEDITS survey in 2023 (summer period in GSA11, autumn in GSAs 9 and 10) led the group to consider downgrading the advice from an index-based one to a catch only advice approach (ICES Category 5). In addition, the characteristics of the species with i) sexual dimorphism, where the majority of catches of larger individuals are females while the proportion of males increases in the lower commercial category landed, ii) the difficulty in ageing the species and iii) the stock boundaries suggested that a benchmark is needed for this stock in the near future.

Also for MUT 10, due to the lack of index in 2022 and a late survey in 2023 (with partial coverage in terms of hauls), EWG 24-10 confirmed the catch only advice (ICES Category 5) provided by EWG 23-09, which was valid for 2024, 2025 and 2026.

For MUR5 and NEP5, the index-based advice provided in 2023 (2 years advice) have been evaluated again looking for a plausible fully analytical assessment. For NEP5, none of the model setting tried was able to provide acceptable results, therefore a biomass index-based advice is given again. This is reiterated in the EWG 24-10 report (Section 5). For MUR5, an age-based assessment with a4a was considered by EWG 24-10 as suitable to provide advice (a surplus production model with a longer time-series of landings was also presented to the group).

For NEP9, the update of the age-based assessment with a4a did not produce robust results (residuals and retrospective patterns). Alternative methods were tested (e.g., SS3, SPiCT, LBB), providing different patterns in F in the most recent years. EWG 24-10 noted that different assumptions led to contrasting results in recent years (e.g., down-weighting the survey information in SS3, scaling recruitment to 2019, etc.). The general instability of the models tested led EWG 24-10 to not validate any of the models tested. Due to the lack of MEDITS survey in 2022, EWG 24-10 agreed in downgrading this stock to ICES Category 5 (catch only

advice). Further work is needed to better investigate the dynamics of this stock and incorporate them into an assessment model.

Finally, for ARA1-2, the new data point added (2023) increased slightly the stability of the a4a model (in combination with an update in the biological parameters used to produce the stock object and index), and the advice is provided based on the age-based assessment. However, EWG 24-10 agreed in not estimating biological reference points for this stock, waiting for further evaluation over time. Also for this stock as for ARA in EMU2 a revaluation of the life history traits and stock boundaries should be considered (i.e., benchmark process).

The EWG carried out short term forecasts for the sixteen accepted age-based and production assessments. The reference points were re-evaluated for most of the stocks, due to changes in the input data (e.g., re-submission by MSs of historical landings, revised biological parameters for building the stock objects, etc.). For five stocks (ARA1-2, MUT1, MUR5, DPS1 and DPS567) further evaluation over time of model stability are needed before reference points can be calculated.

During the EWG, the experts highlighted how the time available is quite short to run both a data preparation and an assessment procedure at the same time. Time constraint is one of the most limiting factors within this EWG which some of the experts suggest could potentially lead to overlook data issues or mistakes in the assessment procedure. Specifically for more than one stock it was highlighted how a data preparation EWG (or a methodological EWG where clear guidelines are provided for exploring data, assessing data quality, and preparing input stock objects), in advance of the assessment EWG, would allow to better review the available data and the biological parameters of each stock. This would improve not only the data preparation process, but also the following assessment process which would focus solely on the technicalities of the modelling procedures, also allowing to test alternative model frameworks, something that is often overlooked due to time constraints.

Table 2.1 Summary of the work attempted and basis for advice in 2023 and 2024 assessments. a4a: an age-based assessment method; Index refers to the ICES Category 3 approach to provide advice for stocks without analytic assessment; Catch only option refers to the ICES Category 5 approach. Catch projection means that the stock was projected one year assuming the 2022 observed catches.

Area	Species	Basis 2023	Basis 2024	Changes
1_5_6_7	Hake	a4a	a4a	
1	Deep-water rose shrimp	a4a	a4a	
5_6_7	Deep-water rose shrimp	a4a	a4a	
1	Red Mullet	a4a	a4a	
5	Striped Red Mullet	Index 2023	a4a	Upgrade
6	Red Mullet	a4a	a4a	
7	Red Mullet	a4a	a4a	
5	Norway lobster	Index 2023	Index 2023	
6	Norway lobster	a4a	a4a	
8_9_10_11	Hake	Catch projection, STF	a4a	Upgrade
8_9_10_11	Deep-water rose shrimp	Catch projection, STF	a4a	Upgrade

9	Red Mullet	Catch projection, STF	a4a	Upgrade
10	Red Mullet	ICES Category 5	ICES Category 5	
9	Norway lobster	Catch projection, STF	ICES Category 5	Downgrade
11	Norway lobster	Index 2022	SPiCT	Upgrade
1_2	Blue and red shrimp	Index 2023	a4a	Upgrade
5	Blue and red shrimp	a4a	a4a	
6_7	Blue and red shrimp	a4a	a4a	
8_9_10_11	Blue and red shrimp	Index 2022	ICES Category 5	Downgrade
8_9_10_11	Giant red shrimp	Catch projection, STF	a4a	Upgrade

Source: Own elaborations

The main results are summarized in the bullet point list below and in Table 2. Overall, the assessments indicate that for 12 out of the 16 stocks with analytical assessment overfishing occurred, while four stocks are being fished below F_{MSY} (Tables 2.2 and 2.3).

- European hake in GSA 1_5_6_7: the biomass is not showing any sign of recovery, and F is almost stable at high levels well above F_{MSY}. Biomass reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and below B_{lim}. Catches should be reduced by at least 55% to reach F_{MSY} in 2025. As SSB is projected to be below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in catches of 91 % with respect to 2023 ($F_{reduced}$).

- Deep-water rose shrimp in GSA 1: the biomass is increasing. F in 2023 is below F_{MSY}. When MSY considerations are applied, catches in 2025 should be reduced by at least 41% (this reduction is mainly due to a decline in recruitment). Biomass reference points were not estimated by EWG 24-10. Short-term forecast were performed but should not be taken into account due to stock dynamics instability.

- Deep-water rose shrimp in GSA 5_6_7: the biomass is increasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 56%. F in 2023 is below F_{MSY}. Biomass reference points were not estimated by EWG 24-10. Short-term forecast were performed but should not be taken into account due to stock dynamics instability.

- Red Mullet in GSA 1: the biomass is decreasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 49%. The assessment

has been significantly revised, and EWG 24-10 agreed in not estimating biomass reference points for this year.

- Striped red Mullet in GSA 5: the biomass is increasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 32%. This is a new assessment, and EWG 24-10 agreed in not estimating biomass reference points for this year.

- Red Mullet in GSA 6: the biomass is increasing. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and above B_{lim}. Catches should be reduced by at least 61% to reach F_{MSY} in 2025. As SSB is projected below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in advised catches of 74% with respect to 2023 ($F_{reduced}$).

- Red Mullet in GSA 7: the biomass is increasing. F in 2023 is below F_{MSY}. When MSY considerations are applied, catches in 2025 may be increased by no more than 54%. Short-term forecast were performed but should not be taken into account due to stock dynamics instability.

- Norway lobster in GSA 5: the biomass is fluctuating. When MSY considerations are applied, catches in 2025 may be increased by no more than 11%. Reference points are not available.

- Norway lobster in GSA 6: the biomass is stable in recent years. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and below B_{lim}. For this stock the target fishing mortality is reduced below F_{MSY}. Catches in 2025 should be reduced to at least 50% to reach F_{MSY} in 2025. As SSB is projected below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in advised catches of 78% with respect to 2023 ($F_{reduced}$)

- European Hake in GSA 8_9_10_11: the biomass increased in 2023. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and below B_{lim}. For this stock the target fishing mortality is reduced below F_{MSY} and catches should be reduced by at least 10% to reach F_{MSY} in 2025. As SSB is projected below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in advised catches of 47 % with respect to 2023 ($F_{reduced}$).

- Deep-water rose shrimp in GSA 8_9_10_11: the biomass is decreasing. When MSY considerations are applied, catches in 2025 may be increased by no more than 11%. F in 2023 is below F_{MSY}. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be above B_{MSY}, and above B_{pa} and B_{lim}.

- Red Mullet in GSA 9: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 7%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, above B_{pa} and above B_{lim}.

- Red Mullet in GSA 10: When precautionary considerations are applied, catches in 2025 should be reduced by at least 5%. Reference points are not available.

- Norway lobster in GSA 9: When precautionary considerations are applied, catches in 2025 should be reduced by at least 20%. Reference points are not available.

- Norway lobster in GSA 11: the biomass is decreasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 27%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}.

- Blue and red shrimp in GSA 1_2: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 25%. The assessment has been significantly revised, and EWG 24-10 agreed in not estimating biomass reference points for this year.

- Blue and red shrimp in GSA 5: the biomass is increasing since 2021. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and above B_{lim}. For this stock the target fishing mortality is reduced below F_{MSY} and catches should be reduced by at least 64% to reach F_{MSY} in 2025. As SSB is projected below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in advised catches of 76 % with respect to 2023 ($F_{reduced}$).

- Blue and red shrimp in GSA 6_7: the biomass is fluctuating. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be below B_{MSY}, below B_{pa} and above B_{lim}. For this stock the target fishing mortality is reduced below F_{MSY} and catches should be reduced by at least 62% to reach F_{MSY} in 2025. As SSB is projected below B_{pa}, in 2025 catches could be further reduced, leading to a reduction in advised catches of 68 % with respect to 2023 ($F_{reduced}$).

- Blue and red shrimp in GSA 8_9_10_11: When precautionary considerations are applied, catches in 2025 should be reduced by at least 18%. Reference points are not available.

- Giant red shrimp in GSA 8_9_10_11: the biomass is increasing. When MSY considerations are applied, catches in 2025 should be reduced by at least 29%. Reference points are available (EWG 24-10) and SSB in 2023 is estimated to be above B_{MSY}, above B_{pa} and above B_{lim}.

Table 2.2 Summary of advice and stock status from EWG 24-10 by area (GSA) and species based on **F_{MSY} target for F2025**. Stock status is provided as change in Biomass and F from 2021 to 2023 and where reference points are available status above or below B_{msy}, B_{pa} and B_{lim}. (Reference point definitions and calculations are reported in Sections 4 and 6 of the EWG report respectively) Fishing mortality (F) 2023 is estimated F in the assessment. Where SSB at the start of 2025 is estimated to be below B_{pa} an additional option based on reduced F is also provided (Section 4 of the EWG report). Catch in 2025 is based on F_{MSY} and reduced F when relevant. Change in F is the difference (%) between target F (F_{MSY} or Freduced) in 2025 and the estimated F for 2023. Change in catch is the difference (%) between model estimated catch in 2023 and forecasted catch in 2025. For catch only and index based methods the catch in 2023 are the observed catch. Biomass and catch 2021-2023 are given as an indication of trends over the last 3 years for stocks with time series analytical assessments or biomass indices.

Area (GSA)	Species	Method/Basis	Age Fbar	Biomass 2021-2023	Catch 2021-2023	B / Bmsy 2023	B / Bpa 2023	B / Blim 2023	F 2023	F MSY	Change in F**	Catch 2023*	Catch 2025	Change in catch**
1_5_6_7	European ~~H~~ake	a4a	1-3	stable	stable	below	below	below	1.68	0.57	-66%	2651.3	1189.9	-55%
										0.09^	-94%		236.1	-91%
1	Deep-water rose shrimp	a4a	1-2	increasing	increasing				0.99	1.02	3%	960.0	-	-
5_6_7	Deep-water rose shrimp	a4a	1-2	increasing	increasing				0.88	1.49	69%	1552.1	-	-
1	Red Mullet	a4a	1-2	decreasing	increasing				1.24	0.63	-49%	217.3	110.1	-49%
5	Striped Red Mullet	a4a	1-3	increasing	decreasing				0.57	0.46	-19%	55.8	73.4	32%
6	Red Mullet	a4a	1-3	decreasing	decreasing	below	below	above	1.40	0.44	-69%	1164.0	455.4	-61%
										0.27^	-81%		299.2	-74%
7	Red Mullet	a4a	0-3	increasing	increasing	above	above	above	0.32	0.45	42%	438.8	-	-
5	Norway lobster	Index 2023		fluctuating	decreasing							23.2	25.7	11%
6	Norway lobster	a4a	3-6	stable	decreasing	below	below	below	0.68	0.29	-57%	147.6	74.3	-50%
										0.11^	-84%		31.8	-78%
8_9_10_11	European ~~H~~ake	a4a	1-3	increasing	decreasing	below	below	below	0.40	0.25	-38%	1476.7	1326.7	-10%
										0.14^	-65%		777.0	-47%
8_9_10_11	Deep-water rose shrimp	a4a	1-2	decreasing	decreasing	above	above	above	1.15	1.39	20%	1575.5	1741.7	11%
9	Red Mullet	a4a	1-3	increasing	increasing	below	above	above	0.58	0.48	-17%	801.4	743.1	-7%

10	Red Mullet	Catch only			decreasing							274.0	261.0	-5%
9	Norway lobster	Catch only			increasing							150.6	120.4	-20%
11	Norway lobster	SPICT		decreasing	decreasing	below			0.46	0.24	-48%	26.1	19.1	-27%
1_2	Blue and red shrimp	a4a	1-2	increasing	increasing				0.42	0.29	-31%	204.9	154.5	-25%
5	Blue and red shrimp	a4a	1-3	increasing	increasing	below	below	above	1.46	0.33	-77%	145.8	52.6	-64%
										0.21^	-86%		34.4	-76%
6_7	Blue and red shrimp	a4a	1-2	fluctuating	fluctuating	below	below	above	1.08	0.25	-77%	547.4	207.9	-62%
										0.21^	-81%		174.5	-68%
8_9_10_11	Blue and red shrimp	Catch only			stable							210.0	171.9	-18%
8_9_10_11	Giant red shrimp	a4a	1-3	increasing	increasing	above	above	above	0.62	0.48	-23%	441.5	312.0	-29%

Source: Own elaborations

* Estimated Catch from 2024 Assessments STECF EWG 24-10 or observed catch for the Index based advice or catch only methods.
**Change in F is % change in F 2025 relative to 2023; change in catch % change forecasted catch in 2025 relative to estimated catch in 2023.
^ Freduced = Fmsy proxy * B/Bpa (ICES advice rule)

Table 2.3 Summary of stock and fishery status by area (GSA) and species, **based on $F_{MSY\ Transition}$ target for F_{2025}**. Recent change gives general change in F and catch over the last three years. F_{2019} and F_{2023} are both estimated F in the 2024 assessment. F_{2025} is F_{MSY} the target for the end of transition, F_{2019} is the starting point of the MAP. The estimate of progress so far is shown as the F change % 2021 to 2023 and the F status relative to transition with $F_{MSY\ Transition}$ 2023. **Advice for 2025** is based on the $F_{MSY\ Transition}$ for the next advice year (2025) which is set at a level to reach F_{MSY} in 2025, the change in F and implied by the MAP is the difference (as a fraction) between $F_{MSY\ Transition}$ in 2025 and the F in 2019 and the most recent year for which we have estimates, F in 2023. Change in catch is from model estimated catch in 2023 and forecasted catch in 2025. Shaded cells are index based for which catch in 2023 are actually the observed ones.

Area	Species	F change 2021-2023	Catch Change 2021-2023	F 2019	F 2023	Fmsy Transition 2023	Target F 2025 F MSY	F Change % 2019-2023	F Status 2023 Rel to FMSY transition 2023	F Change % 2019-2025	F Change % 2023-2025	Catch 2023	Catch 2025 Fmsy Transition	Catch Change 2023-2025
1_5_6_7	European hake	stable	stable	1.78	1.68	0.97	0.57	-6%	behind transition	-68%	-66%	2651.3	1189.9	-55%
1	Deep-water rose shrimp	stable	increasing	0.91	0.99	0.98	1.02	9%	F below FMSY	12%	3%	960.0	-	-
5_6_7	Deep-water rose shrimp	decreasing	increasing	1.41	0.88	1.46	1.49	-38%	F below FMSY	6%	69%	1552.1	-	-
1	Red Mullet	increasing	increasing	1.59	1.24	0.95	0.63	-22%	behind transition	-60%	-49%	217.3	110.1	-49%
5	Striped Red Mullet	decreasing	decreasing	1.47	0.57	0.80	0.46	-61%	ahead of transition	-69%	-19%	55.8	73.4	32%
6	Red Mullet	increasing	decreasing	1.33	1.40	0.74	0.44	5%	behind transition	-67%	-69%	1164.0	455.4	-61%
7	Red Mullet	decreasing	increasing	0.51	0.32	0.47	0.45	-38%	F below FMSY	-11%	42%	438.8	-	-
5	Norway lobster		decreasing									23.2	25.7	11%
6	Norway lobster	decreasing	decreasing	1.12	0.68	0.57	0.29	-39%	behind transition	-74%	-57%	147.6	74.3	-50%
8-9-10-11	European hake	decreasing	decreasing	0.74	0.40	0.41	0.25	-46%	ahead of transition	-66%	-38%	1476.7	1326.7	-10%
8_9_10_11	Deep-water rose shrimp	decreasing	decreasing	1.11	1.15	1.29	1.39	4%	F below FMSY	25%	20%	1575.5	1741.7	11%
9	Red Mullet	decreasing	increasing	1.24	0.58	0.73	0.48	-53%	ahead of transition	-61%	-17%	801.4	743.1	-7%
10	Red Mullet		decreasing									274.0	261.0	-5%
9	Norway lobster		increasing									150.6	120.4	-20%
11	Norway lobster	decreasing	decreasing	0.51	0.46		0.24	-10%		-53%	-48%	26.1	19.1	-27%
1_2	Blue and red shrimp	stable	increasing	0.64	0.42	0.41	0.29	-34%	behind transition	-55%	-31%	204.9	154.5	-25%
5	Blue and red shrimp	decreasing	increasing	2.14	1.46	0.93	0.33	-32%	behind transition	-84%	-77%	145.8	52.6	-64%

6_7	Blue and red shrimp	decreasing	fluctuating	1.16	1.08	0.55	0.25	-7%	behind transition	-78%	-77%	547.4	207.9	-62%
8_9_10_11	Blue and red shrimp		stable									210.0	171.9	-18%
8_9_10_11	Giant red shrimp	decreasing	increasing	0.70	0.62	0.55	0.48	-12%	behind transition	-32%	-23%	441.5	312.0	-29%

Source: Own elaborations

2.2 Quality of the assessments

There has been recent deterioration in the data collection in Italian MEDITS surveys, timing has been late in 2020, 2021, and 2023 (at least in some GSAs), and the survey was not performed in 2022. In addition, sampling of commercial catches and discards in GSA 10 has been unacceptably poor across almost all species in the same years (2020-2023). This has resulted in problems for the red mullet assessment in GSA 10, and because of these data collection failures it has not been possible to obtain either an assessment or an index-based advice for this species. Due to the lack of survey data in 2022, this stock has been downgraded by EWG 23-09 to ICES Category 5; EWG 24-10 had the only option to reiterate the advice of EWG 23-09 (please see below and Section 6.12.). For the other stocks that include data from GSA 10, and are assessed along with other GSAs, it has been possible to cover the missing data by borrowing catch sample information from other GSAs (i.e., GSAs 9 and 11); however, the deterioration in data does result in poorer assessments. It is a matter of considerable urgency that sampling of commercial catches and discards in GSA 10 is improved immediately. In addition, the MEDITS survey In Italian GSAs needs to be carried out at a specific time of year. The survey is used for several short-lived summer spawning species and timing is critical for collecting consistent data for these species.

Hake

The assessment of hake in GSA 1567 is an update from last year and following the GFCM December 2019 benchmark. The results are very consistent with last year's results with biomass 2022 like 2021. There is need to explore some of the historic survey data from 2010, 2011 in the hope that very low values could be explained and removed from the data. Currently MEDITS values at age 4 are probably slightly distorting the assessment in these years, though age 4 is outside the main age range used to compute Fbar. Recruitment in 2022 is observed to be high, but information is sparse and may of course be revised in the light of more data, but currently SSB is expected to rise if F can be further reduced. Discards are observed to be increasing in recent years and are now included in this year's assessment. The reference points calculated by EWG 22-09 were confirmed.

The assessment of hake in GSA 8,9,10 & 11 is an update of last year model and follows the GFCM benchmark settings (December 2019). The results are consistent and fully in line with previous years assessments. The assessment includes GSA 10 data sampling issues in recent years (e.g. poor samplings, missing quarter data, lack of discard data); this has an impact on the model, but it is not considered critical to the assessment, because the data from other GSAs can be used to mask some of the issues. The model is stable, and the reference points are very similar to those calculated last year.

Red Mullet

The assessment of red mullet in GSA 1 is new and is not comparable with previous year assessment. Some problems were identified, and new slicing procedures were applied. The t0 correction was not applied to either Medits or Catch data. Also, Fbar was changed from 1-3 to 1-2. The lack of survey in 2020 is not causing significant issues. Some discards are reported in the last years and those are correctly considered in the assessment. Reference points have not been estimated due to the slight instability of the model. The EWG 24-10 decided to evaluate reference point next year.

The assessment of red mullet in GSA 6 is a new assessment as some settings in the model has been changed and no T0 correction has been applied unlike last year. Therefore, new biological referent points have been calculated which are slightly different from the last year. There is also uncertainty in the correct growth parameters with differences between published and DCF values. There are still some inconsistences in the data between the FDI and Med and Black Sea calls, which has been explained and the EWG used Med BS following information from Spanish authorities. In addition, there are some differences in reported catch in 2009 and 2010 between GFCM and Med and Black Sea data call. There is no obvious explanation for these differences that should be resolved. These issues are reported in the DTMT and should be followed up. Overall, the new assessment is improved from last year.

For red mullet in GSA 7, the formulation of the model was consistent with previous years. The results are also consistent, although slightly different in absolute terms due to the updating of landings data (re-estimation of Spanish mixed landings) and other biological parameters. Reference points were estimated by EWG 24-10, but are consistent with the ones computed by previous EWGs.

The red mullet in GSA 9 assessment is an update with the same settings as EWG 22-09 (EWG 23-09 performed a 1-year catch projection and STF due to the lack of 2022 MEDITS). The assessment is a little more unstable, due partly to sharp change in landings in recent years. There is a decline in retrospective performance. However, the model is still stable enough for advice. The MEDITS survey has been conducted later in the years 2020, 2021 and 2023. The reference point calculated with the new assessment are like those calculated by previous EWGs.

For red mullet in GSA 10, due to the lack of both MEDITS survey and catch LFDs data in 2022, EWG 23-09 opted to apply the ICES framework for category 5 stocks. Due to the unavailability of reliable catch at age information in the last three years, the lack of the MEDITS survey in 2022 and a late MEDITS in 2023 (with partial coverage), EWG 24-10 reiterated the advice of EWG 23-09. For stocks without information on abundance or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was applied in EWG 23-09 based on 2022 data. Discards are considered negligible.

Striped Red Mullet

For striped red mullet in GSA 5, an index-based advice (ICES Cat. 3) was given for 2 years by EWG 22-09. EWG 24-10 attempted to run a statistical catch-at-age model (a4a). Commercial catches showed better internal consistency than MEDITS survey index. The retrospective analysis showed better consistency than in the previous attempts and all the diagnostics were considered acceptable. Recruitment and SSB increased for the last year. Fbar (1-3) showed a clear decreasing trend since 2020, with the minimum value for the time series in 2023, where it reached a value of 0.58, 1.25 times higher than F_{MSY} (0.46). A complementary assessment using production models (SPiCT) was carried out using historical data from the RECFISH project and showed the same decreasing trend of F, with F currently under F_{MSY}.

Norway lobster

For Norway lobster in GSA 5 advice was given for 2 years in EWG 23-09. In the present EWG 24-10, attempts were made to run an age-based model. However, due to pattern in the residuals and retrospective, the assessment was not endorsed by EWG 24-10, and last year's advice is reiterated in Section 5.7. New data is documented in Section 6.7.

For Norway lobster in GSA 6, several revisions have been made to the input data for this species. A correction was reported in the DTMT table regarding unrealistic lengths observed in the TC data, with lengths of up to 400mm being noted. Additionally, it was highlighted that the peak of discards data pertains to 2012 instead of 2019, but as it does not influence the final assessment, the correction wasn't considered. A new maturity ogive from the DCF was utilized as well as corrections of the slots “harvest.spwn” and “m.spwn”. The growth function remains unchanged from the previous year's report. The recommendation to exclude the 2020 catch data was upheld due to the low number of individuals sampled for the DWS metier and the irregular size structure for the DEF metier in that year. No changes have been made to the final model. The reference points were based on considering F_{max} as a proxy for F_{msy}, as recommended in the reference point report STECF-24-02. The corresponding biomass B_{lim} and B_{pa} were calculated based on 25% and 50% of Bmsy, respectively. These adjustments have minimal influence on the biomass behaviour against the reference points but indicate that the stock is altered and requires recovery.

For Norway lobster in GSA 9 it was attempted an update of the most recent available stock assessment model (a4a model). After the failure of model diagnostics, it was attempted a re-parameterization of the a4a model. In addition, alternative stock assessment models (an Integrated model, a Surplus production model and a Length based model) were attempted to obtain an analytical evaluation of the stock status. Overall, no satisfactory solution could be found. Nonetheless, the model exploration also functioned as data exploration, and the stock chapter offers suggestions for moving forward with an analytical assessment. For this year advice is based on ICES cat 5 catch advice (no index data in 2022 to apply ICES cat 3).

For Norway lobster in GSA 11 a full exploration of the data was carried out, and slight differences were found in total landing compared to last year, due to an update in the MEDBS data call submission. In addition, the time series available for landings was extended (1972-2003) for the first time through the results of RECFISH project (Ligas, 2019), while the value for 2004 was reconstructed with GFCM capture production in Division 37.1.3. Many assessment approaches were tested: length- based methods, a surplus production model, and an analitical model (LBSPR, LBB, SPiCT, SS3). All the results gave the same picture of the status of the stock; however, it was selected a SPiCT model run to give advice because in the SS3 the MEDITS fit of the LFDs had a pattern in the residuals. In general, catches, survey index, as well as mean lengths from all sources are decreasing. The outcome is that the stock is in overexploitation.

Deep-water Rose Shrimp

Following the separate GSA evaluations carried out in 2021 (EWG 21-11), it was decided to assess GSA 1 separately because the survey suggested that stock dynamics was different from GSA 5, 6 & 7, with the recent recruitments occurring in different years, whereas GSA 5, 6 & 7 show more coherence. For both stocks in GSAs 1, and GSA 5, 6 and 7 there is strong evidence of increased recruitment in recent years this gives rise to uncertainty in model fit particularly for selection, though both areas show similar selection at age in the fishery. The two assessments were run with the same input data (plus 2023 data) and model settings from EWG 23-09. No reference points were calculated for these stocks as the assessments need to be carried out for a few years to assess their stability before setting reference points.

For deep-water rose shrimp in GSA 1, there is poor cohort consistency in the survey and the assessment suggests high values for F at age 2 particularly in the beginning of the time series. There is also uncertainty in the correct growth parameters with differences between published and DCF values. Overall, the assessment diagnostics were considered acceptable, but model

uncertainty was particularly high in the last years, because there is a steep increasing trend in catches and SBB in last years, while recruitment decreased in the last year. A few more years of data are needed to assess the stability of the assessment. A reflection on growth parameter with new more certain values would help for better model fitting and improved stability.

This year it is the third time the deep-water rose shrimp in GSAs 5, 6 and 7 has been assessed. Data preparations were carried out successfully. The first available year of Spanish landings data in GSA7 was 2008, the time series used has been constrained to 2008 to 2023. The stock is seen to be continuously evolving showing in all the 3 GSAs sharp increases both in catch and index values in the last years. Although these dynamics didn't preclude the fitting of a sensible model it did give a residual pattern in age 0 in the catches. The chosen model is still considered to give an acceptable range of uncertainty but does result in some instability in the retrospective when more than two years have been removed. This is a short-lived species in which almost 100% of the catches concentrated in age 1 and 2. Due to the retrospective instability, and because this is the third assessment, the group agreed in using the assessment results for providing stock advice (F/FMSY =0.593). It is not yet considered stable enough for providing the biomass reference points.

For the assessment of deep-water rose shrimp in GSAs 8, 9, 10, and 11, a new stock object and indices were generated for the 2009–2023 time series. The growth parameters, age-at-maturity, and mortality rates from the EWG 22-09 were applied consistently across the assessment. Due to the absence of MEDITS survey data in 2022, the updated index extends to 2023, with missing values (NA) recorded for 2022. The a4a model employed in this assessment aligns with that used by STECF EWG 22-09, with the exception of the smoothing parameter (k) in the fmodel (~ factor(replace(age, age > 2, 2)) + s(year, k = 6)), which was adjusted to 6 from its previous value of 5. The revised model demonstrated stability in comparison to the previous assessment, and the results were consistent with last year's findings, except for the fishing mortality (F), which is now showing a declining trend rather than the previously reported increase. The status of the deep-water rose shrimp stock across GSAs 8, 9, 10, and 11 reflects a declining trend in both biomass and catch over recent years. Many of the data quality issues identified for GSA 10 also affect this species, with particularly low-quality catch sampling over the past three years and delays in survey data. However, data from GSA 9 partially compensate for these deficiencies, allowing the assessment to proceed. Both landings and discards are inadequately sampled, and this issue extends to the length-frequency distribution (LFD) data as well. Reference points were calculated using the geometric mean as in EWG 22-03 and were used to inform stock management advice.

Blue and red Shrimp

In last year's assessment, the advice for blue and red shrimp in GSA 1 and 2 was based on the ICES category 3 biomass index method. A new a4a model configuration has been accepted, using growth parameters by sex (from GFCM-SAF, 2023) after different tests. The configuration seems stable, but conducting a more thorough review of the data is crucial, as some problems were found (e.g., males aged 5 for GSA1). The issues encountered in the previous year's assessment regarding residuals in ages three and four are solved with the new model. However, some new patterns need to be reviewed in detail. As this is a new assessment for this stock, and stability must be confirmed with new data, reference biomass points have not been calculated.

For blue and red shrimp in GSA 5, the last year assessment was updated. T0 correction is applied from length distribution from catches and survey and thus age0 was removed from the data to run the assessment, following the recommendations of the group in previous years. Commercial catches showed better internal consistency than MEDITS survey index. All

diagnostics were considered acceptable. F shows a clear decreasing trend, while Rec and SSB are increasing.

For blue and red shrimp in GSA 6 and 7, the assessment from EWG 22-09 was updated with the same model settings. There are a few minor issues; there is a shortage of discard information; some small length in the catch in 2021 were assigned to age 0 but moved to age 1 because they came from 1st quarter catches and must have come from spawning in the previous year. The MEDITS index for 2020, where sampling was different, was evaluated spatially and found to be consistent so despite the partial area coverage no correction was applied and 2020 MEDITS index included. A very few samples with strange numbers could not be corrected so they were removed. Reference points calculated from the revised assessment were very similar to those calculated in September 2022 (EWG 22-09), therefore it was decided to keep the 2022 reference points.

In 2023 for blue and red shrimp in GSAs 8-9-10-11, a precautionary catch advice reduction of 20% was suggested as the lack of survey data for GSAs 9, 10, and 11 for 2022 did not allow to attempt an age-based model fitting or the update of the biomass index-based advice from 2022. This year, during EWG 24-10, an age-based model fitting through a4a was attempted but the final model was rejected based on retrospective and hindcasting diagnostics. Therefore, this stock should have been evaluated following the ICES Category 3 advice decision tree. Unfortunately, the lack of survey (MEDITS) data in 2022 for GSAs 9-10-11 did not allow to apply such methodologies and the stock was downgraded to a Category 5 stock (following ICES categories). Catches in the last three years are stable and precautionary advice was based on suggesting a 20% reduction of catches for 2025, 2026 and 2027.

Giant Red Shrimp

For giant red shrimp, it was decided by the group to add the few available data from GSA8, both from the catches and MEDITS survey, to provide a unit stock for the GSAs 8, 9, 10 & 11. The new assessment was updated also with the new data that Italy resubmitted for 2020 and 2021 to deal with operative GSAs. Some data sampling issues for GSA 10, already highlighted in previous years, were observed and reported. The model used is unchanged with respect to the one used in previous EWG, reference points were recalculated with the new data and the outputs are in line to those calculated in the previous EWG.

2.3 Reference Points

For 11 of the stocks evaluated here reference points were re-estimated. According to STECF PLEN 24-02, F_{max} was considered as a proxy of F_{MSY} for the three Type 1 stocks identified by EWG 24-02, namely hake in EMU1 and EMU2, and NEP in GSA 6. Other stocks have assessments, but their stability is unchecked, thus reference points for these stocks have not been calculated. The remaining stocks do not have analytical assessments. The reference points have been recalculated following the agreed procedures from EWG 22-03. The calculations are documented by stock in Section 6 and included in the summary sheets in Section 5. The reference points are tabulated in Table 2.4.

Table 2.4. Reference points.

		Reference point value EWG 23-09				Reference points value EWG 24-10				Notes
Area	Species	$F_{0.1}$	$B_{F0.1}$	B_{lim}	B_{pa}	$F_{0.1}$	$B_{F0.1}$	B_{lim}	B_{pa}	

1_5_6_7	Hake	0.41	63696	3872	7743	0.57	35754	3970	7940	F_{max} as F_{MSY} proxy
1	Deep-water rose shrimp	-	-	-	-	1.02	-	-	-	Uncertainty due to fast moving dynamics
5_6_7	Deep-water rose shrimp	-	-	-	-	1.49	-	-	-	Uncertainty due to fast moving dynamics
1	Red Mullet	0.61	399	170	338	-	-	-	-	Revised assessment
5	Striped Red Mullet	-	-	-	-	-	-	-	-	New assessment
6	Red Mullet	0.31	3079	770	1540	0.44	2091	523	1045	
7	Red Mullet	0.46	775	134	267	0.45	831	147	293	Uncertainty due to fast moving dynamics
5	Norway lobster	-	-	-	-	-	-	-	-	
6	Norway lobster	0.17	1890	472	944	0.29	953	238	476	F_{max} as F_{MSY} proxy
8-9-10-11	Hake	0.17	49500	5132	10264	0.25	43750	5394	10788	F_{max} as F_{MSY} proxy
8-9-10-11	Deep-water rose shrimp	1.26	855	214	427	1.39	794	199	397	
9	Red Mullet	0.50	1846	462	923	0.48	2280	570	1140	
10	Red Mullet	-	-	-	-	-	-	-	-	
9	Norway lobster	0.13	1022	255	511	-	-	-	-	
11	Norway lobster	-	-	-	-	0.24	169	-	-	F_{MSY} and B_{MSY}
1_2	Blue and red shrimp	-	-	-	-	0.29	-	-	-	New assessment
5	Blue and red shrimp	0.38	819	75	151	0.33	299	75	150	
6_7	Blue and red shrimp	0.26	1520	261	521	0.25	1520	261	521	
8-9-10-11	Blue and red shrimp	-	-	-	-	-	-	-	-	

8-9-10-11	Giant red shrimp	0.43	772	193	386	0.48	703	176	352	

Source: Own elaborations

3 Future Developments

The EWG briefly addressed future development for data requirements and data issues currently affecting assessments. EWG 24-10 reiterates the points already noted as important by previous EWGs:

- Improved data on differences by sex: a considerable number of species assessed by this EWG show quite strong sexual dependency on growth. This is particularly the case for hake, blue and red shrimp, giant red shrimp, Norway lobster and deep-water rose shrimp. For these species many have separate growth models by sex, but often the supporting sex-based information is sparse, particularly fraction at length by sex by year. However, if recruitment varies fraction by sex at length will be expected to change by year as individual cohort abundances appear at different length at different times due to the different growth rates. There is a need for such data to be made available to the EWG if already available from the sampling, and if not, it is important to amend the sampling programs to obtain sex at length data on an annual basis.
- There has been a major failure to collect sufficient catch sample data for GSA 10 in 2020-2023 over almost all species dealt within the EWG. It is affecting all the assessments but has proved critical for red mullet in GSA 10 which has failed due to this poor sampling. The poor sampling in 2020 (and 2021) was thought to be due to COVID, but it now seems likely this was not the case, as the problem did not occur with the same severity elsewhere, and the fact that it is persisting through 2021, 2022 and 2023 suggests there is some other reason for the failure. The issue should be followed up with urgency with the Italian authorities as this is identified as a critical issue that has caused an assessment to fail. Without this data it will not be possible to obtain a length/age-based assessment for red mullet in GSA 10, and all other assessments using catch from GSA 10 will be poorer and may fail.
- It has been noted that MEDITS survey is being conducted by Italy in several GSAs very late in the year in 2020, 2021 and 2023. This departs from the ‘standard’ period specified by the MEDITS survey coordination group. This delayed survey is influencing the ability of the EWG to do some assessment (e.g. MUT in 10) and is impacting on any of the assessments that use MEDITS from GSAs 9 10 and 11. This issue needs to be resolved, and the survey should be carried out at a consistent time of the year.
- The lack of MEDITS survey data in 2022 in the EMU2 was considered a major issue, which impeded to run quantitative assessment for the stocks in EMU2. EWG 23-09 agreed on a procedure to provide advice for five of the stocks in EMU2. EWG 24-10 agreed in updating previous stock assessments in EMU2 adding data for 2023 and leaving NAs in the index information for 2022. This approach proved to work efficiently in all the assessments performed by EWG 24-10.
- EWG 24-10 further discussed the approach of t0 correction in the age slicing procedure, and suggested the use of simple plots of LFDs of both survey and catch data to better understand the need of performing the correction on a stock-by-stock basis.

4 Methods

The methods used in both data checking (Section 4.1) and in reference point calculation (Section 4.2) are provided below. In addition, a further section exploring sensitivity of approach is provided to explore how the reference points are affected by the choices taken (Section 4.3)

4.1 Data Quality

4.1.2 JRC Script on quality checks

4.1.2.1 General introduction

The quality checks on commercial data, provided through the Official Mediterranean and Black Sea Data Calls, were based on a suite of R scripts initially developed during the EWG2102 (https://stecf.jrc.ec.europa.eu/ewg2102) but reorganized and extended before and during EWG 2203 to provide a single pdf output structure.

Listed below the R scripts developed by EWG 21-02

1) Check_landings.R
2) Check_discards.R
3) Cumulative.R
4) Quality checks.R
5) Landings_LFgaps_metier.R
6) Discards_LFgaps_metier.R
7) Relative weights.R

For the EWG2202 all these R scripts have been just saved as an rmd file named “Checking_DCF.rmd” which when knitted produces a pdf output as Rmarkdown output. All the outputs produced in running the script chunks (plots and csv) are still saved in a dedicated folder as in the EWG2102 (see below) but adding as a main output a pdf document by stock which would be expected to be easier to check. The Checking_DCF.rmd file and all the pdf files produced for the ToR1 list of stocks have been attached as Annex 1 to this report (Annex 1 – Rscript, pdfs and main outputs on commercial quality checks”). The Rcode has been tested under R version 4.2.0 (64bit) and RStudio 2002.02.2 environments. The data sets are in the MEDBS DCF output formats which are shared with the STECF EWGs (by using output files it ensures that the data checked is the uploaded data, but *it means that columns headers and number of fields are not the same of the ones used in the input templates*). The details for using these can be found in Section 4.1 of EWG 22-03 report

4.1.2.2 Data Preparation

In addition to quality checks a series of fill-in procedures were developed in EWG 21-02 for replacing poor or missing commercial catch sampling, the basis of these is described below.

4.1.2.3 Fill-in procedures

All stratified sampling programs can result in fleets or metiers that are missed or severely under-sampled[1]. These strata are most often a very small part of the total catch; however, they require the allocation of size/age as part of the stock assessment. This allocation of LFDs can be done within some assessment packages that operate by fleet/metier and handle patchy data on length frequency distributions (LFDs) and fit the missing data as part of the assessment model process. Other packages that operate by combining catch data to the total catch require a procedure that either leaves a year without an LFD, or alternatively fill-ins the small proportion of the catch with a suitable LFD. The modelling methods that work by fleet/metier and fit the missing observation often require more complex modelling but also the strong additional assumption that the catch is a true census (including discards) in order to estimate the missing LFDs. When a combined catch assessment is used with a minor fill-in the assumption that allows some error in catch estimation is then possible. For the purposes of estimating stock status (F and SSB) and giving catch advice the differences between the approaches are usually small, for example hake in GSA 17-18 (REF STECF 2020 report). The procedures used in this EWG for filling in landings and discard LFDs are documented below.

4.1.2.4 Fill in for length Frequency distributions for landings

If a metier is not sampled but another metier for the same gear is fully sampled, then the procedure is to use the samples at fleet level and apply these directly or through the use of a SOP correction.

For missing year(s) the procedure for filling-in LFDs for landings is first to identify combinations of years/fleets or metiers with catches but missing LFDs. If there is sufficient data on length from the same metier then the other years of data are used as fill-ins based on the mean or the median of the LFDs.

mean is used for normal distributions, which have no outliers.

median is generally used to return the central tendency for skewed distribution or when outliers are observed.

For the choice of year ranges for fill-ins, the two main options are to use the mean of the available data or to use two or more adjacent years either side of the gap.

Less than 5%. If fill-in is a small part of catch (less than 5%) then any solution is acceptable as the impact of the fill-in will be negligible.

Trend in mean length: If there is trend in the LFDs (seen as trends on mean or quartile values) then using adjacent data may be preferable.

High annual variability: If variability in the data (again seen as variability on mean and quartiles) is large then full data set is likely to be better the best source of the fill-in.

Similar to a sampled metier: If the missing LFDs are expected to be similar to another well sampled metier of fleet then data from that fleet is used to provide the LFDs. In some cases,

[1] The Regional Coordination Group Med & BS runs every year a ranking system of metiers at level 6 at regional level. According to this, a ranking of the métiers is performed three times: firstly, according to their share in the total landings, secondly according to their share in the total value of the commercial landings and thirdly according to their share in the total effort (days at sea). For each ranking, the shares are cumulated starting with the largest, until a cut-off level of 90% is reached. At the end of the procedure, all métiers selected through each ranking are added.

this is done by assuming the whole fishery is the best source of information for a year and the whole catch is raised with the available data.

Years with substantial gaps: If a fill-in is more than 50% of the catch users need to consider highlighting this for estimation in the model.

4.1.2.5 Fill-in for discards data

STECF has been requested to provide advice based on catch rather than landings, so inclusion of discard data is important in that context. In any case advice on landings based on a landings-only assessment is conditional on the assumption that discarding is constant both as a proportion of catch and in fraction at length discarded, so the use of landings data alone would not solve the problem of missing discard information. In a few cases discarding has been found to be negligible and consisting of individuals that are damaged and unmarketable, thus any discard amounts can be raised using landing LFDs. In other cases, discarding is occurring but information is often much more sparse than that for landings and the total amount of discards is found to be non-negligible especially for species such as red mullet, and possibly hake. Also discarding can be confined to the trawl fleets only, both otter or beam trawls, with rarer occurrences of discarding by size in gillnet, trammel net or longline fisheries.

4.1.2.6 Quantities of discards by years:

Unlike landings data where the total amount is available, in some years there has been very poor or missing information on both the total amount of discards as well as the LFDs either because discard sampling failed or was not required or implemented in those years. In these cases, where the sampling has missed discarding that is found in all other years for a fleet or where fishing was from years before a discard program was started, as a first step the quantity of discards is inserted for years without discard records. This is computed based on the discard fraction from years with discard data and is suitable for situations where discard rates are variable due to natural variability of uncertainty due to low levels of sampling. If trends in discard rates are observed or regulations have changed subsets of years should be used. In either case the specific years/fleets used to obtain discard rates should be specified in the report.

4.1.2.7 Missing LFDs

Fleets with known discarding: missing LFDs are filled in following the same procedure as for landings, using the LFDs from available years. In this case, the median is often used, as distributions tend to be skewed, and there are few observations.

Fleets with occasional discard reports: In some cases, the discards are not the result of undersized or small individuals but are likely the result of damaged individuals with a similar size distribution as the catch. In this case, the LFD may be taken from the landed component, usually by raising the fleet level with a Sum of Products (SoP) correction applied at fleet of total catch level as appropriate.

4.1.3 Length slicing

Data for most stocks in this EWG are collected as length samples. In most cases ages are obtained by deterministic length slicing based on calendar year growth points derived from von Bertalanffy growth functions, by sex or sex combined. This aligns growth to the fishery management year, and assigns catch at length correctly through the calendar year. In the case of red mullet in GSA 7 slicing to age is by fixed ALK across years, but with the same age assignment with time discussed below for summer spawning. In the case of the deterministic length slicing from von Bertalanffy growth functions, stocks such as both hake stocks assume

growth is calculated from time 0 at spawning at 1st of January thus the calendar aligns with the growth year and catches are correctly assigned by year. However, many stocks in the EWG have midyear spawning or spawning throughout the year assigned to midyear as the 'average' point. In this case average growth from spawning to the end of the calendar will occur for 6 months from 1st July to 31 December in the first year (age 0) and then for 12 months January to January in subsequent years. If the growth curves have been calculated on a time bases with the origin (time 0) at spawning time then growth in the first 6 months is at age 0 and 6 to 18 months to age 1 etc. For these species the T0 in the von Bertalanffy function is increased by 0.5 of a year, the time in the year that it is assumed spawning occurs. The size at each birthday is then checked to ensure the function is working as expected. For some species with midyear spewing the growth functions come from calendar year evaluations and already account for the 1st of January annual birthday in the aging, in this case no correction is needed or applied. Again, checking length at 1st January ensures the function is working as expected.

4.2 Basis of the catch and fishing mortality advice

The summary sheets by stock, provided in Section 5 contain catch advice. The basis of this advice depends on the type and quality of information available from the analyses and is as follows:

Full assessment and full MSY reference points or with surplus production model with F and biomass relative to F_{MSY} proxy and B_{MSY}: Catch advice at MSY based on short term forecast. F and catch advice reduced if SSB is forecast to be below B_{pa} at the start of the advice year. **Used for 13 stocks for this year**

Full assessment without full evaluation MSY reference points due to short time historic series: Catch advice based on MSY proxy of $F_{0.1}$ based on short term forecast. **Used for 3 stocks for this year**

Assessment providing SSB tend information historic F evaluation, not suitable for STF Catch / Effort advice under precautionary considerations (Patterson 1992) F= F_{MSY} with Harvest Rate (HR) based estimated SSB in most recent year. **Not used.**

For sparse data with insufficient years for VPA type analysis, but with catch at length or age for most of the fishery: advice is based on pseudo cohort analysis at equilibrium, with estimate of current F relative to $F_{0.1}$. **Not used.**

Trend based indicator with exploitation and stock status know to be OK: Catch / Effort advice under precautionary considerations based on ICES smoothed index of trend without precautionary buffer, giving 2 years advice. **Not used.**

Trend based indictor: Catch / Effort advice under MSY considerations based on ICES smoothed index of trend **Used for 3 stocks this year and for 2 from last year**.

Valid length analysis: statement of stock status, indication of direction of change required. **Not used**

No valid analysis: no advice. **Not needed**

Section 6 contains the main input data and assessment results for this report.

4.3 MSY Reference points for stocks in this report

Following STECF decision in the absence of full MSY evaluations, and/or biomass reference points STECF considers that $F_{0.1}$ forms a good proxy for MSY. Thus, for all stocks here with

analytical assessments $F_{0.1}$ has been evaluated based on the stock conditions over the last three years. MSY advice in terms of F and catch for 2023 are based on this approach. According to STECF PLEN 24-02, F_{max} was considered as a proxy for F_{MSY} for the three Types 1 stocks identified by EWG 24-02, namely hake in EMU1 and EMU2, and NEP in GSA 6.

4.4 MSY Ranges

The EWG has been requested to provide MSY ranges for the stocks considered by the EWG. The usual procedure used by ICES would be to establish S-R functions and to evaluate the ranges using this method, constraining the upper interval to be precautionary. As discussed above it has not been possible to establish such relationships for these stocks, either because the data series are too short.

To evaluate MSY ranges for stocks in this report the EWG uses the values of F associated with $F=F_{0.1}$ which are given in Table 2.2. These are the F_{MSY} values from the most updated assessments carried out on Mediterranean stocks assessment. Those values were then used in the formulas provided by STECF EWG 15-06 (STECF, 2015) to derive F_{MSY} range (F_{low} and F_{upp}). The empirical relationships used to estimate F_{MSY} range are the following:

$F_{low} = 0.00296635 + 0.66021447 \times F_{0.1}$

$F_{upp} = 0.007801555 + 1.349401721 \times F_{0.1}$

where $F_{0.1}$ is a proxy of F_{MSY}.

None of these methods add information on the precautionary nature of the F_{MSY} ranges; the values of F_{upp} and F_{low}. In the case of stock based on $F_{0.1}$ the F_{MSY} is precautionary, and because F_{low} is a lower exploitation rate this is will also be precautionary. As the WG is unable to parameterise stock recruit models and does not currently have B_{lim} reference values, it has not been possible to evaluate F_{upp}, until further evaluations can be completed should not be used for exploitation and should be replaced with F_{MSY}.

4.5 Values of FMSY Fupp and Flow

The values of $F_{0.1}$, Fupp and Flow are calculated in the assessment sections Section 6 by species. The values are given in the short-term forecast table in the stock assessment sections. These are reproduced in the table in Section 5 but with the Fupp value replaced with $F_{0.1.}$ This approach conforms to the one used by ICES (ICES 2014, ICES 2015)

4.6 Basis of Short-Term Forecasts

The objective of the short term forecast is to provide the best estimate of catch in year Y+1 based on the assessment with final year y-1. This is then to predict 2 years forward for a range of catch options based on range of F options. The F option that corresponded to MSY approach or precautionary approach (see section 2.1) is then presented as advice. The basis of short term forecasts is as follows:

Biological conditions are assumed to be recent biological conditions

This is mean Maturity, Natural Mortality (M), Fraction M and F before spawning from the last three years of the assessment. In many cases there are constant.

Recruitment **-** Most probable recruitment

If recruitment trend occurs ---- Recent recruitment is selected … Arithmetic Mean of recent years … at least 3 years

If no trend occurs, expected value…….Geometric mean of series

Fishery is assumed to be the same as the recent fishery

Fishery selection is assumed to be recent averages over the last three years

F in intermediate year ---- is assumed to be F status quo for all options

If F is fluctuating (F_{y-2} outside F_{y-1} and F_{y-3}, or $F_{y-2}=F_{y-3}$) – mean of 3 years

F trend - (F_{y-2} between F_{y-1} and F_{y-3} or $F_{y-2}=F_{y-1}$) – F last year of assessment

Where the stock is considered to be below Blim and/or Bpa, STF provide catch options to restore rapidly SSB above Bpa. To this purpose an F reduced is computed following ICES rule as a linear reduction of F to restore the stock to Bpa by 2025. $F_{Reduced}$ $B<B_{pa}$ is based on ICES advice rule when SSB in TAC year is less than B_{pa}, and has never been tested in Mediterranean fisheries.

F reduced = F0.1 x (SSB/Bpa)

4.7 MSY Transition

The EWG continues to provide the main catch option presented in section 5 based on the target of F_{MSY} in 2023 (modified if necessary if B at the beginning of the advice year is forecast to be below B_{pa}. This MSY option remains the primary advice. However, in Plenary November 2019 the STECF considered if it would be possible to give an additional advice option or options associated with the Western Med MAP. The MAPs have the objective of achieving F_{MSY} either by 2020 or at latest 2025. For a few stocks F_{2018} is close to F_{MSY}, but for many stocks such as hake F is substantially higher than F_{MSY} and it seems likely that these stocks will be considered under the objective for reaching F_{MSY} by 2025. For such stocks the plans do not specify how it is expected that F should change over the 6 years from 2020 to 2025. Currently STECF reports the F_{MSY} and expected catch in the advice year based on EWG assessment and short-term forecasts. However, if the approach is to attempt a reduction in F to F_{MSY} by 2025 it may be helpful to give advice in relationship to such a transition, and the EWG has included an additional 'F_{MSY} Transition' option for the STF Table (Section 5 and 6). In 2010 and the following years ICES provided advice following an MSY transition approach with a linear change in F from 2010 to achieve F_{MSY} in 2015. This approach is updated below for transition from 2020 to 2025.

FMSY Transition (2020) = {•0.833 F (2019) + 0.167• FMSY(2019)}

whereas for the following years:

FMSY-Transition (2021) = {0.667• F (2019) + 0.333• FMSY(2020)}

FMSY-Transition (2022) = {0.5• F (2019) + 0.5• FMSY(2021)}

FMSY-Transition (2023) = {0.333• F (2019) + 0.667• FMSY(2022)}

FMSY-Transition (2024) = {0.166• F (2019) + 0.833• FMSY(2023)}

FMSY-Transition (2025) = {0.0 • F (2019) + 1.0 • FMSY(2024)}

Where for the first year F_{2019} =F_{2018}, but for subsequent years F_{2019} is the F in 2019 estimated/updated in the subsequent annual assessments and $F_{MSY(year)}$ is the estimate of F_{MSY} updated as F_{MSY}(2020, 2021 etc.) in each subsequent estimation of reference points following annual assessments.

In Section 5, Table 5.X.1 gives the exploitation status in terms of F_{MSY} and $F_{MSY\ Transition}$ the F status is defined as above or below the reference value for $F_{MSY\ Transition}$ this is calculated using the values of F_{2019} and F_{MSY} from the current assessment. Therefore, the reference point $F_{MSY\ Transition\ 2020}$ is defined using the equation above with values of F_{2019} and F_{MSY} from the 2022 assessment. This value and subsequent values will be updated each year based the most up to date assessment.

4.8 Reference points Methods

Following the methods developed in EWG 22-03 to provide biomass reference points, the STECF summer plenary in July 2022 endorsed the approach and the EWG 22-11 was requested to provide biomass reference point for stocks considered by the EWG. The results of these evaluations are reported in Section 6.X.4 and summarised by stock in Section 5.X. The methods used are described here.

4.8.1 Stock assessment data

The final stock assessment outputs used for reference point evaluation for the Western Mediterranean Sea 2022 are documented below in section 6.X.3.

4.8.2 Glossary

A summary of definitions of abbreviations of key biological quantities and reference points used in this section of the report are listed below.

Biological quantities:

N_a: Numbers at age

w_a: weight at age quantifying the somatic growth

mat_a: proportion of mature specimens at age

M_a: natural mortality at age

F_a: fishing mortality at age

F: here the average F_a over exploited age classes ($fbar$)

SSB: spawning stock biomass being a function of N_a, w_a and mat_a

SPR_0: un-fished spawning biomass per recruit at $F = 0$ at equilibrium being a function of w_a, mat_a and M_a

SPR_F: equilibrium spawning biomass per recruit at a specific F

SPR: spawning potential ratio of SPR_F/SPR_0

R_0: average recruitment of un-fished stock at $F = 0$

B_0: un-fished spawning stock biomass being a function of $B_0 = R_0 SPR_0$

Reference points:

B_{lim}: A deterministic biomass limit below which a stock is considered to have reduced reproductive capacity.

B_{pa}: A precautionary deterministic biomass reference point intended to represent a spawning stock size that is associated with low risk of impaired recruitment potential. B_{pa} is typically estimated as a function of B_{lim}.

F_{lim}: Fishing mortality corresponding to B_{lim}. Fishing at levels above

F_{pa}: Fishing mortality corresponding to B_{pa}. Fishing at levels above F_{pa} will result in a decline in the stock to levels below B_{pa}.

F_{MSY}: The fishing mortality rate that maximises the long-term catch (or surplus production) corresponding the Maximum Sustainable Yield (MSY)

B_{MSY}: Expected biomass of a stock that is exploited at F_{MSY}

$F_{0.1}$: The fishing mortality at which the slope of the yield-per-recruit curve is 10% of that at the origin. Accepted here as robust proxy for F_{MSY}

$B_{F0.1}$: Spawning Biomass reference point corresponding to $F_{0.1}$

4.8.3 Basis of reference points

B_{lim} is the central biomass limit reference point used for North-East Atlantic stocks particularly by ICES, which is defined as the biomass below which recruitment is impaired so that reduces with SSB. The other reference points (B_{lim}, F_{lim}, and F_{pa}) used in the context of the precautionary approach are all estimated from B_{lim}. Principles for deriving reference for data-limited Mediterranean stocks

Considering international practice, biological principles and the characteristics of the fairly short S-R time series, the EWG 22-03 agreed on two guiding principles for estimating B_{lim}:

- Plausible B_{lim} estimates are assumed to within the range 0.1% - 20% of SSB_0 (equivalent to $0.01 - 0.2SPR_0$) if determined by way of fitting a segmented regression
- If no clear break point can be identified within this range, B_{lim} can be derived analytically as $B_{lim} = 0.25B_{F0.1}$, where $B_{F0.1}$ is the equilibrium SSB corresponding to $F_{0.1}$. In the absence of reliable stock recruitment function, the $B_{F0.1}$ can based on geometric mean of the available recruitment estimates.

It follows that a direct estimate of B_{lim} shall only be derived empirically in cases where there is sufficient contrast in the S-R data to estimate a well-defined break-point that falls within plausible biological limits. Alternatively, it is suggested that B_{lim} be specified as a ratio of B_{MSY} or its proxy, which is taken as $B_{F0.1}$. The EWG selected 0.25 $B_{F0.1}$ as a suitable default and STECF endorsed this.

4.8.4 Fitting Stock Recruitment Relationships

Where a break point is observed stock recruitment relationships (SSR) were fitted and evaluated with the **FLR** (Fisheries Library in R: Kell et al., 2007) package **FLSRTMB**(Winker and Mosqueira; https://github.com/flr/FLSRTMB), using maximum likelihood estimation in Template Model Builder (**TMB**; Kristensen 2015). The EWG concluded a conditioned Hockey-Stick (**segreg**) was the primary method for estimating such a break point. To estimate the break-point $b = B_{lim}$ within the expected range of 1% - 20% of SSB_0, a new conditional Hockey-Stick formulation was implemented in **FLSRTMB**. The Hockey-Stick function is based on a continuous, quadratic hockey-stick formulation (c.f. Barrowman and Myers, 2000), which is re-

parameterized as a function of SPR_0 and a "re-purposed" steepness parameter *s**. In addition, the parameter P_{lim} is introduced, which then determines the lower of the ratio B_{lim}/B_0, where B_{lim} corresponds to break point *b* of the segmented regression and the un-fished B_0 being a function of $B_0 = R_0 SPR_0$.

$$R_y = \frac{s^*}{2P_{lim}SPR0}\left(SSB_{y-a_r} + P_{lim}R_0SPR_0/s^* - \sqrt{\left(SSB_{y-a_r} - P_{lim}R_0SPR_0/s^*\right)^2}\right)$$

where R_y is the number of recruits in year y, SSB_{y-a_r} is the spawning biomass in year y minus minimum age a_{min} defined for the stock (typically age-0 or age-1). The break point b (B_{lim}) and slope a are given by

$$b = P_{lim}R_0SPR_{0,y}/s^*$$

$$a = R_0/b$$

This formulation allows to bound the parameter s^* over an approximately uniform range defined for $0 > s^* \leq 1$ using a truncated logistic prior distribution (Thorson and Cope, 2014)

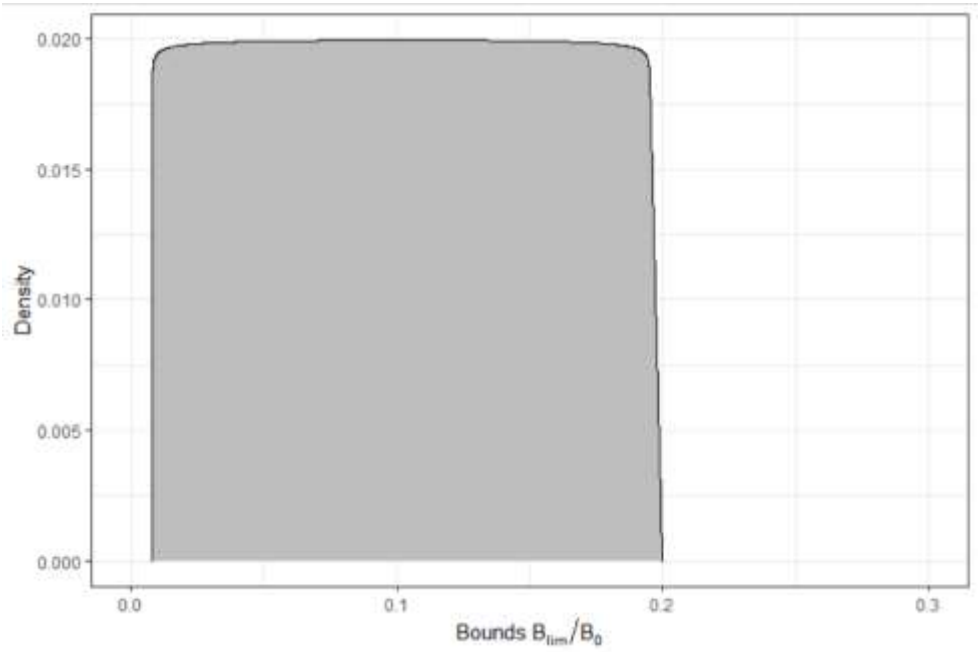
$$s \sim TrunkLogit\left(s_{logit}, \sigma_{logit}\right)$$

where $\square_{logit}$ is set by default to 20 and s* can be truncated by specifying the parameter c.

$$s^* = c + 1/\left(1 + exp\left(-s_{logit}\right)\right)$$

where c is specified by ratio lower to upper fraction of SPR_0. For example, by considering a range bounded between 0.1% - 20% of SPR_0, c is taken a ratio of c = 0.001/0.2, resulting in an approximately uniform parameter space for which the ratio B_{lim}/B_0, but with soft penalties towards the bounds to facilitate robust convergence (Figure 4.6.3.1).

Figure 4.6.3.1: Representation of uninformative prior that constrains the defined range for the breakpoint to B_{LIM} / B_0 = 0.01-0.2.



Source: Own elaborations

A retrospective/ stability analysis was carried out at EWG 22-03 and the results are presented in the report. In addition a sensitivity analysis evaluated the implications of the choices in the procedure. Overall the procedure was judged to be useful.

4.8.5 Summary of reference point evaluation

The full basis of the reference points is described in detail in STECF EWG 22-03 report from April 2023.

- The Framework from EWG 22-03 consists of :-
  - F_{MSY} the fishing mortality which would provide a catch of MSY.
    - For Western Med MAP the EWG used $F_{0.1}$ as a proxy for F_{MSY}
  - A decision tree (Figure 4.6.3.2) developed in EWG 22-03 to obtain B_{lim} either from fit to data or 25% $B_{F0.1}$ (B_{MSY})

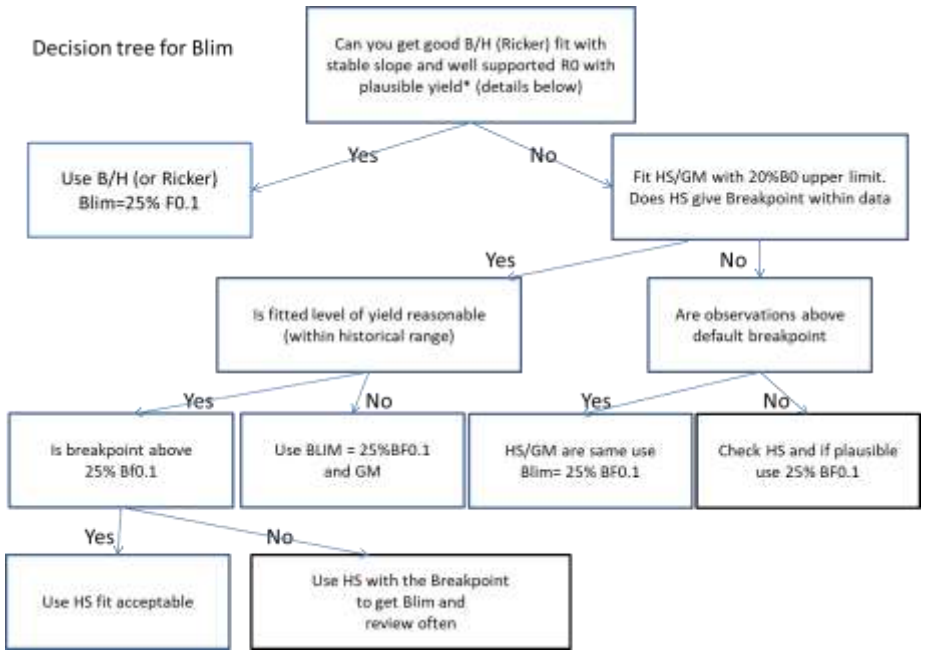
STECF stated that it "considers this decision-tree is highly useful and would merit scientific dissemination beyond EU Mediterranean stock assessment EWGs".

  - B_{pa} is the biomass reference point '*which ensures that the spawning stock biomass has less than 5 % probability of being below* B_{lim}*'* B_{pa} is set to 2*B_{lim} (accounting for uncertainty in assessment and B_{lim}).

STECF stated that it "endorses this adjustment which is justified to account for the larger presumed uncertainties in the estimates of the SSB in the terminal year in the assessment of the Mediterranean stocks".

Overall STECF endorsed the proposed framework developed by the EWG 22-03 and stated it was "suitable/appropriate to estimate biological reference points in general as well as for short time series and stocks in poor conditions".

Figure 4.6.3.2 Approach to establishing B_{lim} and S-R relationship. Decision tree applied for 14 stocks with assessments in EWG 22-03.



Source: Own elaborations

4.8.6 Practical implementation of reference point estimation in FLRef

For the estimation and evaluation reference points, the R package **FLRef** (Winker) was developed and is available on https://github.com/Henning-Winker/FLRef. This package is implemented with **FLR** and makes of the optimization routine for estimating fisheries reference points at equilibrium that is available in **FLBRP**. **FLRef** requires the stock data as **FLStock** objects and the stock recruitment functions in the form of **FLSR** objects, which were produced with the package **FLSRTMB** (Winker and Mosqueira). The EWG Expert Henning Winker (JRC) developed tested the package on the stock data prior to the meeting with the support of the FLR Core Team Members Iago Mosqueira (Wageningen University) and Laurence Kell (Imperial College).

Main features of **FLRef** include:

- Automation of estimating and visualizing a wide range of limit and target plots
- New plotting options for illustrating reference points both as relative or absolute quantities
- New plotting options for compare the impact of various stock recruit model assumptions on the estimated reference points
- Newly designed fisheries advice plots

FLRef user guidelines are provided in Annex 2 and reproducible R code and results based worked example for Mediterranean stocks are available in Annex 3.

4.9 Index based method used for stock without assessments

ICES has updated the index approaches used for stock without analytical assessment using age based or surplus production methods. Accordingly, the EWG has updated the approach applied for stocks in this situation and has implemented two options so far. The full set of methods and their calculations are documented in Section 16.4.11 of the basis for ICES advice "ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3".

Currently the STECF assessment EWG utilised two of the options:

- **Cat 3 Option with index, length data on catch, and growth (VB k) available:**

ICES Method 2.1: rfb rule copied directly from ICES documentation:

This HCR provides MSY advice for category 3 stocks based on the stock trend from a biomass index (similar to the previous "2-over-3 rule"), the mean length in the catch relative to an MSY proxy length and a biomass safeguard to ensure compliance with ICES precautionary approach (ICES, 2017; Fischer *et al*., 2020, 2021a, 2021b). The three name-giving elements of the rfb rule are:

r : biomass ratio (survey trend)

f : fishing proxy (length data, target)

b : biomass safeguard

This HCR improves on the "2-over-3" rule (ICES, 2012a) with the addition of multipliers based on a stock's life history characteristics, its status in terms of relative biomass, and its status relative to a target reference length (ICES, 2018c, 2019a).

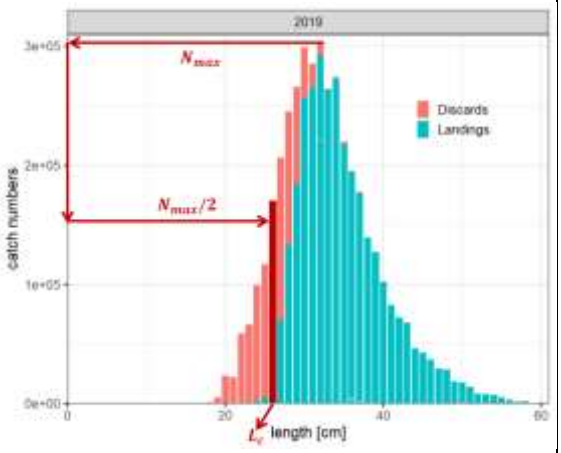
The rfb catch rule is defined as:

$A_{y+1} = A_y \times r \times f \times b \times m$ (5)

where the advised catch (*A*) for next year *y*+1 (set on a biennial basis) is based on the most recent year's advised catch A_y adjusted by the components in Table 4.7.1.

Table 4.7.1 Data requirements of the rfb rule.

Component	Details
Previous catch advice	• If no previous catch advice (A_y) exists, use the most recent catch (C_{y-1}), or the average of the last three years of catch • If C_y is very different from A_y, consider replacing A_y as the **rfb** rule is meant to adjust realised catches influencing the stock
Biomass index	• At least five years of data needed • Without age structure • Should be representative of the stock • It is possible to combine indices for better coverage of the stock unit (e.g. VAST [Thorson *et al*., 2019) was used for ple.27.7h-k in 2021 [ICES, 2021b]).
Length data	• At least one year of data needed • Should be representative of the fishery (ideally covering all fleets or gears; if not possible, ensure that mean length in the catch and length reference points are comparable) • Use total catch (if available) • Calculate mean length in the catch (consider lengths greater than length at first capture L_c) • If the distribution is noisy, consider increasing the bin width or applying a smoother • Length at first capture L_c should be determined following ICES (Section 3.4.1 in 2012b)

	• 1. Find the mode of length distribution (length class with highest catch numbers N_{max}) 2. Find first length class where catch is at or above $N_{max}/2$. This is the length at first capture L_c 3. For estimating the mean catch length, consider only length classes above L_c 
Life history parameters	• von Bertalanffy growth parameters: k, L_∞

Source: Own elaborations

- **Cat 3 Option short lived species with index, no catch length data, and without MSE:**

ICES Method 3.3: One-over-two rule for short-lived stocks copied directly from ICES documentation

When knowledge of catchability and observation errors of the abundance index are so poor as to preclude the selection of a robust constant harvest rate, a HCR that determines next year's advised catch based on the last advised catch can be used.

The HCR is defined as:

$$A_{y+1} = \left\{ \begin{cases} 0.2\,A_y & \frac{I_y}{\sum_{y-1}^{y-2} I_y/2} < 0.2 \\ A_y \frac{I_y}{\sum_{y-1}^{y-2} I_y/2} & 0.2 \le \frac{I_y}{\sum_{y-1}^{y-2} I_y/2} < 1.8 \\ 1.8\,A_y & \frac{I_y}{\sum_{y-1}^{y-2} I_y/2} \ge 1.8 \end{cases} \right\} \cdot \left[min\left(1, \frac{I_{current}}{I_{trig}}\right) \right] \qquad (9)$$

where A_y and I_y represent the advised catch and the biomass indicator for year y, respectively.

The first and third cases of the formula correspond to the application of an 80% symmetrical uncertainty cap.

The last term in the equation refers to the biomass safeguard based on a trigger index value, below which the advice would be corrected downwards in proportion to the drop of the most recent abundance index over the $I_{trigger}$ value. This is a term which has been shown to further reduce the risks associated to this management system. A recommendation is made to take $I_{trigger}$ as I_{stat} = *geometric mean* (I_{hist}) exp(−1.645 *sd*(log (I_{hist})), where I_{hist} is the available historical series of the abundance index.

- The notation of these rules is for in-year advice where the advised catch for the current year is based on last year's advised catch adjusted by the trend in the most recent abundance index, I_y, relative to the average of the index value in the previous two years.
- An uncertainty cap is applied to limit the change in the index trend, the I_y component of the HCR, to ±80%, which allows the current years advised catch to increase or decrease up to 80% relative to the previous years advised catch.
- Note that $\frac{I_y}{\sum_{y-1}^{y-2} I_y/2}$ should be replaced by $\frac{I_{y+1}}{\sum_{y}^{y-1} I_y/2}$ in the formula above if the index is available at the beginning of the management year *y+1*, instead of being available at the end of the interim (management) year *y*.

The first time this rule is applied to a stock, the initial catch should be taken from the mean of the catch from the previous two years (ICES, 2019b).

Short-lived stocks with high interannual variability of biomass can show large biomass fluctuations from one year to the next. A symmetrical 80% uncertainty cap allows appropriate adjustment of the HCR accordingly from year to year. Large reductions in catch may be necessary between years to respond accordingly to reductions in the underlying stock biomass.

The precautionary buffer will certainly reduce the initial risks associated with a historic substantial exploitation of the stock (above F_{MSY}), though is probably unnecessary for lightly exploited stocks. The performance of the rule has been tested without any precautionary buffer. Therefore, the convenience of applying such a precautionary buffer would depend on an early assessment of the exploitation levels and depletion of the resource.

5 Stock Summaries Sheets

5.1 Summary sheet for European hake in GSA 1, 5, 6 & 7

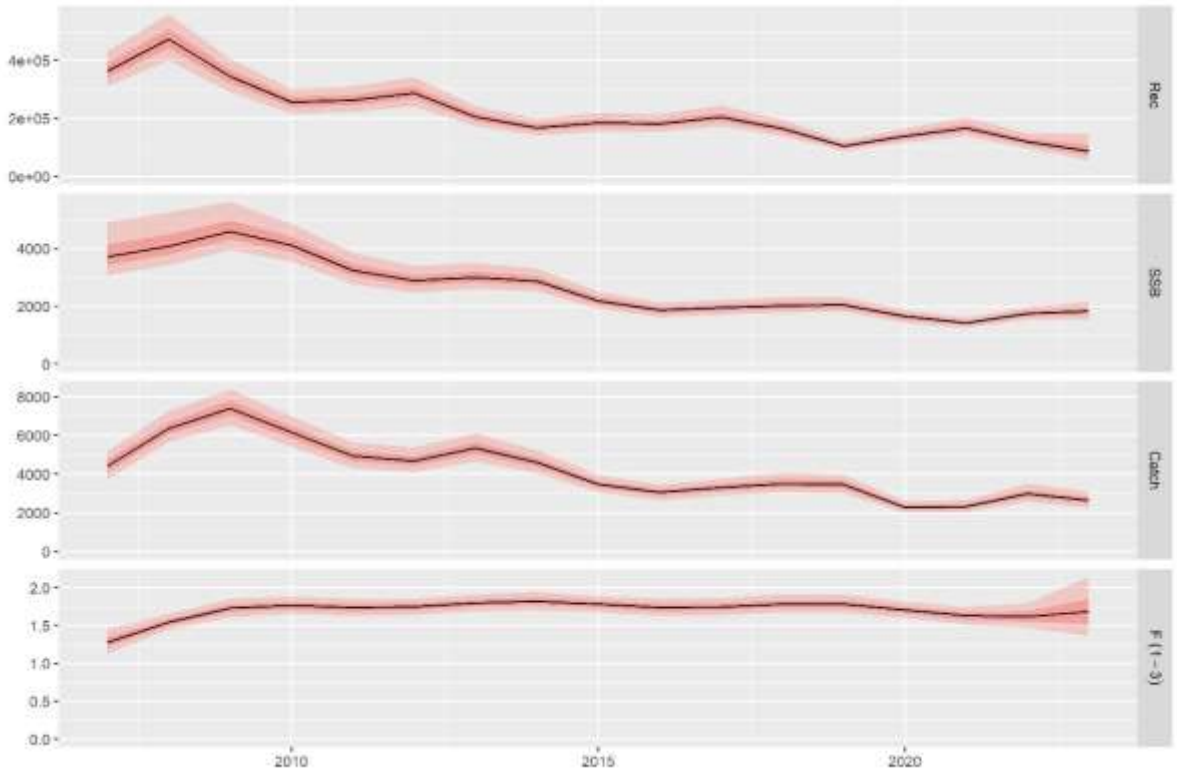
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.57 and corresponding catches in 2025 should be no more than 1190 tons. Since the stock is below B_{pa}, F could be further reduced (Freduced = 0.09) in order to increase the likelihood of biomass being above B_{pa} in the short term, corresponding to 236 tons of catch in 2025.

Stock development over time

Catches and SSB of European hake show a decreasing trend from 2009 to 2020, with some oscillations in the time series since then, with values in 2023 slightly minor than in 2022. The assessment shows a general long term declining trend in the number of recruits, which, despite the oscillations has continued until 2023. Fbar (1-3) shows oscillations across the trend with increasing values in 2023 (Fbar=1.68).

Figure 5.1.1 European hake in GSAs 1, 5, 6 and 7: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (1.68) is 2.94 times the reference point F_{max}, used as a proxy of F_{MSY} (=0.57). F in 2023 is also higher than both $F_{MSY\ Transition}$ (2023 and 2025) (0.97 and 0.57 respectively) indicating progress to F_{MSY} in 2025 is behind transition.

Table 5.1.1 European hake in GSAs 1, 5, 6 and 7: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY} F / $F_{MSY\ Transition}$	F > F_{MSY}	F > F_{MSY} F > F_{MSY} Transition	F > F_{MSY} F > F_{MSY} Transition	F > F_{MSY} F > F_{MSY} Transition	F > F_{MSY} F > F_{MSY} Transition
B/B_{lim}	$B<B_{lim}$	$B<B_{lim}$	$B<B_{lim}$	$B<B_{lim}$	$B<B_{lim}$
B/B_{pa}	$B<B_{pa}$	$B<B_{pa}$	$B<B_{pa}$	$B<B_{pa}$	$B<B_{pa}$
B/B_{MSY}	$B<B_{MSY}$	$B<B_{MSY}$	$B<B_{MSY}$	$B<B_{MSY}$	$B<B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.1.2 European hake in GSAs 1, 5, 6 and 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 1-3 (2024)	1.643982	Fsq = average of the last 3 years
SSB (2024)	1396.7	SSB intermediate year from STF output
Rage0 (2024,2025)	147642.2	Recruitment will be set as geometric mean of the last 10 years
Total Catch (2024)	1941.1	Catch intermediate year from STF output
Fbar (2019)	1.78	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

Table 5.1.3 European hake in GSAs 1, 5, 6 and 7: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2025)	F_{total} (ages 1-3) (2025)	SSB (2026)	% SSB change**	% Catch change^
STECF advice basis					
F_{MSY}	1189.9	0.57	3527.3	152.5	-55.1
$F_{reduced}$ $B<B_{pa}$^^^	236.1	0.09	5273.5	277.6	-91.1
Other scenarios					
Zero catch	0	0	5723.7	309.8	-100
Status quo	2396.6	1.64	1602.8	14.7	-9.6

Source: Own elaborations

* FMSY upper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
** % change in SSB 2025 to 2023
^Total catch in 2025 relative to Catch in 2023.
^^^$F_{reduced}$ B<B_{pa} is based on ICES advice rule when B in TAC year is less than B_{pa}

Basis of the advice

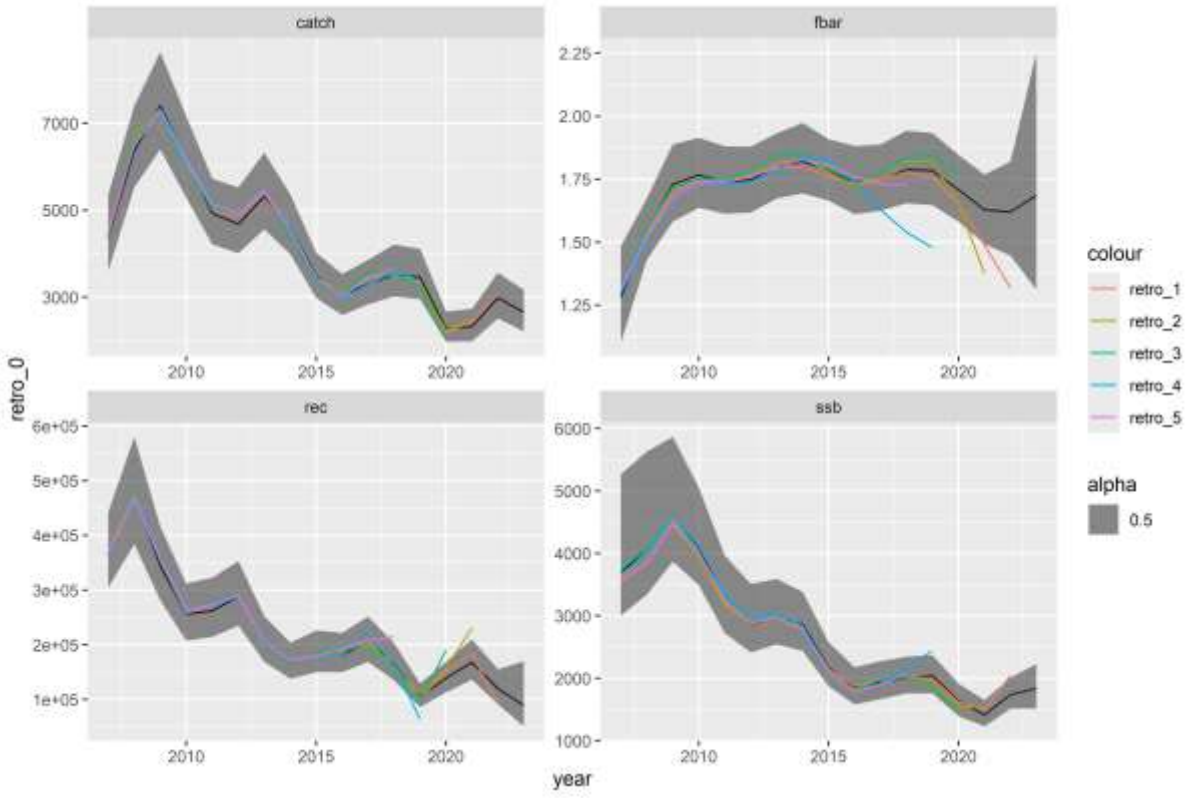
Table 5.1.4 European hake in GSAs 1, 5, 6 and 7: The basis of the advice.

Advice basis	F_{MSY}
Management plan	

Quality of the assessment

Commercial catches showed better internal consistency than MEDITS survey index. The historic assessment is stable, and the assessment model was not modified. The retrospective analysis indicates important differences in model estimates compared to 2023 assessment. Estimated SSB in years 2021 and 2022 is lower, and estimated catch is higher, which results in higher estimates of Fbar in years 2021 and 2022. Recruitment retrospective pattern also shows important corrections.

Figure 5.1.2 European hake in GSAs 1, 5, 6 and 7: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

New estimations of survey abundance index at age resulted in lower index values for the period 2007-2020. Due to time constraints, it was not possible to clarify the reason for those differences.

Reference points

Table 5.1.5 European hake in GSAs 1, 5, 6 and 7: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.57	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	3970	Estimated	STECF EWG 24-10
	B_{pa}	7940	Blim*2	STECF EWG 24-10
	B_{MSY}	35754	B Fmax	STECF EWG 24-10
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.57	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.39	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.79	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.1.6 European hake in GSAs 1, 5, 6 and 7: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included in the total catch
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.1.7 European hake in GSAs 1, 5, 6 and 7: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		819	3148	
2020	$F = F_{MSY}$		1269	2011	
2021	$F = F_{MSY}$		721	2350	
2022	$F = F_{MSY}$		1220	2890	
2023	$F = F_{MSY}$		1930	2651	
2024	$F = F_{MSY}$		1156		
2025	$F = F_{MSY}$		1189.9		

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

History of the catch and landings

Table 5.1.8 European hake in GSAs 1, 5, 6 and 7: Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF.

2023		Wanted catch				Discards
	2178	Otter trawl 91.0%	Gillnets 4.4%	Trammel nets 3.4%	Other 1.2%	212 t
Effort	NA					
		Fishing days				

Source: Own elaborations

Table 5.1.9 European hake in GSAs 1, 5, 6 and 7: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	SPAIN GSA1	SPAIN GSA5	SPAIN GSA6	SPAIN GSA7	FRANCE GSA7	Total landings	Total Effort * (Fishing Days)
2002	496	95	2835	369	2343	6138	40688
2003	398	48	4633	315	2273	7667	47254

2004	503	63	3151	182	1140	5039	254061
2005	359	98	3473	223	1002	5155	240706
2006	385	125	3627	261	1160	5558	236842
2007	340	185	2540	237	1394	4696	200309
2008	330	121	3341	280	2009	6081	211574
2009	619	67	3847	345	2485	7363	253312
2010	576	99	2822	195	2049	5741	334986
2011	683	85	3182	134	1381	5465	332830
2012	463	61	2641	180	1039	4384	321059
2013	375	109	2950	216	1534	5184	315785
2014	283	118	2489	224	1629	4743	313268
2015	183	102	1726	126	977	3114	284887
2016	176	67	1810	120	886	3059	286594
2017	299	72	1728	95	741	2935	272981
2018	410	97	2443	87	777	3814	260000
2019	290	107	1630	73	1062	3162	262069
2020	182	68	1099	36	512	1897	241834
2021	273	76	1529	43	565	2486	--
2022	251	69	1469	85	815	2689	--
2023	257	47	1085	56	733	2178	--

*Effort data is taken from STECF EWG 23-11. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.1.10 European hake in GSAs 1, 5, 6 and 7: Assessment summary. Weights are in tonnes.

Year	Recruitment age 1 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2007	365569	3679	4377	1.281
2008	473501	4088	6364	1.545
2009	344251	4594	7394	1.729
2010	255953	4099	6162	1.767
2011	262498	3219	4926	1.739
2012	288032	2865	4676	1.748
2013	205458	2980	5327	1.798
2014	168123	2855	4603	1.821
2015	185218	2174	3474	1.782
2016	181736	1853	3044	1.738
2017	205317	1937	3305	1.746
2018	164452	2013	3518	1.787
2019	104444	2039	3458	1.784
2020	138655	1639	2273	1.707
2021	167542	1412	2323	1.628
2022	119518	1740	2982	1.62
2023	88820	1834	2651	1.684

Source: Own elaborations

Sources and references

STECF EWG 24-10

5.2 Summary sheets for Deep-water rose shrimp in GSAs 1, 5, 6 & 7

5.2.1 Summary sheet for Deep-water rose shrimp in GSA 1

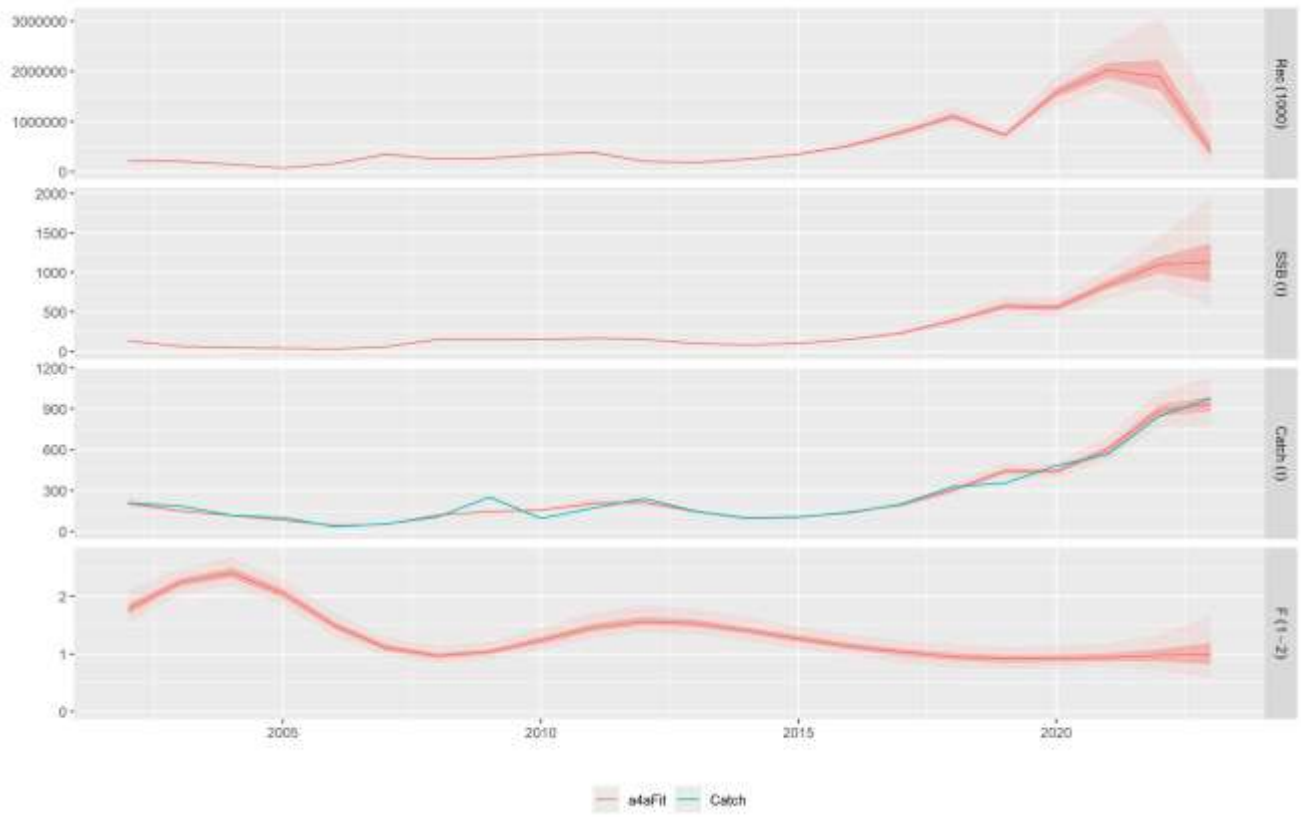
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 1.02 and corresponding catches in 2025 should be no more than 522.3 tons.

Stock development over time

The stock appears to have been quite stable from 2007 to 2016. From 2017 the stock has increased rapidly with a maximum in 2022. SSB and recruitment show an increasing pattern in the last years, while F show an unusual opposite trend that can be justified by the huge increase in recruitment in the last year.

Figure 5.2.1.1Deep-water rose shrimp in GSA 1: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model. Original catches are also shown.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality is below the reference point $F_{0.1}$, used as proxy of F_{MSY} (=0.99). No biomass reference points are calculated.

Table 5.2.2.1 Deep-water rose shrimp in GSA 1: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022
F / F_{MSY}	$F < F_{MSY}$	$F < F_{MSY}$	$F < F_{MSY}$	$F < F_{MSY}$
$F / F_{MSY\ Transition}$		$F < F_{MSY\ Transition}$	$F < F_{MSY\ Transition}$	$F < F_{MSY\ Transition}$

Source: Own elaborations

Catch scenarios

Table 5.2.1.2 Deep-water rose shrimp in GSA 1: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1–2}$ (2023)	0.99	F current in the last year used to give F status quo for 2024
SSB (2024; middle year)	573.97 t	Stock assessment 1 January 2024
R_0 (2024-2025)	1450033 thousands	Mean of the last 3 years
Total catch (2024)	522.3 t	Assuming F status quo for 2023

Source: Own elaborations

Table 5.2.1.3 Deep-water rose shrimp in GSA 1: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2024)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY} / MAP	566.7	1.01	841.4	46.6	-40.98
Other scenarios					
Zero catch	0.0	0.00	1673.5	191.6	-100.0
Status quo	555.0	0.99	855.2	49.0	-42.2
$F_{MSY\ lower}$	412.6	0.67	1033.95	80.14	+57.03
MSY upper**	701.2	1.38	692.3	20.62	-26.98

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.
Source: Own elaborations

Basis of the advice

Table 5.2.1.4 Deep-water rose shrimp in GSA 1: The basis of the advice.

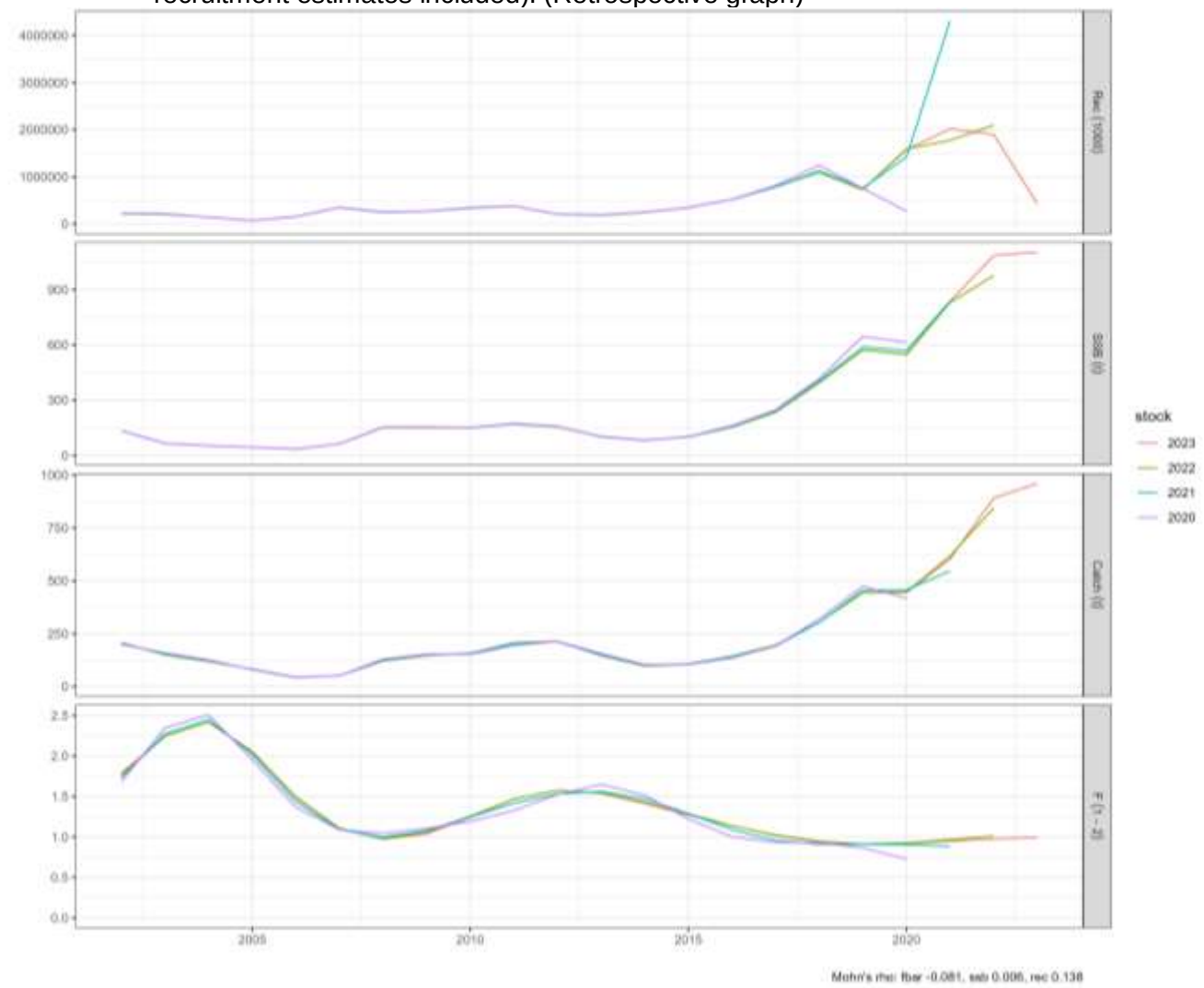
Advice basis	F_{MSY}
Management plan	0.99

Source: Own elaborations

Quality of the assessment

Commercial catches showed better internal consistency than MEDITS survey index.
The assessment is new. As this is a new assessment no reference points are calculated.
All the diagnostics from the a4a assessment were considered acceptable although survey data residuals are high for age 2.From the retrospective analysis model results stable with the exception of recruitment.
The values of F at age show extremely high values for age 2 in the first 4 years of the assessment remaining high until 2016 but are below F_{MSY} in recent years.
MEDITS survey incomplete for 2020, a sensitivity analysis suggests the assessment results are not influenced by the incomplete survey.

Figure 5.2.1.2 Deep-water rose shrimp in GSA 1: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.2.1.5 Deep-water rose shrimp in GSA 1: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	1.02	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	B_{MSY}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	1.02	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.68	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	1.38	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.2.1.6 Deep-water rose shrimp in GSA 1: Basis of assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards NOT included in the total catch because negligible
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings
Source: Own elaborations

History of the advice, catch, and management

Table 5.2.1.7 Deep-water rose shrimp in GSA 1: STECF advice and official landings. All weights tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	Index GSA 1,5,6 & 7 combined			355.2	1.1
2020	Index GSA 1,5,6 & 7 combined			484.9	2
2021				564.2	0
2022	$F = F_{MSY}$		1543.3	849.2	1.9
2023	$F = F_{MSY}$		1007.2	980.1	2.6
2024	$F = F_{MSY}$		567		
2025	$F = F_{MSY}$		567		

Source: Own elaborations

History of the catch and landings

Table 5.2.6 Deep-water rose shrimp in GSA 1: Catch distribution by fleet in 2023 as estimated by STECF.

Catch (2023)	Landings			Discards
980.1 t	100 % trawl	% set nets t	% others	2.6 t

2022		Wanted catch				Discards
Catch (t)		Bottom Otter Trawl (OTB) 100%				0%
	980.1	980.1				
Effort (2023)		(100%)				
		Fishing Days				

Source: Own elaborations

Table 5.2.7 Deep-water rose shrimp in GSA 1: History of commercial official landings presented by area for each country participating in the fishery. All weights in tonnes.

Year	Landings	Discards	Total	Total Effort * (Fishing Days)
2002	209.75	2.27	212	28002

Year	Landings	Discards	Total	Total Effort * (Fishing Days)
2003	187.17	2.026	189.2	32892
2004	118.14	1.279	119.4	34951
2005	103.03	1.71	104.7	32295
2006	37.59	0.407	38	31443
2007	56.16	0.608	56.8	29917
2008	108.87	0.55	109.4	26201
2009	253.93	1.74	255.7	27017
2010	97.6	1.81	99.4	28476
2011	171.57	0.38	171.9	28170
2012	241.52	1.65	243.2	25851
2013	149.12	0.87	150	22657
2014	100.42	4.25	104.7	21506
2015	108.55	1.17	109.7	20559
2016	136.75	0.88	137.6	20528
2017	201.79	1.71	203.5	22026
2018	329.62	0.66	330.3	20425
2019	354.15	1.071	355.2	22006
2020	482.93	2	484.9	18718
2021	564.23	0	564.2	13984
2022	847.311	1.886	849.2	
2023	977.486	2.6	980.1	

*Effort data is taken from STECF EWG 23-10. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Source: Own elaborations

Summary of the assessment

Table 5.2.8 Deep-water rose shrimp in GSA 1: Assessment summary. Weights are in tonnes.

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-2
2002	216508	134	208	1.78
2003	207089	65	150	2.24
2004	143043	53	119	2.41
2005	73590	43	83	2.06
2006	157471	34	44	1.49
2007	348540	63	52	1.11
2008	248896	153	121	0.97
2009	266367	154	147	1.04
2010	344314	151	156	1.24
2011	382601	171	207	1.46
2012	206947	156	215	1.57
2013	184932	103	147	1.54
2014	246879	82	97	1.41
2015	346132	101	105	1.27
2016	518721	154	144	1.13
2017	787275	235	196	1.02
2018	1101793	395	305	0.95
2019	728754	573	443	0.91
2020	1575538	551	444	0.92
2021	2018112	837	603	0.95
2022	1900315	1087	891	0.97
2023	431673	1105	960	0.99

Source: Own elaborations

Sources and references

For analysis and data supporting this summary sheet see STECF EWG 24-10.

5.2.2 Summary sheet for Deep-water rose shrimp in GSAs 5, 6 & 7

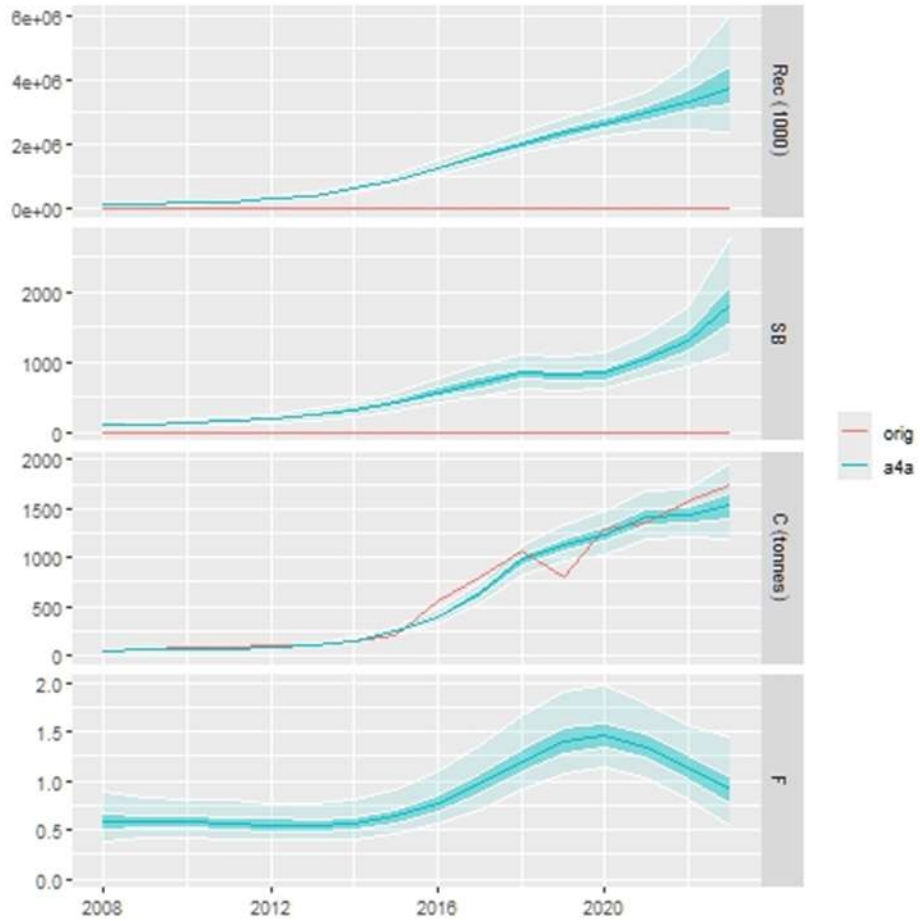
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 1.488 and corresponding catches in 2025 should be no more than 2421.3 tons.

Stock development over time

Catches, SSB and Recruitment show an increasing pattern from 2015. F increased in the period 2016-2020 and in the last three years F values decrease likely due to the huge increasing in the estimated population biomass.

Figure 5.2.2.1 Deep-water rose shrimp in GSAs 5, 6, and 7: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model. Original catches are also shown.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.882) is well below the reference point $F_{0.1}$, used as proxy of F_{MSY} (=1.488). No biomass reference points are calculated.

Table 5.2.2.1 Deep-water rose shrimp in GSAs 5, 6 & 7: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY} F / F_{MSY} Transition	$F < F_{MSY}$	$F < F_{MSY}$ $F < F_{MSY}$ Transition	$F < F_{MSY}$ $F < F_{MSY}$ Transition	$F < F_{MSY}$ $F < F_{MSY}$ Transition	$F < F_{MSY}$ $F < F_{MSY}$ Transit

Source: Own elaborations

Catch scenarios

Table 5.2.2.2 Deep-water rose shrimp in GSAs 5, 6 & 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1–2}$ (2024)	0.882	F current in the last year used to give F status quo for 2024
SSB (2024; middle year)	2142.3 t	Stock assessment 1 January 2024
R_0 (2024-2025)	3369605.53 thousands	Geometric mean of the period 2021-2023
Total catch (2024)	1797.6 t	Catch intermediate year from STF output

Source: Own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of last three years.

Table 5.2.2.3 Deep-water rose shrimp in GSAs 5, 6 & 7: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY} / MAP	2421.3	1.488	1430.1	-33.2	56
Other scenarios					
Zero catch	0.0	0.00	4248.5	98.3	-100.00
Status quo	1734.9	0.882	2107.0	-1.6	11.8
$F_{MSY\ lower}$	1873.3	0.986	1962.3	-8.4	20.7
$F_{MSY\ upper}$**	2831.5	2.016	1070.6	-50	82.4

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2024 to 2026
^Total catch in 2025 relative to Catch in 2023.
Source: Own elaborations

Basis of the advice

Table 5.2.2.4 Deep-water rose shrimp in GSAs 5, 6 & 7: The basis of the advice.

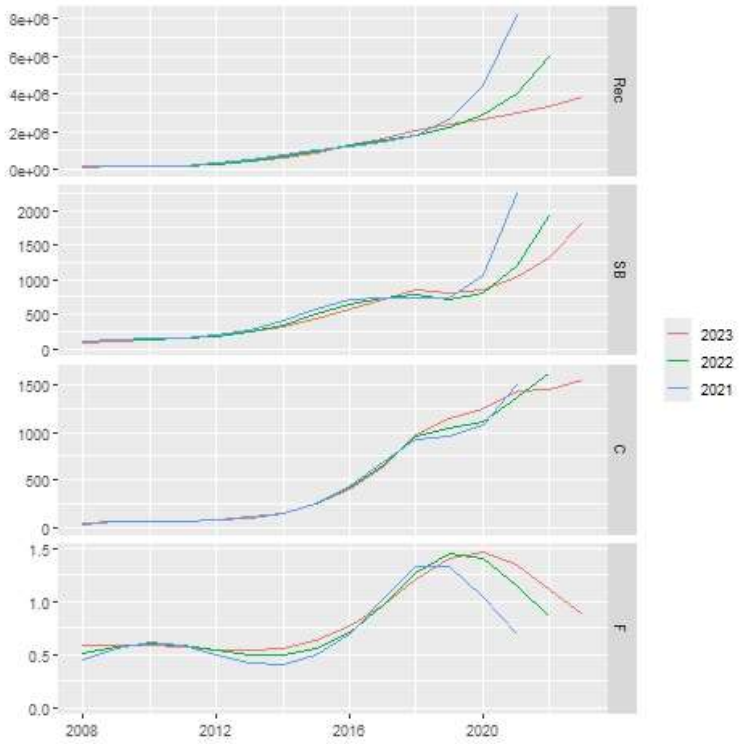
Advice basis	F_{MSY}
Management plan	1.49

Source: Own elaborations

Quality of the assessment

The stock has been assessed for the third time in the STECF. The assessment model was not modified. Both catches and survey indices showed good internal consistency. All the main diagnostics were considered acceptable. The species has a short life cycle (basically 3 years). The stock displays a continuous sharp increasing in the population, specially in the last 3 years.

Figure 5.2.2.2 Deep-water rose shrimp in GSAs 5, 6 & 7: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.2.2.5 Deep-water rose shrimp in GSAs 5, 6 & 7: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	1.49	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	B_{MSY}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	1.49	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.99	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	2.02	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Due to the instability on the retrospective the assessment has been considered only able in providing advice in term of fishing mortality level but not robust enough to compute biomass reference point.

Basis of the assessment

Table 5.2.2.6 Deep-water rose shrimp in GSAs 5, 6 & 7: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.2.2.7 Deep-water rose shrimp in GSAs 5, 6 & 7: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catches	STECF discards
2022	Index GSA 1,5,6 & 7 combined			1469	
2023	$F = F_{MSY}$		4459		
2024	$F = F_{MSY}$		3092		
2025	$F = F_{MSY}$		2421.3		

Source: Own elaborations

History of the catch and landings

Table 5.2.2.8 Deep-water rose shrimp in GSAs 5, 6 & 7: Catch in 2022 and effort distribution by fleet in 2022 as estimated by and reported to STECF.

2023	Wanted catch			Discards
Catch (t)	Bottom Otter Trawl (OTB) 97.28%	Twins Otter Trawl (OTT) 2.71%	Others gears 0.01%	Bottom Otter Trawl (OTB) 100%
	1674.96	46.67	0.20	12.61
Effort	NA			
	Fishing Days			

Source: Own elaborations

Table 5.2.2.9 Deep-water rose shrimp in GSAs 5, 6 & 7: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days of OTB and OTT gear extracted from the Mediterranean and Black Sea database (2002-2012) and from the Fisheries Dependent Information (2013 onward).

Year	ESP GSA5	ESP GSA6	ESP GSA7	FRA GSA7	Total landings	Total Effort
2002	36.18	144.08	0.00	0.00	180.26	NA
2003	22.13	116.02	0.00	0.00	138.15	NA
2004	6.53	66.19	0.00	0.00	72.72	133802
2005	1.60	44.66	0.00	0.00	46.26	126080
2006	1.01	25.18	0.00	0.00	26.19	124065
2007	1.39	28.81	0.00	0.00	30.20	115098
2008	5.20	38.95	0.13	0.00	44.28	122787
2009	5.11	49.09	0.14	0.00	54.34	115947
2010	6.25	71.89	0.36	3.77	82.27	125640
2011	4.53	66.27	1.15	6.21	78.16	119418
2012	4.17	85.61	1.95	3.42	95.15	111134
2013	6.20	86.75	2.30	2.38	97.63	106518
2014	5.59	131.27	3.37	4.27	144.50	112031
2015	7.58	174.64	4.73	13.68	200.63	105936
2016	9.09	471.28	27.12	42.89	550.38	103712
2017	68.03	634.71	36.28	46.60	785.62	102037
2018	101.16	914.60	17.86	37.73	1071.35	97512
2019	59.76	703.99	7.29	24.53	795.56	96075
2020	67.94	1094.83	15.99	102.48	1281.25	88948
2021	81.89	1107.93	29.01	118.23	1337.06	69631
2022	58.15	1367.87	22.54	101.66	1550.22	
2023	58.23	1584.20	19.38	60.02	1721.83	

Source: Own elaborations

Summary of the assessment

Table 5.2.2.10 Deep-water rose shrimp in GSAs 5, 6 & 7: Assessment summary. Weights are in tonnes.

Year	Recruitment age 0 (‘000)	SSB (t)	Catch (t)	F_{bar} ages 1-2
2008	138086.9	91.69	44.73	0.581
2009	153844.6	113.73	61.21	0.586
2010	177285.7	133.98	66.62	0.581
2011	217956.0	151.55	72.87	0.566
2012	289786.9	182.13	84.89	0.547
2013	412134.2	239.17	113.79	0.540
2014	607398.4	310.85	154.98	0.563
2015	890126.0	430.12	245.40	0.634
2016	1249603.1	571.68	396.96	0.767
2017	1643278.0	706.07	637.98	0.968
2018	2018810.7	840.67	975.83	1.208
2019	2350961.1	809.97	1136.39	1.409
2020	2657242.0	842.10	1237.43	1.467
2021	2981100.3	1047.65	1422.95	1.349
2022	3362500.7	1310.14	1446.46	1.120
2023	3816789.5	1835.59	1552.06	0.882

Source: Own elaborations

Sources and references

EWG 24-10: Stock assessments in the Western Mediterranean Sea

5.3 Summary sheet for Red mullet in GSA 1

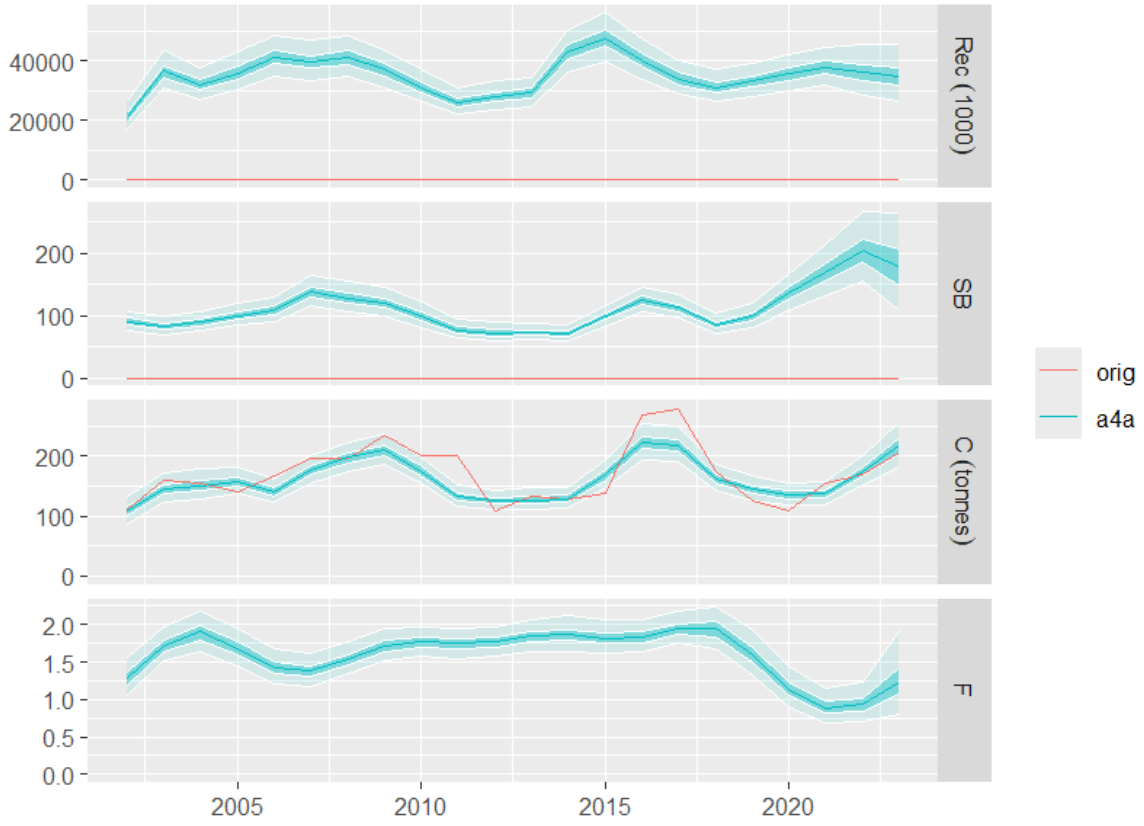
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.63 and corresponding catches in 2025 should be no more than 110 tons.

Stock development over time

The assessment shows fluctuation of all indicators along the available time series, while a slightly effective reduction of fishing mortality has occurred after 2018 but increasing again after 2021. Recruitment and SSB of red mullet show a decreasing trend since in the last years by contrast catch increased after 2022. Modelled catch follows properly the observed catch, excluding some years (2011, 2016, 2017) in the middle of the time series, where de model had larger problems to fit the catch data.

Figure 5.3.1 Red mullet in GSA 1: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model. Original catches are also shown.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (1.24) is almost double the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.63).

Table 5.3.1 Red mullet in GSA 1: State of the stock and fishery relative to reference points.

Status	2020	2021	2022	2023
F / F_{MSY}	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}
F / $F_{MSY\ Transition}$		F > F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition
B / B_{lim}	B < B_{lim}	B < B_{lim}	B > B_{lim}	NA
B / B_{pa}	B < B_{pa}	B < B_{pa}	B < B_{pa}	NA
B / B_{MSY}	B < B_{MSY}	B < B_{MSY}	B < B_{MSY}	NA

Source: Own elaborations

Catch scenarios

Table 5.3.2 Red mullet in GSA 1: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-2 (2024)	1.24	Fsq = F in the last year
SSB (2024)	154.13	SSB intermediate year from STF output
Rage0 (2024,2025)	36298.04	Recruitment will be set as geometric mean of the last 11 years
Total Catch (2024)	178.78	Catch intermediate year from STF output
Fbar (2019)	1.59	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Source: Own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of last three years.

Table 5.3.3 Red mullet in GSA 1: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	110.1	0.63	240.7	+56.2	-49.3
Other scenarios					
$F_{MSY\ lower}$	79.2	0.42	288.5	+87.2	-63.6
$F_{MSY\ upper}$**	138.5	0.86	200.8	+17.66	-49.3
Zero catch	0	0	430.5	+179.3	-100
Status quo	176.0	1.24	154.0	-0.1	-19.0

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.

Source: Own elaborations

Basis of the advice

Table 5.3.4 Red mullet in GSA 1: The basis of the advice.

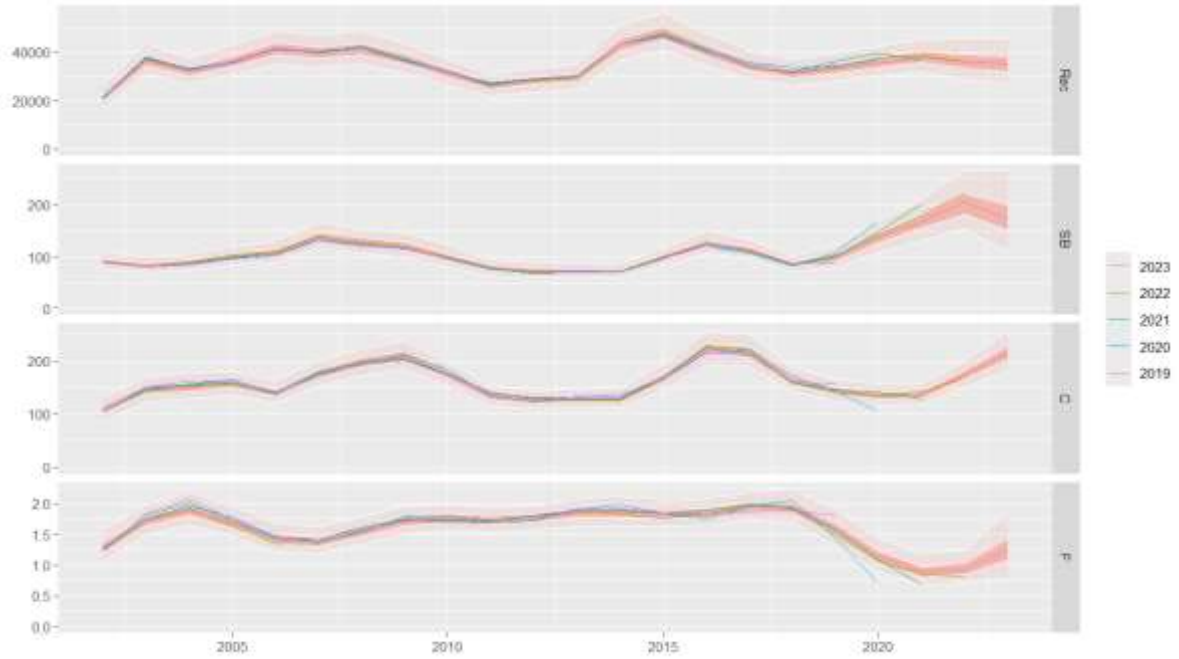
Advice basis	F_{MSY}
Management plan	

Source: Own elaborations

Quality of the assessment

Commercial catches showed similar poor internal consistency to the MEDITS survey index. The assessment is quite stable. The retrospective analysis is quite stable removing 4 years particularly for recruitment and catches. Overall all the diagnostics were considered acceptable. As the assessment is based on a new model and sliced data the EWG 24 10 decided to evaluate biological reference points next year.

Figure 5.3.2 Red mullet in GSA 1: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

The group decided to postpone at least for one year the calculation of the biological reference points, since this is a new assessment and there are still doubts on the growth parameters of this stock.

Reference points

Table 5.3.5 Red mullet in GSA 1: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.63	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	NA	Not Defined	
	B_{pa}	NA	Blim * 2	
	B_{MSY}	NA	B F0.1	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.63	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.42	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.86	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.3.6 Red mullet in GSA 1: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings

Source: Own elaborations

History of the advice, catch, and management

Table 5.3.7 Red mullet in GSA 1: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catches	STECF discards
2019	$F = F_{MSY}$		99	125	
2020	$F = F_{MSY}$		97.7	107.6	
2021	$F = F_{MSY}$		103.2	151.1	
2022	$F = F_{MSY}$		180.7	170.4	
2023	$F = F_{MSY}$		96.12		
2024	$F = F_{MSY\ Reduced}\ B<B_{pa}$		68		
2025	$F = F_{MSY}$		110.1		

Source: Own elaborations

History of the catch and landings

Table 5.3.8 Red mullet in GSA 1: Catch in 2023 as distributed by gear (for discards and landings)

2023	Wanted catch					Discards
Catch (t)	Otter trawl 84.3%	Trammel nets 14.2%	Gillnets and trammel nets 0.87%	Purse Seine 0.21%	Other 0.426%	Otter trawl 100%
	164	27.6	1.68	0.4	0.5	11.2

Source: Own elaborations

Table 5.3.9 Red mullet in GSA 1: History of commercial landings and dioscards; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	MUT GSA1 Landings	MUT GSA1 Discards	Total Effort Fishing
2002	111.28	0.8	NA
2003	159.68	1.1	32749
2004	154.07	1.1	38426
2005	140.21	1.0	40760
2006	164.54	1.1	37895
2007	194.01	1.4	37380
2008	193.65	1.7	35391
2009	228.37	5.2	32165
2010	201.65	0.0	36472
2011	201.18	0.1	37515
2012	107.31	1.7	38558
2013	131.63	0.3	36023
2014	123.87	3.3	36757
2015	135.9	1.8	36058
2016	260.49	7.7	31397
2017	274.67	3.5	31534
2018	170.23	2.8	33123
2019	124.63	0.4	30057
2020	107.32	0.3	26302
2021	153.05	1.0	24856
2022	164.96	5.5	NA
2023	194.17	11.2	NA

Source: Own elaborations

*Effort data is taken from STECF EWG 21-13. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Summary of the assessment

Table 5.3.10 Red mullet in GSA 1: Assessment summary. Weights are in tonnes. '

Year	Recruitment age 0 ('000)	SSB (t)	Catch (t)	F_{bar} ages 1-2
2002	21214.6	89.9	107.7	1.28
2003	36556.4	82.5	144.8	1.71
2004	31936.5	88.2	151.3	1.90
2005	36057.7	99.4	157.5	1.68
2006	41203.5	107.1	140.3	1.42
2007	39803.9	137.1	175.8	1.38
2008	41113.2	126.8	196.3	1.53
2009	36974.7	118.7	209.1	1.71
2010	31220.1	97.4	175.0	1.76
2011	26019.4	76.3	133.4	1.73
2012	28054.7	71.0	125.6	1.76
2013	29242.0	71.7	127.6	1.84
2014	42995.1	70.6	128.6	1.86
2015	47598.7	97.9	167.9	1.82
2016	40325.2	124.2	221.9	1.84
2017	34088.1	112.3	217.2	1.95
2018	31146.7	84.3	162.6	1.94
2019	33217.2	97.4	144.5	1.59
2020	35605.4	135.2	136.0	1.14
2021	37881.4	167.2	137.6	0.89
2022	36089.9	202.2	176.0	0.93
2023	34786.6	174.1	217.3	1.24

Source: Own elaborations

Sources and references

5.4 Summary sheet for Striped red mullet in GSA 5

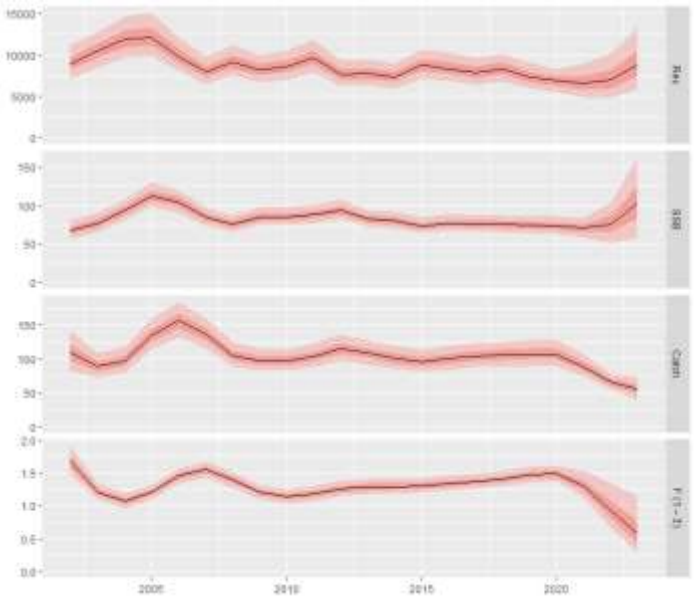
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied, the fishing mortality in 2025 should be no more than 0.46 and corresponding catches in 2025 should be no more than 73.4 tons.

Stock development over time

Catches of striped red mullet showed a maximum around 2007, were very stable for much for the time series and a decreasing trend since 2020. Recruitment and SSB increased for the last year. Fbar (1-3) showed a clear decreasing trend since 2020, with the minimum value for the time series in 2023, where it reached a value of F of 0.58.

Figure 5.4.1 Striped red mullet in GSA 5: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.57) is 1.25 times the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.46).

Table 5.4.1 Striped red mullet in GSA 5: State of the stock and fishery relative to reference points.

Status	2020	2021	2022	2023
F / F_{MSY}	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}
F / F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition

Source: Own elaborations

Catch scenarios

Table 5.4.2 Striped red mullet in GSA 5: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1-3}$ (2024)	0.57	Fsq = F in the last year
SSB (2024)	145.5	SSB intermediate year from STF output
R_{age0} (2024,2025)	7470	Geometric mean last three years
Total catch (2024)	76.1	Catch intermediate year from STF output

Source: Own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Table 5.4.3 Striped red mullet in GSA 5: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2025)	F_{total} (ages 1-3) (2025)	SSB (2026)	% SSB change**	% Catch change^
STECF advice basis					
F_{MSY}	73.4	0.46	166.6	14.5	32.9
Other scenarios					
Zero catch	0	0.00	273.2	87.8	-100.0
Status quo	84.0	0.57	153.3	5.4	52.1
$F_{MSY\ lower}$	52.2	0.31	194.8	33.9	-5.4
$F_{MSY\ upper*}$	93.6	0.63	141.7	-2.6	69.6

* FMSY upper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.
Source: Own elaborations

Basis of the advice

Table 5.4.4 Striped red mullet in GSA 5: The basis of the advice.

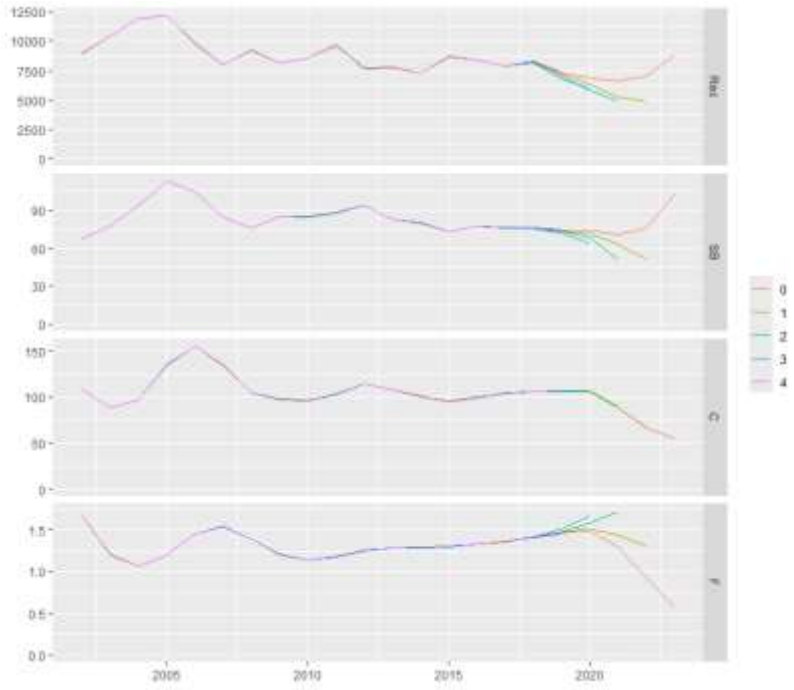
Advice basis	F_{MSY}
Management plan	

Source: Own elaborations

Quality of the assessment

Commercial catches showed better internal consistency than MEDITS survey index. The retrospective analysis showed better consistency than the last year and all the diagnostics were considered acceptable, so the stock was updated from ICES category 3 stock to provision of advice based on reference points (F) from statistical catch-at-age model (a4a).

Figure 5.4.2 Striped red mullet in GSA 5: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

A complementary assessment carried out using a production model (SPiCT) was developed. The results showed a similar trend, with a clear decrease in F for the last years, even reaching values under the Reference Point. Full results are included in section 6.

Reference points

Table 5.4.5Striped red mullet in GSA 5: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	F_{MSY}	0.46	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	F_{pa}		Not Defined	STECF EWG 24-10
Management plan	F_{MSY}	0.46	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.31	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.63	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.4.6 Striped red mullet in GSA 5: Basis of assessment and advice.

Assessment type	Statistical catch-at-age
Input data	DCF commercial catches and scientific survey (MEDITS) data
Discards and bycatch	Negligible
Indicators	MEDITS indices (2007-2023)
Other information	
Working group	EWG 24 – 10

Source: Own elaborations

History of the advice, catch, and management

Table 5.4.7 Striped red mullet in GSA 5: STECF advice and official landings. All weights tonnes.

Year	STECF advice	Predicted catch corresp. to advice	Official landings in (areas)	STECF landings	STECF discards	STECF catch
2019	$F = F_{MSY}$	113				85.55
2020	$F = F_{MSY}$	110				83.69
2021	$F = F_{MSY}$	121				78.9
2022	precautionary advice reduce catch	84.6				65.55
2023	precautionary advice reduce catch	84.6				49.33
2024	Precautionary advice catch	59.2				
2025	$F = F_{MSY}$	73.4				

Source: Own elaborations

History of the catch and landings

Table 5.4.8 Striped red mullet in GSA 5: Catch distribution by fleet in 2023 as estimated by and reported to STECF.

Catch	Wanted catch				Discards
49.33	Otter trawl 82.4%	Trammelnet 15.8%	Other 01.8%		0 t
	40.7	7.8	0.9		

Effort	NA	
	NA	

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 5.4.9 Striped red mullet in GSA 5: History of commercial landings. All weights are in tonnes.

Year	Spain GSA5	STECF total landings	Total Effort* (Fishing days)
2002	131.68	131.68	
2003	101.62	101.62	
2004	152.95	152.95	13606
2005	148.51	148.51	13063
2006	152.88	152.88	12265
2007	170.06	170.06	12374
2008	139.16	139.16	12693
2009	72.97	72.97	15342
2010	93.15	93.15	15563
2011	107.36	107.36	14769
2012	100.36	100.36	15227
2013	87.88	87.88	15309
2014	95.35	95.35	16552
2015	96.60	96.60	16071
2016	106.46	106.46	13777
2017	109.91	109.91	12277
2018	132.40	132.40	9569
2019	85.55	85.55	9290
2020	83.69	83.69	8431
2021	79.02	79.02	
2022	65.55	65.55	
2023	49.33	49.33	

*Effort data is taken from STECF EWG 24-10. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Summary of the assessment

Table 5.4.10 Striped red mullet in GSA 5: Assessment summary. Weights are in tonnes.

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2002	8989	67.3	108.4	1.67
2003	10481	76.9	88.4	1.21
2004	11861	93.7	97.4	1.06
2005	12171	112.7	135.7	1.20
2006	9949	104.2	155.8	1.45
2007	7988	84.9	136.4	1.55
2008	9195	75.3	105.8	1.39

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2009	8163	85.2	97.9	1.20
2010	8601	84.7	96.6	1.13
2011	9641	87.9	103.8	1.18
2012	7666	93.5	115.3	1.25
2013	7768	82.4	108.0	1.28
2014	7317	80.1	101.0	1.28
2015	8707	73.2	95.4	1.30
2016	8331	77.0	100.2	1.34
2017	7911	75.5	103.9	1.37
2018	8290	75.8	105.7	1.41
2019	7340	73.8	106.5	1.47
2020	6830	73.9	107.2	1.49
2021	6587	70.7	88.8	1.30
2022	6976	75.5	66.2	0.93
2023	8944	102.4	55.8	0.57

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10.

5.5 Summary sheet for Red mullet in GSA 6

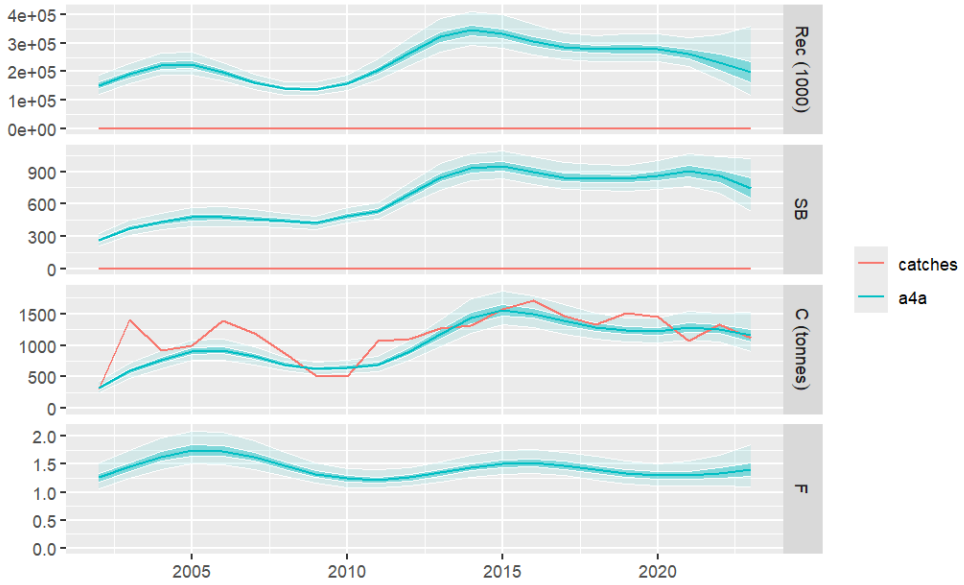
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.27 and corresponding catches in 2025 should be no more than 299 tons.

Stock development over time

Catches of red mullet have fluctuated along the analysed period with a slight decrease in 2023. Since 2013 both recruitment and SSB remained at similar values, although recruitment decreased since 2020, though recruitment in the final years is particularly uncertain. F slightly increases in the last years.

Figure 5.5.1 Red mullet in GSA 6: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (1.40) is 3.2 times the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.44).

Table 5.5.1 Red mullet in GSA 6: State of the stock and fishery relative to reference points.

Status	2020	2021	2022	2023
F / FMSY	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}	F > F_{MSY}
F / F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition	F > F_{MSY} Transition

Source: Own elaborations

Catch scenarios

Table 5.5.2 Red mullet in GSA 6: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1-3}$ (2024)	1.40	Fsq = F in the last year
SSB (2024)	637	SSB intermediate year from STF output
R_{age0} (2024,2025)	230740	Recruitment will be set as geometric mean of the last 3 years
Total catch (2024)	1012.1	Catch intermediate year from STF output

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

Table 5.5.3 Red mullet in GSA 6: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-3) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	455	0.44	1472	131.1	-60.9
$F_{MSY\ Reduced}$ B<B_{pa}^^^	299	0.27	1748.3	174.5	-74.3
Other scenarios					
Zero catch	0	0	2341.9	267.6	-100.0
Status quo	1163.9	1.40	692.1	8.6	-12.6
$F_{MSY\ lower}$	323.7	0.297	1703.5	167.42	-72.2
$F_{MSY\ upper}$**	582.4	0.608	1265.6	98.7	-49.97

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}

*** % change in SSB 2026 to 2024

^Total catch in 2025 relative to Catch in 2023.

^^^$F_{MSY\ Reduced}$ B<B_{pa} is based on ICES advice rule when B in TAC year is less than B_{pa}

Source: Own elaborations

Basis of the advice

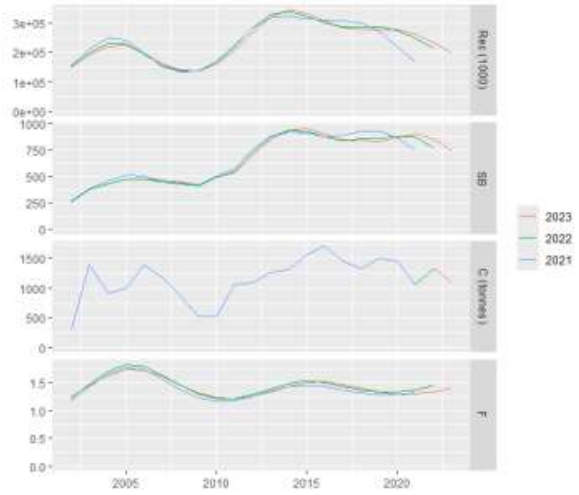
Table 5.5.4 Red mullet in GSA 6: The basis of the advice.

Advice basis	F_{MSY}
Management plan	

Quality of the assessment

The historic assessment is stable, despite the assessment model was slightly modified. The retrospective analysis showed consistency in the estimation of F estimated in the assessment of 2023. All the diagnostics were considered acceptable.

Figure 5.5.2 Red mullet in GSA 6: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.5.5 Red Mullet in GSA 6: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.44	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	522.7	New	STECF EWG 24-10
	B_{pa}	1045.4	Blim * 2	STECF EWG 24-10
	B_{MSY}	2090.7	B F0.1	STECF EWG 24-10
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.44	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.297	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.608	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.5.6 Red mullet in GSA 6: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data.
Discards, BMS landings*, and bycatch	Discards included in the total catch
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.5.7 Red mullet in GSA 6: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		482	1445.8	
2020	$F = F_{MSY}$		448	1539.0	
2021	$F = F_{MSY}$		306	1306.4	
2022	$F = F_{MSY}$		842	1416.6	
2023	$F = F_{MSY}$		397	1100.5	
2024	$F = F_{MSY}$		438		
2025	$F = F_{MSY}$		455		

Source: Own elaborations

History of the catch and landings

Table 5.5.8 Red mullet in GSA 6: Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF.

2023		Wanted catch				Discards
Catch (t)	1100.5	Otter trawl 90.2%	Trammel nets 9.6%		Other 0.2	14.87 t
Effort						
		Fishing days				

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 5.5.9 Red mullet in GSA 6 History of commercial landings and total effort expressed in fishing days. All weights are in tonnes.

Year	GSA6 Landings (t)	Total Effort
2003	1400.0	
2004	919.5	150341
2005	995.0	144733
2006	1387.8	141557
2007	1183.6	125910
2008	872.1	138151
2009	520.9	141813
2010	514.1	132612
2011	1063.1	130739
2012	1069.9	125529
2013	1248.0	126112
2014	1309.2	132837
2015	1518.7	123658
2016	1673.9	125006
2017	1449.3	118221
2018	1280.7	105891
2019	1501.8	
2020	1446.3	
2021	1066.3	
2022	1321.1	
2023	1100.5	

Summary of the assessment

Table 5.5.10 Red mullet in GSA 6: Assessment summary. Weights are in tonnes.

Year	Recruitment age 0 thousands	SSB (tonnes)	Catch tonnes	Fbar(1-3)
2002	150521.8	260.8156	320.5962	1.254292
2003	190510.9	373.5561	589.1841	1.450756
2004	221939.3	431.553	762.1457	1.632693
2005	224154.1	476.189	906.6361	1.740173
2006	197198.1	478.3648	916.4074	1.731723
2007	162807	463.2061	822.7382	1.619743
2008	140494	444.7404	698.0753	1.461428
2009	138238.2	422.2995	629.1003	1.318659
2010	158906.7	490.0529	649.1665	1.230158
2011	203580.6	532.8606	691.0548	1.209331
2012	265208.1	693.7067	904.3939	1.251679
2013	321202.6	846.6699	1172.023	1.338207
2014	345377.9	936.894	1433.635	1.435815
2015	333982.4	957.4737	1564.409	1.504535
2016	307057.7	900.4304	1508.801	1.51611
2017	285523	848.881	1392.417	1.471063
2018	277477.7	838.77	1288.824	1.39666
2019	278774.9	835.3748	1230.198	1.328105
2020	277696.2	862.3061	1221.606	1.291161
2021	263032.4	905.817	1284.213	1.295809
2022	233863.3	855.6347	1260.095	1.337304
2023	199709.8	744.1581	1163.951	1.400593

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10, STECF EWG 23-09, 22-09, EWG 22-10

5.6 Summary sheet for Red Mullet in GSA 7

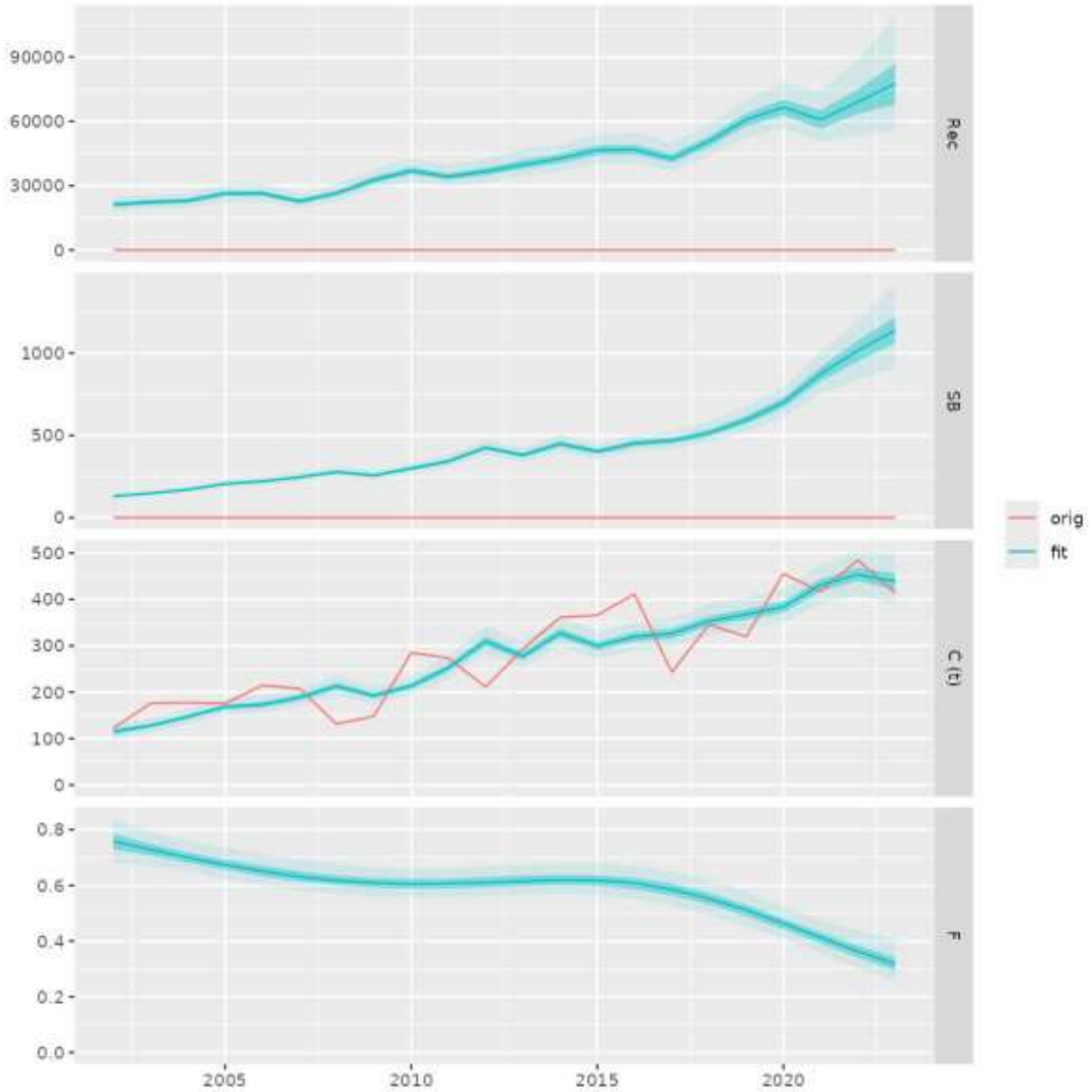
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.45 and corresponding catches in 2025 should be no more than 674 tons.

Stock development over time

Catches and SSB of Red Mullet show a slow but increasing initiated in 2007, with a slowing down in 2012, a date since which the number of recruits seems to have reached a plateau before resuming growth (with higher uncertainty) in 2017 until 2020. Fbar (0-3) shows some fluctuations around a slowly decreasing trend and its value in 2023 is associated to some uncertainty.

Figure 5.6.1 Red Mullet in GSA 7: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.32) is 0.71 times the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.45). The stock is now below F_{MSY}.

Table 5.6.1 Red Mullet in GSA 7: State of the stock and fishery relative to reference points.

Status	2021	2022	2023
F / F_{MSY}	F = F_{MSY}	F = F_{MSY}	F < F_{MSY}
F / F_{MSY} Transition		F = F_{MSY} Transition	F < F_{MSY} Transition

Source: Own elaborations

Catch scenarios

Table 5.6.2 Red Mullet in GSA 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 0-3 (2024)	0.32	F 2024 used to give F status quo for 2023
SSB (2024)	1288.5	Stock assessment 1 January 2022
Rage0 (2024,2025)	63716	Geometric mean of the last 6 years
Total Catch (2024)	488	Assuming F status quo for 2022

Source: Own elaborations

Other biological parameters (maturity, natural mortality, mean weights) and fishery selection are taken as mean of the last three years

Table 5.6.3 Red Mullet in GSA 7: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 0-3) (2024)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	674	0.45	1069	-17	54
Other scenarios					
Zero catch	0	0	1961	52	-100
Status quo	461	0.32	1263	-2	16.5
$F_{MSY\ lower}$	489	0.3	1291	0.21	11.36
$F_{MSY\ upper}$**	843	0.62	882	-31	92.2

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2024 to 2023
^Total catch in 2023 relative to Catch in 2021
Source: Own elaborations

Basis of the advice

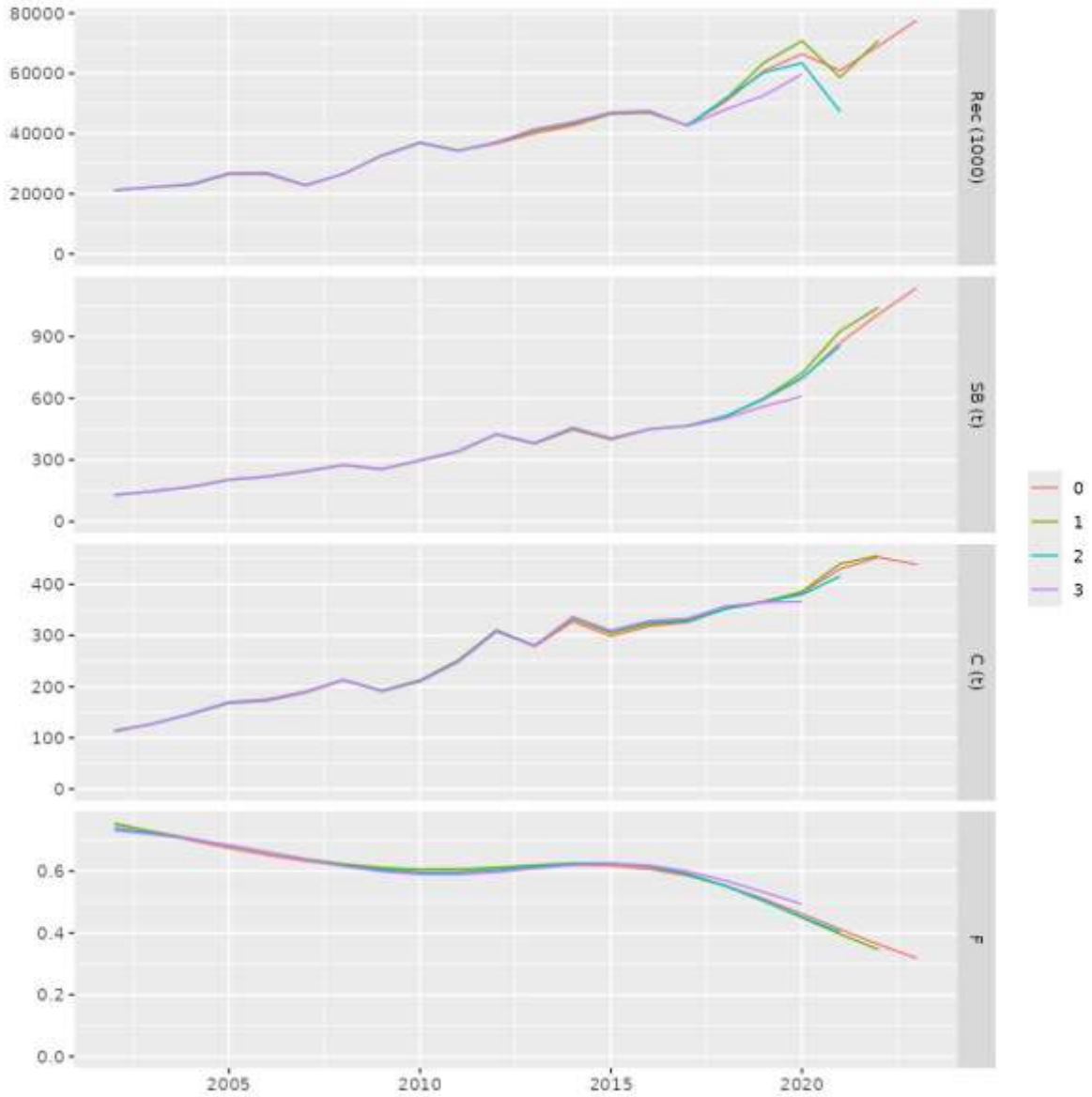
Table 5.6.4 Red Mullet in GSA 7: The basis of the advice.

Advice basis	F_{MSY}
Management plan	

Quality of the assessment

This assessment is an update of the previous year assessment, including a minor update on the fishing mortality model. It confirms the fact that MSY has been reached for MUT7. Recruitments levels remain high for this stock.

Figure 5.6.2 Red Mullet in GSA 7: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.6.5 Red Mullet in GSA 7: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.45	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}		146.49	
	B_{pa}		292.97	
	F_{lim}		2.12	
	F_{pa}		1.04	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.45	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.30	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.62	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.6.6 Red Mullet in GSA 7: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included in the total catch
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.6.7 Red Mullet in GSA 7: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2020	$F = F_{MSY}$		320	389	
2021	$F = F_{MSY}$		252	432	
2022	$F = F_{MSY}$		467	467	

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2023	$F = F_{MSY}$		439	413	
2024	$F = F_{MSY}$		488		
2025	$F = F_{MSY}$		674		

Source: Own elaborations

History of the catch and landings

Table 5.6.8 Red Mullet in GSA 7: Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF. Note that due to uncertainty in spanish landings in GSA 7, only reported french landings are reported above.

Year	Fra_GSA7	Spa_GSA7	Total_landings	Discards	Catch
2002	111.424	11.08	122.504	0	122.504
2003	164.141	11.87	176.011	0	176.011
2004	151.646	25.84	177.486	0	177.486
2005	148.086	27.48	175.566	0	175.566
2006	183.478	31.4	214.878	0	214.878
2007	171.526	36.16	207.686	0	207.686
2008	110.494	20.73	131.224	0.18	131.404
2009	122.555	26.13	148.685	0	148.685
2010	253.837	28.23	282.067	2.828	284.895
2011	241.764	28.13	269.894	3.584	273.478
2012	173.939	29.17	203.109	8.219	211.328
2013	250.871	37.53	288.401	4.676	293.077
2014	315.874	41.18	357.054	4.204	361.258
2015	324.626	33.05	357.676	8.423	366.099
2016	365.128	43.31	408.438	3.056	411.494
2017	209.532	31.09	240.622	2.352	242.974
2018	318.349	23.83	342.179	3.361	345.54
2019	290.489	22.168	312.657	7.488	320.145
2020	422.153	23.704	445.857	9.151	455.008
2021	383.777	26.943	410.72	6.511	417.231
2022	446.37	28.309	474.679	10.053	484.732
2023	368.939	29.328	398.267	15.356	413.623

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 5.6.9 Red Mullet in GSA 7: History of commercial landings, discards and catch; official reported values are presented by country and GSA,. All weights are in tonnes.

Landings 2023 (t)						Discards
368.939	OTB: 36.5%	OTT: 60.8%	Gillnets 2.6%	Longlines <1%	Other <1%	15.36 t

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.6.10 Red Mullet in GSA 7: Assessment summary. Weights are in tonnes.

year	rec	ssb	Catch	Fbar
2002	21236.03	129.61	114.415	0.7557
2003	22270.85	147.40	127.387	0.727137
2004	22906.46	169.79	146.589	0.699921
2005	26488.3	204.39	167.751	0.67457
2006	26506.41	219.82	172.371	0.651909
2007	22713.81	245.62	188.277	0.632918
2008	26588.36	275.63	212.376	0.6185
2009	32740.14	254.93	191.991	0.609277
2010	36994.63	298.38	212.486	0.605373
2011	34353.72	340.92	251.465	0.606239
2012	36676.14	424.78	309.638	0.610512
2013	40048.75	378.60	278.250	0.615939
2014	42592.69	447.96	327.226	0.619461
2015	46505.92	399.13	298.634	0.617574
2016	46880.1	449.38	318.123	0.606994
2017	42801.11	465.62	325.772	0.585503
2018	50651.23	513.58	352.710	0.552723
2019	60842.29	594.06	367.111	0.510385
2020	66464.08	696.11	383.387	0.461911
2021	60935.91	870.66	430.345	0.411452
2022	69113.16	1009.81	453.046	0.362769
2023	77568.51	1136.66	438.778	0.318397

Source: Own elaborations

Sources and references

STECF EWG 24-10

5.7 Summary sheet for Norway lobster in GSA 5

STECF advice on fishing opportunities

The ICES category 3 advice and reference points provided for this stock are those computed in the EWG 23-09, since the provided advice were considered valid for 2024 and 2025.

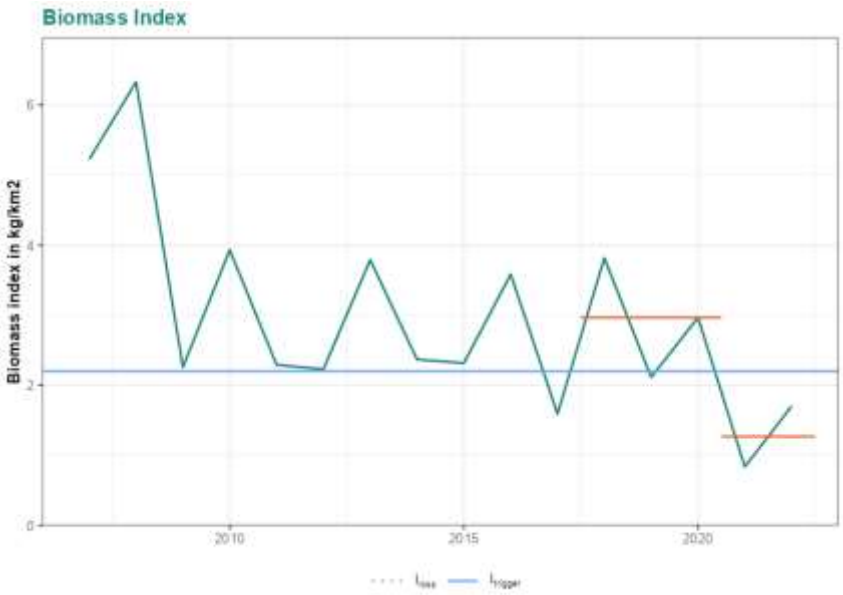
The EWG 24-10 recommends trying to perform a full analytical assessment for the next year.

Based on MSY considerations, STECF EWG 24-10 advises to decrease the total catch by 30% relative to the catches in 2022 equivalent to catches of no more than 25.7 tons in each of 2024 and 2025 implemented through either catch restrictions or effort reduction for the relevant fleets.

Stock development over time

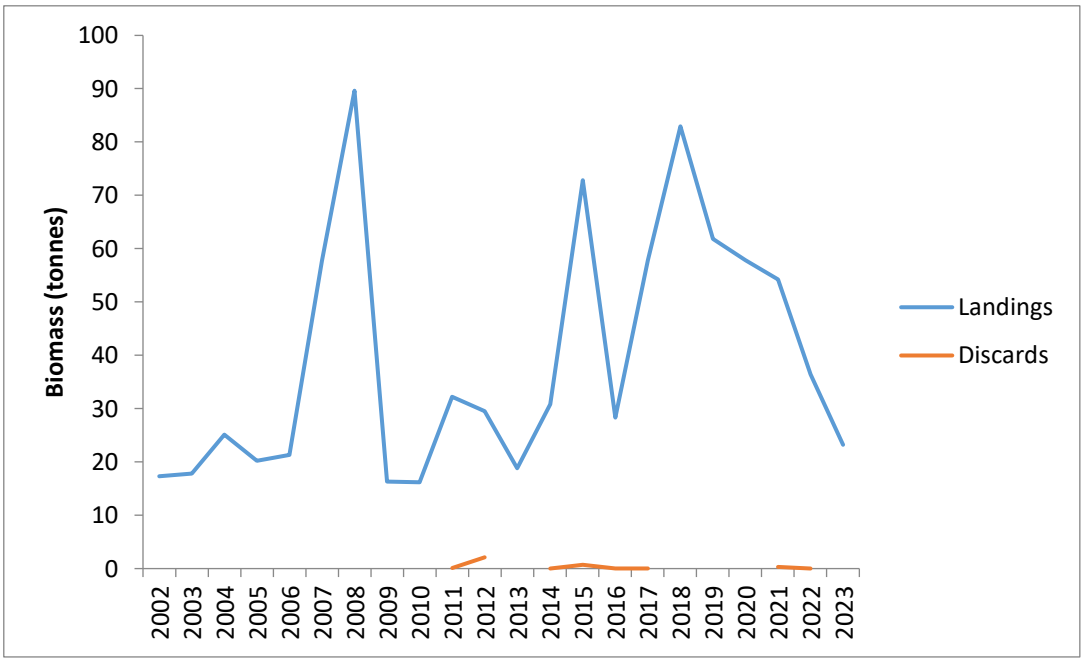
The MEDITS biomass index was used to provide an index for change (Figure 5.7.1). Only recent survey data since 2007 is considered useful due to the very small number of hauls prior to that year. MEDITS indicated that abundance has fluctuated in recent years. From 2009 the stock has decreased rapidly reaching a minimum in 2021. The biomass in 2021 is below the reference point $I_{trigger}$ and is the lowest observed. Catches (Figure 5.7.2) in 2015 and 2018 have increased considerably relative to earlier years. Since 2019 catches are declining.

Figure 5.7.1 Norway lobster in GSA 5: MEDITS biomass index. The blue line represents $I_{trigger}$. The two red segments represent the mean index of 2021-2022 and of 2018-2020.



Source: Own elaborations

Figure 5.7.2 Norway lobster in GSA 5: Catch (tonnes) from 2009 to 2023.



Source: Own elaborations

Stock and exploitation status

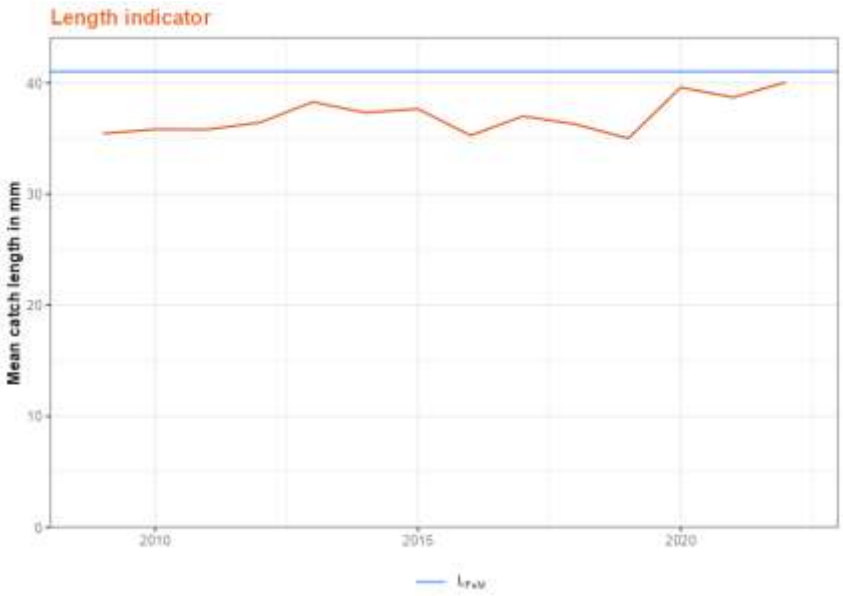
The power of the fishing pressure proxy is considered to be poor. The fishing pressure proxy on the stock is below FMSY proxy (Table 5.7.1), and the stock size index is below MSY Btrigger proxy (Itrigger) (Figure 5.7.3).

Table 5.7.1 Norway lobster in GSA 5: State of the stock and fishery relative to reference points.

Status	2020	2021	2022
F / $F_{MSY\ proxy}$	F > $F_{MSY\ proxy}$	F > $F_{MSY\ proxy}$	F > $F_{MSY\ proxy}$
B / MSY $B_{trigger\ proxy}$	B < MSY $B_{trigger\ proxy}$	B < MSY $B_{trigger\ proxy}$	B < MSY $B_{trigger\ proxy}$

Source: Own elaborations

Figure 5.7.3 Norway lobster in GSA 5: Length indicator (mean length of fish in the catch divided by MSY proxy reference length). The exploitation status is below $F_{MSY\ proxy}$ when the indicator ratio value is higher than 1 (shown by the blue line).



Source: Own elaborations

Catch scenarios

ICES framework for category 3 stocks was applied (rfb rule, method 2.1, ICES, 2022). A survey biomass index was used as an indicator of stock development. The advice is based on the recent catches, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a ratio of observed mean length in the catch relative to the target mean length, a biomass safeguard, and a precautionary multiplier. The stability clause was considered but not applied since the stock is below $I_{trigger}$.

Table 5.7.2 Norway lobster in GSA 5: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables.

Last year catch Cy-1 (catch in 2022)	36.67 tonnes
Stock biomass trend	
Index A (2022, 2022)	1.27 kg/km2
Index B (2018, 2019, 2020)	3.00 kg / km2
r: Index ratio (A/B)	0.43
Fishing pressure proxy	
Mean catch length ($\bar{L}$y−1=L2022)	40 mm
MSY proxy length (LF=M)	41 mm
f: multiplier for relative mean length in catches ($\bar{L}$y−1/ LF=M 2021)	0.98
Biomass safeguard	
Last index value (I2021)	1.70 kg / km2
Index trigger value (Itrigger=1.4*Iloss)	1.17 kg / km2
b: index relative to trigger value, min{I2021/Itrigger, 1}	1.00
Precautionary multiplier to maintain biomass above Blim with 95% probability	
m: multiplier (generic multiplier based on life history)	0.95

rfb calculation*	
Uncertainty cap (+20%/-30% compared to Cy-1, only considered if b≥1)	Applied
Discard rate	0.7%
Catch advice for 2023	25.7 tonnes
% advice change**	-30%

* A(y+1) = Ay × r × f × b × m limited by stability clause if applicable.
** Advice value for 2024 relative to the catch in 2022 (36.67 tonnes).
Source: Own elaborations

Basis of the advice

Table 5.7.3 Norway lobster in GSA 5: The basis of the advice.

Advice basis	MSY approach (ICES category 3). Method 2.1
Management plan	

Quality of the assessment

Due to the model instability as shown by the retrospective analysis and by the residuals pattern, the EWG 23-09 concluded that the output of this model was not suitable to provide advice from the basis of the current status of the stock. The ICES category 3 Method 2.1 was applied.

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.7.4 Norway lobster in GSA 5: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	1.17	Biomass index trigger value (Itrigger), defined as Itrigger = Iloss×1.4, where Iloss is the lowest observed historical biomass index value from 2021 MEDITS in GSA 5. In kg / km2.	STECF EWG 23-09
	F_{MSY}	1.00	$L_{mean}/L_{F=M}$; Mean catch length divided by MSY proxy reference length ($L_{F=M}$).	STECF EWG 23-09
Precautionary approach	B_{lim}		Not defined	
	B_{pa}		Not defined	
	F_{lim}		Not defined	
	F_{pa}		Not defined	
Management plan	MSY $B_{trigger}$		Not defined	
	B_{lim}			
	F_{MSY}		Not defined	

	target range F_{lower}			
	target range F_{upper}			

Source: Own elaborations

Basis of the assessment

Table 5.7.5 Norway lobster in GSA 5: Basis of assessment and advice.

Assessment type	Survey biomass trend applying the rfb rule for advice (ICES, 2022)
Input data	DCF commercial data (landings) and scientific survey (MEDITS) data
Discards and bycatch	Discards were negligible (<1%) but included.
Indicators	Length-based indicator
Other information	
Working group	STECF EWG 23–09

Source: Own elaborations

History of the advice, catch, and management

Table 5.7.6 Norway lobster in GSA 5: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2020	$F = F_{MSY}$		44.1	57.8	
2021	$F = F_{MSY}$		44.1	53.5	
2022	$F = F_{MSY}$		37.4	36.6	
2023	$F = F_{MSY}$		37.4	23.2	
2024	MSY approach (ICES category 3 method 2.1)		26.7		
2025	MSY approach (ICES category 3 method 2.1)		26.7		

Source: Own elaborations

History of the catch and landings

Table 5.7.7 Norway lobster in GSA 5: Catch and effort distribution by fleet in 2023 as estimated by and reported to STECF.

2023	Wanted catch	Discards
Catch (t)	Otter trawl 100%	
	23.2 t	0 t

Effort	Fishing days	
	NA	NA

Source: Own elaborations

Table 5.7.8 Norway lobster in GSA 5: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	Spain – GSA5	STECF total landings	Total Effort* (Fishing days)
2002	17.3	17.3	
2003	17.8	17.8	
2004	25.1	25.1	12012
2005	20.2	20.2	11497
2006	21.3	21.3	10507
2007	57.8	57.8	11907
2008	89.6	89.6	12226
2009	16.3	16.3	10934
2010	16.2	16.2	11239
2011	32.3	32.3	10498
2012	29.5	29.5	10568
2013	18.8	18.8	9942
2014	30.8	30.8	11817
2015	72.9	72.9	11965
2016	28.3	28.3	10490
2017	57.8	57.8	10162
2018	82.9	82.9	8715
2019	61.8	61.8	8202
2020	57.8	57.8	7306
2021	54.3	54.3	6439
2022	36.4	36.4	
2023	23.2	23.2	

*Effort data is taken from STECF EWG 22-10. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.7.19 Norway lobster in GSA 5: Assessment summary. Weights are in tonnes.

Year	Biomass Index	Landings tonnes	Discards tonnes	Total Catch
2009	2.26	16.34	0.05	16.39

Year	Biomass Index	Landings tonnes	Discards tonnes	Total Catch
2010	3.93	16.19	0	16.19
2011	2.25	32.26	0.07	32.33
2012	2.23	29.50	2.11	31.61
2013	3.79	18.82	0	18.82
2014	2.37	30.80	0.03	30.83
2015	2.32	72.87	0.74	73.61
2016	3.58	28.33	0.02	28.35
2017	1.59	57.82	0.02	57.84
2018	3.82	82.91	0	82.91
2019	2.12	61.85	0.1	61.95
2020	2.97	57.80	0	57.80
2021	0.84	54.26	0.32	54.58
2022	1.70	36.41	0.04	36.45
2023	1.48	23.21	0	23.21

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 23-09.

ICES. 2022. ICES technical guidance for harvest control rules and stock assessments for stocks in category 2 and 3. In: Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. https://doi.org/10.17895/ices.advice.19801564

5.8 Summary sheet for Norway lobster in GSA 6

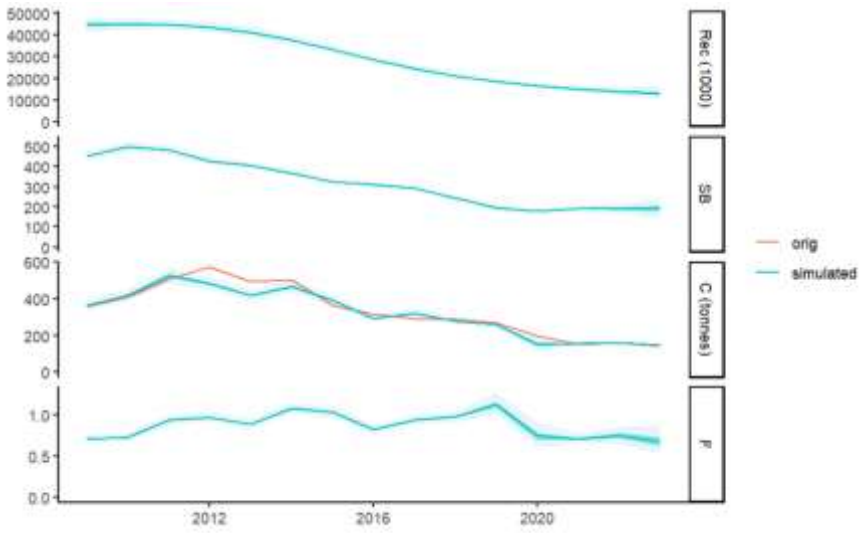
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.29 and corresponding catches in 2025 should be no more than 74.3 tons. Since the stock is below B_{pa}, F could be further reduced (Freduced = 0.11) in order to increase the likelihood of biomass being above B_{pa} in the short term, corresponding to 31.8 tons of catch in 2025.

Stock development over time

Catches of Norway lobster show a decreasing trend from 2011 to 2021 and then maintain the same tendency for the year 2023, with a drastic reduction since 2020. SSB and Recruitment decreased until 2019 and then maintain stable during the last years. Fbar (3-6) shows fluctuation with a sharp reduction in 2020. Catches decreased progressively over time since 2010. Fbar (3-6) reached the value of 0.68 in 2023, at a level nearly two times F_{max}.

Figure 5.8.1 Norway lobster in GSA 6: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.68) is 2.34 times the reference point F_{max}, used as a proxy of F_{MSY} (=0.29).

Table 5.8.1 Norway lobster in GSA 6: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F/F_{MSY}	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$

$F/F_{MSY\ Transition}$		$F < F_{MSY}$ Transition	$F < F_{MSY}$ Transition	$F > F_{MSY}$ Transition	$F > F_{MSY}$ Transition
B/ B_{lim}	$B< B_{lim}$	$B< B_{lim}$	$B< B_{lim}$	$B< B_{lim}$	$B< B_{lim}$
B/ B_{pa}	$B< B_{pa}$	$B< B_{pa}$	$B< B_{pa}$	$B< B_{pa}$	$B< B_{pa}$
B/ B_{MSY}	$B< B_{MSY}$	$B< B_{MSY}$	$B< B_{MSY}$	$B< B_{MSY}$	$B< B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.8.2 Norway lobster in GSA 6: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 3-6 (2023)	0.68	Fsq = F in the last year
SSB (2023)	188.02	SSB intermediate year from STF output
Rage2 (2023 - 2024)	14 011.68	Recruitment will be set as geometric mean of the last 3 years
Total Catch (2023)	144.95	Catch intermediate year from STF output

Source: Own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years.

Table 5.8.3 Norway lobster in GSA 6: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total} (ages 3-6) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	74.31	0.29	301.19	60.19	-49.64
$F_{Reduced}$ $B<B_{pa}$^^^	31.8	0.11	374.85	99.37	-78.45
Other scenarios					
Zero catch	0	0	434.27	130.97	-100
Status quo	146.81	0.68	191.91	2.07	-0.51

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.
^^^$F_{Reduced}$ $B<B_{pa}$ is based on ICES advice rule when B in TAC year is less than B_{pa}
Source: Own elaborations

Basis of the advice

Table 5.8.4 Norway lobster in GSA 6: The basis of the advice.

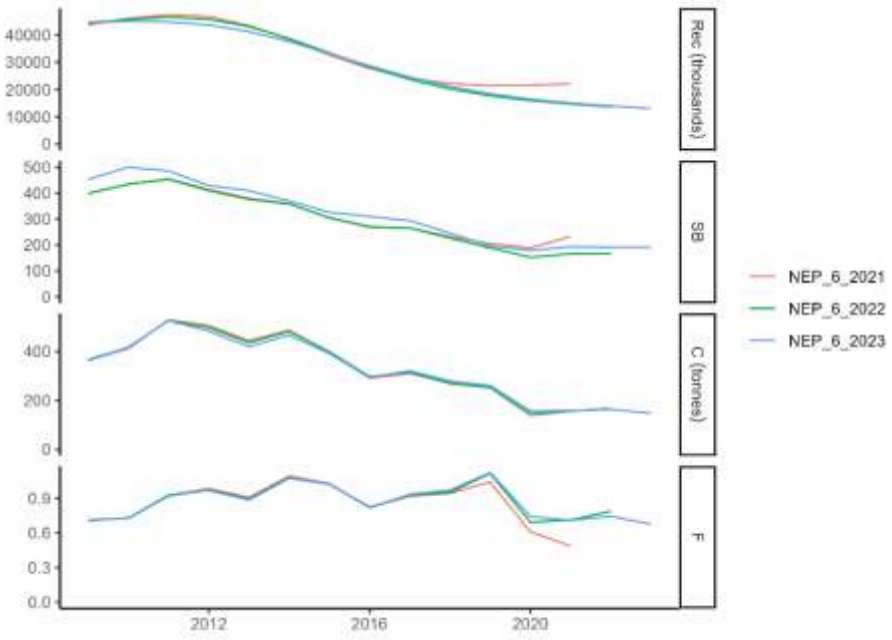
Advice basis	F_{MSY}
Management plan	Western Mediterranean Multi-Annual Plan

Quality of the assessment

Commercial catches showed better internal consistency than MEDITS survey index. The historic assessment is stable, and the assessment model was kept the same as during the

previous working group EWG23-09. The retrospective analysis showed consistency in the estimation of F estimated in the assessment of 2023. All the diagnostics were considered acceptable.

Figure 5.8.2 Norway lobster in GSA 6: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.8.5 Norway lobster in GSA 6: Reference points, values, and their technical basis (Gm stock / recruitment model).

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Fpa	STECF EWG 24-10
	F_{MSY}	0.29	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	238		STECF EWG 24-10
	B_{pa}	476	2 x Blim	STECF EWG 24-10
	B_{MSY}	953		STECF EWG 24-10
	F_{pa}		Not defined	STECF EWG 24-10
Management plan	MSY $B_{trigger}$		Not defined	STECF EWG 24-10
	B_{lim}		Not defined	STECF EWG 24-10
	F_{MSY}	0.29	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.19	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.39	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.8.6 Norway lobster in GSA 6: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included in the total catch; neither the landings nor the discards contain a significant amount of catches BMS (<1%).
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.8.7 Norway lobster in GSA 6: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	F = FMSY		125	245	1.2
2020	F = FMSY		128	200	1.5
2021	F = FMSY		169	149	0
2022	F = FMSY		206	167	
2023	F = FMSY*		111	147.56	
2024	F = FMSY*		41.57	144.95	
2025	F = FMSY*		74.31		

Source: Own elaborations
*Note that from this year the proxy to Fmsy is Fmax instead of F0.1

History of the catch and landings

Table 5.8.8 Norway lobster in GSA 6: Catch and effort distribution by fleet in 2023 as estimated by and reported to STECF.

2023		Wanted catch				Discards
Catch (t)	162.63	Otter trawl 100%	Gillnets 0%	Trammel nets 0%	Other 0%	0
Effort	NA	NA	NA	NA	NA	
		NA				

Source: Own elaborations

Table 5.8.9 Norway lobster in GSA 6: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	SPAIN GSA6	Total Effort (Fishing Days)
2002	187.5	
2003	381.8	
2004	321.7	
2005	352.0	
2006	390.2	
2007	409.4	
2008	393.8	
2009	355.6	

2010	406.5	
2011	496.8	
2012	506.1	
2013	478.4	
2014	490.0	
2015	355.2	
2016	308.1	
2017	282.2	
2018	287.0	
2019	269.1	
2020	198.8	
2021	149.4	
2022	162.63	
2023	142.27	

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.8.10 Norway lobster in GSA 6: Assessment summary. Weights are in tonnes.

Year	Recruitment age 2 (x1000)	SSB (t)	Catch (t)	Fbar 3-6
2009	44716.1	453.0	361.49	0.704
2010	45004.5	499.9	417.21	0.730
2011	44830.5	485.7	525.29	0.930
2012	43685.1	429.1	482.68	0.968
2013	41251.6	409.5	419.17	0.886
2014	37609.5	369.7	467.05	1.074
2015	33215.2	325.9	390.98	1.023
2016	28687.5	310.2	293.58	0.819
2017	24556.3	293.4	320.77	0.935
2018	21124.4	245.7	279.11	0.972
2019	18466.6	195.8	259.77	1.123
2020	16501.2	178.7	152.03	0.743
2021	15066.4	193.3	157.21	0.708
2022	13976.2	191.3	163.68	0.745
2023	13063.9	191.3	147.56	0.677

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10

5.9 Summary sheet for European hake in GSA 8, 9, 10 and 11

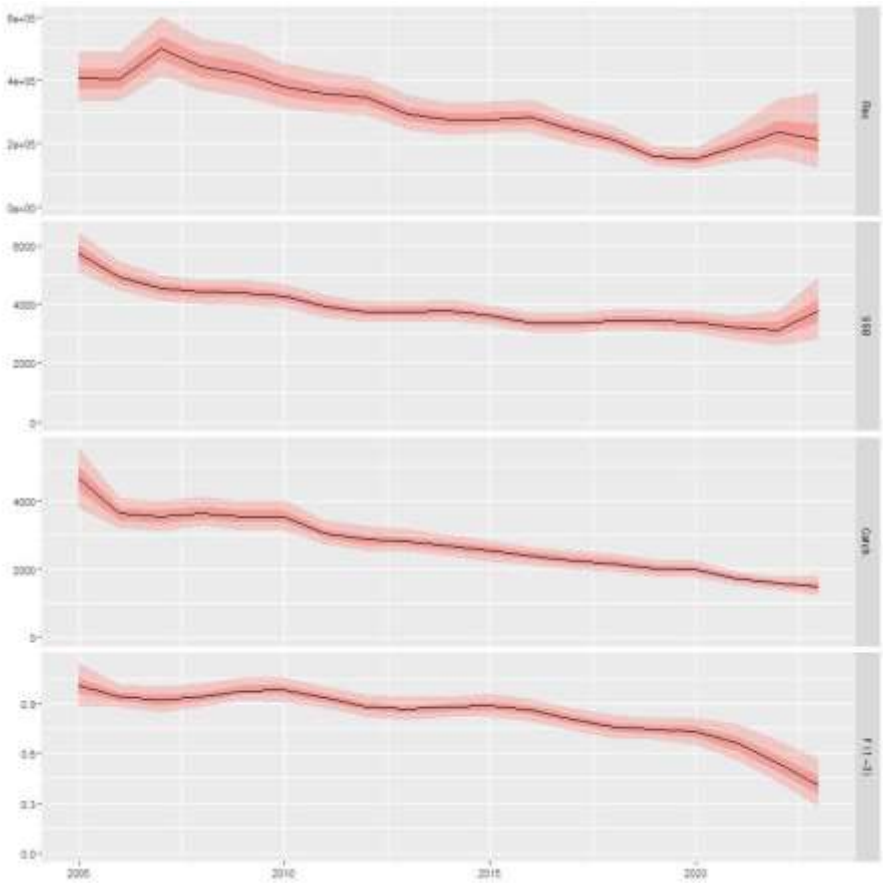
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.25 and corresponding catches in 2025 should be no more than 1326.7 tons. Since the stock is below B_{pa}, F could be further reduced (Freduced = 0.14) in order to increase the likelihood of biomass being above B_{pa} in the short term, corresponding to 777 tons of catch in 2025.

Stock development over time

Catches of European hake show a decline in the whole time series. SSB declines in the first part of the time series, reaching the lowest value in 2022, and slightly increases in the last year. The assessment shows a decreasing trend in the number of recruits with the minimum value reached in 2020 (150797 thousand) and a peak in 2022. Fbar (1-3) shows a declining trend, with the lowest value of 0.40 reached in 2023.

Figure 5.9.1. European hake in GSAs 8, 9, 10 & 11. Trends in catch, recruitment, fishing mortality resulting from the a4a model. The values from 2022 come from the catch in weight projection.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality is above the reference point F_{max}, used as proxy of F_{MSY} (=0.25).

Table 5.9.1. European hake in GSAs 8, 9, 10 & 11. State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY}	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$
F / F_{MSY} transition		$F > F_{MSY}$ transition	$F > F_{MSY}$ transition	$F > F_{MSY}$ transition	$F > F_{MSY}$ transition
B / B_{lim}	$B < B_{lim}$	$B < B_{lim}$	$B < B_{lim}$	$B > B_{lim}$	$B > B_{lim}$
B / B_{pa}	$B < B_{pa}$	$B < B_{pa}$	$B < B_{pa}$	$B < B_{pa}$	$B < B_{pa}$
B / B_{MSY}	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.9.2. European hake in GSAs 8, 9, 10 & 11. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 1-3 (2024)	0.40	Fsq = F in the last year
SSB (2024)	4998.5	SSB intermediate year from STF output
Rage0 (2024,2025)	210890.5	Recruitment will be set as mean of the last 8 years
Total Catch (2024)	1793.7	Catch intermediate year from STF output

Source: Own elaborations

Biological parameters and fishery selection taken as a mean of the last three years.

Table 5.9.3. European hake in GSAs 8, 9, 10 & 11. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-3) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY} / MAP	1326.66	0.25	7886.76	57.78	-10.16
$F_{Reduced}$ $B<B_{pa}$ ^^^	776.97	0.14	8657.68	73.21	-47.38
Other scenarios					

Basis	Total catch* (2025)	F_{total}# (ages 1-3) (2025)	SSB (2026)	% SSB change***	% Catch change^
Zero catch	0	0	9766.72	95.39	-100
Status quo	2013.54	0.4	6941.48	38.87	36.35

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}

*** % change in SSB 2026 to 2024

^Total catch in 2025 relative to catch in 2023.

^^^$F_{Reduced}$ B<B_{pa} is based on ICES advice rule when B in TAC year is less than B_{pa}

Source: Own elaborations

Basis of the advice

Table 5.9.4. European hake in GSAs 8, 9, 10 & 11. The basis of the advice.

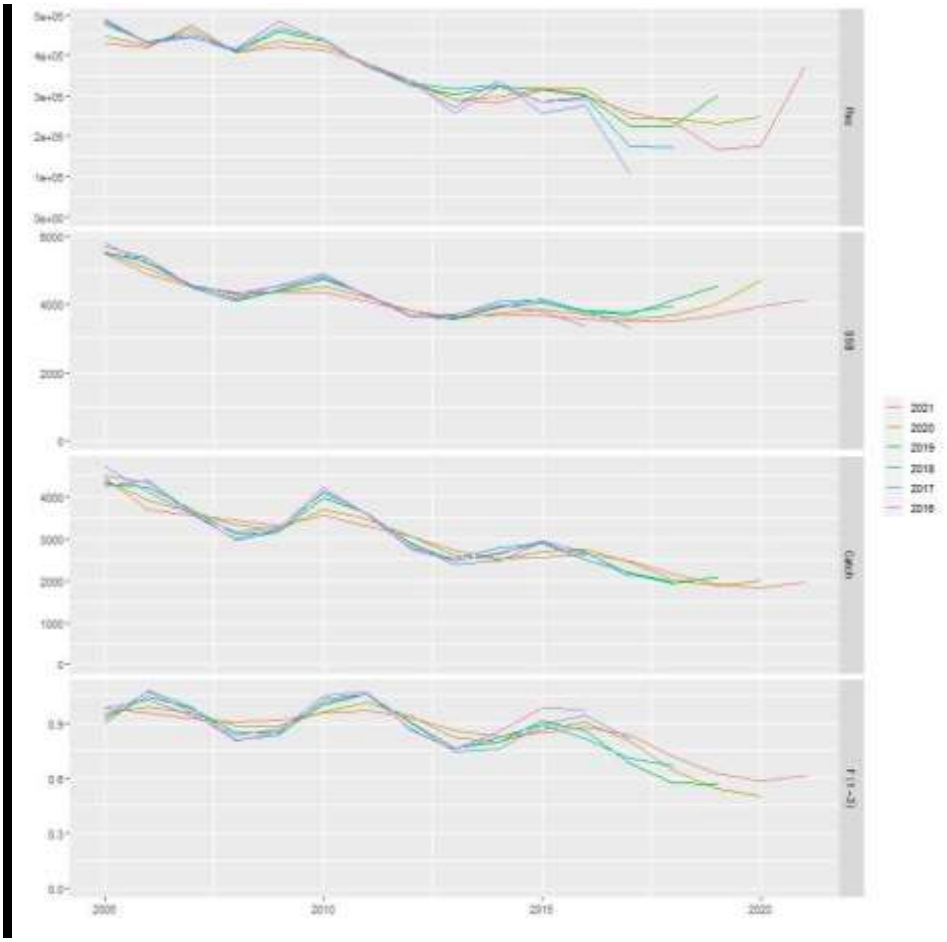
Advice basis	F_{MSY}
Management plan	0.25

Quality of the assessment

The assessment was carried out using a catch-at-age model (a4a).

Both catches and survey indices showed good internal consistency. The assessment carried out during the benchmark meeting is stable and the assessment model was not modified. All the diagnostics were considered acceptable. The retrospective shows some instability, but overall the conclusion of F greater than F_{MSY} over the time series is consistent.

Figure 5.9.2. European hake in GSAs 8, 9, 10 & 11. Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.9.5. European hake in GSAs 8, 9, 10 & 11. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.25	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	5394	Estimated	STECF EWG 24-10
	B_{pa}	10788	Blim*2	STECF EWG 24-10
	B_{MSY}	43749.9	B_{max}	STECF EWG 24-10
	F_{pa}		Not defined	
Management plan	MSY $B_{trigger}$		Not defined	
	B_{lim}		Not defined	
	F_{MSY}	0.25	F_{max} as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.17	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.35	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.9.6. European hake in GSAs 8, 9, 10 & 11. Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?
Source: Own elaborations

History of the advice, catch, and management

Table 5.9.7. European hake in GSAs 8, 9, 10 & 11. STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		494	2075	
2020	$F = F_{MSY}$		772	1983	
2021	$F = F_{MSY}$		953.6	1964	
2022	$F = F_{MSY}$		920.3	1536	
2023	$F = F_{MSY}$		814.1	1477	
2024	$F = F_{MSY}$		919		
2025	$F = F_{MSY}$		1326.66		

Source: Own elaborations

History of the catch and landings

Table 5.9.8. European hake in GSAs 8, 9, 10 & 11. Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF.

2023		Wanted catch				Discards
Catch (t)		Beam trawl 72.3%	Gillnets 15.4%	Trammel nets 3.8%	Other 8.5%	t
	1499.04	1083.3	231.3	56.4	128	168.6
Effort		NA	NA	NA	NA	
		Fishing days				

Source: Own elaborations

Table 5.9.9. European hake in GSAs 8, 9, 10 & 11. History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	FRANCE GSA8	ITALY GSA9	ITALY GSA10	ITALY GSA11	Total landings	Total Effort
2005		1859.98	1484.74	928.02	4287.74	884051

2006		2176.49	1544.07	341.06	4076.62	896282
2007		1733.03	1268.66	169.58	3186.27	828912
2008		1321.13	1122.85	138.77	2597.75	665886
2009	15.10	1308.47	1090.51	260.54	2674.62	757456
2010	12.59	1467.11	1329.45	175.88	2985.03	716822
2011	13.24	1351.74	1278.52	277.42	2920.92	780290
2012	17.68	1011.52	1107.24	263.45	2399.89	661755
2013	2.98	1341.63	1052.19	267.37	2664.17	638490
2014	12.86	1264.95	1271.11	258.65	2807.57	660790
2015	11.77	1047.70	1043.44	326.23	2429.14	705043
2016	34.49	782.25	1051.95	339.38	2208.06	727409
2017	13.54	572.37	870.43	357.29	1813.63	654761
2018	19.79	605.35	821.02	392.81	1838.97	650271
2019	17.14	722.26	765.17	445.53	1950.10	
2020	19.01	507.82	933.24	248.39	1708.46	
2021	18.58	455.40	886.82	211.98	1572.78	
2022	14.06	391.06	602.51	237.12	1244.75	
2023	13.41	568.59	568.91	179.50	1330.40	

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.9.10. European hake in GSAs 8, 9, 10 & 11. Assessment summary. Weights are in tonnes.

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2005	407309	5697.3	4616	1.01
2006	403689	4907.6	3607.3	0.94
2007	501527	4534.1	3523.5	0.92
2008	444801	4408.1	3630.2	0.94
2009	422576	4377	3526.6	0.98
2010	379301	4258	3526.5	0.98
2011	356905	3905.6	3029.8	0.93

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2012	347110	3730.6	2863.3	0.88
2013	293848	3715	2790.4	0.86
2014	274501	3757.5	2666.8	0.87
2015	279020	3597.5	2527.4	0.88
2016	282831	3357.7	2372	0.85
2017	243253	3337.4	2251	0.80
2018	211813	3442.4	2155.9	0.76
2019	159310	3424.9	2011	0.74
2020	150797	3374	1977.5	0.73
2021	192183	3189.3	1721.5	0.66
2022	234134	3131.4	1576.8	0.54
2023	212802	3753.5	1476.7	0.40

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10, STECF EWG 24-02

5.10 Summary sheet for Deep-water rose shrimp in GSAs 8, 9, 10 & 11

STECF advice on fishing opportunities

STECF EWG 24-10 advises that the catches of Deep-water rose shrimp in 2025, consistent with F0.1 (1.39), should not exceed 1742 tonnes.

Stock development over time

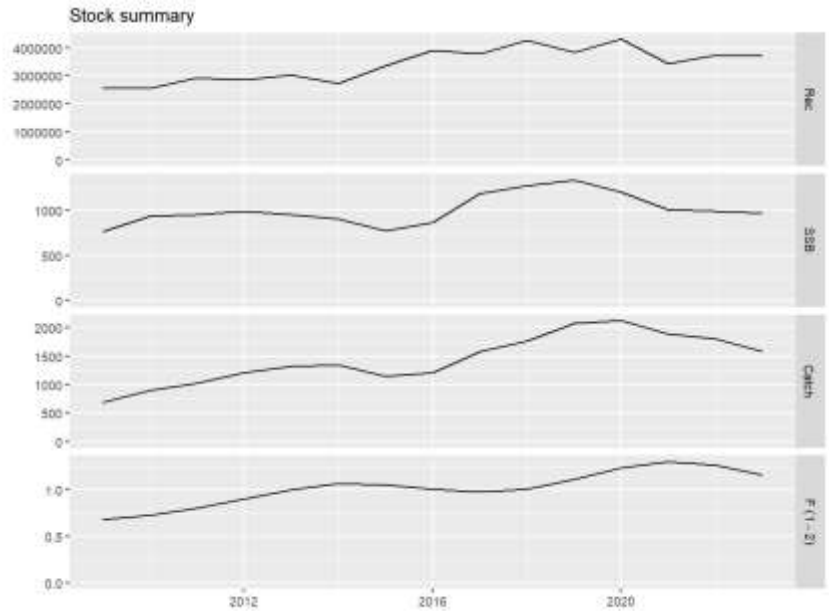
Recruitment
The recruitment fluctuates across the years, showing a general increase from 2009 (2,591,147 thousand individuals) to a peak in 2020 (4,319,066 thousand individuals), after which it declines slightly but remains elevated in 2022 and 2023 (around 3,730,804 and 3,724,172 thousand individuals, respectively).

Spawning stock biomass (SSB)
The SSB shows an initial increase from 2009 (764.91 tons) to 2019 (1335.97 tons), indicating a general rise in reproductive biomass during this period. However, after 2019, there is a noticeable decline, with SSB falling to 968.32 tons by 2023.

Catch
After the minimum value in 2009 (638 tons), the catches have shown a constant increase over the years, until reaching the maximum value in 2020, corresponding to 2082 tons. A fluctuation was observed in the last two years of the time series.

Fishing mortality (F)
The fishing mortality shows a consistent increase from 2009 (0.677) to 2021 (1.299), indicating escalating fishing pressure. However, there is a slight reduction in F from 2021 (1.299) to 2023 (1.153).

Figure 5.10.1 Deep-water rose shrimp in GSAs 8, 9, 10 & 11. Outputs of the a4a assessment.



Source: Own elaborations

Stock and exploitation status

(1) Current F (1.15), estimated applying catch in biomass projection as F_{bar1-2} in the last year of the time series (2023), is below the reference point $F_{0.1}$ (1.39), which is a proxy of F_{msy} and is used as the exploitation reference point consistent with high long-term yields. This indicates that Deep-water rose shrimp stock in GSAs 8, 9, 10 and 11 is sustainably exploited. SSB is above BMSY.

Table 5.10.1 Deep-water rose shrimp in GSAs 8, 9, 10 & 11. State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / FMSY	F < FMSY	F > FMSY	F > FMSY	F < FMSY	F < FMSY
F / FMSY Transition		F > FMSY Transition	F > FMSY Transition	F < FMSY Transition	F < FMSY Transition
B / Blim	B > Blim	B > Blim	B > Blim	B > Blim	B > Blim
B / Bpa	B > Bpa	B > Bpa	B > Bpa	B > Bpa	B > Bpa
B / BMSY	B > BMSY	B > BMSY	B > BMSY	B > BMSY	B > BMSY

Catch scenarios

Table 5.10.2 Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 1-2 (2024)	1.15	Fsq = F in the last year
SSB (2024)	1024.4	SSB intermediate year from STF output
Rage0 (2024,2025)	3357265	Recruitment will be set as geometric mean of the last 15 years
Total Catch (2024)	1667.8	Catch intermediate year from STF output

Source: Own elaborations

Table 5.10.3 Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY} / MAP	1742	1.39	800	-21.9	10.5
Other scenarios					
$F_{MSY\ lower}$	1330	0.92	1097	7.1	-15.6
$F_{MSY\ upper}$	2060	1.88	599	-41.5	30.7

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
Zero catch	0.0	0.0	2390	133.3	-100.0
Status quo	1553	1.15	930	-9.2	-1.4

* $F_{MSY\ transition}$ is based on a linear change in F from 2019 to F_{MSY} in 2025.
** $F_{MSY\ upper}$ is not tested and is assumed not to be precautionary STECF does not advise fishing at F > F_{MSY}.
*** % change in SSB 2024 to 2026
^Total catch in 2025 relative to 2023.
Source: Own elaborations

Basis of the advice

Table 5.10.4 Deep-water rose shrimp in GSAs 8, 9, 10 & 11 The basis of the advice.

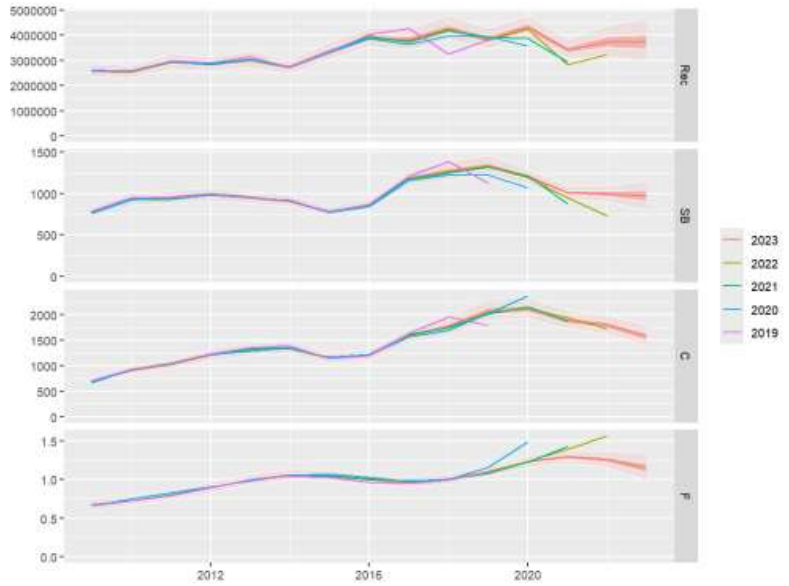
Advice basis	F_{MSY}
Management plan	1.39

Source: Own elaborations

Quality of the assessment

The a4a model employed in this assessment aligns with that used by STECF EWG 22-09, with the exception of the smoothing parameter (k) in the fmodel (~ factor(replace(age, age > 2, 2)) + s(year, k = 6)), which was adjusted to 6 from its previous value of 5. The revised model demonstrated stability in comparison to the previous assessment, and the results were consistent with last year's findings, except for the fishing mortality (F), which is now showing a declining trend rather than the previously reported increase. The status of the deep-water rose shrimp stock across GSAs 8, 9, 10, and 11 reflects a declining trend in both biomass and catch over recent years.

Figure 5.10.2 Deep-water rose shrimp in GSAs 8, 9, 10 & 11 Results of the retrospective analysis (a4a) in the stock assessment performed in 2022 (STECF EWG24-10).



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.10.5 Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	1.39	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	199	Default based on 25%BF0.1 and GM recruitment	STECF EWG 24-10
	B_{pa}	397	Blim * 2	STECF EWG 24-10
	B_{MSY}	794	B F0.1	STECF EWG 24-10
	F_{pa}		Not defined	STECF EWG 24-10
Management plan	MSY $B_{trigger}$		Not defined	STECF EWG 24-10
	B_{lim}		Not defined	STECF EWG 24-10
	F_{MSY}	1.39	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	MAP target range F_{lower}	0.92		STECF EWG 24-10
	MAP target range F_{upper}	1.88		STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.10.6 Basis of the assessment and advice.

Assessment type	Statistical catch-at-age (a4a)
Input data	Landings at length to landings at age (age slicing) from DCF data
Discards, BMS landings*, and bycatch	Discards included
Indicators	MEDITS in GSAs 8, 9, 10 & 11
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.10.7 STECF advice, and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catches	STECF discards
2019	F = FMSY		1800	2035	
2020	F = FMSY		2082	1644	
2021	F = FMSY		1784	1818	
2022	F = FMSY		1545	1685	
2023	F = FMSY		1465	1576	
2024	F = FMSY		1412		
2025	F = FMSY		1742		

Source: Own elaborations

History of the catch and landings

Table 5.10.8 Catch and effort distribution by fleet in 2023 as estimated by and reported to STECF.

2023		Wanted catch				Discards
Catch (t)		Bottom trawl 99.5%	Gillnets %	Trammel nets %	Other 0.5%	t
	1462	tonnes				138
Effort						
		Nominal effort (‘000 kW*fishing days)				

Source: Own elaborations

Table 5.10.9 History of commercial landings; both the official reported values are presented by country, official reported BMS landings, STECF estimated landings and the TAC are presented. All weights are in tonnes.

Year	GSA8 FRA	GSA9 ITA	GSA10 ITA	GSA11 ITA	Total landings	Discards	STECF total catches
2009		303	379	22	704	46	688
2010	4	473	370	23	870	30	906
2011	5	551	405	53	1015	66	1024
2012	6	621	459	42	1129	12	1212
2013	5	576	597	23	1200	39	1319
2014	2	561	509	30	1103	48	1345
2015	7	791	547	39	1385	103	1143

2016	8	836	542	46	1432	41	1204
2017	7	857	519	48	1431	46	1581
2018	7	904	555	209	1675	50	1771
2019	6	896	667	181	1750	285	2078
2020	7	1000	840	130	1976	71	2120
2021	10	988	533	154	1686	222	1893
2022	10	835	488	148	1481	208	1798
2023	10	1013	368	71	1462	138	1576

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.10.10 Assessment summary. Weights are in tonnes. SSB estimated at mid-year.

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-2
2009	2591147	765	688	0.677
2010	2547348	935	906	0.727
2011	2945119	952	1024	0.798
2012	2862406	990	1212	0.896
2013	3022595	951	1319	1.001
2014	2735828	906	1345	1.062
2015	3354791	776	1143	1.053
2016	3910025	866	1204	1.002
2017	3797758	1183	1581	0.97
2018	4275666	1273	1771	1.01
2019	3847642	1336	2078	1.11
2020	4319066	1203	2120	1.23
2021	3428528	1009	1893	1.30
2022	3730804	994	1798	1.26
2023	3724172	968	1576	1.15

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10

5.11 Summary sheet for Red mullet in GSA 9

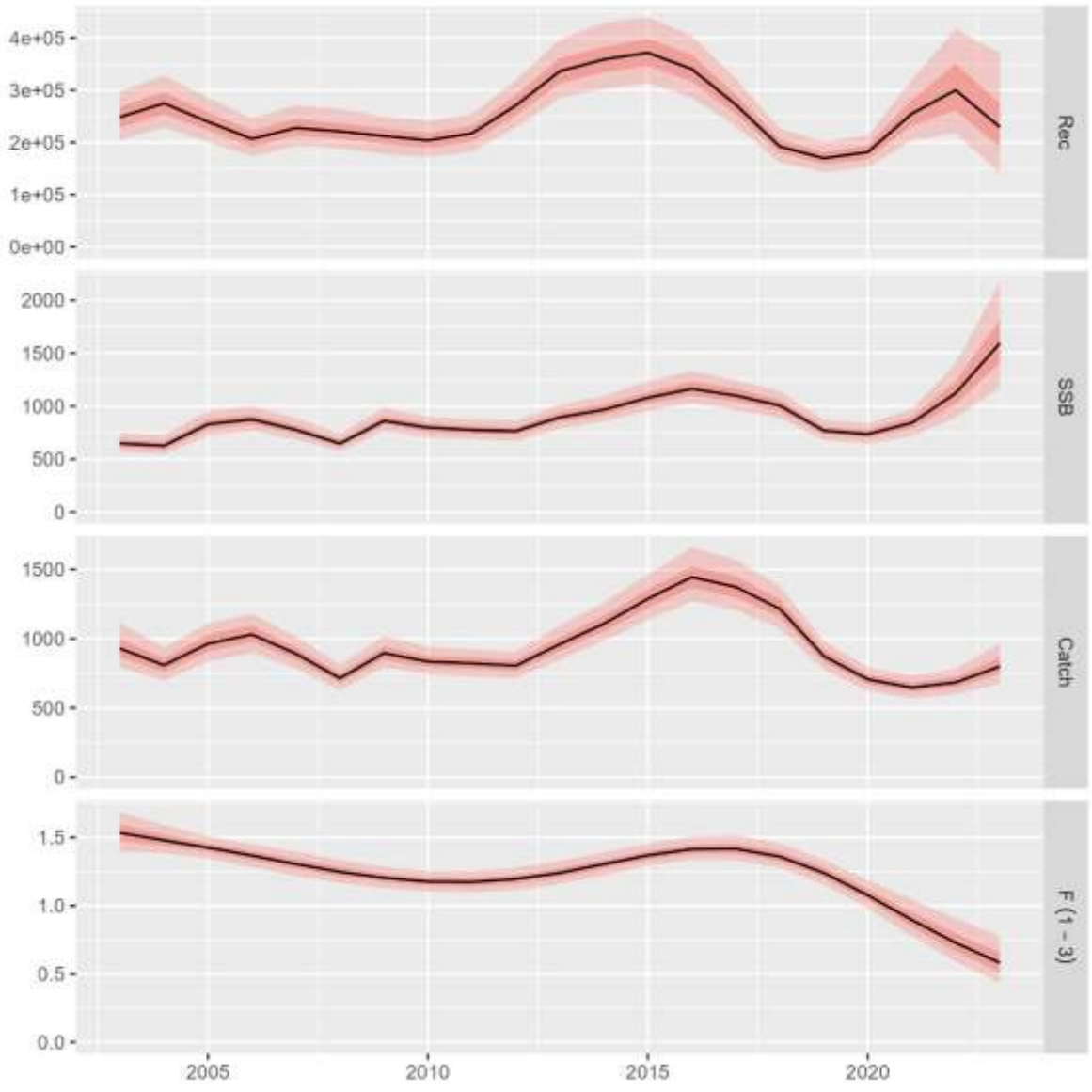
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.482 and corresponding catches in 2025 should be no more than 743 tons.

Stock development over time

Catches show an increasing pattern up to 2016, and then a steady decrease until 2021, in the last two years the catches started to increase again. SSB is increasing since 2020. F has reached its zenith in 2017 and has been decreasing since then, also during the increase of catches in the last two years.

Figure 5.11.1 Red mullet in GSA 9: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality is below the reference point $F_{0.1}$, used as proxy of F_{MSY} (0.482). SSB in 2023 is above B_{pa} and below B_{MSY}.

Table 5.11.1 Red mullet in GSA 9: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY}	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$
$F / F_{MSY\ Transition}$	-	$F > F_{MSY\ Transition}$	$F < F_{MSY\ Transition}$	$F < F_{MSY\ Transition}$	$F > F_{MSY\ Transition}$
B / B_{lim}	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$
B / B_{pa}	$B < B_{pa}$	$B < B_{pa}$	$B < B_{pa}$	$B < B_{pa}$	$B > B_{pa}$
B / B_{MSY}	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.11.2 Red mullet in GSA 9: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 1-3 (2024)	0.58	Fsq = F in the last year
SSB (2024)	1553	SSB intermediate year from STF output
Rage0 (2024,2025)	247385	Recruitment will be set as geometric mean of the last 21 years
Total Catch (2024)	867	Catch intermediate year from STF output

Source: Own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of last three years.

Table 5.11.3 Red mullet in GSA 9: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2025)	F_{total} (ages 1-3) (2025)	SSB*** (2026)	% SSB change^	% Catch change^^
STECF advice basis					
F_{MSY} / MAP	743	0.48	1730	+11.41	-7.27
Other scenarios					
$F_{MSY\ lower}$	528	0.32	1996	+28.53	-34.12
$F_{MSY\ upper}$**	949	0.66	1495	-3.69	+18.38
Zero catch	0.0	0.00	2735	+76.13	-100.0
Status quo	862	0.58	1592.21	+2.55	+7.54

* $F_{MSY\ transition}$ is based on a linear change in F from 2019 to F_{MSY} in 2025.

** $F_{MSY\ upper}$ is not tested and is assumed not to be precautionary STECF does not advise fishing at F > F_{MSY}.

*** SSB in the middle of the year.

^ % change in SSB 2026 to 2024.

^^ Total catch in 2025 relative to catch in 2023.
Source: Own elaborations

Basis of the advice

Table 5.11.4 Red mullet in GSA 9: The basis of the advice.

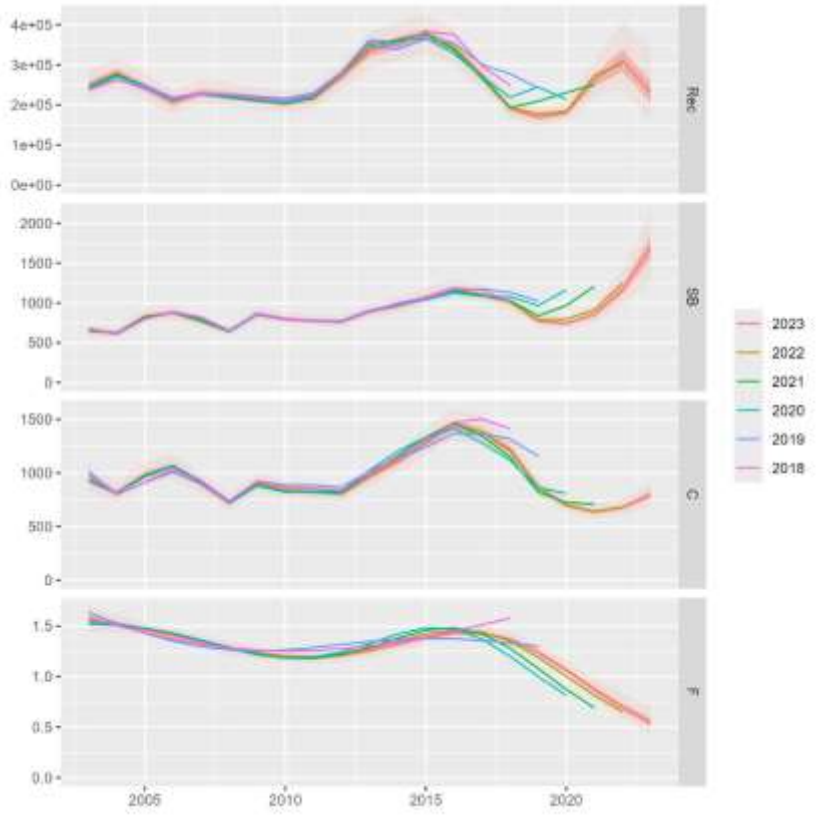
Advice basis	F_{MSY}
Management plan	0.48

Source: Own elaborations

Quality of the assessment

A new assessment model was used, as the update of the previous model lead to retrospective patterns deemed unacceptable. It is still a separable model, with less degrees of freedom across the years. This was necessary as the information in the tail of the time series was sparse due to the missing medits survey in 2022. In combination with a change in fishing pressure the model needed less freedom to lead to appropriate results. As the years go on, it is expected that the model will change again. All the diagnostics were considered acceptable.

Figure 5.11.2 Red mullet in GSA 9: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

Changed assessment model as outlined above.

Reference points

Table 5.11.5 Red mullet in GSA 9: Reference points, values, and their technical basis, they were re-estimated in EWG24-10 as the assessment model had changed.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.482	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	570	Default based on 25% $B_{F0.1}$ and GM recruitment	STECF EWG 24-10
	B_{pa}	1140	B_{lim} * 2	STECF EWG 24-10
	B_{MSY}	2280	$B_{F0.1}$	STECF EWG 24-10
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.482	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.321	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.658	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.11.6 Red mullet in GSA 9: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings
Source: Own elaborations

History of the advice, catch, and management

Table 5.11.7 Red mullet in GSA 9: STECF advice and STECF estimates of catches reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catches
2019	$F = F_{MSY}$		821.0	942.1
2020	$F = F_{MSY}$		521	599.0
2021	$F = F_{MSY}$		667.6	853.4
2022	$F = F_{MSY}$		1033	712.7
2023	$F = F_{MSY}$		861.9	796
2024	$F = F_{MSY}$		976	
2025	$F = F_{MSY}$		743	

Source: Own elaborations

History of the catch and landings

Table 5.11.8 Red mullet in GSA 9: Catch in 2023 and effort distribution by fleet in 2021 as estimated by and reported to STECF.

2023	Wanted catch				Discards
Catch 795.55 t	Otter trawl 91.8%	Gillnets 3.1%	Trammel nets 2.12%	Others 3.1%	79.4 t
	730	24.5	16.4	24.6	
Effort	NA				
	Fishing Days				

Source: Own elaborations

Table 5.11.9 Red mullet in GSA 9: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	ITA GSA9	Total landings
2003	1223.6	1223.6
2004	657.1	657.1
2005	780.8	780.8
2006	1179	1179
2007	1200.5	1200.5
2008	803.9	803.9
2009	825	825
2010	806.8	806.8
2011	909.9	909.9
2012	772	772
2013	867.4	867.4
2014	1338.6	1338.6
2015	1354.6	1354.6
2016	1311.4	1311.4
2017	1632.7	1632.7
2018	1343.4	1343.4
2019	949.5	949.5
2020	493.8	493.8
2021	625.2	625.2
2022	721.2	721.2
2023	730.4	730.4

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.11.10 Red mullet in GSA 9. Assessment summary. Weights are in tonnes.

year	Recruitment (1000s)	SSB (t)	Catch (t)	F(1-3)
2003	248035	648	930	1.54
2004	274248	627	806	1.48
2005	239208	828	963	1.43
2006	206817	872	1030	1.37
2007	228476	778	889	1.31
2008	221633	648	713	1.25
2009	211393	863	894	1.2
2010	203251	796	833	1.18
2011	215721	774	820	1.17
2012	270247	762	802	1.19
2013	335625	895	959	1.24
2014	358588	966	1105	1.3
2015	371434	1080	1287	1.37
2016	340891	1166	1442	1.42
2017	271766	1101	1371	1.42
2018	191883	1006	1215	1.36
2019	169855	766	872	1.24
2020	180446	735	704	1.08
2021	255480	841	646	0.9
2022	300700	1121	685	0.73
2023	228887	1592	801	0.58

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

* From the catch in weight projection.

Sources and references

STECF EWG 23-09, STECF EWG 22-09

5.12 Summary sheet for Red mullet in GSA 10

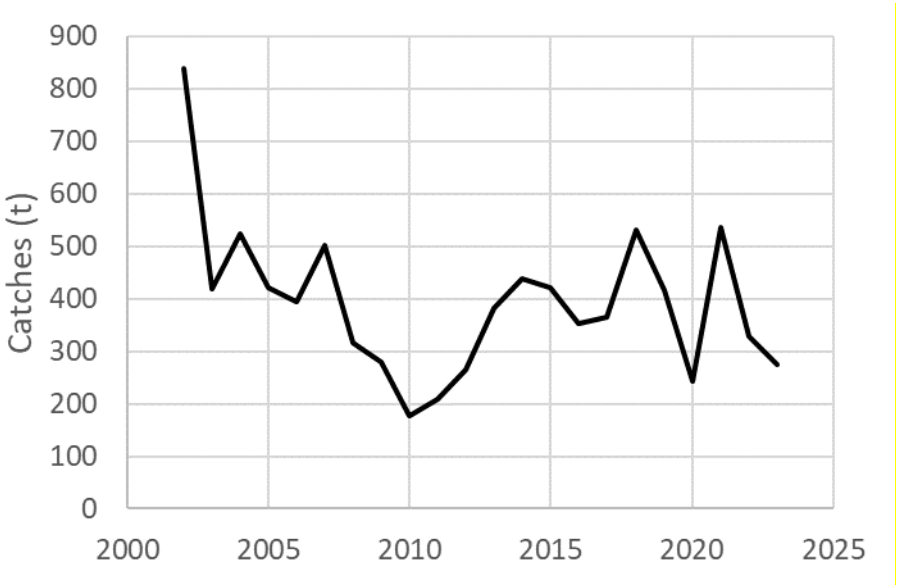
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when the precautionary approach is applied catches should be no more than 261 tonnes in each of the years 2024, 2025 and 2026.

Stock development over time

STECF EWG 24-10 cannot assess the stock and exploitation status relative to MSY and precautionary approach (PA) reference points because information to define reference points is not available.

Figure 5.12.1 Red mullet in GSA 10: Catches by year.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Stock and exploitation status

It was not possible to evaluate the exploitation status in terms of fishing mortality respect to the reference point $F_{0.1}$, used as proxy of F_{MSY}.

Table 5.12.1 Red mullet in GSA 10: State of the stock and fishery relative to reference points.

Status	2021	2022	2023
F / F_{MSY}	Unknown	Unknown	Unknown

Catch scenarios

ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was applied in EWG 23-09 with based on 2022 data. Discards are considered negligible.

Table 5.12.2 Red mullet in GSA 10: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables.

Recent advised catches (2022)		326
Discard rate		Negligible
Precautionary buffer	Applied	0.8
Catch advice *		261
% advice change **		-20%

* Advised catches for each of the years 2024, 2025 and 2026.

** Advice value for 2024 relative to the advice for 2022 (326 tonnes).

Source: Own elaborations

Basis of the advice

Table 5.12.4 Red mullet in GSA 10: The basis of the advice.

Advice basis	Precautionary approach (ICES category 5)
Management plan	

Quality of the assessment

Due to the unavailability of reliable catch at age information in the last three years, the lack of the MEDITS survey in 2022 and that the MEDITS survey was carried out in 2023 only partially and in December, the EWG 24-10 concluded that it is not possible to produce any assessment to evaluate the current status of the stock.

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

No reference point was estimated.

Table 5.12.5 Red mullet in GSA 10: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}		Not Defined	
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	F_{lim}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}		Not Defined	
	target range F_{lower}		Not Defined	
	target range F_{upper}		Not Defined	

Source: Own elaborations

Basis of the assessment

Table 5.12.6 Red mullet in GSA 10: Basis of the assessment and advice.

Assessment type	No assessment.
Input data	DCF commercial data (landings)
Discards and bycatch	Discards null
Indicators	-
Other information	
Working group	STECF EWG 24-10

Source: Own elaborations

History of the advice, catch, and management

Table 5.12.7 Red mullet in GSA 10: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF landings	STECF discards
2019	$F = F_{MSY}$		1056	392	
2020	$F = F_{MSY}$		309	242	
2021	$F = F_{MSY}$		314	301	
2022	$F = F_{MSY}$		485	328	
2023	Precautionary approach (ICES category 3 short lived species)		326		
2024	Precautionary approach (ICES category 5)		261		
2025	Precautionary approach (ICES category 5)		261		
2026	Precautionary approach (ICES category 5)		261		

Source: Own elaborations

History of the catch and landings

Table 5.12.8 Red mullet in GSA 10: Catch and effort distribution by fleet in 2023 as reported to STECF.

2023	Landings				Discards
Catch 275 t	Otter trawl 81.9%	Trammel nets 15.5%	Gillnets 2.1%	Others 0.5%	2.3
	225	43	6	1	
Effort (2023)	NA				
	Fishing Days				

Source: Own elaborations

Table 5.12.9 Red mullet in GSA 10: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes.

Year	ITA	Total
2002	839	839
2003	419	419
2004	524	524
2005	421	421
2006	393	393
2007	502	502
2008	315	315
2009	279	279
2010	177	177
2011	210	210
2012	264	264
2013	381	381
2014	438	438
2015	421	421
2016	353	353
2017	365	365
2018	532	532
2019	416	416
2020	242	242
2021	536	536

2022	328	328
2023	275	275

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10.

5.13 Summary sheet for Norway lobster in GSA 9

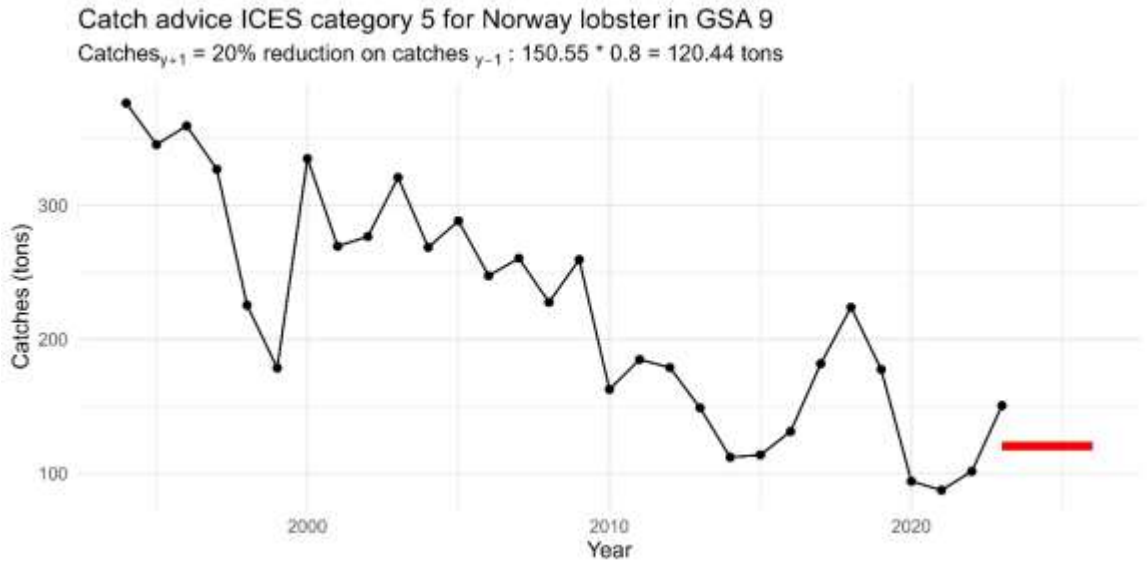
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when the precautionary approach is applied catches in 2025 should be no more than 120.44 tons.

Stock development over time

Catches of Norway lobster slow a decreasing pattern until 2015, then they started to oscillate. Catch trend in last three year was increasing. STECF 24-10 cannot assess the stock and exploitation status relative to MSY because no analytical evaluation on the stock, and the relative reference points, was possible.

Figure 5.13.1 Norway lobster in GSA 9: Trends in catch. The black line shows the trend in the above quantities. The red line shows the catches computed using ICES category 5 methodology.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Stock and exploitation status

It was not possible to evaluate the exploitation status in terms of fishing mortality respect to the reference point $F_{0.1}$, used as proxy of F_{MSY}.

Table 5.13.1 Norway lobster in GSA 9 State of the stock and fishery relative to reference points.

Status	2023
F / F_{MSY}	Unknown

Source: Own elaborations

Catch scenarios

ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was never applied to this stock.

Table 5.13.2 Norway lobster in GSA 9: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables

Recent observed catches (2023)	156
Discard rate	Negligible
Precautionary buffer applied	0.8
Catch advice *	120
% advice change **	-20%

* Advised catches for each of the years 2025 and 2026.

** Advice value for 2025 relative to the advice for 2023.

Source: Own elaborations

Basis of the advice

Table 5.13.4 Norway lobster in GSA 9: The basis of the advice.

Advice basis	Precautionary approach (ICES category 5)
Management plan	

Source: Own elaborations

Quality of the assessment

The stock of Norway lobster in GSA 9 has been evaluated with quantitative methods in the past. STECF EWG 24-10 attempted to update the most recent stock assessment with novel information. Also, it was attempted to evaluate the status of this stock with alternative quantitative methods. It was not possible to identify a model performing satisfactorily when tested against a comprehensive set of diagnostics (Carvalho et al., 2021). EWG 24-10 concluded that it is not possible to produce any assessment to evaluate the status of the stock.

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

No reference point was estimated.

Table 5.13.5 Norway lobster in GSA 9: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}		Not Defined	
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	B_{MSY}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}		Not Defined	

	target range F_{lower}		Not Defined	
	target range F_{upper}		Not Defined	

Source: Own elaborations

Basis of the assessment

Table 5.13.6 Norway lobster in GSA 9: Basis of the assessment and advice.

Assessment type	No assessment.
Input data	DCF commercial data (landings and discards), RECFISH project (landings and discards)
Discards, BMS landings*, and bycatch	Discards null
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?

Source: Own elaborations

History of the advice, catch, and management

Table 5.13.7 Norway lobster in GSA 9: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		90	177.5	0.5
2020	$F = F_{MSY}$		142	90.1	1
2021	$F = F_{MSY}$		180	89.9	0.6
2022	$F = F_{MSY}$		220	101.2	0
2023	$F = F_{MSY}$		123.9*		
2024	$F = F_{MSY}$		128.2		
2025	Precautionary approach (ICES category 5)		120.44		
2026	Precautionary approach (ICES category 5)		120.44		

*Based on the rerun of the 1994-2021 assessment done in EWG 23-09

Source: Own elaborations

History of the catch and landings

Table 5.13.8 Norway lobster in GSA 9: Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF.

2023		Wanted catch				Discards
Catch (t)	150.55	Otter trawl 100%	Gillnets 0.00%	Trammel nets 0%	Other 0%	0.0 t
Effort	NA	NA	NA	NA	NA	
		Fishing days				

Table 5.13.9 Norway lobster in GSA 9: History of commercial landings; both the official reported values are presented by country, official reported BMS landings, STECF estimated.

Year	ITA GSA landings	Discards	STECF total catches	Total Effort* (Fishing days)
1994	376.4	0.00	376.4	
1995	345.4	0.00	345.4	
1996	359.4	0.00	359.4	
1997	727.6	0.00	327 ǂ	
1998	225.5	0.00	225.5	
1999	178.6	0.00	178.6	
2000	335.0	0.00	335	
2001	269.5	0.00	269.5	
2002	276.9	0.00	276.9	62616
2003	320.9	0.0	320.9	63331
2004	268.7	0.0	268.7	67828
2005	288.5	0.0	288.5	67714
2006	247.5	0.0	247.5	62517
2007	260.5	0.0	260.6	64161
2008	227.7	0.0	227.7	49759
2009	250.3	9.2	259.5	53330
2010	161.6	1.0	162.6	52606
2011	184.0	1.0	185	50737
2012	178.2	0.8	179	47851
2013	147.6	1.3	149	51722
2014	111.6	0.4	112	51284
2015	113.6	0.1	113.7	52936
2016	130.9	0.4	131.3	51301
2017	173.6	8.2	181.8	47459
2018	223.2	0.7	223.9	44251
2019	177.0	0.5	177.5	42227
2020**	93.64	0.43	94.07	33550
2021**	87.4	0	87.4	36566
2022**	101.16	0.3	101.46	
2023	150.55	0	150.55	

*Effort data is taken from STECF EWG 22-10. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onwards.

** data have been revised after national data re-submission and can differ if compared to STECF 23-09 or previous EWG reports.

ǂ data revised as explained in section 6.13.2.1

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.13.10 Norway lobster in GSA 9: Assessment summary. Weights are in tonnes.

Year	Total catch
1994	376.4
1995	345.4
1996	359.4
1997	327
1998	225.5
1999	178.6
2000	335
2001	269.5
2002	276.9
2003	320.9
2004	268.7
2005	288.5
2006	247.5
2007	260.6
2008	227.7
2009	259.5
2010	162.6
2011	185
2012	179
2013	149
2014	112
2015	113.7
2016	131.3
2017	181.8
2018	223.9
2019	177.5
2020	94.07
2021	87.4
2022	101.46
2023	150.55

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., Schirripa, M., et al. 2021. A cookbook for using model diagnostics in integrated stock assessments. Fisheries Research, 240.
https://www.sciencedirect.com/science/article/pii/S0165783621000874

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp. https://doi.org/10.17895/ices.pub.5322.

Ligas A., 2019. Recovery of fisheries historical time series for the Mediterranean and Black Sea stock assessment (RECFISH). EASME/EMFF/2016/032. Final Report, 95 pp.

5.14 Summary sheet for Norway lobster in GSA 11

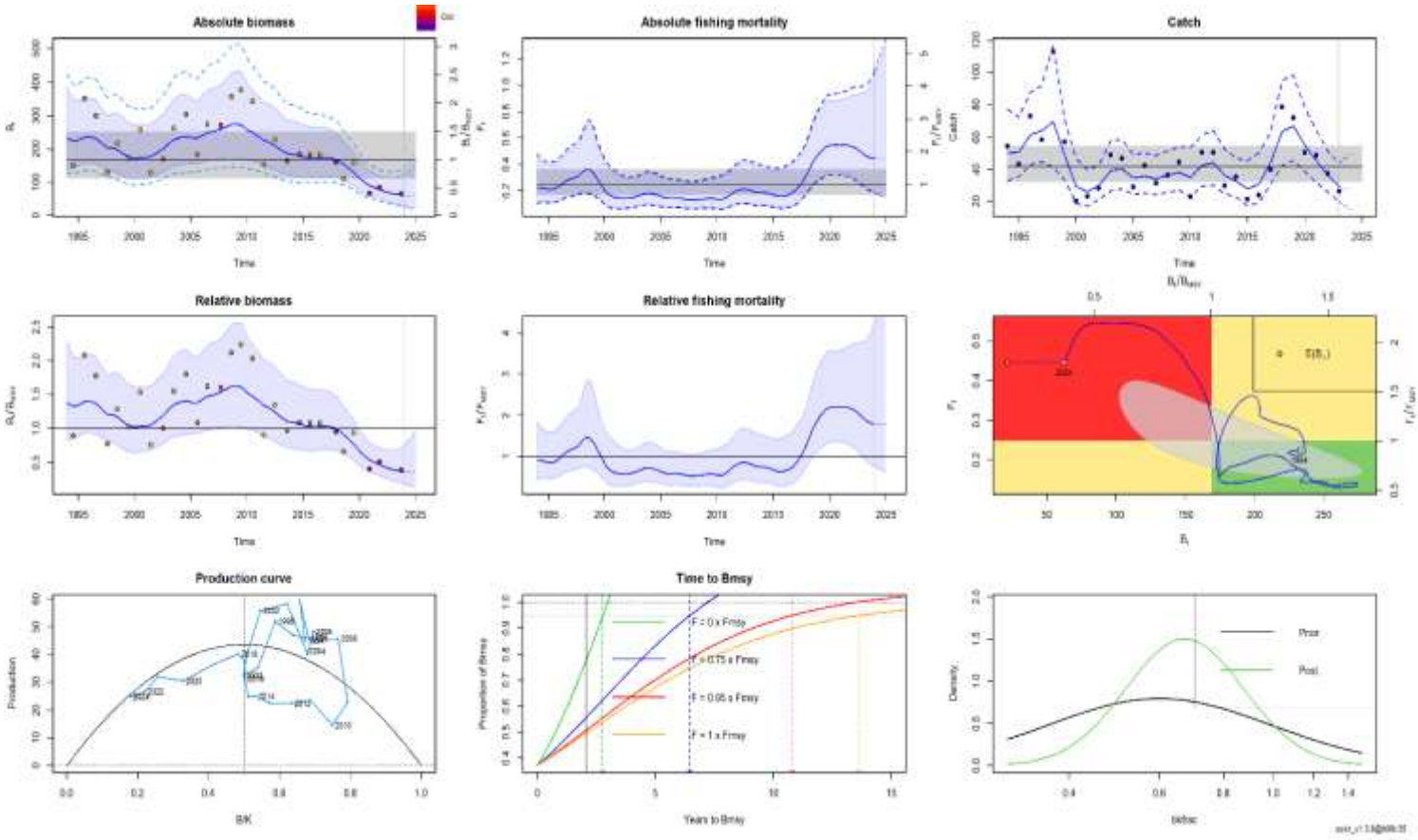
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.24 and corresponding catches in 2025 should be no more than 19.13 tons.

Stock development over time

The assessment shows fluctuation of all indicators along the available time series, while a slightly increase of fishing mortality has occurred after 2018. It is reflected in a sharp decrease of the biomass, since 2018 above the reference point. Modelled catch follows properly the observed catch, excluding some years (1998 and 2000) that represent the highest and the lowest peak.

Figure 5.14.1 Norway lobster in GSA 11: Trends in biomass, fishing mortality and catches resulting from the SPiCT model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.45) is 1.8 times the reference point F_{msy} (0.24).

Table 5.14.1 Norway lobster in GSA 11: State of the stock and fishery relative to reference points. * indicates past assessments.

Status	2019*	2020*	2021*	2023
F / F_{MSY}	$F > F_{MSY\ proxy}$	$F > F_{MSY\ proxy}$	$F > F_{MSY\ proxy}$	$F > F_{MSY}$
B / B_{MSY}	$B > MSY\ B_{trigger\ proxy}$	$B < MSY\ B_{trigger\ proxy}$	$B < MSY\ B_{trigger\ proxy}$	$B < B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.14.2 Norway lobster in GSA 11: Different catch scenarios produced through short term forecasts. The values in the columns represent F = fishing mortality, C = catches, B = biomass.

STF Scenario	Year	F	B	C

Keep_current_catch	2024	0.45	60.99	27.40
Keep_current_catch	2025	0.45	58.54	26.30
Keep_current_catch	2026	0.45	56.37	25.33
Keep_current_F	2024	0.45	61.07	27.24
Keep_current_F	2025	0.45	58.79	26.22
Keep_current_F	2026	0.45	56.77	25.32
Fish@Fmsy	2024	0.25	66.91	16.59
Fish@Fmsy	2025	0.25	77.18	19.13
Fish@Fmsy	2026	0.25	87.69	21.74
No_fishing	2024	0.00	75.28	0.03
No_fishing	2025	0.00	108.13	0.05
No_fishing	2026	0.00	147.36	0.07
Reduce_F25%	2024	0.33	64.27	21.50
Reduce_F25%	2025	0.33	68.53	22.93
Reduce_F25%	2026	0.33	72.63	24.30
Increase_F25%	2024	0.56	58.09	32.39
Increase_F25%	2025	0.56	50.42	28.11
Increase_F25%	2026	0.56	44.22	24.65

Source: Own elaborations

Basis of the advice

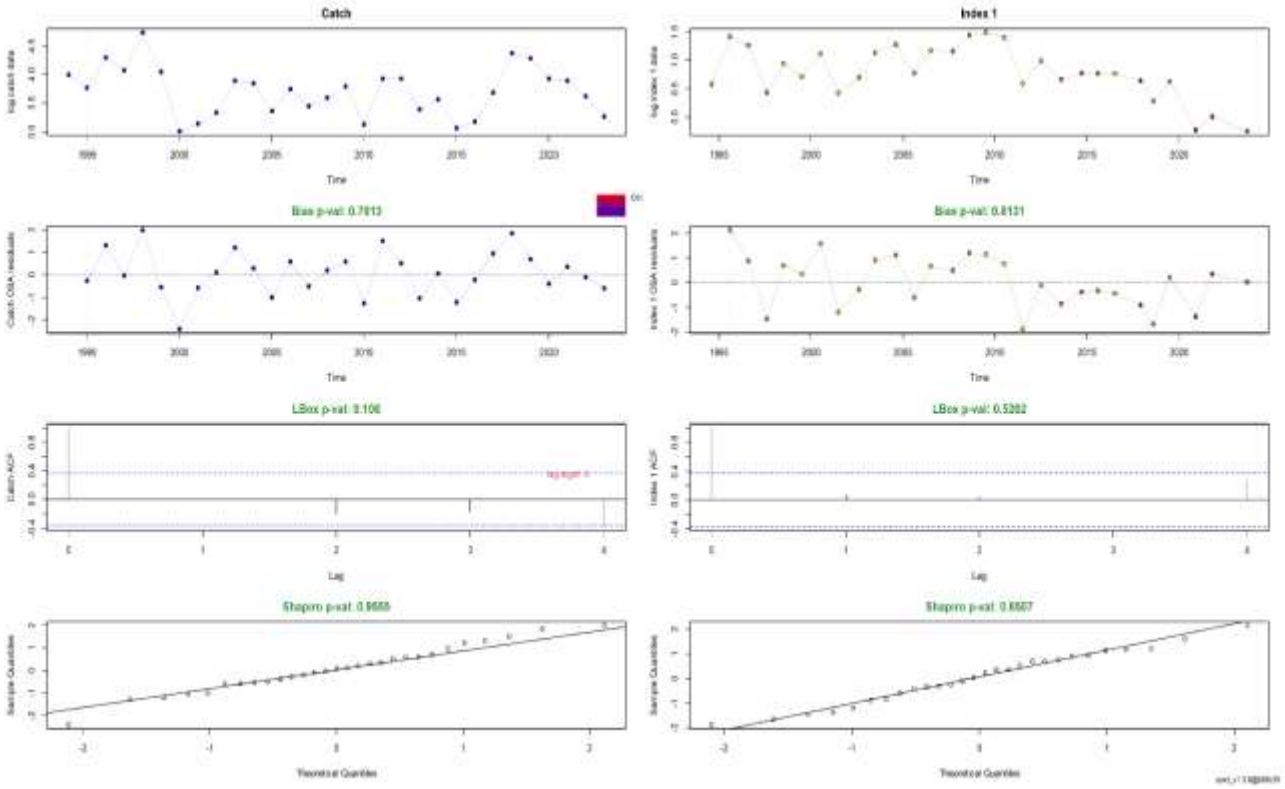
Table 5.14.3 Norway lobster in GSA 11: The basis of the advice.

Advice basis	F_{MSY}
Management plan	0.24

Quality of the assessment

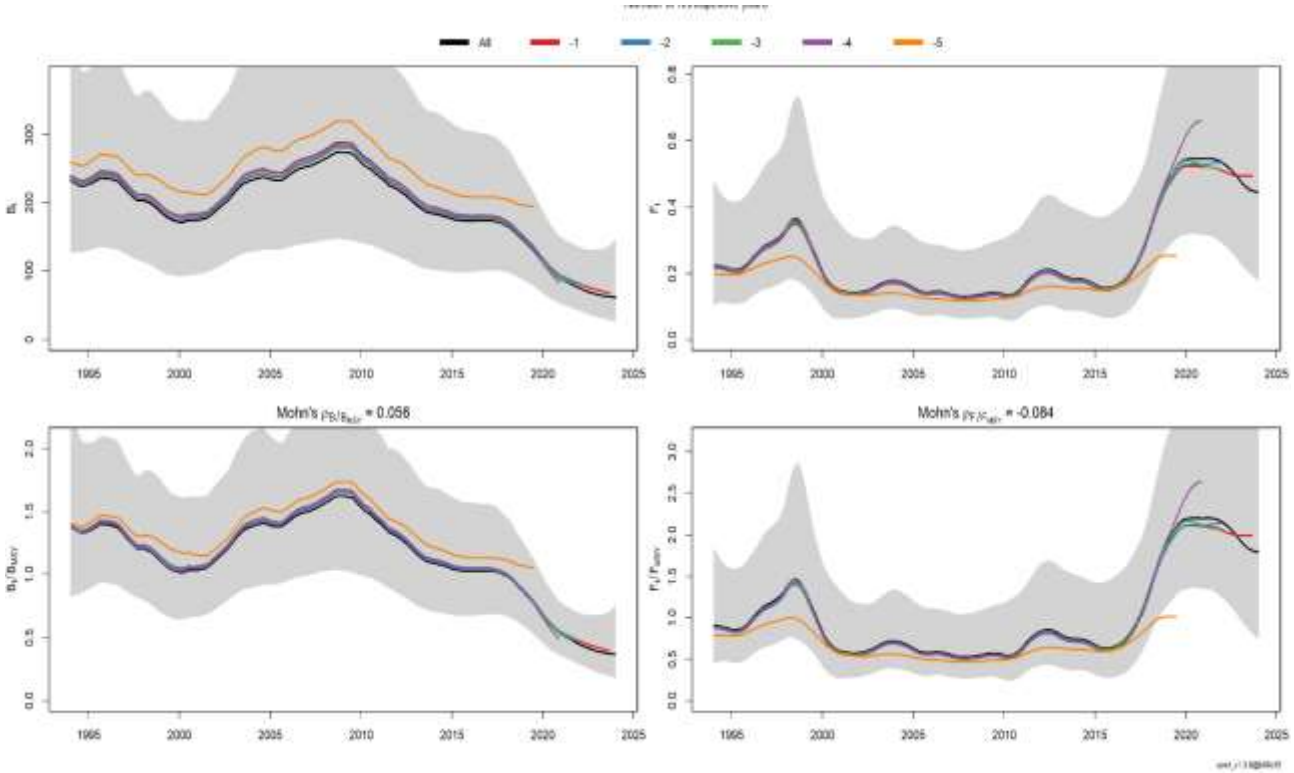
The model passed all the diagnostic of the SPiCT checklist. Point 3 and 4, namely residuals and retrospective, are graphically presented here.

Figure 5.14.2 Norway lobster in GSA 11. Residuals analysis (point 3 of the checklist) that shows no violation of the model assumptions (bias, auto-correlation, normality).



Source: Own elaborations

Figure 5.14.3 Norway lobster in GSA 11. Retrospective analysis (point 4 of the checklist) showing a consistent pattern.



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.14.4 Norway lobster in GSA 11: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	B_{msy}	168.67		STECF EWG 24-10
	F_{MSY}	0.24		STECF EWG 24-10
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	F_{lim}		Not Defined	
	F_{pa}		Not Defined	
Management plan	SSB_{mgt}		Not Defined	
	F_{mgt}		Not Defined	

Source: Own elaborations

Basis of the assessment

Table 5.14.5 Norway lobster in GSA 11: Basis of the assessment and advice.

Assessment type	Production model (SPiCT)
Input data	DCF commercial data (landings) and scientific survey (MEDITS) data
Discards and bycatch	Discards were not reported
Indicators	
Other information	
Working group	STECF EWG 24-10

Source: Own elaborations

History of the advice, catch, and management

Table 5.14.6 Norway lobster in GSA 11: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2024	F=Fmsy		16.59	26	
2025	F=Fmsy		19.13		
2026	F=Fmsy		21.74		

Source: Own elaborations

History of the catch and landings

Table 5.14.7 Norway lobster in GSA 11: Catch and effort distribution by fleet in 2022 as estimated by and reported to STECF.

2024		Wanted catch	Discards
Catch (t)	26	Otter trawl 100%	0 t
		26 t	
Effort	NA	NA	
		Fishing days	

Source: Own elaborations

Table 5.14.8 Norway lobster in GSA 11: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	ITALY - GSA11	STECF total landings	Total Effort*
2003	-	-	
2004	-	-	

2005	28.9	28.9	
2006	42.3	42.3	
2007	31.3	31.3	
2008	36.2	36.2	
2009	44.4	44.4	
2010	22.8	22.8	
2011	50.5	50.5	
2012	50.5	50.5	
2013	29.8	29.8	
2014	35.3	35.3	
2015	21.4	21.4	
2016	23.9	23.9	
2017	39.6	39.6	
2018	78.8	78.8	
2019	72.0	72.0	
2020	50.5	50.5	
2021	48.7	48.7	
2022	37.3	37.3	
2023	26.1	26.1	

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.14.9 Norway lobster in GSA 11: Assessment summary.

Year	F (all ages)	Biomass (tonnes)	Catch (tonnes)
1994	0.22	227	50
1995	0.22	233	51
1996	0.27	231	61
1997	0.31	209	64
1998	0.35	197	70
1999	0.27	178	49
2000	0.17	174	30
2001	0.14	179	26
2002	0.15	200	30
2003	0.17	226	39
2004	0.17	236	40
2005	0.15	235	35
2006	0.14	248	36
2007	0.13	258	34
2008	0.13	271	36
2009	0.14	270	38
2010	0.14	249	35
2011	0.19	228	42
2012	0.21	210	44
2013	0.19	190	36
2014	0.18	181	33
2015	0.16	175	28

2016	0.18	174	31
2017	0.26	172	44
2018	0.41	157	64
2019	0.52	130	67
2020	0.55	101	55
2021	0.54	83	45
2022	0.51	71	36
2023	0.46	64	29

Source: Own elaborations

Sources and references

STECF EWG 24-10

5.15 Summary sheet for Blue and red shrimp in GSAs 1 & 2

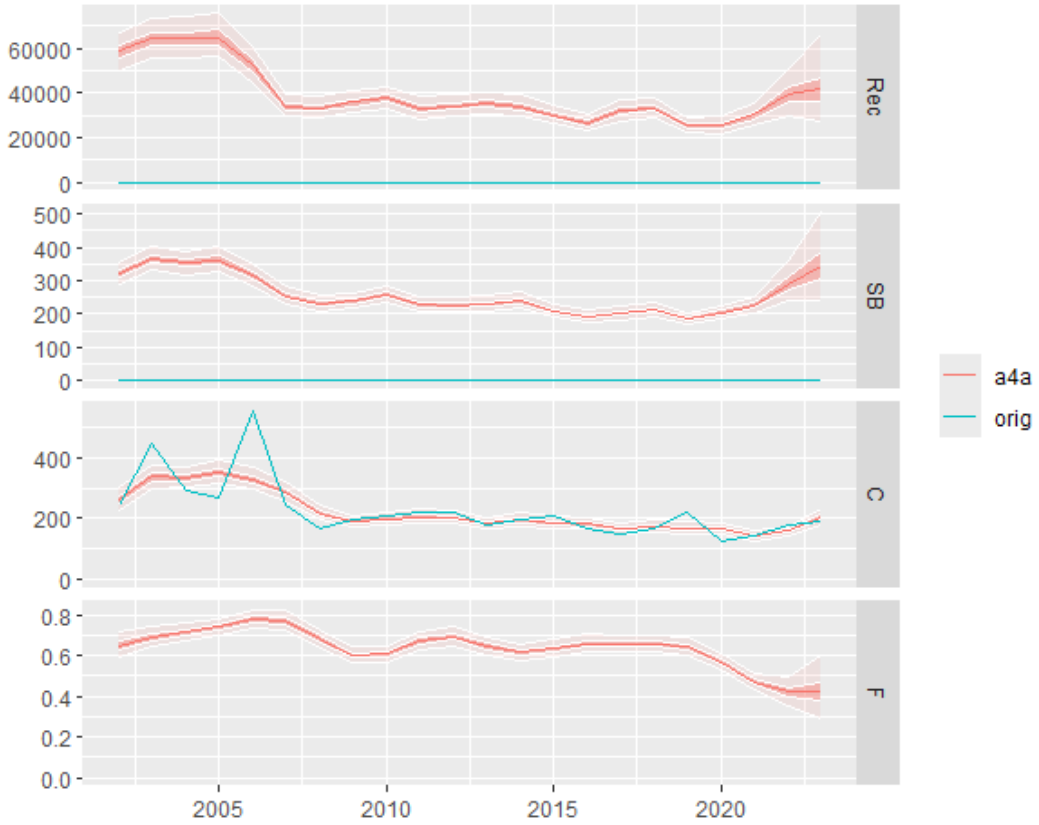
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.29 and corresponding catches in 2025 should be no more than 155 tons.

Stock development over time

Recruitment, SSB, catches, and fishing mortality (Fbar 1-2) of blue and red shrimp in GSA1&2 show an oscillation pattern since 2006 (the highest value in the time series) except for the last years, when recruitment, SSB, and caches show a slight increase since 2019. Fishing mortality has decreased since 2019 but has remained more stable over the last three years.

Figure 5.15.1 Blue and red shrimp in GSAs 1&2: Trends in catch, recruitment, fishing mortality (Fbar 1-2) and SSB resulting from the a4a model. Original catches are also shown.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.42) is 1.45 times the reference point F0.1, used as a proxy of FMSY (=0.29). No biomass reference points are calculated.

Table 5.15.1 Blue and red shrimp in GSAs 1&2: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
$F / F_{MSY\ proxy}$	$F > F_{MSY}$	$F > F_{MSY\ proxy}$	$F > F_{MSY\ proxy}$	$F > F_{MSY\ proxy}$	$F > F_{MSY\ proxy}$
F / F_{MSY} Transition		$F > F_{MSY}$ Transition	$F > F_{MSY}$ Transition	$F > F_{MSY\ Transition}$	$F > F_{MSY}$ Transition

Source: Own elaborations

Catch scenarios

Table 5.15.2 Blue and red shrimp in GSA 1 & 2: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}2}$ (2024)	0.437	Fsq = average of the last 3 years
SSB (2024)	328.38	SSB intermediate year from STF output
R_{age0} (2024,2025)	32335.21	Recruitment will be set as geometric mean of the last 14 years
Total catch (2024)	224.64	Catch intermediate year from STF output

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

Table 5.15.3 Blue and red shrimp in GSA 1 & 2: Annual catch scenarios. All weights are in tonnes.

Basis	Ftotal# (ages 1-2) (2025)	Total catch* (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY} (F0.1)	0.292	155	348.3	6.1	-24.6
Other scenarios					
F_{upper}	0.402	194.9	302.6	-7.8	-4.9
F_{lower}	0.196	112.4	400.6	22.0	-45.1
Zero catch	0.000	0.0	563.6	71.6	-100.0
Status quo	0.437	206.6	290.2	-11.6	0.9

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.
Source: Own elaborations

Basis of the advice

Table 5.15.3 Blue and red shrimp in GSAs 1&2: The basis of the advice.

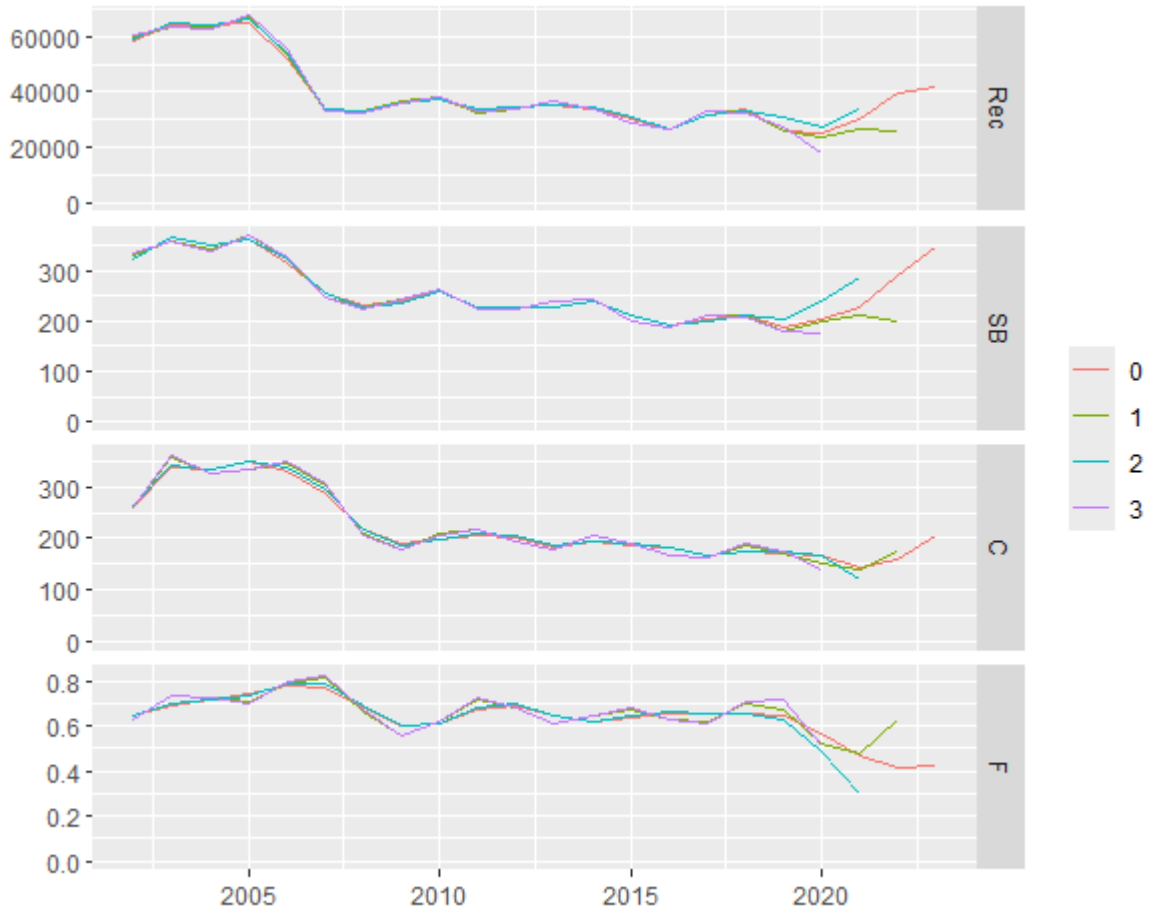
Advice basis	F_{MSY}
Management plan	

Source: Own elaborations

Quality of the assessment

A new a4a model configuration has been accepted during EWG 24-10, using growth parameters by sex after different tests. The configuration seems stable, but conducting a more thorough review of the data is crucial, as some problems were found (e.g., males aged 5 for GSA1). The issues encountered during EWG 23-09 regarding residuals in ages three and four are solved with the new model. All the diagnostics and retrospective analysis from the a4a assessment were acceptable. However, some new patterns need to be reviewed in detail. As this is a new assessment no reference points are calculated.

Figure 5.15.2 Blue and red shrimp in GSA 1 & 2: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

The group decided to postpone at least for one year the calculation of the biological reference points, since this is a new assessment

Reference points

Table 5.15.4 Blue and red shrimp in GSAs 1&2: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger\ proxy}$		Not defined	
	$F_{MSY\ proxy}$	0.29	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	F_{lim}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	

	F_{MSY}	0.29	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.20	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.40	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.15.5 Blue and red shrimp in GSAs 1&2: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings) and scientific survey (MEDITS) data
Discards and bycatch	Discards were negligible (<1%)
Indicators	
Other information	
Working group	STECF EWG 24-10

Source: Own elaborations

History of the advice, catch, and management

Table 5.15.6 Blue and red shrimp in GSAs 1&2: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$	98	98	166	
2020	$F = F_{MSY}$	96	96	164	
2021	$F = F_{MSY}$	103.23	103.23	118	
2022	$F = F_{MSY}$	33.05	33.05	174.2	
2023			52.0	197.6	
2024	MSY approach (ICES category 3)		76		
2025	$F = F_{MSY}$		155		

Source: Own elaborations

History of the catch and landings

Table 5.15.7 Blue and red shrimp in GSAs 1&2: Catch and effort distribution by fleet in 2022 as estimated by and reported to STECF.

2023		Wanted catch	Discards
Catch (t)		Otter trawl 100%	Negligible
		204.9 t	

Source: Own elaborations

Table 5.15.8 Blue and red shrimp in GSAs 1&2: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	SPAIN GSA1	SPAIN GSA2	Total landings	Total Effort * (Fishing Days)
2002	157.0	89.8	246.8	28002
2003	335.7	114.4	450.1	32892
2004	225.2	69.3	294.5	34951
2005	232.1	82.2	314.3	32295
2006	288.8	137.5	426.3	31443
2007	178.4	78.6	257.0	29917
2008	133.5	49.3	182.8	26201
2009	144.6	67.7	212.3	27017
2010	152.1	48.7	200.8	28476
2011	131.4	47.4	178.8	28170
2012	148.6	45.0	193.6	25851
2013	125.0	63.9	188.9	24334
2014	184.0	41.0	225.0	22395
2015	170.2	51.9	222.1	21587
2016	138.2	40.1	178.3	21345
2017	99.2	48.0	147.2	22537
2018	123.2	47.5	170.7	21633
2019	132.1	72.0	204.1	
2020	137.4	31.7	169.1	
2021	86.7	47.9	134.6	
2022	107.7	66.5	174.2	
2023	145	52.6	197.6	

*Effort data is taken from STECF EWG 21-13. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Source: Own elaborations

Summary of the assessment

Table 5.15.9 Blue and red shrimp in GSA 1 & 2: Assessment summary. Weights are in tonnes. SSB estimate at mid-year.

Year	Recruitment age 1 thousands	SSB tonnes	Catch tonnes	F ages 1-2
2002	58363	322.4	260.9	0.648
2003	64246	365.6	336.4	0.692
2004	64537	351.6	332.9	0.715
2005	64995	361.6	349.8	0.740
2006	52168	314.0	329.3	0.779
2007	34049	253.9	288.1	0.771
2008	33328	231.3	218.5	0.682
2009	35726	238.9	189.5	0.602
2010	37575	258.2	198.0	0.609
2011	32982	227.8	205.9	0.673
2012	34127	226.2	203.2	0.692
2013	35200	228.9	184.1	0.646
2014	33992	240.4	193.9	0.617
2015	30156	209.5	185.9	0.635
2016	26415	192.0	182.2	0.659
2017	31862	202.0	166.9	0.659
2018	33383	212.3	173.8	0.657
2019	25480	185.7	169.3	0.643
2020	25311	204.8	167.4	0.570
2021	30024	226.0	141.6	0.470
2022	39374	292.1	157.4	0.419
2023	41790	345.0	204.9	0.423

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10.

5.16 Summary sheet for Blue and red shrimp in GSAs 5

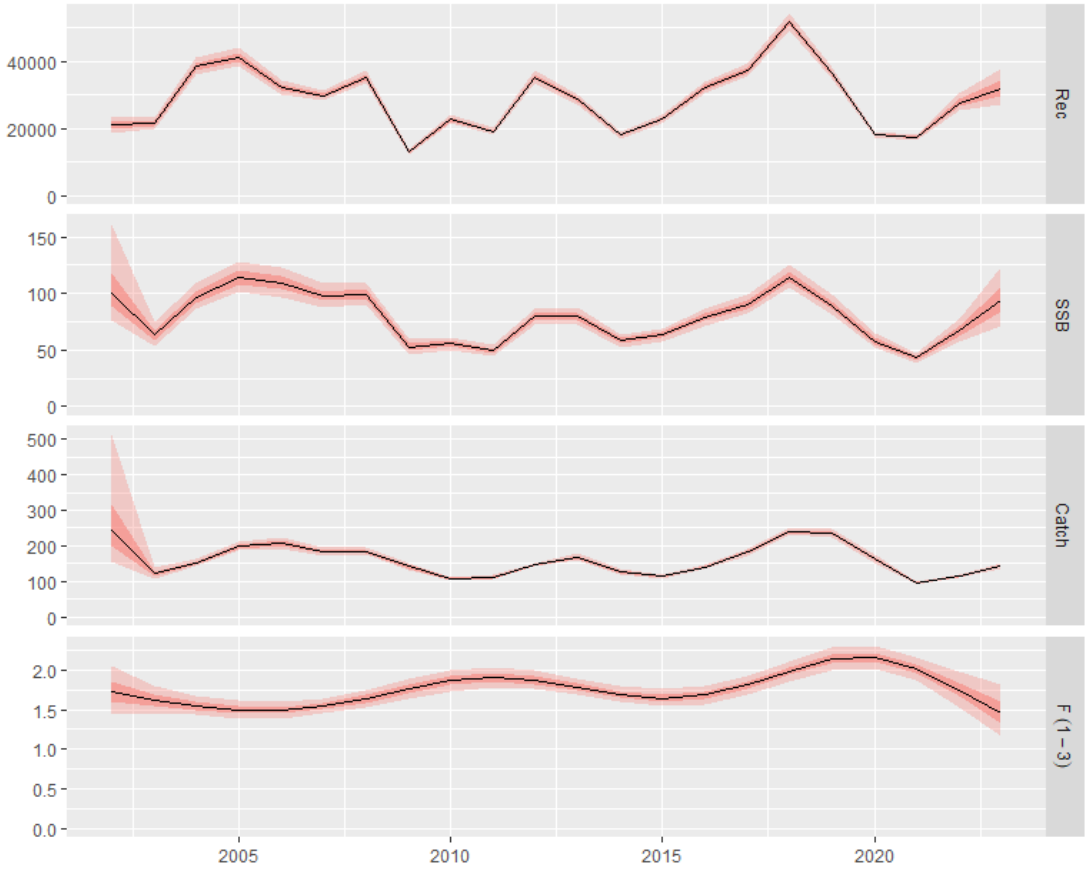
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.21 and corresponding catches in 2025 should be no more than 34 tons.
STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.33 and corresponding catches in 2025 should be no more than 52.6 tons. Since the stock is below B_{pa}, F could be further reduced (Freduced = 0.21) in order to increase the likelihood of biomass being above B_{pa} in the short term, corresponding to 34.4 tons of catch in 2025.

Stock development over time

The results of the assessment show a fluctuation of all indicators along the available time series. After a fluctuating trend since the beginning of the time series until 2014, catches, recruitment and SSB showed a progressive increasing trend from 2014-2015 to 2018, but then a sharp decrease until 2021 (more attenuated for recruitment) and in 2022 increased again. Fbar (1-3) shows a fluctuating trend along all the time series (between 1.46 and 2.11), but with a noticeable decrease since 2020, reaching a value of 1.46 in 2023.

Figure 5.16.1 Blue and red shrimp in GSA 5: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (1.46) is 4.4 times the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.33). F in 2023 is also higher than $F_{MSY\ Transition}$ (0.33) indicating progress to F_{MSY} in 2025 is behind transition. SSB in 2023 is estimated to be above B_{lim} but is still below B_{pa}.

Table 5.16.1 Blue and red shrimp in GSA 5: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY}	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$
F / F_{MSY} Transition	NA	$F > F_{MSY}$ Transition	$F > F_{MSY}$ Transition	$F > F_{MSY}$ Transition	$F > F_{MSY}$ Transition
B/B_{lim}	NA	NA	NA	$B>B_{lim}$	$B>B_{lim}$
B/B_{pa}	NA	NA	NA	$B<B_{pa}$	$B<B_{pa}$
B/B_{MSY}	NA	NA	NA	$B<B_{MSY}$	$B<B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.16.2 Blue and red shrimp in GSA 5: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}3}$ (2024)	1.46	F current in the last year used to give F status quo for 2023
SSB (2024)	92.95	SSB intermediate year from STF output
R_{age1} (2024,2025)	28360	Catch intermediate year from STF output. Recruitment will be set as geometric mean of the last 6 years
Total catch (2024)	161.17	Catch intermediate year from STF output

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

Table 5.16.3 Blue and red shrimp in GSA 5: Annual catch scenarios. All weights are in tonnes. SSB estimated at mid-year

Basis	Total catch (2025)	F_{total} (ages 1-3) (2025)	SSB*** 2026	% SSB change**	% Catch change^
STECF advice basis					
F_{MSY}	52.55	0.33	206.53	122.20	-63.98
$F_{Reduced}$ B<B_{pa} ^^	34.42	0.21	233.83	151.58	-76.41
Other scenarios					
Zero catch	0	0	291.42	213.53	-100
Status quo	155.85	1.46	91.34	-1.73	6.83

*Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
** % change in SSB 2024 to 2026
^Total catch in 2025 relative to Catch in 2023.

^^$F_{Reduced}$ B<B_{pa} is based on ICES advice rule when B in TAC year is less than B_{pa}

Source: Own elaborations

Basis of the advice

Table 5.16.4 Blue and red shrimp in GSA 5: The basis of the advice.

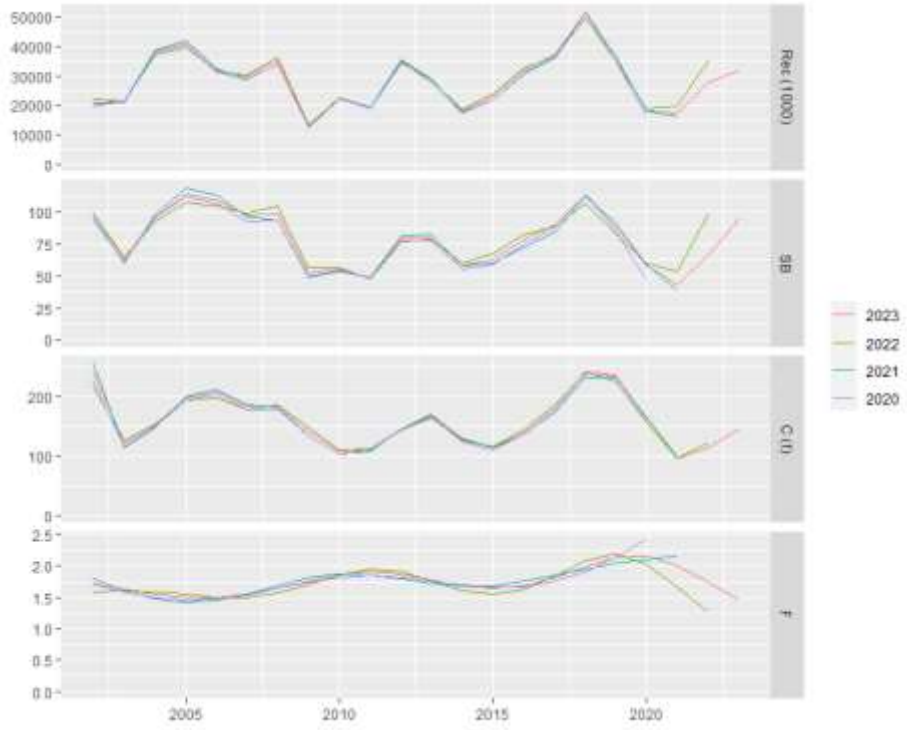
Advice basis	F_{MSY}
Management plan	0.332

Source: Own elaborations

Quality of the assessment

This assessment is an update of the last year assessment. T0 correction was applied from length distribution from catches and survey and thus age0 was removed from the survey and catch data to run the assessment. Commercial catches showed better internal consistency than MEDITS survey index. However, the general results of the assessment are a bit unstable, especially in terms of the stability of residuals (both for commercial catches, especially in age class 3, as well as for MEDITS survey, in age classes 3 and 5). The retrospective analysis of three years run on the a4a model showed acceptable results. All the diagnostics were considered acceptable.

Figure 5.16.2 Blue and red shrimp in GSA5: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.16.5 Blue and red shrimp in GSA 5: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.33	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	74.8	Geometric mean fit to S-R data from 2023 assessment	
	B_{pa}	149.6	B_{lim}*2	
	B_{MSY}		B $F_{0.1}$ 2022 assessment	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.33	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10

	target range F_{lower}	0.22	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.46	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.16.6 Blue and red shrimp in GSA 5: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Not included, considered negligible
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings?
Source: Own elaborations

History of the advice, catch, and management

Table 5.16.7 Blue and red shrimp in GSA5: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2021	$F = F_{MSY}$		98.8	120.1	
2022	$F = F_{MSY}$		127.1	166.7	
2023	$F = F_{MSY}$		46.3	162.6	
2024	$F = F_{MSY}$		161.2		
2025	$F = F_{MSY}$		52.6		

Source: Own elaborations

History of the catch and landings

Table 5.16.8 Blue and red shrimp in GSA5: Catch and effort distribution by fleet in YEAR as estimated by and reported to STECF.

2023	Wanted catch				Discards
Catch (t)	Otter trawl 100%	Gillnets 0%	Trammel nets 0%	Other 0%	Negligible
	162.6				Negligible
Effort	NA				
	Fishing days				

Source: Own elaborations

Table 5.16.9 Blue and red shrimp in GSA5: History of commercial landings; official reported values are presented by country and GSA, all weights are in tonnes. Effort in Fishing Days.

Year	SPAIN GSA5	Total landings	Total Effort * (Fishing Days)
2002	141.5	141.5	
2003	122.0	122.0	
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	120.1	120.1	6439
2022	166.7	166.7	
2023	162.6	162.6	

*Effort data is taken from STECF EWG 24-10. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.16.10 Blue and red shrimp in GSA5: Assessment summary. Weights are in tonnes.

Year	Recruitment age 1 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2002	21017	99.6	242.7	1.72
2003	21481	62.6	121.6	1.62
2004	38385	96.6	152.2	1.55
2005	41143	113.9	198.8	1.50
2006	32026	109.2	208.0	1.49
2007	29813	97.5	183.2	1.54
2008	35264	99.4	184.7	1.64
2009	13078	52.5	142.4	1.76
2010	22656	55.7	107.7	1.87
2011	19186	49.2	112.4	1.91
2012	35230	79.5	147.0	1.88
2013	28673	79.8	168.6	1.78
2014	17931	58.1	127.4	1.69
2015	22838	63.0	114.2	1.65
2016	32116	78.7	140.7	1.69
2017	37241	90.1	182.5	1.81
2018	51605	114.5	241.4	1.99
2019	36251	89.2	236.5	2.14
2020	18294	57.8	164.0	2.16
2021	17216	43.0	96.0	2.01
2022	27630	67.0	115.1	1.75

2023	31959	94.1	145.9	1.46

Source: Own elaborations

Sources and references

STECF EWG 24-10, STECF EWG 23-09, STECF EWG 22-10

5.17 Summary sheet for Blue and red shrimp in GSA 6 & 7

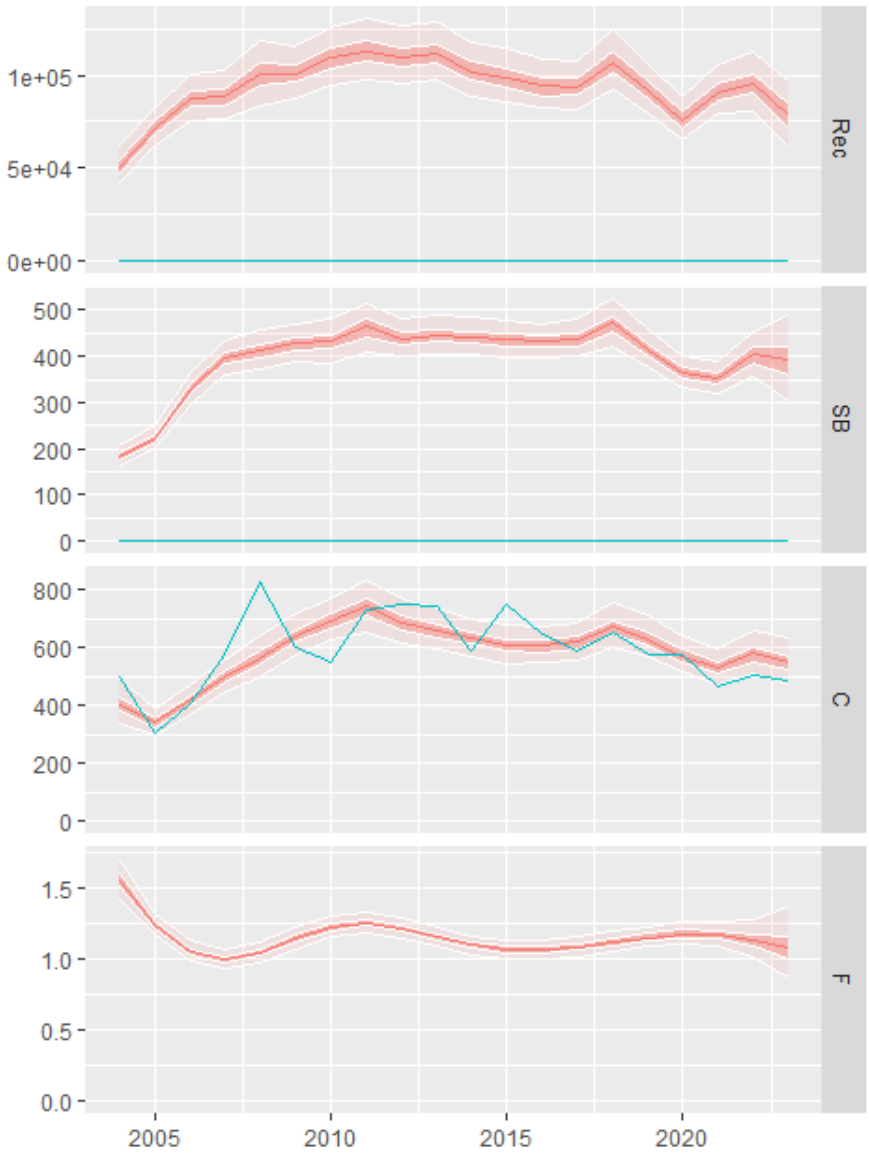
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied the fishing mortality in 2025 should be no more than 0.25 and corresponding catches in 2025 should be no more than 208 tons. Since the stock is below B_{pa}, F could be further reduced (Freduced = 0.21) in order to increase the likelihood of biomass being above B_{pa} in the short term, corresponding to 175 tons of catch in 2025.

Stock development over time

Catches of Blue and red shrimp show a decrease after reaching a maximum in 2011 and are now fluctuating around 486 tonnes. SSB is fluctuating since 2020 showing a slight decrease over the last year with 391 tonnes. The assessment shows a stable recruitment since 2010, but from 2014 and onwards there decrease with considerable fluctuations in recent years, with the final year's value the most uncertain. Fbar (1-2) shows a decrease for the past three years, having been at higher levels since the beginning of the time series.

Figure 5.17.1 blue and red shrimp in GSAs 6 and 7: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (1.1) is more than 4 times the reference point $F_{0.1}$, used as a proxy of F_{MSY} (=0.26). F in 2023 is also higher than $F_{MSY\ Transition}$ (=0.23) indicating progress to F_{MSY} in 2025 is behind transition. SSB in 2023 is above B_{lim} and below B_{pa}.

Table 5.17.1 blue and red shrimp in GSAs 6 and 7: State of the stock and fishery relative to reference points.

Status	2020	2021	2022	2023
F / F_{MSY}	F > FMSY	F > FMSY	F > FMSY	F > FMSY
$F / F_{MSY\ Transition}$	F > FMSY Transition	F > FMSY Transition	F > FMSY Transition	F > FMSY Transition
B / B_{lim}	B > Blim	B > Blim	B > Blim	B > Blim
B / B_{pa}	B < Bpa	B < Bpa	B < Bpa	B < Bpa
B / B_{MSY}	B < BMSY	B < BMSY	B < BMSY	B < BMSY

Source: Own elaborations

Catch scenarios

Table 5.17.2 blue and red shrimp in GSAs 6 and 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}2}$ (2024)	1.08	F 2023 used to give F status quo for 2024
SSB (2024)	428.9	Stock assessment 1 January 2024
R_{age0} (2024,2025)	102000	Recruitment will be set on Hockey Stick relationship
Total catch (2024)	586.9	Assuming F status quo for 2024

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

5.17 Summary sheet for Blue and red shrimp in GSA 6 & 7

STECF advice on fishing opportunities

Table 5.17.3 blue and red shrimp in GSAs 6 and 7: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	207.86	0.25	1071.51	+149.83	-62.02
$F_{Reduced\ B<B_{pa}}$^^	174.54	0.21	1130.32	+163.54	-68.11
Other scenarios					
$F_{MSY\ lower}$	145.12	0.17	1183.67	+175.98	-73.49

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
$F_{MSY\ upper}$**	274.78	0.35	958.66	+123.52	-49.80
Zero catch	0	0	1466.80	+241.99	-100
Status quo	637.64	1.08	468.22	+9.17	+16.31

** Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
*** % change in SSB 2026 to 2024
^Total catch in 2025 relative to Catch in 2023.
^^$F_{Reduced}$ B<B_{pa} is based on ICES advice rule when B in TAC year is less than B_{pa}

Basis of the advice

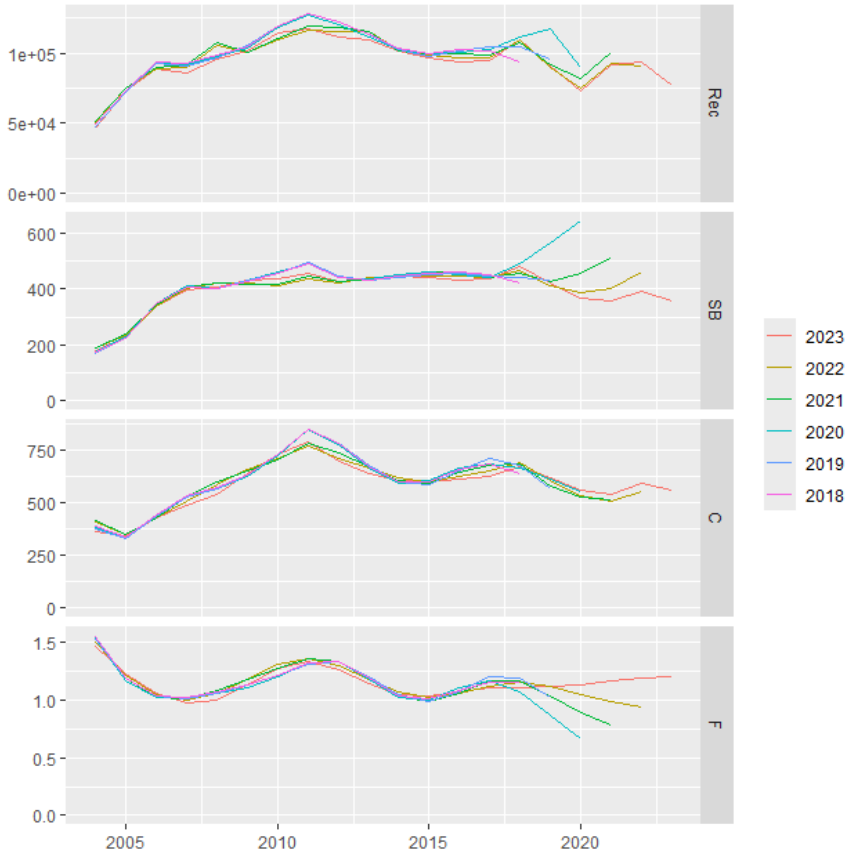
Table 5.17.4 blue and red shrimp in GSAs 6 and 7: The basis of the advice.

Advice basis	F_{MSY}
Management plan	Western Mediterranean Multi-Annual Plan

Quality of the assessment

This is an update assessment of 2023 with reconstructed data. Historical assessment a4a submodels were used for blue and red shrimp in GSA 6 and 7. Due to incompatibility during the years 2002 and 2003 between landings reported in Catalonia (which produces around 70% of the total landings in GSAs 6 and 7) and those reported in the DCF (GSA 6), and also the mean weights out of trend reported for those same years, the assessment was carried out with data from 2004 to 2021. No length frequencies for discards were found for both GSAs, which is associated with the majority of discards in this fishery are related to damaged individuals. Discards were directly added to the catch data. The retrospective analysis showed consistency in the estimation of F estimated in the assessment of 2023. Also, the estimation of recruitment maintained the trend of the one obtained from the assessment of the previous year. All the diagnostics were considered acceptable and are in accordance with EWG 23-09 report.

Figure 5.17.2 blue and red shrimp in GSAs 6 and 7: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.17.5 blue and red shrimp in GSAs 6 and 7: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.26	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 22-09
Precautionary approach	B_{lim}	261	Estimated from HS fit to 2022 assessment	STECF EWG 22-09
	B_{pa}	521	B_{lim} * 2	STECF EWG 22-09
	B_{MSY}	1520	$B_{F0.1}$	STECF EWG 22-09
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.26	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 22-09
	target range F_{lower}	0.17	Based on regression calculation (see section 2)	STECF EWG 22-09
	target range F_{upper}	0.36	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 22-09

Source: Own elaborations

Basis of the assessment

Table 5.17.6 blue and red shrimp in GSAs 6 and 7: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included in the total catch
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings

Source: Own elaborations

History of the advice, catch, and management

Table 5.17.7 blue and red shrimp in GSAs 6 and 7: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		223	566	
2020	$F = F_{MSY}$		226	549	
2021	$F = F_{MSY}$		188	510	
2022	$F = F_{MSY}$		267	553	
2023	$F = F_{MSY}$		257	547	
2024	$F = F_{MSY}$		229		
2025	$F = F_{MSY}$		208		

Source: Own elaborations

History of the catch and landings

Table 5.17.8 blue and red shrimp in GSAs 6 and 7: History of commercial landings; official reported values are presented by country and GSA,. All weights are in tonnes. Effort in Fishing Days.

Year	SPAIN GSA6	SPAIN GSA7	FRANCE GSA7	Total landings	Total Effort * (Fishing Days)
2004	448	50.8	0	498.8	254061
2005	294	11.9	0	305.9	240706
2006	396	15.7	0	411.7	236842
2007	527	47.5	0	574.5	200309
2008	737	90.5	0	827.5	211574
2009	515	84.5	0	599.5	253312
2010	509	38	0.105	547.1	334986
2011	663	62.8	0	725.8	332830
2012	703	32.9	0	735.9	321059
2013	679	51.7	0	730.7	315785
2014	546	45	0	591.0	313268
2015	689	61.1	0	750.1	284887
2016	570	76.5	0	646.5	286594
2017	523	58.4	0.0754	581.5	272981
2018	606	49.6	0	655.6	260000
2019	547	24	0	571.0	262069
2020	543	34.6	0	577.6	241834
2021	433	32.6	0.00044	465.6	
2022	480	27.5	0	507.5	

2023	456	27.3	0	483.3	

*Effort data is taken from STECF EWG 21-13. For some fleets effort reported under the Fishery Dependent Information (FDI) data call differs from effort previously reported under the Mediterranean and Black Sea (MEDBS) data call. Effort time series refer to MEDBS before 2014 and to FDI from 2014 onward

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.17.9 blue and red shrimp in GSAs 6 and 7: Assessment summary. Weights are in tonnes.

Year	Recruitment age 1 thousands	SSB tonnes	F ages 1-2	Catches tonnes
2004	51068.3	182.4	1.56	403.6
2005	71588.3	224.7	1.24	341.3
2006	87584.6	328.8	1.05	418.3
2007	88135.0	395.5	1.00	497.4
2008	100398.3	411.5	1.05	562.6
2009	100605.9	426.2	1.15	638.8
2010	109146.3	431.0	1.23	692.4
2011	112927.7	460.9	1.26	741.6
2012	110037.0	438.3	1.22	687.2
2013	111527.1	445.5	1.16	661.1
2014	102631.0	442.3	1.10	632.2
2015	98524.8	434.2	1.07	606.7
2016	94265.4	431.9	1.07	605.6
2017	93832.1	436.7	1.09	617.0
2018	107207.4	470.1	1.12	669.7
2019	92118.0	414.1	1.16	631.3
2020	75891.6	365.0	1.18	572.3
2021	91075.7	352.2	1.17	531.4
2022	95106.1	403.1	1.14	578.5

Year	Recruitment age 1 thousands	SSB tonnes	F ages 1-2	Catches tonnes
2023	77677.4	390.9	1.08	547.4

Source: Own elaborations

Sources and references

STECF EWG 23-09, EWG 22-10

5.18 Summary sheet for Blue and red shrimp in GSAs 8, 9, 10 & 11

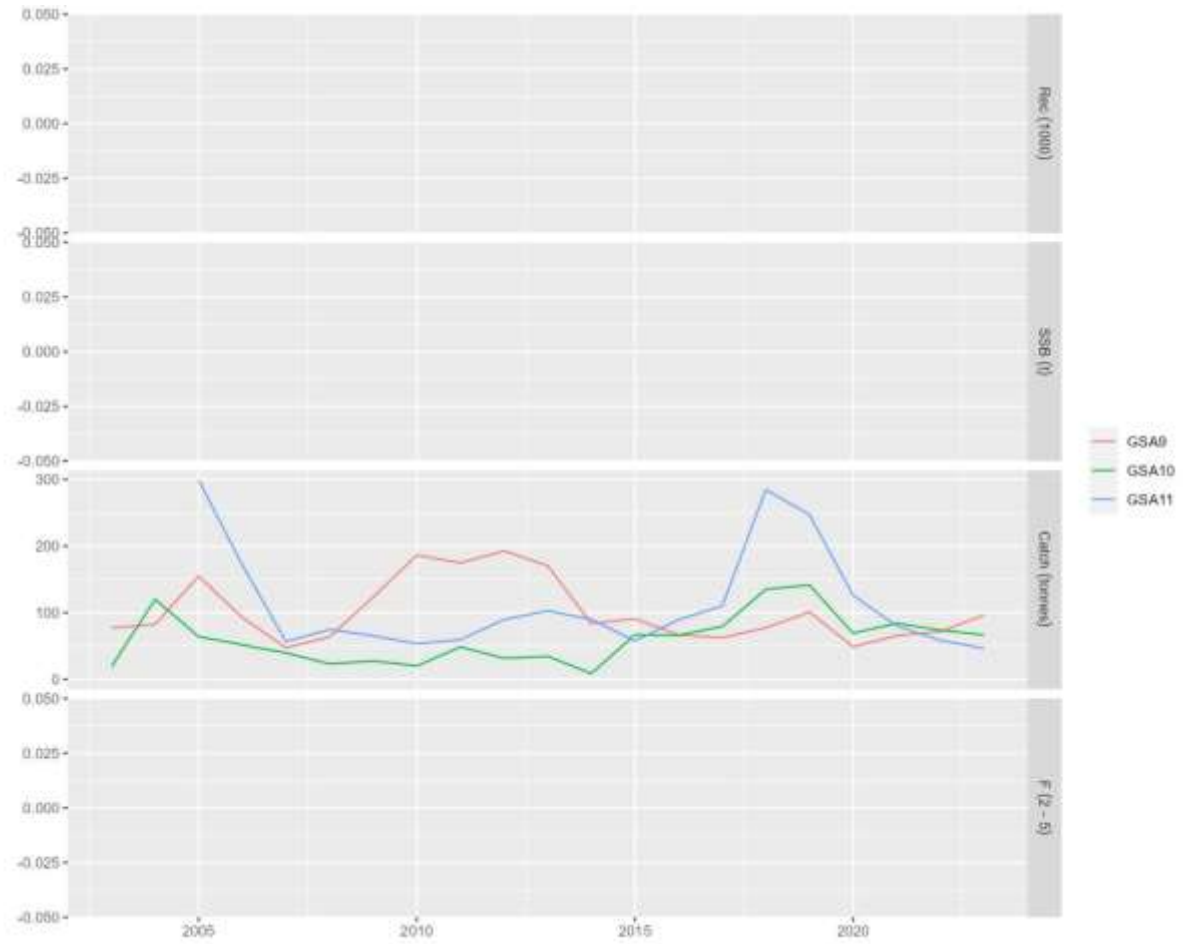
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when the precautionary approach is applied catches should be no more than 171.86 tons in each of the years 2024, 2025 and 2026.

Stock development over time

STECF EWG 24-10 cannot asses the stock and exploitation status relative to MSY and precautionary approach (PA) reference points as it was not possible to assess the state of the stock through a fully analytical method. The stock was downgraded to ICES Category 5 (ICES, 2012).

Figure 5.18.1 Blue and red shrimp in GSAs 8, 9, 10 and 11: Catch by year and GSA. GSA 8 is not included in the plot as low catches are available only for 2010, 2011, 2022 and 2023.



Source: Own elaborations

Stock and exploitation status

It was not possible to evaluate the exploitation status in terms of fishing mortality with respect to the reference point $F_{0.1}$, used as proxy of F_{MSY}.

Table 5.18.1 Blue and red shrimp in GSAs 8, 9, 10 and 11: State of the stock and fishery relative to reference points.

Status	2021	2022	2023
F / $F_{MSY\ proxy}$	Unknown	Unknown	Unknown
B / MSY $B_{trigger\ proxy}$	Unknown	Unknown	Unknown

Source: Own elaborations

Catch scenarios

ICES framework for category 5 stocks was applied (ICES, 2012). For stocks with no information on biomass (from scientific surveys) and/or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating if the current level of exploitation is appropriate for the stock. The precautionary buffer was never applied and has therefore been applied on 2023 data. Discards are considered negligible.

Table 5.18.2 Blue and red shrimp in GSAs 8, 9, 10 and 11: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables.

Recent advised catches		127 tonnes
Discard rate		Negligible
Precautionary buffer	Applied	0.8
Catch advice		171.86 tonnes
% advice change**		-20%

* Advised catches for each of the years 2025, 2026, 2027.
** Advice value for 2025 relative to the catch in 2023 (215 tonnes).
Source: Own elaborations

Basis of the advice

Table 5.18.3 Blue and red shrimp in GSAs 8, 9, 10 and 11: The basis of the advice.

Advice basis	Precautionary approach (ICES category 5)
Management plan	

Source: Own elaborations

Quality of the assessment

Due to the model instability as shown by the retrospective analysis, the EWG 24-10 concluded that the output of the analytical model was not suitable to provide the basis of the current status of the stock. Due to the lack of survey data in 2022, the stock was downgraded to a Category 5 stock.

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.18.4 Blue and red shrimp in GSAs 8, 9, 10 and 11: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger\ proxy}$		Not Defined	
	$F_{MSY\ proxy}$		Not Defined	
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	F_{lim}		Not Defined	
	F_{pa}		Not Defined	
Management plan	SSB_{mgt}		Not Defined	
	F_{mgt}		Not Defined	

Source: Own elaborations

Basis of the assessment

Table 5.18.5 Blue and red shrimp in GSAs 8, 9, 10 and 11: Basis of the assessment and advice.

Assessment type	No assessment
Input data	DCF commercial data (landings)
Discards and bycatch	Discards were negligible (<1%) but included.
Indicators	-
Other information	
Working group	STECF EWG 24-10

Source: Own elaborations

History of the advice, catch, and management

Table 5.18.6 Blue and red shrimp in GSAs 8, 9, 10 and 11: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF landings	STECF discards
2019	$F = F_{MSY}$		-	490	
2020	$F = F_{MSY}$		72	267*	
2021	$F = F_{MSY}$		61	209*	
2022	$F = F_{MSY}$		45	203	
2023	MSY approach (ICES category 3)		145	210	
2024	Catch projections		127		
2025	Precautionary approach (ICES category 5)		172		

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF landings	STECF discards
2026	Precautionary approach (ICES category 5)		172		
2027	Precautionary approach (ICES category 5)		172		

*Values reported at the time of the evaluation

Source: Own elaborations

History of the catch and landings

Table 5.18.7 Blue and red shrimp in GSAs 8, 9, 10 and 11: Catch and effort distribution by fleet in 2021 as estimated by and reported to STECF.

2023		Wanted catch	Discards
Catch (t)	210	Otter trawl 100%	0 t
		210 t	
Effort	NA	NA	
		Fishing days	

Source: Own elaborations

Table 5.18.8 Blue and red shrimp in GSAs 8, 9, 10 and 11: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes. Effort in Fishing Days.

Year	FRANCE GSA8	ITALY GSA9	ITALY GSA10	ITALY GSA11	Total landings
2003	-	77	19	-	95**
2004	-	82	120	-	203**
2005	-	155	64	98	317
2006	-	93	52	172	316
2007	-	47	39	57	143
2008	-	63	23	75	161
2009	-	123	27	65	216
2010	3.5	186	20	53	263***
2011	4.3	175	48	59	287***
2012	-	193	31	57	281
2013	-	170	34	103	307
2014	-	84	9	90	182
2015	-	91	67	58	215
2016	-	67	66	89	222
2017	-	62	79	110	252
2018	-	77	135	285	497
2019	-	101	141	247	490
2020	-	49	83*	126	257
2021	-	65	84	80	230
2022	3.5	72	74	58	203***
2023	5.5	96	67	47	210***

* Data from 2020 from FDI data.
** Incomplete
*** Includes GSA 8

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.18.9 Blue and red shrimp in GSAs 8, 9, 10 and 11: Assessment summary. Weights are in tonnes.

Year	Total Catch
2006	316
2007	143
2008	161
2009	216
2010	264
2011	287
2012	281
2013	307
2014	182
2015	215
2016	222
2017	252
2018	497
2019	490
2020	257
2021	230
2022	203
2023	210

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Sources and references

STECF EWG 24-10.

ICES. 2012 ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp. https://doi.org/10.17895/ices.pub.5322

5.19 Summary sheet for Giant red shrimp in GSAs 8, 9, 10 & 11

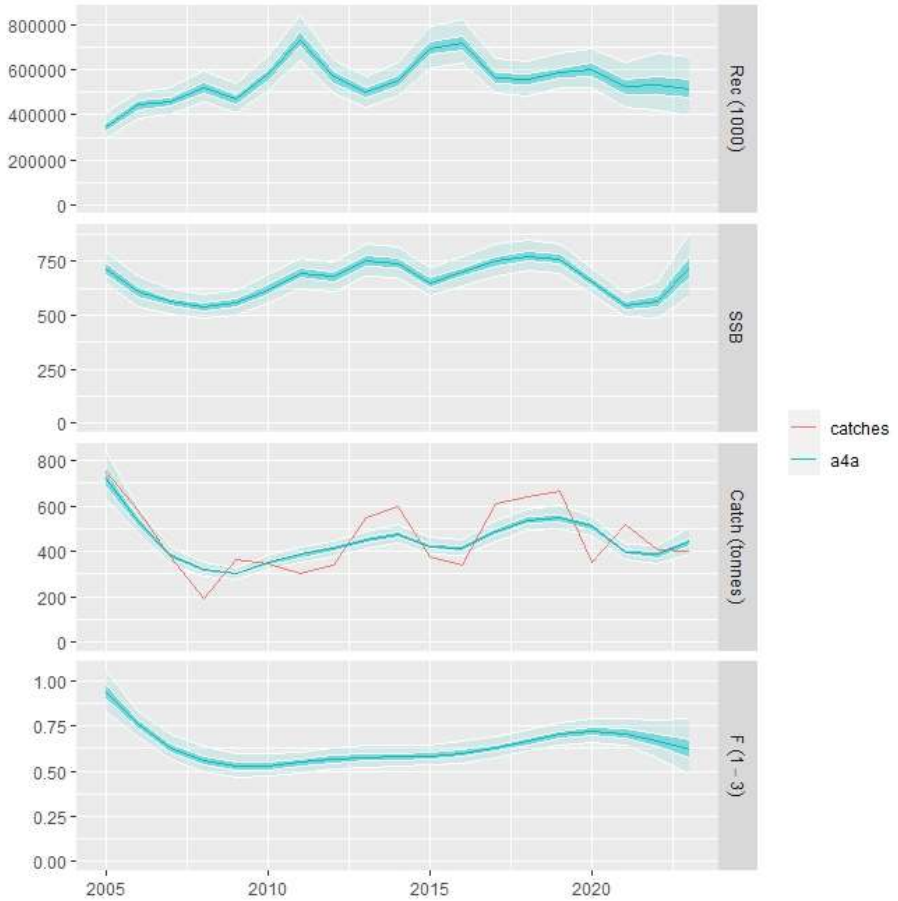
STECF advice on fishing opportunities

STECF EWG 24-10 advises that when MSY considerations are applied, the fishing mortality in 2025 should be no more than 0.48 and corresponding catches in 2025 should be no more than 312 tons.

Stock development over time

The assessment of the giant red shrimp in GSAs 8, 9, 10, 11 show a fluctuating pattern of the catches with a slight increase in the last two years. Recruitment appears mostly constant since 2017 while SSB, after a decreasing trend in the period 2018-2021, is gradually increasing in the last years.
Fishing mortality (Fbar 1-3) gradually increased since 2009 and, after reaching a high value in 2020 (0.72), is slowly decreasing. Fbar in 2023 is 0.62.

Figure 5.19.1 Giant red shrimp in GSAs 8, 9, 10 & 11: Trends in catch, recruitment, fishing mortality and SSB resulting from the a4a model. Original catches are also shown.



Source: Own elaborations

Stock and exploitation status

The current level of fishing mortality (0.62) is above the reference point $F_{0.1}$, used as proxy of F_{MSY} (=0.48). SSB in 2023 is estimated to be above B_{lim}, above B_{pa} and, differently from previous assessment, above B_{msy}. This could indicate a slight improvement in the state of exploitation of the giant red shrimp.

Table 5.19.1 Giant red shrimp in GSAs 8, 9, 10 & 11: State of the stock and fishery relative to reference points.

Status	2019	2020	2021	2022	2023
F / F_{MSY}	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$	$F > F_{MSY}$
F / F_{MSY} Transition		$F > F_{MSY}$ transition	$F > F_{MSY}$ transition	$F > F_{MSY}$ transition	$F > F_{MSY}$ transition
B / B_{lim}	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$	$B > B_{lim}$
B / B_{pa}	$B > B_{pa}$	$B > B_{pa}$	$B > B_{pa}$	$B > B_{pa}$	$B > B_{pa}$
B / B_{MSY}	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B < B_{MSY}$	$B > B_{MSY}$

Source: Own elaborations

Catch scenarios

Table 5.19.2 Giant red shrimp in GSAs 8, 9, 10 & 11: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}3}$ (2024)	0.62	Fsq = F in the last year
SSB (2024)	597	SSB intermediate year from STF output
R_{age0} (2024,2025)	544684	Recruitment will be set as geometric mean of the last 19 years
Total catch (2024)	379	Catch intermediate year from STF output

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Source: Own elaborations

Table 5.19.3 Giant red shrimp in GSAs 8, 9, 10 & 11: Annual catch scenarios. All weights are in tonnes.

Basis	Total catch^ (2025)	F_{total} (ages 1-3) (2025)	SSB (2026)	% SSB change**	% Catch change
STECF advice basis					
F_{MSY}	312	0.48	682	14.3	-29.3
Other scenarios					
$F_{MSY\ lower}$	224	0.32	779	30.6	-49.4
$F_{MSY\ upper*}$	396	0.66	599	0.34	-10.4
Zero catch	0	0	1072	79.6	-100.0
Status quo	380	0.62	614	2.9	-14.0

* Fupper is not tested and is assumed not to be precautionary; STECF does not advise fishing at F> F_{MSY}
** % change in SSB 2024 to 2026
^Total catch in 2025 relative to Catch in 2023.

Source: Own elaborations

Basis of the advice

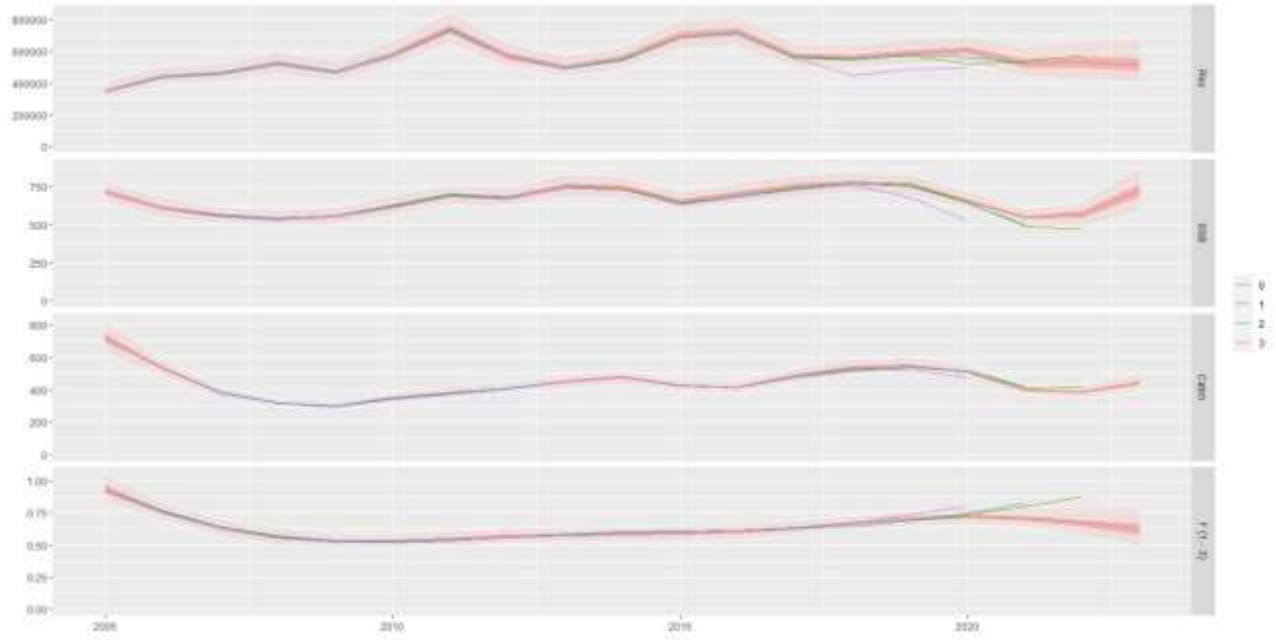
Table 5.19.4 Giant red shrimp in GSAs 8, 9, 10 & 11: The basis of the advice.

Advice basis	F_{MSY}
Management plan	

Quality of the assessment

Commercial catches showed better internal consistency than MEDITS survey index, as in the previous assessment. The historic assessment is stable, and the a4a assessment model employed was not modified from the one used by STECF EWG 23-09. All the diagnostics were considered acceptable. The retrospective analysis showed consistent results.

Figure 5.19.2 Giant red shrimp in GSAs 8, 9, 10 & 11: Historical assessment results (final-year recruitment estimates included). (Retrospective graph)



Source: Own elaborations

Issues relevant for the advice

No additional relevant issues for the advice.

Reference points

Table 5.19.5 Giant red shrimp in GSAs 8, 9, 10 & 11: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.48	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}	176.0	Default based on 25% $B_{F0.1}$ and GM recruitment	STECF EWG 24-10
	B_{pa}	352.0	B_{lim} * 2	STECF EWG 24-10
	B_{MSY}	703.0	$B_{F0.1}$	STECF EWG 24-10
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.48	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.32	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.66	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: Own elaborations

Basis of the assessment

Table 5.19.6 Giant red shrimp in GSAs 8, 9, 10 & 11: Basis of the assessment and advice.

Assessment type	Statistical catch at age
Input data	DCF commercial data (landings and discards) and scientific survey (MEDITS) data
Discards, BMS landings*, and bycatch	Discards included in the total catch
Indicators	
Other information	
Working group	STECF EWG 24-10

*BMS (Below Minimum Size) landings

Source: Own elaborations

History of the advice, catch, and management

Table 5.19.7 Giant red shrimp in GSAs 8, 9, 10 & 11: STECF advice and STECF estimates of landings, discards reported to STECF. All weights are in tonnes.

Year	STECF advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	STECF catch	STECF discards
2019	$F = F_{MSY}$		171	571	
2020	$F = F_{MSY}$		199	351	
2021	$F = F_{MSY}$		323	519	
2022	$F = F_{MSY}$		241	405	
2023	$F = F_{MSY}$		270	402	
2024	$F = F_{MSY}$		279		
2025	$F = F_{MSY}$		312		

Source: Own elaborations

History of the catch and landings

Table 5.19.8 Giant red shrimp in GSAs 8, 9, 10 & 11: Catch and effort distribution by fleet in YEAR as reported to STECF.

2023	Wanted catch				Discards
Catch 402 t	Otter trawl 100%	Gillnets 0%	Trammel nets 0%	Other 0%	
	402				
Effort	NA	NA	NA	NA	
	Fishing days				

Source: Own elaborations

Table 5.19.9 Giant red shrimp in GSAs 8, 9, 10 & 11: History of commercial landings; official reported values are presented by country and GSA. All weights are in tonnes.

Year	ITALY GSA8	ITALY GSA9	ITALY GSA10	ITALY GSA11	MALTA GSA9	MALTA GSA11	Total landings
2005		77.4	505.1	170.7			753.2
2006		62.6	419.6	98.1			580.3
2007		36.7	300.3	42.0			378.9
2008		33.8	120.1	38.6			192.6
2009		34.3	211.7	117.4			363.4
2010		54.6	190.2	98.6			343.4
2011		68.4	140.9	94.7			304.0
2012		62.0	159.8	117.3			339.0
2013		23.1	399.4	124.1			546.6
2014		16.8	454.1	123.9			594.8
2015		44.2	232.1	97.8			374.1
2016		35.8	179.1	127.6			342.5

2017		33.6	326.0	249.2			608.8
2018		36.4	416.2	188.4			640.9
2019		46.2	450.2	170.0			666.3
2020		30.2	224.625	96.3			351.1
2021	0.3	30.8	317.1	170.6	0.5	0.0	519.4
2022	0.6	42.5	224.2	138.3			405.7
2023	2.0	113.6	172.8	113.3			401.7

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Summary of the assessment

Table 5.19.10 Giant red shrimp in GSAs 8, 9, 10 & 11: Assessment summary. Weights are in tonnes. SSB estimated at mid-year

Year	Recruitment age 0 thousands	SSB tonnes	Catch tonnes	F ages 1-3
2005	349204	712.2	715.8	0.935
2006	442226	606.9	530.7	0.756
2007	460984	560.9	379.9	0.631
2008	522380	538.2	318.7	0.557
2009	470531	555.0	301.2	0.528
2010	579832	618.3	349.8	0.529
2011	739607	692.9	382.8	0.547
2012	569816	676.0	408.4	0.566
2013	499486	750.9	447.4	0.578
2014	552770	743.0	474.4	0.582
2015	698767	650.5	421.1	0.586
2016	722196	700.4	412.2	0.599
2017	566924	750.0	486.0	0.628
2018	559310	773.3	535.2	0.667
2019	590325	758.4	546.2	0.704
2020	603388	656.5	507.0	0.722
2021	524951	545.0	395.3	0.709
2022	531013	565.5	384.0	0.670
2023	517108	722.2	441.5	0.621

Source: Own elaborations

Sources and references

STECF EWG 24-10.

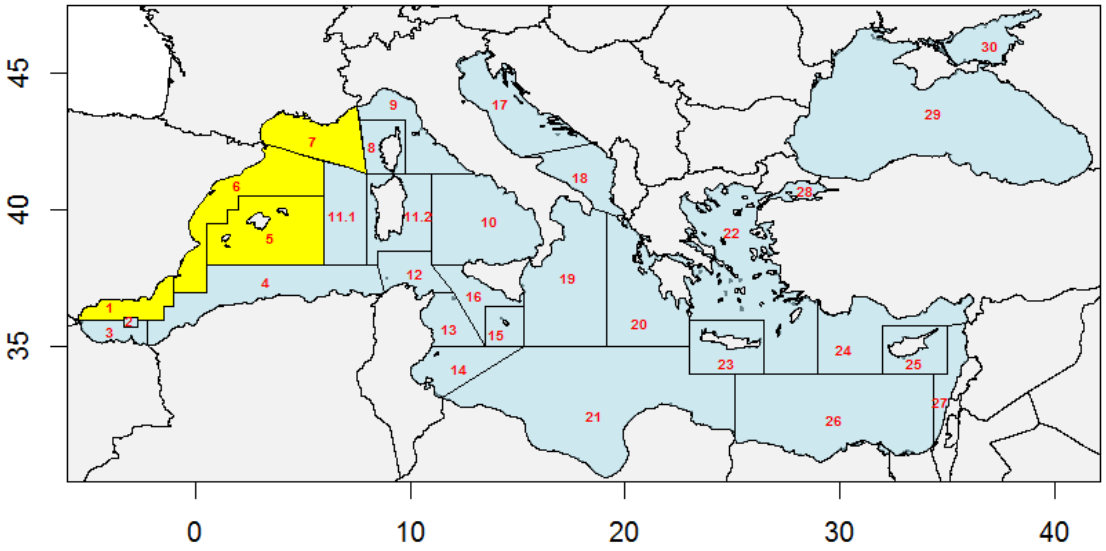
6 Stock assessment details

6.1 Hake in GSA 1, 5, 6 &7

6.1.1 Stock Identity and Biology

The assessment of European hake carried out during the STECF EWG 24-10 considered the stock shared by GSAs 1, 5, 6 and 7.

Figure 6.1.1.1 Geographical location of GSAs 1, 5, 6 and 7.



Source: Own elaborations

A sex combined model was applied to this stock. All the parameters used were the same used during the GFCM hake benchmark carried out in December 2019 ("Working Group on Stock Assessment of Demersal Species (WGSAD) benchmark session for the assessment of European hake in GSAs 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 22, 23", Rome, Italy, 2-7 December 2019).

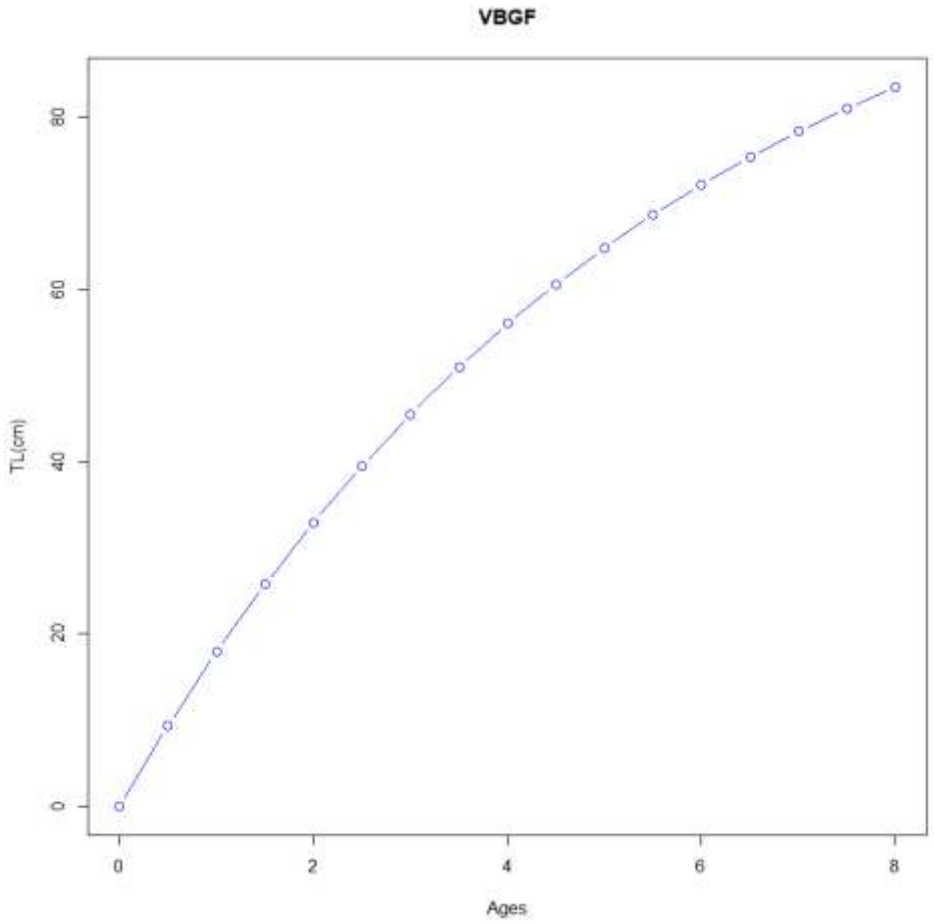
The growth parameters used were those estimated by Mellon-Duval et al. (2010) from tagging experiments in the Gulf of Lions; length-weight relationship parameters were those estimated in the Spanish Data Collection Framework (Tab. 6.1.1.1 and Fig. 6.1.1.2).

Table 6.1.1.1 European hake in GSAs 1, 5, 6 and 7. Growth parameters and length-weight relationship parameters.

L_{inf}	k	t0	a	b
110	0.178	-0.005	0.00677	3.0351

Source: Own elaborations

Figure 6.1.1.2. European hake in GSAs 1, 5, 6 and 7. Von Bertalanffy growth curve.



Source: Own elaborations

The maturity vector was taken from García-Rodríguez and Esteban (1995); the natural mortality vector was estimated as an average of different methods (Gislason, Prodbiom revised version with unique solution, Chen & Watanabe, Brodziak (2011 and 2012), Lorenz and Gulland), consistently with the approach used in the GFCM benchmark assessment of hake in Adriatic Sea in 2019 (Tab. 6.1.1.2).

Table 6.1.1.2. European hake in GSAs 1, 5, 6 and 7. Maturity and natural mortality vectors used in the assessment.

Age	Maturity	M
0	0	1.63
1	0.15	0.68
2	0.82	0.41
3	0.98	0.31
4	1	0.25
5+	1	0.22

Source: Own elaborations

6.1.2 Data

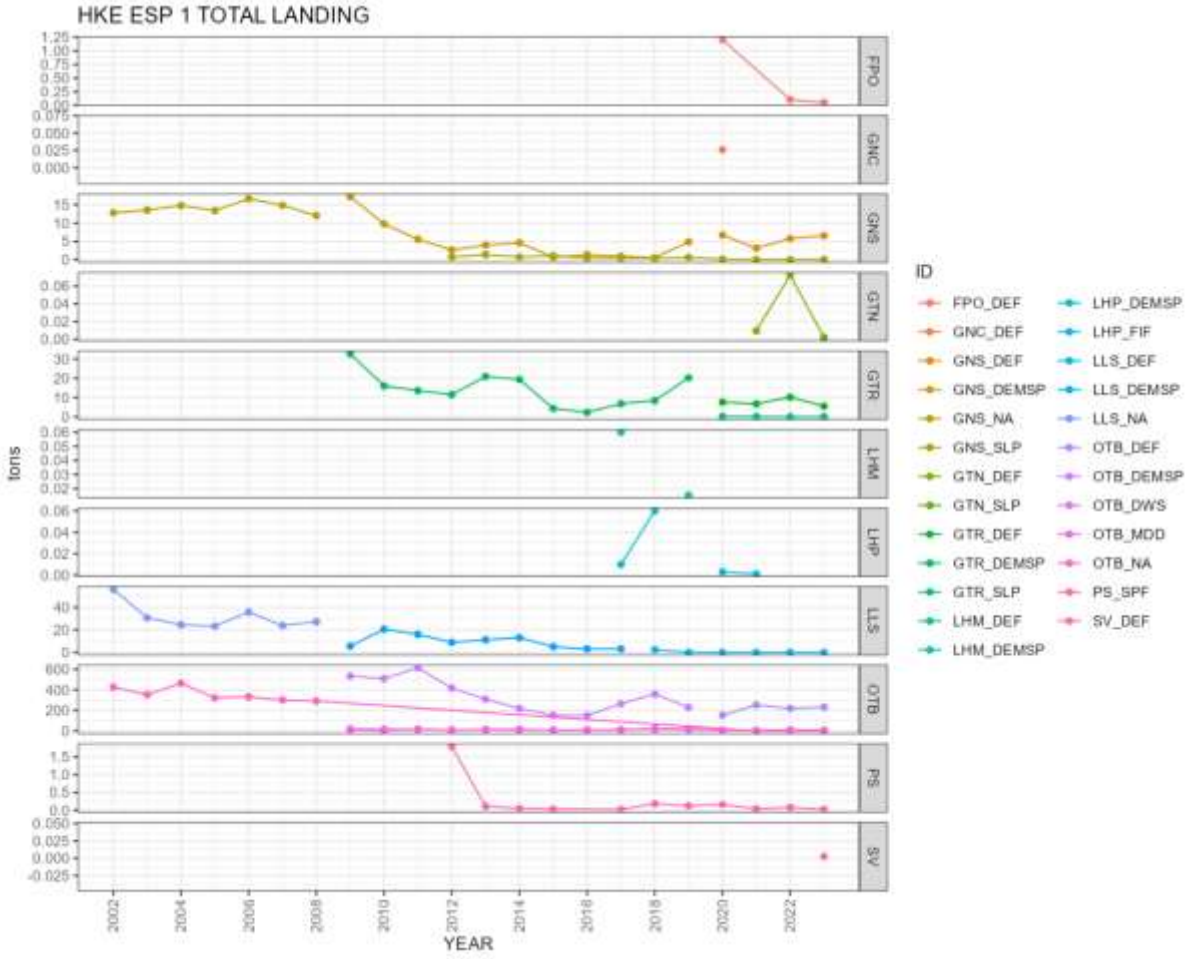
6.1.2.1 Catch (landings and discards)

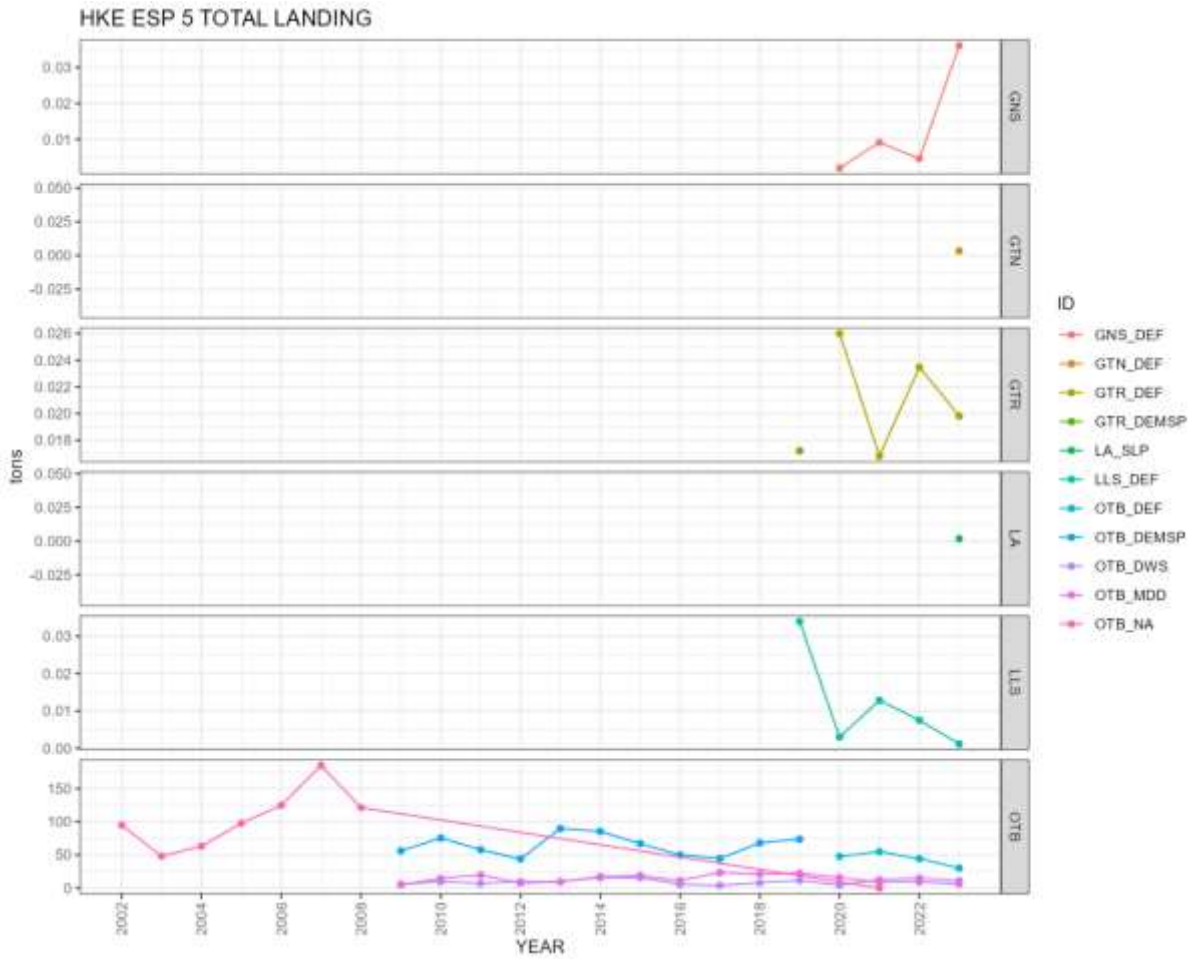
European hake is largely exploited in GSAs 1 and 6, mainly by trawlers on the shelf and slope, but also by small-scale fisheries using long lines, gill nets and trammel nets. In GSA 5, hake catches come exclusively from bottom trawlers. They show important variation along the data series, between 50 and 200 tons. In the Gulf of Lions (GSA 7), hake is exploited by French trawlers, French gillnetters, Spanish trawlers and Spanish longliners.

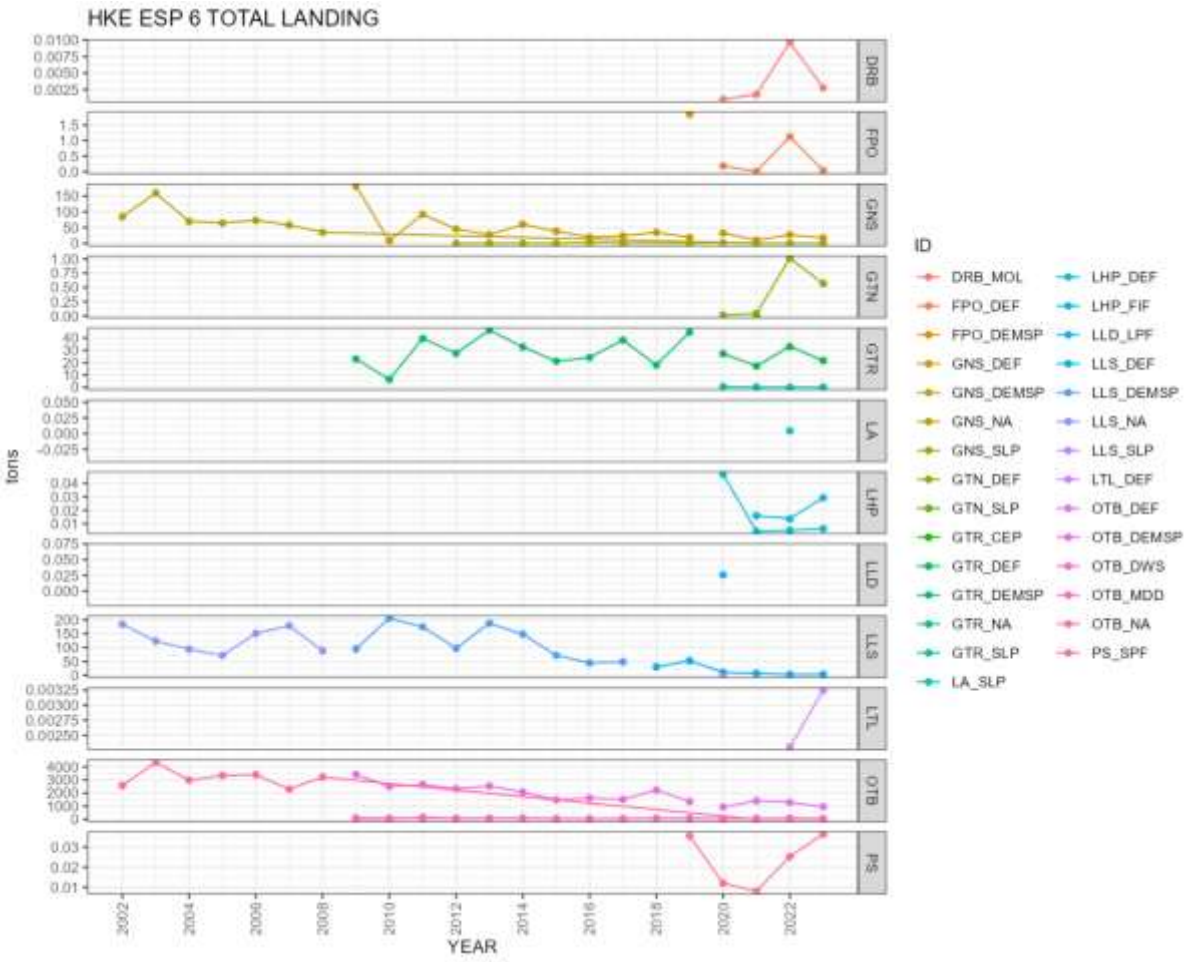
Landings

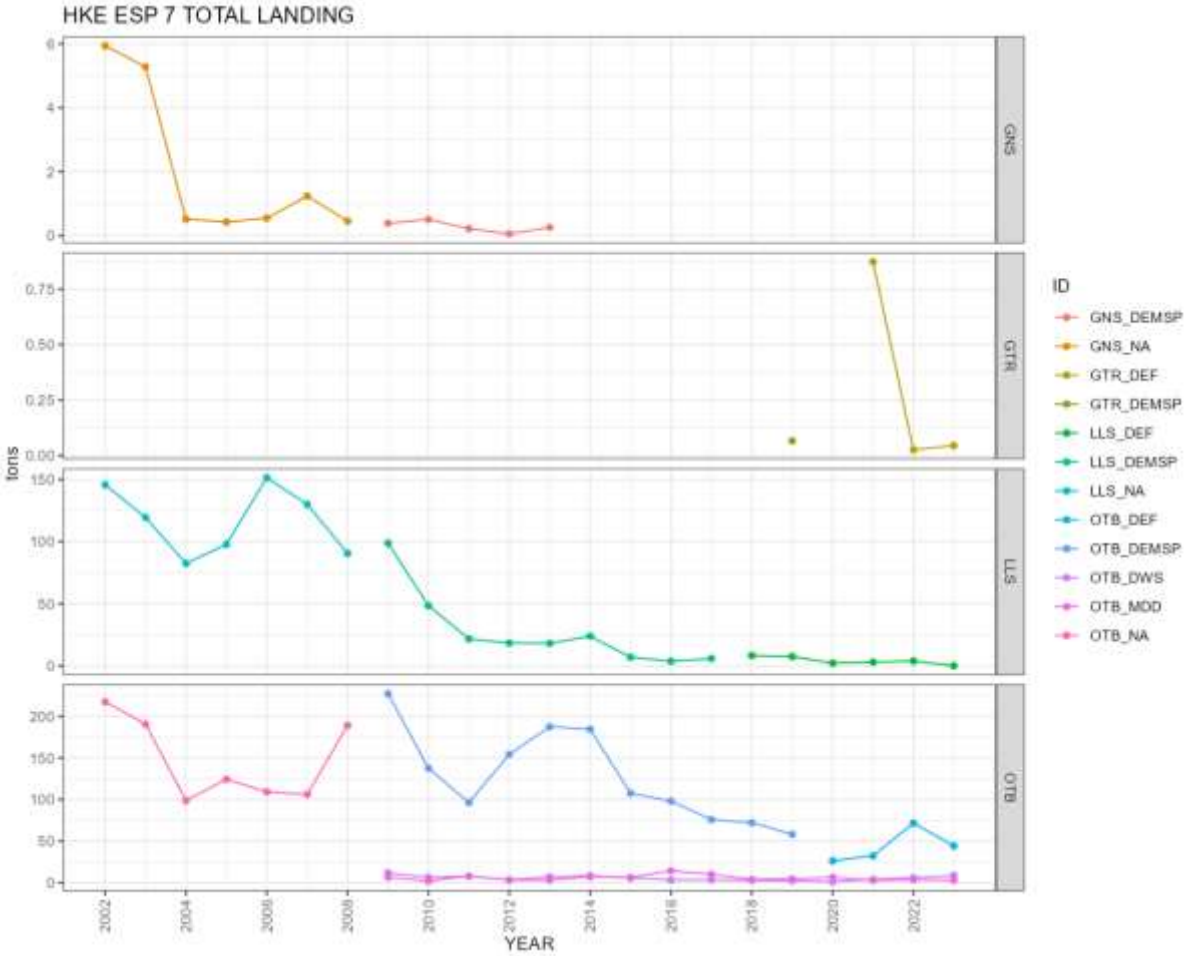
Landings data were reported to STECF EWG 24-10 through the DCF. In GSAs 1, 5, 6 and 7, most of the landings come from otter trawls. The contribution of set nets is around 7% and of longlines is now around 1% to the total landing after a constant reduction since 2014. Landings data by year, GSA, country and fleet are presented in Figure 6.1.2.1.1, total landings by year are presented in Table 6.1.2.1.1.

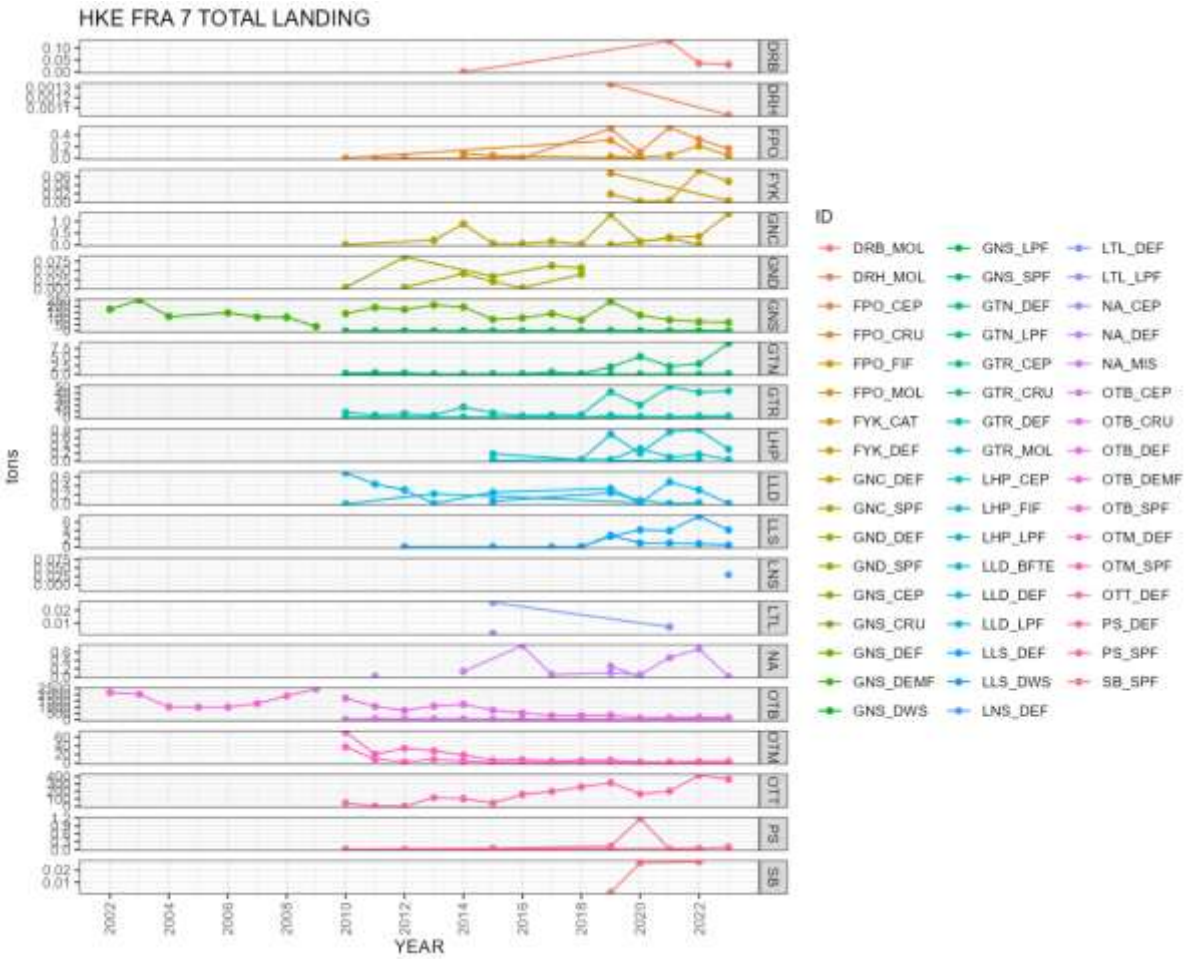
Figure 6.1.2.1.1. European hake in GSAs 1, 5, 6 and 7. Landings data in tons by year GSA country and fleet. From 2015 onwards there can be two points in the same year due to the increase in “fishery classes” for the same gear. Showing all the fishery classes and gears was overly complex, so the fishery classes for the same gear are both sown. As each fishery has different values it is possible to get double points or trends.


HKE ESP 1 TOTAL LANDING
tons
YEAR
FPO
GNC
GNS
GTN
GTR
LHM
LHP
LLS
OTB
PS
SV
ID
FPO_DEF
GNC_DEF
GNS_DEF
GNS_DEMSP
GNS_NA
GNS_SLP
GTN_DEF
GTN_SLP
GTR_DEF
GTR_DEMSP
GTR_SLP
LHM_DEF
LHM_DEMSP
LHP_DEMSP
LHP_FIF
LLS_DEF
LLS_DEMSP
LLS_NA
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA
PS_SPF
SV_DEF


HKE ESP 5 TOTAL LANDING
GNS
GTN
GTR
LA
LLS
OTB
tons
YEAR
ID
GNS_DEF
GTN_DEF
GTR_DEF
GTR_DEMSP
LA_SLP
LLS_DEF
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA


HKE ESP 6 TOTAL LANDING
tons
YEAR
DRB
FPO
GNS
GTN
GTR
LA
LHP
LLD
LLS
LTL
OTB
PS
ID
DRB_MOL
FPO_DEF
FPO_DEMSP
GNS_DEF
GNS_DEMSP
GNS_NA
GNS_SLP
GTN_DEF
GTN_SLP
GTR_CEP
GTR_DEF
GTR_DEMSP
GTR_NA
GTR_SLP
LA_SLP
LHP_DEF
LHP_FIF
LLD_LPF
LLS_DEF
LLS_DEMSP
LLS_NA
LLS_SLP
LTL_DEF
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA
PS_SPF


HKE ESP 7 TOTAL LANDING
tons
YEAR
GNS
GTR
LLS
OTB
ID
GNS_DEMSP
GNS_NA
GTR_DEF
GTR_DEMSP
LLS_DEF
LLS_DEMSP
LLS_NA
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

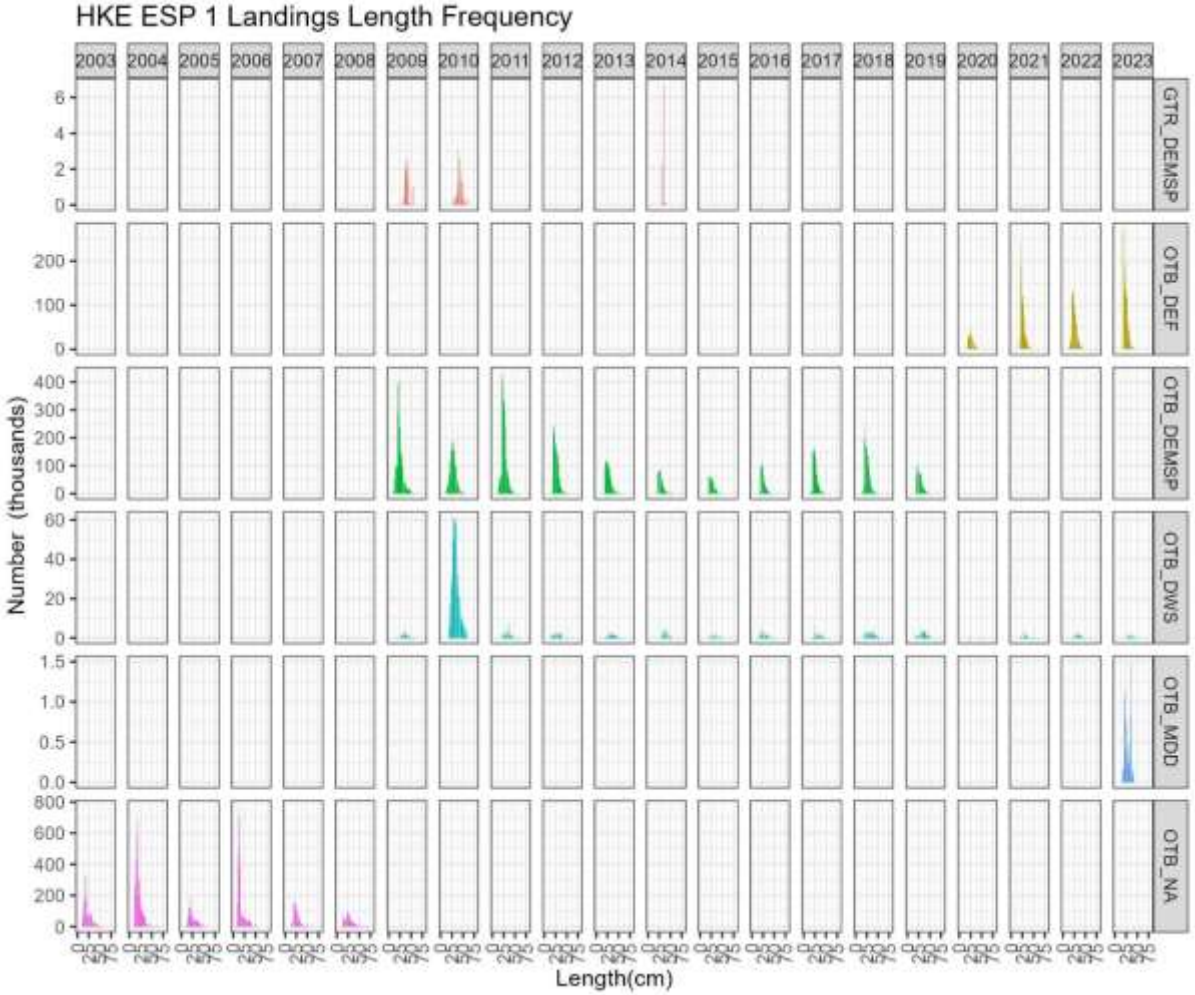
Table 6.1.2.1.1. European hake in GSAs 1, 5, 6 and 7. Total landings data in tons by year.

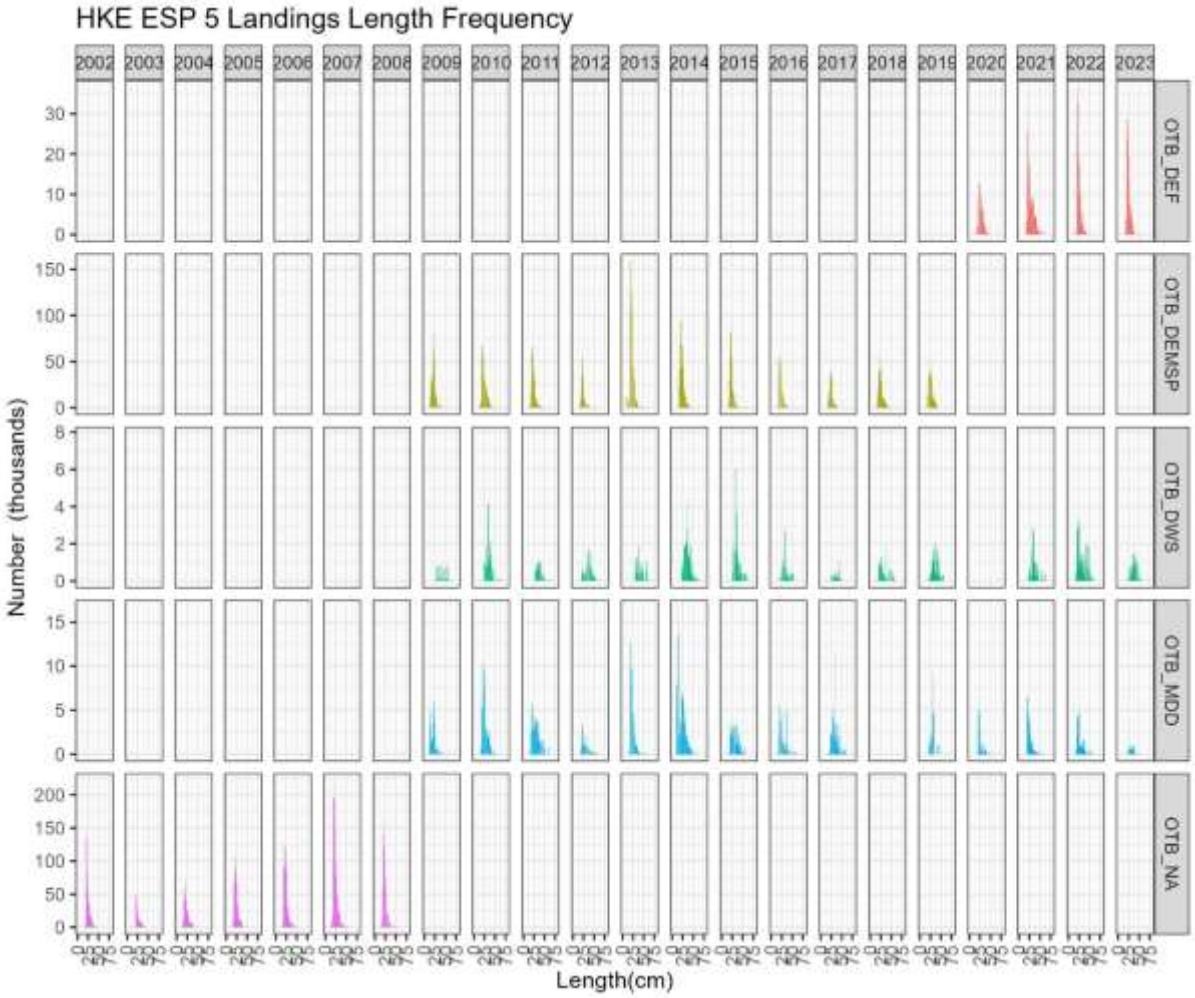
	Total Landing (tons)
2002	6138
2003	7667
2004	5039
2005	5155
2006	5558
2007	4696
2008	6081
2009	7363
2010	5741
2011	5465
2012	4384
2013	5184
2014	4743
2015	3114
2016	3059
2017	2935
2018	3814
2019	3162
2020	1897
2021	2486
2022	2689
2023	2178

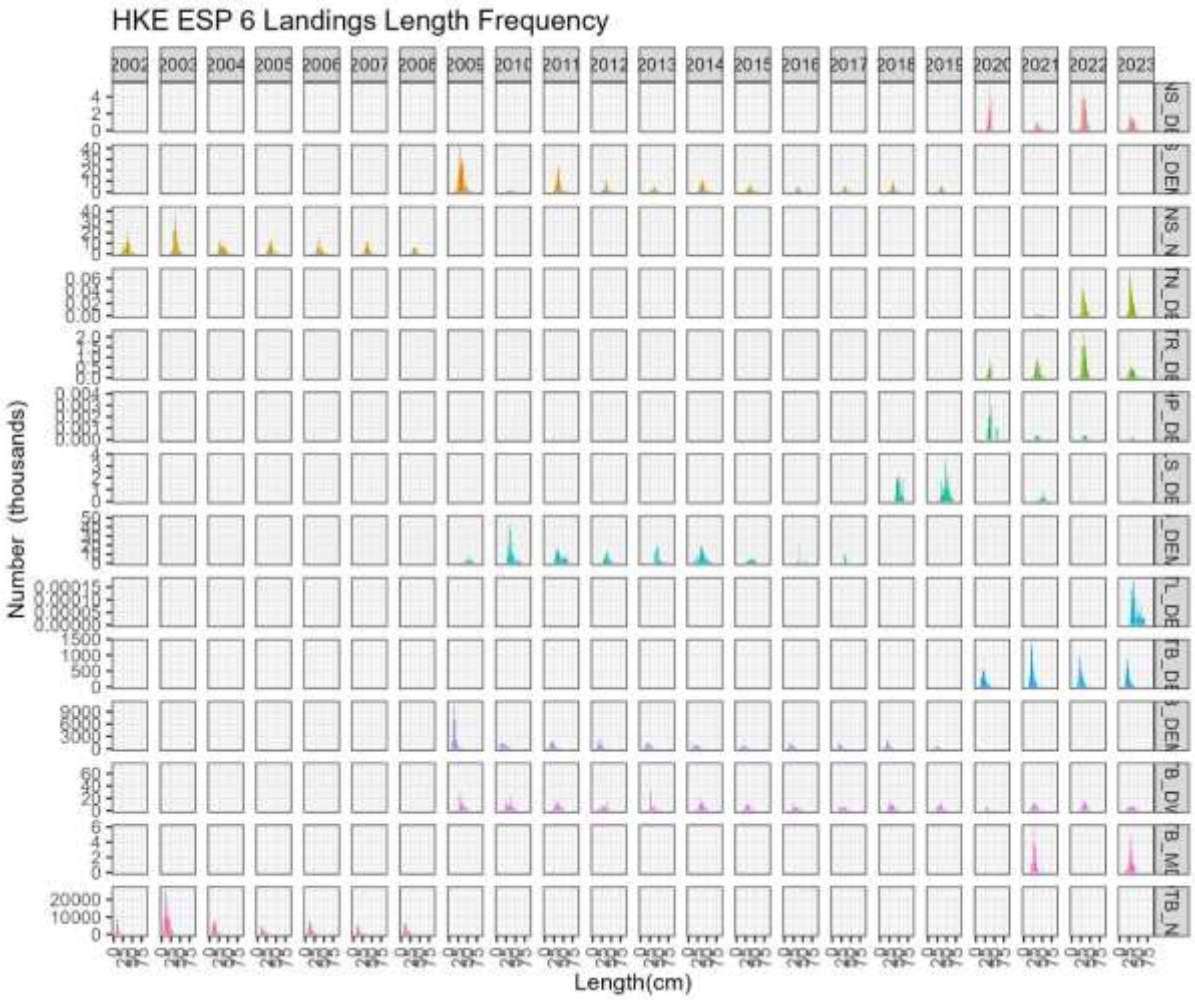
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

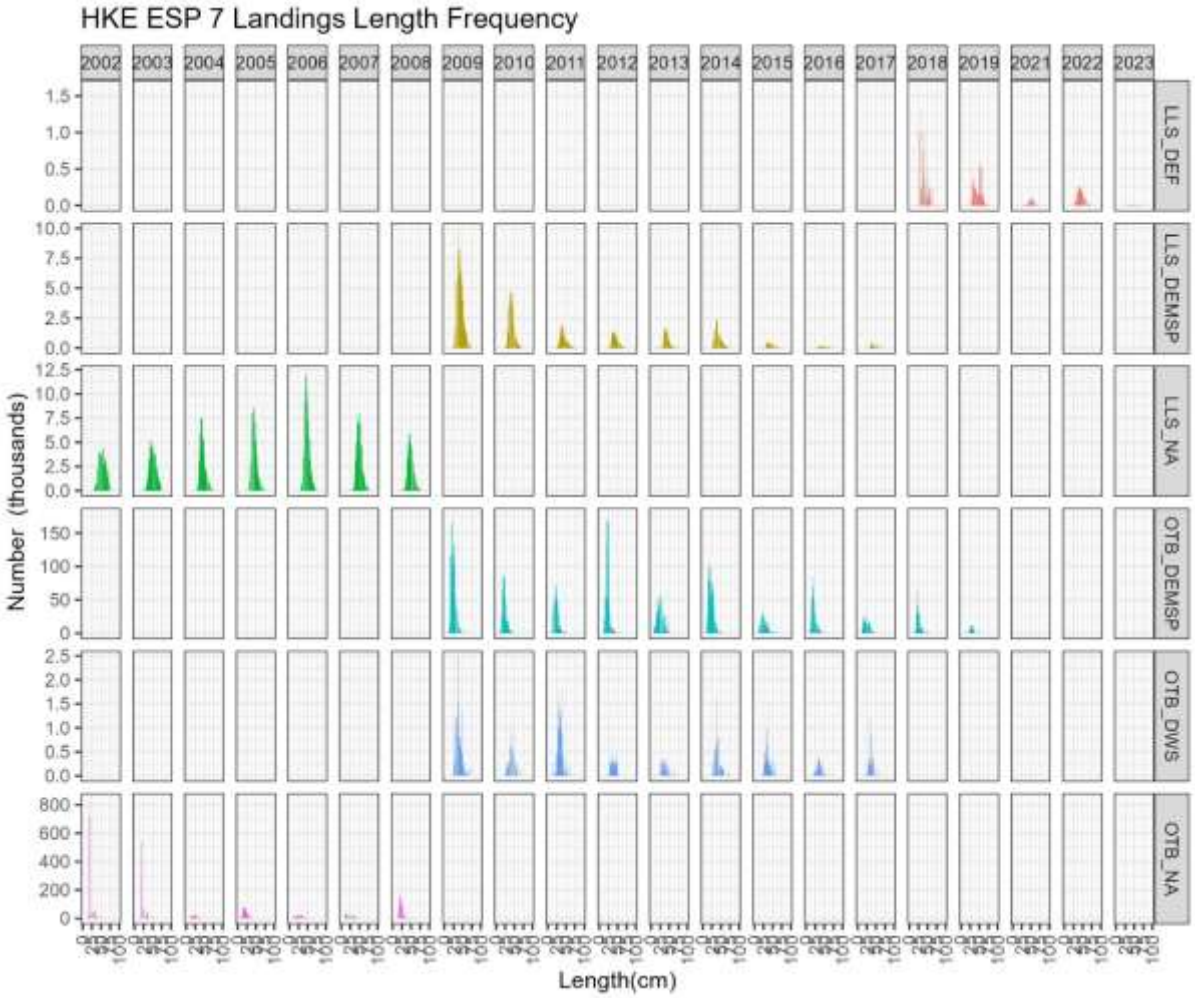
Length frequency distribution of the landings by year and gear or fleet from the DCF database is presented in Figure 6.1.2.1.2. When data are reported by gear different fisheries within gears are represented by different colours (to reduce number of rows).

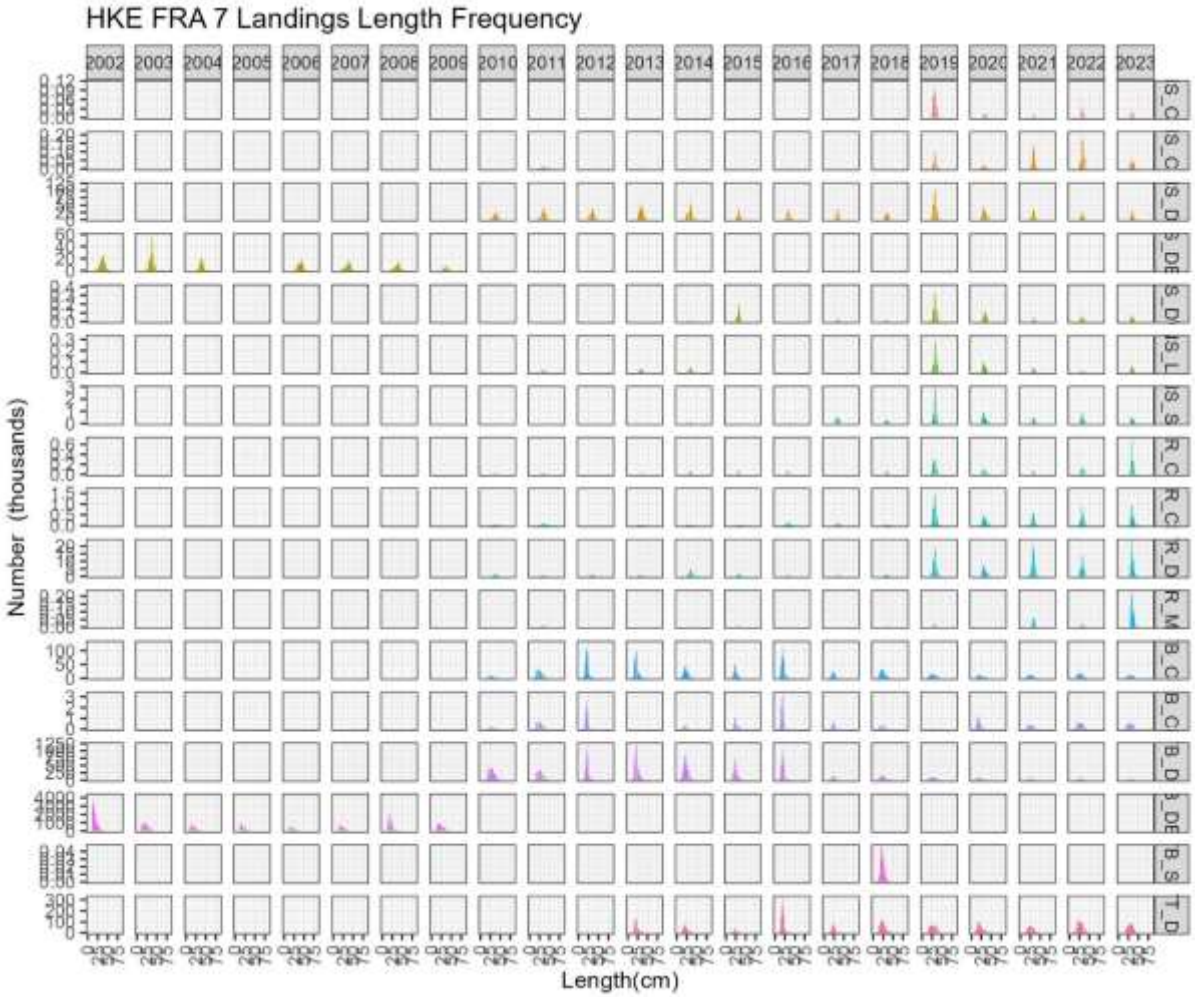
Figure 6.1.2.1.2. European hake in GSAs 1, 5, 6 and 7. Length frequency distribution of the landings by year and gear or fleet.


HKE ESP 1 Landings Length Frequency
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GTR_DEMSP
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA
Number (thousands)
Length(cm)


HKE ESP 5 Landings Length Frequency
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
OTB_DEF
OTB_DEMSP
OTB_DWS
OTB_MDD
OTB_NA
Number (thousands)
Length(cm)


HKE ESP 6 Landings Length Frequency
Number (thousands)
Length(cm)


HKE ESP 7 Landings Length Frequency
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
2023
LLS_DEF
LLS_DEMSP
LLS_NA
OTB_DEMSP
OTB_DWS
OTB_NA
Number (thousands)
Length(cm)



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Discards

Discards data were reported to STECF EWG 24-10 through the DCF, and they were included in the stock assessment. For the years in which discards data were missing, they were estimated on the basis of the discard ratio (discard/landing) of the available years and the landing time series. Total discard by year is presented in Table 6.1.2.1.2.

Table 6.1.2.1.2. European hake in GSAs 1, 5, 6 and 7 discards data in tons by GSA.

	GSA_1	GSA_5	GSA_6	GSA_7ESP	GSA_7FRA
2002	0	0	0	0	0
2003	0	0	0	0	0.1
2004	0	0	0	0	0.29
2005	19.31	12.24	0.11	1.2	0.23
2006	0	0	0	0	0.4
2007	0	0	0	0	0.09
2008	13.2	7.1	0.45	13.38	173

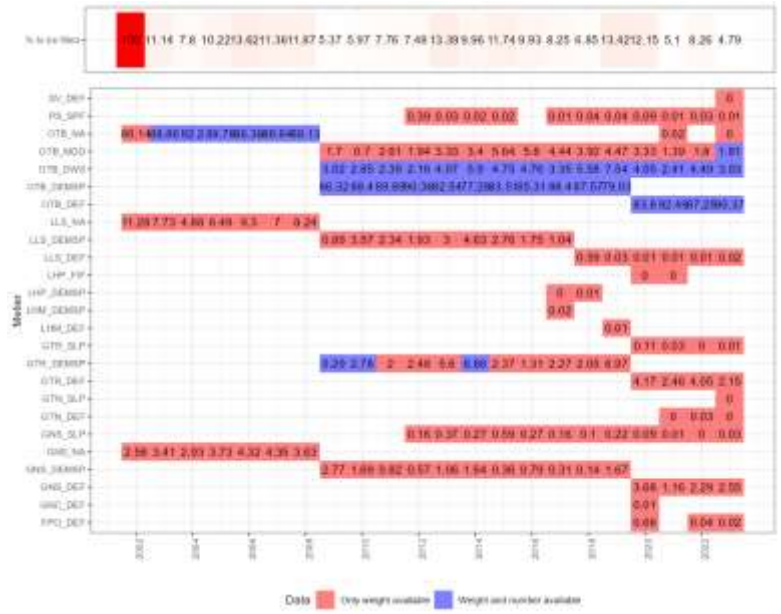
2009	20.75	16.17	0.31	0.83	8.75
2010	14.94	19.16	0.81	1.45	20.85
2011	5.98	6.53	141.59	3.34	7.27
2012	20.78	6.5	194.28	1.16	8.75
2013	10.38	13.05	156.61	0.29	27.42
2014	30.78	5.56	151.83	2.3	58.18
2015	23.48	0.61	52.16	1.32	26.01
2016	24.88	2.97	71.09	1.2	28.4
2017	21.4	0.89	68.96	0.1	7.62
2018	27.57	46.27	139.19	1.53	32.22
2019	9.99	17.15	28.12	0	15.68
2020	4.33	21.58	34.22	0	21.96
2021	24.77	5.91	254.07	0	22.27
2022	20.75	8.37	112.47	0	59.61
2023	43.87	2.97	154.83	0	10.66

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Length and age frequency distributions of discards were available from DCF data only for France in GSA 7 while for Spain were available only since 2017 in GSAs 1 and 6 since 2018 in GSA 5.

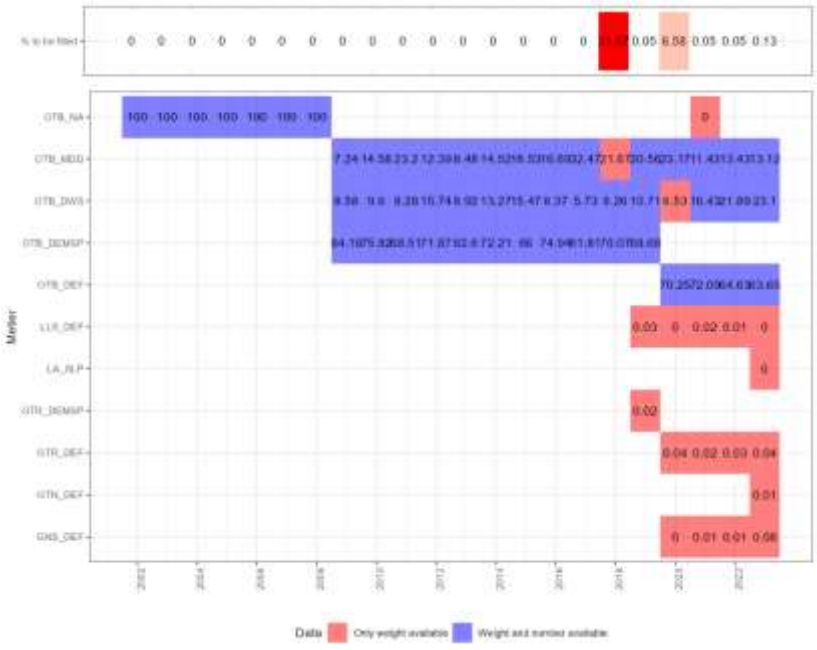
Considering that this is a preliminary benchmarked stock, data were not reconstructed during STECF EWG 24-10 for years up to 2019. Data from 2023 was added to the time series used in the EWG 23-09. Nevertheless, the code from EWG 20-05 was used to show where sampling gaps are present in the data (Figure 6.1.2.1.3 - 7) and how these can affect the SOP correction values which are presented in Table 6.1.3.1 within the “Stock Assessment” section. Length measurements were completely lacking for 2022 as well from the Spanish commercial sampling of GSA 7, therefore only for these three years LFDs were reconstructed following the JRC routine.

Figure 6.1.2.1.3 Time series of GSA 1 showing were landings were sampled by length (blue) or only total weight was reported (red). On the top row is reported the proportion of data that would need reconstruction for that year.



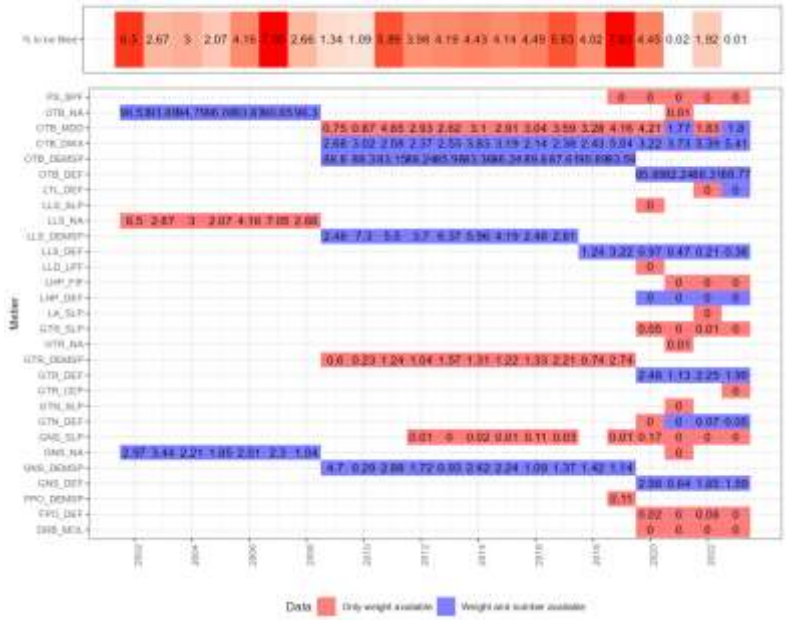
Source: Own elaborations

Figure 6.1.2.1.4 Time series of GSA 5 showing were landings were sampled by length (blue) or only total weight was reported (red). On the top row is reported the proportion of data that would need reconstruction for that year.



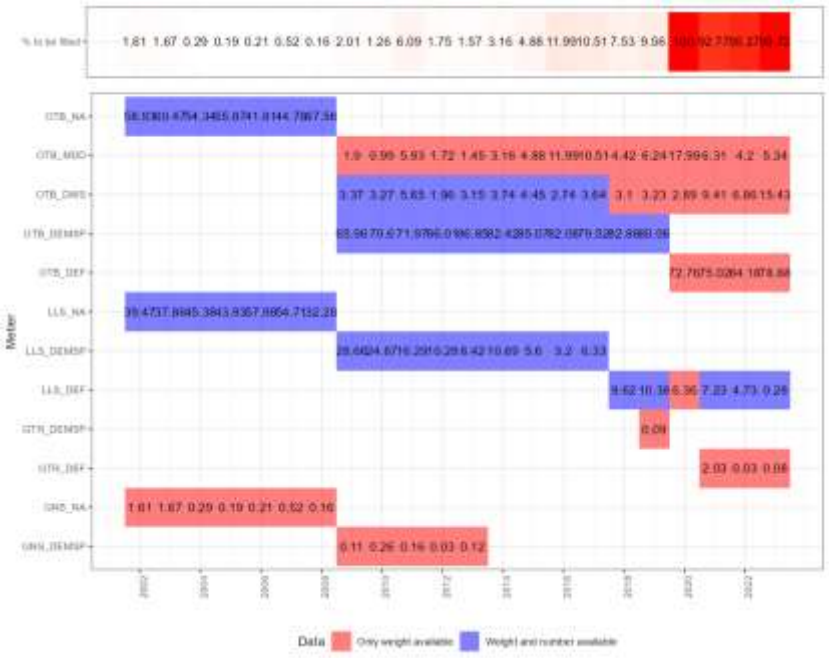
Source: Own elaborations

Figure 6.1.2.1.5 Time series of GSA 6 showing were landings were sampled by length (blue) or only total weight was reported (red). On the top row is reported the proportion of data that would need reconstruction for that year.



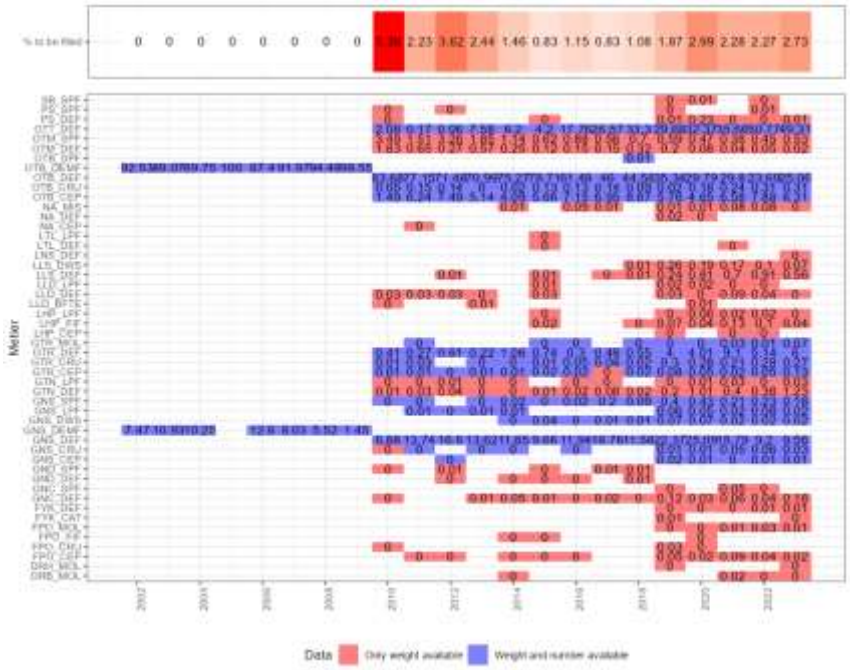
Source: Own elaborations

Figure 6.1.2.1.6 Time series of GSA 7 (Spanish data) showing were landings were sampled by length (blue) or only total weight was reported (red). On the top row is reported the proportion of data that would need reconstruction for that year.



Source: Own elaborations

Figure 6.1.2.1.7 Time series of GSA 7 (French data) showing were landings were sampled by length (blue) or only total weight was reported (red). On the top row is reported the proportion of data that would need reconstruction for that year.



Source: Own elaborations

6.1.2.2 Effort Data

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

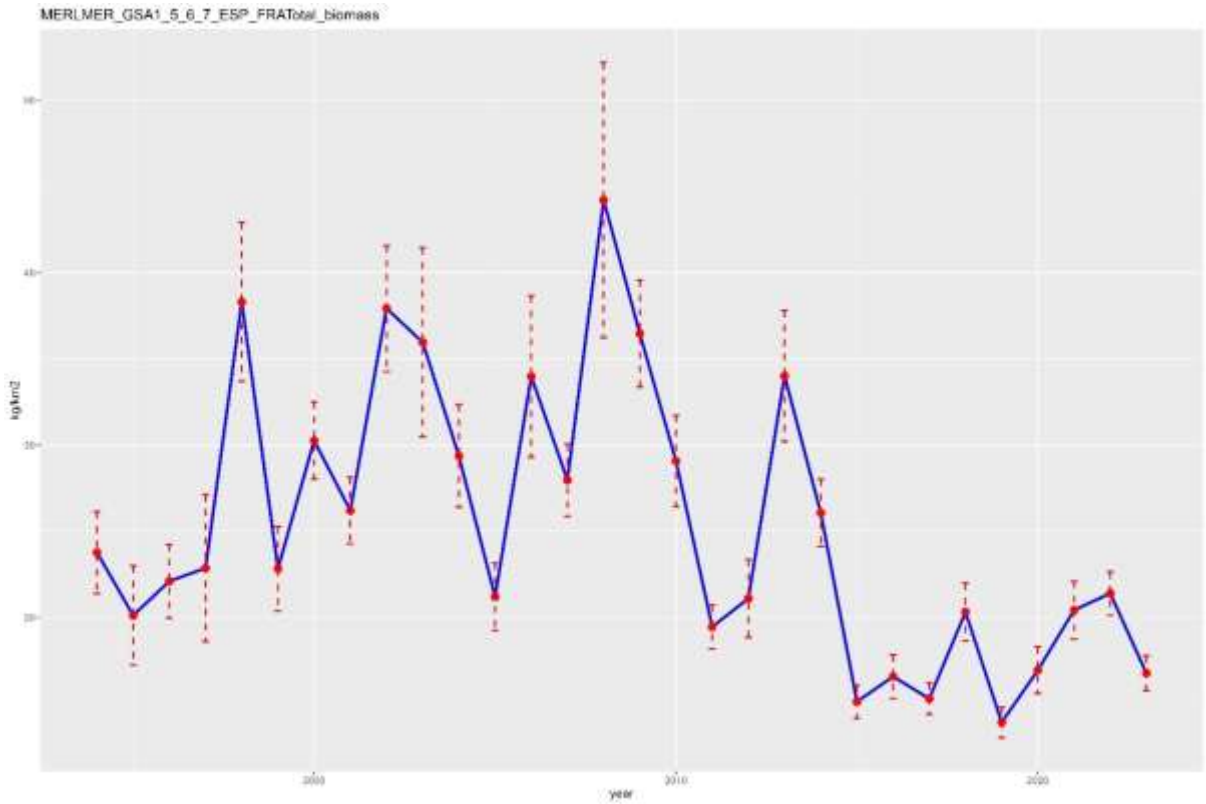
6.1.2.3 Survey data

The MEDITS (Mediterranean International Trawl Survey) survey is an extensive trawl survey occurring in all European countries and included in the Data Collection Framework. According to the MEDITS protocol (Bertrand et al., 2002), it takes place 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 maintained fixed throughout the time. Same sampling gear (GOC73), characterized by a 20 mm stretched mesh size cod-end, and is used throughout GSAs and years.

Since 1994, the MEDITS surveys have been regularly carried out each year during the spring season. In the current assessment combined MEDITS data for GSAs 1-5-6-7 from 2007 onwards were used, as in GSA 5 the survey has been carried out consistently only from that year. The Balearic Islands, in fact, were partially covered by the MEDITS survey during 1994-2006, with a very low number of hauls by year, covering only a small part of the area (Ibiza channel). Thus, only the information collected from 2007, when the sampling was extended, was considered reliable for the analysis.

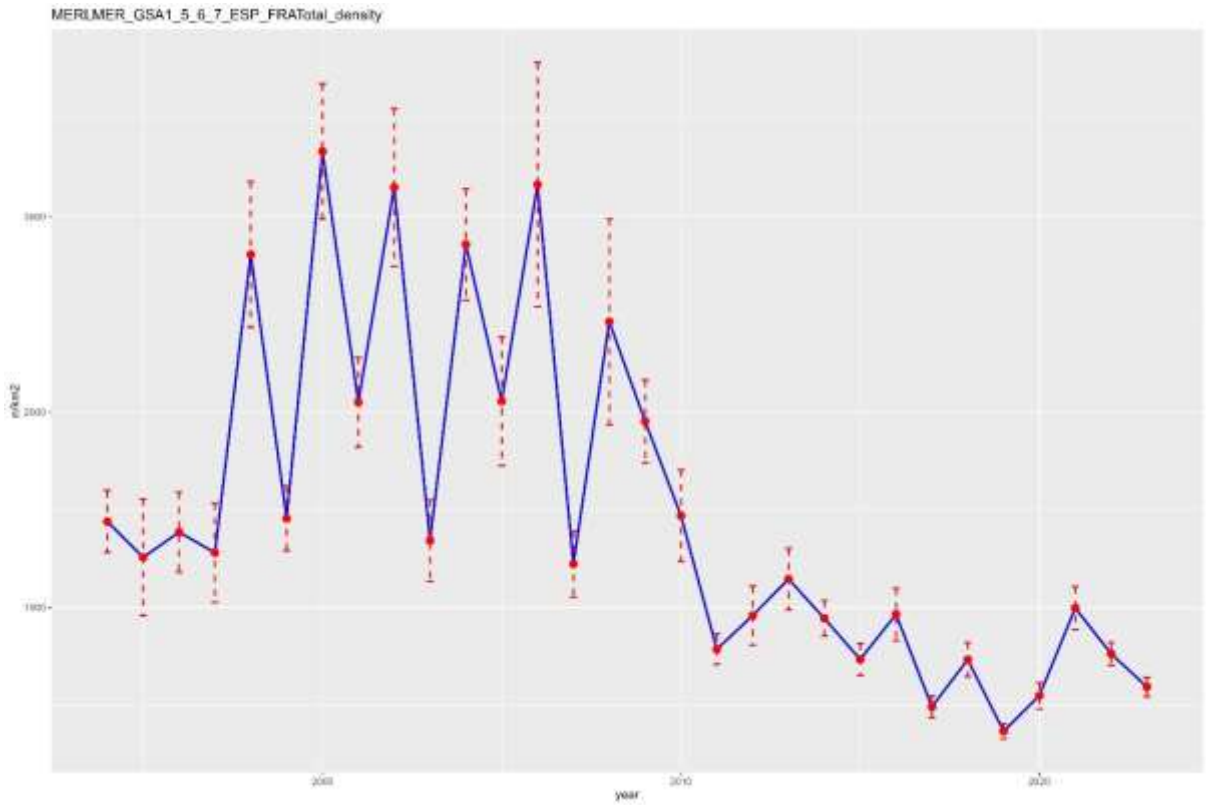
The combined MEDITS indexes were calculated using the script provided by JRC (Figures 6.1.2.3.1 and 6.1.2.3.2).

Figure 6.1.2.3.1. European hake in GSAs 1, 5, 6 and 7. Estimated biomass indices from the MEDITS survey (kg/km^2).



Source: Own elaborations

Figure 6.1.2.3.2. European hake in GSAs 1, 5, 6 and 7. Estimated density indices from the MEDITS survey (n/km^2).

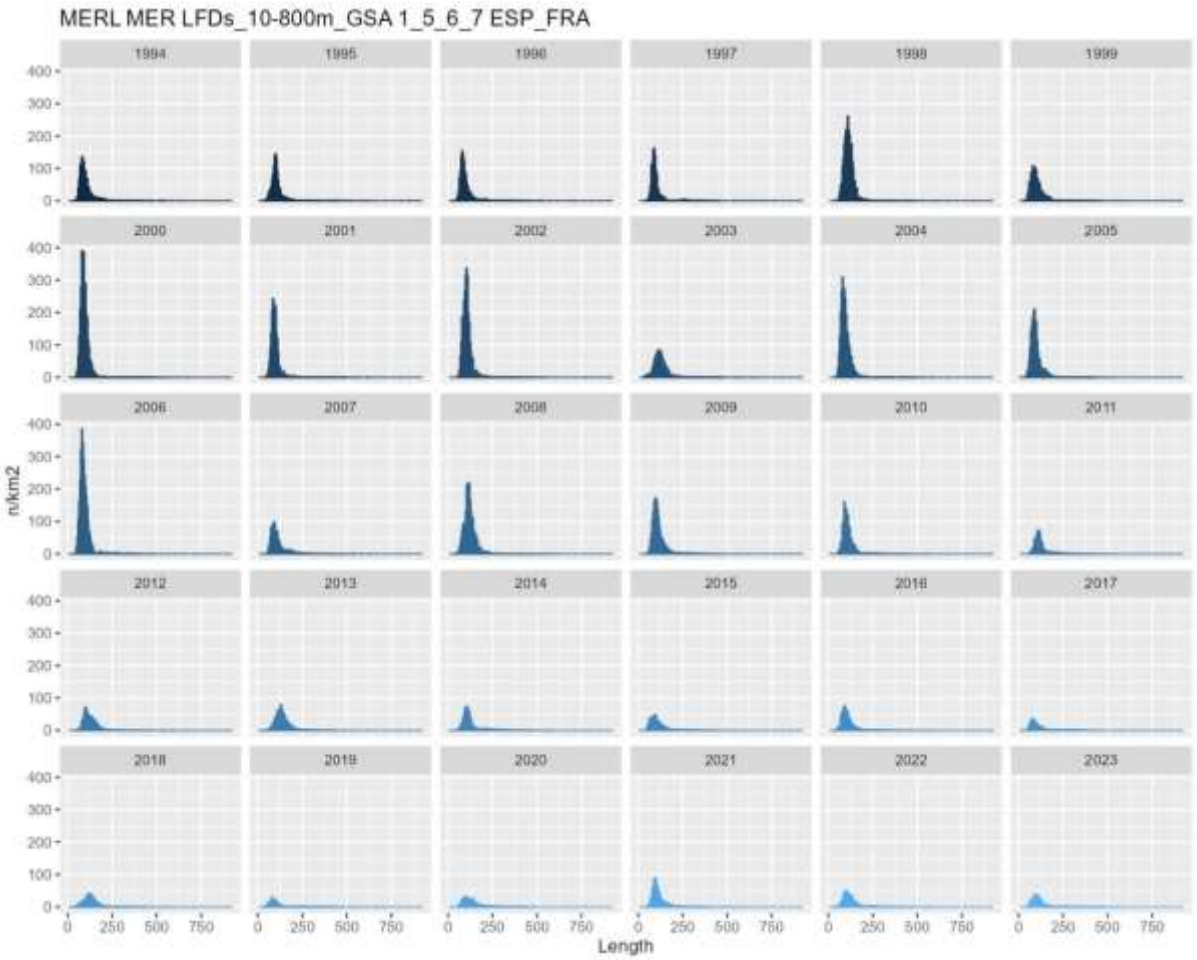


Source: Own elaborations

Both estimated abundance and biomass indices show similar trends, with strong fluctuations throughout the time series and a decreasing trend since 2008, that than stabilized in a low range since 2011, decreasing between 2013 and 2020 but showing an increase since 2020.

Size structure indices are shown in Figure 6.1.2.3.3.

Figure 6.1.2.3.3. European hake in GSAs 1, 5, 6 and 7. Length frequency distribution by year of MEDITS survey.



Source: Own elaborations

Due to the COVID-19 outbreak the MEDITS survey was not carried out in 2020 in GSA 1, only half of GSA 6 was covered and the timing was delayed, and coverage was also reduced in GSA 7 with some offshore stations omitted, the survey was carried out normally in GSA 5. In order to account for the lack of data in GSA1, indices for this year were simulated as the average of the whole time series in GSA1 and a sensitivity analysis on the stock assessment analysis was run. The survey in 2022 was run in the correct time of the year and all hauls were carried out in all GSAs.

6.1.3 Stock assessment

A statistical catch-at-age assessment was carried out for this stock, using the Assessment for All Initiative (a4a) method (Jardim et al., 2015). The a4a method utilizes catch-at-age data to derive estimates of historical population size and fishing mortality. However, unlike XSA, model parameters estimated using catch-at-age analysis are done so by propagation of population forward in time and analyses do not require the assumption that removals from the fishery are known without error.

The assessment was carried out using the period 2007-2023 for catch data and tuning file, as survey indices data were available only from 2007 for GSA 5. Both catch numbers at length and index number at length were sliced using the a4a age slicing routine in FLR. The analyses

were carried out for the ages 0 to 5+. Concerning the Fbar, the age range used was 1-3 age classes.

Input data

The growth parameters used for VBGF were the one reported in table 6.1.1.1.

Total catches and catch numbers at age from the single GSAs were used as input data. SOP correction was applied to catch numbers at age by GSA (Table 6.1.3.1).

Table 6.1.3.1. European hake in GSAs 1, 5, 6 and 7. SOP correction vector after reconstruction in GSA 7 ESP.

year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
GSA1	1.07	1.15	1.08	0.66	1.04	1.19	1.24	1.37	1.35	1.34	1.10	1.12	1.20	2.33	1.12	1.15	1.12
GSA5	0.90	0.95	1.13	1.07	1.02	1.11	1.06	0.98	1.06	1.10	1.08	1.41	1.17	1.64	1.06	1.30	1.13
GSA6	1.03	1.21	0.98	0.92	1.05	1.18	1.17	1.17	1.14	1.16	1.14	1.10	1.15	1.41	1.08	1.11	1.10
GSA7 ESP	0.93	1.06	0.91	1.07	0.97	1.01	0.79	0.95	1.06	1.19	1.06	1.07	1.62	1.00	1.04	1.00	1.00
GSA 7 FRA	1.03	0.97	1.04	1.10	1.10	1.06	1.04	1.04	1.05	1.04	1.79	1.04	1.04	1.05	1.04	1.07	1.01

Source: Own elaborations

Table 6.1.3.2 lists the input data for the a4a model, namely catches, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age.

Table 6.1.3.2. European hake in GSAs 1, 5, 6 and 7. Input data for the a4a model.

Catches (t)

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
4697	6289	7409	5836	5662	4654	5438	5061	3243	3195	3063	4077	3228	1974	2791	2891	2391

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Catch numbers at age (thousands)

	0	1	2	3	4	5+
2007	41426	17907	3455	509	92	21
2008	74783	38015	2846	301	106	16
2009	69423	32247	5461	528	123	12
2010	15050	25481	5559	400	92	8
2011	9875	29764	4709	364	66	10
2012	11192	31142	2965	245	66	4
2013	11100	32903	3635	381	44	10
2014	16617	25095	4312	268	29	4
2015	8870	17994	2420	181	27	2
2016	14709	22347	1761	121	21	1
2017	10324	18455	2185	142	18	3

2018	16668	27571	2310	194	14	2
2019	4894	14101	3218	235	17	3
2020	6884	11536	1528	75	5	2
2021	12286	16949	1845	116	36	4
2022	7963	15192	2548	102	20	2
2023	8180	12100	2180	1120	14	1

Source: Own elaborations

Weights at age (Kg)

	0	**1**	**2**	**3**	**4**	**5+**
2007	0.02	0.1	0.4	0.94	1.6	2.68
2008	0.02	0.09	0.4	0.96	1.61	2.6
2009	0.02	0.1	0.41	0.94	1.52	2.65
2010	0.02	0.11	0.41	0.93	1.61	2.34
2011	0.02	0.11	0.39	0.92	1.63	2.46
2012	0.02	0.09	0.39	0.9	1.67	2.47
2013	0.03	0.1	0.39	0.92	1.63	2.53
2014	0.02	0.11	0.39	0.92	1.56	2.55
2015	0.02	0.11	0.38	0.92	1.58	2.41
2016	0.02	0.09	0.38	0.93	1.57	2.53
2017	0.02	0.1	0.37	0.91	1.53	2.53
2018	0.02	0.1	0.39	0.92	1.58	2.48
2019	0.02	0.12	0.37	0.9	1.66	2.34
2020	0.02	0.1	0.38	0.86	1.59	2.63
2021	0.02	0.1	0.37	0.94	1.63	2.48
2022	0.02	0.11	0.37	0.91	1.64	2.61
2023	0.02	0.12	0.38	0.93	1.51	2.53

Source: Own elaborations

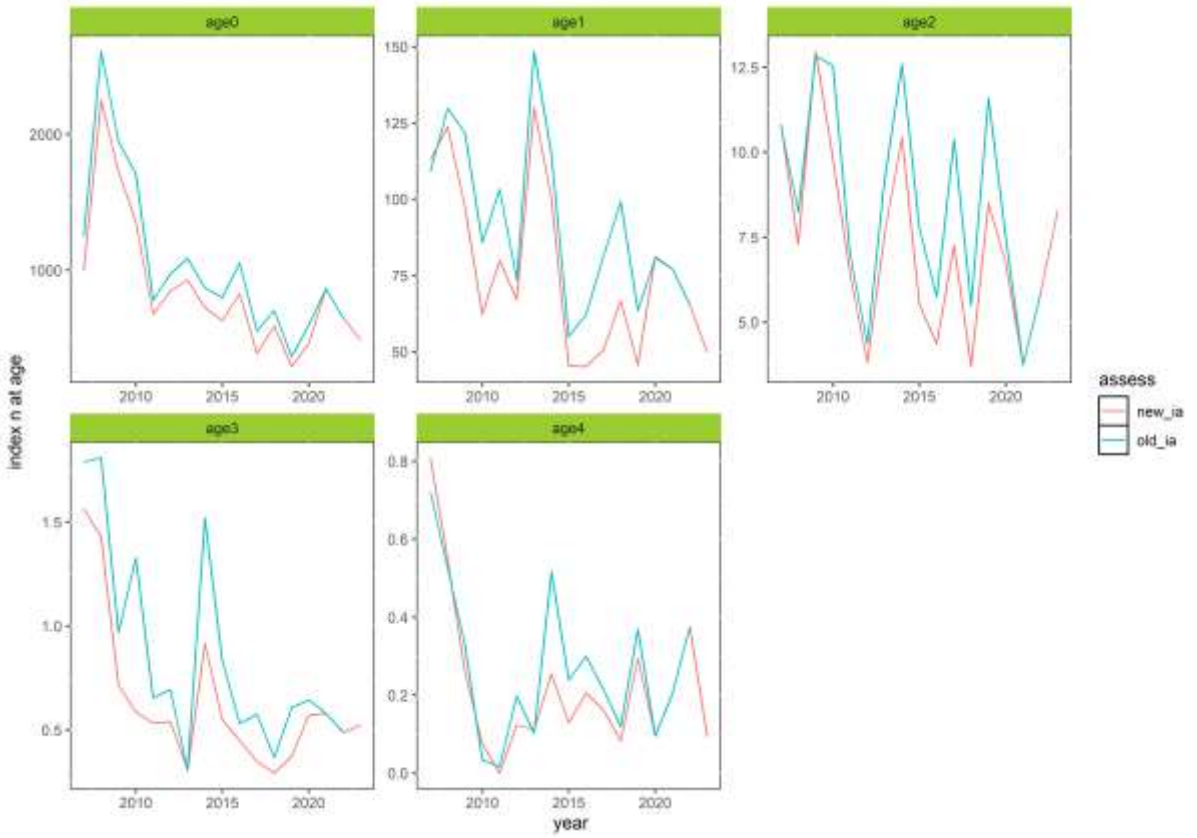
Maturity and Natural Mortality vectors

	0	**1**	**2**	**3**	**4**	**5+**
Maturity	0	0.15	0.82	0.98	1	1
Natural Mortality	1.63	0.68	0.41	0.31	0.25	0.22

Source: Own elaborations

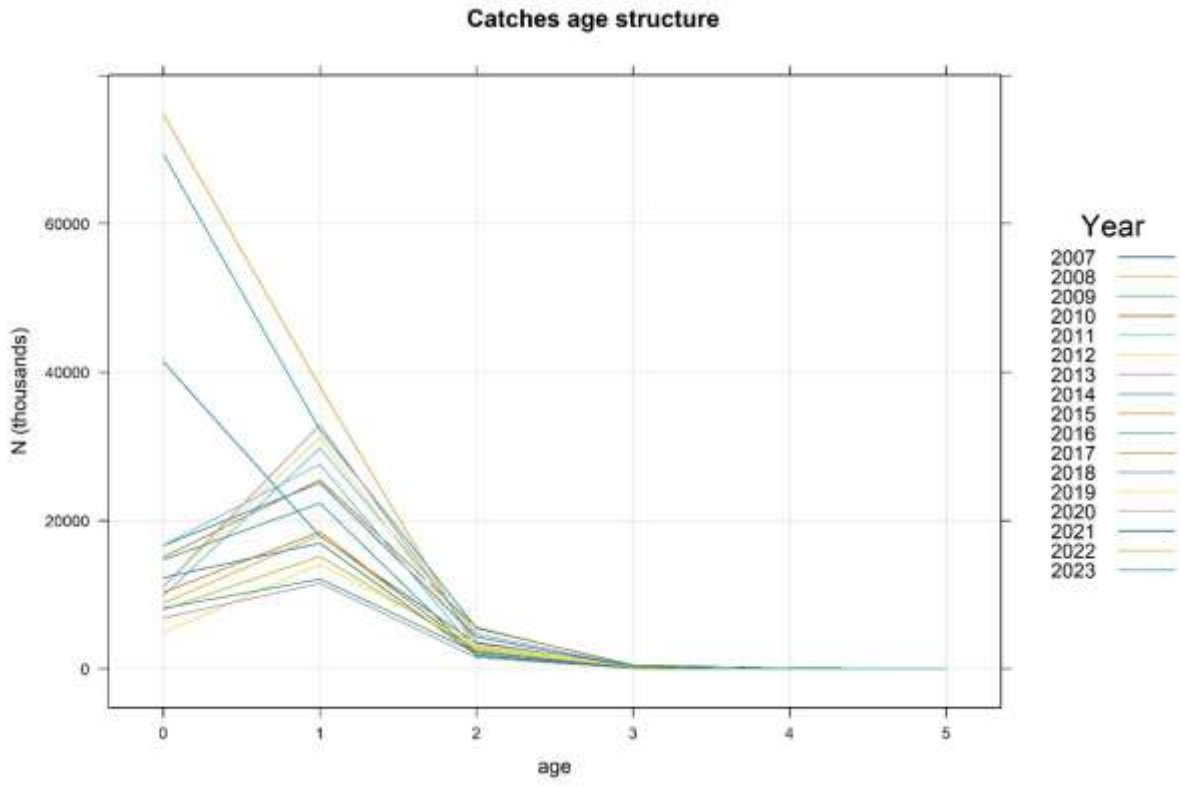
New estimations of survey abundance index at age resulted in lower index values for the period 2007-2020 (figure 6.1.3.1) Due to time constraints, it was not possible to clarify the reason for those differences, and it was agreed to follow the same approach as in 2023 assessment, i.e. adding the last year of data to the input object for the previous year stock assessment input object (figure 6.1.3.3)

Figure 6.1.3.1. European hake in GSAs 1, 5, 6 and 7. Comparison of the abundance survey index at age used in the EWG 23-09 (red lines) and the new estimations obtained in EWG 24 10 (blue lines) over the period 2007-2022. Since 2021 both estimations rendered the same values.



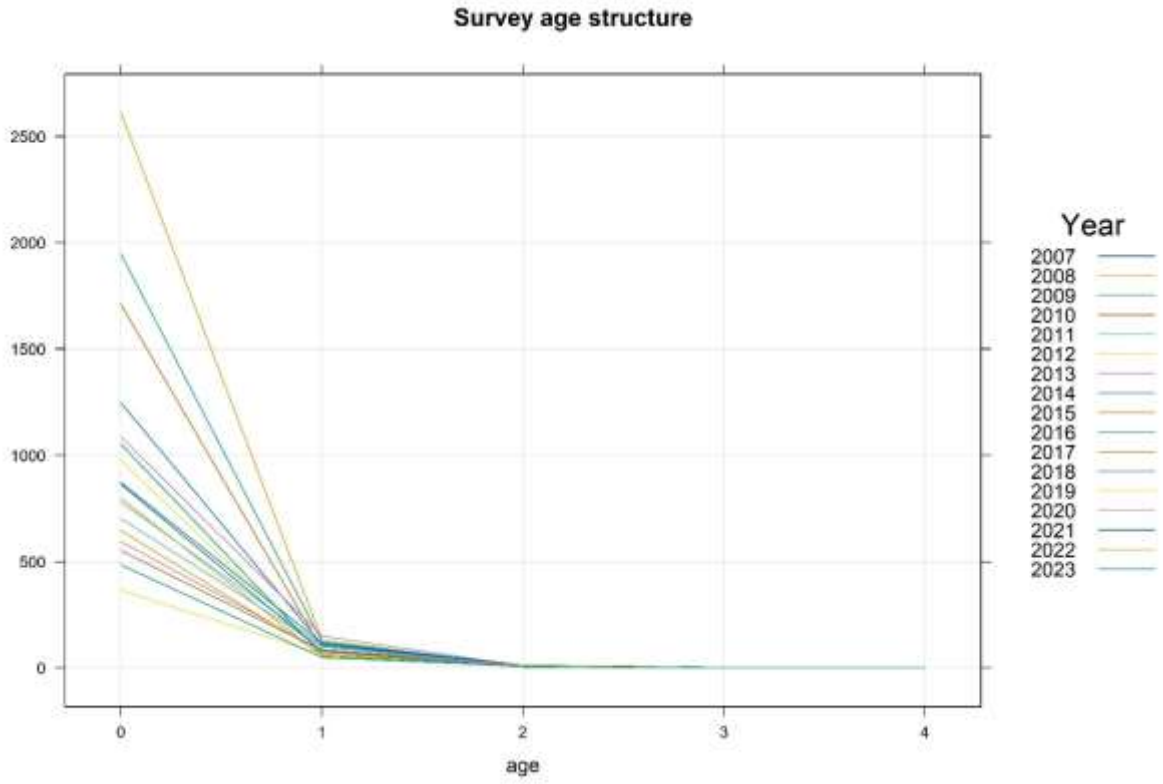
Source: Own elaborations

Figure 6.1.3.2. European hake in GSAs 1, 5, 6 and 7. Catch at age input data.



Source: Own elaborations

Figure 6.1.3.3. European hake in GSAs 1, 5, 6 and 7. Age structure of the index.



Source: Own elaborations

Assessment results

Taking as a starting point the model configuration agreed by EWG 23-09, a wide range of different options, and its combinations, for the F model and Q model were tested, and their performance in terms of AIC, BIC as well as basic diagnostics (residuals and retrospective pattern). Finally, it was decided to use the same model configuration of last year:

fmodel: ~s(age, k = 4) + s(year, k = 6) +

+ s(year, k = 7, by = as.numeric(age == 0)) +

+ s(year, k = 7, by = as.numeric(age == 4))

srmodel: ~factor(year)

n1model: ~s(age, k = 3)

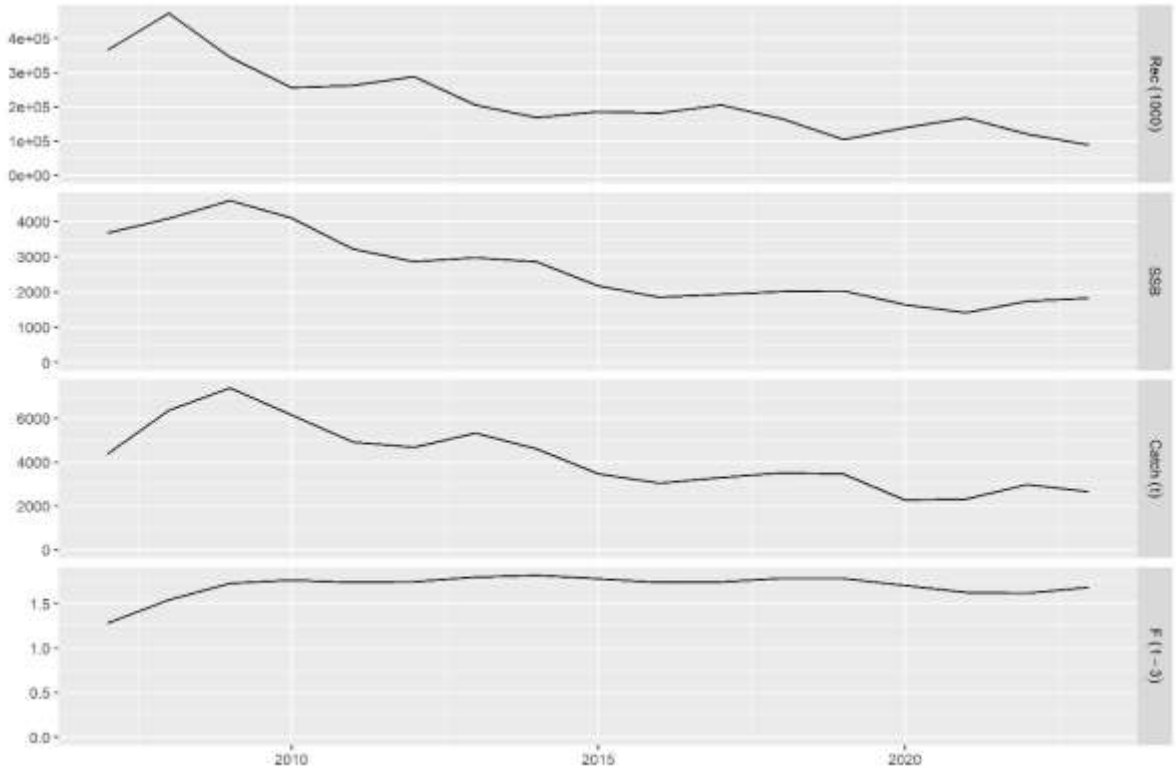
qmodel: ~I(1/(1 + exp(-age)))

vmodel:catch: ~s(age, k = 3) and Index:~1

The use of additional parameters on age 0 and age 4 in the fishery model were included to allow the model to fit better to the first few years of the data which show higher catches particularly at age 0. These extra terms also improved the retrospective performance, suggesting the early years are indeed different from the recent year's fishery.

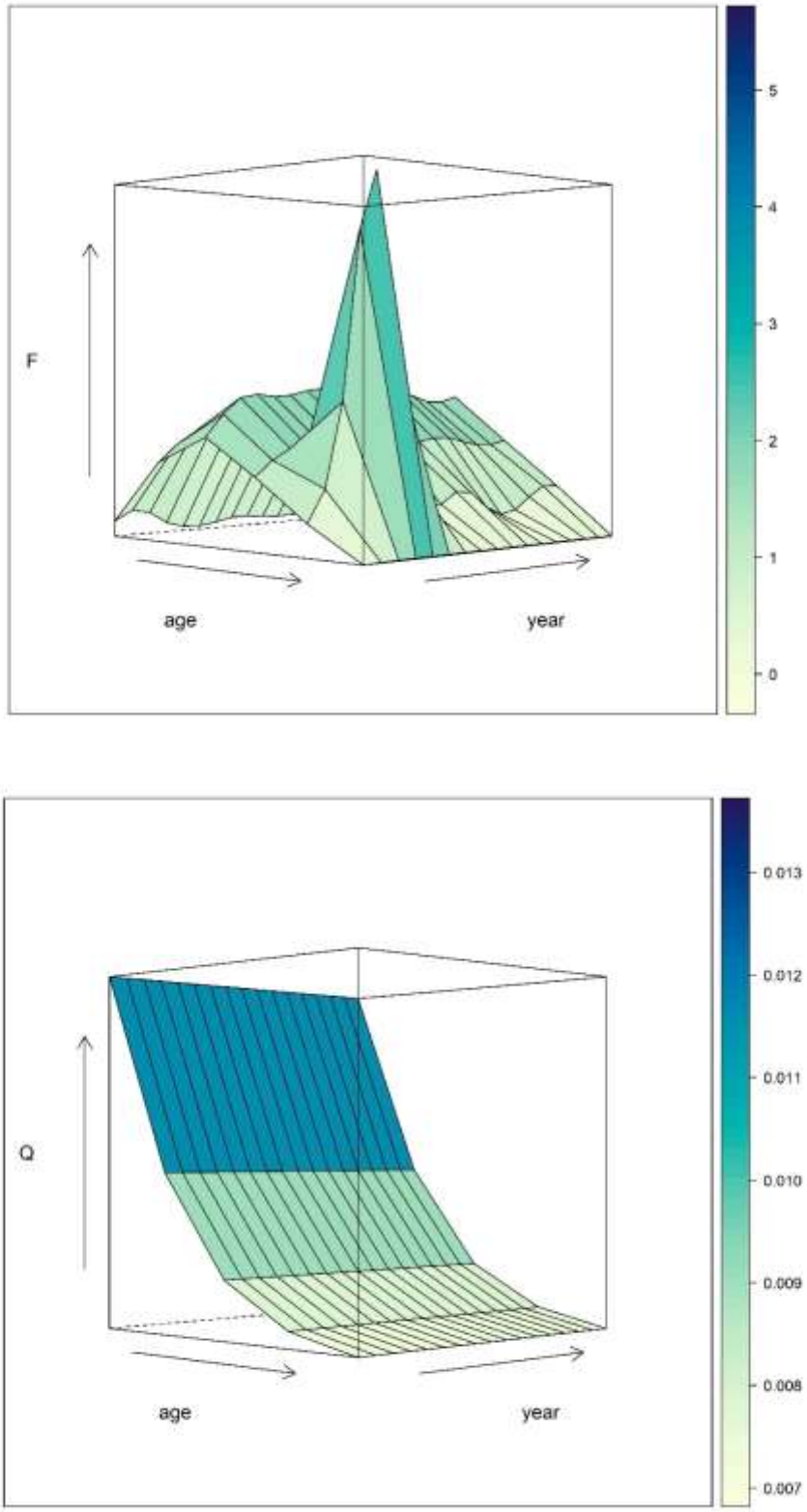
Results are shown in Figures 6.1.3.4 – 6.1.3.10

Figure 6.1.3.4. European hake in GSAs 1, 5, 6 and 7. Stock summary from the final a4a model.



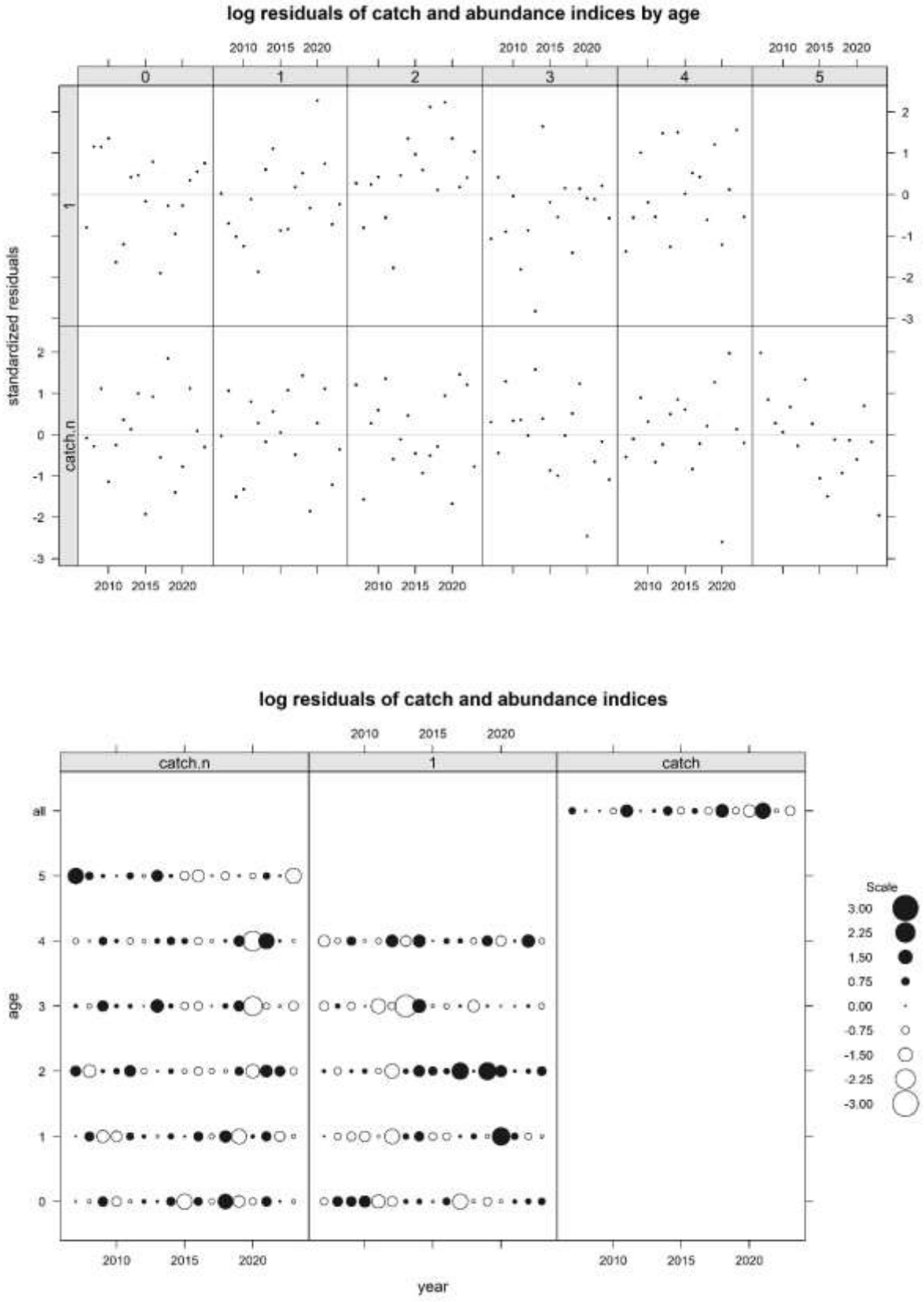
Source: Own elaborations

Figure 6.1.3.5. European hake in GSAs 1, 5, 6 and 7. 3D contour plot of estimated fishing mortality (top) and 3D contour plot of estimated survey catchability (bottom) at age and year.



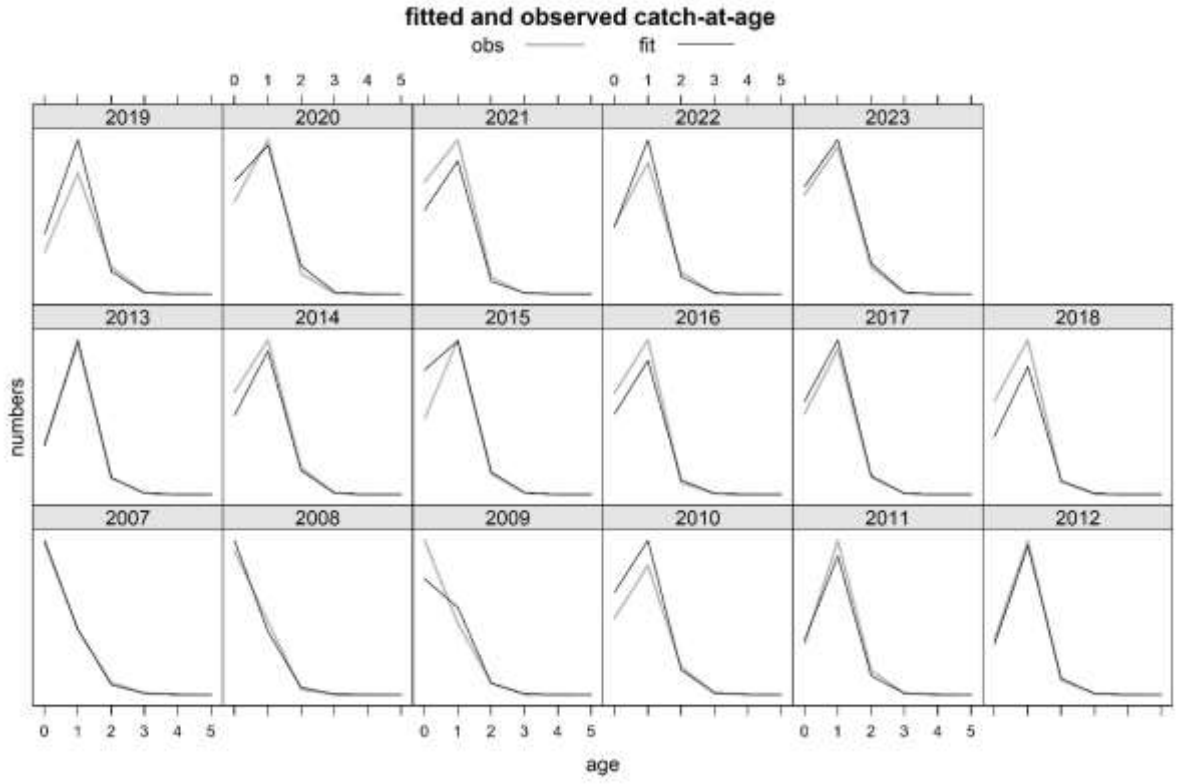
Source: Own elaborations

Figure 6.1.3.6. European hake in GSAs 1, 5, 6 and 7. Standardized residuals for abundance indices and for catch numbers.



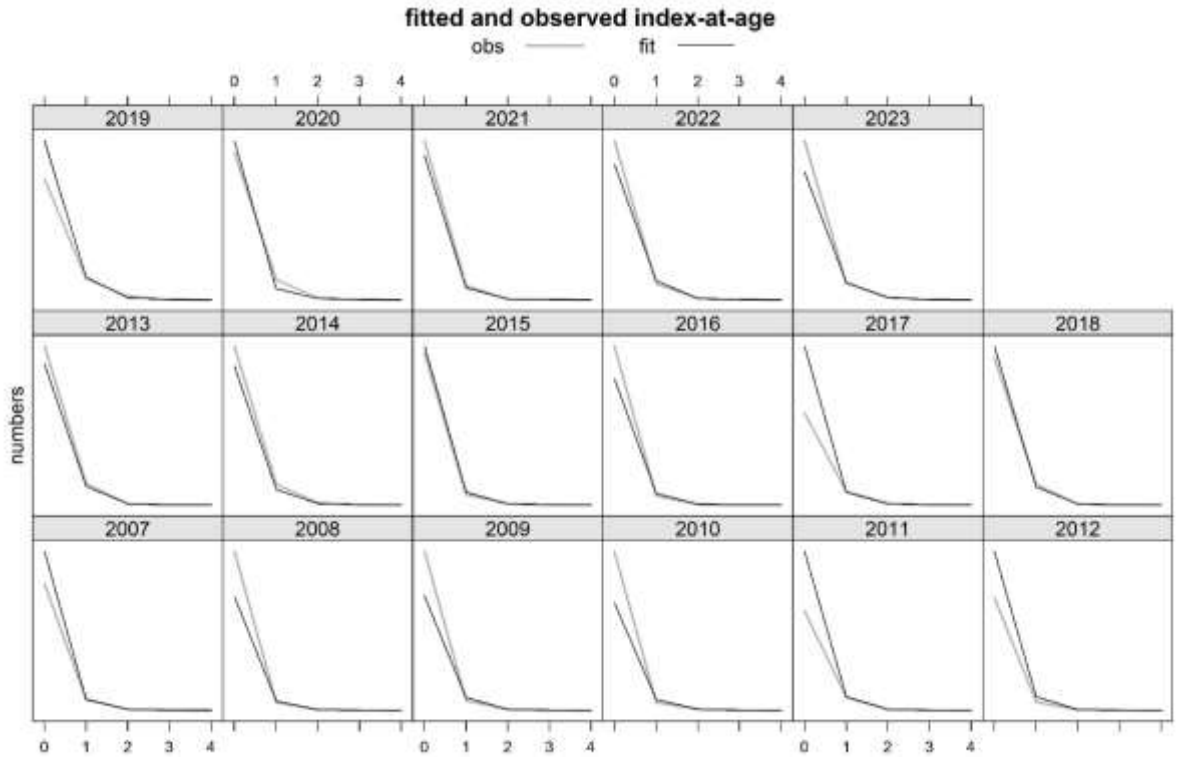
Source: Own elaborations

Figure 6.1.3.7. European hake in GSAs 1, 5, 6 and 7. Fitted and observed catch at age.



Source: Own elaborations

Figure 6.1.3.8. European hake in GSAs 1, 5, 6 and 7. Fitted and observed index at age.

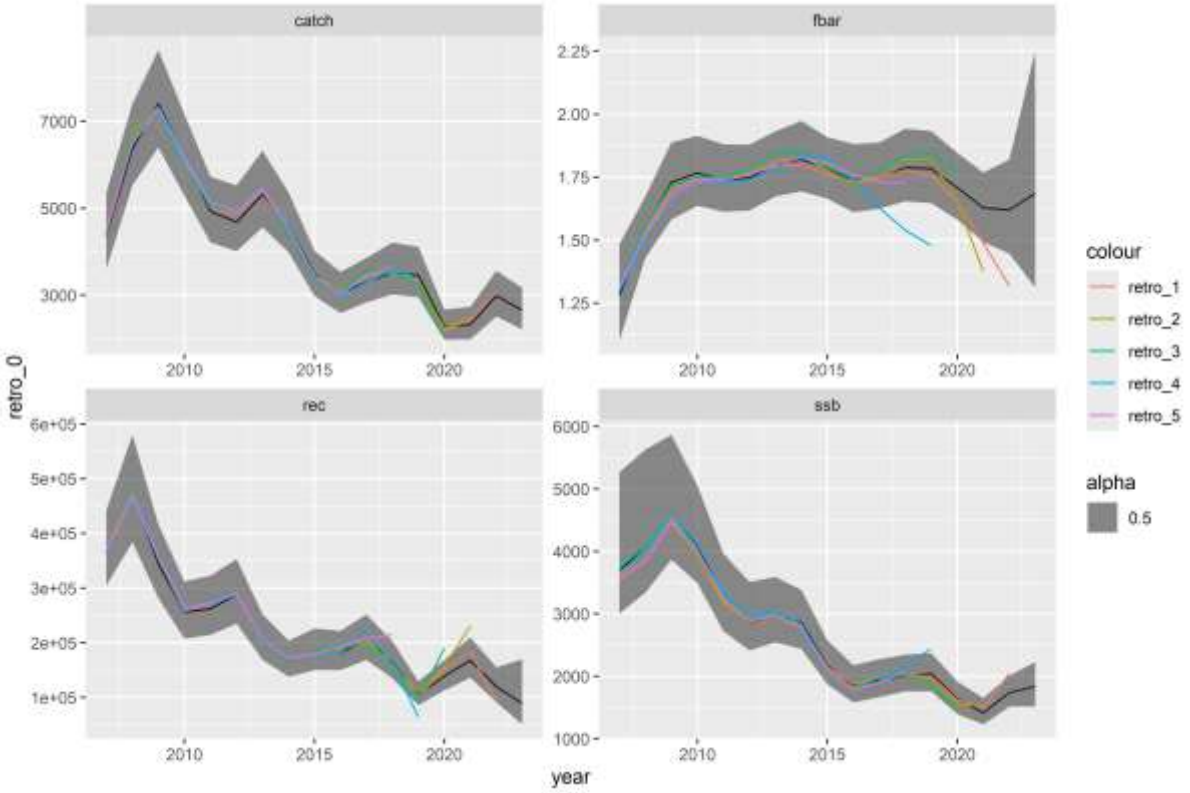


Source: Own elaborations

Retrospective

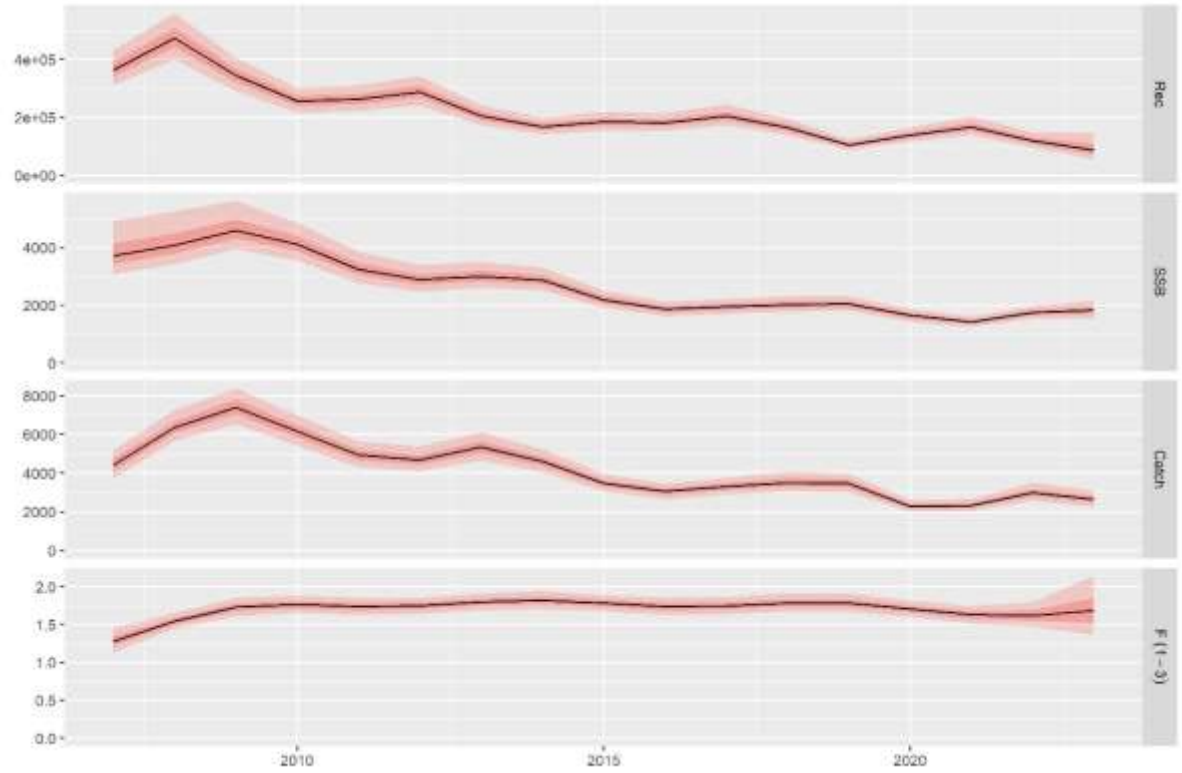
The retrospective analysis (Figure 6.1.3.9) indicates important differences in model estimates compared to 2023 assessment. Estimated SSB in years 2021 and 2022 is lower, and estimated catch is higher, which results in higher estimates of Fbar in years 2021 and 2022. Recruitment retrospective pattern also shows significant corrections.

Figure 6.1.3.9. European hake in GSAs 1, 5, 6 and 7. Retrospective analysis.



Source: Own elaborations

Figure 6.1.3.10. European hake in GSAs 1, 5, 6 and 7. Simulations over summary results. Blue line represents the observed catches.



Source: Own elaborations

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

Table 6.1.3.3. European hake in GSAs 1, 5, 6 and 7. Stock numbers at age (thousands) as estimated by a4a.

	0	1	2	3	4	5+
2007	365568.77	33430.11	3993.49	792.98	322.34	217.8
2008	473500.98	55365.75	5162.63	541.96	199.81	323.89
2009	344251.08	62446.81	6695.7	505.39	109.61	312.72
2010	255952.66	47655.89	6364.1	521.5	87.63	252.57
2011	262497.63	42311.56	4690.06	473.08	87.63	196.34
2012	288032.32	47294.71	4274.29	361.02	81.38	152.46
2013	205457.71	52419.79	4737.61	325.33	61.64	121.67
2014	168123.41	36051.39	5011.01	338.75	53.25	110.26
2015	185218.16	27938.83	3376.09	348.58	54.43	108.18
2016	181735.94	30646.98	2711.02	246.27	57.83	106.98
2017	205316.8	31069.32	3098.16	208.88	42.39	103.84
2018	164451.69	35581.75	3116.69	236.26	35.71	96.35
2019	104444.05	28169.25	3436.47	225.92	39.03	91.41
2020	138655.15	17730.73	2730.03	250.26	37.44	91.62
2021	167542.5	23884.98	1844.3	218.52	44.2	90.17
2022	119518.04	29222.02	2675.49	162.98	41.25	88.94
2023	88819.93	20382.57	3296.42	238.66	30.96	84.29

Source: Own elaborations

Table 6.1.3.4. European hake in GSAs 1, 5, 6 and 7. a4a summary results and F at age.

	Recruitment	TSB	SSB	Catch	Fbar(1-3)
2007	365569	13523	3679	4377	1.281
2008	473501	16781	4088	6364	1.545
2009	344251	17079	4594	7394	1.729
2010	255953	13638	4099	6162	1.767
2011	262498	13538	3219	4926	1.739
2012	288032	13842	2865	4676	1.748
2013	205458	13002	2980	5327	1.798
2014	168123	9918	2855	4603	1.821
2015	185218	8527	2174	3474	1.782
2016	181736	8554	1853	3044	1.738
2017	205317	8719	1937	3305	1.746
2018	164452	8371	2013	3518	1.787
2019	104444	6805	2039	3458	1.784
2020	138655	5963	1639	2273	1.707
2021	167542	7072	1412	2323	1.628
2022	119518	7036	1740	2982	1.62
2023	88820	5785	1834	2651	1.684

Source: Own elaborations

	F at age					
	0	**1**	**2**	**3**	**4**	**5+**
2007	0.257	1.188	1.587	1.068	0.491	0.026
2008	0.396	1.432	1.914	1.288	0.94	0.031
2009	0.347	1.604	2.143	1.442	2.122	0.035
2010	0.17	1.639	2.189	1.474	4.502	0.036
2011	0.084	1.612	2.154	1.45	5.347	0.035
2012	0.074	1.621	2.166	1.458	2.877	0.035
2013	0.11	1.668	2.228	1.5	1.092	0.036
2014	0.165	1.688	2.256	1.518	0.594	0.037
2015	0.169	1.653	2.208	1.486	0.601	0.036
2016	0.136	1.612	2.153	1.449	0.766	0.035
2017	0.123	1.619	2.164	1.456	0.73	0.035
2018	0.134	1.657	2.214	1.491	0.502	0.036
2019	0.143	1.654	2.21	1.487	0.377	0.036
2020	0.129	1.583	2.115	1.424	0.421	0.034
2021	0.116	1.509	2.016	1.357	0.599	0.033
2022	0.139	1.502	2.007	1.351	0.748	0.033
2023	0.218	1.562	2.087	1.405	0.742	0.034

Source: Own elaborations

Based on the a4a results, the European hake SSB shows a decreasing trend from 2009 to 2016 (from 4594 to 1853 tons), which than decreased again reaching an historical minimum in 2021 (1412 t). In 2023 the estimated ssb reaches 1834 t. The assessment shows a constant decreasing trend in the number of recruits in the time series from 2008 until 2023 that reached the minimum of the time series (88820*10^3 individuals). F_{bar} (1-3) shows an upward trend from 2007 (1.281) until 2014 (1.821) which than stabilizes until 2019 (1.784) to then decrease up to 2022 (1.62), but it is estimated to increase again in 2023 (1.684).

6.1.4 Reference Points

During the EWG 24 02, the upper and lower F_{msy} proxy reference points were estimated. In addition, it was decided to use F_{max} as a proxy of F_{msy} instead of $F_{0.1}$. In this EWG 24 10, precautionary (B_{lim} and B_{pa}) as well as MSY proxy reference points (F_{max}), were re-estimated. The obtained reference points values were very similar to those in EWG 24 02 (table 6.1.4.1)

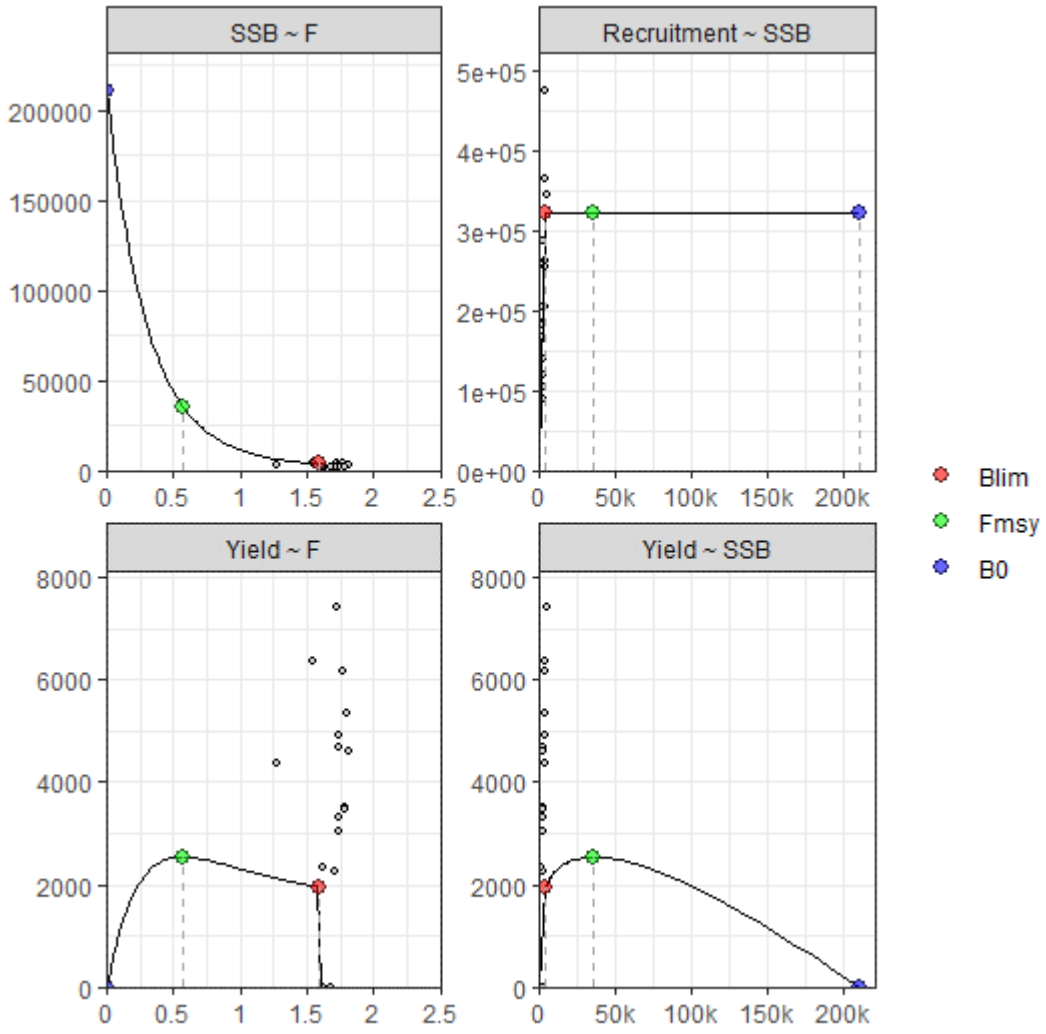
Current F (1.684, corresponding to the F of the last year of the time series) is 2.94 times higher than F_{max} (0.572), chosen as a proxy for F_{MSY} and as the exploitation reference point consistent with high long-term yields. This indicates that European hake stock in GSAs 1, 5, 6 and 7 is highly over-exploited.

Table 6.1.4.1 summaries the reference point values based on the Hockey-Stick model fitted to the data. B_{pa} is set to 2* B_{Lim} as defined in STECF EWG 22-03. The implied dynamics are illustrated in Figure 6.1.4.1, and the historic assessment information is shown in this context in Figures 6.1.4.2.-.3 In conclusion the stock is considered to be below B_{Lim} in 2022 as well.

F_{max}	B_{Fmax}	B_{lim}	B_{pa}
0.572	35754	3970	7940

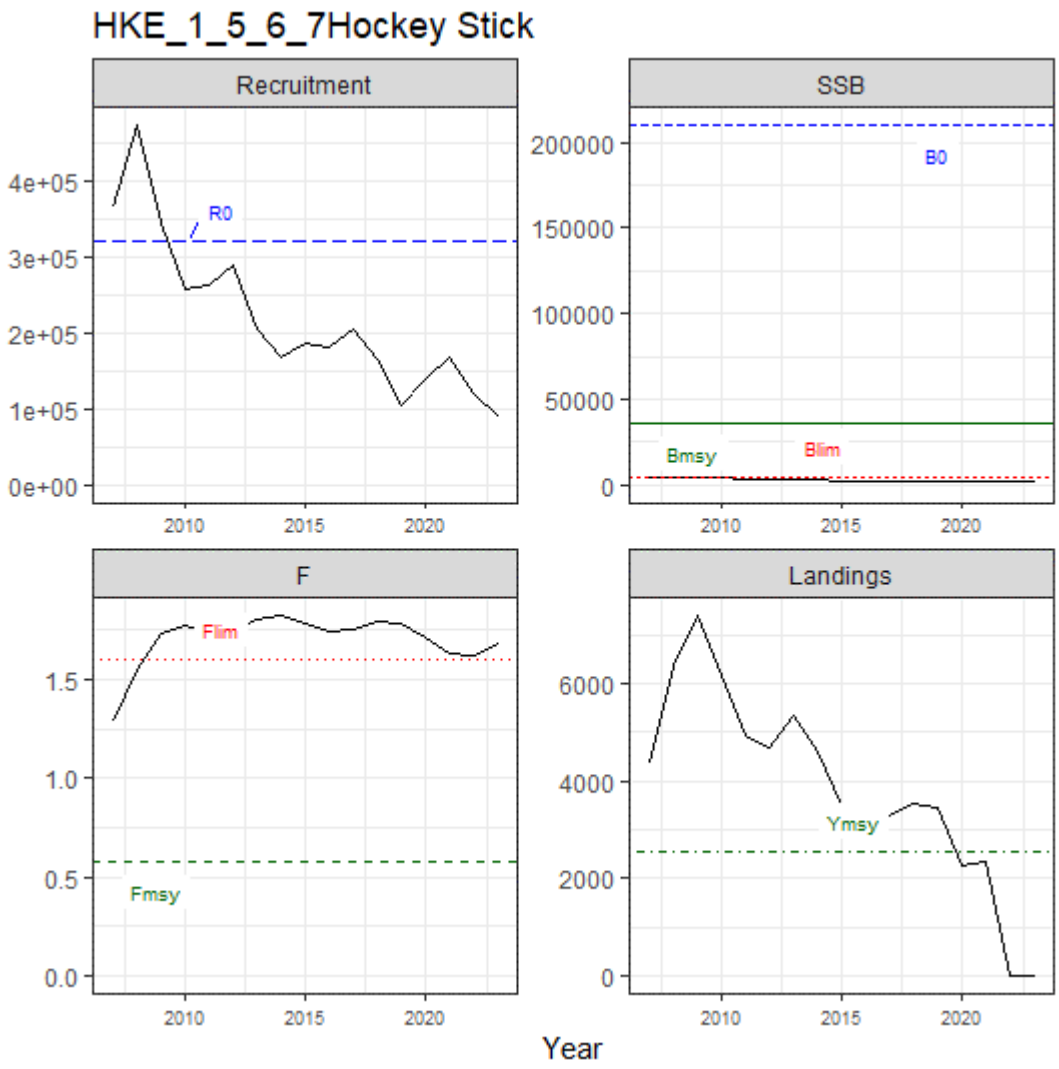
Source: Own elaborations

Figure 6.1.4.1. European hake in GSAs 1, 5, 6 and 7. Yield analysis with HS model.



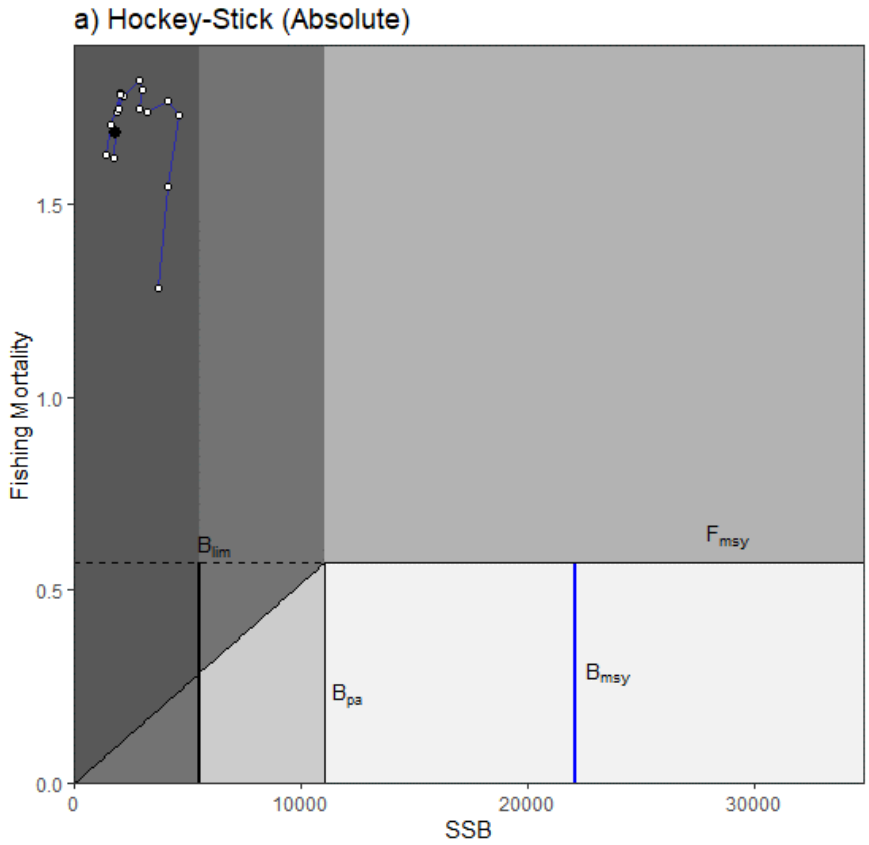
Source: Own elaborations

Figure 6.1.4.2. European hake in GSAs 1, 5, 6 and 7. Status Advice plot showing stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Hockey-Stick stock-recruitment relationship.



Source: Own elaborations

Figure 6.1.4.3. European hake in GSAs 1, 5, 6 and 7. Advice Rule plots, with BLim fitted to the data and Bpa = 2 BLim.



Source: Own elaborations

6.1.5 Short term Forecast and Catch Options

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age and maturity at age, while the mean F_{bar} for the last 3 years was used for F in 2024, as F shows a stable pattern (See section 4.3). As for this stock the SSB is lower than Bpa across the time series, the recruitment estimated at the breakpoint with the HS model will not be used for the short term projections. Instead the Geometric mean of the estimated time series of recruitment will be used. Recruitment is observed to oscillate (Figure 6.1.3.9), so the last 10 years are used as an estimate of recruits in 2024 to 2025. Recruitment (age 0) was estimated from the population results as the geometric mean of the last 10 years (147642.2 thousands).

Table 6.1.5.1 European hake in GSAs 1, 5, 6 and 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	mean weights at age, maturation at age, natural mortality at age and selection at age, are based average of years 2020-2022
Fages 1-3 (2024)	1.64	The F estimated in 2021-2023 was used to give F status quo for 2024
SSB (2024)	1397	Stock assessment 1 January 2024

Variable	Value	Notes
Rage0 (2024,2025)	147642.2	Geometric mean of the last 10 years (in thousands)
Total Catch (2024)	1941	Assuming F status quo for 2024

Source: Own elaborations

Table 6.1.5.2. European hake in GSAs 1, 5, 6 and 7. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	0.35	0.57	2651.27	1941.09	1189.88	1396.70	3527.31	152.55	-55.12
F upper	0.47	0.78	2651.27	1941.09	1503.48	1396.70	2987.23	113.88	-43.29
F lower	0.23	0.38	2651.27	1941.09	851.76	1396.70	4130.84	195.76	-67.87
FMSY transition	0.35	0.57	2651.27	1941.09	1189.88	1396.70	3527.31	152.55	-55.12
F/Catch_option	0.06	0.09	2651.27	1941.09	236.08	1396.70	5273.56	277.57	-91.10
Zero catch	0.00	0.00	2651.27	1941.09	0.00	1396.70	5723.74	309.81	-100.00
Status quo	1.00	1.64	2651.27	1941.09	2396.63	1396.70	1602.81	14.76	-9.60
Different Scenarios	0.10	0.16	2651.27	1941.09	400.99	1396.70	4962.72	255.32	-84.88
	0.20	0.33	2651.27	1941.09	750.73	1396.70	4314.82	208.93	-71.68
	0.30	0.49	2651.27	1941.09	1056.63	1396.70	3762.79	169.41	-60.15
	0.40	0.66	2651.27	1941.09	1324.99	1396.70	3292.06	135.70	-50.02
	0.50	0.82	2651.27	1941.09	1561.16	1396.70	2890.31	106.94	-41.12
	0.60	0.99	2651.27	1941.09	1769.68	1396.70	2547.13	82.37	-33.25
	0.70	1.15	2651.27	1941.09	1954.43	1396.70	2253.70	61.36	-26.28
	0.80	1.32	2651.27	1941.09	2118.70	1396.70	2002.56	43.38	-20.09
	0.90	1.48	2651.27	1941.09	2265.30	1396.70	1787.38	27.97	-14.56
	1.10	1.81	2651.27	1941.09	2514.73	1396.70	1444.31	3.41	-5.15
	1.20	1.97	2651.27	1941.09	2621.37	1396.70	1308.01	-6.35	-1.13
	1.30	2.14	2651.27	1941.09	2718.05	1396.70	1190.64	-14.75	2.52
	1.40	2.30	2651.27	1941.09	2806.06	1396.70	1089.41	-22.00	5.84
	1.50	2.47	2651.27	1941.09	2886.49	1396.70	1001.97	-28.26	8.87
	1.60	2.63	2651.27	1941.09	2960.31	1396.70	926.30	-33.68	11.66
	1.70	2.79	2651.27	1941.09	3028.34	1396.70	860.68	-38.38	14.22
	1.80	2.96	2651.27	1941.09	3091.27	1396.70	803.67	-42.46	16.60
	1.90	3.12	2651.27	1941.09	3149.72	1396.70	754.02	-46.01	18.80
	2.00	3.29	2651.27	1941.09	3204.22	1396.70	710.67	-49.12	20.86

Source: Own elaborations

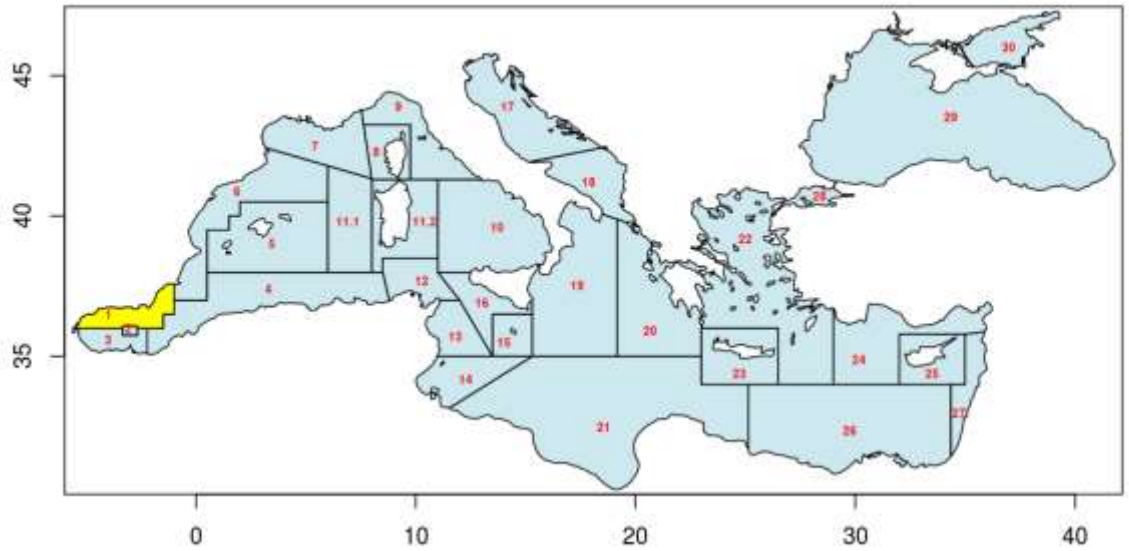
6.2 Deep-water rose shrimp in GSAs 1, 5, 6 &7

An evaluation of Deep-water rose shrimp by GSA was carried out this year. The individual evaluations are presented below by GAS in section 6.2.1 and 6.2.2 respectively.

6.2.1 Deep-water rose shrimp in GSAs 1

6.2.1.1 Stock Identity and Biology

Figure 6.2.1.1.1. Geographical location of GSA 1.



Source: Own elaborations

STECF EWG 24-10 was asked to assess the state of Deep-water rose shrimp stocks in the GSA 1.
Growth parameters and length-weight relationship parameters were available within the DCF 2023. However, the growth parameters used in the assessment for sexes combined and carapace length expressed in mm were taken from Guijarro et al,. (2009) in line with the last year assessment (EWG 23-09) and the t0 correction was applied for the slicing.

Table 6.2.1.1.1. Deep-water rose shrimp GSA 1. Growth parameters and length-weight relationship parameters.

Source	Area	L_∞	K	t_0	a	b
Guijarro et al., 2009	GSA 1	40	0.69	-0.230	0.0019	2.61

Source: Own elaborations

Maturity and Natural mortality have also been assumed to be equal to the values used in the last assessment from EWG 23-09.

Table 6.2.1.1.2. Deep-water rose shrimp GSA 1. Proportion of mature specimens at age and natural mortality at age.

Age	Area	0	1	2	3+
Maturity	GSA 1	0.022	1	1	1
M	GSA 1	2.05	1.06	0.57	0.4

Source: Own elaborations

6.2.1.2 Data

6.2.1.2.1 Catch (landings and discards)

General description of Fisheries

Deep-water rose shrimp is targeted mainly by bottom trawlers in these areas.

Deep-water rose shrimp is a target species for trawling vessels operating on the upper slope and it is one of the most important crustacean species for the trawl fisheries of GSA 1. No artisanal boats target this species.

Landings

Landings data were reported to STECF EWG 24-10 through the DCF. In GSA 1 most of the landings come from otter trawls. DCF data coming from other gears were considered inaccurate or sampled inconsistently; nevertheless, their catches were included in the stock assessment to ensure consistency with reported catch. Accuracy of these is not considered a majopr issue due to the low amounts (Table 6.2.1.2.1.1). It is noted that catch is fitted in the assessment with error.

Table 6.2.1.2.1.1. Deep-water rose shrimp GSA 1. Landings data in tonnes by fleet.

Year	FPO	GTR	OTB
2002			209.75
2003			187.17
2004			118.14
2005			103.03
2006			37.59
2007			56.16
2008			108.87
2009			253.93
2010			97.6
2011			171.57
2012			241.52
2013			149.12
2014			100.42
2015			108.55
2016			136.75
2017		0.02	201.77
2018			329.62
2019			354.15
2020	0.008		482.92
2021	0.01	0.002	564.2
2022			847.311
2023	0.065	0.001	946.7

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

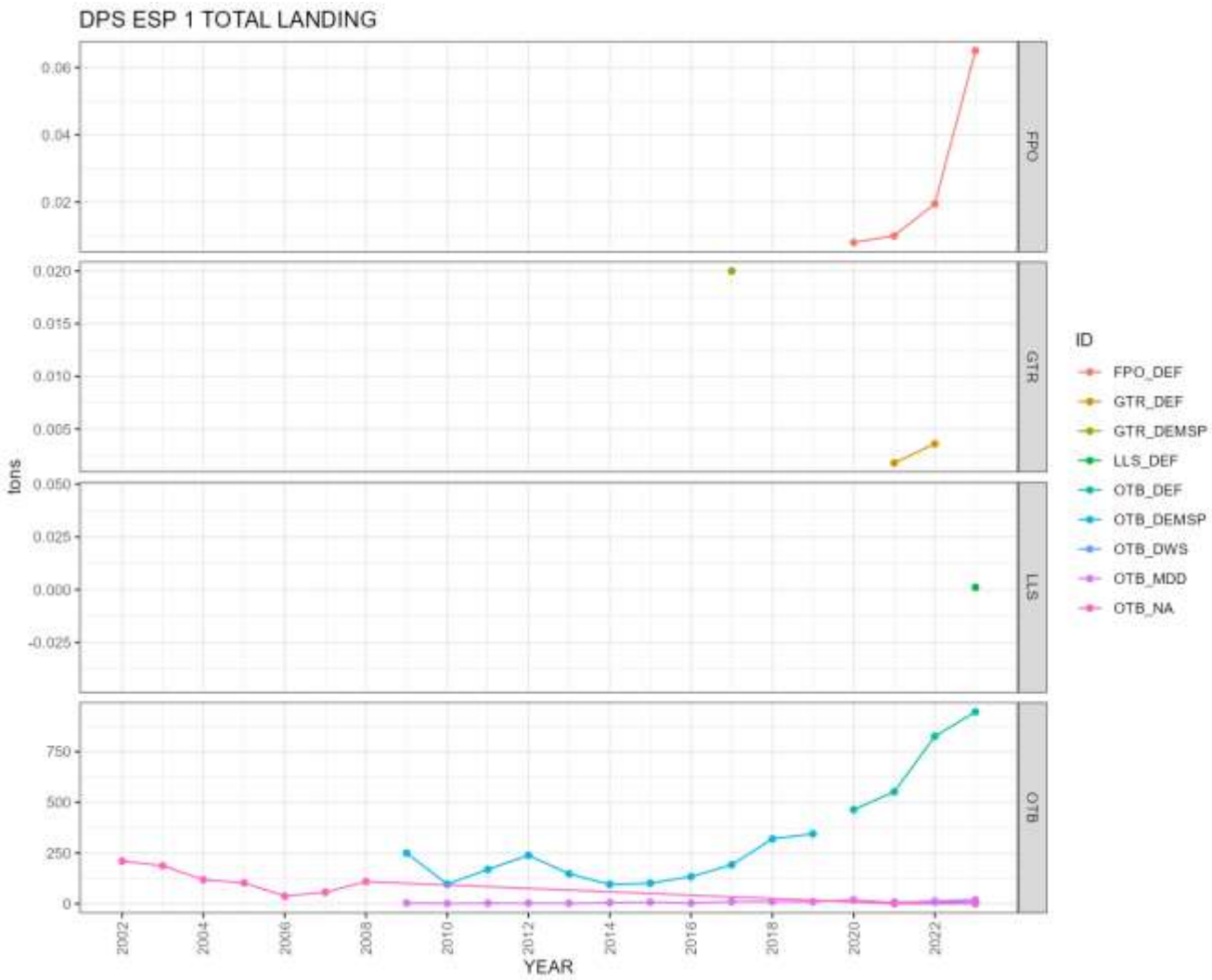
Landings data by year are presented in Table 6.2.1.2.1.2. Landings by year and fleet are presented in Figure 6.2.1.2.1.1.

Table 6.2.1.2.1.2. Deep-water rose shrimp GSA 1. Landings data in tonnes by year.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
212	189.2	119.4	104.7	38	56.8	109.4	255.7	99.4	171.9	243.2
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
150	104.7	109.7	137.6	203.5	330.3	355.2	484.9	564.2	847.3	977.5

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.1.2.1.1. Deep-water rose shrimp GSA 1. Landings data in tonnes by year and fleet in GSA 1.



Source: Own elaborations

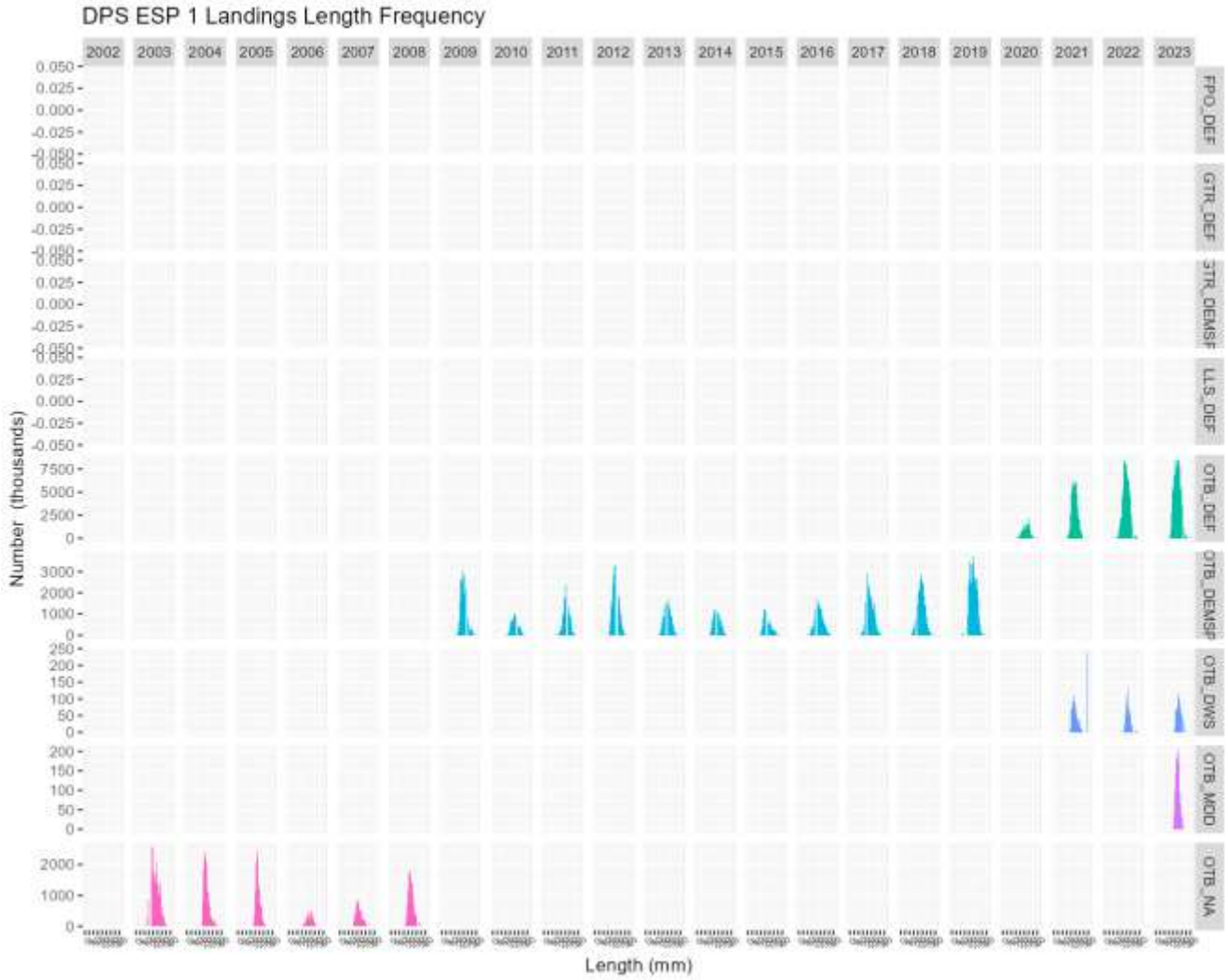
Length frequency distribution of the landings by year and fleet from the DCF database are presented in Figure 6.2.1.2.1.2.

In GSA 1, length frequency distributions were not available for 2002.

The group decided to use the scripts developed during EWG 2102 to fill the missing length frequency distributions for the metiers without any length information. However, raising of the landings from the metiers with partial length frequency distributions was performed together with the SOP correction.

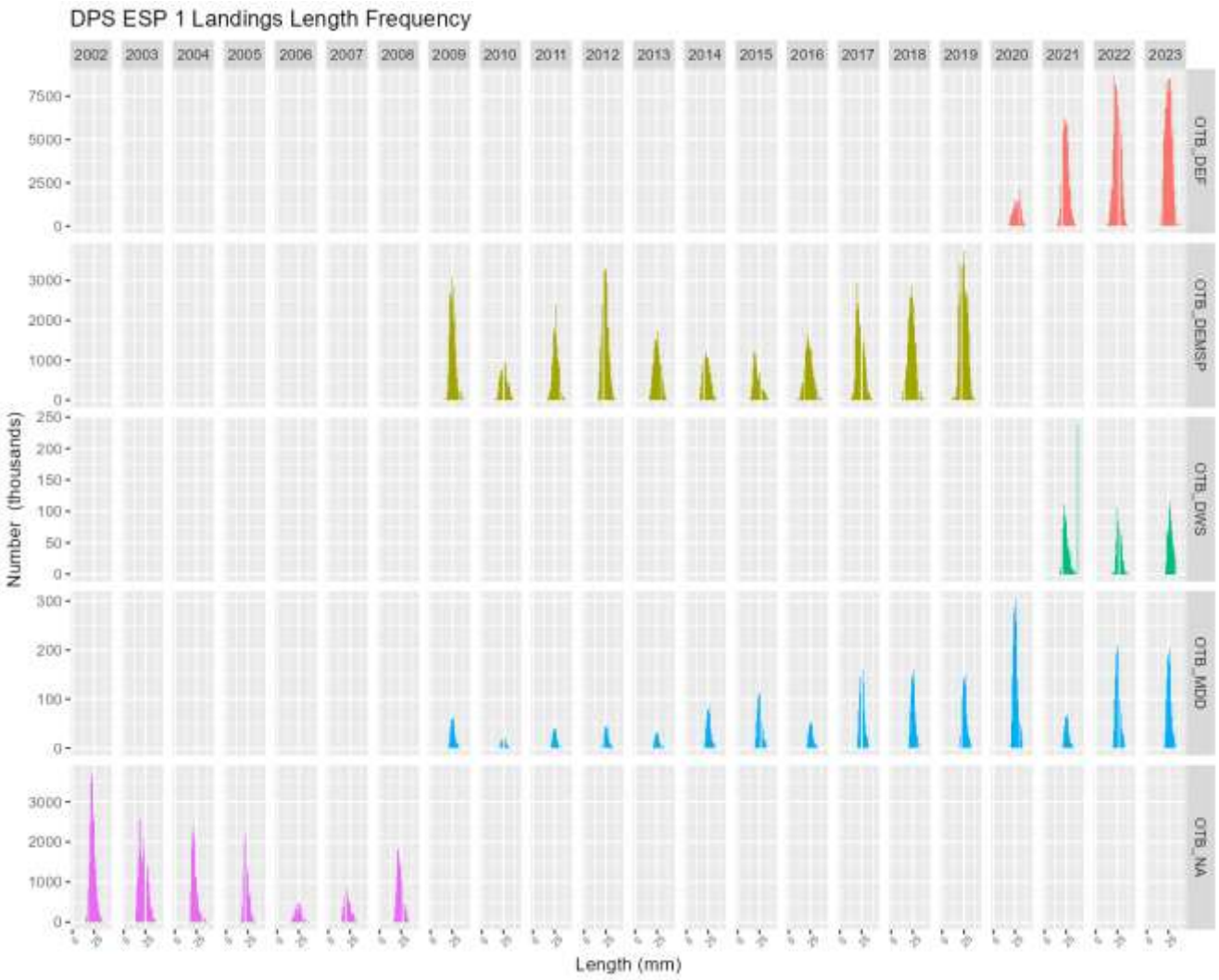
Reconstructed and revised length frequency distribution of the landings by year and fleet and the reconstruction procedure are presented in Figures 6.2.1.2.1.3-4.

Figure 6.2.1.2.1.2. Deep-water rose shrimp GSA 1. Original length frequency distribution of the landings by year and fleet in GSA 1.



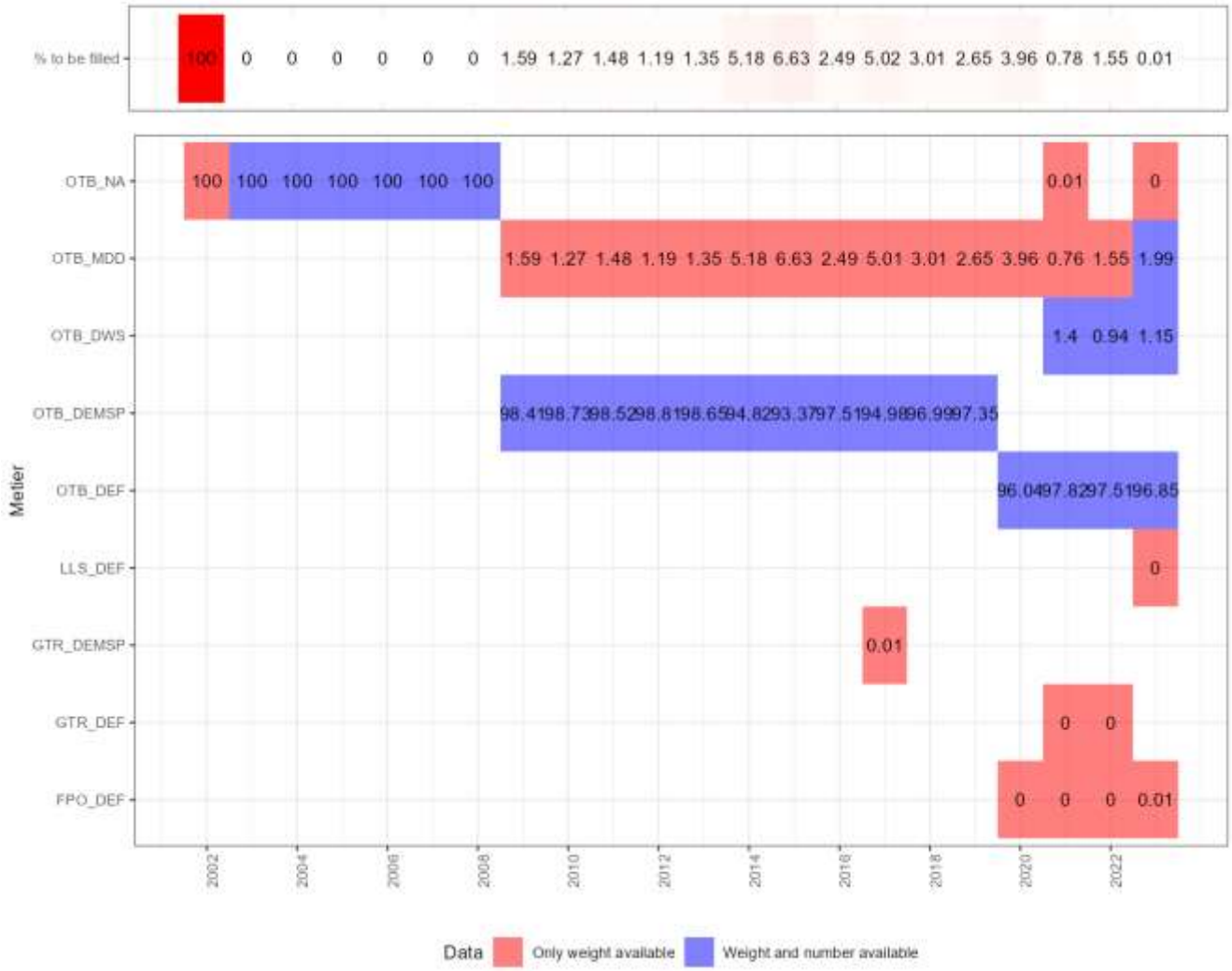
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.1.2.1.3. Deep-water rose shrimp GSA 1. Reconstructed length frequency distribution of the landings by year and fleet in GSA 1.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.1.2.1.4. Deep-water rose shrimp GSA 1. Reconstruction of the length frequency distribution of the landings by year and fleet in GSA 1. The upper panel (single row) shows the total percentage of the weight to be reconstructed over total landings per year. The lower panel shows the percentage of the weight of each metier to be reconstructed over total landings per year.



Source: Own elaborations

Discards

Discards data were reported to STECF EWG 24-10 through the DCF. Discard weight were neglible in comparison of landings. Total discard by fleet and year are presented in table 6.2.1.2.1.3.

Table 6.2.1.2.1.3. Deep-water rose shrimp GSA 1. Official discards data in tonnes by fleet.

Year	OTB
2002	0
2003	0
2004	0
2005	1.71
2006	0
2007	0
2008	0.55
2009	1.74
2010	1.81
2011	0.38
2012	1.65
2013	0.87
2014	4.25
2015	1.17
2016	0.88
2017	1.71
2018	0.66
2019	1.07
2020	2.00
2021	
2022	1.89
2023	2.60

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Discards were not included in the stock assessment. Therefore, we will refer to catches as landings in the rest of the report.

Length frequency distributions of the discards were available for one year only in the DCF data.

6.2.1.2.2 Effort

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.2.1.2.3 Survey data

Since 1994, MEDITS trawl surveys has been regularly carried out each year during the spring season with the exception of 2020 when the survey was not carried out at all.

The sampling design of MEDITS is random stratified with number of haul by stratum proportional to stratum surface. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Hauls noted as valid were used only, including stations with no catches (zero catches are included). Based on the DCF data call, abundance and biomass indices for GSA 1 were re-calculated.

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 for GSA 1 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 GSA 1:

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

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

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

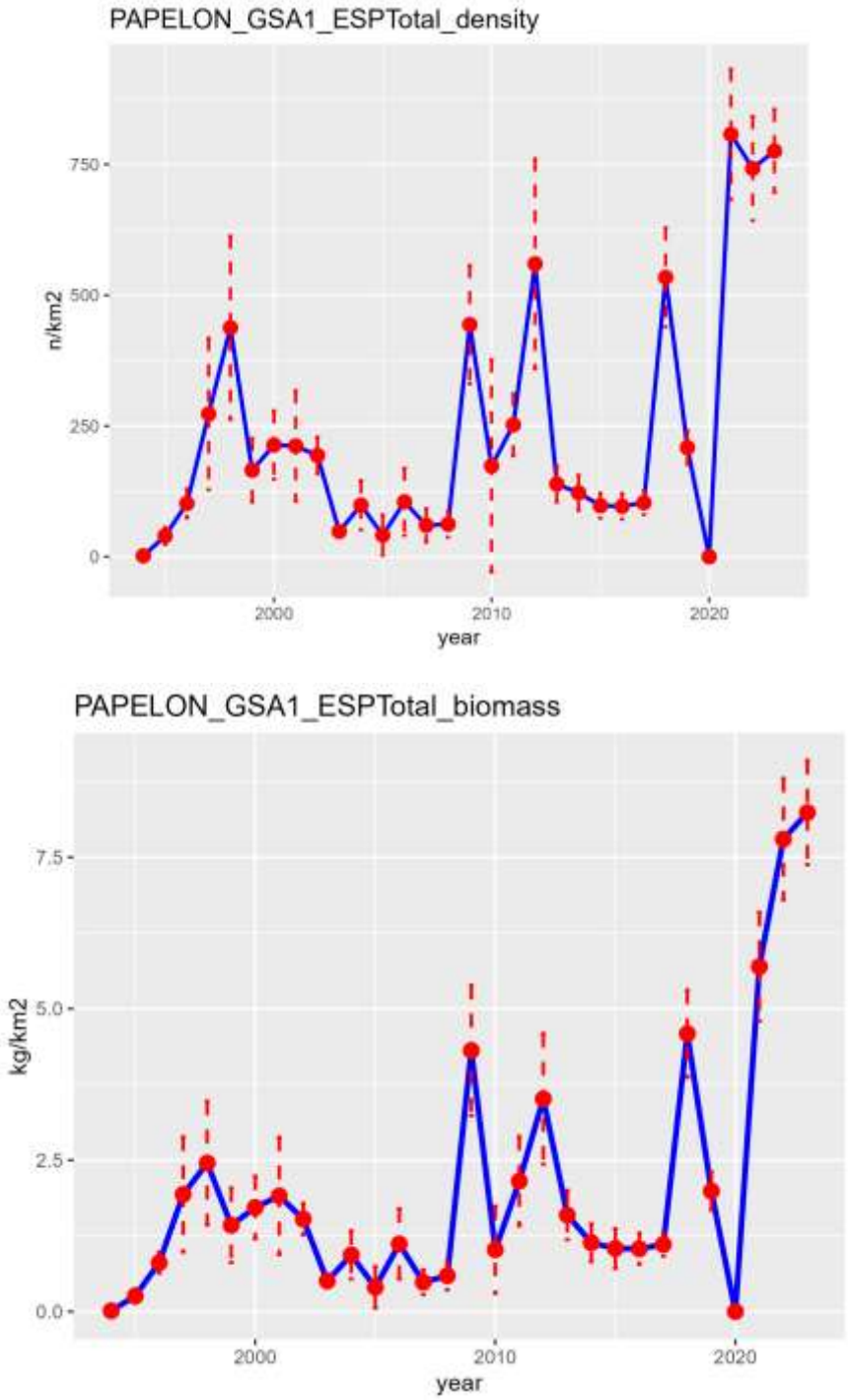
The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that this is a standard approach, and hence assumptions over the distribution of data affect estimates of precision. 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.

Observed abundance and biomass indices of Deep-water rose shrimp and the length frequency distributions are given in the figures below both for GSA 1 (Figures 6.2.1.2.2.1-10).

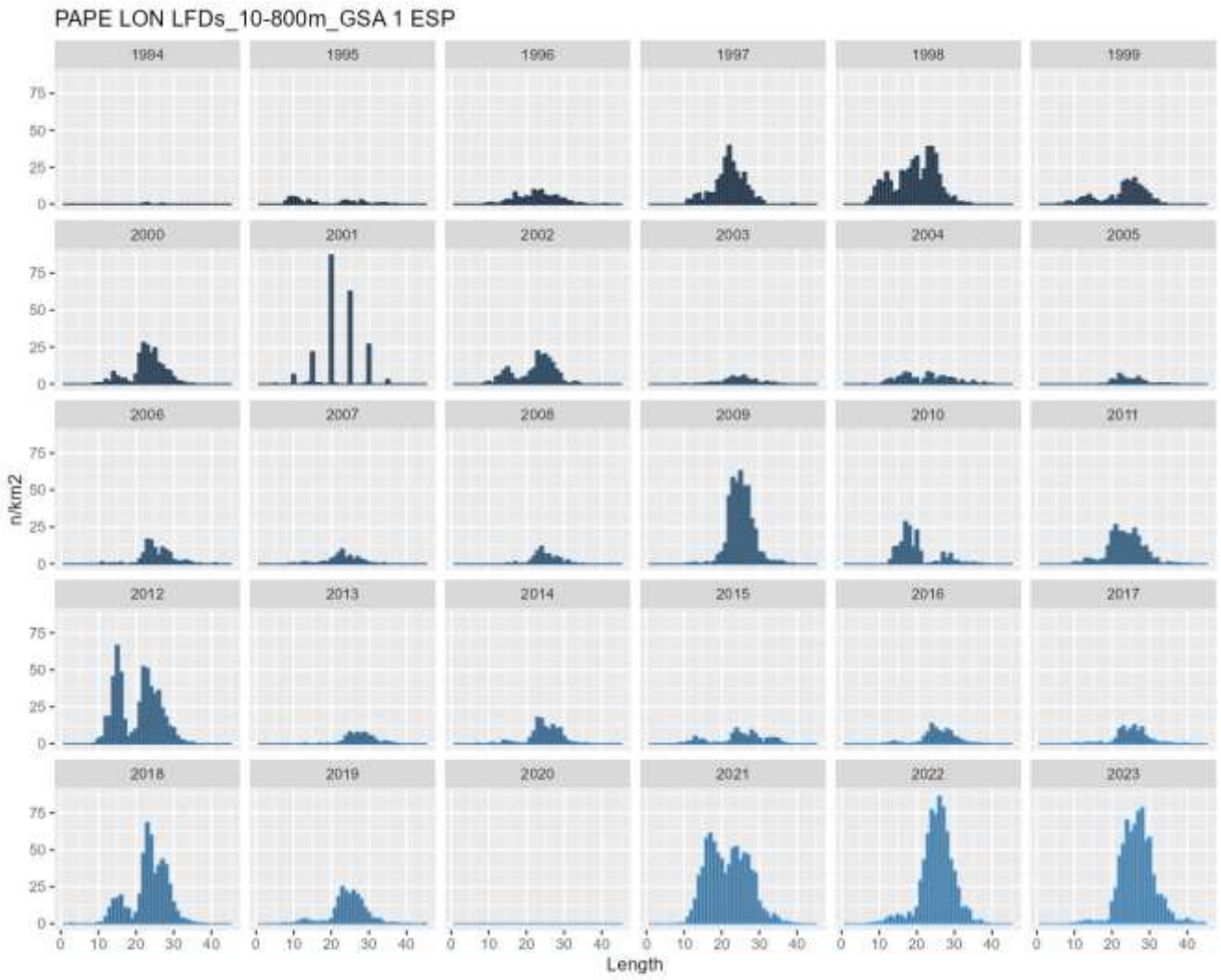
In GSA 1 the trends in both abundance and biomass have fluctuated throughout the time series; however, in this area a high value is observed in 2018.

Figure 6.2.1.2.2.1. Deep-water rose shrimp GSA 1. Estimated density (N/km^2) and biomass (kg/km^2) indices in GSA 1.



Source: Own elaborations

Figure 6.2.1.2.2.2. Deep-water rose shrimp GSA 1. Length frequency distribution by year of MEDITS GSA 1.



Source: Own elaborations

The length frequency distributions of the Spanish MEDITS in 2001 are wrong. This issue has been recurring and needs to be fixed.

6.2.1.3 Stock assessment

An age based method was used for this stock. a4a is a statistical catch-at-age method that utilize catch-at-age data to derive estimates of historical population size and fishing mortality. However, unlike XSA, 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. Specifically, for Deep-water rose shrimp GSA 1 we used the Assessment for All Initiative (a4a) (Jardim et al., 2015) in FLR environment. The model was fitted using as input data the period 2002-2023 for the catch data (landings only) and 2002-2023 for the tuning file where MEDITS in 2020 is missing. Both catch numbers at length and index number at length were sliced using the l2a routine in FLR using the GSA 1 growth parameters reported in table 6.2.1.1.1. Sensitivity analyses has been done for growth parameters derived from DCF. The t0 of the von Bertalanffy was always changed (adding 0.5) in order to account for the assumed spawning time in the middle of the year.

A single tuning fleet was used based on the biomass at age estimates from MEDITS GSA 1.

The analyses were carried out for the ages 0 to 3+. Concerning the Fbar, the age range used was 1-2 age groups.

Input data

The growth parameters used for VBGF were the one reported in table 6.2.1.1.1.

Total catches and catch numbers at age were used as input data. SOP correction was applied to catch numbers at age. Table 6.2.1.3.1 present the SOP correction vector applied. The SOP correction is quite high in 2007, 2015, 2018 and 2020 partly because of missing length frequency distributions in the catches of those years.

Table 6.2.1.3.1. Deep-water rose shrimp GSA 1. SOP correction vector by year.

2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1.08	1.04	1.04	1.04	1.05	1.23	1.04	1.11	1.10	1.10	1.00
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
1.00	1.06	1.38	1.01	1.01	1.40	1.01	2.34	1.11	1.12	1.13

Source: Own elaborations

Table 6.2.1.3.2 lists the input data for the a4a model, namely catches, catch number at age, weight at age, maturity at age, natural mortality at age, Proportion of M and F before spawning, and the tuning series at age. In the table also the values of 2020 are presented even if they are only used in the sensitivity analysis.

Table 6.2.1.3.2. Deep-water rose shrimp GSA 1. Input data for the a4a model.

Catches (t)

2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
209.7	187.1	118.1	103.0			108.8	253.9		171.5	241.5
5	7	4	3	37.59	56.16	7	3	97.6	7	2
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**

149.12	100.42	108.55	136.75	201.79	329.62	354.15	482.93	564.38	847.34	977.49

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Catch numbers-at-age matrix (thousands)

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	25.1	1251.9	21.0	4.8	17.0	7.7	5.0	17.8	15.9	9.4	2.6
1	25990.9	21240.4	15656.4	12843.3	3463.3	7383.5	12655.2	20569.7	7233.0	11933.1	23987.6
2	2732.8	4238.4	1330.5	1312.0	904.2	893.5	1750.2	5986.3	2763.4	5307.8	5195.8
3	139.3	303.7	205.7	46.4	72.2	58.6	29.1	992.3	245.9	242.5	179.5
age	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
0	4.4	5.0	154.8	649.3	296.0	906.3	203.1	16.3	160.5	571.5	25.7
1	11986.5	11334.6	12952.8	13957.3	21435.4	32841.4	29286.0	24042.0	56206.4	71517.4	79928.2
2	4256.3	2042.1	2033.3	2893.1	4592.6	7133.2	10682.9	19504.8	11139.3	24440.6	29261.8
3	239.8	38.9	147.3	336.5	374.5	548.7	438.8	1482.2	1007.9	907.5	1066.2

Source: Own elaborations

Weights-at-age (kg)

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0020	0.0019	0.0022	0.0022	0.0022
1	0.0066	0.0058	0.0061	0.0067	0.0070	0.0058	0.0067	0.0076	0.0076	0.0081	0.0071
2	0.0131	0.0131	0.0136	0.0124	0.0129	0.0131	0.0133	0.0128	0.0137	0.0133	0.0131
3	0.0202	0.0210	0.0206	0.0196	0.0215	0.0242	0.0231	0.0204	0.0199	0.0204	0.0202
age	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
0	0.0022	0.0022	0.0021	0.0019	0.0020	0.0020	0.0016	0.0022	0.0021	0.0020	0.0022
1	0.0073	0.0065	0.0060	0.0064	0.0062	0.0068	0.0069	0.0077	0.0070	0.0071	0.0071
2	0.0134	0.0129	0.0137	0.0135	0.0130	0.0131	0.0134	0.0138	0.0131	0.0132	0.0132
3	0.0200	0.0196	0.0198	0.0207	0.0204	0.0206	0.0208	0.0204	0.0215	0.0202	0.0204

Source: Own elaborations

Maturity, Natural mortality, proportion of M and F before spawning vectors.

Age	0	1	2	3+
Maturity	0.022	1	1	1
M	2.05	1.06	0.57	0.4
Prop M	0.5	0.5	0.5	0.5
Prop F	0.5	0.5	0.5	0.5

Source: Own elaborations

Deep-water rose shrimp GSA 1. MEDITS number (n/km^2) at age for GSA 1.

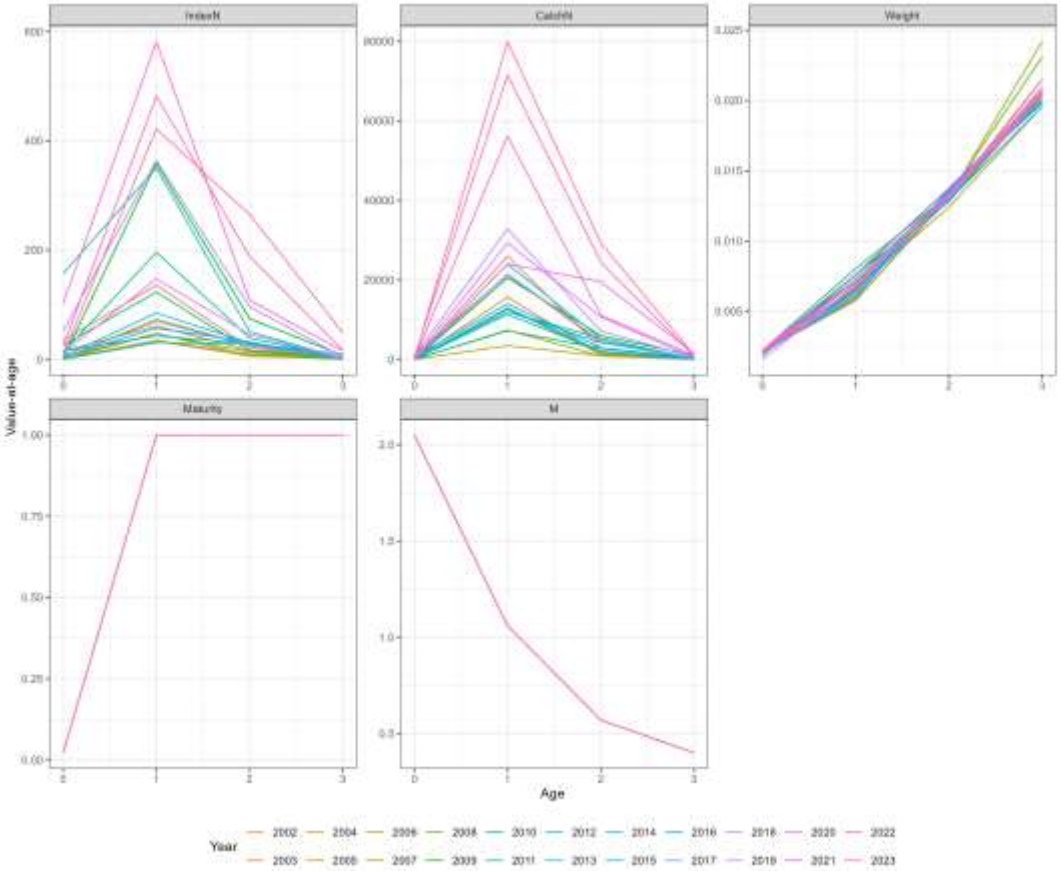
age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	34.55	1.48	14.90	0.14	2.55	4.40	0.61	2.23	26.18	13.34	157.31
1	135.92	35.03	61.23	33.97	73.28	47.47	47.24	359.21	123.34	195.83	350.59
2	22.27	10.10	16.82	6.19	26.01	7.46	14.00	74.74	16.76	39.58	50.77
3	0.87	1.78	5.68	1.23	3.82	0.68	0.31	7.63	2.70	3.38	1.94
age	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
0	0.29	5.77	15.47	4.56	2.99	51.80	11.94	NA	101.96	24.14	9.39
1	31.06	85.01	43.07	57.48	69.66	363.74	147.66	NA	581.46	482.41	421.70
2	29.07	30.45	29.24	31.95	25.31	96.65	45.61	NA	108.53	188.68	265.51

3	4.84	0.96	9.68	2.49	3.07	4.66	3.36	NA	15.68	16.97	48.86

Source: Own elaborations

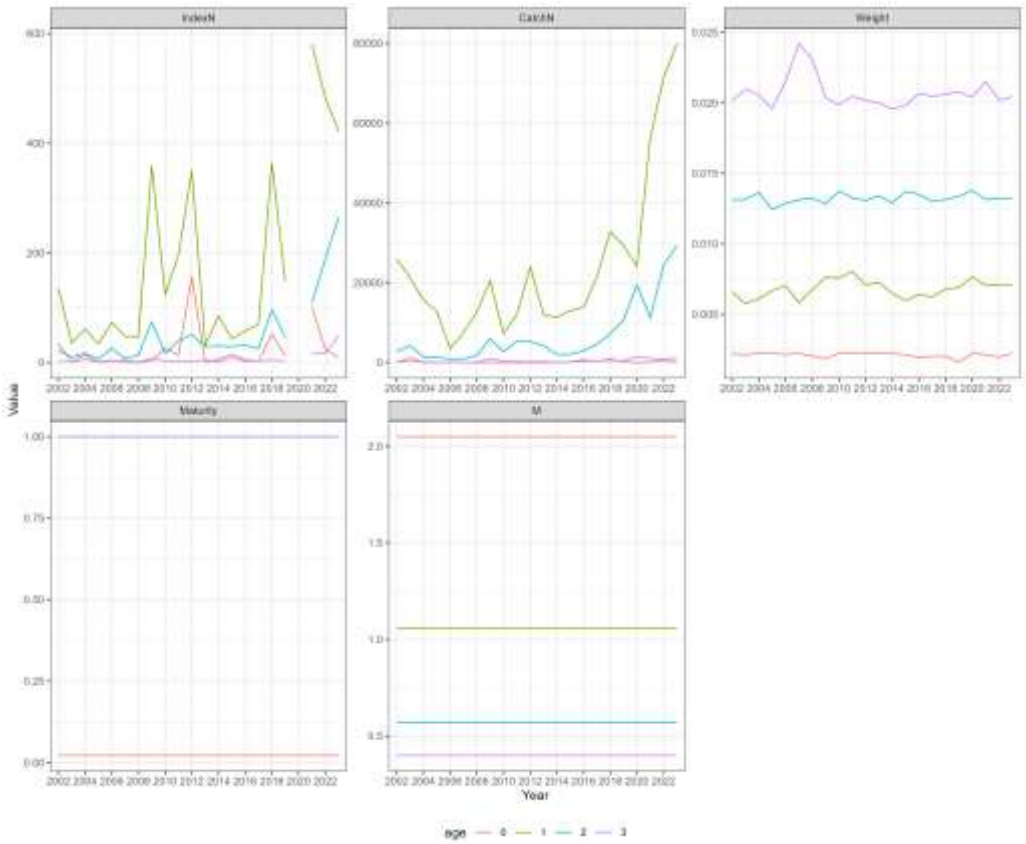
Figures 6.2.1.3.1-6.2.1.3.2 show the structure of input data (index, catches, mean weight, maturity and natural mortality) by year and age perspective.

Figure 6.2.1.3.1. Deep-water rose shrimp GSA 1. Structure of input data by year.



Source: Own elaborations

Figure 6.2.1.3.1. Deep-water rose shrimp GSA 1. Structure of input data by age.



Source: Own elaborations

Assessment results

Method a4a

Different a4a models were performed (combination of different f, q and sr). The best model (according to residuals and retrospective) included:

f ~ factor(age) + s(year, k = 9)

q ~ list(~ s(replace(age, age> 1, 1), k=3))

sr ~ factor(year)

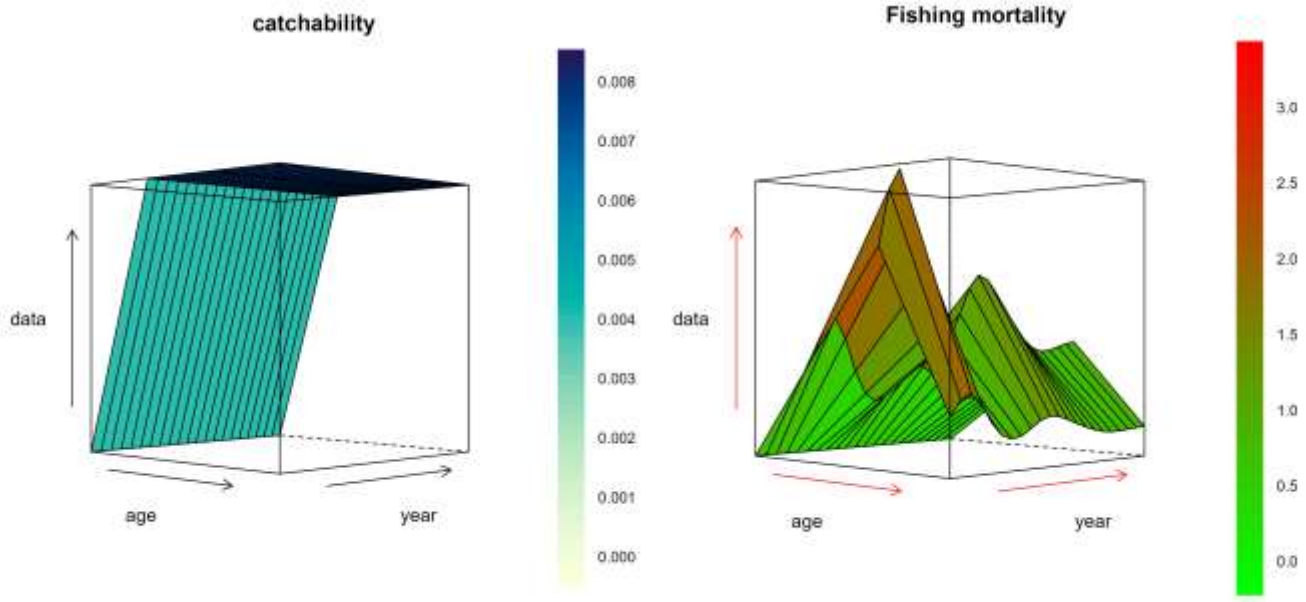
Results are shown in Figures 6.2.1.3.4-6.2.1.3.10.

Figure 6.2.1.3.4. Deep-water rose shrimp GSA 1. Stock summary from the a4a model for Deep-water rose shrimp GSA 1 recruits, SSB (Stock Spawning Biomass), catch and harvest (fishing mortality for ages 1 to 2).



Figure 6.2.1.3.5. Deep-water rose shrimp GSA 1. 3D contour plot of catchability and estimated fishing mortality at age and year.

Source: Own elaborations



Source: Own elaborations

Figure 6.2.1.3.6. Deep-water rose shrimp GSA 1. 3D contour plot and estimated f at age and year.

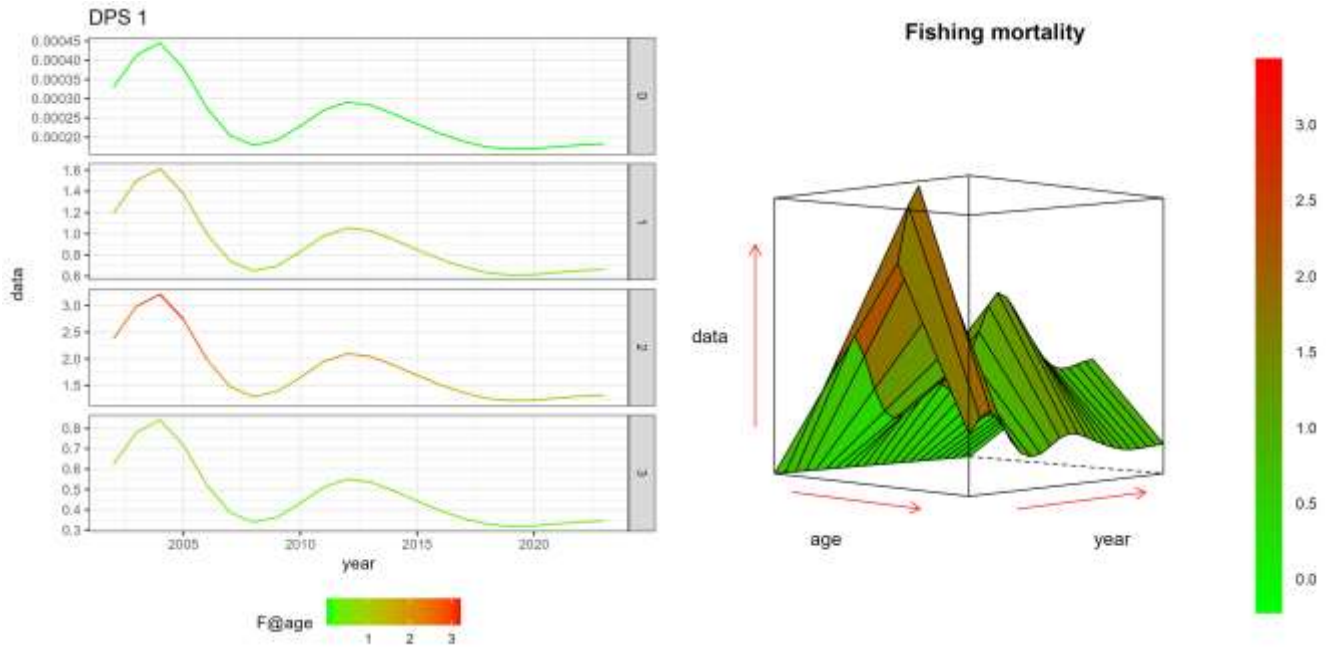
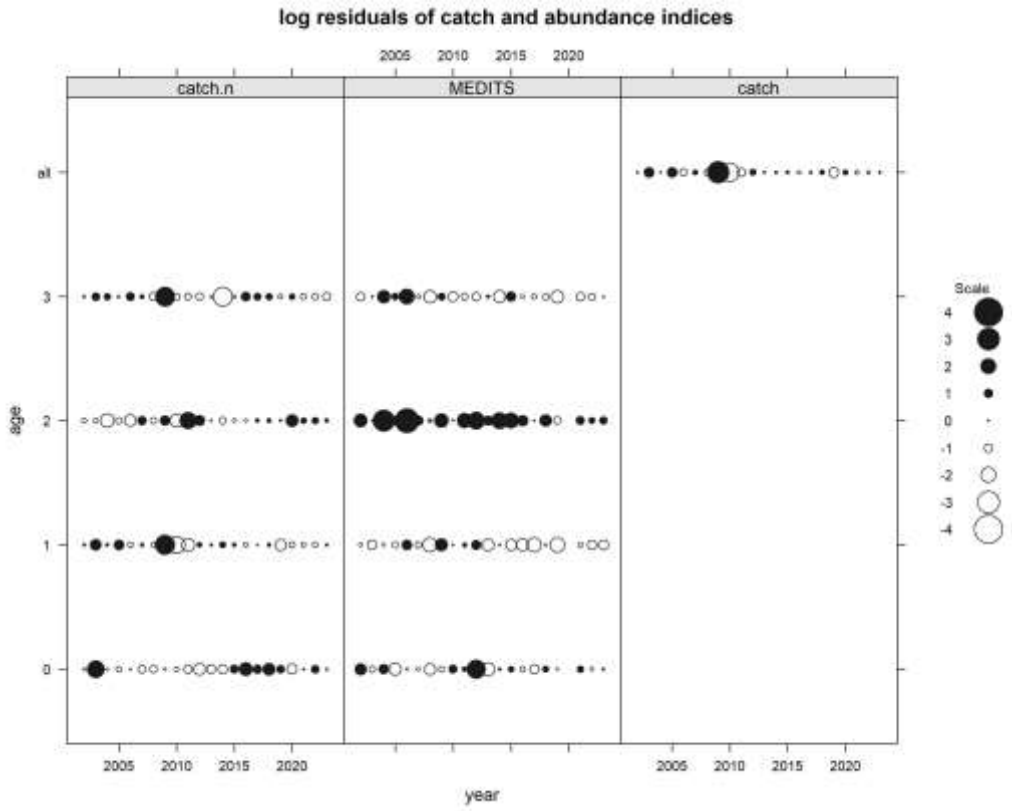


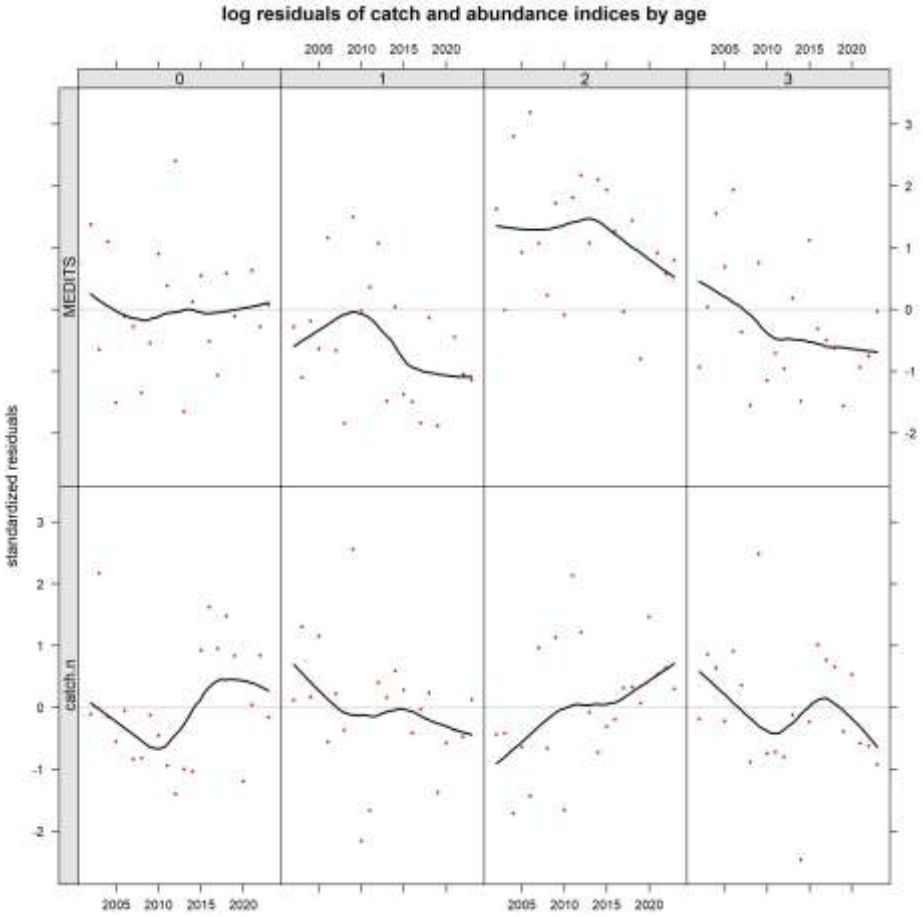
Figure 6.2.1.3.7. Deep-water rose shrimp GSA 1. Bubble plot of the log residuals of catch and abundance indices.

Source: Own elaborations



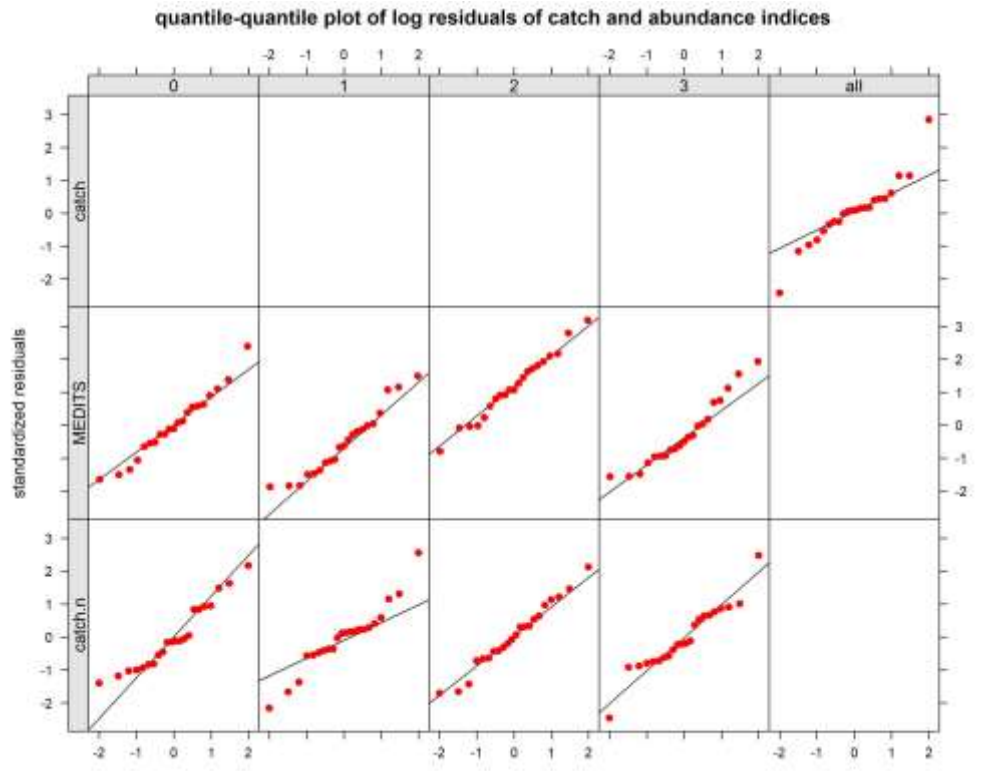
Source: Own elaborations

Figure 6.2.1.3.7. Deep-water rose shrimp GSA 1. Standardized residuals for abundance indices and for catch numbers (catch.n). Each panel is coded by age class; dots represent standardized residuals and lines simple smoothers.



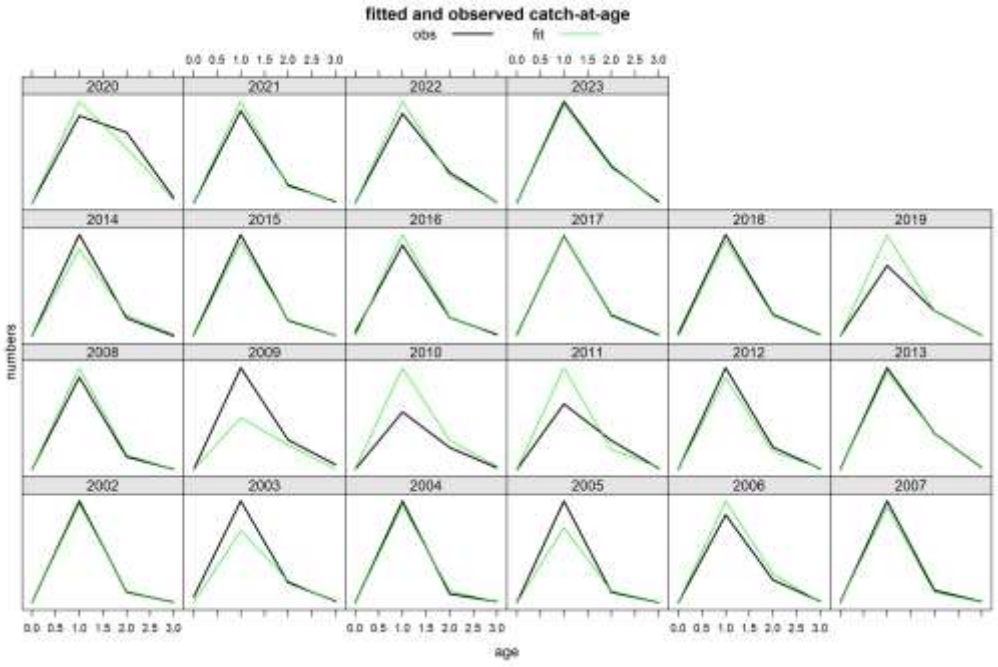
Source: Own elaborations

Figure 6.2.1.3.8. Deep-water rose shrimp GSA 1. Quantile-quantile plot of standardized residuals for abundance indices and for catch numbers (catch.n). Each panel is coded by age class; dots represent standardized residuals and lines the normal distribution quantiles.



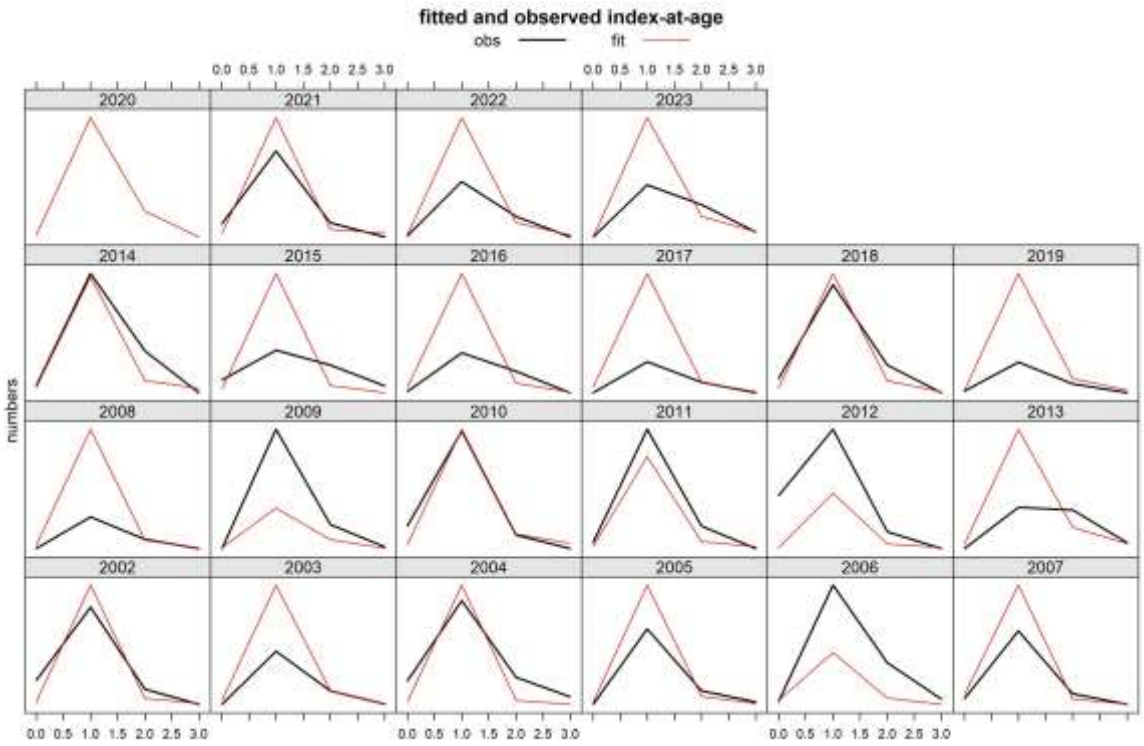
Source: Own elaborations

Figure 6.2.1.3.9. Deep-water rose shrimp GSA 1. Fitted and observed catch at age.



Source: Own elaborations

Figure 6.2.1.3.10. Deep-water rose shrimp GSA 1. Fitted and observed index at age.

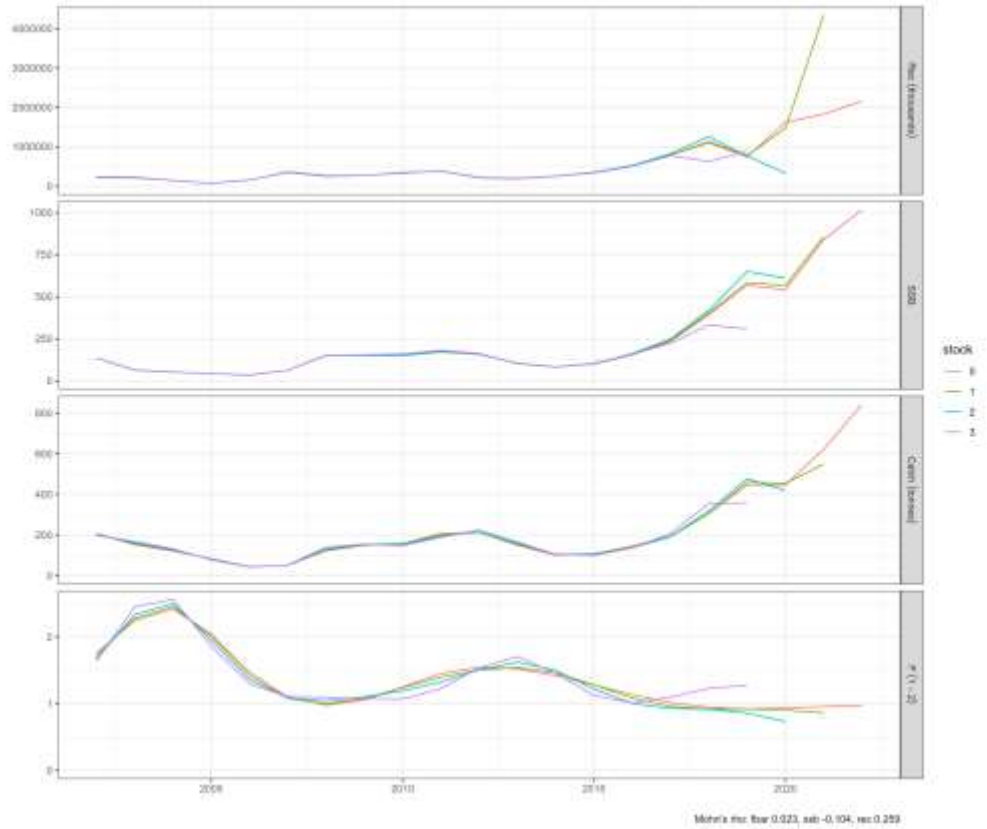


Source: Own elaborations

Retrospective

The retrospective analysis was applied up to 4 years back. Model results stable with the exception of recruitment (Figure 6.2.1.3.12). Changing the kfrac from 0.33 to 0.5 do not sensible change neither the pattern nor the mohn's rho values.

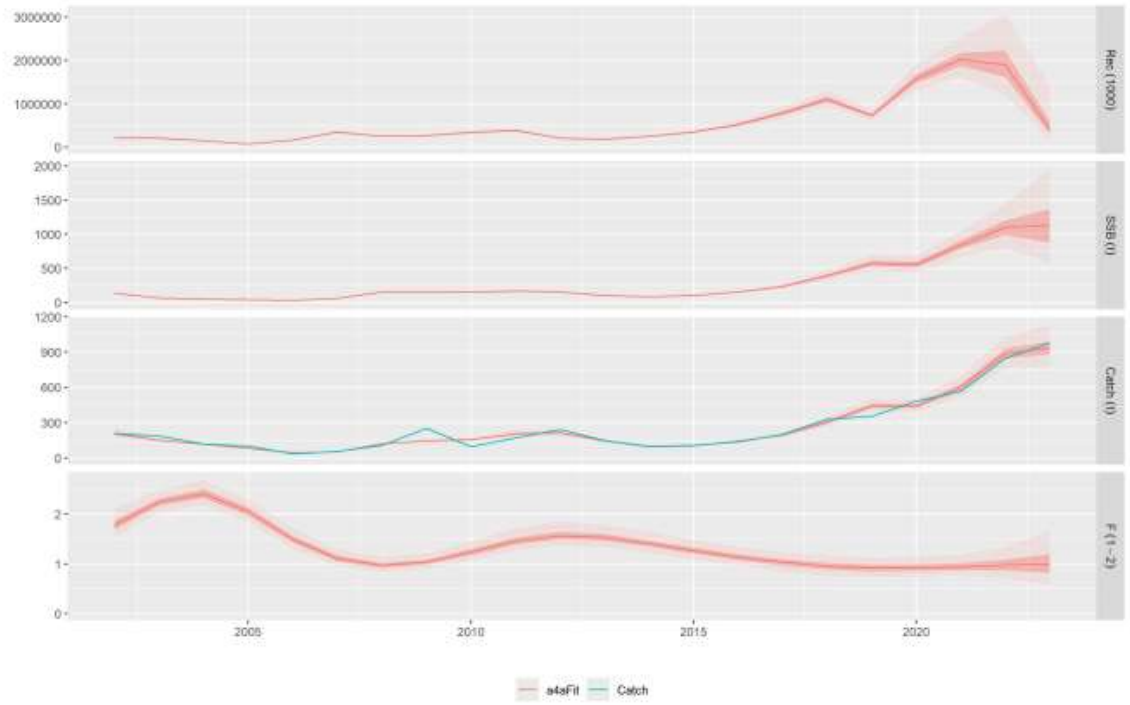
Figure 6.2.1.3.11. Deep-water rose shrimp GSA 1. Retrospective analysis output for the a4a model.



Source: Own elaborations

Simulations

Figure 6.2.1.3.12. Deep-water rose shrimp GSA 1. Stock summary of the simulated and fitted data for the a4a model.



Source: Own elaborations

In the tables 6.2.1.3.3 and 4 the population estimates of Deep-water rose shrimp obtained by a4a are provided.

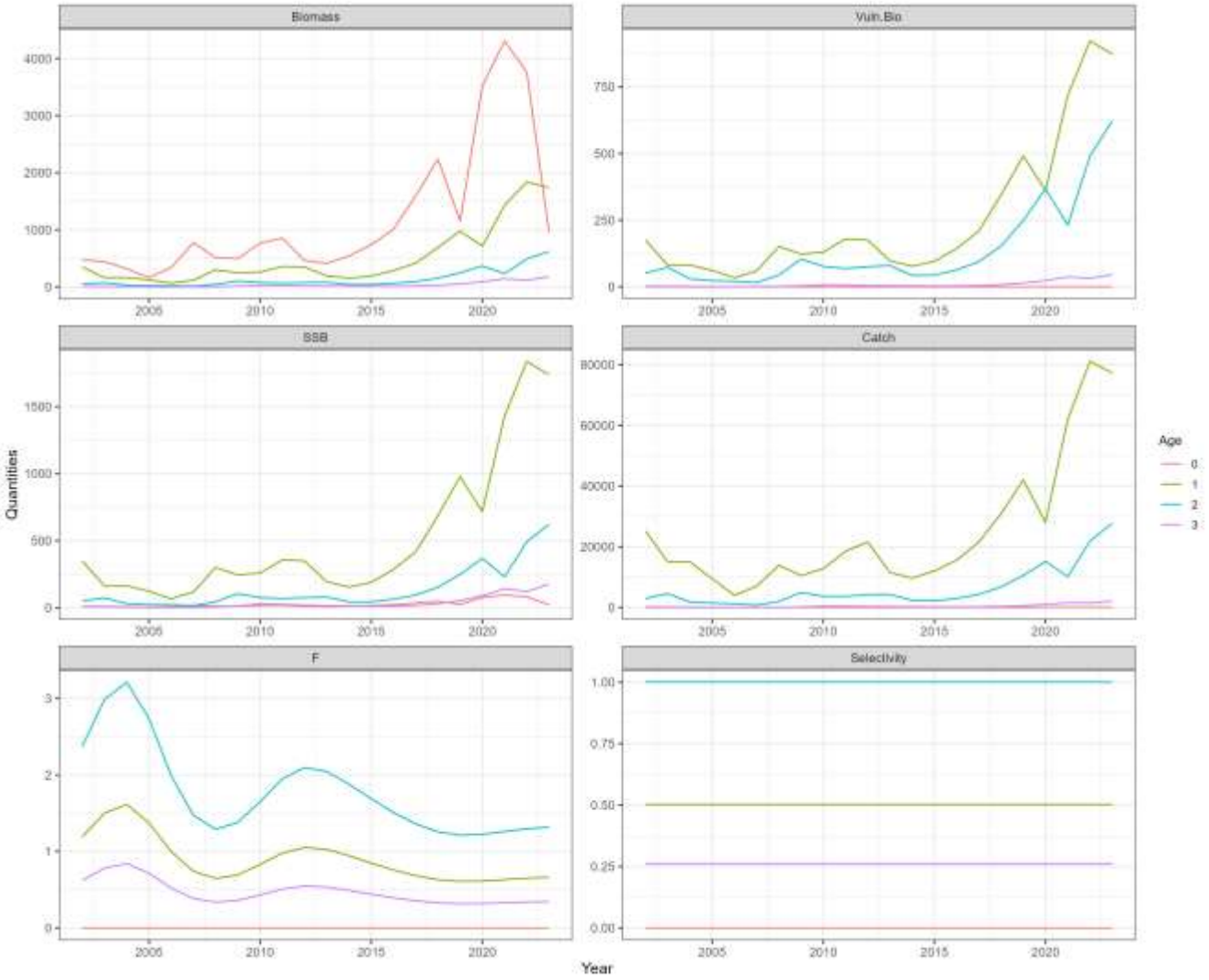
Table 6.2.1.3.3. Deep-water rose shrimp GSA 1. Stock numbers at age (thousands) as estimated by a4a.

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0	216508.4	207089.0	143042.7	73589.9	157471.4	348540.1	248896.2	266367.0	344314.2	382601.0	206947.0
1	53168.4	27863.1	26648.5	18406.4	9470.0	20266.4	44860.2	32035.9	34284.2	44315.2	49240.7
2	3855.1	5584.8	2150.1	1836.4	1612.1	1207.3	3349.2	8121.2	5542.4	5177.5	5765.7
3	412.5	351.3	266.7	125.9	108.5	167.9	233.1	632.0	1448.4	1230.4	912.0

age	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
0	184932.4	246878.5	346132.1	518721.2	787275.3	1101792.9	728754.2	1575538.4	2018111.9	1900314.7	431672.5
1	26633.6	23800.5	31773.6	44548.8	66763.5	101330.8	141814.9	93800.7	202792.5	259756.0	244592.4
2	5949.1	3300.9	3205.6	4711.8	7225.8	11671.5	18654.0	26692.0	17570.4	37269.2	46896.1
3	753.8	730.8	584.2	586.6	853.3	1448.2	2573.8	4388.3	6575.2	5981.1	8615.9

Source: Own elaborations

Figure 6.2.1.3.12. Deep-water rose shrimp GSA 1. Summary of trajectories at age for the a4a model.



Source: Own elaborations

Based on the a4a results, the Deep-water rose shrimp SSB fluctuated around 100 tons at the beginning of the time series (2002-2016) and then steeply increased reaching a peak of 1105 tons in the last year. The recruitment (age 0) reached a maximum of 2018112 thousand individuals in 2021. F_{bar} (1-2) shows a peak at the beginning of the time series in 2004, but in the last years shows a decreasing trend because a very steep decreas in the last year.The values of F at age show extremely high values particularly for age 2 for the first four years and remaining relatively high (between 1.3 and 2.0) until 2016.

Table 6.2.1.3.4. Deep-water rose shrimp GSA 1. a4a summary results and F at age.

	Fbar1-2	Recruitment (thousands)	SSB (t)	TB (t)	Catch (t)
2002	1.78	216508	134	883	208
2003	2.24	207089	65	684	150
2004	2.41	143043	53	517	119
2005	2.06	73590	43	312	83
2006	1.49	157471	34	429	44
2007	1.11	348540	63	915	52
2008	0.97	248896	153	860	121
2009	1.04	266367	154	858	147
2010	1.24	344314	151	1132	156
2011	1.46	382601	171	1304	207
2012	1.57	206947	156	904	215
2013	1.54	184932	103	701	147
2014	1.41	246879	82	756	97
2015	1.27	346132	101	983	105
2016	1.13	518721	154	1370	144
2017	1.02	787275	235	2121	196
2018	0.95	1101793	395	3108	305
2019	0.91	728754	573	2434	443
2020	0.92	1575538	551	4689	444
2021	0.95	2018112	837	6110	603
2022	0.97	1900315	1087	6210	891
2023	0.99	431673	1105	3498	960

Source: Own elaborations

Table 6.2.1.3.5. Deep-water rose shrimp GSA 1. F at age estimations.

F at age	0	1	2	3+
2002	0.0003	1.1934	2.3745	0.6222
2003	0.0004	1.5018	2.9882	0.7830
2004	0.0004	1.6150	3.2133	0.8420
2005	0.0004	1.3752	2.7362	0.7170
2006	0.0003	0.9997	1.9892	0.5212
2007	0.0002	0.7402	1.4729	0.3860
2008	0.0002	0.6491	1.2915	0.3384
2009	0.0002	0.6944	1.3817	0.3621
2010	0.0002	0.8304	1.6522	0.4329
2011	0.0003	0.9794	1.9487	0.5106
2012	0.0003	1.0535	2.0961	0.5493
2013	0.0003	1.0280	2.0454	0.5360
2014	0.0003	0.9448	1.8799	0.4926
2015	0.0002	0.8486	1.6884	0.4424

2016	0.0002	0.7589	1.5100	0.3957
2017	0.0002	0.6840	1.3610	0.3566
2018	0.0002	0.6323	1.2582	0.3297
2019	0.0002	0.6102	1.2140	0.3181
2020	0.0002	0.6150	1.2236	0.3206
2021	0.0002	0.6340	1.2615	0.3306
2022	0.0002	0.6518	1.2969	0.3398
2023	0.0002	0.6627	1.3186	0.3455

Source: Own elaborations

All the diagnostics from the a4a assessment were considered acceptable although survey data residuals are high for age 2 showing a negative trend.
The model poor fit data for some years. Further, model uncertainty was particularly high in the latest years both for recruitment and SSB. The values of F at age show extremely high values for age 2, particularly at the beginning of the time series. However, Fbar results stable in the last period of time.
From the retrospective analysis model results relatively stable with the exception of recruitment.

6.2.1.4 Reference Points

The assessment is an update of the assessment performed by EWG 23-09. As last year, because the dynamic of the stock is still increasing and shows both an unstable dynamic and instable retrospective, no biomass reference points are calculated though F_{MSY} is estimated. The STECF EWG 24-10 recommended using $F_{0.1}$ as a proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ = 0.99 from the stock object resulting from the outputs of the a4a assessment (Table 6.2.1.3.1).

Current F_{1-2} (0.99), corresponding to the F of the last year of the time series) is 4 % below $F_{0.1}$ (1.02), chosen as a proxy for F_{MSY} and as the exploitation reference point consistent with high long-term yields. This indicates that deepwater rose shrimp in GSA 1 is being exploited within MSY limits and below F_{MSY}.

6.2.1.5 Short term Forecast and Catch Options

A deterministic short term prediction for the period 2022 to 2024 was performed using the FLR libraries and scripts, and based on the results of the stock assessment.

The basis for the choice of values is given in Section 4.3. An average of the last three years has been used for weight at age, maturity at age. F_{bar} =0.99 as the F of last year from the a4a assessment was used for estimate F in 2023. Recruitment (age 0) for 2023 to 2024 has been estimated from the population results as the mean of the last 3 years (1450033).

Table 6.2.1.4.1. Deep-water rose shrimp stocks in GSAs 1: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Biological Parameters	average of 2021-2023	mean weights at age, maturation at age, natural mortality at age and selection at age
$F_{ages\ 1-2}$ (2024)	0.99	F 2023 used to give F status quo for 2024

Variable	Value	Notes
$F_{ages\ 1\text{-}2}$ (2019)	0.92	MAP base year fishing mortality from current assessment
SSB (2024)	1105	Stock assessment 1 January 2024
R_{age0} (2023,2024)	1450033 (thousands)	mean of last 3 years
Total catch (2024)	960	Assuming F status quo for 2024

Source: Own elaborations

The short term forecast was carried out estimating a catch for 2023-2025 on the basis of a recruitment hypothesis constant and equal to the mean of last 3 years and an F by age equal to that of the terminal year. These assumptions resulted in a catch and a SSB in 2023 equal to 960 and 1105 tons, respectively.

The analysis, carried out with stf.r FLR script made available to the EWG, shows that fishing at a level equal to $F_{0.1}$ (=1.02) would icrease biomass by 47% from 2024 to 2026, while decreasing catches by 41 % from 2023 to 2025.

Table 6.7.5.2. Deep-water rose shrimp stocks in GSAs 1: Catch options.

Rationale	Ffactor	Fbar	Recruitment 2024	Fsq 2024	Catch 2023	Catch 2024	Catch 2025	SSB 2024	SSB 2026	SSB_change 2024-2026(%)	Catch_change 2023-2025(%)
High long term yield (F0.1)	1.029	1.02	1450033	0.991	960.3	522.3	566.7	574.0	841.5	46.60	-40.98
F upper	1.396	1.38	1450033	0.991	960.3	522.3	701.1	574.0	692.3	20.62	-26.99
F lower	0.682	0.68	1450033	0.991	960.3	522.3	412.6	574.0	1033.9	80.14	-57.04
FMSY transition	1.029	1.02	1450033	0.991	960.3	522.3	566.7	574.0	841.5	46.60	-40.98
Zero catch	0	0.00	1450033	0.991	960.3	522.3	0.0	574.0	1673.5	191.56	-100.00
Status quo	1	0.99	1450033	0.991	960.3	522.3	555.1	574.0	855.2	49.00	-42.20
Different Scenarios	0.1	0.10	1450033	0.991	960.3	522.3	71.8	574.0	1548.7	169.82	-92.52
	0.2	0.20	1450033	0.991	960.3	522.3	139.3	574.0	1436.7	150.31	-85.50
	0.3	0.30	1450033	0.991	960.3	522.3	202.7	574.0	1336.1	132.77	-78.90
	0.4	0.40	1450033	0.991	960.3	522.3	262.3	574.0	1245.4	116.98	-72.69
	0.5	0.50	1450033	0.991	960.3	522.3	318.4	574.0	1163.6	102.72	-66.84
	0.6	0.59	1450033	0.991	960.3	522.3	371.4	574.0	1089.6	89.83	-61.33
	0.7	0.69	1450033	0.991	960.3	522.3	421.3	574.0	1022.4	78.13	-56.13
	0.8	0.79	1450033	0.991	960.3	522.3	468.4	574.0	961.5	67.51	-51.22
	0.9	0.89	1450033	0.991	960.3	522.3	513.0	574.0	905.9	57.83	-46.59
	1.1	1.09	1450033	0.991	960.3	522.3	594.9	574.0	808.8	40.91	-38.05
	1.2	1.19	1450033	0.991	960.3	522.3	632.7	574.0	766.2	33.49	-34.12
	1.3	1.29	1450033	0.991	960.3	522.3	668.5	574.0	727.1	26.67	-30.39
	1.4	1.39	1450033	0.991	960.3	522.3	702.4	574.0	691.0	20.38	-26.85
	1.5	1.49	1450033	0.991	960.3	522.3	734.7	574.0	657.6	14.57	-23.50
	1.6	1.59	1450033	0.991	960.3	522.3	765.3	574.0	626.7	9.18	-20.31
	1.7	1.68	1450033	0.991	960.3	522.3	794.4	574.0	598.0	4.19	-17.28
	1.8	1.78	1450033	0.991	960.3	522.3	822.1	574.0	571.3	-0.47	-14.39
	1.9	1.88	1450033	0.991	960.3	522.3	848.5	574.0	546.4	-4.80	-11.65

	2	1.98	1450033	0.991	960.3	522.3	873.6	574.0	523.1	-8.86	-9.03

Source: Own elaborations

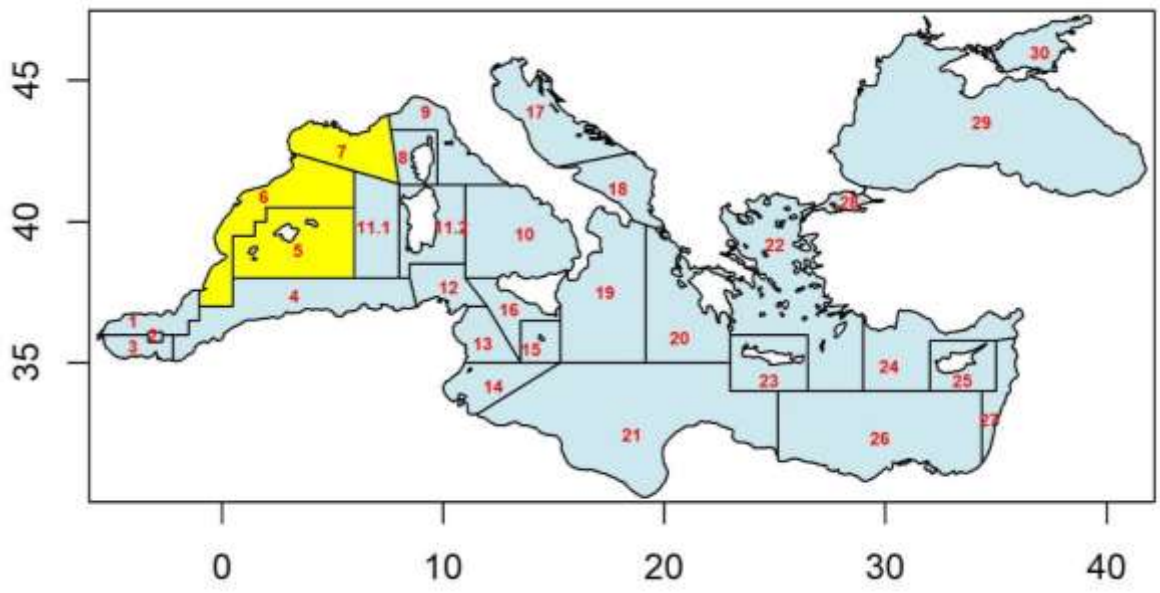
EWG advises that when the MSY approach is applied, catches in 2025 should be no more than 566.7 tonnes.

6.2.2 Deep-water rose shrimp in GSAs 5, 6 & 7

6.2.2.1 Stock Identity and Biology

The deep-water rose shrimp stock in Spanish and France waters (GSA1,5,6 and 7) has been already investigated in the previous years as stock jointed or split by GSAs. The main findings during those recent working groups suggested considering two main stock units: GSA1 alone and GSA5, 6 and 7 combined based mainly on similar dynamics in the combined areas. (https://stecf.jrc.ec.europa.eu/documents/43805/5780344/STECF+21-11++Stock+assess+west+MED.pdf/f22d3551-6e71-4b63-bb19-5afef7e07863)

Figure 6.2.2.1 Deep-water rose shrimp in GSAs 5, 6 & 7: Location of the GSAs 5, 6 and 7 in the Mediterranean Sea.



Source: Own elaborations

Growth

Sex combined von Bertalanffy growth parameters and length weight relationships of deep-water rose shrimp were available both for GSA5 and GSA6 from 2002 to 2023 from DCF data. EWG-22-09 analysed the available data (see EWG-22-09 report) and for the aim of the stock assessment a set of values by GSA given by the median along the years was used (Table 6.2.1.1). EWG24-10 used the same growth parameters as in EWG-22-09 and EWG-23-09.

Table 6.2.2.1 Deep-water rose shrimp in GSAs 5, 6 & 7: Von Bertalnaffy growth and length weight relationships parameters used in the assessment.

Area	L∞	K	t0	a	b
GSA5	45	0.71	-0.14	0.002624	2.53
GSA6	45	0.71	-0.08	0.002624	2.53

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

According to the maturity information available for the area, the reproductive period, based on the percentages of maturity and GSI development, was found to range throughout the year, with some peaks of activity especially in summer (García-Rodríguez et al 2009). Based on these findings the values of fishing and natural mortality values before spawning have been set as 0.5.

Using the von Bertalanffy growth parameters in Table 6.2.2.1 the biological length at age0-age1 transition have been re-estimated being the DCF data provided with data on calendar year basis which are not in agreement with the assessment parametrization of the age0-age1 transtion on 31st December year n – 1st January year n+1 having set the spawning period in the middle of the year. On the basis of the discussions the EWG 22-09 agreed to shift the length slicing by adding a value of 0.5 to the t0 value to assign the ages to calendar year correctly (Table 6.2.2.2).

Table 6.2.2.2 Deep-water rose shrimp in GSAs 5, 6 & 7: Length at transtion between age0-age1 on biological and calendar ("assessment") basis.

Area	Mean length at the end of the calendar year	Mean length at the end of the biological year
GSA5	16.43	24.56
GSA6	15.18	24.09

Source: Own elaborations

Natural mortality

Natural mortality (M) was estimated according to Chen and Watanabe model (1989) on the age vector at half year (0.5, 1.5, 2.5,…) using the original growth parameters, without the adjustement of the t0 (Table 6.2.2.3). During EWG-22-09 the natural mortality vectors by GSAs were weighted by catch number at age by GSA when the final combined stock object had been set. EWG-24-10 used the same M vector as in EWG-22-09 and EWG-23-09.

Table 6.2.2.3 Deep-water rose shrimp in GSAs 5, 6 & 7: Natural mortality vector applied by GSAs

Age	GSA5	GSA6

0	1.94429	2.10343
1	1.03214	1.05293
2	0.83870	0.84536
3+	0.76793	0.77607

Source: Own elaborations

Maturity

In literature this species is reported as to be able in spawning all along the year (García-Rodríguez et al 2009). However the main reproductive period seems to be in the middle Summer. Based on these considerations the EWG agreed in setting the natural and fishing before spawning values as 0.5.

Maturity ogives by age weren't available in the DCF data for any of the 3 GSAs. So, the vector of matures by year and age have been derived from the maturity length vectors available in GSA5 and 6. The VBGF parameters (having included the t0+0.5 corrections) have been used to derive the corresponding age at length. EWG-22-09 derived the final vector by GSA as mean of the values obtained by age weighted for the number of samples by age. Table 6.2.2.4 shows the two final vectors by GSA and age. The proportion of fully mature in the GSA6 plus group didn't reach the maximum (due to the difference in the maturation stage in the length/samples available in the older ages / bigger sizes). However, the EWG agreed in setting the maturity level in the plus group as 1 matching the level observed in GSA 1 in the final input stock object used in fitting the final model.

Table 6.2.2.4 Deep-water rose shrimp in GSAs 5, 6 & 7: Maturity at age vector applied by GSAs

Age	GSA5	GSA6
0	0	0
1	0.5	0.5
2	0.8	0.8
3+	1	0.9

Source: Own elaborations

6.2.2.2 Data

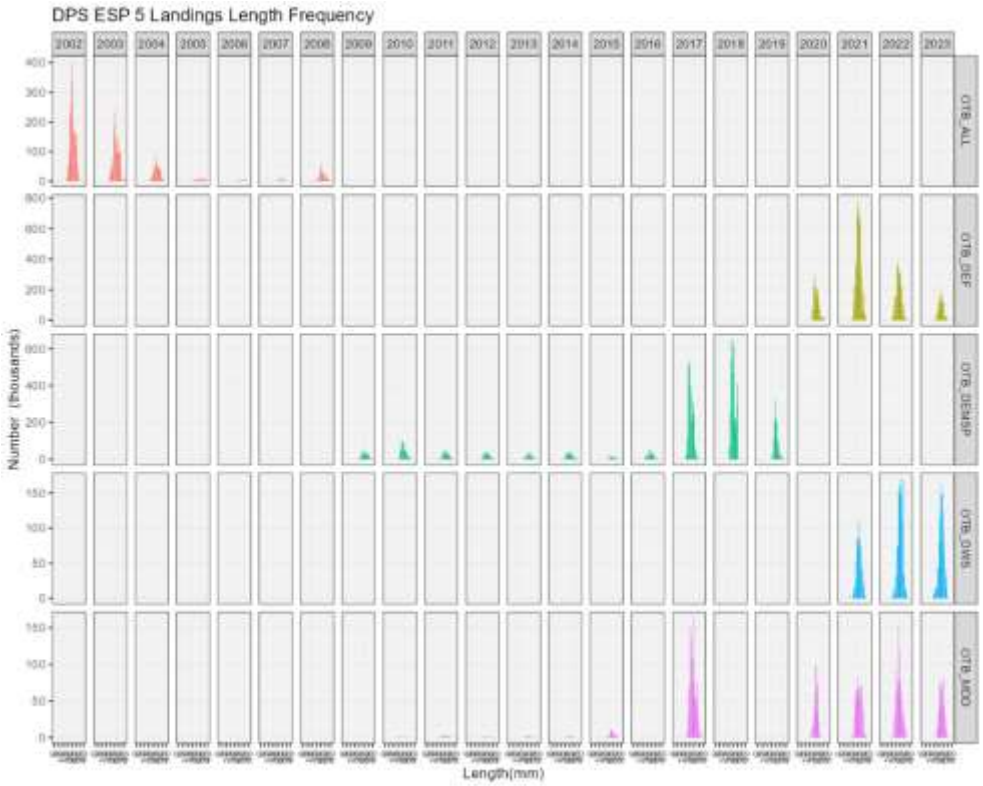
6.2.2.2.1 Catch (landings and discards)

In GSA5, GSA6 and GSA7 the main Spanish fleets targeting the deep-water rose shrimps are the bottom otter trawlers (OTB) while in GSA7 even if the OTB still target this species, the main French fleet fishing the deep-water rose shrimps are the twins otter trawlers (OTT). A minor proportion of landings derives from the set nets and others less mobile gear fleets. The discards values are basically on the OTB. The discards amounts by weight were negligible (maximum proportion in the catch 3% in 2011 having a mean values in the whole series of 0.8%). Nevertheless they have been added in the total catches used in the assessment (Table 6.2.2.5).

The landings length structure of deep-water rose shrimps available in the DCF dataset in GSA5, 6 & 7 (Spain) are shown in Figures 6.2.2.2-4. There aren't any length frequencies

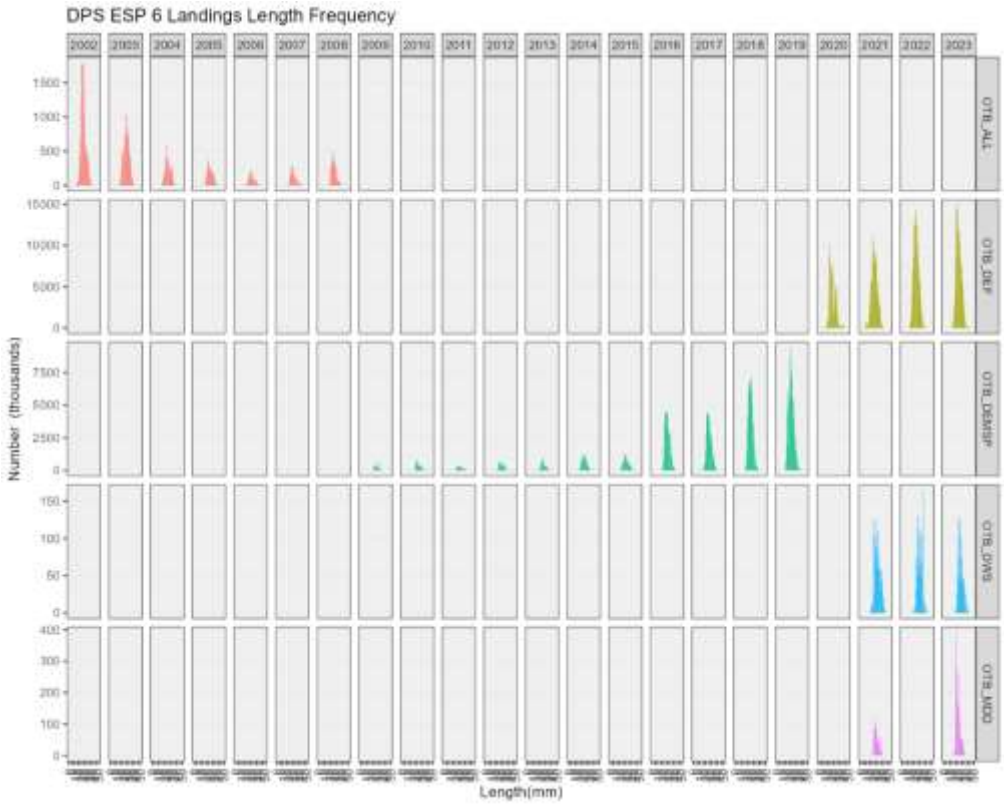
distributions available for GSA7 French fleets. In Figure 6.2.2.5 the discards length frequencies distributions available for GSA6 are shown. There weren't any length frequencies distributions of discards in GSA5 and GSA7 (Spain and France). The landings and discards weight by GSAs and gear are shown in Figures 6.2.2.6-12. No discards reported for GSA7 (France).

Figure 6.2.2.2 Deep-water rose shrimp in GSAs 5, 6 & 7: GSA5 landings length structures of the deep-water rose shrimps by fishing gear and fishery.



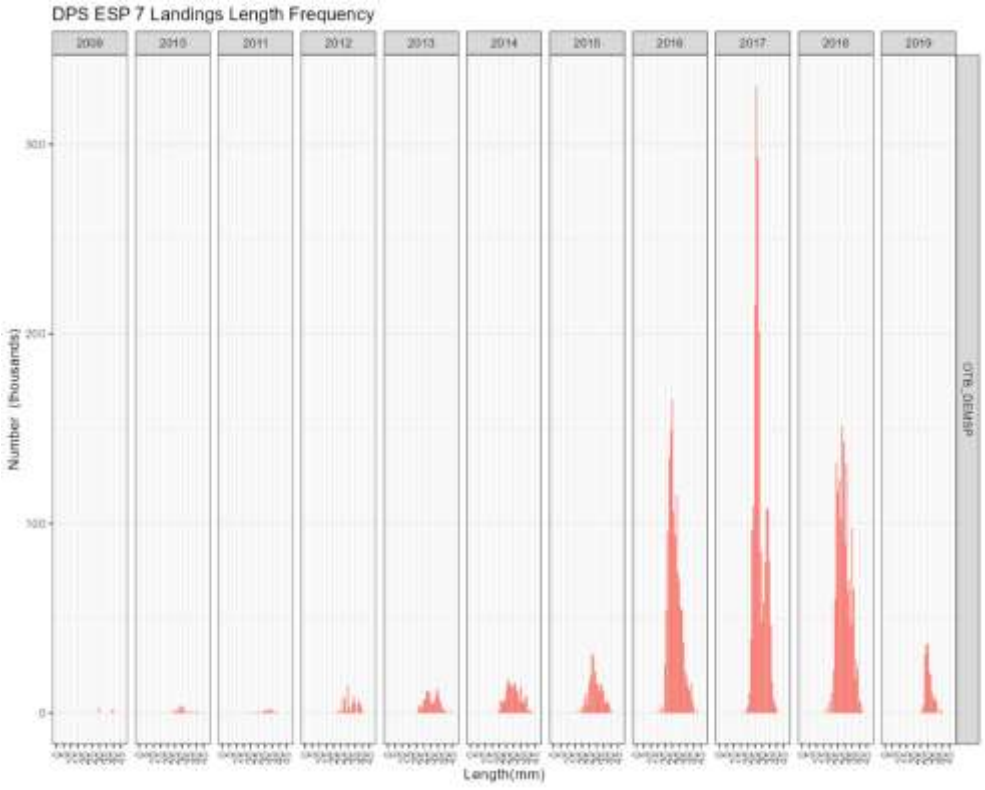
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.3 Deep-water rose shrimp in GSAs 5, 6 & 7: GSA6 landings length structures of the deep-water rose shrimps by fishing gear and fishery.



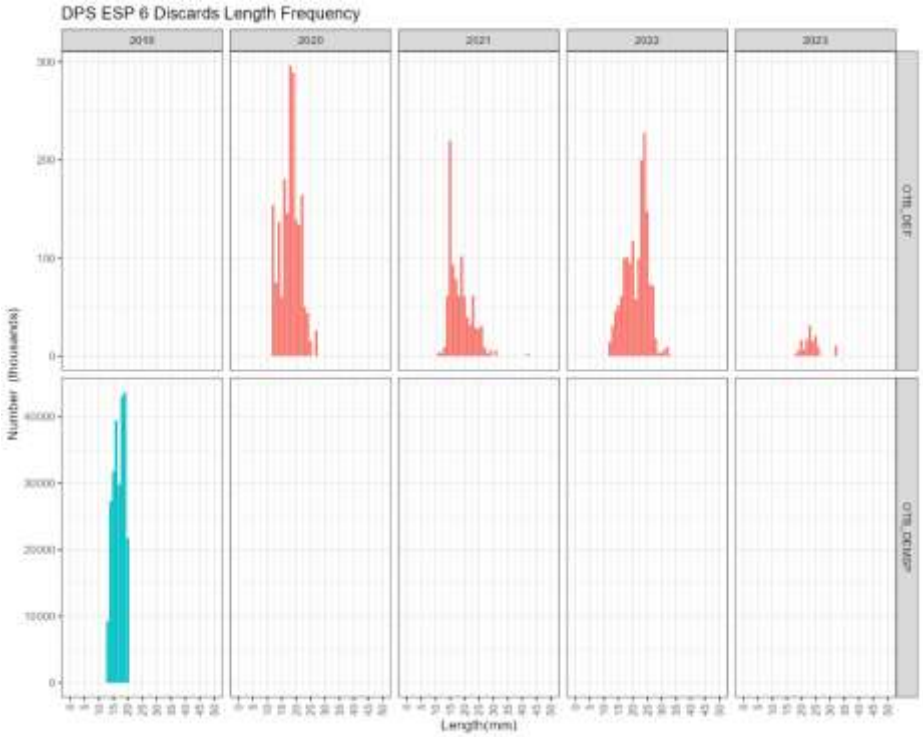
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.4 Deep-water rose shrimp in GSAs 5, 6 & 7: GSA7 (Spain) landings length structures of the deep-water rose shrimps by fishing gear and fishery.



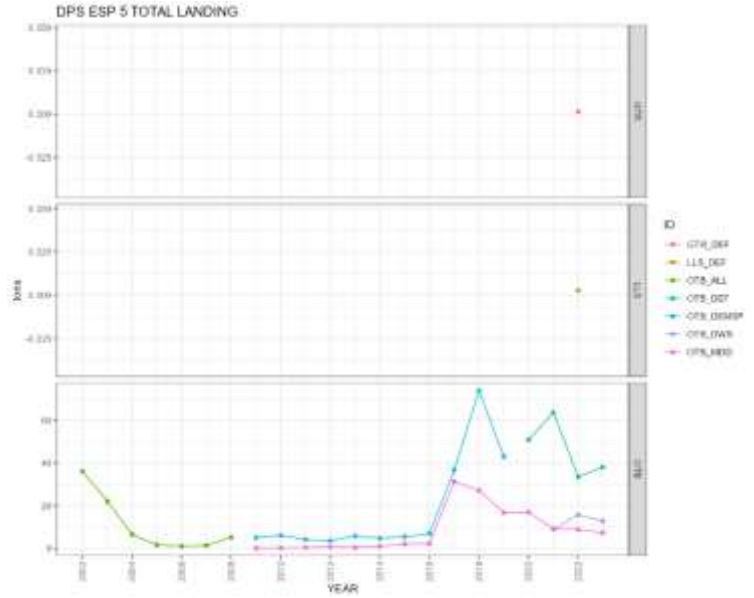
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.5 Deep-water rose shrimp in GSAs 5, 6 & 7: GSA6 discards length structures of the deep-water rose shrimps by fishing gear and fishery.



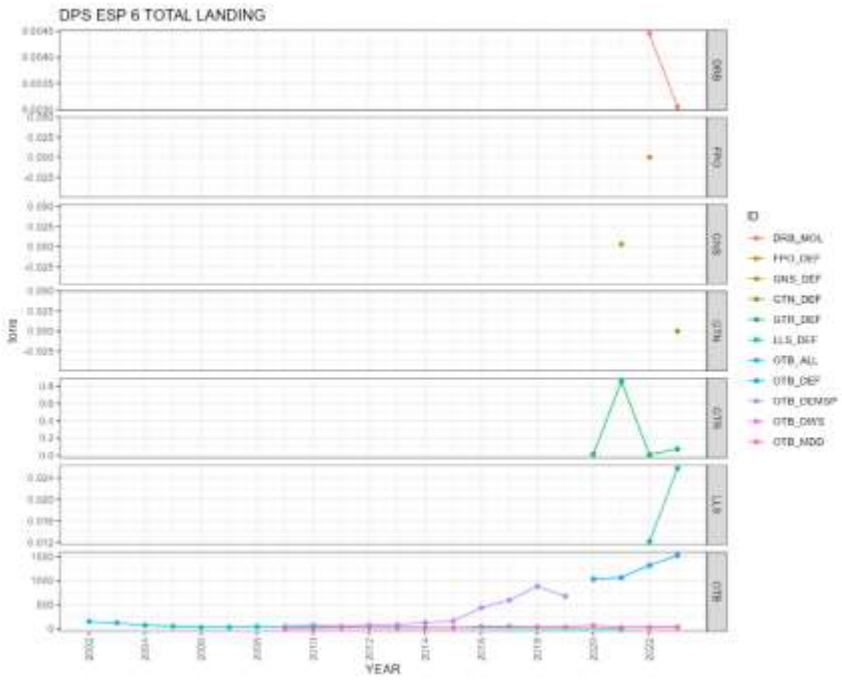
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.6 Deep-water rose shrimp in GSAs 5, 6 & 7: Landings (t) of deep-water rose shrimp in GSA 5 by fishing gear and fishery.



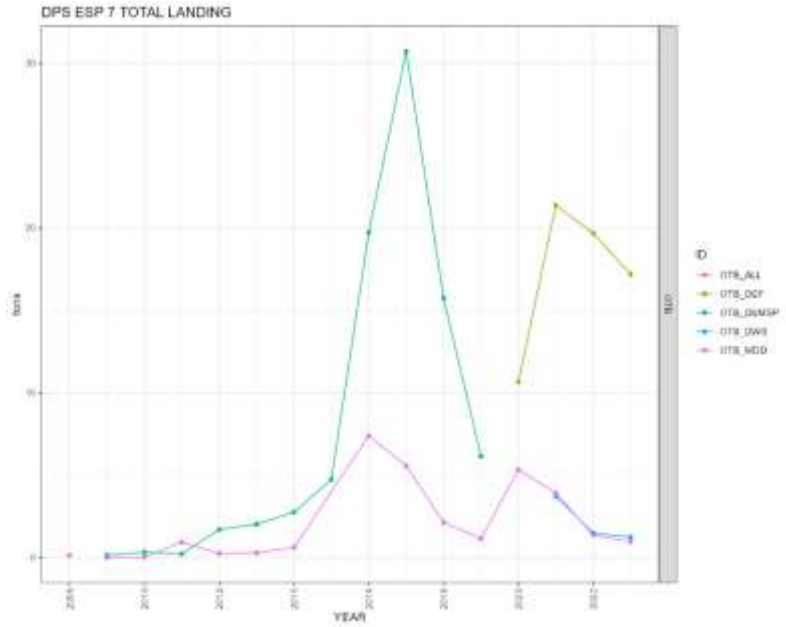
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.7 Deep-water rose shrimp in GSAs 5, 6 & 7: Landings (t) of deep-water rose shrimp in GSA 6 by fishing gear and fishery.



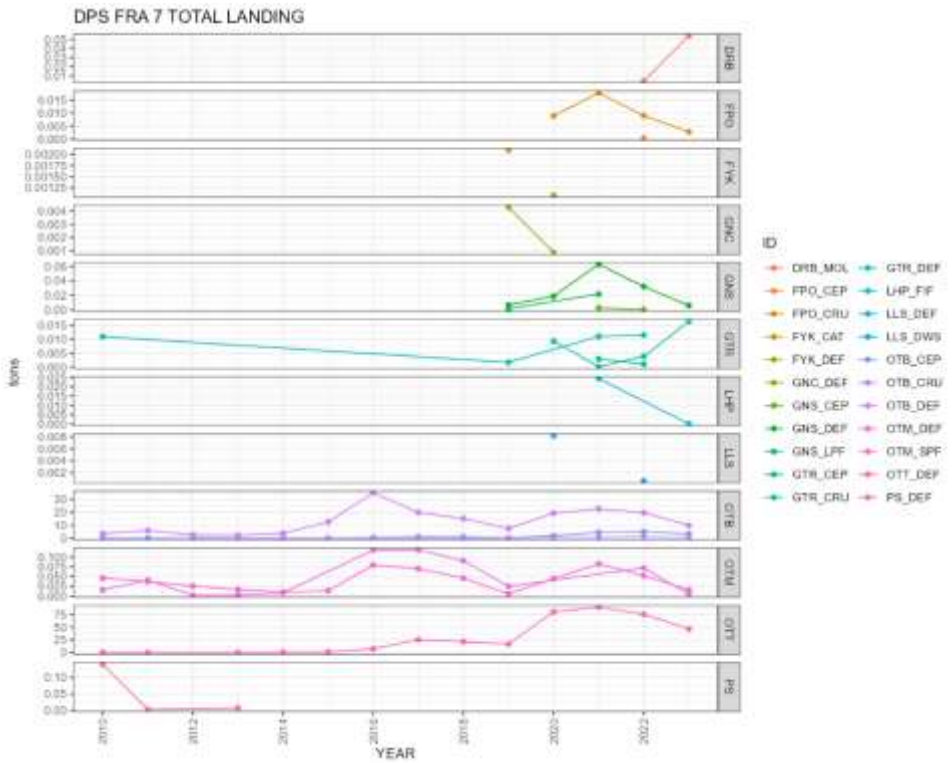
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.8 Deep-water rose shrimp in GSAs 5, 6 & 7: Landings (t) of deep-water rose shrimp in GSA 7 (Spain) by fishing gear and fishery.



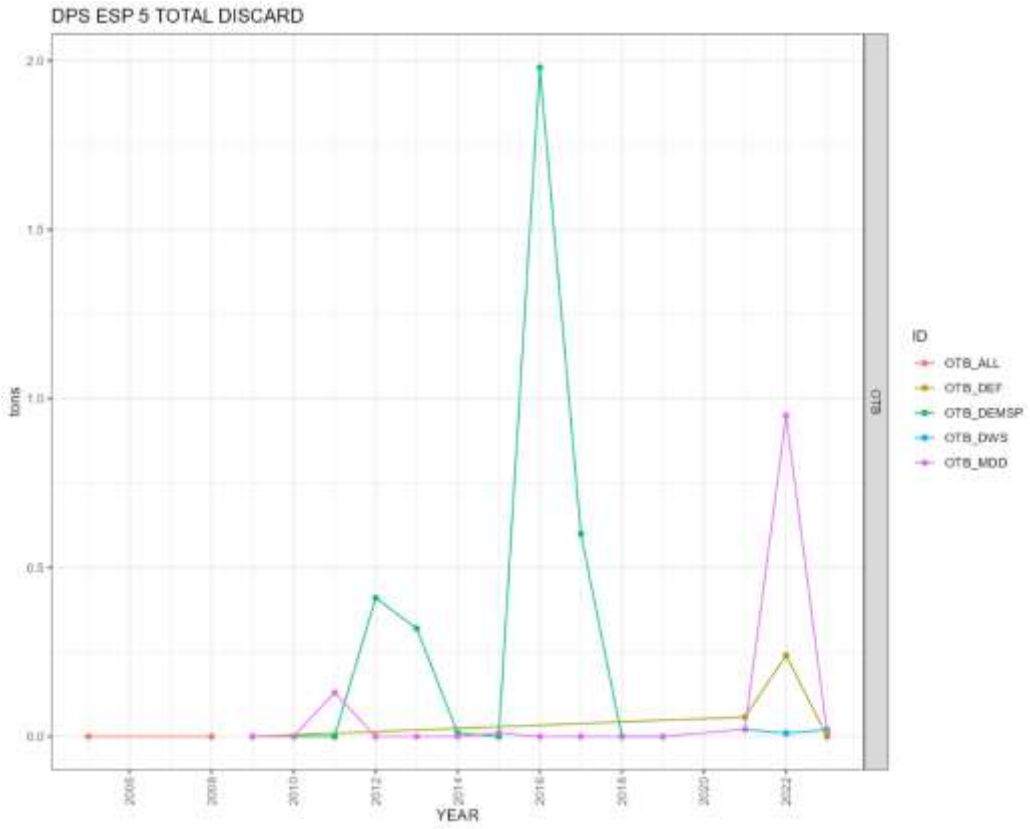
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.9 Deep-water rose shrimp in GSAs 5, 6 & 7: Landings (t) of deep-water rose shrimp in GSA 7 (France) by fishing gear and fishery.



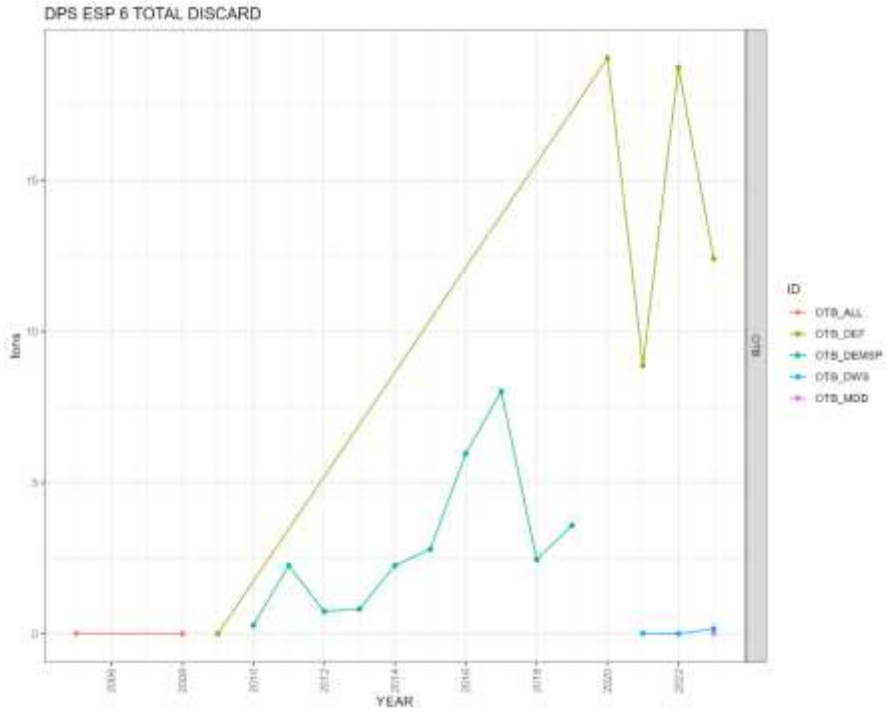
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.10 Deep-water rose shrimp in GSAs 5, 6 & 7: Discards (t) of deep-water rose shrimp in GSA 5 by fishing gear and fishery.



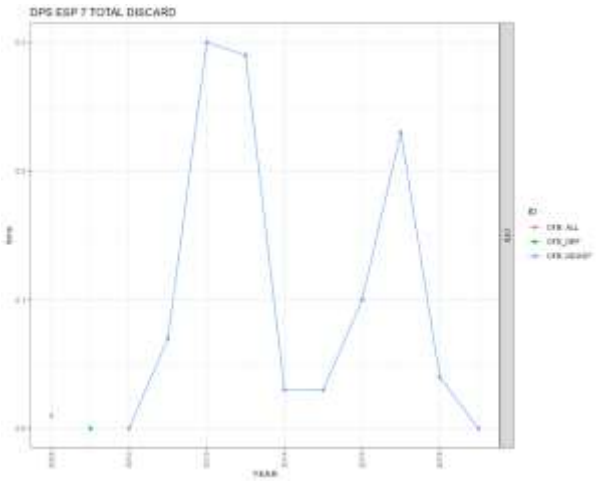
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.11 Deep-water rose shrimp in GSAs 5, 6 & 7: Discards (t) of deep-water rose shrimp in GSA 6 by fishing gear and fishery.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.2.2.12 Deep-water rose shrimp in GSAs 5, 6 & 7: Discards (t) of deep-water rose shrimp in GSA 7 by fishing gear and fishery.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.2.2.5 Deep-water rose shrimp in GSAs 5, 6 & 7: Landings and discards (t) of deep-water rose shrimps in GSAs 5, 6 & 7 by gear.

LANDINGS	DISCARDS

Year	OTB	OTT	Others	Total	OTB
2002	180.26	0.00	0.00	180.26	0.00
2003	138.15	0.00	0.00	138.15	0.00
2004	72.72	0.00	0.00	72.72	0.00
2005	46.26	0.00	0.00	46.26	0.01
2006	26.19	0.00	0.00	26.19	0.00
2007	30.20	0.00	0.00	30.20	0.00
2008	44.28	0.00	0.00	44.28	0.01
2009	54.34	0.00	0.00	54.34	0.00
2010	81.91	0.15	0.21	82.27	0.28
2011	78.07	0.01	0.08	78.16	2.46
2012	95.12	0.00	0.03	95.15	1.45
2013	97.60	0.00	0.03	97.63	1.43
2014	144.03	0.44	0.02	144.50	2.30
2015	199.62	1.00	0.01	200.63	2.84
2016	543.15	7.04	0.20	550.38	8.04
2017	760.06	25.20	0.36	785.62	8.85
2018	1049.85	21.36	0.14	1071.35	2.49
2019	778.89	16.62	0.05	795.56	3.58
2020	1200.73	80.42	0.11	1281.25	19.04
2021	1246.00	89.98	1.16	1337.14	8.99
2022	1474.38	75.73	0.22	1550.33	19.94
2023	1674.96	46.67	0.20	1721.83	12.61

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.2.2.2.2 Effort

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.2.2.2.3 Survey data

The survey indices used as fisheries independent information to tune the commercial catch data originate from the MEDITS scientific bottom trawl survey. These surveys in the two countries and three GSAs usually took place between May and June. Only in 2020 the France MEDITS survey has been carried out in delay while the Spain MEDITS in GSA6 had less number of hauls (no southern fishing ground explored).

Figure 6.2.2.15 Deep-water rose shrimp in GSAs 5, 6 & 7: Survey periods of MEDITS in GSA 5.



Source: Own elaborations

Figure 6.2.2.16 Deep-water rose shrimp in GSAs 5, 6 & 7: Survey periods of MEDITS in GSA 6.



Source: Own elaborations

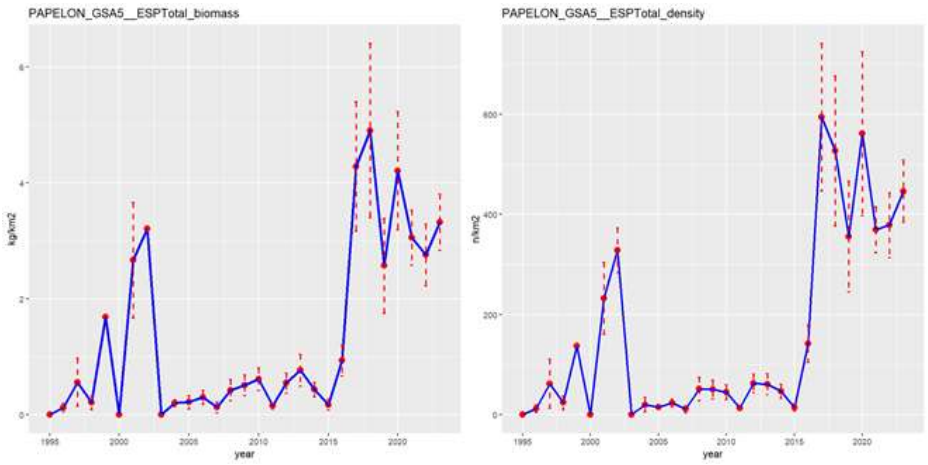
Figure 6.2.2.17 Deep-water rose shrimp in GSAs 5, 6 & 7: Survey periods of MEDITS in GSA 7.

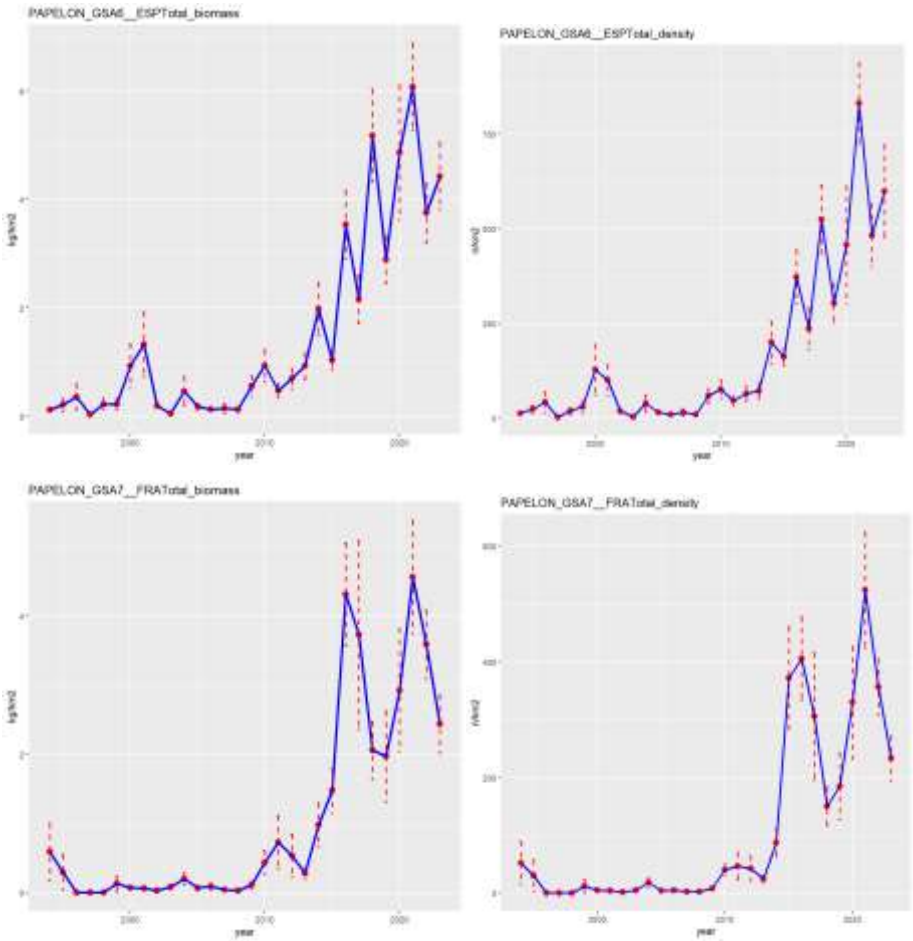


Source: Own elaborations

The biomass and abundance indexes in the three areas show a quite similar pattern having a sharp increase in the last 7-8 years (Figure 6.2.2.18). Abundance and biomass values in 2023 were higher than in 2022 in GSAs 5 and 6. Values reported in GSA5 before 2007 are derived from experimental hauls not following the MEDITS protocol.

Figure 6.2.2.18 Deep-water rose shrimp in GSAs 5, 6 & 7: Biomass (kg/km2) and abundance (n/km2) indices of deep-water rose shrimp in GSas 5, 6 and 7 as derived from trawl surveys (MEDITS, 1994-2023).

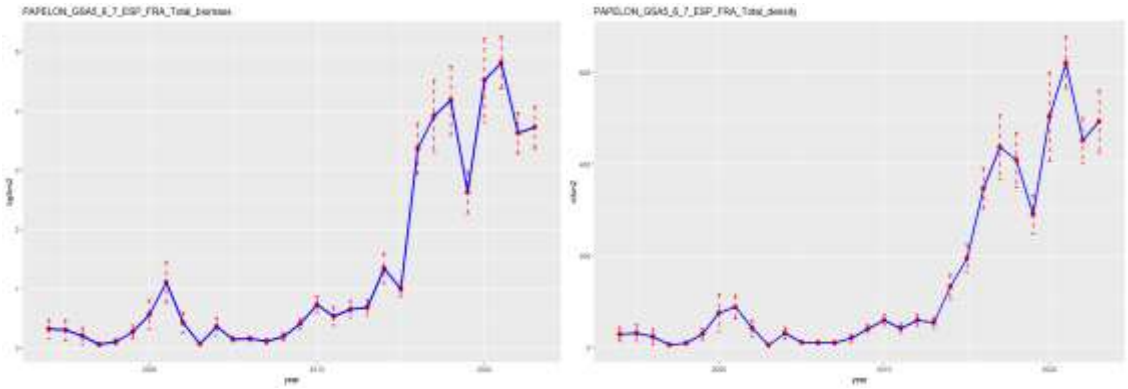




Source: Own elaborations

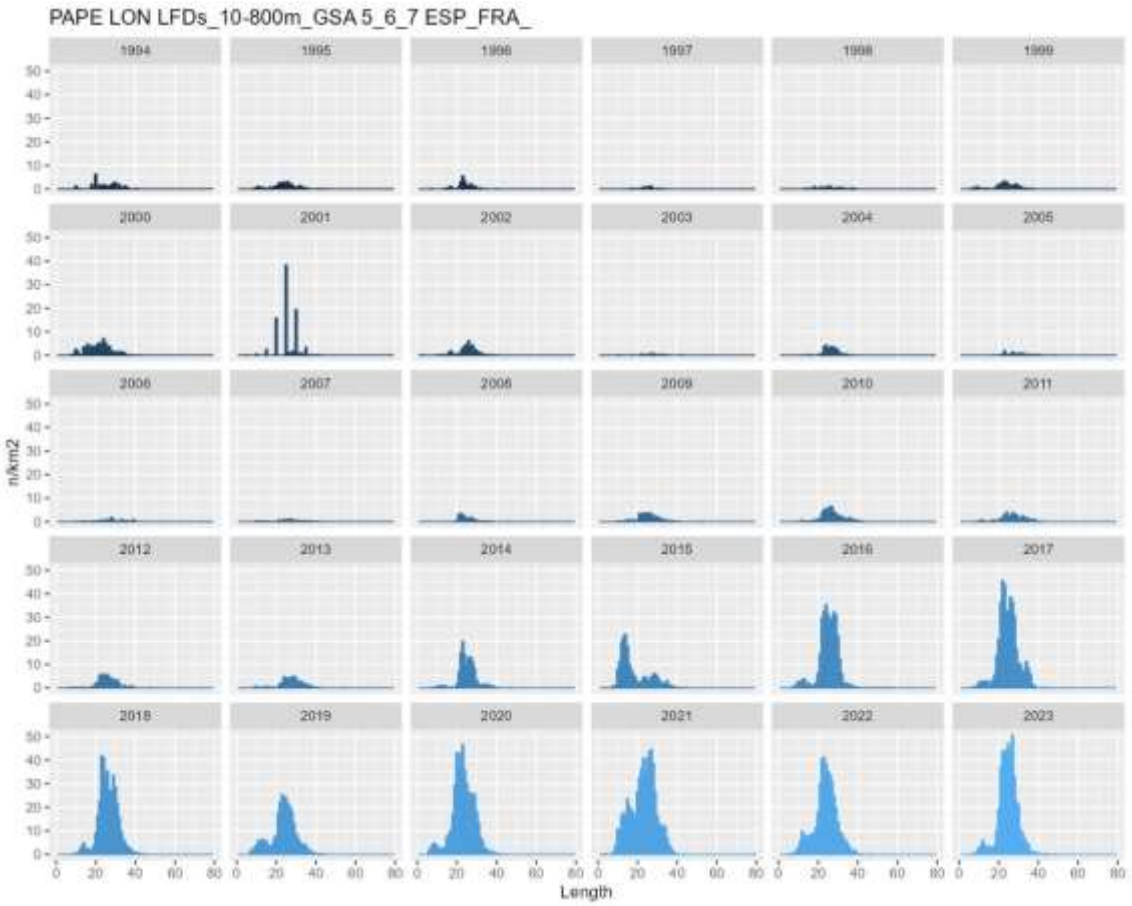
In Figures 6.2.2.19-20 the biomass and abundance indexes from the combined survey (GSAs 5, 6 and 7) and the standardized length frequencies distributions (n/km2) respectively are shown.

Figure 6.2.2.19 Deep-water rose shrimp in GSAs 5, 6 & 7: Biomass (kg/km2) and abundance (n/km2) indices of deep-water rose shrimp as GSAs combined index from trawl surveys (MEDITS, 1994-2023).



Source: Own elaborations

Figure 6.2.2.20 Deep-water rose shrimp in GSAs 5, 6 & 7: Combined sex size structure indices of deep-water rose shrimp in GSAs 5, 6 and 7 as derived from trawl surveys (MEDITS, 1994-2023).



Source: Own elaborations

6.2.2.3 Stock assessment

The present assessment of deep-water rose shrimp in GSAs 5, 6 and 7 has been based on a4a model. The a4a model is a flexible statistical catch at age stock assessment model, based on linear modelling techniques, not working by gear. The method was developed within FLR framework. This assessment is an update of EWG-23-09 assessment.

All the input data used were extracted and derived from the data collected through the official DCF Med&BS data call 2024.

The length data have been converted in age by a deterministic slicing method (l2a) available in the Fla4a package.

The set used in the slicing procedures are the ones shown in the section 6.2.2.1 having applied the 0.5 correction of the t0 values (applied both on commercial and surveys data) to match with the calendar year basis of the assessment.

The slicing has been carried out by sex combined for each of the GSA length frequencies distributions available and on the combined (by sex and areas) survey length frequencies distributions.

Catch, landings and discards weight have been computed as sum of the corresponding values by year and GSAs. Because from GSA7 France data only total landings were avilable those values have been added to the corresponding slots throught a vector of values by year.

Catch, landings and discards at age have been computed as sum of the corresponding values by year and GSAs.

Catch, landings and discards mean weight at age, maturity at age and natural mortality at age have been obtained as weighted mean of the corresponding values by GSAs with the associated catch number at age by GSA.

Harvest and natural mortality values before spawning have been set equal to 0.5 in all the GSAs

The formula applied are shown in Figure 6.2.2.21 as extracted directly from the script used.

Figure 6.2.2.21 Deep-water rose shrimp in GSAs 5, 6 & 7: Combining the stock objects of different GSAs.

```
## Merging stock object and adding France landings
FRA_land.flq <- FLQuant(c(0,0,3.77,6.21,3.42,2.38,4.26,13.68,42.89,46.60,37.22,24.53,102.48,118.22),
                        dimnames=list(age="all", year = (2008:2021)))

catch.totale <- catch(stk5)+ catch(stk6)+ catch(stk7)+FRA_land.flq
catch.n.totale <- catch.n(stk5)+catch.n(stk6)
catch.wt.totale <- (catch.wt(stk5)*catch.n(stk5) + catch.wt(stk6)*catch.n(stk6))/catch.n.totale

landings.totale <- landings(stk5)+ landings(stk6)+landings(stk7)+FRA_land.flq
landings.n.totale <- landings.n(stk5)+landings.n(stk6)
landings.wt.totale <- (landings.wt(stk5)*landings.n(stk5) + landings.wt(stk6)*landings.n(stk6))/landings.n.totale

discards.totale <- discards(stk5)+ discards(stk6)
discards.n.totale <- discards.n(stk6)

mat.totale <- (mat(stk5)*catch.n(stk5) + mat(stk6)*catch.n(stk6))/catch.n.totale
m.totale <- (m(stk5)*catch.n(stk5) + m(stk6)*catch.n(stk6))/catch.n.totale

stk <- FLStock(catch.n=catch.n.totale,catch.wt=catch.wt.totale,stock.wt=catch.wt.totale,
               landings.n=landings.n.totale,landings.wt=catch.wt.totale,
               discards.n=discards.n.totale,discards.wt=catch.wt.totale,
               mat=mat.totale,
                   harvest.spwn = harvest.spwn(stk5),m.spwn = m.spwn(stk5), m=m.totale,
                   catch=catch.totale,landings=landings.totale,discards=discards.totale)

units(catch(stk)) <- units(discards(stk)) <- units(landings(stk)) <- units(stock(stk)) <- 'tonnes'
units(catch.n(stk)) <- units(discards.n(stk)) <- units(landings.n(stk)) <- units(stock.n(stk)) <- '1000'
units(catch.wt(stk)) <- units(discards.wt(stk)) <- units(landings.wt(stk)) <- units(stock.wt(stk)) <- 'kg'
units(harvest(stk)) <- 'f'
units(m(stk)) <- 'm'
```

Source: Own elaborations

Finally, the whole stock object has been trimmed from 2008 onward just because the first landings/catch data available from GSA7 (Spain) start in that year.

A small sum of product correction (SoP) was needed in most years to raise the catch at age number to final production (Table 6.2.2.8).

Table 6.2.2.8 Deep-water rose shrimp in GSAs 5, 6 & 7: Sum of Product (SoP) applied by year to correct catch at age number in matching the correspondig total production.

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	1	1.05	1.1	1.06	1.05	1.06	1.1	1.14	1.12	1.05	1.04	1.1	1.12	1.09	1.05

Source: Own elaborations

In the following tables (Table 6.2.2.9-15) all the final input values are listed.

In Figures 6.2.2.31-32 the catch and index at age number respectively are showed. Finally in Figure 6.2.2.33 the complete input data are showed.

Table 6.2.2.9 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of catch (t) per year used in the assessment.

Year	Catch (t)
2008	44.29
2009	54.34
2010	82.55
2011	80.62
2012	96.60
2013	99.06
2014	146.80
2015	203.47
2016	558.42
2017	794.47
2018	1073.84
2019	799.14
2020	1300.29
2021	1346.05
2022	1570.16
2023	1734.44

Source: Own elaborations

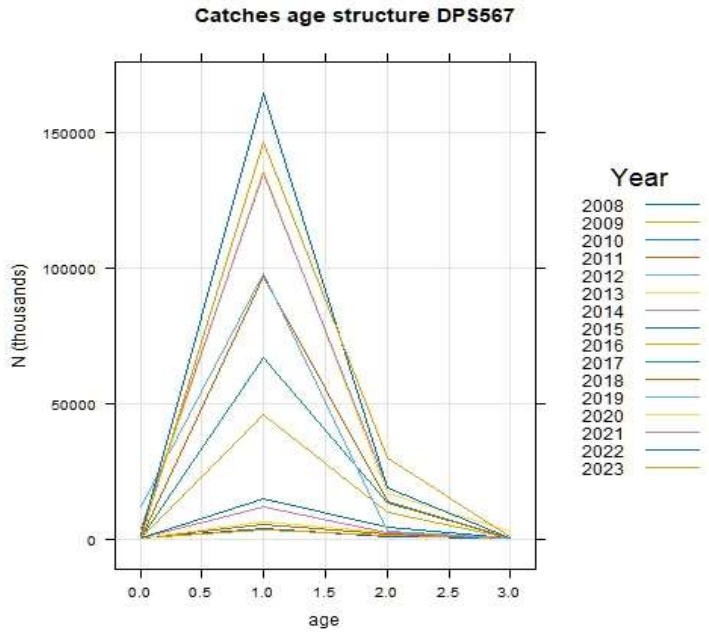
Table 6.2.2.10 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of catch at age number (*1000) per year used in the assessment.

	Catch at age number (*1000)			
Year	Age0	Age1	Age2	Age3+
2008	19.9	4050.8	498.7	29.6
2009	22.3	4123.9	1281.2	26.4

2010	25.5	4567.3	1284.8	45.2
2011	30.5	5144.8	1409.0	52.5
2012	39.3	6152.7	1601.5	59.0
2013	55.1	8094.7	1982.3	68.8
2014	84.8	11919.8	2734.3	88.3
2015	139.8	19339.2	4157.8	126.1
2016	237.5	32945.2	6605.3	193.6
2017	396.3	55058.2	10077.0	293.2
2018	604.4	85835.2	13661.4	394.0
2019	820.4	114360.1	16227.5	436.7
2020	966.0	136523.8	16945.6	407.2
2021	996.1	146422.3	18053.3	348.8
2022	932.9	145328.0	20371.7	332.0
2023	836.0	138330.8	23886.3	388.1

Source: Own elaborations

Figure 6.2.2.11 Deep-water rose shrimp in GSAs 5, 6 & 7: Catch at age numbers (*1000) used in the assessment.



Source: Own elaborations

Based on the catch at age pattern a Fbar range between age1 and age2 has been set.

Table 6.2.2.11 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of mean weight at age (kg) per year used in the assessment.

	Mean weight at age (kg)			
Year	Age0	Age1	Age2	Age3+
2008	0.002	0.009	0.018	0.029
2009	0.002	0.010	0.016	0.028
2010	0.002	0.010	0.017	0.032
2011	0.002	0.009	0.018	0.033
2012	0.002	0.009	0.017	0.031
2013	0.002	0.009	0.018	0.027
2014	0.002	0.009	0.017	0.027
2015	0.002	0.009	0.017	0.027
2016	0.002	0.009	0.016	0.029
2017	0.001	0.008	0.017	0.027
2018	0.002	0.009	0.016	0.027
2019	0.002	0.007	0.017	0.027
2020	0.002	0.007	0.016	0.030
2021	0.001	0.008	0.017	0.027
2022	0.002	0.008	0.016	0.027
2023	0.002	0.008	0.017	0.029

Source: Own elaborations

Table 6.2.2.12 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of maturity at age per year used in the assessment.

	Maturity at age			
Year	Age0	Age1	Age2	Age3+
2008	0	1	1	1
2009	0	1	1	1
2010	0	1	1	1
2011	0	1	1	1
2012	0	1	1	1
2013	0	1	1	1
2014	0	1	1	1
2015	0	1	1	1
2016	0	1	1	1
2017	0	1	1	1
2018	0	1	1	1
2019	0	1	1	1
2020	0	1	1	1
2021	0	1	1	1
2022	0	1	1	1
2023	0	1	1	1

Source: Own elaborations

Table 6.2.2.13 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of natural mortality at age per year used in the assessment.

	Natural mortality at age			
Year	Age0	Age1	Age2	Age3+
2008	2.103	1.051	0.844	0.770
2009	2.103	1.051	0.845	0.770
2010	2.103	1.051	0.845	0.771
2011	2.103	1.051	0.845	0.771
2012	2.103	1.052	0.845	0.771
2013	2.103	1.052	0.845	0.771

2014	2.103	1.052	0.845	0.771
2015	2.103	1.052	0.845	0.771
2016	2.103	1.052	0.845	0.771
2017	2.086	1.050	0.845	0.771
2018	2.103	1.050	0.845	0.771
2019	2.103	1.052	0.845	0.771
2020	2.103	1.052	0.845	0.771
2021	2.103	1.052	0.845	0.771
2022	2.103	1.052	0.845	0.771
2023	2.096	1.052	0.845	0.771

Source: Own elaborations

Table 6.2.2.14 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of harvest and natural mortality at age before spawning per year used in the assessment.

	Harvest and M before spawning at age			
Year	Age0	Age1	Age2	Age3+
2008	0.5	0.5	0.5	0.5
2009	0.5	0.5	0.5	0.5
2010	0.5	0.5	0.5	0.5
2011	0.5	0.5	0.5	0.5
2012	0.5	0.5	0.5	0.5
2013	0.5	0.5	0.5	0.5
2014	0.5	0.5	0.5	0.5
2015	0.5	0.5	0.5	0.5
2016	0.5	0.5	0.5	0.5
2017	0.5	0.5	0.5	0.5
2018	0.5	0.5	0.5	0.5
2019	0.5	0.5	0.5	0.5
2020	0.5	0.5	0.5	0.5
2021	0.5	0.5	0.5	0.5
2022	0.5	0.5	0.5	0.5

Source: Own elaborations

Table 6.2.2.15 Deep-water rose shrimp in GSAs 5, 6 & 7: Values of index number at age (n/km2) per year used in the assessment.

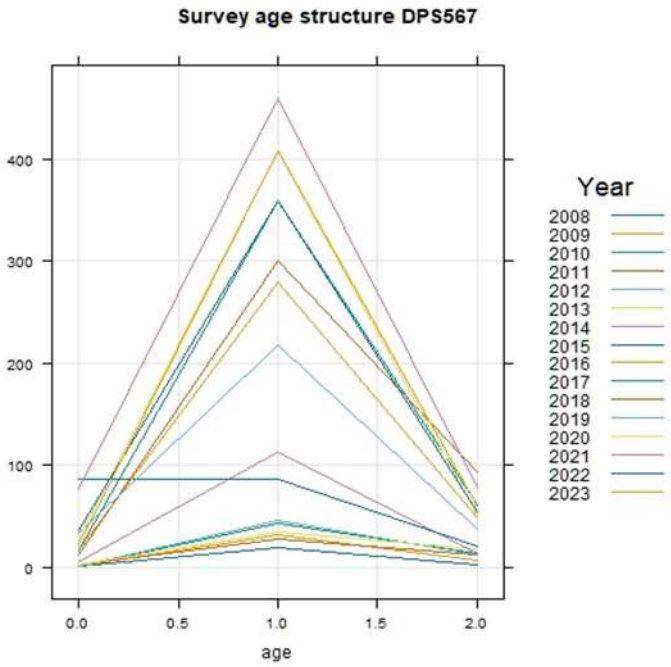
	Index at age (n/km2)		
year	Age0	Age1	Age2
2008	0.00	18.75	1.70
2009	1.26	31.97	7.00
2010	0.85	43.20	13.08
2011	1.68	27.42	11.59
2012	1.17	46.13	11.32
2013	1.83	33.86	17.45
2014	4.82	113.43	12.77
2015	86.05	85.71	19.87

2016	16.82	280.00	48.97
2017	15.65	360.03	60.69
2018	11.63	300.07	93.14
2019	33.25	217.31	37.59
2020	27.22	409.17	51.40
2021	76.29	460.98	77.77
2022	35.88	358.97	53.60
2023	21.86	408.28	59.54

Source: Own elaborations

The index has been trimmed at age 2 because it was considered as last true age to be used in tuning catches.

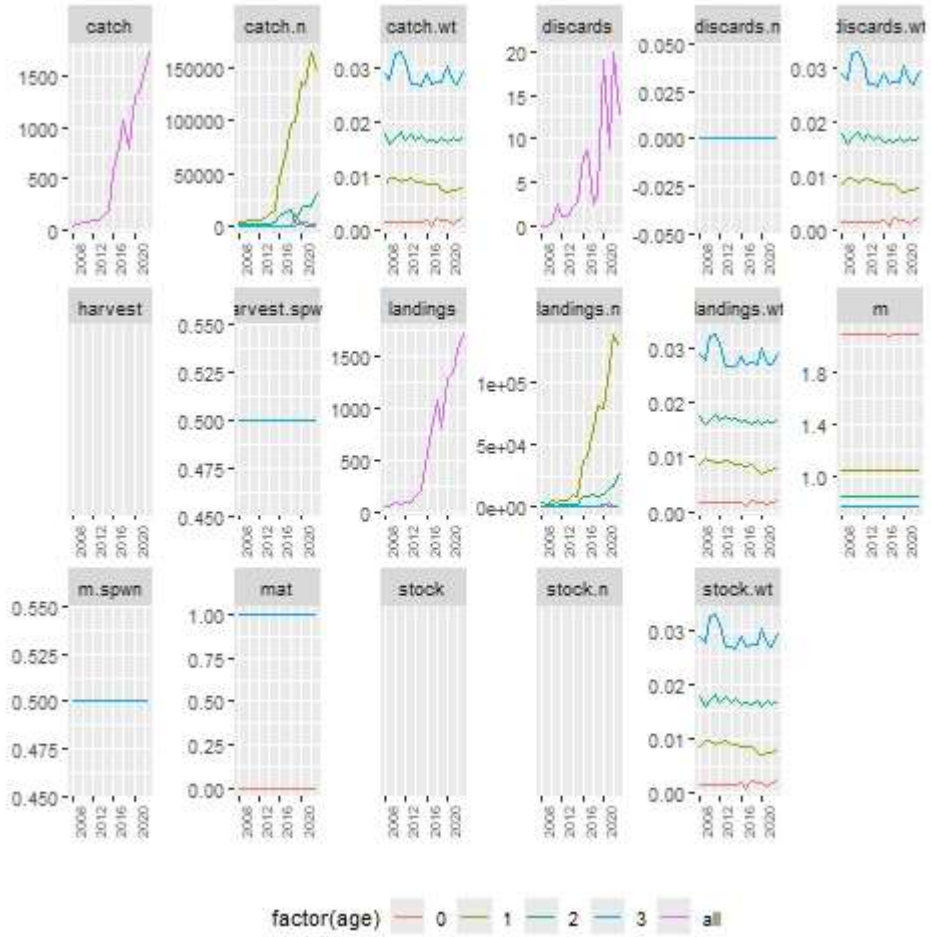
Figure 6.2.2.12 Deep-water rose shrimp in GSAs 5, 6 & 7: Index at age numbers (*1000) used in the assessment.



Source: Own elaborations

In 2015 the index at age number values are almost equal because it was the only year in which the amount of smaller individuals was higher than the following group (see Figure 6.2.2.12). Applying the t0 corrections splits the first modal group almost in half ending up with same values by Age0 and Age1.

Figure 6.2.2.13 Deep-water rose shrimp in GSAs 5, 6 & 7: the whole stock object inputs.



Source: Own elaborations

All the input stock objects have been created using the R scripts developed in the JRC and made available in the EWG2410 ftp. Below the version of R, Rstudio and Rpackages used in running the assessment:

R: 4.2.1

RStudio: 2023.06.1

FLCore: 2.6.20.9204

FLa4a: 1.8.2

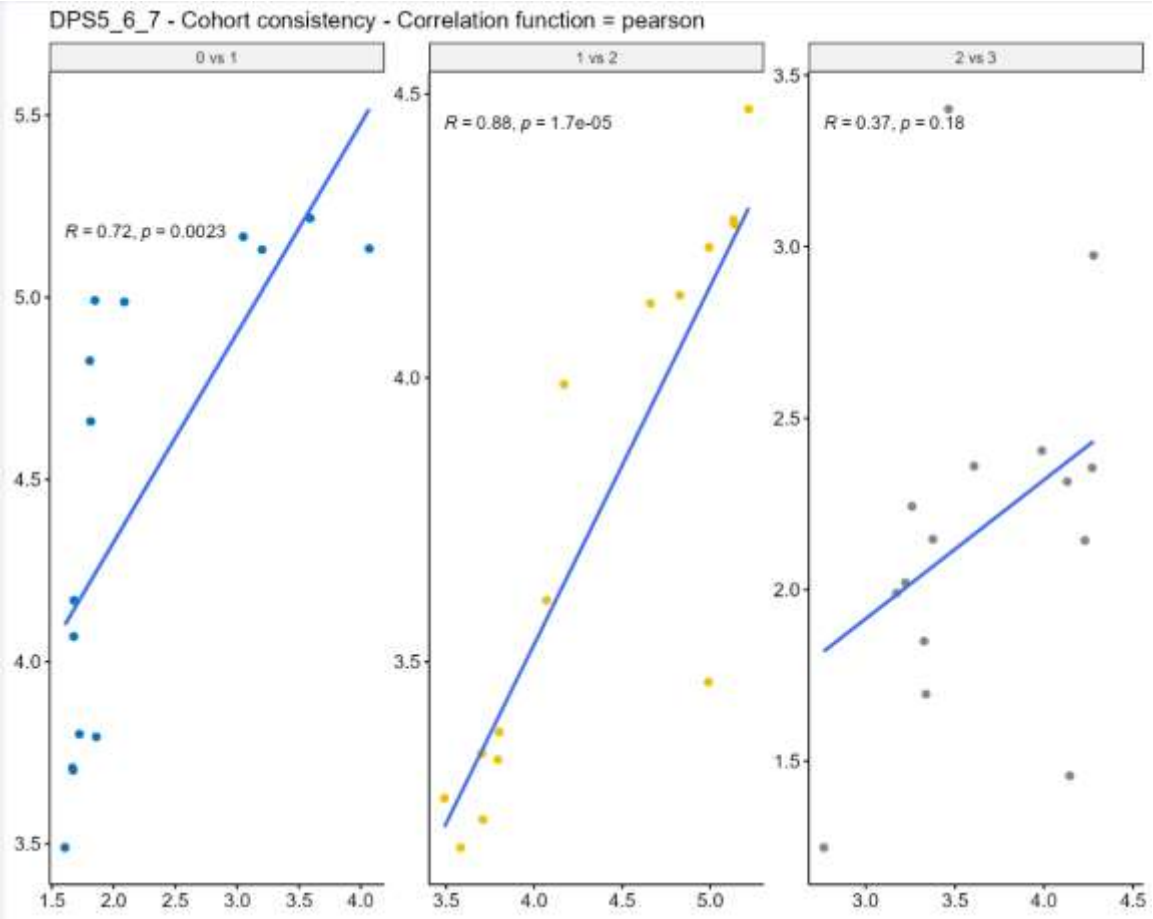
Flash: 2.5.11

FLBRP: 2.5.9.9025

Source: Own elaborations

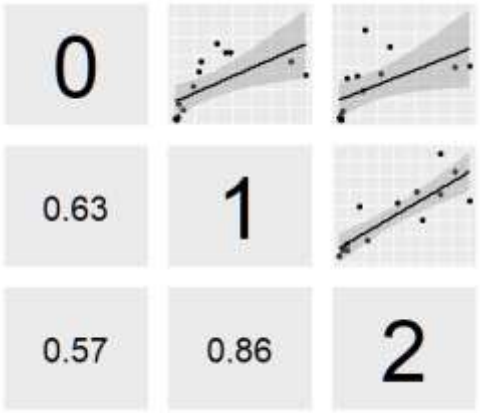
In Figures 6.2.2.14-15 Cohorts' internal consistency in the catch and in MEDITS index.

Figure 6.2.2.14 Deep-water rose shrimp in GSAs 5, 6 & 7: Catch at age numbers cohorts internal consistency.



Source: Own elaborations

Figure 6.2.2.15 Deep-water rose shrimp in GSAs 5, 6 & 7: Index number at age cohorts internal consistency.



Source: Own elaborations

EWG-23-09 updated the assessment carried out by EWG-23-09.
The model used is:

fmodel: ~factor(age) +s(year, k=5)
qmodel: list(~factor(replace(age, age > 1, 1)))
srmodel: ~s(year,k=5)
n1model: ~s(age, k = 3)
vmodel: catch: ~s(age, k = 3) index: ~1

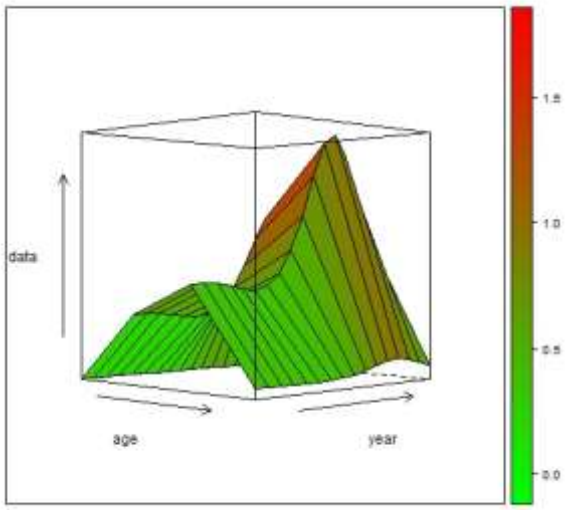
Summary of the model fit using the fitSumm command:

```
 fitSumm(fit)
            iters
                1
  nopar
2.200000e+01
  nlogl       1.086534e+02
  maxgrad     7.204680e-
07
  nobs        1.120000e+02
  gcv         8.780415e-01
```

convergence
0.000000e+00
accrate
NA
nlogl_comp1
6.069100e+01
nlogl_comp2
4.796230e+01

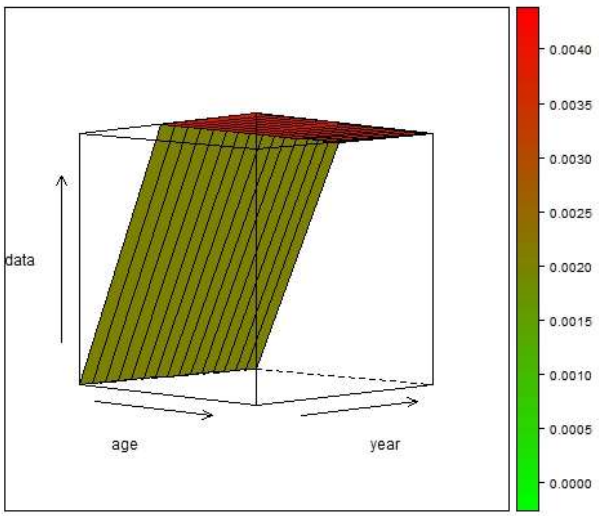
The results and diagnostics of the assessment model are shown below.

Figure 6.2.2.16 Deep-water rose shrimp in GSAs 5, 6 & 7: Harvest at age wireframe.



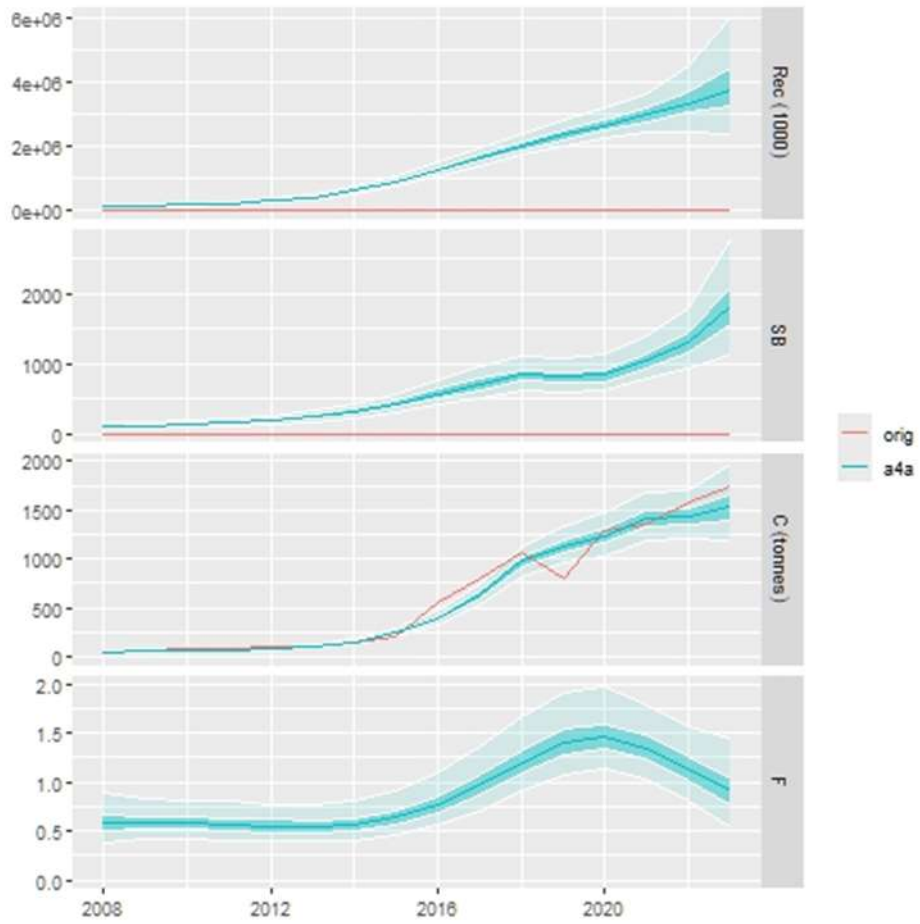
Source: Own elaborations

Figure 6.2.2.17 Deep-water rose shrimp in GSAs 5, 6 & 7: Survey Catchability at age wireframe



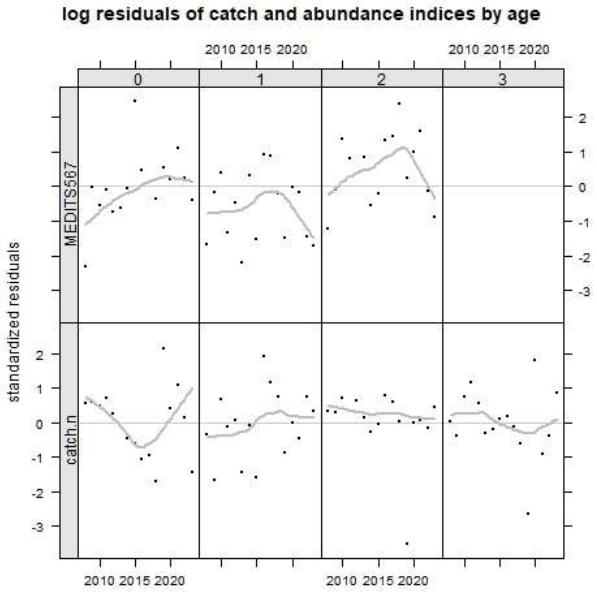
Source: Own elaborations

Figure 6.2.2.18 Deep-water rose shrimp in GSAs 5, 6 & 7: Results of the best a4a model. The observed catches are shown by the red line.



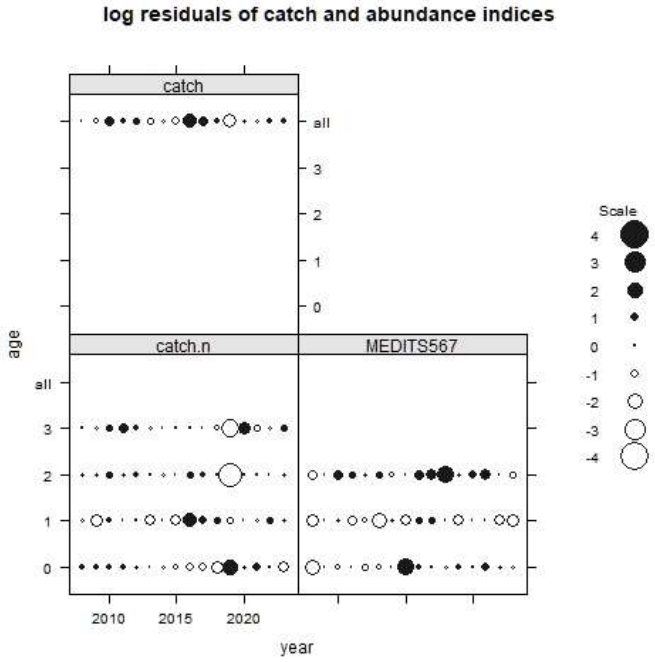
Source: Own elaborations

Figure 6.2.2.19 Deep-water rose shrimp in GSAs 5, 6 & 7: Log residuals of catch and abundance indices by age.



Source: Own elaborations

Figure 6.2.2.20 Deep-water rose shrimp in GSAs 5, 6 & 7: Bubble plot of the log residuals of catch and abundance indices by age.



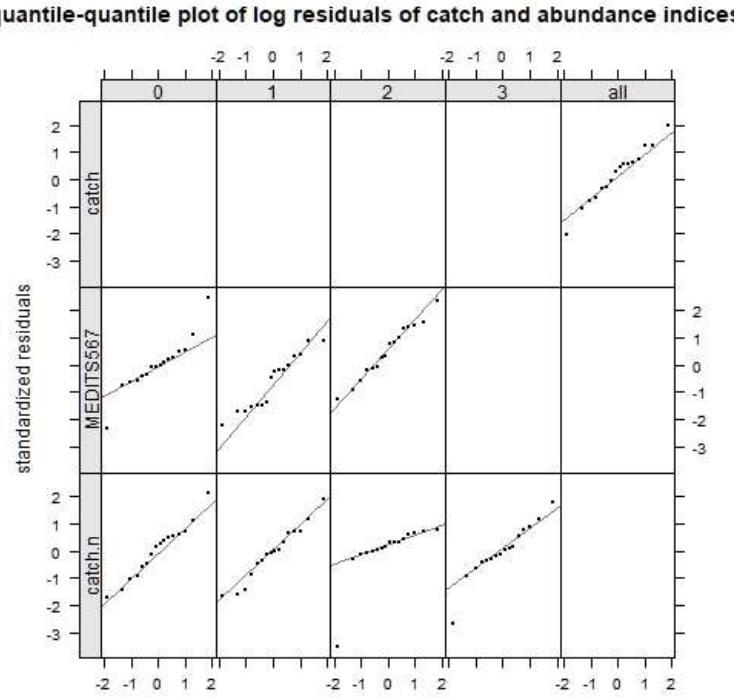
Source: Own elaborations

Table 6.2.2.16 Deep-water rose shrimp in GSAs 5, 6 & 7: Range of variation of minimum and maximum residuals values estimated.

Variable	Minimum_residual_value	Maximum_residual_value
Catch	-2.021	1.959
Catch_at_age	-3.529	2.132
Index_at-age	-2.336	2.466

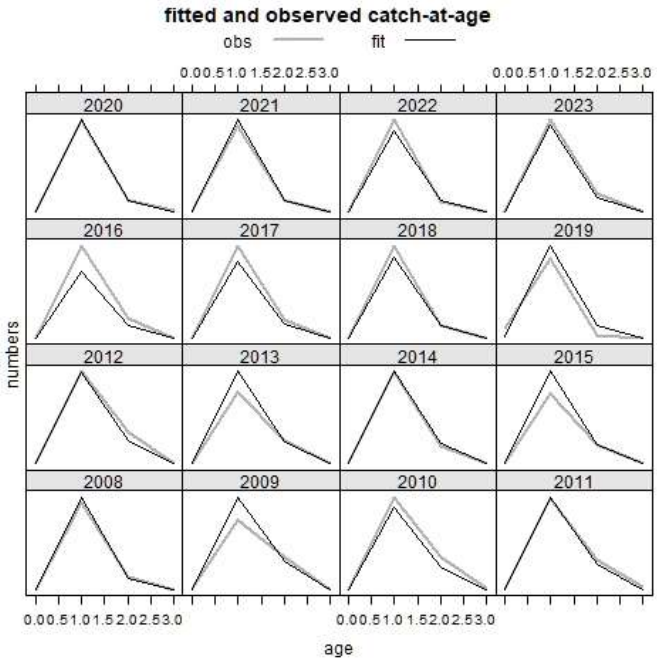
Source: Own elaborations

Figure 6.2.2.21 Deep-water rose shrimp in GSAs 5, 6 & 7: QQ-plot of the log residuals of catch and abundance indices by age.



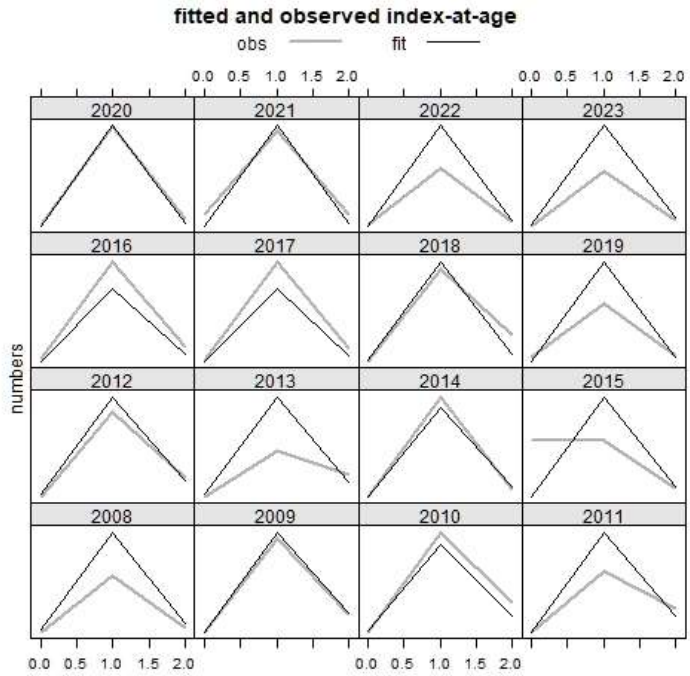
Source: Own elaborations

Figure 6.2.2.22 Deep-water rose shrimp in GSAs 5, 6 & 7: Fitting of the catch-at-age data.



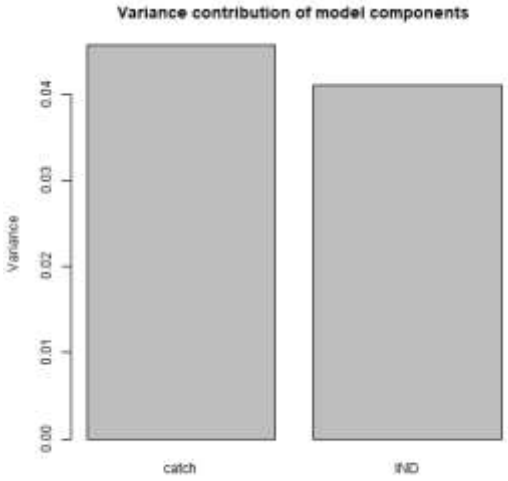
Source: Own elaborations

Figure 6.2.2.23 Deep-water rose shrimp in GSAs 5, 6 & 7: Fitting of the index-at-age data.



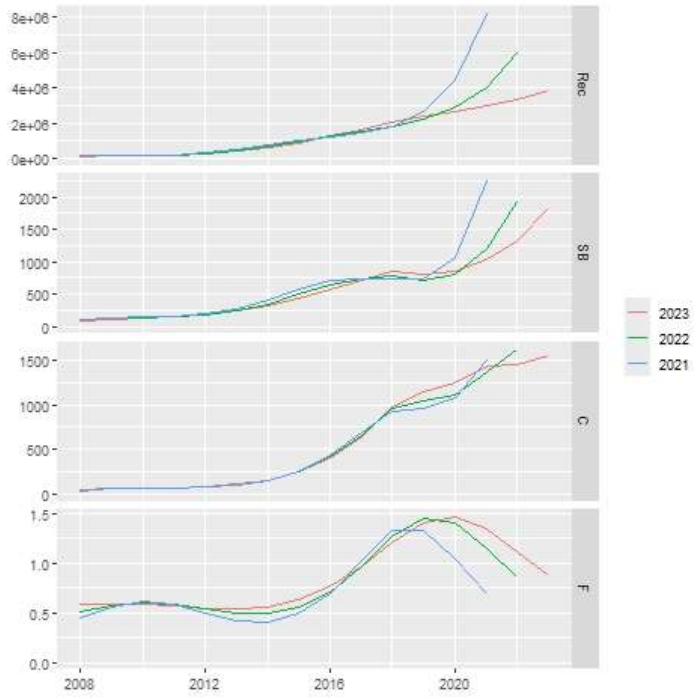
Source: Own elaborations

Figure 6.2.2.24 Deep-water rose shrimp in GSAs 5, 6 & 7: Variance contribution of model components: catches and survey.



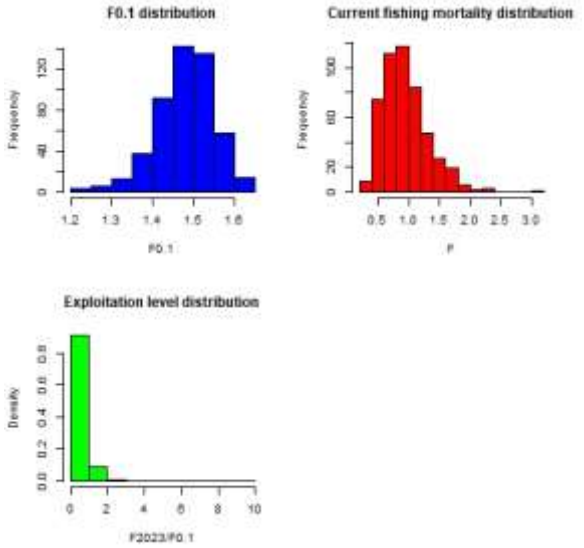
Source: Own elaborations

Figure 6.2.2.25 Deep-water rose shrimp in GSAs 5, 6 & 7: Retrospective analysis of the selected a4a model.



Source: Own elaborations

Figure 6.2.2.26 Deep-water rose shrimp in GSAs 5, 6 & 7: Histograms of probability for $F_{0.1}$, Fcurr and level of exploitation (Fcurr/F01 ratio) values.



Source: Own elaborations

Final assessment outcomes are given in Tables 6.2.2.17-19.

Table 6.2.2.17 Deep-water rose shrimp in GSAs 5, 6 & 7: Times series of the recruitment, SSB, catch and fishing mortality estimated by the model.

	Recruitment age0 ('000)	SSB(t)	Catch(t)	Fbar(1-2)	Total biomass
2008	138086.9	91.69	44.73	0.581	417.5
2009	153844.6	113.73	61.21	0.586	492.6
2010	177285.7	133.98	66.62	0.581	567.4
2011	217956.0	151.55	72.87	0.566	668.4
2012	289786.9	182.13	84.89	0.547	847.5
2013	412134.2	239.17	113.79	0.540	1169.2
2014	607398.4	310.85	154.98	0.563	1645.9
2015	890126.0	430.12	245.40	0.634	2389.6
2016	1249603.1	571.68	396.96	0.767	3490.6

2017	1643278.0	706.07	637.98	0.968	3138.7
2018	2018810.7	840.67	975.83	1.208	6483.8
2019	2350961.1	809.97	1136.39	1.409	6454.5
2020	2657242.0	842.10	1237.43	1.467	7386.8
2021	2981100.3	1047.65	1422.95	1.349	6706.9
2022	3362500.7	1310.14	1446.46	1.120	9772.1
2023	3816789.5	1835.59	1552.06	0.882	12421.7

Source: Own elaborations

Table 6.2.2.18 Deep-water rose shrimp in GSAs 5, 6 & 7: Stock numbers at age.

	Age0	Age1	Age2	Age3+
2008	138086.9	16645.4	1416.2	679.6
2009	153844.6	16848.6	3620.0	600.9
2010	177285.7	18769.9	3651.0	1038.3
2011	217956.0	21630.1	4085.7	1238.6
2012	289786.9	26608.8	4764.3	1436.8
2013	412134.2	35362.0	5950.9	1697.1
2014	607398.4	50290.3	7952.2	2088.6
2015	890126.0	74111.2	11089.2	2661.2
2016	1249603.1	108614.8	15425.7	3397.3
2017	1643278.0	152475.1	20279.2	4115.8
2018	2018810.7	203859.3	24220.8	4480.3
2019	2350961.1	246240.9	26601.7	4301.1
2020	2657242.0	286663.5	27249.6	3860.2
2021	2981100.3	324002.7	30239.8	3578.2
2022	3362500.7	363593.6	37658.1	4057.6
2023	3816789.5	410324.9	50920.9	5955.2

Source: Own elaborations

Table 6.2.2.19 Deep-water rose shrimp in GSAs 5, 6 & 7: Fishing mortality at age.

	Age0	Age1	Age2	Age3+
2008	0.000	0.474	0.688	0.064
2009	0.000	0.478	0.693	0.065
2010	0.000	0.474	0.688	0.064
2011	0.000	0.462	0.670	0.063
2012	0.000	0.446	0.647	0.060
2013	0.000	0.441	0.639	0.060
2014	0.000	0.460	0.667	0.062
2015	0.000	0.517	0.750	0.070
2016	0.000	0.626	0.908	0.085

2017	0.001	0.790	1.146	0.107
2018	0.001	0.986	1.431	0.134
2019	0.001	1.150	1.668	0.156
2020	0.001	1.197	1.737	0.162
2021	0.001	1.101	1.597	0.149
2022	0.001	0.914	1.326	0.124
2023	0.001	0.720	1.044	0.098

Source: Own elaborations

6.2.2.4 Reference Points

The STECF EWG recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the assessment.

Values of $F_{0.1}$ calculated by FLBRP package on the a4a assessment results is equal to 1.488. Current F values (2023), as calculated by model a4a, is 0.882 indicating that the stock is in underfishing conditions (Fcurr/ $F_{0.1}$=0.593). Because the stock shows an increasing trend in biomass in the las years and considering that it is the third year this stock has been assessed, the EWG agreed not to run any procedures to estimate biomass reference points.

6.2.2.5 Short term Forecast and Catch Options

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the stock assessment.

An average of the last three years has been used for weight at age, maturity at age, natural mortality at age and selectivity at age while the F_{bar} = 0.882 terminal F (2023) from the a4a assessment was used for F in 2024. Recruitment is in a clear increasing phase over the period of the assessment so the geometric mean across the last three years has been used as an estimate of recruits from 2024.

Table 6.2.2.20 Deep-water rose shrimp in GSAs 5, 6 & 7: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-2 (2024)	0.882	Fsq = F in the last year
SSB (2024)	2142.301	SSB intermediate year from STF output
Rage0 (2024,2025)	3369605.53	Recruitment will be set as geometric mean of the last 3 years
Total Catch (2024)	1797.563	Catch intermediate year from STF output
Fbar (2019)	1.409	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Source: Own elaborations

The analysis, carried out with the ad-hoc script developed by JRC and made available o the EWG, shows that fishing at a level equal to $F_{0.1}$ (=1.488) would reduce biomass by 33.2% from 2024 to 2026, while increasing catches by 56.0% from 2023 to 2025.

Table 6.2.2.20 Deep-water rose shrimp in GSAs 5, 6 & 7: Short term forecast table.

Rationale	Ffactor	Fbar	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	1.69	1.488	1797.6	2421.3	2142.3	1430.1	-33.2	56.0
F upper	2.29	2.016	1797.6	2831.5	2142.3	1070.6	-50.0	82.4
F lower	1.12	0.986	1797.6	1873.6	2142.3	1962.3	-8.4	20.7
FMSY transition	1.69	1.488	1797.6	2421.3	2142.3	1430.1	-33.2	56.0
Zero catch	0	0	1797.6	0.0	2142.3	4248.5	98.3	-100.0
Status quo	1	0.882	1797.6	1734.9	2142.3	2107.0	-1.6	11.8
Different Scenarios	0.1	0.088	1797.6	231.4	2142.3	3928.7	83.4	-85.1
	0.2	0.176	1797.6	447.2	2142.3	3639.6	69.9	-71.2
	0.3	0.265	1797.6	648.4	2142.3	3378.0	57.7	-58.2
	0.4	0.353	1797.6	836.4	2142.3	3141.0	46.6	-46.1
	0.5	0.441	1797.6	1011.9	2142.3	2925.9	36.6	-34.8
	0.6	0.529	1797.6	1176.1	2142.3	2730.5	27.5	-24.2
	0.7	0.617	1797.6	1329.7	2142.3	2552.6	19.2	-14.3
	0.8	0.706	1797.6	1473.6	2142.3	2390.5	11.6	-5.1
	0.9	0.794	1797.6	1608.4	2142.3	2242.4	4.7	3.6
	1.1	0.970	1797.6	1853.6	2142.3	1983.0	-7.4	19.4
	1.2	1.058	1797.6	1965.0	2142.3	1869.2	-12.7	26.6
	1.3	1.146	1797.6	2069.9	2142.3	1764.5	-17.6	33.4
	1.4	1.235	1797.6	2168.5	2142.3	1668.2	-22.1	39.7
	1.5	1.323	1797.6	2261.3	2142.3	1579.2	-26.3	45.7
	1.6	1.411	1797.6	2348.8	2142.3	1497.1	-30.1	51.3
	1.7	1.499	1797.6	2431.3	2142.3	1421.0	-33.7	56.7
	1.8	1.587	1797.6	2509.2	2142.3	1350.4	-37.0	61.7
	1.9	1.676	1797.6	2582.8	2142.3	1284.8	-40.0	66.4
	2	1.764	1797.6	2652.4	2142.3	1223.7	-42.9	70.9

Source: Own elaborations

*SSB at mid year

EWG advises that when the MSY approach is applied, catches in 2025 should be no more than 2421.3 tonnes.

6.3 Red mullet in GSA 1

6.3.1 Stock Identity and Biology

Red mullet (*Mullus barbatus*) is among the most important target species for the trawl fisheries but is also caught with set gears, in particular trammel nets (about the 30% of the catches). From official data, the total trawl fleet of the geographical sub area GSA 1 (Northern Alboran Sea region) is composed by about 170 boats (data compiled in EWG 22-09). Smaller vessels operate almost exclusively on the continental shelf (targeting red mullets, octopus, hake and sea breams), bigger vessels operate almost exclusively on the continental slope (targeting decapod crustaceans) and the remaining can operate indistinctly on the continental shelf and slope fishing grounds. Red mullet is intensively exploited during its recruitment from August to November.

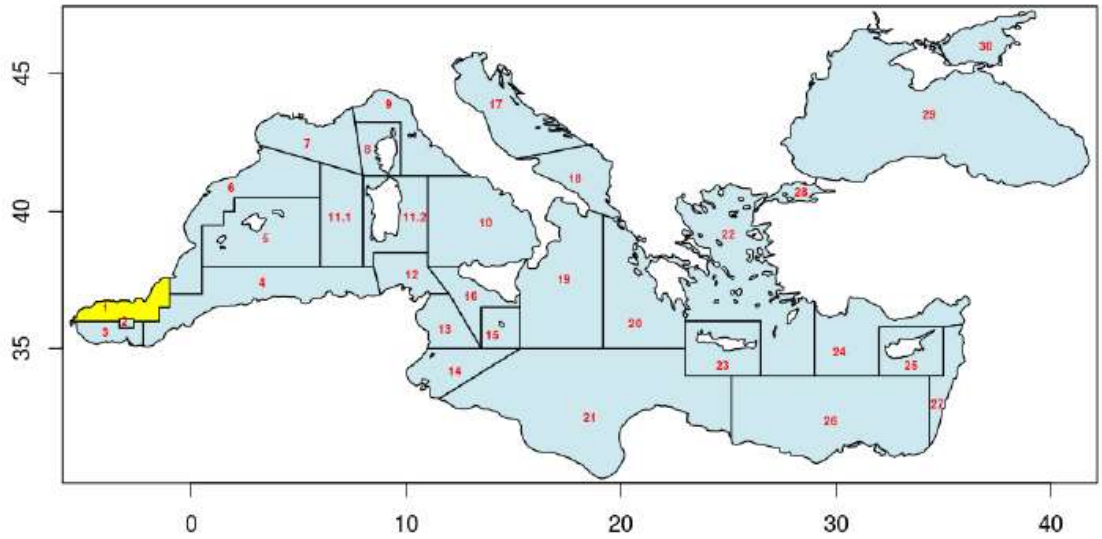


Figure 6.3.1.1 Red mullet in GSA 1: Location of GSA 1 in the Mediterranean Sea.

Trawl fisheries in GSA 1 are regulated by “Oren AAA/2808/2012” published in the Spanish Official Bulletin (BOE nº 313 29 December 2012) containing an Integral Management Plan for Mediterranean fishery resources. Fisheries are subject to the traditional fisheries regulations already in place (e.g. the daily and weekly fishing effort limited to 12 hours per day five days a week; trawl cod end 40 mm square mesh or 50 mm diamond stretched mesh; engine power of maximum 373 kW; license system; minimum landing size of 11 cm TL). Minimum landing size for red mullet is established at 11 cm TL from the CE Regulation 1967/2006. Currently this species is included in the regulatory EU MAP body (EU No 508/2014 and Orden APA, 423/2020).

Growth

The Von Bertallanfy growth parameters estimated within the Spanish DCF considered to have a very low t0, (STECF EWG 12 02) and thus, the STECF EWG 19 10 decided to use the ones selected during EWG 15 06 meeting. This year, in contrary with previous EWG decisions, and after further analysis it was decided not to use a t0 correction of 0.5 to perform the deterministic age slicing of catch data; the t0 correction was instead used to age slice the survey LFDs

Table 6.3.1.1 Red mullet in GSA 1: Von Bertallanfy growth parameters

Parameter	Value
L_{inf}	34.5
k	0.34
t_0	-0.1431

Length-weight reationship

Length weight parameters (a=0.0102, b=3.03) were derived from Spanish DCF for the year 2007 for sexes combined and total length expressed in cm. used in EWG 21-11.

Natural mortality

A vector of natural mortality was estimated by Chen & Watanabe method (Chen S. & Watanabe S., 1989) using growth and length-weight relationship parameters for sex combined.

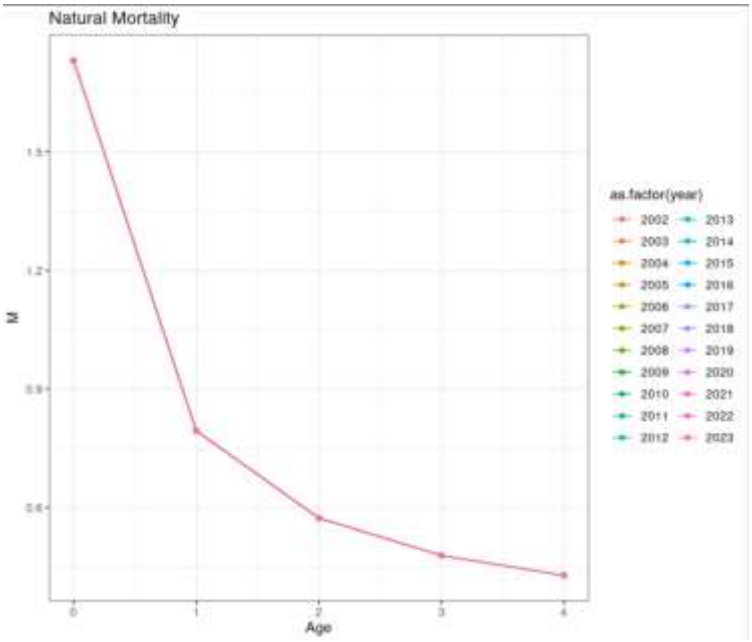


Figure 6.3.1.2 Red mullet in GSA 1: Natural mortality estimated from the parameters presented in the **Table 6.3.1.2**

Maturity

The species reaches sexual maturity at one year old. The vector of maturity at age was provided by the experts of the EWG 23–09, in line with the previous assessments.

Table 6.3.1.2 Red mullet in GSA 1: natural mortality and maturity vector at age.

Age	Maturity	M
1	1	0.79
2	1	0.57
3	1	0.47
4+	1	0.42

6.3.2 Data

6.3.2.1 CATCH (LANDINGS AND DISCARDS)

Principal fishing gears used to catch red mullet in GSA 1 together with other species (mixed catches) are trammel nets (GTR) and bottom trawls (OTB).

Landings: Missing LFDs were reconstructed for the two main fleets (GTR and OTB) with catches of MUT in GSA1. Discards: LFDs were available for 2003-2022 for OTB_DEMSP. The median was used to reconstruct discards LFD for the two metiers OTB_NA and OTB_MDD. No discards are reported for GTR and they can be considered negligible.

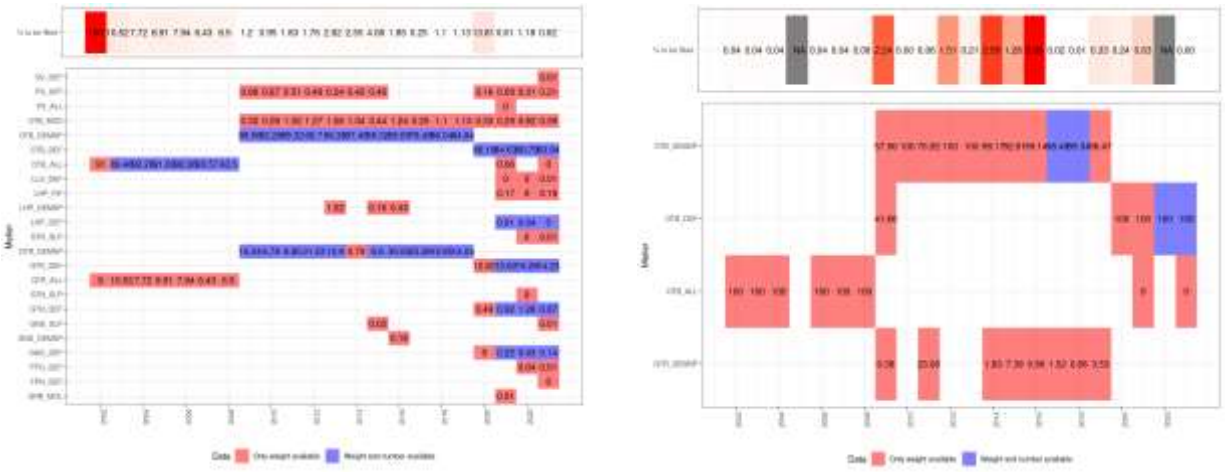


Figure 6.3.2.1.1 Red mullet in GSA 1: Summary of the reconstruction of landings and discards data carried by EWG 24-10.

Table 6.3.2.1.1 Red mullet in GSA 1: History of commercial landings and discards; official reported values are presented. Catches are used in the stock assessment. All weights are in tonnes.

Year	Landings	Discards	Catch
2005	140.21	0	140.21
2007	194.01	0	194.01
2008	193.65	0.16	193.81
2009	228.37	1.09	229.46
2010	201.65	0.01	201.66
2011	201.18	0.13	201.31
2012	107.31	1.65	108.96
2013	131.63	0.28	131.91
2014	123.87	3.28	127.15
2015	135.9	1.76	137.66
2016	260.49	7.61	268.1
2017	274.67	3.48	278.15
2018	170.23	2.79	173.02
2019	124.63	0.4	125.03
2020	107.32	0.26	107.58
2021	153.05	0.97	154.03
2022	164.96	5.51	170.47
2023	194.17	11.2	205.37

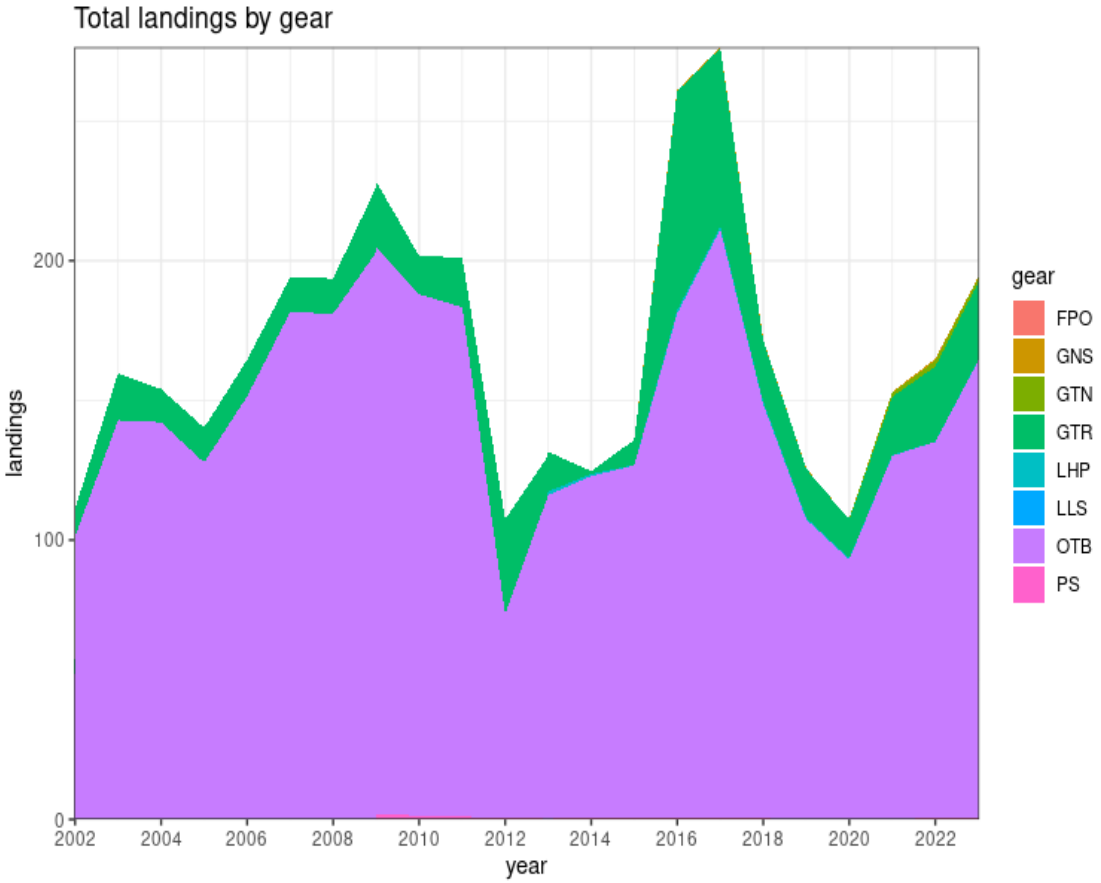


Figure 6.3.2.1.2 Red mullet in GSA 1: Landings (t) of red mullet in GSA 1 in the period from 2002 to 2023 by fishing gear and fishery.

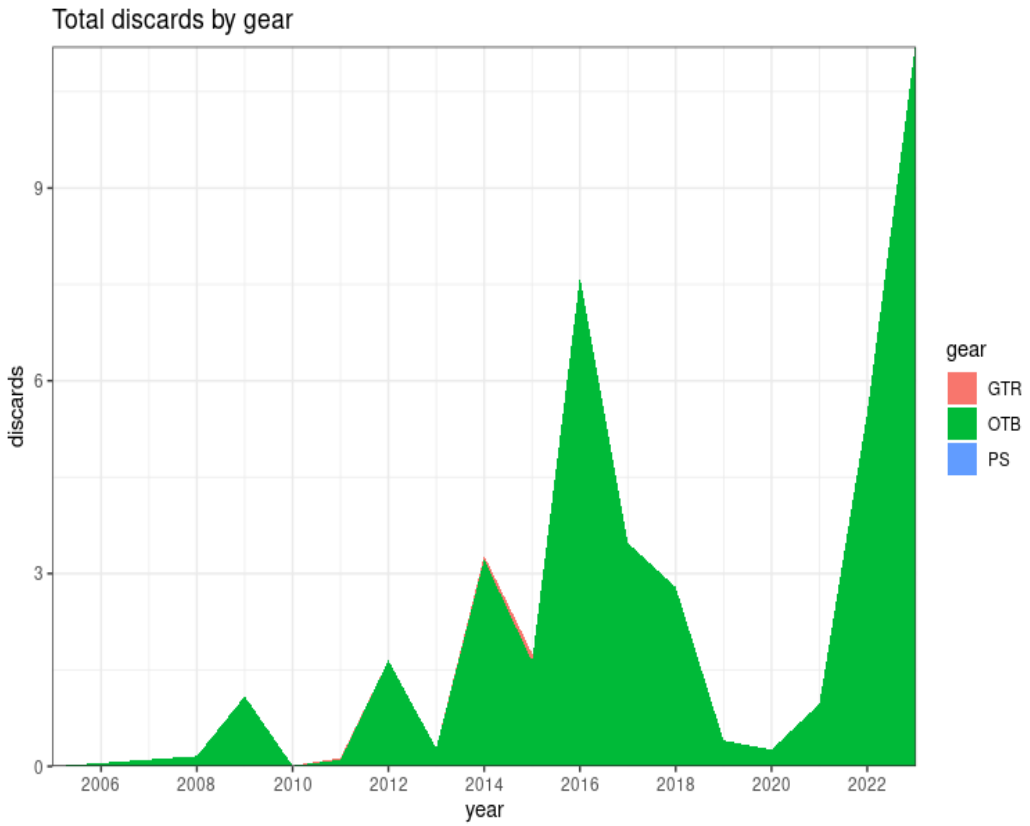


Figure 6.3.2.1.3 Red mullet in GSA 1: Discards (t) of red mullet in GSA 1 in the period from 2002 to 2022 by fishing gear and fishery.

Length structure of red mullet catches (landings and discards) for all gears in the period from 2002 to 2023 are shown in Figures 6.3.2.1.4 - 6.3.2.1.5 for landings and discards respectively. Reconstructed Length structure of red mullet catches (landings and discards) for all gears in the period from 2002 to 2023 are shown in Figures 6.3.2.1.6 - 6.3.2.1.7 for landings and discards respectively. Final length catches structure of red mullet are shown in Figure 6.3.2.1.8.

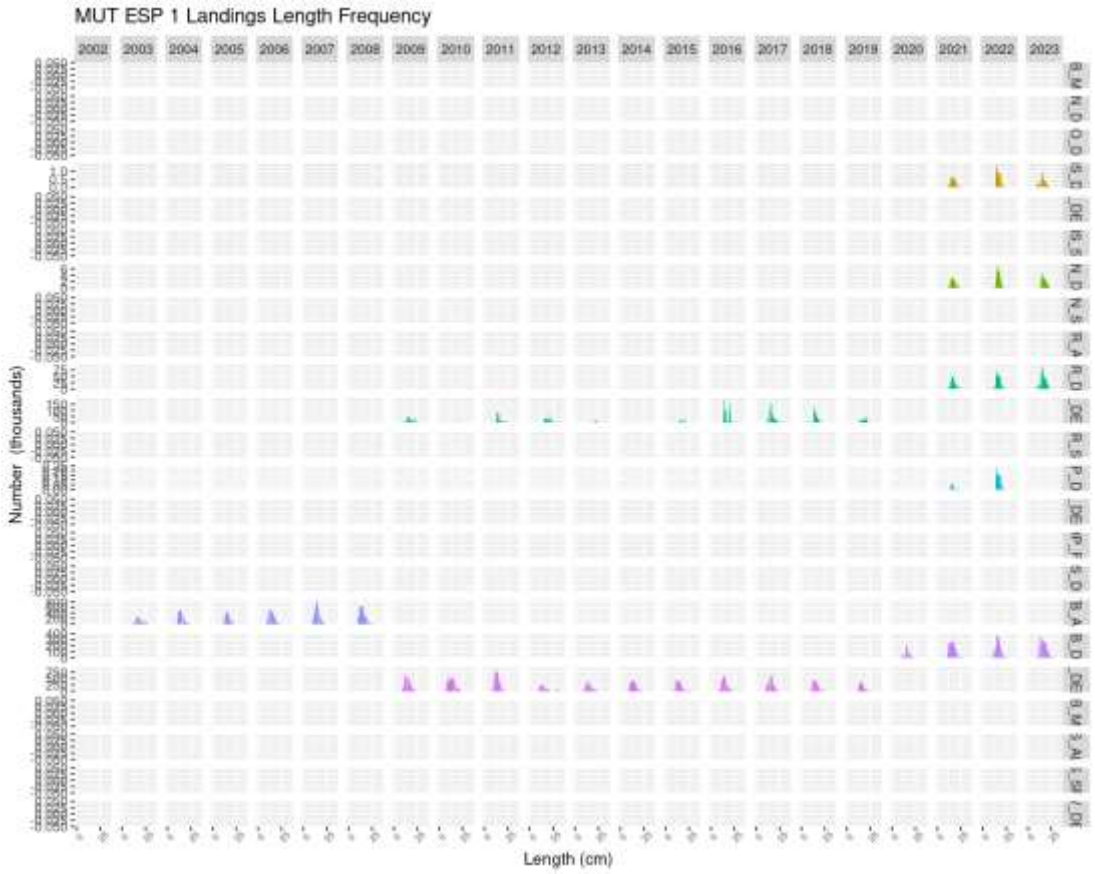


Figure 6.3.2.1.4 Red mullet in GSA 1: Length structure of red mullet landed in GSA 1 in the period from 2002 to 2023 by fishing gear and fishery.

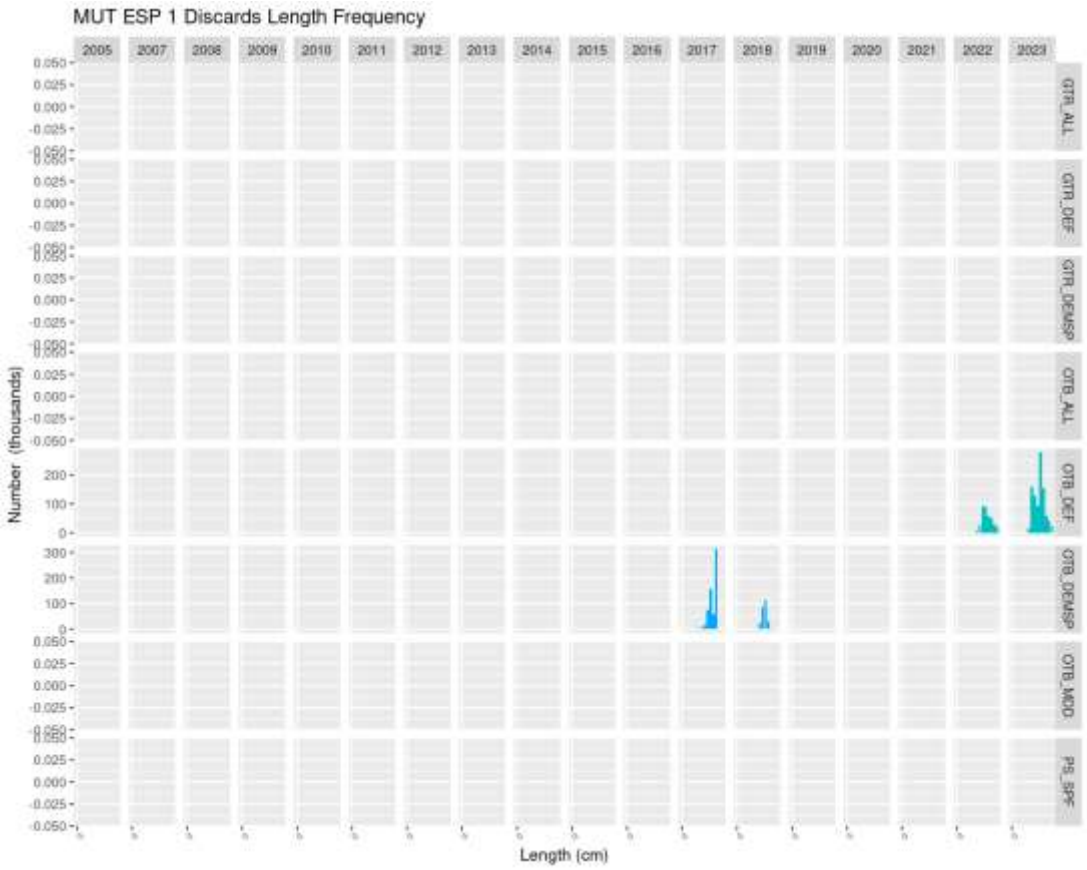


Figure 6.3.2.1.5 Red mullet in GSA 1: Length structure available of red mullet discards in GSA 1 in the period from 2006 to 2023 by fishing gear and fishery.

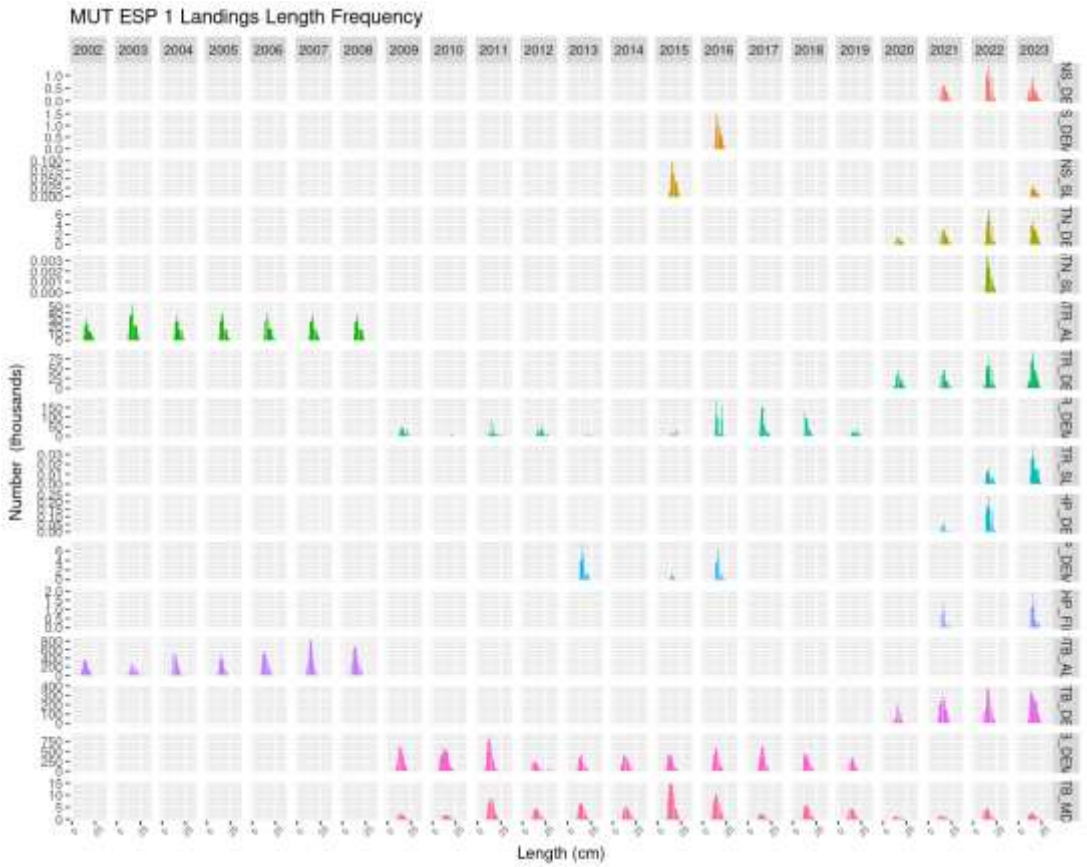


Figure 6.3.2.1.6 Red mullet in GSA 1: Length structure of red mullet landed in GSA 1 in the period from 2002 to 2023 by fishing gear and fishery as reconstructed by EWG 24-10.

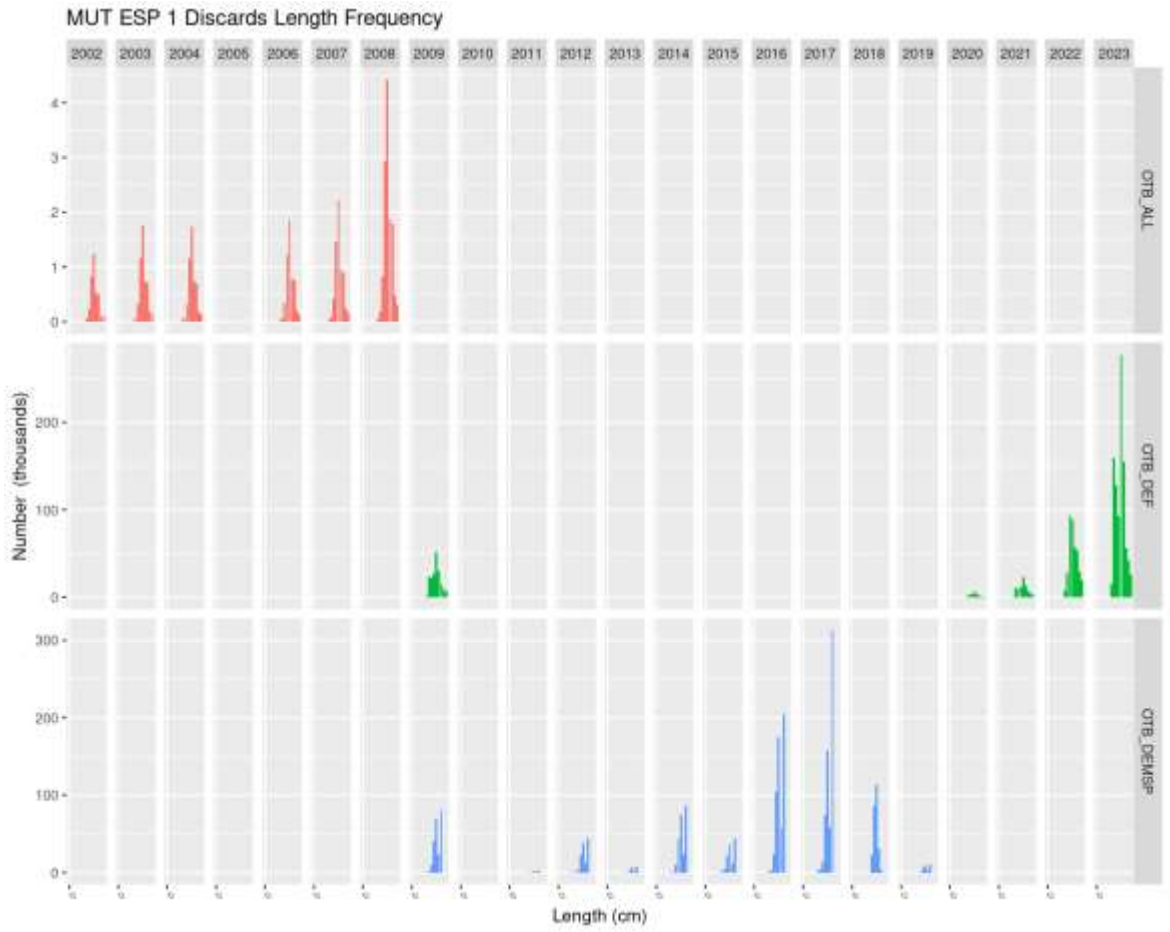


Figure 6.3.2.1.7 Red mullet in GSA 1: Length structure of red mullet catch discarded in GSA 1 in the period from 2002 to 2023 by fishing gear and fishery as reconstructed by EWG 24-10.

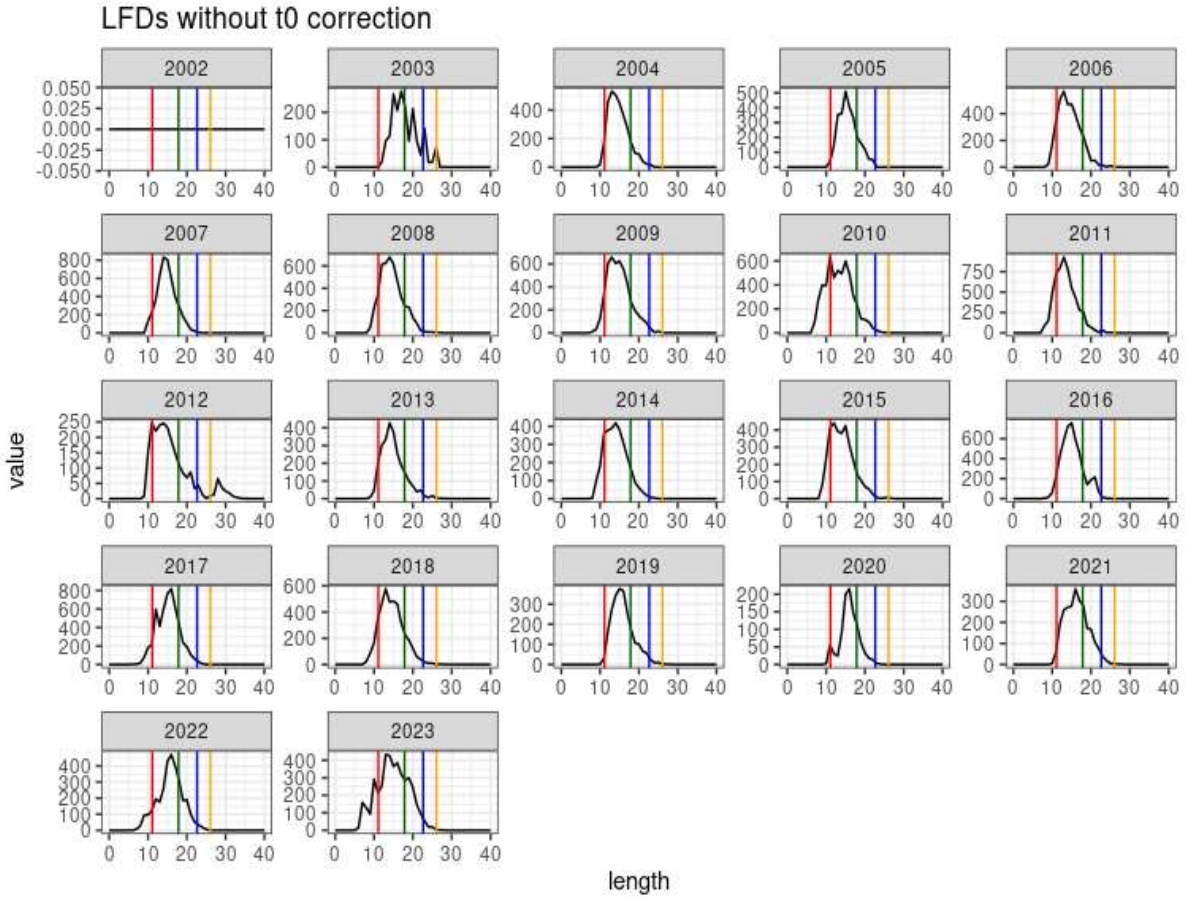


Figure 6.3.2.1.8 Red mullet in GSA 1. Total catch length frequency distribution, by year (TL cm). Vertical lines represent the length at age for age 1 (red), age 2 (green), age 3 (blue) and age 4 (orange).

6.3.2.2 EFFORT

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.3.2.3 SURVEY DATA

Since 1994, MEDITS trawl surveys have been carried out during the end of spring –beginning of the summer season, as part of the DCF National Program (Figure 6.3.2.3.1). In the current assessment, for the a4a method, MEDITS data from 2002 onwards were used.

The sampling design of MEDITS is random stratified sampling with number of hauls by stratum proportional to stratum surface. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Only hauls noted as valid were used, including stations with no catches (zero catches are included). Based on the DCF data call, abundance and biomass indices were calculated.

Observed abundance and biomass indices of Red mullet are given on the figures below (Figures 6.3.2.3.1). Both estimated abundance and biomass indices show similar stable trends throughout the years with a peak through years 2006 -2009-2021. Length frequency distributions are given on the figures below 6.3.2.3.4/5/6).

MEDITS survey in GSA 1 in 2020 was not carried out due to the COVID pandemic, therefore abundance and biomass indices for this year are added in the a4a analysis as NAs. A significant increase in the MEDITS indices in GSA1 for Red mullet has been observed in the year 2021.

Figure 6.3.2.3.1 Red mullet in GSA 1: Survey periods of MEDITS in GSA 1.



Figure 6.3.2.3.2 Red mullet in GSA 1: Abundance indices (Density, n/km^2) of red mullet in GSA 1 as derived from trawl surveys (MEDITS, 1994-2023).

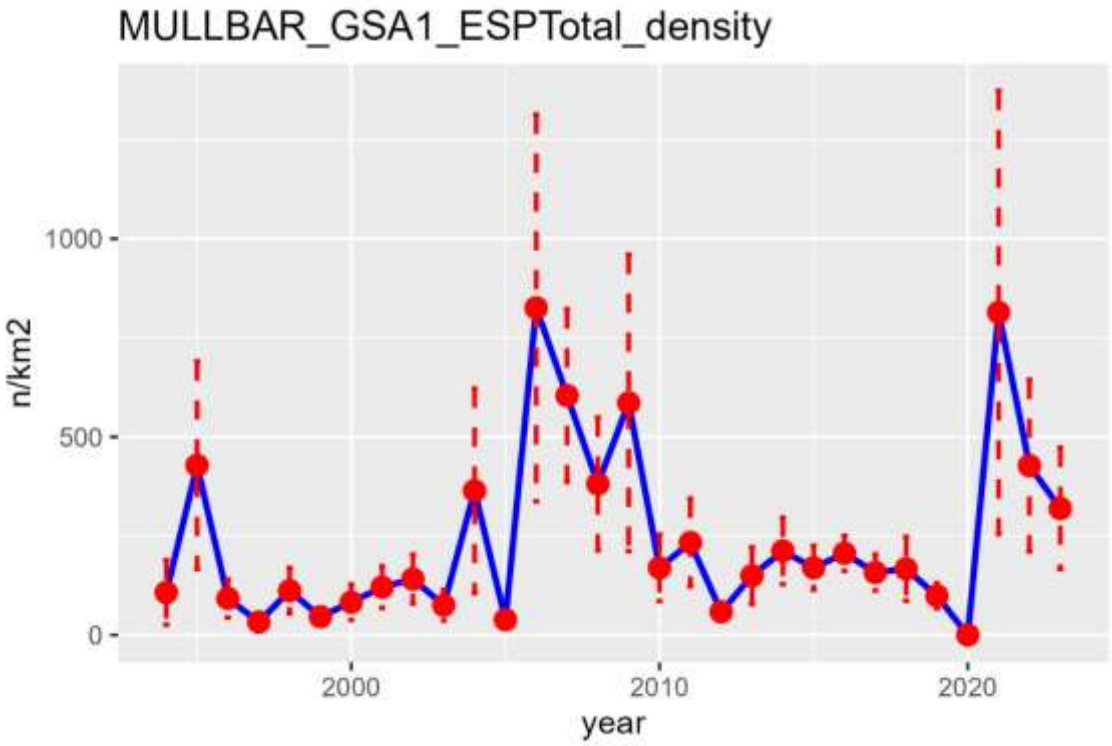


Figure 6.3.2.3.3 Red mullet in GSA 1: Biomass indices of red mullet in GSA 1 as derived from trawl surveys (MEDITS, 1994-2023).

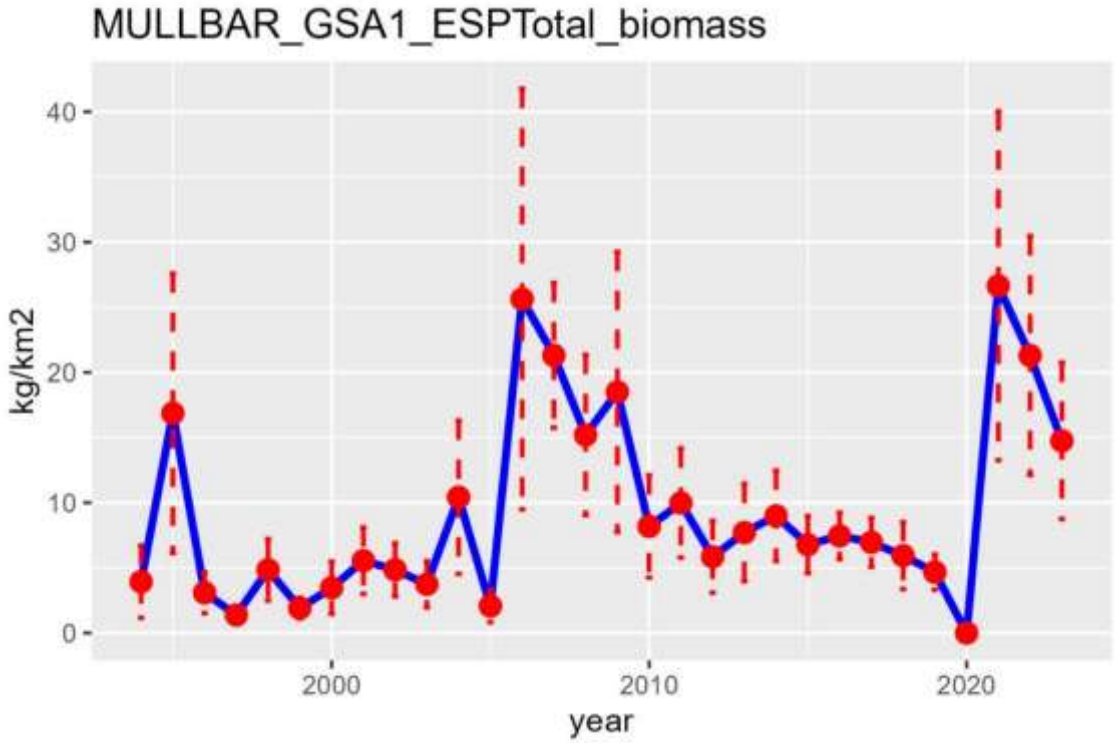


Figure 6.3.2.3.4 Red mullet in GSA 1: Size structure indices (females) of red mullet in GSA 1 as derived from trawl surveys (MEDITS, 1994-2021,2023).

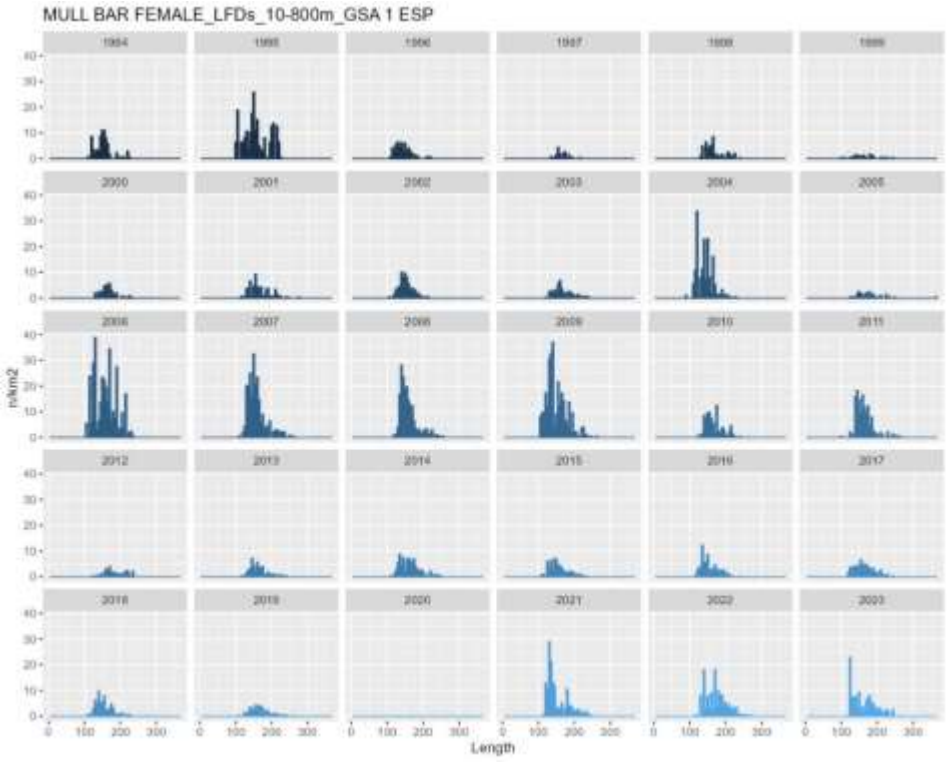


Figure 6.3.2.3.5 Red mullet in GSA 1: Size structure indices (males) of red mullet in GSA 1 as derived from trawl surveys (MEDITS, 1994-2021,2023).

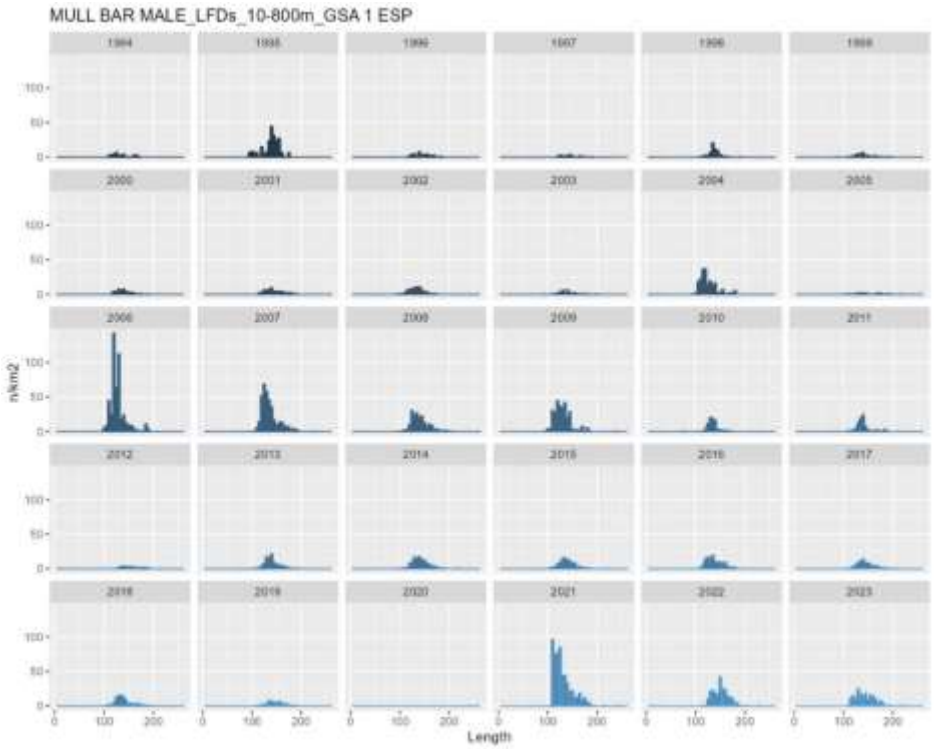
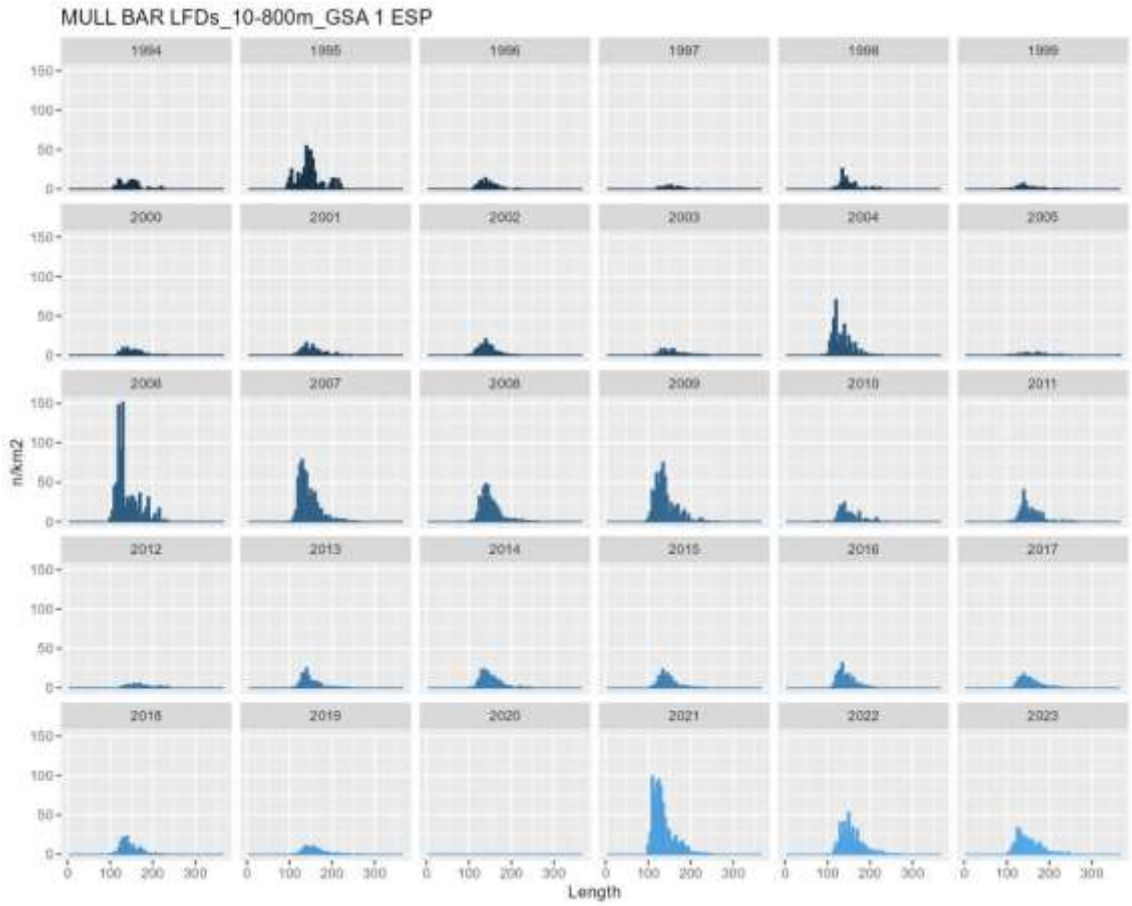


Figure 6.3.2.3.6 Red mullet in GSA 1: Size structure indices (total) of red mullet in GSA 1 as derived from trawl surveys (MEDITS, 1994-2022,2023).



6.3.3 STOCK ASSESSMENT

Assessment for all Initiative (a4a) (Jardim et al., 2015) is a statistical catch at age method that utilize catch at age data to derive estimated of historical population size and fishing mortality. Model parameters are estimated by working forward in time and analyses do not require the assumption that removals from the fishery are known without error. A4a is implemented as a package (Fla4a) of the FLR library. The present assessment of red mullet in GSA 1 has been based on an a4a model.

Catch numbers at age and index numbers at age were derived by slicing the catch numbers at length and index numbers at length respectively. For the slicing procedure the R routine of FLR was used. The growth parameters for the slicing are reported in Table 6.3.1.1 and were chosen as the most suitable for this species and this area. Sum of Products (SoP) correction was applied in catch numbers at age to match the total catch by year reported in the DCF. Most of the years the SoP is very close to 1.

	0	1	2	3	4
2002	54	2180	469	18	0
2003	1	1218	804	195	76
2004	21	3299	560	25	0
2005	1	2325	668	6	0
2006	208	3513	615	34	2
2007	132	4029	717	13	0
2008	291	3859	797	34	8
2009	467	4442	907	61	5
2010	1372	4153	698	39	4
2011	819	5127	544	46	3
2012	172	1231	297	44	138
2013	78	2561	497	46	9
2014	457	2869	418	14	0
2015	425	3024	465	17	9
2016	469	4945	1080	23	1
2017	328	4677	1193	44	3
2018	295	3376	683	42	8
2019	20	1984	545	45	6
2020	29	1580	537	19	0
2021	66	1927	876	67	8
2022	240	2213	897	63	0
2023	712	2503	1116	97	6

Table 6.3.3.1 Red mullet in GSA 1: Values of catch at age per year used in the assessment.

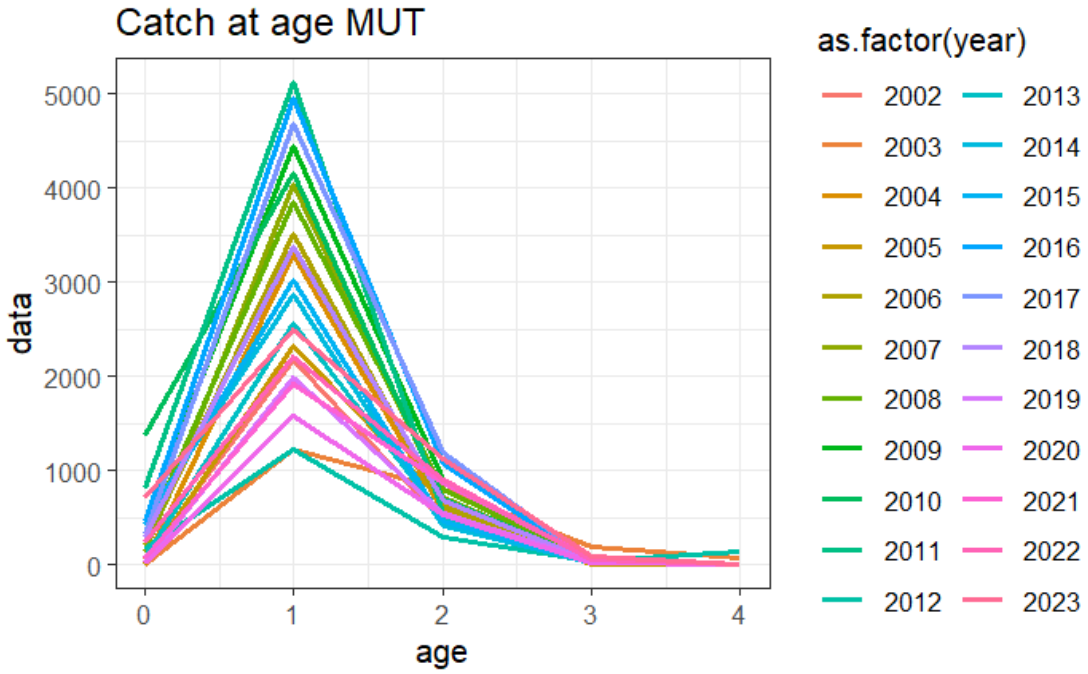


Figure 6.3.3.1 Red mullet in GSA 1: Catch-at-age data of red mullet in GSA1 used in assessment.

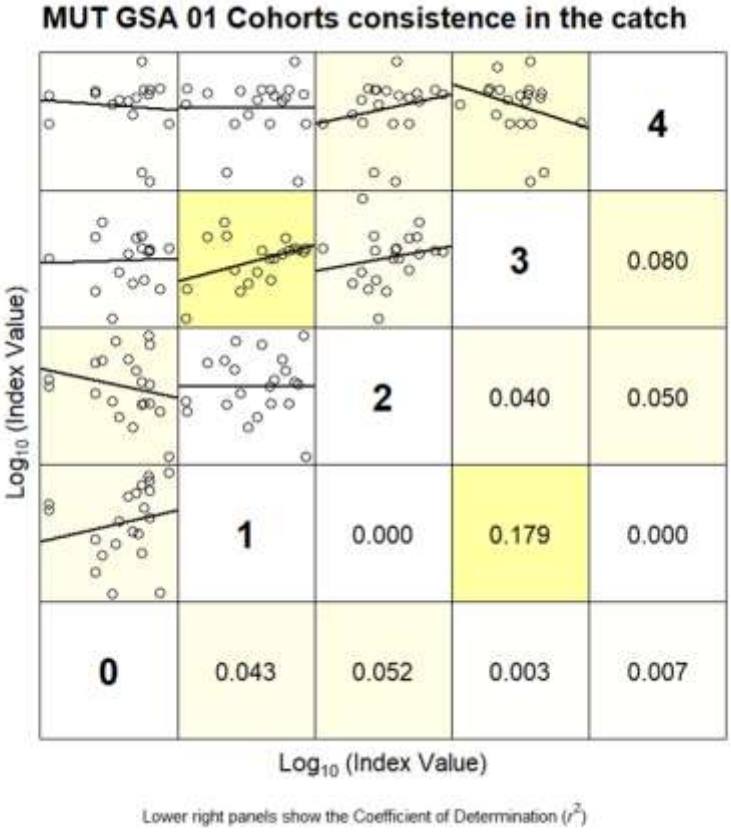


Figure 6.3.3.2 Red mullet in GSA 1: Cohort concistency of catches used in the assessment.

Table 6.3.3.2 Red mullet in GSA 1: Values of catch in the assessment.

Year	Catch
2002	112
2003	161
2004	155
2005	141
2006	166
2007	195
2008	195
2009	234
2010	202
2011	201
2012	109
2013	132
2014	127
2015	138
2016	268
2017	278
2018	173
2019	125
2020	108
2021	154
2022	170
2023	205

Table 6.3.3.3 Red mullet in GSA 1: Values of mean weight at age per year used in the assessment.

	0	1	2	3	4
2002	0.0110	0.033	0.080	0.145	0.198
2003	0.0100	0.041	0.084	0.142	0.198
2004	0.0110	0.032	0.080	0.138	0.198
2005	0.0100	0.037	0.082	0.143	0.198
2006	0.0110	0.031	0.078	0.151	0.217

	0	1	2	3	4
2007	0.0110	0.034	0.077	0.139	0.198
2008	0.0100	0.031	0.080	0.151	0.203
2009	0.0100	0.032	0.083	0.147	0.216
2010	0.0080	0.031	0.082	0.145	0.275
2011	0.0100	0.028	0.075	0.143	0.198
2012	0.0110	0.031	0.085	0.141	0.276
2013	0.0100	0.032	0.082	0.156	0.220
2014	0.0100	0.031	0.078	0.144	0.198
2015	0.0100	0.03	0.081	0.151	0.202
2016	0.0100	0.034	0.085	0.144	0.247
2017	0.0110	0.037	0.079	0.141	0.209
2018	0.0110	0.032	0.080	0.151	0.232
2019	0.0110	0.036	0.083	0.149	0.217
2020	0.0110	0.039	0.079	0.142	0.198
2021	0.0110	0.036	0.083	0.145	0.212
2022	0.0110	0.039	0.081	0.146	0.198
2023	0.0110	0.035	0.084	0.148	0.210

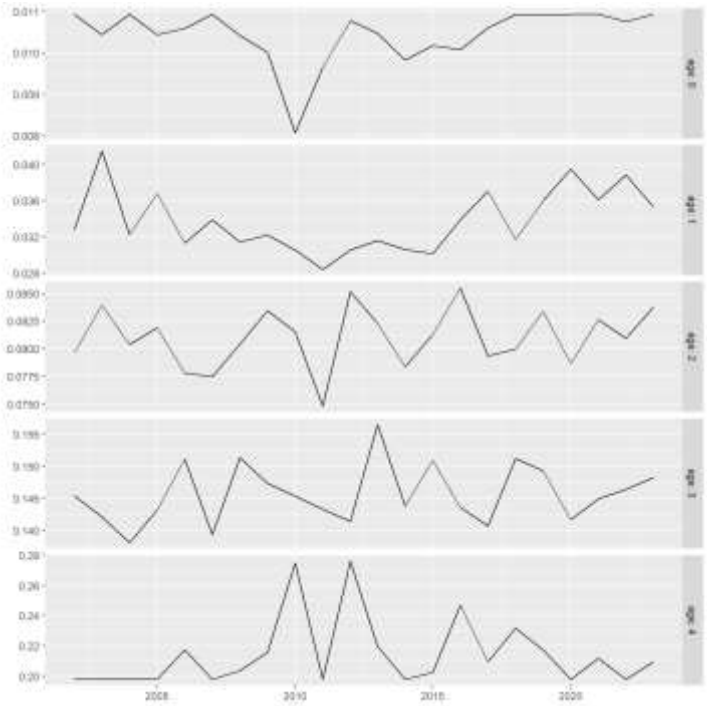


Figure 6.3.3.3 Red mullet in GSA 1: Values of mean weight at age per year used in the assessment.

Table 6.3.3.4 Red mullet in GSA 1: Survey index (MEDITS) values at age per year used in the assessment.

	1	2	3
2002	140.76	7.47	0.1
2003	60.44	13.39	1.76
2004	368.93	15.28	0.69
2005	27.78	8.69	2.17
2006	746.01	95.43	4.83
2007	556.55	40.35	7.64
2008	348.36	28.09	6.47
2009	549.4	45.93	7.07
2010	149.57	20.5	0.76
2011	194.56	24.96	4.55
2012	37.87	17.39	3.2
2013	140.04	9.01	1.44
2014	189.78	19.86	3.49
2015	156.82	13.43	0.46
2016	190.87	15.75	0.2
2017	134.68	21.43	1.65
2018	156.24	11.43	0.49
2019	83.67	13.8	1.15
2020	NA	NA	NA
2021	791.49	56.87	5.32
2022	353.94	65.51	7.76
2023	269.75	43.38	8.44

Survey indices (density by age) from MEDITS were used assuming that spring surveys are not designed to detect recruitment of red mullet. Recruitment (age class 0) was detected just in some years when surveys were carried out in late summer or autumn. For those few years, the EWG 24 10 group decided to add these few age 0 class to age 1 due to the fact they represent real age 1. MEDITS indices (density by age) are shown in figure 6.3.3.4.

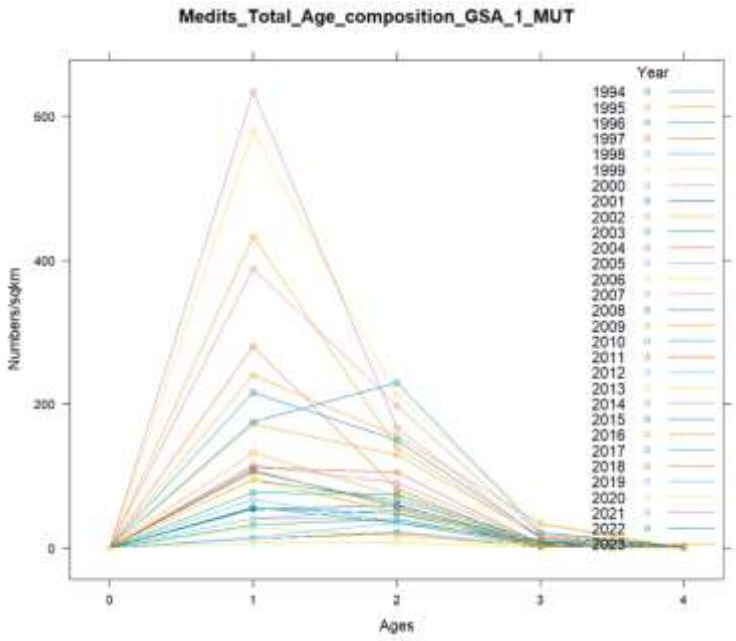


Figure 6.3.3.4 Red mullet in GSA 1: MEDITS indices describing density (n/km2) by age of red mullet in GSA1 by year

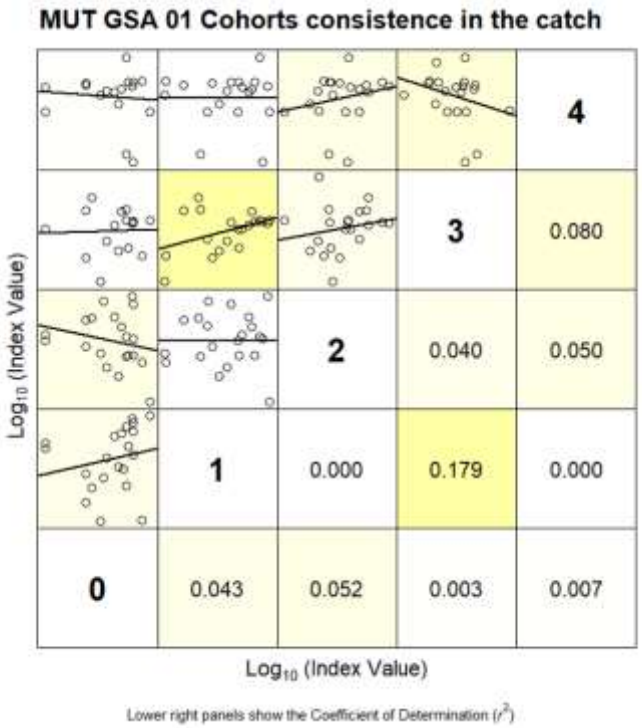


Figure 6.3.3.5 Red mullet in GSA 1: Cohort concistency of survey data used in the assessment.

Different a4a models were investigated in terms of fishing mortality, catchability of the survey index and stock –recruitment relationship models (fmodel, qmodel, and srmodel). Smoothing splines were essential in fitting a model, both in the recruitment and the fishing mortality model.

The a4a model had some issue trying to modelling age 0 which is present in the catch but absent in the index. For this reason an fsubmodel for age 0 was used. The final model selected is different from the last year (EWG 22-09).

The following model was selected on the basis of best fit, both for residuals as well as fitted vs observed data, Mohn' rho value and retrospective.

fmod<- ~ s(age, k=3) + s(year, k=10) + s(year, k=7, by = as.numeric(age==0))

qmod<- list(~I(1/(1 + exp(-age))))

srmod<- ~geomean(CV=0.2)

n1model: ~s(age, k = 3)

vmodel: catch: ~s(age, k = 3)

The following figure presents the summary of the stock object after the fit of the model. The recruitment, spawning stock biomass catch and fishing mortality.

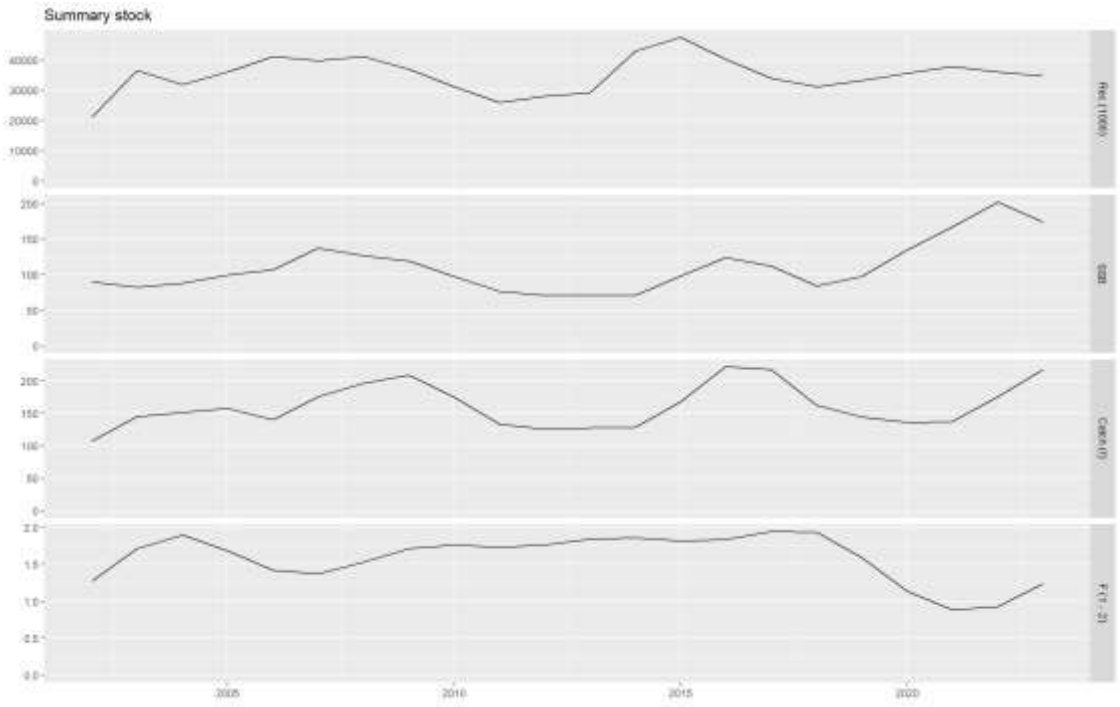


Figure 6.3.3.6 Red mullet in GSA 1: Stock indicators derived from the stock assessment.

The results and diagnostics of the assessment model are shown below.

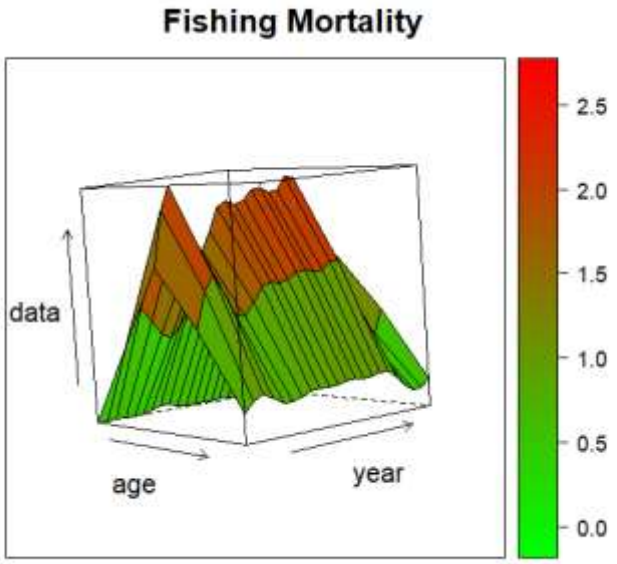


Figure 6.3.3.7 Red mullet in GSA 1: 3D-plot of the F-at-age for red mullet in GSA1.

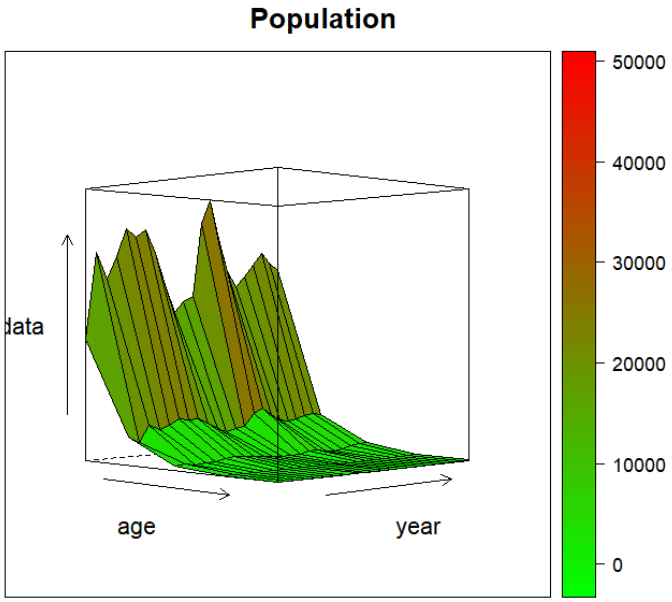


Figure 6.3.3.8 Red mullet in GSA 1: 3D-plot of the population for red mullet in GSA1.

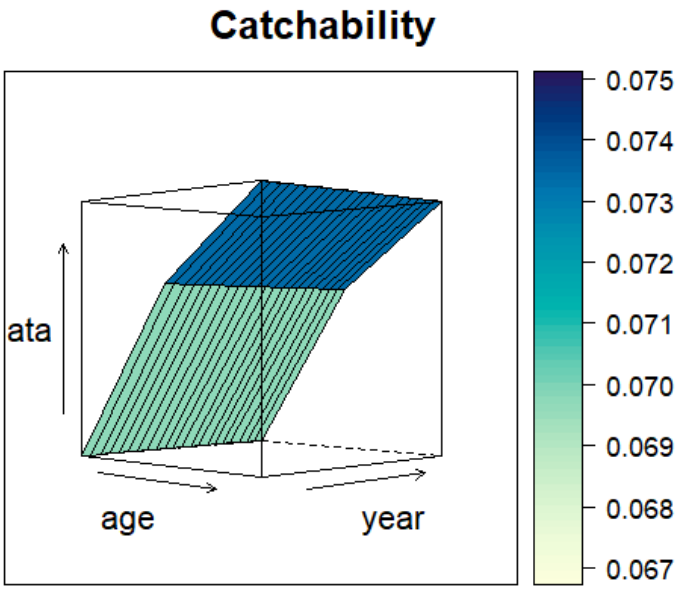


Figure 6.3.3.9 Red mullet in GSA 1: 3D-plot of the catchability of the MEDITsurvey for red mullet in GSA1.

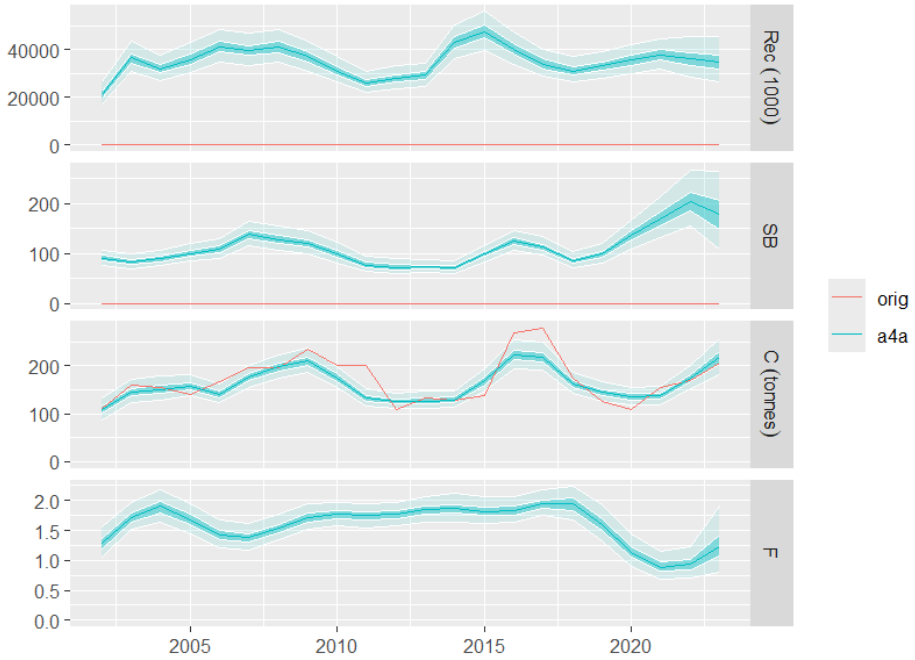


Figure 6.3.3.10 Red mullet in GSA 1: Results of the best a4a model for red mullet in GSA1. The observed catches are shown by the red line.

The Mohn' rho for F_{bar1-3}, SSB and recruitment are shown below:

fbar	ssb	rec
-0.1400	0.13422	0.0189

The results of the retrospective analysis are shown in Figure 6.3.3.11.

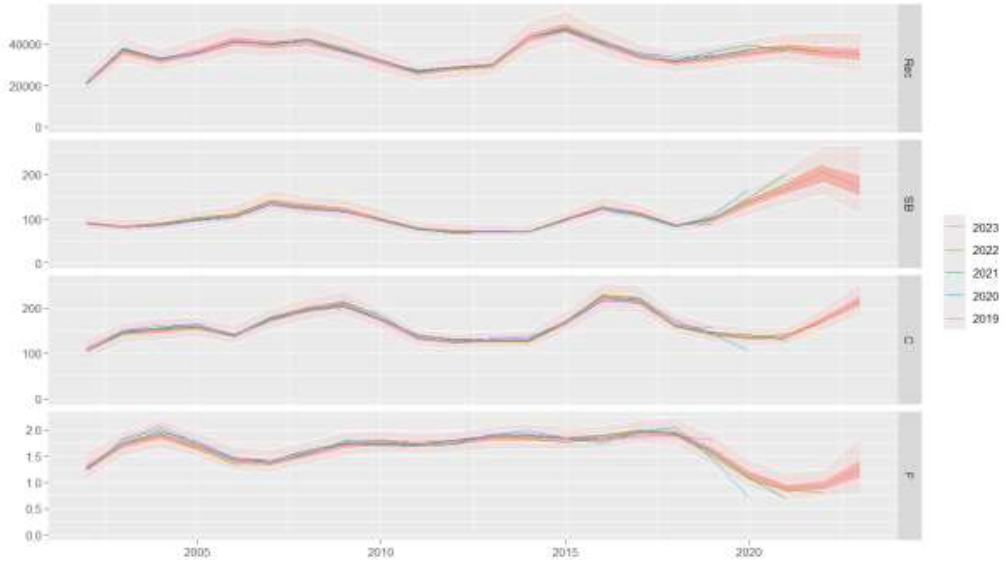


Figure 6.3.3.11 Red mullet in GSA 1: Retrospective analysis of the selected a4a model for red mullet in GSA1.

Several diagnostic plots presented below for the goodness of fit of the selected model for the assessment of Red mullet stock.

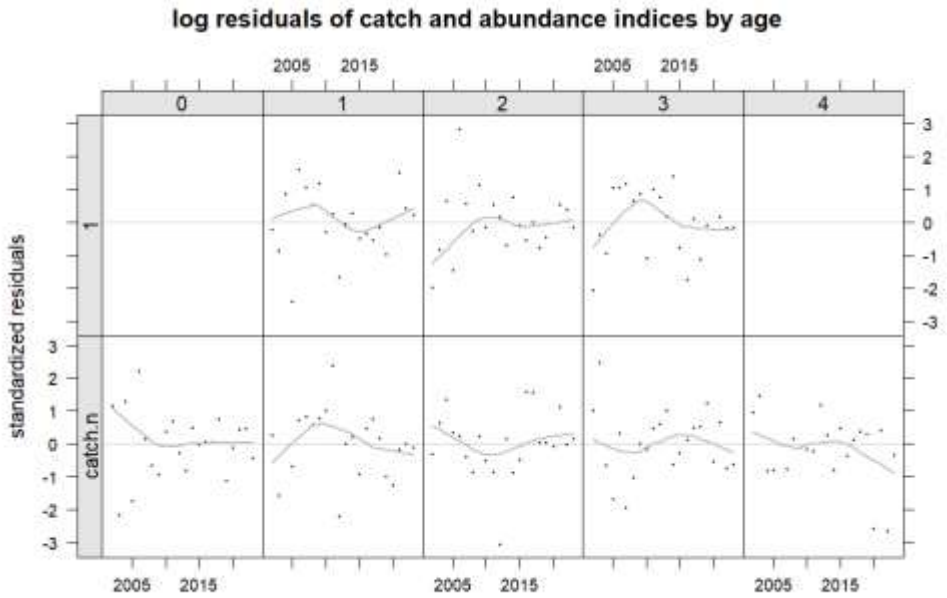


Figure 6.3.3.12 Red mullet in GSA 1: Log residuals of catch and abundance indices for red mullet in GSA1

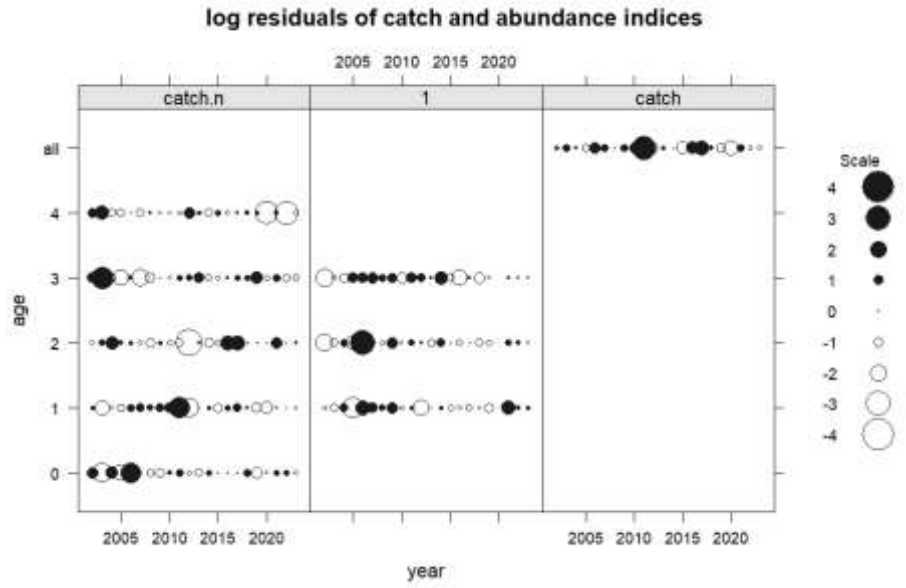


Figure 6.3.3.13 Red mullet in GSA 1: Bubble plot of the log residuals of catch and abundance indices for red mullet in GSA1.

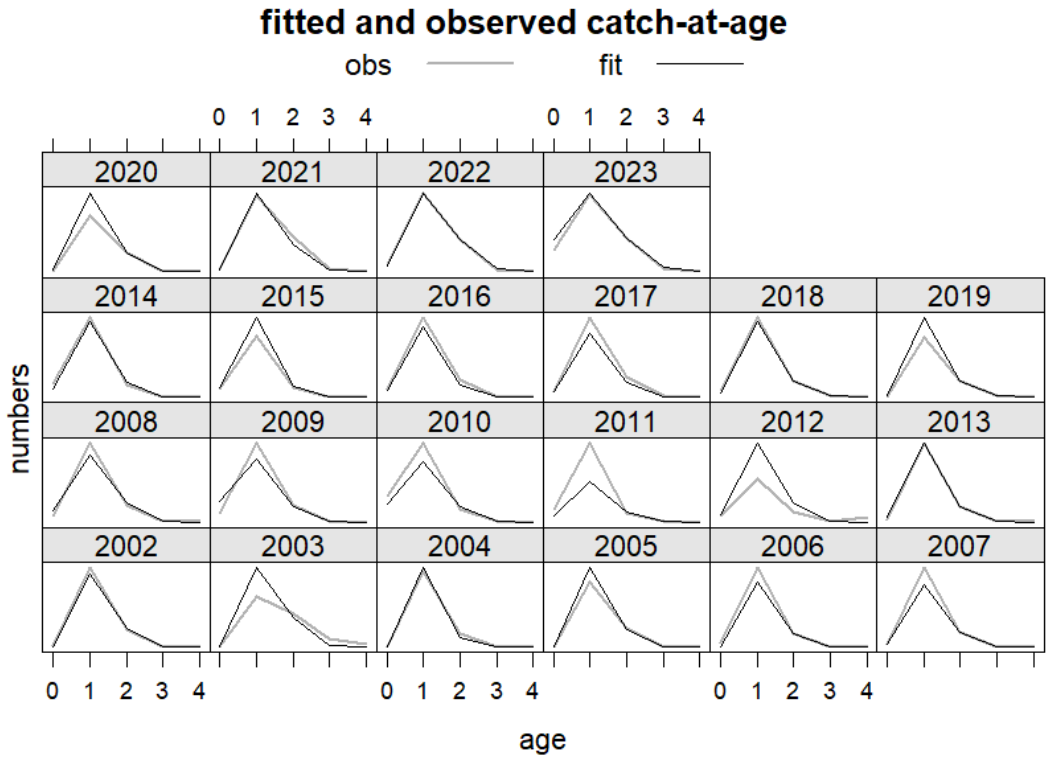


Figure 6.3.3.14 Red mullet in GSA 1: Fitting of the catch-at-age data for red mullet in GSA1.

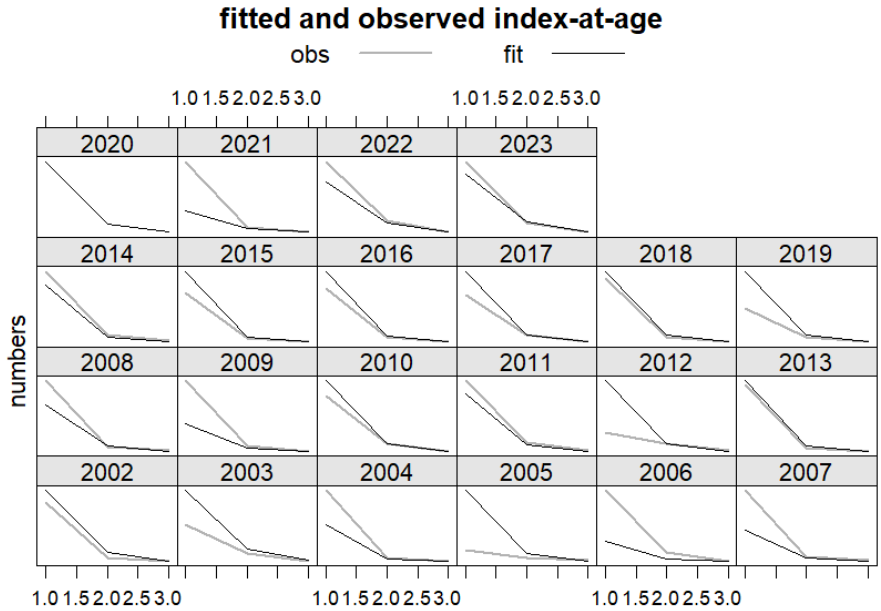


Figure 6.3.3.15 Red mullet in GSA 1: Fitting of the numbers-at-age data of the MEDITS survey for red mullet in GSA1.

Table 6.3.3.5 Red mullet in GSA 1: Final results of the red mullet assessment in GSA1.

Year	Recruitment age 0 ('000)	SSB (t)	Catch (t)	F_{bar} ages 1-2
2002	21214.6	89.9	107.7	1.28
2003	36556.4	82.5	144.8	1.71
2004	31936.5	88.2	151.3	1.90
2005	36057.7	99.4	157.5	1.68
2006	41203.5	107.1	140.3	1.42
2007	39803.9	137.1	175.8	1.38
2008	41113.2	126.8	196.3	1.53
2009	36974.7	118.7	209.1	1.71
2010	31220.1	97.4	175.0	1.76
2011	26019.4	76.3	133.4	1.73
2012	28054.7	71.0	125.6	1.76
2013	29242.0	71.7	127.6	1.84
2014	42995.1	70.6	128.6	1.86
2015	47598.7	97.9	167.9	1.82
2016	40325.2	124.2	221.9	1.84

2017	34088.1	112.3	217.2	1.95
2018	31146.7	84.3	162.6	1.94
2019	33217.2	97.4	144.5	1.59
2020	35605.4	135.2	136.0	1.14
2021	37881.4	167.2	137.6	0.89
2022	36089.9	202.2	176.0	0.93
2023	34786.6	174.1	217.3	1.24

Table 6.3.3.6 Red mullet in GSA 1: Stock number at age for red mullet in GSA 1.

	Age				
Year	0	1	2	3	4
2002	54	2180	469	18	0
2003	1	1218	804	195	76
2004	21	3299	560	25	0
2005	1	2325	668	6	0
2006	208	3513	615	34	2
2007	132	4029	717	13	0
2008	291	3859	797	34	8
2009	467	4442	907	61	5
2010	1372	4153	698	39	4
2011	819	5127	544	46	3
2012	172	1231	297	44	138
2013	78	2561	497	46	9
2014	457	2869	418	14	0
2015	425	3024	465	17	9
2016	469	4945	1080	23	1
2017	328	4677	1193	44	3
2018	295	3376	683	42	8
2019	20	1984	545	45	6
2020	29	1580	537	19	0
2021	66	1927	876	67	8
2022	240	2213	897	63	0
2023	712	2503	1116	97	6

Table 6.3.3.7 Red mullet in GSA 1: Fishing mortality at age for red mullet in GSA 1.

	Age				
Year	0	1	2	3	4
2002	0.00	0.85	1.71	1.08	0.30
2003	0.00	1.14	2.29	1.44	0.40
2004	0.00	1.26	2.53	1.60	0.44
2005	0.00	1.12	2.25	1.42	0.39
2006	0.00	0.95	1.90	1.20	0.33
2007	0.01	0.91	1.84	1.16	0.32
2008	0.03	1.02	2.04	1.29	0.36
2009	0.07	1.14	2.29	1.44	0.40
2010	0.07	1.17	2.35	1.48	0.41
2011	0.03	1.15	2.32	1.46	0.41
2012	0.02	1.17	2.35	1.48	0.41
2013	0.01	1.22	2.46	1.55	0.43
2014	0.01	1.24	2.49	1.57	0.44
2015	0.02	1.21	2.43	1.53	0.43
2016	0.02	1.22	2.45	1.55	0.43
2017	0.02	1.29	2.60	1.64	0.45
2018	0.01	1.29	2.58	1.63	0.45
2019	0.00	1.06	2.13	1.34	0.37
2020	0.00	0.76	1.52	0.96	0.27
2021	0.00	0.59	1.19	0.75	0.21
2022	0.01	0.62	1.24	0.78	0.22
2023	0.07	0.82	1.65	1.04	0.29

6.3.4 REFERENCE POINTS

Biological reference points have not been estimated due to the slightly instability of the model. The EWG 24 10 decided to evaluate biological reference points next year.

6.3.5 SHORT TERM FORECAST AND CATCH OPTIONS

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age and maturity at age, while the F_{bar} =1.24 (the last year's F estimated by the assessment model) was used for F in 2024, as F shows an increasing trend (See section 6.3.3). The Geometric mean from 2013 to 2023 of recruitment is be used.

Table 6.3.5.1 Red mullet in GSA 1: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-2 (2024)	1.24	Fsq = F in the last year
SSB (2024)	154.13	SSB intermediate year from STF output
Rage0 (2024,2025)	36298.04	Recruitment will be set as geometric mean of the last 11 years
Total Catch (2024)	178.78	Catch intermediate year from STF output
Fbar (2019)	1.59	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Table 6.3.5.2 Red mullet in GSA 1: Short term forecast table for red mullet in GSA 1.

Rationale	Ffactor	Fbar	Recruitment 2024	Fsq2024	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change _2024-2026(%)	Catch_change_ 2023-2025(%)
High long term yield (F0.1	0.51	0.63	36298	1.24	217.3	178.8	110.1	154.1	240.7	56.2	-49.3
F upper	0.70	0.86	36298	1.24	217.3	178.8	138.5	154.1	200.8	30.3	-36.3
F lower	0.34	0.42	36298	1.24	217.3	178.8	79.2	154.1	288.5	87.2	-63.6
FMSY transition	0.51	0.63	36298	1.24	217.3	178.8	110.1	154.1	240.7	56.2	-49.3
Zero catch	0.00	0.00	36298	1.24	217.3	178.8	0.0	154.1	430.5	179.3	-100.0
Status quo	1.00	1.24	36298	1.24	217.3	178.8	176.0	154.1	154.0	-0.1	-19.0
Different Scenarios	0.10	0.12	36298	1.24	217.3	178.8	26.1	154.1	380.6	146.9	-88.0
	0.20	0.25	36298	1.24	217.3	178.8	49.7	154.1	338.1	119.3	-77.1
	0.30	0.37	36298	1.24	217.3	178.8	71.1	154.1	301.7	95.8	-67.3
	0.40	0.50	36298	1.24	217.3	178.8	90.5	154.1	270.5	75.5	-58.4
	0.50	0.62	36298	1.24	217.3	178.8	108.1	154.1	243.7	58.1	-50.3
	0.60	0.74	36298	1.24	217.3	178.8	124.2	154.1	220.5	43.0	-42.9
	0.70	0.87	36298	1.24	217.3	178.8	138.8	154.1	200.3	30.0	-36.1
	0.80	0.99	36298	1.24	217.3	178.8	152.3	154.1	182.8	18.6	-29.9
	0.90	1.12	36298	1.24	217.3	178.8	164.6	154.1	167.5	8.6	-24.3
	1.10	1.36	36298	1.24	217.3	178.8	186.4	154.1	142.1	-7.8	-14.2
	1.20	1.49	36298	1.24	217.3	178.8	196.1	154.1	131.6	-14.6	-9.8
	1.30	1.61	36298	1.24	217.3	178.8	205.0	154.1	122.2	-20.7	-5.7
	1.40	1.73	36298	1.24	217.3	178.8	213.3	154.1	113.8	-26.2	-1.9
	1.50	1.86	36298	1.24	217.3	178.8	221.0	154.1	106.3	-31.0	1.7
	1.60	1.98	36298	1.24	217.3	178.8	228.2	154.1	99.5	-35.5	5.0
	1.70	2.11	36298	1.24	217.3	178.8	234.9	154.1	93.3	-39.4	8.1
	1.80	2.23	36298	1.24	217.3	178.8	241.1	154.1	87.7	-43.1	11.0
	1.90	2.35	36298	1.24	217.3	178.8	247.0	154.1	82.6	-46.4	13.6
	2.00	2.48	36298	1.24	217.3	178.8	252.5	154.1	77.9	-49.4	16.2

The analysis, carried out with stf.r FLR script made available to the EWG, shows that fishing at a level equal to $F_{0.1}$ (=0.63) would increase biomass by 56.2 % from 2024 to 2026, while reducing catches by 49.3% from 2023 to 2025.

6.4 STRIPED RED MULLET IN GSA 5

6.4.1 STOCK IDENTITY AND BIOLOGY

GSA 5 (Figure 6.4.1.1) has been selected as an individualized area for assessment and management purposes in the western Mediterranean (Quetglas *et al.*, 2012) due to its main specificities. These include: 1) Geomorphological, 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; 5) 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 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.

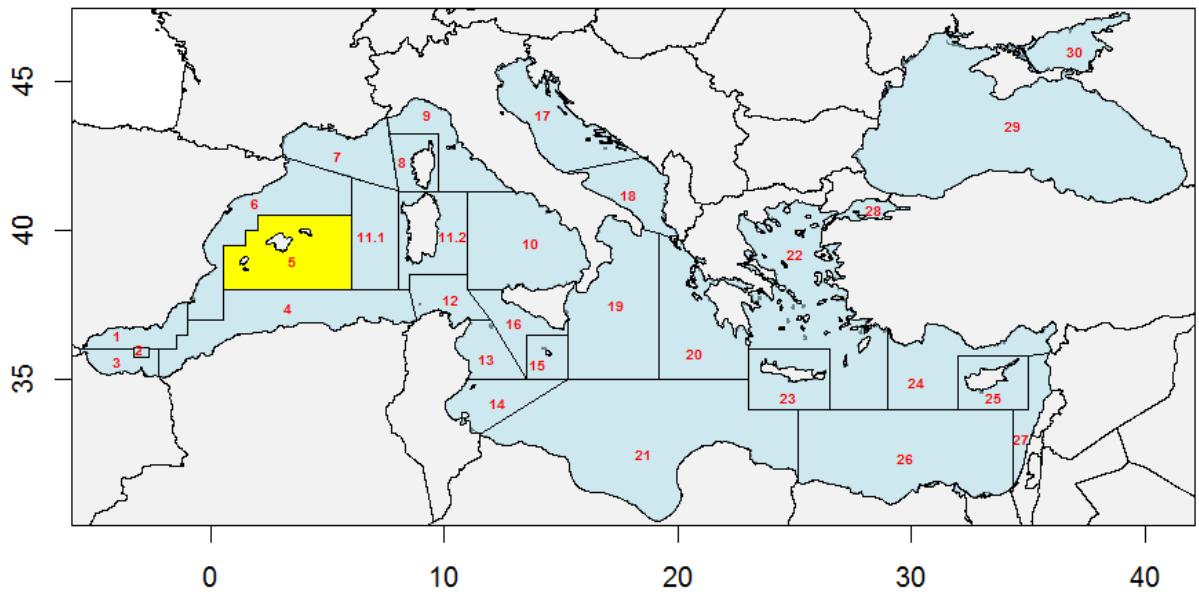


Figure 6.4.1.1. Geographical localization of GSA 5.

The biological parameters, natural mortality vector and maturity ogive used for the assessment of the striped red mullet (*Mullus surmuletus* designated by the ASFIS 3-letters code “MUR”) were those shown in the following tables. Growth parameters (Table 6.4.1.1) and natural mortality vector (Table 6.4.1.2) and correspond to those available from the STECF EWG 22-09 report. They were those used in the 2020 assessment of this stock carried out by the Working Group of Stock Assessment of Demersal Stocks in the Western Mediterranean Sea of the STECF (EWG-20-09), from Campillo (1992). Length-weight relationship (Table 6.4.1.1.)

was obtained from the STECF Med&BS data call, using the median value of the parameters, excluding 2021. Proportion of matures (Table 6.4.1.3) has been set considering all the individuals become mature in age 1.

Table 6.4.1.1. Striped red mullet in GSA 5. Growth and length-weight parameters.

Growth	
L_{inf} (cm)	33.4
k	0.43
t_0	-0.1
Length-Weight	
a	0.0085
b	3.115

Table 6.4.1.2. Striped red mullet in GSA 5. Natural Mortality vector.

Age	0	1	2	3	4	5+
M	1.14	0.86	0.64	0.55	0.50	0.47

Table 6.4.1.3. Striped red mullet in GSA 5. Maturity ogive.

Age	0	1	2	3	4	5+
Prop. Mature	0.00	1.00	1.00	1.00	1.00	1.00

6.4.2 DATA

General description of the fisheries

In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (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 shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus spp.*, *Zeus faber* and a mixed fish category on the deep shelf (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 upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The striped red mullet, *M. surmuletus*, is one of the target species in the shallow shelf, although it is also caught in the deep shelf. It is also the target species of part of the artisanal fleet, being caught during the second semester of the year mainly by trammel nets but also by gillnets.

Management regulations

- Bottom trawl

  - Fishing license
  - Engine power limited to 316 KW or 500 CV
  - Mesh size in the cod-end (before Jun 1st 2010: 40 mm diamond; from Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-)
  - Fishing forbidden upper 50 m depth
  - Time at sea (12 hours per day and 5 days per week)
  - MCRS: 11 cm TL
  - Weekly temporal bans (winter, 2016-2019)
  - EU multiannual plan (from 2020): Fishing reduction (2020-2023) (number of days); Spatio-temporal closures (in force since 2020 and 2021); four weeks temporal ban for protecting hake spawners (150-500 m).

- Trammel net

  - Fishing license
  - Fishing season (July to December) (Not officially regulated)
  - Maximum length of nets (2000 m/fisherman and 5000 m/boat)
  - Minimum mesh size (50 mm)
  - Limitation to 6 fishing days per week
  - Time at sea (from sunrise to sunset)
  - Fishing forbidden deeper than 50 m depth

6.4.2.1 CATCH (LANDINGS AND DISCARDS)

Landings for striped red mullet in GSA 5 come both from bottom trawlers and trammel nets, with bottom trawlers representing around 80% of total landings. Following a reduction in 2007-2009, from 2013 to 2018 an increase in bottom trawl catches is observed. Since then, again a reduction was noted from 2018-2023, which showed the minimum values of the data series (Figure 6.4.2.1 and Table 6.4.2.1.).

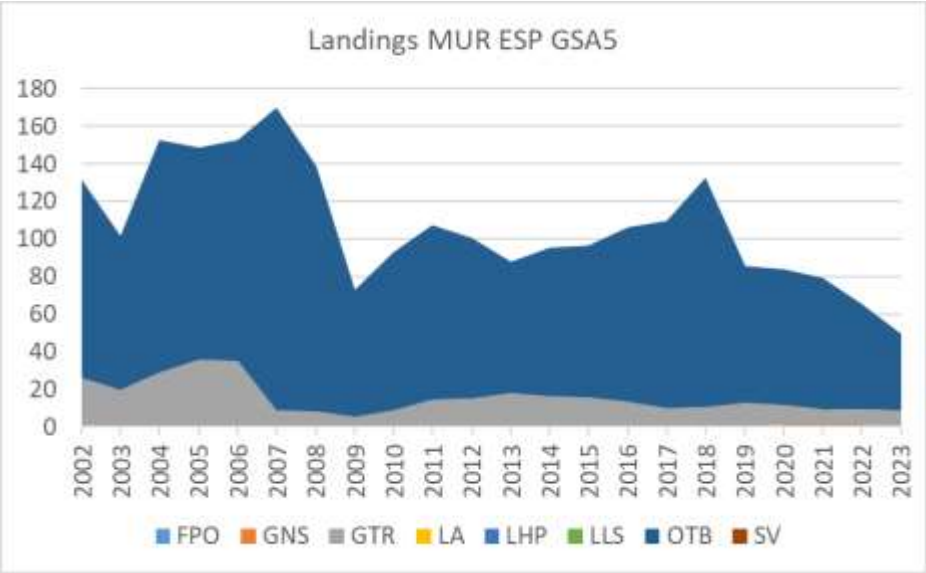


Figure 6.4.2.1.1. Striped red mullet in GSA 5. Reported landings (in tons) from the STECF Med&BS data call by gear.

Table 6.4.2.1.1. Striped red mullet in GSA 5. Reported landings by gear from the STECF Med&BS data call.

year	FPO	GNS	GTR	LA	LHP	LLS	OTB	SV	Total
2002	0.00	0.00	25.72	0.00	0.00	0.00	105.96	0.00	131.68
2003	0.00	0.00	19.75	0.00	0.00	0.00	81.87	0.00	101.62
2004	0.00	0.00	28.55	0.00	0.00	0.00	124.40	0.00	152.95
2005	0.00	0.00	35.80	0.00	0.00	0.00	112.71	0.00	148.51
2006	0.00	0.00	35.04	0.00	0.00	0.00	117.84	0.00	152.88
2007	0.00	0.00	8.76	0.00	0.00	0.00	161.30	0.00	170.06
2008	0.00	0.00	8.09	0.00	0.00	0.00	131.07	0.00	139.16
2009	0.00	0.00	5.43	0.00	0.00	0.00	67.54	0.00	72.97
2010	0.00	0.00	8.95	0.00	0.00	0.00	84.20	0.00	93.15
2011	0.00	0.00	14.69	0.00	0.00	0.00	92.67	0.00	107.36
2012	0.00	0.00	14.85	0.00	0.00	0.00	85.51	0.00	100.36
2013	0.00	0.00	18.20	0.00	0.00	0.00	69.68	0.00	87.88
2014	0.00	0.00	16.09	0.00	0.00	0.00	79.26	0.00	95.35
2015	0.00	0.00	15.48	0.00	0.00	0.00	81.12	0.00	96.60
2016	0.00	0.00	13.57	0.00	0.00	0.00	92.89	0.00	106.46
2017	0.00	0.00	9.76	0.00	0.00	0.00	100.15	0.00	109.91
2018	0.00	0.00	10.56	0.00	0.00	0.00	121.84	0.00	132.40
2019	0.00	0.00	12.65	0.00	0.00	0.00	72.89	0.00	85.55
2020	0.00	1.17	10.17	0.00	0.00	0.00	72.32	0.01	83.69
2021	0.00	1.32	7.66	0.00	0.03	0.08	69.91	0.01	79.02
2022	0.14	0.89	8.13	0.00	0.12	0.04	56.23	0.00	65.55
2023	0.00	0.83	7.78	0.01	0.00	0.03	40.66	0.01	49.33

Discards for this stock was considered as negligible and catches are assumed to be equal to landings. Nevertheless, it is recognized that some years as 2010 and 2012 presented discards

over 5 tonnes for GTR and OTB, respectively (Figure 6.4.2.2 & Table 6.4.2.2). Such small amounts are not expected to change the assessment in any important way. For 2023, discards were zero.



Figure 6.4.2.1.2. Striped red mullet in GSA 5. Reported discards (in tons) by gear from the STECF Med&BS data call.

Table 6.4.2.1.2. Striped red mullet in GSA 5. Reported discards (in tons) by gear from the STECF Med&BS data call.

year	FPO	GNS	GTR	LA	LHP	LLS	OTB	SV	Total
2005	2005	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00
2006	206	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	2008	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00
2009	2009	0.00	0.00	0.10	0.00	0.00	0.00	0.04	0.00
2010	2010	0.00	0.00	9.06	0.00	0.00	0.00	0.26	0.00
2011	2011	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
2012	2012	0.00	0.00	3.98	0.00	0.00	0.00	5.54	0.00
2013	2013	0.00	0.00	0.40	0.00	0.00	0.00	0.08	0.00
2014	2014	0.00	0.00	0.14	0.00	0.00	0.00	2.72	0.00
2015	2015	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
2016	2016	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00
2017	2017	0.00	0.00	0.00	0.00	0.00	0.00	1.48	0.00
2018	2018	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
2019	2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	2021	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00
2021	2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	2005	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00

Evaluation of length frequency distribution data from STECF Med&BS shows that most of the information comes from OTB_DEMSP up to 2019 and OTB_DEF since 2020 (Figure 6.4.2.3). The change in gear type results not from a change in the fishery, just a redefinition of the gear designations.

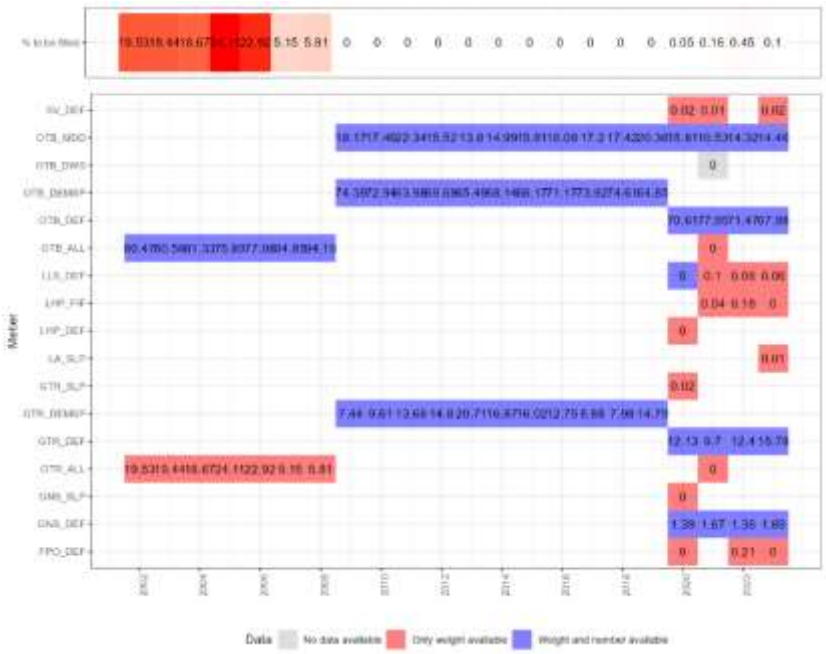


Figure 6.4.2.1.3. Striped red mullet in GSA5. Sampling of landings by gear from the STECF Med&BS data call.

Length frequency distribution for the striped red mullet in GSA 5 shows differences between métiers, with trammel-nets targeting larger individuals than bottom trawlers (Figure 6.4.2.4).

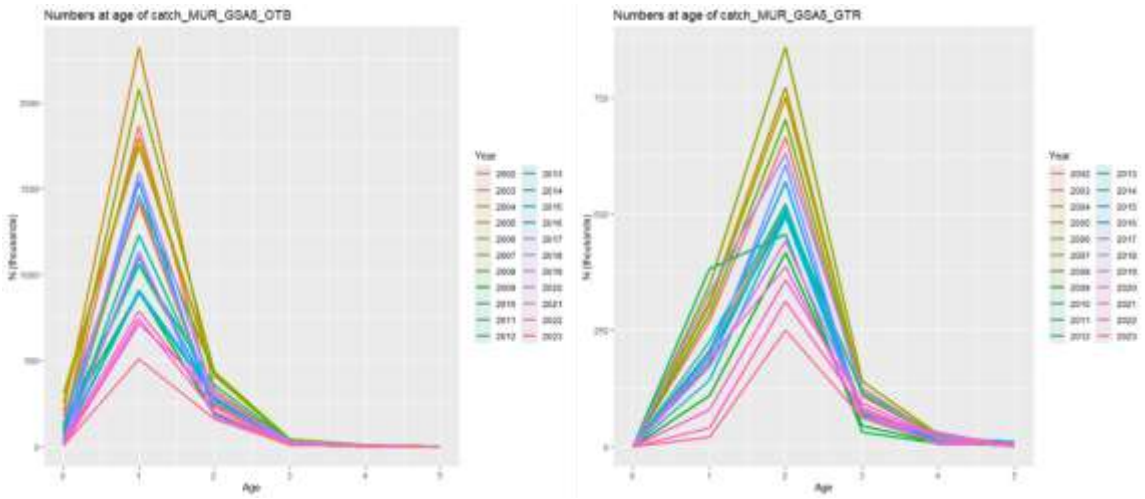


Figure 6.4.2.1.4. Striped red mullet in GSA5. Catch at age frequency distribution, by year and gear (left, OTB; right, GTR) (ages, numbers in thousands) from the STECF Med&BS data call.

Table 6.4.2.1.3. Striped red mullet in GSA 5. Catch length structure (TL in cm, numbers in thousands) reported in STECF Med&BS data call (2011-2023).

Length (cm)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	2.21	0.00	0.00	0.50	1.02	1.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	12.40	1.17	0.44	1.08	3.22	9.71	3.35	0.00	0.00	0.39	1.38	0.00	0.00

11	37.21	2.79	3.67	9.21	9.06	10.22	56.21	0.52	0.00	0.97	5.06	1.44	0.96
12	63.77	14.70	23.99	26.00	15.09	25.50	56.64	5.08	8.52	0.39	16.36	3.11	3.95
13	112.64	49.11	41.69	56.44	29.51	87.49	118.56	17.11	10.15	1.57	19.18	8.98	8.83
14	116.40	105.74	72.52	50.94	83.75	99.54	174.63	59.56	77.17	2.47	17.27	60.09	26.73
15	158.26	202.64	109.52	85.64	132.40	198.18	155.57	161.67	121.79	6.19	34.15	94.99	56.85
16	170.48	245.89	133.45	143.78	179.87	311.39	211.61	307.24	178.52	46.18	143.45	105.11	78.35
17	158.24	183.16	126.55	158.67	185.74	245.44	217.63	320.26	187.79	103.65	135.75	107.86	80.94
18	151.66	148.13	144.96	165.12	153.46	193.11	191.57	277.46	185.51	104.53	164.61	118.88	81.96
19	139.38	143.62	142.13	163.88	117.84	118.48	154.98	177.58	105.93	68.85	135.31	95.60	56.44
20	148.20	115.76	121.49	124.70	89.59	83.27	87.55	110.88	75.44	78.85	65.90	96.39	51.17
21	121.30	77.84	84.72	88.63	58.83	65.44	70.97	68.01	46.62	25.45	84.20	59.19	53.11
22	87.04	55.48	61.69	67.14	55.90	38.96	43.05	61.91	35.42	19.46	41.86	18.22	33.50
23	68.55	37.57	37.90	36.39	30.88	23.87	33.44	30.14	21.26	28.54	27.38	18.55	15.06
24	45.50	20.93	28.21	27.16	34.17	13.14	21.48	16.13	16.68	8.67	21.72	8.09	10.94
25	28.67	14.93	17.32	21.16	10.51	14.04	9.61	16.54	6.97	5.19	7.00	9.06	10.48
26	20.30	6.71	8.44	11.12	7.52	4.32	5.30	14.42	6.11	1.34	3.47	6.12	4.74
27	13.08	5.40	8.26	8.00	6.36	3.83	1.61	3.46	3.67	3.11	4.18	2.69	2.78
28	7.37	4.92	3.52	5.27	4.78	1.92	1.30	5.65	0.51	0.88	2.06	1.62	1.14
29	4.62	0.59	1.53	2.26	3.44	0.81	5.26	0.82	0.39	0.87	0.80	1.46	0.42
30	0.60	0.12	0.80	1.72	0.25	1.34	0.37	0.31	0.49	0.00	0.33	0.16	0.29
31	0.34	0.16	0.25	0.39	0.08	0.03	0.00	0.00	0.54	0.00	0.11	0.10	0.03
32	0.16	0.04	0.00	0.12	0.42	0.00	0.00	0.00	0.08	0.00	0.03	0.03	0.04
33	0.15	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
34	0.09	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Age composition is mainly formed by age 1 individuals, although age 0 and age 2 and 3 are also frequent in the catches (Figure 6.4.2.5, Table 6.4.2.4). Cohorts showed good consistency for most of the classes (figure 6.4.2.6). An “age plus” group was defined at age 5.

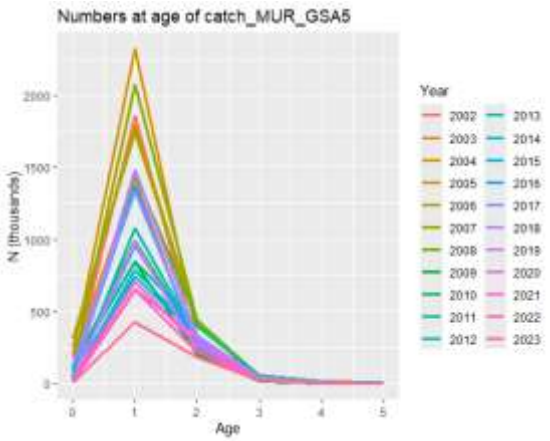


Figure 6.4.2.1.5. Striped red mullet in GSA 5. Landings at age, numbers in thousands.

Table 6.4.2.1.4. Striped red mullet in GSA 5. Landings at age, numbers in thousands.

age	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
0	97.4	18.7	26.9	35.2	30.8	51.5	126.6	6.3	9.6	3.4	24.8	5.0	5.3
1	848.2	1079.1	738.6	789.9	956.7	1367.0	1334.4	1484.1	981.9	655.9	706.7	645.4	423.1
2	396.3	307.8	320.1	329.6	292.0	245.0	279.5	322.6	221.4	316.5	261.9	218.5	177.5
3	52.3	27.1	32.6	38.6	26.4	24.2	18.0	38.7	19.0	18.9	15.9	19.5	19.5
4	10.1	5.5	4.8	7.2	8.9	3.0	7.2	7.3	1.0	3.4	3.0	3.3	1.7
5	1.2	0.3	1.0	2.1	1.1	1.5	0.4	0.3	1.3	0.3	0.5	0.3	0.4

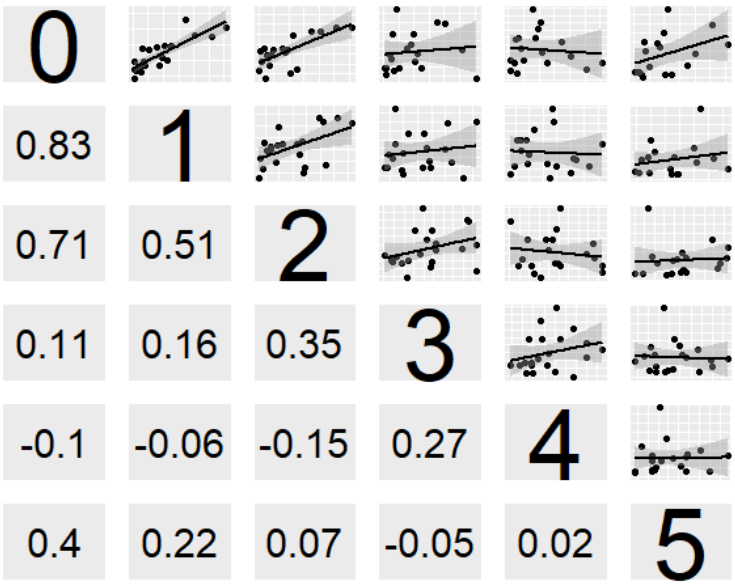


Figure 6.4.2.1.6. Striped red mullet in GSA 5. Cohort consistency for the commercial landings.

6.4.2.2 EFFORT

6.4.2.3 SURVEY DATA

The MEDITS (MEDiterranean International Trawl Survey) survey is an extensive trawl 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.

MEDITS survey started in GSA 5 in 2007. Before 2007, data were collected for only a few stations in the westernmost part of GSA 5 (Pitiuses: Ibiza and Formentera), so these years were considered non representative and not included. Mean stratified abundances and biomass by km^2 have been computed using the methodology described by Grosslein and Laurec (1982). Only Mallorca-Menorca islands were covered during the survey. Since 2021, Ibiza-Formentera islands also started to be sampled. The MEDIT Steering Committee in 2022 recommended to use survey index independently for Mallorca-Menorca and Ibiza-Formentera and thus the abundance index was calculated considering only Mallorca-Menorca.

Density and biomass indices showed variations along the data series, with high values for 2007, 2009 and 2017 (Figure 6.4.2.9). Length frequency distributions are shown in Figure 6.4.2.10 and Table 6.4.2.5.

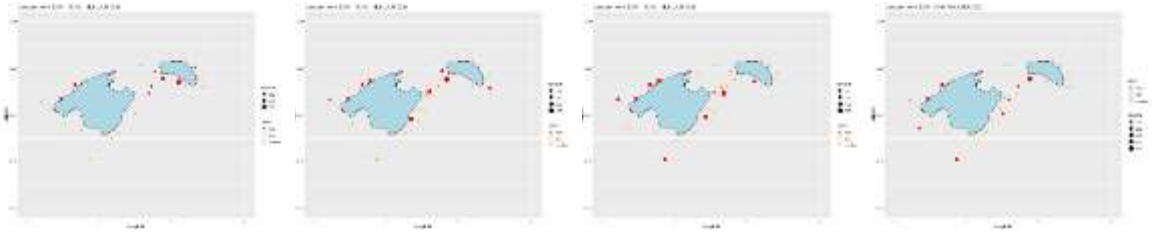


Figure 6.4.2.2.1. Striped red mullet in GSA 5. MEDITS Biomass index by stations for 2019-2022. Maps from the previous years are available in report STECF 22-09.

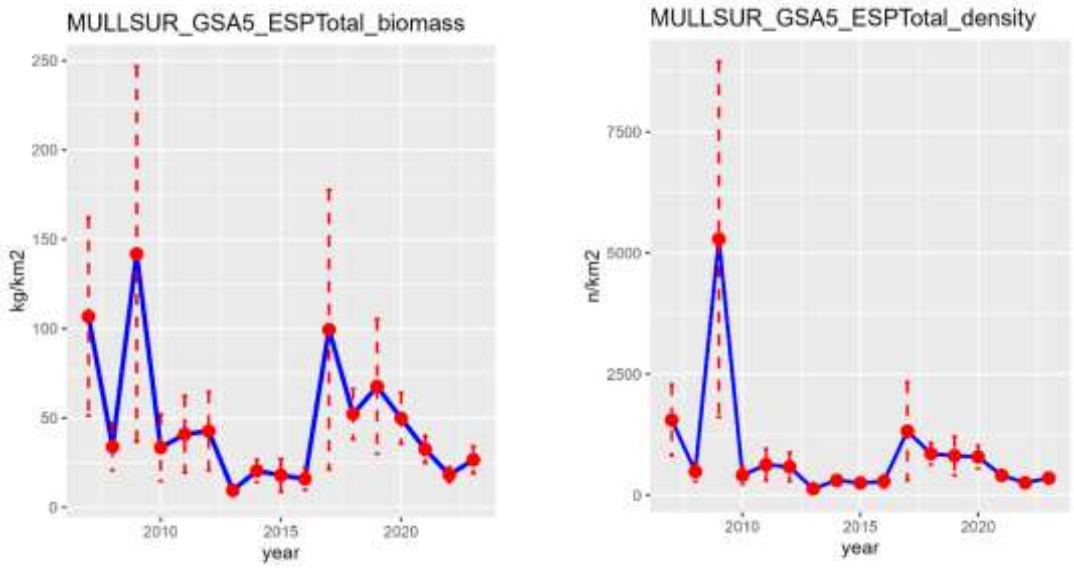


Figure 6.4.2.2.2. Striped red mullet in GSA 5. MEDITS abundance (n/km^2) and biomass (kg/km^2) indices over 2007-2023.

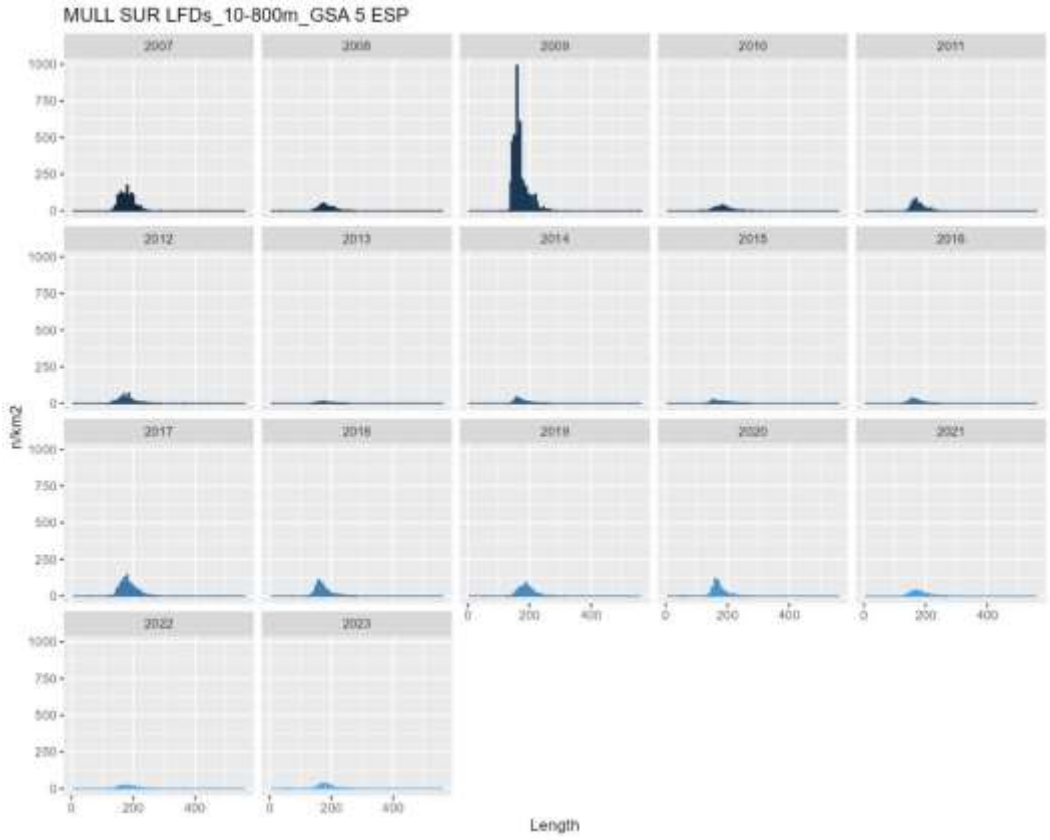


Figure 6.4.2.2.3. Striped red mullet in GSA 5. Length frequency distribution (TL in mm, numbers in n/km^2) reported in MEDITS (2007-2023) survey data.

Table 6.4.2.2.1. Striped red mullet in GSA 5. Length frequency distribution (TL in mm, numbers in n/km^2) reported in MEDITS (2014-2023) survey data. Data from previous years is included in STECF EWG 22-09.

Length	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
11	0.00	0.00	0.00	0.76	0.00	0.00	0.00	0.00	0.37	1.14
12	0.00	0.00	0.37	1.90	1.31	0.81	1.30	0.00	0.37	0.00
13	2.87	2.51	7.52	7.96	10.57	0.45	0.81	4.13	0.98	1.12
14	12.35	16.55	29.52	46.43	54.94	3.15	29.11	28.42	9.76	5.20
15	51.13	47.57	52.49	124.45	160.94	43.99	116.40	48.40	29.57	24.04
16	79.11	37.74	65.15	188.96	195.00	90.04	227.16	66.93	41.33	54.68
17	51.58	29.59	49.53	213.57	154.94	110.69	177.62	74.08	40.29	71.41
18	39.23	28.60	33.55	231.72	98.33	121.86	91.40	55.65	38.30	59.18
19	24.23	21.99	20.42	164.01	65.93	163.67	57.84	48.13	32.10	53.36
20	18.71	21.75	13.59	125.25	31.96	110.83	30.57	30.90	29.65	32.93
21	12.01	15.63	8.29	86.19	28.99	71.71	25.26	22.46	17.37	12.70
22	5.81	13.02	2.31	60.94	19.45	31.87	16.64	10.76	7	11.96
23	3.82	7.97	1.11	37.81	13.03	32.09	10.32	9.32	8.78	6
24	2.93	4.74	0.84	13.96	9.46	16.49	1.19	4.87	4.81	7.09
25	1.74	1.75	0.00	10.29	3.94	4.29	1.32	1.46	0.65	2.26
26	0.24	0.81	0.00	4.91	1.89	7.67	0.00	1.62	1.03	2.28
27	0.00	1.68	0.00	0.31	1.31	1.69	0.87	0.36	0.75	0.38
28	0.00	0.00	0.00	0.76	0.44	1.69	0.00	0.00	0.00	0.38
									0.33	0.00

Age composition of the catches from the survey showed that most of the individuals correspond to age 1, although age 2 is also important (Figure 6.4.2.10). Cohorts showed no consistency (Figure 6.4.2.11).

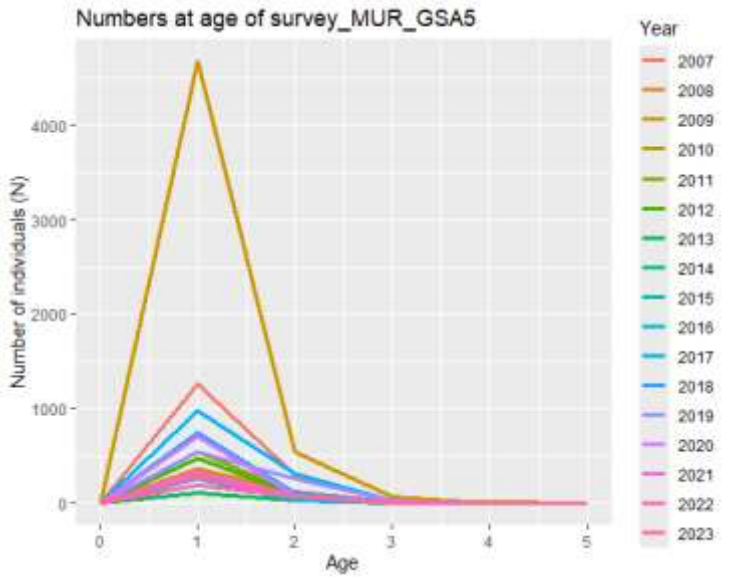


Figure 6.4.2.2.4. Striped red mullet in GSA 5. Age structure (numbers in n/km^2) estimated from length frequency distribution reported in MEDITS (2007-2023) survey data, with plus group set at age 5.

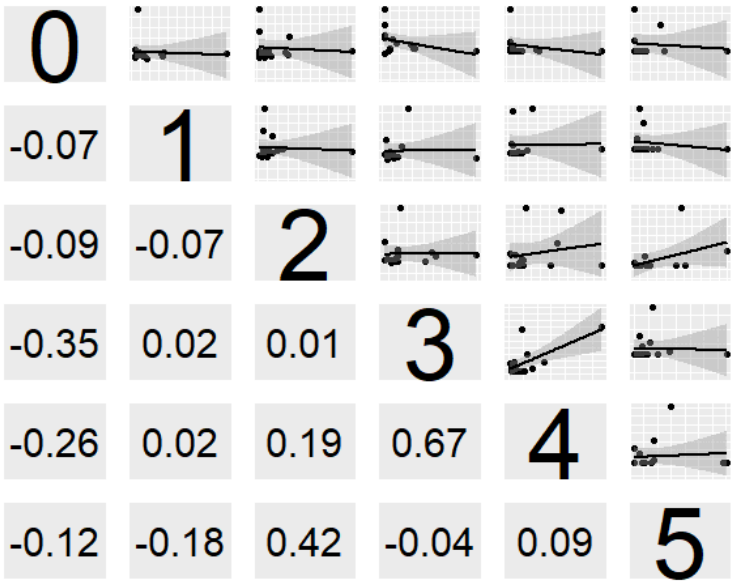


Figure 6.4.2.2.5. Striped red mullet in GSA 5. Cohort consistency for the MEDITS data with age estimated from length frequency distribution reported in MEDITS (2007-2023) survey data, with plus group set at age 5.

6.4.3 STOCK ASSESMENT

Two different approaches were considered: A Statistical-catch-at-age (a4a) assessment using catch data collected under DCR-DCF from 2002 to 2023 and calibrated with survey data (MEDITS 2007-2023) and a Production model (SPiCT) using historical catch and effort data collected during the RECFISH project (Recovery of fisheries historical time series for Mediterranean and Black Sea stock assessment, EASME/EMFF/2016/032 Specific Contract No.01) from 1968 to 2017 and updated with the most recent information. The provision of advice was based on a4a and SPiCT results were considered complementary information.

- **a4a**

FLR libraries were employed in order to perform the analyses. Input parameters used were those described in previous sections. Given that the catches were composed mainly of individuals between 1 and 3 years, these ages were selected as the F_{bar}. For the survey index, ages considered in the assessment were between 0 and 3.

The assessment was performed by sex combined. Several model settings were considered in the assessment, combining several possibilities for each of the sub-models, following the models tried in the previous year. All the models run are summarized in Table 6.4.3.1.

Table 6.4.3.1. Striped red mullet in GSA 5. Description of the different models run, showing the sub-models for fishing mortality, catchability and recruitment.

Model	Fishing mortality sub-model	Catchability sub-model	Recruitment sub-model
1*	~s(replace(age,age>2,2), k=3) + s(year,k=10)	list(~ factor(replace(age,age>2,2)))	~factor(year)
2	~ factor(age) + s(year, k=10)	list(~factor(age))	~factor(year)
3	~factor(replace(age, age > 4, 4)) + s(year, k=10)	list(~factor(replace(age,age>2,2)))	~factor(year) ~geomean(CV = 0.25)
4**	~factor(replace(age, age > 3, 3)) + s(year, k=5)	list(~factor(replace(age,age>2,2)))	~factor(year) ~geomean(CV = 0.25)
5	~s(replace(age, age > 3, 3),by = breakpts(year, 2012),k=3) + s(year, k=10)	list(~factor(replace(age,age>2,2)))	~factor(year) ~geomean(CV = 0.25)
6	<- ~s(age, k=3) + s(year, k=10) + s(year, k=10, by=as.numeric(age==0))	list(~factor(replace(age,age>2,2)))	~factor(year) ~geomean(CV = 0.25)

* Model used in EWG 20 09.

**Additional runs were carried out considering k between 5 and 11.

** Models 12 and 13 were run removing age 0 from the catch matrix.

The final model considered was:

fmodel: ~factor(replace(age, age > 4, 4)) + s(year, k=10)

qmodel: list(~factor(replace(age,age>2,2)))

srmodel: ~geomean(CV = 0.25)

Results are shown in Figures 6.4.3.1-6.4.3.5. Both catches and F show a clear decreasing trend since 2020. Recruitment and SSB showed an increase in the last year. Residuals did not show any strong trend. The fit for the model was good for the catch-at-age and a bit poorer for the survey index.

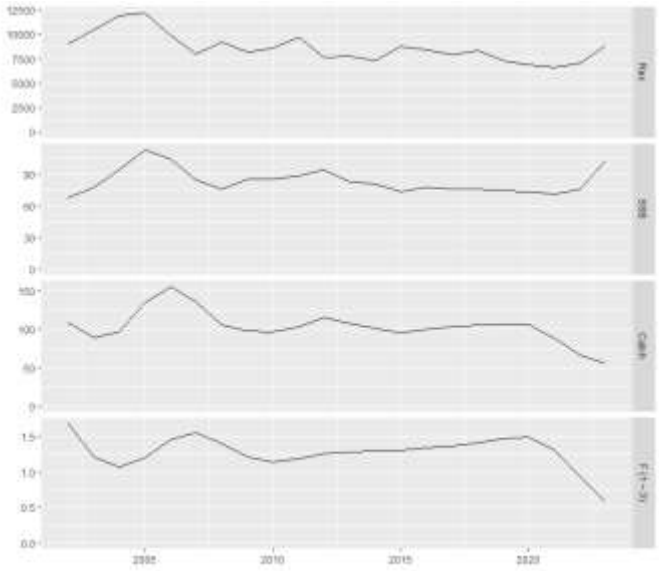


Figure 6.4.3.1. Striped red mullet in GSA 5. Stock summary from the final a4a model.

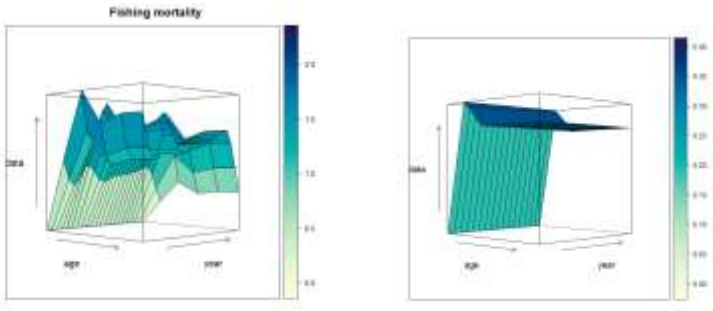


Figure 6.4.3.2. Striped red mullet in GSA 5. 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated survey catchability (right) at age and year.

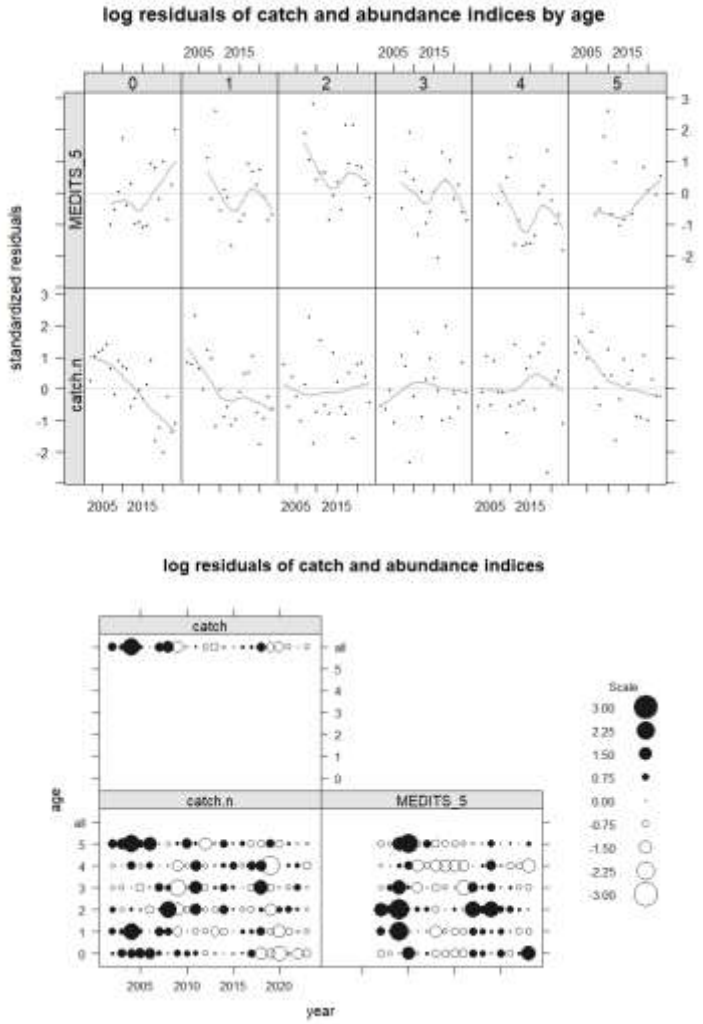


Figure 6.4.3.3. Striped red mullet in GSA 5. Standardized residuals for abundance indices and for catch numbers.

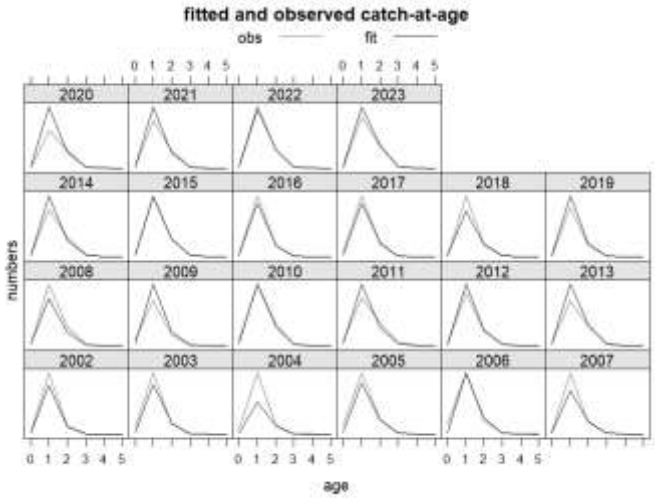


Figure 6.4.3.4. Striped red mullet in GSA 5. Fitted and observed catch at age.

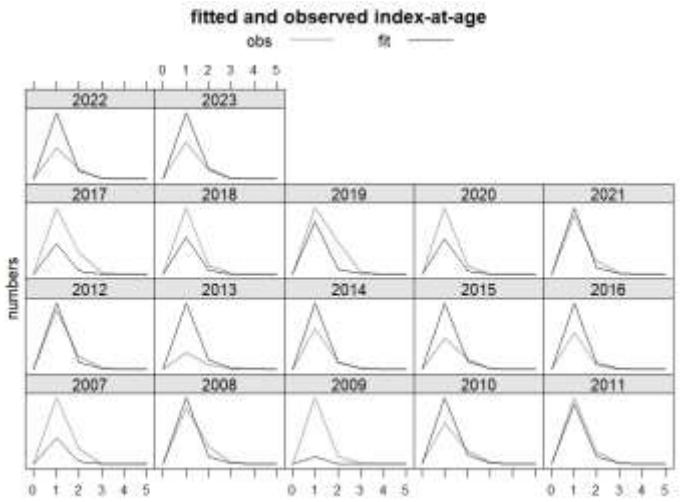


Figure 6.4.3.5. Striped red mullet in GSA 5. Fitted and observed index at age.

Retrospective

The retrospective analysis was applied up to 4 years back and the results were considered adequate (Figure 6.4.3.6).

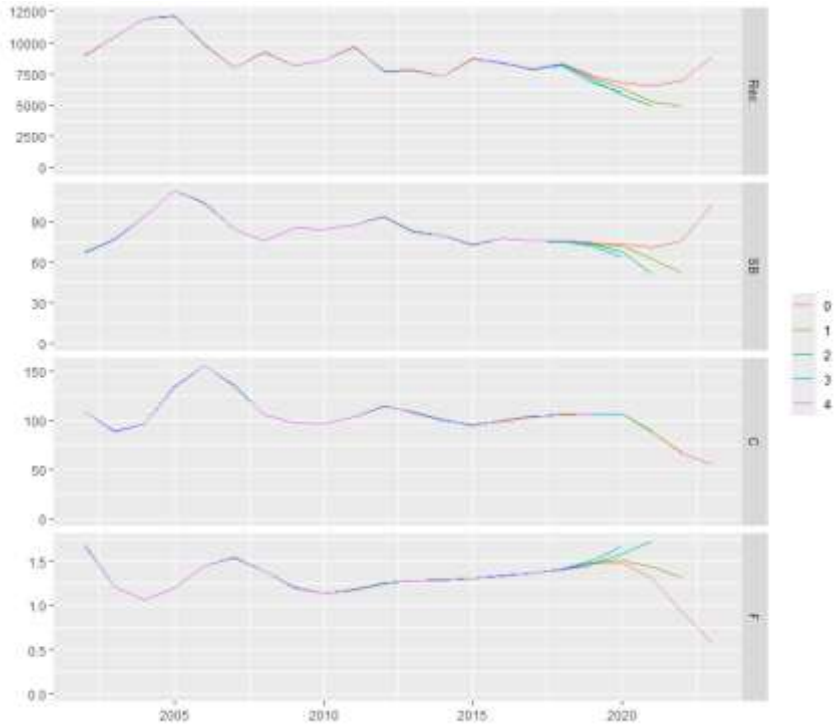


Figure 6.4.3.6. Striped red mullet in GSA 5. Retrospective analysis.

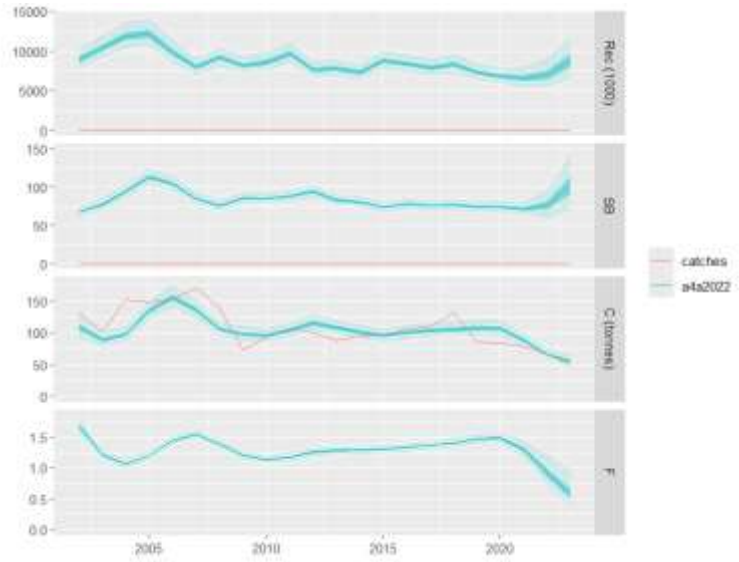


Figure 6.4.3.7. Striped red mullet in GSA 5. Simulations over summary results. Blue line represents the observed catches.

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

Table 6.4.3.2. Striped red mullet in GSA 5. Stock numbers at age (thousands) as estimated by a4a.

	0	1	2	3	4	5
2002	8958.60	2998.20	314.36	27.52	1.86	0.11
2003	10512.00	2830.00	394.63	18.30	2.97	0.20
2004	11878.00	3331.40	521.90	42.25	3.17	0.52
2005	12147.00	3773.20	675.11	67.57	8.40	0.71
2006	9897.40	3854.60	696.30	73.61	11.86	1.52
2007	8009.70	3135.20	601.51	54.79	10.03	1.70
2008	9229.00	2535.90	456.51	41.53	6.80	1.34
2009	8176.30	2924.20	409.22	38.60	5.99	1.11
2010	8601.10	2595.60	536.55	44.53	6.74	1.17
2011	9686.50	2730.00	500.97	63.87	8.23	1.41
2012	7655.50	3070.50	511.79	55.91	11.31	1.65
2013	7791.60	2426.80	546.42	51.94	9.20	2.04
2014	7318.80	2470.90	424.58	53.31	8.29	1.73
2015	8814.20	2322.50	430.36	41.27	8.52	1.51
2016	8410.50	2792.70	399.29	41.11	6.46	1.50
2017	7939.70	2665.00	466.95	36.40	6.22	1.15
2018	8311.50	2516.50	436.24	40.84	5.36	1.03
2019	7317.10	2632.80	401.97	36.58	5.78	0.86
2020	6837.90	2317.30	403.55	30.55	4.84	0.83
2021	6544.30	2164.50	352.31	30.48	4.02	0.68
2022	6994.10	2073.30	372.19	33.24	4.75	0.69
2023	8656.70	2220.60	461.27	57.41	7.52	1.21

Table 6.4.3.3. Striped red mullet in GSA 5. a4a summary results.

Year	Recruitment	SSB	Catch	Fbar
2002	8989	67.3	108.4	1.67
2003	10481	76.9	88.4	1.21
2004	11861	93.7	97.4	1.06
2005	12171	112.7	135.7	1.20
2006	9949	104.2	155.8	1.45
2007	7988	84.9	136.4	1.55
2008	9195	75.3	105.8	1.39
2009	8163	85.2	97.9	1.20
2010	8601	84.7	96.6	1.13
2011	9641	87.9	103.8	1.18
2012	7666	93.5	115.3	1.25
2013	7768	82.4	108.0	1.28
2014	7317	80.1	101.0	1.28
2015	8707	73.2	95.4	1.30
2016	8331	77.0	100.2	1.34
2017	7911	75.5	103.9	1.37
2018	8290	75.8	105.7	1.41
2019	7340	73.8	106.5	1.47
2020	6830	73.9	107.2	1.49
2021	6587	70.7	88.8	1.30
2022	6976	75.5	66.2	0.93
2023	8944	102.4	55.8	0.57

Based on the a4a results, the striped red mullet in the GSA 5 showed the largest values at the beginning of the time series (90-110 t, 2004-2006), very stable values between 2007 and 2022 (70-90 t) and an increase in 2023 (103 t). For Recruitment, the trend was similar, with the largest values for 2003-2005 (10-12 millions), with a general decreasing trend for the entire series, with the minimum values in 2020-2022 (6.7-7.0 millions), and an increase in 2023 (8.9 millions). F_{bar} (1-3) showed oscillations between 2002 and 2010 (minimum 1.06, maximum 1.67), a slight increasing trend until 2020 and a clear decreasing trend since tend, with the minimum historical value in 2023 (0.58).

- **SPiCT**

Input data were catches and effort collected during the RECFISH project from 1968 to 2017 and updated with the most recent information (Figure 6.4.3). Effort consisted in annual horse power of the fleet. In addition to this, more recent effort data were used days of the fleet targeting the shallow shelf, where the striped red mullet inhabits, calculated i) from the Vessel Monitoring System (2006-2023) and ii) from the daily sale bills of the fleet (2000-2023). The three sources of effort data were combined using Bcrumb (Winker et al., 2018) (Figure 6.4.3.9)

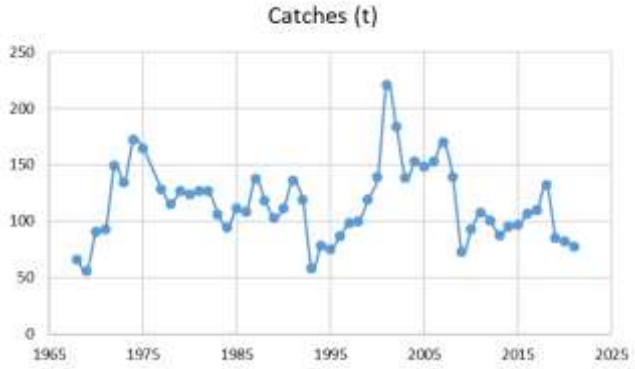


Figure 6.4.3.8. Striped red mullet in GSA 5. Historical catches data.

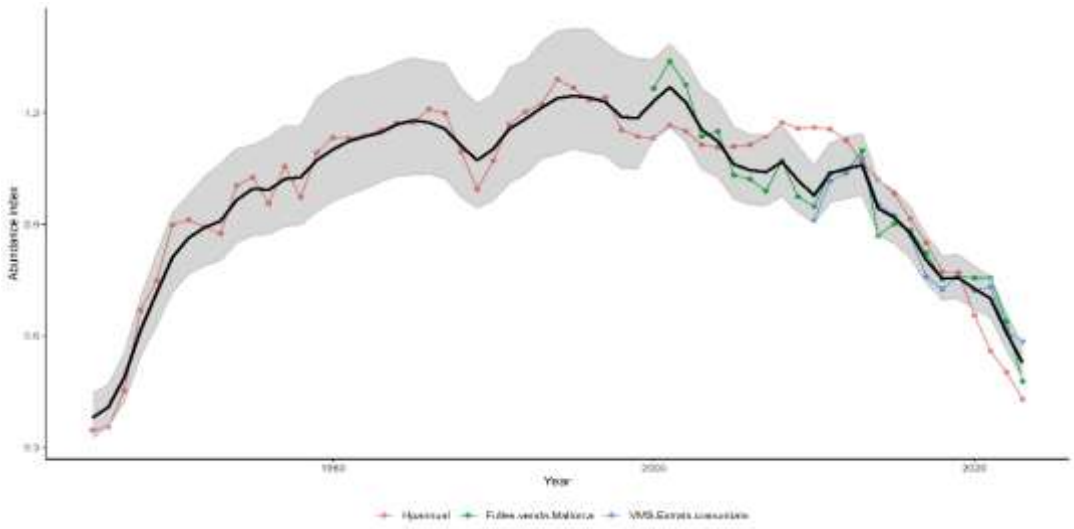


Figure 6.4.3.9. Striped red mullet in GSA 5. Results of Bcrumb with the three effort time series used (annual HP in red, fishing days in the shallow shelf from VMS in blue and fishing days from daily sale bills in red) and their combination (black).

The priors used in the model were those already applied in the RECFISH assessment, as follows:

Bk.pr=0.87,0.1,1

fdevs=c(0.4, 0.5, 1)

Oe (survey)= 0.4

Oe (cpue)=0.3

pe=0.15, 0.3, 1

r.pr1=0.48, 0.471

The results from the assessment are summarized in Figures 6.4.3.10-6.4.3.13. The results show a similar trend than the ones from a4a, with values of F decreasing, although this decrease started before in time (2012) but is more abrupt since 2020.

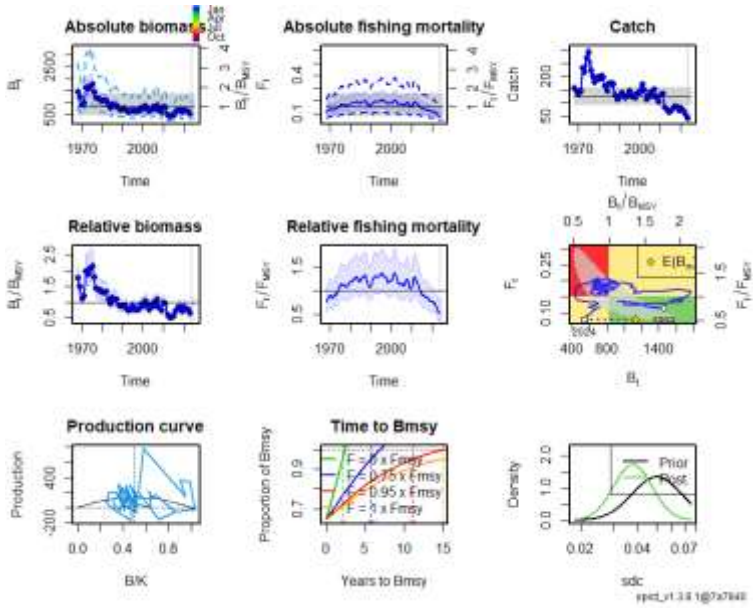


Figure 6.4.3.10. Striped red mullet in GSA 5. Results of the assessment carried out using SPiCT.

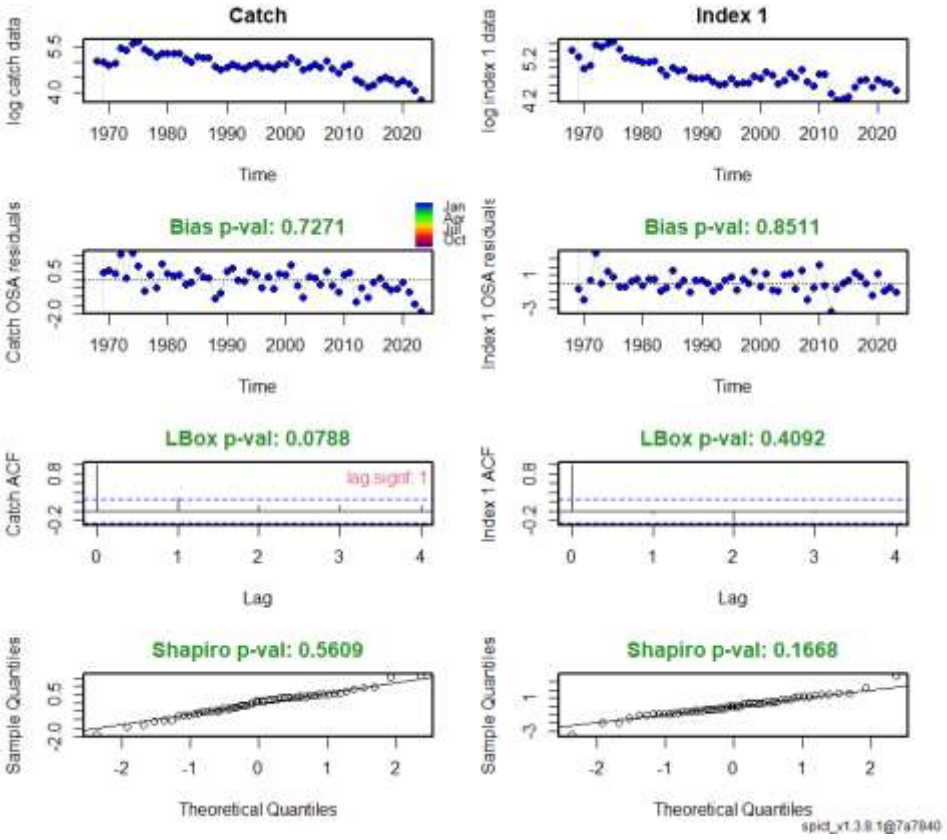


Figure 6.4.3.11. Striped red mullet in GSA 5. Residuals of the model.

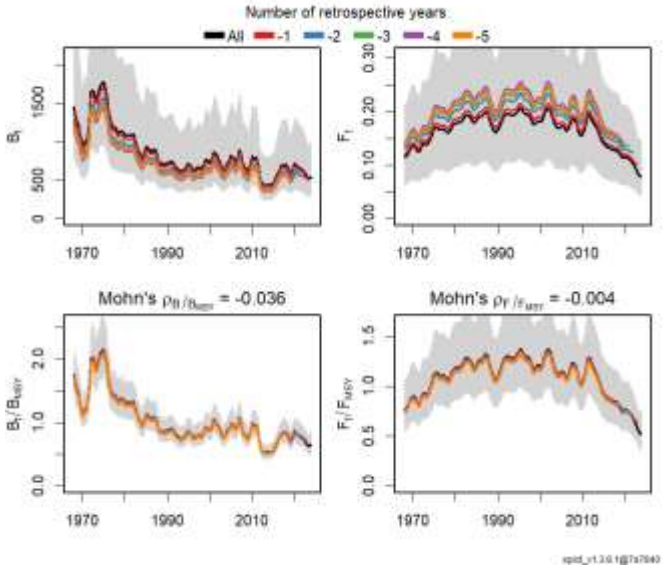


Figure 6.4.3.12. Striped red mullet in GSA 5. Retrospective analysis.

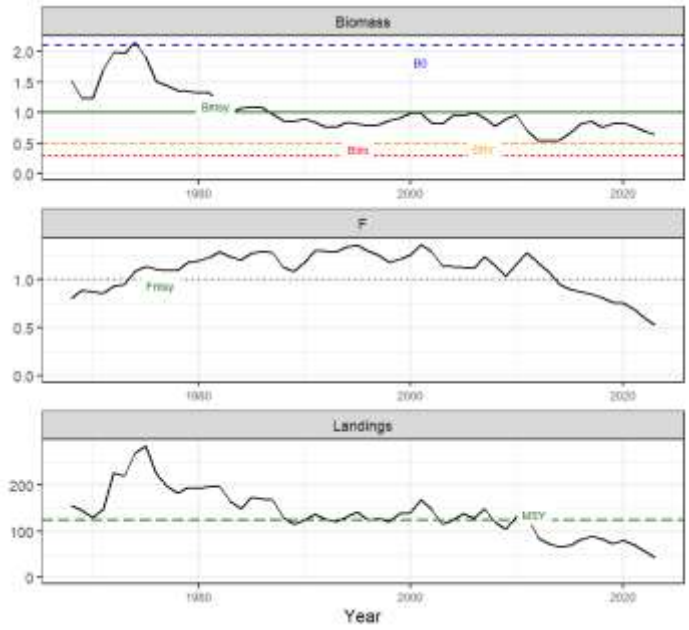


Figure 6.4.3.13. Striped red mullet in GSA 5. Reference points as calculated from SPiCT.

6.4.4 REFERENCE POINTS

For a4a, the time series is too short to fit a stock recruitment relationship, therefore reference points are based on equilibrium methods. The STECF EWG 18-02 recommended using $F_{0.1}$ as a proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the a4a assessment. Current F (0.57, corresponding to the F of the last year of the time series) is 1.25 times higher than $F_{0.1}$ (0.46), chosen as a proxy for F_{MSY} and as the exploitation reference point consistent with high long-term yields. This indicates that striped red mullet in GSA 1 is over-exploited, but a low level.

6.4.5 SHORT TERM FORECAST AND CATCH OPTIONS

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age and maturity at age, while the F_{bar} =0.57 (the last year's F estimated by the assessment model) was used for F in 2024, as F shows a decreasing trend (See section 4.3). The geometric mean of the last three years of the time series of recruitment was used (7408).

Table 6.4.5.1 Striped red mullet in GSA 5: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	mean weights at age, maturation at age, natural mortality at age and selection at age, are based average of years 2021-2023
Fages 1-3 (2024)	0.57	The F estimated in 2023 was used to give F status quo for 2024
SSB (2024)	140.5	SSB intermediate year from STF output
Rage0 (2024,2025)	7408	Geometric mean of the last 3 years
Total Catch (2024)	77.4	Assuming F status quo for 2024

Table 6.4.5.2 Striped red mullet in GSA 5: Short term forecast in different F scenarios.

Basis	Total catch (2025)	F_{total} (ages 1-3) (2025)	SSB (2026)	% SSB change**	% Catch change^
STECF advice basis					
F_{MSY}	73.4	0.46	166.58	14.49	32.95
Other scenarios					
$F_{MSY\ Transition}$ ^^	73.4	0.46	166.58	14.49	32.95
$F_{MSY\ lower}$	52.2	0.31	194.76	33.86	-5.39
$F_{MSY\ upper}$*	93.6	0.63	141.72	-2.6	69.57
Zero catch	0.0	0	273.22	87.79	-100
Status quo	84.0	0.54	153.35	5.4	52.06
Different scenarios	10.4	0.05	256.63	76.39	-81.19
	20.3	0.11	241.31	65.86	-63.3
	29.7	0.16	227.14	56.12	-46.28
	38.6	0.22	214.04	47.11	-30.1
	47.1	0.27	201.91	38.78	-14.69
	55.2	0.33	190.68	31.06	-0.02
	62.9	0.38	180.27	23.91	13.95
	70.3	0.44	170.62	17.27	27.27
	77.3	0.49	161.67	11.12	39.96
	90.3	0.6	145.63	0.09	63.61
	96.4	0.65	138.44	-4.85	74.63
	102.2	0.71	131.75	-9.44	85.15
	107.8	0.76	125.52	-13.73	95.2
	113.1	0.82	119.72	-17.72	104.8
	118.2	0.87	114.3	-21.44	113.97
	123.0	0.93	109.24	-24.92	122.75
	127.6	0.98	104.51	-28.17	131.14
	132.1	1.03	100.09	-31.21	139.17
	136.3	1.09	95.95	-34.05	146.86

6.5 RED MULLET IN GSA 6

6.5.1 STOCK IDENTITY AND BIOLOGY

Red mullet, benthic species that inhabits coastal waters, is among the main demersal fishing target species in the Mediterranean fisheries. Its fishing displays characteristics which typically define the Mediterranean fisheries, that is, marked seasonality, strong dependence on recruitment, and exploitation based on a very small number of age classes, basically age classes 1 and 2.

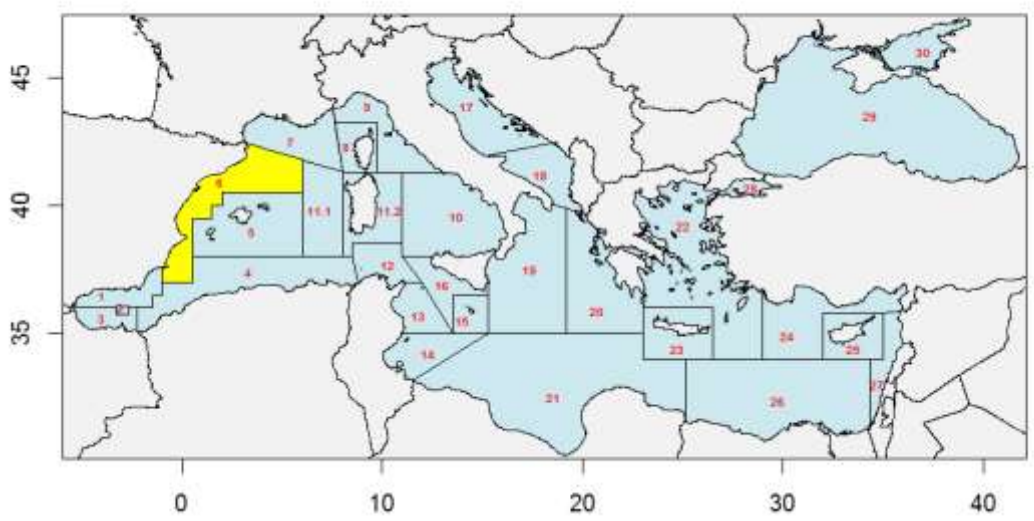


Figure 6.5.1.1 Red mullet in GSA 6: Location of GSA 6 in the Mediterranean Sea.

The red mullet's genetic distribution was found to be highly structured, resembling that of a meta-population composed by independent, self-recruiting sub-populations with some connections between them. This species showed significant genetic differentiation across Cabo de Gata (GSA 1)- Blanes (northern GSA 6)- Italy (GSA 9) comparisons (Galarza *et al.* 2009).

Gonadal maturation and spawning take place in late spring (May-June in the western Mediterranean). Larvae are found in the plankton during June-July in the upper levels of the water column, above thermocline. Horizontal and vertical distribution of larvae showed good correspondence with that of cladocera, their preferential prey from 8 mm standard length. Prey items consumed by the smallest size classes of larvae <8 mm SL were dominated by copepod nauplii, then diet and prey selectivity shifted towards the cladoceran *Evadne* spp. (Sabatés and Palomera 1987; Sabatés *et al*. 2015).

M. barbatus is a batch spawner with an income breeding strategy (continues feeding throughout the spawning period), an asynchronous development of oocytes and indeterminate fecundity (Ferrer-Maza *et al.* 2015). Recruitment to the benthic life on coastal bottoms takes place during a well-defined season, in summer and early autumn (Lloret and Lleonart, 2002), in relation to the short spawning period. The maximum abundance and frequency of pre-adults and adults occurs on muddy bottoms in waters between 50 and 200 m deep (Lombarte *et al.* 2000). Red mullet feeds on small benthic crustaceans, worms and molluscs (Hureau 1986). Size groups (that correspond to different cohorts) are concentrated in specific areas. The massive presence of the O+ year class, very close to the coast immediately after recruitment to the bottom (in late summer) is followed by a dispersal towards deeper waters (Suau and Vives 1957; Voliani et al 1998).

Maturity

Red mullet has a short spawning period of around two months (May-June). The EWG assumed that age0 corresponds to juveniles and at age1 all individuals will spawn, that is, are mature the spawning season following the spawning season when they were born.

Age	0	1	2	3	4

Proportion mature	0	1	1	1	1

Growth

The growth parameters submitted by the MS did not fit the observed length-at-first maturity and spawning timing because of the very negative t_0 values. EWG-20-02 used DCF supplied vBGF estimates as the median values across the DCF dataset: Linf = 35.0, k= 0.17, t0= -2.81 (sexes combined), but concentrated on producing LFDs with the responsibility for selecting growth being allocated to the assessment EWG. According to these parameters, by the end of the first year (12 months) the fish length would be much larger than that at first maturity (around 11-12 cm TL; ICES 2012). Thus, the growth parameters proposed by Demestre *et al.* 1997 were selected to be used in the assessment of the stock (Linf=34.5, k=34, t_0=-0.14), as in previous EWG assessments. The parameters of the length-weight relationship were a=0.0096 and b=3.04 (DCF (2017), the same as used in the previous EWG23-09 assessment.

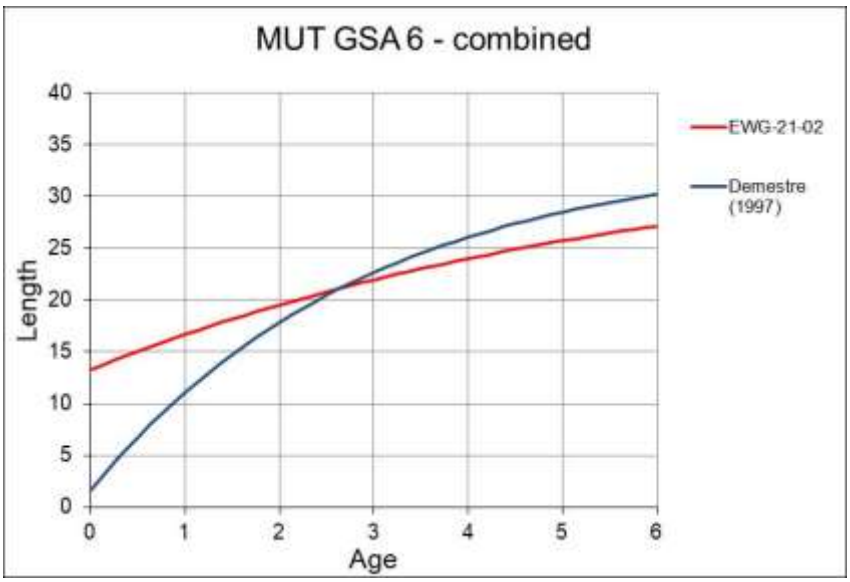


Figure 6.5.1.2 Red mullet in GSA 6: Growth curves according to the parameters used by EWG-21-02 and Demestre *et al.* (1997).

Natural mortality vector

M vector was estimated with the method proposed by Chen and Watanabe (1989).

Age	0	1	2	3	4
M	1.74	0.8	0.57	0.48	0.43

6.5.2 DATA

6.5.2.1 CATCH (LANDINGS AND DISCARDS)

Landings: Missing LFDs were reconstructed for the two main fleets with catches of MUT in GSA06. For GTR_NA 2002-2008 the median LFDs of GTR_DEMSP 2009-2023 were used. LFDs for the metier OTB_MDD (2009-2023) were reconstructed from the median OTB_DEMSP LFDs, applying SOP correction.

Discards: LFDs were available for 2017-2023 for OTB_DEMSP. The median was used to reconstruct discards LFD for the two metiers OTB_NA and OTB_MDD. No discards are reported for GTR but they can be considered negligible.

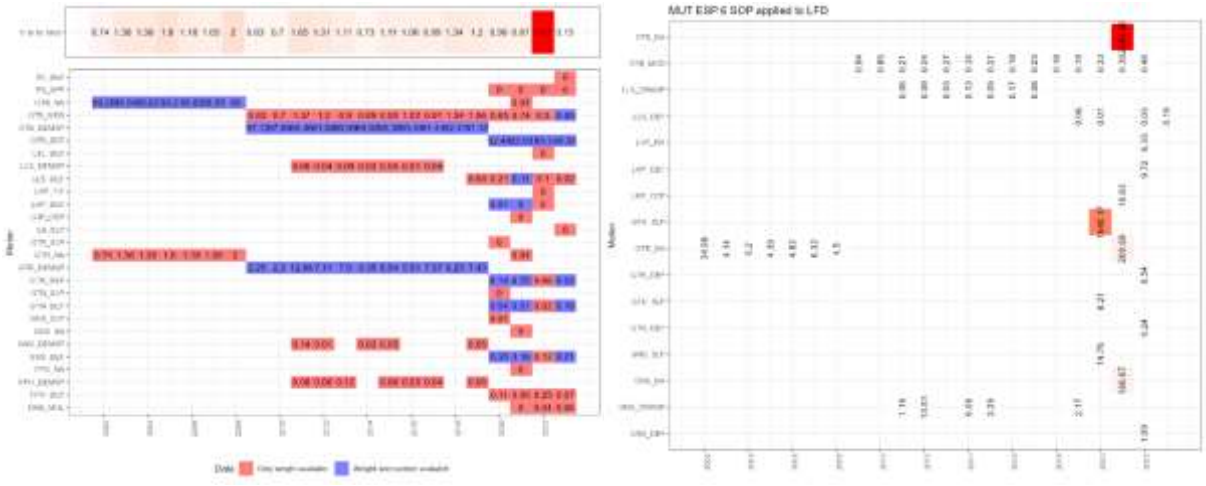


Figure 6.5.2.1.1 Red mullet in GSA 6: Summary of the reconstruction of landings and discards data carried by EWG-24-10.

Red mullet landings in GSA 6 come predominantly from OTB; a small amount is reported for small-scale fishing gears (trammel-net). Red mullet discards come from OTB. Landings from small-scale gears other than entangling nets may be a mistake when coding the fishing gear.

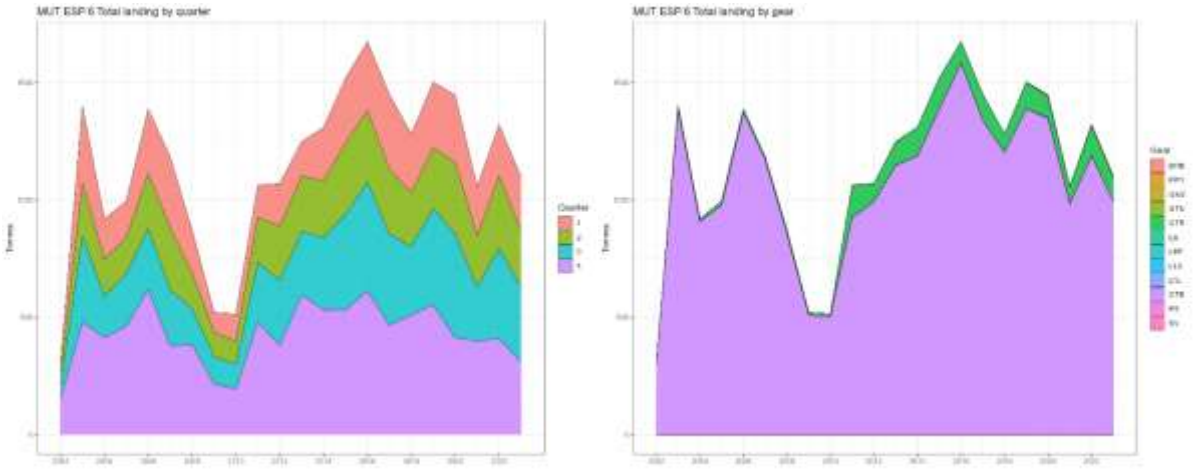


Figure 6.5.2.1.2 Red mullet in GSA 6: Landings (t) by quarter (left) and gear (right) over 2002-2023 data carried by EWG-24-10.

Table 6.5.2.1.1 Red mullet in GSA 6. Landings (t) by fishing gear over 2002-2023 (tonnes; FPO=pots and traps; GNS=gillnet; GTN= combined gillnets-trammel nets; GTR=trammel net; LHP= pole lines; LLS=longlines; PS=purse seine; DRB:drags; SV=boat seine OTB=otter bottom trawl).

	FPO	GNS	GTN	GTR	LHP	LLS	PS	DRB	SV	OTB	LANDINGS
2002				2.3						303.1	305.4
2003				19						1381	1400
2004				12.7						906.8	919.5
2005				17.9						977.1	995
2006				16.4						1371.4	1387.8
2007				12.5						1171.1	1183.6
2008				17.5						854.6	872.1
2009				11.7						509.2	520.9
2010				11.3						502.8	514.1
2011	0.9	1.5		137		0.6				923.1	1063.1
2012	0.6	0.1		76.1		0.4				992.7	1069.9
2013	1.5			98.6		1.2				1146.7	1248
2014		0.3		122.4		0.3				1186.2	1309.2
2015	0.9	0.8		129.7		0.8				1386.5	1518.7
2016	0.6			92.2		0.2				1580.9	1673.9
2017	0.6			109.8		0.5				1338.4	1449.3
2018				80						1200.7	1280.7
2019	0.7	0.8		111.6		0.5				1388.2	1501.8
2020	1.6	5.1	0.6	88.8	0.1	3				1347	1446.3
2021	0.5	1.9	0.1	71.3		1.2				981.7	1056.7
2022	3.28	0.009		129.5	0.003	1.33	0.006	0.574		1186.5	1321.202
2023	0.77	2.26	1.94	101.45	0.02	0.21	0.007	0.695	0.003	993.1	1100.5

Table 6.5.2.1.2 Red mullet in GSA 6. Discards (t) by fishing gear (left) and total catch (right) over 2002-2023 (tonnes; GNS=gillnet; GTR=trammel net; OTB=otter bottom trawl).

	GNS	GTR	OTB	DISCARDS
2002			0	0
2003			0	0
2004			0	0
2005			0.01	0
2006			0	0
2007		0	0	0
2008			0.08	0.1
2009		0	0	0
2010		0	0.4	0.4
2011	0	0	5.4	5.4
2012	0	0	21.9	21.9
2013		0	14.2	14.2
2014	0	0	3.3	3.3
2015	0	0	51.5	51.5
2016		0	30.2	30.2
2017		0	14.7	14.7
2018		0	43.9	43.9
2019	0	0	1.8	1.8
2020	0	0	7.7	7.7
2021	0	0	9.7	9.7
2022	0	0	6.7	6.7
2023	0	0	14.87	14.87

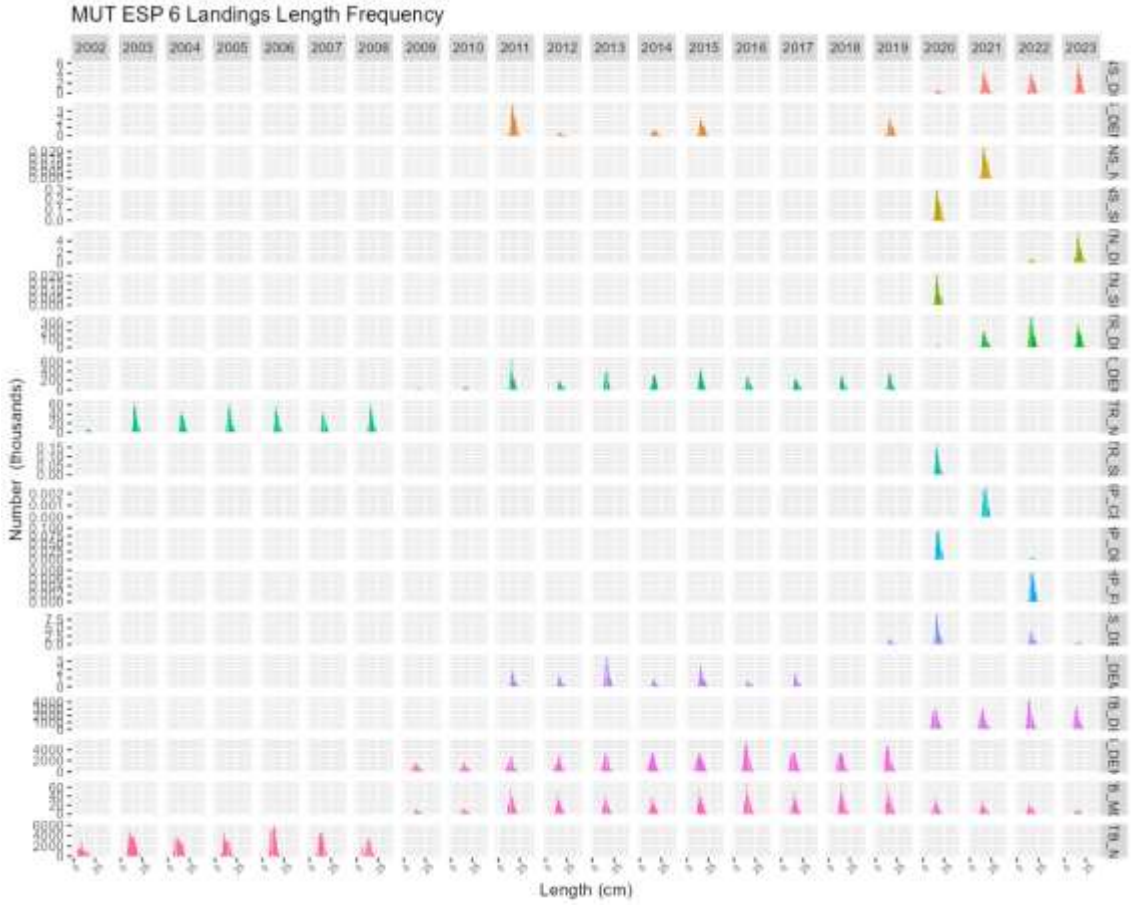


Figure 6.5.2.1.3 Red mullet in GSA 6. Landings length frequency distribution by gear and year (TL cm). LFDs until 2023 as reconstructed by EWG24-10.

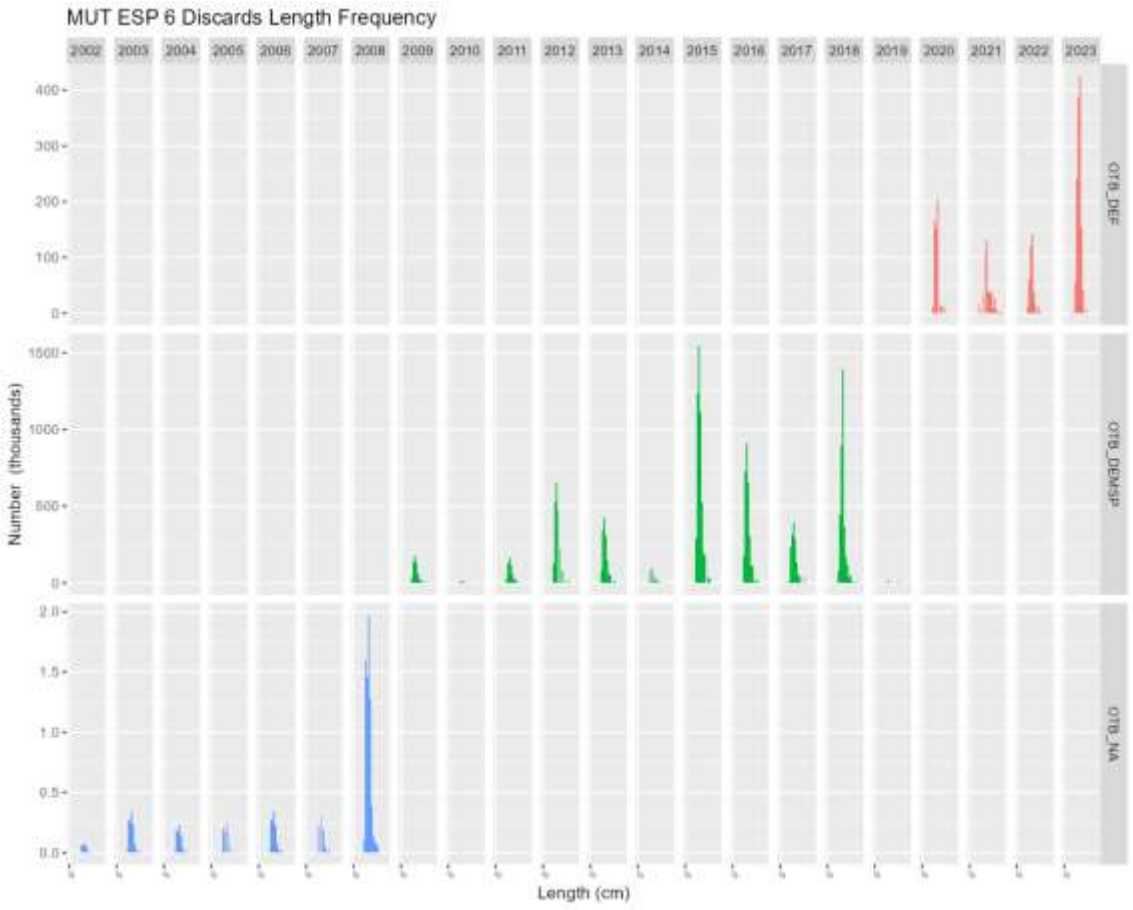


Figure 6.5.2.1.4 Red mullet in GSA 6. Discards length frequency distribution, by year (TL cm). LFDs until 2023 as reconstructed by EWG24-10.

SOP correction was applied in the preparation of the input data for the a4a assessment. The 2020 value was high because no measurements were available for the second quarter and in the fourth quarter, and the landings were not raised, numbers provided were around half of those the previous year 2019

Table 6.5.2.1.3 Red mullet in GSA 6. SoP correction.

2002	2003	2004	2005	2006	2007	2008	2009
1.13414	1.12727	1.10732	1.1111	1.1222	1.11158	1.10669	1.14905
2010	2011	2012	2013	2014	2015	2016	2017
0.96092	1.27796	1.1439	1.15113	1.1552	1.13475	1.14254	1.14979
2018	2019	2020	2021	2022	2023		
1.0943	1.06827	1.50592	1.10398	1.10636	1.108177		

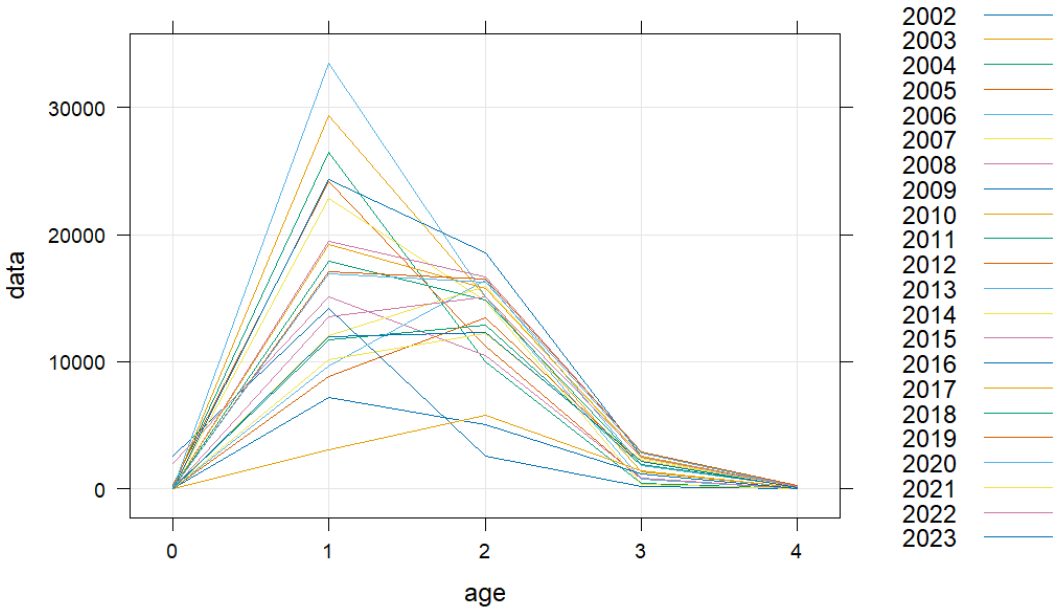


Figure 6.5.2.1.5 Red mullet in GSA 6. Catch at age, input to a4a.

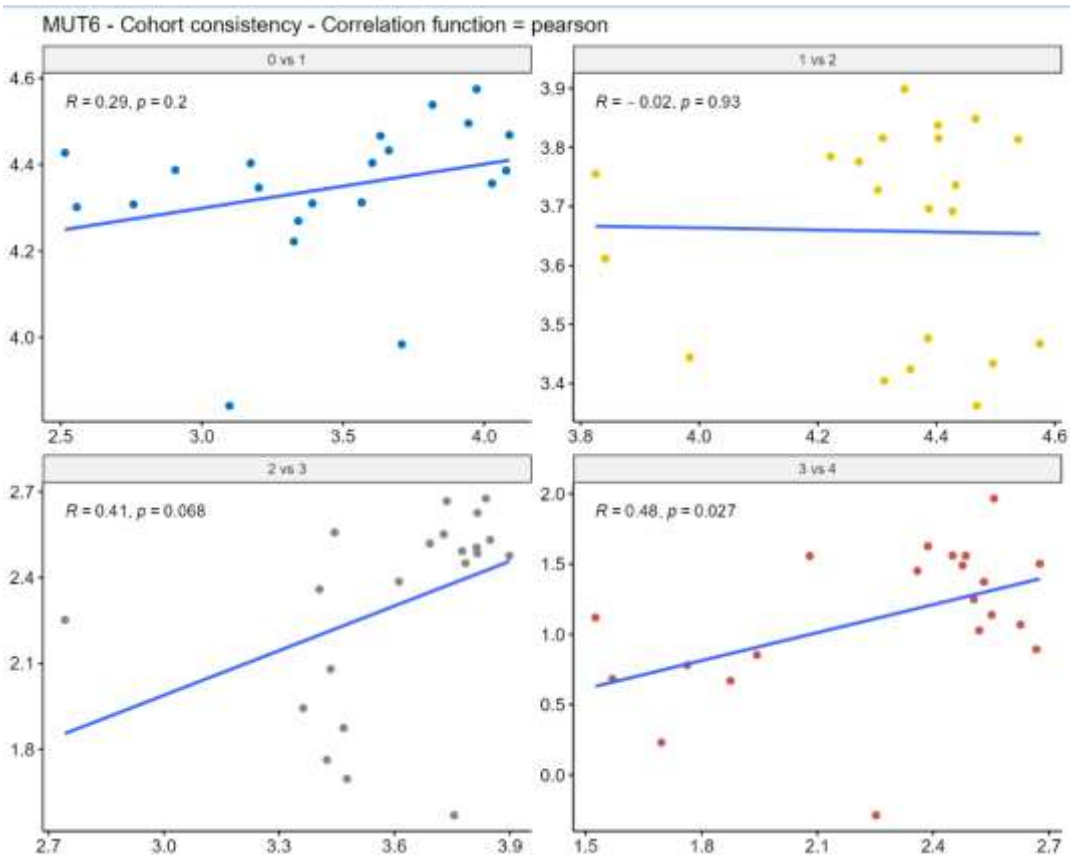


Figure 6.5.2.1.6 Red mullet in GSA 6. Cohorts internal consistency in the catch.

6.5.2.2 EFFORT

No new effort data were available to STECF EWG 24-10 so this section has not been updated.

6.5.2.3 SURVEY DATA

Survey indices used in this assessment originate from the MEDITS bottom trawl survey. This survey was carried out regularly in late spring, in May-June, over the period 1994-2023 (Fig. 6.5.2.3.1). In 2023 the survey coverage was similar as that previous to 2020, when because of covid-19 half of the usual survey area was covered (Fig.6.5.2.3.2).



Figure 6.5.2.3.1 MEDITS survey period in GSA 6.

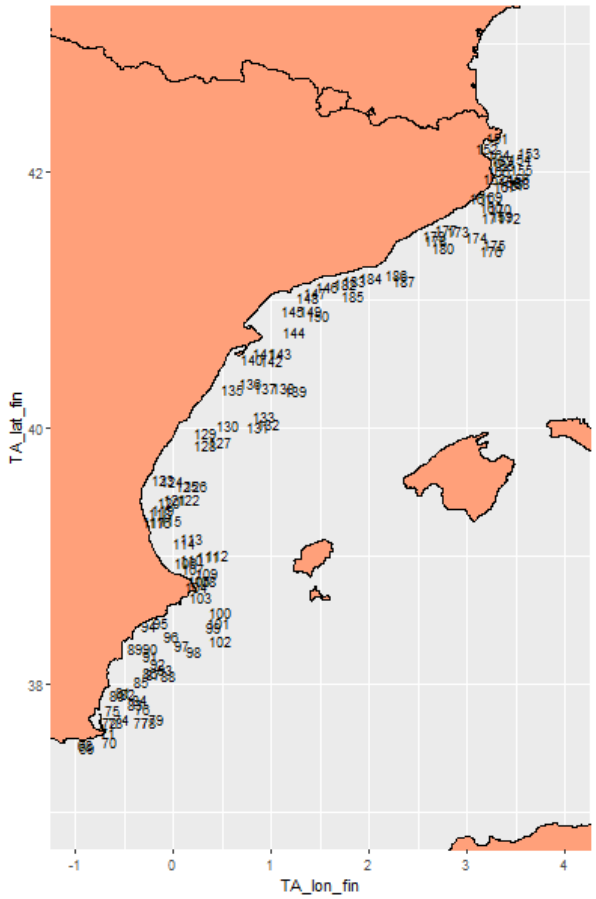


Figure 6.5.2.3.2 MEDITS survey in GSA 6 in 2023, hauls position.

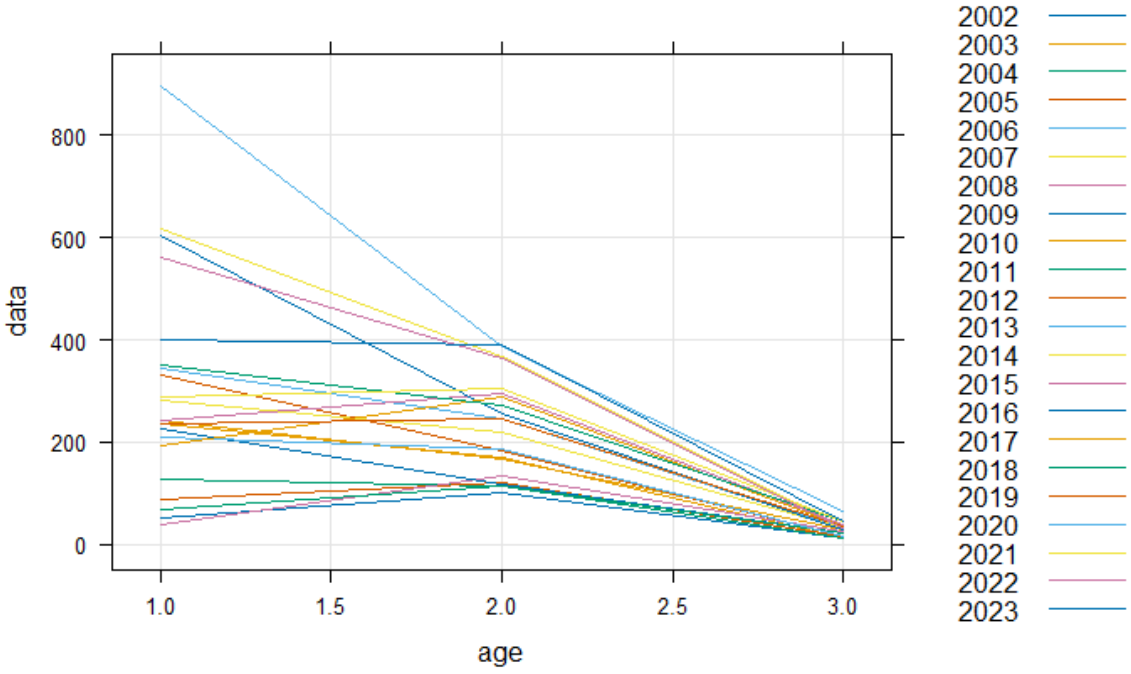


Figure 6.5.2.3.3 MEDITS catches at age structure in GSA 6.

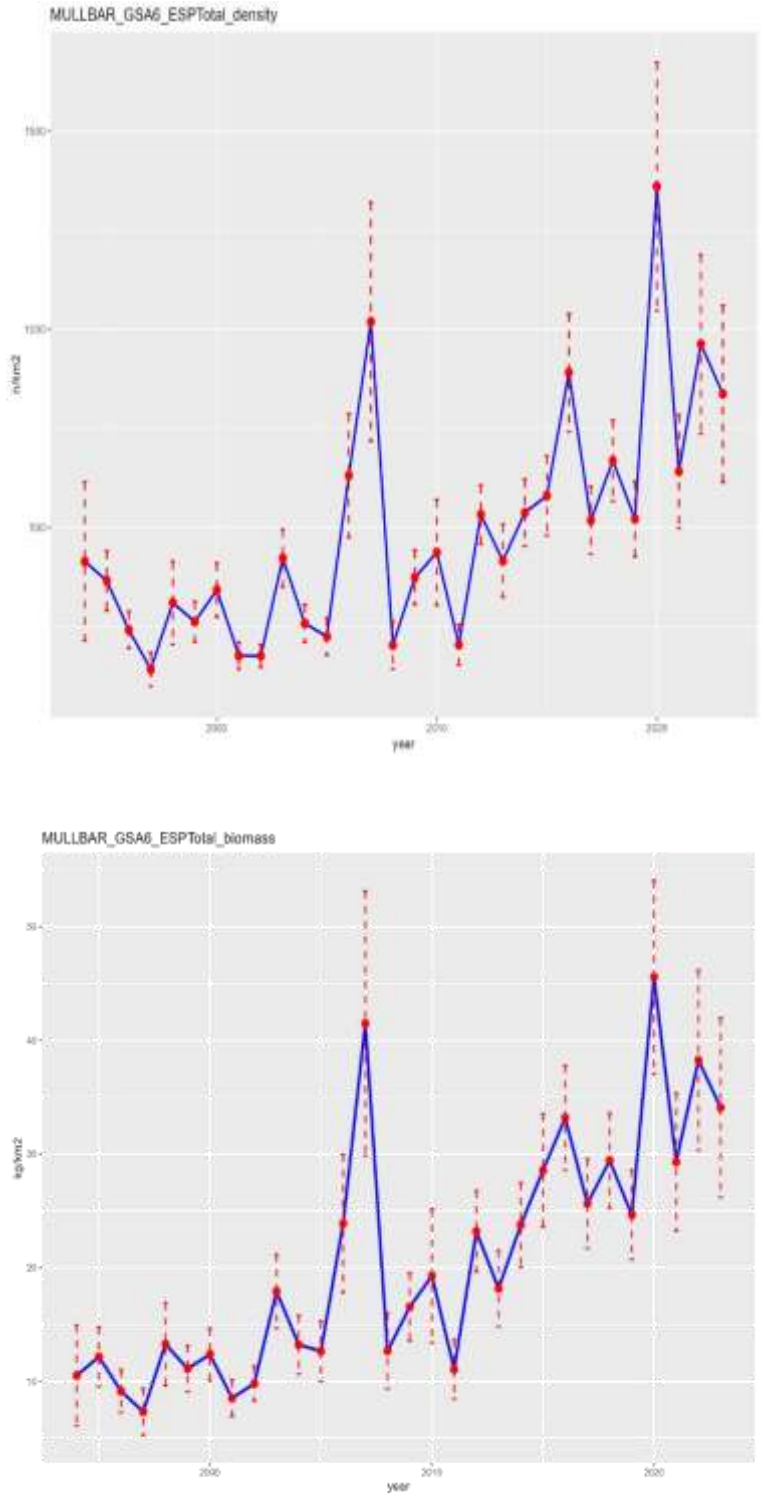


Figure 6.5.2.3.4 Red mullet in GSA 6. MEDITS abundance (n/km^2) (Top) and biomass (kg/km^2) (Bottom) over 1994-2023.

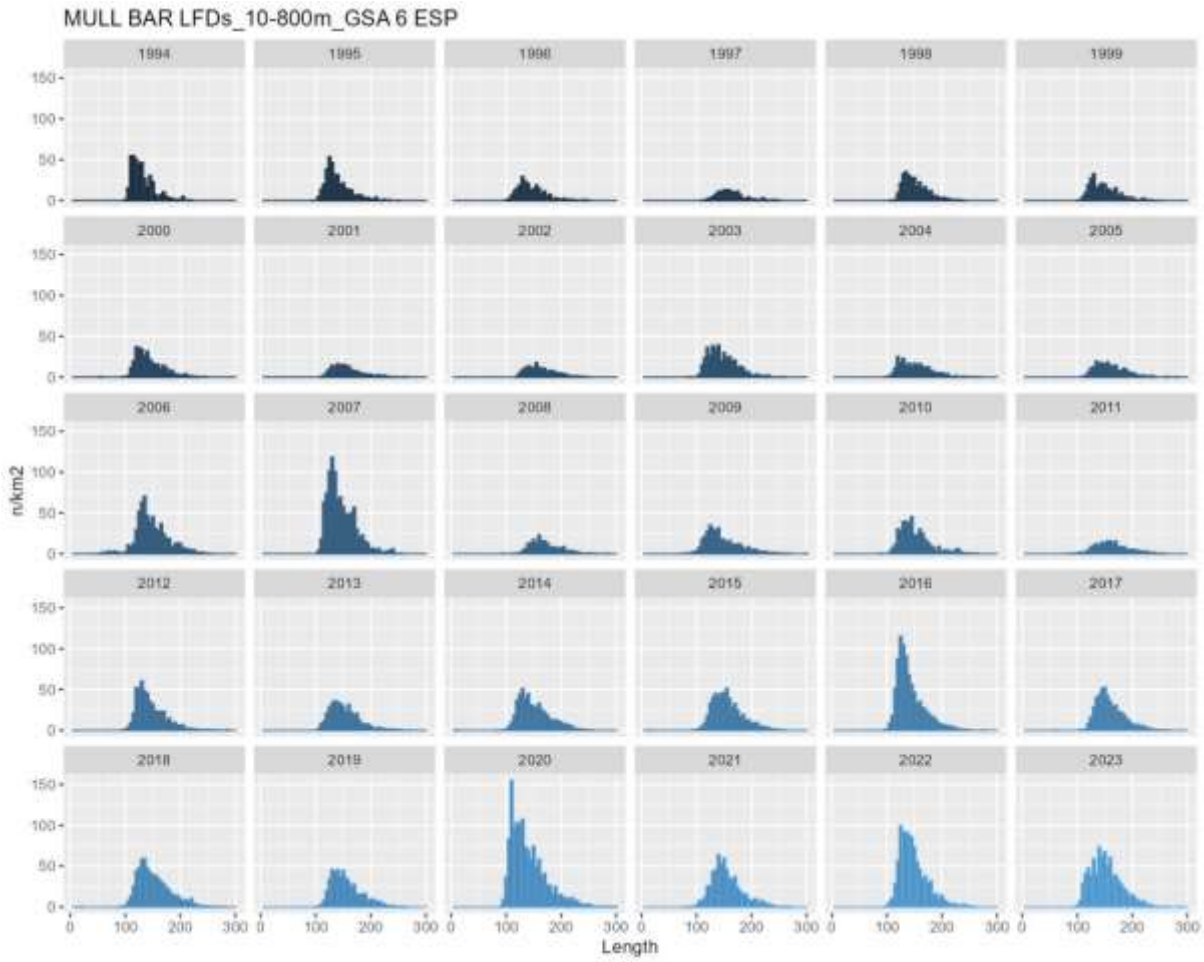


Figure 6.5.2.3.5 Red mullet in GSA 6. MEDITS total length frequency distribution n/km^2).

Table 6.5.2.3.1 Red mullet in GSA 6. MEDITS age structure

age	2002	2003	2004	2005	2006	2007	2008	2009
1	53.481	237.528	128.474	86.663	345.811	615.798	38.557	227.503
2	101.45	170.587	115.399	122.113	247.425	367.867	135.723	118.911
3	14.675	14.756	14.112	16.155	34.813	35.677	28.716	27.219
age	2010	2011	2012	2013	2014	2015	2016	2017
1	241.327	67.759	330.673	210.601	283.602	243.681	604.81	191.832
2	166.578	113.491	183.2	186.709	219.018	293.571	254.214	290.123
3	30.788	24.215	19.801	18.742	34.618	42.49	31.906	35.929
age	2018	2019	2020	2021	2022	2023		
1	349.451	236.778	896.833	289.821	562.316	401.732		
2	271.182	246.531	386.904	304.084	364.609	388.935		
3	47.802	38.458	77.18	47.719	35.487	44.844		

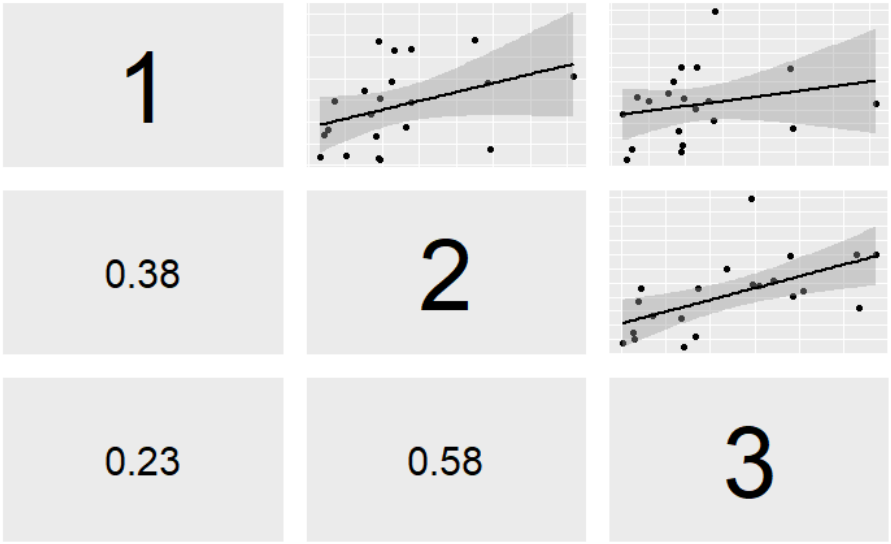


Figure 6.5.2.3.6 Red mullet in GSA 6. Cohorts internal consistency in MEDITS survey.

6.5.3 ASSESSMENT

Method a4a

Assessment for All Initiative (a4a) (Jardim et al., 2015) is a statistical catch–at– age method that utilizes catch at age data to derive estimates of historical population size and fishing mortality. Model parameters are estimated by working forward in time and analyses do not require the assumption that removals from the fishery are known without error. A4a is implemented as a package (Fla4a) of the FLR library.

Input data growth parameters, total catch, numbers at age, natural mortality M, maturity at age and survey index are given in previous sections. Fbar was set to F (1-3).

Table 6.5.3.1 Red mullet in GSA 6. Input data. Catch number at age

age	2002	2003	2004	2005	2006	2007	2008	2009
0	3889.0486	5675.5372	7419.6049	7973.4014	6981.4161	5400.7074	4215.5534	3751.1364
1	7329.8792	11318.5518	15311.1247	18395.3744	18436.6157	15575.2639	12103.3993	9822.2898
2	1133.4776	2692.3163	3430.234	3882.43	4173.2937	4141.9327	3805.2538	3385.8993
3	42.3248	57.7704	101.2477	95.6077	88.8236	93.2931	106.642	122.9826
4	1.6184	12.8683	17.7454	25.4478	23.1665	20.8056	22.3544	28.0914

age	2010	2011	2012	2013	2014	2015	2016	2017
0	4028.2387	5075.0113	6838.2131	8842.4023	10185.6508	10309.7786	9549.8048	8622.3589
1	9271.4633	10572.4471	13886.7064	18902.0952	23900.6092	26378.2286	25555.7763	23030.6775
2	3151.8748	3287.4297	3897.4205	4979.3526	6262.0885	7188.9535	7371.9743	6986.6112
3	137.0064	149.7125	166.4612	189.7275	214.4371	230.68	234.0207	230.595
4	37.0248	46.9477	55.7403	62.461	66.8345	68.5776	67.9176	66.4312

age	2018	2019	2020	2021	2022	2023
0	7964.9695	7617.6832	7381.4516	7016.3192	6433.7836	5748.4413
1	20738.7605	19549.3792	19325.3888	19329.6416	18701.8921	17119.4677
2	6502.8595	6254.8455	6317.2363	6532.166	6571.2735	6151.4743
3	230.0753	238.4836	256.6255	278.9446	291.7594	279.1045
4	66.484	69.8911	77.2545	87.6007	97.6266	101.7268

Table 6.5.3.2 Red mullet in GSA 6. Input data. Stock weight at age (kg)

age	2002	2003	2004	2005	2006	2007	2008	2009
0	0.0057816	0.0085301	0.0075432	0.0083302	0.0089848	0.009645	0.0035839	0.0094252
1	0.0280393	0.0293123	0.0290808	0.0290872	0.0287171	0.0299034	0.0310853	0.0304583
2	0.0760758	0.073639	0.0708679	0.0737168	0.073498	0.0693685	0.0755379	0.0802146
3	0.1428153	0.1430514	0.14203	0.1433447	0.1447892	0.1423345	0.1404051	0.1397337
4	0.1925345	0.1923321	0.1941581	0.2059281	0.2004705	0.2064818	0.1930274	0.20616

age	2010	2011	2012	2013	2014	2015	2016	2017

0	0.0093837	0.0094603	0.0097761	0.0092524	0.00975	0.0096697	0.0095663	0.0097651
1	0.0355049	0.0334464	0.0362878	0.0358251	0.0338058	0.0327142	0.0314552	0.0311454
2	0.0808313	0.0785883	0.0767532	0.0748638	0.0771735	0.0772656	0.0769128	0.0779392
3	0.1362417	0.1422248	0.1423342	0.1444028	0.1405585	0.1416705	0.1396801	0.1417538
4	0.2362882	0.2084682	0.1936246	0.206056	0.1935819	0.1988204	0.204579	0.2062322

age	2018	2019	2020	2021	2022	2023
0	0.0101094	0.0101985	0.0098567	0.0101202	0.0104247	0.0099104
1	0.0320907	0.0312023	0.0313879	0.0329275	0.0328798	0.0325676
2	0.0763234	0.0789568	0.0776039	0.0794653	0.0782612	0.0793918
3	0.1432209	0.1441504	0.1423601	0.1406047	0.141097	0.141123
4	0.2031885	0.2043623	0.2005038	0.210363	0.2321988	0.2130874

Assessment Results

This assessment is an update of the EWG-21-11 assessment. In previous assessments different a4a models were performed (combination of different f, q and sr) and k values for the fmodel were explored. The following model, new in EWG-24-10, was selected, according to residuals and retrospective:

fmodel: ~s(replace(age, age > 3, 3), k = 3) + s(year, k = 6)

srmodel: ~s(year, k = 7)

qmod <- list(~ factor(replace(age, age>2, 2)))

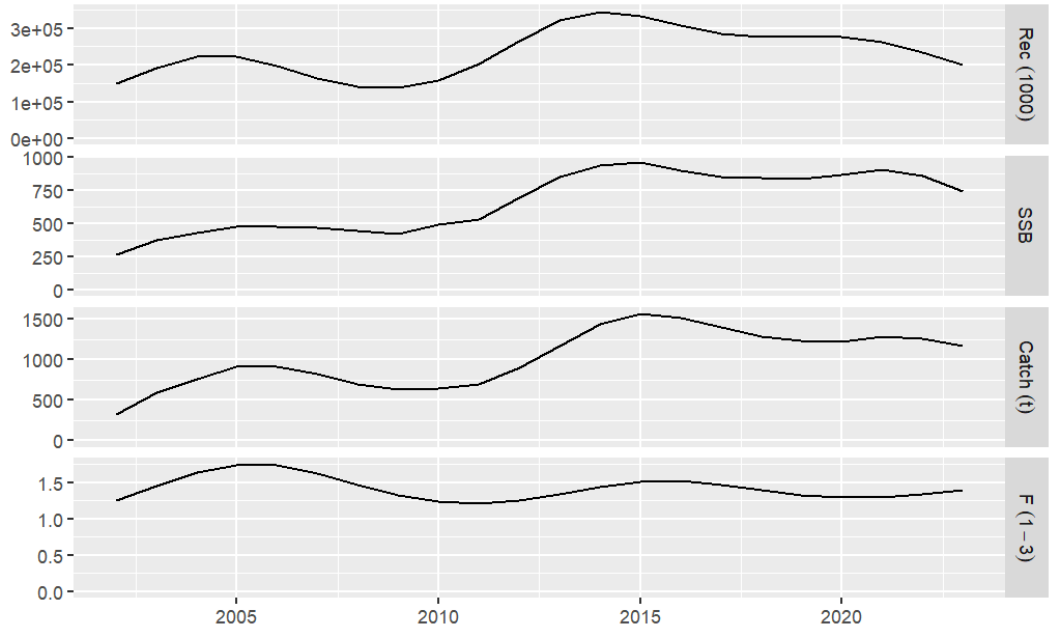


Figure 6.5.3.1 Red mullet in GSA 6. Stock summary from the a4a model for Red mullet in GSA 6, recruits, SSB (Stock Spawning Biomass), catch and harvest (fishing mortality for ages 1 to 3).

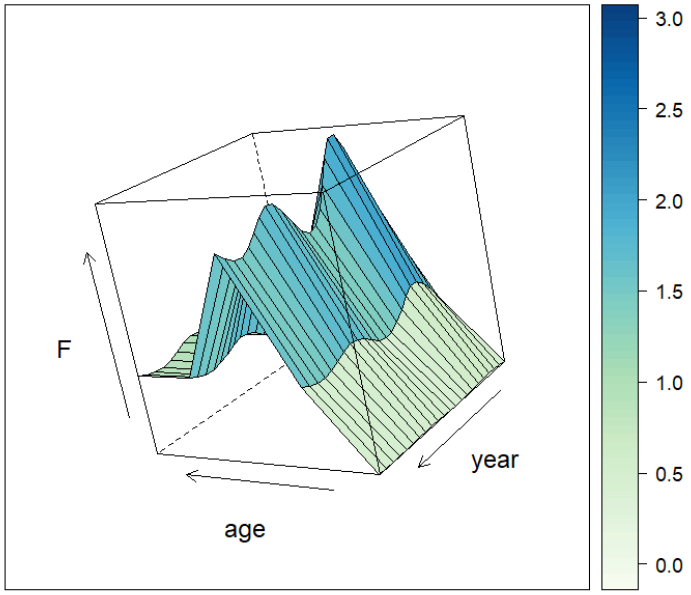


Figure 6.5.3.2 Red mullet in GSA 6. 3D contour plot of estimated fishing mortality by age and year.

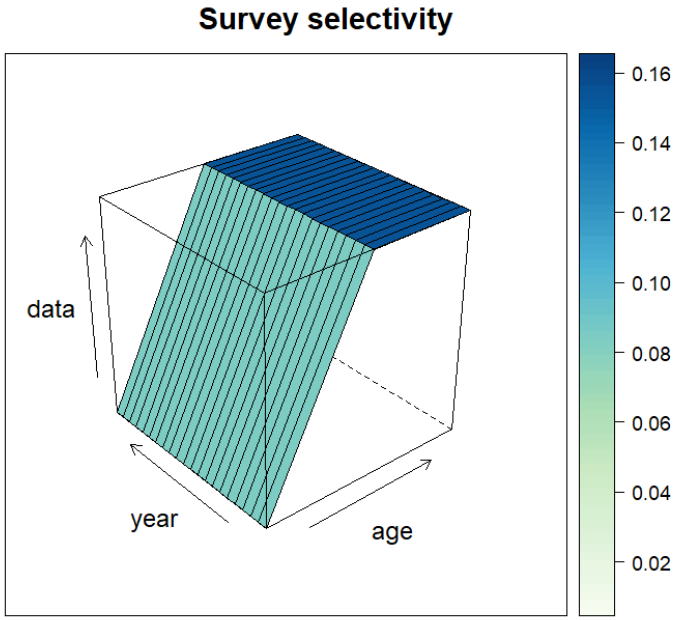


Figure 6.5.3.3 Red mullet in GSA 6. 3D contour plot of estimated catchability by age and year.

Diagnostics

Several diagnostic plots presented below for the goodness of fit of the selected model for the assessment of red mullet stock.

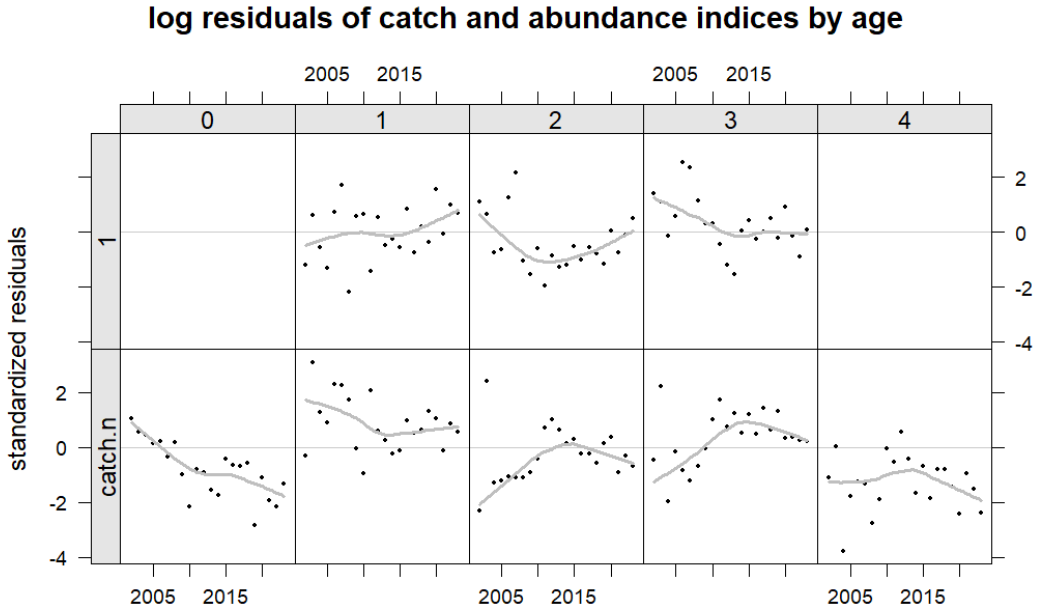


Figure 6.5.3.4 Red mullet in GSA 6. Standardized residuals for catch, abundance indices and for catch numbers.

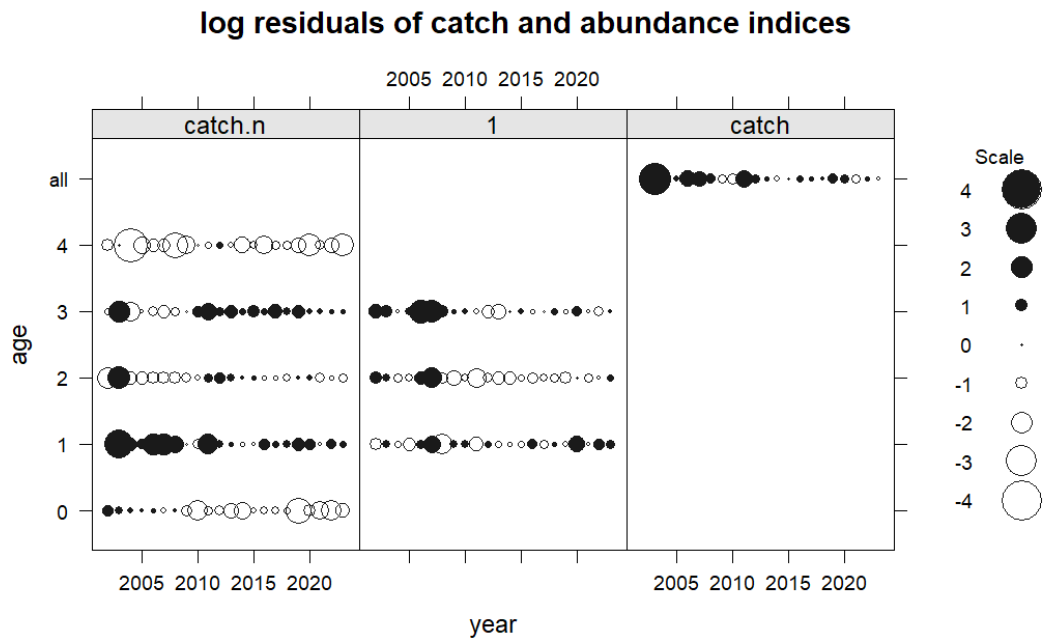


Figure 6.5.3.5 Red mullet in GSA 6. Bubble plot of standardized residuals for catch, abundance indices and for catch numbers.

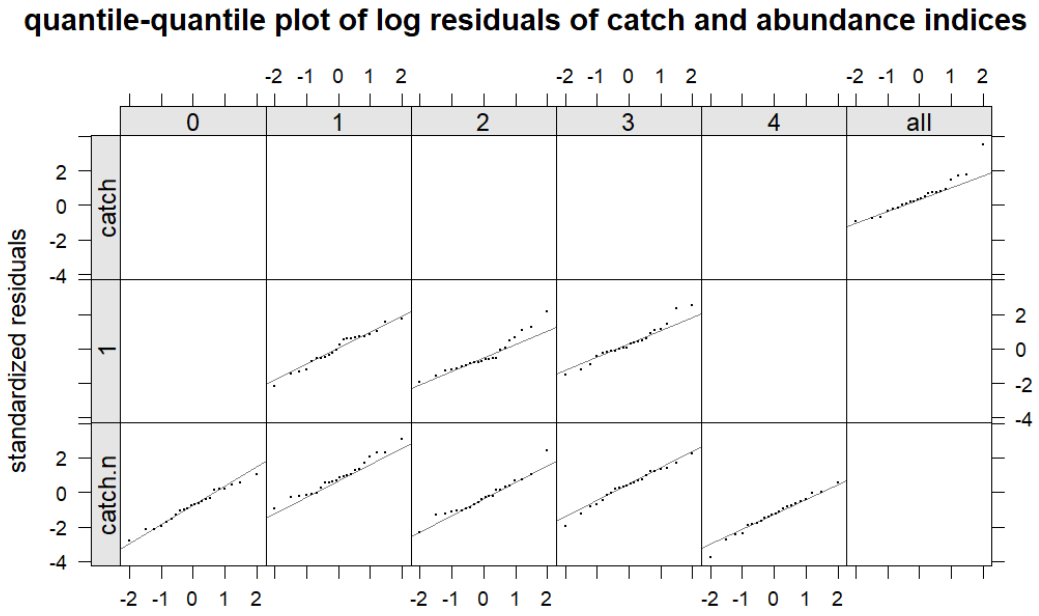


Figure 6.5.3.6 Red mullet in GSA 6. QQ-plot of the log residuals of catch and abundance indices in GSA 6.

Table 6.5.3.3 Red mullet in GSA 6. Catches log residuals.

age	2002	2003	2004	2005	2006	2007	2008	2009
0	1.03158	0.565193	0.428488	0.148093	0.20734	-0.344183	0.1716	-0.984498
1	-0.299849	3.098106	1.280352	0.906061	2.309504	2.265336	1.713157	-0.061562
2	-2.313422	2.414421	-1.285007	-1.226441	-1.070558	-1.112325	-1.088402	-0.92748
3	-0.456742	2.207931	-1.96451	-0.167627	-0.836256	-1.230858	-0.6906	-0.044082
4	-1.107999	0.026095	-3.766353	-1.773532	-1.254582	-1.316226	-2.742651	-1.907946
age	2010	2011	2012	2013	2014	2015	2016	2017
0	-2.166053	-0.784569	-0.916485	-1.539042	-1.725777	-0.405421	-0.656672	-0.686511
1	-0.938205	2.072357	0.591577	0.250589	-0.238407	-0.136065	0.978348	0.526725
2	-0.402489	0.704986	1.020294	0.649003	0.141437	0.312974	-0.222994	-0.227394
3	1.000861	1.722385	0.743079	1.230051	0.535896	1.1849	0.481212	1.410968
4	-0.025571	-0.537573	0.54093	-0.411093	-1.681639	-0.673626	-1.86919	-0.8113
age	2018	2019	2020	2021	2022	2023		
0	-0.554531	-2.823888	-1.088297	-1.942452	-2.171087	-1.32553		
1	0.650241	1.310017	1.054947	-0.125192	0.86425	0.556979		
2	-0.572449	0.142804	0.357264	-0.9159	-0.310568	-0.690855		
3	0.646001	1.304858	0.338757	0.387028	0.243466	0.211123		

4	-0.784737	-1.455517	-2.43611	-0.93907	-1.507856	-2.398846

Table 6.5.3.4 Red mullet in GSA 6. MEDITS survey log residuals.

age	2002	2003	2004	2005	2006	2007	2008	2009
1	-1.1912526	0.5941980 5	-0.5601252	-1.302653	0.7196412	1.7047320 2	-2.164381	0.5859080 2
2	-1.0872693 3	0.6512776 9	-0.7360052	-0.6374584	1.2603184 5	2.1693466 8	-1.0583175	-1.5428489
3	-1.4211814 8	1.0854882 4	-0.1579918	0.5838930 9	2.5319133 9	2.3357527 9	1.1416028 5	0.2930970 6
age	2010	2011	2012	2013	2014	2015	2016	2017
1	-0.5437142 3	-0.4660581	-0.2604431	-0.552612	-0.8423265 5	-0.7412753	-0.5437142 3	-0.4660581
2	-0.8730605	-1.2830675	-1.1946058	-0.5200727	-0.9984207	-0.5686245	-0.8730605	-1.2830675
3	-1.2065001	-1.5367862	0.0304940 2	0.4270339 6	-0.2381516	-0.0009441	-1.2065001	-1.5367862
age	2018	2019	2020	2021	2022	2023		
1	0.2103868	-0.3554717	1.5736073 6	-0.0810472	0.9917828 2	0.7016481 0		
2	-0.780322	-1.1634921	0.0556963 1	-0.7609725	-0.0982012	0.4930344 7		
3	-0.4915068 4	-0.2156869	0.9076864 3	-0.1255582	-0.9067386	0.0699812 4		

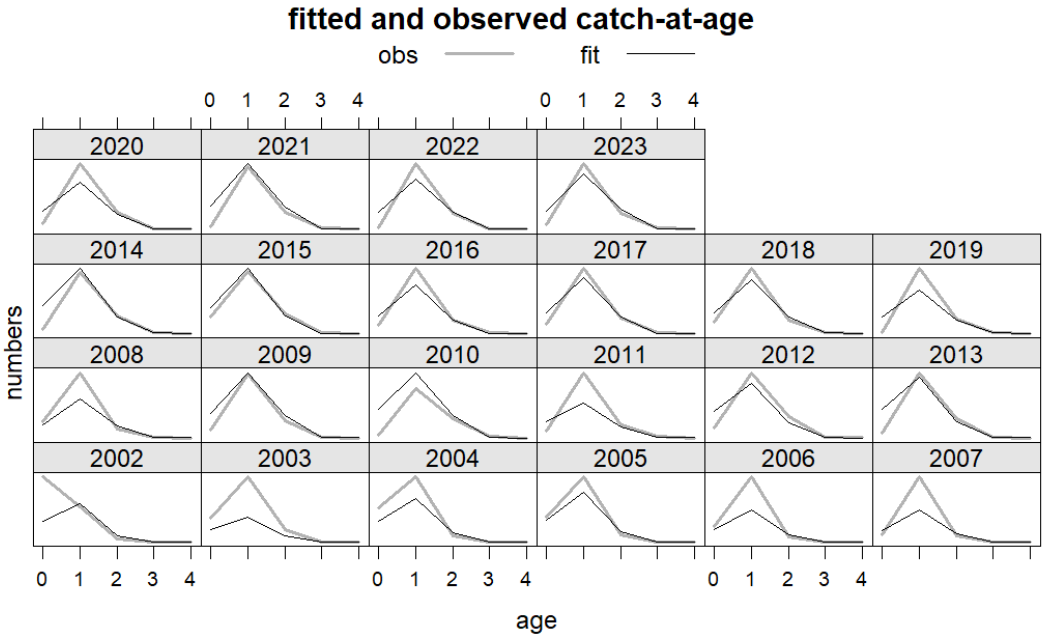


Figure 6.5.3.7 Red mullet in GSA 6. Fitted and observed catch at age.

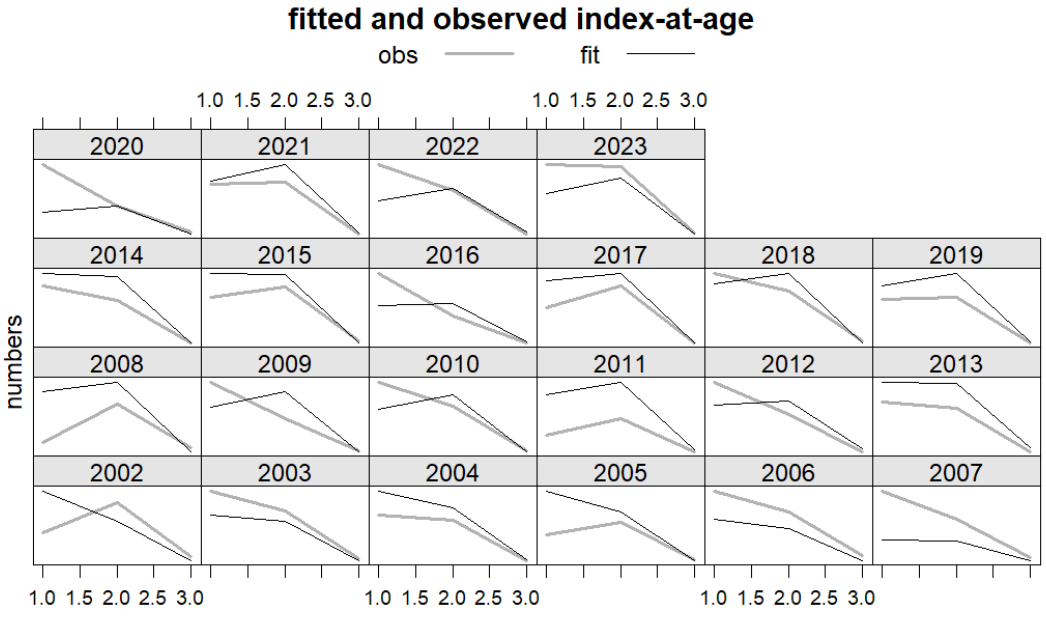


Figure 6.5.3.8 Red mullet in GSA 6. Fitted and observed index at age

Retrospective

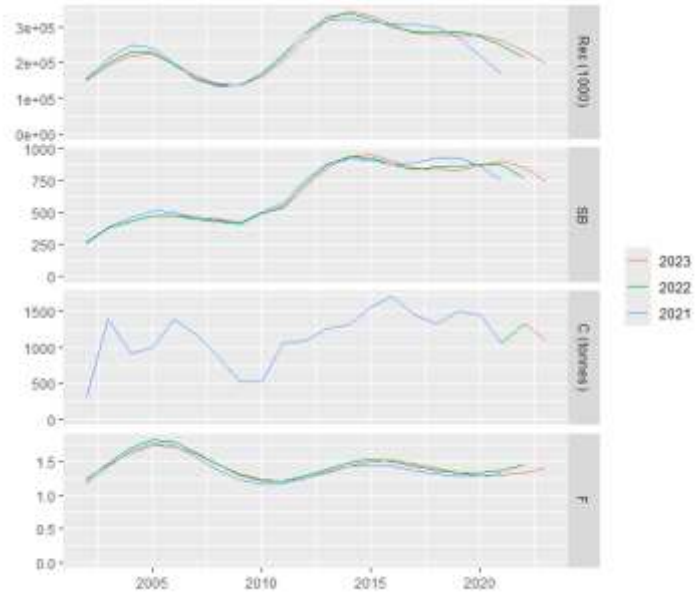


Figure 6.5.3.9 Red mullet in GSA 6. Retrospective analysis for the a4a model.

Simulations

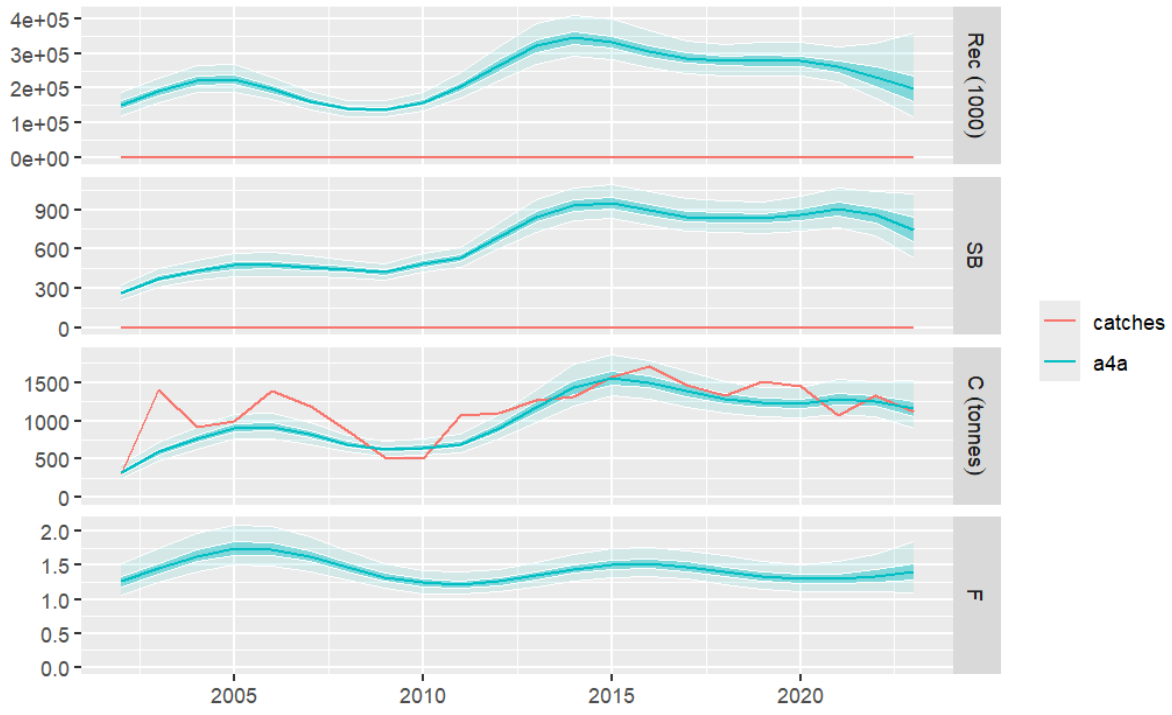


Figure 6.5.3.10 Red mullet in GSA 6. Stock summary of the simulated and fitted data for the a4a model.

Table 6.5.3.5 Red mullet in GSA 6. F at age from a4a assessment.

age	2002	2003	2004	2005	2006	2007	2008	2009

0	0.055602	0.064312	0.072377	0.077142	0.076767	0.071803	0.064785	0.058456
1	0.829868	0.959852	1.08023	1.15134	1.14575	1.07166	0.966913	0.872454
2	2.07003	2.39427	2.69453	2.87191	2.85796	2.67316	2.41188	2.17626
3	0.862977	0.998147	1.12332	1.19727	1.19146	1.11441	1.00549	0.907262
4	0.862977	0.998147	1.12332	1.19727	1.19146	1.11441	1.00549	0.907262
age	2010	2011	2012	2013	2014	2015	2016	2017
0	0.054533	0.053609	0.055487	0.059323	0.063649	0.066696	0.067209	0.065212
1	0.813901	0.80012	0.828138	0.885388	0.949967	0.995435	1.00309	0.973289
2	2.0302	1.99583	2.06572	2.20852	2.36961	2.48302	2.50213	2.42778
3	0.846373	0.832042	0.861178	0.920712	0.987868	1.03515	1.04311	1.01212
4	0.846373	0.832042	0.861178	0.920712	0.987868	1.03515	1.04311	1.01212
age	2018	2019	2020	2021	2022	2023		
0	0.061914	0.058875	0.057237	0.057443	0.059283	0.062088		
1	0.924062	0.878704	0.85426	0.857336	0.884791	0.926664		
2	2.30499	2.19185	2.13088	2.13855	2.20703	2.31148		
3	0.960929	0.913761	0.888343	0.891541	0.920092	0.963635		
4	0.960929	0.913761	0.888343	0.891541	0.920092	0.963635		

Table 6.5.3.6 Red mullet in GSA 6. N at age from a4a assessment.

age	2002	2003	2004	2005	2006	2007	2008	2009
0	150522	190511	221939	224154	197198	162807	140494	138238
1	17874.5	25024.2	31397.7	36283.6	36471.5	32097.7	26631.7	23143.7
2	1558.5	3518.48	4325.47	4811.64	5178.71	5234.71	4961.23	4570.94
3	89.1	110.782	180.844	164.657	153.392	167.413	203.574	250.546
4	3.34	24.204	31.104	43.02	39.27	36.637	41.858	56.114
age	2010	2011	2012	2013	2014	2015	2016	2017
0	158907	203581	265208	321203	345378	333982	307058	285523
1	22916.6	26446.5	33912.8	44095.9	53201.5	56958.9	54912	50459.3
2	4365.77	4583.61	5363.04	6687.1	8211.25	9287.3	9501.21	9089.93
3	292.168	322.939	350.91	382.866	413.861	432.58	436.808	438.414
4	77.399	99.267	115.194	123.595	126.515	126.155	124.365	123.89
age	2018	2019	2020	2021	2022	2023		
0	277478	278775	277696	263032	233863	199710		

1	47014.2	45840.4	46195	46091.6	43648.7	38736.9
2	8605.52	8422.56	8593.36	8874.11	8827.09	8132.83
3	451.806	483.612	530.031	574.778	589.019	547.115
4	128.039	138.971	156.44	176.977	193.263	195.567

Table 6.5.3.7 Red mullet in GSA 6. Summary results of Recruitment, Spawning stock biomass, Catch and F at ages 1-3.

Year	Rec	SSB(t)	Catch(t)	Fages(1-3)
2002	150522	260.82	320.6	1.2543
2003	190511	373.56	589.18	1.4508
2004	221939	431.55	762.15	1.6327
2005	224154	476.19	906.64	1.7402
2006	197198	478.36	916.41	1.7317
2007	162807	463.21	822.74	1.6197
2008	140494	444.74	698.08	1.4614
2009	138238	422.3	629.1	1.3187
2010	158907	490.05	649.17	1.2302
2011	203581	532.86	691.05	1.2093
2012	265208	693.71	904.39	1.2517
2013	321203	846.67	1172.02	1.3382
2014	345378	936.89	1433.63	1.4358
2015	333982	957.47	1564.41	1.5045
2016	307058	900.43	1508.8	1.5161
2017	285523	848.88	1392.42	1.4711
2018	277478	838.77	1288.82	1.3967
2019	278775	835.37	1230.2	1.3281
2020	277696	862.31	1221.61	1.2912
2021	263032	905.82	1284.21	1.2958
2022	233863	855.63	1260.1	1.3373
2023	199710	744.16	1163.95	1.4006

6.5.4 REFERENCE POINTS

The time series is too short to give stock recruitment relationship, so reference points are based on equilibrium methods. The STECF EWG 18-02 recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the a4a assessment.
Values of $F_{0.1}$ calculated by FLBRP package on the a4a assessment results is equal to 0.44. Current F values (2023), as calculated by model a4a, is 1.40 indicating that the stock is being overfished.

During the EWG-24-10, the referent points were recalculated since the model configuration has slightly changed and no T0 correction has been applied.

Once compared with those from the EWG-22-09 and since they were not consistent (see Table 6.5.4.1), it was decided to use the new ones computed in EWG-24-10, in agreement with STECF plenary 22-03 decision.

Table 6.5.4.1 Red mullet GSA 6: Referent points comparison

	EWG-22-09	EWG-23-09	EWG-24-10
Blim	770	819	522.7
Bpa	1540	1638	1045.4
F01	0.314	0.304	0.44
R0	371343.4	373750.7	230740

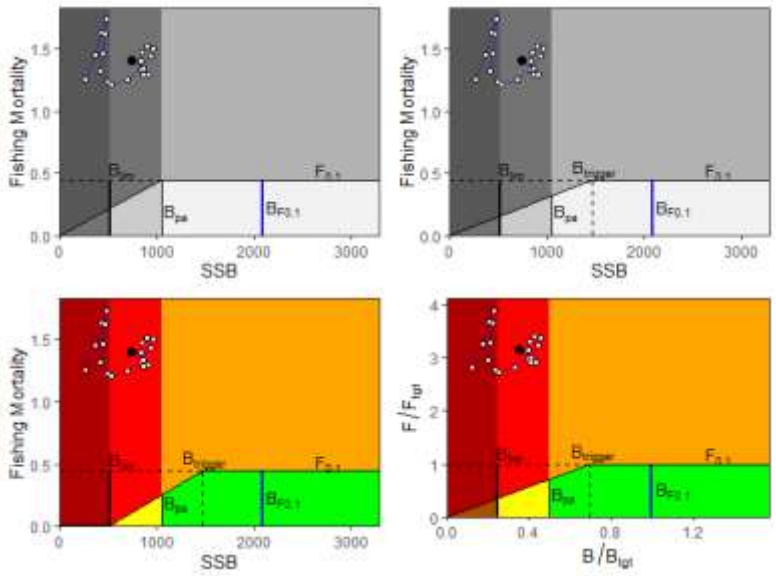


Figure 6.5.4.1 Red mullet in GSA 6. Advice rule plots for the geometric mean model.

6.5.5 Short term Forecast and Catch Options

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

The basis for the choice of values is given in Section 5.3. An average of the last three years has been used for the biological parameters, while the F_{bar} =1.40 terminal F (2023) from the

a4a assessment was used for F in 2024. Recruitment for 2024 to 2025 has been estimated from the population results as the geometric mean of the last 3 years (230115).

EWG advises that when the MSY approach is applied, catches in 2025 should be no more than 455 tonnes.

Table 6.5.5.1 Red mullet GSA 6: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-3 (2024)	1.40	Fsq = F in the last year
SSB (2024)	637.014	SSB intermediate year from STF output
Rage0 (2024)	230740	Recruitment will be set as geometric mean of the last 3 years
Total Catch (2023,2024)	1012.15	Catch intermediate year from STF output
Fbar (2019)	1.33	MAP base year fishing mortality from current assessment
a and b values	a=1/3 and b=2/3	Regression parameters from Ftransition regression line

The short term forecast was carried out estimating a catch for 2023-2025 on the basis of a recruitment hypothesis constant and equal to the mean of the last 3 years and an F by age equal to that of the terminal year. These assumptions resulted in a catch and a SSB in 2024 equal to 1012.15 and 637.0.14 tons, respectively.

Table 6.5.5.2 Red mullet GSA 6. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Fsq2024	Catch2023	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	0.32	0.44	1.40	1163.95	455.38	637.01	1472.04	131.08	-60.88
F upper	0.43	0.61	1.40	1163.95	582.40	637.01	1265.62	98.68	-49.96
F lower	0.21	0.30	1.40	1163.95	323.70	637.01	1703.50	167.42	-72.19
FMSY transition	0.32	0.44	1.40	1163.95	455.38	637.01	1472.04	131.08	-60.88
F/Catch_option	0.19	0.27	1.40	1163.95	299.26	637.01	1748.35	174.46	-74.29
Zero catch	0.00	0.00	1.40	1163.95	0.00	637.01	2341.93	267.64	-100.00
Status quo	1.00	1.40	1.40	1163.95	1017.14	637.01	692.08	8.64	-12.61

Different Scenarios	0.10	0.14	1.40	1163.95	164.07	637.01	2006.56	214.99	-85.90
	0.20	0.28	1.40	1163.95	307.83	637.01	1732.56	171.98	-73.55
	0.30	0.42	1.40	1163.95	434.53	637.01	1507.53	136.66	-62.67
	0.40	0.56	1.40	1163.95	546.82	637.01	1321.72	107.49	-53.02
	0.50	0.70	1.40	1163.95	646.89	637.01	1167.38	83.26	-44.42
	0.60	0.84	1.40	1163.95	736.54	637.01	1038.38	63.01	-36.72
	0.70	0.98	1.40	1163.95	817.24	637.01	929.85	45.97	-29.79
	0.80	1.12	1.40	1163.95	890.26	637.01	837.91	31.54	-23.51
	0.90	1.26	1.40	1163.95	956.60	637.01	759.48	19.23	-17.81
	1.10	1.54	1.40	1163.95	1072.61	637.01	633.75	-0.51	-7.85
	1.20	1.68	1.40	1163.95	1123.63	637.01	582.88	-8.50	-3.46
	1.30	1.82	1.40	1163.95	1170.71	637.01	538.21	-15.51	0.58
	1.40	1.96	1.40	1163.95	1214.30	637.01	498.71	-21.71	4.33
	1.50	2.10	1.40	1163.95	1254.79	637.01	463.54	-27.23	7.80
	1.60	2.24	1.40	1163.95	1292.51	637.01	432.03	-32.18	11.05
	1.70	2.38	1.40	1163.95	1327.74	637.01	403.62	-36.64	14.07
	1.80	2.52	1.40	1163.95	1360.74	637.01	377.87	-40.68	16.91
	1.90	2.66	1.40	1163.95	1391.71	637.01	354.41	-44.36	19.57
	2.00	2.80	1.40	1163.95	1420.86	637.01	332.93	-47.74	22.07

6.6 RED MULLET IN GSA 7

6.6.1 STOCK IDENTITY AND BIOLOGY

Red mullet (*Mullus barbatus*) in the Gulf of Lions (GSA 7) is a shared stock exploited by both Spanish and French fisheries. Trawlers landings are documented since 2002 and represent ~90% of landings. Since 2011, landings from other gears are also documented.

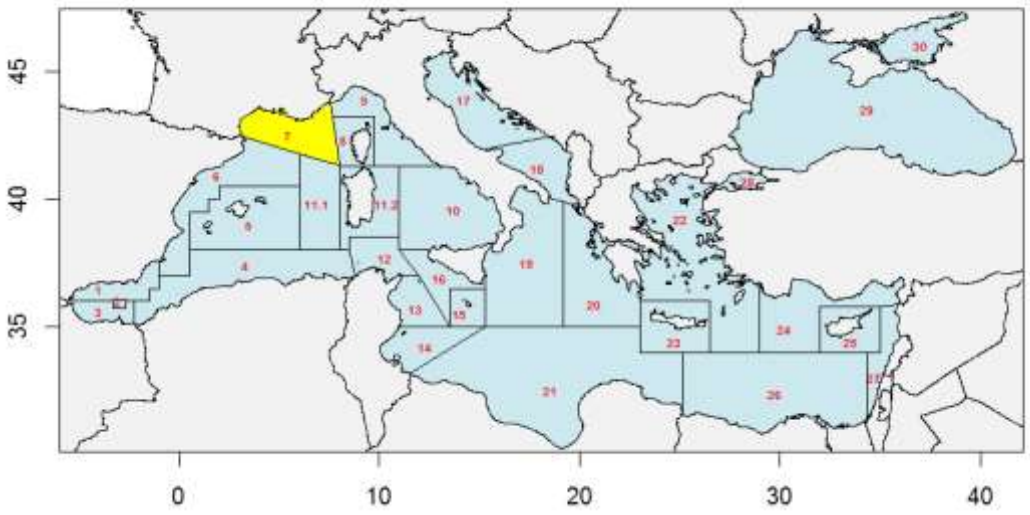


Figure 6.6.1. Localisation of GSA 7 (in Yellow) in the Mediterranean Sea.

Age-slicing and growth

The process of age slicing has been performed using a global Age-Length-Key obtained from age reading data, but exlucing 2010-2013 and 2020 readings due to inconsistencies in the data (see EWG 22_09 for further explanations).

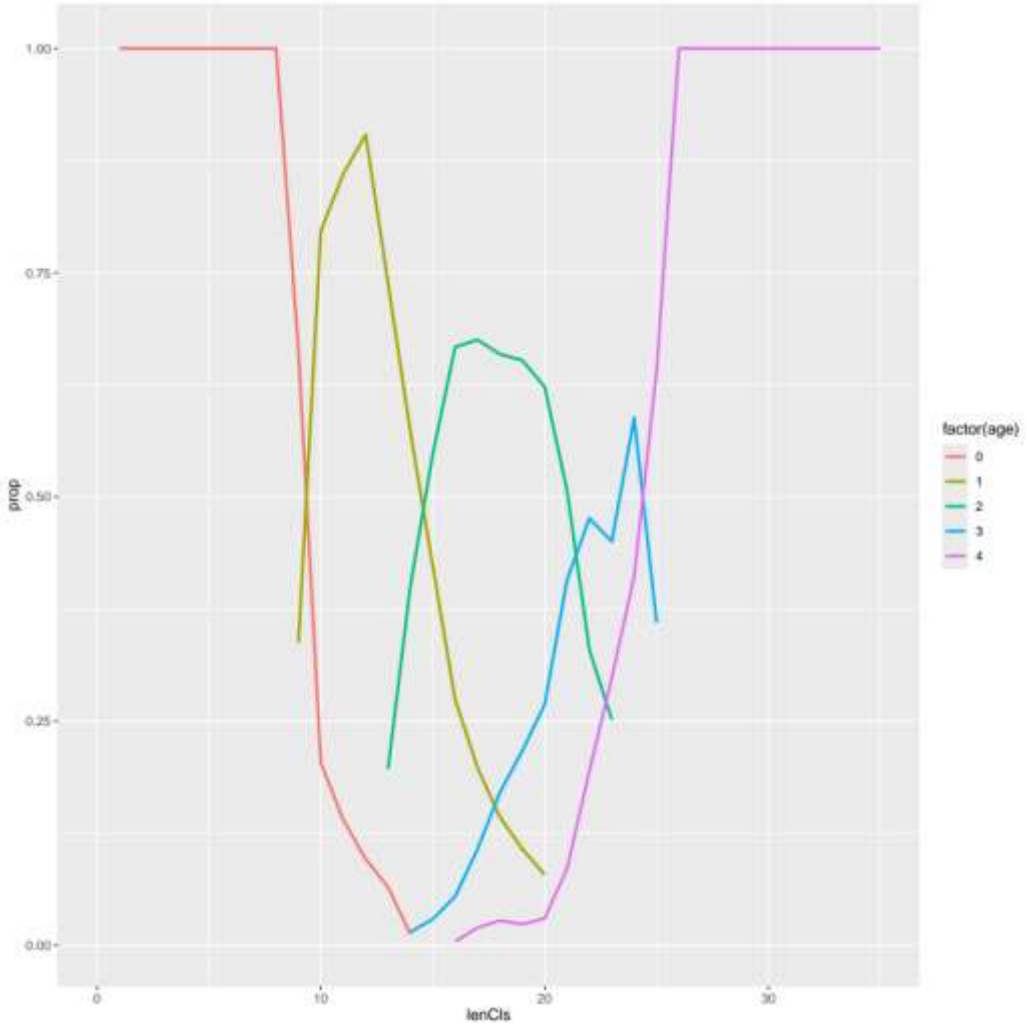


Figure 6.6.2. Age-length Key derived from age-reading data. The purple line corresponds to age 4 or more.

Length-Weight relationships

For the purpose of computing biomass and average weights at age from numbers at length, we used a length weight relationships fitted on individual DCF sample data – the same that were used to produce the ALK. The resulting relationships has parameters ln(a)=-4.50, and b=3.015.

Maturity and natural mortality

Regarding maturity, spawning red mullet season is quite short (April-July). We decided to assume that individuals reaching age 1 (~12cm) should be considered as mature.

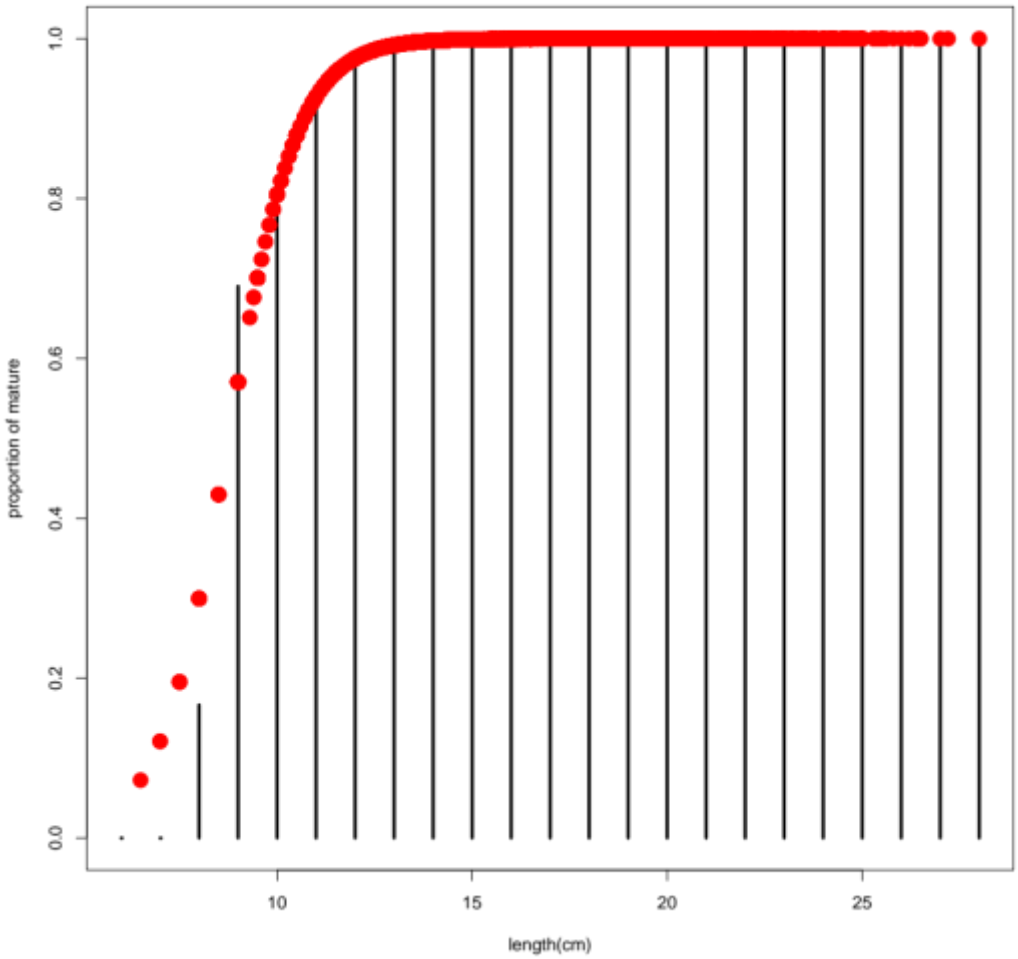


Figure 6.6.3. Proportion of mature Red Mullet per length in GSA 7. The red line corresponds to the predicted proportion following a logistic regression model.

Regarding natural mortality estimate, we applied the one derived from Chen-Watanabe model, using a VB model fitted to MUT7 age-reading data (Linf = 26.32, k = 0.38, t0 = -0.79). Applying Chen and Watanabe estimate of natural mortality with these fitted VB parameters leads to a mortality vector consistent with the age-length key used for age slicing (both VB fitted growth and age-length key are derived from the same data).

Hence, the natural mortality vector retained this year is based on Chen-Watanabe formula, applied to the fitted VB growth parameters provided above: M at ages 0 to 4+ are 0.942, 0.643, 0.529, 0.473, 0.449, respectively.

6.6.2 DATA

Available catch, landing and discards data were recovered from the Med and Black Sea (MBS) data call. One important problem was noted within spanish data in GSA7 (Figure 4): From 2020 onward, the proportion assumed between MUT and MUR landings became unrealsitic, with MUR making up to 95% of landings while in the past (see Figure 6.6.4) and in the french data, MUR only accounts for 10-30% of landings (Figure 6.6.5).

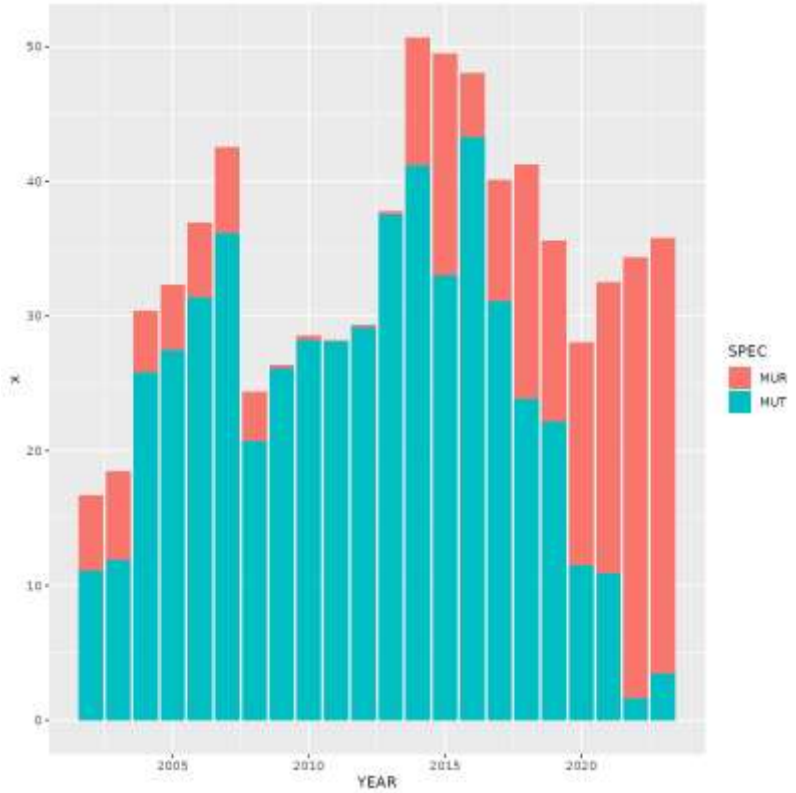


Figure 6.6.4. MUT & MUR Landings by species provided by Spain in GSA 7

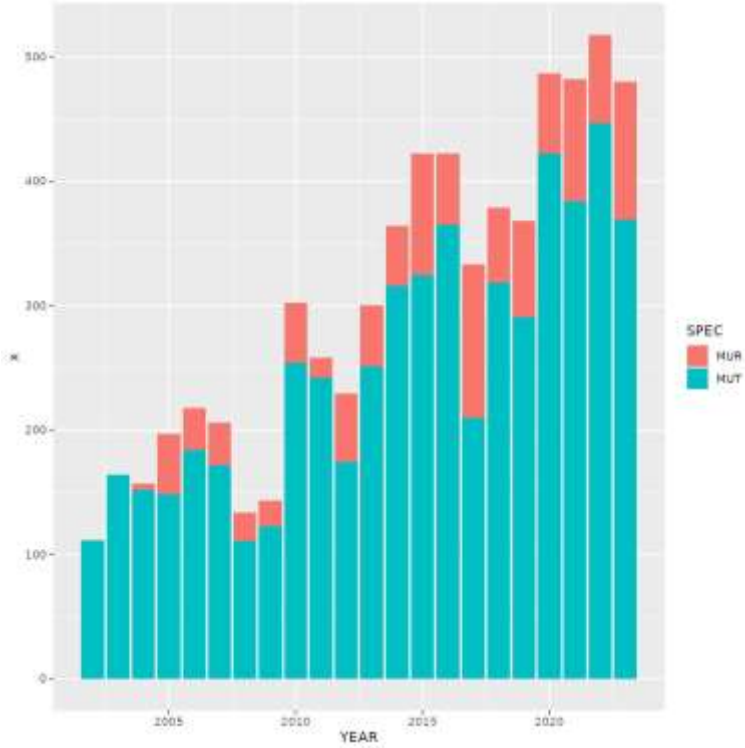


Figure 6.6.5. MUT & MUR Landings by species provided by France in GSA 7

Hence, spanish MUT landings data in GSA7 are likely to be strongly under-estimated. From discussions with spanish experts in the group, it appears that no more sample observations are available for this fishery since 2020, hence landings are solely based on fishermen's declaration without correction coming from any DCF observation programme, which explains

the drift in MUT/MUT attribution since 2020. In addition, another consequence of these missing observation is that no length-frequency distributions are available in spanish landings since 2020, not only for MUT and MUR but also for many other species (hake, balck-bellied angler, cephalopods, see Figure 6.6.6).

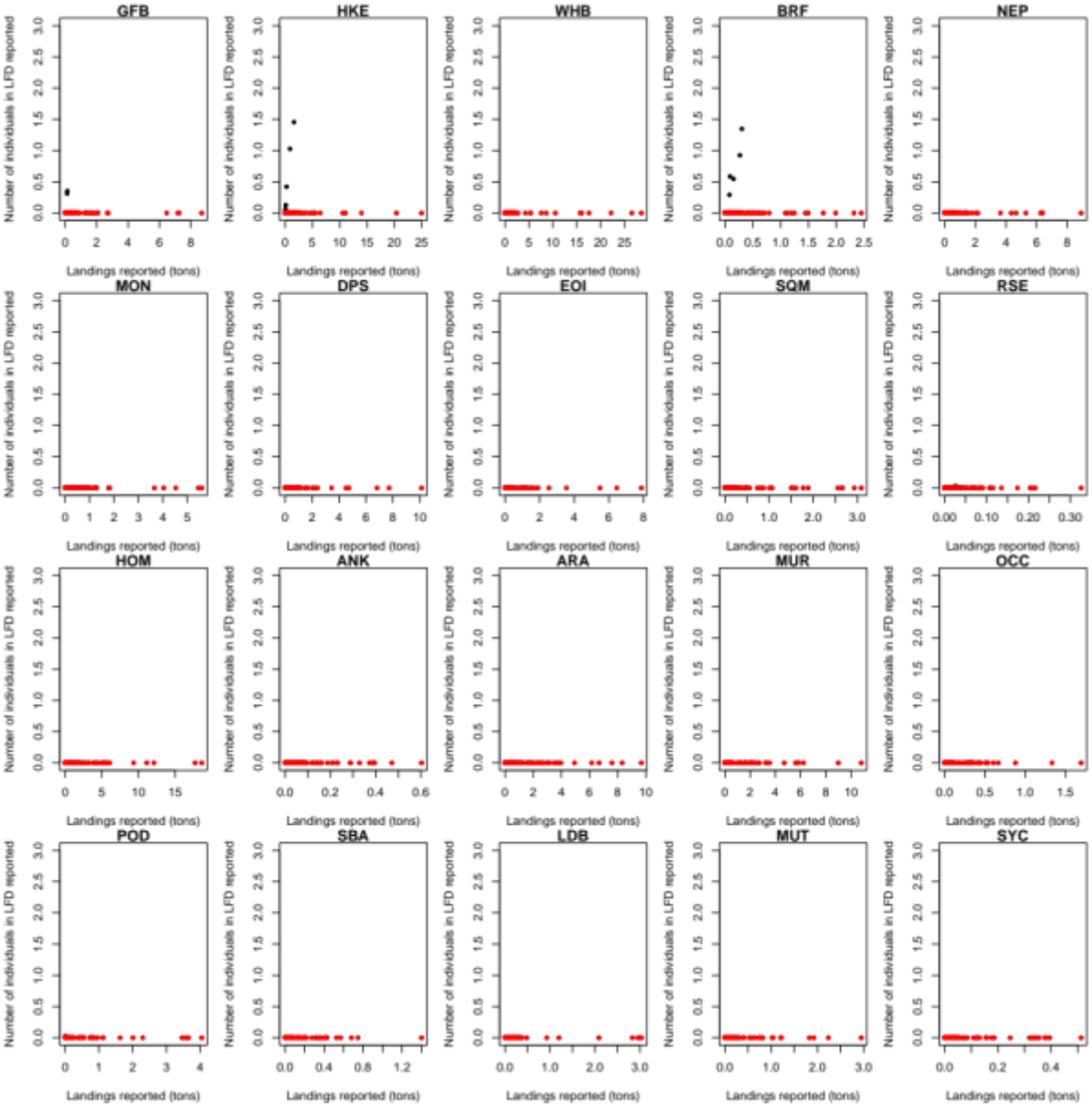


Figure 6.6.6. reported landings (x-axis) versus numbers of individuals present in LFD (y-axis) in spanish data submitted to the MBS data call since 2020 in GSA 7. red dots corresponds to data point were landings are reported, but no size information is available.

Hence, from 2020 and onward, data reconstructions are required to properly account for spanish landings in GAS 7. For MUT, we first re-estimated MUT landings from MUX (e.g. MUT + MUR + MUX) landings using a linear regression fitted to 2002-2019 data (Figure 6.6.7.)

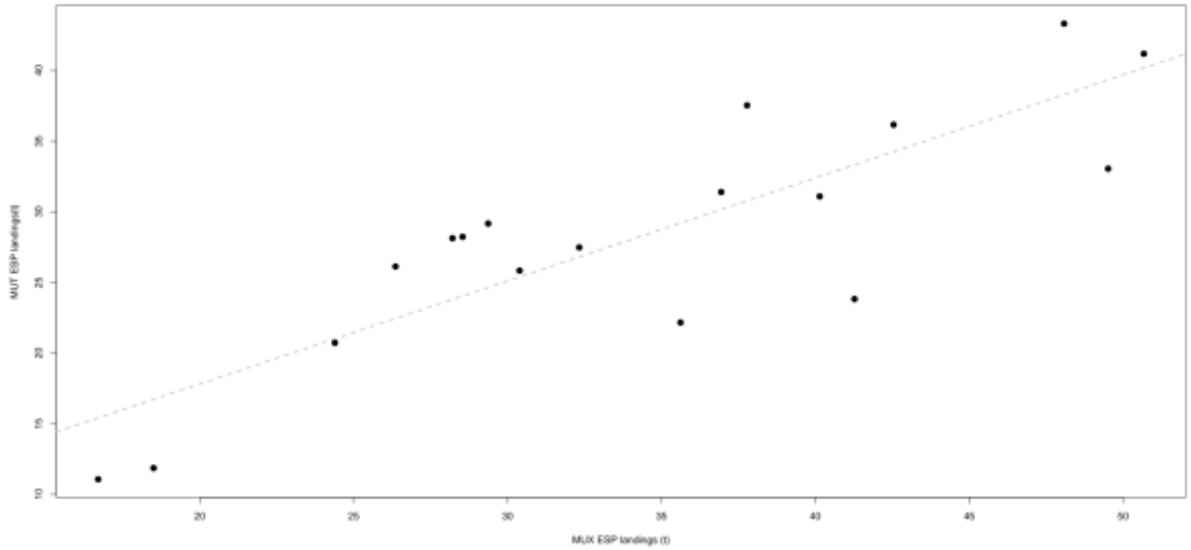


Figure 6.6.7. linear regression between MUT and MUX spanish landings in GSA 7. The estimated linear regression has the following parameters: intercept = 3.25; slope = 0.73, and is significant (p = 1.21e-5) with a multiple R^2 = 0.708.

Then, the reconstructed spanish MUT landings were spread at length following the french documented LFD distribution.

6.6.2.1 CATCH, LANDINGS AND DISCARDS AT LENGTH

Total catch by year is reported in table 1 (in terms of landings and discards). The french fleet is usually responsible for ~90% of the catch (table 6.6.1) most of which results from trawlers (>95%, Figure 6 & Table 2). Catch by gear could only be represented for the french fleet, due to undertainties tainting the spanish data in GSA 7 since 2020 (see section above)

Table 6.6.1. Total Landings per country, discards and total catch per year, in tons.

Year	Gillnet	Longline	OTB	Other	OTT	Catch
2002	0	0	111.424	0	0	122.504
2003	0	0	164.141	0	0	176.011
2004	0	0	151.646	0	0	177.486
2005	0	0	148.086	0	0	175.566
2006	0	0	183.478	0	0	214.878
2007	0	0	171.526	0	0	207.686
2008	0	0	110.494	0	0	131.404
2009	0	0	122.555	0	0	148.685
2010	0	0	249.644	0	4.193	284.895
2011	28.337	0	212.86	0	0.568	273.478
2012	33.395	0	140.522	0	0.021	211.328
2013	17.523	0	216.076	0	17.272	293.077
2014	15.363	0	276.182	0	24.33	361.258
2015	0	0	304.945	0	19.681	366.099
2016	19.787	0	252.886	0.561	91.894	411.494
2017	5.67	0	130.492	0.099	73.271	242.974
2018	19.385	0	180.213	0.17	118.58	345.54
2019	13.992	0	143.839	0.228	132.293	320.145
2020	24.409	0.004	186.546	0.498	210.622	455.008
2021	23.214	0.017	146.461	0.588	213.497	417.231
2022	43.848	0.037	161.699	0.852	239.772	484.732
2023	9.661	0.105	134.498	0.363	224.312	413.623

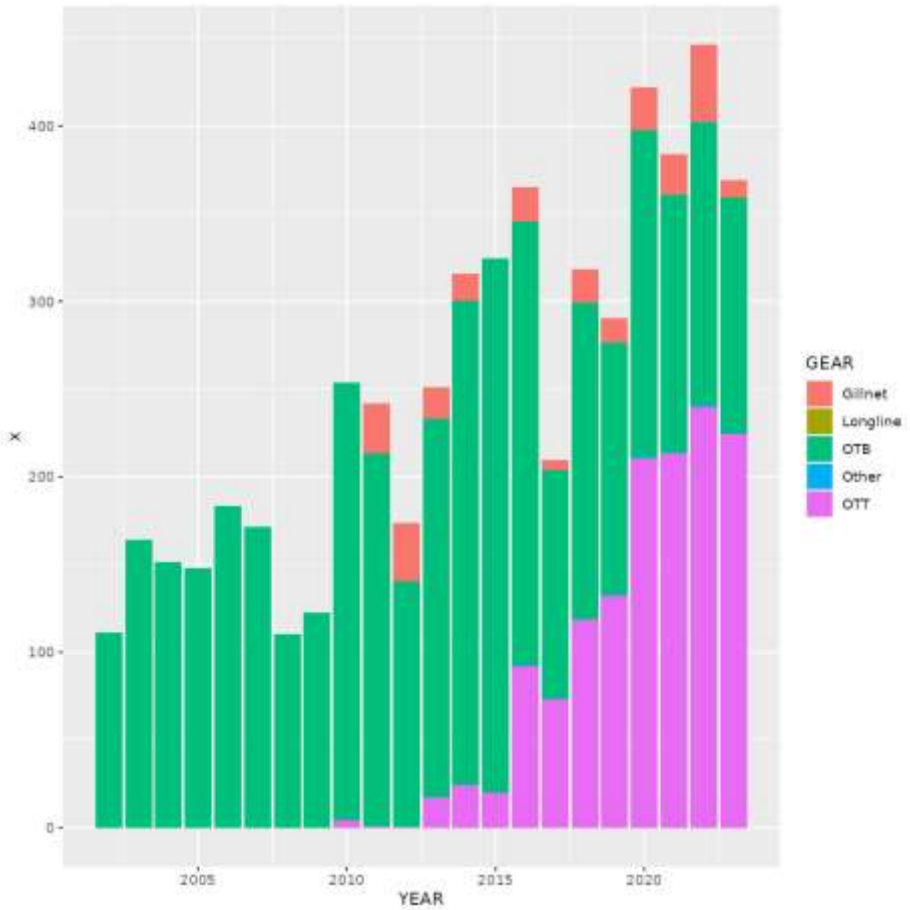


Table 6.6.2. Red Mullet Landings per Year and Gear, French data

Figure 6.6.8. Red Mullet Landings per year and gear in GSA 7 (French fleet).

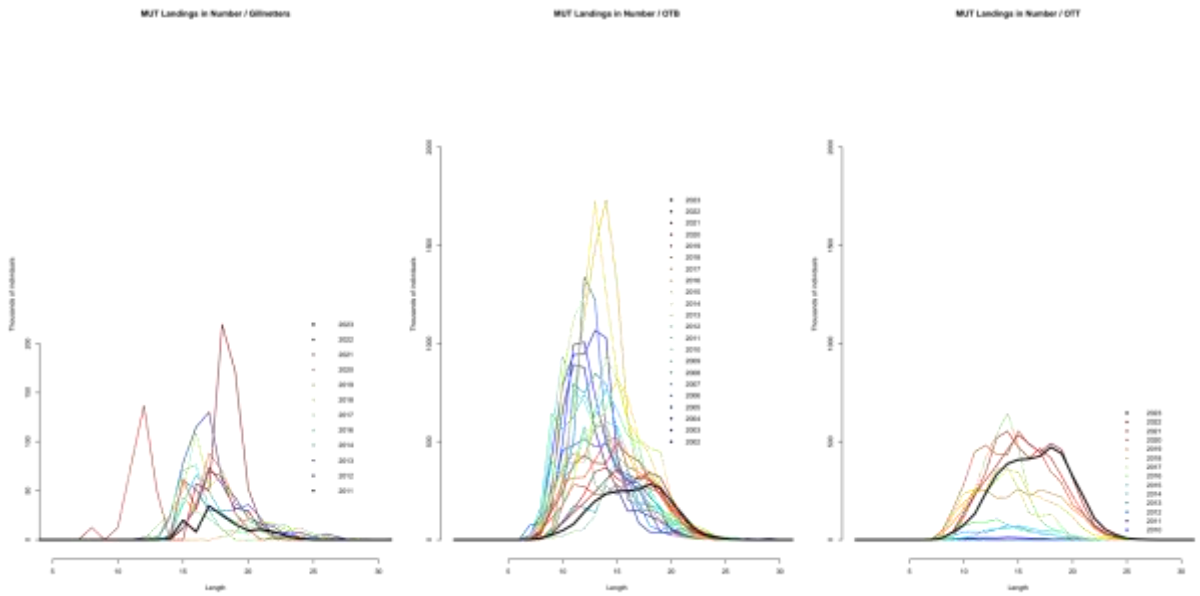


Figure 6.6.9. Size-Class distribution of Red Mullet french landings per year and mains gear. The thick black line corresponds to the most recent year (2023).

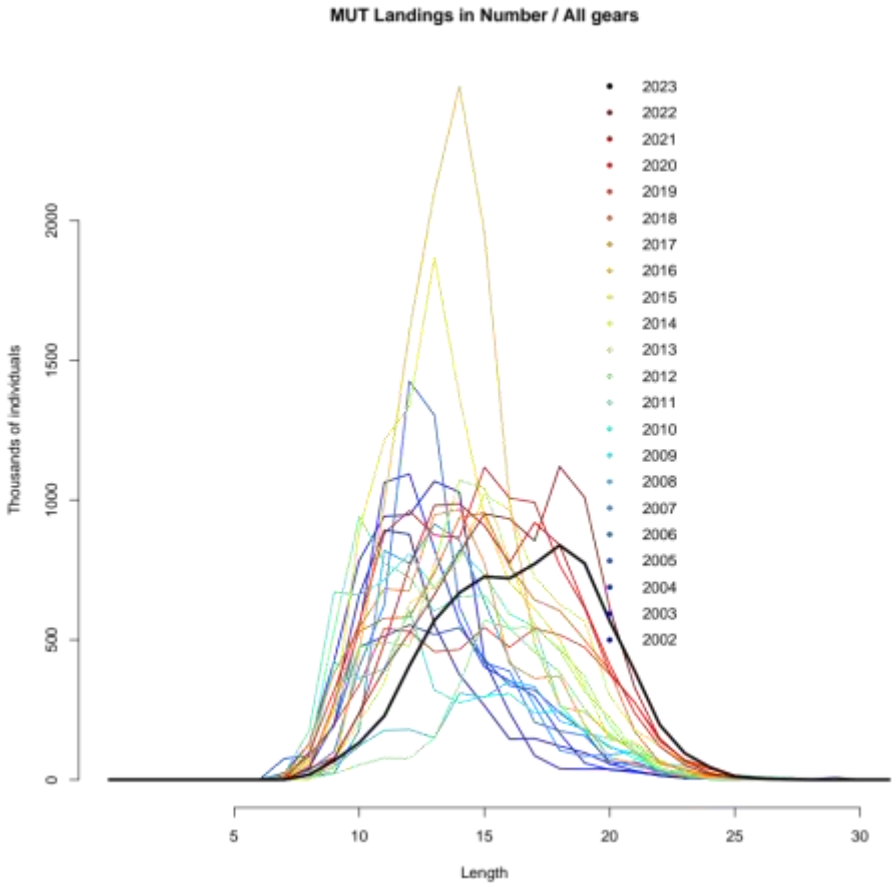


Figure 6.6.10. Size-Class distribution of Red Mullet total landings (including spanish reconstructed landings) per year. The thick black line corresponds to the most recent year (2023).

Catches in recent years have peaked around 450 tons, with a historical minimum in 2002 (Table 6.6.1&6.6.2). The majority of the landings of red mullet comes from trawlers, and the other part are mainly nets. Landings of gears other than OTB, OTT, GNS and GTR are on

average less than 1%. Since 2014, the French Trawl fleet are separated by OTB, OTM and OTT trawlers. The majority of landings were initially due to OTB, but OTT displayed an increasing importance over the last years and became slightly predominant over OTB since 2020 (Figure 6.6.8). The length distribution of landings in the recent years shifted towards longer individuals: While landings were mostly composed of individuals between 10 and 15cm in 2002-2010, since 2021 the individual landed size ranged between 12 and 22cm (Figure 6.6.10).

Discards (Figure6.6.11) were regularly reported since 2010 (Table 6.6.1). They are mostly composed of small individuals and account for [1-3]% of the landed biomass, depending on year. They seem to increase in the recent years.

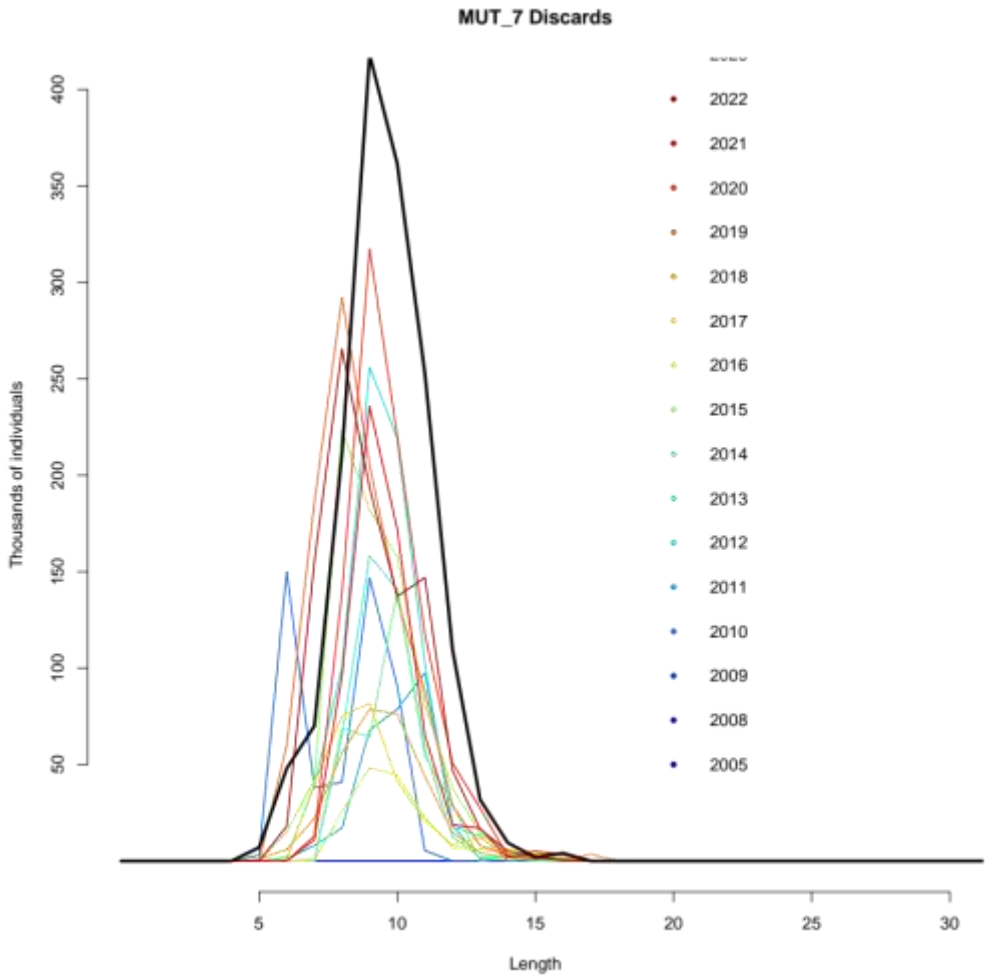


Figure 6.6.11. Size-Class distribution of Red Mullet discards per year.

Landings and discards at age.

Landings and discards at age have been recovered by combining landings and discards at length data, the Age-Length-Key (Figure 6.6.2) and the length-weight relationship. The resulting numbers and average weight at age are summarized below (Tables 6.6.3 – 6.6.6), and the resulting catch at age is displayed in Figure 6.6.12.

Table 6.6.3. Landings at age (Thousands of individuals)

Year	0	1	2	3	4+
2002	621.054	3082.706	817.417	119.911	19.859
2003	1018.555	4638.514	1327.692	115.521	18.51
2004	677.513	4071.867	1361.764	165.18	30.967
2005	596.337	2678.118	1455.131	239.249	66.521
2006	584.878	4477.542	1651.838	221.7	43.556
2007	377.403	3626.867	1800.787	248.028	47.595
2008	123.78	1131.557	1239.949	246.548	42.257
2009	591.144	2146.621	1171.538	241.858	45.563
2010	1118.882	4134.816	2337.864	405.833	107.065
2011	956.358	3991.607	2176.102	404.411	106.555
2012	63.897	1147.23	2005.802	401.493	75.665
2013	505.038	3432.437	2806.735	433.952	70.7
2014	254.575	3049.13	3279.073	664.632	140.503
2015	851.087	6062.71	3058.469	460.744	88.685
2016	592.439	6849.285	3936.56	428.927	74.375
2017	796.261	3887.657	2133.436	296.196	62.701
2018	537.749	3568.445	3104.738	601.234	106.836
2019	473.092	2598.909	2430.19	662.935	161.098
2020	711.807	4506.442	3849.232	818.522	176.376
2021	364.405	3673.119	3674.214	775.88	150.744
2022	276.297	3134.021	4195.219	1010.063	192.841
2023	197.437	2297.711	3325.92	900.414	199.342

Table 6.6.4. Average weight of landings at age (Kg)

Year	0	1	2	3	4+
2002	0.013	0.02	0.049	0.077	0.097
2003	0.012	0.022	0.04	0.073	0.109
2004	0.014	0.022	0.046	0.072	0.103
2005	0.011	0.024	0.051	0.079	0.15
2006	0.016	0.023	0.047	0.078	0.114
2007	0.017	0.025	0.047	0.081	0.108
2008	0.014	0.031	0.057	0.079	0.094
2009	0.011	0.023	0.057	0.083	0.102
2010	0.011	0.024	0.052	0.084	0.128
2011	0.011	0.023	0.054	0.083	0.135
2012	0.015	0.039	0.058	0.077	0.123
2013	0.013	0.028	0.052	0.075	0.098
2014	0.017	0.032	0.057	0.083	0.112
2015	0.015	0.025	0.05	0.078	0.107
2016	0.018	0.027	0.044	0.073	0.121
2017	0.012	0.025	0.048	0.074	0.124
2018	0.013	0.028	0.056	0.08	0.102
2019	0.012	0.028	0.063	0.092	0.119
2020	0.013	0.028	0.058	0.084	0.112
2021	0.016	0.031	0.058	0.082	0.104
2022	0.016	0.034	0.062	0.084	0.108
2023	0.016	0.035	0.064	0.09	0.113

Table 6.6.5. Discards at age (Thousands of individuals)

Year	0	1	2	3	4+
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	387.135	140.609	0	0	0
2011	111.198	204.174	1.185	0.036	0
2012	384.668	387.796	4.085	0.089	0.002
2013	211.337	233.181	2.124	0.111	0.007
2014	152.281	208.793	0.842	0.031	0
2015	450.568	305.536	6.451	0.205	0.009
2016	70.268	86.241	6.362	0.246	0.002
2017	197.403	105.347	5.813	0.155	0
2018	162.269	145.79	5.332	0.487	0.071
2019	743.806	299.297	7.181	0.356	0.018
2020	433.525	455.771	7.855	0.137	0.005
2021	315.514	311.581	9.193	0.364	0.015
2022	621.981	360.243	6.686	0.151	0
2023	702.914	743.005	13.156	0.398	0.017

Table 6.6.6. Average weight of discards at age (Kg)

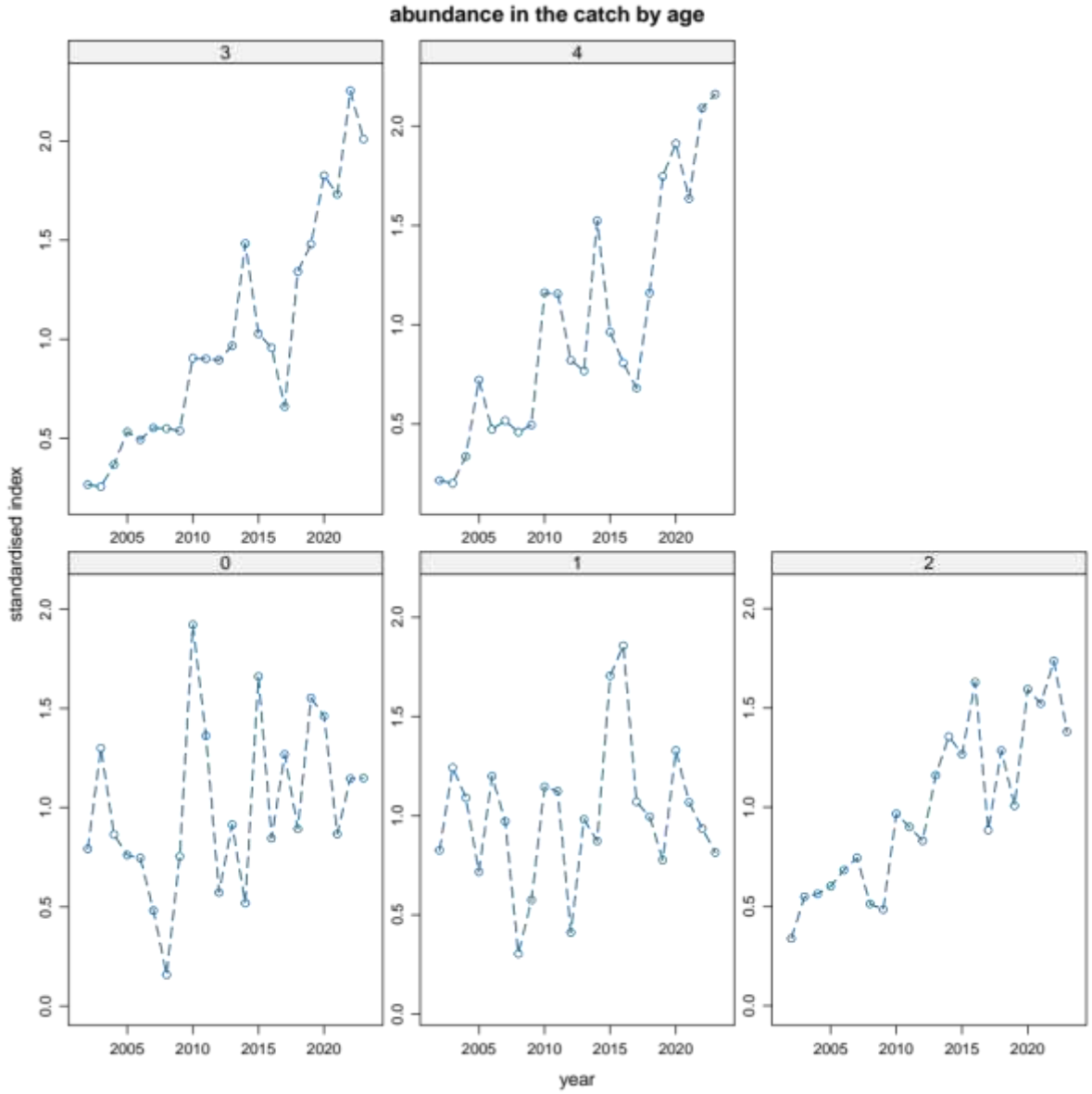


Figure 6.6.12. Catch at age of Red Mulled in GSA 7. Y-axis is standardised.

6.6.2.2 EFFORT

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.6.2.3 SURVEY DATA

Distribution and abundances

According to the MEDITS protocol (Bertrand et al. 2002), trawl surveys were yearly carried out from end of May until end of June, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small

sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. Abundances at trawl were standardized to square kilometer, using the swept area method, then MEDITS abundances (numbers of fish at length over the GSA 7 area) were computed.

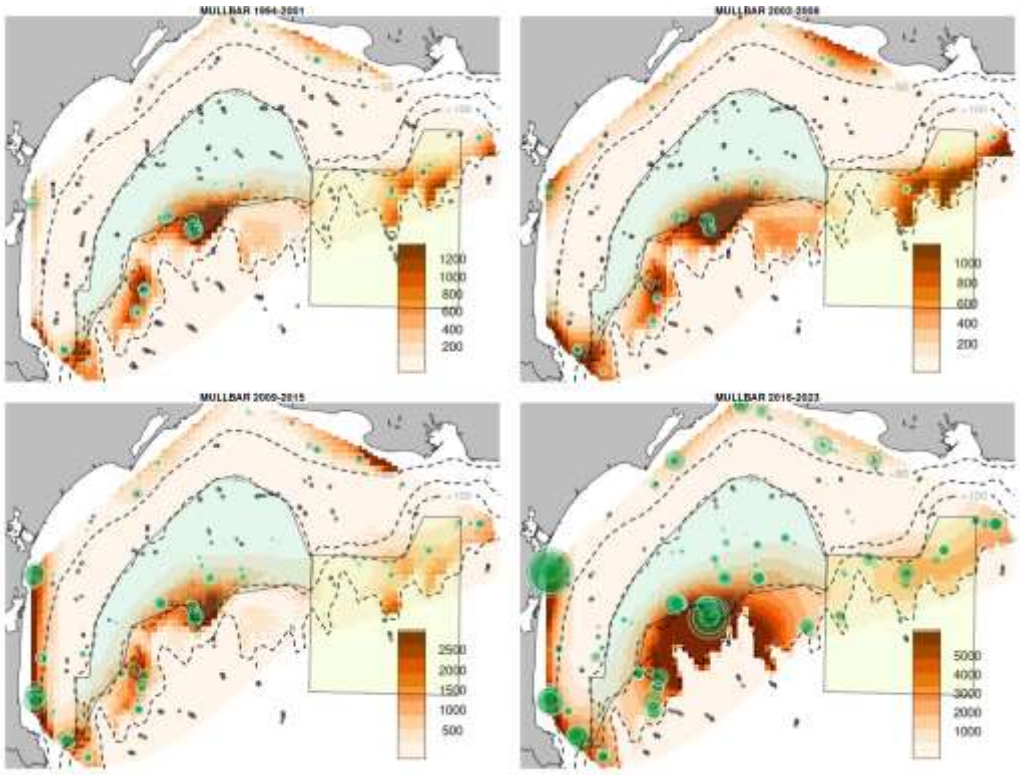


Figure 6.6.13. Orange shades: Estimates of Red Mullet densities from MEDITS survey in N/km2. Green circles correspond to trawls with red mullet, their size is proportional to densities. Coloured areas show spatio-temporal closures, in blue the bathymetric area (closed from September to April) and in yellow the GFCM box (closed from November to April).

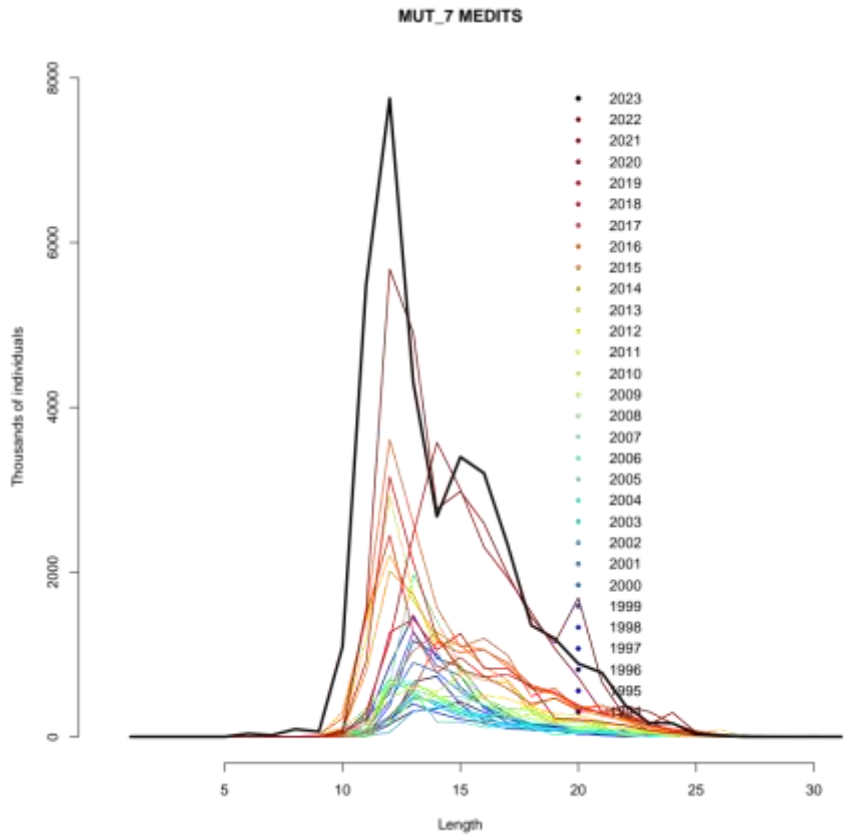


Figure 6.6.13 shows MEDITS sampling and estimates of red mullet spatial distribution for 4 time periods, exemplifying quite well their core area of distribution in the Gulf of Lion in June in the South-Western upper slope and coast, and their increasing numbers since 1994.

MEDITS index at length and age

The size range caught by the survey (Figure 6.6.14) has been quite constant [8 – 27cm] over the years, with a substancial increase in the abundances first of younger individuals (since 2014) and now also observable with older individuals (in 2021 and 2022), illustrating increased recruitment over the last decade. In 2021 and 2022, MEDITS abundances at length are strikingly important for older [14 – 22cm] individuals compared to other years. MEDITS 2022 is the largest abundance estimate ever recorded in GSA 7.

Figure 6.6.14. Length distribution of MEDITS abundance index over the years. The black thick line corresponds to 2023.

MEDITS at age data preparation

Numbers and average weight at age issued from the MEDITS survey are summarized below in tables 6.6.7 and 6.6.8. The evolution of the MEDITS index at age is shown in Figure 6.6.15.

Table 6.6.7. MEDITS index at age (Numbers in thousands for the 13800 km^2 of the Gulf of Lion)

Year	0	1	2	3	4
2002	63.659	1073.071	901.882	196.534	77.021
2003	30.234	704.534	779.723	158.918	46.658
2004	125.34	1676.267	1000.411	187.076	69.366
2005	69.673	1172.226	1036.382	185.777	53.452
2006	146.719	1544.861	584.48	119.183	57.449
2007	220.613	3567.772	2548.736	398.306	131.862
2008	169.258	2052.816	1425.51	335.162	114.531
2009	127.821	1754.178	1328.648	415.435	191.742
2010	605.594	6107.364	1962.244	323.368	190.827
2011	117.414	1927.261	1856.392	354.763	72.078
2012	54.052	1264.888	1852.788	456.493	143.252
2013	600.153	6107.384	2736.582	493.87	147.128
2014	440.147	5441.602	3408.389	696.958	187.541
2015	145.461	3150.572	3853.991	920.753	262.157
2016	795.658	8658.323	4402.201	909.657	259.814
2017	80.357	2405.74	3655.008	815.386	216.417
2018	548.832	5778.67	3018.249	770.103	265.667
2019	264.692	4107.854	3754.063	889.949	290.258
2020	599.742	6778.305	3177.736	575.603	139.77
2021	359.522	7852.168	8894.446	1709.556	444.335
2022	1123.694	14525.66	9959.985	2062.909	477.498
2023	2232.271	20492.217	10269.925	1969.479	441.554

Table 6.6.8. MEDITS average weight at age.

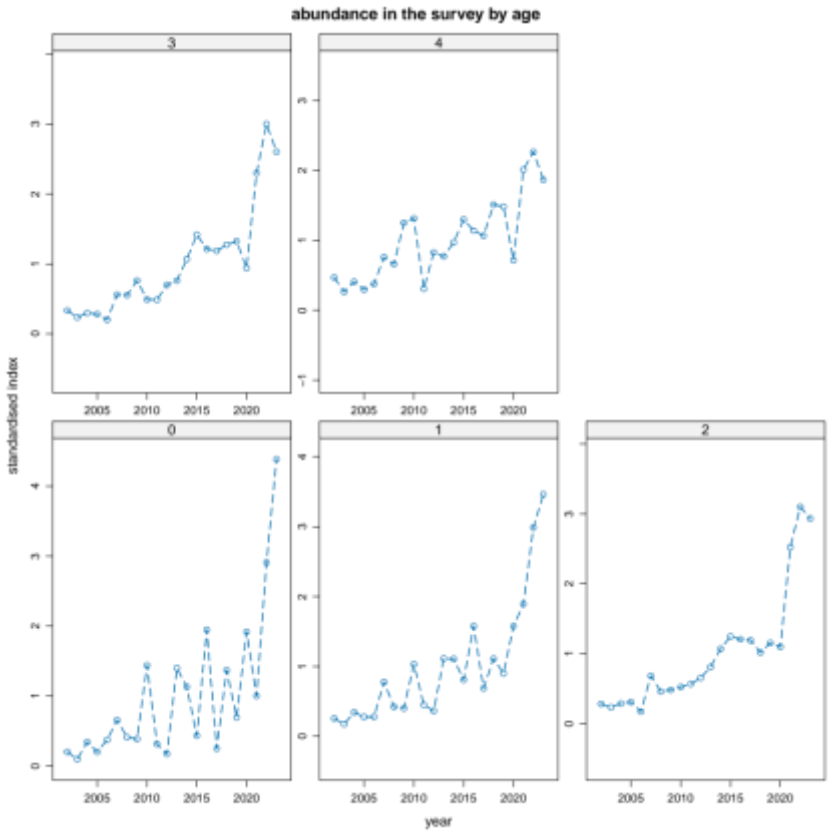

abundance in the survey by age
3
4
0
1
2
standardised index
year
2005
2010
2015
2020

Figure 6.6.15. MEDITS index at age of Red Mulled in GSA 7. Y-axis is standardised.

6.6.3 ASSESSMENT

Method: a4a.

Input data & model specifications.

Input data for the stock assessment are those summarised in tables 6.6.3 – 6.6.8 above, together with assumed maturity and natural mortality (see section 6.6.4). The model used for this year has been slightly updated compared to STECF 23_09, reducing the number of knots k in the smoother over the years of the fishing mortality model:

fmodel = ~ factor(age) + s(year, k = 5)

qmodel = ~factor(replace(age,age>3,3))

srmodel = ~geomean(CV=0.35)

Final Run

Recruitment, SSB, catch and Fbar (ages 0-3) estimates from the final model are provided in table 6.6.9, the resulting fishing mortality at age in Table 6.6.10 and the estimated stock abundance in table 6.6.11.

Table 6.6.9. Recruitment (rec, in thoudands), spawning stock biomass (ssb, in tons), catch (in tons) and fbar estimated by the stock assessment model.

year	rec	ssb	catch	fbar
2002	21236.03	129.61	114.415	0.756
2003	22270.85	147.405	127.387	0.727
2004	22906.46	169.791	146.589	0.7
2005	26488.3	204.394	167.751	0.675
2006	26506.41	219.822	172.371	0.652
2007	22713.81	245.618	188.277	0.633
2008	26588.36	275.63	212.376	0.619
2009	32740.14	254.93	191.991	0.609
2010	36994.63	298.384	212.486	0.605
2011	34353.72	340.917	251.465	0.606
2012	36676.14	424.779	309.638	0.611
2013	40048.75	378.598	278.25	0.616
2014	42592.69	447.959	327.226	0.619
2015	46505.92	399.129	298.634	0.618
2016	46880.1	449.384	318.123	0.607
2017	42801.11	465.616	325.772	0.586
2018	50651.23	513.58	352.71	0.553
2019	60842.29	594.061	367.111	0.51
2020	66464.08	696.107	383.387	0.462
2021	60935.91	870.658	430.345	0.411
2022	69113.16	1009.813	453.046	0.363
2023	77568.51	1136.661	438.778	0.318

Table 6.6.10. Fishing mortality at age resulting from the stock assessment model.

Year	0	1	2	3	4+
2002	0.038	0.552	1.328	1.105	0.486
2003	0.036	0.531	1.278	1.064	0.467
2004	0.035	0.511	1.23	1.024	0.45
2005	0.034	0.492	1.186	0.987	0.434
2006	0.032	0.476	1.146	0.954	0.419
2007	0.032	0.462	1.112	0.926	0.407
2008	0.031	0.452	1.087	0.905	0.398
2009	0.03	0.445	1.071	0.891	0.392
2010	0.03	0.442	1.064	0.885	0.389
2011	0.03	0.443	1.065	0.887	0.39
2012	0.03	0.446	1.073	0.893	0.392
2013	0.031	0.45	1.082	0.901	0.396
2014	0.031	0.452	1.089	0.906	0.398
2015	0.031	0.451	1.085	0.903	0.397
2016	0.03	0.443	1.067	0.888	0.39
2017	0.029	0.427	1.029	0.856	0.376
2018	0.028	0.403	0.971	0.808	0.355
2019	0.025	0.373	0.897	0.747	0.328
2020	0.023	0.337	0.812	0.676	0.297
2021	0.021	0.3	0.723	0.602	0.264
2022	0.018	0.265	0.638	0.531	0.233
2023	0.016	0.232	0.56	0.466	0.205

Table 6.6.11. Stock abundance (in thousands) at age estimated by the model

Year	0	1	2	3	4
2002	21236.03	7792.17	1400.897	295.201	72.911
2003	22270.85	7972.812	2359.508	218.718	89.535
2004	22906.46	8373.188	2465.061	387.345	82.861
2005	26488.3	8623.851	2640.813	424.499	120.434
2006	26506.41	9984.978	2770.678	475.485	148.439
2007	22713.81	10003.083	3261.485	519.135	176.494
2008	26588.36	8579.959	3313.016	631.837	203.175
2009	32740.14	10050.747	2871.739	658.29	246.467
2010	36994.63	12381.883	3386.748	579.934	274.589
2011	34353.72	13993.604	4184.166	688.649	267.842
2012	36676.14	12994.105	4725.819	849.499	292.579
2013	40048.75	13869.541	4374.602	952.288	342.862
2014	42592.69	15140.895	4650.88	873.145	388.328
2015	46505.92	16099.794	5064.156	922.565	386.317
2016	46880.1	17580.663	5392.309	1007.873	398.741
2017	42801.11	17731.473	5933.941	1093.332	430.752
2018	50651.23	16206.026	6079.47	1249.463	478.04
2019	60842.29	19209.667	5691.014	1356.01	560.771
2020	66464.08	23123.446	6957.539	1367.415	658.341
2021	60935.91	25321.123	8676.727	1820.4	745.825
2022	69113.16	23273.501	9857.966	2480.725	986.818
2023	77568.51	26460.733	9388.529	3070.178	1408.166

Through the years, the fishing mortality has decreased by roughly 30% on Red Mullet, starting from 0.75 to reach 0.32 in 2023 (Table 6.6.9 & Figure 6.6.16). The model estimates that recruitment has increased steadily since 2008, reached a maximum in 2020, and after a short decrease in 2021 is on the rise again. As a result, spawning stock biomass has increased since 2010, and is estimated in 2023 to be almost 10 times higher than at the beginning of the serie in 2002.

The reasons behind this increase are unclear. First, an environmental regime shift occurred in the Gulf of Lions between 2005 and 2010. Small pelagics and especially sardines responded to it with increased mortality at higher ages, leaving only smaller individuals in the population with sizes unsuitable for commercial purpose. As a result, the fishery strongly reconfigured in GSA 7, with former pelagic trawlers reporting their effort on demersal species. Then, effort on demersal stocks have been exceptionably strong and economically unsustainable between 2008 and 2012, ultimately leading to the reduction of the number of active demersal trawlers in 2012. Furthermore, red mullet is known to be a relatively fast growing, productive species. All these factors have probably all contributed to the positive trend of the stock. New environmental conditions in the Gulf of Lion after the regime shift, while detrimental to sardine survival, may have been more suitable for red mullet recruitment, while fishing effort reduction after 2012 also possibly contributed to the increased survival of adults.

A last element of caution is the increase in the use of OTT in the french fleet, the fishing efficiency of which is globally superior to OTB (see EWG 21_01 on conversion factors), with possibly a differing selectivity when compared to OTB. The assessment now assumes the same selectivity for all trawlers, but gear-specific selectivity patterns could be investigated to explicitly distinguish between OTB and OTT in the assessment. However, as both gears displays similar mesh size and pattern, such effect, if it exists, is not expected to be strong.

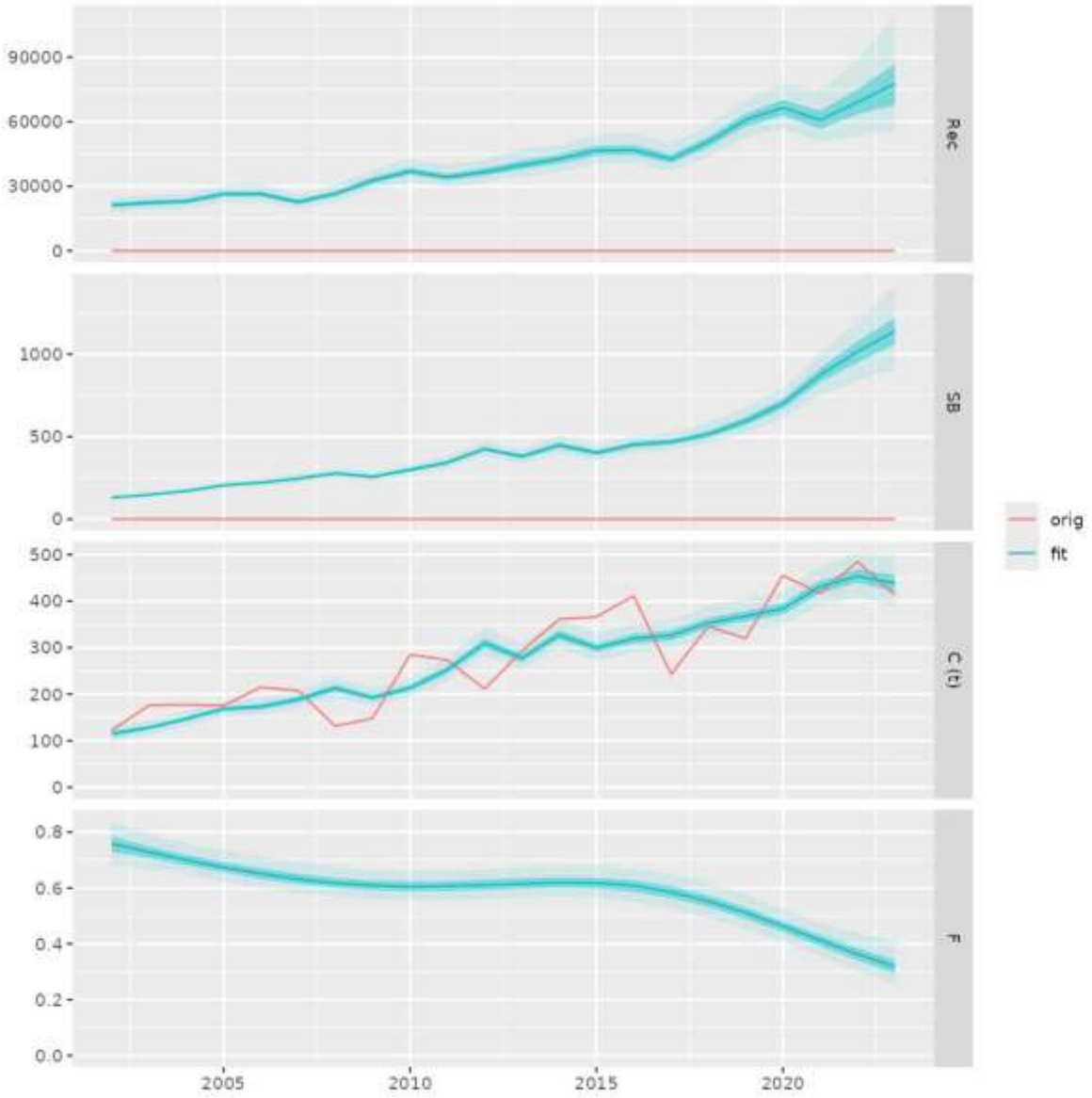


Figure 6.6.16. Time series and confidence intervals of Recruitment, SSB, Catch and Fbar estimated by the model, together with confidence intervals. The red line in the catch series corresponds to the observed catch.

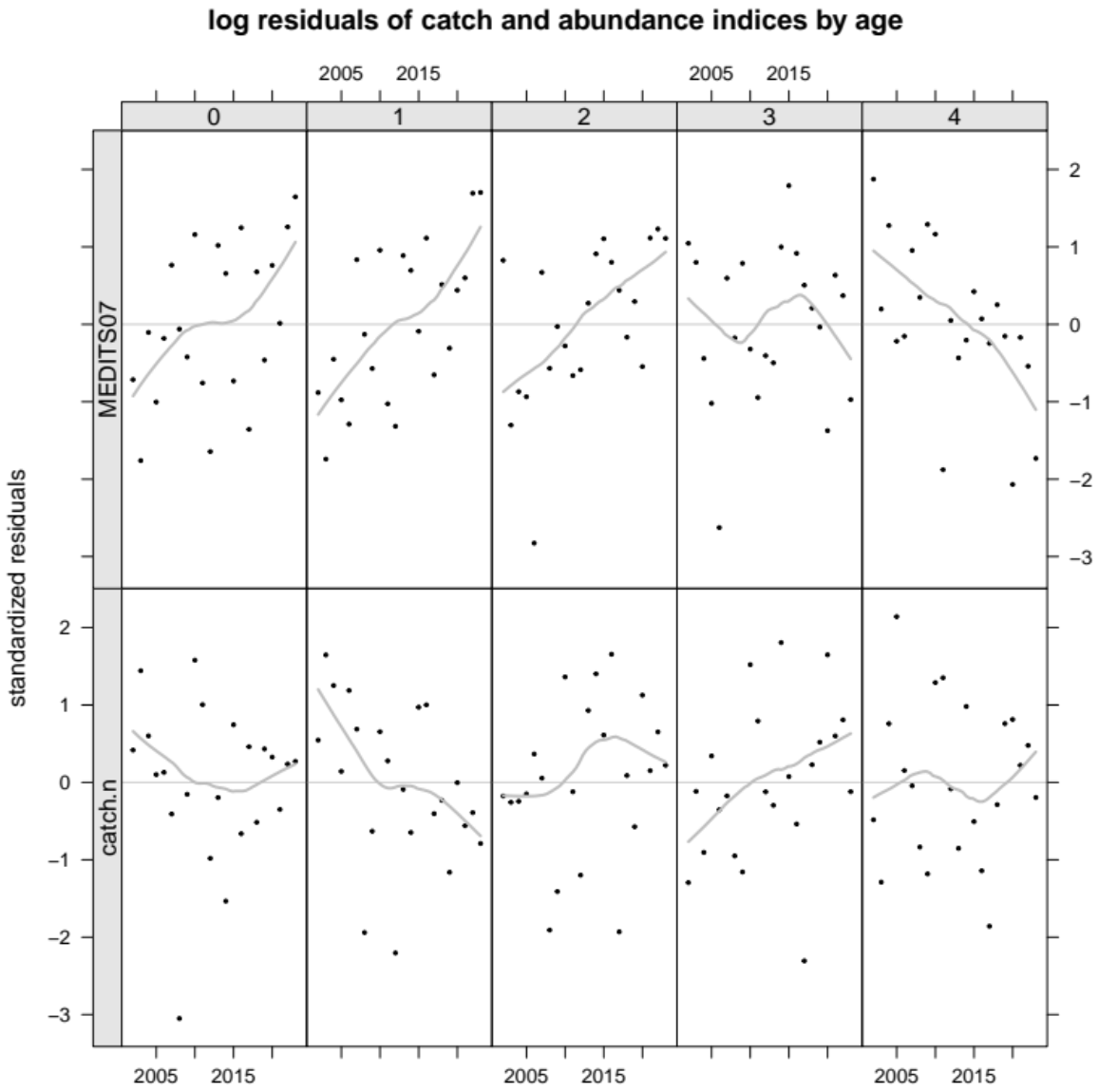


Figure 6.6.17. Log residuals from the stock assessment model.

As in previous years, Log-residuals (Figure 6.6.17) exhibited few patterns, except for positive residuals at age 1 for the catch at the first half of the serie (up to 2010).

Tri-dimensional representation of fishing mortality at age through the years (Figure 6.6.18) suggests that fishing mortality is quite low at age 0 compared to other ages, and is also somewhat reduced at older ages. Survey catchability (Figure 6.6.19) is assumed constant through the years, but increases with age up to age 3, in accordance with the catchability submodel specification.

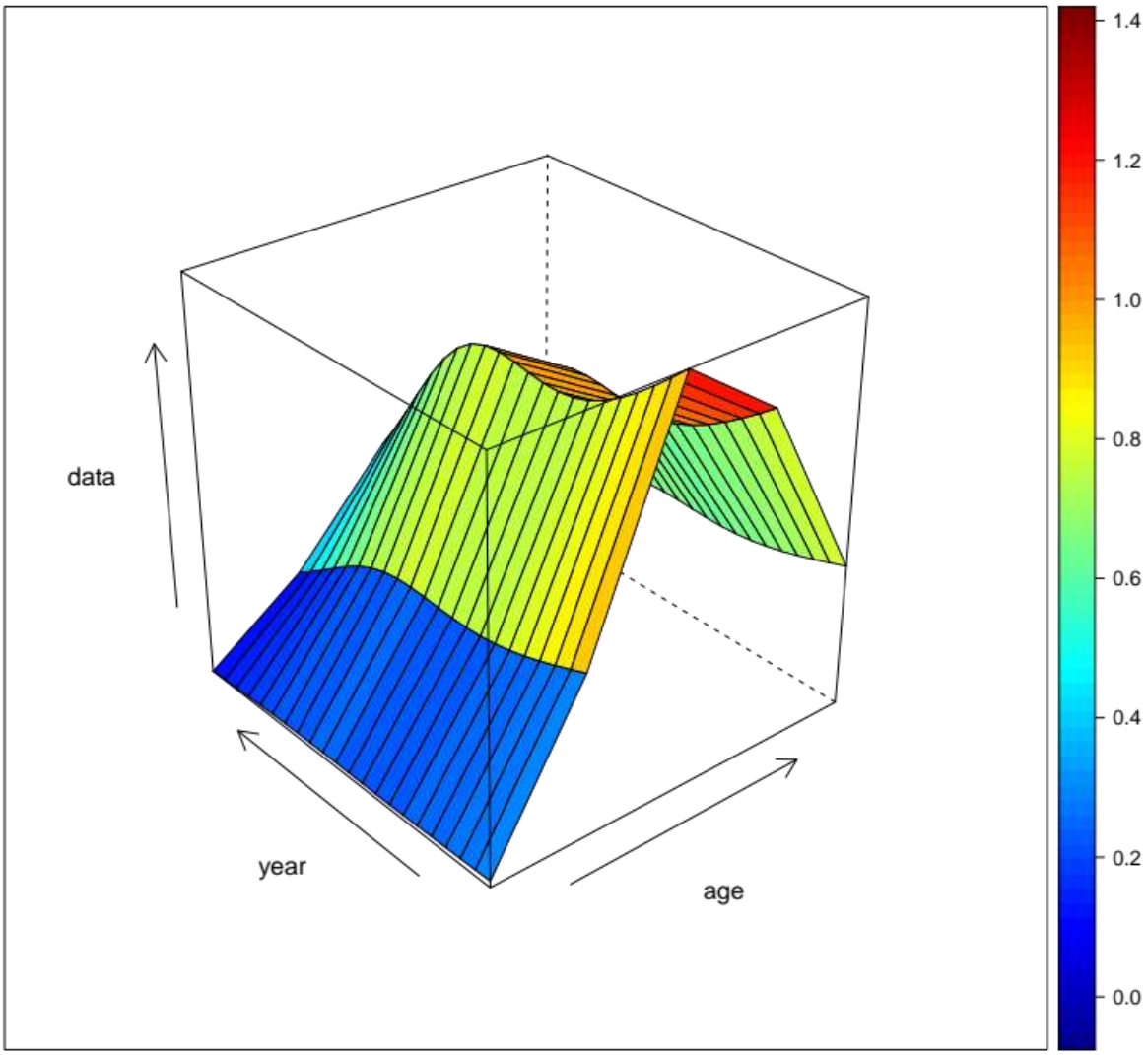


Figure 6.6.18. Fishing mortality at age through the years

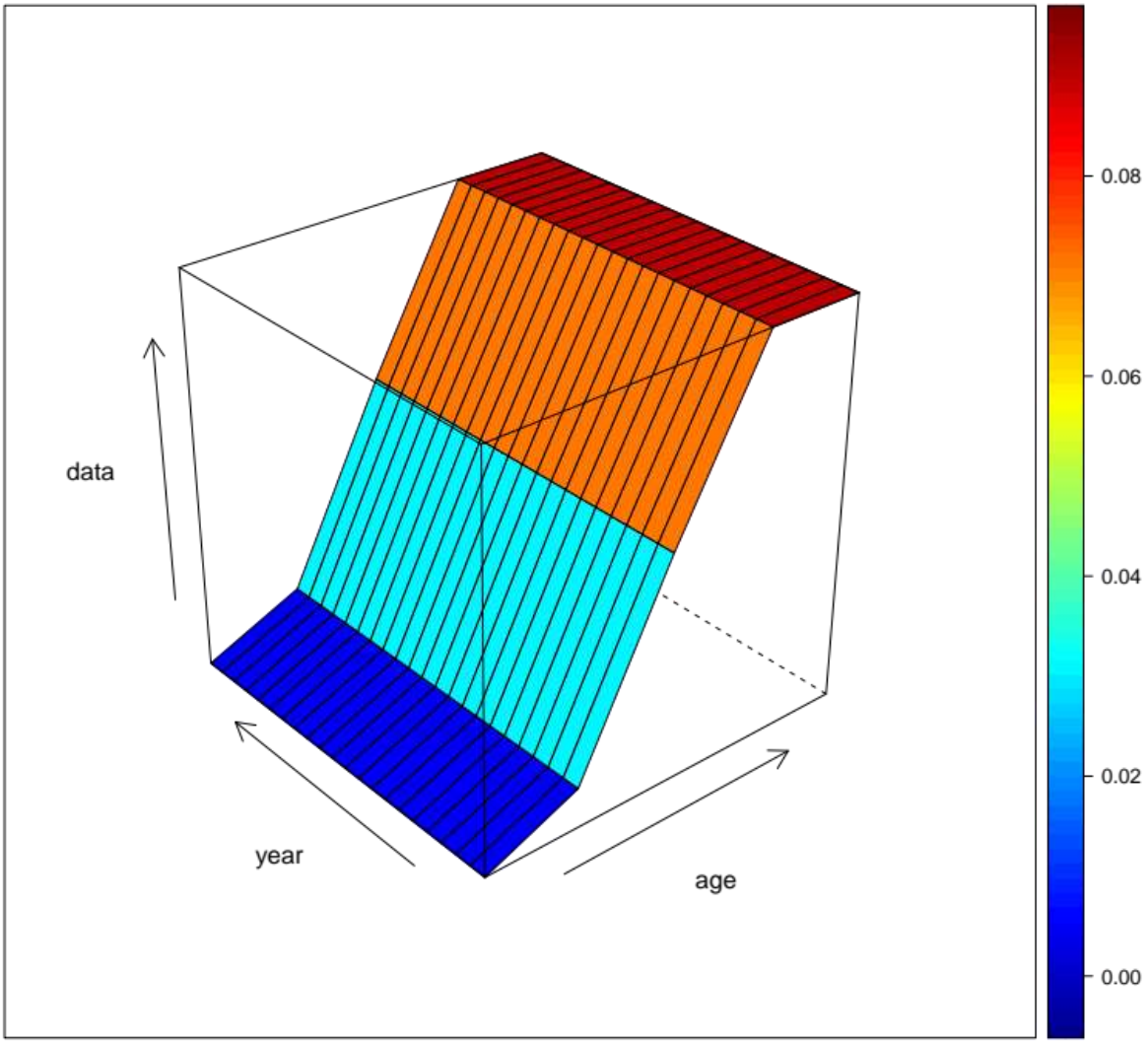


Figure 6.6.19. Survey catchability at age through the years

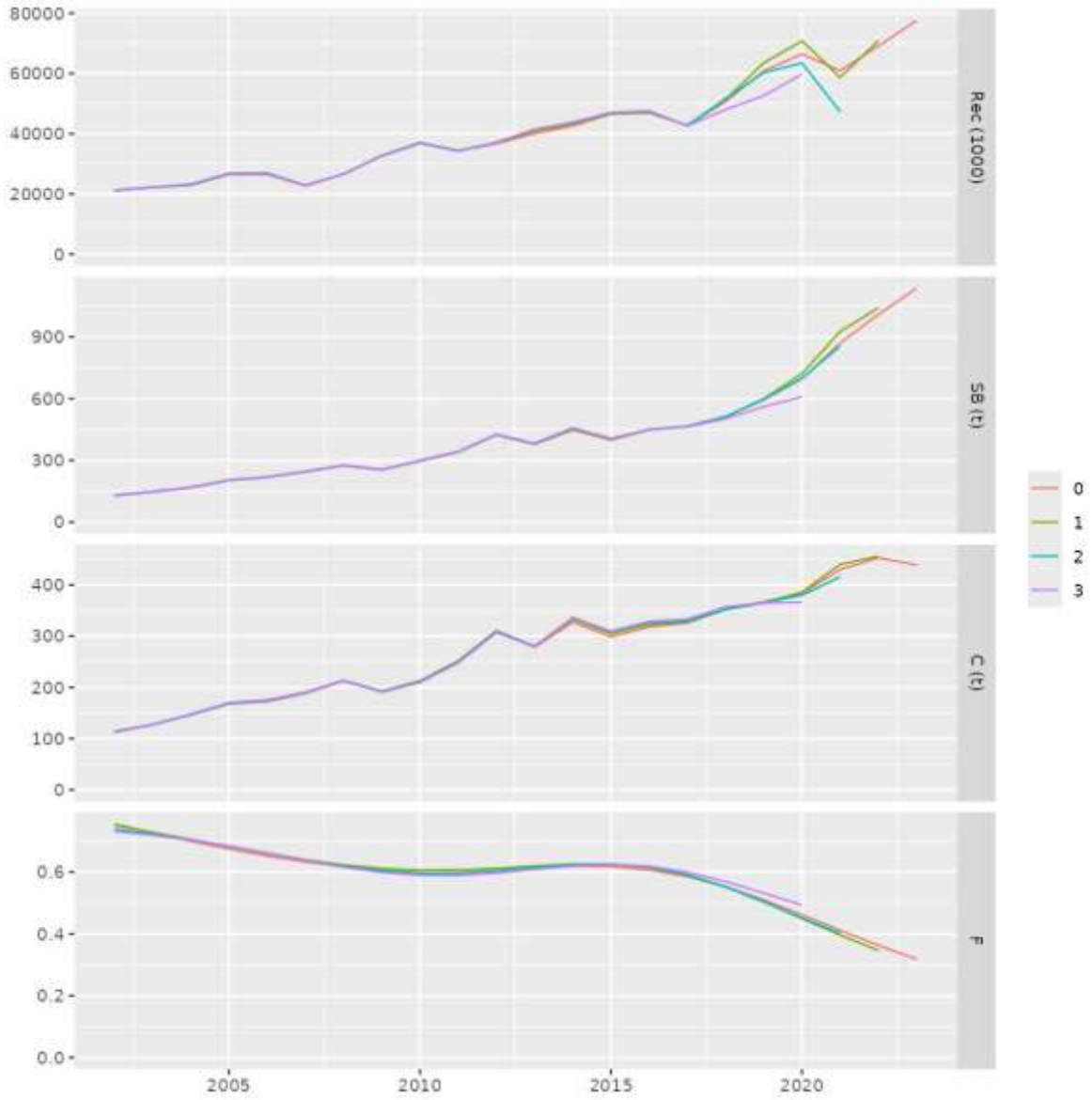


Figure 6.6.20. Retrospective analysis carried out for the selected model.

6.6.4 REFERENCE POINTS AND ADVICE PLOTS

The reference points for MUT7 have been computed with the exact same procedure as implemented in EWG 23_09 and are provided in table 6.6.12. For the sake of comparison, table 6.6.12 also shows the reference points from last year. From these, it is quite obvious that changes from last year are marginal.

Table 6.6.12. Final reference points for MUT 7 based on the geometric mean model.

EWG	F_0.1	Blim	Bpa	B_f0.1	B_0	Fpa
23_09	0.456	133.53	267.07	774.67	1591.23	1.029
24_10	0.452	146.49	292.97	830.47	1701.74	1.04

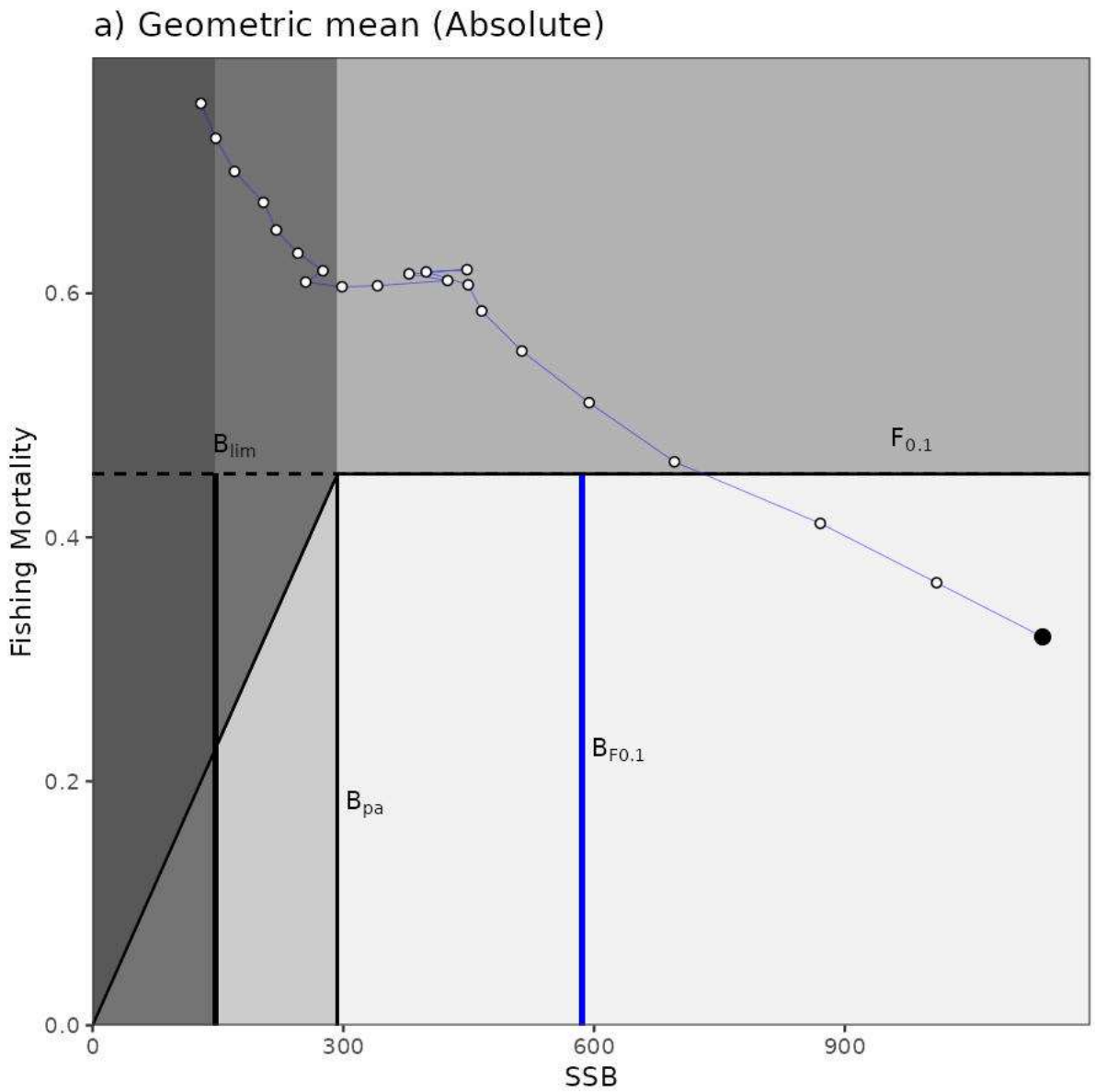


Figure 6.6.21. Advice Rule plots, with Bpa = 2*Blim, showing the results of the Geometric mean model with an empirical Blim set as 0.25*BF0.1.

6.6.5 SHORT-TERM FORECAST

Input parameters used in the stock assessment were used for the STF (Table. 6.6.13). Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 0 to 3 and F status quo (F_{stq} = 0.32 based on F in 2023) were performed. Recuitment (class 0) has been estimated as the geometric mean of the stock assessment output since 2015 as it corresponds to the high-recruitment time period. FMSY transition has been estimated as a gradual linear transition to reach FMSY in 2025.

Table 6.6.13. Short-term forecast

Rationale	Ffactor	Fbar	Recruitment 2024	Fsq2024	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	1.42	0.45	63,716.27	0.32	438.78	488.08	673.59	1,288.52	1,069.66	-16.99	53.52
F upper	1.94	0.62	63,716.27	0.32	438.78	488.08	843.29	1,288.52	882.94	-31.48	92.19
F lower	0.95	0.30	63,716.27	0.32	438.78	488.08	488.64	1,288.52	1,291.21	0.21	11.36
FMSY transition	1.42	0.45	63,716.27	0.32	438.78	488.08	673.59	1,288.52	1,069.66	-16.99	53.52
Zero catch	0.00	0.00	63,716.27	0.32	438.78	488.08	0.00	1,288.52	1,960.59	52.16	-100.00
Status quo	1.00	0.32	63,716.27	0.32	438.78	488.08	511.24	1,288.52	1,263.16	-1.97	16.51
Different Scenarios	0.10	0.03	63,716.27	0.32	438.78	488.08	60.74	1,288.52	1,871.09	45.21	-86.16
0.2	0.06	63,716.27	0.32	438.78	488.08	119.07	1,288.52	1,786.78	38.67	-72.86	-76.03
0.3	0.10	63,716.27	0.32	438.78	488.08	175.10	1,288.52	1,707.30	32.50	-60.09	-64.96
0.4	0.13	63,716.27	0.32	438.78	488.08	228.95	1,288.52	1,632.37	26.69	-47.82	-54.45
0.5	0.16	63,716.27	0.32	438.78	488.08	280.70	1,288.52	1,561.68	21.20	-36.03	-44.46
0.6	0.19	63,716.27	0.32	438.78	488.08	330.45	1,288.52	1,494.97	16.02	-24.69	-34.97
0.7	0.22	63,716.27	0.32	438.78	488.08	378.29	1,288.52	1,431.99	11.13	-13.78	-25.94
0.8	0.25	63,716.27	0.32	438.78	488.08	424.32	1,288.52	1,372.50	6.52	-3.29	-17.35
0.9	0.29	63,716.27	0.32	438.78	488.08	468.61	1,288.52	1,316.30	2.16	6.80	-9.18
1.1	0.35	63,716.27	0.32	438.78	488.08	552.28	1,288.52	1,212.91	-5.87	25.87	6.04
1.2	0.38	63,716.27	0.32	438.78	488.08	591.81	1,288.52	1,165.36	-9.56	34.88	13.12
1.3	0.41	63,716.27	0.32	438.78	488.08	629.89	1,288.52	1,120.35	-13.05	43.56	19.87
1.4	0.45	63,716.27	0.32	438.78	488.08	666.58	1,288.52	1,077.72	-16.36	51.92	26.32
1.5	0.48	63,716.27	0.32	438.78	488.08	701.96	1,288.52	1,037.33	-19.49	59.98	32.48
1.6	0.51	63,716.27	0.32	438.78	488.08	736.06	1,288.52	999.04	-22.47	67.75	38.37
1.7	0.54	63,716.27	0.32	438.78	488.08	768.96	1,288.52	962.73	-25.28	75.25	44.00
1.8	0.57	63,716.27	0.32	438.78	488.08	800.70	1,288.52	928.27	-27.96	82.48	49.39
1.9	0.60	63,716.27	0.32	438.78	488.08	831.33	1,288.52	895.56	-30.50	89.46	54.55
2	0.64	63,716.27	0.32	438.78	488.08	860.90	1,288.52	864.49	-32.91	96.20	59.49

Fishing at $F_{0.1}$ (0.45) generates an increase of the catch of 53.5% from 2023 to 2025 and will reduce the SSB (-17% from 2024 to 2026.

6.7 Norway Lobster in GSA 5

6.7.1 Stock Identity and Biology

GSA 5 (Figure 6.7.1.1) has been pointed as an individualized area for assessment and management purposes in the western Mediterranean (Quetglas *et al.*, 2012) due to its main specificities. These include: 1) particular geomorphology, since 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 compared to GSA 6, which 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 peninsular vessels targeting red shrimp in GSA 5 but landing their catches in GSA 6; 5) the density of trawlers around the Balearic Islands is one order of magnitude lower than in adjacent peninsular waters, fact that causes that the fishing exploitation in GSA 5 is much lower than in GSA 6; and 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 in general larger modal sizes and lower percentages of small-sized individuals), and in the higher abundance and diversity of elasmobranch assemblages.

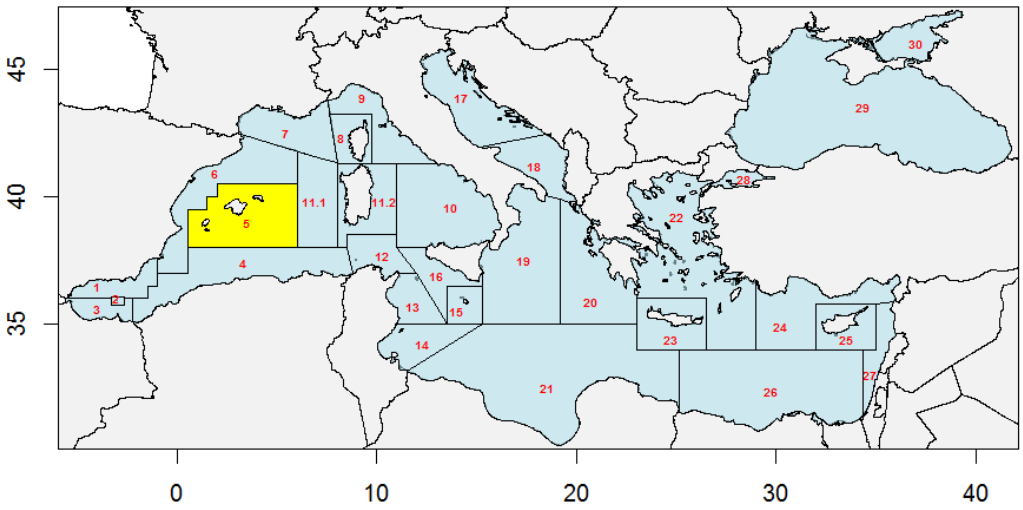


Figure 6.7.1.1. Geographical localization of GSA 5.

For Norway lobster (*Nephrops norvegicus* designated by the ASFIS 3-letters code “NEP”), the biological parameters, natural mortality vector and maturity ogive used for the assessment were those shown in the following tables. Growth and length-weight parameters (Table 6.7.1.1) were those from the last DCF 2023 Official data call. Natural mortality vector (Table 6.7.1.2) and the maturity ogive (Table 6.7.1.3) were the same presented in the last EWG 23-09.

Table 6.7.1.1. Norway Lobster in GSA 5. Growth and length-weight parameters.

Growth	
L_{inf} (cm)	86.1
k	0.126
t_0	0

Length-Weight	
a	0.000398
b	3.136485

Table 6.7.1.2. Norway Lobster in GSA 5. Natural Mortality vector.

Age	1	2	3	4	5	6	7	8	9+
Mortality	0.732	0.466	0.353	0.291	0.252	0.226	0.206	0.191	0.18

Table 6.7.1.3. Norway Lobster in GSA 5. Maturity ogive.

Age	1	2	3	4	5	6	7	8	9+
Maturity	0.10	0.25	0.80	1.00	1.00	1.00	1.00	1.00	1.00

6.7.2 DATA

General description of the fisheries

In the Balearic Islands (western Mediterranean), commercial bottom trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (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 shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus* and *Parapenaeus longirostris*, but with an important by-catch of big individuals of *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m).

The Norway lobster (*N. norvegicus*) is an economically important resource in the Balearic Islands caught in the upper slope, although its importance in biomass landed and fishing trips targeting it is small due to the narrow bathymetric range and the limited number of fishing grounds where it can be found in the Balearic Islands, especially around Mallorca and Menorca islands.

Furthermore, the fleet operating deeper than 150 m around Ibiza and Formentera islands are vessels whose base ports are in the mainland (GSA 6), not from local harbours (GSA 5), whose fleet exclusively operates shallower than 150 m. This peculiar activity is regulated by the Spanish legislation. Thus, the mainland fleet fishing in GSA5 upper slope fishing can land their

catches, depending on their fishing tactics, alternatively in GSA 5 or its original GSA 6 ports. This makes that the official reporting of the real catch data are often not clear, and consequently may cause that catch data from GSA5 can be slightly biased and not properly reported. This bias can especially affect *N. norvegicus* data in comparison with other species caught in the upper slope, since considering the low effort and catches from Mallorca and Menorca, the percentage of *N. norvegicus* catches from mainland fleet can be proportionally higher with respect to the total GSA 5 catches of the species. This situation has to be taken into account when performing the assessment of this stock, interpretation of results and extraction of conclusions.

Management regulations

- Fishing license: fully observed
- Engine power limited to 316 KW or 500 CV: not observed
- Mesh size in the cod-end (before Jun 1st 2010: 40 mm diamond; from Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-): fully observed
- Fishing forbidden upper 50 m depth: fully observed
- Time at sea (12 hours per day and 5 days per week): fully observed
- Weekly temporal bans (winter, 2016-2019)
- EU multiannual plan (from 2020): Fishing reduction (2020, 2021 & 2022) (number of days, 23.5% with 2015-2017 as reference); Spatio-temporal closures (2020) (juveniles hake); Spatio-temporal closures (2021) (juveniles & spawners); four weeks temporal ban for protecting hake spawners (150-500 m).

6.7.2.1 CATCH (LANDINGS AND DISCARDS)

Catch data are available from Official DCF data call since 2002. Landings for Norway lobster in GSA 5 come almost exclusively from bottom trawlers and have shown an oscillating pattern along the time series (Figure 6.7.2.1.1, Table 6.7.2.1.1). Since 2013 to 2018, catches showed an increasing trend, but this pattern has not continued in the last five years, where catches has decreased constantly. Discards are reported at very low levels in for most of years (Figure 6.7.2.1.1, Table 6.7.2.1.2). In fact, in 2023 there were no discards reported. Therefore, overall discards for this species can be considered negligible.

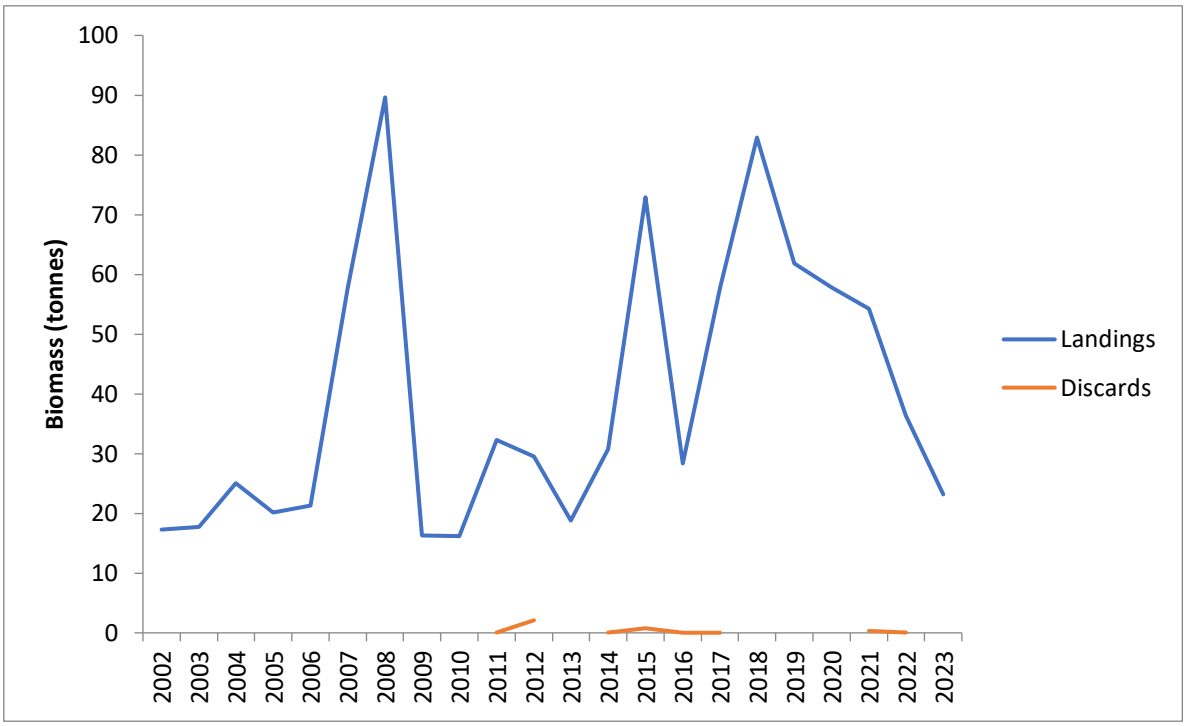


Figure 6.7.2.1.1. Norway Lobster in GSA 5. Reported landings (tonnes) and discards (tonnes) from the Official DCF Data Call by all gears (2002-2023).

Table 6.7.2.1.1. Norway Lobster in GSA5. Reported landings (tonnes) by all metiers gear from the Official DCF Data Call by all metiers.

year	GNS_DEF	GTR_DEF	GTR_NA	LLS_DEF	OTB_DEF	OTB_DEMSP	OTB_DWS	OTB_MDD
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	12.63	1.34	2.37
2010	0	0	0	0	0	11.35	1.22	3.62
2011	0	0	0	0	0	19.08	0.04	13.14
2012	0	0	0	0	0	13.04	8.42	8.04
2013	0	0	0	0	0	11.26	3.58	3.98
2014	0	0	0	0	0	19.96	4.65	6.19
2015	0	0	0	0	0	37.83	14.03	21.01
2016	0	0	0	0	0	14.76	5.77	7.80
2017	0	0	0	0	0	25.37	4.98	27.47

2018	0	0	0	0	0	46.51	8.08	28.32
2019	0	0	0	0	0	30.12	8.91	22.81
2020	0	0.02	0	0.01	36.69	0	4.55	16.53
2021	0	0.01	0	0	36.97	0	11.66	5.63
2022	0.00	0.02	0	0	19.88	0	11.70	4.79
2023	0.00	0.01	0.01	0	11.19	0	8.37	3.63

Table 6.7.2.1.2. Norway Lobster in GSA5. Reported discards (tonnes) by all metiers gear from the Official DCF Data Call by all metiers.

year	OTB_DEMSP	OTB_DWS	OTB_MDD	Total
2009	0	0	0.05	0.05
2010	0	0	0	0
2011	0	0	0.07	0.07
2012	0.06	1.19	0.86	2.11
2013	0	0	0	0
2014	0	0	0.03	0.03
2015	0	0	0.74	0.74
2016	0.02	0	0	0.02
2017	0.01	0.01	0	0.02
2018	0	0	0	0
2019	0	0	0.11	0.11
2020	0	0	0	0
2021	0	0.00	0.32	0.32
2022	0	0	0.04	0.04
2023	0	0	0	0

Length frequency distributions per gear, metier and year of landings from the Official DCF 2023 data call before reconstructions are presented in Figure 6.7.2.1.2. Length structure by gear, fishery and year after reconstruction is shown in Figure 6.7.2.1.3 and in Table 6.7.2.1.3 only per year. The percentage of total landings that were reconstructed applying the SoP correction to LFDs is shown in Figure 6.7.2.1.4.

Evaluation of length frequency distribution for the Norway lobster in GSA 5 shows that most of the information comes from OTB_DEMSP, OTB_DWS and OTB_MDD from 2009 to 2017, and from OTB_DEF and OTB_DWS since 2019 (Figure 6.7.2.1.2 and 6.7.2.1.2). There is no lengths data before 2009. The change in gear type results not from a change in the fishery, just a redefinition of the gear designations. In order to account this change in fishing gear, it was decided to use in assessment only the commercial data from 2009.

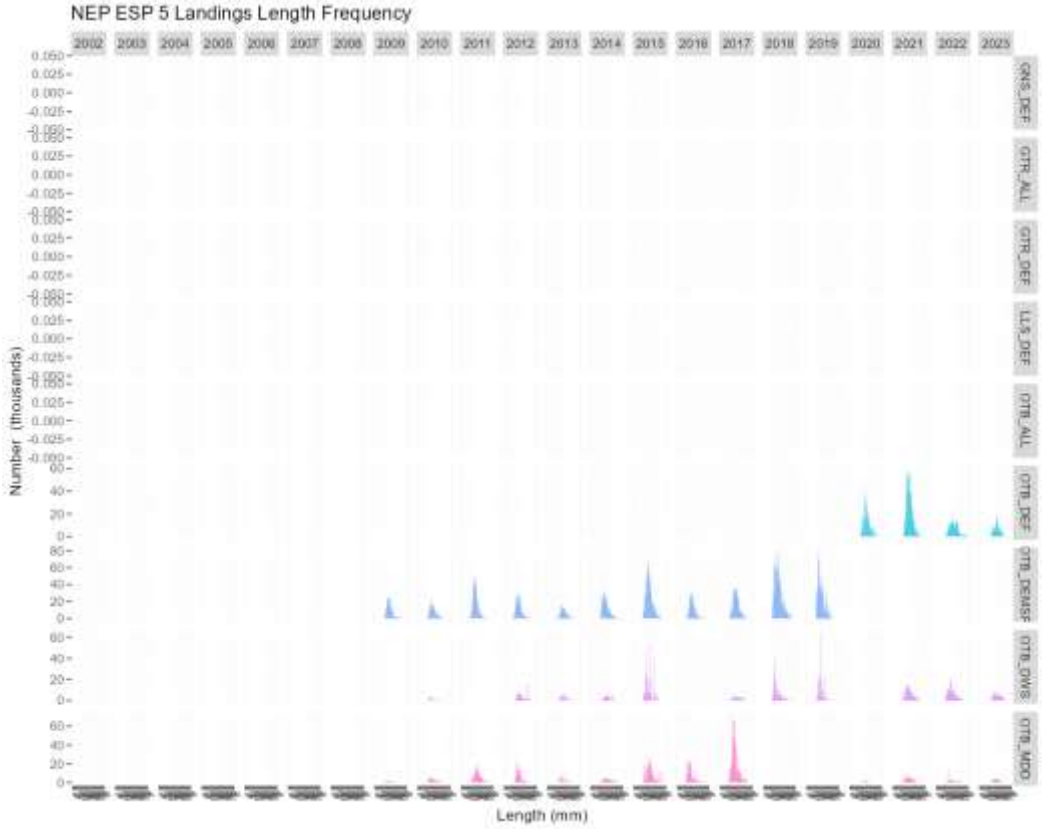


Figure 6.7.2.1.2 Norway Lobster in GSA 5. Original length frequency distribution, by year and métier (CL in mm, numbers in thousands), before reconstruction from the DCF 2023 Official data call.

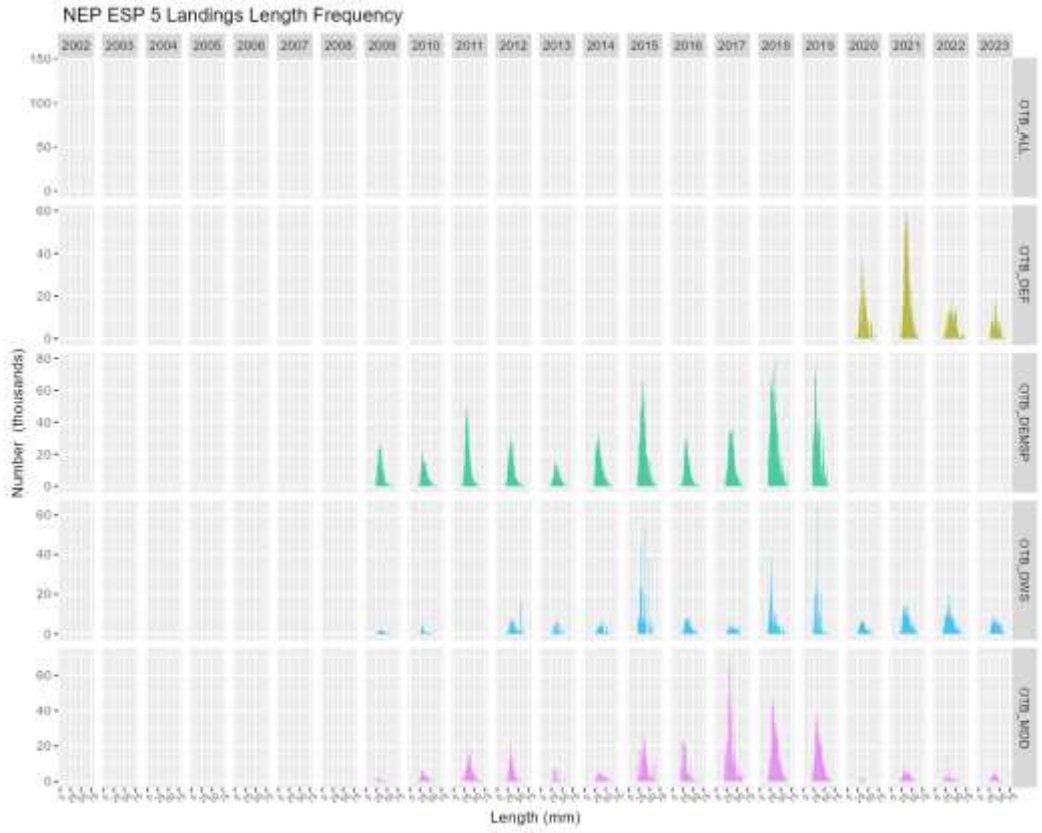


Figure 6.7.2.1.3. Norway Lobster in GSA 5. Landings length frequency distribution, by year and métier (CL in mm, numbers in thousands), after reconstruction from the DCF 2023 Official data call.

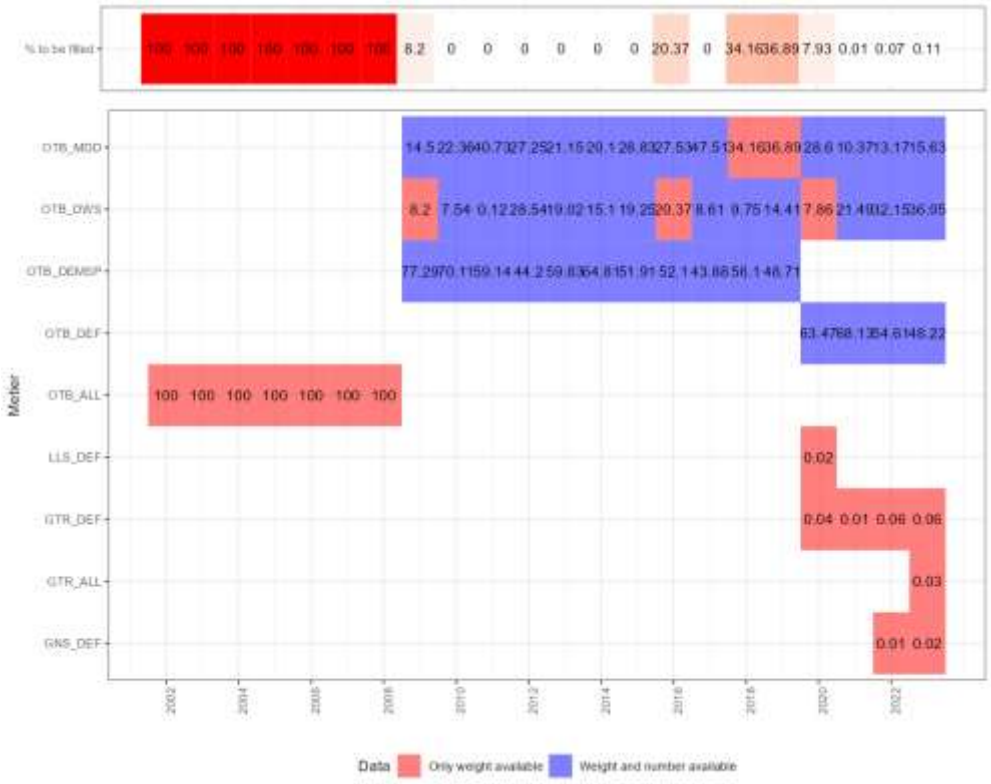


Figure 6.7.2.1.4. Norway Lobster in GSA 5. Percentages of total landings LFDs that were reconstructed by year and gear and SoP applied to LFD from the DCF 2023 Official data call.

Table 6.7.2.1.3. Norway Lobster in GSA 5. Length structure (CL in mm, numbers in thousands) for total landings reported in the DCF 2023 Official data call.

length	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
12	0	0	0	0	0	0	0	0	0	0	0	0	0.87	0	0
13	0.23	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0.25	0.24	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0.38	0	0	0	0	0	0	0	0	0	0	0.20	0	0
16	0	0.44	0	0.28	0	0	0	0.12	0	0	0	0	0	0	0
17	0.11	0.38	0.25	0	0	0.06	0	0	0	0	0	0	0	0	0
18	0.23	0.38	0.25	0.11	0	0.10	0	0	0	0	0	0	0	0.25	0
19	0.74	0.55	0.23	0.72	0	0.05	0	0	0	2.49	0	0	0.32	0.16	0
20	0.46	1.36	1.71	1.60	0.24	0.29	0.61	1.25	3.53	8.12	2.18	0.01	0.68	1.98	0.02
21	1.49	2.26	3.14	2.72	0.63	1.05	7.01	8.56	14.13	31.68	3.43	0.04	0.69	3.99	0.07
22	0.72	2.19	2.12	2.71	1.99	1.53	14.13	5.22	6.70	27.15	33.67	1.48	1.18	4.12	0.24
23	0.46	2.07	3.93	6.48	1.05	6.33	20.83	25.51	22.68	50.54	26.11	0.46	10.26	4.02	0.61
24	5.72	4.18	9.15	12.53	0.63	10.15	25.44	10.49	15.03	56.35	38.85	3.21	5.30	10.78	0.68
25	5.54	6.96	14.06	17.13	3.25	19.19	50.91	17.26	24.76	94.82	54.46	1.45	5.86	15.27	0.87
26	14.12	14.26	17.56	24.24	4.62	23.14	35.89	31.54	33.59	111.65	65.17	1.99	12.61	15.38	0.98
27	14.35	15.85	29.70	19.10	5.21	23.20	58.52	35.50	60.86	123.59	109.60	8.73	20.57	15.35	4.46
28	17.12	22.45	41.67	43.09	15.29	33.02	45.81	37.39	37.63	123.66	115.79	18.91	29.67	32.24	3.34

29	19.47	26.64	47.20	46.49	7.08	30.59	99.24	44.41	45.15	88.25	115.56	18.10	33.03	23.87	7.27
30	26.72	33.89	50.63	34.31	17.67	30.35	87.13	51.82	103.73	107.02	91.03	24.10	37.48	17.86	13.85
31	26.35	30.94	55.33	55.23	18.50	37.28	91.68	57.02	96.93	107.20	90.27	12.35	51.39	19.28	14.04
32	26.11	22.98	59.69	46.87	20.59	41.20	84.22	50.06	81.04	121.35	98.60	13.07	67.81	27.07	18.30
33	27.47	23.49	65.72	51.00	28.45	34.62	100.09	44.81	102.55	112.05	133.52	44.97	71.66	32.28	12.15
34	26.76	20.22	52.40	45.51	14.05	35.85	94.18	49.44	72.00	85.40	60.21	20.86	75.64	34.50	19.29
35	28.01	19.20	49.99	48.61	20.16	34.02	76.57	42.45	86.29	116.26	82.71	36.65	70.62	32.55	15.48
36	19.02	16.60	38.59	46.30	22.93	30.35	68.69	36.66	74.08	84.44	65.28	7.98	59.01	22.29	18.96
37	23.16	19.54	38.16	36.03	19.67	27.51	83.07	33.09	49.36	96.60	67.42	24.27	54.81	22.36	19.12
38	13.46	12.97	35.68	29.05	20.21	32.10	74.57	29.88	71.40	85.95	71.78	42.30	75.17	21.43	15.74
39	13.15	13.88	36.98	29.27	15.95	24.45	115.90	25.60	49.73	73.17	60.86	28.87	73.92	29.70	26.43
40	18.15	12.53	26.64	21.93	15.21	24.16	58.02	27.75	49.18	75.09	46.53	34.90	65.54	24.99	26.97
41	10.91	12.54	26.41	11.29	14.70	25.03	61.20	21.86	43.84	51.84	32.73	18.45	52.00	20.68	25.86
42	11.33	9.18	19.09	18.35	14.99	17.80	35.10	19.78	39.11	64.30	31.53	19.96	38.19	21.42	18.39
43	8.41	8.33	16.06	13.38	15.26	14.94	26.57	16.95	40.32	47.12	53.98	21.67	52.62	16.75	19.54
44	8.03	7.25	14.38	9.79	6.72	14.70	28.70	20.38	41.23	54.22	31.56	25.49	30.10	14.63	16.02
45	4.31	7.75	10.76	9.69	12.93	15.87	28.57	11.78	22.16	38.46	27.30	18.08	34.10	17.85	17.72
46	3.07	6.79	11.70	8.06	4.57	11.83	26.86	10.85	30.26	30.45	15.35	7.48	25.54	16.98	8.88
47	3.10	6.27	10.17	6.59	6.86	9.74	17.96	8.99	20.53	27.03	42.19	12.18	17.70	16.66	11.99
48	3.15	4.82	6.98	9.28	6.84	8.64	54.87	9.39	19.98	34.03	25.24	11.57	30.13	18.89	12.11
49	2.84	5.16	8.97	6.17	4.26	7.99	11.34	7.78	18.11	17.88	35.45	5.76	19.60	17.29	15.19
50	2.11	4.99	8.06	5.37	4.85	11.54	14.30	5.91	9.17	31.60	15.44	8.91	21.88	18.51	13.01
51	2.43	3.86	6.70	6.53	6.98	6.70	21.90	6.44	10.46	19.56	17.43	7.02	10.50	16.40	7.43
52	2.88	2.47	3.99	3.14	3.41	10.54	13.68	3.74	11.65	20.28	10.96	2.82	14.65	14.72	9.54
53	1.89	2.23	2.76	4.84	3.19	4.84	12.41	5.61	16.57	14.37	7.89	2.97	9.27	9.51	11.77
54	1.39	2.17	2.22	19.21	4.30	5.43	17.62	2.35	5.16	16.58	10.20	1.34	15.13	8.22	3.88
55	1.09	1.52	4.04	15.46	0.35	4.37	7.32	3.69	7.31	14.09	13.77	8.59	10.59	5.42	6.11
56	2.25	1.35	3.53	2.12	1.17	2.57	4.45	1.12	12.60	13.01	5.00	9.61	2.87	5.09	3.27
57	1.08	0.90	2.08	1.61	2.00	2.39	12.95	1.52	3.89	16.01	5.97	7.34	4.36	5.46	3.91
58	0.45	1.11	1.30	1.03	2.55	2.86	6.41	3.66	6.04	7.61	3.02	7.09	8.50	2.94	1.84
59	1.03	0.56	1.15	2.04	1.67	3.13	2.82	0.73	6.11	5.05	2.24	0.20	2.85	6.31	2.28
60	1.21	0.33	1.38	1.54	0.97	3.27	9.70	2.34	1.72	6.47	2.41	0.04	3.45	1.71	1.16
61	0.39	0.85	0.88	0.77	2.51	1.78	14.11	1.10	2.07	2.94	1.63	2.08	2.14	1.39	2.06
62	0.34	0.63	0.13	3.20	0.13	2.84	2.38	2.94	5.20	4.14	1.48	3.16	1.95	1.04	0.70
63	0.43	0.48	1.28	1.21	0.16	1.25	1.67	0.87	4.54	4.67	0.54	0.12	3.24	3.40	0.30
64	0.25	0.51	1.74	0.98	0.11	0.86	2.03	1.77	0.95	1.90	1.53	0.02	1.25	0.74	0.21
65	0.22	0.50	0.11	0.97	0.64	0.63	0.69	0.43	0.47	8.79	0.89	0.07	0	1.97	0.18
66	0.917	0.08	0.24	0.07	0.30	0.72	13.69	0	0.50	1.00	0	1.39	0	0.58	0
67	0	0.37	0.08	0.06	0.08	0.12	0.94	0.05	1.01	1.37	0	0	0.33	1.51	0
68	0	0	0.43	0.09	0	0.05	1.70	0	1.24	0	0	0	0.33	1.77	0
69	0.20	0	0.50	0.36	0	0.05	0	0	0	0	0	0	0	0.73	0.16
70	0	0	0	0.02	0.02	0	0	1.09	0	0	0	0	0	2.66	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0.02	0.05	0	0	0	0	0	0	0	0.76	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0.38	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0.38	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

78	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0

In the catches, age composition is mainly formed by age 3 to age 5 individuals (Figure 6.7.2.1.5 and Table 6.7.2.1.4). Age class 0 was not considered in the assessment because is this age class is not catched by the fleet and is absent along the entire times series. An “age plus” group was defined at age 9+. Cohorts showed acceptable consistency, except for age 1 to 2 and for age 8 to 9 (figure 6.7.2.1.6).

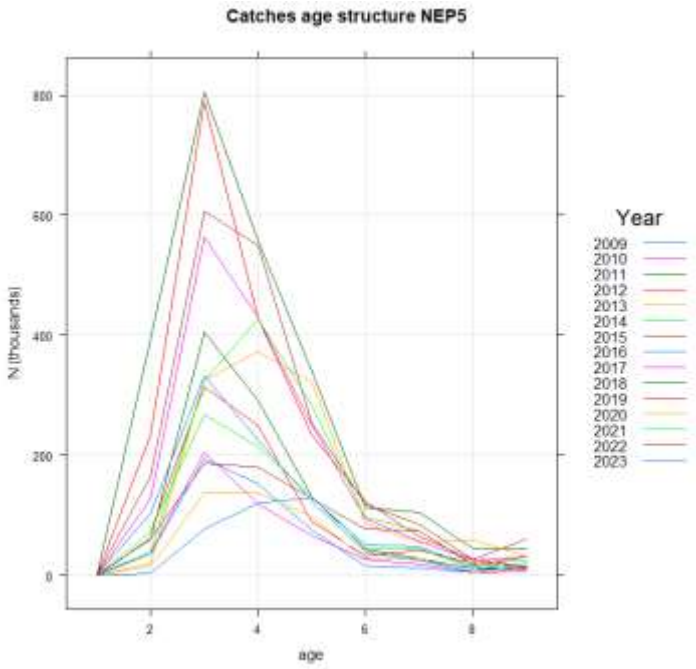


Figure 6.7.2.1.5. Norway Lobster in GSA 5. Age structure of the catches. Plus group set at age 9.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	0.57	1.89	0.74	0.39	0.06	0.16	0.06	0.12	0.06	0.06	0.06	0.06	1.07	0.25	0.57
2	29.25	33.82	51.89	68.12	12.42	61.72	154.82	99.83	120.40	382.81	223.87	8.65	36.89	55.70	29.25
3	157.60	176.23	349.94	296.09	112.78	230.24	566.69	321.01	527.90	783.11	754.36	140.22	311.60	167.95	157.60
4	123.56	102.42	251.81	234.78	112.97	184.26	512.98	217.10	402.85	541.81	408.26	160.93	409.18	162.83	123.56
5	61.13	57.57	113.33	84.45	79.81	112.50	238.15	118.50	235.84	331.03	223.64	138.56	272.55	116.32	61.13
6	12.16	23.04	37.82	30.10	22.54	38.21	111.02	37.01	88.88	109.39	118.22	36.99	92.98	69.82	12.16
7	10.71	15.71	23.73	39.09	22.73	39.05	79.91	24.05	53.00	102.39	61.92	23.05	71.42	67.36	10.71
8	4.42	3.77	9.65	19.19	3.52	9.34	24.71	6.33	23.79	43.11	24.73	25.53	17.82	15.97	4.42
9+	5.43	5.45	9.21	12.33	9.15	17.60	56.12	14.97	29.83	43.94	13.74	14.17	24.03	28.28	5.43

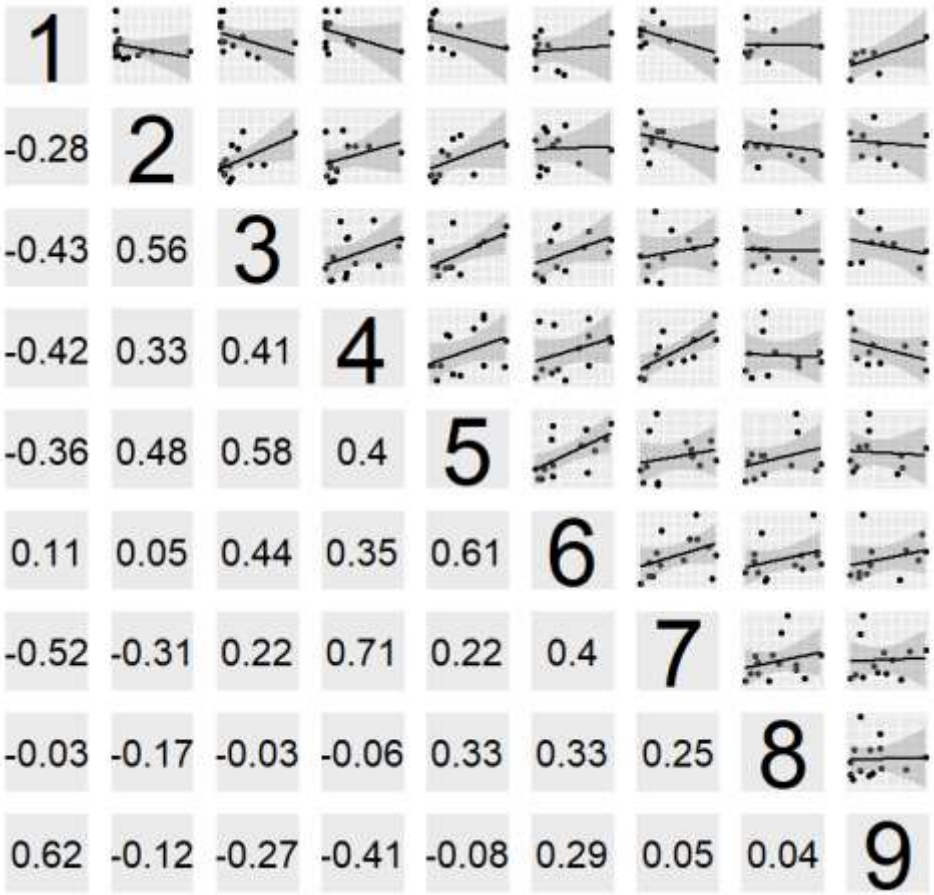


Figure 6.7.2.1.6. Norway Lobster in GSA 5. Cohort consistency for the commercial landings.

Table 6.7.2.1.4. Norway Lobster in GSA 5. Landings at age, numbers in thousands.

6.7.2.2 EFFORT DATA

Fishing effort data for 2023 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.7.2.3 SURVEY DATA

The MEDITS (MEDiterranean International Trawl Survey) survey is an extensive trawl 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 partially covered by the MEDITS survey for years 1994-2006, with a very low number of surveys by year and covering only a small part of the area (Ibiza channel). For this reason, survey data prior to 2007 was excluded

from the stock assessment analysis. Since 2007, the survey has taken place between May and June, and in 2022 and 2023 also extended until July (Figure 6.16.2.3.1). However, this aspect seems not to influence the assessment.



Figure 6.7.2.3.1 Norway Lobster in GSA 5. Year period when the hauls of MEDITS survey are being conducted in GSA 5.

Despite MEDITS survey started in GSA5 in 2007, to maintain consistency with the commercial dataset, MEDITS time series used in the model was also considered to start from 2009.

Since 2021, MEDITS survey in GSA5 also extended to Ibiza and Formentera Islands. However, in order to harmonize the MEDITS dataset to avoid the effect of this new stations in the time series survey index, only stations with a longitude > 2°E (Mallorca and Menorca islands) were conserved for the computation of index (Figure 6.7.2.3.2). Besides, the main Nephrops norvegicus stock and fishing grounds of GSA5 are fished mostly around Menorca and Mallorca, so considering only the Mallorca and Menorca parts of MEDITS survey helps to standardize the commercial and survey data series. Then mean stratified abundances and biomass by km^2 have been computed using the methodology described by Grosslein and Laurec (1982).

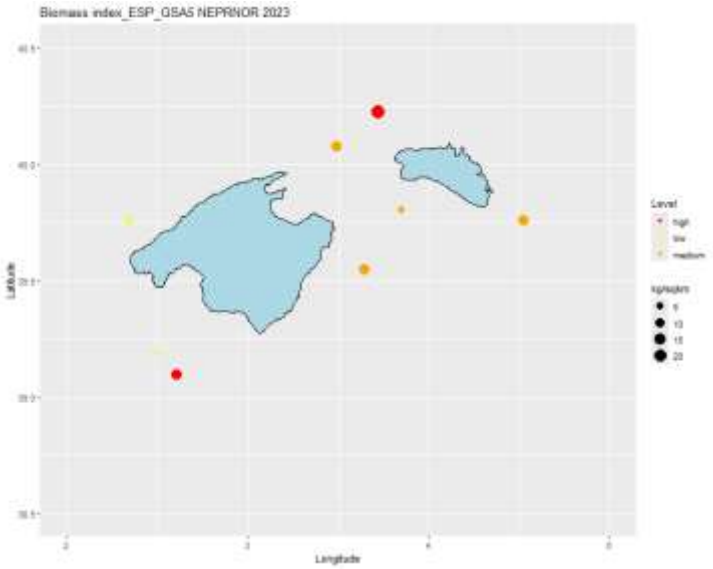
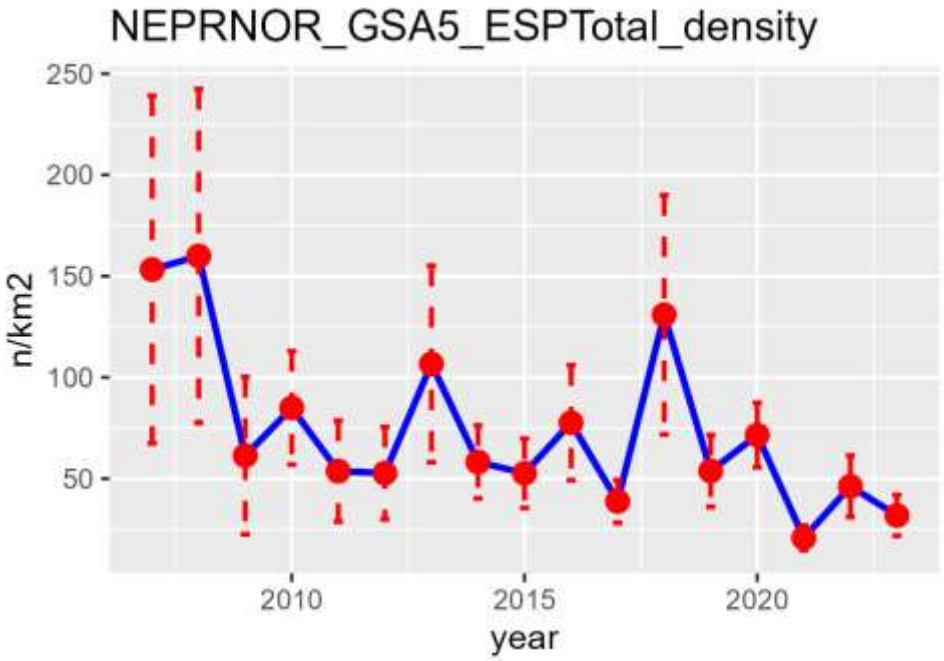


Figure 6.7.2.3.2. Norway Lobster in GSA 5. MEDITS Biomass index by stations in 2023.

The time series of abundance and biomass indices of Nephrops norvegicus from MEDITS bottom trawl survey in GSA5 are shown in Figure 6.7.2.3.3. Noticeable variations trends over the available period can be observed, with maximum values at the beginning of the data series and And the highest recent values of abundance in 2010, 2013, 2016 and 2018. Density and abundance values showed an important decline from 2021, year when the lowest values of the time series were observed. Length frequency distributions are shown in Figure 6.7.2.3.4 and Table 6.7.2.3.1. Possible errors were highlighted in 2013 length frequency distribution that may influence the abundance index. For this reason, the dataset was corrected removing this affected records. These potential errors are reported in Section 7.



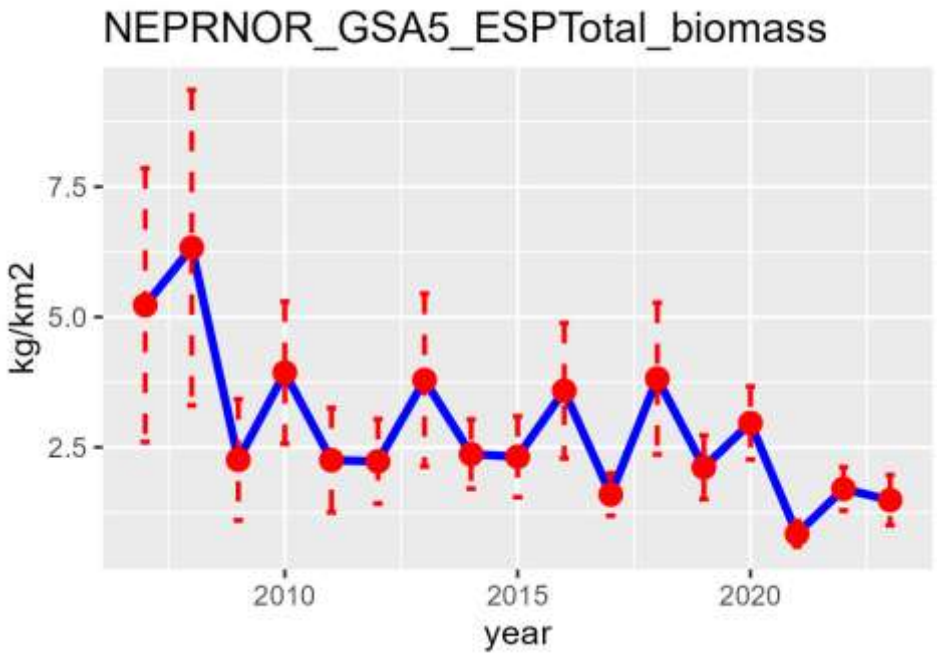


Figure 6.7.2.3.3. Norway Lobster in GSA 5. MEDITS abundance (n/km^2) and biomass (kg/km^2) indices over 2007-2023.

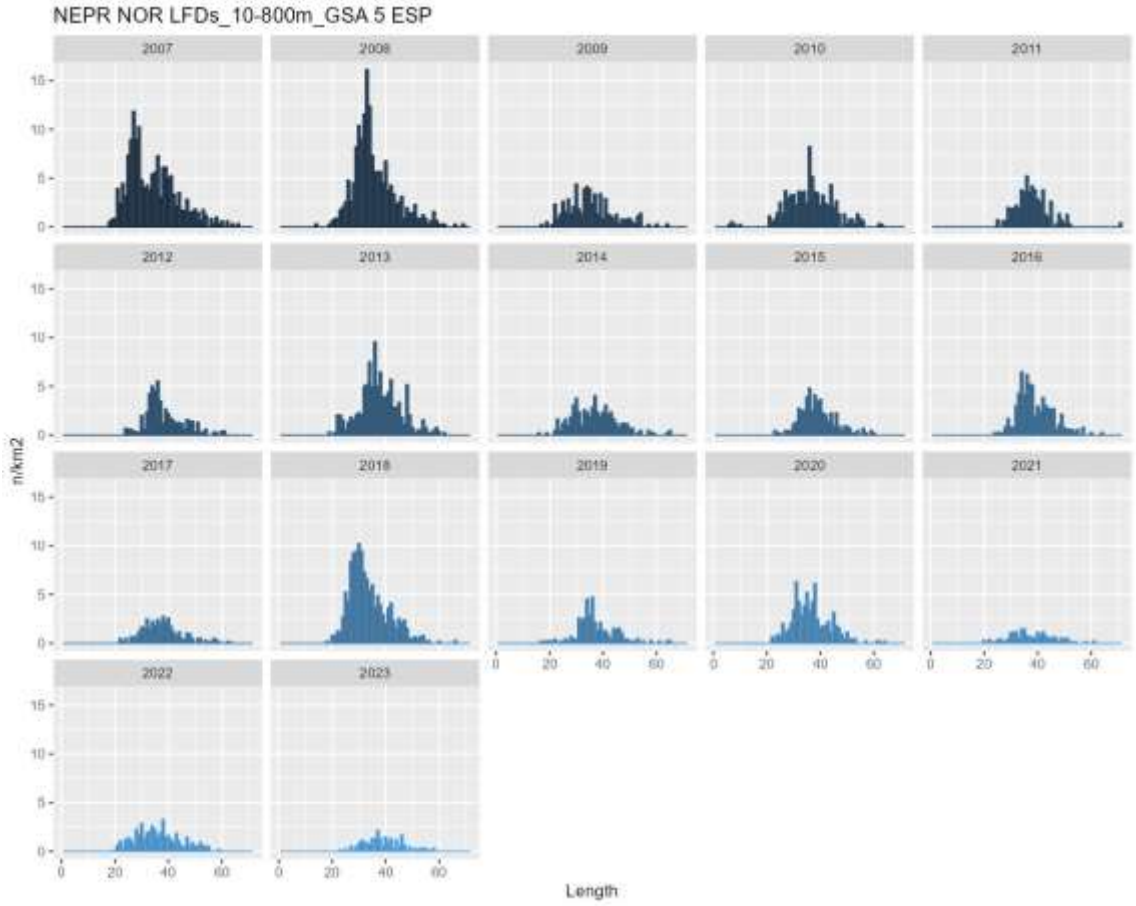


Figure 6.7.2.3.4. Norway Lobster in GSA 5. MEDITS Length Frequency distribution (TL in mm, numbers in n/km^2) reported in MEDITS survey data (2007-2023).

Table 6.7.2.3.1. Norway Lobster in GSA5. Length structure (CL in mm) reported in MEDITS (2007-2023) for survey data.

Length	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
6	0	0	0	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0.53	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0.24	0	0	0	0	0	0	0	0	0
17	0	0	0.26	0	0	0	0	0	0	0	0	0	0.22	0	0	0	0
18	0.53	0	0	0	0	0	0	0	0	0	0	0.23	0.22	0	0	0	0
19	0.79	0.28	0.52	0	0	0	0.34	0.24	0	0	0	0	0.22	0	0	0	0
20	0.85	0.62	0	0	0	0	0	0	0	0	0	0.80	0.27	0	0.34	0.17	0
21	3.95	0.84	0.26	1.13	0	0	0.26	0	0	0	0	0.80	0.22	0	0	0.68	0
22	2.37	0.88	2.33	0.53	0	0	2.66	0.47	0	0	0.48	1.25	0.44	0.68	0.39	1.69	0
23	4.47	1.73	0.78	0.80	0	0	2.66	1.65	0.46	0	0.17	1.19	0	0.45	0	0.34	0.17
24	3.16	2.86	1.29	1.45	0	0.77	1.55	0.47	0.23	0.27	0.48	2.73	0.22	0.97	0.17	1.20	0
25	7.37	2.57	2.59	2.52	0.72	0.59	0.52	1.19	0.23	0.27	0	5.24	0.22	0.68	0.34	1.37	0.24
26	8.95	4.78	1.55	1.33	0	0.59	1.29	1.65	0	0.27	0.65	4.34	0.44	2.45	0.50	1.20	0
27	11.84	2.57	2.85	3.78	0.64	0.41	1.88	0.94	0.46	0.27	0.65	8.40	0.22	1.14	0.23	0.68	0.57
28	8.95	4.59	1.29	2.94	0.64	0.30	1.55	1.89	0.46	0.87	0.70	9.30	0.70	1.37	0.23	2.27	0.17
29	1.26	8.20	2.73	3.26	1.99	0.30	2.66	3.68	0.46	1.73	1.17	9.42	0.44	2.50	0.50	1.71	0.50
30	4.80	1.48	4.40	3.32	1.89	2.46	2.32	3.78	1.14	0.82	1.70	1.20	0.44	3.40	1.12	2.86	0.83
31	3.95	9.17	1.81	2.25	1.89	0.59	2.66	2.36	1.38	0.82	1.55	9.46	2.58	6.33	1.16	1.37	1.16
32	4.27	11.57	1.29	3.65	2.28	2.37	4.99	0.94	2.75	3.70	2.48	7.34	2.37	4.29	1.16	1.92	1.00
33	3.75	16.11	3.88	3.52	1.89	4.25	5.16	2.59	2.52	4.32	1.49	6.59	2.58	2.94	0.50	2.54	0.83
34	5.39	12.38	4.15	3.65	3.79	5.17	7.49	2.36	2.52	6.48	2.28	5.46	4.52	3.84	1.46	2.62	0.83
35	5.59	7.31	3.88	2.40	3.56	4.54	4.96	1.89	3.90	4.76	1.83	5.98	2.85	5.20	1.49	2.22	1.33
36	7.29	5.67	2.33	8.24	5.23	5.55	9.55	2.83	4.86	6.22	2.44	3.67	4.74	3.40	0.79	1.55	1.33
37	3.24	5.67	3.36	5.18	3.56	3.48	4.99	4.59	2.52	5.25	2.61	4.91	2.15	4.29	0.66	1.92	2.16
38	6.14	5.67	1.29	3.59	4.19	1.18	6.46	2.35	4.12	5.11	2.75	3.95	1.29	6.12	0.66	3.25	1.33
39	6.12	4.59	3.42	3.46	3.79	2.66	3.87	1.89	3.43	1.94	2.29	2.93	2.15	2.49	0.50	1.45	0.50
40	4.99	6.75	0.83	2.25	2.84	2.18	3.96	2.36	3.66	2.97	2.58	2.27	1.29	1.58	1.12	1.62	1.54
41	5.25	3.70	2.90	3.26	2.52	1.80	4.39	3.66	2.29	2.46	1.70	3.64	1.29	1.81	0.83	1.20	1.00
42	3.35	4.26	1.29	2.40	3.79	1.48	5.69	2.12	2.62	3.84	1.14	4.12	0.86	1.82	1.18	0.90	1.33
43	2.15	3.38	1.88	2.19	1.26	1.18	2.84	2.36	1.38	3.50	0.79	2.31	0.44	2.28	0.79	1.83	0.33
44	3.53	2.29	0.78	4.32	0.95	1.30	2.84	1.65	2.29	2.77	1.17	1.58	1.57	1.13	0.56	1.28	1.16
45	1.75	2.57	1.29	1.99	2.62	1.18	3.36	1.19	0.91	2.77	0.48	2.54	1.40	3.17	0.50	0.51	0.50
46	1.64	3.13	0.26	2.66	0	0.59	1.88	0.75	2.29	2.77	0.35	2.89	1.56	1.86	0.66	0.51	1.66
47	2.88	0.84	0.78	1.33	0.32	1.59	1.33	1.18	0.92	0.53	1.36	2.38	1.77	1.58	0.50	1.45	0.67
48	1.54	1.97	0.78	0	1.36	1.41	5.16	1.18	0.46	1.69	0.96	1.54	0.44	0.94	0.17	0.51	0.17
49	1.57	1.45	0.78	1.33	0.72	1.41	2.66	1.18	0.92	2.14	0.48	0.51	0.44	0.46	0.56	0.90	0.50
50	1.83	1.47	0.88	0.27	0.32	0.30	0.77	0.76	0.92	0.82	0	0.51	0.27	1.13	0.39	0.60	0

51	1.44	2.29	0.52	0.80	1.26	1.30	0.26	0.76	0.68	0.57	0.48	0.68	0.22	0.46	0.56	0.51	0.33
52	0.59	0.88	0.26	0.80	0.32	0.30	0.52	0	0.23	0.57	0.52	0.46	0.22	0.46	0.23	0.94	0.17
53	1.77	0.84	1.88	0.27	0	0.30	0.52	0.23	0.23	0.57	0	0.68	0.48	0.46	0	0.55	0.33
54	1.18	1.24	1.46	1.33	0	0.59	1.55	0.47	0.46	0.27	0.39	0.80	0	0	0.17	0.55	0.33
55	0	0.84	0	0.86	0	0	0.77	0	0	0.57	0.17	0.23	0.27	0	0	0.51	0.33
56	0.85	0.28	0	0.59	0	0	0.26	0	0.69	0	0.17	0.29	0	0	0	0	0
57	0.33	0.62	0.26	0	0	0.30	0.26	0.47	0.23	0.82	0.52	0	0	0.23	0	0	0.17
58	0.98	1.56	0	0	0	0.30	0.52	0.23	0	0	0.35	0	0.27	0	0.17	0	0.33
59	0.26	0.64	0	0	0	0	0.77	0.23	0.46	0	0.17	0	0	0	0	0.21	0
60	0.59	0.28	0.31	0	0	0.41	0.34	0	0.23	0.27	0	0.23	0	0	0	0	0
61	0	0.28	0	0	0	0.41	0	0	0	0	0	0	0.22	0.23	0.23	0	0
62	0.59	0.28	0	0.33	0	0	0.26	0	0	0	0.17	0	0	0.23	0	0	0
63	0	0	0	0.27	0	0	0	0	0	0	0.17	0	0	0	0	0	0
64	0.33	0	0.31	0	0	0	0	0.23	0	0.27	0	0	0.27	0.23	0	0	0
65	0	0	0	0	0	0	0	0.47	0	0	0	0	0.27	0	0	0	0
66	0.33	0.28	0	0	0	0	0	0	0	0	0	0.29	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0.49	0	0	0	0	0	0	0	0	0	0	0	0

Age composition of the catches from the survey showed that most of the individuals correspond to age 3-5, although age 2 is also important (Figure 6.7.2.3.5 and Table 6.7.2.3.2). In year 2018 there is an important peak of individuals of age 3. Cohorts showed, in general, no consistency for all the age classes (Figure 6.4.2.10).

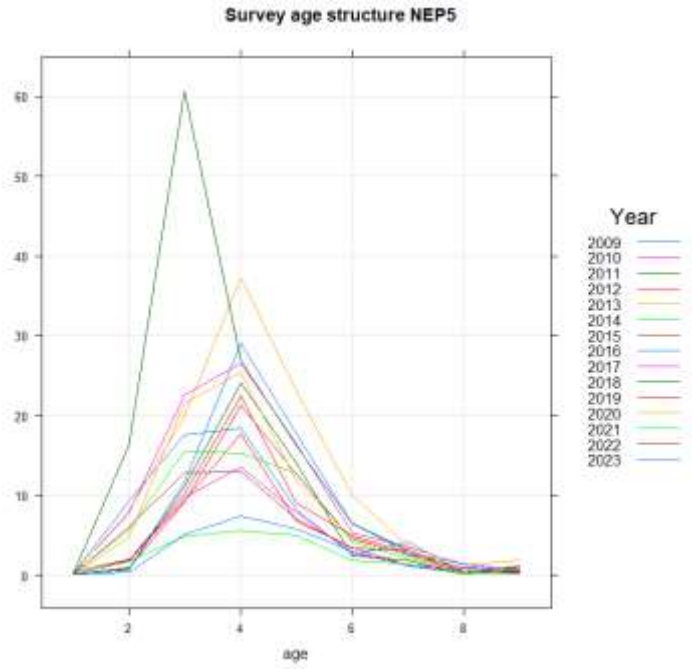


Figure 6.7.2.3.5. Norway Lobster in GSA 5. Age structure of the MEDITS survey (n/km2). Plus group set at age 9.

Table 6.7.2.3.2. Norway Lobster in GSA 5. Age structure (numbers in n/km^2) estimated from length frequency distribution reported in MEDITS (2009-2023) survey data, with plus group set at age 9.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	0.26	0.27	0	0	0	0.24	0	0	0	0.23	0.43	0	0	0	0
2	9.32	7.76	0.72	1.89	8.09	5.67	0.92	0.80	1.79	16.32	1.99	4.77	1.72	6.03	0.40
3	17.60	22.64	11.13	10.21	19.97	15.57	9.16	11.76	9.72	60.70	9.31	21.50	4.89	12.87	5.06
4	18.43	26.51	24.13	22.42	37.27	15.32	21.29	29.04	13.56	26.85	17.71	25.33	5.55	12.99	7.48
5	8.18	16.41	13.97	9.03	23.07	12.73	12.59	17.68	7.85	16.18	6.78	11.78	4.98	7.09	5.83
6	2.59	5.33	2.40	5.01	10.07	4.24	4.58	6.45	2.83	6.51	3.50	4.75	1.88	3.38	2.99
7	4.15	3.46	1.89	2.77	3.62	2.12	2.51	2.77	1.31	3.11	1.18	2.50	1.35	3.16	1.16
8	0.26	1.45	0	0.30	1.29	0.47	0.91	1.37	0.86	0.51	0.27	0.23	0.50	0.51	0.50
9	0.62	0.59	0.41	1.12	1.89	1.18	0.69	0.53	0.86	0.51	1.02	0.69	0.39	0.21	0.33

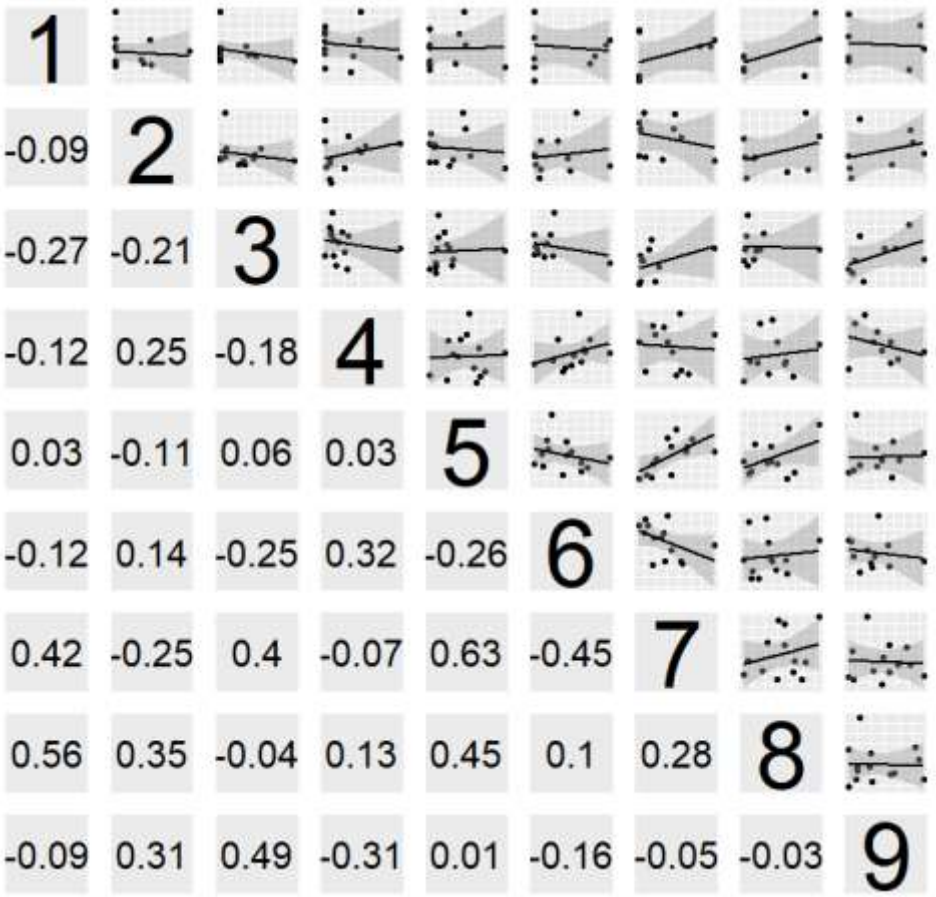


Figure 6.7.2.3.6. Norway Lobster in GSA 5. Cohort consistency for the MEDITS data.

6.7.3 STOCK ASSESSMENT

A statistical catch-at-age assessment was carried out for this stock, using the Assessment for All Initiative (a4a) method (Jardim *et al*. 2015). The a4a method utilizes catch-at-age data to derive estimates of historical population size and fishing mortality. 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. A4a is implemented as a package (FLa4a) of the FLR library.

The model was fitted using as input data the period 2009-2023 for the catch data (landings + discards) and for the tuning index.

Both catch numbers at length and index number at length were sliced using the a4a age slicing routine in FLR, using the same sex combined growth parameters. Catch at age were obtained by splitting commercial total length distribution according to a sex-ratio vector model obtained from DCF available sex ratio vectors. The analyses were carried out for the ages 1 to 9+. Concerning the Fbar, the age range used was 2-6.

Input data for the assessment and selected results from the best model are presented in the following section.

Input data

Data used were catch data and length frequency distribution of the commercial landings (table 6.7.3.1 and Figure 6.7.2.1.3), as well as the index and length frequency distributions of the MEDITS survey (Figures 6.7.2.3.3, 6.16.2.3.4 and Table 6.7.2.3.1).

The growth parameters used for VBGF were the one reported in Table 6.7.1.1, natural mortality in Table 6.7.1.2 and maturity in Table 6.7.1.3.

Table 6.7.3.1 lists the catches used as input data for the a4a model. Table 6.7.3.2 shows the catch number at age estimated by the model, mainly dominated by individual from ages 3-5. Table 6.7.3.3 shows the weight number at age estimated by the model.

Table 6.7.3.1. Norway Lobster in GSA 5. Catch data (tonnes) used as input data for the model

Year	Catch (t)
2009	16.34
2010	16.19
2011	32.26
2012	29.50
2013	18.82
2014	30.80
2015	72.87
2016	28.33

2017	57.82
2018	82.91
2019	61.85
2020	57.80
2021	54.26
2022	36.41
2023	23.21

Table 6.7.3.2. Norway Lobster in GSA 5. Estimation of Catch number-at-age from the a4a assessment model.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	0.12	0.16	0.18	0.19	0.17	0.19	0.24	0.30	0.29	0.24	0.26	0.25	0.27	0.17	0.15
2	30.11	46.49	50.34	44.37	47.38	54.59	65.30	71.49	85.67	89.35	80.97	81.43	65.45	57.18	34.35
3	126.29	236.20	275.70	238.47	221.74	287.83	351.24	375.87	381.70	487.73	544.07	454.89	380.95	265.14	221.33
4	93.64	168.41	229.89	213.95	199.09	225.88	304.50	324.64	319.17	343.49	458.65	456.04	313.98	235.72	166.19
5	57.38	97.64	124.98	135.97	138.08	157.09	182.40	211.17	205.42	213.01	235.38	273.14	221.92	140.63	111.72
6	28.08	45.21	53.78	54.55	65.34	81.55	94.40	93.08	97.77	100.26	106.06	100.27	93.98	70.96	48.74
7	14.00	22.64	25.49	24.04	26.84	39.50	50.16	49.31	44.12	48.85	51.10	46.25	35.33	30.78	25.18
8	7.09	11.48	12.99	11.59	12.03	16.50	24.71	26.65	23.78	22.42	25.32	22.67	16.58	11.77	11.11
9	3.61	8.91	11.88	11.49	11.74	14.85	19.93	24.09	24.86	25.12	25.05	22.71	16.54	11.22	8.44

Table 6.7.3.3. Norway Lobster in GSA 5. Estimation of Weigth-at-age from the a4a assessment model.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
5	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7	0.10	0.09	0.09	0.10	0.09	0.09	0.10	0.09	0.10	0.09	0.09	0.09	0.10	0.09	0.09
8	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9	0.17	0.16	0.17	0.16	0.15	0.16	0.17	0.16	0.16	0.16	0.16	0.15	0.15	0.18	0.15

Assessment results

Several different a4a models were investigated in terms of fishing mortality, catchability of the index and stock–recruitment relationship models (fmodel, qmodel, srmodel).

Many different settings configurations in the fmodel, qmodel and srmodel were tried looking dor the best fitting model for the data, incluing all the following combinations:

fmodel <- ~factor(replace(age, age > 5, 5)) + s(year, k = 5)
k = 6
k = 7
k = 8

qmodel <- list(~factor(replace(age, age > 5, 5)))

srmodel <- ~factor(year)
~geomean(CV=0.2)
~geomean(CV=0.25)
~geomean(CV=0.3)
~geomean(CV=0.35)

fmodel <- ~factor(replace(age, age > 7, 7)) + s(year, k = 5)
k = 6
k = 7
k = 8

qmodel <- list(~factor(replace(age, age > 6, 6)))

srmodel <- ~factor(year)
~geomean(CV=0.2)
~geomean(CV=0.25)
~geomean(CV=0.3)
~geomean(CV=0.35)

Finally, the following model, the same used in the EWG 23-09, was selected on the basis of best fit, both for residuals as well as fitted vs observed data and retrospective.

Submodels:

fmodel <- ~factor(replace(age, age > 5, 5)) + s(year, k = 8)

qmodel <- list(~factor(replace(age, age > 5, 5)))

srmodel <- ~geomean(CV=0.2)

The general results of the a4a assessment, including the summary of the fitting of the model for all the parameters (recruitment, spawning stock biomass SSB, catches and Fishing

mortality F), the estimated fishing mortality and catchability for the survey, the residuals patterns, the fit vs. observed catch at ages, the retrospective analysis and the performed simulations, are shown in Figures 6.7.3.1 to 6.16.3.8. and in Tables 6.7.3.4 to Tables 6.7.3.6

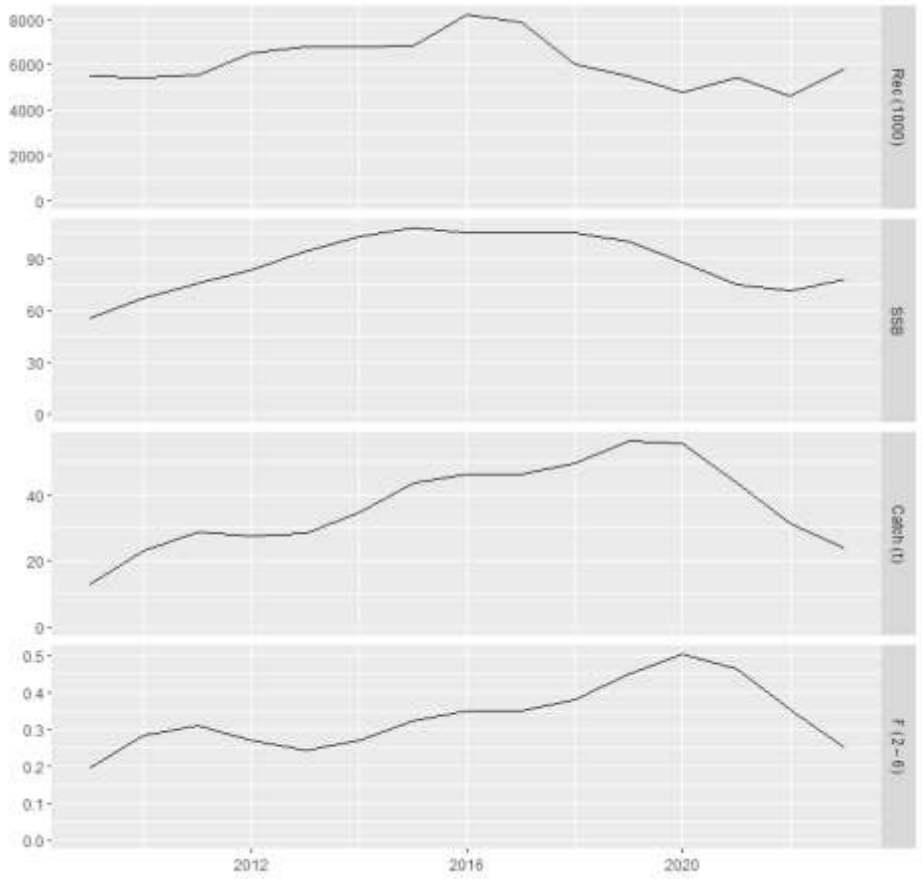


Figure 6.7.3.1. Norway Lobster in GSA 5. Stock summary ofthe final a4a model. Recruits (Age 1), SSB (Stock Spawning Biomass), catch and harvest (fishing mortality for ages 2 to 6).

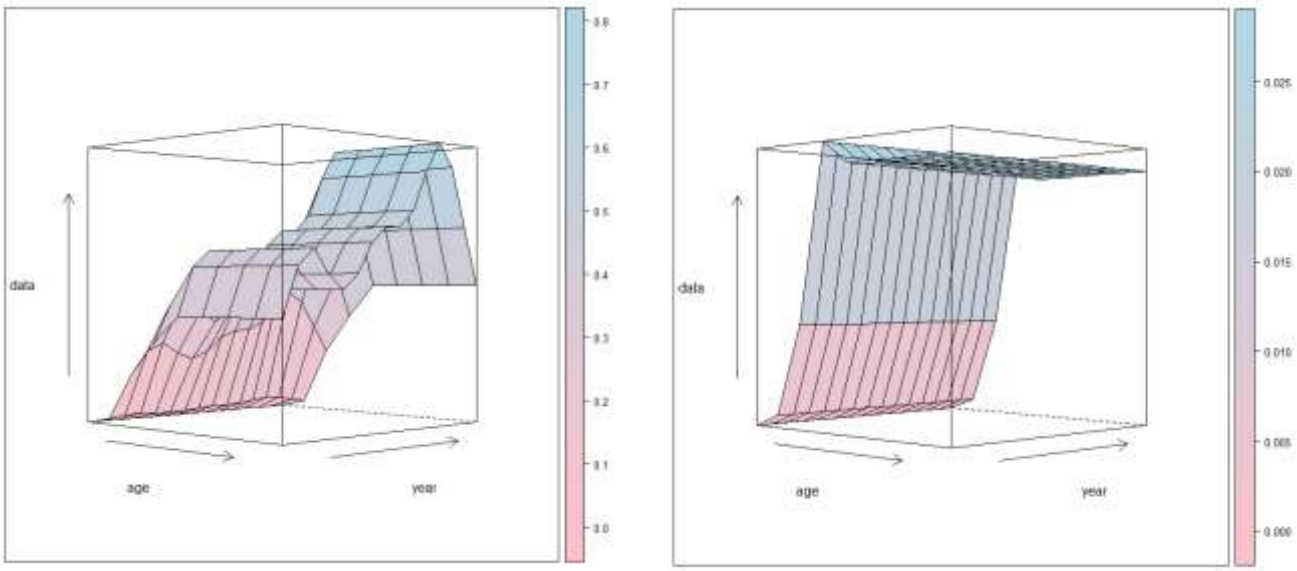


Figure 6.7.3.2. Norway Lobster in GSA 5. 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated survey catchability (right) at age and year.

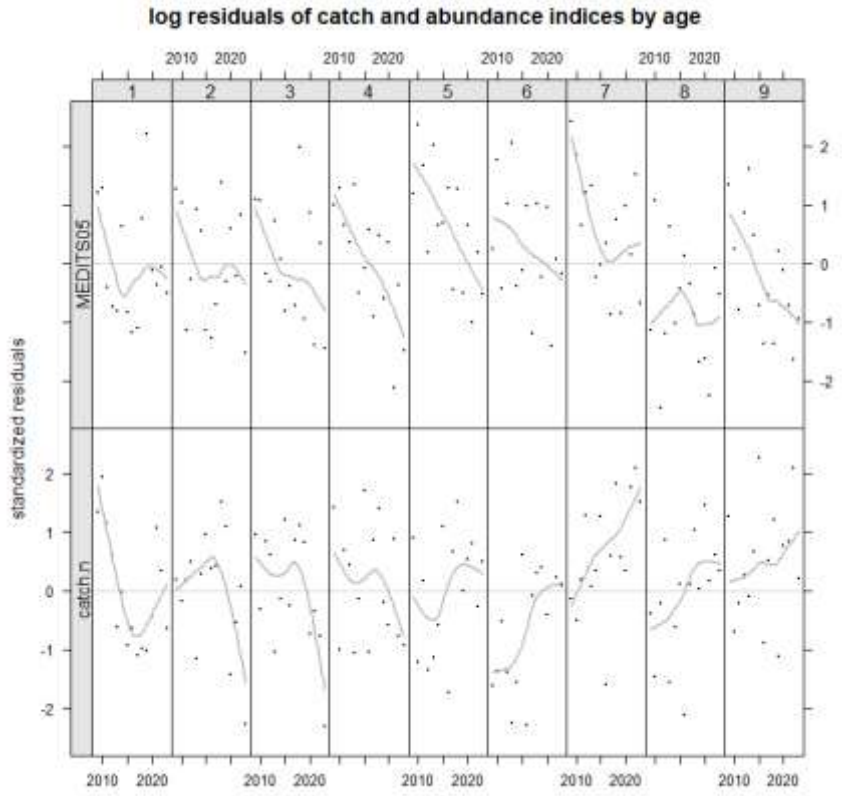


Figure 6.7.3.3. Norway Lobster in GSA 5. Standardized residuals for abundance indices and for catch numbers (catch.n). Each panel is coded by age class; dots represent standardized residuals and lines simple smoothers.

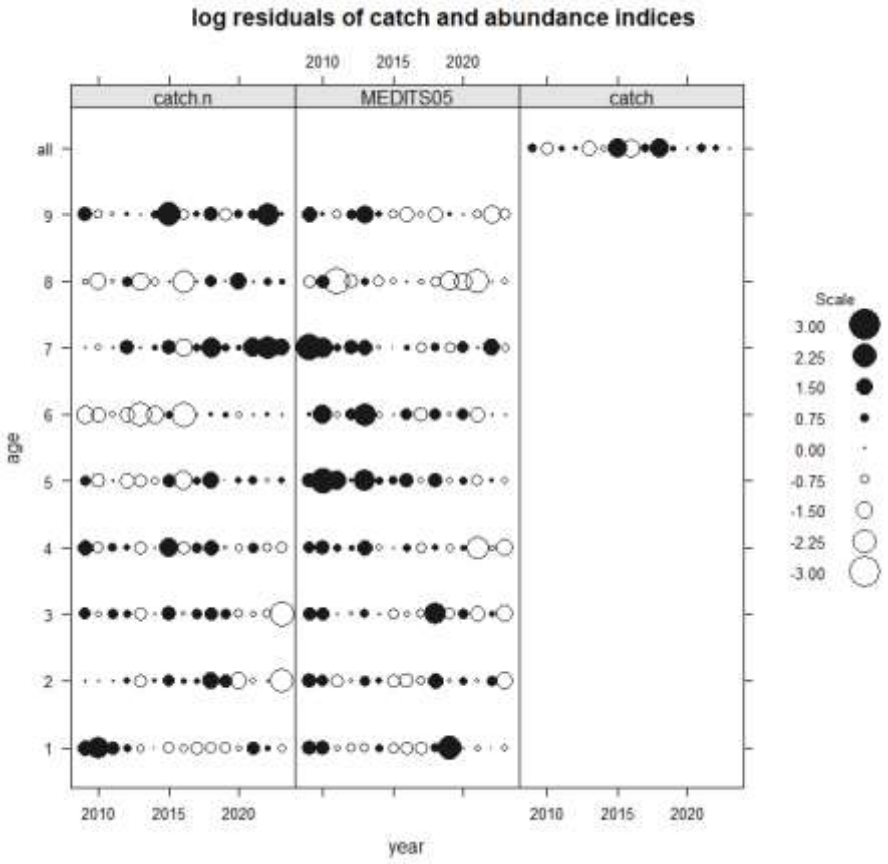


Figure 6.7.3.4. Norway Lobster in GSA 5. Standardized residuals for abundance indices and for catch numbers.

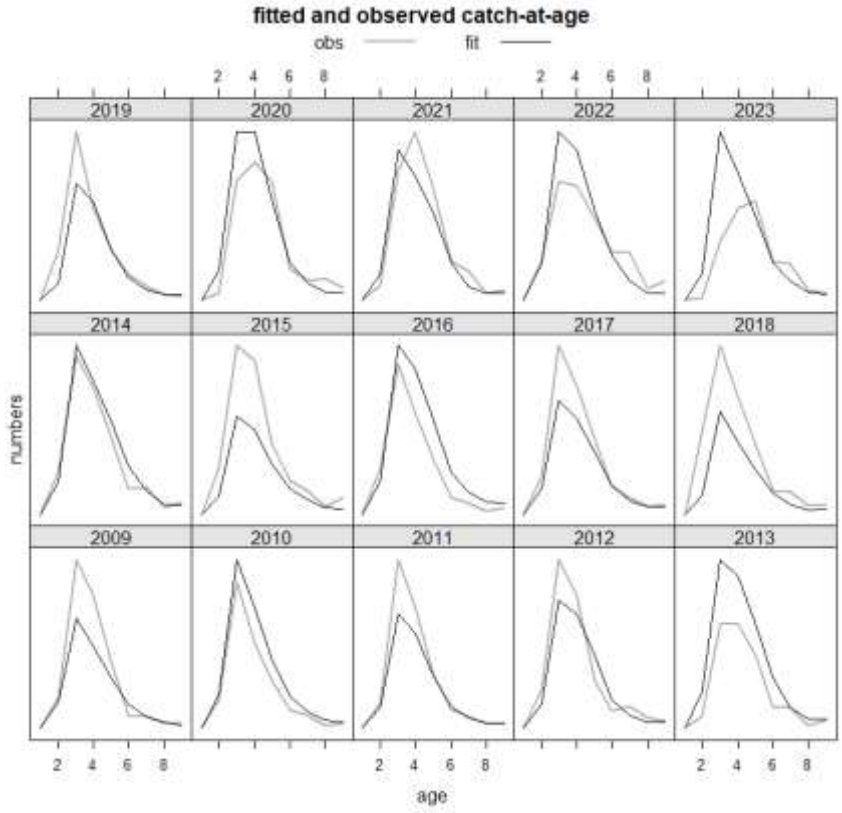


Figure 6.7.3.5. Norway Lobster in GSA 5. Fitted and observed catch at age.

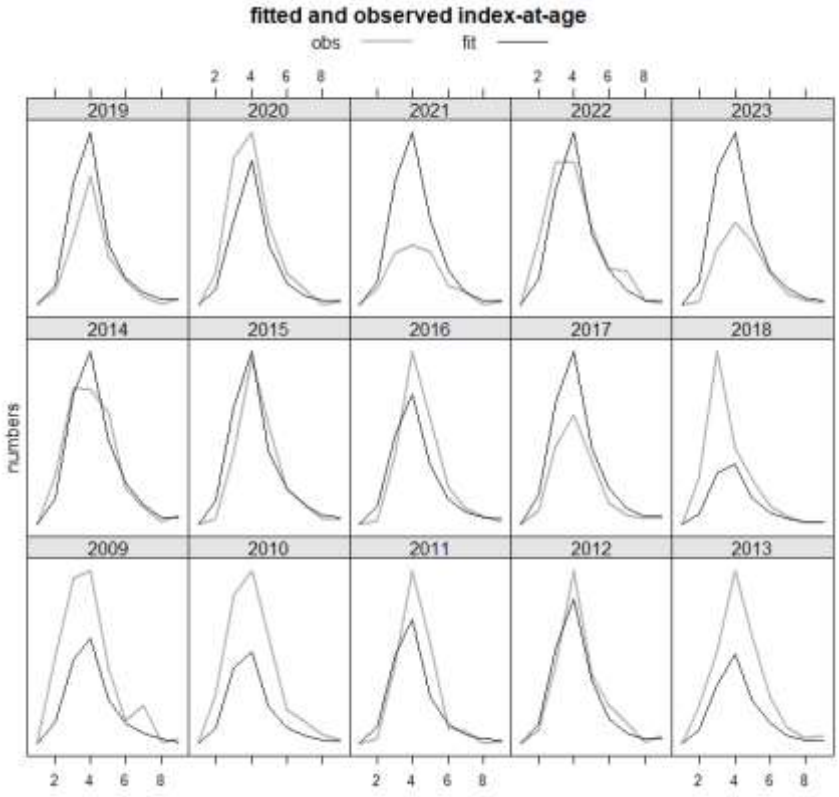


Figure 6.7.3.6. Norway Lobster in GSA 5. Fitted and observed index at age (MEDITS survey data).

Retrospective

The retrospective analysis was applied up to 3 years back (Figure 6.7.3.7). Model results were extremely unstable and the retrospective performance, as well as the residuals configuration, was considered too poor to allow this to be acceptable as an assessment.

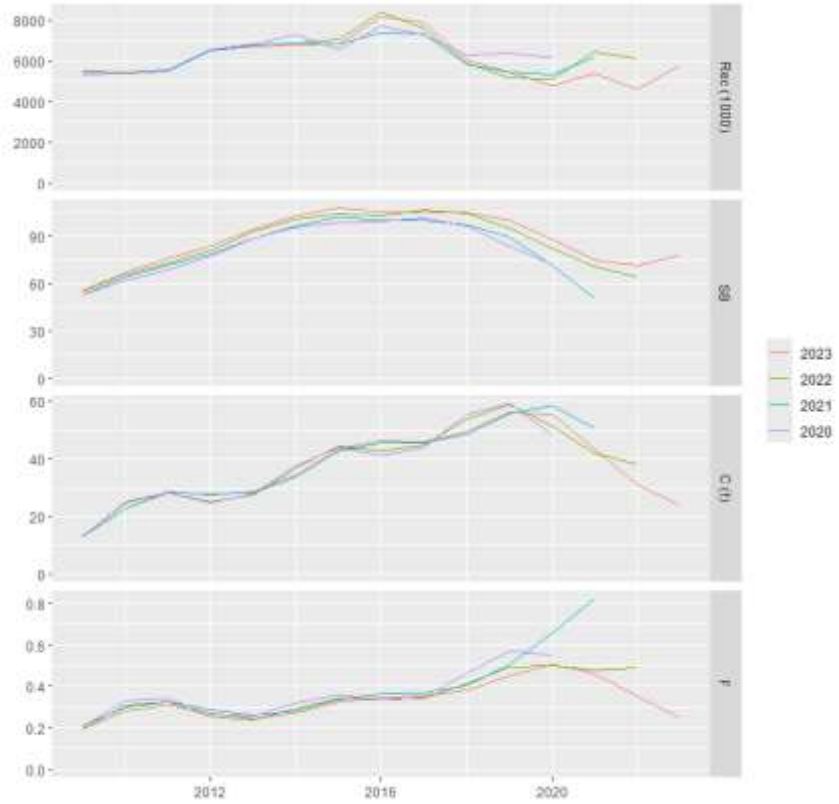


Figure 6.7.3.7. Norway Lobster in GSA 5. Results of Retrospective analysis.

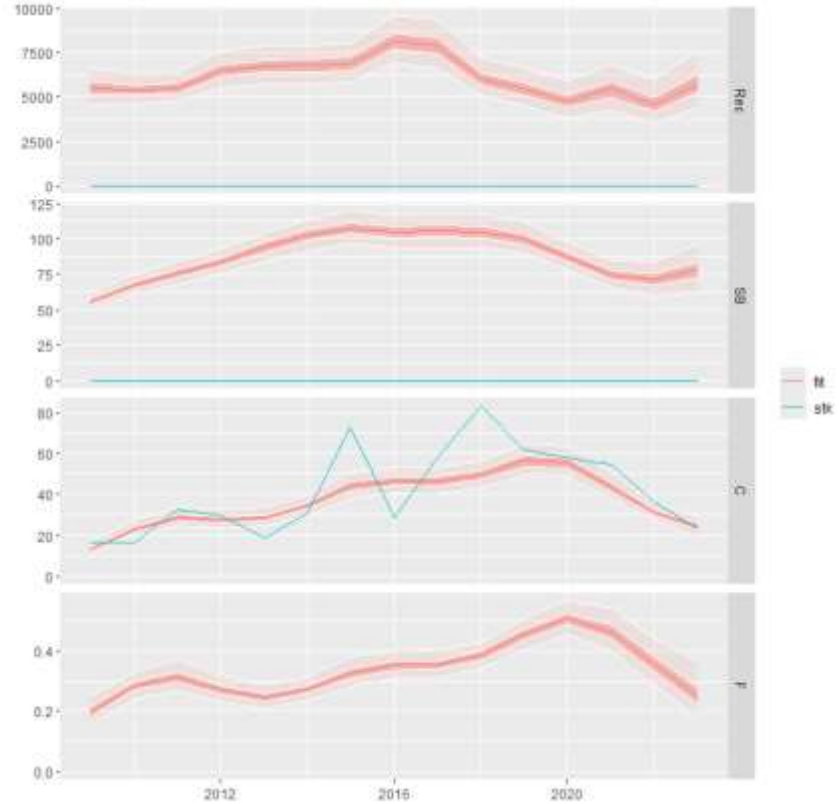


Figure 6.7.3.8. Norway Lobster in GSA 5. Simulations over summary results.

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

Table 6.7.3.4. Norway Lobster in GSA 5. Estimation of Stock number-at-age from the a4a assessment model.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	5503	5430	5512	6495	6755	6768	6855	8172	7885	6044	5461	4772	5413	4594	5788
2	2453	2648	2612	2652	3125	3250	3256	3298	3931	3793	2908	2627	2296	2604	2210
3	1130	1515	1624	1599	1629	1923	1996	1991	2013	2399	2310	1761	1584	1389	1589
4	525	689	868	913	925	960	1112	1111	1088	1098	1282	1173	861	798	756
5	248	312	371	453	499	521	524	571	553	541	528	568	489	377	396
6	120	143	158	180	233	267	268	249	260	252	235	206	205	188	170
7	59	71	74	78	95	128	141	131	116	122	112	94	76	81	87
8	30	36	38	38	42	53	69	70	62	55	55	46	36	31	38
9	15	28	34	37	41	48	56	63	65	62	54	46	35	29	29

Table 6.7.3.5. Norway Lobster in GSA 5. Estimation of Fishing mortality (F) number-at-age from the a4a assessment model.

age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.02
3	0.14	0.20	0.22	0.19	0.18	0.19	0.23	0.25	0.25	0.27	0.32	0.36	0.33	0.25	0.18
4	0.23	0.33	0.36	0.31	0.28	0.31	0.38	0.41	0.41	0.44	0.52	0.58	0.54	0.41	0.29
5	0.30	0.43	0.47	0.41	0.37	0.41	0.49	0.53	0.54	0.58	0.69	0.77	0.70	0.54	0.38
6	0.30	0.43	0.47	0.41	0.37	0.41	0.49	0.53	0.54	0.58	0.69	0.77	0.70	0.54	0.38
7	0.30	0.43	0.47	0.41	0.37	0.41	0.49	0.53	0.54	0.58	0.69	0.77	0.70	0.54	0.38
8	0.30	0.43	0.47	0.41	0.37	0.41	0.49	0.53	0.54	0.58	0.69	0.77	0.70	0.54	0.38
9	0.30	0.43	0.47	0.41	0.37	0.41	0.49	0.53	0.54	0.58	0.69	0.77	0.70	0.54	0.38

Table 6.7.3.6 Norway Lobster in GSA 5. a4a summary results.

Year	Recruitment (thousands)	SSB (t)	Catch (t)	Fbar (2-6)
2009	5503.2	55.74	13.06	0.21
2010	5429.6	67.39	22.92	0.30
2011	5512.4	75.85	28.56	0.33
2012	6495.3	83.53	27.67	0.29
2013	6755.3	94.18	28.48	0.26
2014	6767.9	102.48	34.46	0.29
2015	6854.8	107.58	43.71	0.34
2016	8171.8	105.04	46.27	0.37
2017	7884.8	105.27	46.03	0.37
2018	6043.9	105.07	49.39	0.41
2019	5461.2	100.14	56.17	0.48
2020	4771.7	87.55	55.41	0.54
2021	5413.5	74.67	43.46	0.49
2022	4594.3	71.33	31.19	0.38
2023	5787.6	78.11	24.01	0.27

Based on the a4a results, Norway lobster fishing mortality (F_{bar}) showed an increasing trend from 2009 (0.21) until reaching a peak in 2020 (0.54), and since then sharply decreased until 0.27 in 2023.

Recruitment oscillated but generally remained between 4500 and 6900 thousands of individuals, with a peak in 2016 and 2017 of 8171 and 7884 thousand of individuals, respectively.

Spawning stock biomass (SSB) increased from 55.74 t in 2009 to a peak of 107.58 t in 2015 before declining slightly until 2022 (71.33 t). However, last year of the time series (2023) the SSD increased (78.11 t).

Catch increased over the years, with the highest catch of 56.17 t recorded in 2019, and then sharply decreasing to 24.01 t in 2023.

Overall, the data suggests fluctuations in fishing mortality, recruitment, and catch over the years, with an overall trend of increasing fishing mortality along the time series but with a sharp decrease in the last 3 years, and fluctuations in recruitment, biomass and catch. Due to the model instability as shown by the retrospective analysis and by the residuals pattern, the EWG 24-10 concluded that the output of this model was not suitable to provide advice from the basis of the current status of the stock.

Thus, considering the outputs of the model, the EWG 24-10 suggested to provide ICES category 3 catch advice based on biomass index of the MEDITS survey.

The EWG 24-10 recommends trying to perform a full analytical assessment for the next year.

6.7.4 REFERENCE POINTS

The ICES category 3 advice and reference points provided for this stock are those computed in the EWG 23-09, since the provided advice were considered valid for 2024 and 2025.

The table below summarises reference points for use with ICES category 3 advice for Norway lobster in GSA 5 and his technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	1.17	Biomass index trigger value (Itrigger), defined as Itrigger = Iloss×1.4, where Iloss is the lowest observed historical biomass index value from 2021 MEDITS in GSA 5. In kg / km2.	STECF EWG 23-09
	F_{MSY}	1.00	$L_{mean}/L_{F=M}$; Mean catch length divided by MSY proxy reference length ($L_{F=M}$).	STECF EWG 23-09
Precautionary approach	B_{lim}		Not defined	
	B_{pa}		Not defined	
	F_{lim}		Not defined	
	F_{pa}		Not defined	
Management plan	MSY $B_{trigger}$		Not defined	
	B_{lim}			

	F_{MSY}		Not defined	
	target range F_{lower}			
	target range F_{upper}			

6.7.5 SHORT TERM FORECAST AND CATCH OPTION

Since the a4a models was not accepted, advice is based on the biomass index of the MEDITS survey in GSA 5. Following the ICES procedures and using the package cat3advice (Fischer S., 2023). The advice for 2023 was provided using the ICES framework for category 3 stocks (ICES, 2022) method 2.1 (see Section 4.7 above). Following the decision tree provided in the ICES technical guidance, given the availability of an index of abundance, of length data and a von Bertalanffy *k* of 0.21, the *rfb* rule is chosen to provide advice.

The *rfb* formula contains different factors to determine the catch in the advice year:

$$A_{y+1} = A_y \times r \times f \times b \times m$$

where the advised catch (*A*) for next year *y*+1 is based on the most recent year's advised catch Ay adjusted by the components in table 6.18.5.1. According to the guidelines if the most recent realized catch (catch in 2021 = 209 tonnes) is very different from the latest advice (advice for 2022 = 45 tonnes) it is suggested to consider replacing Ay as the *rfb* rule is meant to adjust realised catches influencing the stock. The two options for substituting Ay are the most recent catch value (catch in 2022) or the average of the last three years (2020-2022). The EWG decided to use as Ay the catches in 2022.

Table 6.7.5.1. Norway Lobster in GSA 5. Components of the *rfb* rule.

Component	Definition	Description and use
A_{y+1}	$A_y \times r \times f \times b \times m$	The advised catch for next year *y*+1.
A_y		The most recent catch (catch in 2021).
r	$\frac{\sum_{i=y-2}^{y-1}(I_i/2)}{\sum_{i=y-5}^{y-3}(I_i/3)}$	The rate of change in the biomass index (I), based on the average of the two most recent years of data (*y*−2 to *y*−1) relative to the average of the three years prior to the most recent two (*y*−3 to *y*−5), and termed the "2-over-3" rule; *y* = 2022.
f	$\frac{\overline{L}_{y-1}}{L_{F=M}}$	The fishing proxy is the mean length in the observed catch ($\overline{L}_{y-1}$) relative to an MSY proxy length ($L_{F=M}$) and is meant to move the stock towards MSY. Only lengths above the length of first capture (L_c) are considered for $\overline{L}_{y-1}$. The target reference length is $L_{F=M} = 0.75L_c + 0.25L_\infty$, where L_c is defined as length at 50% of modal abundance (ICES, 2012, 2018). The reference length follows Beverton and

Component	Definition	Description and use
		Holt (1957), derived by Jardim et al. (2015), and assumes *M*/*k* = 1.5.
b	$min\left\{1, \frac{I_{y-1}}{I_{trigger}}\right\}$	Biomass safeguard. Adjustment to reduce catch when the most recent index data I_{y-1} is less than $I_{trigger} = 1.4I_{loss}$ such that b is set equal to $I_{y-1}/I_{trigger}$. When the most recent index data I_{y-1} is greater than $I_{trigger}$, b is set equal to 1. I_{loss} is generally defined as the lowest observed index value for that stock. $I_{trigger}$ may need to be adapted if the stock has been exploited only heavily or lightly in the past.
m	$[0,1]$	A tuning parameter to ensure that the rfb rule is precautionary (that risk does not exceed 5%). It does not decrease advice continuously but can be considered as adjusting the target in component *f*. ***m*** is linked to von Bertalanffy ***k*** and based on generic MSE simulations. May range from 0 to 1.0. Since ***k*** is 0.13 ***m*** is 0.95
Stability clause	$min\{max(0.7A_y, A_{y+1})$	Asymmetric conditional uncertainty cap. Limits the amount the advised catch (A_{y+1}) can change upwards or downwards relative to the previous catch advice (A_y). The recommended values are +20% and −30%; i.e. the catch would be limited to a maximum 20% increase or a maximum 30% decrease relative to the previous year's advised catch. The stability clause does not apply when **b** < 1.

To obtain the *f* component of the *rfb* rule:

First parameter, calculation of the length at first capture (Lc) by year, which is defined as the first length class where abundance is more than or equal to half of the maximum abundance. Length data without reconstructions from 2009 onwards was used. Lc per year is shown in the table below.

Year	L_c (mm)
2009	26
2010	28
2011	28

2012	28
2013	28
2014	26
2015	27
2016	26
2017	27
2018	25
2019	26
2020	30
2021	31
2022	28

Second parameter, the target reference length LF=M = 0.75Lc + 0.25Linf was 41.025 mm.

Third parameter, the mean length above Lc is calculated.

Year	$L_{mean} > L_c$ (mm)
2009	35.44
2010	35.82
2011	35.81
2012	36.45
2013	38.29
2014	37.32
2015	37.65
2016	35.27
2017	37.01
2018	36.28
2019	35.00
2020	39.60
2021	38.69
2022	40.07

Fourth parameter, the quantity *f* is calculated as the ratio of the mean length above Lc and LF=M and was equal to 0.98.

In all the years the fishing pressure proxy relative to the MSY proxy indicator ratio Lmean / LF = M (*f*) was smaller than 1 (Figure 6.7.5.1).

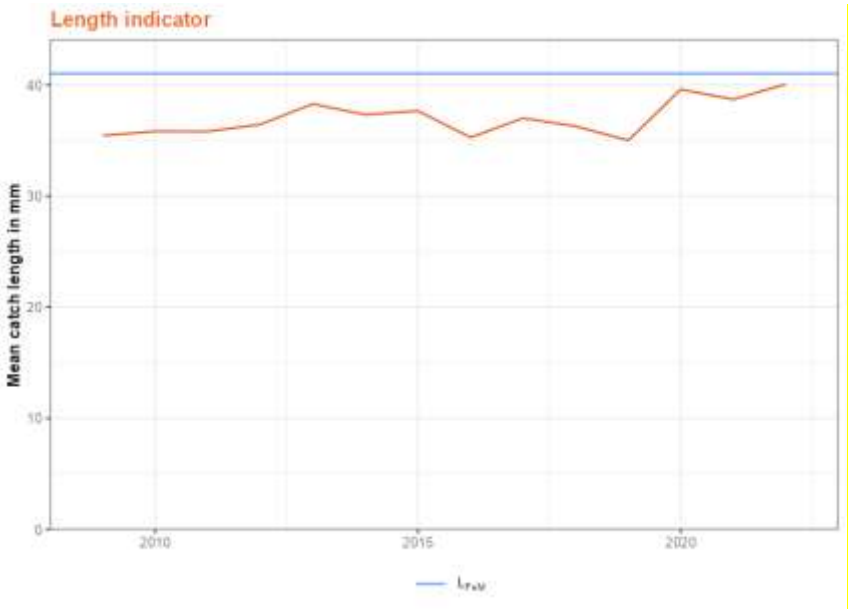


Figure 6.7.5.1. Norway Lobster in GSA 5. Length indicator (mean length of fish in the catch divided by MSY proxy reference length). The exploitation status is above FMSY proxy when the indicator ratio value is lower than 1 (shown by the blue line).

To obtain the *b* component of the *rfb* rule we defined the biomass index trigger value (Itrigger), defined as Itrigger = Iloss×1.4, where Iloss is the lowest observed historical biomass index value from 2021 MEDITS in GSA 5 (figure 6.18.5.2).

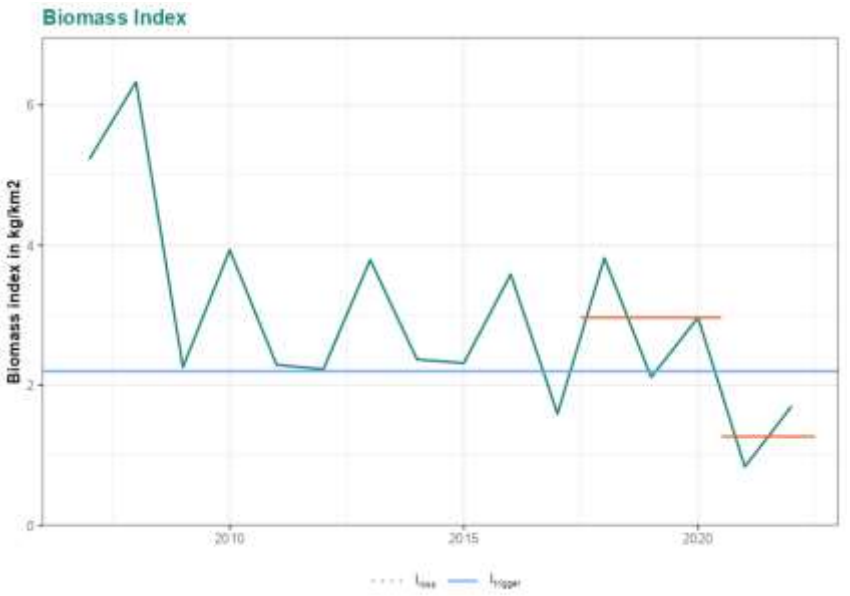


Figure 6.7.5.2. Norway Lobster in GSA 5. MEDITS in GSA 5 biomass index. The blue line represents Itrigger. The two red segments represent the mean index of 2021-2022 and of 2018-2020.

The advice for 2024 was set using the *rfb* as outlined in the table below.

Last year catch Cy-1 (catch in 2022)	36.67 tonnes
Stock biomass trend	
Index A (2022, 2022)	1.27 kg/km2

Index B (2018, 2019, 2020)	3.00 kg / km2
r: Index ratio (A/B)	0.43
Fishing pressure proxy	
Mean catch length ($\overline{L}$y−1=L2022)	40 mm
MSY proxy length (LF=M)	41 mm
f: multiplier for relative mean length in catches ($\overline{L}$y−1/ LF=M 2021)	0.98
Biomass safeguard	
Last index value (I2021)	1.70 kg / km2
Index trigger value (Itrigger=1.4*Iloss)	1.17 kg / km2
b: index relative to trigger value, min{I2021/Itrigger, 1}	1.00
Precautionary multiplier to maintain biomass above Blim with 95% probability	
m: multiplier (generic multiplier based on life history)	0.95
	rfb calculation*
Uncertainty cap (+20%/-30% compared to Cy-1, only considered if b≥1)	Applied
Discard rate	0.7%
Catch advice for 2023	26 tonnes
% advice change**	-30%

$*Ay+1=Ay\times r\times f\times b\times m$ limited by stability clause if applicable.
** Advice value for 2024 relative to the catch in 2022 (36.67 tonnes).

Based on MSY considerations STECF EWG 23-09 advises to decrease the total catch by 30% relative to the catches in 2022 equivalent to catches of no more than 25.67 tons in 2024 and 2025.

6.8 NORWAY LOBSTER IN GSA 6

6.8.1 THE STOCK IDENTITY AND BIOLOGY

spatial extent of the stock is assumed to coincide with the boundaries of GSA 6 (Fig. 6.8.1.1) due to the lack of information on the stock structure for the Norway lobster *Nephrops norvegicus* in the Mediterranean Sea. Norway lobster is distributed in deep waters in GSA 6, from 300 to 600 m approximately. It is a benthic species of fossorial habits, with higher abundance in areas with muddy sediments.

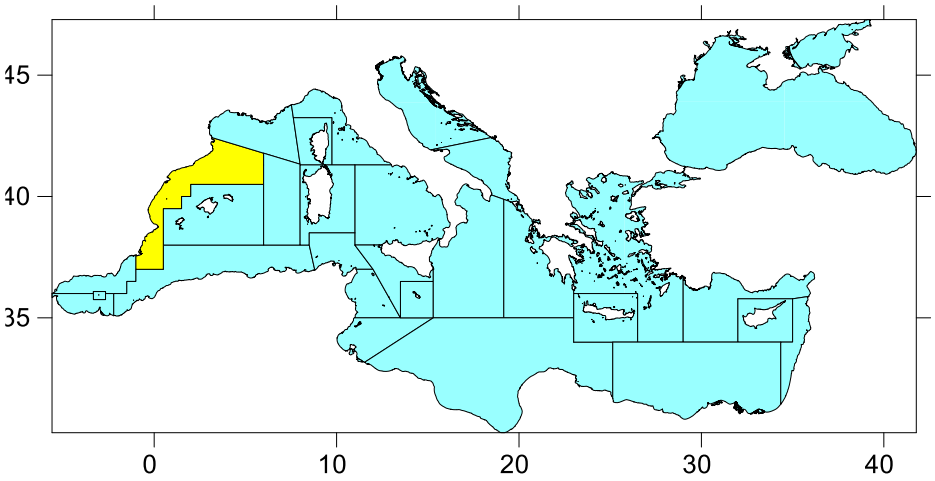


Fig. 6.8.1.1. Geographical location of GSA 6.

Age and growth

The Norway lobster is known to have a dimorphic growth pattern, with males growing slower and reaching larger sizes than females. However, sex-specific growth parameters are not available in the DCF MED_BS data set. As in previous assessments, the parameters of the von Bertalanffy growth function were taken from those estimated for GSA 5 and reported in the DCF as applicable to GSA 6, and which correspond to both sexes combined (reproduced in Table 6.8.1.1). The parameters of the weight-at-length equation were available in the DCF for the 2023 sampling, again not separated by sex.

Table 6.8.1.1. Norway lobster in GSA 6: Parameters used for growth and weight at length.

Growth model	L∞	k	t0
$L_t = L_\infty\left(1 - e^{-k(t-t_0}\right)$	86.1 mm CL	0.126 yr-1	0
Weight at length	a	b	
$W = a\ L^b$	0.000481 g mm-1	3.075	

Gonad maturity for females of this stock peaks during the months May to August. Eggs are not immediately spawned after mating, but females brood the eggs in their pleopods for several months (“brooding”). Eggs hatch in January and February of the following year, approximately

half a year later than female gonad maturity (Fig. 6.8.1.2) (Orsi Relini et al. 1998[2]; Aguzzi et al. 2004[3]).

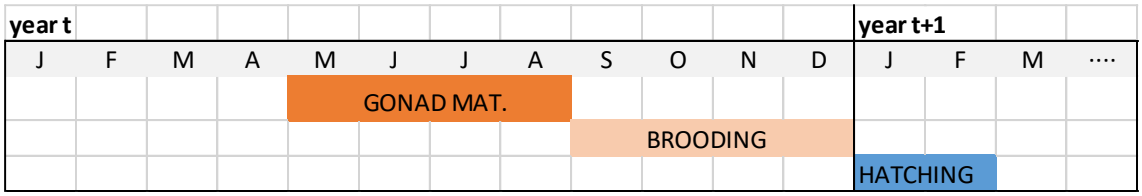


Fig. 6.8.1.2. Schematic reproductive cycle of female Norway lobster in GSA 6. Hatching corresponds to the release of eggs to the sea, equivalent to spawning in fishes.

Maturity and natural mortality

The implementation of a new maturity ogive for the assessment of the Norway lobster this year was necessary due to unrealistic results obtained with the previous one. To improve the quality of the assessment, it was agreed to harmonize the maturity curve with that employed in the GFCM working group (WGSAD, 2023) which was computed using the data from the DCF (2013-2015) (Table 6.8.1.2). It has been observed that the use of this maturity matrix has shown promising improvement compared to the assessment using the maturity ogive from the last report.

Natural mortality was obtained by application of the Chen-Watanabe formula (Table 6.8.1.2).

Table 6.8.1.2. Norway lobster in GSA 6: Maturity and natural mortality at age.

	1	2	3	4	5	6	7	8	9	10
maturity	0.05	0.25	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
M: Chen-Watanabe	0.732	0.466	0.353	0.291	0.252	0.225	0.206	0.192	0.181	0.172

6.8.2 DATA

All data were obtained from the 2023 DCF data call.

6.8.2.1 CATCH (LANDINGS AND DISCARDS)

Data on catches are available from 2002 to 2023 for GSA 6 (Figs. 6.8.2.1.1 and 6.8.2.1.2; Table 6.8.2.1.1). The catches of Norway lobster are produced exclusively by otter bottom trawl (OTB) at depths generally between 300 and 600 m. The main métier is coastal demersal (coded DEMSP and DEF since 2020), with important contributions from métier DWS and MDD. The landings were highest in the first half of the 2010s and have declined importantly since 2016, from ~500 t/yr in 2011-2014 to less than 200 t in 2023. The landings for 2023, for an amount of 142.91 t. Discards, reported since 2009, are negligible, normally below 5% of the catches, but note anomalously high value in 2012.

[2] Orsi Relini et al. 1998, Scientia Marina, vol 62(Suppl. 1), 25-41.
[3] Aguzzi et al. 2004, Biogeographia, vol 25, pp. 81-92.

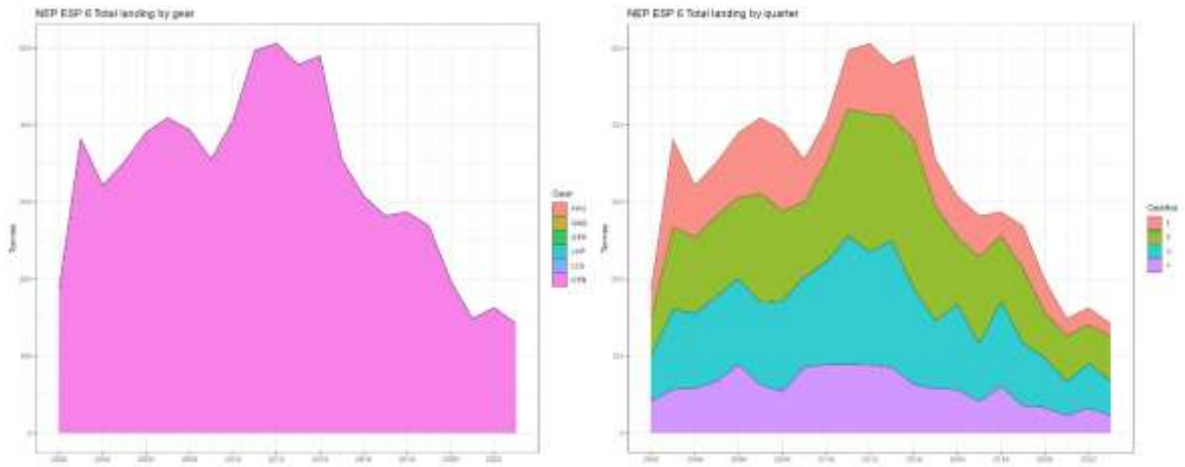


Fig. 6.8.2.1.1. Norway lobster in GSA6: Total landings per year (t).

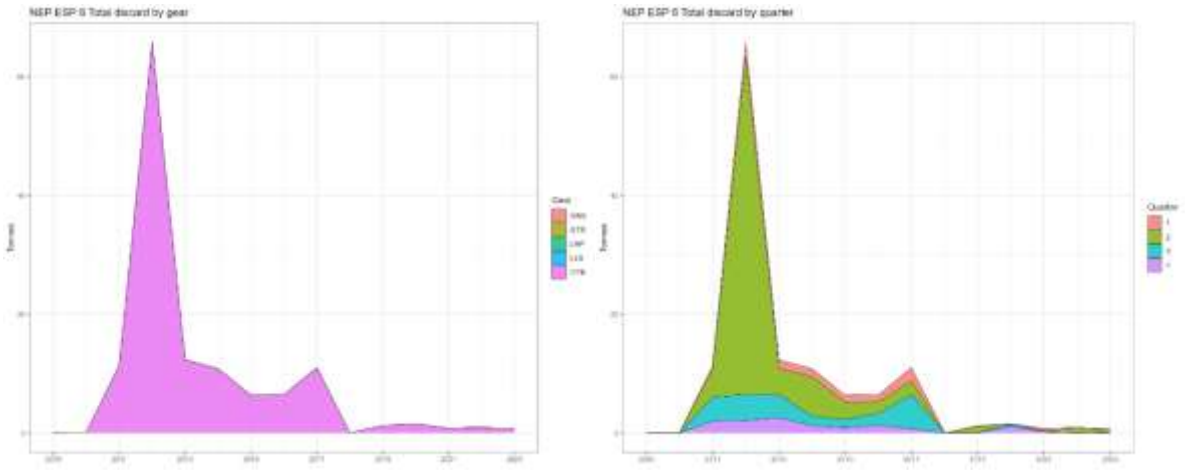


Fig. 6.8.2.1.2. Norway lobster in GSA 6: Total discards per year.

Table 6.8.2.1.1. Norway lobster in GSA 6: Reported landings, discards, catches and calculated proportion of discards.

Year	Landings (t)	Discards (t)	Catches (t)	% discards
2002	187.50		187.5	
2003	381.81		381.81	
2004	321.72		321.72	
2005	351.99		351.99	
2006	390.18		390.18	
2007	409.40		409.4	
2008	393.77		393.77	
2009	355.60	0.01	355.61	0.00%
2010	406.45	0.06	406.51	0.01%
2011	496.84	11.37	508.21	2.24%
2012	506.09	65.80	571.89	11.51%
2013	478.36	12.34	490.7	2.51%
2014	489.95	10.84	500.79	2.16%
2015	355.24	6.34	361.58	1.75%
2016	308.06	6.41	314.47	2.04%

2017	282.22	11.02	293.24	3.76%
2018	287.03	0.00	287.03	0.00%
2019	269.12	1.22	270.34	0.45%
2020	198.79	1.54	200.33	0.77%
2021	149.43	0.78	150.21	0.52%
2022	162.63	0.95	163.58	0.58%
2023	142.91	0.64	147.56	0.45%

Information on the demographic structure of the exploited population is available as quarterly length frequencies from 2009 to 2023. Length frequency distribution for those years or métiers where no length frequencies were available in DCF MEDBS were filled-in (Fig. 6.8.2.1.3 and Fig. 6.8.2.1.4). The length frequency of Norway lobster is reasonably well sampled for métiers OTB_DEMSP (defined as OTB_DEF in 2020) and OTB_DWS since 2009. For métier OTB_MDD length frequencies start to be available in 2021. Discards were generally not sampled, but length frequencies are available for 2019 and 2023 for the principal métier landing *Nephrops*, viz. OTB_DEMSP, recoded OTB_DEF.

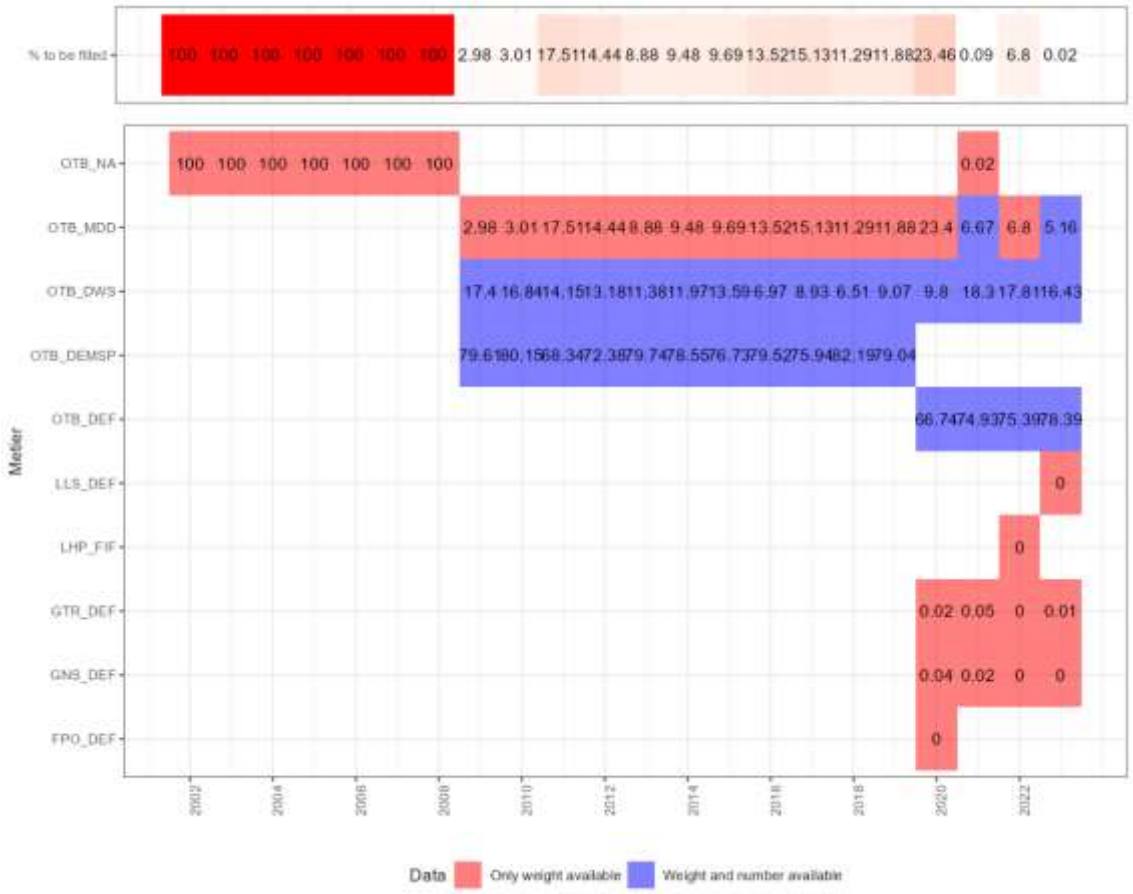


Fig. 6.8.2.1.3. Norway lobster in GSA 6: Available and reconstructed length frequencies for landings. Series of data with weight and length frequencies available in the DCF in blue; series with weight only for which length frequencies were reconstructed using median values in red.

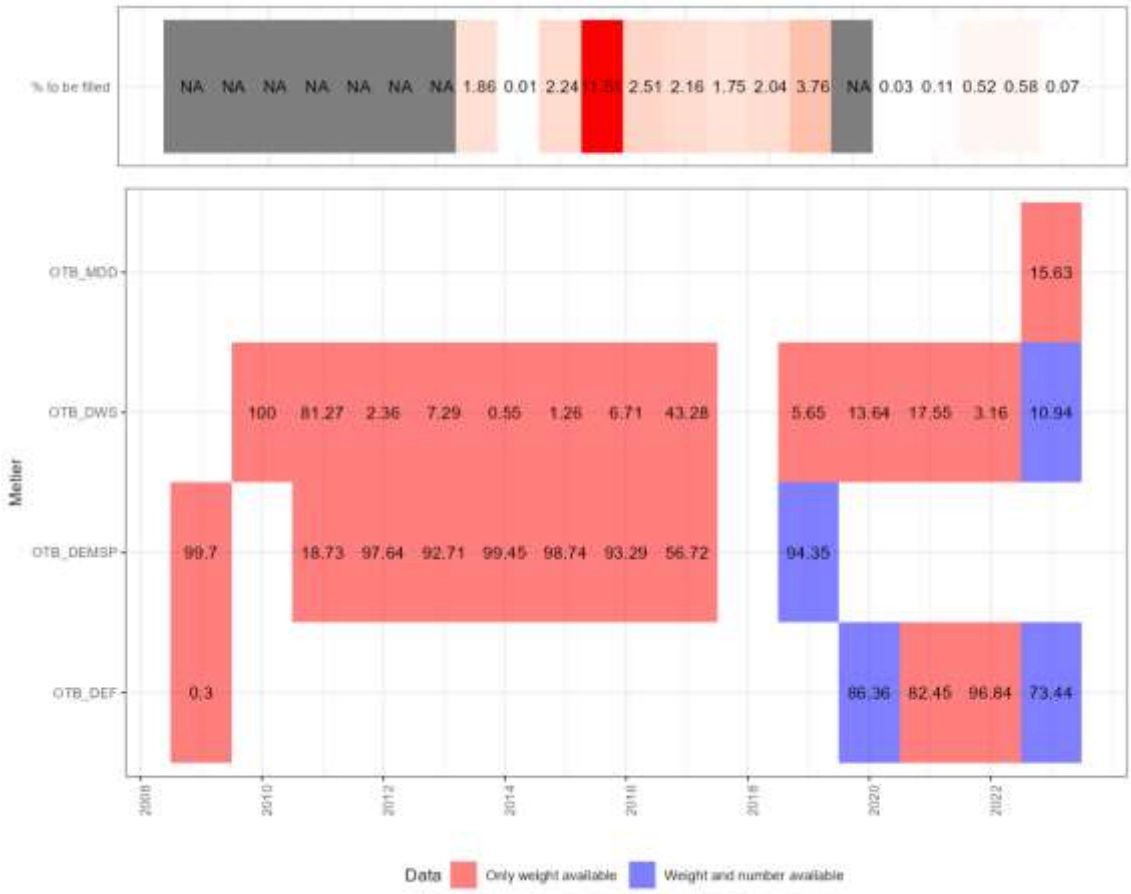
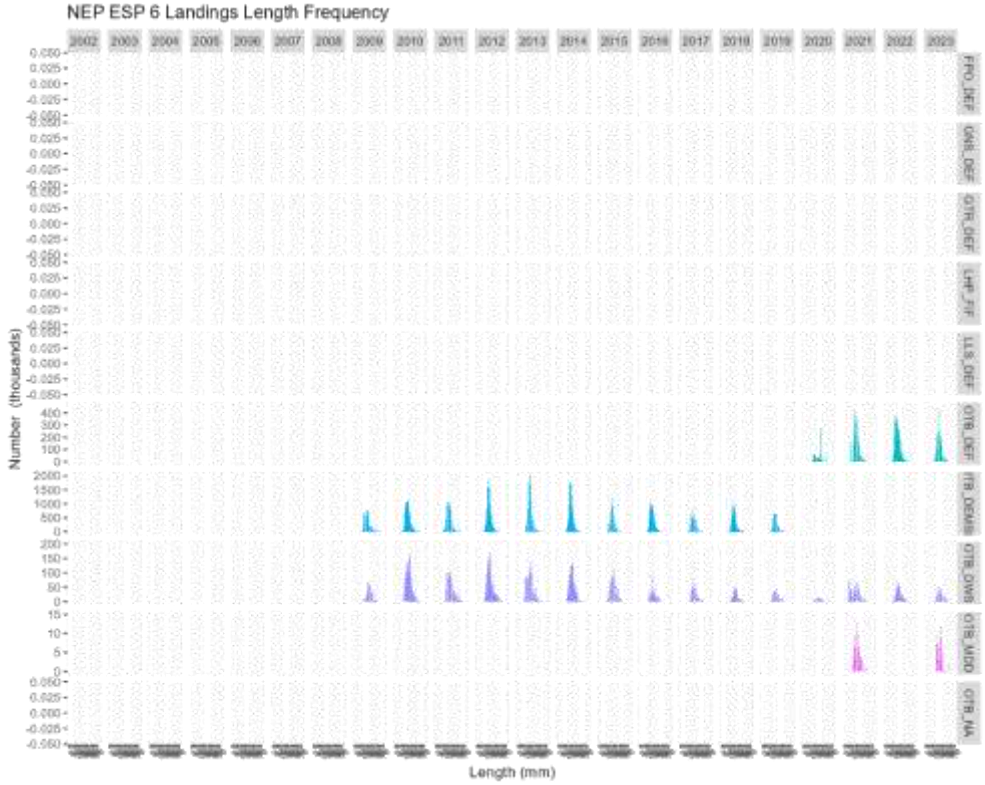


Fig. 6.8.2.1.4. Norway lobster in GSA 6: Available and reconstructed length frequencies for discards. Series of data with weight and length frequencies available in the DCF in blue; series with weight only for which length frequencies were reconstructed using median values in red.

The annual length frequencies by métier for the period 2002-2023 are shown in Fig. 6.8.2.1.5. Note the low number of individuals sampled in 2020 for métier DWS and the irregular size structure for métier DEF in 2020. In typical years (e.g. before 2020 and in 2021) 5000 individuals or more were sampled from the catches in ~150 samplings, while in 2020 only ~1000 individuals were measured in ~100 samlings.

(a)



(b)

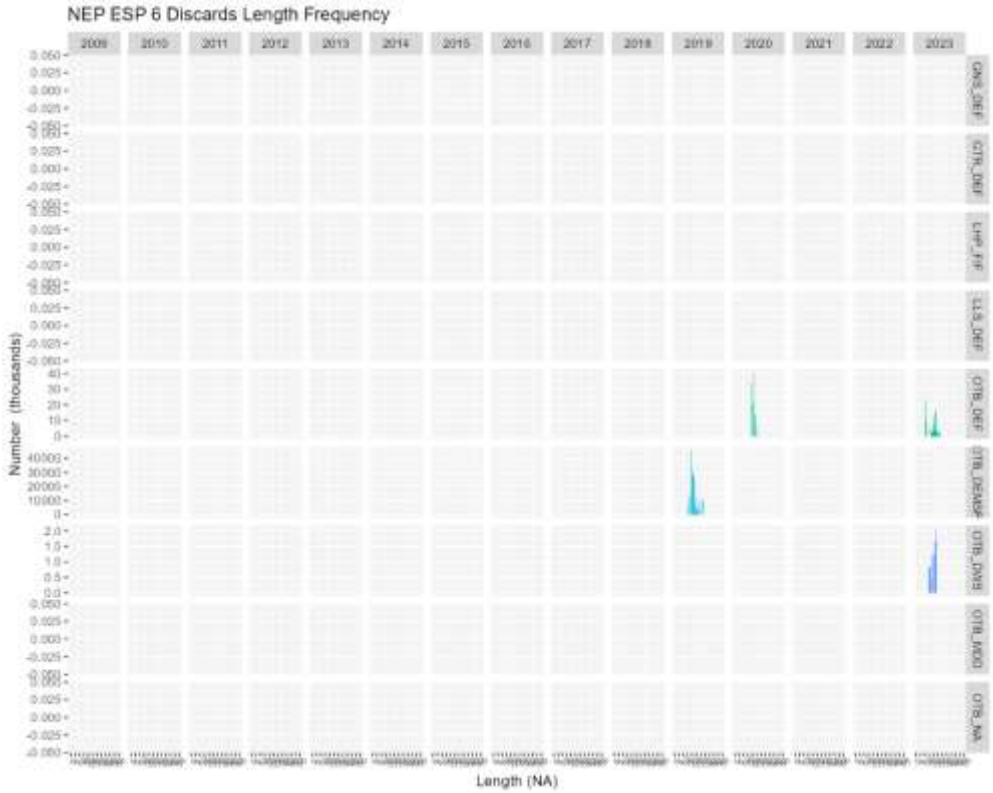


Fig. 6.8.2.1.5. Norway lobster in GSA 6: Length frequency distribution of landings (a) and discards (b).

The catches at length were raised to the total catches with sum-of-products (SOP) correction. The SOP corrections were similar on all years, except in 2020 which was considerably higher than 1 and 2021, which was lower (Table 6.8.2.1.2).

Table 6.8.2.1.2. Norway lobster in GSA 6: values of SOP correction used to raise the annual catches in the length frequency data to total catches.

year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
SOP	1.1325	1.0378	1.0619	1.0180	1.0720	1.0698	1.0711	1.0688	1.0559	1.0807	0.1128	1.6592	1.1348	1.0787	1.1161

6.8.2.2 EFFORT

Fishing effort data were not made available to EWG 24-10. Fishing effort data up to 2023 will be reported to STECF through the FDI data call within the DCF framework.

6.8.2.3 SURVEY DATA

The MEDITS trawl surveys carried out annually in GSA 6 in late spring since 1994 were used to derive a fisheries independent abundance index (Fig. 6.8.2.3.1). Note that in 2020 only the northern half of GSA 6 could be covered by the survey (approximately northwards from 40 º latitude), but in 2021 experimental survey covered again the entire area.

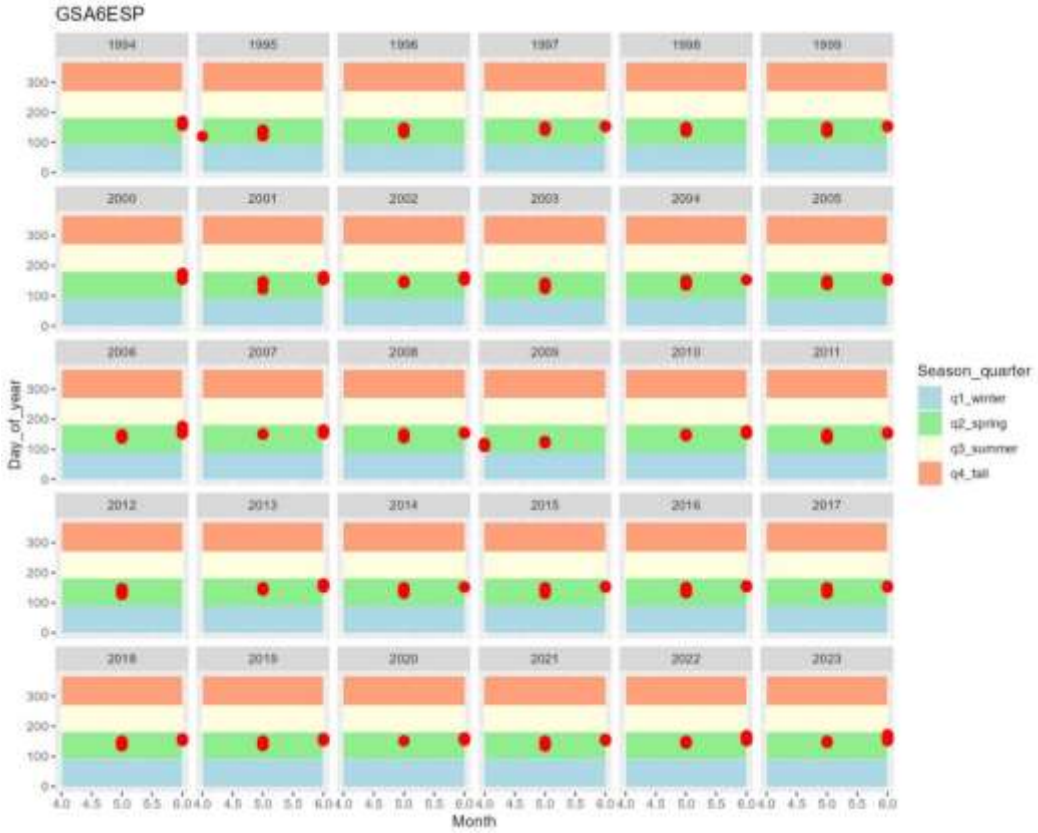


Fig. 6.8.2.3.1. Time of MEDITS surveys in GSA 6.

The length frequency distribution obtained during the MEDITS survey samplings is shown in Fig. 6.8.2.3.2.

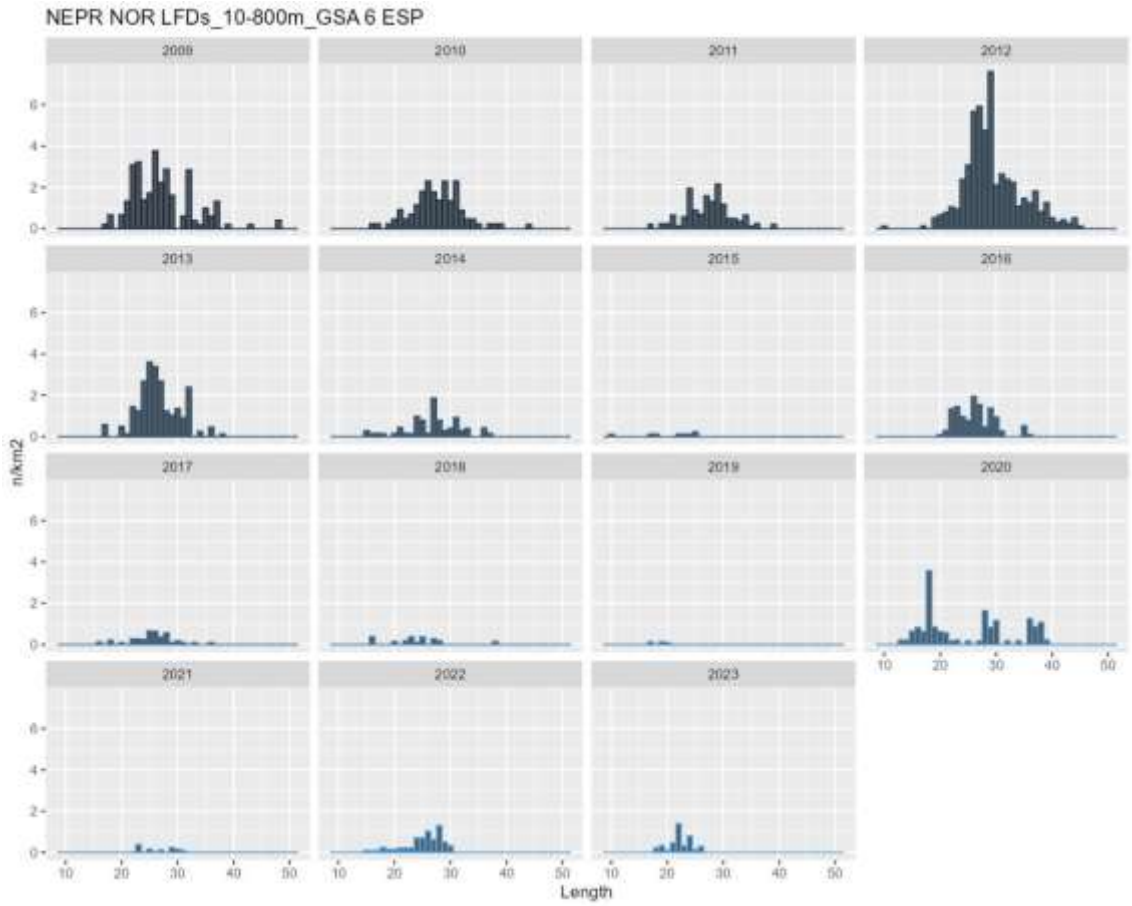


Figure 6.8.2.3.2. Norway lobster in GSA 6: Length frequency distribution by year in the MEDITS sampling.

The abundance indices derived from the MEDITS survey, in number of individuals / km^2 and kg / km^2, are shown in Figs. 6.8.2.3.3 and 6.8.2.3.4. The abundance of Norway lobster fluctuated without a trend over the 28-year period. The indicator n/km^2 in 2020 was the highest in the series (534 ind./km^2), but it decreased to 185.92 ind./km^2 in 2023. The indicator kg/km^2 in recent years is well within the average of the entire series (5 kg/km^2).

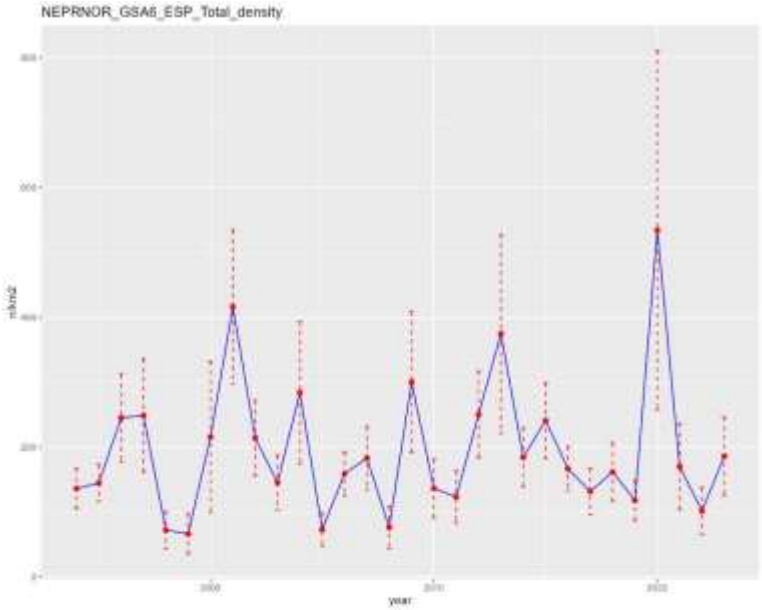


Figure 6.8.2.3.3. Norway lobster in GSA 6: Abundance index (n/km^2) estimated from MEDITS survey over the period 1994-2023.

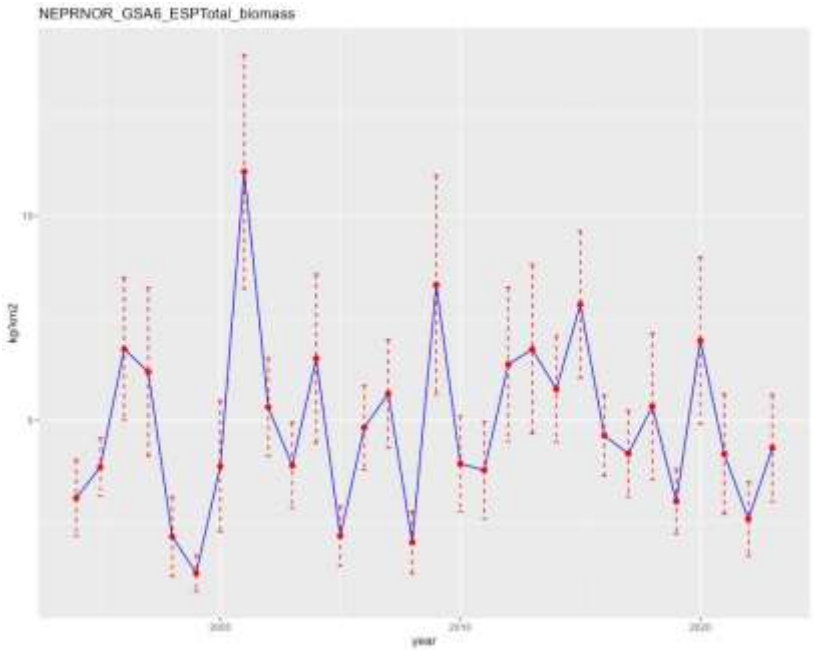


Figure 6.8.2.3.4. Norway lobster in GSA 6: Abundance index (kg/km^2) estimated from MEDITS survey over the period 1994-2023.

The length frequencies from the MEDITS series were converted to age frequencies with the standard **l2a** routine in FLa4a. The resulting catch at age matrix is shown in Fig. 6.8.2.3.5.

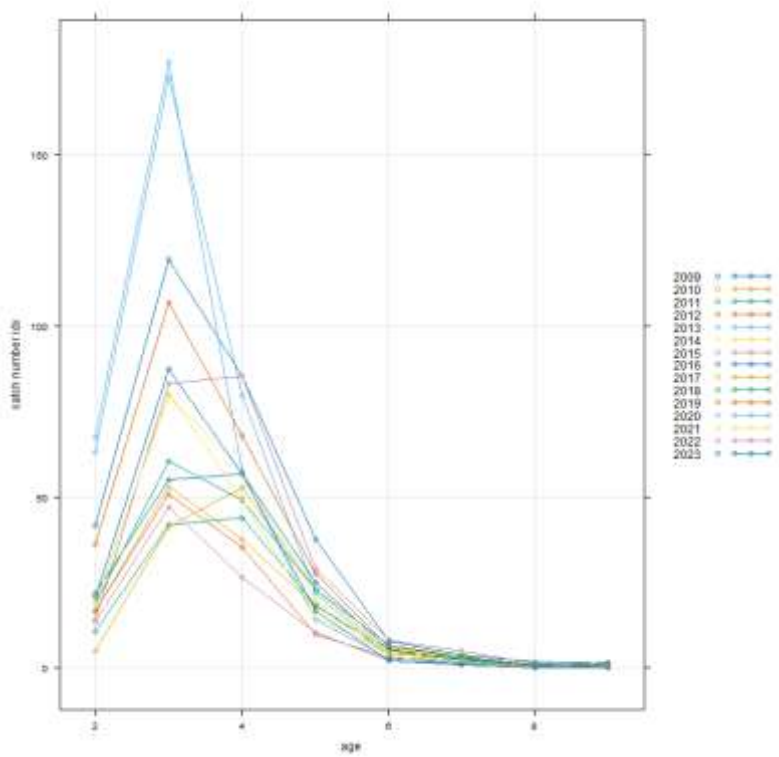


Figure 6.8.2.3.5. Norway lobster in GSA 6: Catch at age distribution in the MEDITS survey samples (data for years before 2009 have been omitted for clarity).

6.8.3 STOCK ASSESSMENT

The basic input data for the stock assessment of Norway lobster in GSA 6 using the **a4a** method are provided in tables 6.8.3.1 to 6.8.3.5. The assessment period covers the years 2009-2023 for which data on length frequencies are available and of reasonably good quality. Nevertheless, initial trial stock assessments with the entire data set led to unreasonably large residuals for 2020, which can be attributed to insufficient quality of the length frequency of commercial catches in 2020, as discussed at the end of Section 6.8.1. It was decided to remove the data from the discards.n, landings.n and catch.n slots for year 2020 to get more robust diagnostics and results for the assessment.

Table 6.8.3.1. Norway lobster in GSA 6: Total Catch by year in tonnes.

2009	2010	2011	2012	2013	2014	2015	2016
361.49	417.21	525.29	482.68	419.17	467.05	390.98	293.58
2017	2018	2019	2020	2021	2022	2023	
320.77	279.11	259.77	152.03	157.21	163.68	147.56	

Table 6.8.3.2. Norway lobster in GSA 6: Catch in numbers by age and by year. Note that data for 2020 was excluded from the final accepted assessment.

Age	2009	2010	2011	2012	2013	2014	2015	2016
2	4967.552	5491.5589	6124.7843	8972.2616	8671.0655	6201.2787	3301.3301	6946.8184
3	6841.914	9549.4389	10563.321	15750.933	13472.148	13665.666	8691.2865	7950.8017
4	3431.521	3497.8518	4994.4257	4033.7252	3621.0699	4339.9692	3705.1063	2509.0819
5	1196.26	1150.1824	1343.4009	1284.7572	1144.7891	1155.319	1042.1608	678.9011
6	277.1043	270.3452	394.4966	336.5457	264.6048	314.4842	250.6821	126.2045
7	135.1159	185.6051	272.1699	220.9754	115.8758	158.8855	71.796	81.8906
8	27.2514	34.5642	76.8793	92.2796	34.1714	18.0428	9.0295	15.9244
9+	61.0496	31.6549	48.7948	46.5963	30.7067	11.5136	1.8127	4.7459

Age	2017	2018	2019	2020	2021	2022	2023
2	5050.33	3361.3838	2411.1949	NA	1584.7669	1827.1951	679.7208
3	5749.704	7612.1922	6558.7085	NA	3559.1524	3102.1201	2629.7008
4	2870.751	2172.158	2609.2598	NA	1332.5332	1573.9228	1572.9682
5	852.9007	713.7904	557.1266	NA	440.2607	567.0703	524.9132
6	147.1525	221.8228	250.5642	NA	120.4015	113.7566	145.5081
7	151.8573	171.4792	158.2493	NA	57.3148	103.993	71.2704
8	19.4627	24.5234	9.9081	NA	14.0854	31.9698	14.2932
9+	11.5494	4.1996	14.7458	NA	4.7072	4.8666	5.1352

The catch at age in numbers is also shown in Fig. 6.8.3.1. it is important to note that there has been a consistent decrease in catch number across all age groups from 2019 to 2023.

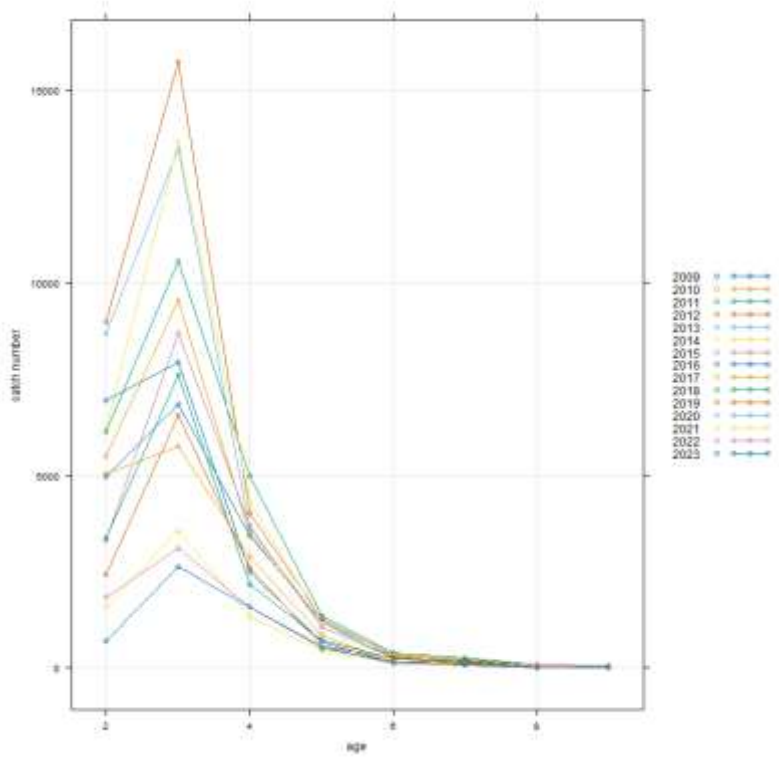


Fig. 6.8.3.1. Norway lobster in GSA 6: Catch in numbers by age and by year.

Table 6.8.3.3. Norway lobster in GSA 6: Stock and catch weights at age.

age	2009	2010	2011	2012	2013	2014	2015	2016
2	0.0084	0.0086	0.0087	0.0088	0.0085	0.0090	0.0088	0.0085
3	0.0168	0.0167	0.0170	0.0162	0.0164	0.0165	0.0172	0.0166
4	0.0287	0.0292	0.0292	0.0292	0.0291	0.0291	0.0295	0.0291
5	0.0483	0.0472	0.0472	0.0473	0.0473	0.0470	0.0470	0.0471
6	0.0698	0.0678	0.0674	0.0678	0.0678	0.0680	0.0674	0.0673
7	0.0878	0.0896	0.0883	0.0898	0.0895	0.0860	0.0893	0.0890
8	0.1129	0.1131	0.1136	0.1121	0.1150	0.1136	0.1120	0.1117
9+	0.1376	0.1348	0.1349	0.1384	0.1310	0.1299	0.1273	0.1365
age	2017	2018	2019	2020	2021	2022	2023	
2	0.0086	0.0088	0.0093	0.0092	0.0088	0.0086	0.0088	
3	0.0170	0.0167	0.0169	0.0152	0.0169	0.0168	0.0176	
4	0.0294	0.0290	0.0294	0.0308	0.0293	0.0296	0.0299	
5	0.0478	0.0463	0.0463	0.0470	0.0473	0.0473	0.0474	
6	0.0681	0.0684	0.0683	0.0680	0.0690	0.0681	0.0680	
7	0.0871	0.0895	0.0888	0.0942	0.0881	0.0899	0.0887	
8	0.1098	0.1143	0.1139	0.1084	0.1145	0.1152	0.1151	
9+	0.1331	0.1362	0.1273	0.1273	0.1337	0.1334	0.1359	

Table 6.8.3.4. Norway lobster in GSA 6: Maturity and Natural mortality at age (2-9+).

	2	3	4	5	6	7	8	9+
maturity	0.25	0.8	1.0	1.0	1.0	1.0	1.0	1.0

M: Chen-Watanabe	0.466	0.353	0.291	0.252	0.225	0.206	0.192	0.181

other conditions:

In previous assessment, it was determined that the average spawning time for *Nephrops* in GSA 6 occurs at 1/6 year, equivalent to a value of 0.1666667 in the m.spwn and harvest.spwn slots. This was based on the understanding that the species spawn (= eggs hatch) in January-February.

However, maintaining this value for the present assessment has proven to be challenging and has resulted in inconsistent outcomes for the Short-Term Forecast.

After extensive discussions during the working group, it was decided that setting the value of these two slots at 0.5, reflecting the species' spawning period (in the middle of the year), would give more realistic and consistent results which are expected to enhance the accuracy and the quality of the final forecasting model.

- The Catch numbers from 2009 to 2023 (excluding 2020);
- Make a trim for ages 2 to 9+
- Set Fbar between ages 3 to 6.

Table 6.8.3.5. Norway lobster in GSA 6: MEDITS tuning index of abundance by age and by year.

age	2009	2010	2011	2012	2013	2014	2015	2016
2	41.5465	16.334405	10.7817	36.17988	62.9852	19.149469	13.9970	21.724453
3	119.4530	53.197845	41.8217	107.01855	172.6148	79.716654	83.0613	54.997749
4	85.4866	37.53725	43.8482	68.086298	79.6261	57.830631	85.5339	56.714967
5	37.6930	18.132232	18.5036	27.696902	21.7230	19.650905	29.0167	24.879263
6	7.8458	5.637879	4.0697	6.073092	3.3188	3.35856	8.1509	5.384904
7	3.8660	2.688497	2.9764	3.21779	1.8156	2.503798	4.9591	2.377286
8	1.8571	1.05621	0.1215	1.087909	0.6604	0.526014	1.2332	0.686361
9+	1.2417	0.884865	1.0933	0.432406	0.5020	0.546787	0.5672	1.62117
age	2017	2018	2019	2020	2021	2022	2023	
2	5.0084	18.776509	16.6593	67.500058	18.7867	13.624594	20.8360	
3	41.2052	60.444123	50.9077	177.37541	80.3637	47.074268	87.3871	
4	52.7413	49.035364	35.3885	57.274653	49.2443	26.468459	56.8141	
5	23.0712	23.117502	9.8214	14.055717	14.7067	10.422071	16.7925	

6	4.2916	6.569715	3.0423	2.79722	4.3327	2.118803	2.2108
7	3.4894	3.267717	0.8292	1.562175	2.0462	1.175542	0.9804
8	0.4432	0.674613	0.0501	0.391407	0.2320	0.100268	0.1122
9+	0.9480	0.142168	0.0561	0.173593	0.0561	0.200536	0.1122

The internal consistency of the catch at age data is robust as demonstrated in Fig. 6.8.3.2. However, the index at age data presents some inconsistencies (Fig. 6.8.3.3)

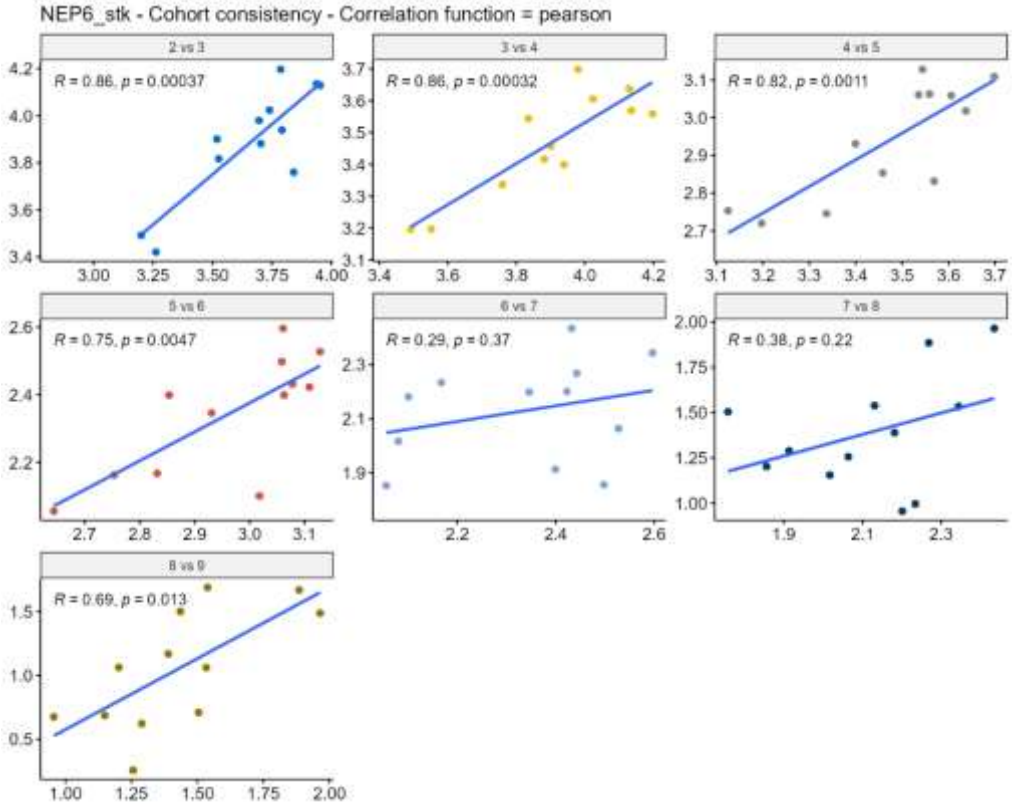


Fig. 6.8.3.2. Norway lobster in GSA6: Consistency of cohorts of the catch-at-age data.

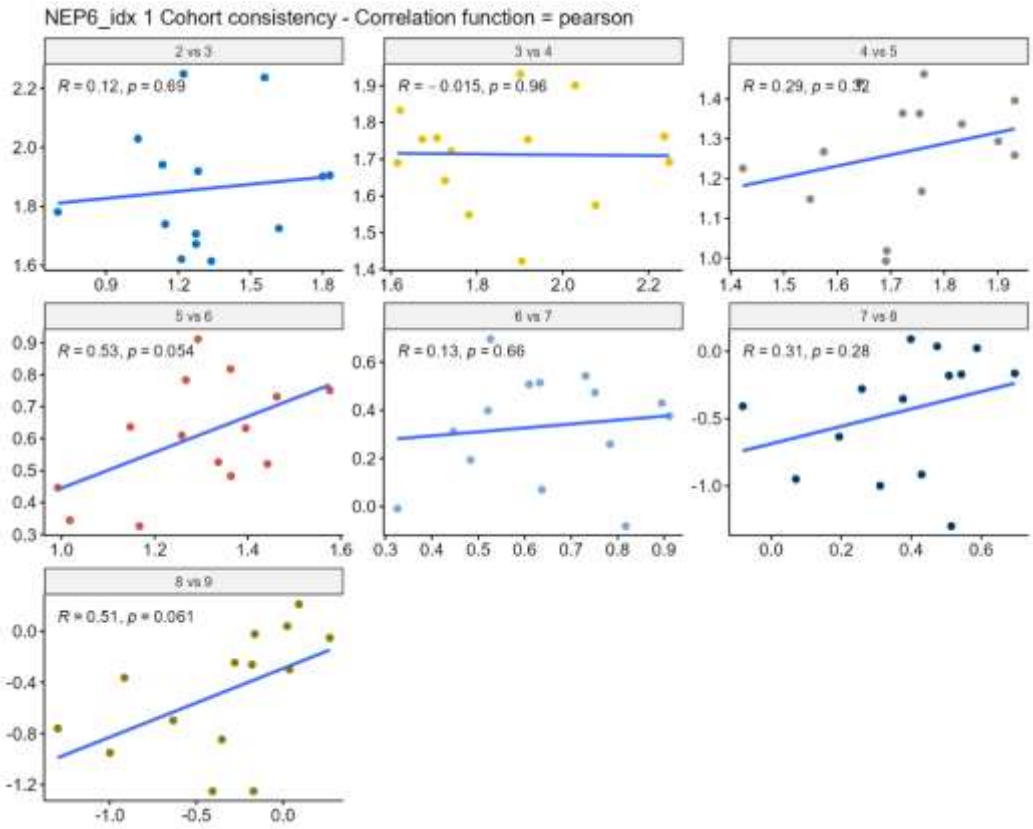


Fig. 6.8.3.3. Norway lobster in GSA6: Consistency of cohorts of the index-at-age data.

Assessment results (a4a)

The stock assessment was based on the following sub-models:

fmodel: ~factor(age) + factor(year)

srmodel: ~s(year, k = 4)

qmodel: list(~factor(replace(age, age > 4, 4)))

The assessment results for Norway lobster in GSA 6 are shown in Figure 6.8.3.4 and in Tables 6.8.3.6 to 6.8.3.8.

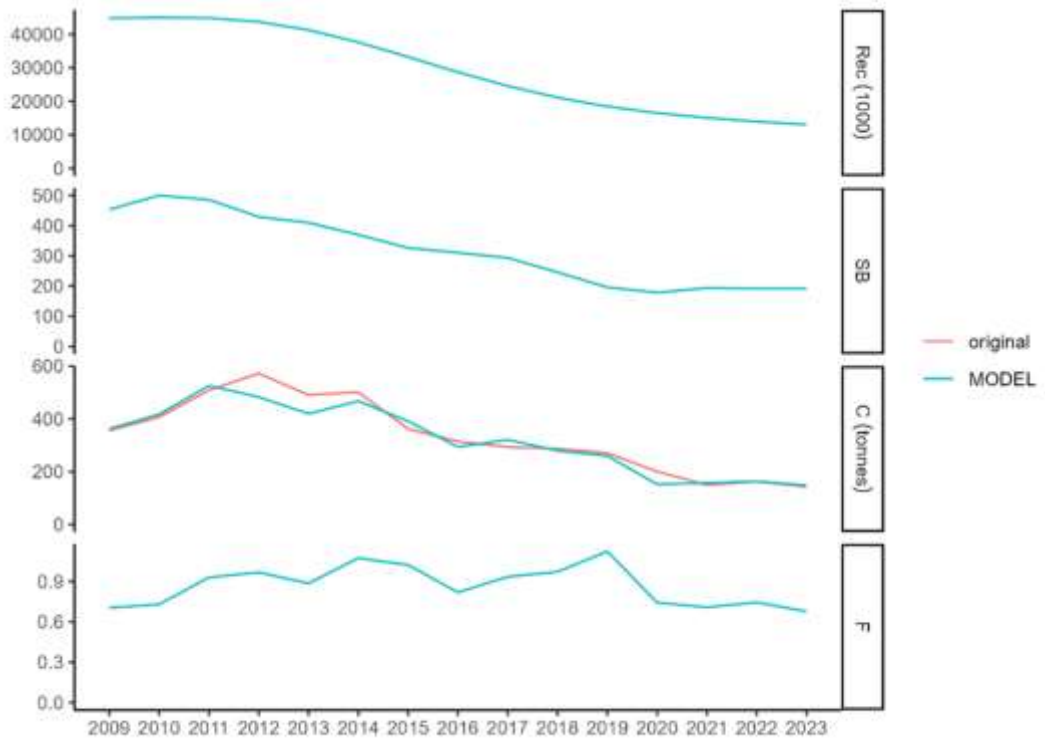


Figure 6.8.3.4. Norway lobster in GSA 6: Stock summary from the final a4a model.

Table 6.8.3.6. Norway lobster in GSA 6: Stock summary from the a4a assessment (base year 2019 for Western Med. MAP).

age	Fbar 3-6	rec (1000)	SSB (t)	catch (t)
2009	0.7042	44716	452.99	361.49
2010	0.72964	45004	499.86	417.21
2011	0.9298	44830	485.7	525.29
2012	0.96773	43685	429.08	482.68
2013	0.8855	41252	409.48	419.17
2014	1.07369	37610	369.71	467.05
2015	1.0226	33215	325.94	390.98
2016	0.8189	28687	310.23	293.58
2017	0.9347	24556	293.36	320.77
2018	0.97199	21124	245.66	279.11
2019	1.1231	18467	195.79	259.77
2020	0.74305	16501	178.65	152.03
2021	0.7084	15066	193.31	157.21
2022	0.74454	13976	191.32	163.68
2023	0.6766	13064	191.26	147.56

Table 6.8.3.7. Norway lobster in GSA 6: Stock number by age and by year (thousands).

age	2009	2010	2011	2012	2013	2014	2015	2016
2	44 716	45 004	44 830	43 685	41 252	37 610	33 215	28 687
3	19 268	24 070	24 091	22 976	22 206	21 347	18 682	16 683
4	6 405	6 977	8 509	7 055	6 492	6 779	5 459	5 013
5	2 169	2 175	2 302	2 244	1 783	1 799	1 522	1 298
6	759	768	748	633	592	515	421	377
7	276	340	336	278	228	228	170	145
8	104	74	88	63	49	46	34	28
9+	40	57	55	49	38	32	23	18

age	2017	2018	2019	2020	2021	2022	2023
2	24 556	21 124	18 467	16 501	15 066	13 976	13 064
3	15 062	12 572	10 728	9 075	8 808	8 103	7 457
4	5 423	4 390	3 538	2 619	3 168	3 177	2 824
5	1 497	1 422	1 104	751	851	1 071	1 031
6	404	410	373	245	255	300	362
7	154	150	147	118	106	114	130
8	33	29	26	20	30	28	29
9+	17	17	15	11	13	17	18

Table 6.8.3.8. Norway lobster in GSA 6: Fishing Mortality by age and by year

age	2009	2010	2011	2012	2013	2014	2015	2016
2	0.15306	0.15860	0.20212	0.21036	0.19249	0.23339	0.22229	0.17801
3	0.66253	0.68651	0.87485	0.91052	0.83319	1.01022	0.96217	0.77049
4	0.78893	0.81748	1.04176	1.08424	0.99215	1.20295	1.14574	0.91749
5	0.78660	0.81508	1.03869	1.08105	0.98923	1.19941	1.14237	0.91479
6	0.57856	0.59950	0.76397	0.79512	0.72759	0.88218	0.84023	0.67284

7	1.10885	1.14898	1.46421	1.52391	1.39448	1.69076	1.61035	1.28954
8	0.84953	0.88028	1.12179	1.16753	1.06836	1.29536	1.23376	0.98797
9+	0.46169	0.47840	0.60965	0.63451	0.58062	0.70399	0.67051	0.53693

age	2017	2018	2019	2020	2021	2022	2023
2	0.20318	0.21128	0.24413	0.16152	0.15398	0.16184	0.14707
3	0.87945	0.91453	1.05670	0.69912	0.66650	0.70053	0.63657
4	1.04723	1.08901	1.25831	0.83250	0.79366	0.83418	0.75802
5	1.04415	1.08580	1.25461	0.83005	0.79133	0.83173	0.75579
6	0.76798	0.79862	0.92278	0.61051	0.58203	0.61174	0.55589
7	1.47190	1.53061	1.76857	1.17009	1.11550	1.17245	1.06541
8	1.12768	1.17266	1.35497	0.89645	0.85463	0.89826	0.81625
9+	0.61286	0.63730	0.73638	0.48719	0.46446	0.48818	0.44361

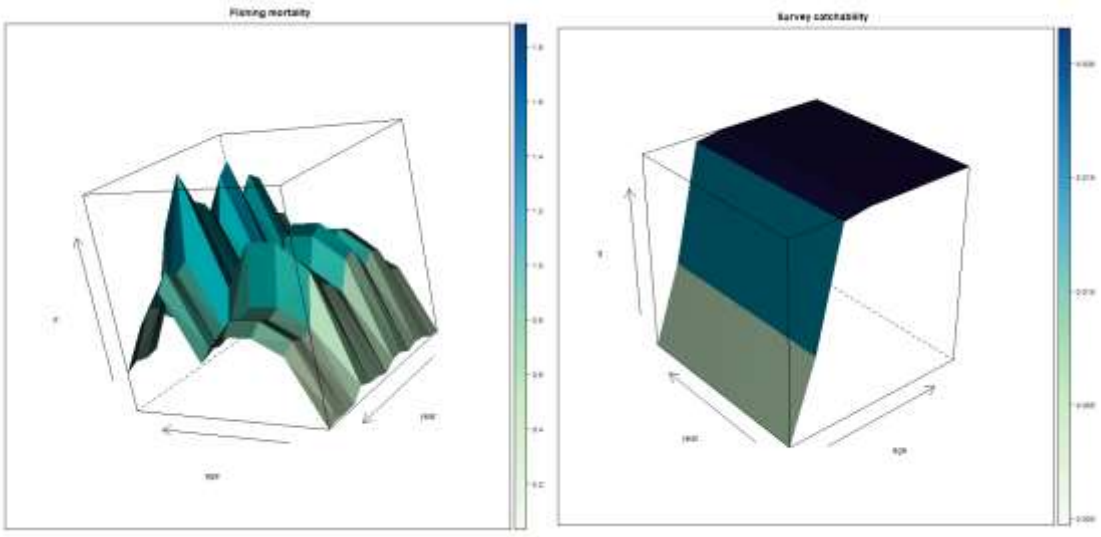


Figure 6.8.3.5. Norway lobster in GSA6: 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated survey catchability (right) at age and year.

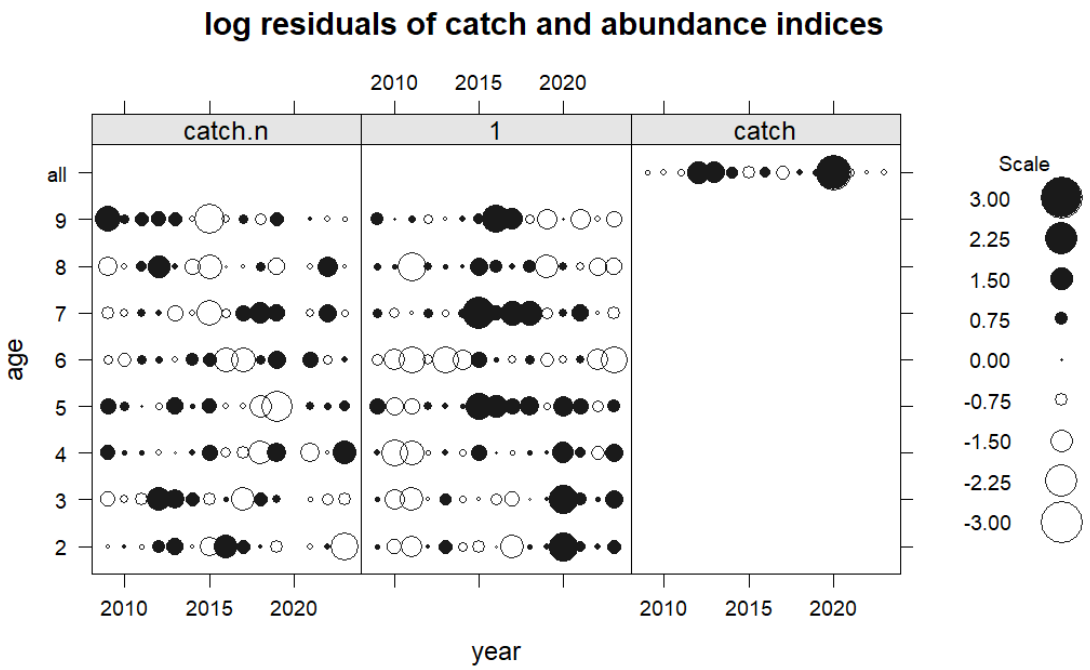


Figure 6.8.3.6. Norway lobster in GSA6: Standardized residuals for abundance indices and for catch numbers.

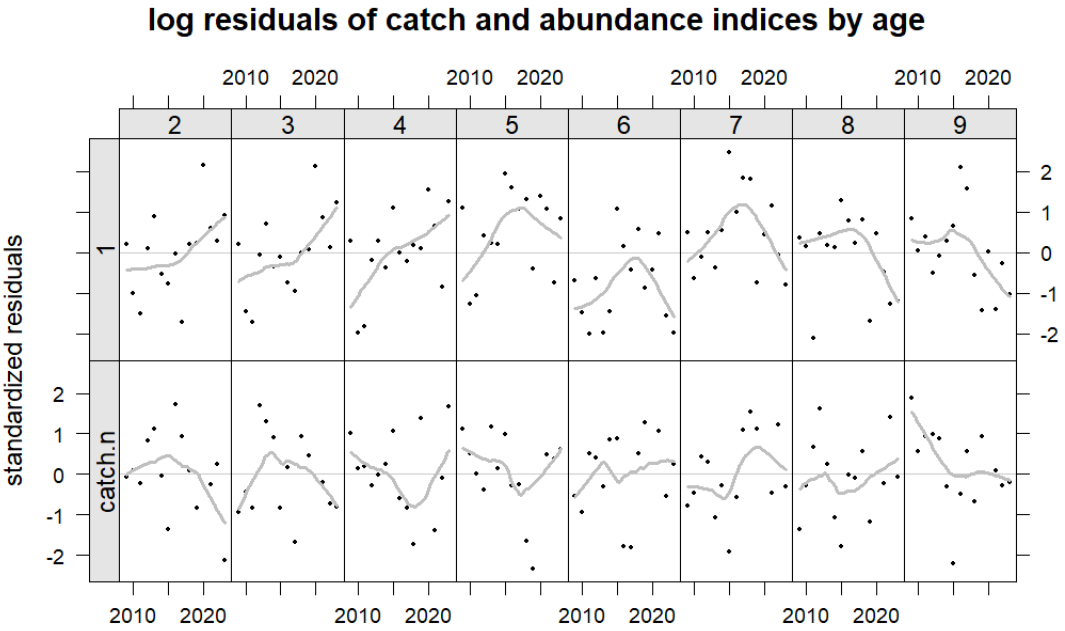


Figure 6.8.3.7. Norway lobster in GSA6: Standardized residuals for abundance indices and for catch numbers.

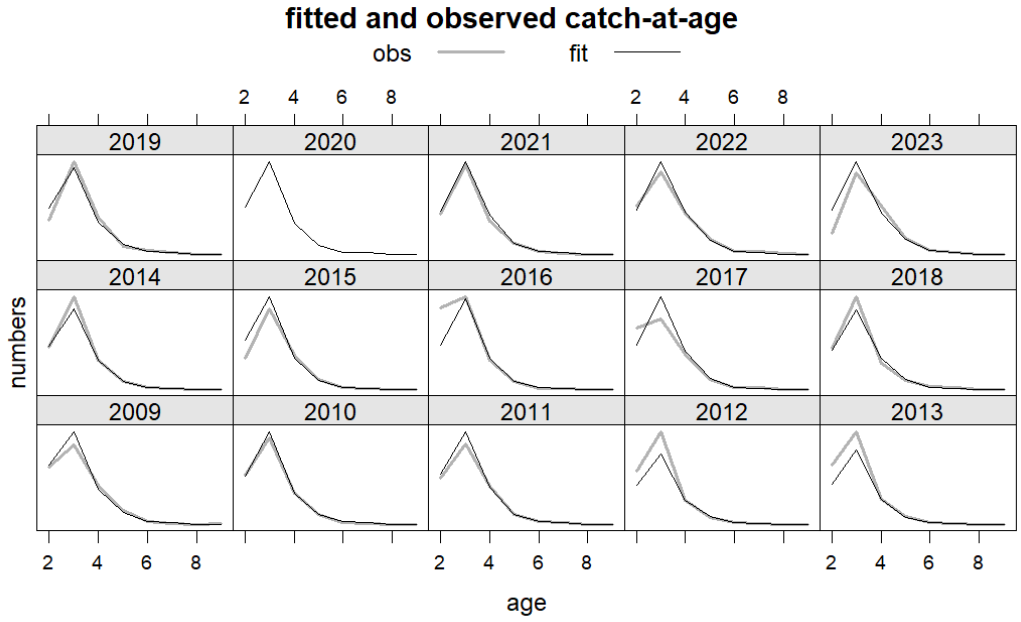


Figure 6.8.3.8. Norway lobster in GSA6: Fitted and observed catch-at-age.

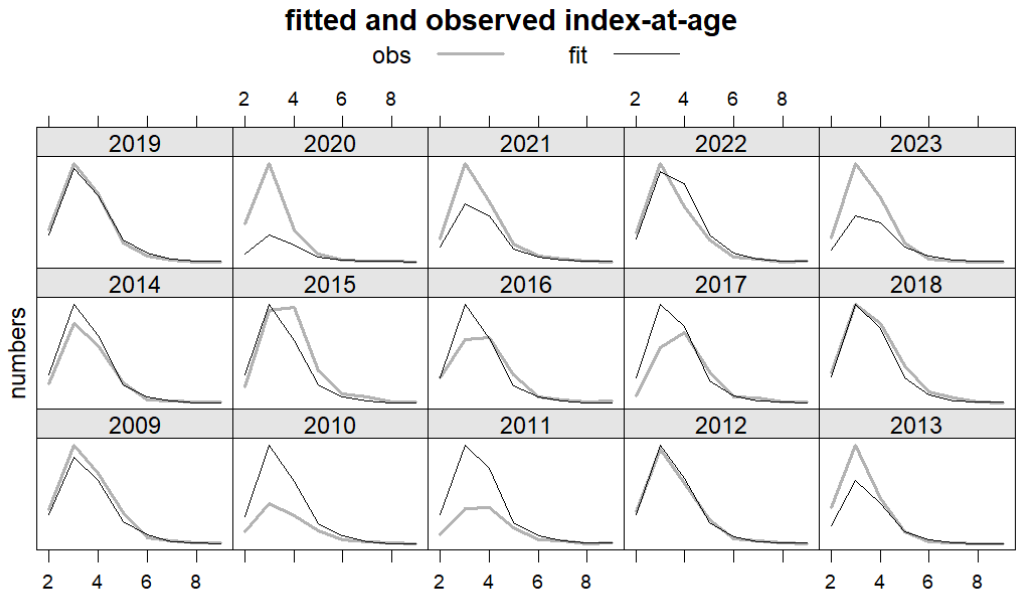


Figure 6.8.3.9. Norway lobster in GSA6: Fitted and observed index-at-age.

Retrospective

The retrospective analysis was conducted over a period of 3 years back. Model results were good (Figure 6.8.3.10) despite the relatively short data series (14 years) for a long-lived species.

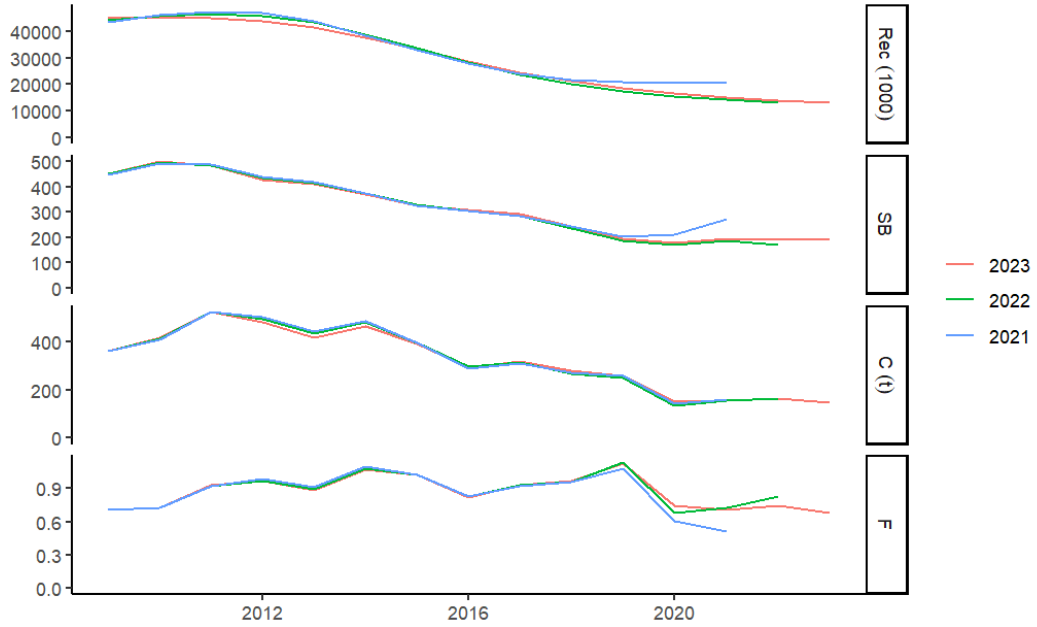


Figure 6.8.3.10. Norway lobster in GSA 6: Retrospective analysis.

Other fit statistics show that the model is not overparameterized (number of parameters / number of observations < 0.25). The Monh's rho value for the ssb (0.15622309) was within the interval established for long lived species [-0.15, 0.2].

fitSumm(fit.ll)

NEP_2023	
nopar	37.00000
nlogl	118.27324
maxgrad	0.00000
nobs	232.00000
gcv	0.18411
nlogl_comp1	0.91581
nlogl_comp2	117.35700
AIC	310.54649
BIC	438.07577
nopar/nobs (%)	15.94828

icesAdvice:: mohn(retro.lst)

fbar	ssb	rec

-0.07926858	0.15622309	0.16827489

Conclusions to the assessment

The stock assessment results (Fig. 6.8.3.11) show that fishing mortality Fbar (3-6) has been fluctuating in all the time series and started to decrease from 2019. Fishing mortality was above F_{MSY} (using the F_{max} proxy, see section 6.8.4) for all years. In the last assessment year Fbar(3:6) [2023] = 0.68 while F_{max} = 0.29. Recruitment and SSB appear to be decreasing since 2012, along with catches.

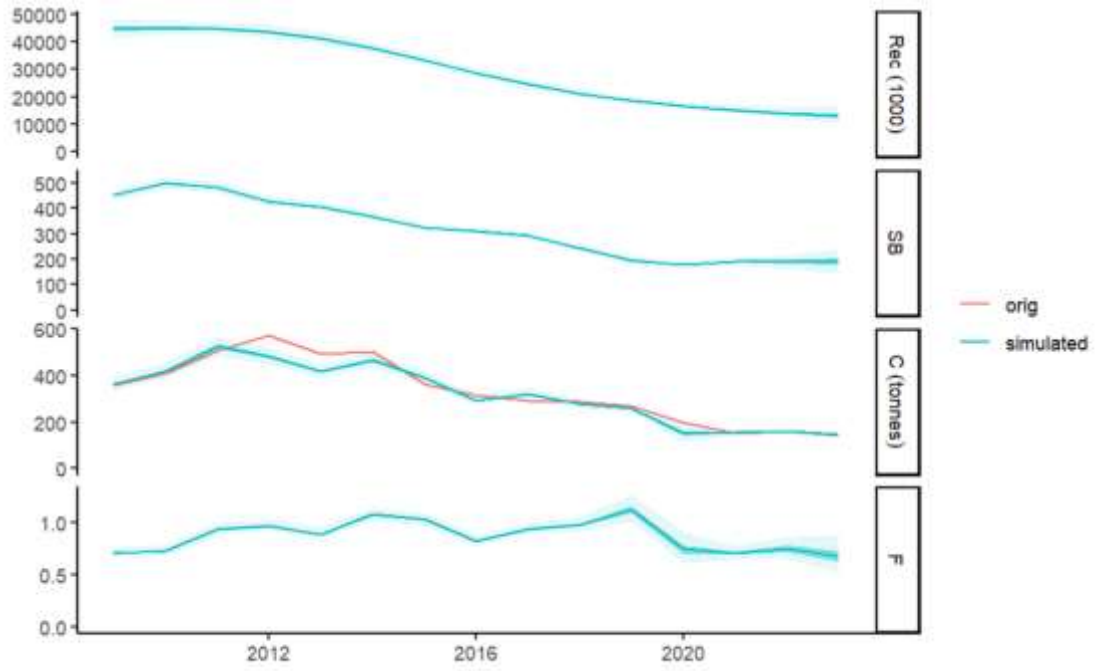


Figure 6.8.3.11. Norway lobster in GSA 6: Stock summary (Recruitment, SSB, catch and Fishing mortality) and 90% confidence intervals for the period 2009 to 2023.

6.8.4. REFERENCE POINTS

The reference points for the EWG24-10 were determined based on the recommendations established during the STECF 24-02 meeting, where it was decided to use the reference point Fmax instead of F0.1 for NEP in GSA 6. However, upon comparison, it has been observed that the estimated values for biomass are lower than that estimated in the previous assessment (table 6.8.4.1).

Table 6.8.3.8. Norway lobster in GSA 6: comparison of final reference points based on Geometric Mean stock-recruitment model fitted to the data.

	EWG22-09	**EWG23-09**
$F_{0.1}$	0.165	0.166
B_{Lim}	472	405

B_{pa}	944	809
$B_{F0.1}$	1890	1620
B_0	5390	4660
F_{pa}	0.324	0.32

	EWG24-10
F_{max}	0.29
B_{Lim}	238
B_{pa}	477
B_{Fmax}	953
B_0	4572
F_{pa}	0.11

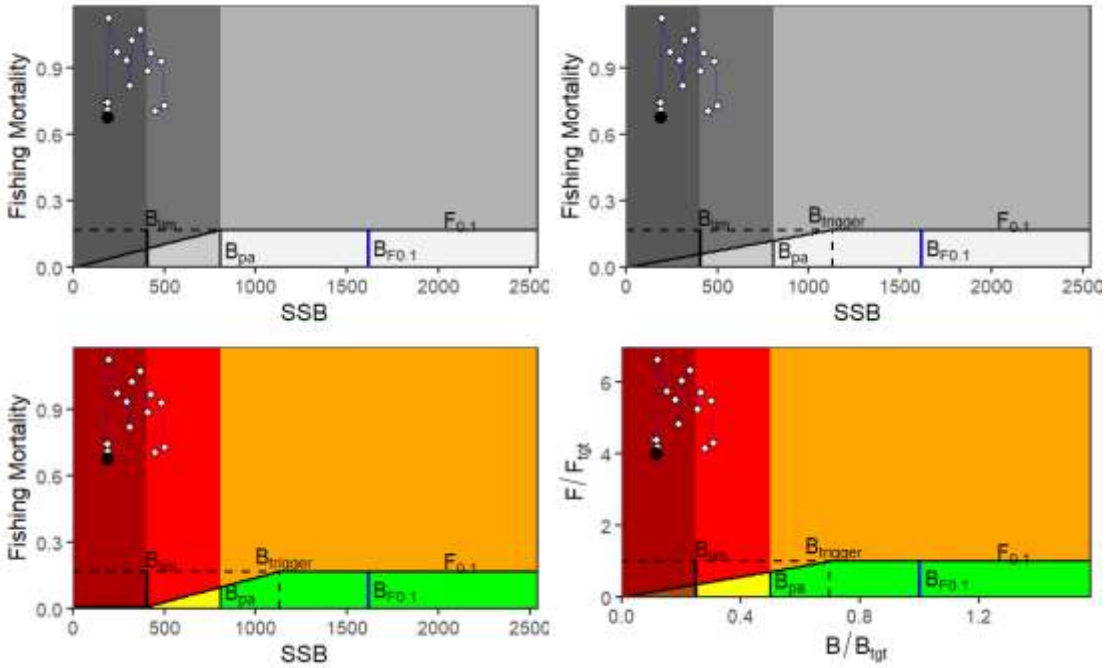


Figure 6.8.3.1. Norway lobster in GSA 6: advice rule plots for the geometric mean model

6.8.5. SHORT-TERM FORECAST AND CATCH OPTIONS

A deterministic short-term prediction for the period 2024 to 2025 was performed using the FLR libraries and scripts provided to the EWG and based on the results of the NEP GSA 6 stock assessment results in section 6.8.3.

For stock mean weight, maturity, natural mortality, and selection pattern an average of the last three years was used. Recruitment was observed to be decreasing over the entire period. Hence, a geometric mean of the estimated recruitment for the last three years was considered (2020 to 2023), corresponding to a value of 14012 x 10^3 individuals. The Fsq was taken as the Fbar(3-6) for the last year, given the decreasing pattern observed in F, Fsq = 0.68.

Table 6.8.5.1. Norway lobster in GSA 6: Assumptions made for the interim year in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 3-6 (2024)	0.68	Fsq = F in the last year
SSB (2024)	188.02	SSB intermediate year from STF output
Rage2 (2024 - 2025)	14 011.68	Recruitment will be set as geometric mean of the last 3 years
Total Catch (2024)	144.95	Catch intermediate year from STF output
Fbar (2019)	1.12	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Rationale	Ffactor	Fbar	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	0.43	0.29	147.56	144.95	74.31	188.02	301.19	60.19	-49.64
F upper	0.59	0.40	147.56	144.95	97.46	188.02	263.99	40.41	-33.96
F lower	0.29	0.19	147.56	144.95	52.02	188.02	338.97	80.29	-64.74
FMSY transition	0.43	0.29	147.56	144.95	74.31	188.02	301.19	60.19	-49.64
F/Catch_option	0.17	0.11	147.56	144.95	31.80	188.02	374.85	99.37	-78.45
Zero catch	0.00	0.00	147.56	144.95	0.00	188.02	434.27	130.97	-100.00
Status quo	1.00	0.68	147.56	144.95	146.81	188.02	191.91	2.07	-0.51
Different Scenarios	0.10	0.07	147.56	144.95	19.18	188.02	398.00	111.68	-87.00
	0.20	0.14	147.56	144.95	37.17	188.02	365.18	94.23	-74.81
	0.30	0.20	147.56	144.95	54.04	188.02	335.47	78.42	-63.37
	0.40	0.27	147.56	144.95	69.89	188.02	308.54	64.10	-52.64
	0.50	0.34	147.56	144.95	84.76	188.02	284.14	51.12	-42.56
	0.60	0.41	147.56	144.95	98.74	188.02	261.99	39.34	-33.09
	0.70	0.47	147.56	144.95	111.88	188.02	241.89	28.65	-24.18
	0.80	0.54	147.56	144.95	124.23	188.02	223.62	18.94	-15.81
	0.90	0.61	147.56	144.95	135.86	188.02	207.02	10.11	-7.93
	1.10	0.74	147.56	144.95	157.12	188.02	178.16	-5.24	6.48
	1.20	0.81	147.56	144.95	166.84	188.02	165.63	-11.91	13.07
	1.30	0.88	147.56	144.95	176.01	188.02	154.20	-17.99	19.28
	1.40	0.95	147.56	144.95	184.66	188.02	143.77	-23.53	25.14
	1.50	1.01	147.56	144.95	192.83	188.02	134.24	-28.60	30.68
	1.60	1.08	147.56	144.95	200.54	188.02	125.53	-33.24	35.90
	1.70	1.15	147.56	144.95	207.83	188.02	117.56	-37.47	40.85

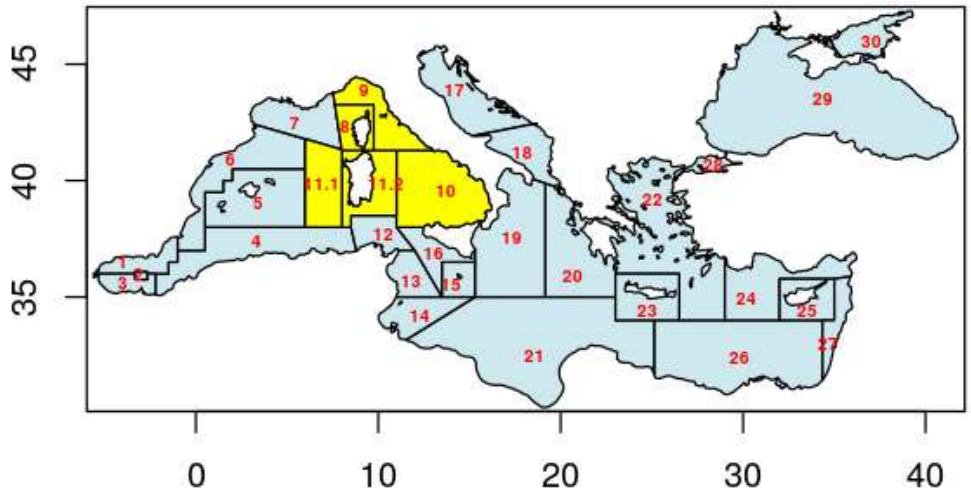
	1.80	1.22	147.56	144.95	214.73	188.02	110.26	-41.36	45.52
	1.90	1.29	147.56	144.95	221.26	188.02	103.56	-44.92	49.94
	2.00	1.35	147.56	144.95	227.44	188.02	97.42	-48.18	54.13

6.9 HAKE IN GSA 8, 9, 10 AND 11

6.9.1 STOCK IDENTITY AND BIOLOGY

The assessment of European hake carried out during the STECF EWG 21-11 considered the stock shared by the GSAs 8, 9, 10 and 11, as agreed during the GFCM Benchmark Session on Hake in the Mediterranean, held in dicember 2019.

Figure 6.9.1.1. **European hake in GSAs 8, 9, 10 & 11.** Map of the stock unit.



Source: Own elaborations

Hake is distributed in the whole area between 10 and 800 m depth (Biagi et al., 2002; Colloca et al., 2003). Recruits peak in abundance between 150 and 250 m depth over the continental shelf-break and appear to move slightly deeper when they reach 10 cm total length. Crinoid (Leptometra phalangium) beds over the shelf-break are the main settlement habitat for hake in the area (Colloca et al., 2004, 2009). Migration from nurseries takes place when juveniles attained a critical size between 13 and 15.5 cm TL (Bartolino et al., 2008a, 2008b). Maturing hakes (15-35 cm TL) persist on the continental shelf with a preference for water of 70-100 m depth, while larger hakes can be found in a larger depth range from the shelf to the upper slope. Juveniles show a patchy distribution with some main density hot spots (i.e. nurseries areas) showing a high spatio-temporal persistence (Abella et al., 2005; Colloca et al., 2009) as also highlighted by the MEDISEH project in areas with frontal systems and other oceanographic structures that can enhance larval transport and retention (Abella et al., 2008). Although hake are demersal fish feeding typically upon fast-moving pelagic preys while ambushed in the water column (Alheit and Pitcher, 1995), there is evidence that hake feed in mid-water or at the surface during night-time, undertaking daily vertical migrations (Orsi-Relini et al., 1989, Carpentieri et al., 2008) which are more intense for juveniles. In GSA 9, many different studies are available on hake diet. Results from stomach data collected in the 1996-2001 period can be found in Sartor et al. (2003) and Carpentieri et al. (2005). Hake diet shifts from euphausids and mysiids consumed by smaller hake (<16 cm TL), to fishes consumed by larger hake.

Before the transition to the complete ichthyophagous phase (TL> 36 cm), hake show more generalized feeding habits where decapods, benthic (Gobiidae, Callionymus spp.,) and

necktonic fish (S. pilchardus, E. encrasicolus) dominated the diet, whereas cephalopods had a lower incidence.
Estimation of cannibalism rate has been provided for the southern part of the GSA (Latium, EU Because project). Cannibalism increased with size and can be considered significant for hakes between 30 and 40 cm TL (up to 20% by weight in diet) and seems to relate closely to hake recruitment density and level of spatial overlapping.
Consumption rate has been estimated for juveniles and piscivorous hakes. Daily consumption of juveniles, calculated in proportion of body weight (%BW), varied between 5 (July) and 5.9 % BW (Carpentieri et al., 2008). The estimated relative daily consumption for hake between 14 and 40 cm TL, using a bioenergetic approach (EU Because project), was between 2.9 and 2.3 BW%.
In GSA 10, European hake ranks among the species with highest abundance indices in the trawl surveys (e.g. Spedicato and Lembo, 2011). It is a long lived fish mainly exploited by trawlers, especially on the continental shelves of the Gulfs (e.g. Gaeta, Salerno, Palermo) but also by artisanal fishers using fixed gears (gillnets, bottom long-line).
Trawl-survey data have evidenced highest biomass indices on the continental shelf of the GSA 10 (100-200 m; Spedicato and Lembo, 2011), where juveniles (less than 12 cm total length) are mainly concentrated. During autumn trawl surveys, one of the main recruitment pulses of this species is observed. Two main recruitment events (in spring and autumn; Spedicato and Lembo, 2011) are reported in GSA 10 as for other Mediterranean areas. European hake is considered fully recruited to the bottom at 10 cm TL (from SAMED, 2002). The length structures from trawl surveys are generally dominated by juveniles, while large size individuals are rare. This pattern might be also due to the different vulnerability of older fish beside the effect of high exploitation rates. The few large European hake caught during trawl surveys are generally females and inhabit deeper waters. The overall sex ratio (~0.41-0.47) estimated from trawl survey data is slightly skewed towards males. The size at first maturity for females was recently estimated by Carbonara et. al. (2019) at 33 cm, with a maturity range of 2.55 cm, and is in line with previous studies in the area (Recasens et al., 2008).
In GSA 11, hake is distributed in the whole area between 10 and 800 m depth. Recruits peak in abundance over the continental shelf-break (between 150 and 250 m depth). The stock is mainly exploited by the local fishing fleet, although seasonally and occasionally some other Italian fleet use to fish in some areas of the GSA 11. Spawning is taking place almost all year round, with a peak during winter–spring.
Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence (Murenu et al., 2010) in western areas.
In GSA 8, hake is distributed along the narrow shelf and slope at depths up to 1000 m, but is mainly concentrated in the depth range 0-400 m. There is not any evidence that inside GSA8 boundaries inhabits a single, homogeneous hake stock that behaves as a single well-mixed and self-perpetuating population. The GSA boundaries are, as for other areas, arbitrary and do not consider neither the existence of local biological features nor differences in the spatial allocation in fishing pressure within it. It is likely some connectivity exists as larval drifts, movements of individuals and sharing of spawning areas in particular with GSA9, 10 and 11.

Growth parameters and length-weight parameters were those used for the assessment carried out during the benchmark meeting in 2019 and the followings (Table 6.9.1.1).

Table 6.9.1.1. **European hake in GSAs 8, 9, 10 & 11.** VBGF parameters used in the assessment.

GSAs	Sex	L_∞	k	t_0	Source	Notes

9, 10, 11	M	60.00	0.265	-0.06	Otolith reading	Benchmark data preparation
	F	95.00	0.16	-0.06	Otolith reading	Benchmark data preparation

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Length-weight relationship parameters were estimated by sex as the average of those available in GSAs 9, 10, 11 under EU DCR/DCF (Table 6.9.1.2). No biological data are available for hake in GSA 8.

Table 6.9.1.2. European hake in GSAs 8, 9, 10 & 11. Length-weight relationship parameters used in the assessment.

GSAs	Sex	a	b
8, 9, 10, 11	M	0.004645	3.133
	F	0.005009	3.107705

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Using the selected VBGF parameters, a combined vector of proportion of matures-at-age was estimated starting from the vectors of maturity-at-length available under the EU DCR/DCF. The maturity vector used for the assessment carried out during the benchmark session is shown in Table 6.9.1.3.

Table 6.9.1.3. European hake in GSAs 8, 9, 10 & 11. Maturity vector used in the assessment.

Age	0	1	2	3	4	5	6	7+
Mat-at-age	0.00	0.25	0.80	1.00	1.00	1.00	1.00	1.00

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

During the benchmark meeting, the selected VBGF and LW relationship parameters were used to estimate a range of natural mortality (M) vectors using different models and empirical formulas, and their mean was used as final M vector. The combined M vector used for the assessment is shown in Table 6.9.1.4.

Table 6.9.1.4. European hake in GSAs 8, 9, 10 & 11. Natural mortality vector combined by sex used in the assessment.

Age	0	1	2	3	4	5	6	7+
M	1.85	0.80	0.48	0.37	0.30	0.27	0.24	0.22

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.9.2 DATA

6.9.2.1 CATCH (LANDINGS AND DISCARDS)

European hake is one of the main target species in terms of landings, incomes and vessel involved in the area. In GSAs 9 and 10, it is mainly exploited by trawlers on the shelf and slope, but also by small-scale fisheries using set nets (gillnets and trammel nets) and bottom long-lines. In GSA 11, although hake is not target of a specific fishery, it is one of the most important species in terms of biomass landed. It is caught exclusively by a mixed bottom trawl fishery that operates at depth between 50 and 800 m. No gillnet or longline fleets target this species, but it can be find as by catch of gillnet fleets targeting other species. In Corsica (GSA 8), six trawlers are active and their average length is 15 m, these ships operate with bottom trawls with panels (OTB) and are targeting demersal species (Norway lobster, striped red mullet, deep-water rose shrimp, etc.) including some very few catches of hake (average 8.2 t per year on the period 2015-2017). Even though small-scale fisheries are quite important along the coasts, fishers target other resources such as lobster, finfish living on hard bottoms. There are no available data for the size structure of the landings of hake, since it is not a target species of trawlers and it is mainly absent from other gears catches (very few catches from gillnetters). Moreover, it is important to notice that trawlers can only work on the eastern part of Corsica since the western part is characterized by a very narrow continental shelf and steep slopes.

Landings and discards

Landings data were reported to STECF EWG 24-10 through the DCF. In GSAs 9, 10 and 11, most of the landings come from otter trawls. The contribution of set nets to the total landing is around the 30% in GSAs 9 and 10; longlines in GSA 10 contribute for around the 13% to the total landing. In GSA 11 landing data come exclusively from the bottom trawl fishery. In GSA8, landings are very low in all the years where data are available (2009-2021) and the discards are not reported. Reconstructed data were estimated from 2005 to 2008, considering an average of the available information.
In addition, discards were not available in GSA 9, 10 and 11 for some years, therefore they were estimated using an average proportion between landings and discards computed on the available years.
Landings and discards by GSA, total landings and discards and total catches used in the assessment are shown in Table 6.9.2.1.1; the estimated values are highlihted in red.

Table 6.9.2.1.1. **European hake in GSAs 8, 9, 10, 11.** Landings and discards data in the four GSAs. Values highlighted in red were missing, and re-estimated from adjacent years.

	GSA8	GSA9		GSA10		GSA11		Total		
Year	Landings	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Total catches
2005	**15.00**	1859.98	**348.30**	1484.74	**66.70**	928.02	160.02	4287.74	575.02	4862.77
2006	**15.00**	2176.49	105.20	1544.07	26.57	341.06	595.48	4076.62	727.25	4803.87
2007	**15.00**	1733.03	**338.74**	1268.66	**69.84**	169.58	**106.57**	3186.27	515.15	3701.42
2008	**15.00**	1321.13	**302.32**	1122.85	**54.57**	138.77	**87.20**	2597.75	444.09	3041.84
2009	15.10	1308.47	697.27	1090.51	99.78	260.54	106.87	2674.62	903.92	3578.54

2010	12.59	1467.11	116.41	1329.45	68.06	175.88	164.79	2985.03	349.26	3334.29
2011	**13.24**	1351.74	527.79	1278.52	54.93	277.42	268.67	2920.92	851.39	3772.31
2012	17.68	1011.52	174.23	1107.24	117.90	263.45	16.72	2399.89	308.85	2708.74
2013	2.98	1341.63	242.43	1052.19	35.63	267.37	32.27	2664.17	310.33	2974.50
2014	12.86	1264.95	285.84	1271.11	17.00	258.65	13.46	2807.57	316.30	3123.87
2015	11.77	1047.70	231.04	1043.44	29.71	326.23	102.85	2429.14	363.60	2792.74
2016	34.49	782.25	305.13	1051.95	28.38	339.38	102.29	2208.06	435.80	2643.86
2017	13.54	572.37	75.68	870.43	3.18	357.29	212.34	1813.63	291.20	2104.83
2018	19.79	605.35	114.35	821.02	0.18	392.81	166.70	1838.97	281.23	2120.20
2019	17.14	722.26	199.60	765.17	0.37	445.53	45.99	1950.10	245.96	2196.06
2020	19.01	507.82	104.94	**933.24**	6.00	248.39	19.10	1708.46	130.04	1838.50
2021	18.58	455.40	189.15	886.82	0	211.98	12.20	1572.78	201.35	1774.13
2022	14.06	391.06	244.86	602.51	0	237.12	17.34	1244.75	262.20	1506.96
2023	13.41	568.59	155.24	568.91	9.24	179.50	4.17	1330.40	168.64	1499.04

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

In addition to the landings reported by the countries corresponding to each GSA, DCF provided the amount of landings coming from countries corresponding to other GSAs, but exploiting the resources in neighbouring GSAs (Tab. 6.9.2.1.2); these data were included in the assessment.

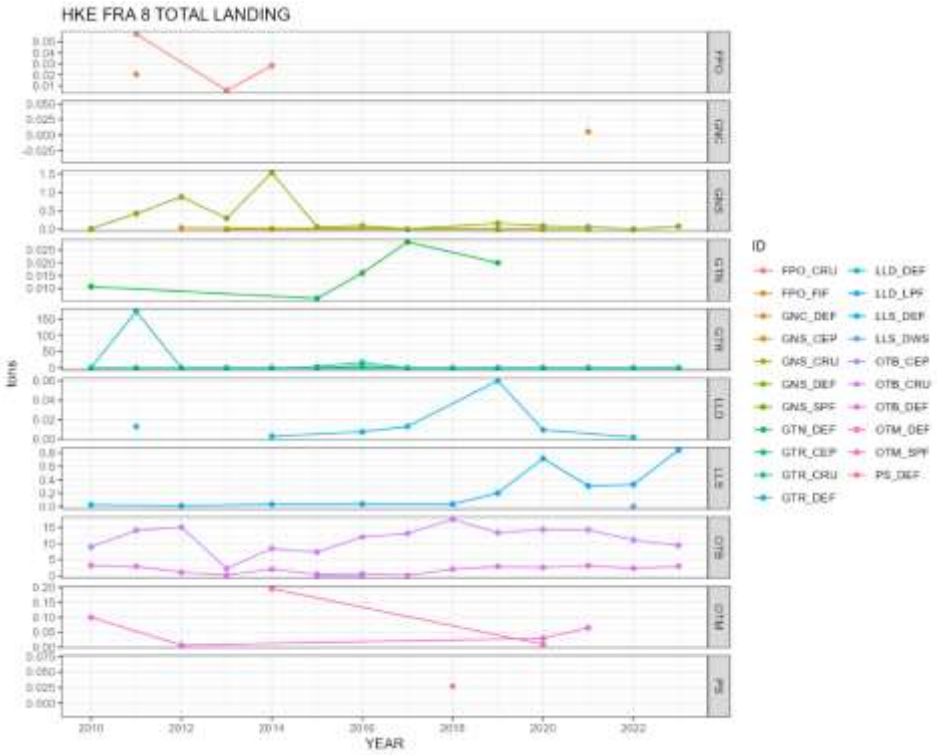
Table 6.9.2.1.2. **European hake in GSAs 8, 9, 10, 11.** Landings data (tons) coming from countries not included in the reference GSA.

	ITA	MLT	MLT	ESP
Year	GSA 8	GSA 8	GSA 9	GSA 9
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				
2014				
2015				
2016				
2017				
2018				
2019				
2020	0.18			0.09
2021	1.58	0.04	0.23	
2022	1.33		0.03	0.05
2023	1.31			

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Landing and discard data by year and fishing gear are presented in Figures 6.9.2.1.1-6.9.2.1.7, while length-frequency distributions of landings and discards by GSA, year and fishing gear are shown in Figures 6.9.2.1.8-6.9.2.1.14.

Figure 6.9.2.1.1. **European hake in GSAs 8, 9, 10 & 11.** Landings data in tons by year and fleet in GSA 8.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.9.2.1.2. European hake in GSAs 8, 9, 10 & 11. Landings data in tons by year and fleet in GSA 9.

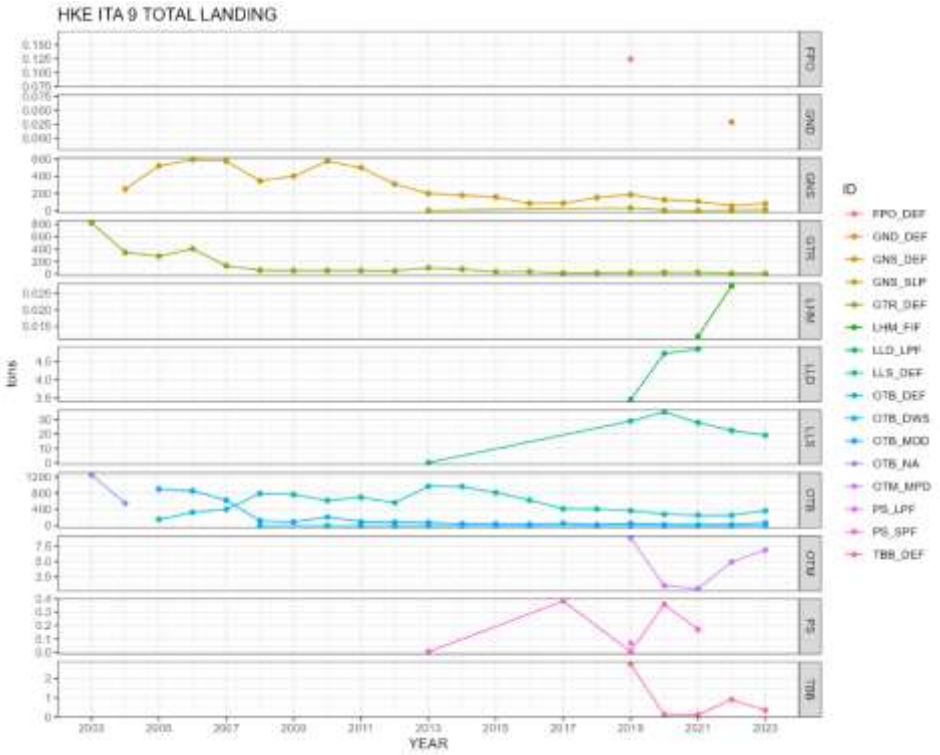


Figure 6.9.2.1.3. European hake in GSAs 8, 9, 10 & 11. Landings data in tons by year and fleet in GSA 10.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

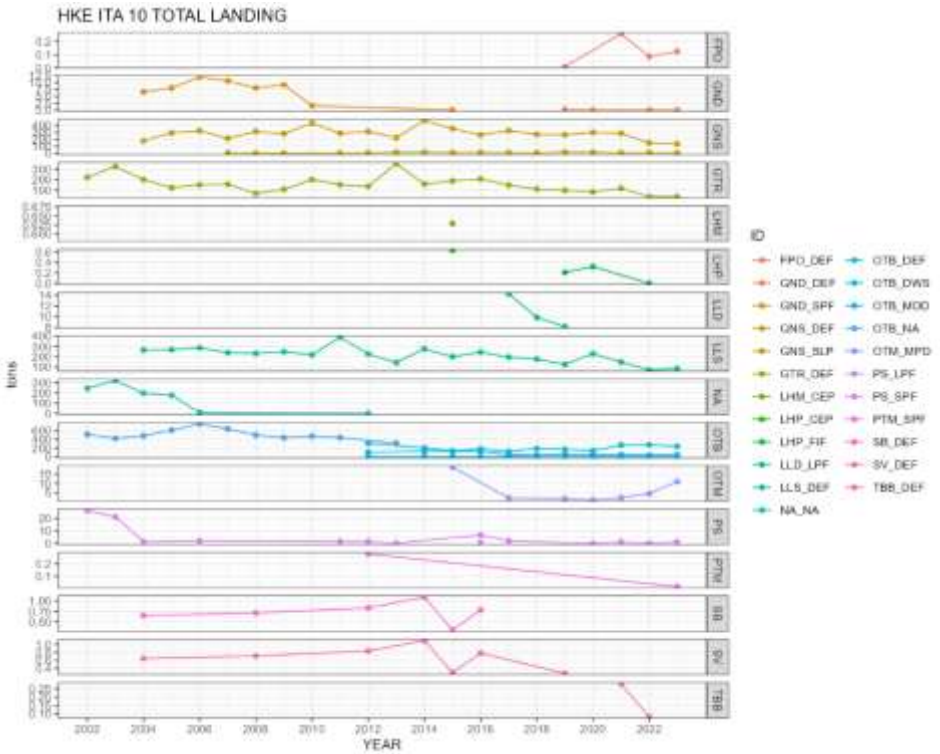


Figure 6.9.2.1.4. European hake in GSAs 8, 9, 10 & 11. Landings data in tons by year and fleet in GSA 11.

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

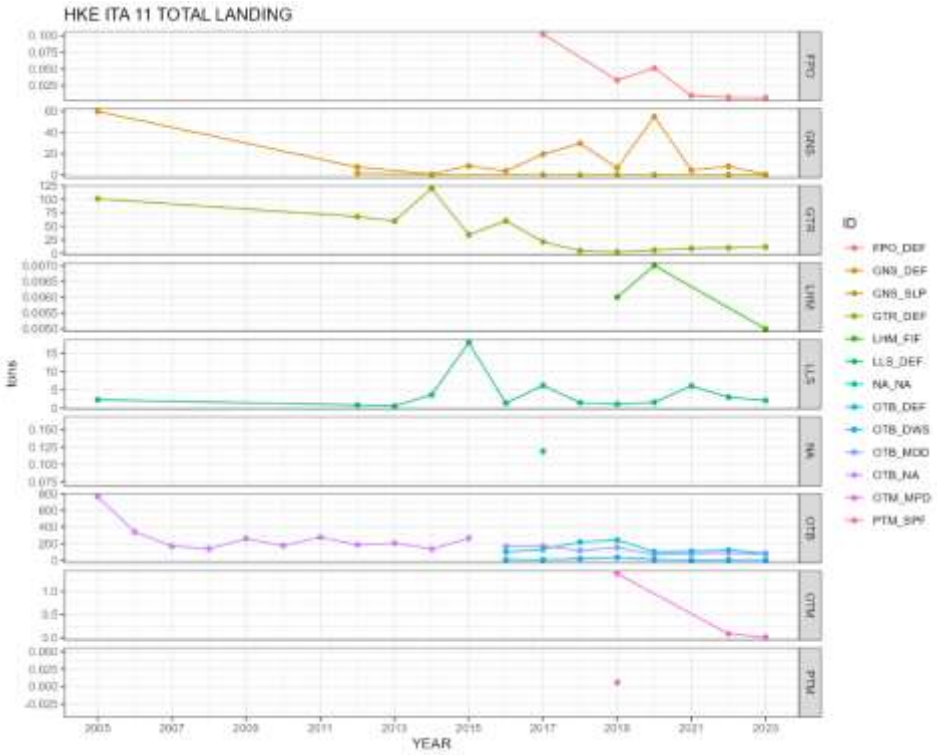


Figure 6.9.2.1.5. European hake in GSAs 8, 9, 10 & 11. Discards data in tons by year and fleet in GSA 9.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

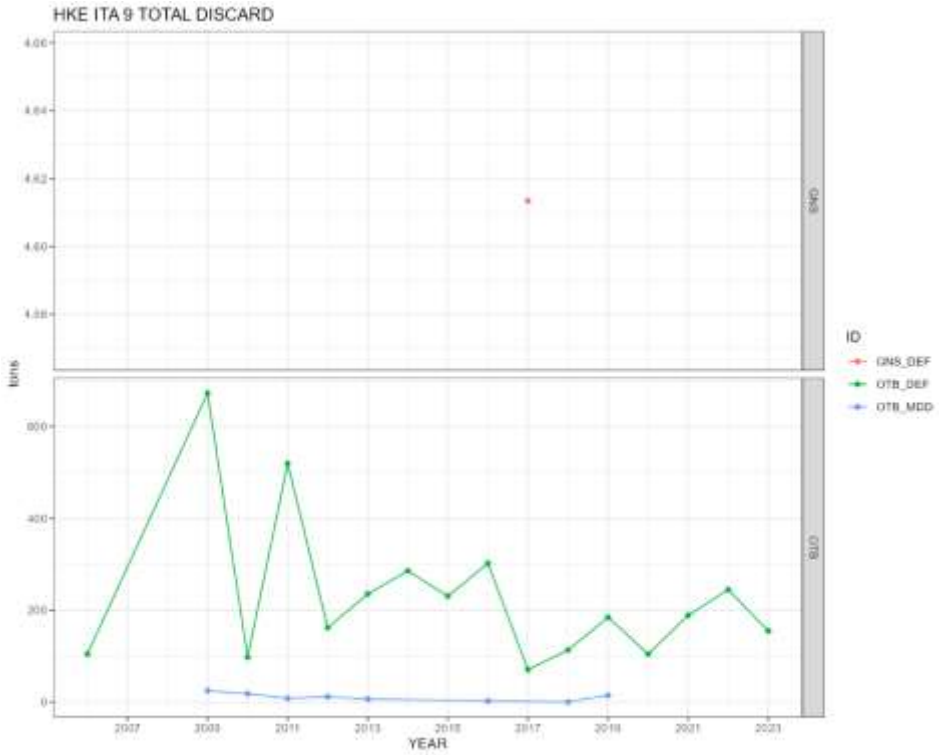


Figure 6.9.2.1.6. European hake in GSAs 8, 9, 10 & 11. Discards data in tons by year and fleet in GSA 10.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

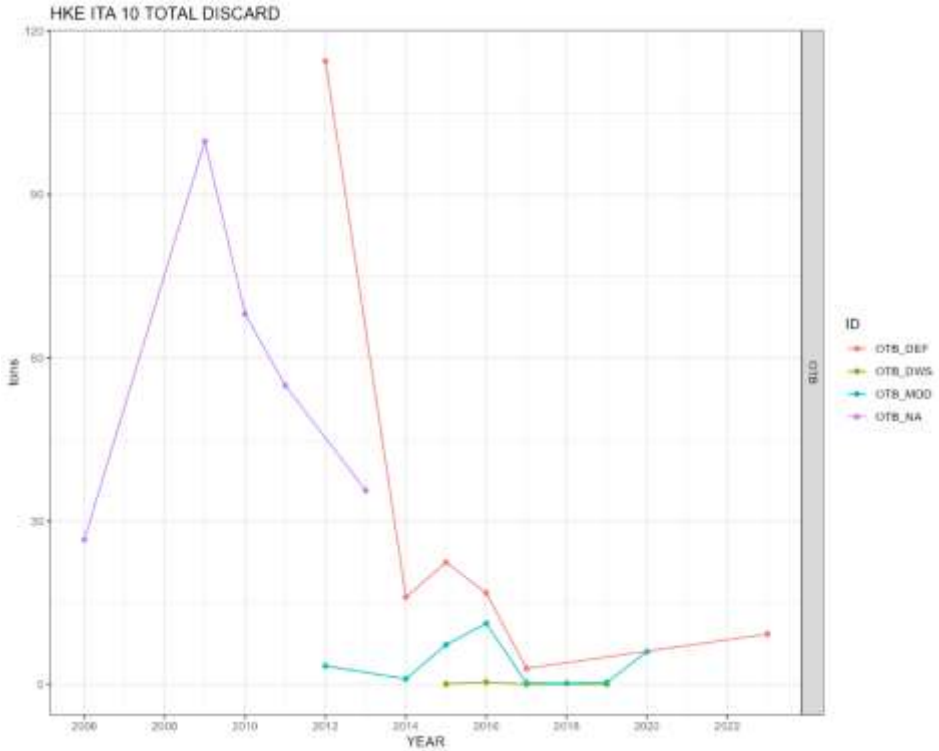


Figure 6.9.2.1.7. European hake in GSAs 8, 9, 10 & 11. Discards data in tons by year and fleet in GSA 11.

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

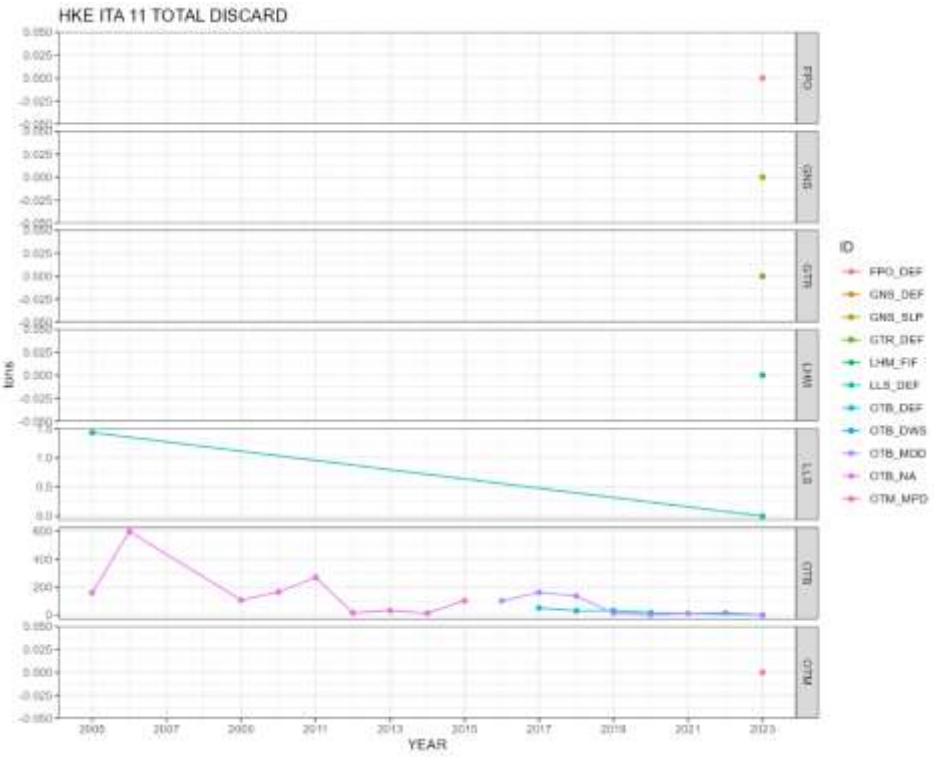
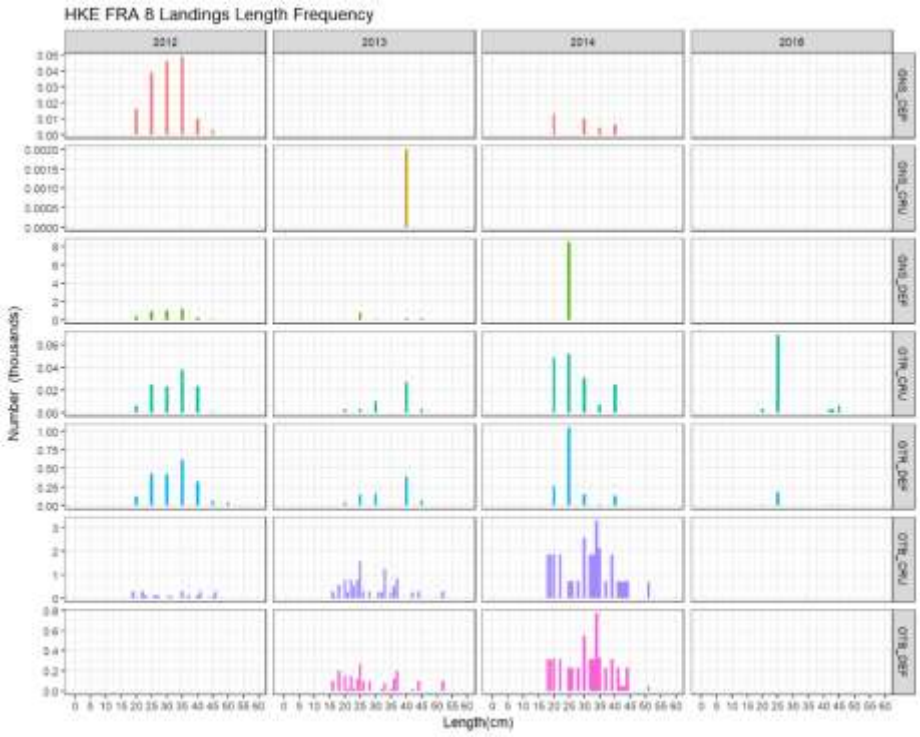


Figure 6.9.2.1.8. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the landings by year and fleet in GSA 8.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)



9.

Figure 6.9.2.1.9. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the landings by year and fleet in GSA 9.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

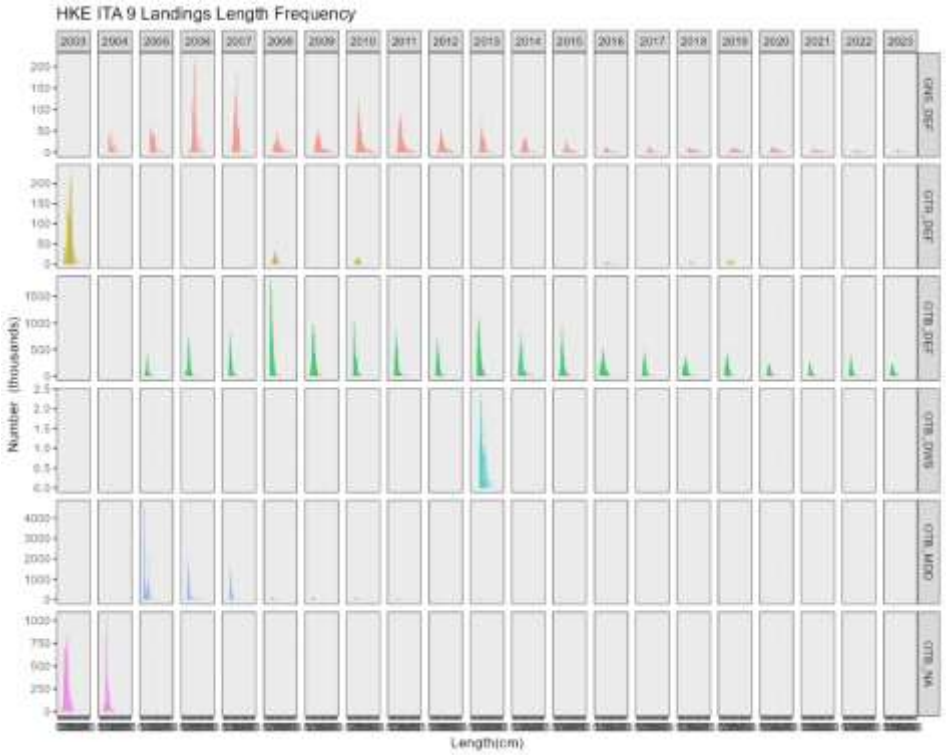


Figure 6.9.2.1.10. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the landings by year and fleet in GSA 10.

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

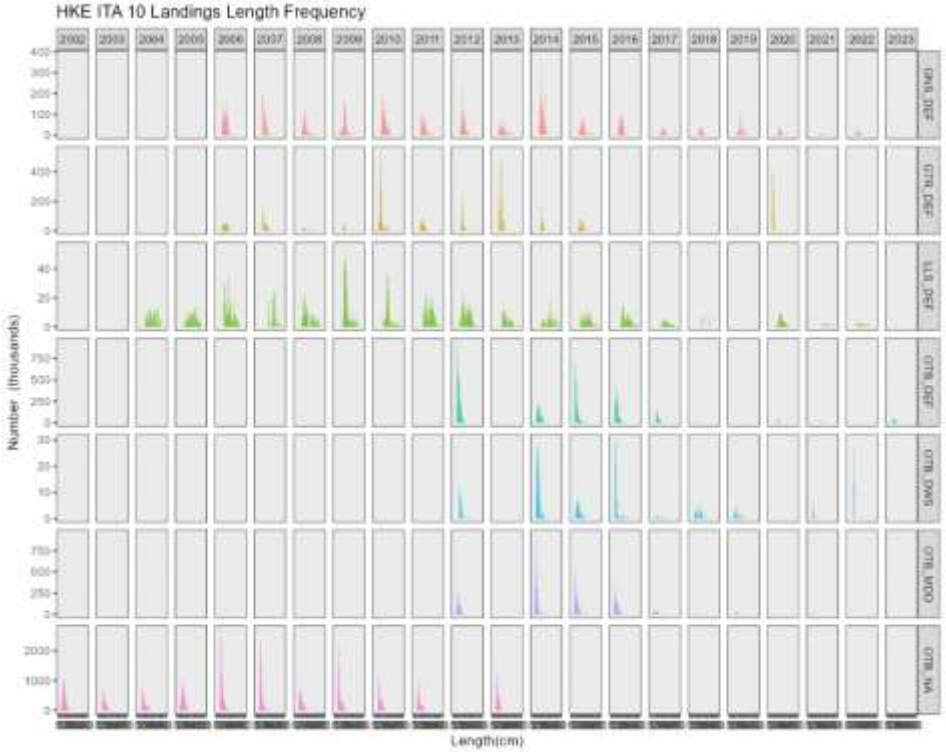


Figure 6.9.2.1.11. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the landings by year and fleet in GSA 11.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

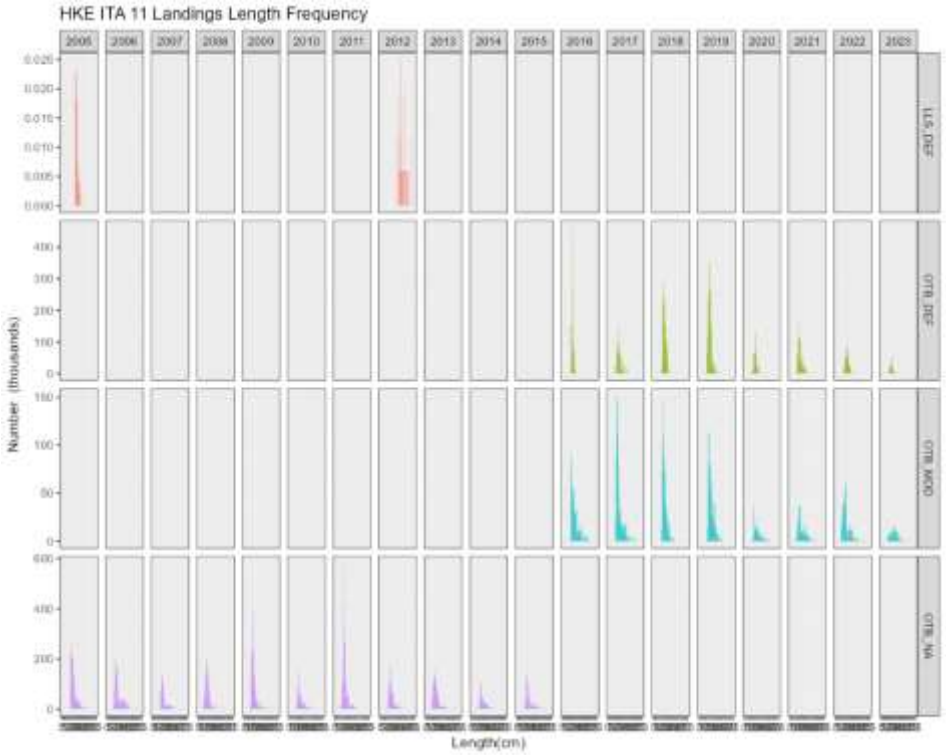


Figure 6.9.2.1.12. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the discards by year and fleet in GSA 9.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

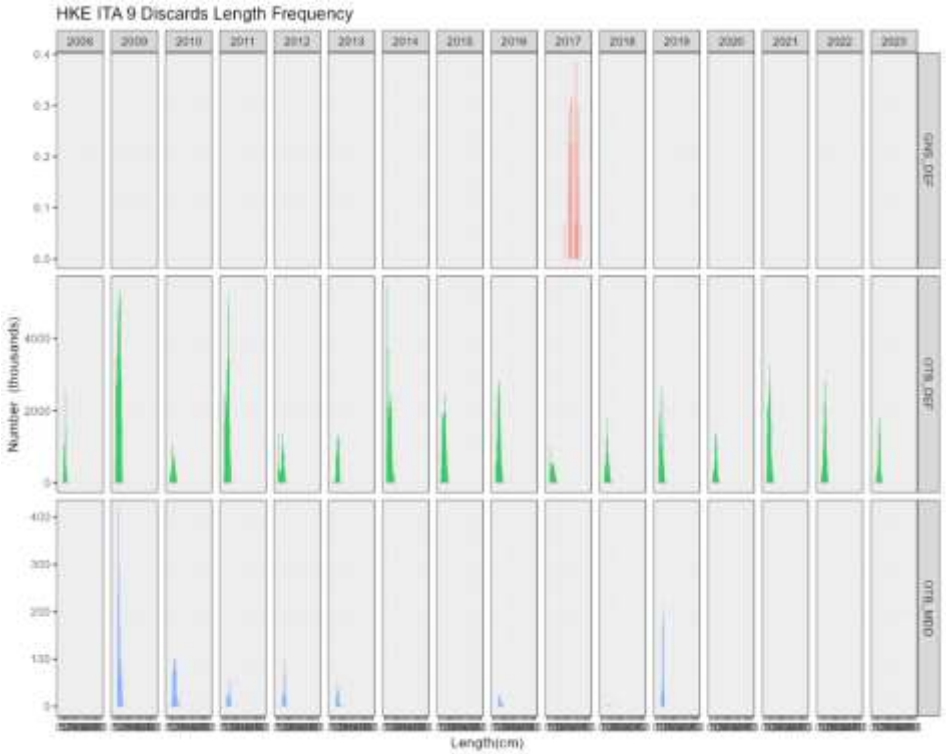


Figure 6.9.2.1.13. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the discards by year and fleet in GSA 10.
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

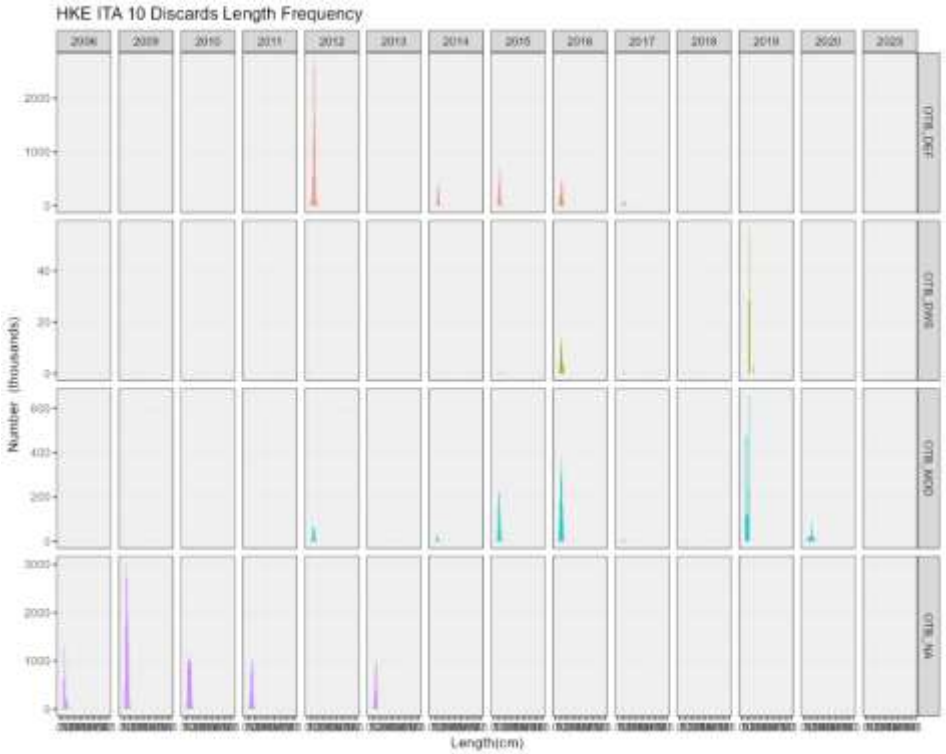
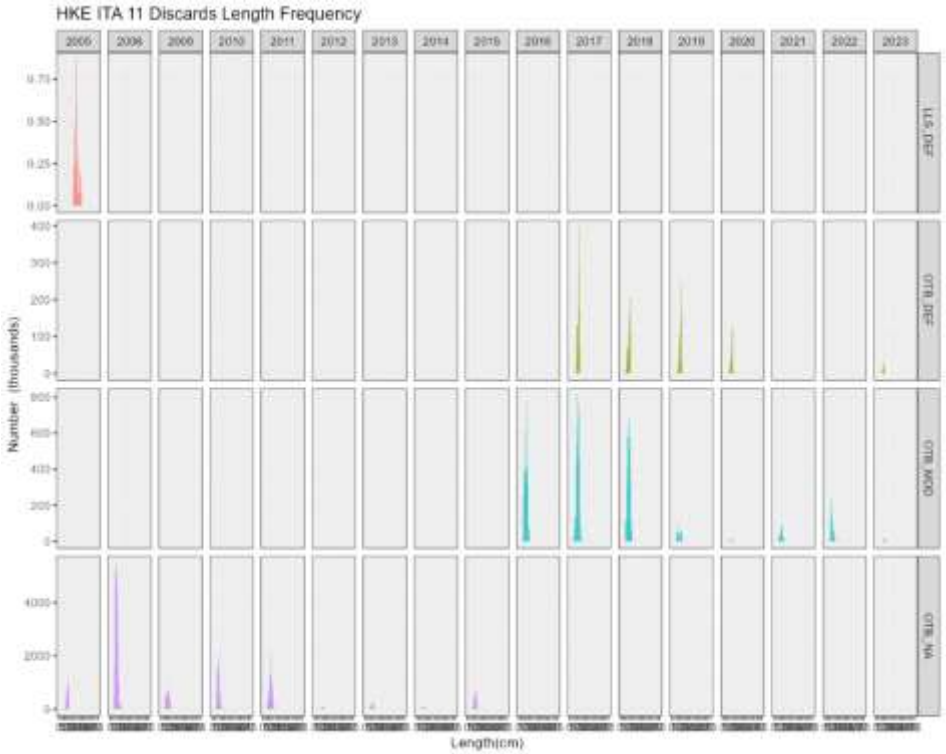


Figure 6.9.2.1.14. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution of the discards by year and fleet in GSA 11.

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)



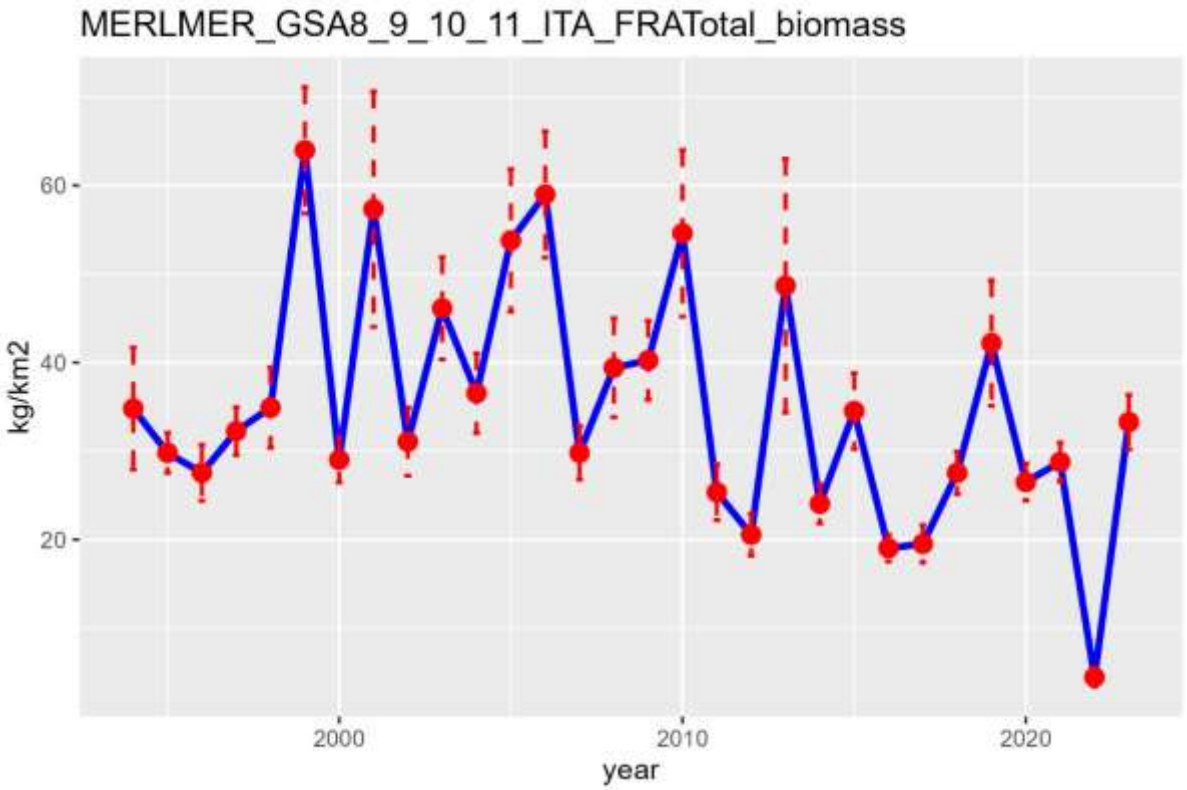
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.9.2.2 EFFORT

6.9.2.3 SURVEY DATA

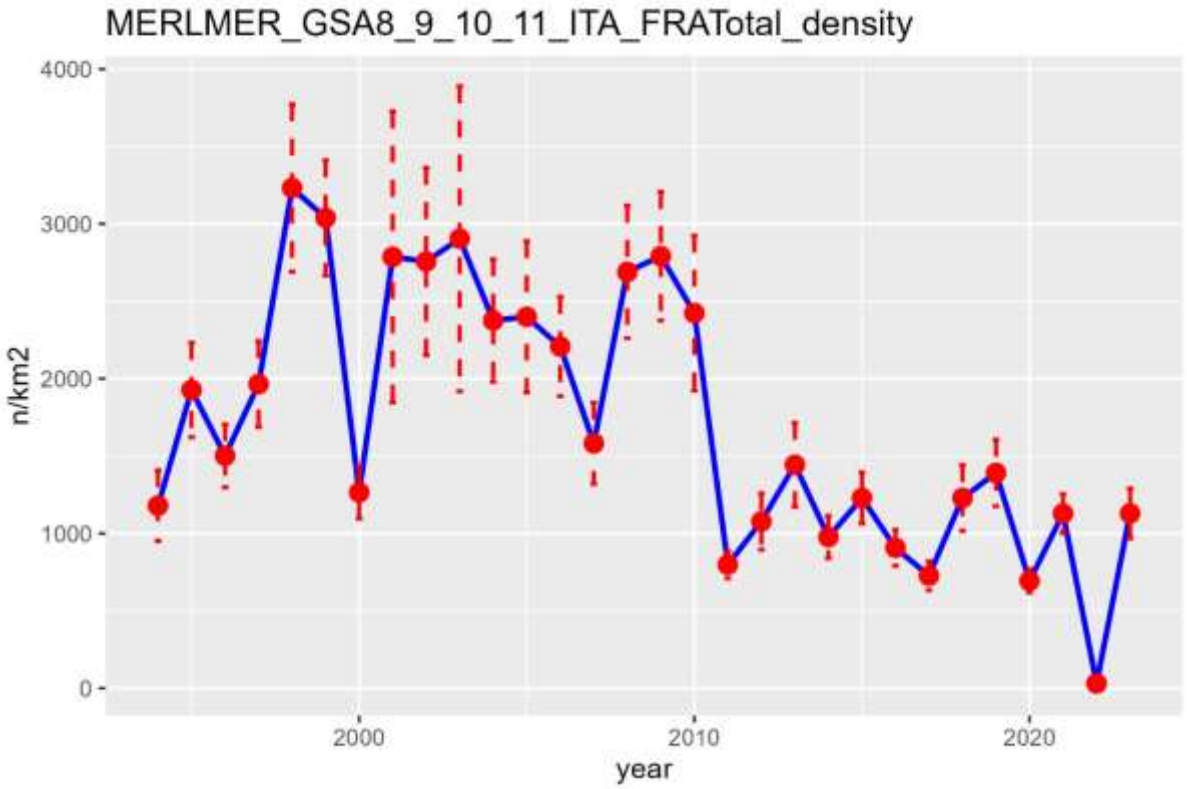
The MEDITS (MEDiterranean International Trawl Survey) survey is an extensive trawl survey occurring in all European countries and included in the Data Collection Framework. According to the MEDITS protocol (Bertrand et al., 2002), it takes places every year during springtime, following a random stratified 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 maintained fixed throughout the time. Same sampling gear (GOC73), characterized by a 20 mm stretched mesh size cod-end, is used throughout GSAs and years.
In the current assessment, combined MEDITS data for GSAs 8, 9, 10 and 11 from 2005 onwards were used, as commercial data were available for the three GSAs starting from that year. In 2022 the MEDITS survey was not carried out in Italy due to administrative problems, therefore the tuning index was set as NA in 2022.
The combined MEDITS indexes were calculated using the script provided by JRC (Figures 6.9.2.2.1 and 6.9.2.2.2).

Figure 6.9.2.2.1. European hake in GSAs 8, 9, 10 & 11. Estimated biomass indices from the MEDITS survey (kg/km^2).



Source: Own elaborations

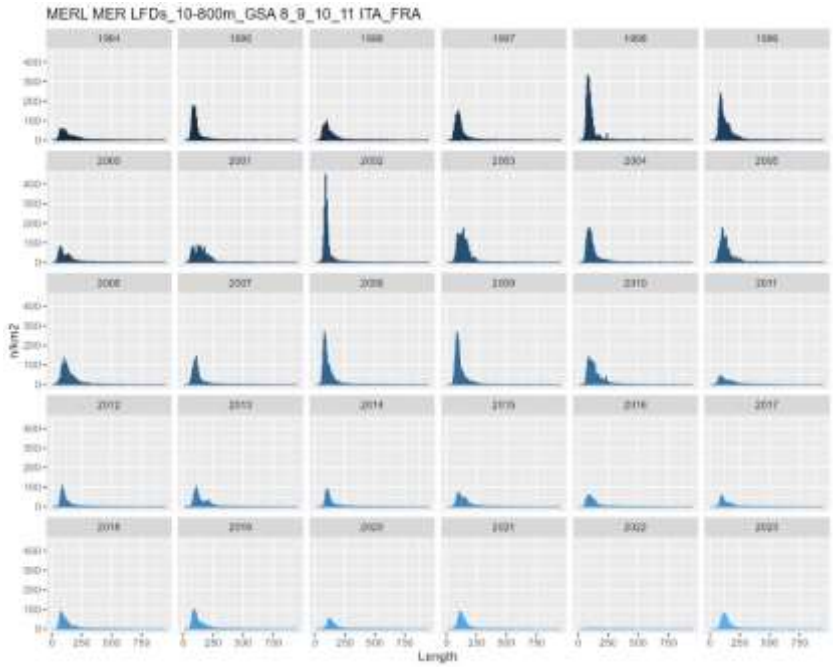
Figure 6.9.2.2.2. European hake in GSAs 8, 9, 10 & 11. Estimated density indices from the MEDITS survey (n/km^2).



Source: Own elaborations

Both estimated abundance and biomass indices show similar trends, with strong fluctuations throughout the time series, with a general decreasing trend from the beginning of the time series.
Size structure indices are shown in Figure 6.9.2.2.3.

Figure 6.9.2.2.3. European hake in GSAs 8, 9, 10 & 11. Length frequency distribution by year of MEDITS survey.



Source: Own elaborations

6.9.3 STOCK ASSESSMENT

A statistical catch-at-age assessment was carried out for this stock, using the Assessment for All Initiative (a4a) method (Jardim et al., 2015). The a4a method utilizes catch-at-age data to derive estimates of historical population size and fishing mortality. However, unlike XSA, model parameters estimated using catch-at-age analysis are done by working forward in time and analyses do not require the assumption that removals from the fishery are known without error. The assessment was carried out using the period 2005-2021 for catch data and tuning file. Both catch numbers at length and index number at length were sliced using the a4a age slicing routine in FLR, using for each GSA the corresponding growth parameters by sex. The analyses were carried out for the ages 0 to 7+. Concerning the Fbar, the age range used was age groups 1-3.

Input data
The growth parameters used for VBGF were the one reported in table 6.9.1.1.
Total catches and catch numbers at age from the single GSAs were used as input data. Catch numbers at age were corrected for SoP differences by yea (see below).

	SOP Landings			SOP Discards		
	GSA9	GSA10	GSA11	GSA9	GSA10	GSA11
2005	1.51	1.77	1.54	1.19	1.05	0.11
2006	1.31	1.04	0.73	1.19	1.05	1.09
2007	1.16	1.07	1.04	1.19	1.05	0.07
2008	1.06	1.07	1.04	1.19	1.08	1.62
2009	0.92	0.99	0.85	1.19	1.08	1.09
2010	1.04	0.98	0.79	1.18	1.04	1.09
2011	0.92	1.03	0.79	1.19	1.11	1.08
2012	0.99	0.97	1.4	1.17	1.08	1.08
2013	1.06	1.03	1.24	1.16	1.07	1.08
2014	0.9	0.99	1.8	1.2	1.08	1.08
2015	0.92	1.05	1.08	1.18	1.09	1.08
2016	0.91	1.28	1.01	1.18	1.07	1.08
2017	1.04	1.94	0.88	1.17	0.84	1.07
2018	0.92	4.03	0.88	1.08	5.95	1.08
2019	0.95	2.73	1.03	1.13	0.02	1.07
2020	1.01	3.6	1.71	1.15	0.02	1.07
2021	0.84	8.05	1.27	1.11		0.95
2022	0.85	5.6	1.37	1.08		1.04
2023	1.28	10.31	2.4			

Source: Own elaborations

Table 6.9.3.2 lists the input data for the a4a model, namely catches, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age.

Table 6.9.3.2. European hake in GSAs 9, 10 and 11. Input data for the a4a model.

Catches (t)

2005	4345.7
2006	4818.9
2007	3716.4
2008	3056.8
2009	3593.6
2010	3346.3
2011	3785.5
2012	2634.4
2013	2906.4
2014	2933.8
2015	2698.7
2016	2683.5
2017	2118.7
2018	2139.3

2019	2214.1
2020	1838.6
2021	1774.4
2022	1507
2023	1499

Source: Own elaborations

Catch numbers at age (thousands)

	0	1	2	3	4	5	6	7+
2005	64080	36024	3574	1002	222	323	71	45
2006	48934	41481	5471	1699	457	134	99	39
2007	45329	31929	3628	1324	191	96	50	29
2008	38497	24398	3422	677	239	118	70	60
2009	77199	28800	4542	719	159	117	46	61
2010	26396	20647	4461	1178	263	134	53	79
2011	46825	28922	4123	1011	343	153	64	81
2012	22431	17528	4038	723	222	114	46	31
2013	12757	24951	5024	643	178	70	31	26
2014	38829	13904	4987	971	299	105	31	49
2015	28331	16010	3605	893	247	139	46	35
2016	30184	18521	3284	756	202	106	46	49
2017	9055	14483	1896	826	270	114	50	39
2018	11201	11514	3149	938	172	128	25	14
2019	17336	10933	3371	892	295	69	29	16
2020	13153	5528	2882	851	218	62	20	13
2021	16918	4795	1256	996	324	72	66	28
2022	11381	7162	2116	458	133	57	39	10
2023	9307	8980	1751	328	125	52	42	28

Source: Own elaborations

Weights at age (Kg)

	0	1	2	3	4	5	6	7+
2005	0.009	0.052	0.178	0.453	0.768	1.269	1.742	2.329
2006	0.011	0.039	0.202	0.437	0.781	1.228	1.738	2.419
2007	0.010	0.048	0.198	0.437	0.765	1.278	1.702	2.582
2008	0.010	0.046	0.181	0.438	0.842	1.270	1.717	2.626
2009	0.009	0.044	0.185	0.410	0.821	1.325	1.753	2.634
2010	0.010	0.050	0.187	0.449	0.764	1.273	1.735	2.801
2011	0.010	0.044	0.193	0.424	0.850	1.280	1.743	2.569

2012	0.010	0.051	0.179	0.431	0.815	1.243	1.755	2.560
2013	0.013	0.049	0.178	0.414	0.828	1.305	1.742	2.664
2014	0.007	0.056	0.191	0.388	0.794	1.245	1.619	2.913
2015	0.009	0.050	0.195	0.427	0.801	1.336	1.687	2.662
2016	0.010	0.050	0.193	0.403	0.834	1.264	1.721	2.927
2017	0.008	0.053	0.186	0.456	0.794	1.250	1.736	2.604
2018	0.010	0.053	0.200	0.437	0.771	1.345	1.735	2.414
2019	0.009	0.057	0.193	0.432	0.823	1.225	1.669	2.291
2020	0.015	0.069	0.205	0.414	0.794	1.239	1.596	2.482
2021	0.015	0.061	0.223	0.434	0.765	1.152	1.759	2.667
2022	0.017	0.062	0.196	0.422	0.749	1.201	1.798	2.599
2023	0.017	0.062	0.179	0.440	0.844	1.242	1.890	2.478

Source: Own elaborations

Maturity vector

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
All years	0	0.25	0.8	1	1	1	1	1

Source: Own elaborations

Natural Mortality vector

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
All years	1.85	0.8	0.48	0.37	0.3	0.27	0.24	0.22

Source: Own elaborations

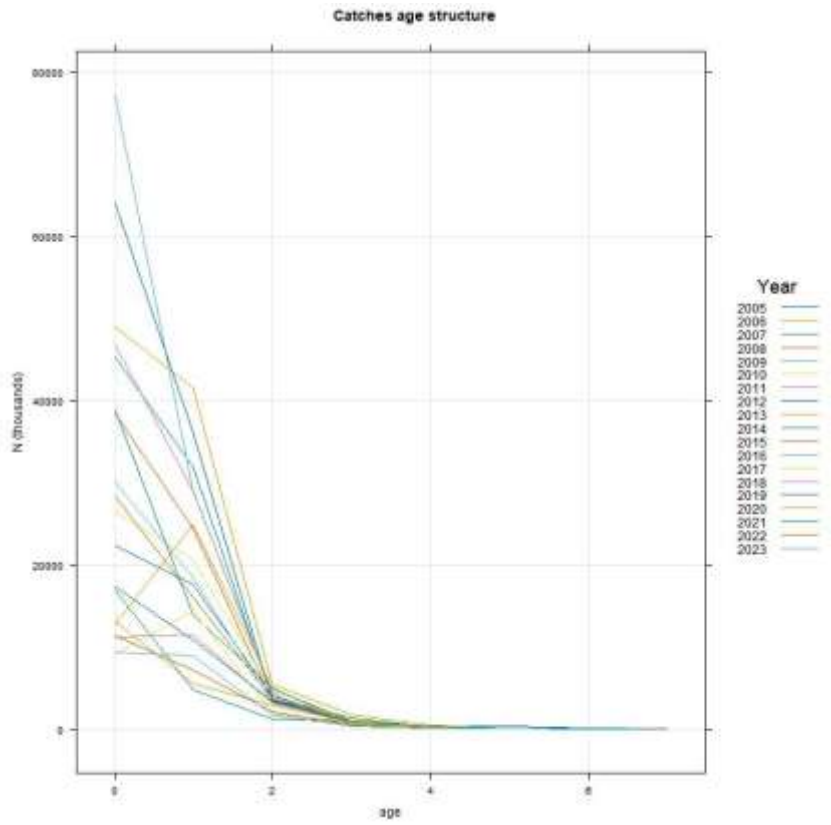
MEDITS numbers at age (n/km^2)

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2005	1726.4	598.4	62.4	10.9	0.5	0.3	0.0	0.2
2006	1455.6	650.9	84.3	11.6	2.8	2.4	0.1	0.1
2007	1342.1	205.0	26.1	6.3	1.9	0.6	0.4	0.1
2008	2327.3	335.3	20.8	3.7	0.7	0.4	1.5	0.2
2009	2353.1	406.7	26.9	1.6	0.5	0.5	0.1	0.2
2010	1688.9	638.0	85.6	9.0	1.8	0.3	0.1	0.2
2011	499.1	257.4	34.7	4.8	2.2	0.2	0.1	0.1
2012	885.2	169.1	19.6	2.3	0.5	0.3	0.1	0.2
2013	900.6	478.3	53.3	6.3	0.6	0.4	0.2	0.2
2014	778.8	164.3	28.2	3.6	0.9	0.5	0.2	0.2

2015	761.8	413.5	48.5	4.6	1.0	0.1	0.2	0.1
2016	727.8	156.2	19.4	2.7	0.8	0.3	0.2	0.2
2017	499.2	206.4	15.7	2.0	0.5	0.6	0.2	0.3
2018	958.0	236.4	29.4	3.9	1.1	0.4	0.2	0.1
2019	1006.9	336.9	38.0	7.7	1.3	0.4	0.2	0.2
2020	419.3	237.9	27.5	6.3	1.6	0.4	0.1	0.5
2021	799.1	304.4	20.2	3.2	1.1	0.4	0.3	0.2
2022	NA	NA	NA	NA	NA	NA	NA	NA
2023	750.9	342.6	29.4	5.1	1.2	0.2	0.1	0.4

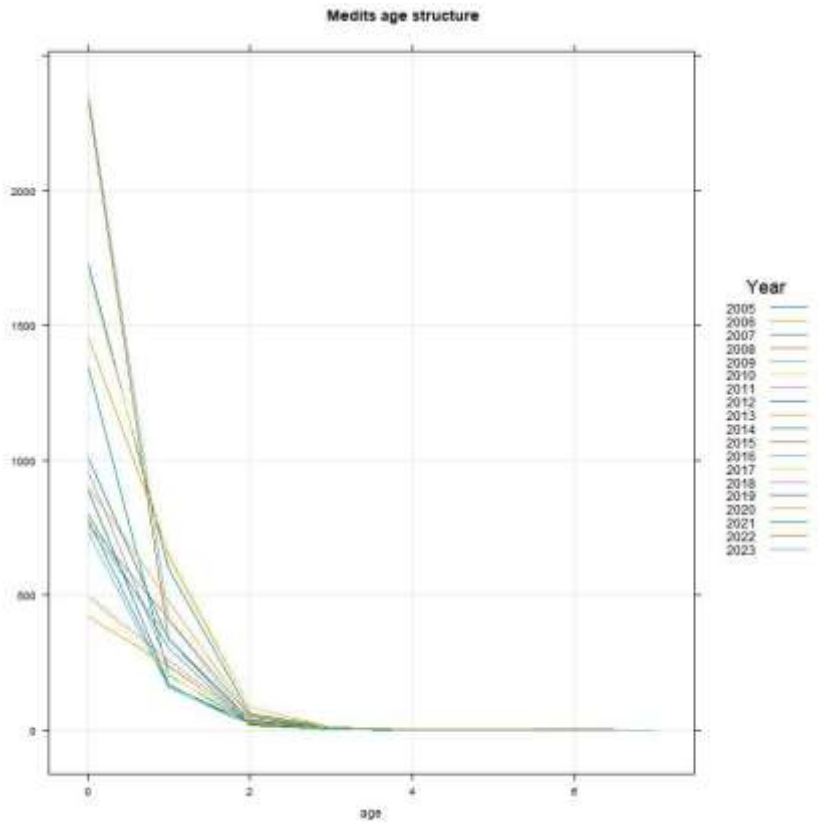
Source: Own elaborations

Figure 6.9.3.1. European hake in GSAs 8, 9, 10 & 11. Catch at age input data.



Source: Own elaborations

Figure 6.9.3.2. European hake in GSAs 8, 9, 10 & 11. Age structure of the index.



Source: Own elaborations

Assessment results

After a sensitivity analysis on the number of knots to be used for the F model, the group decided to apply the same model adopted during the benchmark meeting and the following EWGs. The model specifications are the following:

Submodels:

fmodel: ~factor(replace(age, age > 4, 4)) + s(year, k = 8)

srmodel: ~factor(year)

n1model: ~s(age, k = 3)

qmodel:

MEDITS_SA08091011: ~factor(replace(age, age > 4, 4))

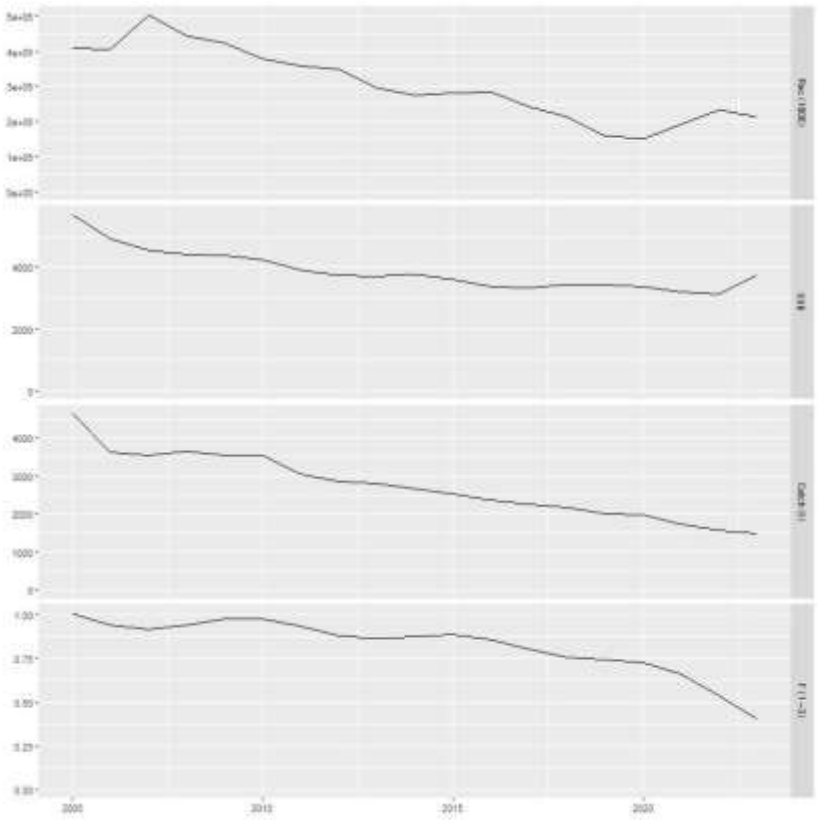
vmodel:

catch: ~s(age, k = 3)

MEDITS_SA08091011: ~1

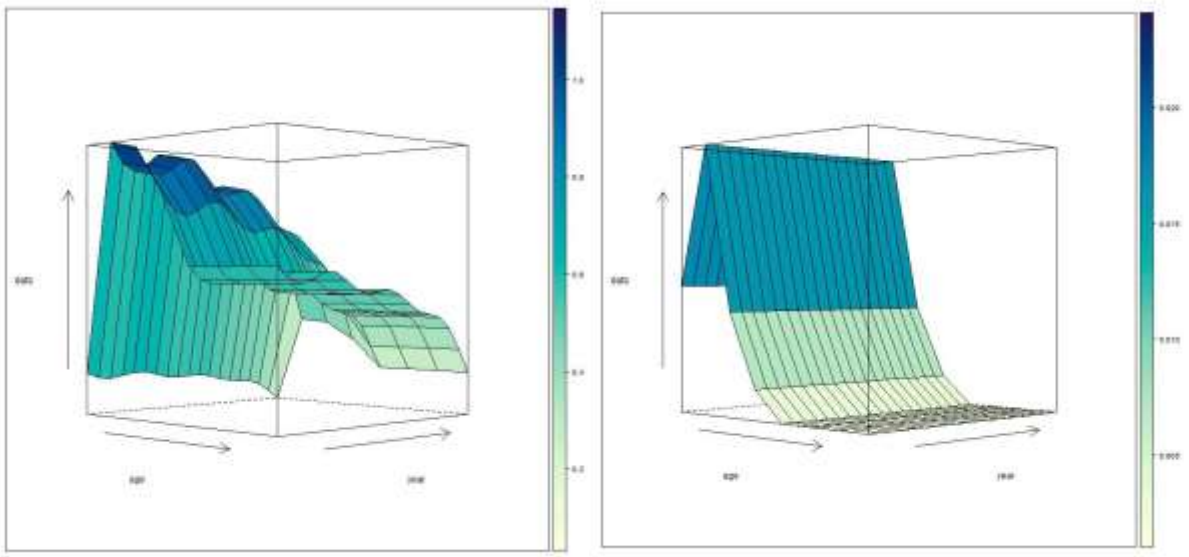
Results of the final model are shown in Figures 6.9.3.5 – 6.9.3.11.

Figure 6.9.3.5. European hake in GSAs 8, 9, 10 & 11. Stock summary from the final a4a model.



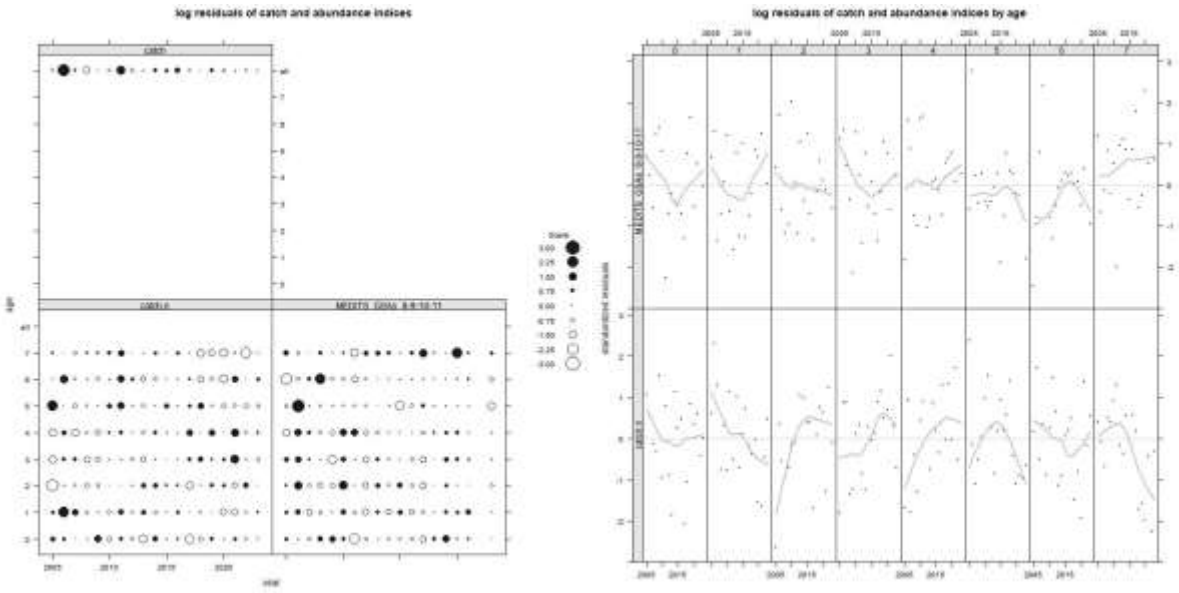
Source: Own elaborations

Figure 6.9.3.6. European hake in GSAs 8, 9, 10 & 11. 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated catchability (right) at age and year.



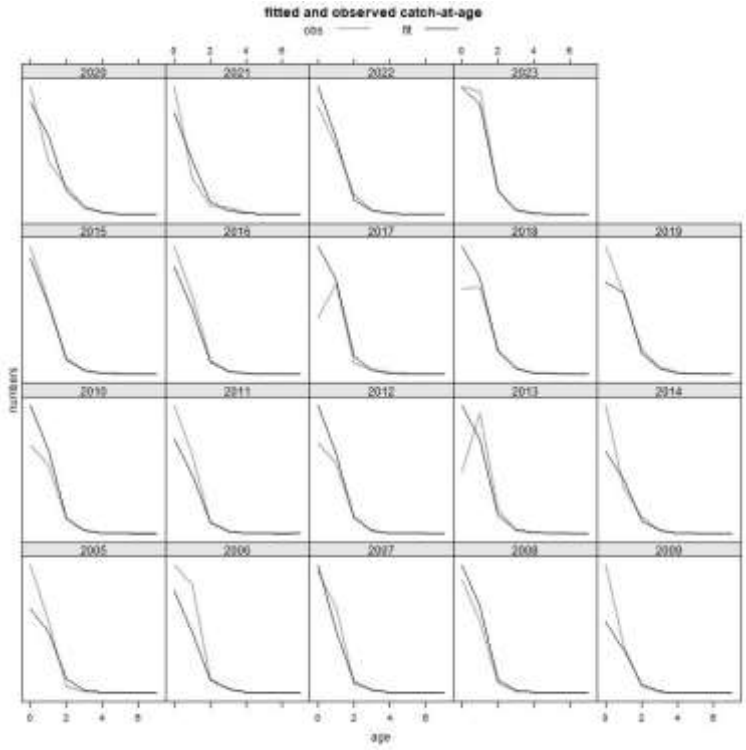
Source: Own elaborations

Figure 6.9.3.7. European hake in GSAs 8, 9, 10 & 11. Standardized residuals for abundance indices and for catch numbers.



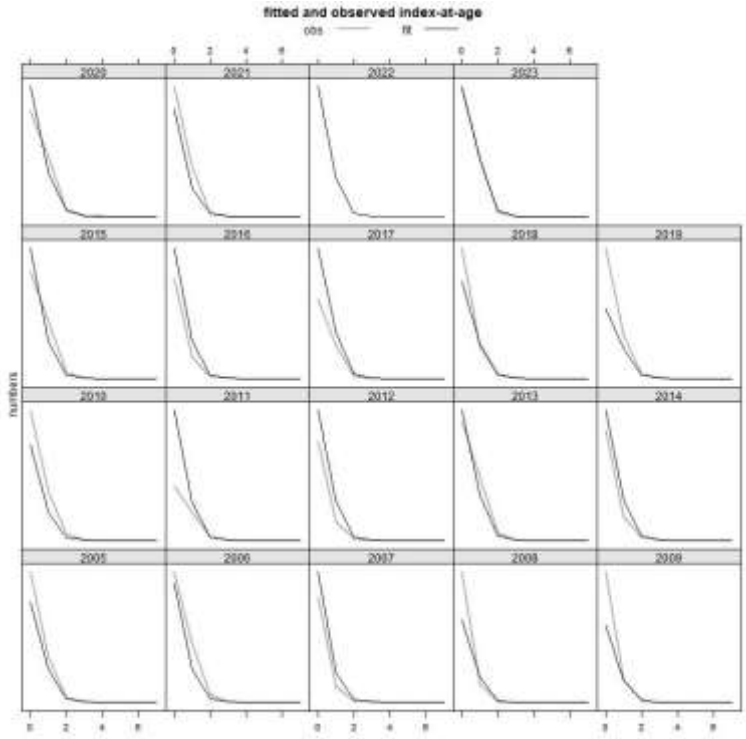
Source: Own elaborations

Figure 6.9.3.8. European hake in GSAs 8, 9, 10 & 11. Fitted and observed catch at age.



Source: Own elaborations

Figure 6.9.3.9. European hake in GSAs 8, 9, 10 & 11. Fitted and observed index at age.

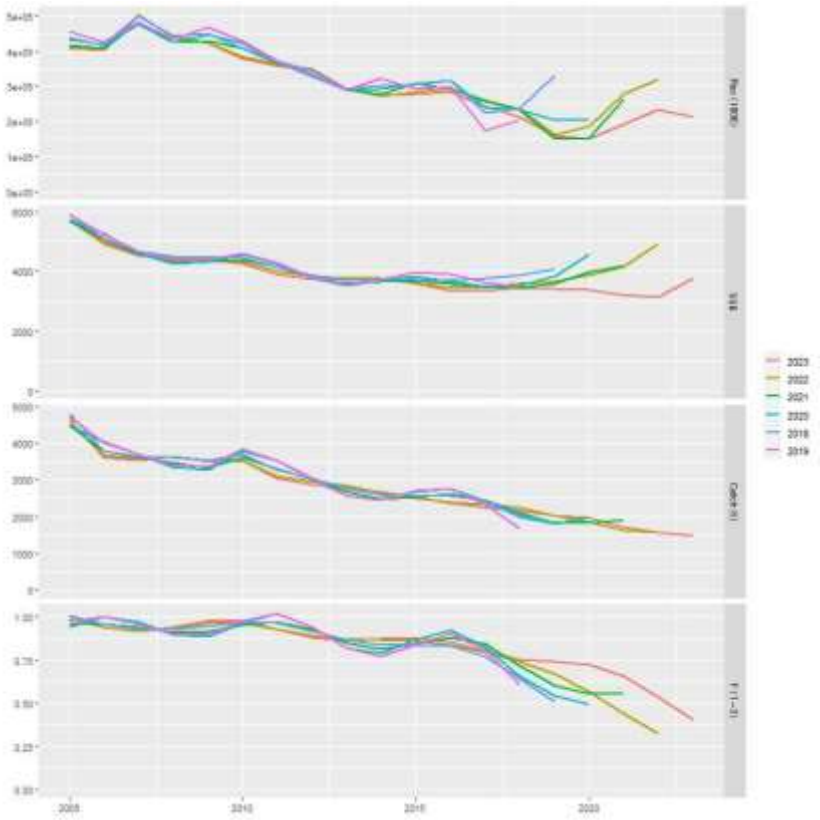


Source: Own elaborations

Retrospective

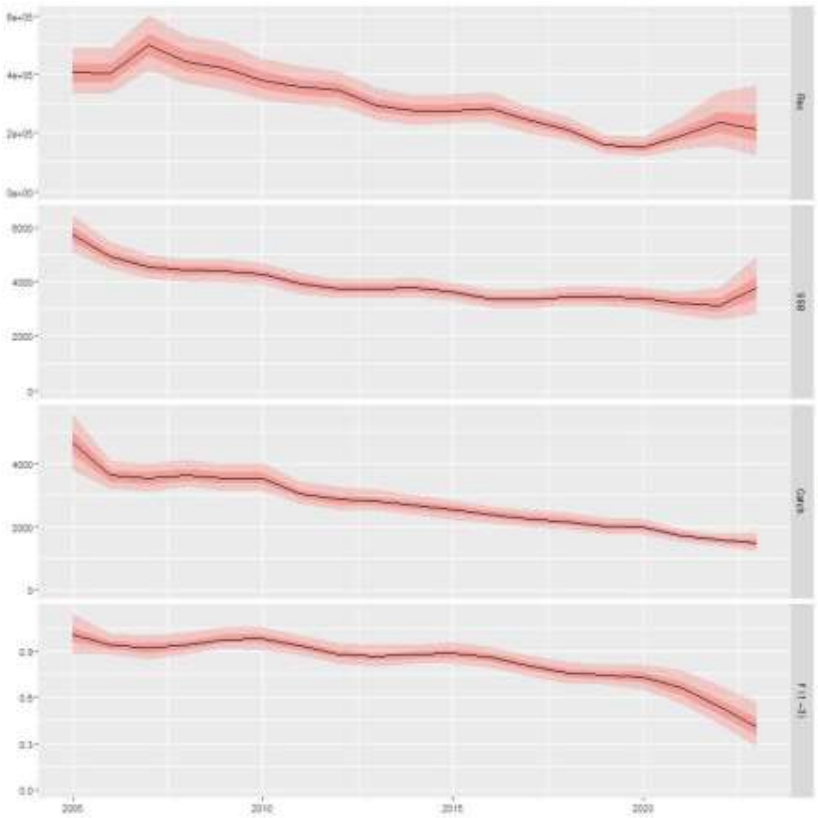
The retrospective analysis was applied up to 5 years back. Models results were quite stable (Figure 6.9.3.10).

Figure 6.9.3.10. European hake in GSAs 8, 9, 10 & 11. Retrospective analysis.



Source: Own elaborations

Figure 6.9.3.11. European hake in GSAs 8, 9, 10 & 11. Stock summary of the simulated and fitted data for the a4a model.



Source: Own elaborations

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

Table 6.9.3.3. European hake in GSAs 8, 9, 10 & 11. Stock numbers at age (thousands) as estimated by a4a.

	0	1	2	3	4	5	6	7+
2005	407309	63447	13180	3090	901	339	159	84
2006	403689	50009	9701	2848	878	355	138	102
2007	501527	50385	8213	2248	858	361	150	106
2008	444801	62957	8485	1950	692	358	155	114
2009	422576	55495	10322	1963	587	284	151	118
2010	379301	52245	8746	2297	572	235	117	116
2011	356905	46898	8236	1947	669	229	97	100
2012	347110	44631	7766	1924	591	276	98	87
2013	293848	43957	7809	1914	611	252	121	85
2014	274501	37382	7845	1962	618	263	112	95
2015	279020	34808	6578	1944	626	264	116	95
2016	282831	35307	6069	1616	616	266	116	96
2017	243253	36041	6348	1536	525	267	119	98
2018	211813	31417	6870	1701	523	235	123	104
2019	159310	27645	6269	1925	602	241	112	112
2020	150797	20870	5607	1785	690	280	115	112
2021	192183	19833	4306	1623	649	324	135	114
2022	234134	25691	4393	1336	626	318	164	131
2023	212802	32271	6502	1552	575	331	173	167

Source: Own elaborations

Table 6.9.3.4. European hake in GSAs 8, 9, 10 & 11. a4a summary results Fbar age 1-3, recritment (thousands SSB and total biomass (tonnes) and F at age.

	Fbar(1-3)	Recruitment	SSB (t)	TB (t)	Catch (t)
2005	1.01	407309	5697.3	12310.3	4616
2006	0.94	403689	4907.6	11366.7	3607.3
2007	0.92	501527	4534.1	11776.5	3523.5
2008	0.94	444801	4408.1	11395.2	3630.2
2009	0.98	422576	4377	10248.8	3526.6

2010	0.98	379301	4258	10357.2	3526.5
2011	0.93	356905	3905.6	9428	3029.8
2012	0.88	347110	3730.6	9182.2	2863.3
2013	0.86	293848	3715	9286	2790.4
2014	0.87	274501	3757.5	7516.5	2666.8
2015	0.88	279020	3597.5	7663.7	2527.4
2016	0.85	282831	3357.7	7688.6	2372
2017	0.80	243253	3337.4	7059.7	2251
2018	0.76	211813	3442.4	7041	2155.9
2019	0.74	159310	3424.9	6195.9	2011
2020	0.73	150797	3374	7002.8	1977.5
2021	0.66	192183	3189.3	7113.4	1721.5
2022	0.54	234134	3131.4	8466.2	1576.8
2023	0.40	212802	3753.5	9211.2	1476.7

Source: Own elaborations

Table 6.9.3.5. European hake in GSAs 8, 9, 10 & 11. Fishing mortality at age as estimated by a4a.

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2005	0.25	1.08	1.05	0.89	0.63	0.63	0.63	0.63
2006	0.23	1.01	0.98	0.83	0.59	0.59	0.59	0.59
2007	0.23	0.98	0.96	0.81	0.58	0.58	0.58	0.58
2008	0.23	1.01	0.98	0.83	0.59	0.59	0.59	0.59
2009	0.24	1.05	1.02	0.86	0.61	0.61	0.61	0.61
2010	0.24	1.05	1.02	0.86	0.61	0.61	0.61	0.61
2011	0.23	1.00	0.97	0.82	0.58	0.58	0.58	0.58
2012	0.22	0.94	0.92	0.78	0.55	0.55	0.55	0.55
2013	0.21	0.92	0.90	0.76	0.54	0.54	0.54	0.54
2014	0.22	0.94	0.91	0.77	0.55	0.55	0.55	0.55
2015	0.22	0.95	0.92	0.78	0.55	0.55	0.55	0.55
2016	0.21	0.92	0.89	0.75	0.54	0.54	0.54	0.54
2017	0.20	0.86	0.84	0.71	0.50	0.50	0.50	0.50
2018	0.19	0.81	0.79	0.67	0.48	0.48	0.48	0.48
2019	0.18	0.80	0.78	0.66	0.47	0.47	0.47	0.47
2020	0.18	0.78	0.76	0.64	0.46	0.46	0.46	0.46
2021	0.16	0.71	0.69	0.58	0.41	0.41	0.41	0.41

2022	0.13	0.57	0.56	0.47	0.34	0.34	0.34	0.34
2023	0.10	0.43	0.42	0.35	0.25	0.25	0.25	0.25

Source: Own elaborations

Based on the a4a results, the European hake SSB declines in the first part of the time series, reaching the lowest value in 2022, and slightly increases in the last year. The assessment shows a decreasing trend in the number of recruits with the minimum value reached in 2020 (150797 thousands) and a peak in 2022. Fbar (1-3) shows a declining trend, with the lowest value of 0.40 reached in 2023.

6.9.4 REFERENCE POINTS

The time series is too short to fit a stock recruitment relationship, therefore reference points are based on equilibrium methods. During STECF EWG 24-02 this stock was identified as type 1 stock, therefore it was recommended using F_{max} as a proxy of FMSY. The library FLBRP available in FLR was used to estimate F_{max} from the stock object resulting from the outputs of the a4a assessment.
Current F (0.40, estimated as the F_{bar1-3} value in 2023) is higher than F_{max} (0.25), chosen as proxy of F_{MSY} and as the exploitation reference point consistent with high long-term yields, which indicates that European hake stock in GSAs 8, 9, 10 and 11 is over-exploited.

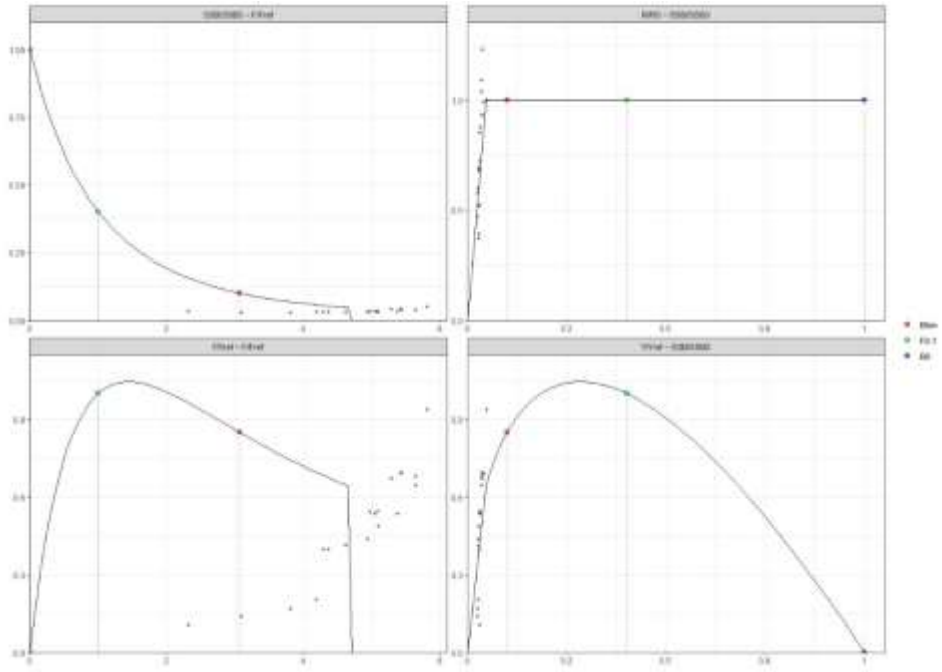
Estimation of biomass reference points

In the light of the outcomes of the exploratory analysis carried out during EWG 24-02, it was decided to consider the Hockey-stick approach the most appropriate to estimate the biomass reference points for the stock of European hake in GSAs 8, 9, 10 and 11. Table 6.9.4.1 summaries the reference point values based on the Hockey-Stick model fitted to the data. B_{pa} is set to 2* B_{Lim}, and the implied dynamics are illustrated in Figure 6.9.4.1.

Table 6.9.4.1. European hake in GSAs 8, 9, 10 & 11. Final reference points based on Hockey-Stick stock recruit model fitted to the data.

F_{max}	B_{Lim}	B_{pa}	B_{Fmax}	B_0	F_{pa}
0.25	5394	10788	43749.89	128781	0.56

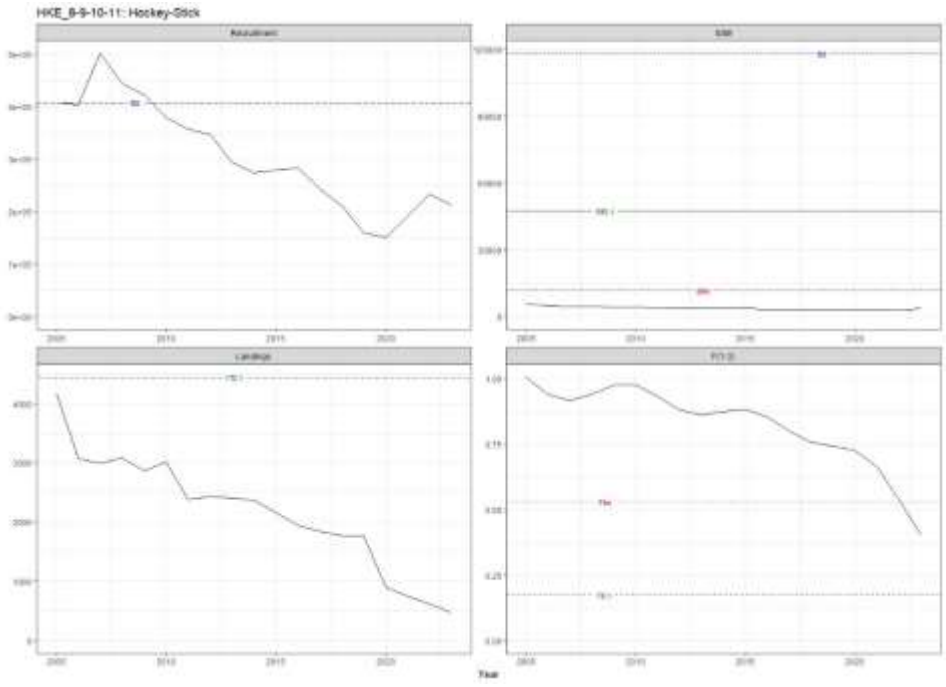
Figure 6.9.4.1. European hake in GSAs 8, 9, 10 & 11. Yield analysis with HS model.



Source: Own elaborations

In conclusion, the stock is considered to be above B_{Lim} in 2023, as shown in figure 6.9.4.2.

Figure 6.9.4.2. European hake in GSAs 8, 9, 10 & 11. Stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Hockey-Stick stock-recruitment relationship.



Source: Own elaborations

6.9.5 SHORT TERM FORECAST AND CATCH OPTIONS

For the interim year (2023), an average of the last three years has been used for weight at age and maturity at age, while the F_{bar} = 0.4 (last year value) was used for F in 2023. Recruitment shows a declining pattern over the period of the assessment, with a peak in the last years, so it has been estimated from the population results as the mean of the last 8 years (210890.5 thousands).

Table 6.9.5.1: European hake in GSAs 8, 9, 10 & 11. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-3 (2024)	0.40164	Fsq = F in the last year
SSB (2024)	4998.51	SSB intermediate year from STF output
Rage0 (2024,2025)	210890.5	Recruitment will be set as mean of the last 8 years
Total Catch (2024)	1793.712	Catch intermediate year from STF output
Fbar (2019)	0.742401	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Source: Own elaborations

Table 6.9.5.2: European hake in GSAs 8, 9, 10 & 11. Short term forecast in different F scenarios.

Rationale	F factor	Fbar	Recruitment 2024	Fsq 2024	Catch 2023	Catch 2025	SSB 2024	SSB 2026	SSB 2024-2026(%)	Catch 2023-2025(%)
F_{max}	0.62	0.25	210890.47	0.4	1476.71	1326.66	4998.51	7886.76	57.78	-10.16
F upper	0.86	0.35	210890.47	0.4	1476.71	1767.91	4998.51	7277.06	45.58	19.72
F lower	0.42	0.17	210890.47	0.4	1476.71	919.69	4998.51	8456.37	69.18	-37.72
F_{MSY} Transition	0.62	0.25	210890.47	0.4	1476.71	1326.66	4998.51	7886.76	57.78	-10.16
Reduced Foption	0.35	0.14	210890.47	0.4	1476.71	776.97	4998.51	8657.68	73.21	-47.38
Zero catch	0	0	210890.47	0.4	1476.71	0	4998.51	9766.72	95.39	-100.00
Status quo	1	0.4	210890.47	0.4	1476.71	2013.54	4998.51	6941.48	38.87	36.35
Different Scenarios	0.1	0.04	210890.47	0.4	1476.71	230.77	4998.51	9435.12	88.76	-84.37
	0.2	0.08	210890.47	0.4	1476.71	454.37	4998.51	9115.55	82.37	-69.23
	0.3	0.12	210890.47	0.4	1476.71	671.07	4998.51	8807.57	76.20	-54.56
	0.4	0.16	210890.47	0.4	1476.71	881.09	4998.51	8510.75	70.27	-40.33
	0.5	0.2	210890.47	0.4	1476.71	1084.68	4998.51	8224.65	64.54	-26.55
	0.6	0.24	210890.47	0.4	1476.71	1282.04	4998.51	7948.87	59.02	-13.18
	0.7	0.28	210890.47	0.4	1476.71	1473.41	4998.51	7683.03	53.71	-0.22
	0.8	0.32	210890.47	0.4	1476.71	1658.99	4998.51	7426.76	48.58	12.34
	0.9	0.36	210890.47	0.4	1476.71	1838.96	4998.51	7179.69	43.64	24.53
	1.1	0.44	210890.47	0.4	1476.71	2182.9	4998.51	6711.80	34.28	47.82
	1.2	0.48	210890.47	0.4	1476.71	2347.22	4998.51	6490.32	29.85	58.95
	1.3	0.52	210890.47	0.4	1476.71	2506.67	4998.51	6276.75	25.57	69.75
	1.4	0.56	210890.47	0.4	1476.71	2661.43	4998.51	6070.78	21.45	80.23
	1.5	0.6	210890.47	0.4	1476.71	2811.64	4998.51	5872.14	17.48	90.40
	1.6	0.64	210890.47	0.4	1476.71	2957.46	4998.51	5680.54	13.64	100.27
	1.7	0.68	210890.47	0.4	1476.71	3099.04	4998.51	5495.74	9.95	109.86
	1.8	0.72	210890.47	0.4	1476.71	3236.53	4998.51	5317.47	6.38	119.17
	1.9	0.76	210890.47	0.4	1476.71	3370.06	4998.51	5145.49	2.94	128.21
	2	0.8	210890.47	0.4	1476.71	3499.76	4998.51	4979.58	-0.38	137.00

Source: Own elaborations

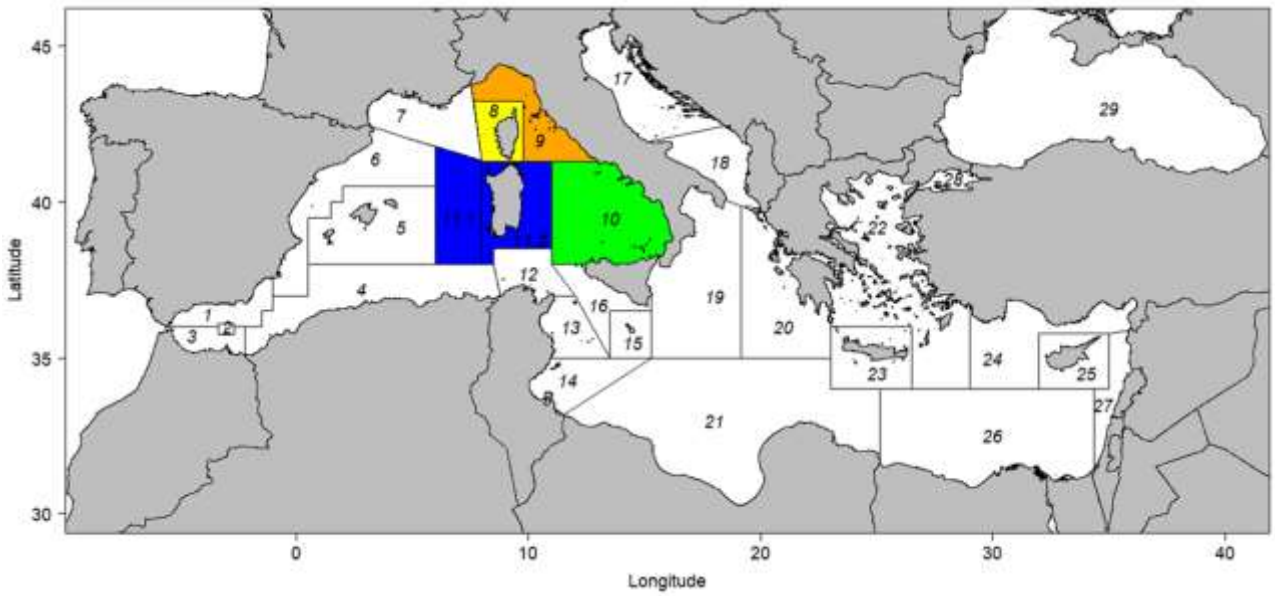
EWG advises that when the MSY approach is applied, catches in 2025 should be no more than 1326.7 tons.

6.10 DEEP-WATER ROSE SHRIMP IN GSAS 8, 9, 10 & 11

6.10.1 STOCK IDENTITY AND BIOLOGY

According to the results of Stockmed project (Fiorentino *et al*., 2014), Deep-water rose shrimp of GSA09 is part of the stock that includes many GSAs of western Mediterranean (GSA01, GSAs 05-08, GSA11). However, the analyses underlined that the southern part of GSA09 presents characteristics more similar to those of GSA10. In the present assessment, the stock was assumed to be confined within the GSAs 08, 09, 10 and 11 boundaries.

Figure 6.10.1.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11.Geographical location of the GSAs.



Source: Own elaborations

The Deep-water rose shrimp is an epibenthic species and inhabits the muddy or sandy-muddy bottoms of the continental shelf. A gradient of size increasing with depth has been observed in the area, being the smallest specimens fished more frequently in the upper part of the continental shelf (100-200 m), while the largest ones are mainly distributed along the slope at depths greater than 200 m (Ardizzone *et al*., 1990; Spedicato *et al*., 1996).

In GSA09, the species shows a wide bathymetric distribution, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms (Ardizzone and Corsi, 1997; Biagi *et al*., 2002). The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium). In GSA10, aggregations with higher abundance were localised between 100 and 200 m depth, with some intrusions in the deeper waters in three sub-areas. Two most important patches were located in the Gulf of Naples and along the Calabrian coasts in correspondence with Cape Bonifati, while a third one in the Gulf of Salerno (Lembo *et al*., 2000a). These are the areas where also the main nurseries are localised.

The Deep-water rose shrimp with hake and red mullet is a key species of fishing assemblages in the area. In the last decade it was generally also ranked among the species with higher abundance indices (number of individuals) in the trawl surveys as observed for different Mediterranean areas (Abelló *et al*., 2002). The species is caught on the same fishing grounds

as European hake and the production of this shrimp is steadily growing in the last decade in the southern basin and it reached in 2006 about 10% of the demersal landings. The core of nursery areas in GSA09 overlap with crinoid beds (*Leptometra phalangium*) areas over the shelf-break (Colloca *et al*., 2004, 2006a; Reale *et al*., 2005). This is a peculiar habitat in the GSA09, which is also an essential fish habitat for other commercially important species as the European hake, *Merluccius merluccius*.

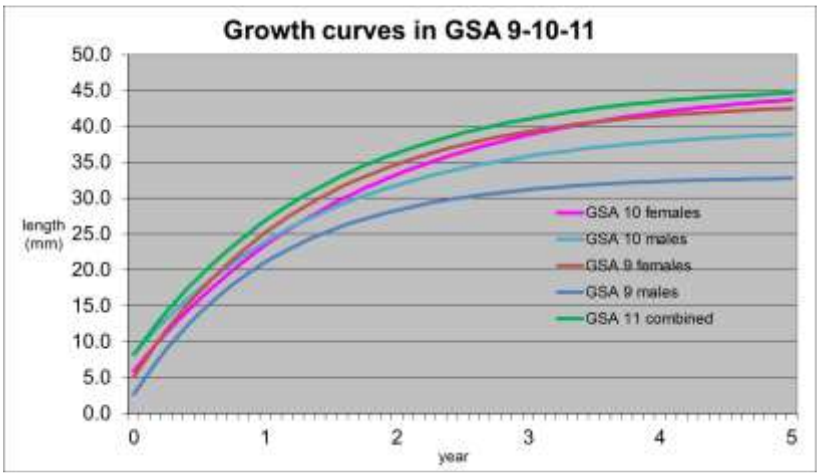
Growth

The structure of the sizes of *P. longirostris* is characterised by differences in growth between the sexes, the larger individuals being females. The Deep-water rose shrimp is a short-living crustacean with a life span of about 4 years (Carbonara *et al*., 1998).

The growth of *P. longirostris* has been studied in the southern part of the GSA09 (central Tyrrhenian Sea) using modal progression analysis (Ardizzone *et al*., 1990). The following sets of Von Bertalanffy growth parameters were estimated: Females: $L\infty$ = 43.5, K=0.74, t0=-0.13; Males: $L\infty$ = 33.1, K=0.93, t0=-0.05. Females grow faster than males attaining larger size-at-age.

In GSA10, past estimates of the growth pattern of the Deep-water rose shrimp females were obtained using different methods based on the LFD analysis (modal progression analysis-MPA, Elefan, Multifan) applied to GRUND data from 1990 to 1995. Parameters of VBGF were as follows: $L\infty$=45.9; K=0.673 t0=-0.251 (Carbonara *et al*., 1998). VBGF parameters were also re-estimated during the Samed project (SAMED, 2002) using the MEDITS time series from 1994 to 1999, that gave the following values: females: $CL\infty$=45.0 mm, K=0.7, t0= -0.15; males: $CL\infty$=40.0 mm; K=0.78; t0= -0.2.

Figure 6.10.1.2 Deep-water rose shrimp in GSAs 09, 10 & 11. Von Bertalanffy curves.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

For the present assessment the growth parameters reported in Tab. 6.10.1.1 has been used. Weight length relationships for the different years and GSAs have been obtained from DCF database.

Table 6.10.1.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Growth parameters used in the present assessment.

Sex	VB_LINF	VB_K	VB_T0
Females	43.5	0.74	-0.13
Males	33.1	0.93	-0.05

Source: Own elaborations

Maturity

In the northern Tyrrhenian Sea (GSA09), 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 (Mori *et al*., 2000a). In the central Tyrrhenian Sea, the southern part of GSA09, a main winter spawning was hypothesized (Ardizzone *et al*., 1990). The size at onset of sexual maturity estimated for different years in northern Tyrrhenian Sea is about 24 mm CL (Mori *et al*., 2000a). 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*CL4.0177 (r = 0.829) (Mori *et al*., 2000b).

In the Central-Southern Tyrrhenian Sea (GSA10) the occurrence of mature females was observed in spring (May), summer (July-August) and autumn (October), with a higher relative frequency in spring-summer seasons (Spedicato *et al*., 1996). Thus, a continuous recruitment pattern is shown which, however, exhibits a main pulse in the autumn season. At 16 mm carapace length the pink shrimp is considered recruited to the grounds (SAMED, 2002). In GSA09, the main nurseries revealed a high spatio-temporal persistency between 60 and 220 m depth. Recruits (CL 15 mm) occur all year round, with a main peak from July to October (De Ranieri *et al*., 1997).

The overall sex ratio is about 0.5.

The maturity proportion at age adopted in the present assessment is reported In Tab. 6.10.1.2.

Table 6.10.1.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Maturity proportion at age adopted in the present assessment.

Age	0	1	2	3+
Maturity	0.0	0.7	1.0	1.0

Source: Own elaborations

Ecology

P. longirostris diet is composed of a great variety of organisms; the prey items consisted mostly of external skeletons of bottom organisms, always crushed and often in an advanced state of deterioration. Crustaceans dominated the diet both qualitatively and quantitatively; they were characterized by a high abundance of peracarids, mainly represented by mysids (*Lophogaster typicus*) and amphipods (Lysianassidae). Molluscs (juvenile bivalves and gastropods), cephalopods (Sepiolids), small echinoderms, annelids, small fishes, foraminiferans, (Globigerinidae) and organic detritus are other important food item in the diet of the species (Mori *et al*., 2000b).

Natural mortality

Natural mortality was estimated applying Chen & Watanabe model. A single M vector was produced combining the vectors obtained by sex. The input growth parameters (k and t_0) used are reported in Tab. 6.10.1.1. The natural mortality vector by age is reported in Tab. 6.10.1.3.

Table 6.10.1.3 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Vector of natural mortality used in the present assessment.

Age	0	1	2	3+
M	2.01	1.13	0.94	0.91

Source: Own elaborations

6.10.2 DATA

Deep-water rose shrimp is one of the most important target species of the bottom trawl fisheries carried out on the continental shelf and upper slope. Some catches coming from gillnet and trammel net are sporadically observed in GSAs 09 and 10.

6.10.2.1 CATCH (LANDINGS AND DISCARDS)

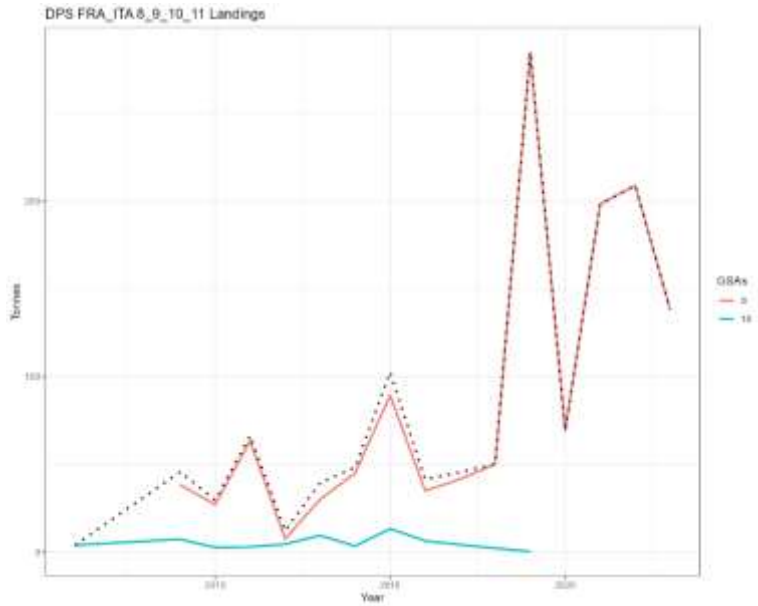
The annual total landing of Deep-water rose shrimp observed from 2002 to 2023 is reported in Figure 6.10.2.1.1 and Table 6.10.2.1.1. The time series available in the DCF database are different for the four GSAs: 2010-2023 for GSA08, 2003-2023 for GSA09, 2002-2023 for GSA10 and 2004-2023 for GSA11. Landings data of 2020 for GSA 10 are partially available in DCR-DCF MEDBS database. Additional data were acquired in FDI database to construct the final dataset used in the present assessment.
In the first years, the landing was higher in GSA10, and then, since 2010, GSA09 has become the most important in terms of biomass landed. The landings from GSA11 were low compared to those from GSAs 09 and 10, while the landings from GSA08 were negligible. The trend of the landings for the combined GSAs (black dotted line) shows fluctuations at the beginning of the series with an evident peak in 2005 and 2006 followed by a sharp decrease. Starting from 2010, a constant increase is observed until the maximum value registered in 2019. A decrease was observed in the last two years.
Discard data (Figure 6.10.2.1.2 and Table 6.10.2.1.1) are available in GSA09 since 2009. In this area this fraction of the catches ranged from 5 to 25% of the total biomass caught. In GSA10, where discard represents a lower percentage of the total catch (around 1-2%), data are available from 2006. Data on discard are not available in 2018, and from 2020 to 2022 in GSA10 and for the whole data series in GSAs 08 and 11. Missing discard data were not reconstructed.

Figure 6.10.2.1.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual landings from 2002 to 2022 by single and combined (black dotted line) GSAs.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual discards from 2002 to 2022 by single GSAs and combined (black dotted line).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.10.2.1.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual catches (t) by GSA and fishing technique as provided through the official DCR-DCF database.

Landings	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSA 8_FPO_CRU											
GSA 8_OTB_CRU									3.5	4.9	6.4
GSA 8_OTB_DEF										0.1	0.0
GSA 8_OTB_DWS											
GSA 8_OTB_MDD											
GSA 8_OTM_MPD											
GSA 9_GNS_DEF			3.6			2.3	0.5				
GSA 9_GNS_SLP											
GSA 9_GTR_DEF		5.9	4.2	0.5							0.2
GSA 9_OTB_DEF				42.0	55.3	89.8	187.3	238.5	309.6	404.5	483.4
GSA 9_OTB_DWS							0.2		9.7	9.7	5.5
GSA 9_OTB_MDD				388.5	407.1	125.3	66.1	64.6	154.0	136.9	132.1
GSA 9_OTB_NA		316.6	367.4								
GSA 9_OTM_MPD											
GSA 9_TBB_DEF											
GSA 10_GND_SPF				0.0							
GSA 10_GNS_DEF			2.9	5.9			0.1	0.2		3.0	3.7
GSA 10_GTR_DEF		71.2	2.5	0.4							
GSA 10_LLD_LPF				0.6							
GSA 10_LLS_DEF			0.6	26.1							
GSA 10_NA_NA	373.4		0.2	0.0							
GSA 10_OTB_DEF									242.0	282.5	262.0
GSA 10_OTB_DWS									3.1	6.6	15.3
GSA 10_OTB_MDD									124.6	113.1	177.7
GSA 10_OTB_NA	1451.6	416.0	544.2	742.7	1087.7	534.3	400.2	378.9			
GSA 10_OTM_MPD											
GSA 10_PS_SPF	33.7		1.3		1.0						
GSA 10_SB_DEF			0.1								
GSA 10_SV_DEF			0.1								
GSA 11_GTR_DEF				4.0	2.7						
GSA 11_OTB_DEF			45.2	46.3	23.0	1.1	5.1				8.1
GSA 11_OTB_DWS							0.5				2.4
GSA 11_OTB_MDD			187.2	501.8	104.5	78.4	40.2				31.8
GSA 11_OTB_NA								21.7	23.3	53.3	
Total	**1858.7**	**809.7**	**1159.6**	**1758.8**	**1681.4**	**831.2**	**700.1**	**703.9**	**869.8**	**1014.6**	**1128.6**

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Landings	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
GSA 8_FPO_CRU	0.0		0.3								
GSA 8_OTB_CRU	3.7	2.3	6.7	7.8	7.2	6.4	6.1	6.5	7.9	5.9	6.9
GSA 8_OTB_DEF	0.8	0.1	0.1	0.1	0.1	0.4	0.1	0.0	1.5	3.0	1.2
GSA 8_OTB_DWS											0.4
GSA 8_OTB_MDD									0.8	1.2	0.8
GSA 8_OTM_MPD											0.4
GSA 9_GNS_DEF		0.0			0.0			0.1	0.0		4.3

GSA 9_GNS_SLP											0.1
GSA 9_GTR_DEF								0.6			0.0
GSA 9_OTB_DEF	426.4	466.7	663.6	648.6	730.1	827.8	725.3	879.2	819.1	665.9	770.7
GSA 9_OTB_DWS	3.8	2.1	8.5	10.5		7.7	15.4	8.4	4.8	8.5	14.9
GSA 9_OTB_MDD	145.5	92.6	119.3	176.6	126.7	68.3	150.1	111.5	164.1	151.1	219.6
GSA 9_OTB_NA											
GSA 9_OTM_MPD							3.7			9.5	3.7
GSA 9_TBB_DEF							1.3			0.0	0.0
GSA 10_GND_SPF											
GSA 10_GNS_DEF		0.3			0.6						
GSA 10_GTR_DEF											
GSA 10_LLD_LPF											
GSA 10_LLS_DEF											
GSA 10_NA_NA											
GSA 10_OTB_DEF		211.0	224.2	311.8	302.1	385.1	410.6	516.2	360.2	328.0	237.6
GSA 10_OTB_DWS		52.3	18.0	9.3	33.3	34.4	89.1	54.6	8.1	34.9	23.3
GSA 10_OTB_MDD		245.6	282.7	221.3	182.9	135.9	166.2	268.9	164.9	124.2	104.6
GSA 10_OTB_NA	596.7										
GSA 10_OTM_MPD			21.8				1.6	0.0	0.1	0.5	2.3
GSA 10_PS_SPF											
GSA 10_SB_DEF											
GSA 10_SV_DEF											
GSA 11_GTR_DEF											
GSA 11_OTB_DEF				17.2	18.3	130.9	78.3	51.4	55.7	57.5	23.1
GSA 11_OTB_DWS				3.7	0.6	9.9	23.4	11.5	2.8	5.9	2.9
GSA 11_OTB_MDD				24.9	29.1	67.9	79.2	67.2	95.8	84.2	45.1
GSA 11_OTB_NA	23.3	30.2	39.5								
Total	**1200.1**	**1103.2**	**1384.7**	**1431.8**	**1431.0**	**1674.6**	**1750.4**	**1976.1**	**1685.8**	**1480.5**	**1462.0**

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Discards	**2006**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
GSA 9_OTB_DEF		38.4	24.4	60.5	6.6	26.8	45.0	89.3	29.7	41.3	50.2	277.8	67.6
GSA 9_OTB_DWS													
GSA 9_OTB_MDD			2.7	2.7	1.0	3.3			5.2	0.2		6.8	1.6
GSA 10_OTB_DEF			1.9	1.6	3.1		1.9	9.2	3.6	3.7		0.0	0.0
GSA 10_OTB_DWS							0.1	0.1	0.0			0.0	0.0
GSA 10_OTB_MDD			0.7	1.3	1.4		1.4	4.0	2.8	0.4		0.3	0.0
GSA 10_OTB_NA	3.9	7.3				9.4							
GSA 10_OTM_MPD												0.0	
Total	**3.9**	**45.7**	**29.7**	**66.2**	**12.1**	**39.5**	**48.3**	**102.6**	**41.4**	**45.6**	**50.2**	**284.9**	**69.2**

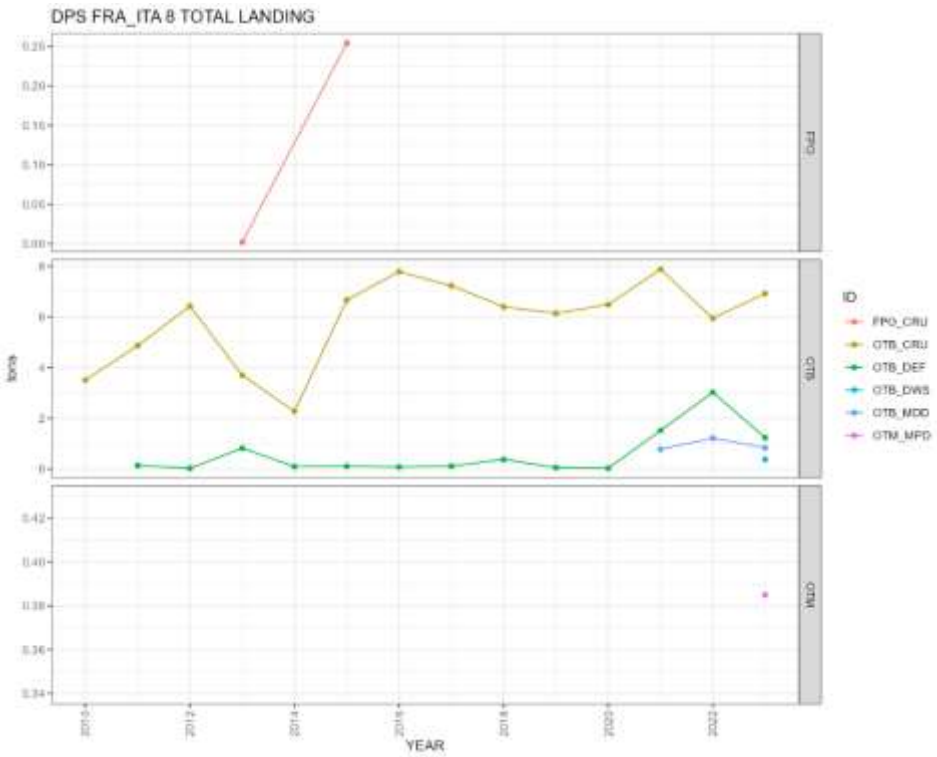
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Discards	2021	2022	2023
GSA 9_OTB_DEF	198.3	208.5	136.7
GSA 9_OTB_DWS	0.0		
GSA 9_OTB_MDD		0.4	1.4
GSA 10_OTB_DEF	0.0	0.0	0.0
GSA 10_OTB_DWS	0.0	0.0	0.0
GSA 10_OTB_MDD	0.0	0.0	0.0
GSA 10_OTB_NA			
GSA 10_OTM_MPD		0.0	0.0
Total	**198.3**	**208.9**	**138.1**

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

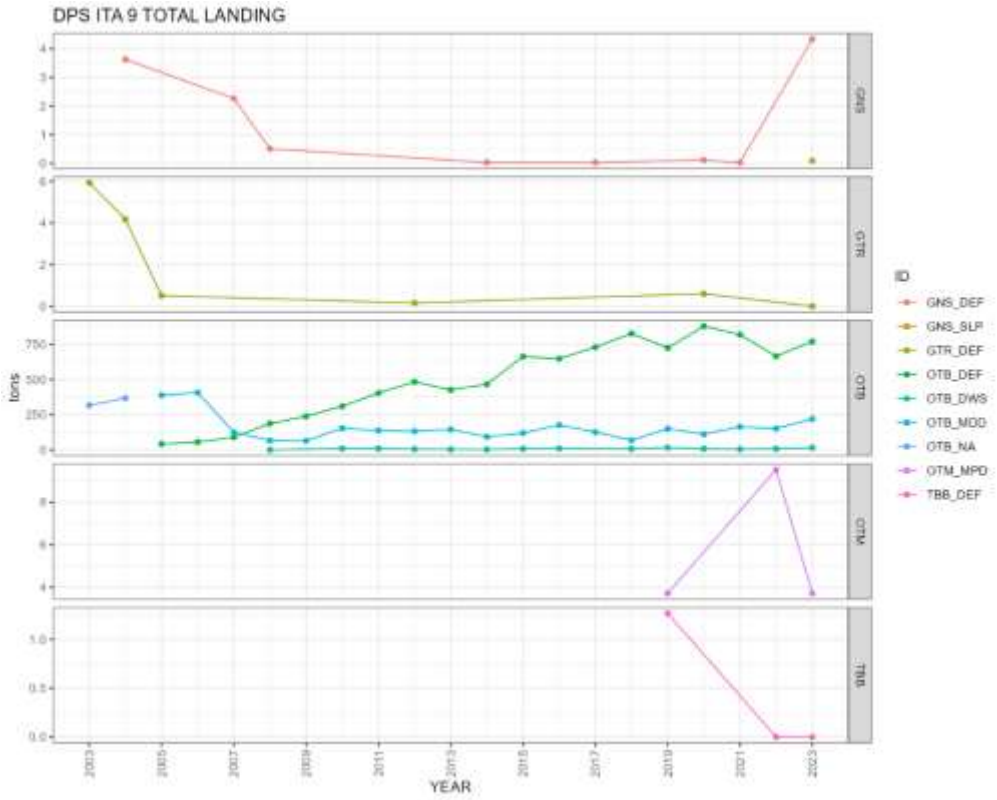
Annual landings in tonnes by year and fleet for GSAs 08 09, 10 and 11 are reported in Figs. 6.10.2.1.3-6. Annual discards in tonnes by year and fleet for GSA09 and GSA10 are displayed in Figs. 6.10.2.1.7-8.

Figure 6.10.2.1.3 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual landings in tonnes by year and fleet for GSA08.



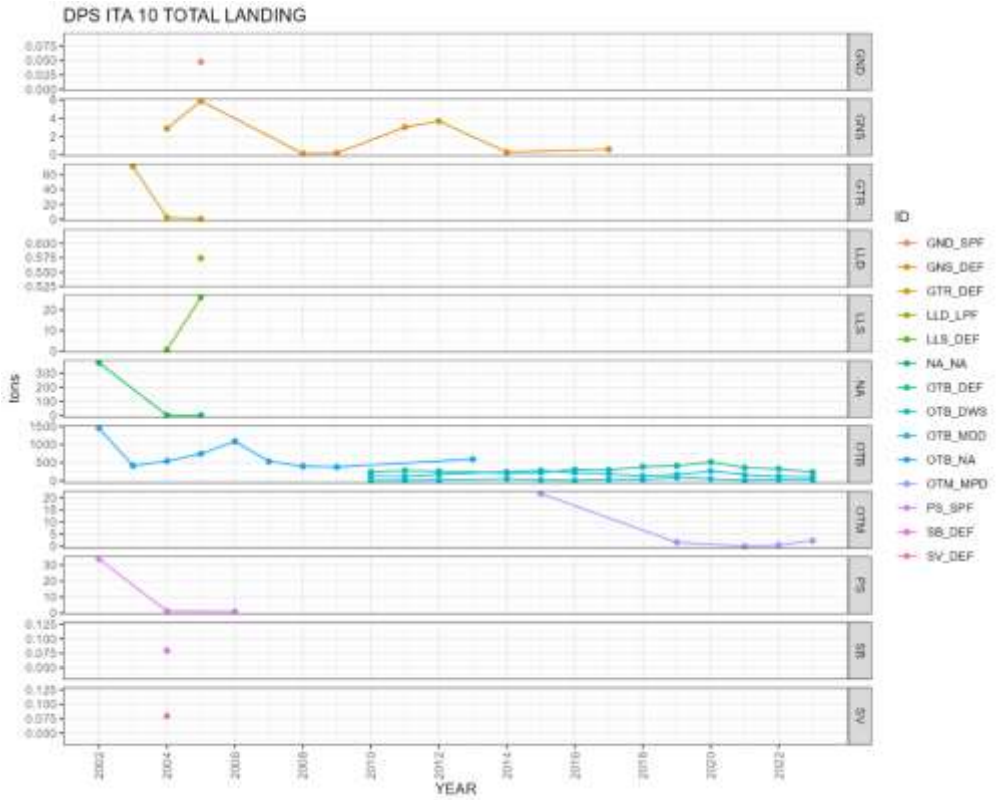
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.4 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual landings in tonnes by year and fleet for GSA09.



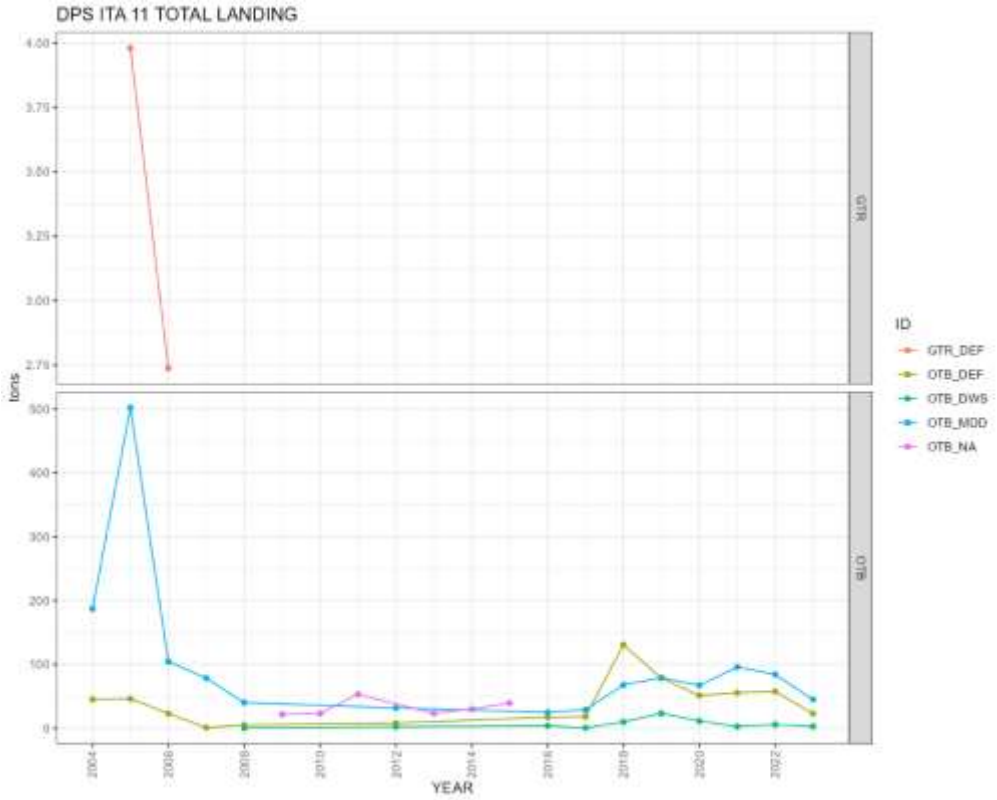
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.5 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual landings in tonnes by year and fleet for GSA10.



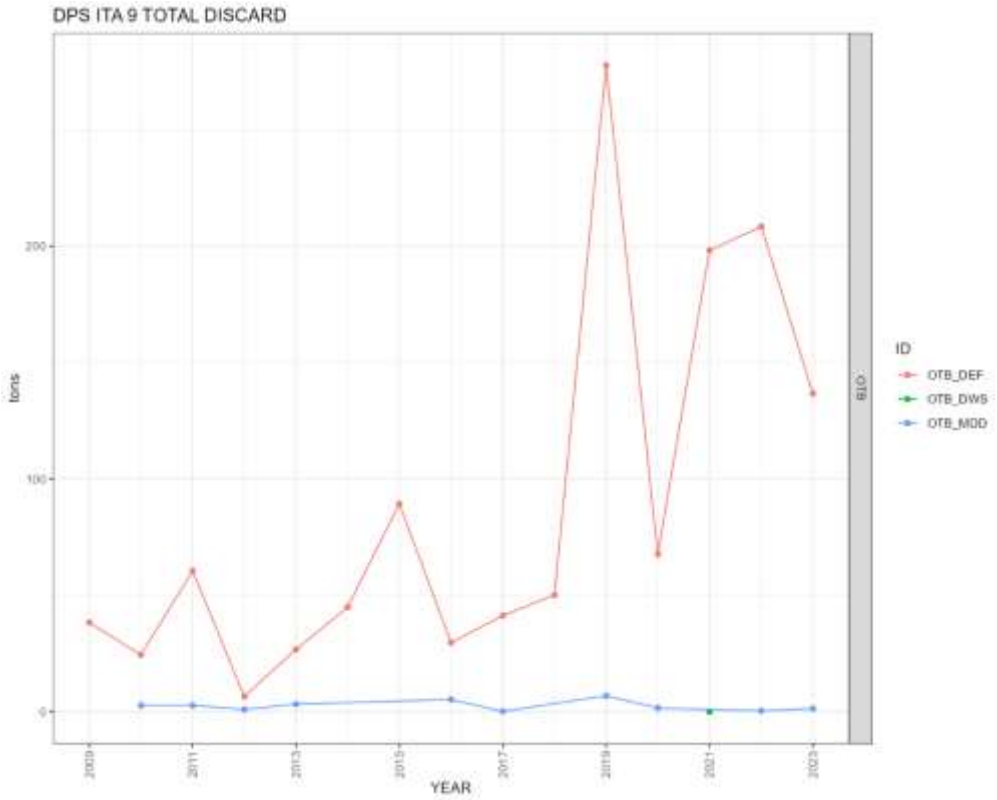
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.6 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual landings in tonnes by year and fleet for GSA11.



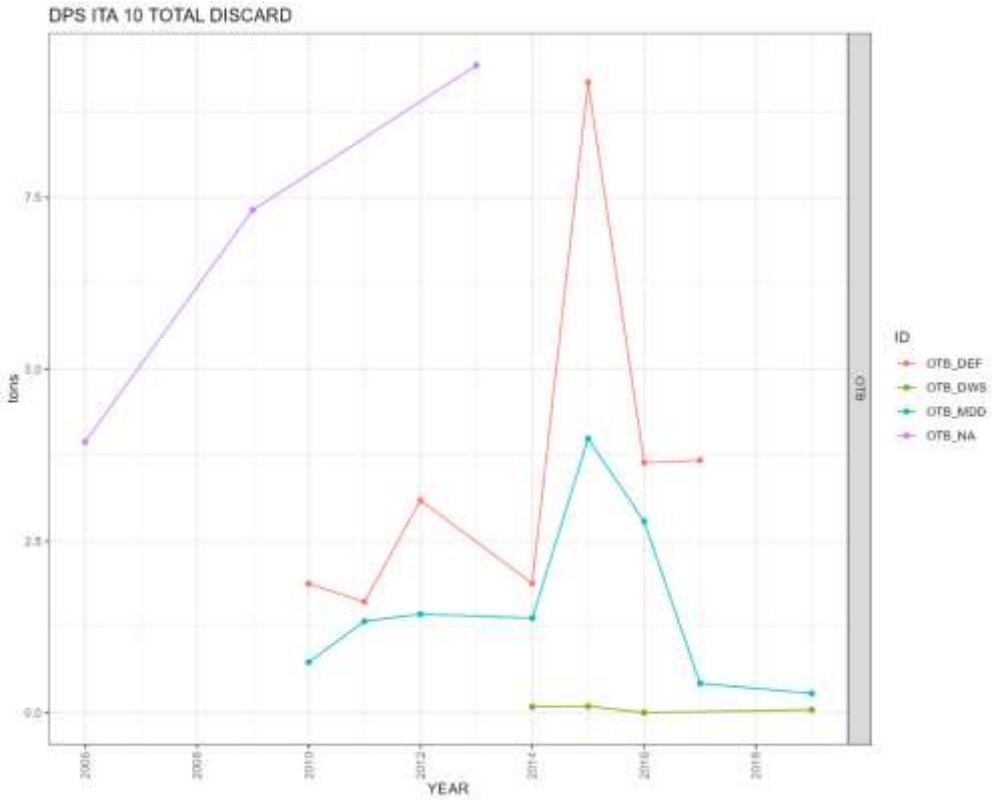
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.7 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual discards in tonnes by year and fleet for GSA09.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.8 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Annual discards in tonnes by year and fleet for GSA10.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Length frequency distributions (LFDs) and the relative impact of the metiers on the year total landings and discards are displayed in Figs. 6.10.2.1.9-18.

LFDs of landing and discard for GSA08 are not available.

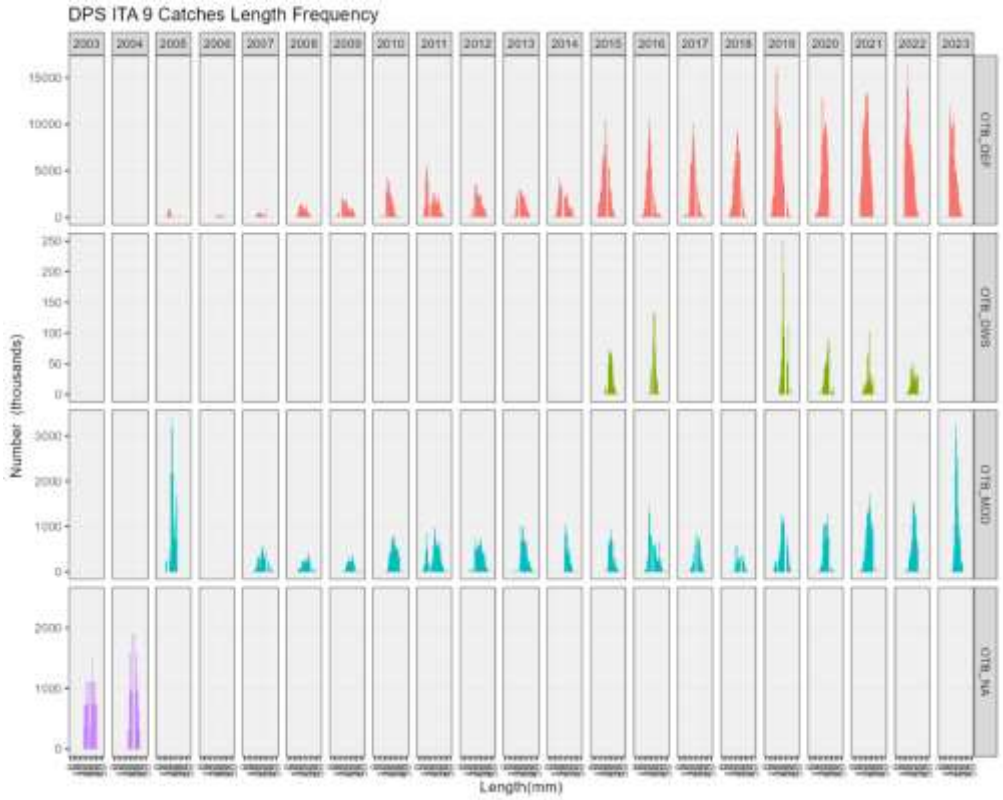
In GSA09, demographic structure of the landing is available for OTB in 2003 and 2004 and by metier from 2005 to 2023 (OTB_DEF, OTB_DEMSP, OTB_DWS and OTB_MDD). For TBB_DEMSP, OTM_MPD, GTR_DEF and GNS_DEF, the LFDs were not available but the contribution of those metiers to the total landing of DPS in the area is negligible. LFDs not available were not reconstructed and a SOP correction to the total landing was performed. In 2023, the LDFs of the main metiers catching for DPS are available.

In GSA10, the demographic structure of the landing is available for the period 2002-2023. For 2023, data were extracted both from DCR-DECF and FDI databases. Length frequency distributions are available from 2002 to 2023. LFDs not available were not reconstructed and a SOP correction to the total landing was performed. In 2023, only LDFs of OTB_DEF are available.

In GSA11, demographic structure of the landing is available from 2004 to 2023. The length frequency distributions of landing are present in the DCR-DCF database for the period 2009-2023. LFDs not available were not reconstructed and a SOP correction to the total landing was performed. In 2023, LFDs are available for OTB_MDD only, while not for the other metiers of OTB.

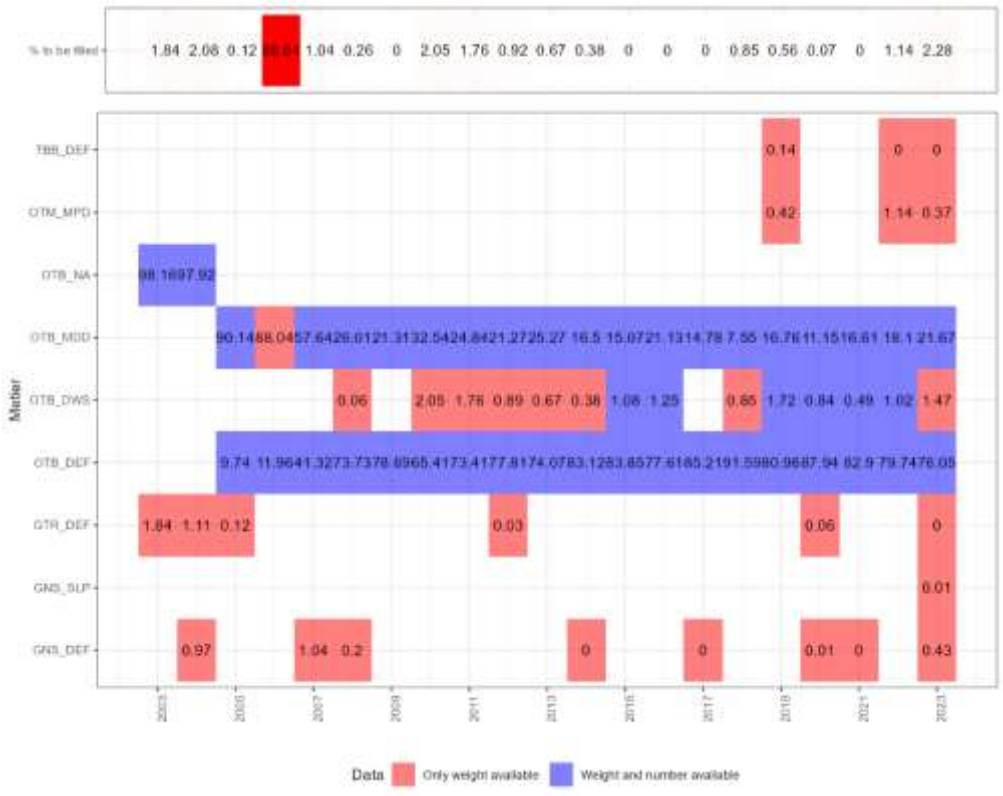
Regarding the discard, the information is coming only from GSA 9 and GSA 10. In GSA 10 the timeseries in from 2006 to 2019, while in GSA 9 data are available from 2009 to 2023. The same is for length frequency distributions data. LFDs not available were not reconstructed.

Figure 6.10.2.1.9 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Size frequency distributions of landing in GSA09.



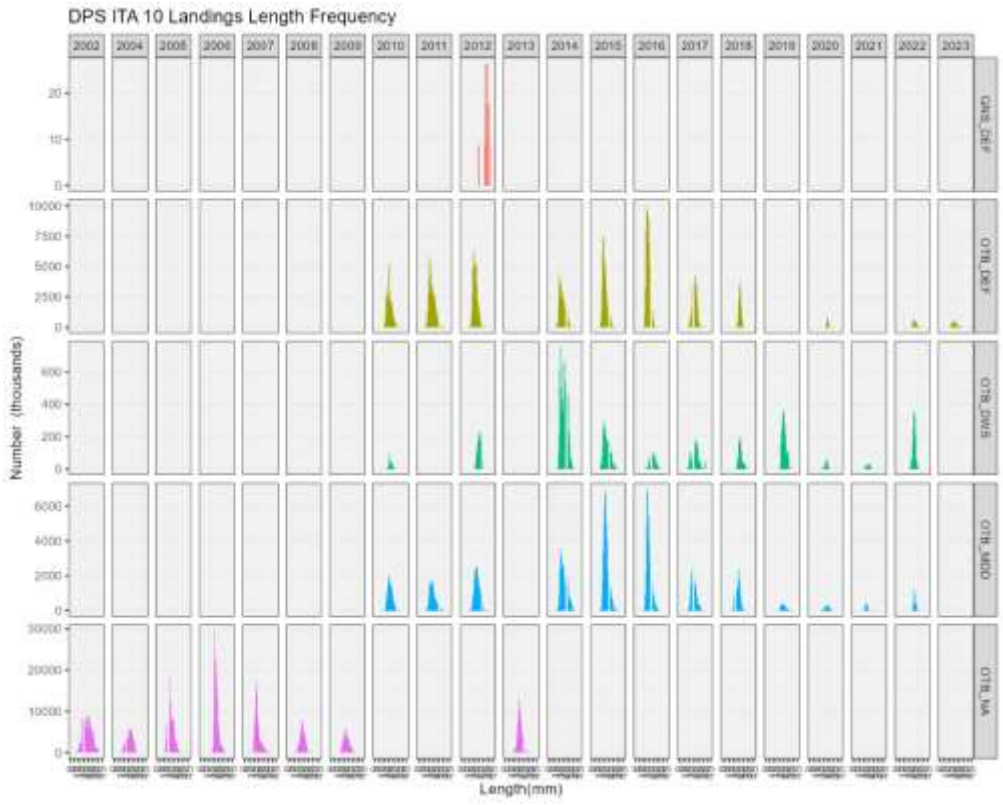
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.10 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Table summarising the relative impact of the metiers on the year total landings in GSA09.



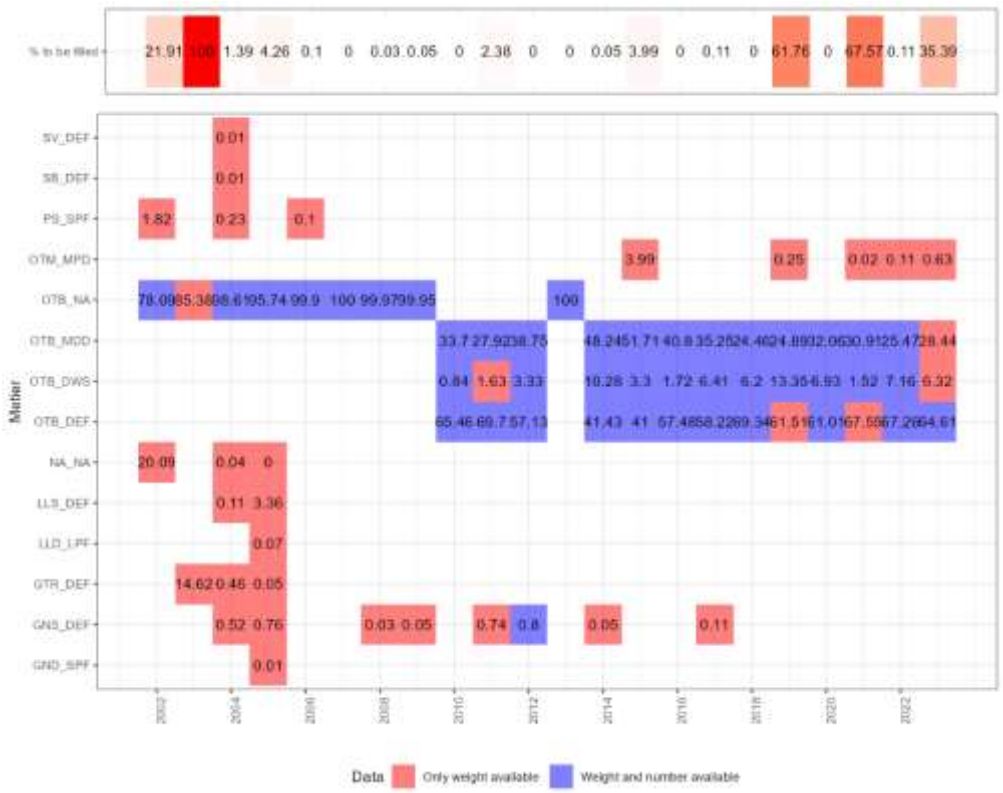
Source: Own elaborations

Figure 6.10.2.1.11 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Size frequency distributions of landing in GSA10.



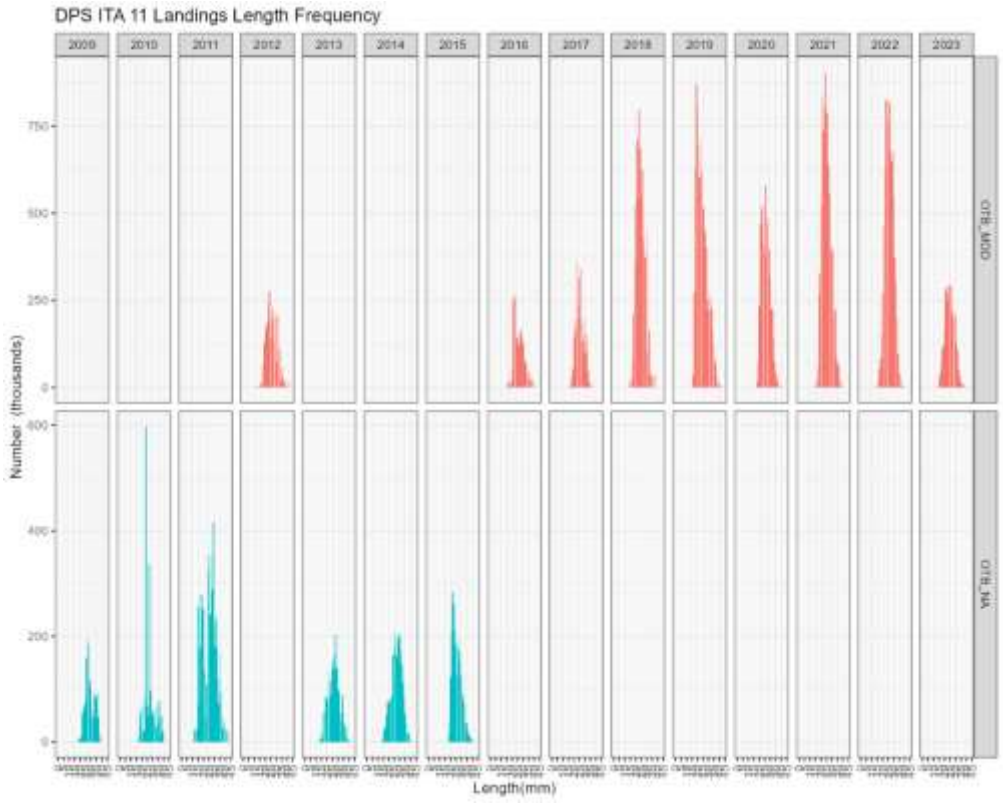
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.12 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Table summarising the relative impact of the metiers on the year total landings in GSA10.



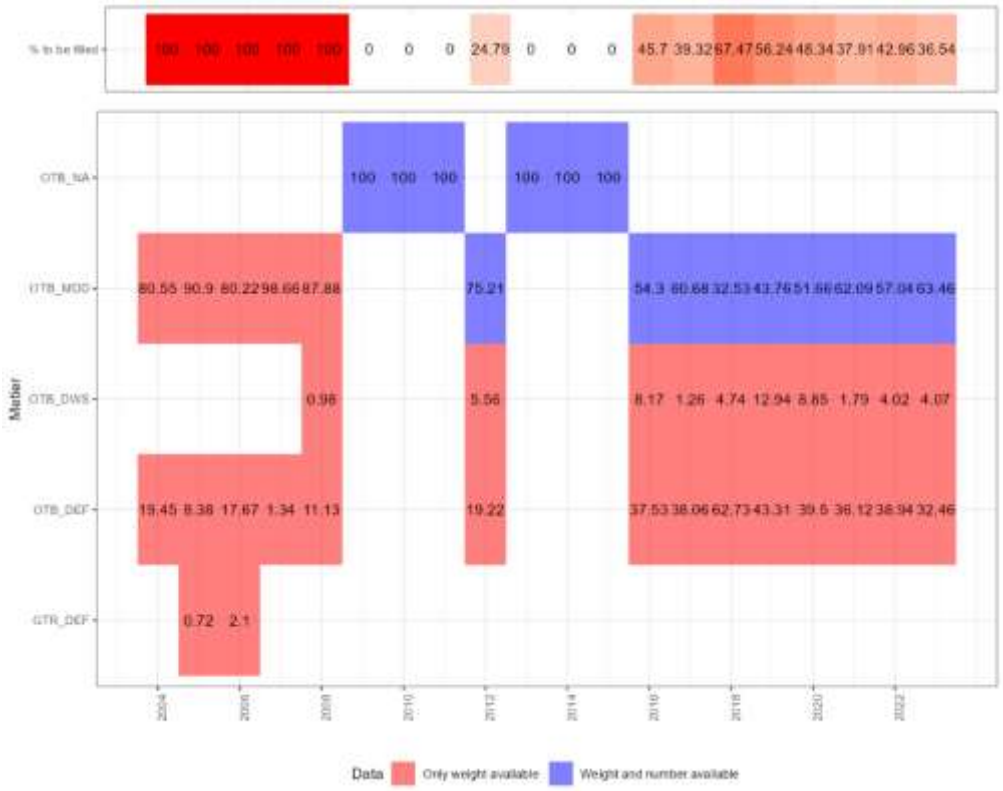
Source: Own elaborations

Figure 6.10.2.1.13 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Size frequency distributions of landing in GSA11.



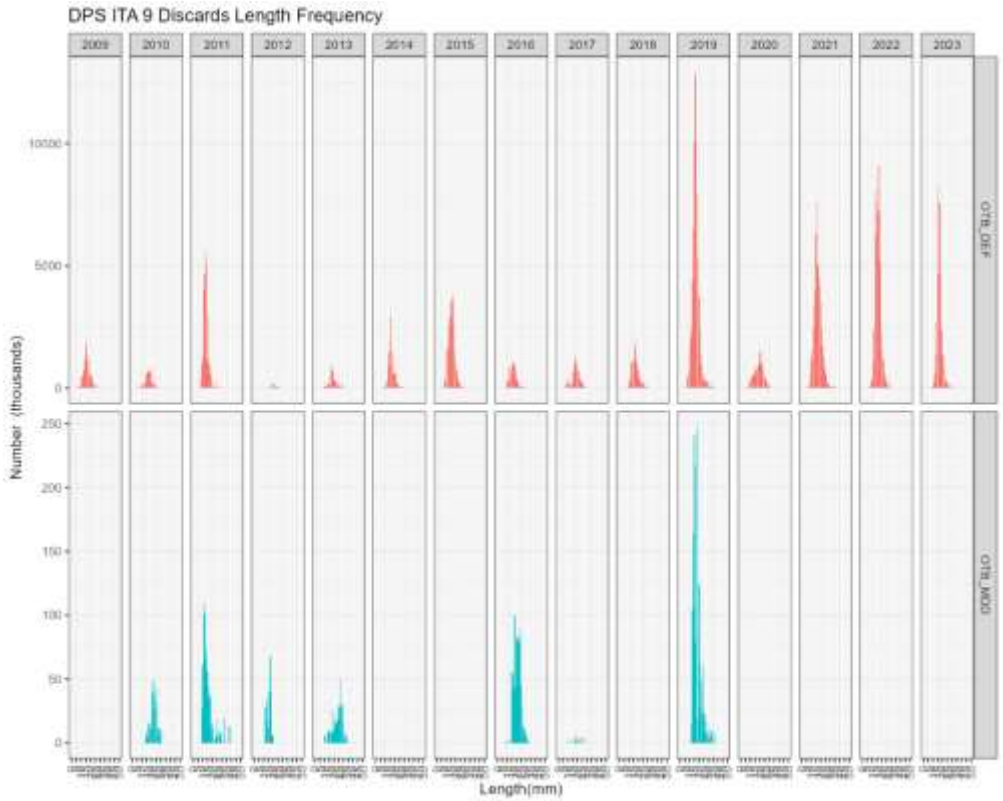
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.14 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Table summarising the relative impact of the metiers on the year total landings in GSA11.



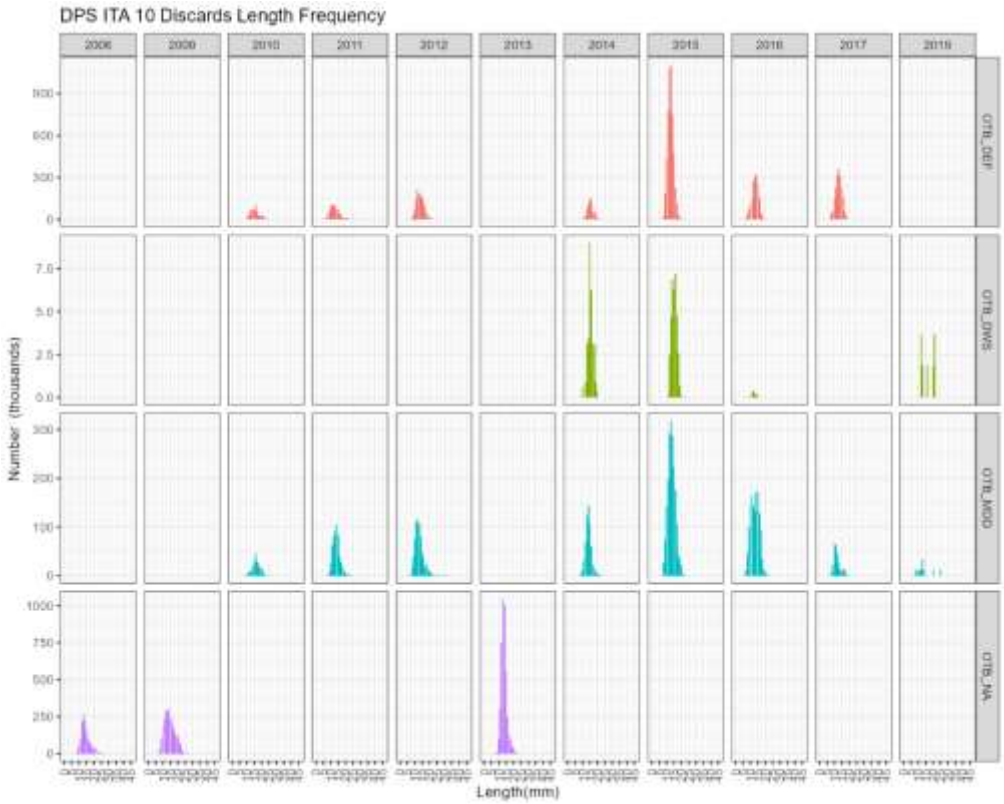
Source: Own elaborations

Figure 6.10.2.1.15 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Size frequency distributions of discard in GSA09.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.10.2.1.16 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Size frequency distributions of discard in GSA10.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

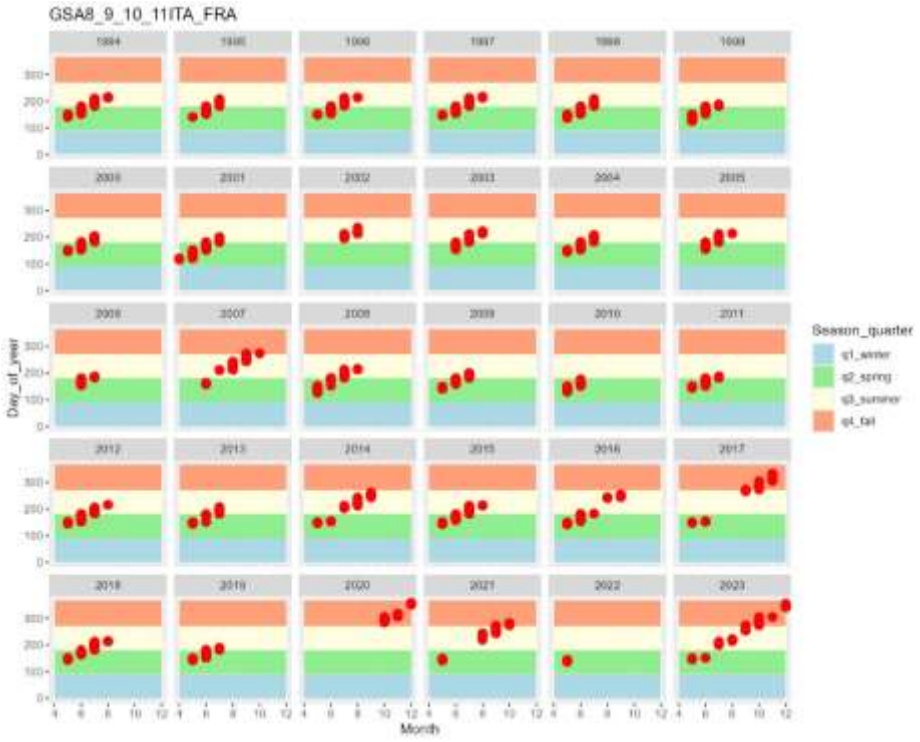
6.10.2.2 EFFORT

6.10.2.3 SURVEY (MEDITS)

Since 1994, MEDITS trawl surveys has been regularly carried out each year, generally during the spring-summer season (Figure 6.10.2.2.1).

In 2017, 2020, 2021 and 2023, the survey was carried out very late (autumn) in GSAs 9, 10 and 11 and about half hauls were performed in GSA10 in 2020. In GSA 9, no survey was carried out in 2022. In 2002 and 2020, the survey in GSA08 was not carried out. In 2022, the survey was not carried out in GSAs 09, 10 and 11. Please note that 2022 data are coming only from GSA 8 (France) and the information wasn't used for stock assessment purposes.

Figure 6.10.2.2.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Table summarising the period in which the surveys have been carried out.



Source: Own elaborations

6.10.2.2.1 Methods

Based on the DCF data, abundance and biomass indices for GSAs 08, 09, 10 and 11 combined were calculated. In Tabs. 6.10.2.2.1.1-4 the number of hauls was reported per depth stratum in each GSA.

Table 6.10.2.2.1.1 Number of hauls per year and depth stratum in GSA08, period 1994-2023.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
10-50													
50-100	4	5	6	2	6	6	6	5		6	6	6	6
100-200	3	4	3		4	4	3	4		4	4	4	4
200-500	6	8	9	7	10	8	9	8		9	8	8	9
500-800	5	5	4	3	3	5	4	5		4	4	5	4
Total	**18**	**22**	**22**	**12**	**23**	**23**	**22**	**22**		**23**	**22**	**23**	**23**

Stratum	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10-50													
50-100	5	7	5	6	6	6	6	6	7	6	6	6	6
100-200	3	4	4	3	4	4	4	4	3	4	4	4	4
200-500	7	10	10	10	9	10	11	10	11	9	11	11	11
500-800	5	4	3	3	4	3	2	3	2	3	2	2	2
Total	**20**	**25**	**22**	**22**	**23**	**23**	**23**	**23**	**23**	**22**	**23**	**23**	**23**

Stratum	2020	2021	2022	2023
10-50				
50-100		8	6	6
100-200		3	4	4
200-500		8	9	9
500-800		4	4	4
Total		**23**	**23**	**23**

Source: Own elaborations

Table 6.10.2.2.1.2 Number of hauls per year and depth stratum in GSA09, period 1994-2023.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
10-50	21	20	20	20	21	20	20	20	15	15	15	16	15
50-100	21	21	20	22	20	21	22	22	17	17	17	16	18
100-200	38	39	40	38	39	39	38	38	30	30	30	31	29
200-500	40	40	40	41	40	41	42	42	33	31	34	34	35
500-800	33	33	33	32	33	32	31	31	25	27	24	23	23
Total	**153**	**153**	**153**	**153**	**153**	**153**	**153**	**153**	**120**	**120**	**120**	**120**	**120**

Stratum	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10-50	15	16	16	15	15	15	16	15	14	14	14	15	15
50-100	18	16	16	19	18	17	17	19	19	18	20	18	18
100-200	29	31	31	29	30	31	30	29	30	31	29	30	30
200-500	35	34	34	34	33	35	35	36	35	36	36	36	37
500-800	23	23	23	23	24	22	22	21	22	21	21	21	20
Total	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**

Stratum	2020	2021	2022	2023
10-50	15	15		15
50-100	20	20		18
100-200	28	28		30
200-500	35	37		35
500-800	22	20		22
Total	**120**	**120**		**120**

Source: Own elaborations

Table 6.10.2.2.1.3 Number of hauls per year and depth stratum in GSA10, period 1994-2023.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
10-50	7	8	8	8	8	8	8	8	7	7	7	7	7

50-100	10	10	10	10	10	10	10	10	8	8	8	8	8
100-200	17	17	17	17	17	17	17	17	14	14	14	14	14
200-500	22	23	22	22	22	22	22	24	18	18	18	18	18
500-800	28	27	28	28	28	27	28	26	23	23	23	23	23
Total	**84**	**85**	**85**	**85**	**85**	**84**	**85**	**85**	**70**	**70**	**70**	**70**	**70**

Stratum	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10-50	7	7	7	7	7	7	7	7	7	7	7	7	7
50-100	8	8	8	8	8	8	7	8	8	8	8	8	8
100-200	14	14	14	14	14	14	14	14	14	14	14	12	14
200-500	18	19	18	18	18	18	18	18	18	18	18	20	18
500-800	23	22	23	23	23	23	23	23	23	23	23	23	23
Total	**70**	**70**	**70**	**70**	**70**	**70**	**69**	**70**	**70**	**70**	**70**	**70**	**70**

Stratum	2020	2021	2022	2023
10-50	3	7		6
50-100	4	8		7
100-200	9	14		12
200-500	9	18		15
500-800	12	23		16
Total	**37**	**70**		**56**

Source: Own elaborations

Table 6.10.2.2.1.4 Number of hauls per year and depth stratum in GSA11, period 1994-2023.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
10-50	16	19	22	21	21	20	19	17	20	18	18	17	19
50-100	25	20	22	23	22	22	22	24	19	19	17	22	19
100-200	20	23	30	31	30	30	31	30	24	24	24	24	24
200-500	32	28	29	26	25	27	24	25	20	24	21	20	20
500-800	23	17	22	25	25	24	27	26	16	14	15	14	16
Total	**116**	**107**	**125**	**126**	**123**	**123**	**123**	**122**	**99**	**99**	**95**	**97**	**98**

Stratum	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
10-50	20	19	18	20	20	20	20	21	18	18	21	19	21
50-100	19	18	20	18	19	19	19	19	19	19	19	18	18
100-200	24	21	24	24	24	24	24	24	24	24	24	24	24
200-500	20	21	19	20	21	21	21	21	21	21	21	21	21
500-800	17	16	16	17	17	17	17	17	17	17	17	17	17

Total	**100**	**95**	**97**	**99**	**101**	**101**	**101**	**102**	**99**	**99**	**102**	**99**	**101**

Stratum	2020	2021	2022	2023
10-50	19	20		18
50-100	19	19		19
100-200	24	24		24
200-500	21	21		21
500-800	17	17		17
Total	**100**	**101**		**99**

Source: Own elaborations

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:

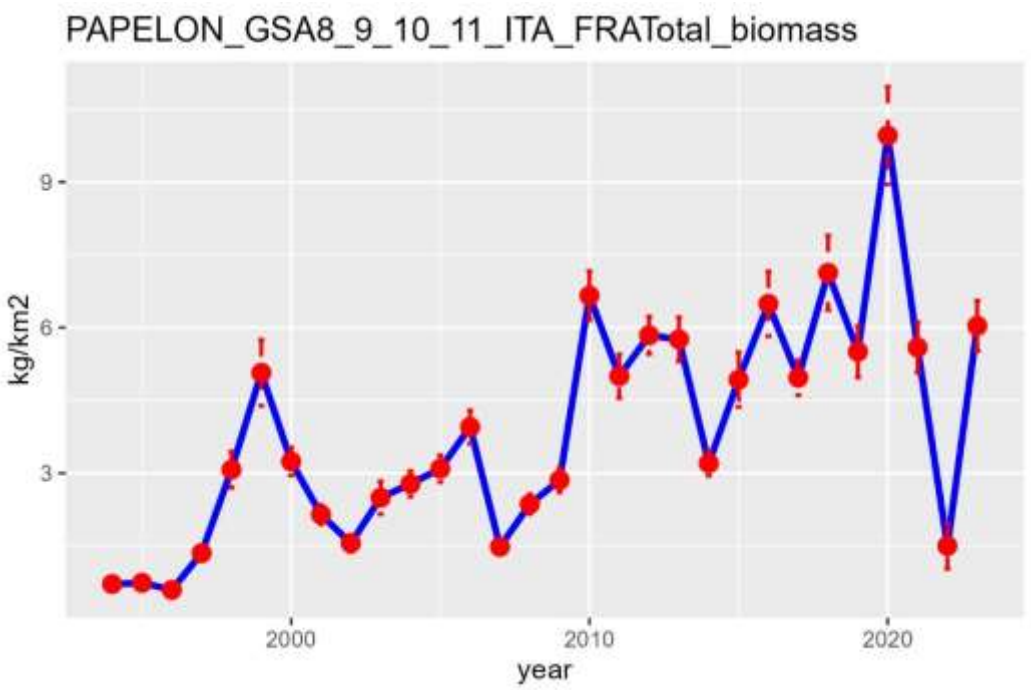
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

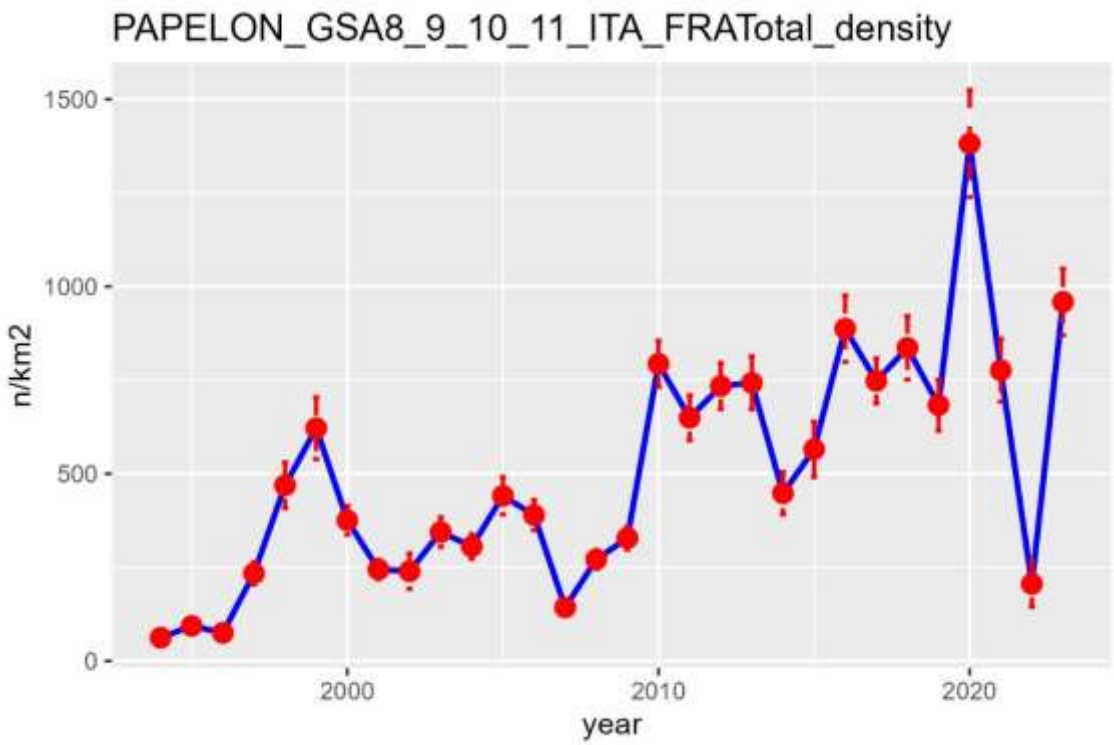
It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson.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

6.10.2.2.3 Trends in abundance and biomass

The trends of the MEDITS indices (density and biomass) for the three GSAs combined are displayed in Fig. 6.10.2.2.3.1. Both indices showed an evident increasing trend with very high values in the periods 2010-2013 and 2015-2020. In 2021, a decreasing was observed both for density and biomass.

Figure 6.10.2.2.3.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. MEDITS standardized abundance and biomass indices (10-800 m).





Source: Own elaborations

6.10.2.2.4 Trends in abundance and biomass by length

Figs. 6.10.2.2.4.1-3 display the stratified abundance indices by length for the three GSAs combined during the MEDITS surveys from 1994 to 2023. Please note that 2022 data are coming only from GSA 8 (France) and the information wasn't used for stock assessment purposes.

Figure 6.10.2.2.4.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Stratified abundance indices by size for females, period 1994-2023.

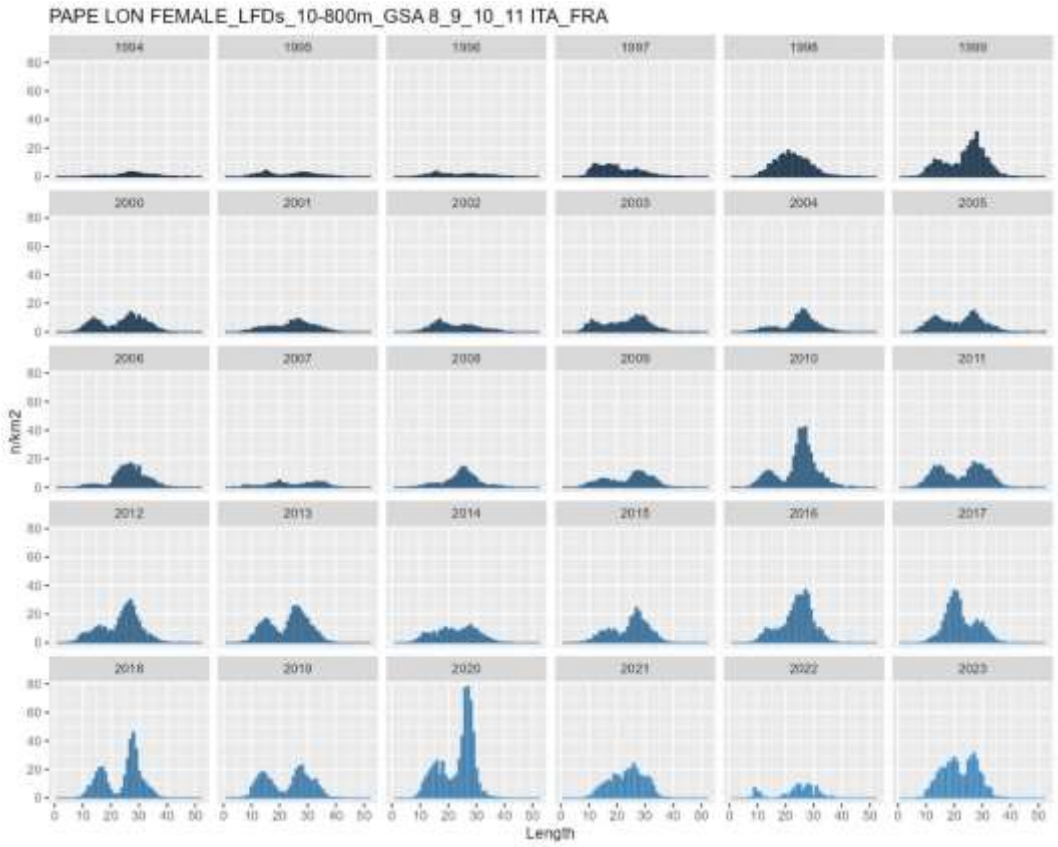


Figure 6.10.2.2.4.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Stratified abundance indices by size for males, period 1994-2023.

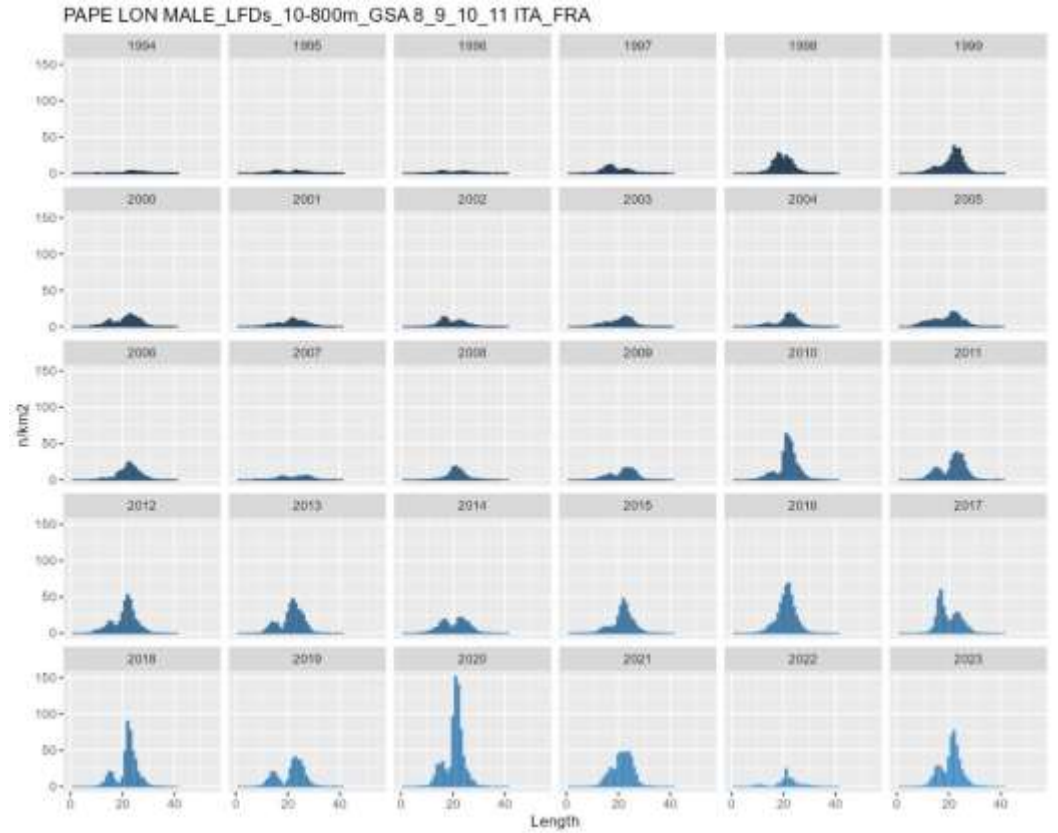
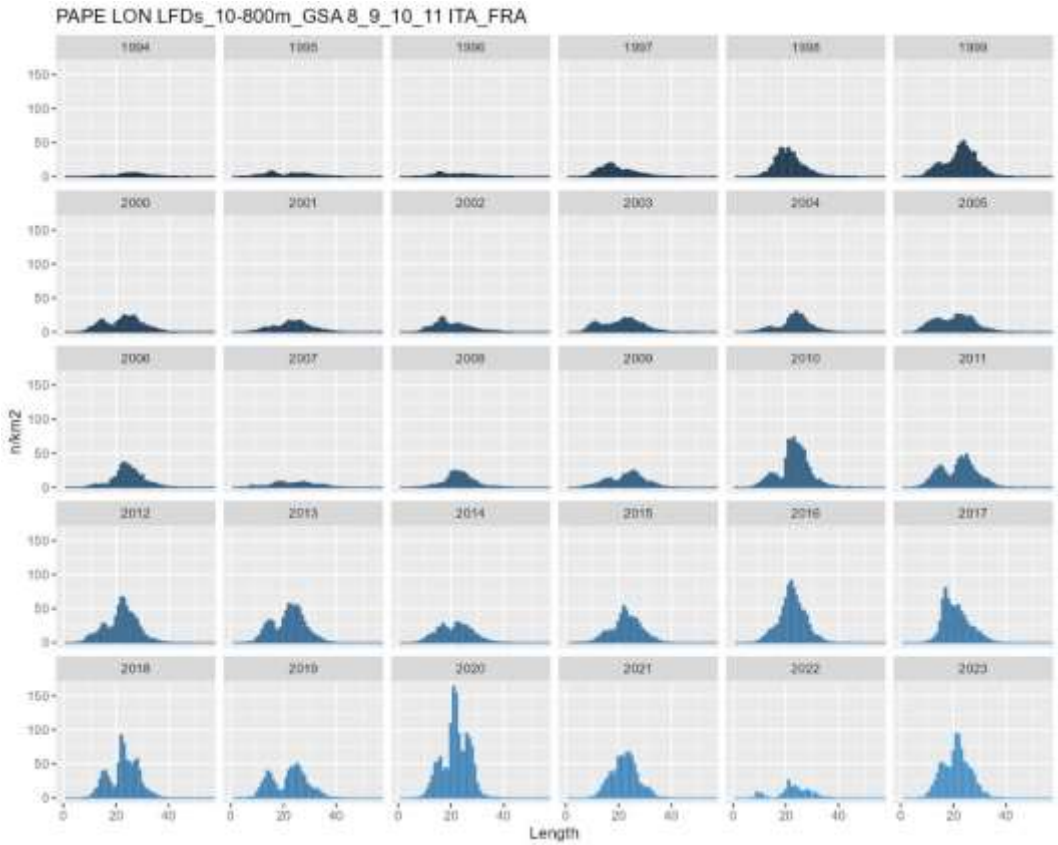


Figure 6.10.2.2.4.3 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Stratified abundance indices by size for the total population, period 1994-2023.



6.10.3 STOCK ASSESSMENT

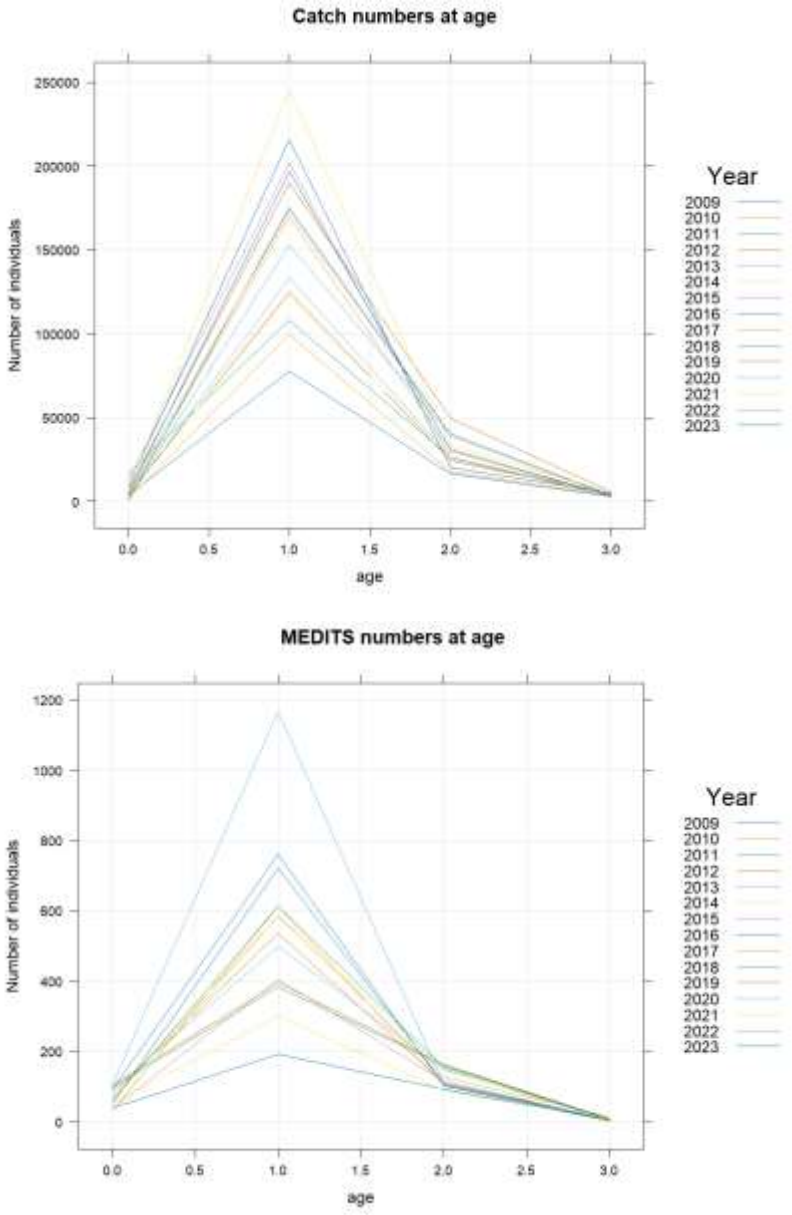
A Statistical Catch-at-age (a4a) assessment was carried out during STECF EWG 24-10 using catch data collected under DCR-DCF from 2009 to 2023 and calibrated with survey data (MEDITS 2009-2023, with a gap in 2022). FLR libraries were employed in order to perform the analyses.

A natural mortality vector computed using Chen and Watanabe model was used in the assessment. Length-frequency distributions of commercial catches (landing + discard) and surveys were split by sex (vectors from DCR-DCF database) and then transformed in age classes using length-to-age slicing with different growth parameters by sex. For the transformation of the frequency distributions into age classes, t_0 growth parameter has been added 0.5 because the peak of reproduction for this species mainly occurs in summer. Plus group was set at age 3 for both commercial and survey data. The number of individuals by age was SOP corrected [SOP = Landings / Σa (total catch numbers at age a x catch weight-at-age a)]. The correction factor resulted low except in very few cases. MEDITS data from the three GSAs for the period 2009-2023 (with a gap in 2022) were used for tuning.

Discards were included in the analysis with the exception of GSAs 08 and 11 for which data is not available. This information was not available in some years also for GSA 10, but LFDs were not reconstructed as discard of DPS is quite low in the area.

Given that the catches were composed mainly of individuals between 1 and 2 years, these ages were selected as the F_{bar}.

Figure 6.10.3.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Age frequency distributions of the total commercial catches (above) and of the MEDITS catches (below) by year.



Tab. 6.10.3.1 Deep-water rose shrimp in GSAs 08, 09, 10 and 11. Input parameters for a4a.

Catch at age (thousands)	Age 0	Age 1	Age 2	Age 3+
2009	2265	67332	17165	2727
2010	2389	97797	18740	3705
2011	3030	103314	26347	4000
2012	3310	130444	26385	5034

2013	3902	137336	30120	4599
2014	3748	151244	27852	4343
2015	4555	135999	27818	3596
2016	5053	161003	24635	3463
2017	4759	183563	30904	3326
2018	5548	182840	37715	4369
2019	5504	220473	37720	5345
2020	6876	213285	41427	4850
2021	5747	247589	34581	4348
2022	6059	192463	36183	3240
2023	5539	197463	28295	3336

Year	Catches (in tons)
2009	688
2010	906
2011	1024
2012	1212
2013	1319
2014	1345
2015	1143
2016	1204
2017	1581
2018	1771
2019	2078
2020	2120
2021	1893
2022	1798
2023	1576

Mean weight at age (Catches)	Age 0	Age 1	Age 2	Age 3+
2009	0.002	0.006	0.013	0.019
2010	0.002	0.006	0.013	0.020
2011	0.002	0.006	0.013	0.018

2012	0.002	0.006	0.013	0.019
2013	0.002	0.006	0.013	0.019
2014	0.002	0.006	0.013	0.019
2015	0.002	0.005	0.012	0.016
2016	0.002	0.005	0.012	0.020
2017	0.002	0.006	0.012	0.017
2018	0.002	0.007	0.011	0.014
2019	0.002	0.007	0.013	0.016
2020	0.002	0.007	0.011	0.013
2021	0.002	0.006	0.012	0.013
2022	0.002	0.007	0.011	0.013
2023	0.002	0.006	0.011	0.015

Mean weight at age (Stock)	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2009	0.002	0.006	0.013	0.019
2010	0.002	0.006	0.013	0.020
2011	0.002	0.006	0.013	0.018
2012	0.002	0.006	0.013	0.019
2013	0.002	0.006	0.013	0.019
2014	0.002	0.006	0.013	0.019
2015	0.002	0.005	0.012	0.016
2016	0.002	0.005	0.012	0.020
2017	0.002	0.006	0.012	0.017
2018	0.002	0.007	0.011	0.014
2019	0.002	0.007	0.013	0.016
2020	0.002	0.007	0.011	0.013
2021	0.002	0.006	0.012	0.013
2022	0.002	0.007	0.011	0.013
2023	0.002	0.006	0.011	0.015

Natural mortality	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2009	2.01	1.13	0.94	0.91
2010	2.01	1.13	0.94	0.91

2011	2.01	1.13	0.94	0.91
2012	2.01	1.13	0.94	0.91
2013	2.01	1.13	0.94	0.91
2014	2.01	1.13	0.94	0.91
2015	2.01	1.13	0.94	0.91
2016	2.01	1.13	0.94	0.91
2017	2.01	1.13	0.94	0.91
2018	2.01	1.13	0.94	0.91
2019	2.01	1.13	0.94	0.91
2020	2.01	1.13	0.94	0.91
2021	2.01	1.13	0.94	0.91
2022	2.01	1.13	0.94	0.91
2023	2.01	1.13	0.94	0.91

Proportion of mature	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2009	0.0	0.7	1	1
2010	0.0	0.7	1	1
2011	0.0	0.7	1	1
2012	0.0	0.7	1	1
2013	0.0	0.7	1	1
2014	0.0	0.7	1	1
2015	0.0	0.7	1	1
2016	0.0	0.7	1	1
2017	0.0	0.7	1	1
2018	0.0	0.7	1	1
2019	0.0	0.7	1	1
2020	0.0	0.7	1	1
2021	0.0	0.7	1	1
2022	0.0	0.7	1	1
2023	0.0	0.7	1	1

MEDITS tuning index	**Age 0**	**Age 1**	**Age 2**	**Age 3+**
2009	39	193	92	4

2010	70	584	126	14
2011	98	384	159	9
2012	78	537	109	9
2013	90	499	148	6
2014	53	301	88	6
2015	37	404	116	7
2016	52	720	110	4
2017	29	613	103	3
2018	60	613	156	7
2019	105	394	164	7
2020	106	1167	106	2
2021	36	586	150	3
2022	NA	NA	NA	NA
2023	92	762	102	3

The assessment was performed with combined sexes. The model configuration that minimized residuals and yielded the most reliable diagnostic outputs was chosen for the final evaluation. The only adjustment from the previous assessment by STECF EWG 22-09 was an update to the parameter k in the fmodel (set to k=6 by STECF EWG 24-10). The model settings adopted by STECF EWG 24-10 are as follows:

Fishing mortality sub-model:

fmodel <- ~ factor(replace(age, age>2,2)) + s(year, k=6)

Catchability sub-model:

qmodel <- list(~ factor(age))

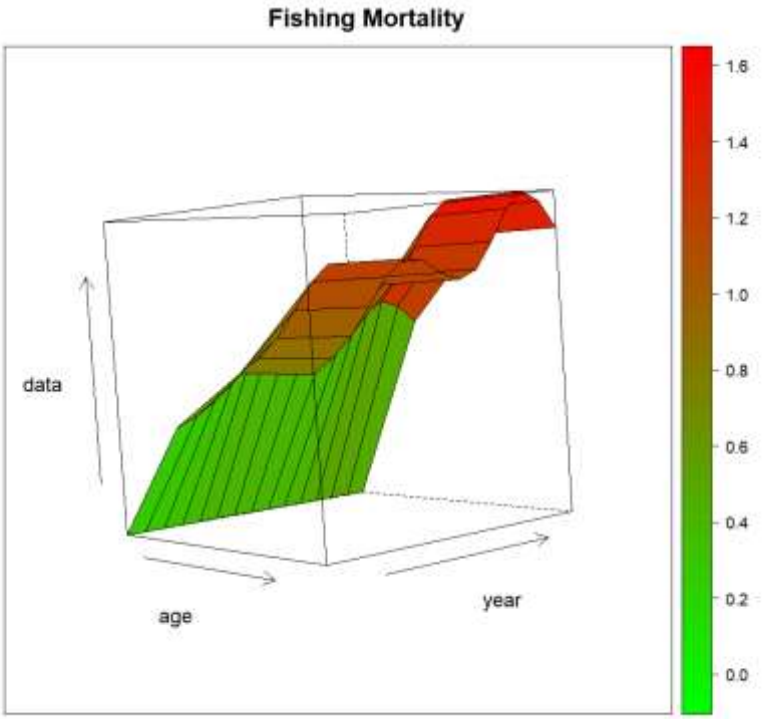
Recruitment sub-model:

srmodel <- ~ geomean (CV=0.2)

Model <- a4aSCA(stock = stk, indices = idx, fmodel, qmodel, srmodel)

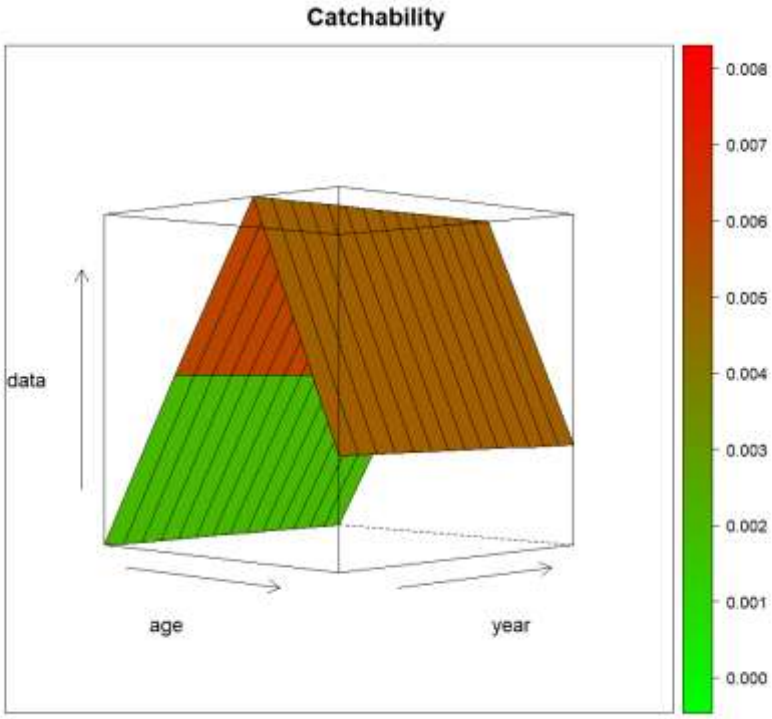
The results are shown in Figs. 6.10.3.2-12 and Tabs. 6.10.3.2-4.

Figure 6.10.3.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Fishing mortality by age and year obtained from the a4a model (2009-2023).



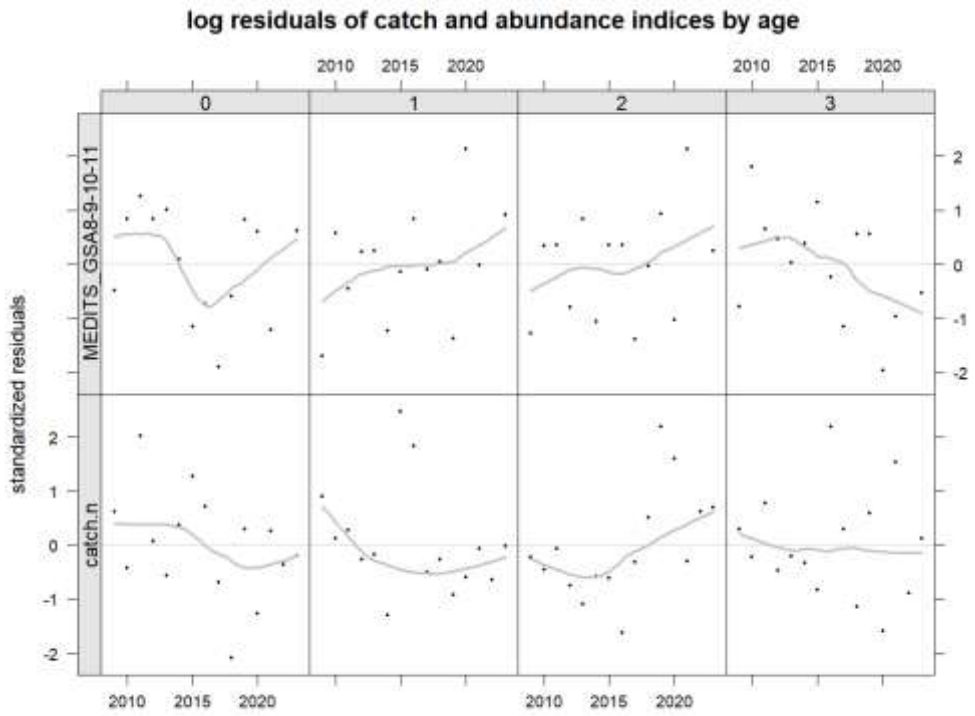
Source: Own elaborations

Figure 6.10.3.3 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Catchability by age and year obtained from the a4a model (2009-2023).



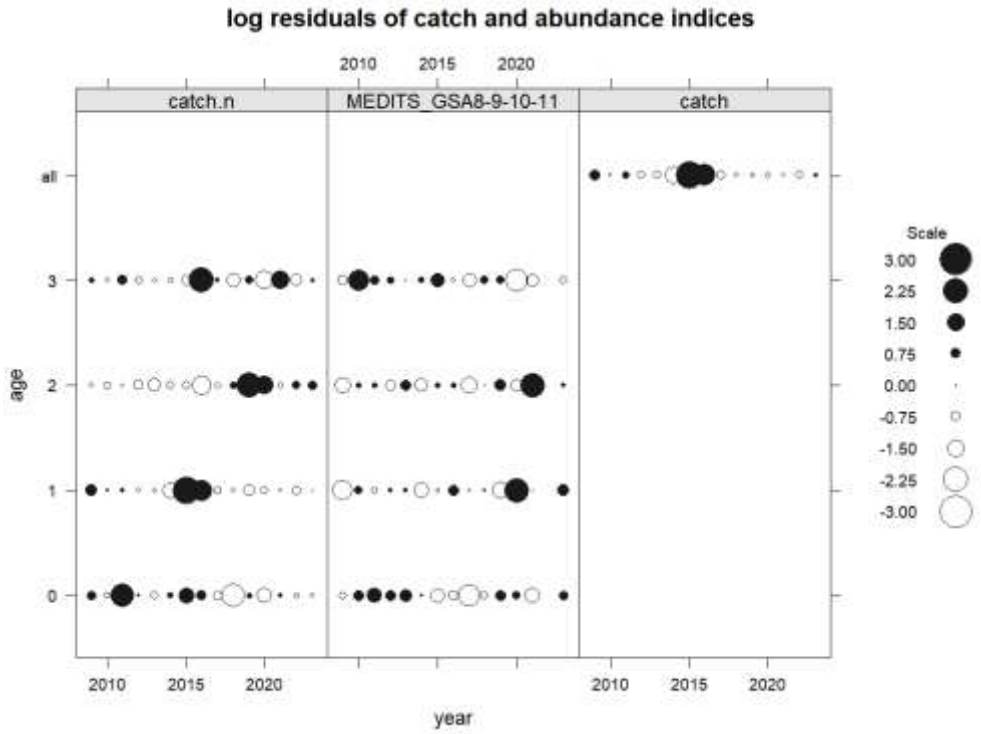
Source: Own elaborations

Figure 6.10.3.4 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Log residuals of the fishery and the survey data by age, and of the total catches.



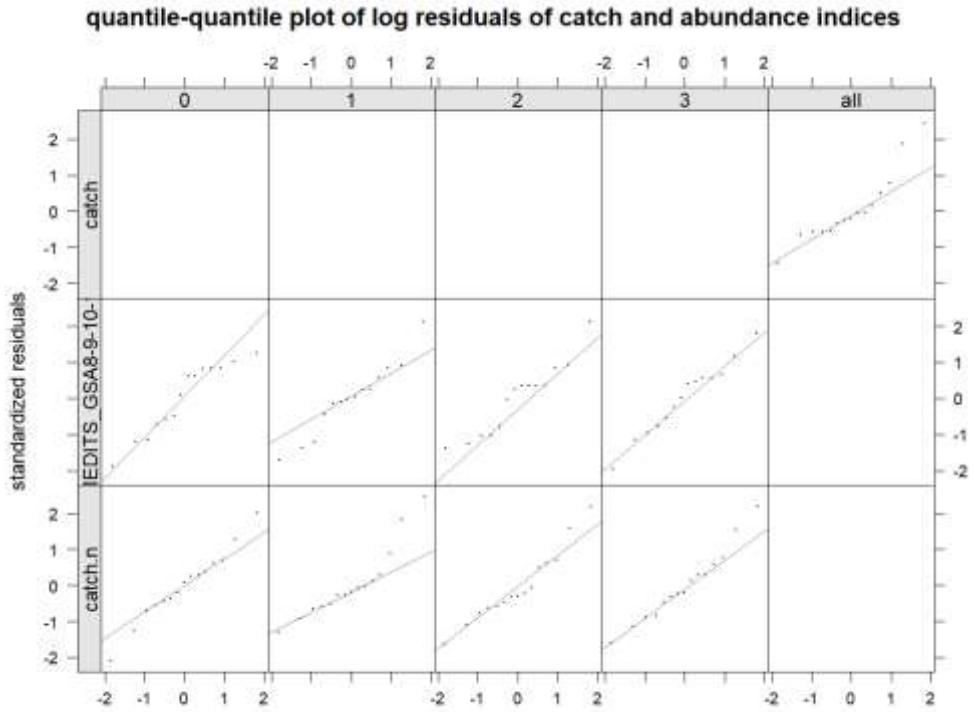
Source: Own elaborations

Figure 6.10.3.5 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Bubble plot of the log residuals of the fishery and the survey data by age, and of the total catches.



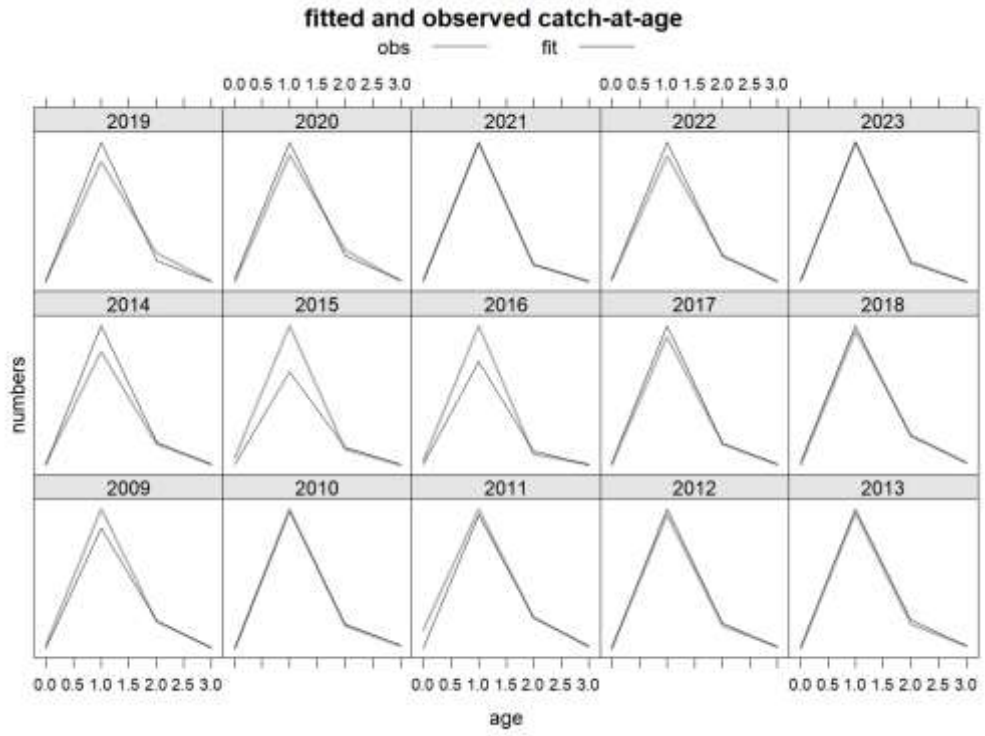
Source: Own elaborations

Figure 6.10.3.6 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. QQ-plot of the log residuals of the fishery and the survey data by age, and of the total catches.



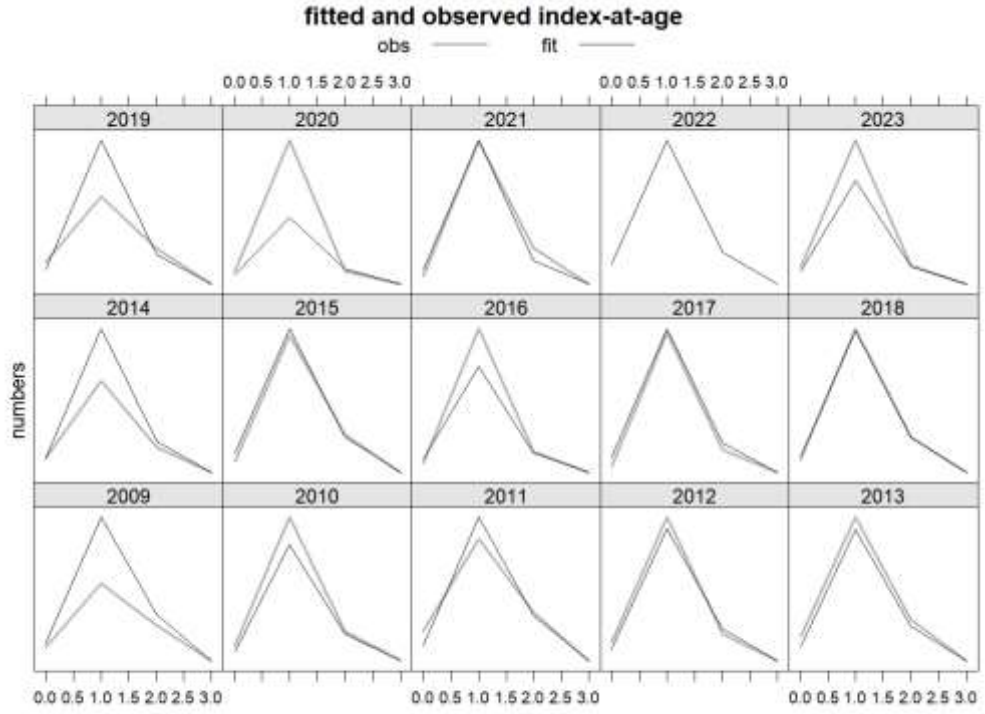
Source: Own elaborations

Figure 6.10.3.7 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Fitted and observed catches at age by year.



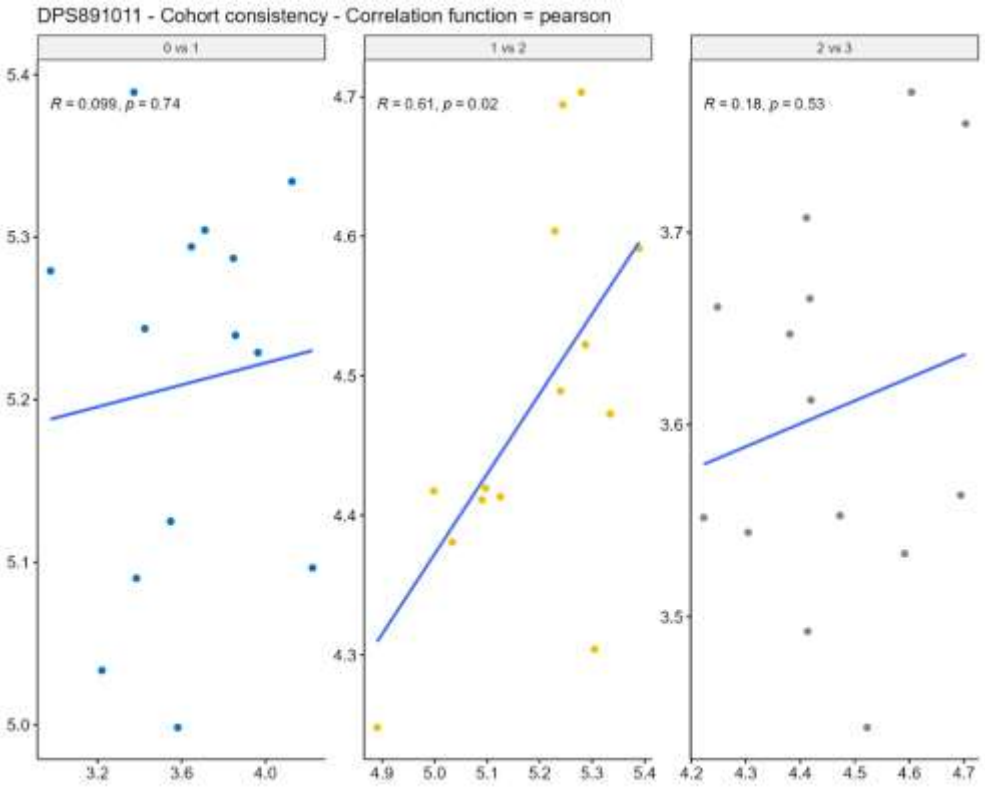
Source: Own elaborations

Figure 6.10.3.8 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Fitted and observed MEDITS index at age by year.



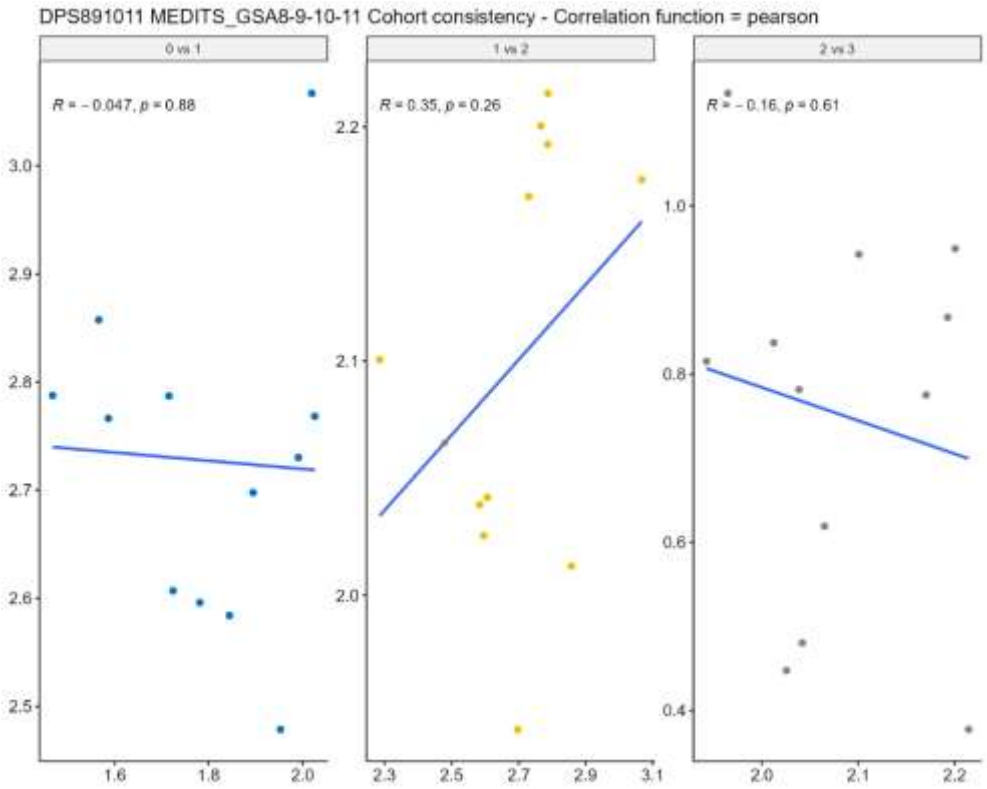
Source: Own elaborations

Figure 6.10.3.9 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Internal consistency of the catch at age data.



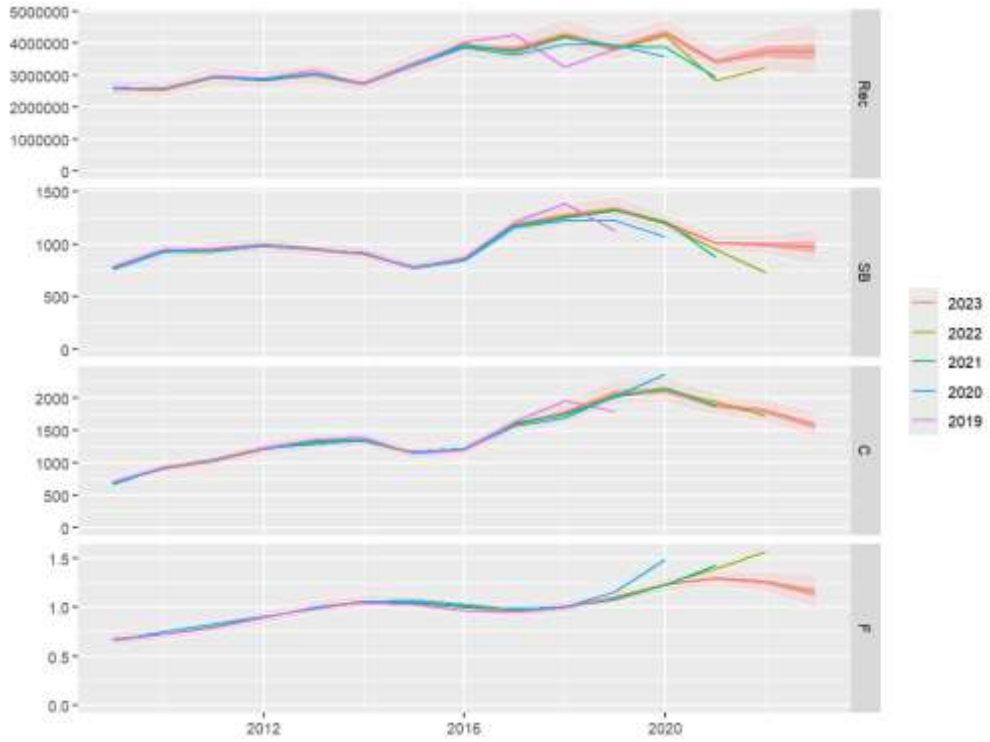
Source: Own elaborations

Figure 6.10.3.10 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Internal consistency of the MEDITS index at age data.



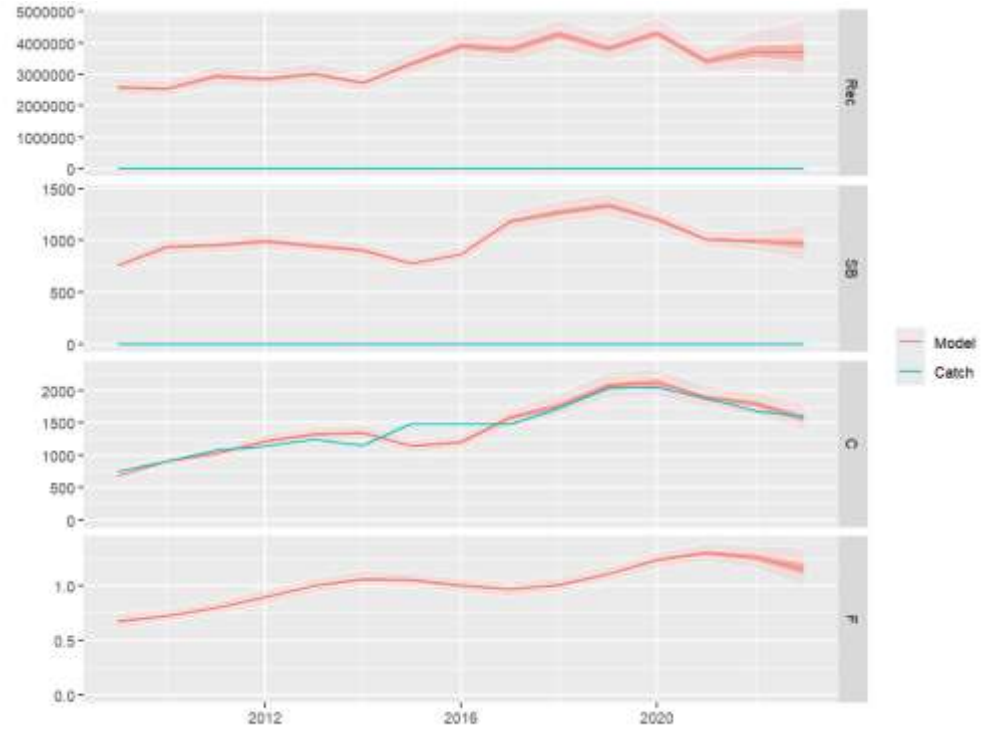
Source: Own elaborations

Figure 6.10.3.11 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Retrospective analysis.



Source: Own elaborations

Figure 6.10.3.12 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Outputs of the a4a stock assessment model with uncertainty. Green line represents the catches observed.



Source: Own elaborations

Tab. 6.10.3.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Outputs of the a4a stock assessment model - Stock number at age (thousands).

Stock number at age (thousands)	Age 0	Age 1	Age 2	Age 3+
2009	2591147	252183	45149	7094
2010	2547348	346480	46924	9177
2011	2945119	340572	61934	9303
2012	2862406	393672	57471	10852
2013	3022595	382500	61288	9263
2014	2735828	403780	54703	8446
2015	3354791	365406	54927	7029
2016	3910025	448088	50097	6971
2017	3797759	522329	64030	6822
2018	4275666	507377	76507	8773
2019	3847642	571166	72260	10139
2020	4319066	513830	74791	8674
2021	3428528	576570	60752	7568
2022	3730804	457598	64634	5733
2023	3724172	498002	53021	6191

Source: Own elaborations

Tab. 6.10.3.3 Deep-water rose shrimp in GSAs 09, 10 & 11. Outputs of the a4a stock assessment – Fishing mortality at age.

Fishing mortality at age	Age 0	Age 1	Age 2	Age 3+
2009	0.002	0.552	0.803	0.803
2010	0.002	0.592	0.862	0.862
2011	0.002	0.649	0.946	0.946
2012	0.003	0.730	1.063	1.063
2013	0.003	0.815	1.187	1.187
2014	0.003	0.865	1.260	1.260
2015	0.003	0.857	1.248	1.248

2016	0.003	0.816	1.188	1.188
2017	0.003	0.791	1.152	1.152
2018	0.003	0.819	1.193	1.193
2019	0.003	0.903	1.315	1.315
2020	0.004	1.005	1.464	1.464
2021	0.004	1.058	1.541	1.541
2022	0.004	1.025	1.493	1.493
2023	0.003	0.939	1.367	1.367

Source: Own elaborations

Tab. 6.10.3.4 Deep-water rose shrimp in GSAs 09, 10 & 11. Outputs of the a4a stock assessment.

Year	$F_{bar\ 1\text{-}2}$	Recruitment (thousands	SSB (t)	Total Biomass (t)
2009	0.677	2591147	765	688
2010	0.727	2547348	935	906
2011	0.798	2945119	952	1024
2012	0.896	2862406	990	1212
2013	1.001	3022595	951	1319
2014	1.062	2735828	906	1345
2015	1.053	3354791	776	1143
2016	1.002	3910025	866	1204
2017	0.971	3797758	1183	1581
2018	1.006	4275666	1273	1771
2019	1.109	3847642	1336	2078
2020	1.234	4319066	1203	2120
2021	1.300	3428528	1009	1893
2022	1.259	3730804	994	1798
2023	1.153	3724172	968	1576

Source: Own elaborations

Based on a4a results, the Deep-water rose shrimp, fishing mortality (Fbar) shows a steady increase from 2009 (0.677) to a peak in 2021 (1.300), followed by a slight reduction in 2022 and 2023. Recruitment fluctuates across the years, peaking in 2020 at 4,319,066 thousand individuals, with slightly lower values in subsequent years. SSB shows a general increase from 2009 to 2019, but declines after 2019, reaching 968 tons in 2023. Total biomass follows a similar pattern, peaking in 2020 (2,120 tons) before decreasing to 1,576 tons in 2023. This suggests that the stock may be experiencing overfishing pressures, as indicated by the elevated Fbar and the recent decline in biomass and SSB.

6.10.4 REFERENCE POINTS

The STECF EWG 22-09 recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the a4a assessment.

Current F (1.15), estimated applying catch in biomass projection as F_{bar1-2} in the last year of the time series (2023), is below the reference point $F_{0.1}$ (1.39), which is a proxy of F_{msy} and is used as the exploitation reference point consistent with high long term yields. This indicates that Deep-water rose shrimp stock in GSAs 8, 9, 10 and 11 is sustainably exploited. SSB is above B_{MSY}.

Estimation of biomass reference points

Based on the results of the exploratory analysis conducted during EWG 22-03, the Geometric Mean model was deemed the most appropriate approach for estimating biomass reference points for the Deep-water rose shrimp stock in GSAs 8, 9, 10, and 11. Table 6.10.4.1 summarizes the reference point estimates derived from the Geometric Mean model fitted to the available data.

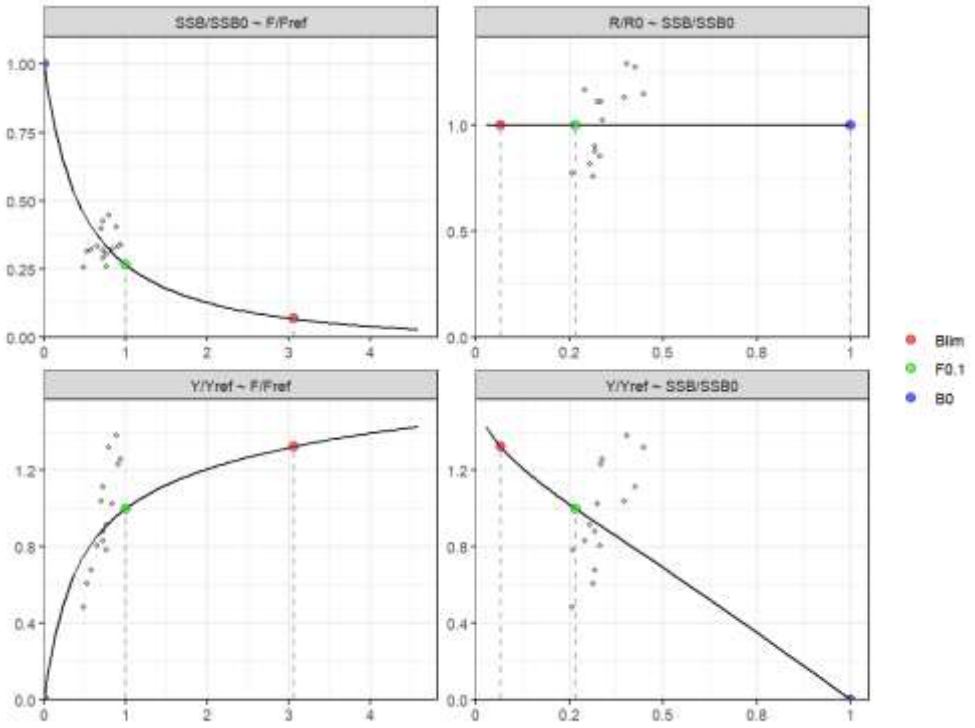
In this model, Bpa is set at twice the value of BLim, reflecting a precautionary buffer to account for uncertainty. The corresponding stock dynamics implied by these reference points are illustrated in Figure 6.10.4.1, which provides visual insights into the relationship between biomass levels and stock status.

Table 6.10.4.1 Deep-water rose shrimp in GSAs 8, 9, 10 & 11. Final reference points based on Geometric mean and a default value of BLim =25% $B_{F0.1}$.

$F_{0.1}$	B_{lim}	B_{pa}	$B_{F0.1}$	B_0	Fpa
1.39	198.5	397	794	2986.4	4.24

Figure 6.10.4.4 Deep-water rose shrimp in GSAs 8, 9, 10 & 11. Reference point estimates. Grey dots show the corresponding observations.

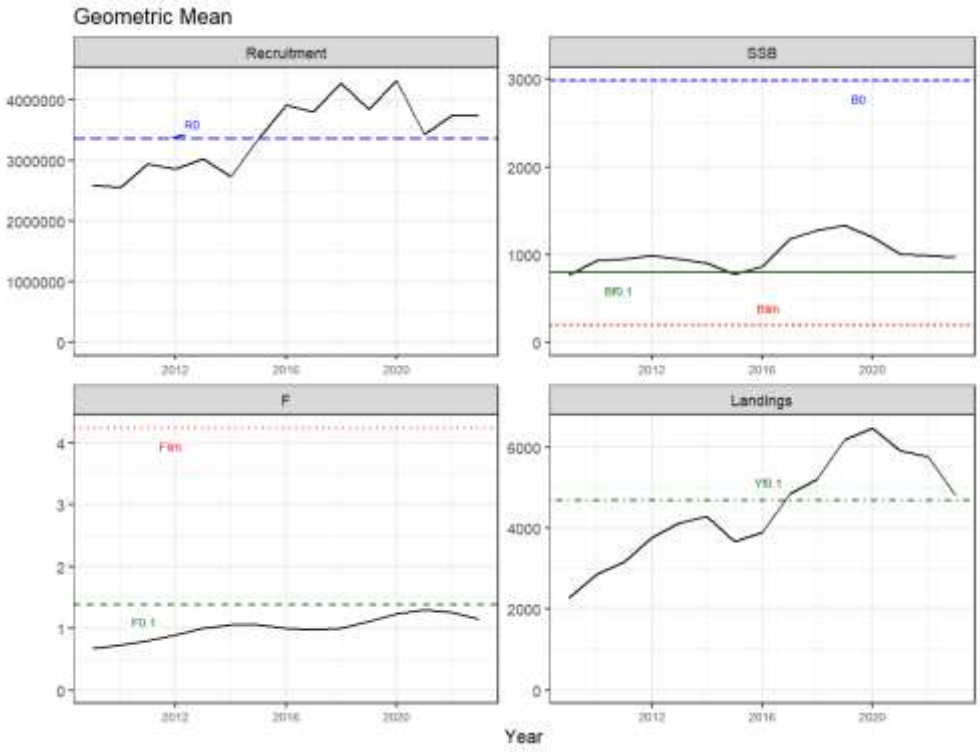
Source: Own elaborations



Source: Own elaborations

Figures 6.10.4.5 show the stock trajectories for recruitment, SSB, F, and landings, comparing them to the estimated reference points, which are based on a Geometric mean stock-recruitment relationship for Deep-water rose shrimp in GSAs 8, 9, 10 and 11. Recruitment shows a fluctuating trend, peaking around 2020 and stabilizing just below the estimated reference point R0, SSB rises significantly from 2015 to 2019 but has slightly declined in recent years, remaining above the B_{lim} threshold and close to the $B_{f0.1}$. Fishing mortality has steadily increased since 2010, nearing the reference point $F_{0.1}$ but remains below the F_{lim}, indicating that overfishing is not currently occurring. Landings have increased significantly from 2010 to 2019, peaking around 2020, but have shown a slight decline in the last few years, still above the yield reference point $Y_{f0.1}$.

Figure 6.10.4.5 Deep-water rose shrimp in GSAs 8, 9, 10 & 11. Status Advice plot showing stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Geometric mean stock-recruitment relationship.



Source: Own elaborations

6.10.5 SHORT TERM FORECAST AND CATCH OPTIONS

For the interim year (2023), an average of the last three years has been used for weight at age and maturity at age, while the F_{bar} = 1.15 was used for F in 2023.

Recruitment (age 0) has been estimated from the population results as the geometric mean of the whole data series (3,357,265 thousand individuals).

The short term forecast (Tab. 6.10.5.1) was carried out estimating a catch for 2024-2026 on the basis of a recruitment constant and equal to the mean on the whole time series and an F by age equal to that of the terminal year. These assumptions resulted in a catch and a SSB in 2024 equal to 1668 and 1024 tons, respectively.

Tab. 6.10.5.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Short term forecast in different F scenarios. SSB refers to the middle of the year.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-2 (2024)	1.15	F in the last year
SSB (2024)	1024	SSB intermediate year from STF output
Rage0 (2024,2025)	3357265	Recruitment will be set as mean of the whole time series
Total Catch (2024)	1668	Catch intermediate year from STF output

Variable	Value	Notes
Fbar (2019)	1.11	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from Ftransition regression line

Source: Own elaborations

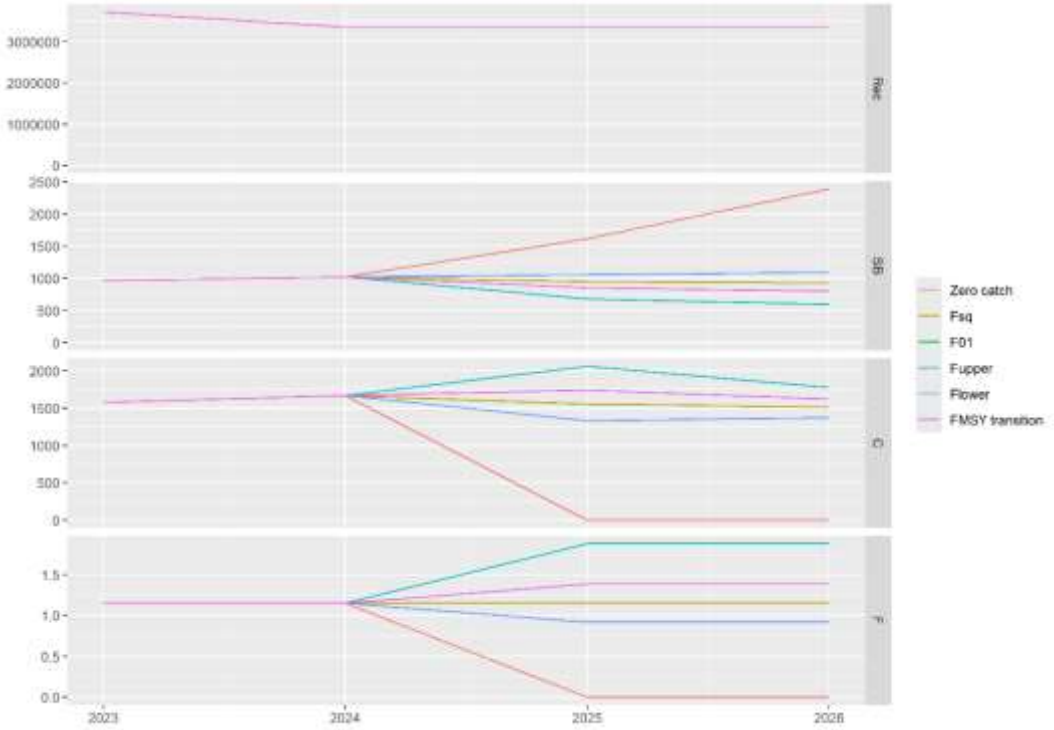
The analysis, carried out with stf.r FLR script made available to the EWG, shows that fishing at a level equal to $F_{0.1}$ (= 1.39) would reduce SSB by 22% from 2024 to 2026 while catch would increase by 10.5% from 2023 to 2025.

Tab. 6.10.5.2 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Short term forecast in different F scenarios. SSB refers to the middle of the year.

Rationale	Ffactor	Fbar	Catch2023	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	1.20	1.39	1575.55	1741.71	1024.37	799.79	-21.92	10.55
F upper	1.63	1.88	1575.55	2059.84	1024.37	598.84	-41.54	30.74
F lower	0.80	0.92	1575.55	1330.04	1024.37	1097.14	7.10	-15.58
FMSY transition	1.20	1.39	1575.55	1741.71	1024.37	799.79	-21.92	10.55
Zero catch	0.00	0.00	1575.55	0.00	1024.37	2390.17	133.33	-100.00
Status quo	1.00	1.15	1575.55	1553.27	1024.37	930.33	-9.18	-1.41
Different Scenarios	0.10	0.12	1575.55	220.62	1024.37	2139.20	108.83	-86.00
	0.20	0.23	1575.55	422.78	1024.37	1922.07	87.63	-73.17
	0.30	0.35	1575.55	608.25	1024.37	1733.65	69.24	-61.39
	0.40	0.46	1575.55	778.59	1024.37	1569.65	53.23	-50.58
	0.50	0.58	1575.55	935.23	1024.37	1426.44	39.25	-40.64
	0.60	0.69	1575.55	1079.45	1024.37	1300.95	27.00	-31.49
	0.70	0.81	1575.55	1212.37	1024.37	1190.61	16.23	-23.05
	0.80	0.92	1575.55	1335.05	1024.37	1093.25	6.72	-15.26
	0.90	1.04	1575.55	1448.40	1024.37	1007.01	-1.69	-8.07
	1.10	1.27	1575.55	1650.40	1024.37	861.90	-15.86	4.75
	1.20	1.38	1575.55	1740.49	1024.37	800.60	-21.84	10.47
	1.30	1.50	1575.55	1824.14	1024.37	745.47	-27.23	15.78
	1.40	1.61	1575.55	1901.91	1024.37	695.71	-32.08	20.71
	1.50	1.73	1575.55	1974.32	1024.37	650.63	-36.48	25.31
	1.60	1.85	1575.55	2041.80	1024.37	609.63	-40.49	29.59
	1.70	1.96	1575.55	2104.79	1024.37	572.22	-44.14	33.59
	1.80	2.08	1575.55	2163.64	1024.37	537.97	-47.48	37.33
	1.90	2.19	1575.55	2218.71	1024.37	506.51	-50.55	40.82
	2.00	2.31	1575.55	2270.30	1024.37	477.52	-53.38	44.10

Source: Own elaborations

Fig. 6.10.5.1 Deep-water rose shrimp in GSAs 08, 09, 10 & 11. Short-term forecast in different F scenarios.



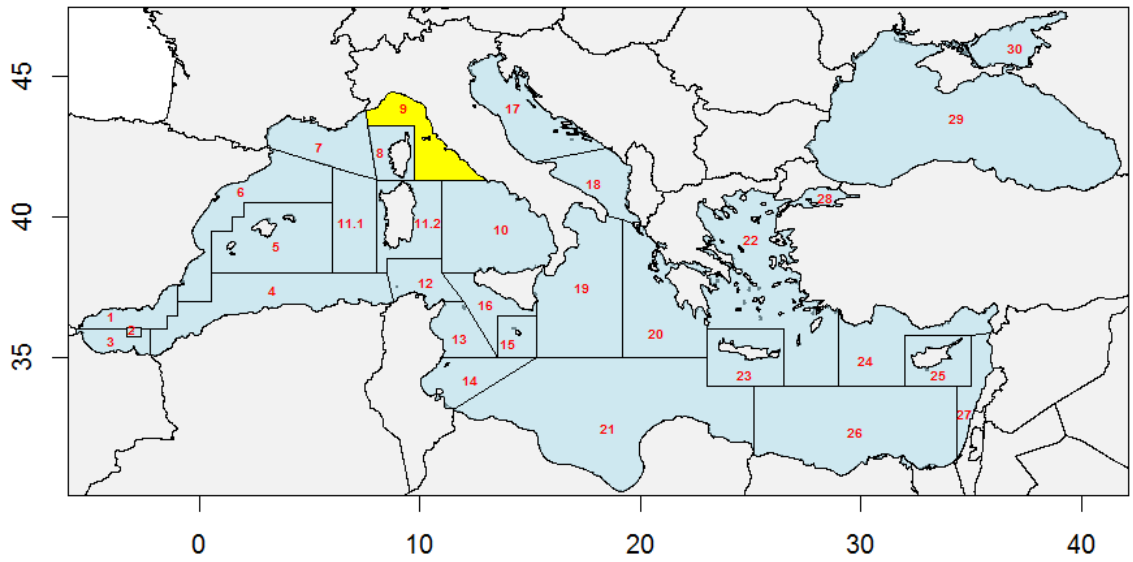
Source: Own elaborations

6.11 Red Mullet in GSA 9

6.11.1 Stock Identity and Biology

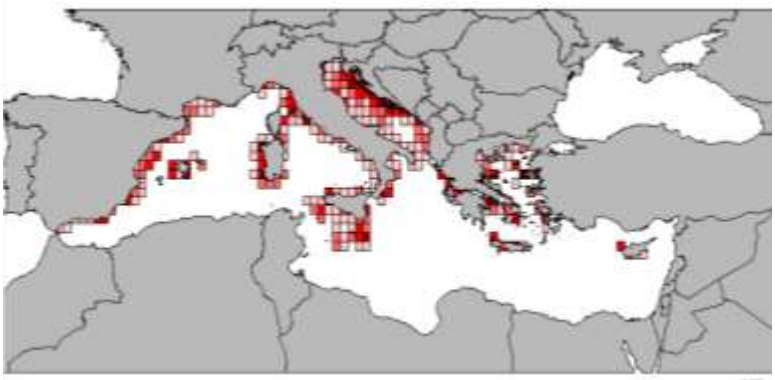
Red mullet (*Mullus barbatus*) is distributed in GSA 9 (Figure 6.11.1.1) along the shelf at depths up to 200m, but mainly concentrated in the depth range 0-100 m. EU project STOCKMED outcomes suggest a single stock unit in the GSA 9 and the rest of Western Mediterranean (see: https://ec.europa.eu/fisheries/documentation/studies/stockmed_en). Available spatial information from MEDITS show continuous distribution of the red mullets along western Italian coast (i.e., connectivity of GSA9 with GSA 10) (Figure 6.11.1.2).

Figure 6.11.1.1 Red mullet in GSA 9. Location of GSA 9 in the Mediterranean Sea.



Source: Own elaborations

Figure 6.11.1.2 Red mullet in GSA 9. Geographical distribution of red mullet in the Mediterranean basin (kg/km^2, average 2004-2014 by GFCM rectangle), STOCKMED Project.



Source: Own elaborations

However, in line with ToR given, EWG 24-10 assumed here that inside the GSA 9 boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population. The hypothesis of a single stock of red mullet in GSA 9, which includes waters belonging to 2 different seas (Ligurian and Tyrrhenian) separated by the Elba Island as well as fleets that do not show any spatial overlapping is unlikely. The inability to account for spatial structure reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources (STECF, 2014).

Growth

Growth parameters of red mullet in GSA 9 are available from 2006 to 2022 from DCF data. For the aim of the stock assessment a set of von Bertalanffy parameters given by the average along the years was used. It should be noticed that these growth parameters are quite different from the ones used for the neighbouring area (GSA 10; Section 6.12.1), that were consistent with the parameters estimated and validated by means of a set of different methods in Carbonara *et al.* (2018).

Similarly to the previous assessment, the mean length at age 0 were associated to the age classes to the mean length at the end of the year, being the a4a model parameterized with calendar year. As in the EWG 22-09 it was agreed to shift length slicing by adding a value of 0.5 to the t_0 value used in earlier assessments (set at -0.33 for both females and males) for internal consistency in the stock assessment model. The adjusted parameters, used in L2a length slicing for the assessment, are:

Linf=26.56, k=0.545, t_0=0.17 for females; Linf=21.55, k=0.56, t_0=0.17 for males.

Original growth curves are used to estimate natural mortality (see below).

Length-weight relationships for females and males were the ones used for the assessment performed by EWG 19-10: females: a = 0.012, b = 3; males: a = 0.017, b = 2.84 (average of DCF data along the years 2002-2017).

Natural mortality

Natural mortality (M) was estimated according to Chen and Watanabe (1989) model on the age vector at half year (0.5, 1.5, 2.5,…) using the orginal growth parameters, without the adjustement of the t_0.

Linf=26.56, k=0.545, t_0=-0.33 for females; Linf=21.55, k=0.56, t_0=-0.33 for males.

Maturity

Maturity ogives by age were available from 2006 to 2022 in the DCF data. The vector of matures by year and age showed a wide uncertainty especially on maturity at age 0 and 1, that seems inconsistent with the growth curve and the spawning season of the species. For this reason the EWG 22-09 preferred to use the vector of maturity agreed and used for all the red mullet stocks assessed in the working group. Mortality and maturity parameters used in assessment are shown in Table 6.11.1.1.

Table 6.11.1.1 Red mullet in GSA 9. Natural mortality and maturity vector at age.

Age	0	1	2	3	4+
M *	1.52	0.87	0.7	0.63	0.59
Proportion mature	0	1	1	1	1

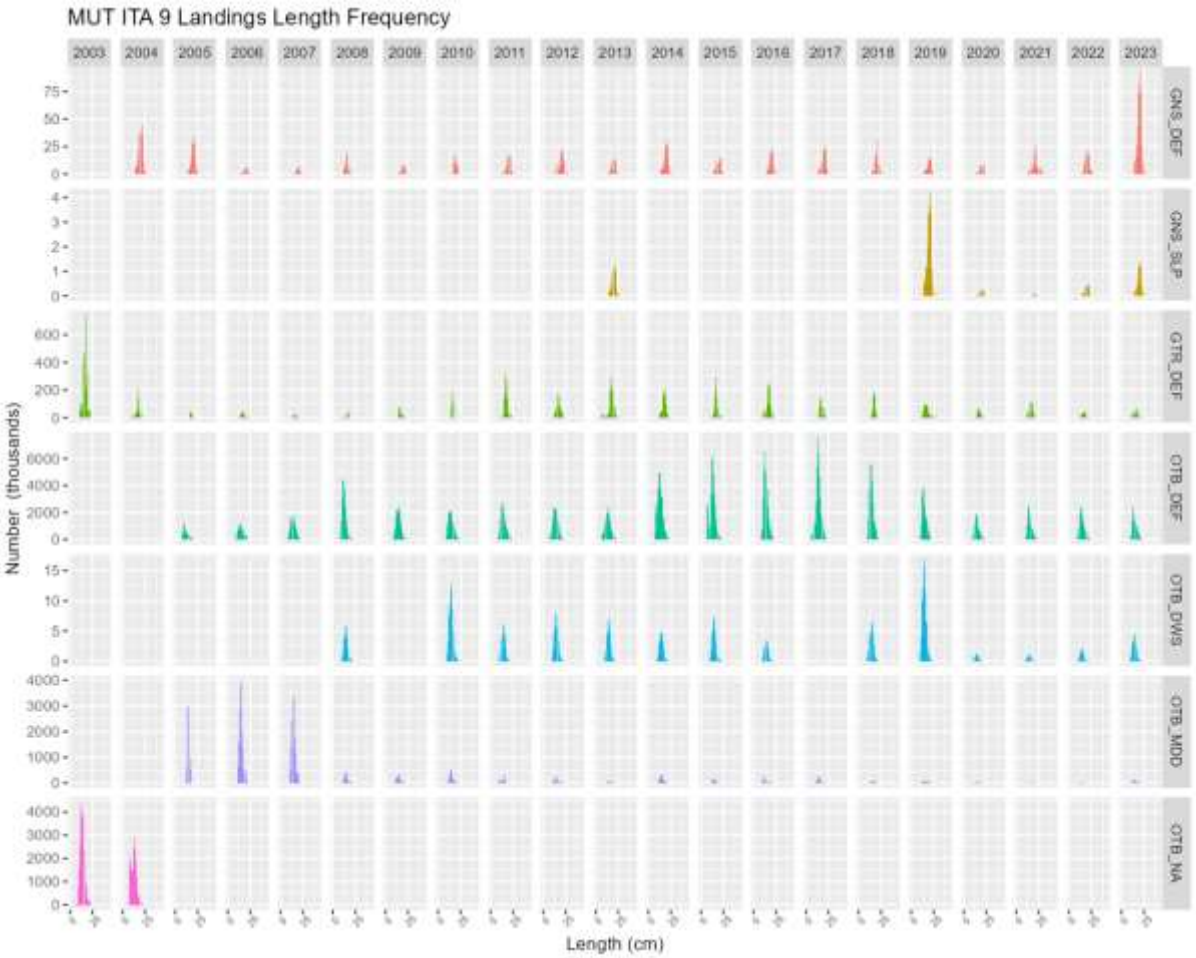
Source: Own elaborations

6.11.2 DATA

6.11.2.1 CATCH (LANDINGS AND DISCARDS)

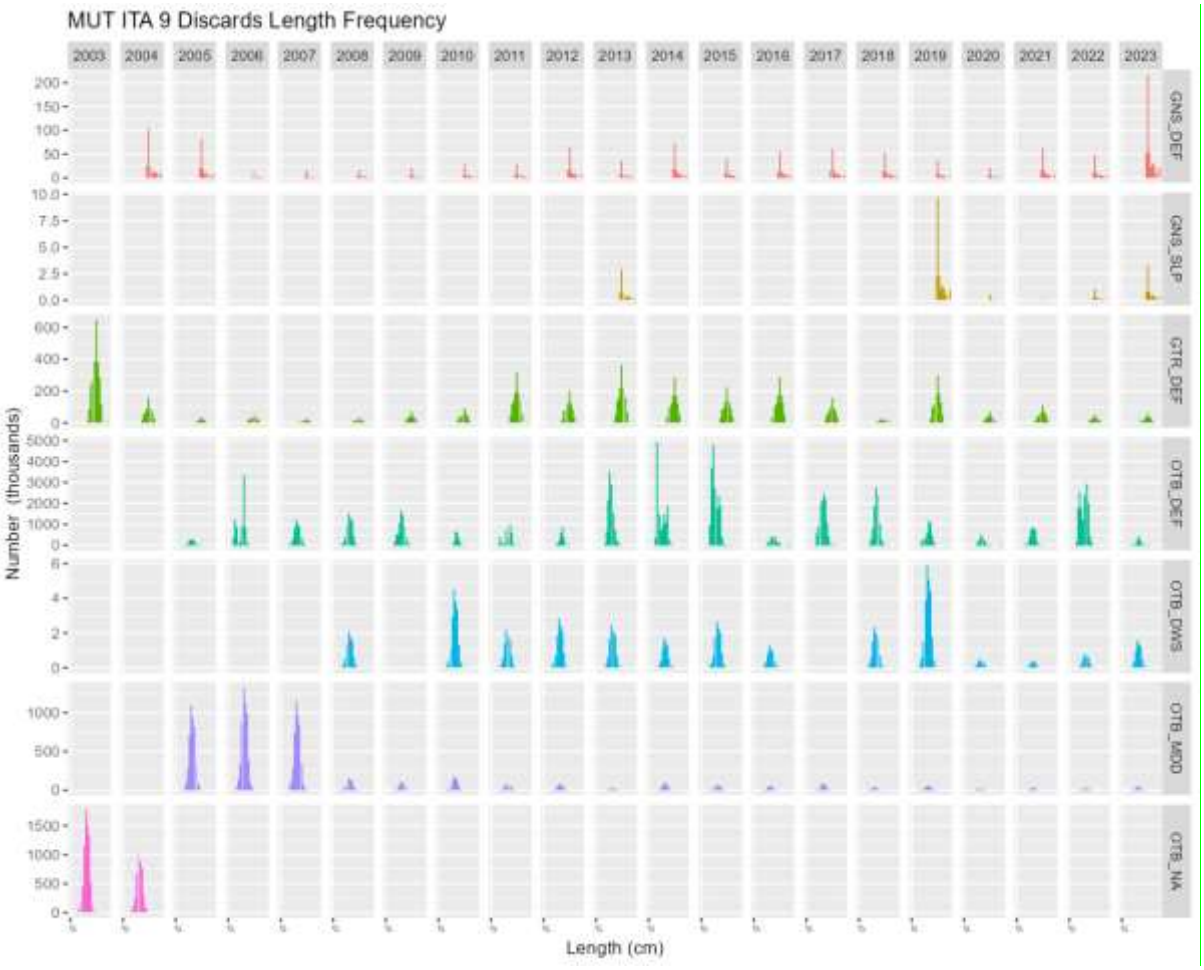
Principal fishing gears used to catch red mullet in GSA 9 together with other species (mixed catches) are gillnets (GNS), trammel nets (GTR) and bottom trawls (OTB). Length structure of red mullet catches (landings and discards) for all gears in the period from 2003 to 2023 are shown in Figures 6.11.2.1.1 - 6.11.2.1.3 for landings, discards and catches respectively.

Figure 6.11.2.1.1 Red mullet in GSA 9. Length structure of red mullet landed in GSA 9 in the period from 2003 to 2022 by fishing gear and fishery.

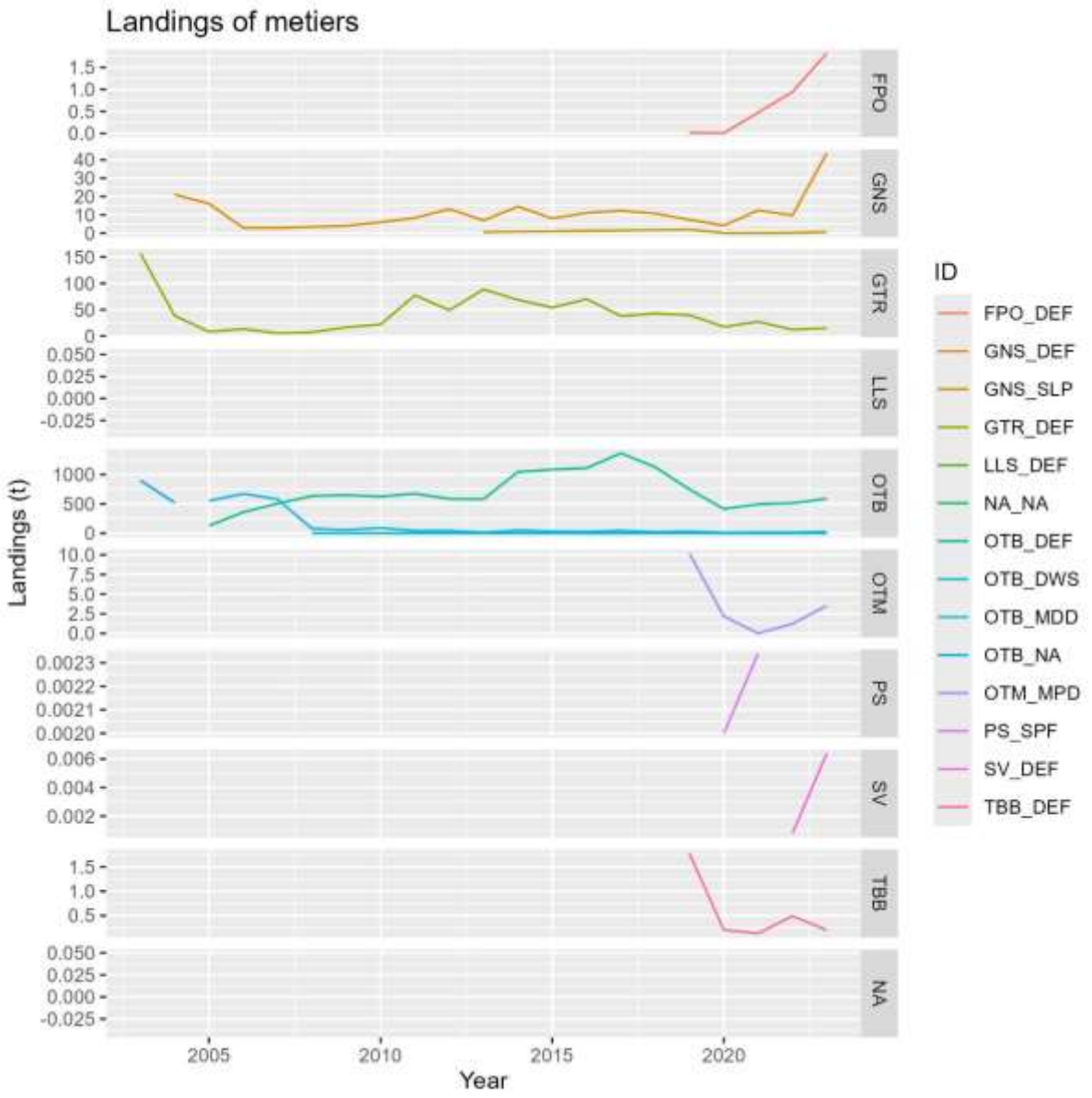


Source: Own elaborations

Figure 6.11.2.1.2 Red mullet in GSA 9. Length structure of red mullet catch discarded in GSA 9 in the period from 2006 to 2023 by fishing gear and fishery.

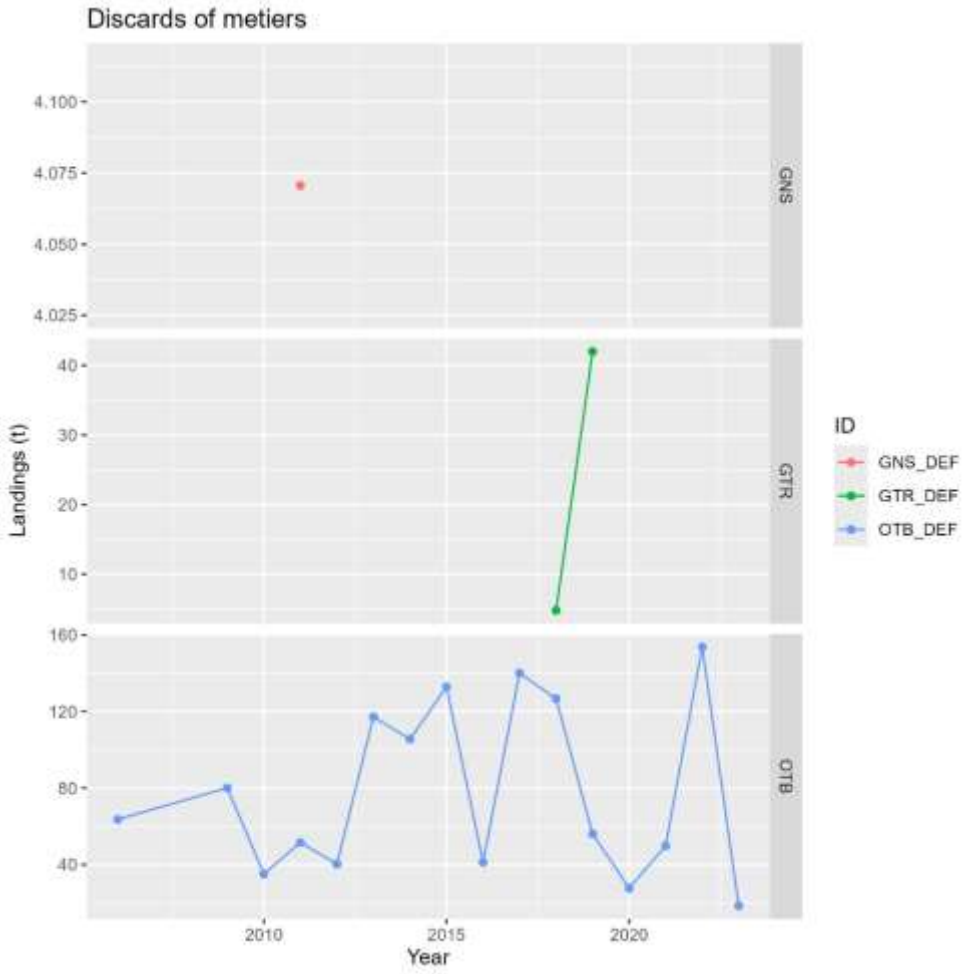


Source: Own elaborations



Source: Own elaborations

Figure 6.11.2.1.5 Red mullet in GSA 9. Discards (t) of red mullet in GSA 9 in the period from 2006 to 2023 by fishing gear and fishery.



Source: Own elaborations

Table 6.11.2.1.1 Red mullet in GSA 9. Landings and discards (t) of red mullet in GSA 9 by gear in the period from 2003 to 2023. Values in red were reconstructed by EWG 21-02.

	Landings (t)					Discards (t)			
Year	GNS	GTR	OTB	Others	Total landings	GNS	GTR	OTB	Total discards
2003	NA	157	899.7	0	1056.7	0	0	0	0
2004	21	38.6	521.1	0	580.7	0	0	0	0
2005	16.1	8.4	684	0	708.5	0	0	0	0
2006	2.9	13.5	1033.2	0	1049.6	0	0	63.6	63.6
2007	2.9	5.6	1087.4	0	1095.9	0	0	0	0
2008	3.4	7.4	716.3	0	727.1	0	0	0	0
2009	4.1	16.8	707.4	0	728.3	0	0	80.1	80.1
2010	6	22.3	719.6	0	747.9	0	0	35.1	35.1
2011	8.4	77.4	719.6	0	805.4	0	4.1	51.6	55.7
2012	13.1	49.3	630.5	0	692.9	0	0	40.3	40.3
2013	7.6	88.4	597.9	0	693.9	0	0	117.2	117.2
2014	14.5	69	1097.9	0	1181.4	0	0	105.6	105.6
2015	8.1	54.1	1121.3	0	1183.5	0	0	132.9	132.9

2016	11.1	70.3	1140.2	0	1221.6	0	0	41.2	41.2
2017	12.3	38.1	1410.3	0	1460.7	0	0	140.1	140.1
2018	10.7	43	1151	0	1204.7	4.8	0	126.7	131.5
2019	9.3	39.9	784.6	0	833.8	42	0	56.1	98.1
2020	4.3	17.8	428.4	0	450.5	0	0	27.7	27.7
2021	12.5	27.2	512.2	0	551.9	0	0	49.9	49.9
2022	10	12.5	529.5	0.9	552.9	0	0	153.7	153.7
2023	44.3	15.2	614.6	1.8	675.9	0	0	18.5	18.5

Source: Own elaborations

Discard of red mullet in GSA 9 occurs mainly from the catches of bottom trawls (OTB). Discard data were available in 2006, and for all years since 2009. For assessment purposes, in the years where discard data were missing, reconstructions were made by EWG 21-02 using the mean of the available LFDs for discards. This was done for OTB discards only.

6.11.2.2 EFFORT

6.11.2.3 SURVEY DATA

After being absent for one year, the medits survey returned in 2023, albeit later in the year (around october). For modelling purposes, 2022 was left empty.

Survey indices used in this assessment originate from MEDITS scientific bottom trawl survey. These surveys in GSA9 took place in different seasons of the year (Figure 6.11.2.3.1). EWG 20-11 considered this fact during interpretation of available survey indices in the assessment excluding age 0 in the tuning index, because not intercepted every year. This procedure was followed by EWG 23-10 too.

Figure 6.11.2.3.1 Red mullet in GSA 9. Survey periods of MEDITS in GSA 9.



Source: Own elaborations

Analyses of available MEDITS data show large variations between years (Figs. 6.11.2.3.2 and 6.11.2.3.3). An increase in red mullet density and biomass indices can be noticed from 2014 onward.

However, in relation to MEDITS data available, EWG 23-10 also noted very different survey periods in these two years, concluding that autumn survey in 2017 and 2020 probably recorded red mullet recruits that were not recorded by 2016 spring survey. This is reflected in the size structure indices of red mullet in GSA 9, as derived from trawl surveys (MEDITS, 1994-2023), shown in Figure 6.11.2.3.6. Large inter-annual variations in length structure can be noticed due to the survey time, that in some years allowed to detect the recruitment of the species.

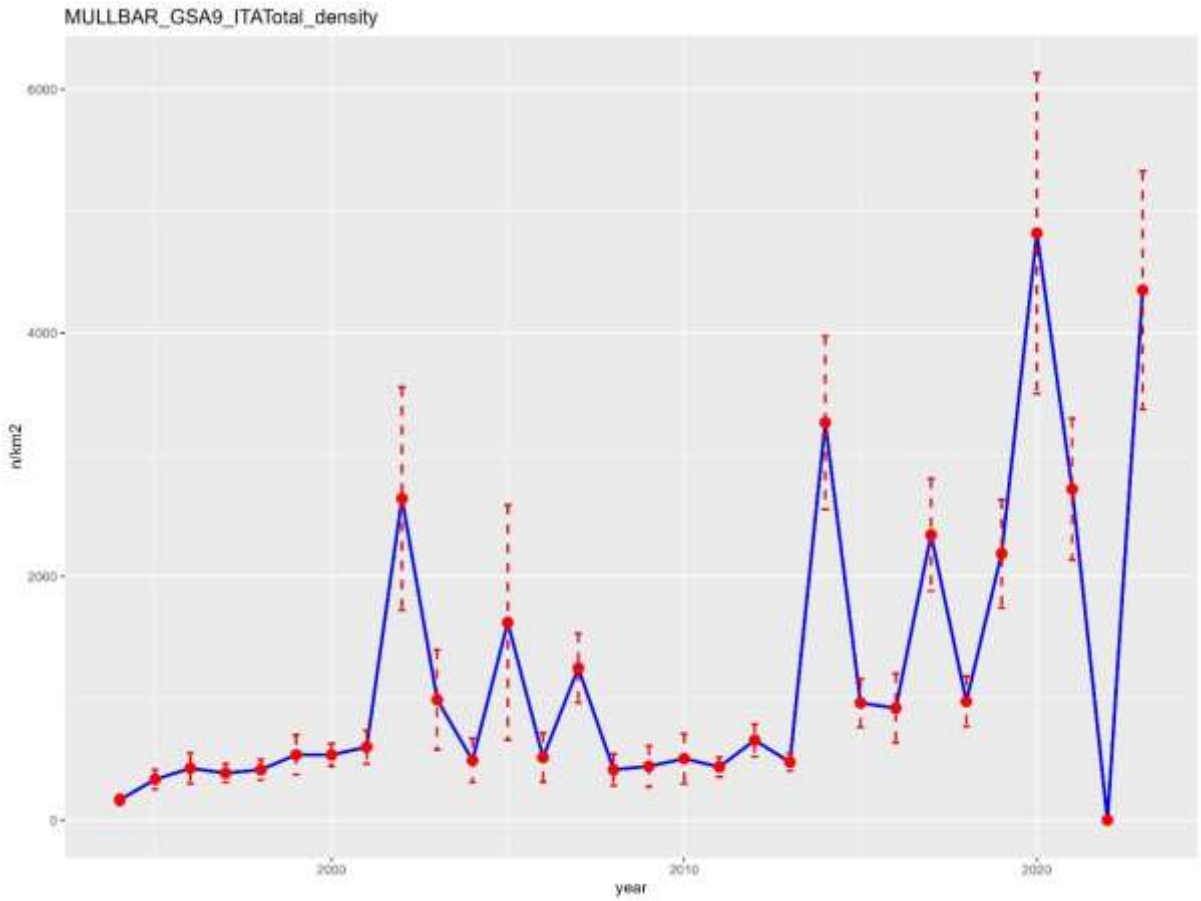
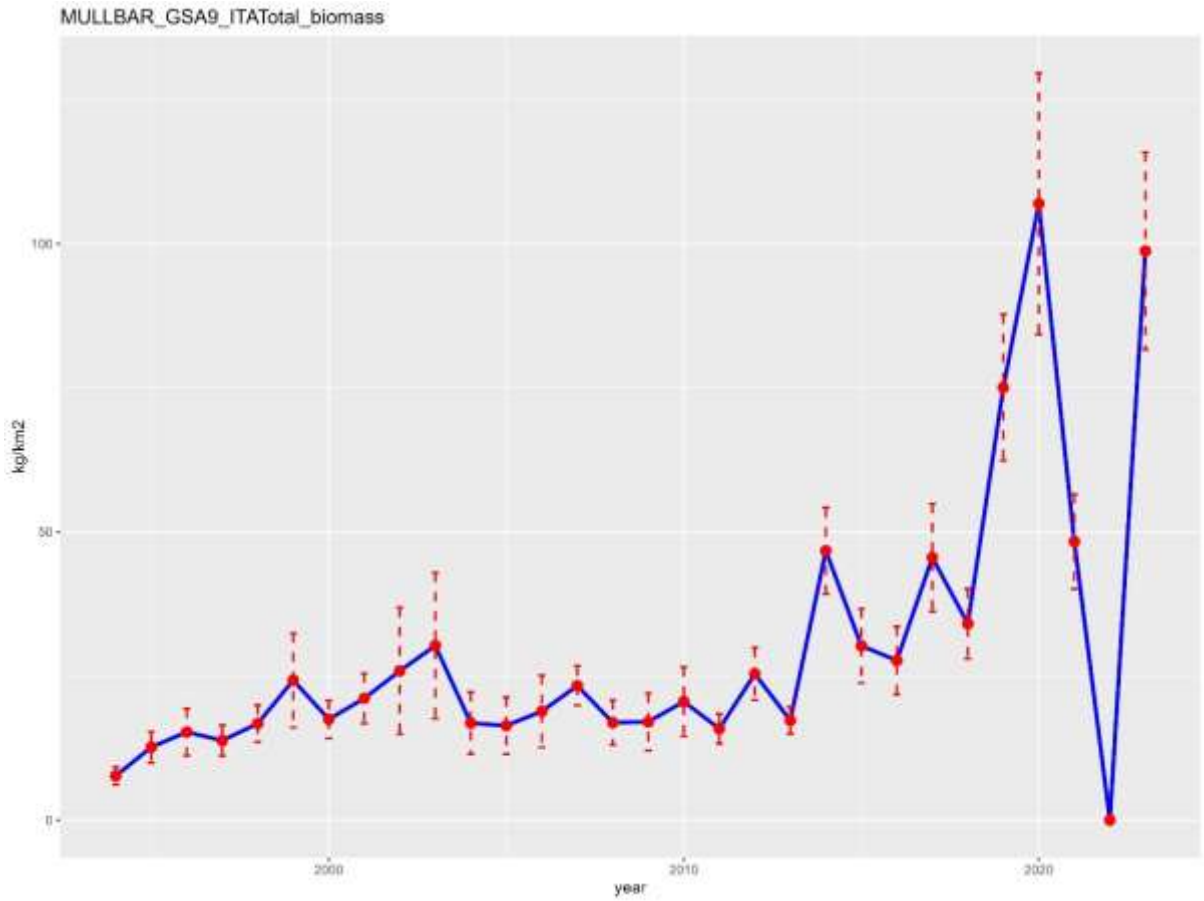
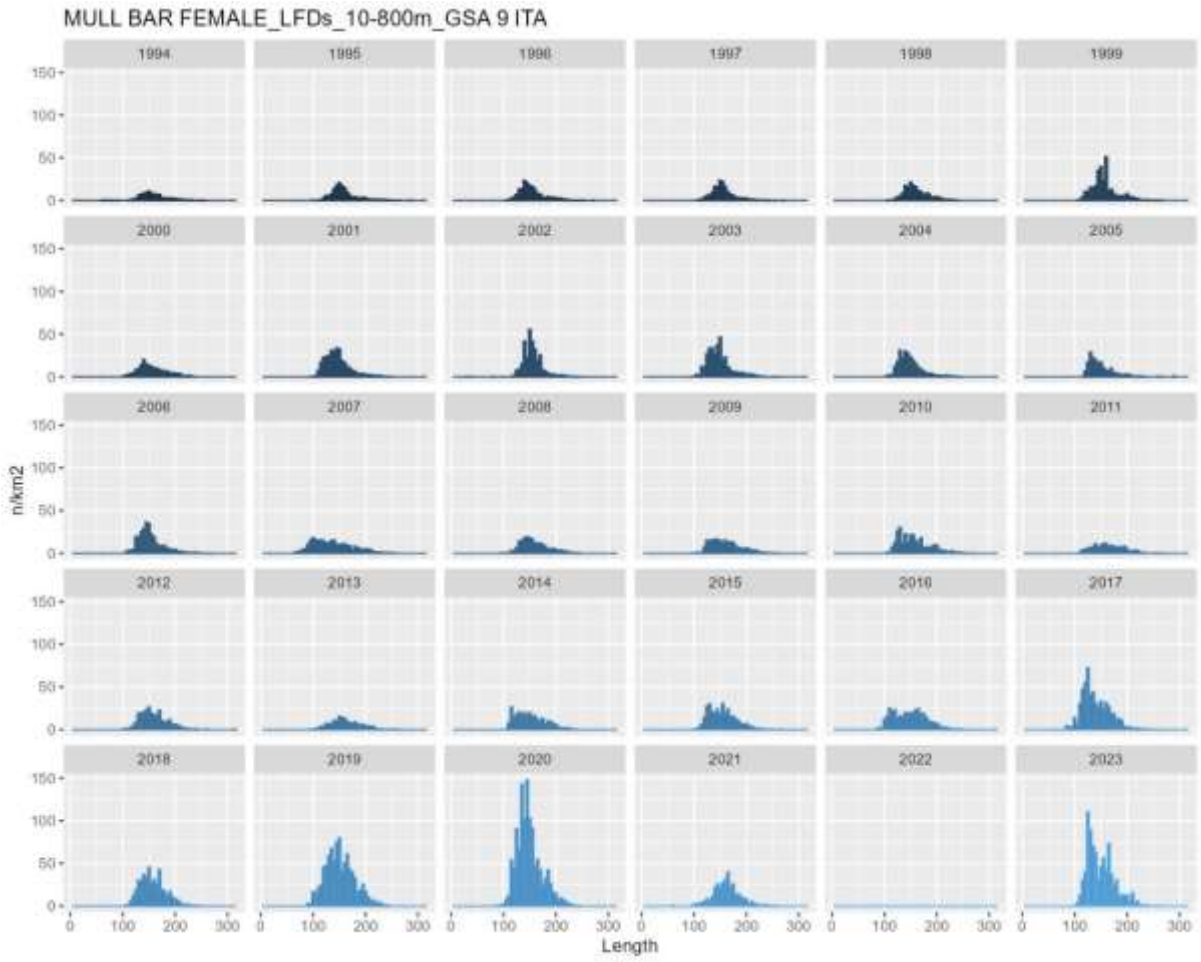


Figure 6.11.2.3.2 Red mullet in GSA 9. Abundance indices of red mullet in GSA 9 as derived from trawl surveys (MEDITS, 1994-2021). The zero value in 2022 should be considered to be NA, as no survey took place in that year.



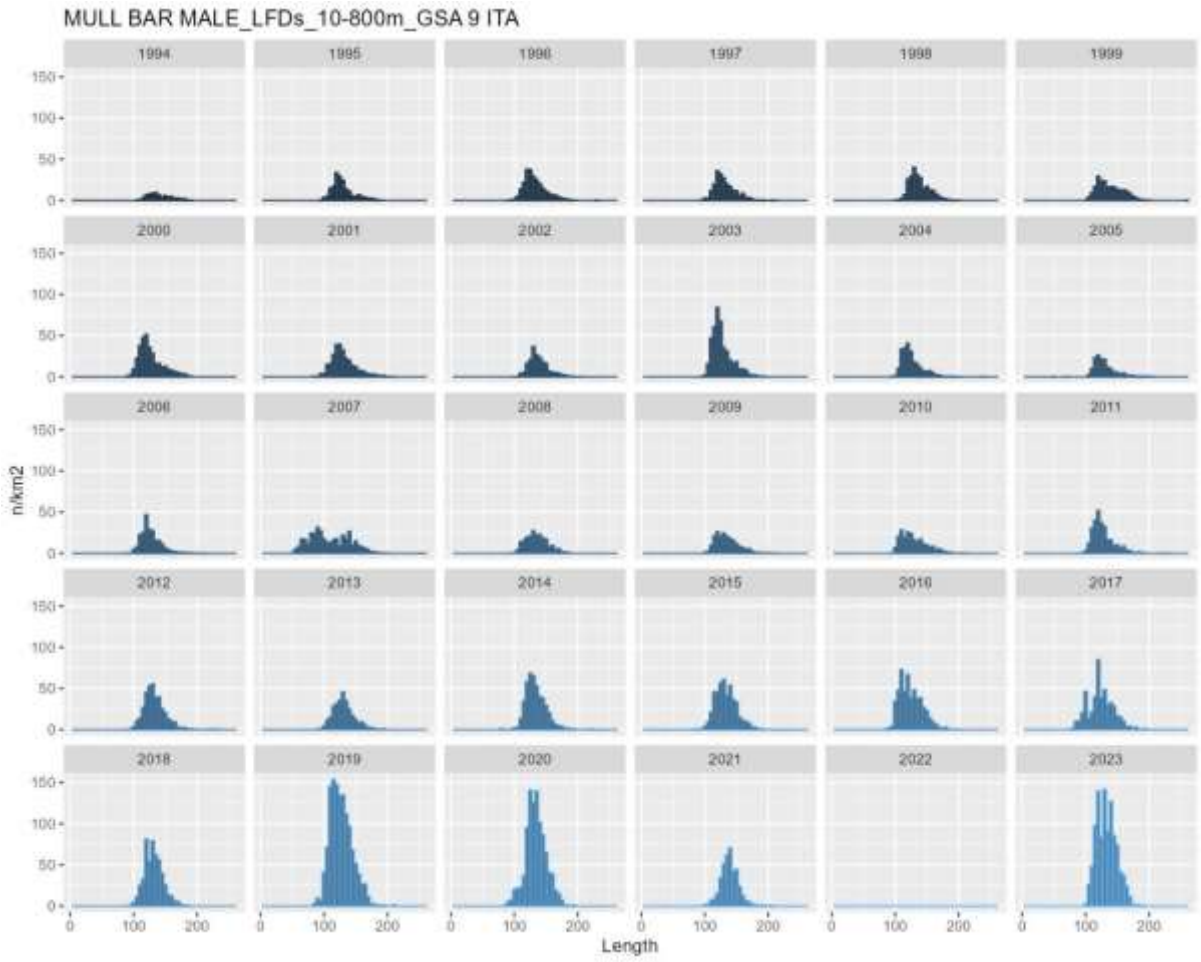
Source: Own elaborations

Figure 6.11.2.3.6 Red mullet in GSA 9. Size structure indices (females) of red mullet in GSA 9 as derived from trawl surveys (MEDITS, 1994-2021).



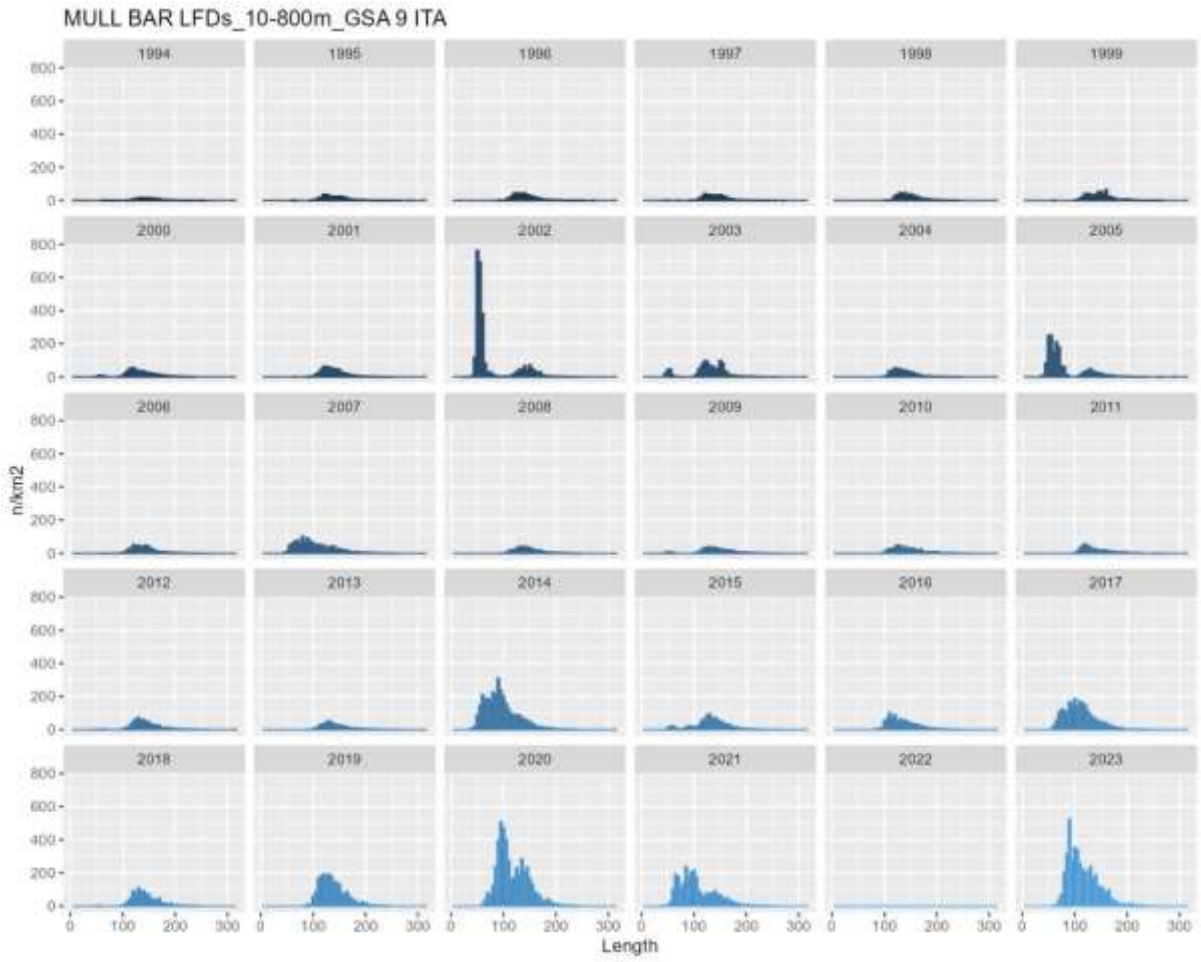
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.11.2.3.7 Red mullet in GSA 9. Size structure indices (males) of red mullet in GSA 9 as derived from trawl surveys (MEDITS, 1994-2021).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.11.2.3.8 Red mullet in GSA 9. Size structure indices (total) of red mullet in GSA 9 as derived from trawl surveys (MEDITS, 1994-2021).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.11.3 STOCK ASSESSMENT

The present assessment of red mullet in GSA 9 has been based on a4a model. The a4a model is a flexible statistical catch at age stock assessment model, based on linear modelling techniques, not working by gear. The method was developed within FLR framework.

Input data considered (landing, discard, age, maturity, MEDITS) originate from DCF Med&BS data call and cover the years 2003-2021.

Age slicing using a4aGr of the length frequency distributions of landing, discard and survey has been carried out by sex (in combination with sex ratio at length) using a4aGr model and then data were combined. The final catch at age data are shown in the figure 6.11.3.1. Age 4 in the survey index is a true age class, and not a plus group, while catches have a plus group at age 4.

Table 6.11.3.1 Red mullet in GSA 9. Values of catch at age per year used in the assessment.

	Age				
Year	0	1	2	3	4+
2003	2416	18233	6616	1039	109
2004	2618	22252	4797	497	92
2005	2205	24325	6069	383	50
2006	1791	20652	6886	515	39
2007	1915	16932	6094	626	54
2008	1775	18333	5233	598	71
2009	1630	17295	5947	554	75
2010	1525	16223	5868	673	76
2011	1597	15505	5700	698	95
2012	2030	16545	5546	692	103
2013	2591	21252	5891	665	101
2014	2907	27095	7352	672	93
2015	3213	29953	8926	776	86
2016	3024	32235	9312	863	89
2017	2413	29359	9540	840	91
2018	1616	22694	8506	842	88
2019	1302	14820	6714	790	92
2020	1193	11778	4680	706	99
2021	1416	10785	4107	587	108
2022	1353	12956	4225	628	113
2023	792	12648	5709	782	146

Source: Own elaborations

Total catches used in the assessment:

Year	Catches (t)
2003	939
2004	812
2005	980
2006	1051
2007	896
2008	718
2009	903
2010	842
2011	828
2012	806
2013	961
2014	1102
2015	1279
2016	1446
2017	1376
2018	1216
2019	869

2020	697
2021	637
2022	676
2023	796

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.11.3.2 Red mullet in GSA 9. Values of mean weight at age per year used in the assessment.

	Age				
Year	0	1	2	3	4+
2003	0.007	0.027	0.049	0.087	0.139
2004	0.007	0.022	0.05	0.087	0.136
2005	0.007	0.028	0.041	0.08	0.147
2006	0.008	0.03	0.053	0.081	0.133
2007	0.007	0.03	0.053	0.078	0.135
2008	0.008	0.022	0.047	0.081	0.135
2009	0.008	0.03	0.053	0.084	0.148
2010	0.008	0.027	0.054	0.082	0.158
2011	0.008	0.027	0.057	0.086	0.129
2012	0.006	0.026	0.052	0.082	0.143
2013	0.005	0.026	0.055	0.086	0.139
2014	0.007	0.023	0.054	0.083	0.131
2015	0.005	0.025	0.05	0.079	0.131
2016	0.008	0.026	0.052	0.085	0.133
2017	0.006	0.027	0.051	0.083	0.129
2018	0.009	0.03	0.053	0.085	0.126
2019	0.008	0.029	0.053	0.082	0.149
2020	0.008	0.03	0.055	0.091	0.125
2021	0.004	0.031	0.055	0.091	0.15
2022	0.009	0.028	0.054	0.088	0.139
2023	0.008	0.029	0.057	0.092	0.139

Source: Own elaborations

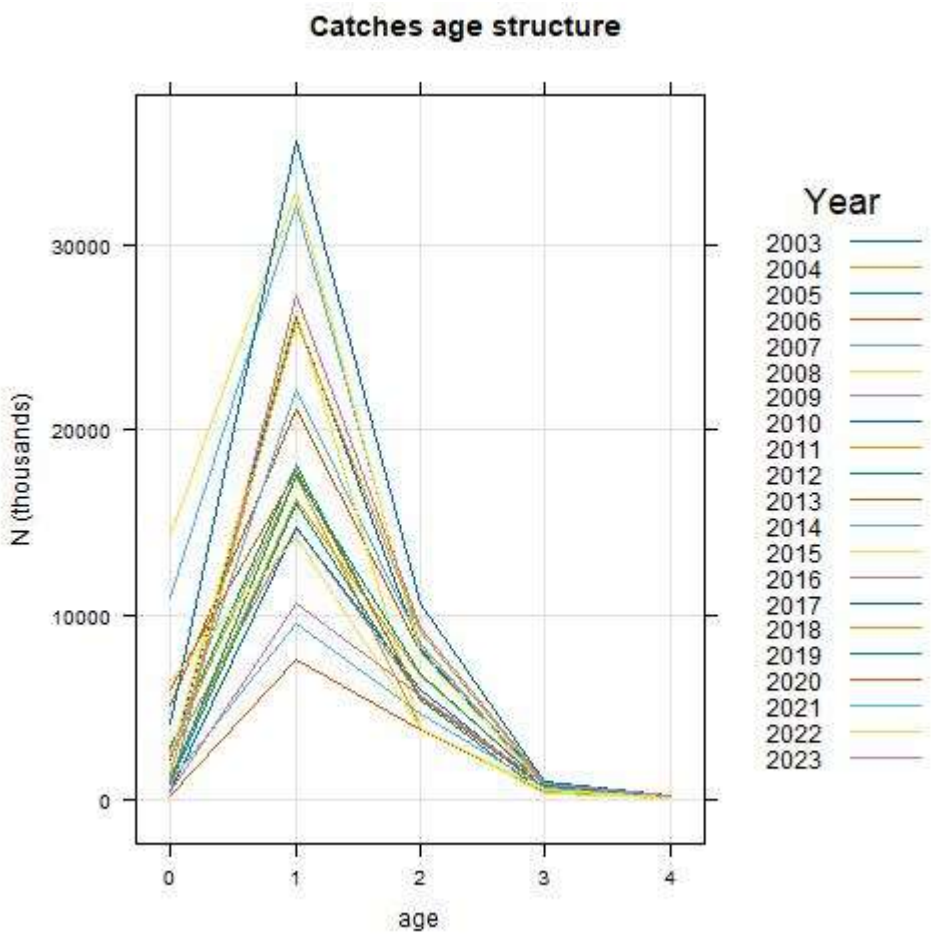
Table 6.11.3.3 Red mullet in GSA 9. Survey index (MEDITS) values at age per year used in the assessment.

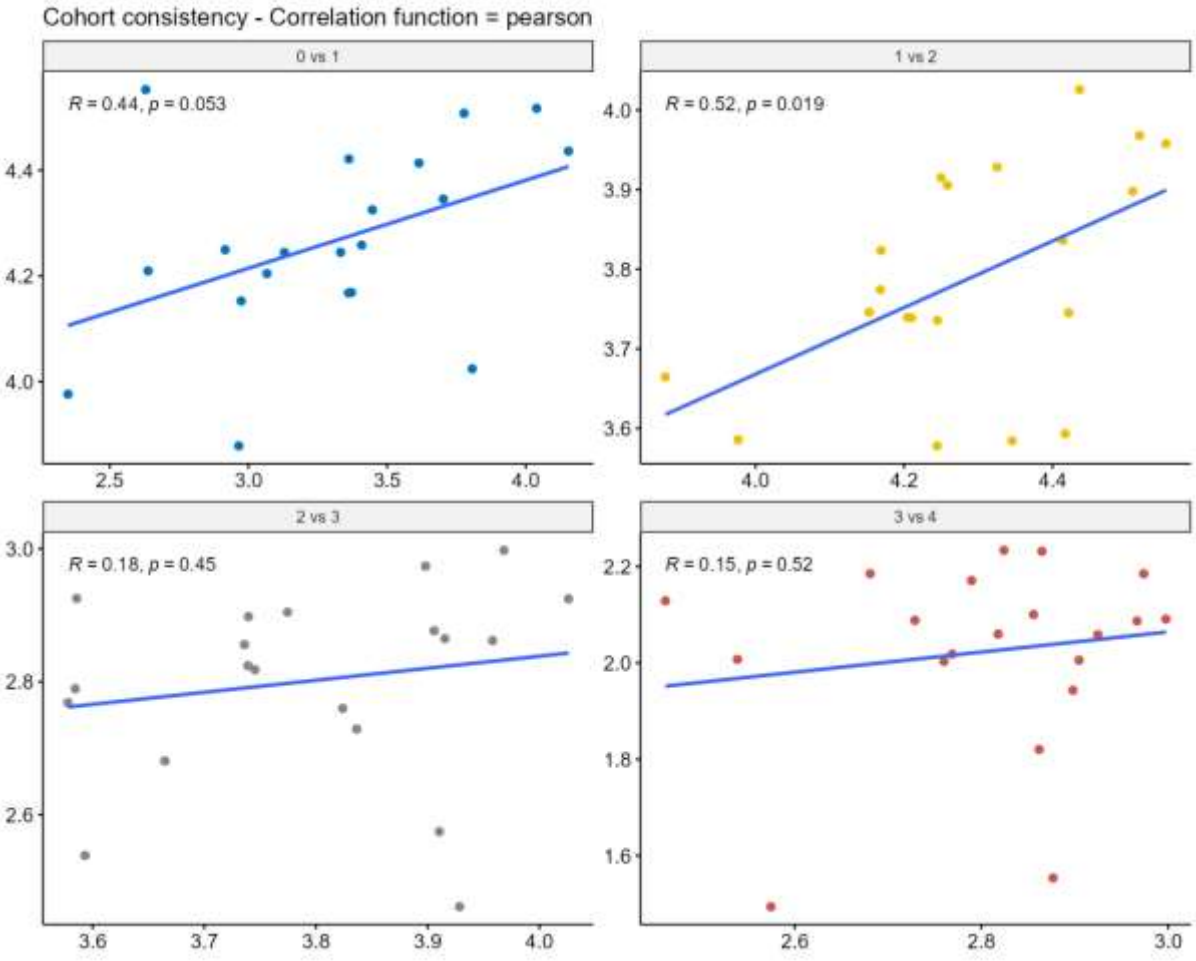
	Age			
Year	1	2	3	4
2003	679.5	166.7	14.8	1.3
2004	407.7	71.7	9.1	1.2
2005	308.5	60.4	7.3	1.1
2006	410.7	89.1	9.4	2.4
2007	668.6	124	17.8	1.6
2008	261.1	132.3	19.6	0.7
2009	266.7	127.1	21.1	1.6
2010	347.7	128	23.7	2.9
2011	311.7	106.1	16.5	1
2012	429	199	18	1.9
2013	318.8	127	15.8	1
2014	1632.8	213.5	18.8	0.7
2015	602.7	240.4	22.9	1
2016	687.7	209.5	16.2	1.2
2017	1620.6	188	13.3	1.9
2018	666.1	287.8	18.5	0.4

2019	1626.7	513.8	41.2	2.9
2020	5897	558.8	50.8	2.6
2021	2744	319.2	22	3.7
2022	5243.4	540.9	43.2	1.7
2023	0.008	0.029	0.057	0.092

Source: Own elaborations

Figure 6.11.3.1 Red mullet in GSA 9. Catch-at-age data of red mullet in GSA9 used in assessment, and cohorts internal consistency.

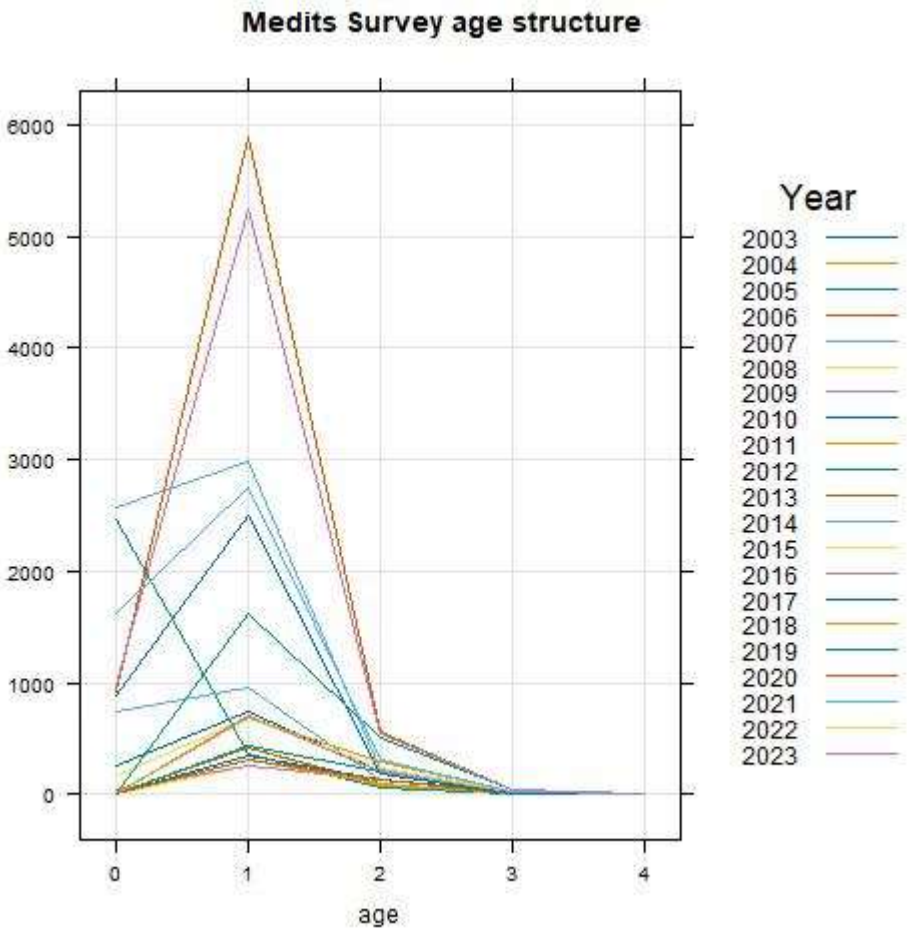


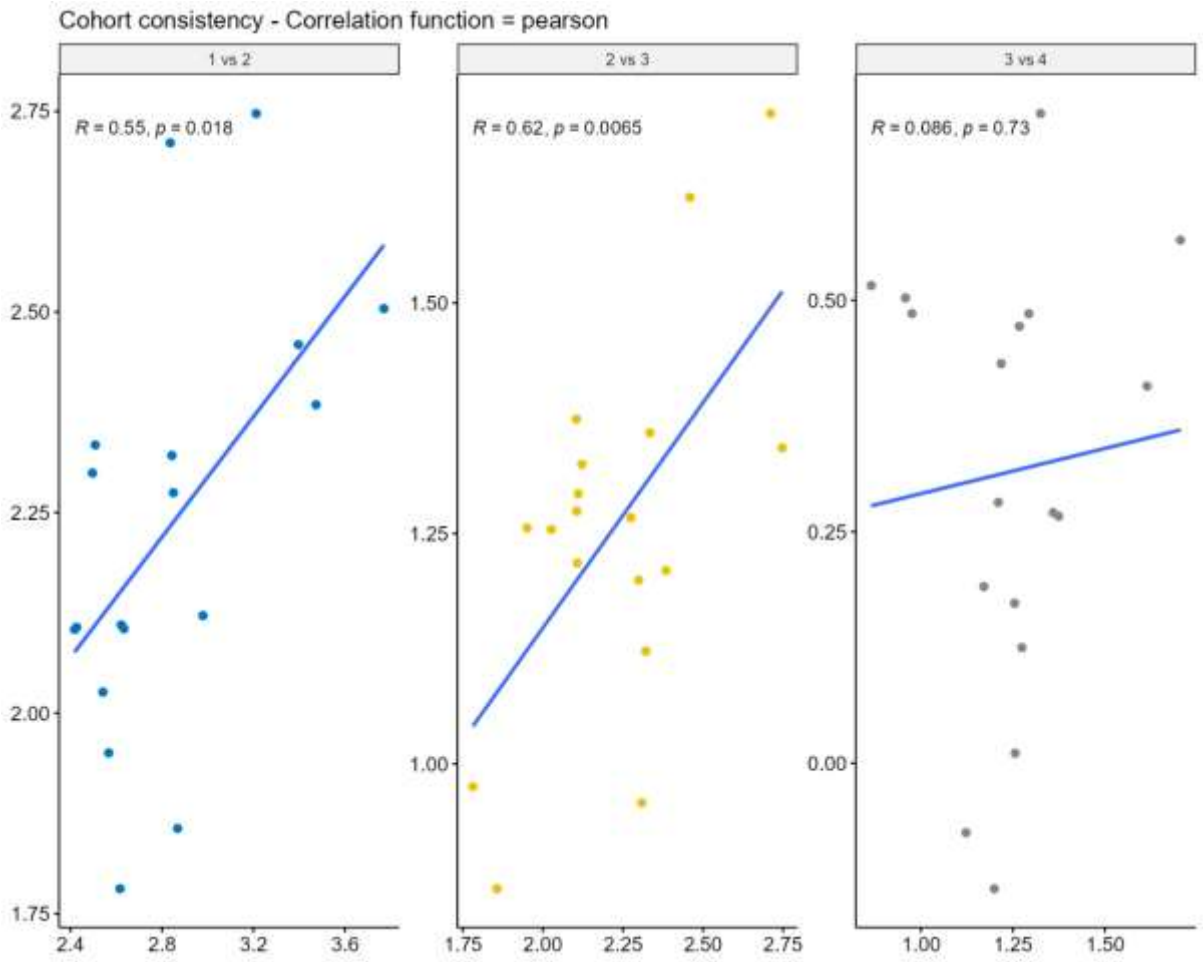


Source: Own elaborations

Survey indices (density by age) from MEDITS were used considering that spring surveys are not designed to detect recruitment of red mullet. Recruitment (age class 0) was detected just in some years when surveys were carried out in late summer or autumn. Due to the variability of survey timing, age 0 class was not included in the tuning indices used for the assessment. MEDITS indices (density by age) are shown in figure 6.11.3.2.

Figure 6.11.3.2 Red mullet in GSA 9. MEDITS indices describing density by age of red mullet in GSA9 by year, and cohorts internal consistency.


Medits Survey age structure
6000
5000
4000
3000
2000
1000
0
0
1
2
3
4
age
Year
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



Source: Own elaborations

For assessment purposes, an atempt was made to run an update of the model selected by EWG 21-11 and EWG 22-09. However, the retrospectives were deemed unacceptable, thus a new f-model was chosen with a reduced number of *k*s in the year smoother (k=5 instead of k=8). The age 0 was removed from the tuning index, as done in previous EWGs. An Fbar range between age 1 and age 3 was used, as in previous assessments.

Sub-models of the a4a assessment used for MUT9 at EWG 21-11:

fmodel: ~s(replace(age, age > 2, 2), k = 3) + s(year, k = 5)

srmodel: ~geomean(CV = 0.3)

n1model: ~s(age, k = 3)

qmodel: ~factor(replace(age, age > 2, 2))

vmodel:

catch: ~s(age, k = 3)

MEDITS_SA09: ~1

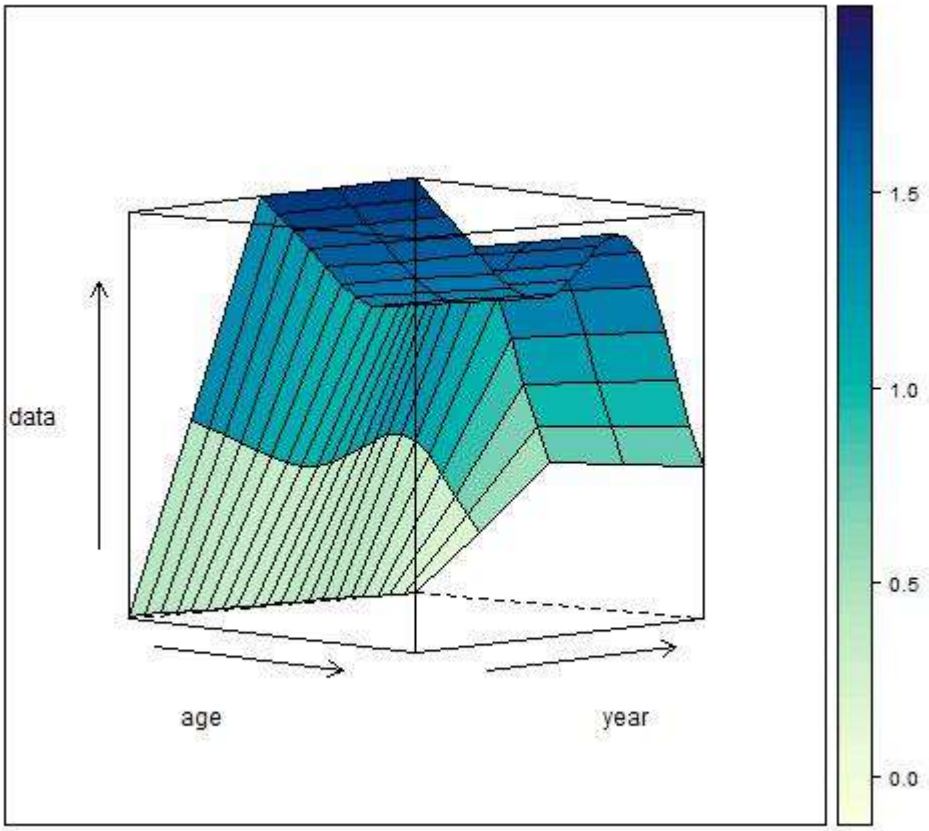
Summary of the model fit using the fitSumm command:

nopar 3.800000e+01

nlogl 1.117655e+02
maxgrad 6.506084e-08
nobs 1.850000e+02
gcv 2.803226e-01
convergence 0.000000e+00
accrate NA
nlogl_comp1 2.997110e+01
nlogl_comp2 8.206630e+01
nlogl_comp3 -2.719500e-01nlogl_comp3 -1.751520e+00

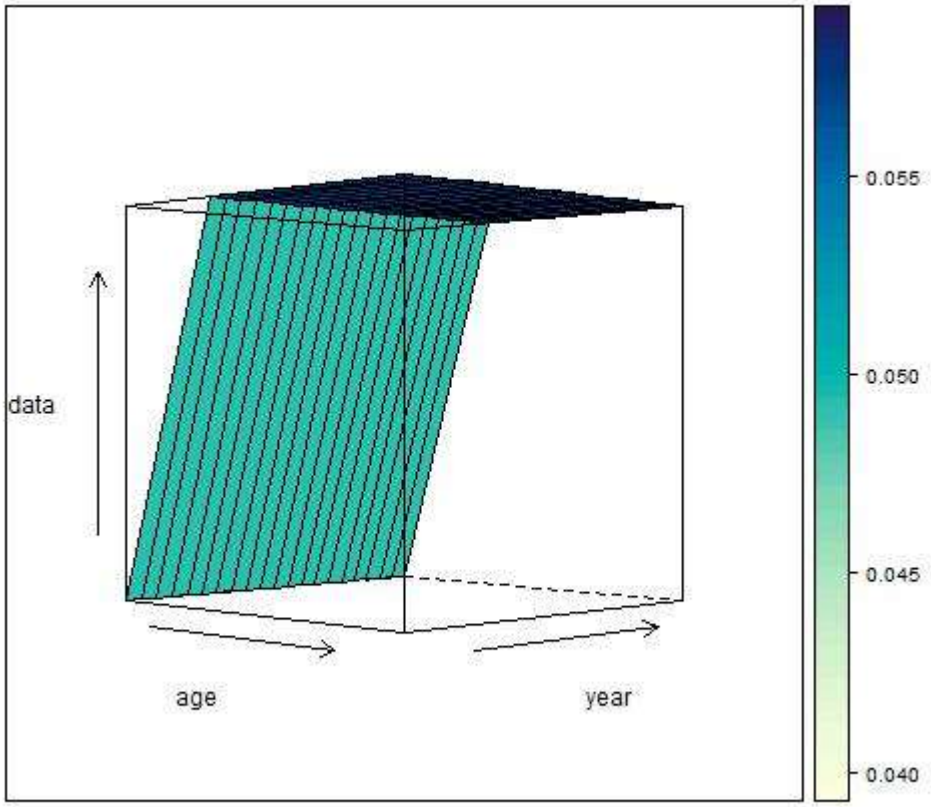
The results and diagnostics of the assessment model are shown below.

Figure 6.11.3.3 Red mullet in GSA 9. 3D-plot of the F-at-age for red mullet in GSA 9.



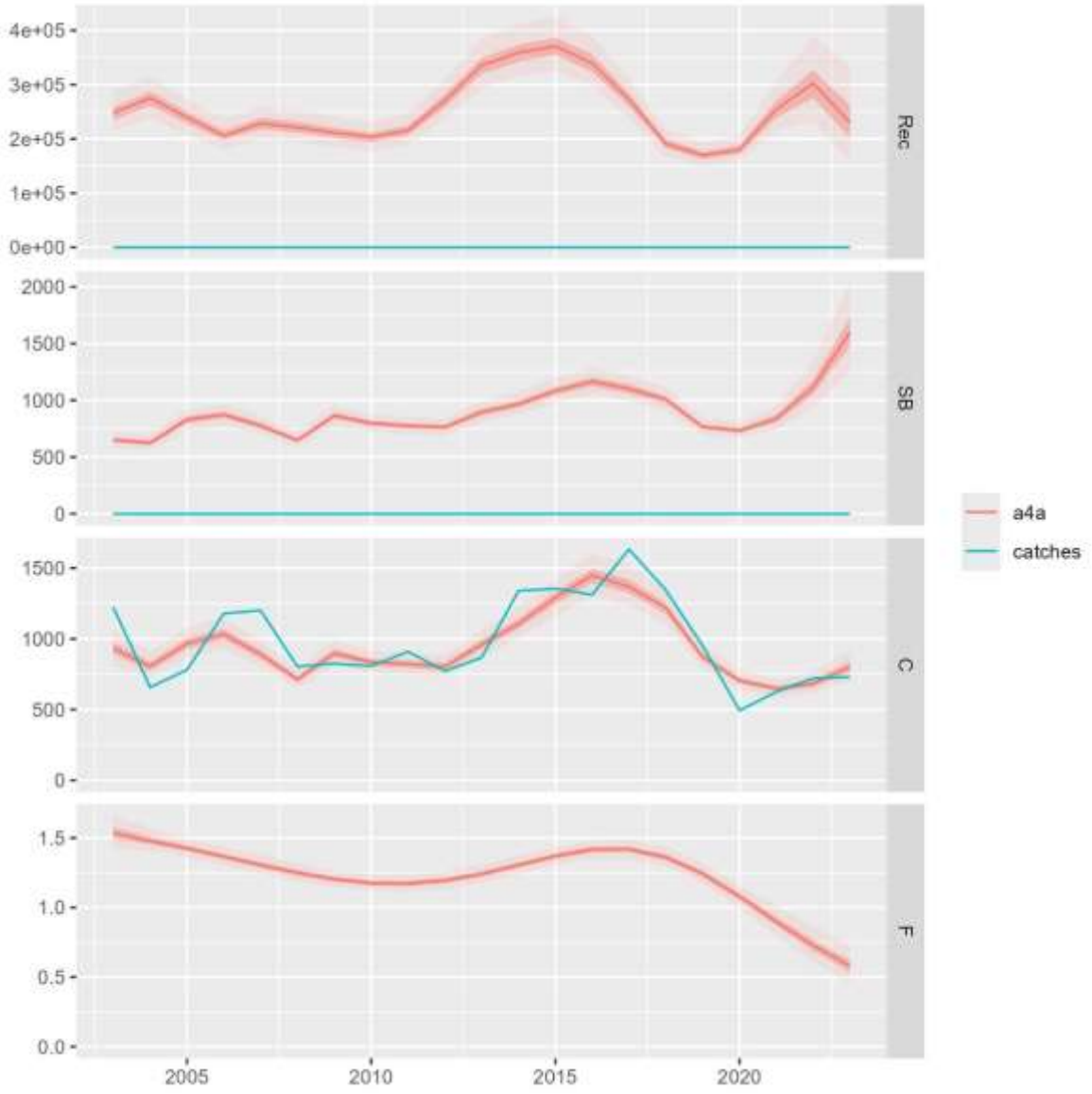
Source: Own elaborations

Figure 6.11.3.4 Red mullet in GSA 9. 3D-plot of the catchability of the MEDITS survey for red mullet in GSA 9.



Source: Own elaborations

Figure 6.11.3.5 Red mullet in GSA 9. Results of the best a4a model for red mullet in GSA 9. The observed catches are shown by the red line.



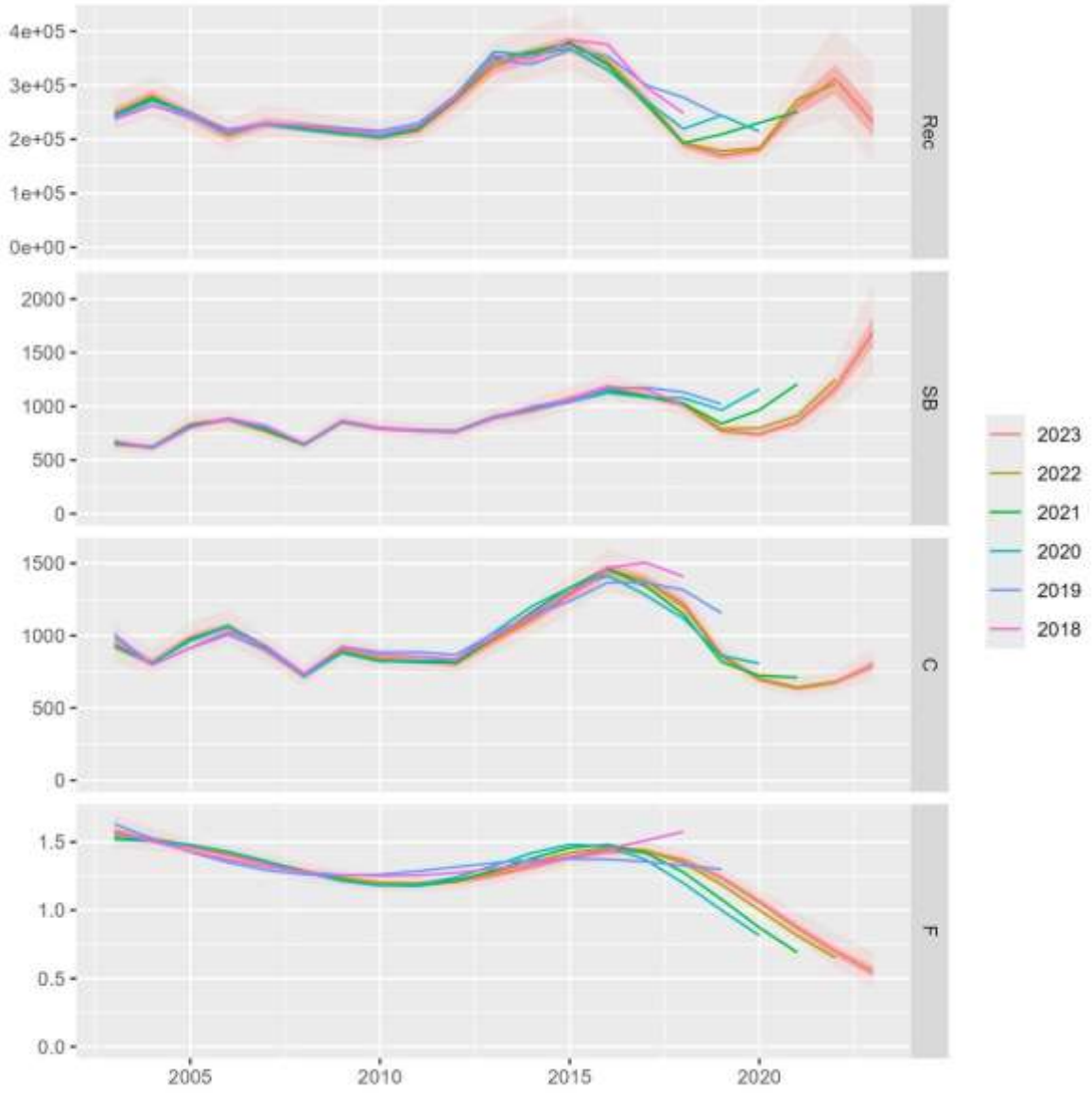
Source: Own elaborations

The results of the retrospective analysis are shown in Figure 6.11.3.6.

The Mohn' rho for F_{bar1-3}, SSB and recruitment are shown below:

Fbar	SSB	rec
-0.06	0.28	0.18

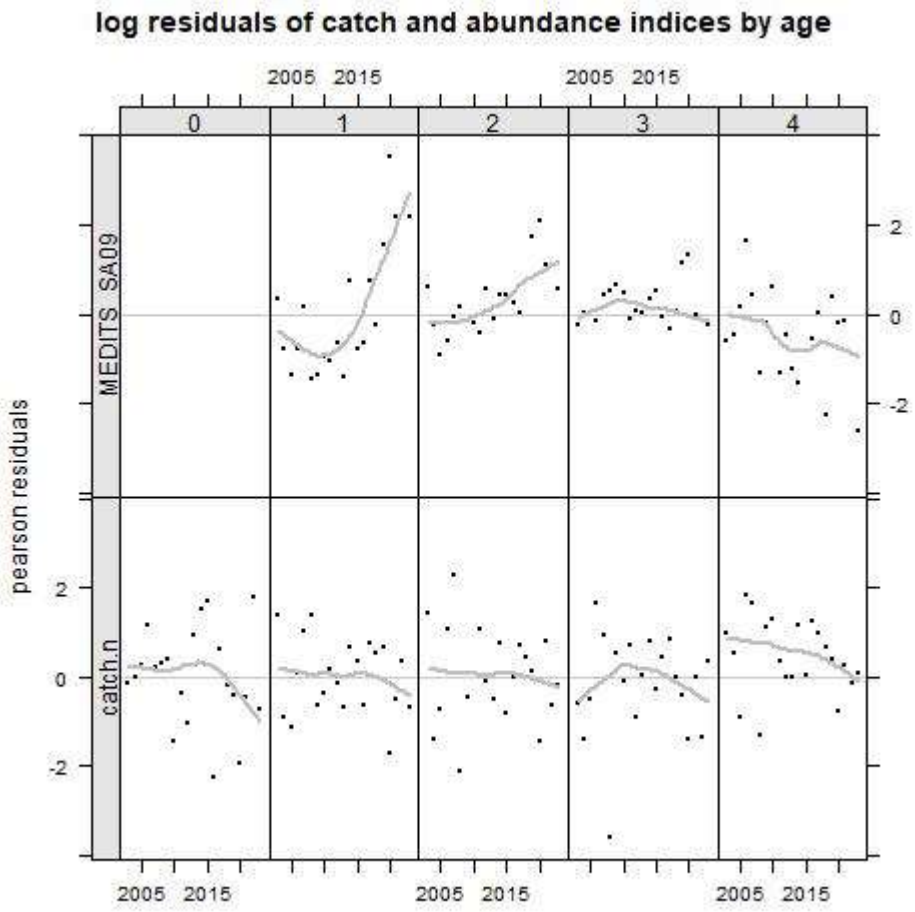
Figure 6.11.3.6 Red mullet in GSA 9. Retrospective analysis of the selected a4a model for red mullet in GSA 9. Confidence intervals of the final assessment run are also shown.



Source: Own elaborations

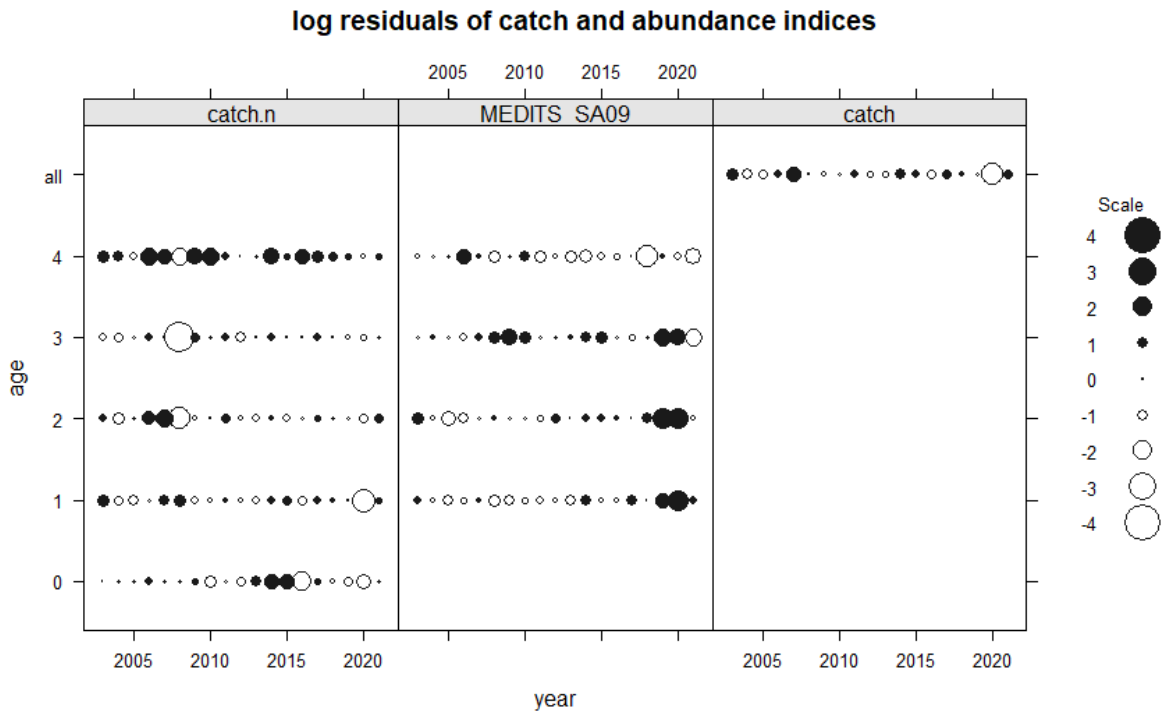
The residuals of the catch and abundance indices related to the outcomes of the best run do not show any particular trend, and they are shown in Figures 6.11.3.7 - 6.11.3.11. The cryptic biomass (% of SSB in the plus group) was also investigated, and resulted to be always lower than 5% of the total SSB.

Figure 6.11.3.8 Red mullet in GSA 9. Log residuals of catch and abundance indices for red mullet in GSA 9.



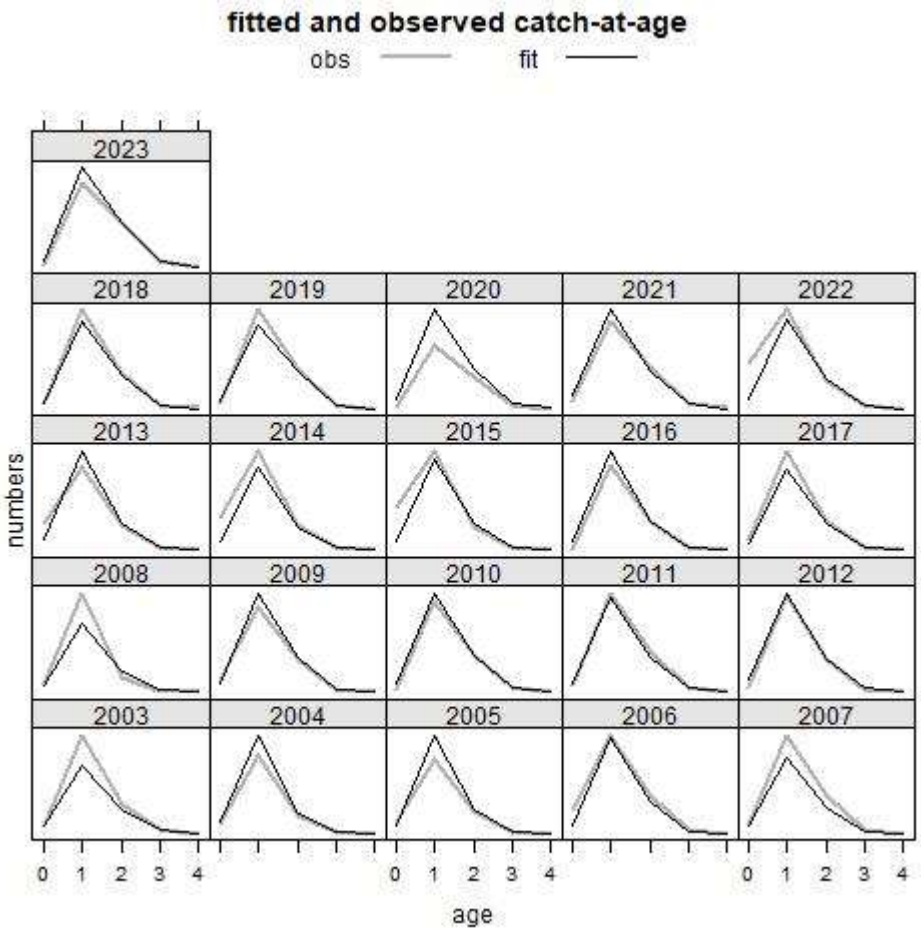
Source: Own elaborations

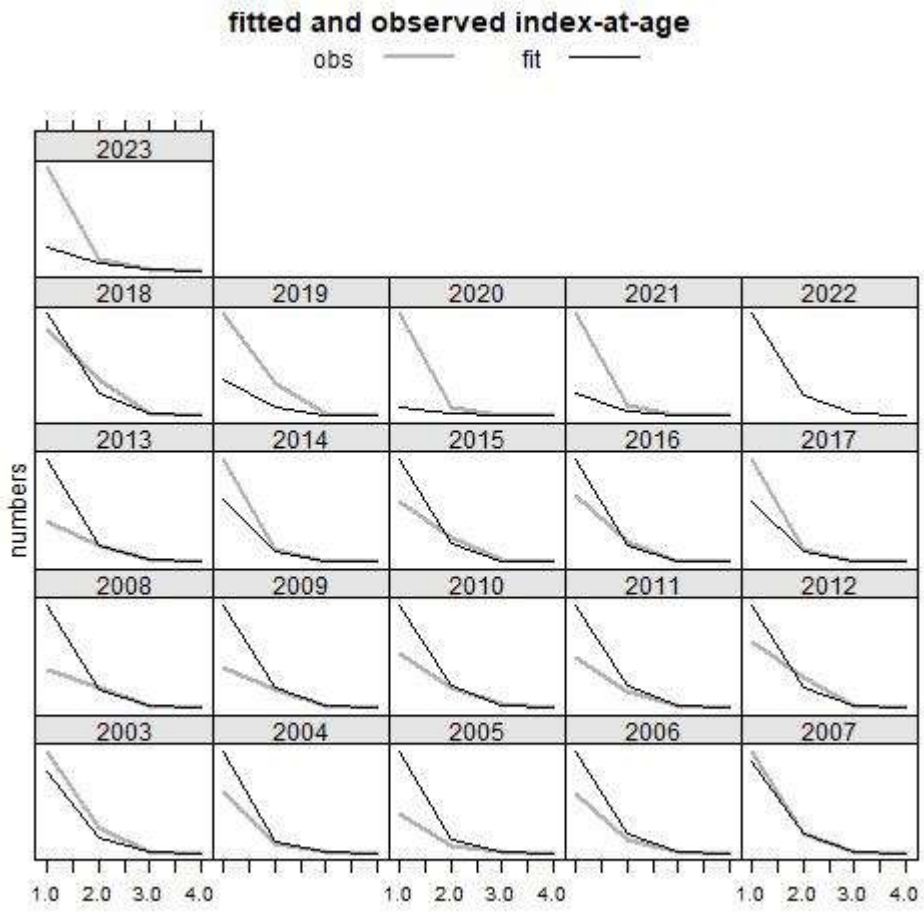
Figure 6.11.3.9 Red mullet in GSA 9. Bubble plot of the log residuals of catch and abundance indices for red mullet in GSA 9.



Source: Own elaborations

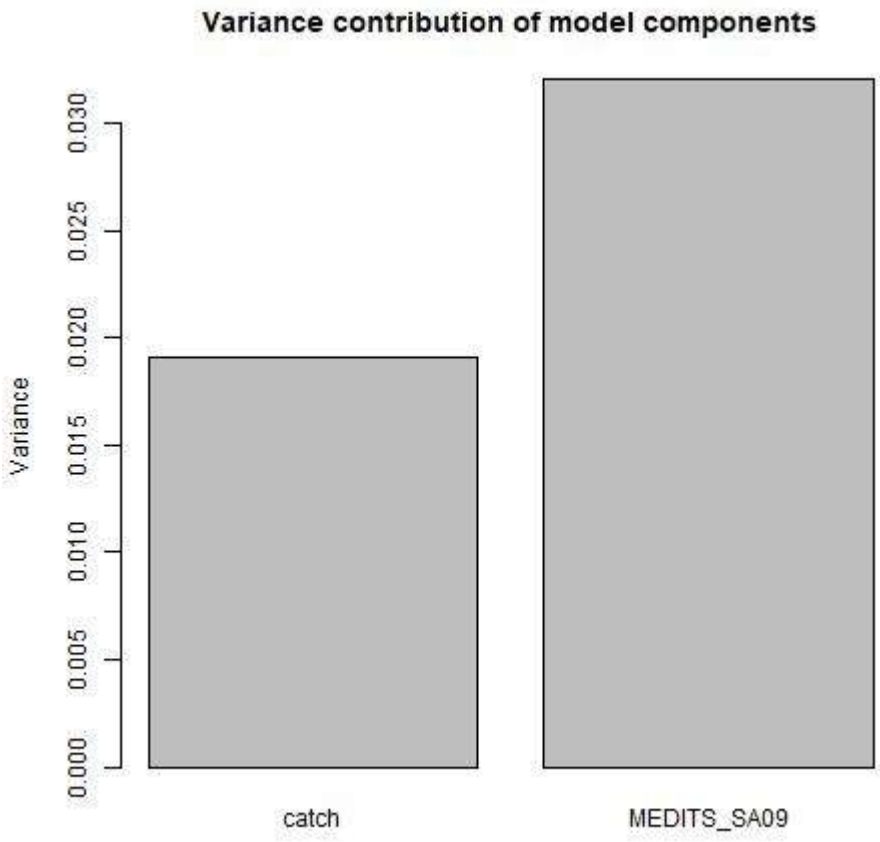
Figure 6.11.3.10 Red mullet in GSA 9. Fitting of the catch-at-age data for red mullet in GSA 9.


fitted and observed catch-at-age
obs
fit
2023
2018
2019
2020
2021
2022
2013
2014
2015
2016
2017
2008
2009
2010
2011
2012
2003
2004
2005
2006
2007
numbers
0 1 2 3 4
age



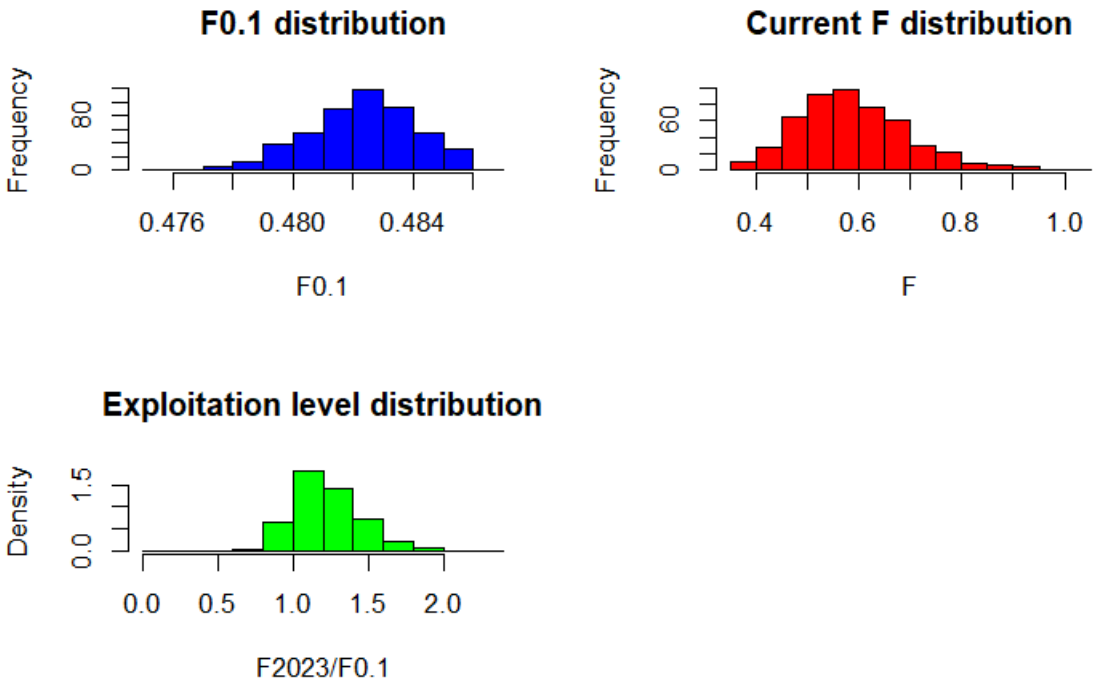
Source: Own elaborations

Figure 6.11.3.12 Red mullet in GSA 9. Variance contribution of model components: catches and survey for red mullet in GSA 9.



Source: Own elaborations

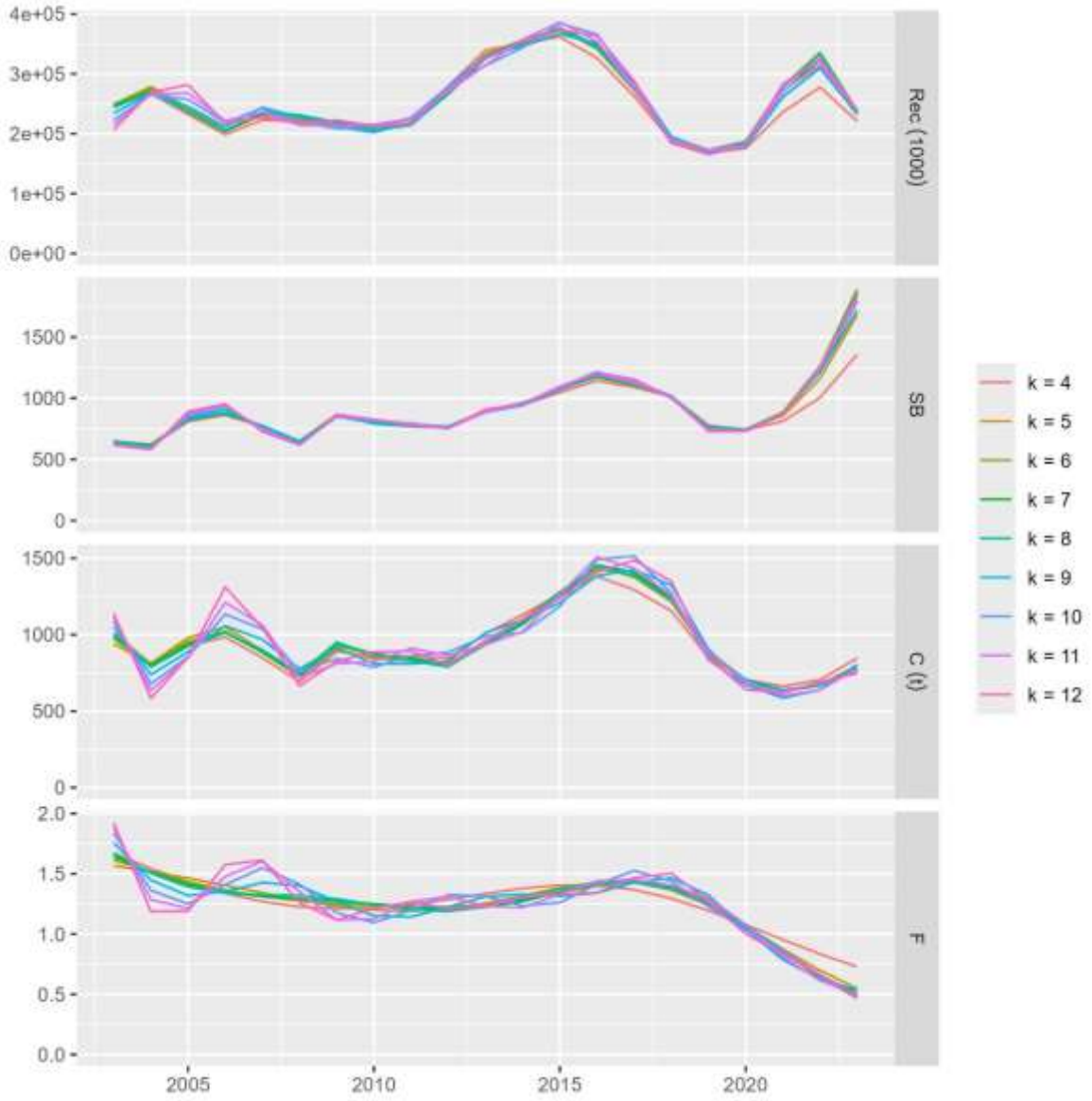
Figure 6.11.3.13 Red mullet in GSA 9. Histograms of probability for $F_{0.1}$, Fcurr and level of exploitation (F_{curr}/F_{01} ratio) values for red mullet in GSA 9.



Source: Own elaborations

A sensitivity analysis was performed on the number of knots (k, ranging from 4 to 12) in the smoother of the variable year in the F sub-model.

Figure 6.11.3.15 Red mullet in GSA 9. Outputs of model runs with different k values on the smoother on year in the fmodel.



Source: Own elaborations

Final assessment outcomes are given in Tables 6.11.3.4-6.11.3.6.

Table 6.11.3.4 Red mullet in GSA 9. Final results of the red mullet assessment in GSA 9.

year	Recruitment (1000s)	SSB (t)	Catch (t)	F(1-3)
2003	248035	648	930	1.54
2004	274248	627	806	1.48
2005	239208	828	963	1.43
2006	206817	872	1030	1.37
2007	228476	778	889	1.31
2008	221633	648	713	1.25
2009	211393	863	894	1.2

2010	203251	796	833	1.18
2011	215721	774	820	1.17
2012	270247	762	802	1.19
2013	335625	895	959	1.24
2014	358588	966	1105	1.3
2015	371434	1080	1287	1.37
2016	340891	1166	1442	1.42
2017	271766	1101	1371	1.42
2018	191883	1006	1215	1.36
2019	169855	766	872	1.24
2020	180446	735	704	1.08
2021	255480	841	646	0.9
2022	300700	1121	685	0.73
2023	228887	1592	801	0.58

Source: Own elaborations

Table 6.11.3.5 Red mullet in GSA 9. Stock numbers at age for red mullet in GSA 9.

	Age				
Year	0	1	2	3	4+
2003	248940.4	42807.5	9788.5	1504.4	155.4
2004	278752	53420.8	7197.9	729.8	133.2
2005	243374.7	59854.9	9252.2	570.7	73.8
2006	205932.1	52292.7	10695.3	782.7	58.7
2007	230313.8	44279.3	9670.3	971.6	82.2
2008	223557.1	49559.4	8492.7	947.7	111.1
2009	213707.7	48140.6	9846.8	895.5	120.3
2010	205181.8	46048	9850	1103.6	122.7
2011	216344.3	44228.2	9600.5	1147.9	153.9
2012	270630.5	46638.8	9263.9	1129.7	165.1
2013	333211.9	58328.1	9659.9	1065	160.5
2014	356104.9	71777	11769.1	1051.8	143.9
2015	374922.6	76649.6	13961	1187.4	130
2016	341646.6	80635.8	14348.9	1300.9	132.2
2017	272678.5	73438.4	14699.4	1265.3	136
2018	191016.1	58613.1	13386.7	1296	133
2019	169737.2	41091.1	11087.7	1274.8	146.5
2020	180815.6	36570.7	8375.5	1232.9	170.2
2021	260884.3	39039.8	8247.6	1149.1	207.5
2022	312007.2	56456.7	9829.4	1422.3	252.5
2023	231960.9	67664.8	15756.1	2099.2	386

Source: Own elaborations

Table 6.11.3.6 Red mullet in GSA 9. Fishing mortality at age for red mullet in GSA 9.

	Age				
Year	0	1	2	3	4+

2003	0.02	0.91	1.9	1.9	1.9
2004	0.02	0.88	1.83	1.83	1.83
2005	0.02	0.85	1.77	1.77	1.77
2006	0.02	0.82	1.7	1.7	1.7
2007	0.02	0.78	1.62	1.62	1.62
2008	0.02	0.75	1.55	1.55	1.55
2009	0.01	0.72	1.49	1.49	1.49
2010	0.01	0.7	1.45	1.45	1.45
2011	0.01	0.69	1.44	1.44	1.44
2012	0.01	0.7	1.46	1.46	1.46
2013	0.02	0.73	1.52	1.52	1.52
2014	0.02	0.77	1.59	1.59	1.59
2015	0.02	0.81	1.67	1.67	1.67
2016	0.02	0.83	1.73	1.73	1.73
2017	0.02	0.83	1.73	1.73	1.73
2018	0.02	0.8	1.65	1.65	1.65
2019	0.02	0.72	1.5	1.5	1.5
2020	0.01	0.62	1.29	1.29	1.29
2021	0.01	0.51	1.06	1.06	1.06
2022	0.01	0.41	0.84	0.84	0.84
2023	0.01	0.32	0.66	0.66	0.66

Source: Own elaborations

6.11.4 REFERENCE POINTS

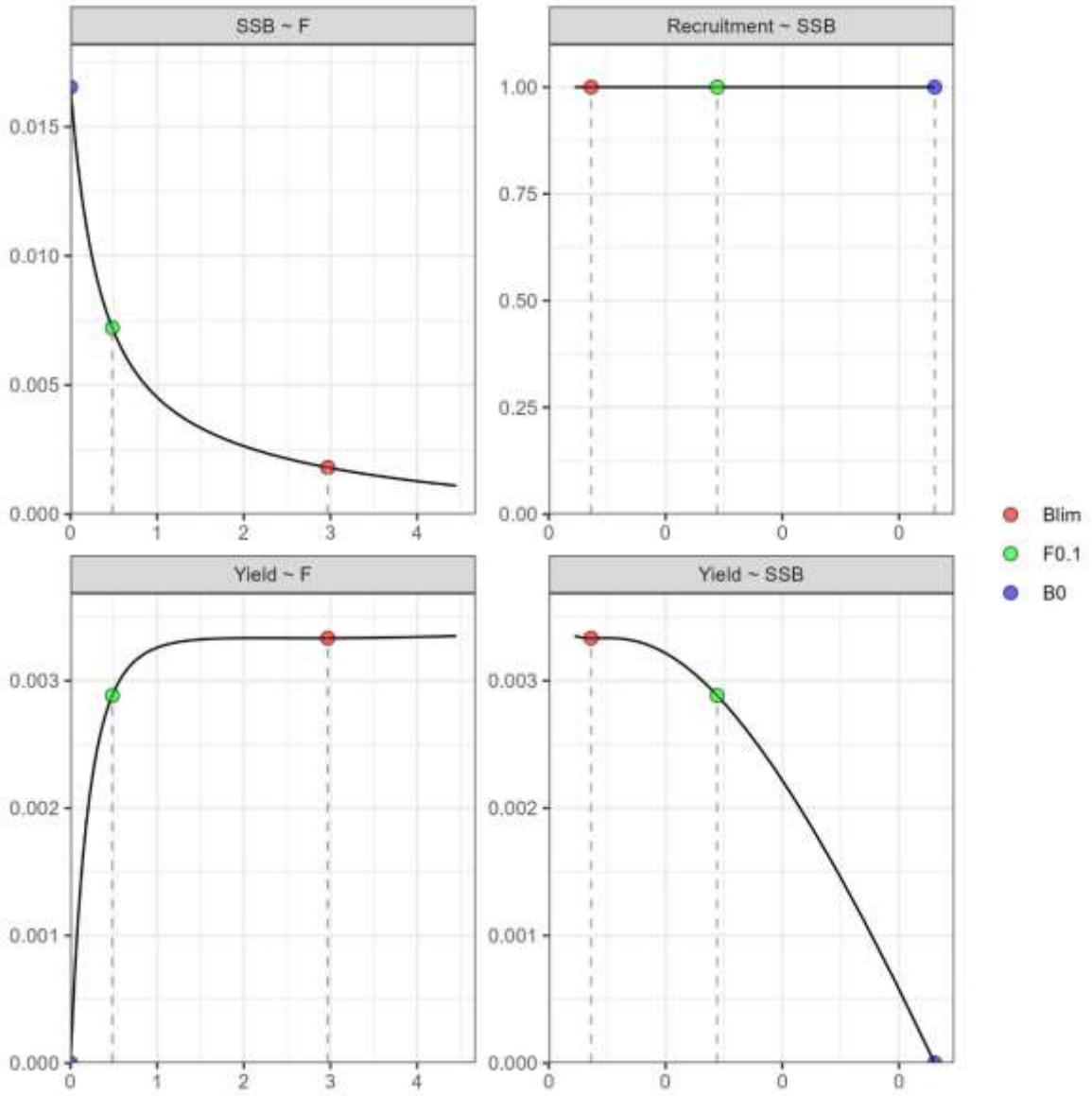
As the production curve is always increasing (Fig 6.11.4.1), the STECF EWG recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the assessment.

Values of $F_{0.1}$ calculated by FLBRP package on the a4a assessment results is equal to 0.48. Current F values (2023), as calculated by model a4a, is 0.58 indicating that the stock is in overexploitation.

The STECF EWG 19-10 recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the a4a assessment.

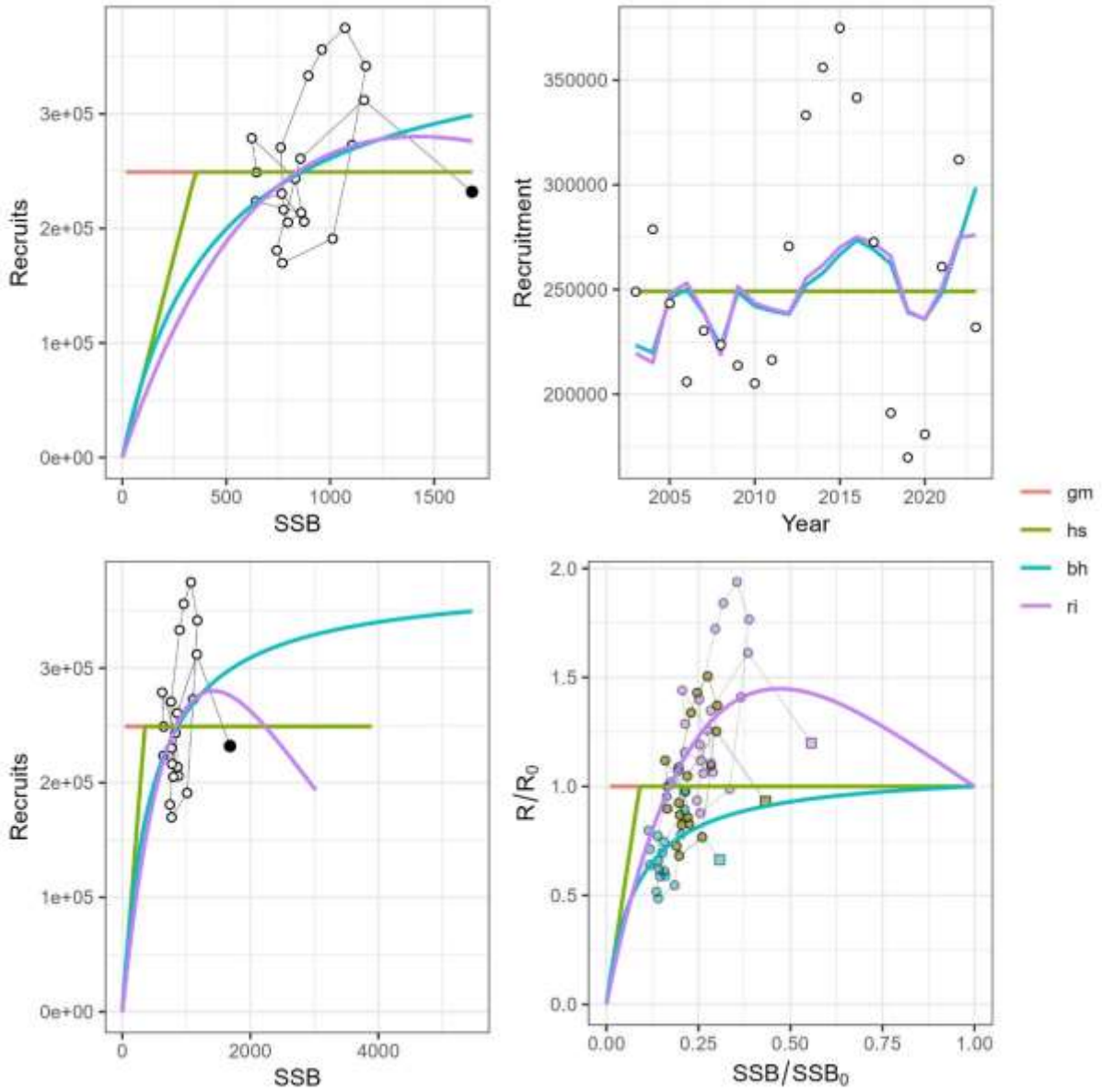
The procedure used follows the methods set out in EWG 22-03 endorsed by STECF in July 2022 and confirmed by STECF 24-02.

Figure 6.11.4.1: Production curves with selected reference points. Note that the yield curve is always increasing and thus F01 was used as a proxy for Fmsy.



Source: Own elaborations

Figure 6.11.4.2: Different stock recruitment curves were fitted, as there is no obvious reason to change the stock-recruitment function from last assessment, a geo-mean relationship was assumed. Note that due to the SSB being above the inflection point of the hockey-stick, both stock recruitment curves would give the same behaviour for the stock.



Source: own elaborations

Results

In the light of the outcomes of the exploratory analysis, because the point of inflection on the HS was outside the data it was decided to consider the Geometric Mean approach as the most suitable to estimate the biomass reference points for the stock of red mullet in GSA 9, this being also equivalent to the asymptote of the HS. Table 6.11.4.3 summaries the reference point values based on the default value of 25% of $B_{F0.1}$ for B_{lim} and Geometric Mean fitted to the data for R_0.

B_{pa} is set to 2* B_{lim}. The implied dynamics, based on a Hockey-stick model with R_0 from GM recruitment and the HS breakpoint at 25% $B_{F0.1}$ are illustrated in Figure 6.11.4.10.

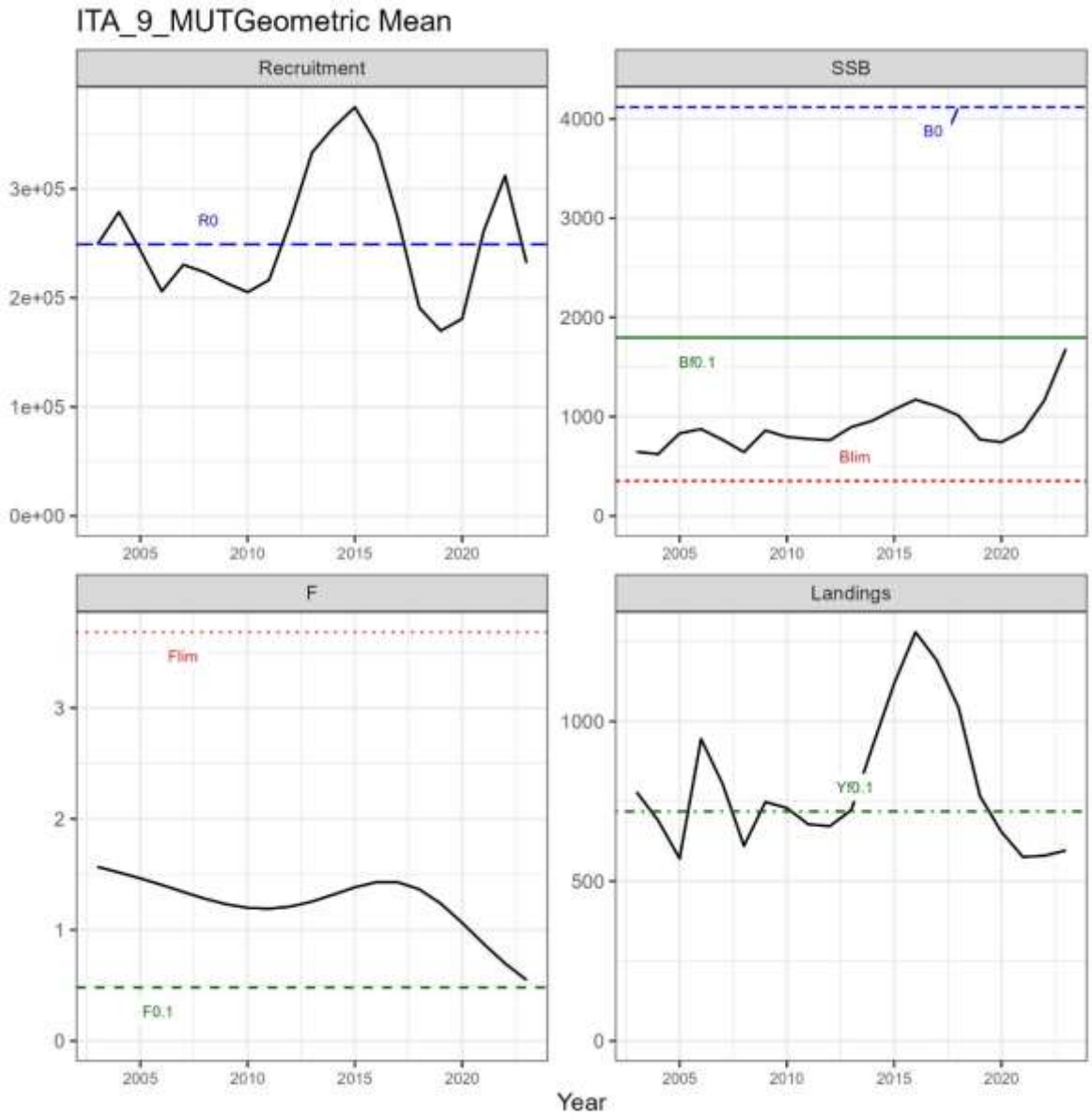
Table 6.11.4.3. Red mullet in GSA 9. Final reference points based on Geometric mean and a default value of B_{lim} =25% $B_{F0.1}$.

$F_{0.1}$	B_{trg}	B_{lim}	F_{lim}	Y_{eq}	B_0
0.482	1796	449	2.97	718	4118

Source: own elaborations

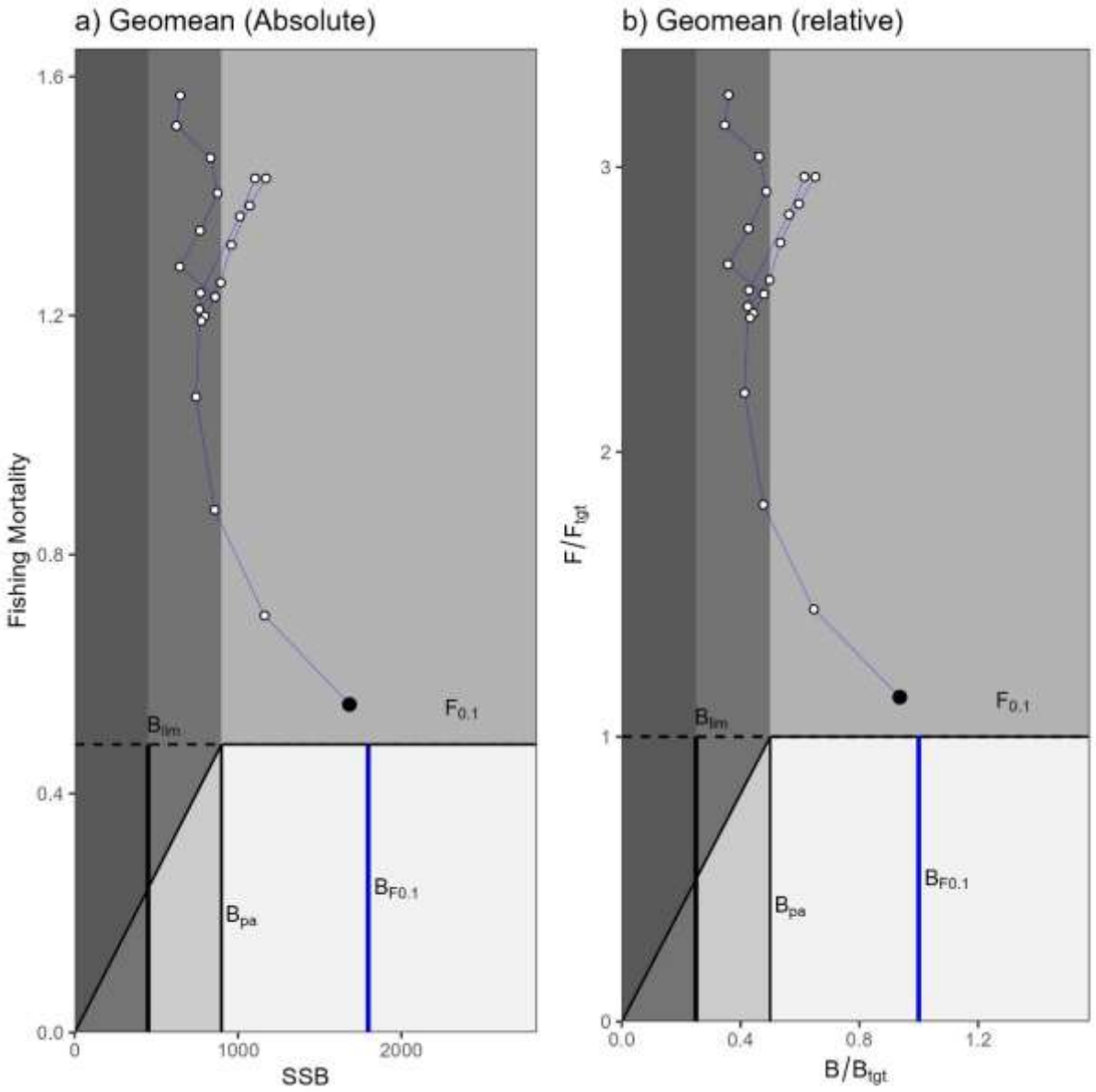
Figures 6.11.4.11 - 6.11.4.12 show the reference points estimated for the Geometric mean model for red mullet in GSA 9.

Figure 6.11.4.11. Red mullet in GSA 9. Status Advice plot showing stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Geometric mean stock-recruitment relationship.



Source: own elaborations

Figure 6.11.4.12. Red mullet in GSA 9. Advice Rule plots for the Geometric mean model, with an empirical B_{lim} = 0.25 $B_{F0.1}$ and B_{pa} = 2x B_{lim}.



Source: own elaborations

Modelling options

The Geometric mean model defined above is considered as the best option for defining reference points for this stock, but it may not be the most suitable for modelling. A Beverton-Holt model may be helpful to as a modelling option. The steepness option that most closely mimics in terms of deviation from slope and asymptote the HS chosen is thought to be steepness = 0.95 (Figure 6.11.4.13).

6.11.5 SHORT TERM FORECAST AND CATCH OPTIONS

The short tem forecast was made using the same assumptions on stock recruitment relationship, mean weight at age and mean fishery selection pattern over the last three years as in the past EWGs (2209, 2309). The stock object from the assessment was used as input to the short term forecast (STF), which was carried out as usual using the FLR libraries and scripts.

For the interim year (2024), an average of the last three years has been used for weight at age, maturity at age, while the F_{bar} = 0.55 (terminal F (2023)) was used for F in 2024. Recruitment is observed to be fluctutating over the period of the assessment (Figure 6.11.3.5) so the geometric mean across the whole time series is used as an estimate of recruits from 2024 (whole time series of 20 years; recruitment 219121 thousands).

Table 6.11.5.1 Red mullet in GSA 9. Assumptions made for the 2024 interim year and in the forecast.

Variable	Value	Notes
Biological Parameters	average of 2021-2023	mean weights at age, maturation at age, natural mortality at age and selection at age
$F_{ages\ 1-3}$ (2024)	0.58	F 2022 used to give F status quo for 2023
$F_{ages\ 1-3}$ (2019)	1.24	MAP base year fishing mortality from current assessment
SSB (2024)	1553	Stock assessment middle of the year 2023
R_{age0} (2003,2023)	247385 (thousands)	Geometric mean of the time series (20 years)
Total catch (2024)	867	Catch intermediate year from STF output

Source: own elaborations

The short term forecast was carried out estimating a catch for 2024-2025 on the basis of a recruitment hypothesis constant and equal to the mean on the whole time series and an F by age equal to that of the terminal year. These assumptions resulted in a catch and a SSB in 2024 equal to 867 and 1553 tons, respectively.

The analysis, carried out with FLR script made available to the EWG, shows that fishing at a level equal to $F_{0.1}$ (0.481) would increase biomass by 11.4% from 2023 to 2025, while decreasing catches by 7.3% from 2023 to 2025.

Table 6.11.5.2 Red mullet in GSA 9. Short term forecast table for red mullet in GSA 9.

Rationale	Ffactor	Fbar	Fsq2024	Catch2023	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	0.83	0.48	0.58	801.39	743.09	1552.62	1729.80	11.41	-7.28
F upper	1.13	0.66	0.58	801.39	948.67	1552.62	1495.24	-3.70	18.38
F lower	0.55	0.32	0.58	801.39	527.91	1552.62	1995.56	28.53	-34.13
FMSY transition	0.83	0.48	0.58	801.39	743.09	1552.62	1729.80	11.41	-7.28
Zero catch	0.00	0.00	0.58	801.39	0.00	1552.62	2734.47	76.12	-100.00
Status quo	1.00	0.58	0.58	801.39	861.80	1552.62	1592.05	2.54	7.54
Different Scenarios	0.10	0.06	0.58	801.39	106.57	1552.62	2575.46	65.88	-86.70
	0.20	0.12	0.58	801.39	207.90	1552.62	2428.87	56.44	-74.06
	0.30	0.17	0.58	801.39	304.26	1552.62	2293.63	47.73	-62.03
	0.40	0.23	0.58	801.39	395.96	1552.62	2168.74	39.68	-50.59
	0.50	0.29	0.58	801.39	483.25	1552.62	2053.31	32.25	-39.70
	0.60	0.35	0.58	801.39	566.38	1552.62	1946.52	25.37	-29.33
	0.70	0.41	0.58	801.39	645.59	1552.62	1847.65	19.00	-19.44
	0.80	0.46	0.58	801.39	721.09	1552.62	1756.01	13.10	-10.02
	0.90	0.52	0.58	801.39	793.10	1552.62	1671.00	7.62	-1.04
	1.10	0.64	0.58	801.39	927.37	1552.62	1518.66	-2.19	15.72
	1.20	0.70	0.58	801.39	989.99	1552.62	1450.37	-6.59	23.53
	1.30	0.76	0.58	801.39	1049.82	1552.62	1386.75	-10.68	31.00
	1.40	0.81	0.58	801.39	1107.01	1552.62	1327.42	-14.50	38.14
	1.50	0.87	0.58	801.39	1161.70	1552.62	1272.04	-18.07	44.96
	1.60	0.93	0.58	801.39	1214.02	1552.62	1220.27	-21.41	51.49
	1.70	0.99	0.58	801.39	1264.11	1552.62	1171.84	-24.53	57.74
	1.80	1.05	0.58	801.39	1312.07	1552.62	1126.47	-27.45	63.72
	1.90	1.10	0.58	801.39	1358.02	1552.62	1083.92	-30.19	69.46
	2.00	1.16	0.58	801.39	1402.06	1552.62	1043.97	-32.76	74.95

* $F_{MSY\ transition}$ is based on a linear change in F from 2019 to F_{MSY} in 2025

** $F_{MSY\ upper}$ is not tested and is assumed not to be precautionary STECF does not advise fishing at F > F_{MSY}

*** SSB in the middle of the year

^ % change in SSB 2025 to 2023

^^ Total catch in 2024 relative to catch in 2022.

Source: own elaborations

EWG advises that when the MSY approach is applied, catches in 2024 should be no more than 976 tonnes.

6.12 Red Mullet in GSA 10

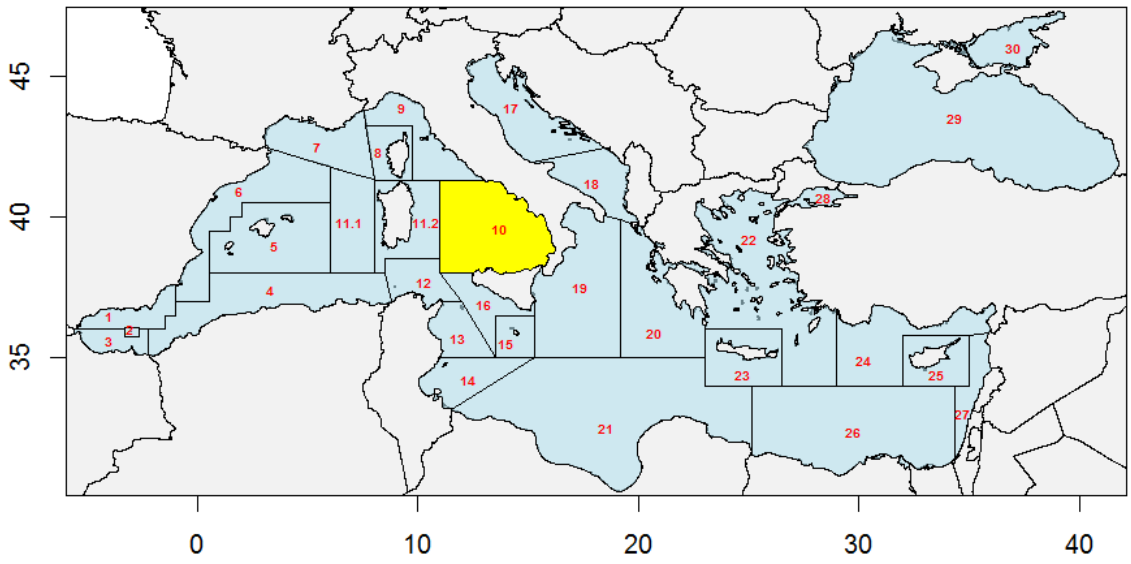
6.12.1 Stock Identity and Biology

Red mullet (*Mullus barbatus*) is distributed in GSA 10 along the shelf at depths up to 200m, but mainly concentrated in the depth range 0-100 m. The area of GSA 10 extends in the South and Central Tyrrhenian Sea, that features one of the most complex structures in the seas around the Italian peninsula, due to its morphological and geophysical characteristics and water mass dynamics (Cataudella and Spagnolo, 2011). In line with the given ToR, it is assumed in the present assessment that inside the GSA 10 boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population.

However, the EWG19-10 noticed that EU project STOCKMED outcomes suggest a single stock unit in Western Mediterranean (see: https://ec.europa.eu/fisheries/documentation/studies/stockmed_en).

In addition, available spatial information from MEDITS shows continuous distribution of the red mullet along western Italian coast (i.e. continuity in spatial distribution in GSA10 and GSA9).

Figure 6.12.1.1. Red mullet in GSA 10. Map of GSA 10.



Source: own elaborations

Growth

The information on the age-length key (ALK) and on the growth von Bertalanffy parameters was available from 2002 to 2023, except for the ALK from 2022.

Growth parameters were available by sex, except for 2023, in which only combined sex were available. For 2021-2023, the values were the same.

Figure 6.12.1.2. Red mullet in GSA 10. Growth curves for red mullet in GSA 10 (DCF) for 2021-2023.



Source: own elaborations

Natural mortality

Last time the assessment was carried out was during EWG 22-09, with natural mortality used estimated according to Chen and Watanabe (1989) model on the age vector at half year (0.5, 1.5, 2.5,…) using the same growth parameters used in the slicing.

Table 6.12.1.1 Red mullet in GSA 10. Natural mortality by age used in EWG 22-09.

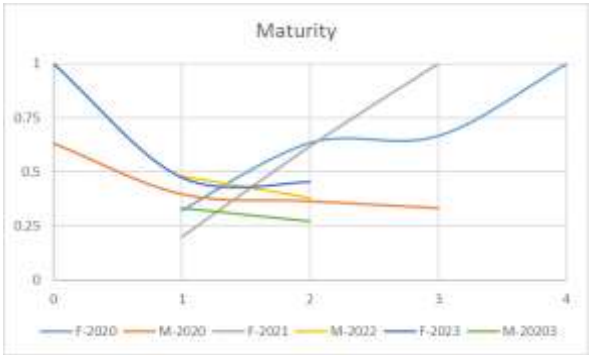
Age	0	1	2	3	4+
M	1.44	0.75	0.57	0.48	0.43

Source: own elaborations

Maturity

Maturity ogives by length and age were available from 2002 to 2023 (except 2022). However, for the last period the ogives showed strange trends (Figure 6.12.2.1.1.)

Figure 6.12.1.3. Red mullet in GSA 10. Maturity at age for 2020-2023.



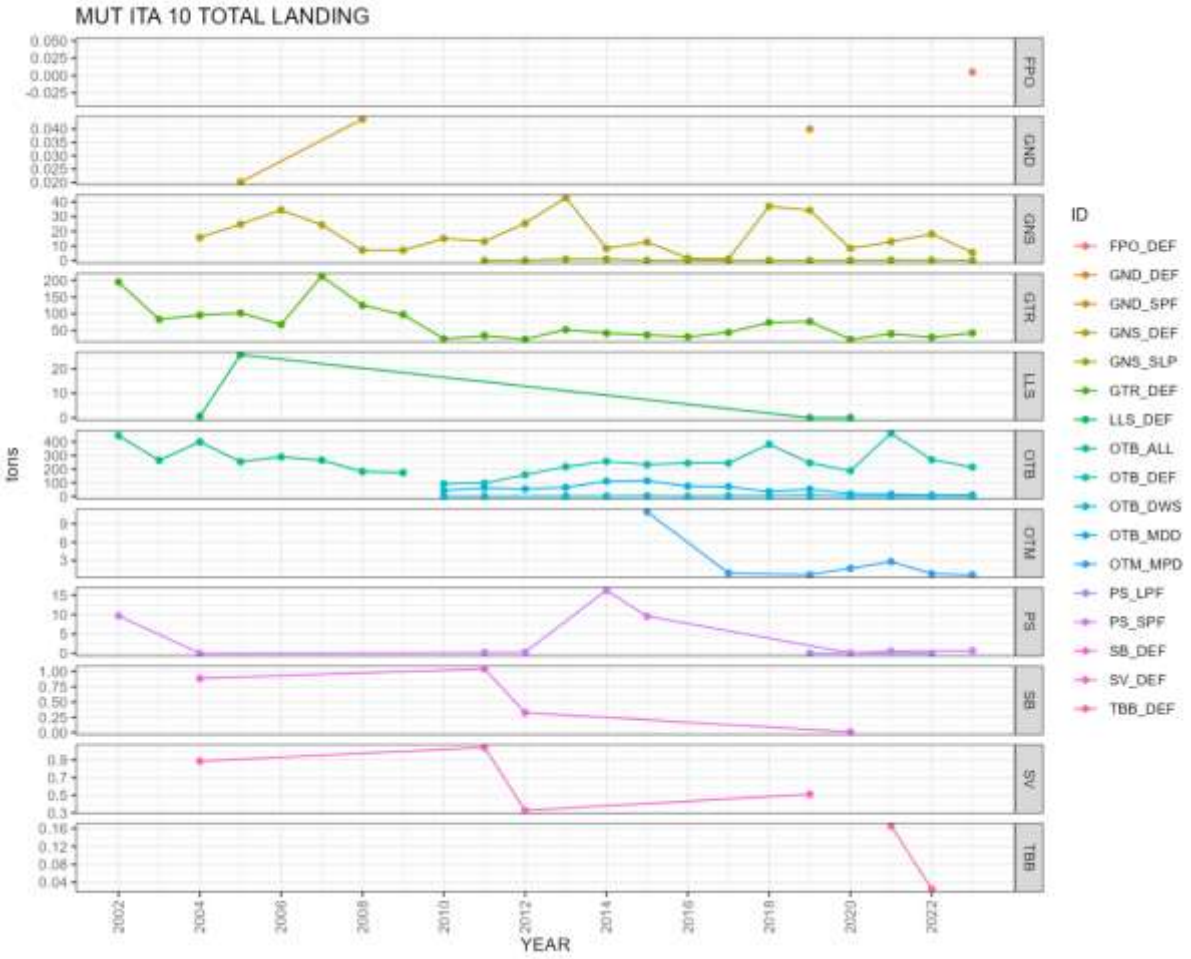
Source: own elaborations

6.12.2 DATA

6.12.2.1 CATCH (LANDINGS AND DISCARDS)

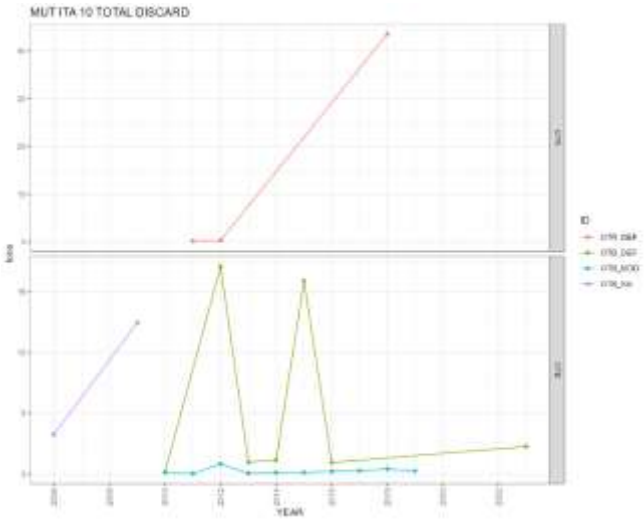
Principal fishing gears used to catch red mullet, together with other species (mixed catches) are gillnets (GNS), trammel nets (GTR) and bottom trawls (OTB). Landings and discards are shown in the following tables and figures. Most of the landings come from otter trawls.

Figure 6.12.2.1. Red mullet in GSA 10. Landings data in tonnes by year and fleet.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.12.2.2. Red mullet in GSA 10. Data data in tonnes by year and fleet.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

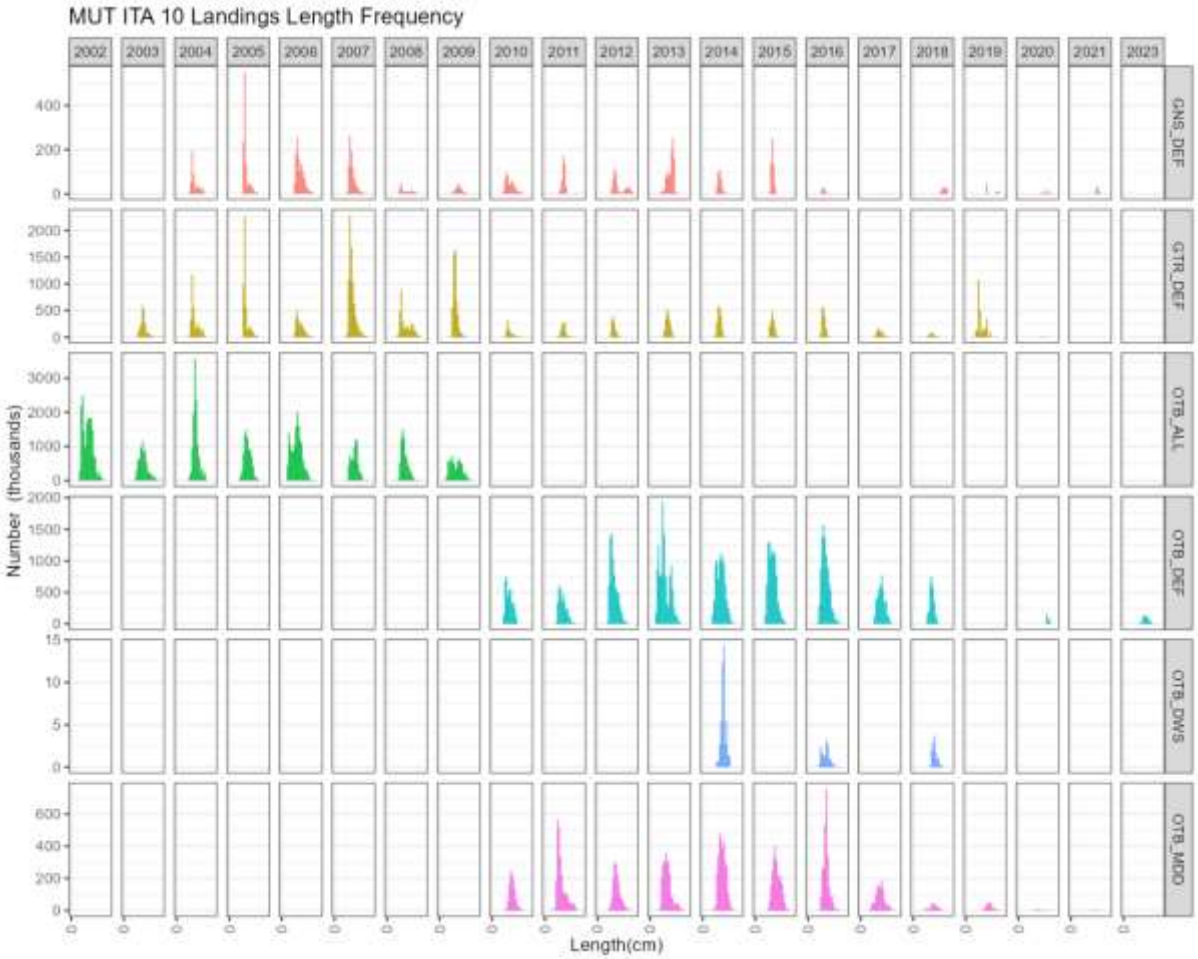
Table 6.12.2.1. Red mullet in GSA 10. Landings and discard data in tonnes by year.

Year	Landings	Discards	Catches
2002	839		839
2003	419		419
2004	524		524
2005	421		421
2006	393	3.2	396
2007	502		502
2008	315		315
2009	279	12.5	291
2010	177	0.3	177
2011	210	0.3	210
2012	264	18.3	283
2013	381	1.0	382
2014	438	1.2	439
2015	421	16.0	437
2016	353	1.2	354
2017	365	0.3	365
2018	532	44.0	576
2019	416	0.3	417
2020	242		242
2021	536		536
2022	328		328
2023	275	2.3	277

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

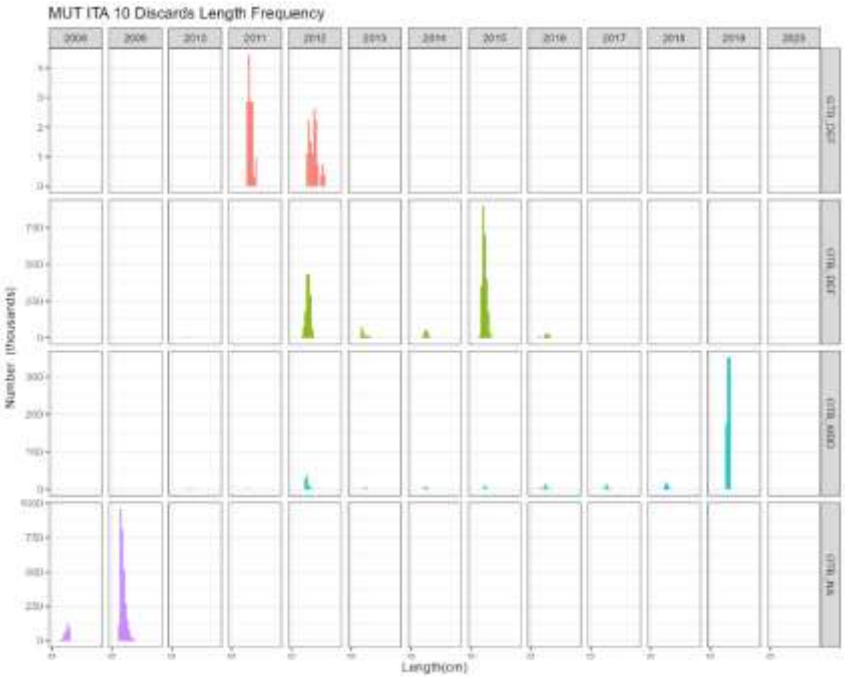
Length structure of red mullet landings and discards for all gears in the period from 2002 to 2023 are shown in the following figures. No length information on both landings and discards was avalable for 2022.

Figure 6.12.2.3. Red mullet in GSA 10. Length structure of red mullet landed in GSA 10 in the period from 2002 to 2023 by fishing gear and fishery. No information is avalable for 2022.



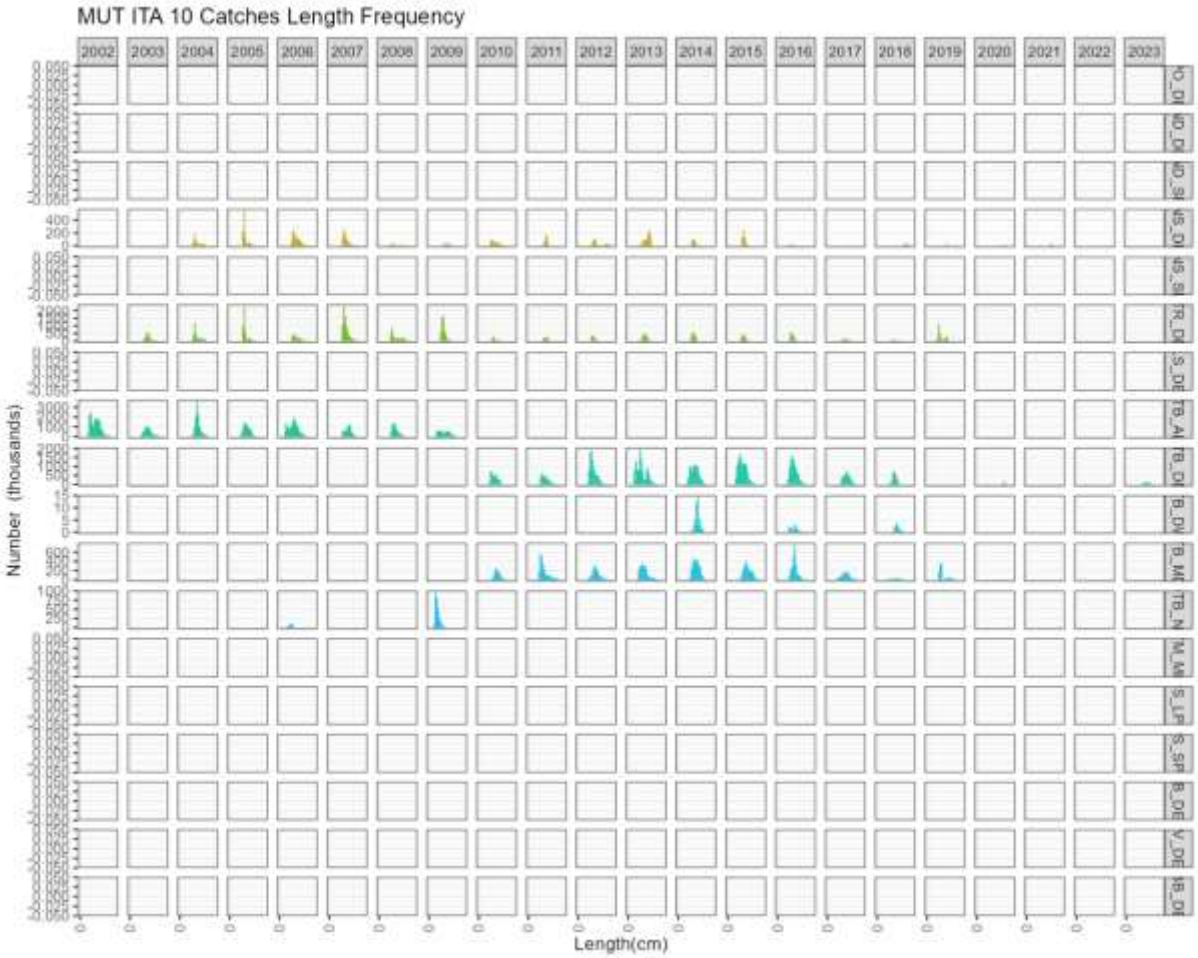
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.12.2.4. Red mullet in GSA 10. Length structure of discarded catch of red mullet in GSA 10 in the period from 2006 to 2023 by fishing gear and fishery. Discards in 2020-2022 are not available.



Source: own elaborations

Figure 6.12.2.5. Red mullet in GSA 10. Length structure of catches (landing+discarded catch) of red mullet in GSA 10 in the period from 2002 to 2023 by fishing gear and fishery. No information is avalable for 2022.



Source: own elaborations

6.12.2.2 EFFORT

Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.12.2.3 SURVEY DATA

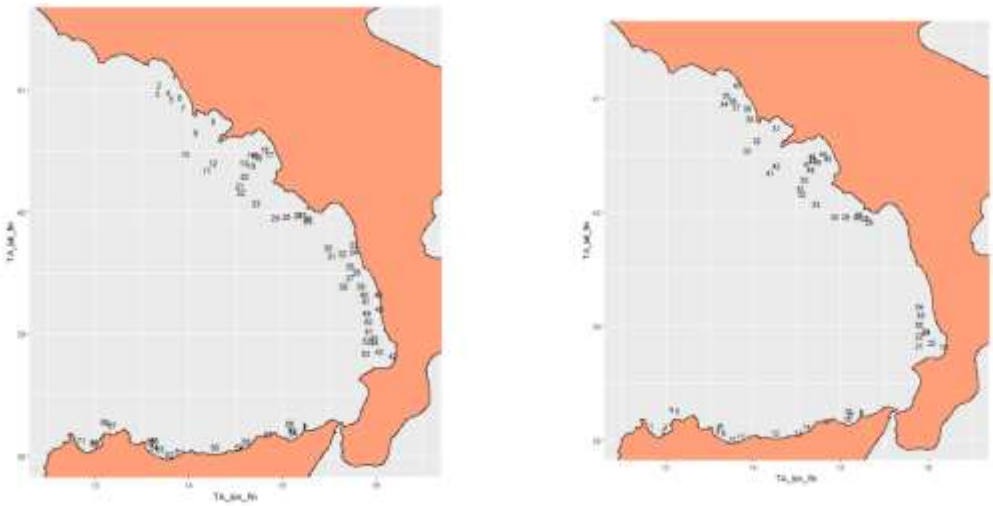
MEDITS survey was conducted in 2023, but at the end of the year and only partially, as shown in the following figures. No MEDITS survey was conducted in GSA 10 in 2022. The surveys in GSA10 took place in different seasons of the year for some periods and in 2020, similarly than in 2023, only partially at the end of the year.

Figure 6.12.3.1. Red mullet in GSA 10. Survey periods (MEDITS, 1994-2023) in GSA 10.



Source: own elaborations

Figure 6.12.3.2. Red mullet in GSA 10. Survey stations carried out during the MEDITS in 2021 (left) and 2023 (rigth).



Source: own elaborations

The following figures showed the trend of the abundance and biomass indices from the trawl surveys, as well as the length distributions. Large inter-annual variations in length structure can be noticed probably related to the survey time, that in some years allowed to detect the recruitment of the species.

Figure 6.12.3.3. Red mullet in GSA 10. Abundance indices (N/km^2) of red mullet in GSA 10 as derived from trawl surveys (MEDITS, 1994-2023).

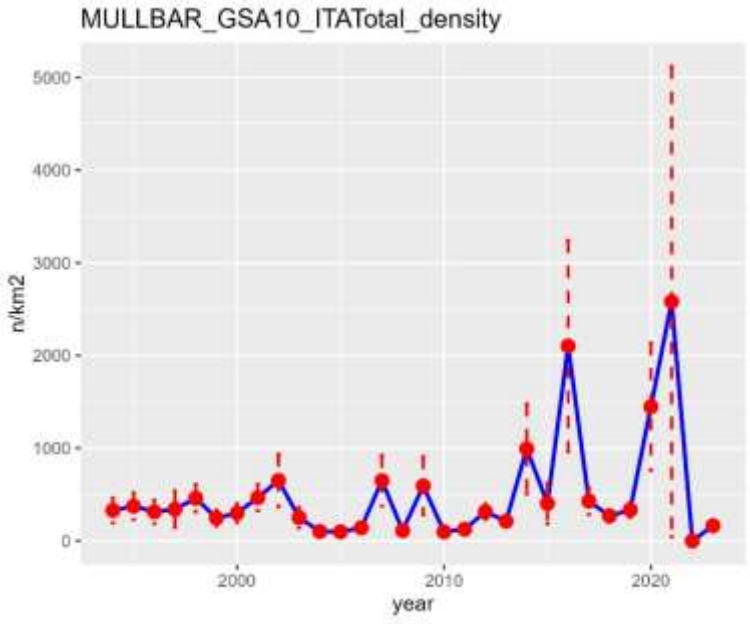
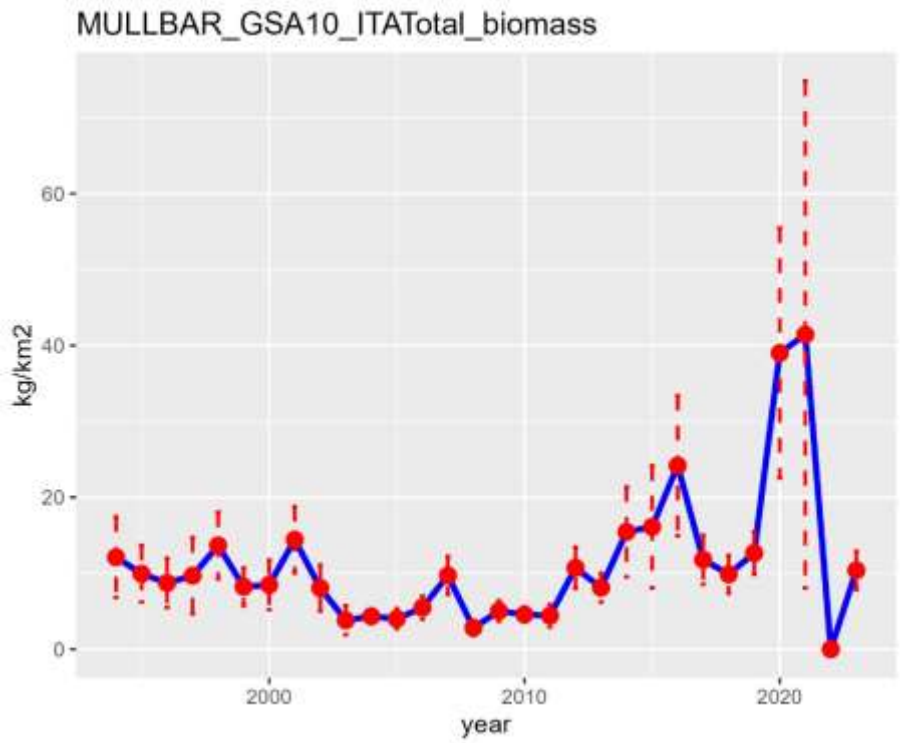
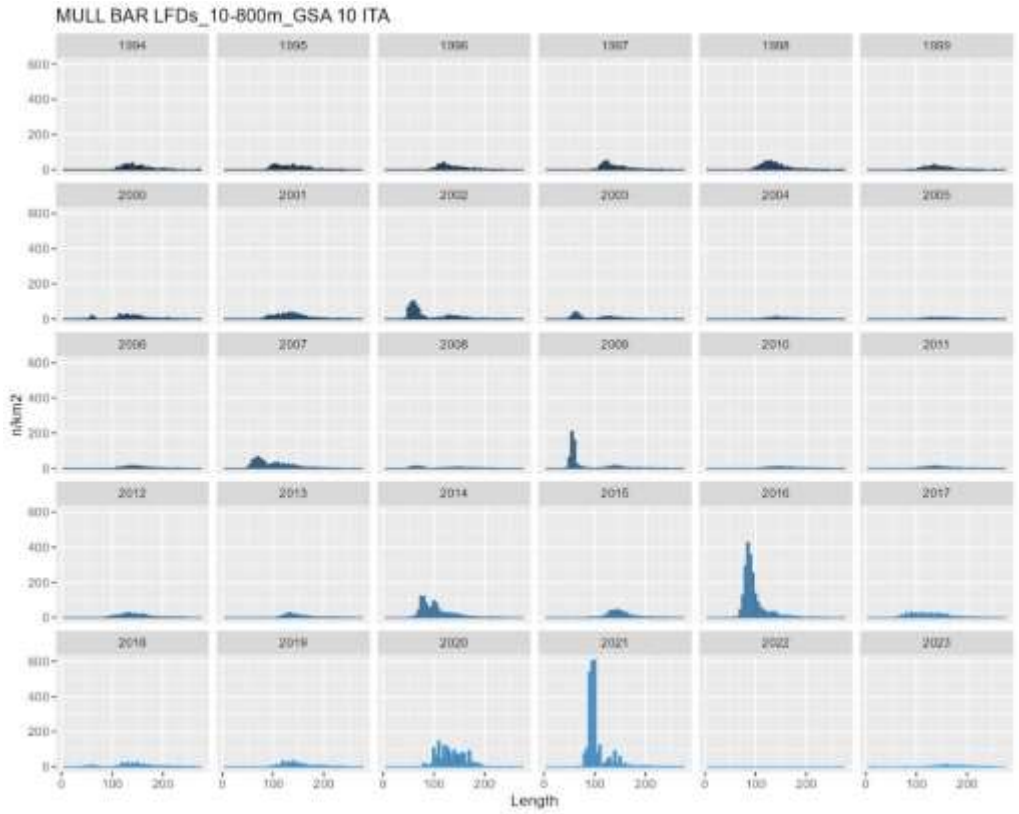


Figure 6.12.3.4. Red mullet in GSA 10. Biomass indices (kg/km^2) of red mullet in GSA 10 as derived from trawl surveys (MEDITS, 1994-2023).



Source: own elaborations

Figure 6.12.3.5. Red mullet in GSA 10. Size structure indices of red mullet in GSA 10 as derived from trawl surveys (MEDITS, 1994-2023).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.12.3 STOCK ASSESSMENT

Due to the unavailability of reliable catch at age information in the last three years, the lack of the MEDITS survey in 2022 and that the MEDITS survey was carried out in 2023 only partially and in December, the EWG 24-10 concluded that it is not possible to produce any assessment to evaluate the current status of the stock.

6.12.4 REFERENCE POINTS

No reference point was estimated.

6.12.5 SHORT TERM FORECAST AND CATCH OPTIONS

Following the decision tree provided in the ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 (ICES, 2022), no method could be used to assess the stock status and provide advice.

Therefore, ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that

the current level of exploitation is appropriate for the stock. The precautionary buffer was applied in EWG 23-09 based on 2022 data. Discards are considered negligible.

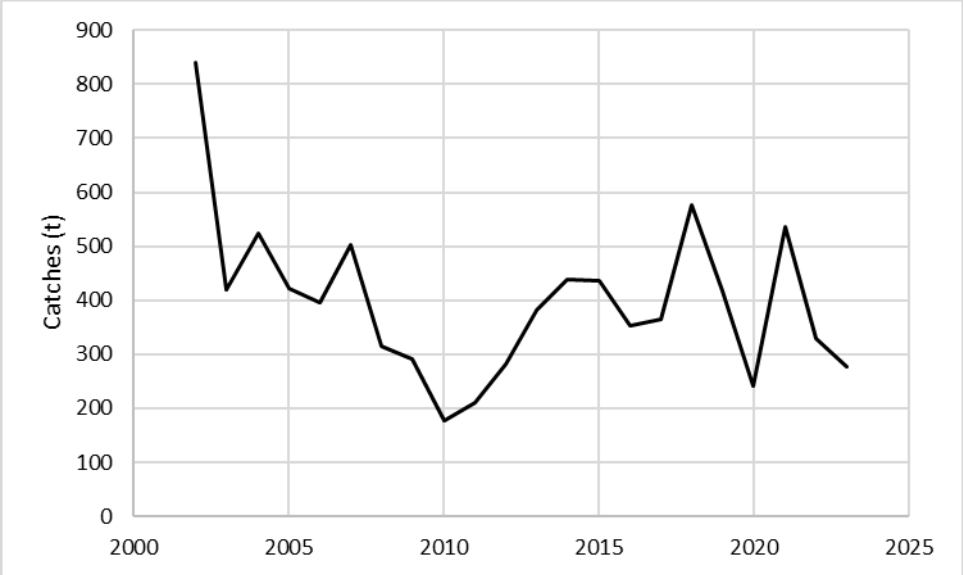
Table 6.12.6.1 Red mullet in GSA 10. Basis for the catch scenarios computed during EWG 23-09. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables.

Recent advised catches		326
Discard rate		Negligible
Precautionary buffer	Applied	0.8
Catch advice *		261
% advice change **		-20%

* Advised catches for each of the years 2024, 2025 and 2026.

** Advice value for 2024 relative to the advice for 2023 (326 tonnes).

Figure 6.12.6.1 Red mullet in GSA 10. Catches by year.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

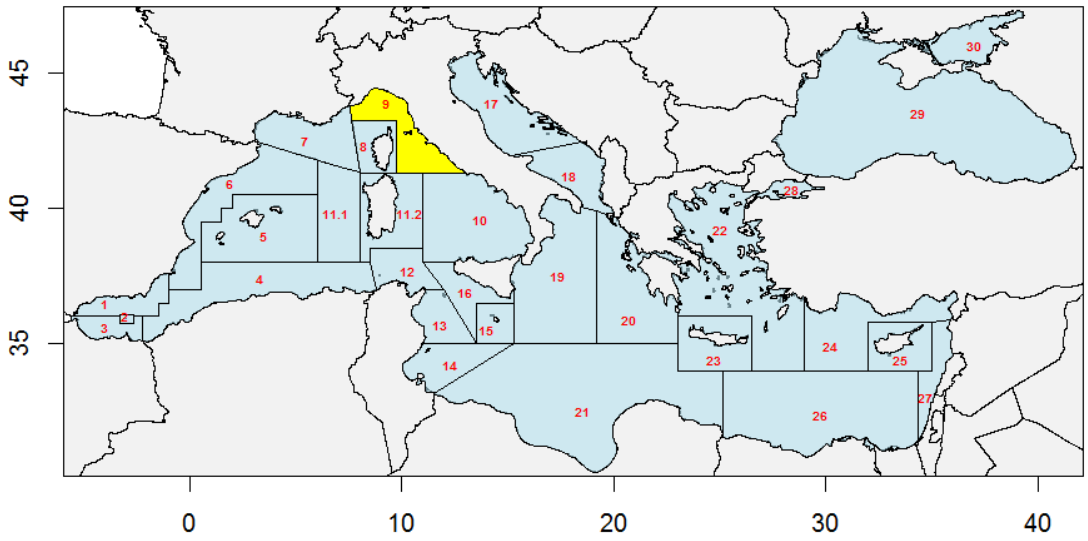
Following the advice of STECF EWG 23-09, STECF EWG 24-10 advises that when the precautionary approach is applied catches should be no more than 261 tonnes in each of the years 2024, 2025 and 2026.

6.13 NORWAY LOBSTER IN GSA 9

6.13.1 STOCK IDENTITY AND BIOLOGY

Due to a lack of information about the structure of *N. norvegicus* population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 *boundaries* (Figure 6.13.1).

Figure 6.13.1 Limit of Geographical Sub-Area (GSA) 9.



Source: own elaborations

Growth, maturity and natural mortality

For *N. norvegicus*, there is a difference in growth between males and females. Males attaining greater lengths at ages and maximum sizes compared to females. Growth parameters for *N. norvegicus* in GSA 9 are provided in Table 6.13.1.1

Several sets of VBGF parameters have been reported in the DCF database. Also for the Length-Weight relationship, several sets of paramentes by sex are provided for GSA 9. The VBGF and LW relationship parameters that were historically used for the assessment (STECF, 2023) are summarized in the following table (Table 6.13.1.1). By consulting previous reports it is nevertheless not possible to exaclty track how the parameters were derived from the information available in the DCF. The consequences are discussed further below in the document.

To account for spawning at middle year, a correction of 0.5 was applied to t0.

Table 6.13.1.1 Norway lobster in GSA 9: VBGF and LW relationship parameters. A correction of 0.5 was applied to t_0 to account for spawning at middle year.

Source	Sex	L_{inf} (mm)	k	t_0 *	a (mm/g)	b (mm/g)
STECF 23-09	M	72.1	0.17	0	0.00038	3.18164
	F	56	0.21	0	0.00032	3.24848

*original value, before the application of 0.5 correction

Source: own elaborations

A vector of proportion of mature-by-age was computed as a weighed average of the vectors available from the DCF database in GSA 9. A natural mortality vector was estimated by sex using the Chen and Watanabe equation and the growth parameters described above. A combined natural mortality vector was then computed as a weighed average of the vectors by sex. The vector of proportion of mature and the natural mortality vector used in the assessment of Norway lobster in GSA 9 are shown in Table 6.13.1.2. The Maturity and natural mortality vectors are the same as the ones applied last year. In addition, point estimates of natural mortality by sex were computed using the Barefoot ecologist toolbox[4], by taking the median value of several methods (Then, Hamel, Jensen, ZM). Maturity acts primarily as a scalling factor on SSB and reference points and has little influece on management parameters, though $F_{0.1}$ does depend in a small way on maturity at age.

Table 6.13.1.2 Norway lobster in GSA 9: proportion of mature vectors by age.

Maturity	0	1	2	3	4	5	6	7	8	9+
Females	0.1	0.4	0.75	1	1	1	1	1	1	1

Source: own elaborations

Table 6.13.1.3 Norway lobster in GSA 9: natural mortality vectors by age.

Mortality	Point estimate*	1	2	3	4	5	6	7	8	9+
Males	0.55									
Females	0.49									
Combined		0.75	0.5	0.39	0.33	0.29	0.26	0.24	0.23	0.23

* From the Barefoot ecologist toolbox

Source: own elaborations

6.13.2 DATA

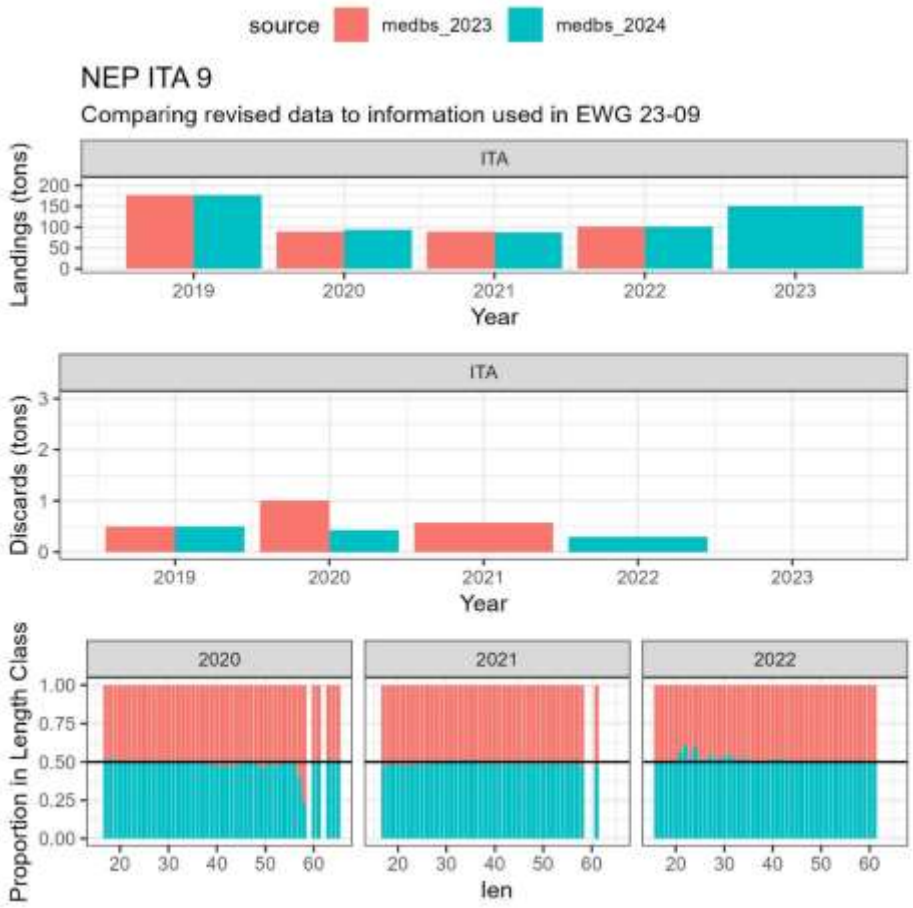
6.13.2.1 CATCH (LANDINGS AND DISCARDS)

Annual landings and discards data have been revised after a re-submission of information from national bodies. Figures 6.13.2.1.1 compares the landings, the discards and the length frequency distribution of the landings. It emerges a sligth difference in all these type of information and EGW 24-10 adopted the updated information. The length composition of discards is not shown since no differences were observed.

Figure 6.13.2.1.1. Norway lobster in GSA 9: comparison of information used in EWG 23-09 (medbs_2023) to information used in EWG 24-10 (medbs_2024). Top panel shows the total landings per year by source of information; central panel shows total discards per year by source of information; bottom panel compares the length frequency distribution of landings using proportions by length class:

[4] http://barefootecologist.com.au/shiny_m

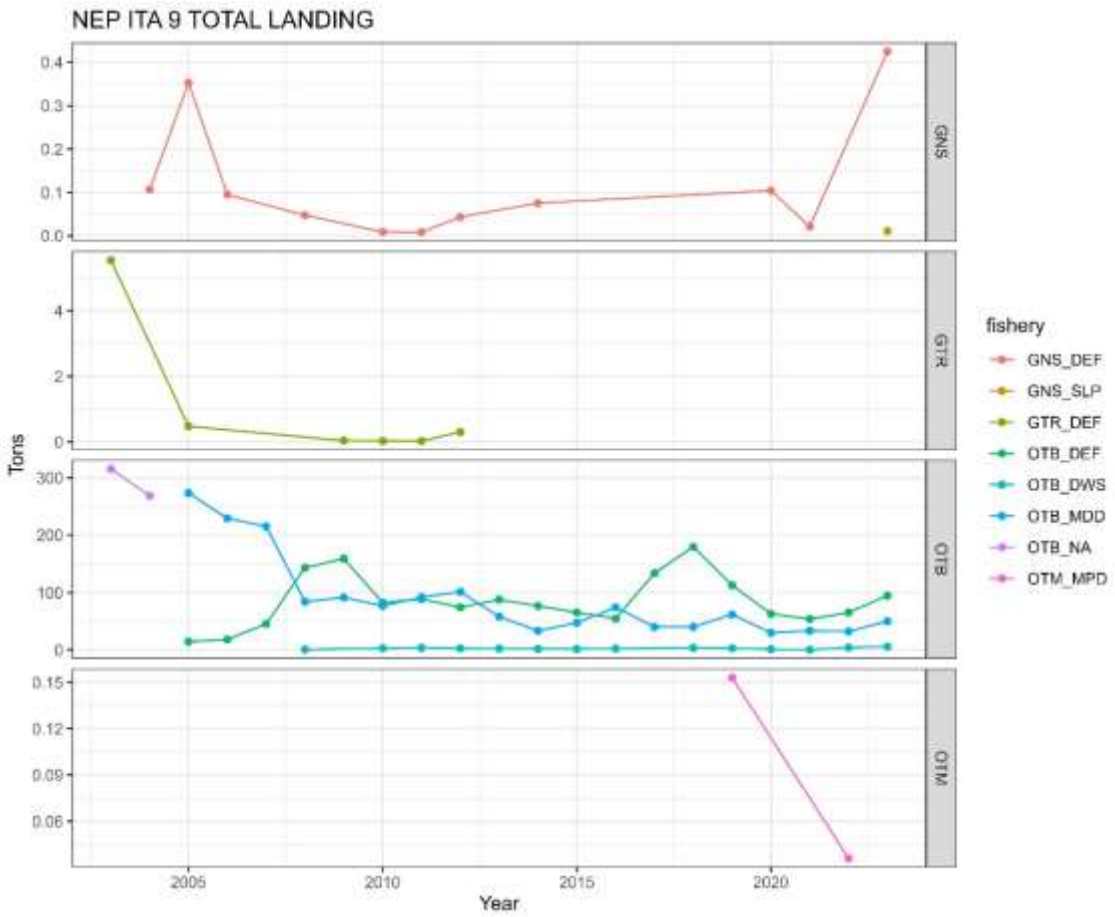
if the number of individual reported by length class is the same in the two datasets, the blue and pink columns should be identical.



Source: own elaborations

The annual total landings of Norway lobster available in the DCF database are reported in Table 6.13.2.1. and Figure 6.13.2.1.2. In general, landings are showing a decreasing pattern along the time series. Although the bulk of the production in GSA 9 is coming from the trawl fisheries (mostly demersal species and mixed demersal and deep-water species trawling), other fisheries (mostly gill nets) provide small contribution to the total production.

Figure 6.13.2.1.2. Norway lobster in GSA 9: landings trend by gear in GSA 9.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.13.2.1.1. Norway lobster in GSA 9: landings by gear.

Year	ITALY OTB GSA 9	ITALY Other gears
2003	315.32	5.54
2004	268.60	0.11
2005	287.65	0.83
2006	247.39	0.09
2007	260.55	0.00
2008	227.67	0.05
2009	250.24	0.04
2010	161.61	0.04
2011	183.92	0.04
2012	177.84	0.34
2013	147.65	0.00
2014	111.52	0.08
2015	113.62	0.00

2016	130.90	0.00
2017	173.60	0.00
2018	223.22	0.00
2019	176.87	0.15
2020	93.54	0.10
2021	87.38	0.02
2022	101.12	0.04
2023	150.12	0.44

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Landings of Norway lobster in GSA 9 in the period 1994-2002 (Table 6.13.2.1.2) were gathered from the Italian official statistics (prior to DCR/DCF) which were collected and stored under the RECFISH project (Ligas, 2019). Landings in 1997 were considered misreported. Checking the data it was pointed out that the landings reported in two ports were unreliably high compared to the other ports and the time series. Therefore the value was re-estimated to 327 t for being used in the assessment.

Table 6.13.2.1.2. Norway lobster in GSA 9: landings from Italian official statistics as collected by the RECFISH project.

Year	OTB
1994	376.4
1995	345.4
1996	359.5
1997	**727.6***
1998	225.5
1999	178.6
2000	334.9
2001	269.5
2002	276.8

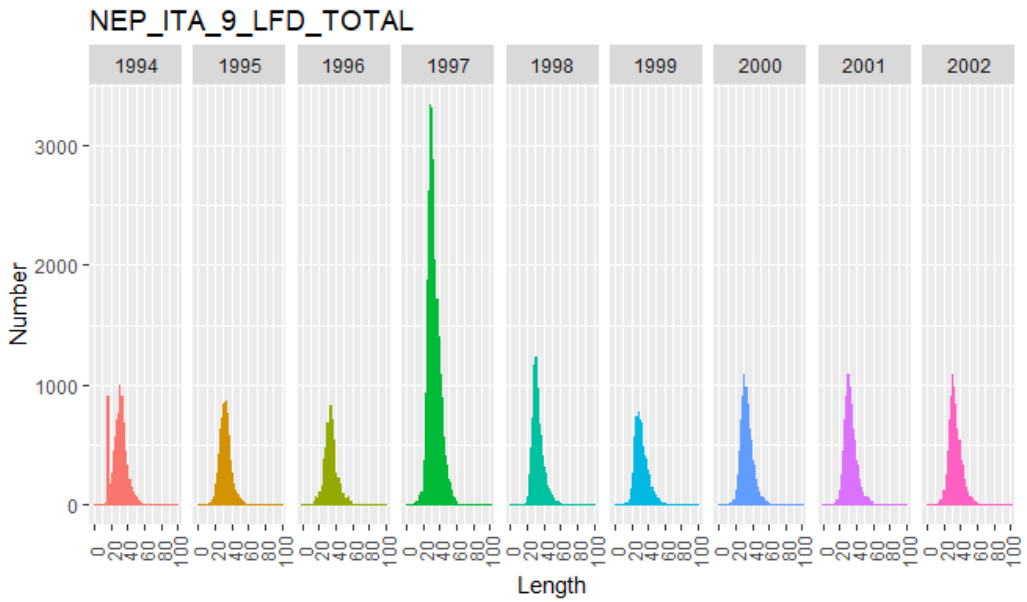
* This value has been revised. See text for details

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

The size structures by year and gear are shown in Figures 6.13.2.1.3-6.13.2.1.4.

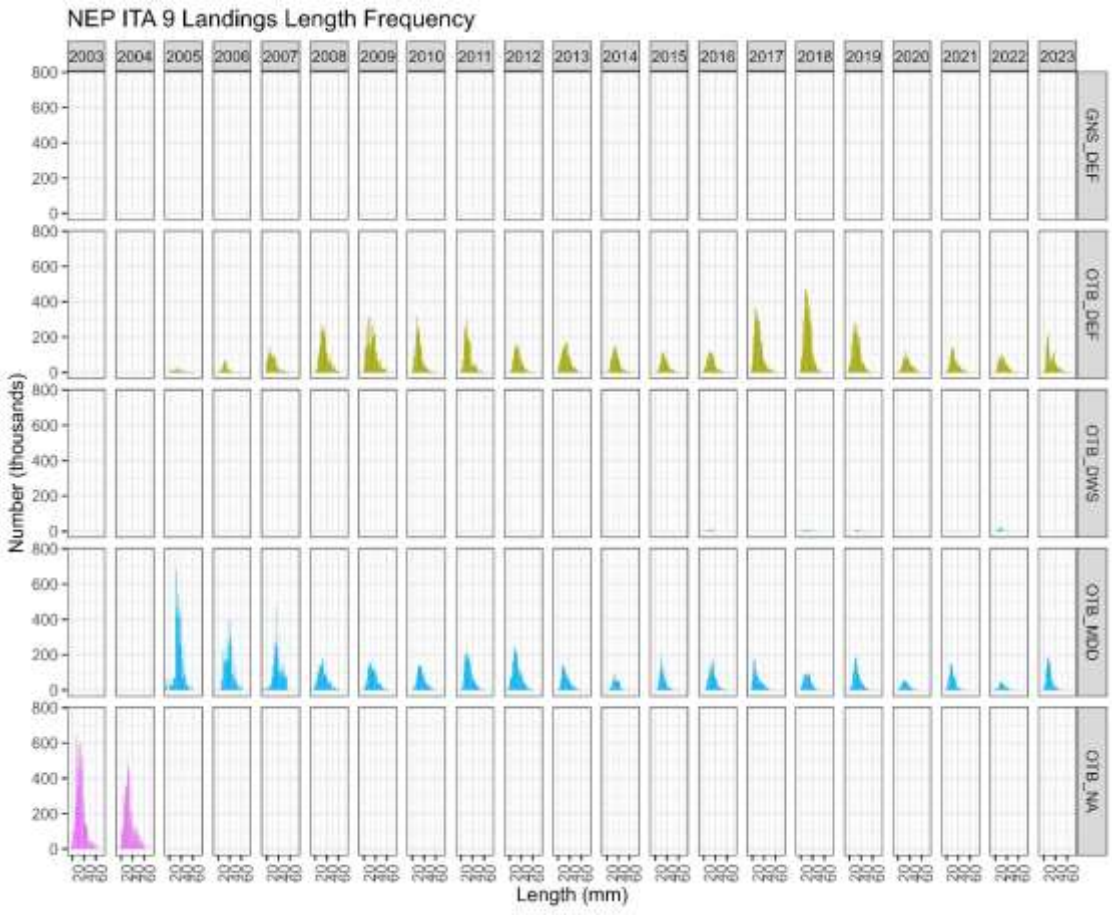
LFDs for the period 1994-2002 were provided by the results of the RECFISH project (Ligas, 2019), who collected historical fishery information from previous projects and studies performed in the Mediterranean and Black Sea. The LFD for 1997 was also adjusted to the reestimated landings.

Figure 6.13.2.1.3. Norway lobster in GSA 9: LFDs of landings by year provided by the RECFISH project.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.13.2.1.4. Norway lobster in GSA 9: LFDs of landings by year and gear of Norway lobster in GSA 9.



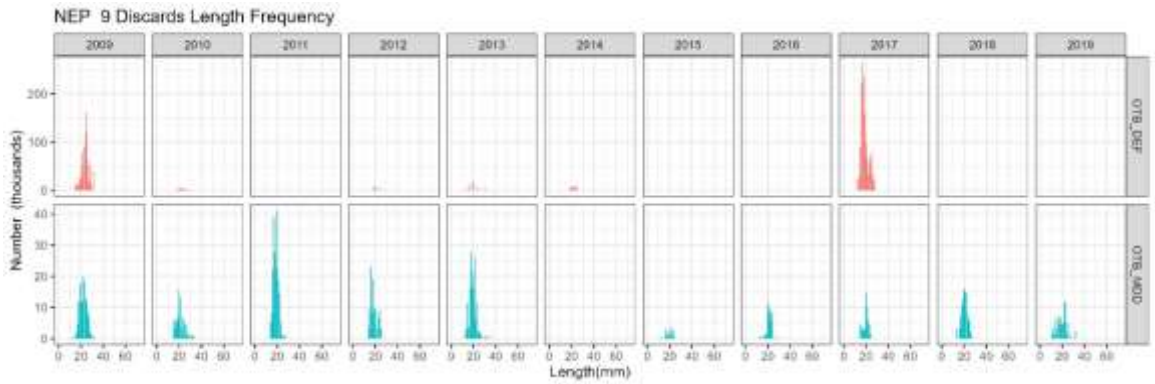
Discards of Norway lobster are low. Low values of discards (from OTB) are reported in GSA 9 from 2009 onwards. The discards are summarized in Table 6.13.2.1.3. Despite the low values of discards, LFDs are available for some years and the data were included into the stock assessment. LFDs of discards of Norway lobster are shown in Figure 6.13.2.1.5.

Table 6.13.2.1.3. Norway lobster in GSA 9: Discards by GSA.

year	GSA9 discards (t)	year	GSA9 discards (t)
2003	0.0	2014	0.41
2004	0.0	2015	0.10
2005	0.0	2016	0.37
2006	0.0	2017	8.24
2007	0.0	2018	0.70
2008	0.0	2019	0.50
2009	9.24	2020	0.43
2010	1.00	2021	0.30
2011	1.02	2022	1.31
2012	0.78	2023	0
2013	1.31		

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.13.2.1.5 Norway lobster in GSA 9: LFDs of discards of Norway lobster in GSA 9.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.13.2.2 EFFORT

No fishing effort data were provided for 2023.

6.13.2.3 SURVEY DATA

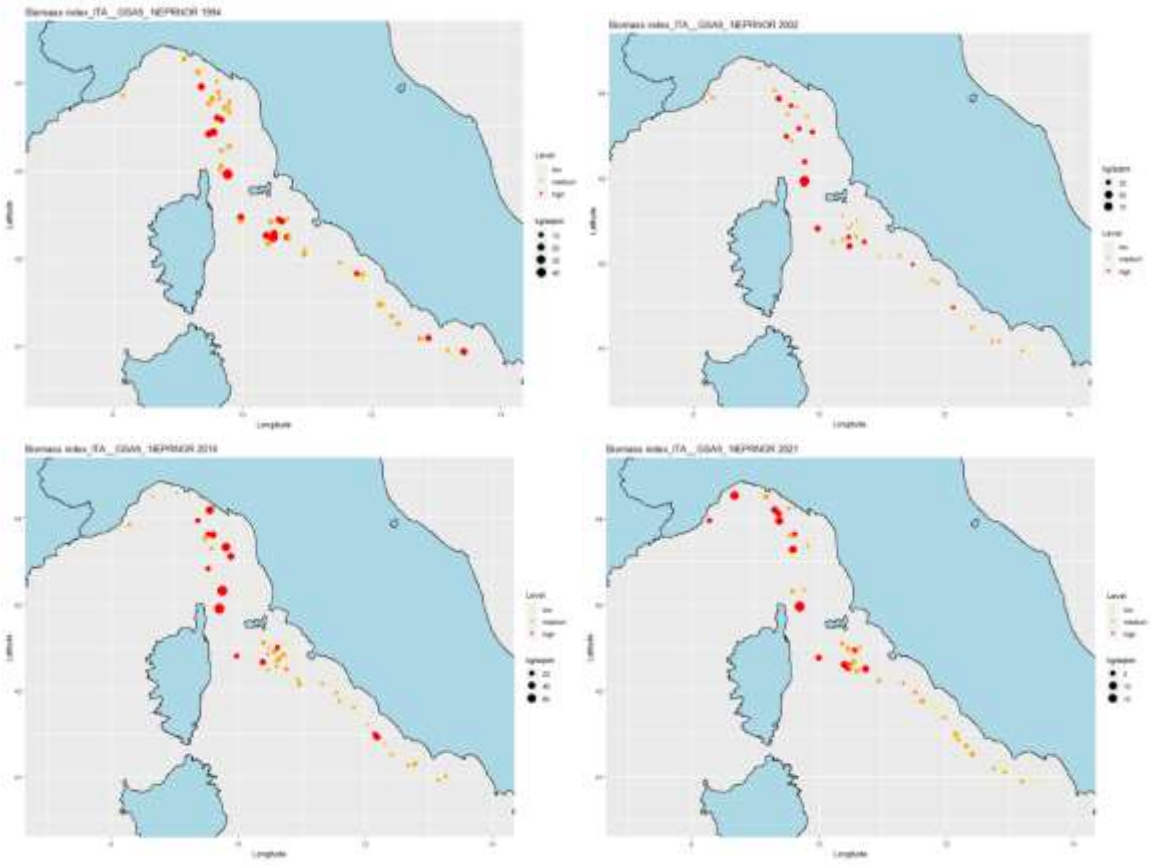
Since 1994, MEDITS trawl surveys have been regularly carried out each year (centred in the early summer). A random stratified sampling scheme by depth (five strata with depth limits at 50, 100, 200, 500 and 800 m) is applied. Haul allocation was proportional to the stratum area. All the abundance data (number and total weight of fish per surface unit) are standardized to the km^2 using the swept area method. MEDITS trawl survey was not conducted in GSA 9 in 2022, and thus no survey data are available for this year.

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 three GSAs.

Geographical distribution and seasonality

The following maps Figure 6.13.2.3.1. show the biomass indices (kg/km^2) by haul of the MEDITS survey. The survey in 2023 was carried out in fall (Figure 6.13.2.3.2).

Figure 6.13.2.3.1. Norway lobster in GSA 9: distribution pattern in the period 1994-2019 (MEDITS survey). Maps for the years 1994, 2002, 2010 and 2021 are shown.



Source: own elaborations

Figure 6.13.2.3.2. Norway lobster in GSA 9: sampling period of the MEDITS survey.



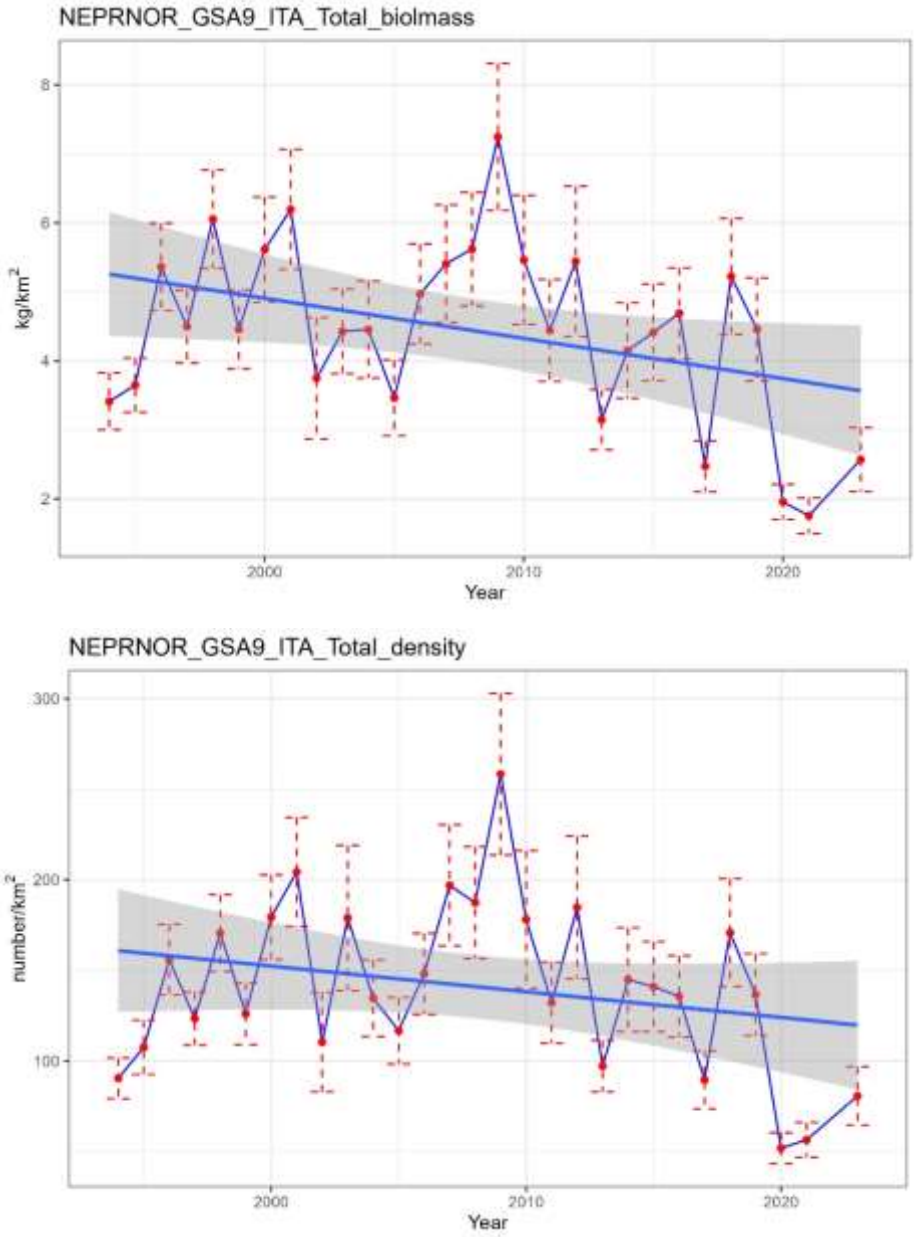
Source: own elaborations

Trends in abundance and biomass

The trends of the MEDITS indices (biomass and density) computed on GSA 9 data are shown in Figure 6.13.2.3.3.

The time series are characterized by wide fluctuations. Generally, the time series display a decreasing pattern since 2009, when the highest values were reported. The biomass index obtained in 2020 and 2021 are the lowest ever reported in this GSA for this stock. The biomass index slightly increased in 2023. The same stands for the densitiy index.

Figure 6.13.2.3.3. Norway lobster in GSA 9: MEDITS standardized biomass and density indices (10-800 m). The blue straight line and the grey shade are the estimates of linear models fit on index as a function of year.

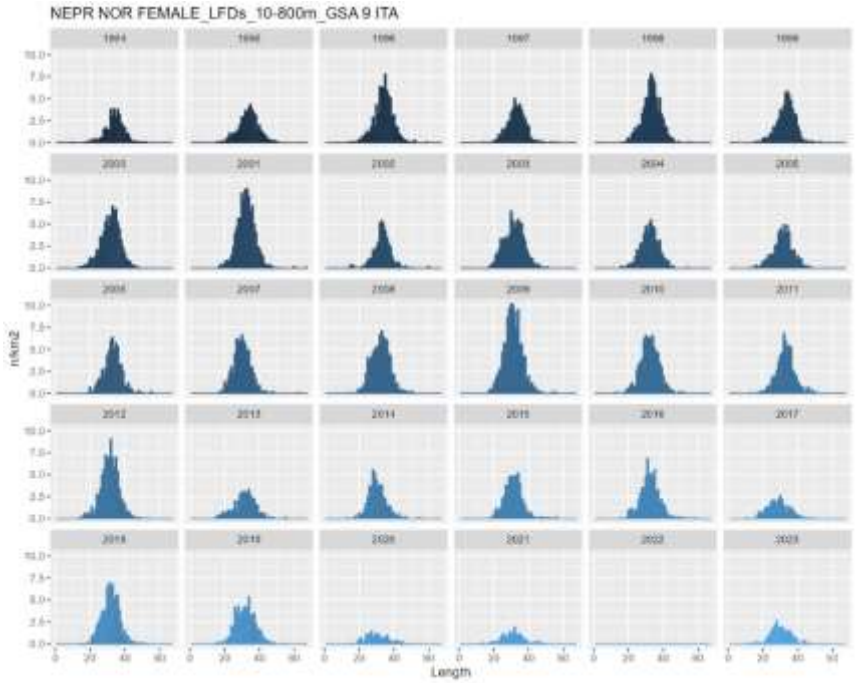


Source: own elaborations

Trends in abundance and biomass by length

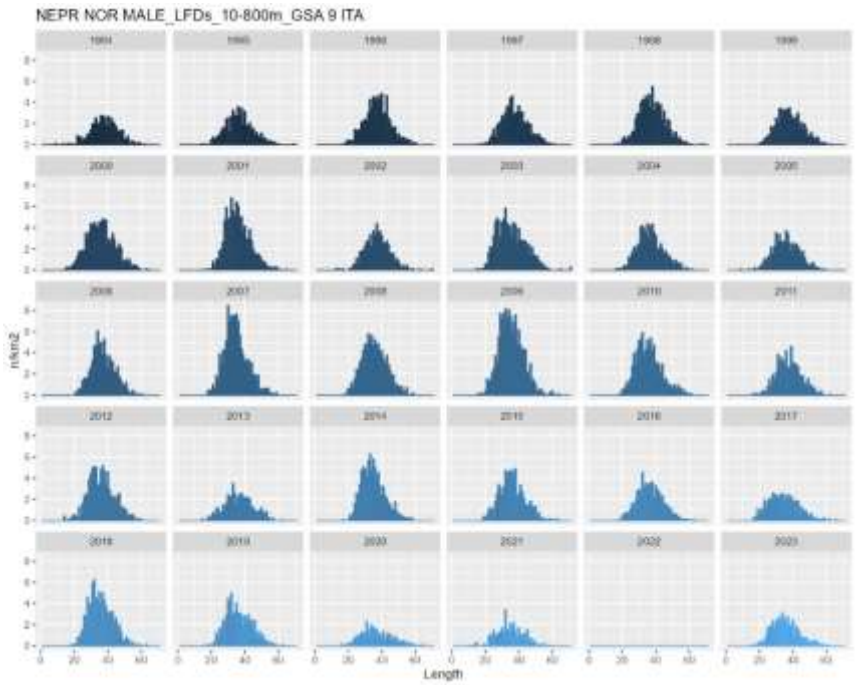
The stratified abundance indices by length (by sex and total) computed on the GSA 9 during the MEDITS surveys from 1994 to 2021 are shown in Figures 6.13.2.3.4-6.13.2.3.6. Also these plots show that the densities observed in 2013, 2017, 2020 and 2021 are among the lowest observed in the whole time series of the MEDITS survey in the GSAs 9.

Figure 6.13.2.3.4. Norway lobster in GSA 9: stratified abundance indices by size for females, 1994-2023.



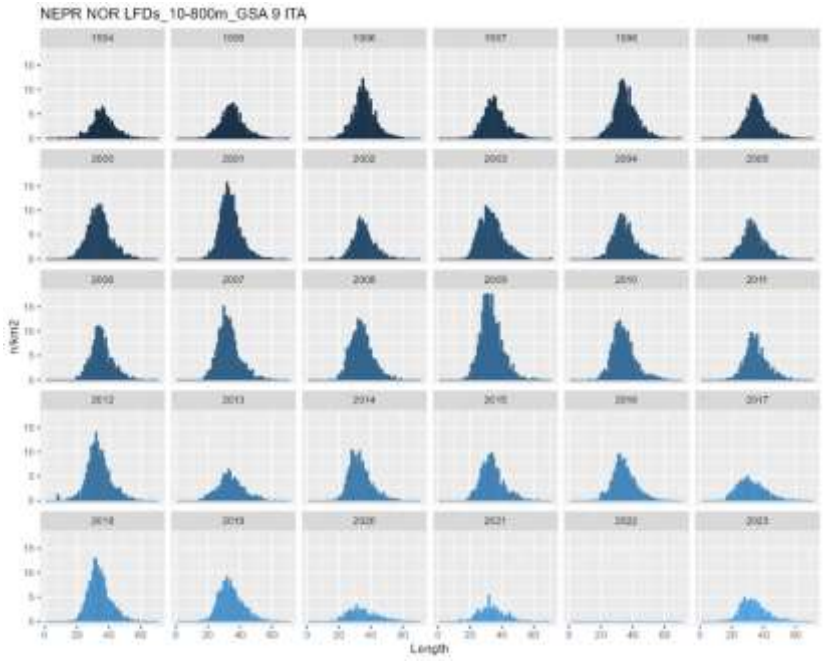
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.13.2.3.5. Norway lobster in GSA 9: stratified abundance indices by size for males, 1994-2023.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.13.2.3.6 Norway lobster in GSA 9: total stratified abundance indices by size, 1994-2023.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.13.3 STOCK ASSESSMENT

The available data for the year 2023 were used to assemble the stock and index objects for the analyses. Also, data for the years 2020-2022 were replaced in the previous stock object to account for data revision from member states. EWG 24-10 attempted to update the most recent stock assessment model, based on Statistical Catch-at-age (a4a) method. After the failure of model diagnostics, it was firstly attempted a reparametrisation of the a4a model. After unsuccessful trials it was considered to apply alternative methods, which used different sources of data (Table 6.13.3.3). The rationale was to explore if the impossibility to fit the a4a model was due to data conflicts. The methods tested were an integrated stock assessment model (ss3), a surplus production model (spict) and a length based method (LBB). In the next sections are briefly reported the setting, the fit to data and the diagnostics of the best runs of each model. A discussion on the main issues identified is also provided.

Table 6.13.3.3. **Norway lobster in GSA 9:** stock assessment models tested.

Model	Reference	Times eries	Input data	Notes
A4a	(Jardim *et al.*, 2014)	1994-2023	Catch at age, index at age	Deterministic slicing by sex done to prepare input data
SS3	(Methot and Wetzel, 2013)		Catches, density index, length frequency distributions of catches	Length frequencies distributions (by sex) are converted in

			and index by sex, biological parameters	ages within the model based on the growth information provided
SpiCT	(Pedersen and Berg, 2017)		Catches, index	Priors used for initial depletion
LBB	(Froese *et al.*, 2018)		Length frequency distributions of catches	

A4a model

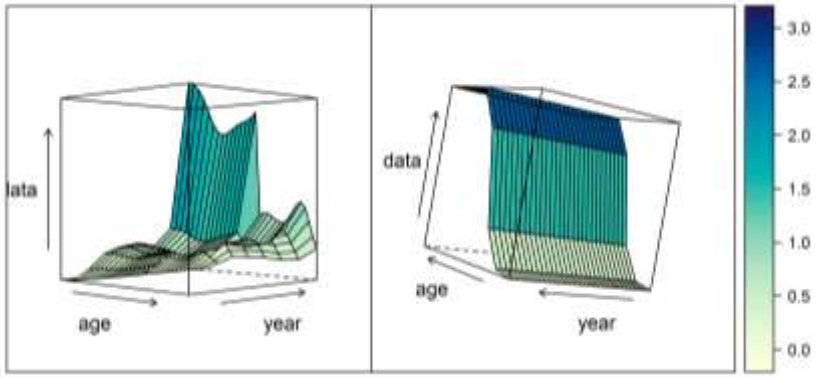
Data preparation: FLR libraries were employed in order to carry out a Statistical Catch-at-age (a4a) assessment adopting as input data the period 1994-2023 for the catch and the index data (MEDITS). No LFD reconstructed was carried out. The missing LFDs were replaced by raising to catch with LFDs available through the use of SoP. A natural mortality vector computed using Chen and Watanabe model was estimated and used in the assessment (Table 6.13.1.3). Length-frequency distributions of commercial catches and surveys were split by sex and then transformed in age classes using length-to-age slicing with different growth parameters by sex (Table 6.13.1.1). A correction of 0.5 was applied to t_0 to account for spawning at middle year. The stock assessment was carried out updating the stock object used in the previous assessment (EWG 23-09), replacing also data for the years 2020-2022. In catches, a plus group at age 9 was set, while the age structure in the MEDITS survey was from age 1 to age 8. F_{bar} range was fixed at 2-6.

Model: the model used by EWG 23-09 was considered the reference run. Alternative runs tested focused on changing the number of knots in the fmodel, on replacing smoothers with factor in the fmodel and on specifying an user defined cv for the survey. After comparing the attempted models with a set of diagnostics (residuals inspection, runs test, retrospective, AIC, MASE) the reference model is still considered the model settings that minimized the residuals and showed the best diagnostics outputs. This settings are:

- Fishing mortality sub-model: fmodel = ~ s(age, k = 6, by = breakpts(year, 2008))+ s(year, k=10)
- Catchability sub-model: qmodel = list(~ factor(replace(age, age>5,5)))
- SR sub-model: srmod = geomean(CV=0.2)

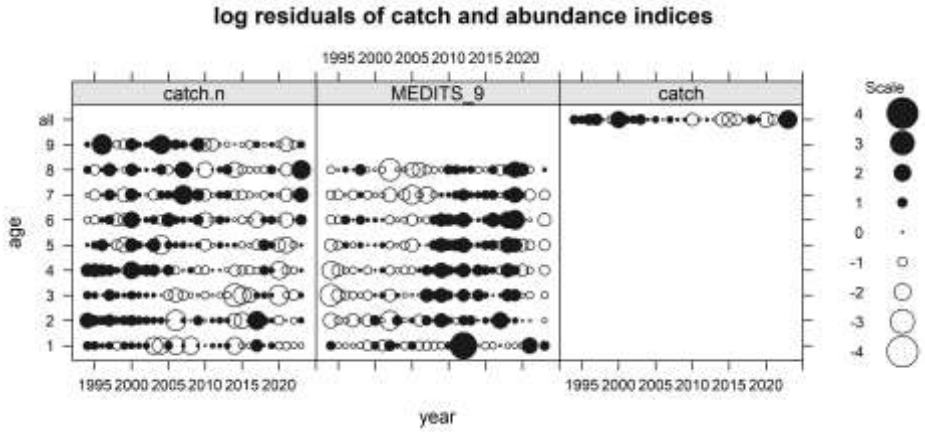
Outputs and fit to the data: the estimated fishing mortality start to act on individuals from age 2 and gradually increase across age classes, while the selectivity of the survey was forced to be logistic with full selection on age 5. The log residuals for the survey and the catches show sign of correlation: the vertical pattern in the residuals plot indicates a systematic misfit on numbers at age. In particular, the model underestimated the survey index and overestimated the catches at age systematically over the period 2015-2019. Also, the size of the residuals suggests that the assessment is especially relying on the signals from the catch with only minor imput from the survey.

Figure 6.13.3.1. Norway lobster in GSA 9: fishing mortality and survey catchability by age and year obtained from the a4a model (1994-2021).



Source: own elaborations

Figure 6.13.3.2. Norway lobster in GSA 9: bubble plot of the log residuals for the catch-at-age data of the fishery and the survey, and the catches.

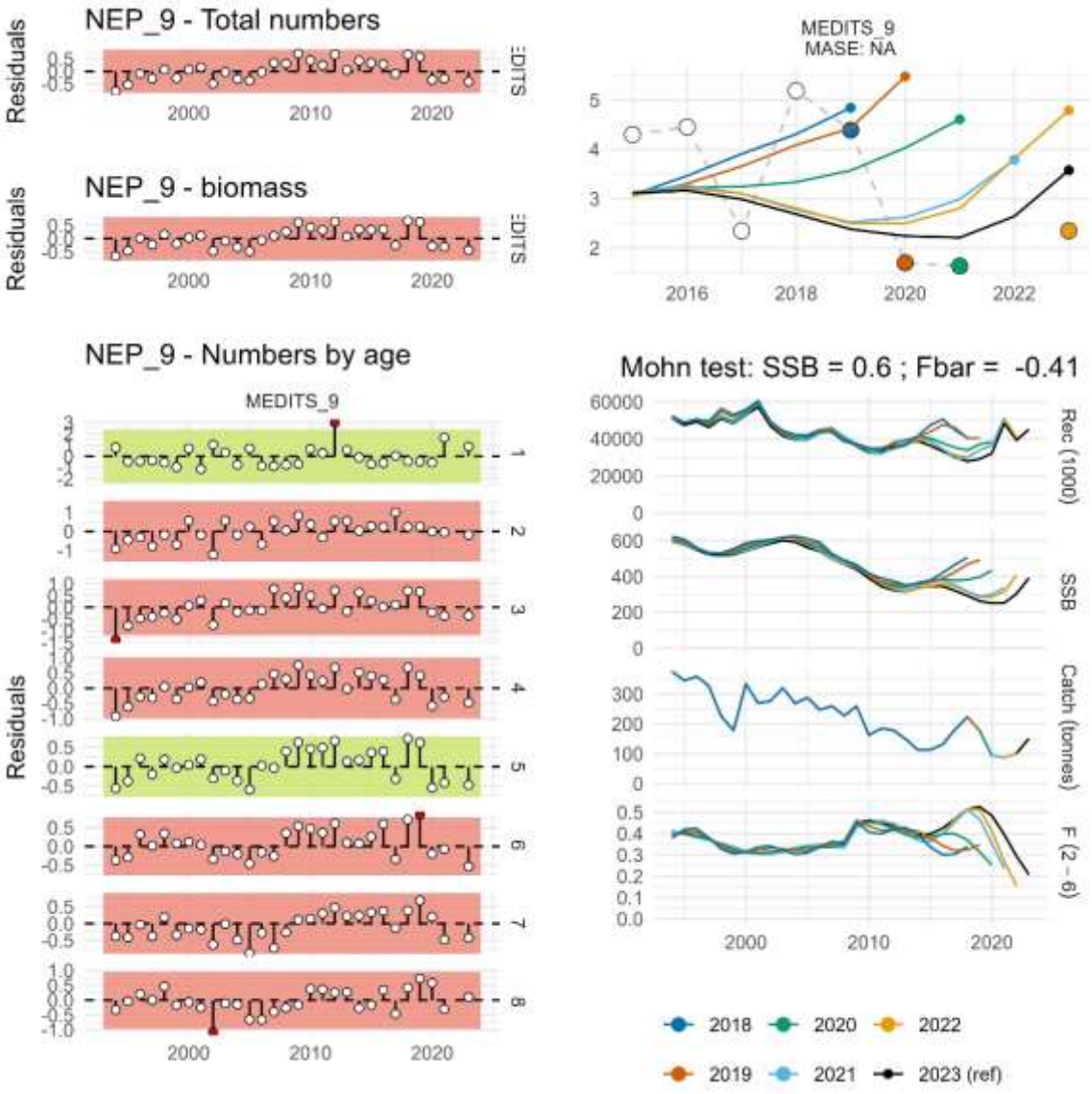


Source: own elaborations

Diagnostics:

The poor fit of the model to the data is confirmed by the quantitative diagnostics (Figure 6.13.3.3). The run test serves to test for residuals autocorrelation, therefore its failure confirm a systematic issue in the fit of the model to the data. The run test failed on the aggregated survey and failed in 7 out of 9 age classes. The retrospective analysis serves to test model consistency and was run for 5 peels (Carvalho *et al.*, 2021). The visual inspection of the diagnostic pattern suggests two main issues: when removing up to 3 years the model tend to systematically downscale the fishing mortality and to upscale the stock biomass; when removing 4 and 5 years the fishing mortality pattern suddenly changes and so does the recruitment. Retrospective analysis performance metrics were outside the acceptability threshold (Hurtado-Ferro *et al.*, 2015) The MASE test failed to produce a number because of the missing information in year 2022, nevertheless the plot suggests a poor predictive power of the model since the survey index was systematically overestimated in the hindcast test.

Figure 6.13.3.3. Norway lobster in GSA 9: diagnostics array. On the left panels are shown the runs tests analysisng residuals autocorrelation, where green indicates that the diagnostic test passed and red indicates failure. On the right panel are shown the hindcast (top) and the retrospective analysis (bottom).



Source: own elaborations

SS3 model

Data preparation: The data used for catches timeseries, as well as for the length composition of survey and catches, were gathered from the same data sources used for the reference model (a4a). Density index was used as tuning index. Length composition by sex, in the case of fishery dependent information, was reconstructed by splitting the length composition observed in year *x* using the sex ratio estimated in the same year. When no sex ratio was available for a specific year, the catch composition were provided for combined sexes and splitted by the model. Medits length composition by sex was used. The mean month of the

survey was provided as input data. Plus group was set as 9+ in analogy with the a4a model. Natural mortality estimation tested were the same provided to the a4a model, and in addition it was tested an estimate derived from the barefott ecologist toolbox (Table 6.13.1.3). Spawning was set at the beginning of the year.

Model: the ss3 model was structured as annual model, sex separated, with one commercial fishery (OTB) and one survey density index (MEDITS). The time series used was 1994-2023. An array of models were fitted to test the effect of alternative assumptions on natural mortality (Chen and wattanabe or the composite estimates, Table 6.13.1.3), selectivity (logistic or dome shaped) and the estimation of length at t0 (fixed or estimated parameter). Models were compared with a set of diagnostics (log likelihood, residuals autocorrelation, retrospective analysis, MASE). The best model was further refined by limiting the estimation of the recruitment deviations to the year 2019: this decision was justified by the timing of the survey, which was systematically shifted to the autumn period from 2020 onward. It was therefore decided to exclude from recruitment estimations these years. Here are reported the lists of fixed and estimated parameters used in the best model.

Fixed parameters:

- Biological parameters by sex Linf, k, t0, a, b (Table 6.13.1.1) and fecundity (Orsi Relini et al., 1998)
- Point estimate of natural mortality from composite estimator (Table 6.13.1.3)
- Stock recruitment (beverton-holt) parameters *h* (0.8) and *sigmaR* (0.9) from the stock assessment of Norway lobster in Southern Adriatic Sea (GSA 18[5])

Estimated parameters and quantities:

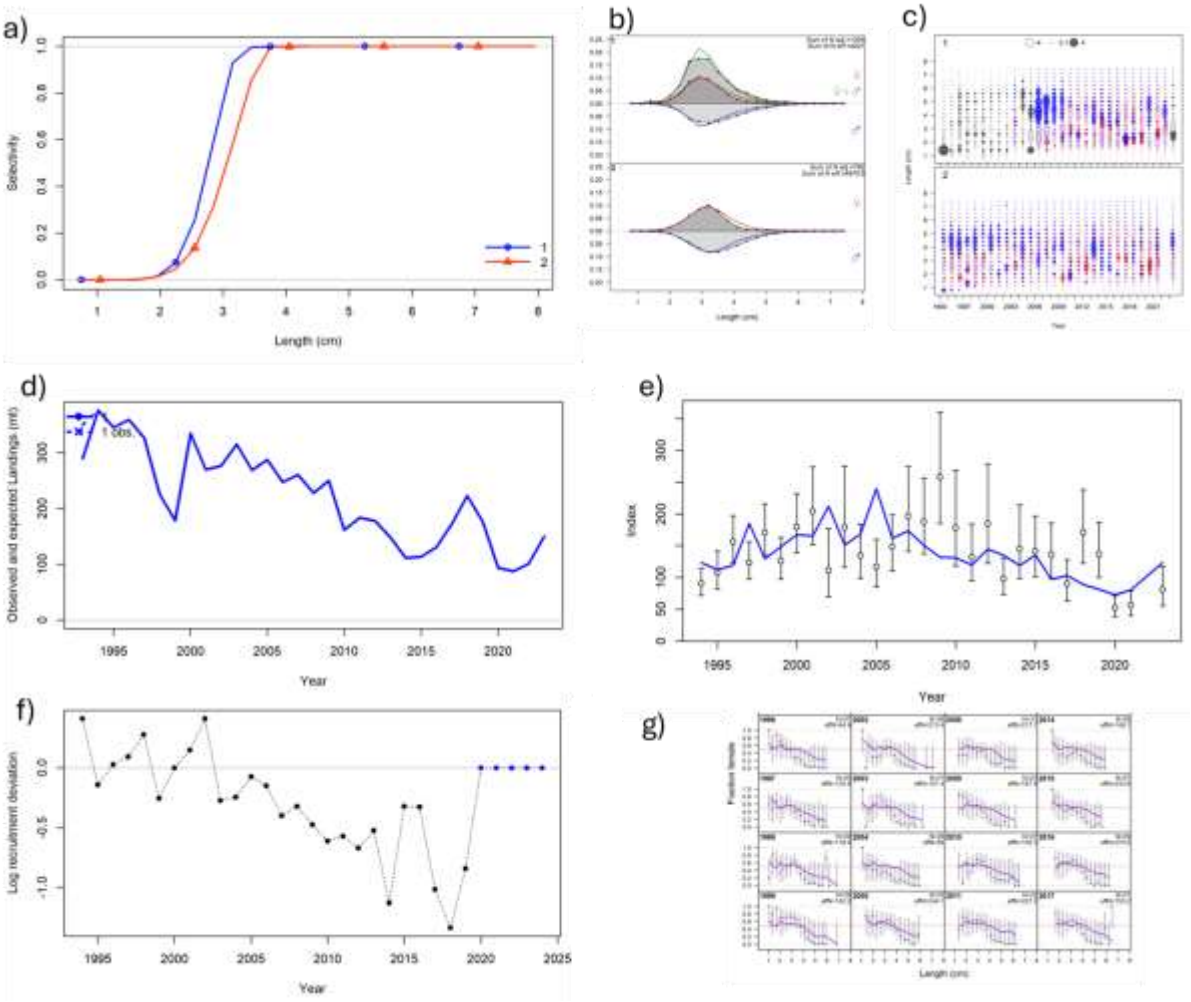
- Logistic selectivity peak and inflection parameters
- Initial F (in year 1993)
- R0
- Recruitment deviations (1994-2019)

Outputs and fit to data: the model estimates a similar selectivity pattern for the commercial and the survey data, with catches being selected at sligthly lower lengths. The fit to the length composition is on overall reasonable, however when looking at the fit by sex it emerges that the model expect more females and less males at sizes larger than 3cm. The mismatch between fit and observation by sex also emerges by the sex ratio, with the model systematically expecting more females than the observations for length > 3 cm. The fit to the catches is almost perfect. The fit to the survey data is able to capture the overall trend, however the model did not fit some high spikes in 2009 and in 2018 and 2019. The estimated deviations from the stock recruitment relation shows a constantly decreasing trend over the period 2004-2019.

Figure 6.13.3.4. Norway lobster in GSA 9: model outputs and fit to data from the ss3 model. Fleet 1 is commercial OTB and fleet 2 is MEDITS survey. Panel a shows the estimated selectivity by fleet; panel b show the cumulative observed (grey shaded) and estimated selectivty, where blue line is for males, red for females and green combined; panel c show residuals of length composition by length, year, fleet and sex, where grey contours are for combined sexes, blue contours are for males and red for females; panel c show observed and estimated (dashed) catches; panel e show the observed and

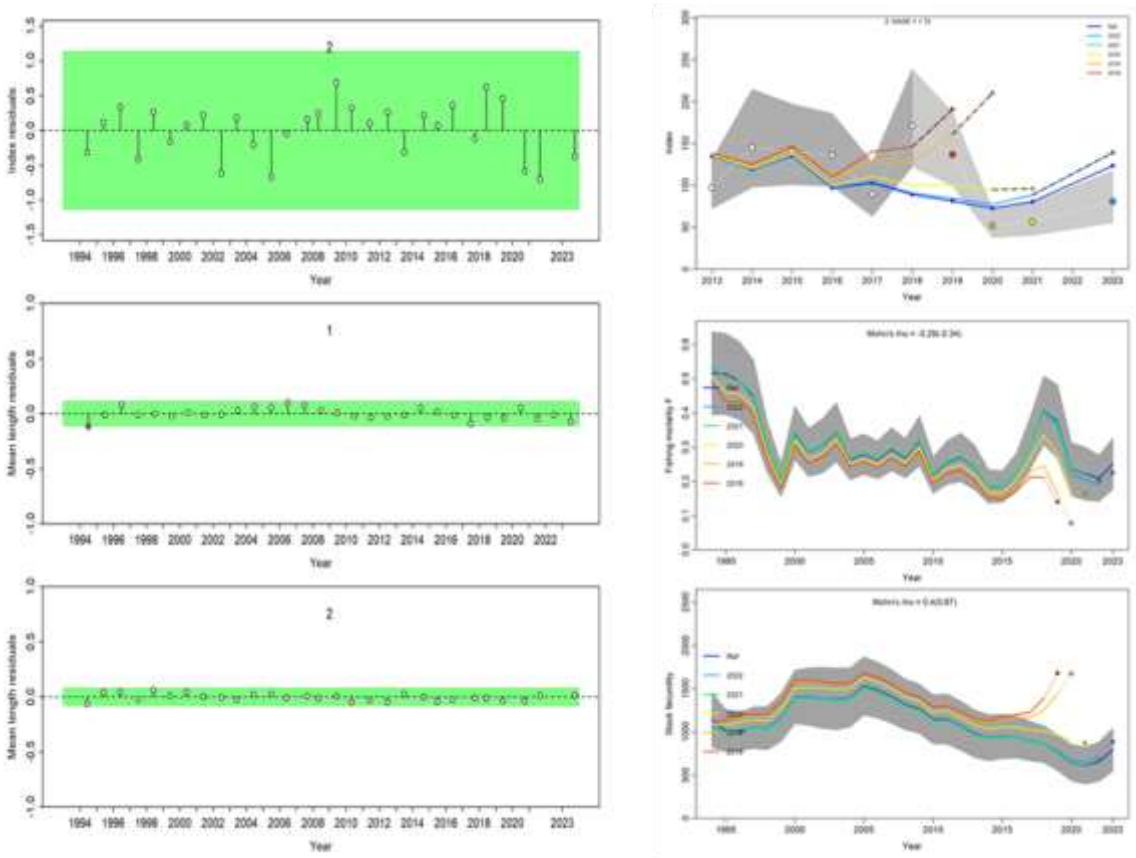
[5] https://gfcmsitestorage.blob.core.windows.net/website/5.Data/SAFs/DemersalSpecies/2022/SAF_NEP_18_RefY2022.pdf

fitted (blue line) density index; panel f show the estimated annual deviations from the stock-recruitment relation; panel g show the observed vs estimated (purple line) sex ratio by length.



Diagnostics: the ability of the model to capture reasonably well the length compositions and the survey index is confirmed by the run test, which never detected serial autocorrelation of the residuals. The model was nevertheless instable as confirmed by the retrospective analysis. In particular, the model started to diverge when the peel was equal or larger to four. Probably the misfit of the index to 2018 and 2019 is linked to the failure of the retrospective for these peels. The MASE index demonstrated a poor predictive performance of the model in respect to the survey index, where again it is shown that the prediction for 2018 and 2019 were sistematically biased.

Figure 6.13.3.5. Norway lobster in GSA 9: diagnostics array for the ss3 model. On the left panels are shown the runs tests analysisng residuals autocorrelation, where green indicates that the diagnostic test passed and red indicates failure. On the right panel are shown the hindcast (top) and the retrospective analysis (bottom).



SpiCT model

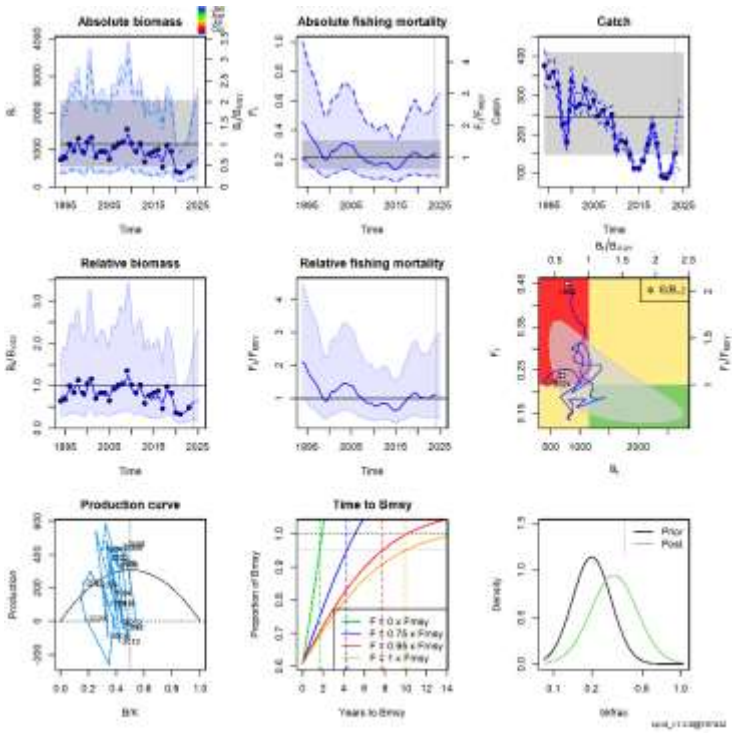
Data preparation: catches and biomass timeseries for the period 1994-2023 were gathered from the same data sources used for the reference model (a4a).

Model: the model was fit to the data by specifying one initial value and two prior distributions, namely the shape of the production curve (*n*), the Intrinsic growth rate (*r*), and the initial depletion (*bkfrac*). The shape of the production curve was initialised equal to 2 (Schaefer curve), the Intrinsic growth rate parameters was derived from sealifebase (Palomares and Pauly, 2018) and the initial depletion was set as 0.2 based on the expert information that exploitation was already high in 1994. The reference run used a tight prior for *bk* (0.3), alternative runs explored the effect of relaxing the *bk* prior by testing an increasing vector of standard deviations (0.35, 0.4). Models were compared using the standard set of diagnostics built in the spict package as well as to inspect the plausibility of the production curve. The model that minimised the residuals and that demonstrated the most plausible production curve had following priors:

- Production curve initial value: 2
- Intrinsic growth rate prior distribution in log space ~ *N(log(0.5),0.2)*
- Initial depletion prior distribution in log space ~ *N(log(0.2),0.35)*

Outputs and fit to data:the model was able to fit the data with a reasonable precision. Nevertheless, the confidence intervals estimated are wide (i.e.: F over Fmsy ranged from 0.8 to 3). The production curve and the stock trajectory is reasonable. The posterior distribution of the parameter bk was only slightly updated compared to prior informatio, suggesting the prior was highly influencing the model outputs.

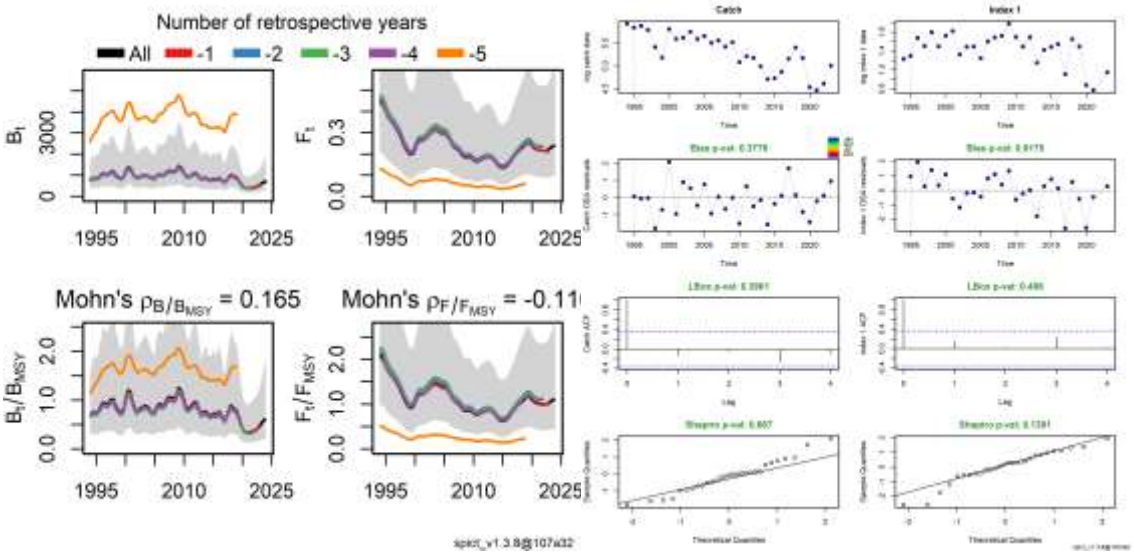
Figure 6.13.3.6. Norway lobster in GSA 9: spict model main outputs.



Source: own elaborations

Diagnostics: the residuals inspection and all the convergence checks did not evidenced any violation of the diagnostics tests. The retrospective analysis shown a deviation of the stock estimates when the peel was equal to five. In addition, when comparing model runs (not shown) it emerges that the choiche of the prior on the initial depletion influenced model estimates.

Figure 6.13.3.7. Norway lobster in GSA 9: diagnostics array for the spict model. On the left panels are shown the retrospective analysis (bottom). On the rigth panel are shown runs residuals autocorrelation tests, where green indicates that the diagnostic test passed and red indicates failure.



Source: own elaborations

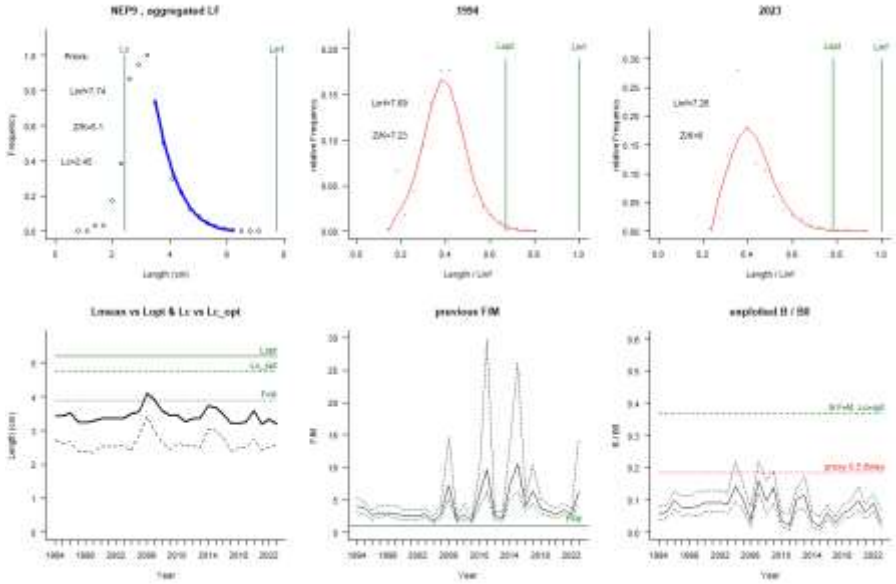
LBB model

Data preparation: commercial length frequency distributions for the years 1994-2023 were used as input data

Model: no prior was needed to fit the model

Output and fit to data: the model fitted reasonably well all the annual length compositions. The results shows large confidence intervals. From the model output does not emerge any evident trend. Therefore, the results of this model are not considerd in the overall comments provided further below.

Figure 6.13.3.8. Norway lobster in GSA 9: output of the LBB model.

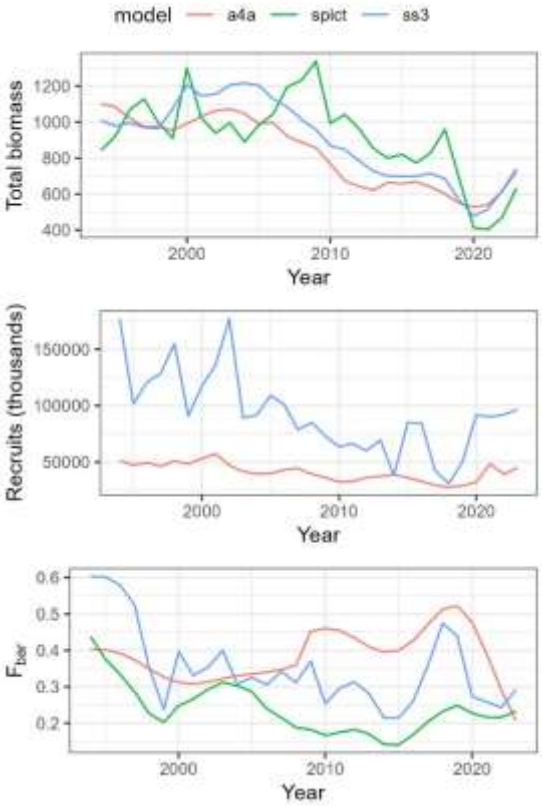


Source: own elaborations

Comparison of models estimates

when comparisng model estimates (total biomass, recruitment and Fbar) it emerges an overall coherency among the methods used. The total biomass pattern describe a continuous drop between 2005 and 2020, followed by a partial recover. Notably, the estimates from a4a and from ss3 in the final year are almost identical. The recruitment estimations from the two catch at age models were different, with stock synthesis estimating far higher values. In this case, differences were expected as the two models have different parametrisations for the recruitment. The Fbar pattern was on overall coherent. Nevertheless, a difference in the trend is observed for the final years between a4a and the other models. It seems that the smoothing effect of the fsubmodel in a4a was constraining the f to follow the overall pattern observed in the last four years (a decrease confirmed by all models). This result evidences that the three different models are estimating a similar status (between 0.2 and 0.3) for the stock in recent years, however the method used can imply a substantial difference in the reactivity to detect changes in the fishong mortality rate.

Figure 6.13.3.8. Norway lobster in GSA 9: comparison of estimates from the a4a (red)., ss3 (blue) and spict (green) models. No reference point is provided.



Source: own elaborations

Overall comment and recommendations for moving forward with an analytical assessment

There were a few similarities as well as some differences in the models fits and diagnostics that might suggests were data conflicts arises.

- Fit to the size or age compositions: it was evidenced a mismatch between the growth expected given the set of growth parameters used and the observations. In the stock synthesis fits we observe a systematic poor fit in the proportion of males and females, more evident at some specific lengths. This implies that models expectations (based on the fixed growth parameters) differs from the data. Considering that no explanation on how the provided growth parameters were estimated in the past, it is recommended to attempt a revision of the biological information for Norway lobster in GSA 9.
- In the years 2018 and 2019 it was observed a sudden increase of both catches and survey biomass. In the subsequent years both the catches and the index drop. Any of the models attempted was not able to capture the dynamic of this sporadic spike: the restrospectives failed irregardless of the model when the peel was 5 (therefore removing up to 2018). Further investigations are needed to give a biological interpretation to this dynamic (*i.e.*: sporadic recruitment, environmentally driven episode, observation error). When a reasonable biological interpretation could be available, it can be attempted to parametrise a stock assessment model accordingly.
- Recruitment deviations: the estimated recruitment from the stock synthesis model showed a systematic downward deviation from the beverton and holt model over the period 2004-2018. Although this information should be taken with caution, it might suggests that other effects apart from fishing mortality are contributing to the total mortality of the stock (*i.e.*: environmental influence on recruitment success).

6.13.4 Reference Points

No reference point was estimated.

6.13.5 Short term Forecast and Catch Options

Following the decision tree provided in the ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 (ICES, 2022), no method could be used to assess the stock status and provide advice.

Therefore, ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation rate, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. Discards are considered negligible.

Table 6.13.1 Norway lobster in GSA 9: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables

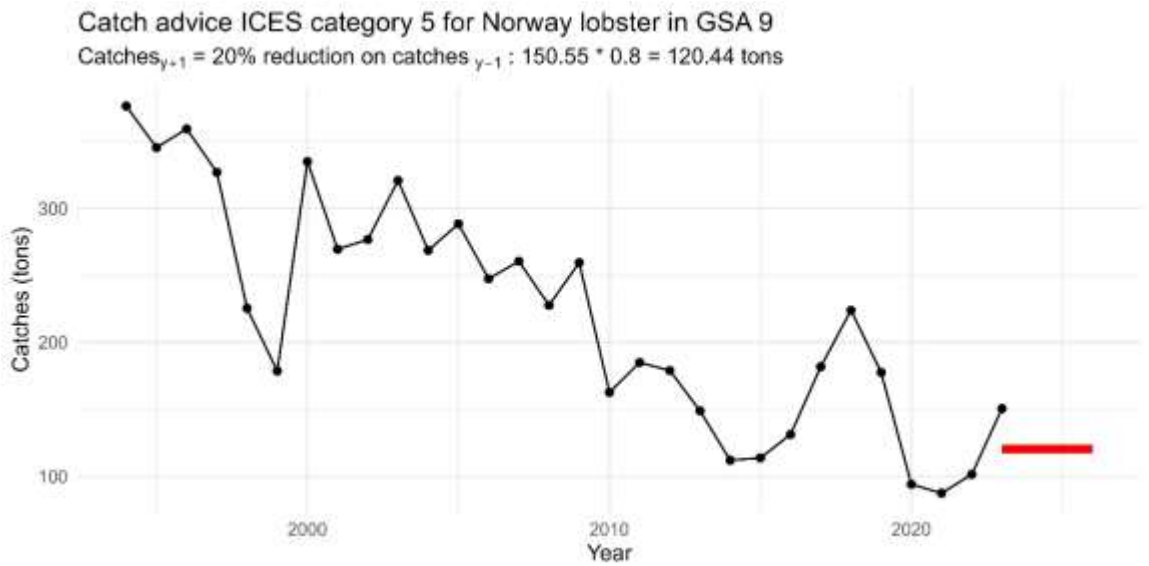
Recent observed catches (2023)	156
Discard rate	Negligible
Precautionary buffer applied	0.8
Catch advice *	120
% advice change **	-20%

* Advised catches for each of the years 2025 and 2026.

** Advice value for 2025 relative to the advice for 2023.

Source: own elaborations

Figure 6.13.5.1.2 Norway lobster in GSA 9: Trends in catch. The black line shows the trend in the above quantities. The red line shows the catches computed using ICES category 5 methodology.



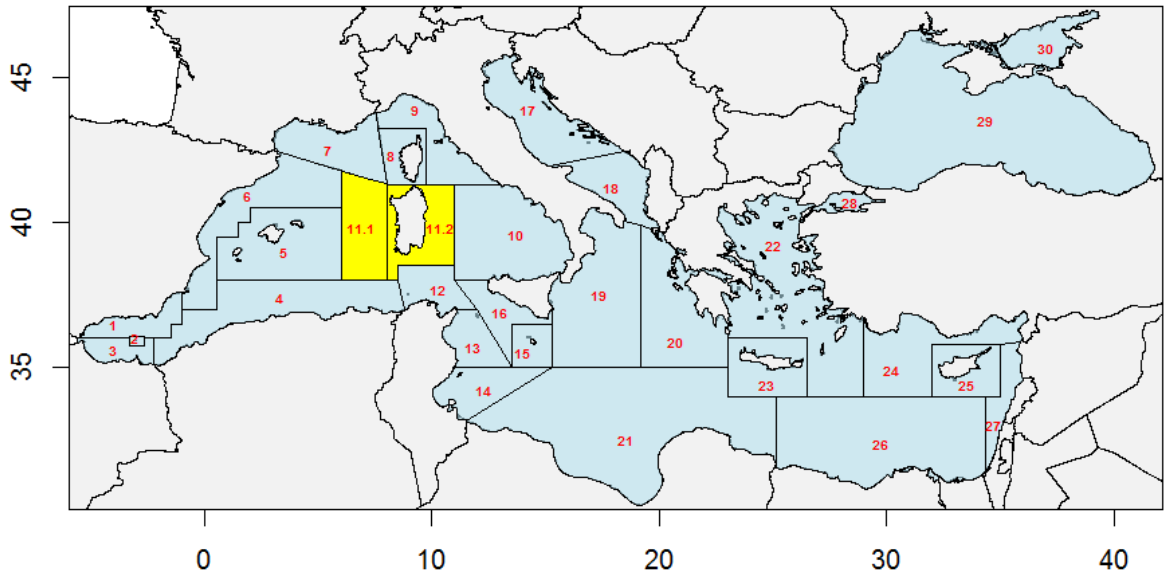
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.14 NORWAY LOBSTER IN GSA 11

Advice on Norway lobster (NEP) in GSA 11 based on MEDITS indices trends was given from STECF EWGs from 2020 to 2023. STECF EWG 24 – 10 was asked to perform new analysis based on new and revised data for the species; various trials using different model approaches were tested, all were giving the same picture of the status of the stock, and SPiCT model was selected for advice.

6.14.1 STOCK IDENTITY AND BIOLOGY

Figure 6.14.1.1. Norway lobster in GSA 11. Geographical location of GSA 11.



Source: own elaborations

The stock is assumed to be confined within GSA 11 (6.14.1.1) boundaries due to the lack of information about the stock structure in the western Mediterranean Sea.

Growth pattern in *Nephrops norvegicus* is known to differ between males and females. Males are characterized by slower growth and higher maximum size than females. Sex ratio in relation to the available landings time series (2005 - 2023) is available from DCF for GSA11 with some years missing. Growth parameters reported by DCF are available by sex and from 2016 onward do not change over the years. The “a” and “b” coefficients slightly differ along the reported years.

Table 6.14.1.1 reports the parameters from the last DCF 2023 Official data call. Growth parameters were retrieved from Mytilineou et al. (1998), while the length-weight parameters were estimated from the samples.

Table 6.14.1.1. Norway lobster in GSA 11. Growth parameters (Linf, K, t0) and parameters of the Length-Weight relationship (a, b) as officially reported in DCF.

Country	Area	Sex	L_∞	K	t_0	a	b

IT	GSA 11	F	69.4	0.12	-0.64	0.0005	3.03
IT	GSA 11	M	80.8	0.13	0.07	0.0009	2.91

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.14.2 DATA

6.14.2.1 CATCH (LANDINGS AND DISCARDS)

For GSA 11 landings were available through the DCF Official data call from 2005 onwards and were related exclusively to OTB, however, in respect to 2022 Italy resubmitted data, and a slight change compared to last year was observed (Table 6.14.2.1.1, Figure 6.14.2.1.1). In addition, the time series available was extended for the first time through the results of RECFISH project (Ligas, 2019). In the period 1972-2003 they were gathered from the Italian official statistics (prior to DCR/DCF). In order to reconstruct the landing value for 2004, GFCM capture production in Division 37.1.3 (namely GSA8, GSA9, GSA10, GSA11, and part of GSA12) by country were used; from the total Italian values, they were removed the landing officially available for GSA9 and GSA10, to obtain the value for GSA11 (Table 6.14.2.1.2, Figure 6.14.2.1.2).

Discards were reported only for 2022 in the second quarter (0.38 tons).

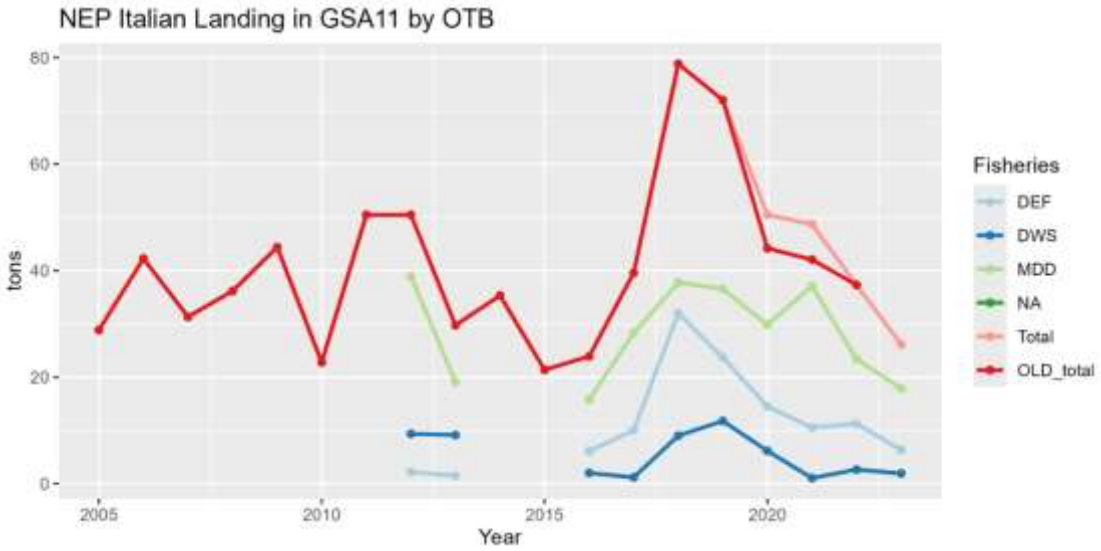
Table 6.14.2.1.1. Norway lobster in GSA 11. Landings data (in tons) in GSA 11.

Year	Landings 2022	Landings 2023
2005	6.3	28.9
2006	42.3	42.3
2007	31.3	31.3
2008	36.2	36.2
2009	44.4	44.4
2010	22.8	22.8
2011	50.5	50.5
2012	41.1	50.5
2013	29.8	29.8
2014	35.3	35.3
2015	21.4	21.4
2016	15.8	23.9
2017	39.6	39.6
2018	78.8	78.8

2019	72.0	72.0
2020	44.2	50.5
2021	42.1	48.7
2022	37.3	37.3
2023		26.1

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.14.2.1.1. Norway lobster in GSA 11. Landings data (in tons) in GSA 11.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

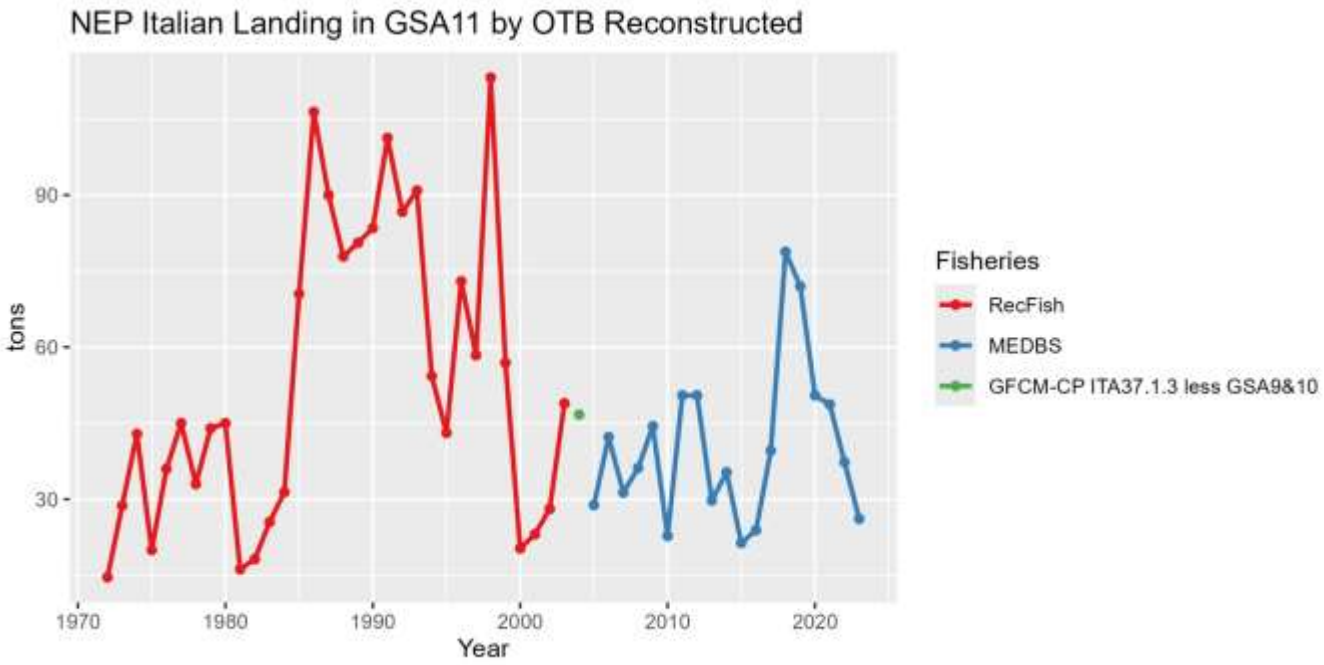
Table 6.14.2.1.2. Norway lobster in GSA 11. Landings data (in tons) in GSA 11 from RECFISH project and reconstructed.

Year	RECFISH landings	Reconstructed
1972	14.6	
1973	28.7	
1974	42.9	
1975	20.0	
1976	36.0	
1977	45.0	
1978	33.0	
1979	44.0	
1980	45.0	
1981	16.2	

1982	18.2	
1983	25.5	
1984	31.4	
1985	70.5	
1986	106.4	
1987	90.0	
1988	77.9	
1989	80.6	
1990	83.5	
1991	101.3	
1992	86.7	
1993	90.9	
1994	54.3	
1995	43.1	
1996	73.0	
1997	58.4	
1998	113.2	
1999	56.9	
2000	20.3	
2001	23.1	
2002	28.1	
2003	48.9	
2004		46.7

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

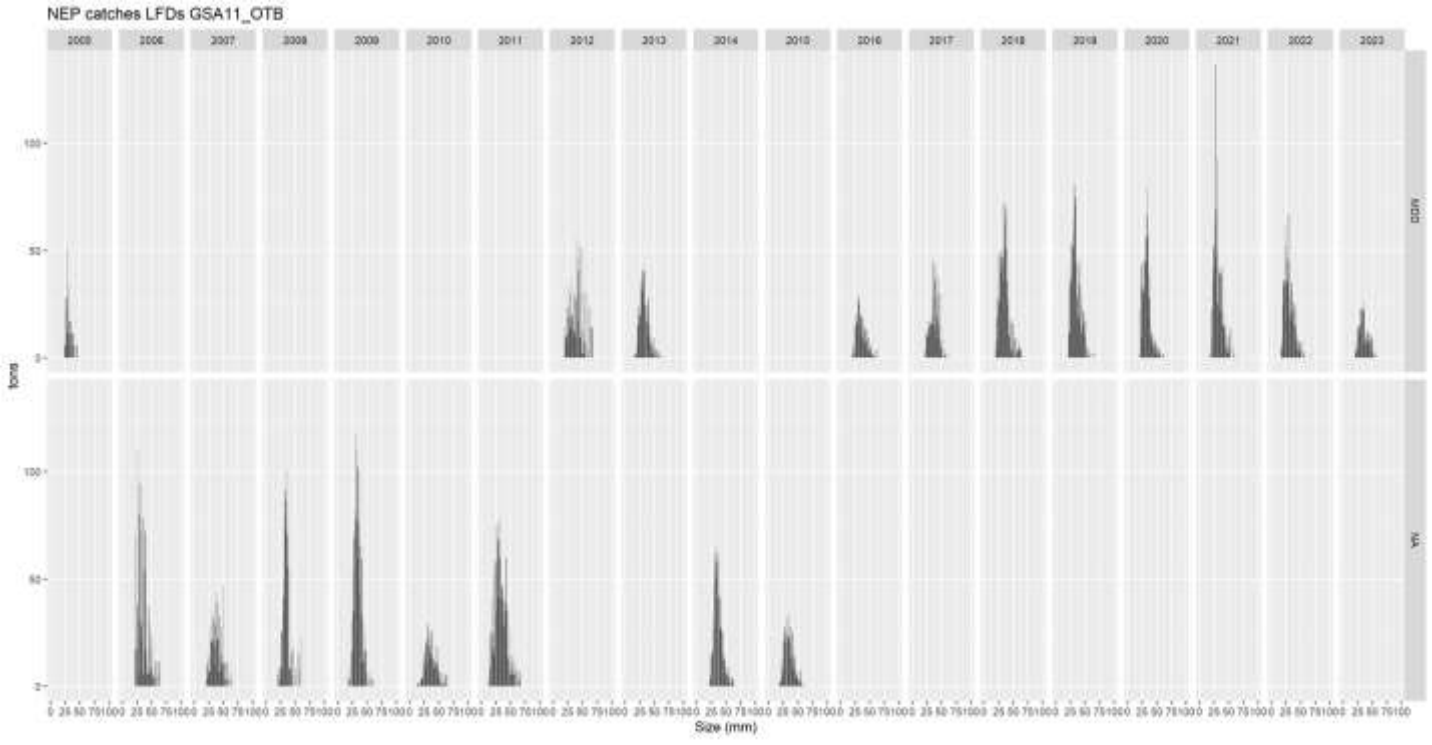
Figure 6.14.2.1.2. Norway lobster in GSA 11. Landings data (in tons) in GSA 11 from RECFISH project and reconstructed, added to the official time series from DCF.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Length frequency distributions by year gear and metier were available through DCF Official data call from the year 2005 onwards. In figure 6.14.2.1.3

Figure 6.14.2.1.3. Norway lobster in GSA 11. Length frequency distribution of the landings by year and gear in GSA 11.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.14.2.2 EFFORT DATA

Fishing effort data for 2023 will be reported to STECF EWG 24-11 through the FDI data call within the DCF framework.

6.14.2.3 SURVEY DATA

MEDITS survey was not carried out in 2022, so the value in the following figures will appear as zero.

The MEDITS surveys are carried mainly from May to July (Figure 16.14.2.3.1). Tables TA, TB, TC were provided according to the MEDITS protocol. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). In recent years the survey has been carried out later in the year.

The abundance and biomass indices for GSA 11 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.

MEDITS data are available in GSA 11 since 1994. In the period 1994 – 2010 MEDITS indices (Figure 6.14.2.3.2-3) show highly fluctuating pattern, ranging between 1.52 (2001) and 4.46 (2009) in terms of biomass (kg/Km^2) and 31.1 (2001) and 129 (2008) in terms of density (n/Km^2), with an average value for this period of 3.01 kg/km^2 and 75.37 n/Km^2. From 2011 onward the stock appears to have been more stable, but with a general decreasing trend both for biomass and densities than decline to the minimum values of the time series in 2023.

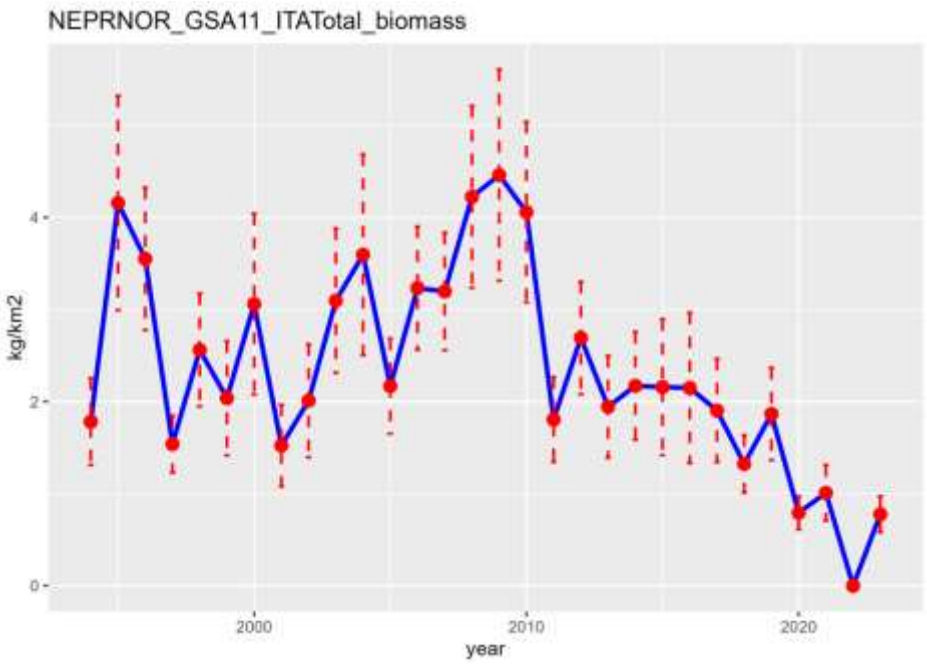
Observed length frequency distribution for MEDITS data are reported in Figure 6.14.2.3.4 and 6.14.2.3.5 by sex and in Figure 6.14.2.3.6 as total.

F**igure 6.14.2.3.1 Norway lobster in GSA 11.** Month of the year when the MEDITS survey is conducted.



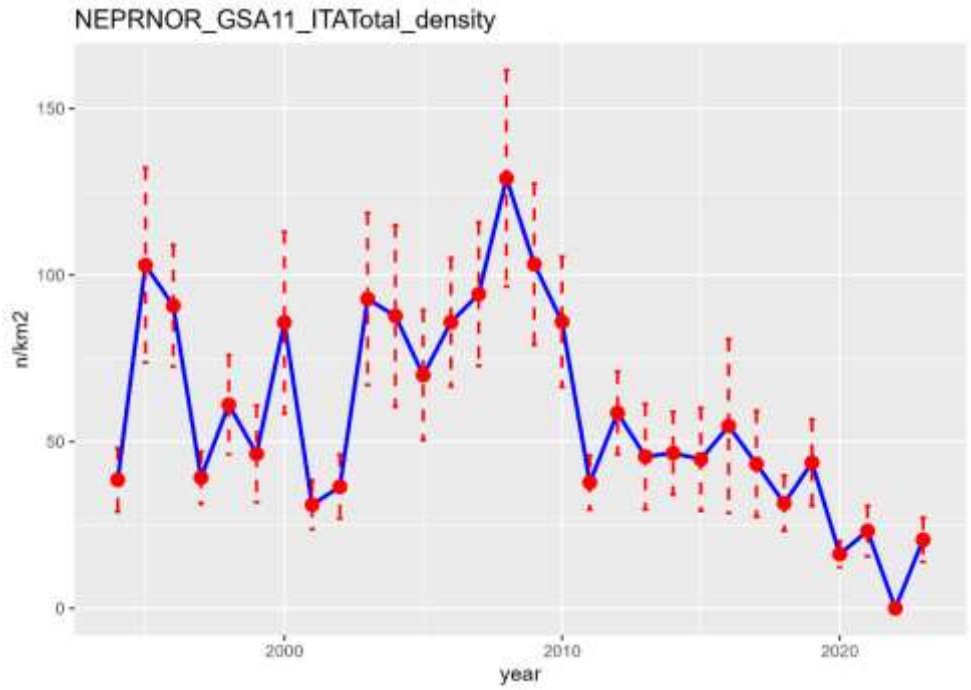
Source: own elaborations

Figure 6.14.2.3.2 Norway lobster in GSA 11. MEDITS indices for the period 1994-2023: relative biomass (kg/km^2).



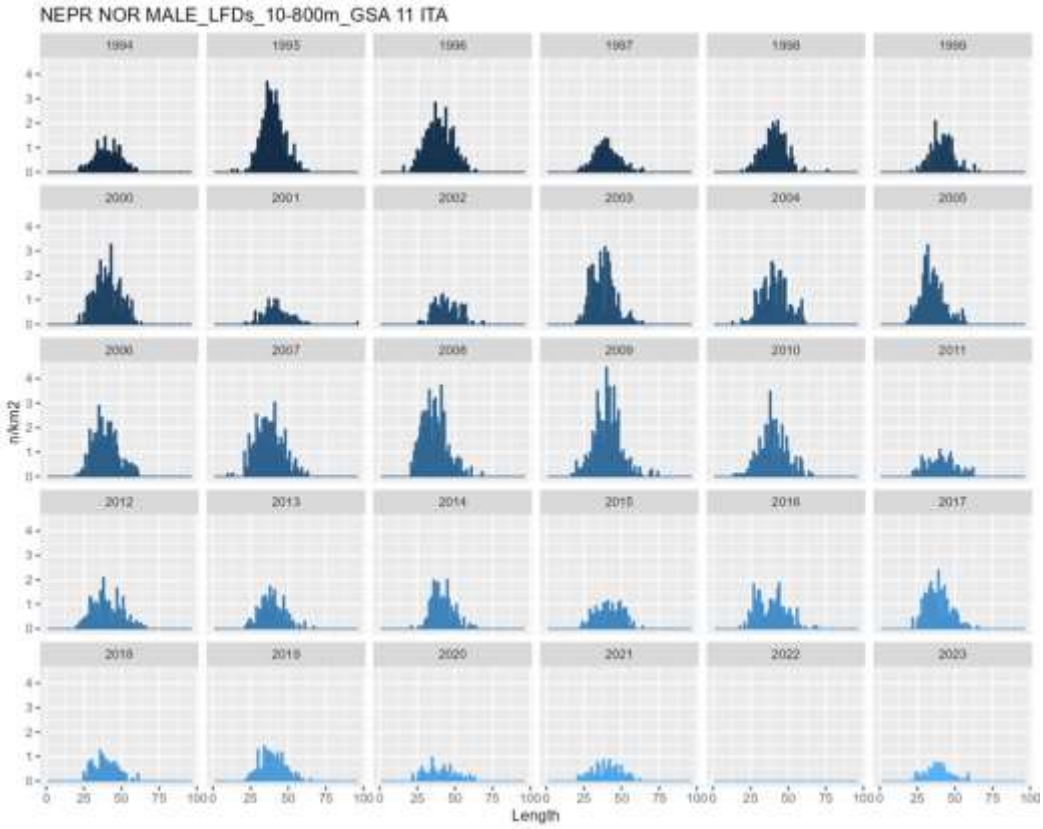
Source: own elaborations

Figure 6.14.2.3.3 Norway lobster in GSA 11. MEDITS indices for the period 1994-2023: density (n km^2).



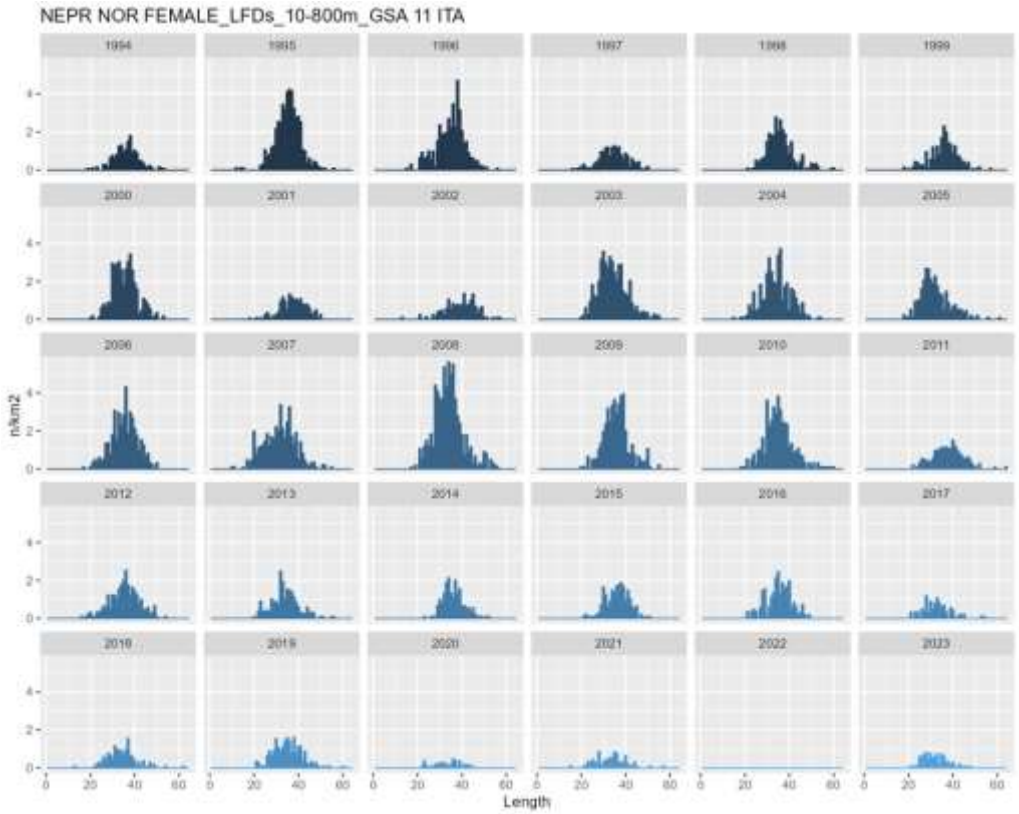
Source: own elaborations

Figure 6.14.2.3.4 Norway lobster in GSA 11. Observed Length-frequency distributions (MEDITS data) for males.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

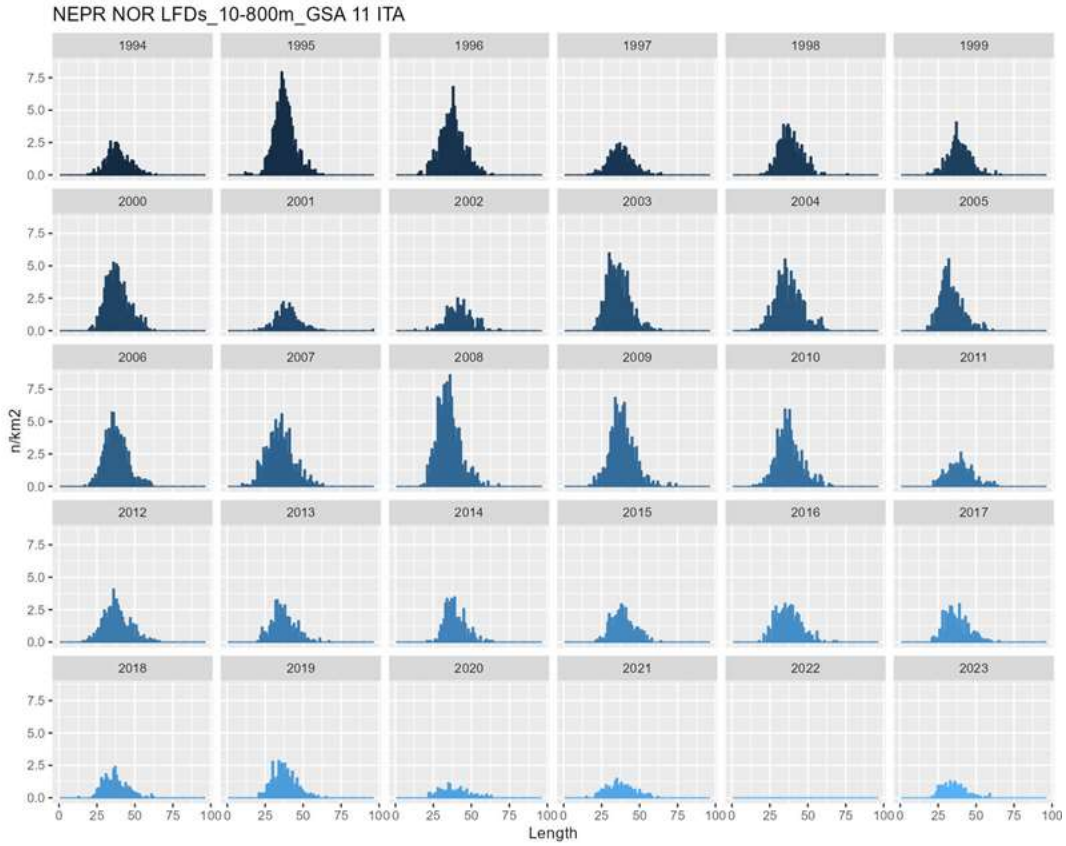
Figure 6.14.2.3.5 Norway lobster in GSA 11. Observed Length-frequency distributions (MEDITS data) for females.



F

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.14.2.3.6 Norway lobster in GSA 11. Observed Length-frequency distributions (MEDITS data).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.14.3 STOCK ASSESSMENT

STECF EWG 24-10 attempted many assessment approaches for this stock because in the past no convergence or acceptable results were obtained through the use of analytical models. They were used two length-based models (LBSPR and LBB), a surpus production model (SpiCT) and a statistical catch at age method (SS3). In the last two models using survey index information, considering the shift in timing relative to the year, the mean month was assigned when inputing data.

The final results selected to provide catch advice and the short term forecast were the ones coming from SPiCT model, however, all the approaches where giving the same picture of the status of the stock. It was selected because all the diagnostics were acceptable; for SS3 model instead, the residuals of the fit of the LFDs for MEDITS index were not normally distributed. However, it was the only failed diagnostic, while retrospective, MASE and hindcasting were acceptable.

Models attempts

Here will be briefly presented the input data (Table 6.14.3.1) and results (Figure 6.14.3.1-3) of the other models attempts not used for the final advice.

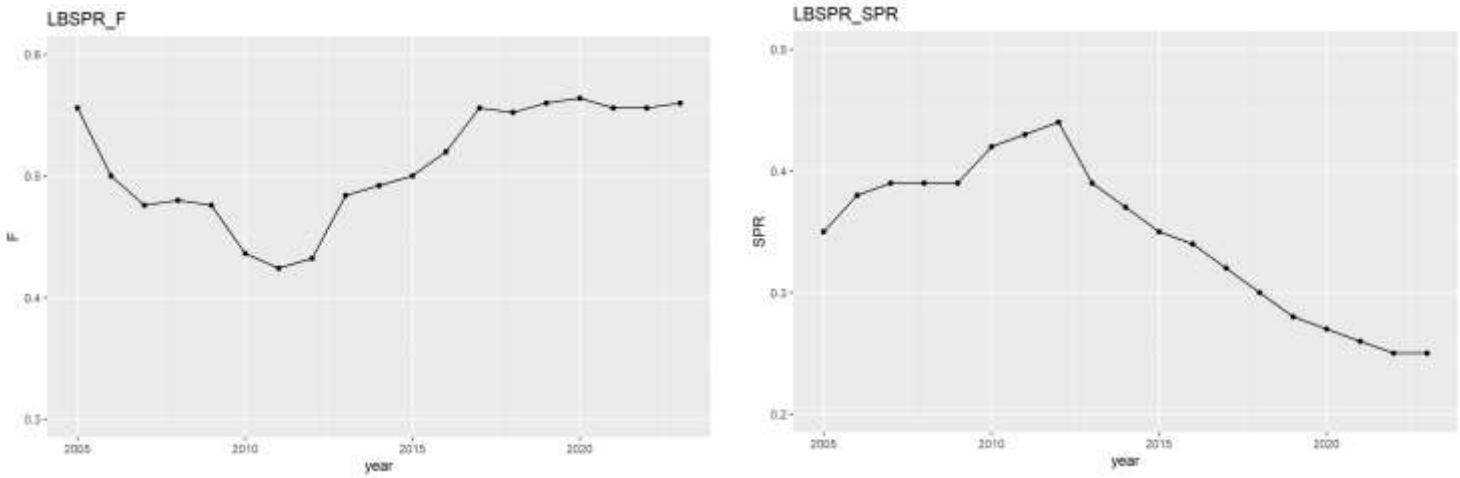
Table 6.14.3.1 Norway lobster in GSA 11. Input data for the model trials.

Model	Timeseries	LFDs	Growth info

LBSPR	2005-2023	From catches, sex combined	Female DCF GP
LBB	2005-2023	From catches, sex combined	No priors
SS3	1972-2023	From catches, sex combined From survey by sex	DCF GP by sex

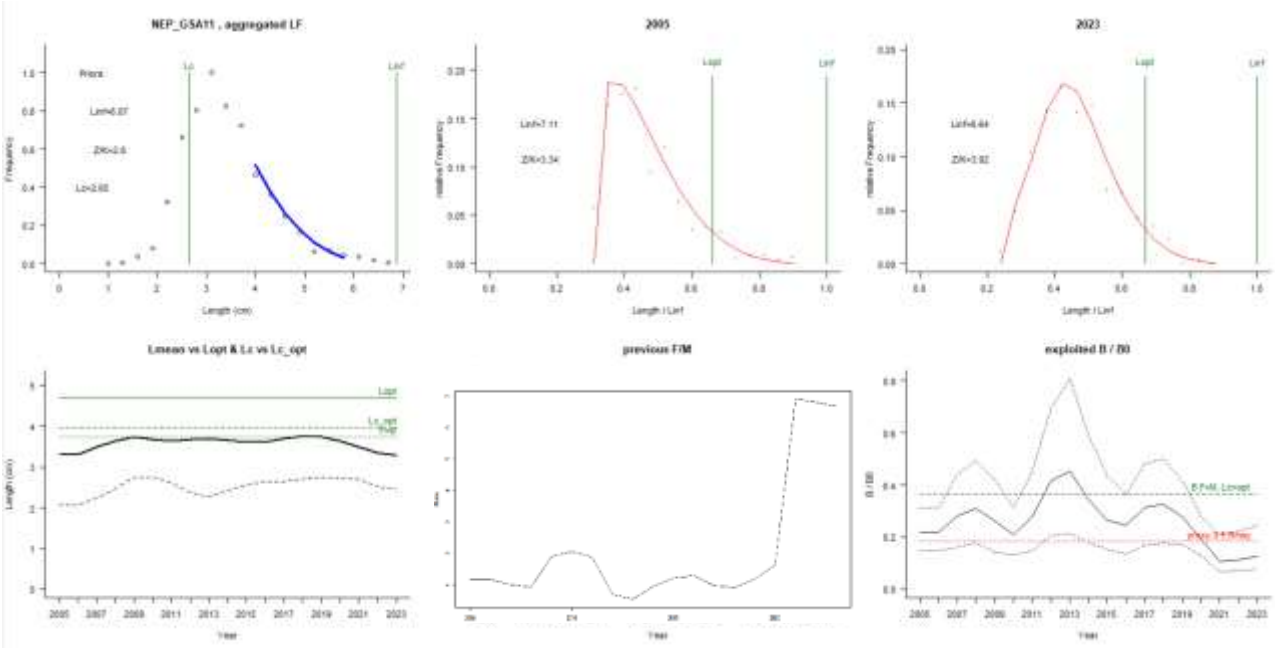
Source: own elaborations

Figure 6.14.3.1 Norway lobster in GSA 11. LBSPR results for Fishing mortality and Spawning Potential Ratio.



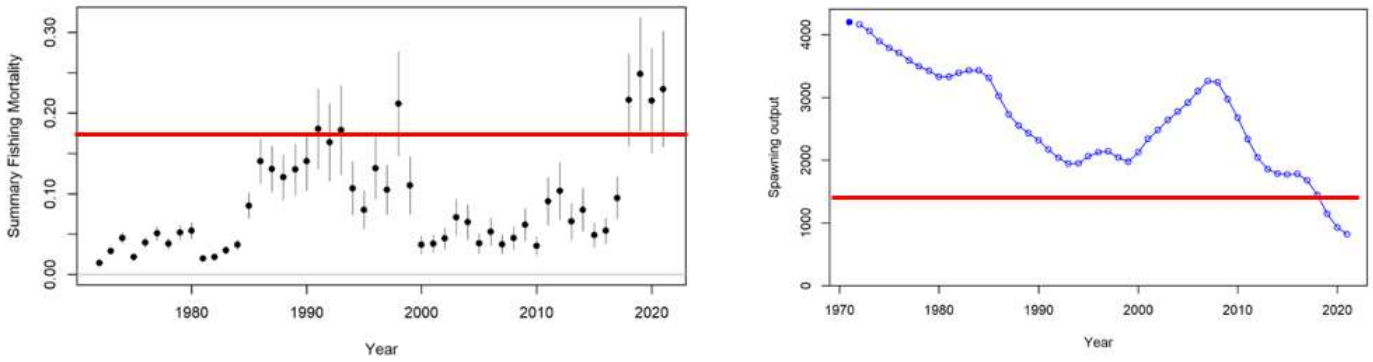
Source: own elaborations

Figure 6.14.3.2 Norway lobster in GSA 11. LBB results.



Source: own elaborations

Figure 6.14.3.3 Norway lobster in GSA 11. SS3 results.



Source: own elaborations

From all the different approaches, using information coming from the catches, the survey or both data sources, the picture of the stock is the same: decreasing spawning potential/biomass and increasing F.

Also for SPiCT model many trials were performed. The first run for the model using the entire time series available (1972-2023) did not converge, even increasing the number of iterations for the search for the best parameters. Cutting the time series starting from 1994, when also the survey information was available, the model converged and different priors and their combination were tested. All the runs and their 8 diagnostics available for the SPiCT model are briefly resumed in Table 6.14.3.2, as well as the different results obtained (Figure 6.14.3.4). The results were practically overlapped. The best run selected for the advice was Run8,

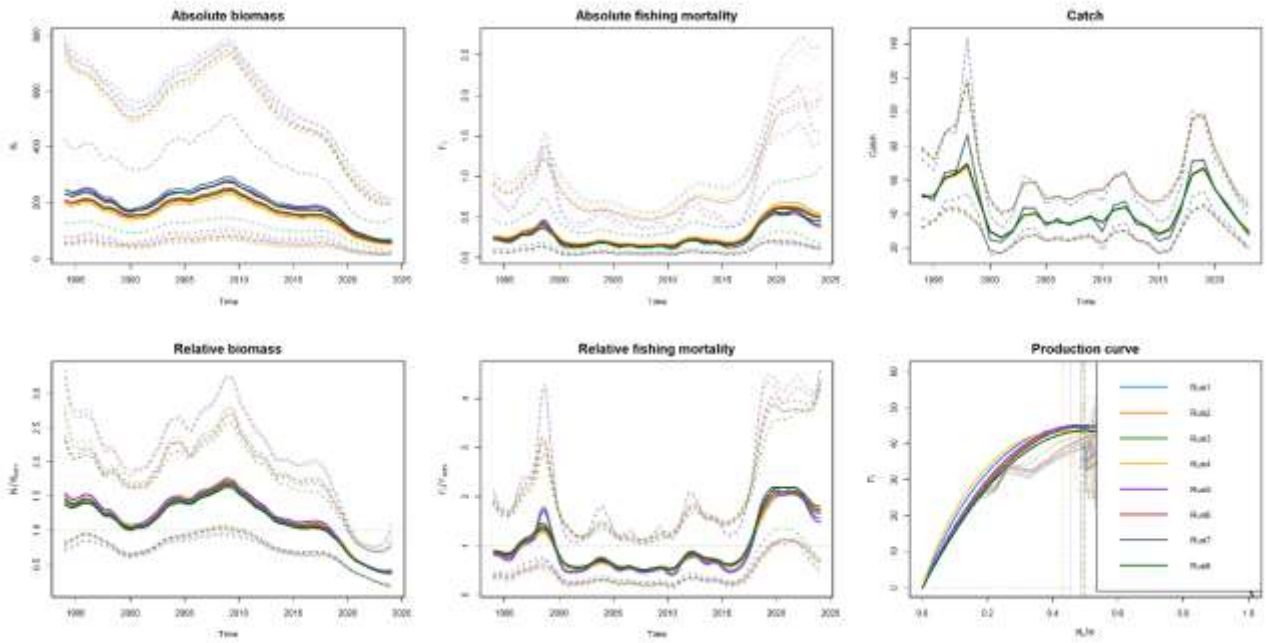
however, based on that prior setting, also different values for the initial status of the biomass were tested, always giving overlapping results.

Table 6.14.3.2 Norway lobster in GSA 11. SPiCT runs and diagnostics from the checklist description.

Run	Prior description	1	2	3	4	5	6	7	8	Comment
1	no priors	Y	Y	Y	Y	Y	Y	9/10	Y	Large CI, Retro -5 not converged
2	logn <- c(log(2), 0.5, 1)	Y	Y	Y	Y	Y	Y	6/10	Y	Smaller CI, Retro -5 not converged
3	logn <- log(2) fixed	Y	Y	Y	Y	Y	Y	9/ 10, 1 diff	Y	Smaller CI, Retro -5 not converged (better MohnsRho)
4	logbkfrac <- c(log(0.6),0.5,1)	Y	Y	Y	F-MR = -0.16 (limit = -0.15)	Y	Y	8/10	Y	Large CI, All retros converged
5	logsdi<- c(log(0.4),0.5,1) & logsdc <- c(log(0.1),0.5,1)	Y	Y	Y	Y	Y	Y	9/10	Y	Smaller CI, Retro -5 not converged
6	3+4	Y	Y	Y	Y	Y	Y	9/10	Y	Smaller CI, All retros converged but strange -5
7	3+4+5	Y	Y	Y	F-MR = -0.17 (limit = -0.15)	Y	Y	8/10	Y	All retros converged but strange -5
8	3+4+logr<-c(log(0.5),0.2,1) from SeaLifeBase	Y	Y	Y	Y	Y	Y	10/ 10	Y	Even smaller CI, All retros converged but strange -5

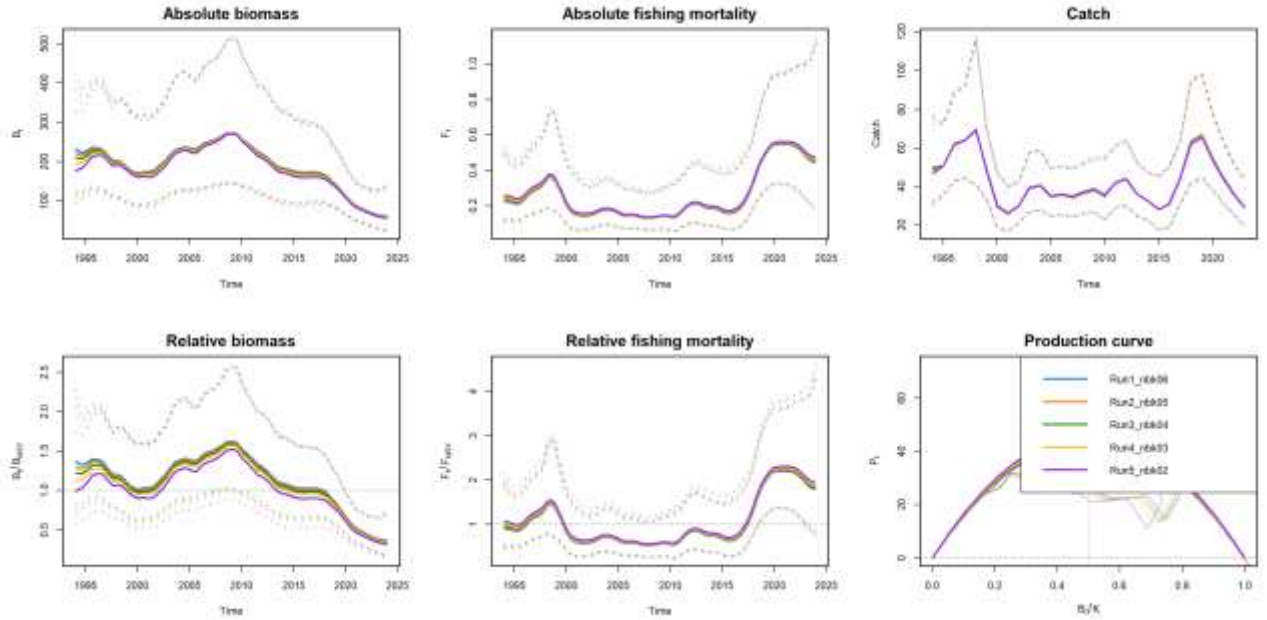
Source: own elaborations

Figure 6.14.3.4 Norway lobster in GSA 11. SPiCT runs results for the priors presented in the previous table.



Source: own elaborations

Figure 6.14.3.5 Norway lobster in GSA 11. SPiCT runs results for the different priors on the initial state of the biomass.



Source: own elaborations

Input data, results, and diagnostics for the assessment based on the selected SpiCT model are presented in the following sections.

Input data

Time series from 1994 – 2023 was used both for catches and index.

The prior combination used was obtained:

- fixing n to resemble the Schaefer production model;
- including a prior for the resilience (r 0.5) derived from SeaLifeBase;
- setting the prior for the initial depletion level to 0.6.

Stock Assessment Results

The model, that was considered the best among the models performed, is presented in the following section. The checklist for the acceptance of a SPiCT assessment for this run was already presented in Table 6.14.3.2, so will be presented only the figures of some of those.

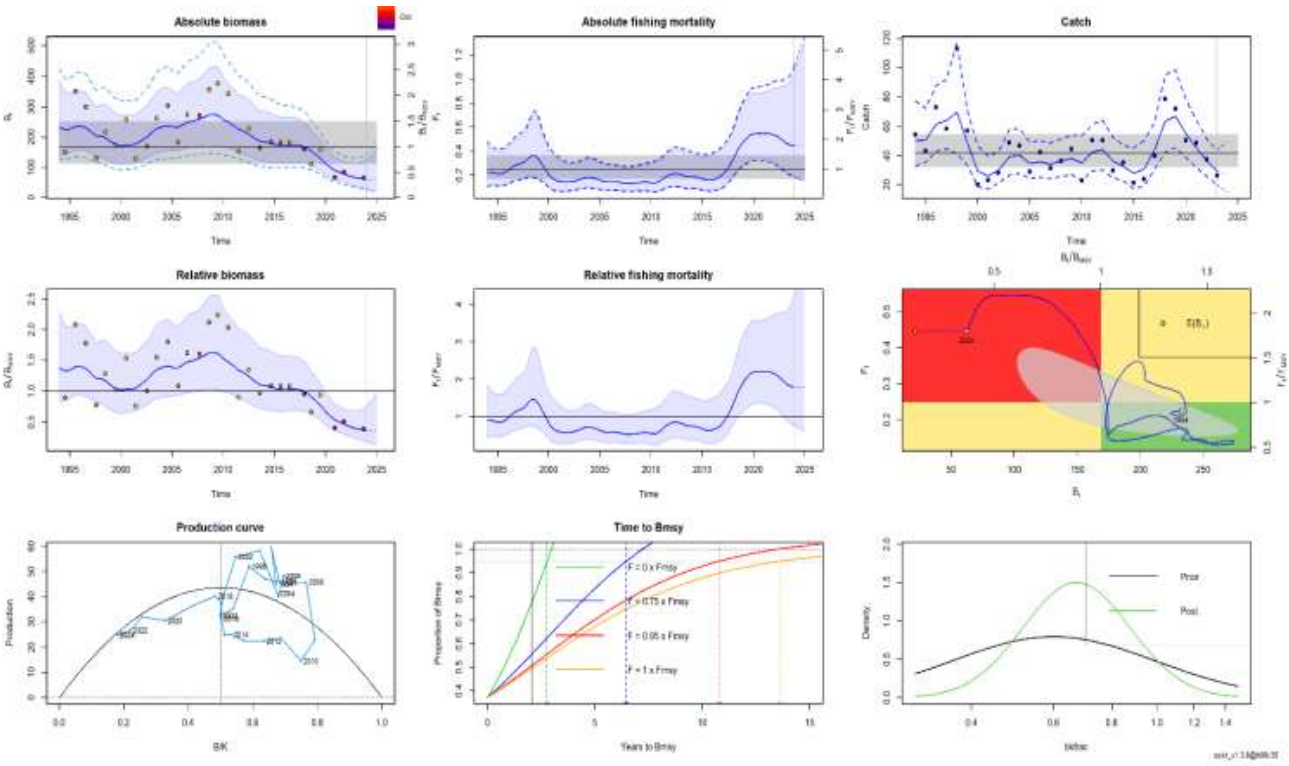
Model setup:

logn <- log(2)

logbkfrac <- c(log(0.6),0.5,1)

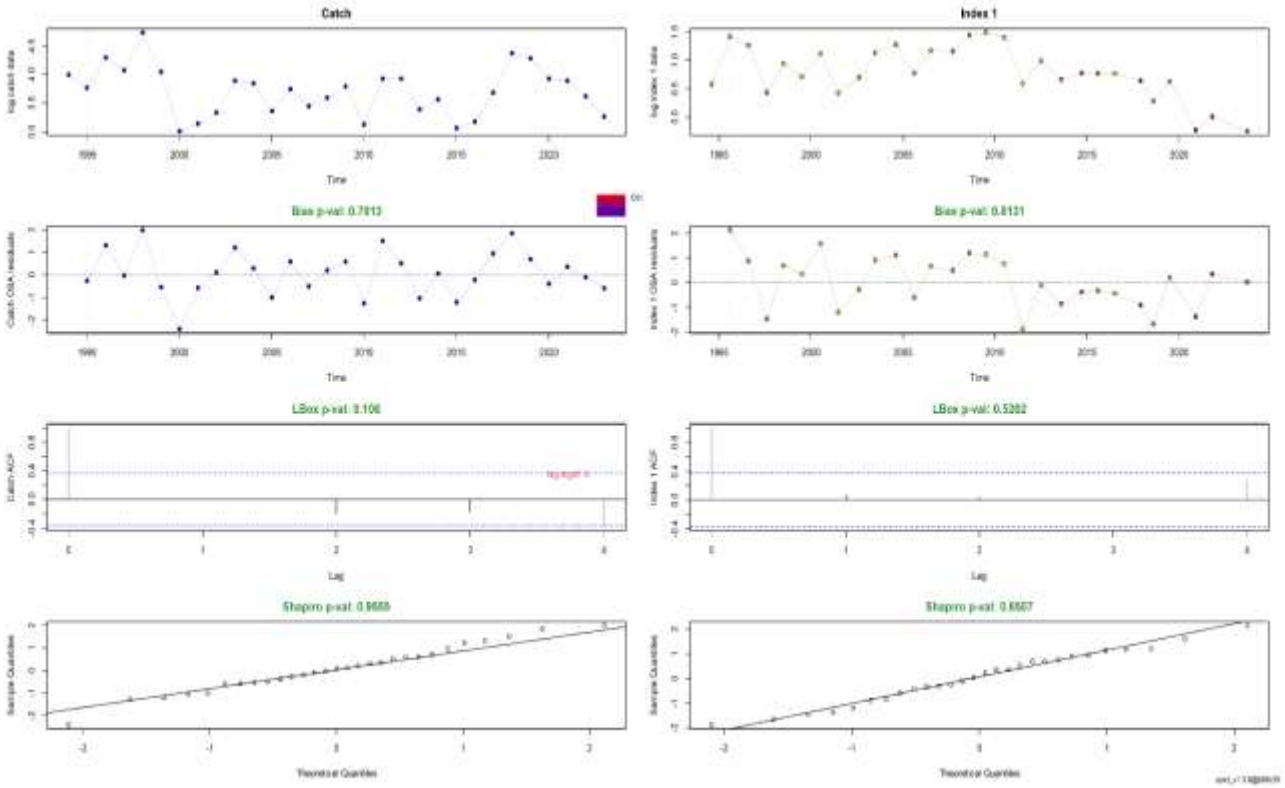
logr<-c(log(0.5),0.2,1)

Figure 6.14.3.6 Norway lobster in GSA 11. Results of the stock assessment.



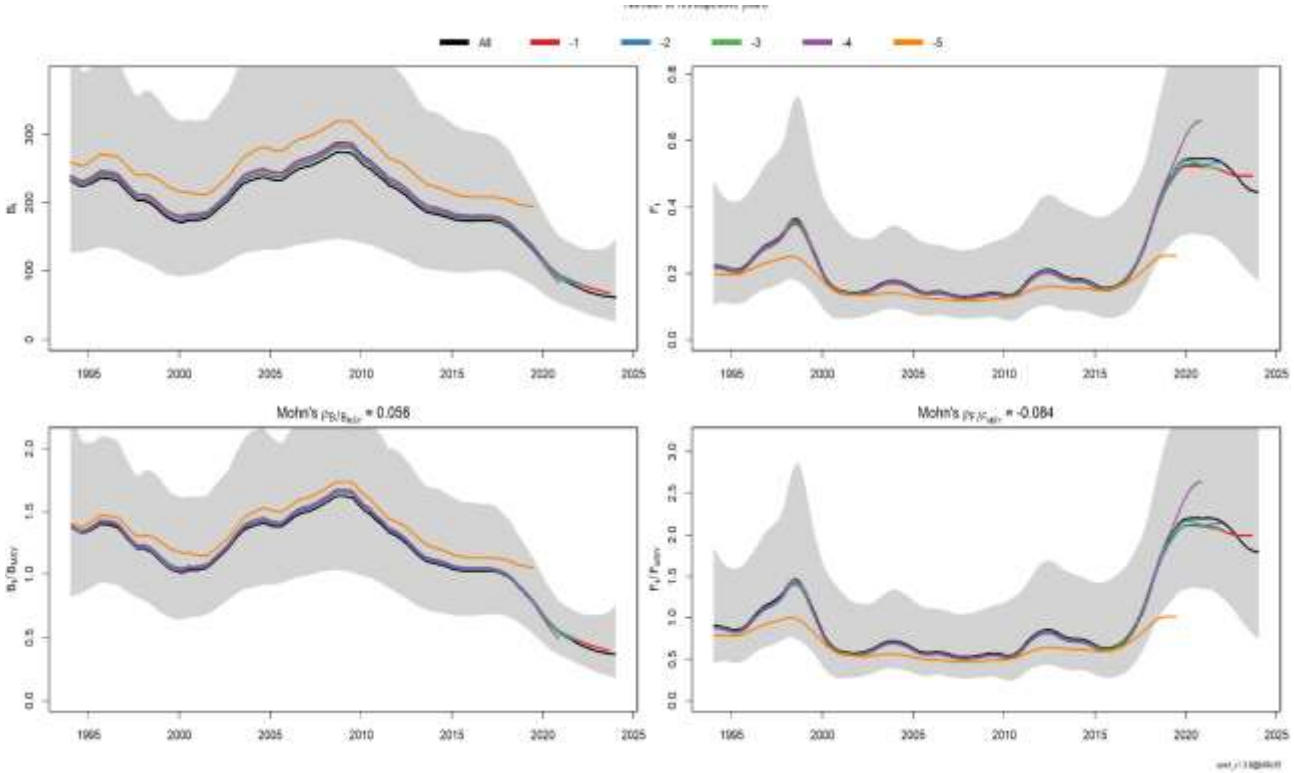
Source: own elaborations

Figure 6.14.3.7 Norway lobster in GSA 11. Residuals analysis (point 3 of the checklist) that shows no violation of the model assumptions (bias, auto-correlation, normality).



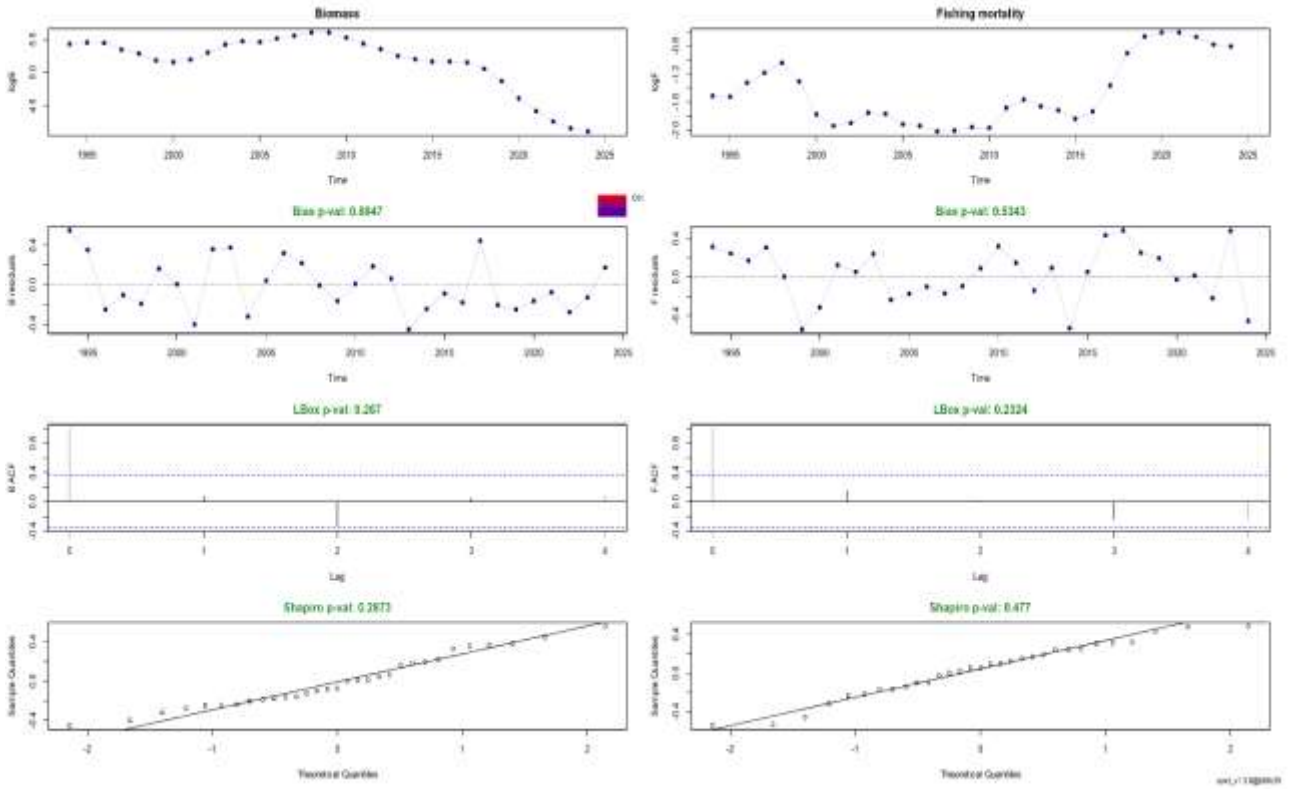
Source: own elaborations

Figure 6.14.3.8 Norway lobster in GSA 11. Retrospective analysis (point 4 of the checklist) showing a consistent pattern.



Source: own elaborations

Figure 6.14.3.9 Norway lobster in GSA 11. Additional analysis on process residuals apart from the checklist.



Source: own elaborations

6.14.4 Reference Points

The table below summarises reference points defined for Norway lobster in GSAs 11 from the SPiCT model.

Being Fcurr = 0.45 and Bcurr = 64.06, the stock is being overexploited.

Table 6.14.4.6 Norway lobster in GSA 11. Summary of reference points.

Fmsy	MSY	Bmsy
0.24	41.79	168.67

Source: own elaborations

6.14.5 Short Term Forecast and Catch Options

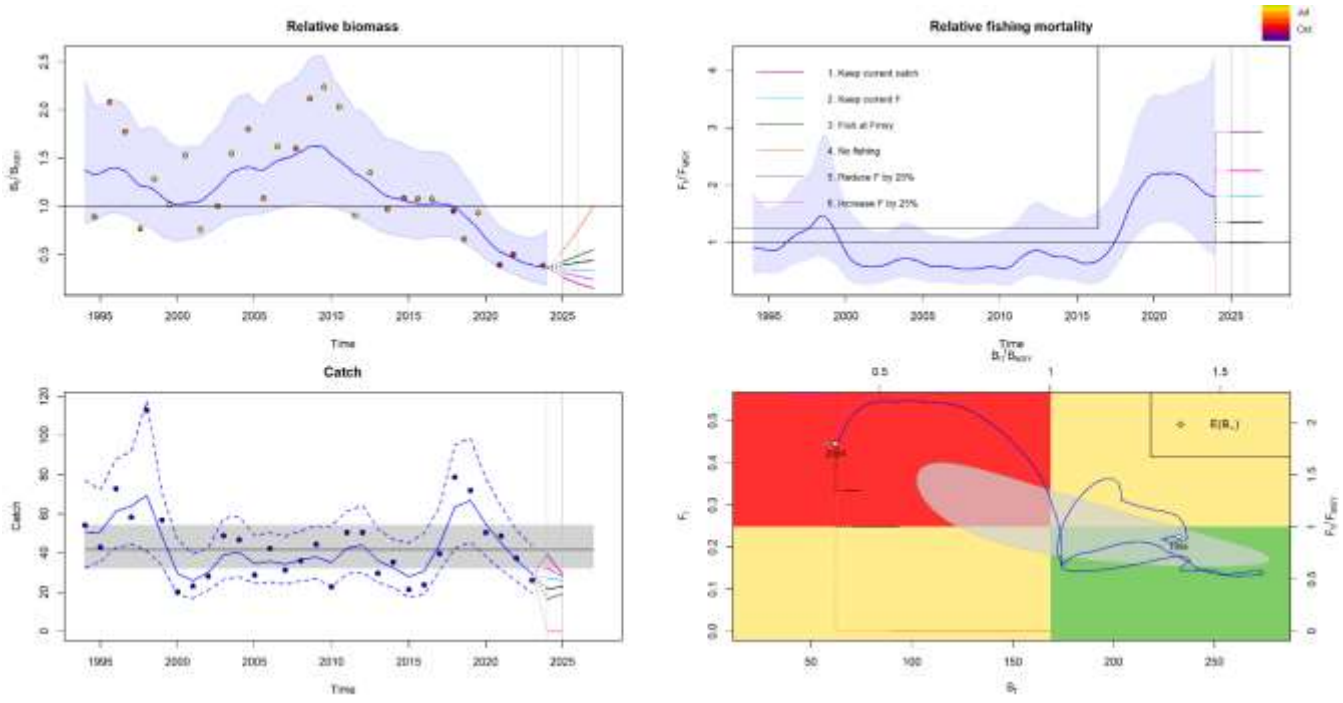
The SPiCT model was used to carry out a short term forecast with the following conditions:

SPiCT timeline:

Observations	Intermediate	Management
1994.00 - 2024.00	2024.00 - 2025.00	2025.00 - 2026.00

Management evaluation: 2026.00

Figure 6.14.5.1 Norway lobster in GSA 11. SPiCT results for STF.



Source: own elaborations

Predicted catch for management period and states at management evaluation time:

Full time series of forecasts are outlined in Table 6.14.5.1.

Table 6.14.5.1 Norway lobster in GSA 11. Short term forecasts of status quo and different fishing mortalities and catch options.

STF Scenario	Year	F	B	C
Keep_current_catch	2024	0.45	60.99	27.40
Keep_current_catch	2025	0.45	58.54	26.30
Keep_current_catch	2026	0.45	56.37	25.33
Keep_current_F	2024	0.45	61.07	27.24
Keep_current_F	2025	0.45	58.79	26.22
Keep_current_F	2026	0.45	56.77	25.32
Fish@Fmsy	2024	0.25	66.91	16.59
Fish@Fmsy	2025	0.25	77.18	19.13
Fish@Fmsy	2026	0.25	87.69	21.74
No_fishing	2024	0.00	75.28	0.03
No_fishing	2025	0.00	108.13	0.05
No_fishing	2026	0.00	147.36	0.07
Reduce_F25%	2024	0.33	64.27	21.50
Reduce_F25%	2025	0.33	68.53	22.93
Reduce_F25%	2026	0.33	72.63	24.30
Increase_F25%	2024	0.56	58.09	32.39
Increase_F25%	2025	0.56	50.42	28.11
Increase_F25%	2026	0.56	44.22	24.65

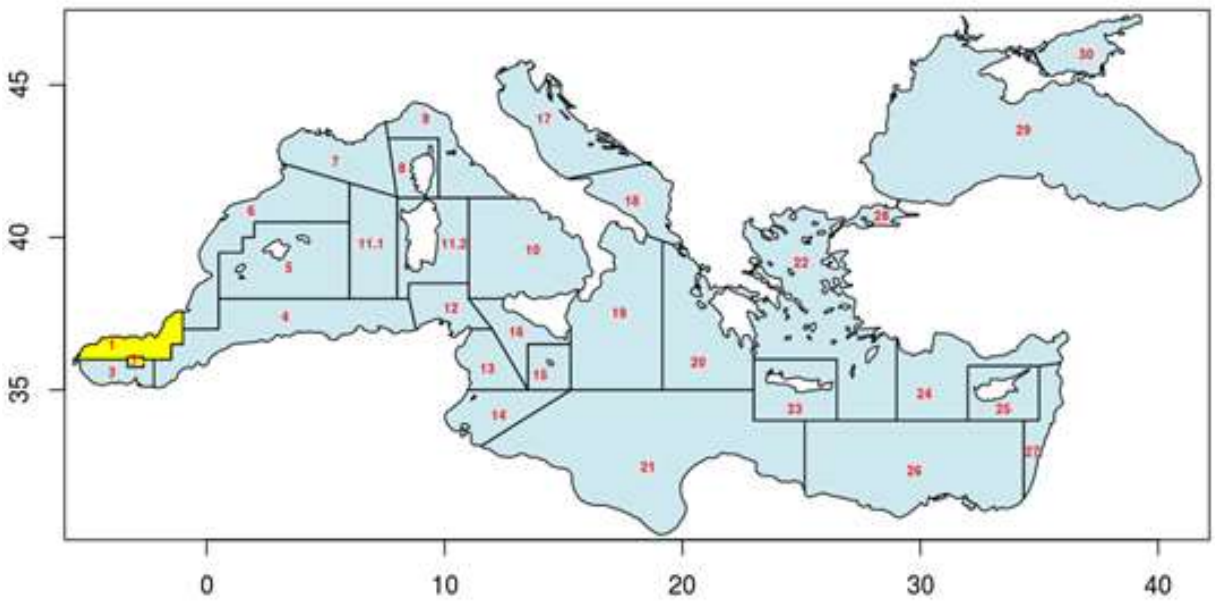
Source: own elaborations

6.15 BLUE AND RED SHRIMP IN GSAS 1&2

6.15.1 STOCK IDENTITY AND BIOLOGY

The assessment of blue and red shrimp carried out during the STECF EWG 22-09 considered the stock shared by GSA 1 & 2 (Figure 6.15.1.1). No information was documented regarding stock delimitation of blue and red shrimp, *Aristeus antennatus* (Risso, 1816).

Figure 6.15.1.1. Blue and red shrimp in GSAs 1&2. Geographical location of GSAs 1&2.



The blue and red shrimp assessment in GSA 1 and 2 input data was revised from last year's assessment. Females reach larger sizes than males, and this year, contrary to previous EWG decisions, after further analysis, it was decided to use growth parameters and length-weight relationship by sex, using the ones available in the Stock Assessment Form (SAF) from the GFCM working group in 2023:

Table 6.15.1.1. Blue and red shrimp in GSA 1 & 2. Growth parameters and length-weight relationship by sex.

	L_{inf} (mm)	k (year^{-1})	t_0 (year)	a	b
Females	77	0.380	-0.082	0.002	2.526
Males	51	0.277	-0.583	0.002	2.500

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

The length slicing for assessment was run, adding t_0 correction (+0.5) to provide correct length transitions for the 1st of January to coincide with the Jan-Dec assessment year. It should be noted that the natural mortality was calculated with t_0 set +0.032.

Length frequency distributions from the Spanish OTB fleet and survey data (MEDITS) were sliced to catch-at-age, using those growth parameters separated by sex and with t_0 correction and age boundaries set to 1,2,3, etc. This indicates that it is rare to catch red and blue shrimp in the commercial catch at age zero, and they are never observed in the survey. The sample

length from which growth parameters and length-weight relationship were estimated ranged between 15 and 64 mm CL.

The proportion of mature individuals at age was not available from the DCF data for blue and red shrimp in GSA 1 & 2 and in 2021, was taken from the 2015 assessment of GSA 1 that was based on the DCF data; this was applied in the present assessment (Table 6.15.1.1). A fixed maturity ogive is used for all years.

Table 6.15.1.2. Blue and red shrimp in GSA 1 & 2. Proportion of mature specimens (Pmat) at age.

Age	**1**	**2**	**3**	**4**	**5**
Pmat	0.7	1.00	1.00	1.00	1.00

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

The natural mortality of blue and red shrimp in the present assessment was calculated as a vector using the Chen Watanabe (1989) model (Table 6.15.1.2). These are calculated using the t0 =+0.032. It has to be noted that age zero natural mortality is for a full 12 months while the actual mortality is lower, only occurring in the last 6 months of the year after spawning.

Table 6.15.1.3. Blue and red shrimp in GSA 1 & 2. Natural mortality (M) at age.

	1	2	3	4	5+
2002	0.826	0.532	0.425	0.371	0.432
2003	0.823	0.556	0.458	0.376	0.432
2004	0.832	0.533	0.455	0.373	0.432
2005	0.829	0.531	0.440	0.378	0.432
2006	0.829	0.536	0.419	0.379	0.421
2007	0.836	0.552	0.439	0.407	0.432
2008	0.833	0.565	0.459	0.440	0.431
2009	0.817	0.568	0.456	0.444	0.431
2010	0.837	0.568	0.447	0.421	0.431
2011	0.835	0.559	0.445	0.422	0.426
2012	0.834	0.570	0.449	0.418	0.431
2013	0.834	0.559	0.443	0.391	0.432
2014	0.836	0.570	0.450	0.395	0.432
2015	0.828	0.554	0.462	0.437	0.430
2016	0.829	0.560	0.456	0.431	0.431
2017	0.835	0.562	0.446	0.423	0.431
2018	0.830	0.561	0.446	0.405	0.430
2019	0.819	0.554	0.442	0.377	0.432
2020	0.837	0.578	0.461	0.441	0.421
2021	0.830	0.575	0.462	0.435	0.431
2022	0.836	0.576	0.468	0.432	0.431
2023	0.833	0.572	0.469	0.431	0.430

Source: own elaborations

6.15.2 DATA

6.15.2.1 CATCH (LANDINGS AND DISCARDS)

General description of Fisheries

The blue and red shrimp (*Aristeus antennatus*) is present in GSA 1 & 2 at depths ranging from 400 to 800 m. The stock is exploited only by deep bottom otter trawl and particularly by the fleet segment composed of the largest trawlers. The blue and red shrimp fishery can be considered as monospecific with no significant discards (less than 0.01 tonnes per year), due to the very high price of the species. Catch is landings taken as landings with negligible discards (typically 0.02% with a max 0.3%) reported in few years that can be safely taken as zero in all years (Table 6.15.2.1.1). The SoP correction is applied and catch is used throughout this report. The total OTB landings per year, as reported by DCF, are shown in Figure 6.15.2.1.1

Table 6.15.2.1.1. Blue and red shrimp in GSA 1 & 2. Blue and red shrimp DCF landings (t) and discards (t) by OTB (all metiers) in GSA 1 & 2.

Year	OTB Landings (t) for GSA1	OTB Landings (t) for GSA 2	OTB Discards (t) for GSA1	OTB Discards (t) for GSA 2
2002	157.0	89.8		
2003	335.7	114.4		
2004	225.2	69.3		
2005	232.1	82.2	0.65	
2006	288.8	137.5		
2007	178.4	78.6		
2008	133.5	49.3		
2009	144.6	67.7		2.58
2010	152.1	48.7	0.01	0.57
2011	131.4	47.4	0.14	0.03
2012	148.6	45.0	0.06	0.06
2013	125.0	63.9	0.05	0.03
2014	184.0	41.0	0.01	0.01
2015	170.2	51.9	0.03	0.22
2016	138.2	40.1	0.01	0.29
2017	99.2	48.0	0.01	0.21
2018	123.2	47.5	0.01	0.04
2019	132.1	72.0	0.07	0.07
2020	137.4	31.7	0	0
2021	86.7	47.9	0.03	0.15
2022	107.7	66.5	0	0
2023	145.0	52.6	0	0

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.15.2.1.1. Blue and red shrimp in GSA 1 & 2. Blue and red shrimp DCF landings (t), in GSA 1 & 2 (2002-2023).

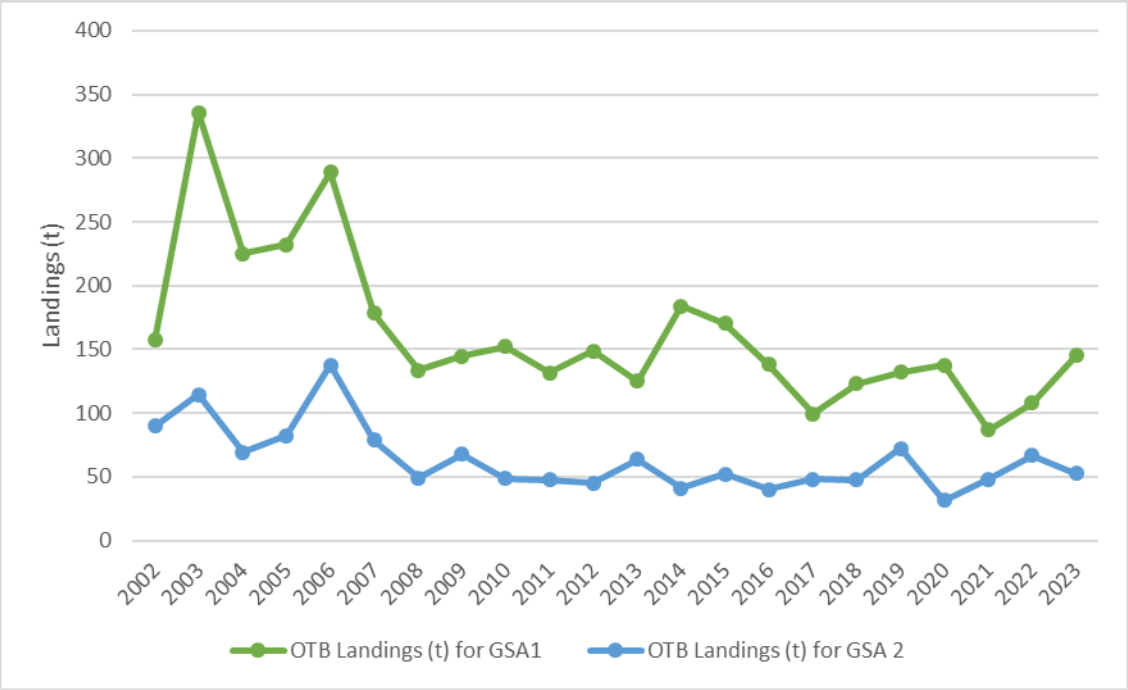
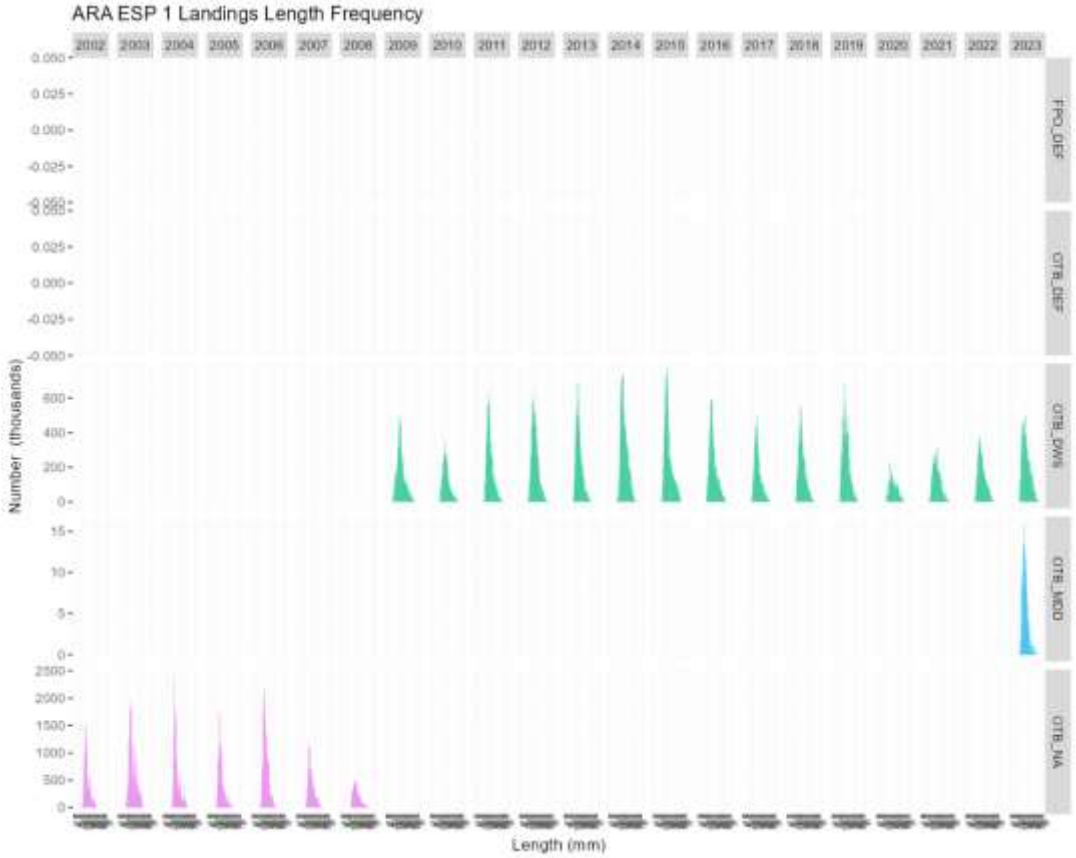
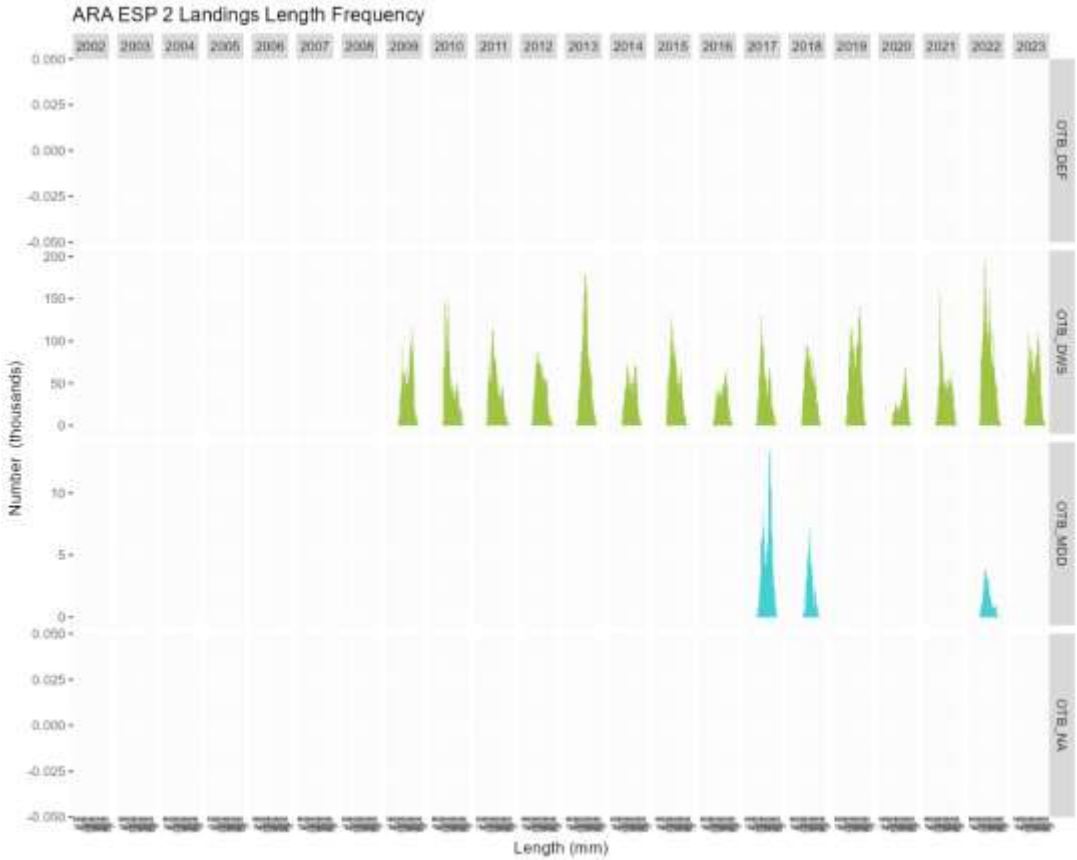


Figure 6.15.2.1.2 shows the LFD per gear and metier before reconstruction for both GSA 1 and 2. Figure 6.15.2.1.3 shows the length structure of blue and red shrimp landed in GSA 1 and 2 from 2002 to 2023 by fishing gear and fishery, as reconstructed.

Figure 6.15.2.1.2. Blue and red shrimp in GSA 1 & 2: Length structure of Blue and red shrimp landed in GSA 1 & 2 from 2002 to 2023 by fishing gear and fishery.

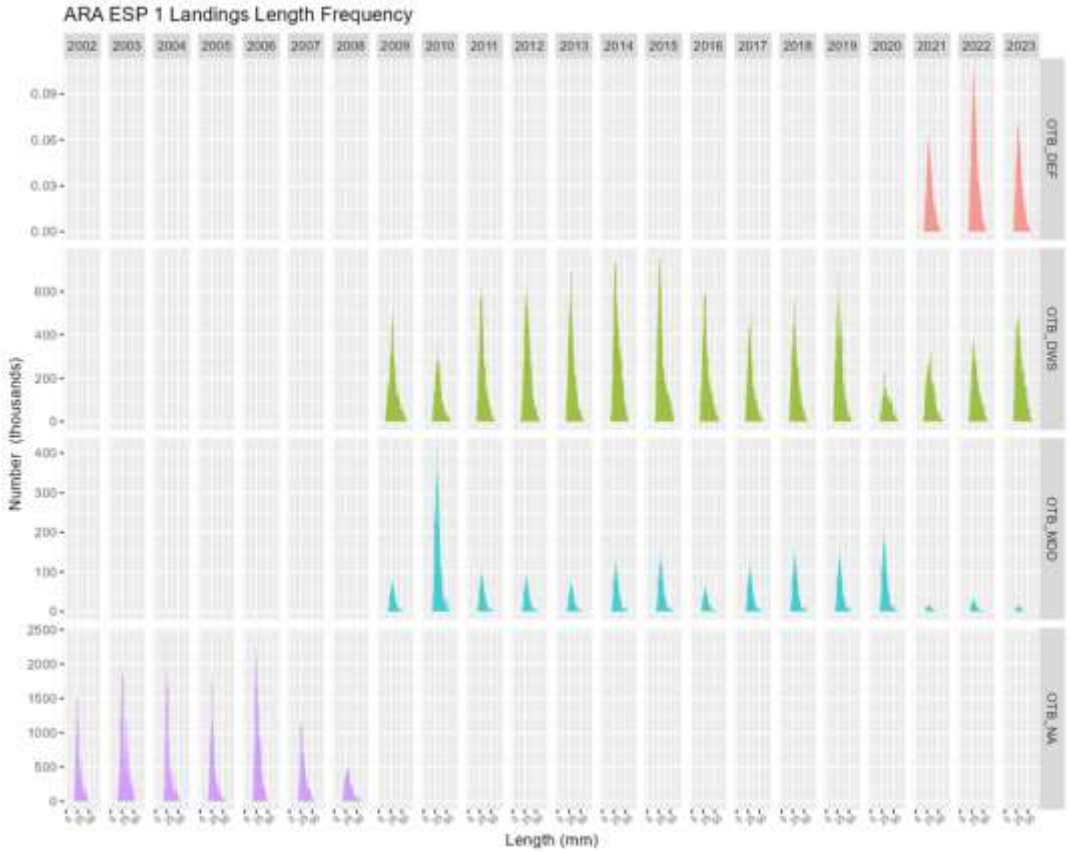


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

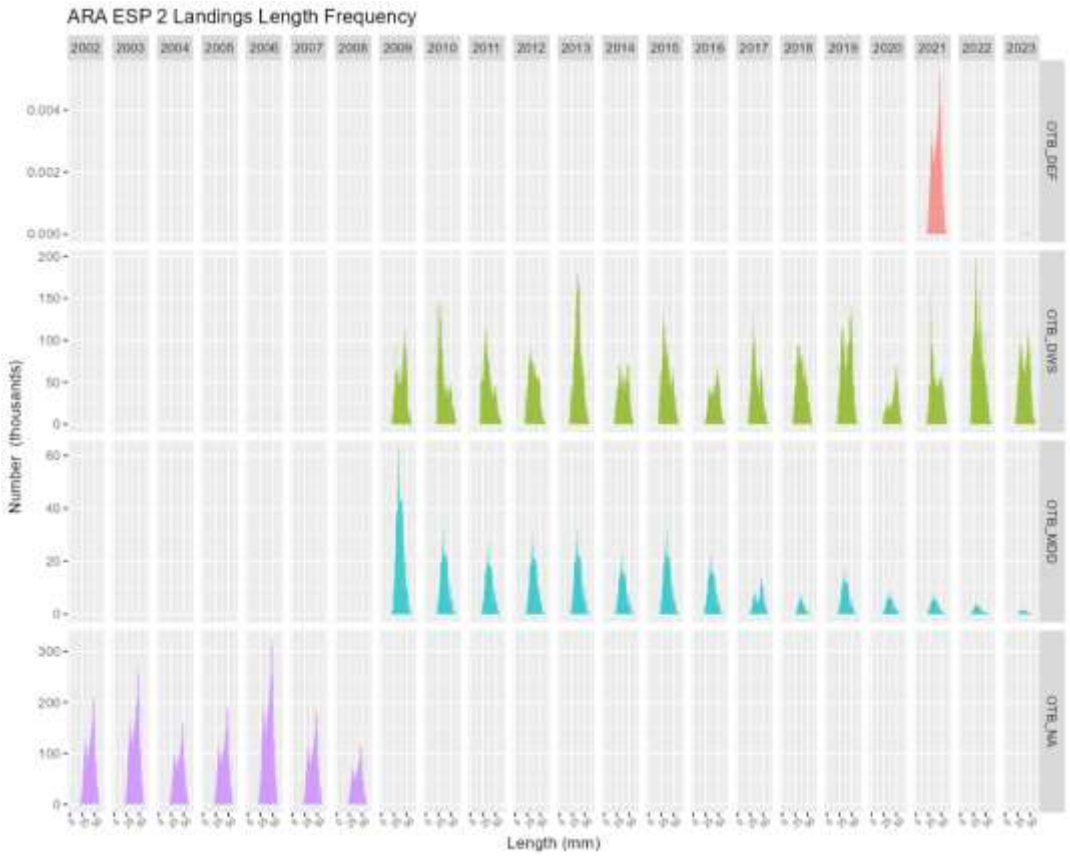


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.15.2. 1.3. Blue and red shrimp in GSA 1 & 2: Length structure of blue and red shrimp landed in GSA 1 & 2 from 2002 to 2023 by fishing gear and fishery as reconstructed.

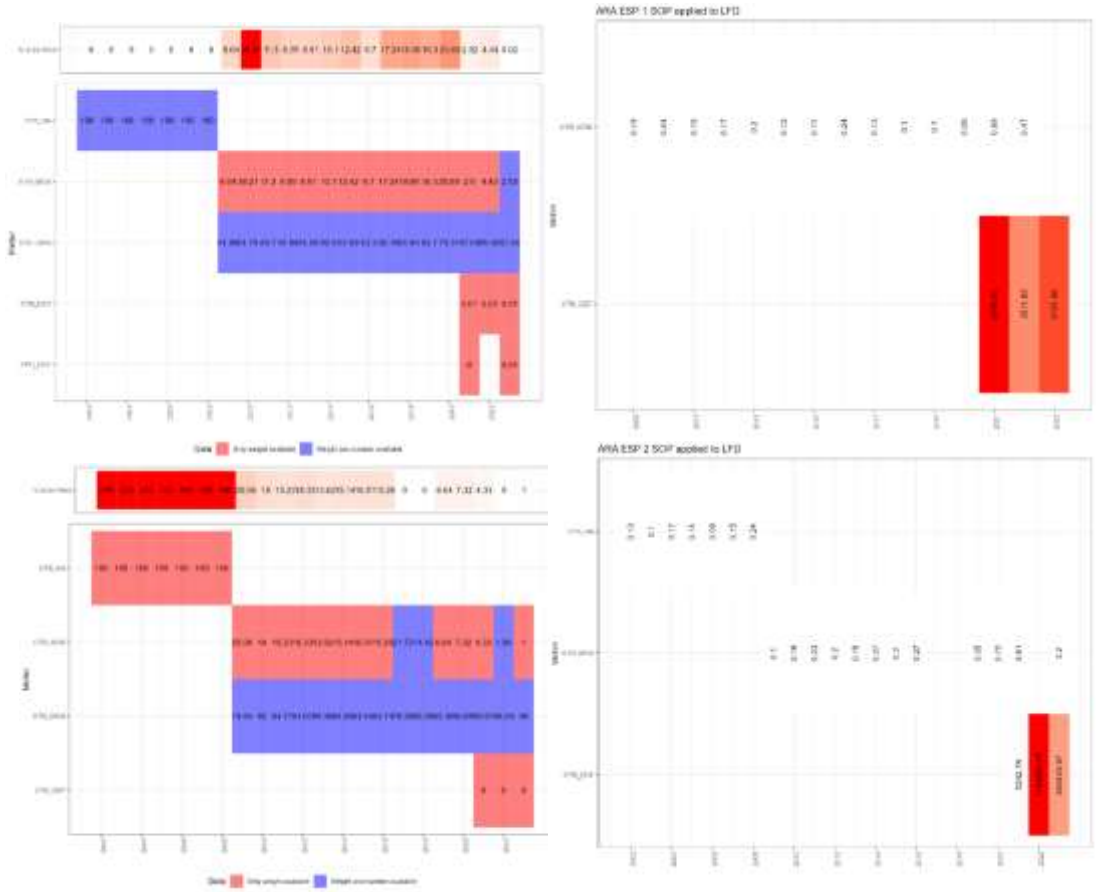


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.15.2.1.4. **Blue and red shrimp in GSA 1 & 2**.



Source: own elaborations

Percentages of total landings LFDs that were reconstructed by year and gear and SoP applied to LFD for Spain in GSA 1 & 2.

6.15.2.2 EFFORT DATA

Fishing effort data for 2023 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

6.15.2.3 SURVEY DATA

The MEDITS survey has been carried out annually from April to June (Figure 16.15.2.3.1) by the Spanish Institute of Oceanography (IEO) since 1994 at fixed haul positions. Tables TA, TB, and TC were provided according to the MEDITS protocol. Data were assigned to strata based on the shooting position and average depth between shooting and hauling depth.
The abundance and biomass indices by GSA were calculated using stratified means. This implies weighting the average values of the individual standardised catches and the variation of each stratum by the respective stratum areas in each GSA. In 2020, no MEDITS survey was carried out.

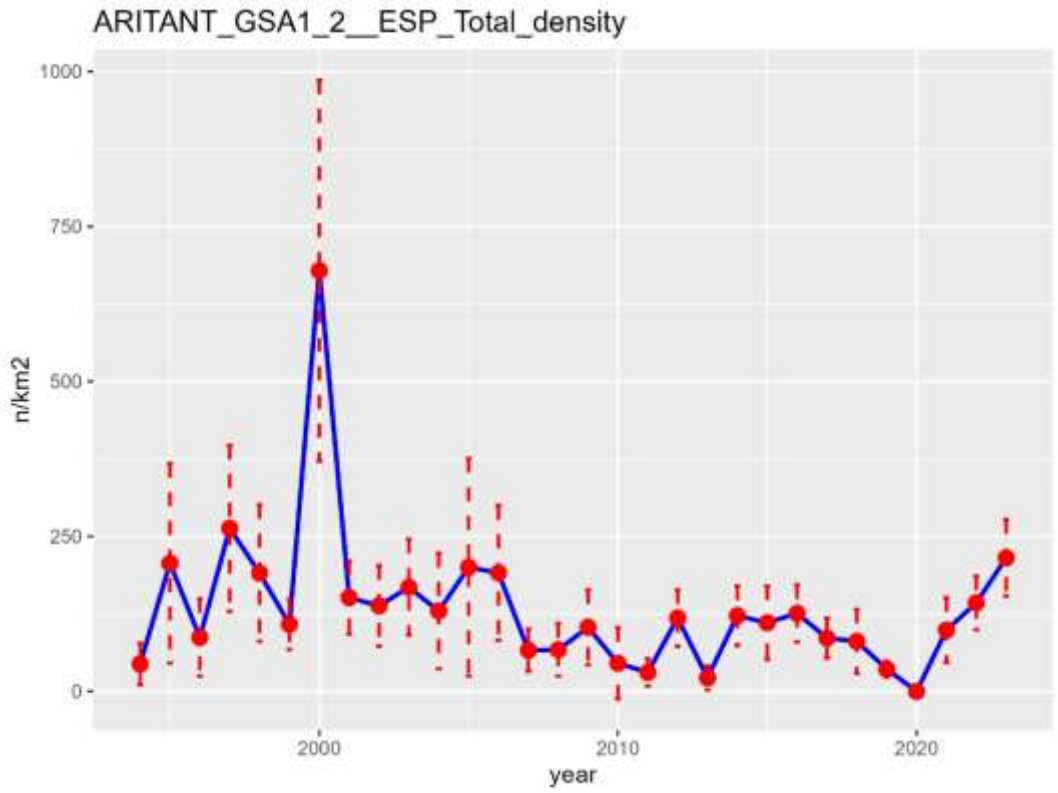
Figure 6.15.2.3.1 Month of the year when the hauls of MEDITS survey are being conducted in GSA 1 & 2.



Source: own elaborations

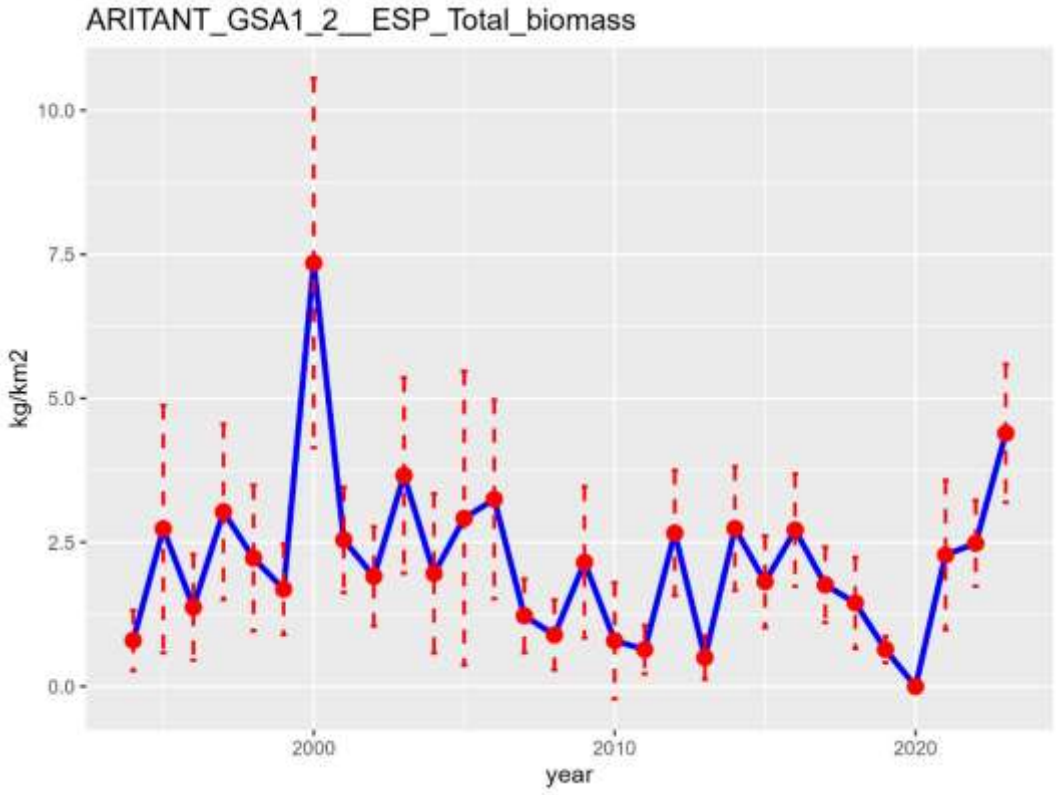
The time series of abundance and biomass indices of blue and red shrimp from MEDITS bottom trawl survey in GSA 1 & 2 are shown in the following figures (Figure 6.15.2.3.2 and 6.15.2.3.3). Both estimated abundance and biomass indices show similar trends, maximised in 2000 and fluctuated around a mean for the last five years. The total biomass time series fluctuated with a lower mean from 2007-2019. In two 2023 the values are increasing since 2019.

Figure 6.15.2.3.2. Blue and red shrimp in GSA 1 & 2. MEDITS survey abundance index (n/km^2) of blue and red shrimp in GSA 1 & 2 as reported by DCF. The survey is carried out from April to June.



Source: own elaborations

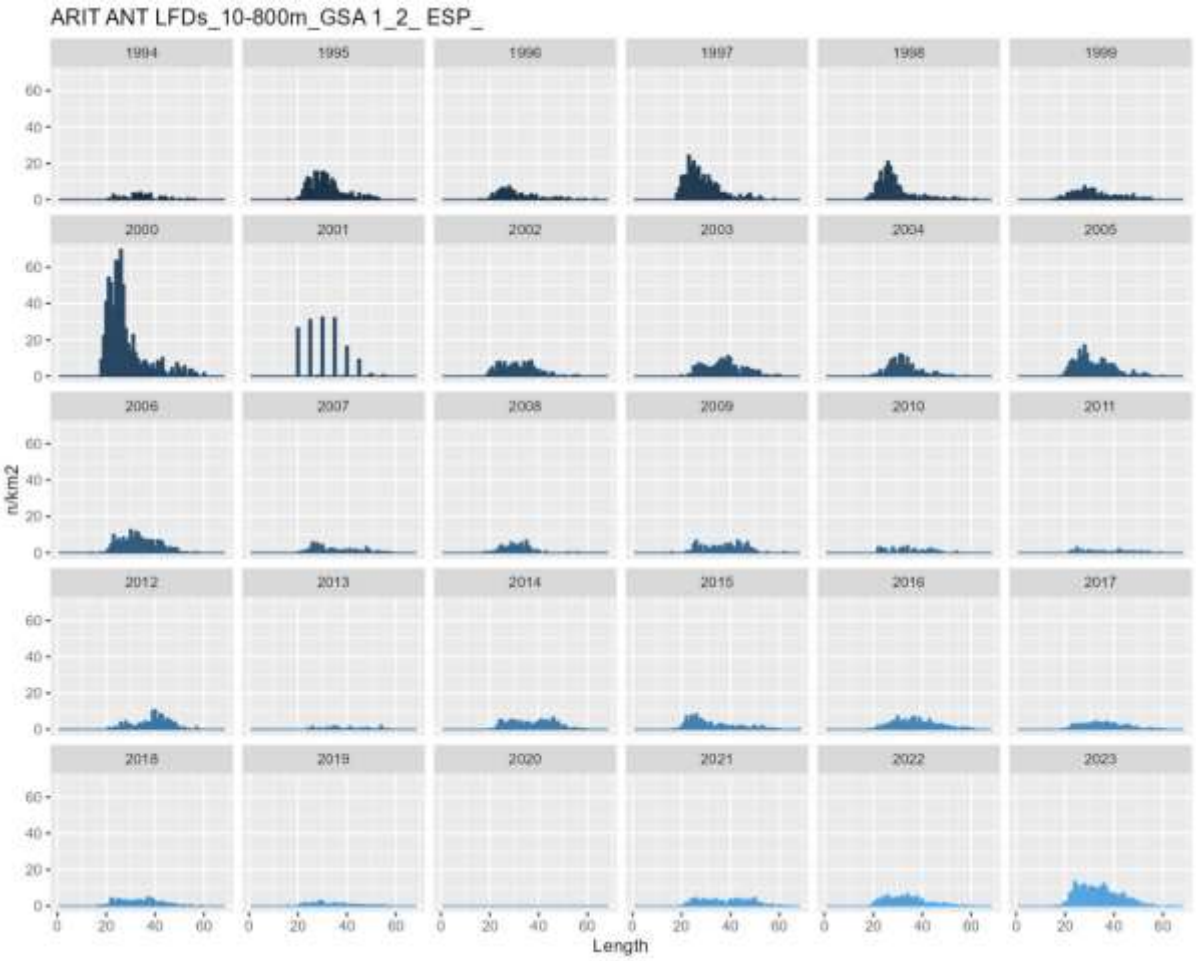
Figure 6.15.2.3.3. Blue and red shrimp in GSA 1 & 2. MEDITS survey biomass index (kg/km^2) of blue and red shrimp in GSA 1 & 2 as reported by DCF. The survey is carried out from April to June.



Source: own elaborations

Trends in abundance by length (Figure 6.15.2.3.4) are shown below.

Figure 6.15.2.3.4. Blue and red shrimp in GSA 1 & 2. Length frequency distribution of the MEDITS survey abundance index (n/km^2) of blue and red shrimp in GSA 1 & 2 as reported by DCF. The survey is carried out from April to June.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.15.3. STOCK ASSESSMENT

The present assessment used a statistical catch-at-age analysis (a4a). This year, new input data was used, as different growth parameters by sex were used, and the same were used for GSA 1 and 2. There's no survey data for 2020. Treatment of length to age that better aligns the the birthday to 1st of January for stocks with summer spawing resultys in different age structure which is considered to better reflect the observed growth.

Input data

As described above, the input growth parameters used were L_{inf} = 77 mm, k = 0.38 y^{-1}, t_0 = -0.082 for females and L_{inf} = 51 mm, k = 0.277 y^{-1}, t_0 = -0.582 for males. 0.5 was added to t_0 to align sizes appropriately with 1 January for length slicing.

The spawning of blue and red shrimp peaks during the summer, although continuous spawning throughout the year has been reported from some areas of the Mediterranean.

The proportion of mature individuals at age was not available for blue and red shrimp in GSA 1 & 2 and was taken from the previous assessment that was based on the DCF data for GSA 1 (Table 6.15.1.1). The maturity at age ogive was used for blue and red shrimp assessment in GSA 1 & 2 as estimated from biological sampling based on length at first maturity and growth, giving 0.7 at age 1 (spawning in the first summer).

Natural mortality (M) was estimated using Chen-Watanabe (1989) model and is shown in Table 6.15.1.2. using the original growth parameters by sex (without adding 0.5 to t_0).

Sum of Products (SoP) correction was applied in catch numbers at age to match the total catch by year reported in the DCF (Table 6.15.3.1)

Table 6.15.3.1. Blue and red shrimp in GSA 1 & 2. Sum of Products (SoP) correction array.

Year	SOP
2002	1.00
2003	1.00
2004	1.00
2005	1.17
2006	0.90
2007	0.95
2008	1.03
2009	1.10
2010	1.01
2011	0.89
2012	0.89
2013	0.95
2014	1.00
2015	0.99
2016	1.05
2017	0.99
2018	1.03
2019	0.96
2020	1.37
2021	0.97
2022	0.97
2023	1.00

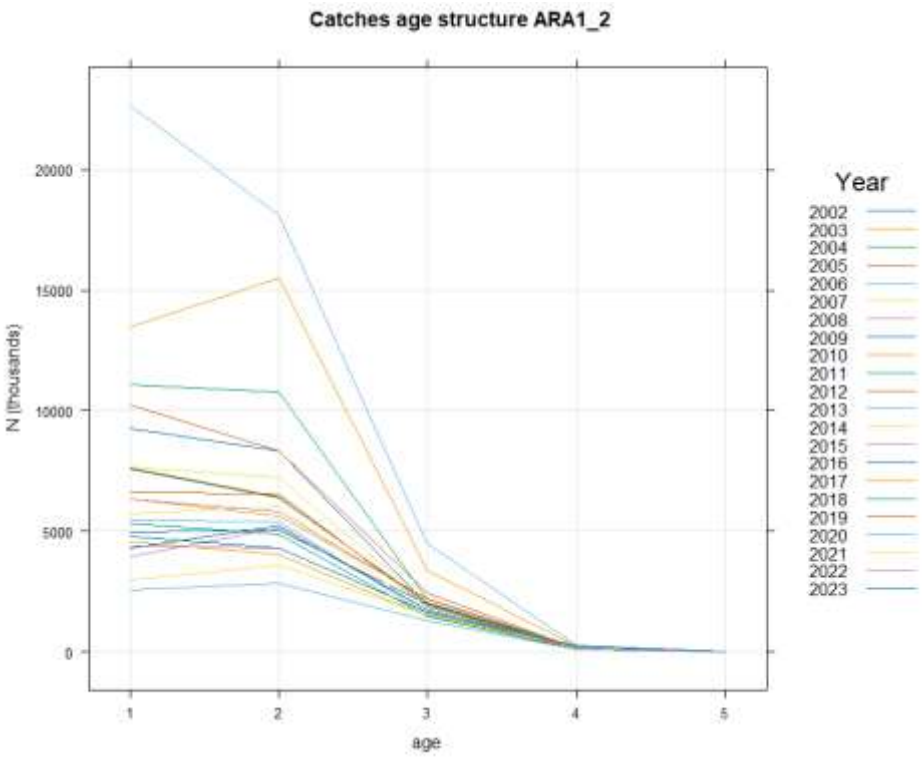
Source: own elaborations

Table 6.15.3.2. Blue and red shrimp in GSA 1 & 2: Values of catch at age per year used in the assessment.

	1	2	3	4	5+
2002	9254	8334	1936	143	16
2003	13480	15529	3360	225	20
2004	11095	10753	2176	127	12
2005	10239	8313	2459	155	17
2006	22644	18102	4464	284	22
2007	7684	7217	2053	132	12
2008	4383	4286	1657	133	10
2009	4985	5077	1972	213	16
2010	6336	5642	2237	179	10
2011	7570	6386	2052	164	11
2012	6589	6543	1860	165	12
2013	5455	5399	1545	162	20
2014	5731	6036	1624	91	7
2015	6362	5808	2194	171	12
2016	4785	4311	1630	139	13
2017	4568	4025	1466	124	8
2018	5333	4875	1453	107	12
2019	7609	6417	1996	130	14
2020	2557	2836	1304	110	5
2021	2954	3605	1498	186	13
2022	3929	5132	1756	158	21
2023	4316	5255	1752	237	14

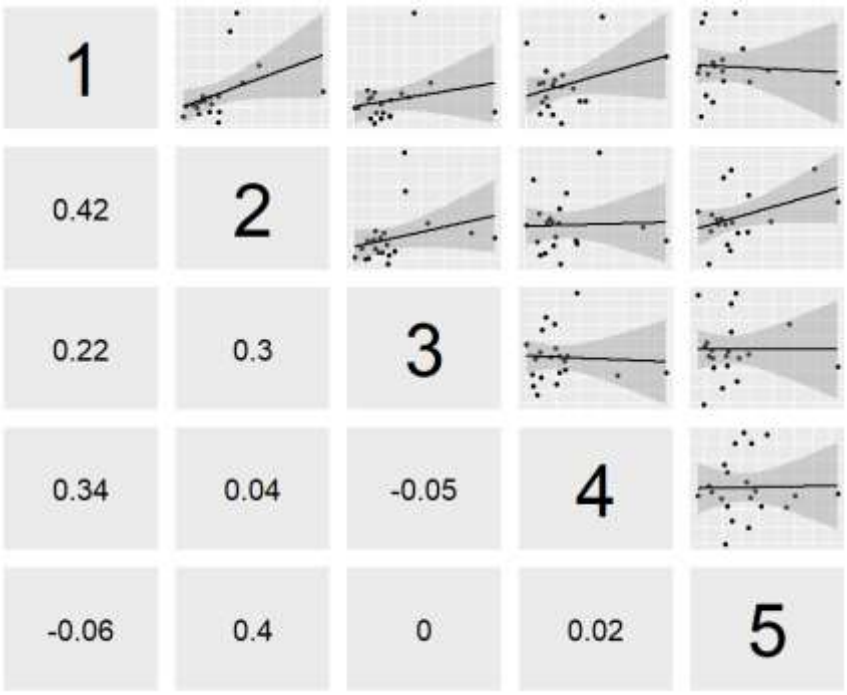
Source: own elaborations

Figure 6.15.3.1. Blue and red shrimp in GSA 1 & 2: Catch-at-age data of blue and red shrimp in GSA 1 & 2 used in assessment.



Source: own elaborations

Figure 6.15.3.2. Blue and red shrimp in GSA 1 & 2. Cohort consistency of catches used in the assessment.



Source: own elaborations

Table 6.15.3.2. Blue and red shrimp in GSA 1 & 2: Values of catch in the assessment.

Year	Catch
2002	246.8
2003	450.1
2004	294.5
2005	314.3
2006	426.3
2007	257.0
2008	182.8
2009	212.3
2010	200.8
2011	178.8
2012	193.6
2013	188.9
2014	225.0
2015	222.1
2016	178.3
2017	147.2
2018	170.7
2019	204.1
2020	169.1
2021	134.6
2022	174.2
2023	197.6

Source: own elaborations

Table 6.15.3.3. Blue and red shrimp in GSA 1 & 2: Values of mean weight at age per year used in the assessment.

	1	2	3	4	5+
2002	0.008	0.014	0.026	0.027	0.021
2003	0.008	0.016	0.027	0.026	0.021
2004	0.008	0.014	0.027	0.026	0.021
2005	0.008	0.014	0.025	0.028	0.021
2006	0.008	0.014	0.023	0.028	0.021
2007	0.009	0.016	0.025	0.031	0.021
2008	0.010	0.017	0.028	0.039	0.031
2009	0.009	0.018	0.026	0.038	0.029
2010	0.010	0.016	0.022	0.034	0.022
2011	0.009	0.016	0.022	0.033	0.024
2012	0.010	0.017	0.023	0.030	0.027
2013	0.009	0.016	0.021	0.021	0.021
2014	0.009	0.017	0.023	0.024	0.021
2015	0.009	0.016	0.025	0.034	0.021
2016	0.009	0.017	0.027	0.038	0.041
2017	0.010	0.017	0.023	0.032	0.026
2018	0.009	0.016	0.023	0.026	0.022
2019	0.009	0.016	0.025	0.026	0.025
2020	0.010	0.019	0.030	0.043	0.022
2021	0.010	0.018	0.027	0.041	0.039
2022	0.010	0.018	0.026	0.032	0.028
2023	0.009	0.018	0.028	0.037	0.027

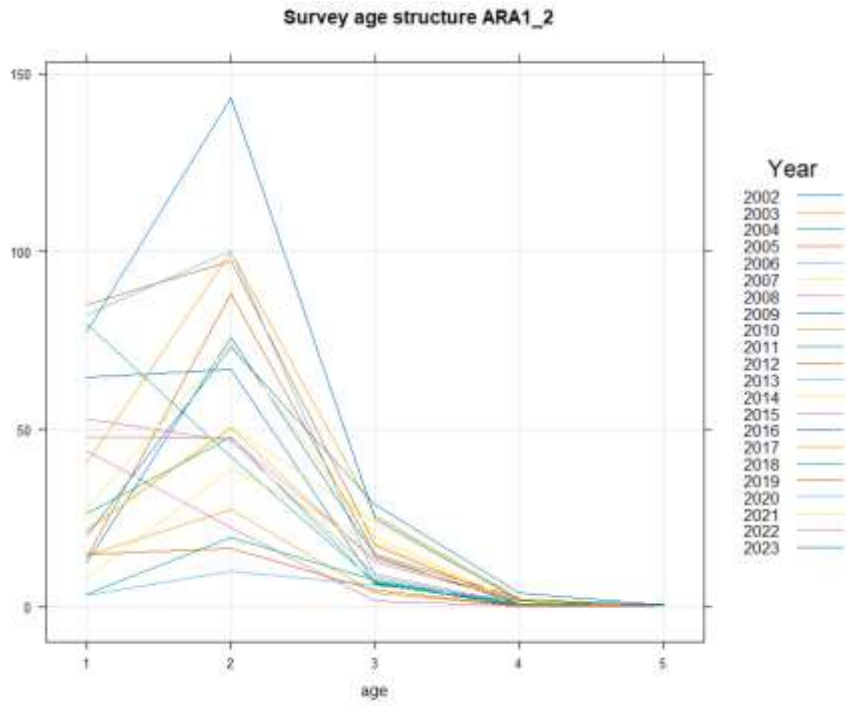
Source: own elaborations

Table 6.15.3.3. Blue and red shrimp in GSA 1 & 2: Survey index (MEDITS) values at age per year used in the assessment.

	1	2	3	4	5+
2002	64.53	66.94	6.63	0.16	0.21
2003	40.38	99.80	25.61	2.30	0.21
2004	79.68	42.13	6.85	0.98	0.44
2005	85.01	97.28	17.17	0.82	0.21
2006	82.23	100.20	8.23	0.36	0.21
2007	8.25	38.71	18.08	0.95	0.42
2008	43.90	22.36	1.43	0.16	0.21
2009	12.39	75.79	14.27	0.60	0.59
2010	14.44	27.21	3.78	0.16	0.21
2011	3.46	19.56	7.42	0.44	0.21
2012	13.80	88.09	14.85	2.45	0.21
2013	3.23	10.02	6.01	1.72	0.21
2014	27.61	74.09	19.59	0.94	0.21
2015	47.77	47.39	13.39	1.87	0.33
2016	20.14	72.86	28.86	3.89	0.32
2017	21.44	50.38	12.51	1.71	0.21
2018	26.11	47.64	6.29	0.72	0.21
2019	14.79	16.53	4.64	0.21	0.21
2020	-	-	-	-	-
2021	22.00	50.46	23.82	2.42	0.31
2022	52.76	46.75	9.01	0.86	0.32
2023	77.33	143.26	24.76	1.79	0.53

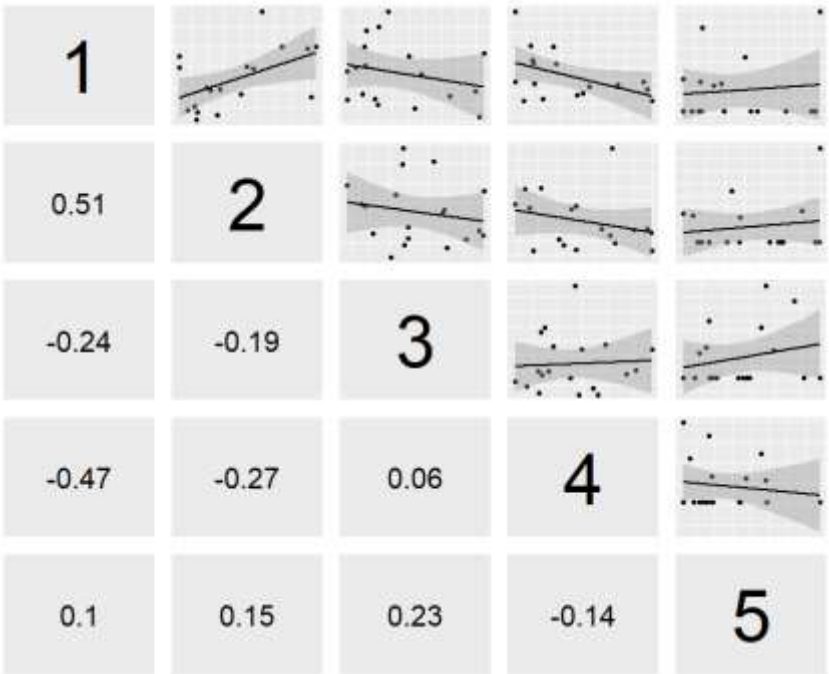
Source: own elaborations

Figure 6.15.3.4. Blue and red shrimp in GSA 1 & 2: MEDITS indices describing density by age of blue and red shrimp in GSA 1 & 2 by year.



Source: own elaborations

Figure 6.15.3.5. Blue and red shrimp in GSA 1 & 2: Cohort consistency of survey data used in the assessment.



Source: own elaborations

Assessment results

Different a4a models were investigated in terms of fishing mortality, catchability of the survey index and stock–recruitment relationship models (fmodel, qmodel, srmodel). The final scenarios were based on fmodel, trying different configurations regarding the use of split or as a factor on ages and also testing different k values for the year.

fmod1 <- ~ factor(age) + s(year, k=8)
fmod2 <- ~ factor(age) + s(year, k=12)
fmod3 <- ~ s(age,k=4) + s(year, k=8)
fmod4 <- ~ s(age,k=4) + s(year, k=12)

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

Although the four scenarios reach good diagnostics, the model selected has the best retrospective analysis.

Models applied and selected:

fmodel <- ~ factor(age) + s(year, k=12)

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

srmodel <- ~factor(year)

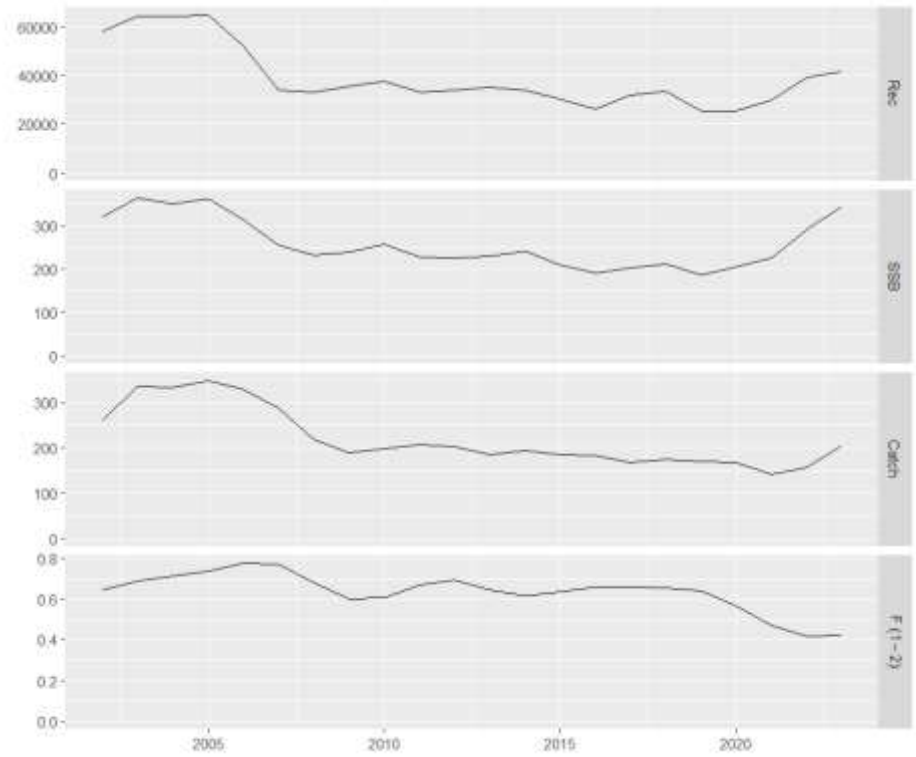
Summary of the model fit using the fitSumm command:

nopar	4.800000e+01
nlogl	1.136822e+02
maxgrad	5.117379e-07
nobs	2.150000e+02
gcv	8.459491e-02
convergence	0.000000e+00
accrate	NA
nlogl_comp1	-7.504700e-01
nlogl_comp2	1.144330e+02

The following figure presents the summary of the stock object after the model's fit. The recruitment, spawning stock biomass catch and fishing mortality.

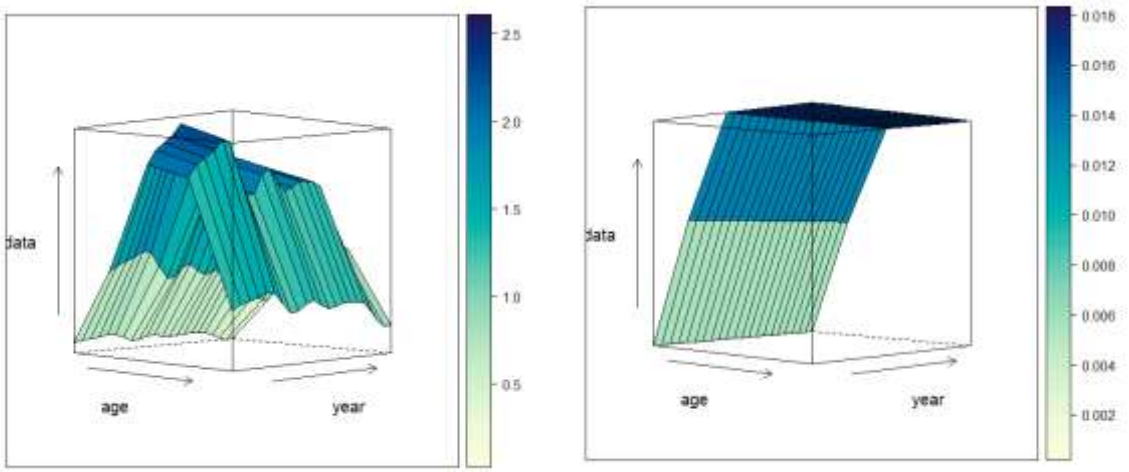
Recruitment, SSB, catches, and fishing mortality (Fbar 1-2) of blue and red shrimp in GSA1&2 show an oscillation pattern since 2006 (the highest value in the time series) except for the last years, when recruitment, SSB, and caches show a slight increase since 2019. Fishing mortality has decreased since 2019 but has remained more stable over the last three years.

Figure 6.15.3.6. Blue and red shrimp in GSA 1 & 2: Stock summary from the final a4a model.

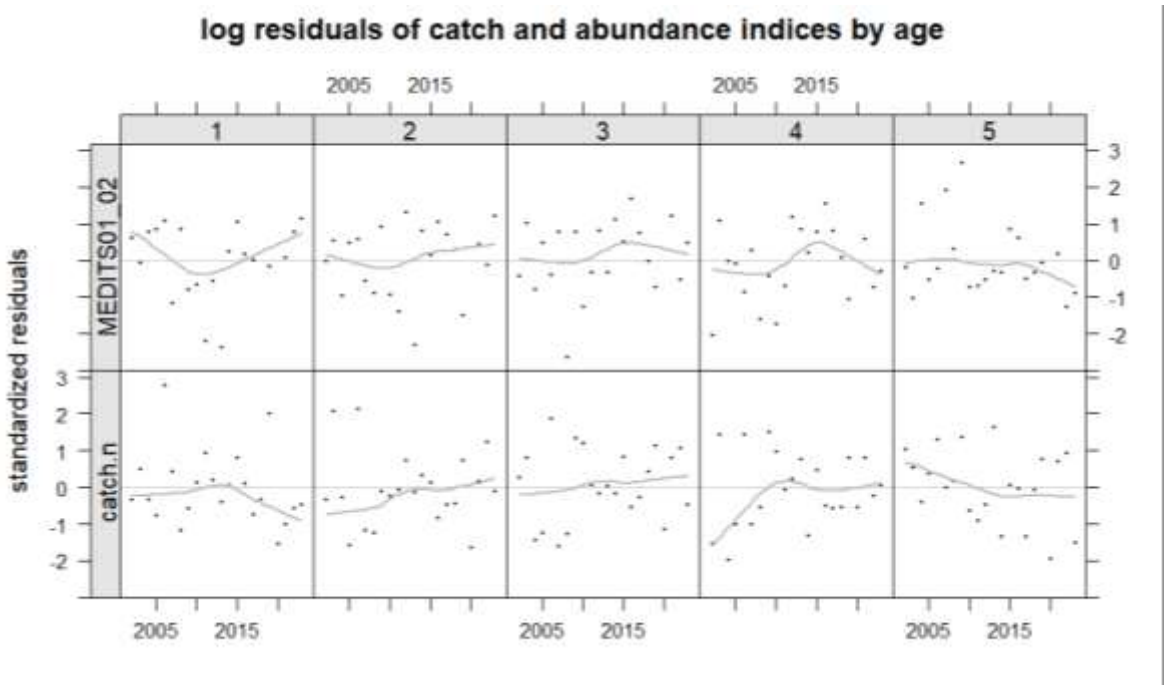


Source: own elaborations

Figure 6.15.3.7. Blue and red shrimp in GSA 1 & 2: 3D contour plot of estimated fishing mortality (left) and 3D contour plot of estimated survey catchability (right) at age and year.

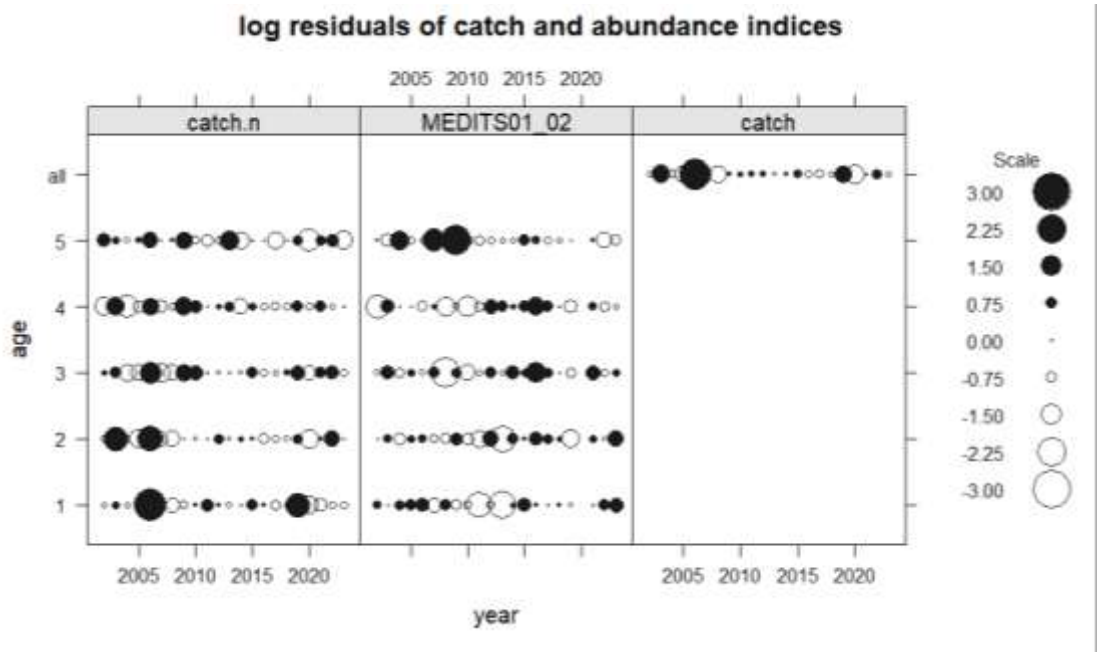


Source: own elaborations



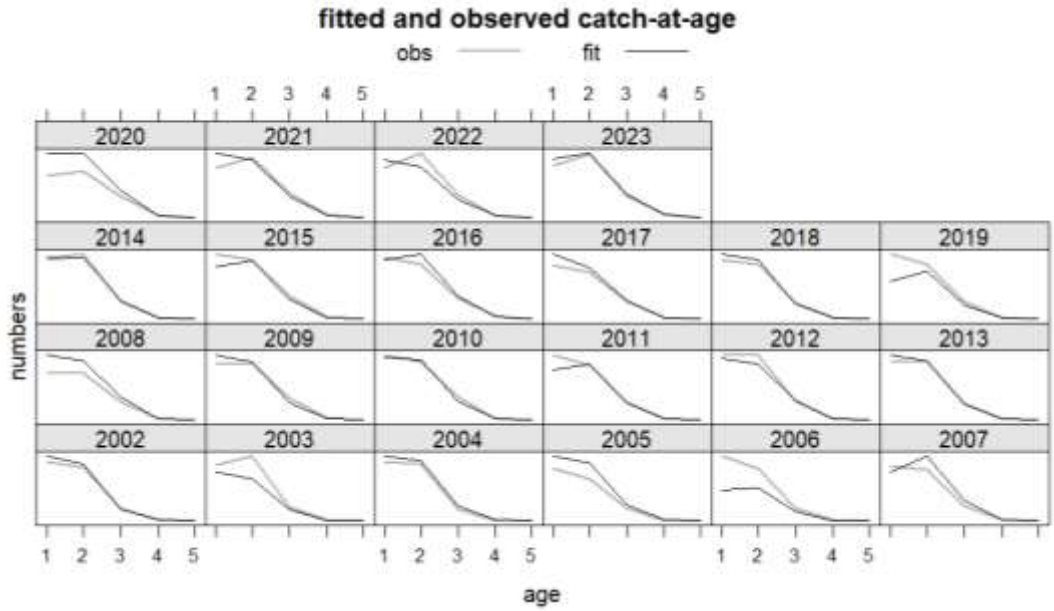
Source: own elaborations

Figure 6.15.3.8. Blue and red shrimp in GSA 1 & 2: Standardized residuals for abundance indices and for catch numbers.



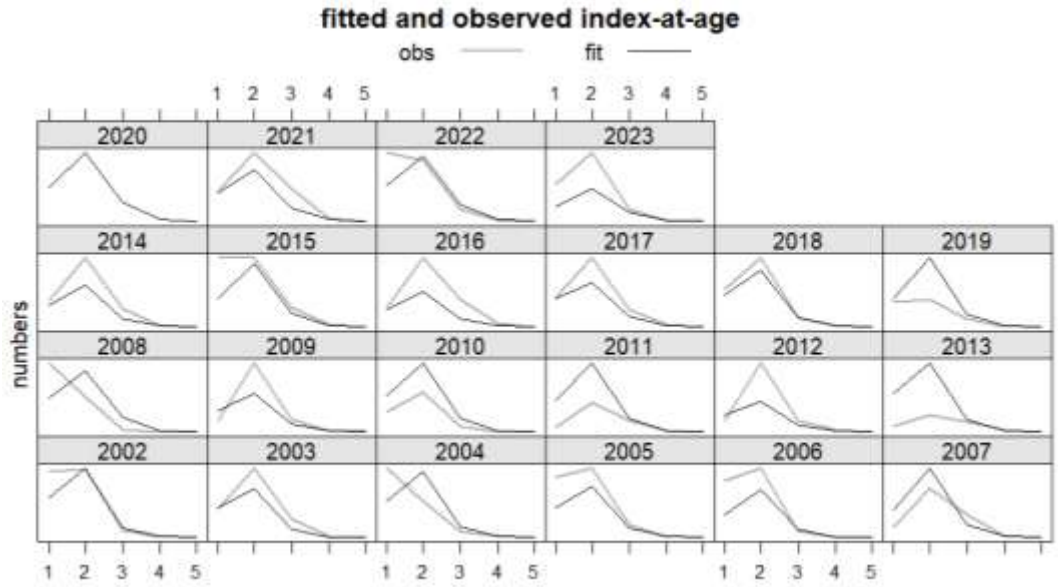
Source: own elaborations

Figure 6.15.3.9. Blue and red shrimp in GSA 1 & 2: Fitted and observed catch at age.



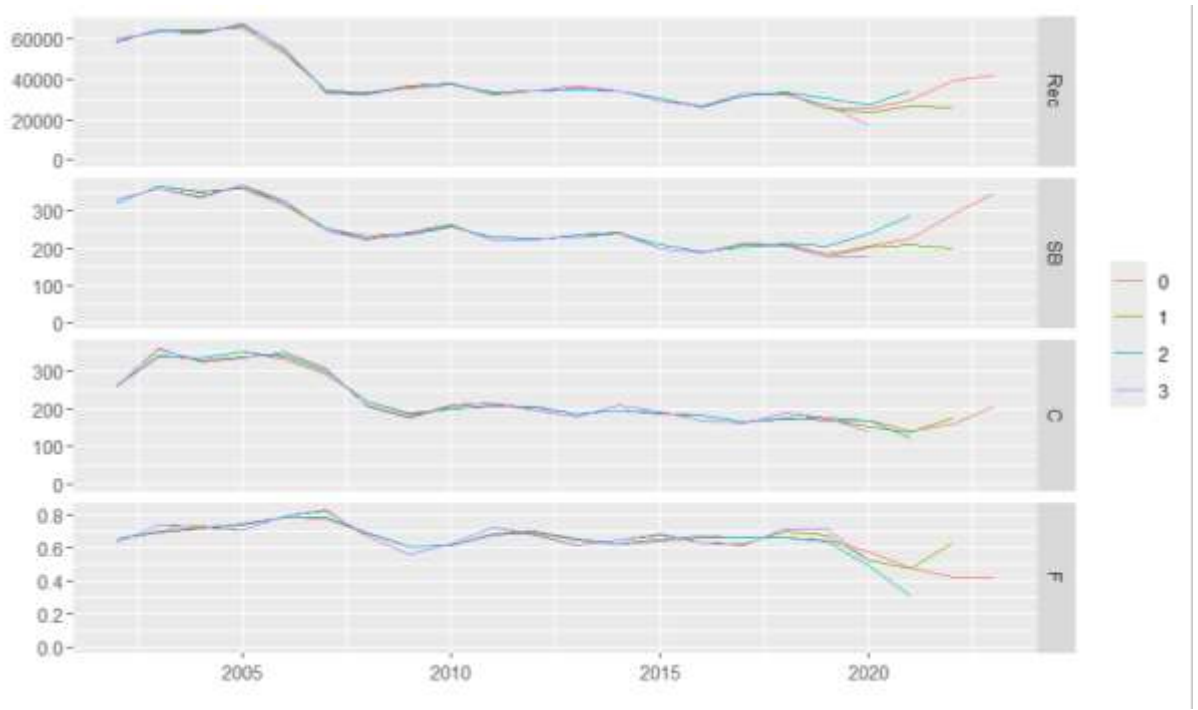
Source: own elaborations

Figure 6.15.3.10. Blue and red shrimp in GSA 1 & 2: Fitted and observed index at age.



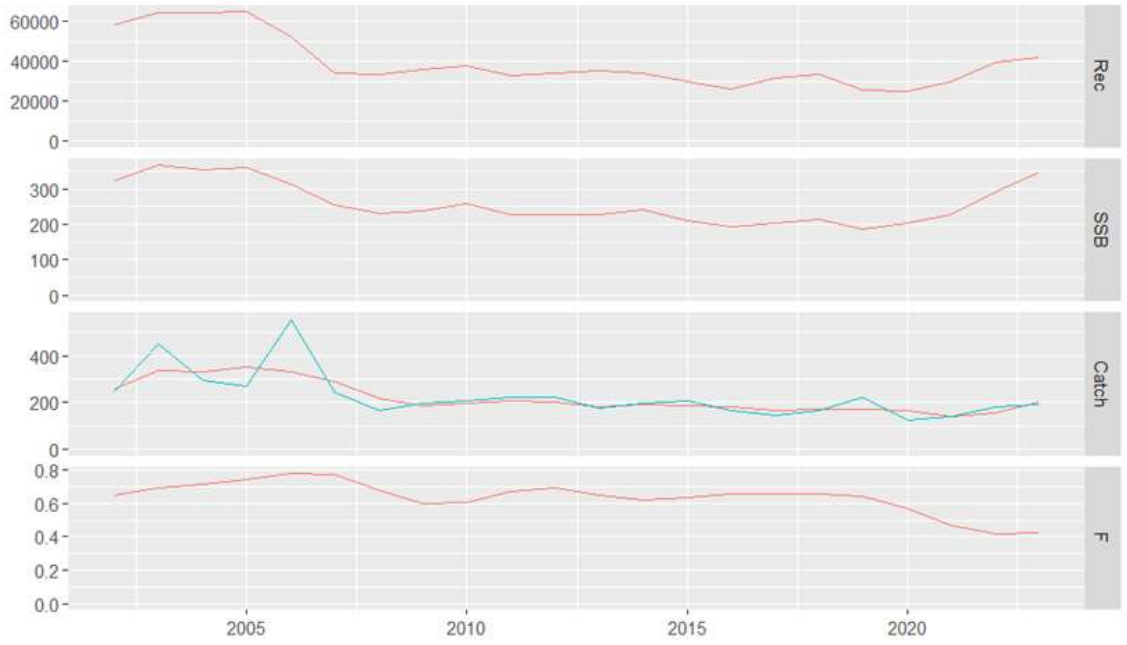
Source: own elaborations

Figure 6.15.3.11. Blue and red shrimp in GSA 1 & 2: Retrospective analysis.



Source: own elaborations

Figure 6.15.3.12. Blue and red shrimp in GSA 1 & 2: Simulations over summary results.



Source: own elaborations

The Mohn' rho for F_{bar1-3}, SSB and recruitment are shown below:

fbar	ssb	rec

0.02	-0.06	-0.17

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

Source: own elaborations

Table 6.15.3.4. Blue and red shrimp in GSA 1 & 2: Stock numbers at age (thousands) as estimated by a4a.

	1	2	3	4	5+
2002	58363	17364	2418	278	27
2003	64246	19185	3719	206	38
2004	64537	20777	3746	267	30
2005	64995	20463	4003	251	32
2006	52168	20446	3801	252	29
2007	34049	16134	3555	216	26
2008	33328	10495	2796	203	22
2009	35726	10713	2063	207	25
2010	37575	12096	2380	197	31
2011	32982	12429	2656	224	32
2012	34127	10630	2494	205	31
2013	35200	10911	2045	180	27
2014	33992	11490	2282	172	27
2015	30156	11219	2487	209	28
2016	26415	9943	2398	212	30
2017	31862	8611	2036	191	30
2018	33383	10333	1760	164	28
2019	25480	10880	2117	143	25
2020	25311	8450	2296	180	23
2021	30024	8512	1952	241	30
2022	39374	10636	2304	280	51

2023	41790	14176	3115	387	75

Source: own elaborations

Table 6.15.3.5. Blue and red shrimp in GSA 1 & 2: a4a summary results and F at age.

	Fbar(1-2)	Recruitment (thousands)	SSB (t)	Catch (t)
2002	0.648	58363	322.4	260.9
2003	0.692	64246	365.6	336.4
2004	0.715	64537	351.6	332.9
2005	0.740	64995	361.6	349.8
2006	0.779	52168	314.0	329.3
2007	0.771	34049	253.9	288.1
2008	0.682	33328	231.3	218.5
2009	0.602	35726	238.9	189.5
2010	0.609	37575	258.2	198.0
2011	0.673	32982	227.8	205.9
2012	0.692	34127	226.2	203.2
2013	0.646	35200	228.9	184.1
2014	0.617	33992	240.4	193.9
2015	0.635	30156	209.5	185.9
2016	0.659	26415	192.0	182.2
2017	0.659	31862	202.0	166.9
2018	0.657	33383	212.3	173.8
2019	0.643	25480	185.7	169.3
2020	0.570	25311	204.8	167.4
2021	0.470	30024	226.0	141.6
2022	0.419	39374	292.1	157.4

2023	0.423	41790	345.0	204.9

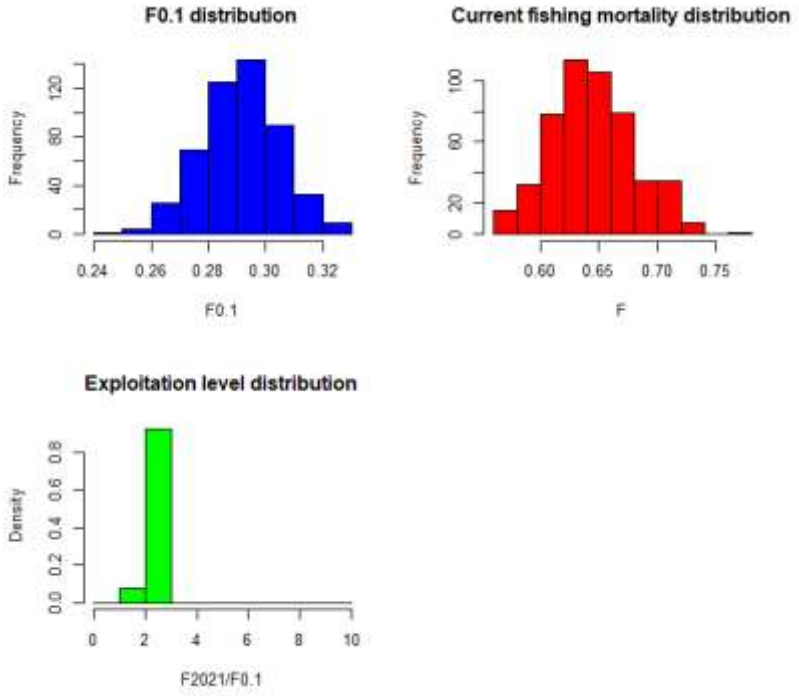
Source: own elaborations

Table 6.15.3.13. Blue and red shrimp in GSA 1 & 2: Fishing mortality at age Blue and red shrimp in GSA 1 & 2

	1	2	3	4	5+
2002	0.287	1.009	2.037	1.885	0.709
2003	0.306	1.077	2.175	2.013	0.757
2004	0.316	1.113	2.249	2.080	0.783
2005	0.327	1.152	2.327	2.153	0.810
2006	0.345	1.213	2.450	2.267	0.853
2007	0.341	1.201	2.425	2.243	0.844
2008	0.302	1.061	2.144	1.983	0.746
2009	0.266	0.937	1.892	1.751	0.659
2010	0.269	0.948	1.914	1.771	0.666
2011	0.298	1.048	2.116	1.957	0.737
2012	0.306	1.078	2.177	2.015	0.758
2013	0.286	1.006	2.032	1.880	0.708
2014	0.273	0.960	1.940	1.795	0.675
2015	0.281	0.990	1.999	1.849	0.696
2016	0.291	1.026	2.071	1.916	0.721
2017	0.291	1.026	2.071	1.916	0.721
2018	0.291	1.024	2.068	1.913	0.720
2019	0.285	1.002	2.023	1.872	0.704
2020	0.252	0.888	1.793	1.659	0.624
2021	0.208	0.732	1.479	1.369	0.515
2022	0.185	0.652	1.317	1.218	0.458

	0.187	0.659	1.330	1.231	0.463

Figure 6.15.3.13. Blue and red shrimp in GSA 1 & 2. Histograms of probability for F0.1, Fcurr and level of exploitation (Fcurr/F01 ratio) values for Blue and red shrimp in GSA 1 & 2.



Source: own elaborations

6.15.4. REFERENCE POINTS

The table below summarises all known reference points for Blue and red shrimp in GSAs 1 and 2 and their technical basis.

The STECF EWG recommended using F0.1 as a proxy for FMSY. The library FLBRP, available in FLR, was used to estimate F0.1 from the stock object resulting from the outputs of the a4a assessment.

The current F (=0.44), which is equal to that of the terminal year (2023), was larger than F0.1 (0.29), which is a proxy of FMSY and is used as the exploitation reference point consistent with high long-term yields. This indicates that blue and red shrimp in GSA 1 & 2 are overexploited.

The group decided to postpone at least for one year the calculation of the biological reference points since this is a new assessment.

Table 6.15.4.1. Blue and red shrimp in GSAs 1&2: Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger\ proxy}$		Not defined	
	$F_{MSY\ proxy}$	0.29	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
Precautionary approach	B_{lim}		Not Defined	
	B_{pa}		Not Defined	
	F_{lim}		Not Defined	
	F_{pa}		Not Defined	
Management plan	MSY $B_{trigger}$		Not Defined	
	B_{lim}		Not Defined	
	F_{MSY}	0.29	$F_{0.1}$ as proxy for F_{MSY}	STECF EWG 24-10
	target range F_{lower}	0.20	Based on regression calculation (see section 2)	STECF EWG 24-10
	target range F_{upper}	0.40	Based on regression calculation but not tested and presumed not precautionary	STECF EWG 24-10

Source: own elaborations

6.15.5. SHORT TERM FORECAST AND CATCH OPTIONS

A deterministic short-term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, based on the results of the A4A stock assessment.

Table 6.15.5.1. Blue and red shrimp in GSA 1 & 2: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}2}$ (2024)	0.437	Fsq = average of the last 3 years
SSB (2024)	328.38	SSB intermediate year from STF output
R_{age0} (2024,2025)	32335.21	Recruitment will be set as geometric mean of the last 14 years
Total catch (2024)	224.64	Catch intermediate year from STF output

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

The analysis, carried out with stf.r FLR script made available to the EWG, shows that fishing at a level equal to F0.1 (=0.29) would increase biomass by 6.1% from 2024 to 2026, while reducing catches by 24.6% from 2023 to 2025.

EWG advises that when the MSY approach is applied, catches in 2025 should be no more than 154.5 tonnes.

Table 6.15.5.2. Blue and red shrimp in GSA 1 & 2: Annual catch scenarios. All weights are in tonnes.

Rationale	Ffactor	Fbar	Recruitment 2024	Fsq 2024	Catch 2023	Catch 2024	Catch 2025	SSB 2024	SSB 2026	SSB Change 2024-2026 (%)	Catch Change 2023-2025 (%)
High long-term yield (F0.1)	0.667	0.29	32335	0.44	204.9	224.6	154.5	328	348	6.1	-24.6
F upper	0.918	0.4	32335	0.44	204.9	224.6	194.9	328	303	-7.8	-4.9
F lower	0.447	0.2	32335	0.44	204.9	224.6	112.4	328	401	22	-45.1
FMSY transition	0.667	0.29	32335	0.44	204.9	224.6	154.5	328	348	6.1	-24.6
Zero catch	0	0	32335	0.44	204.9	224.6	0	328	564	71.6	-100
Status quo	1	0.44	32335	0.44	204.9	224.6	206.6	328	290	-11.6	0.9
Different Scenarios	0.1	0.04	32335	0.44	204.9	224.6	28.9	328	519	57.9	-85.9
	0.2	0.09	32335	0.44	204.9	224.6	55.4	328	479	45.9	-72.9
	0.3	0.13	32335	0.44	204.9	224.6	79.8	328	444	35.3	-61
	0.4	0.18	32335	0.44	204.9	224.6	102.3	328	414	26	-50
	0.5	0.22	32335	0.44	204.9	224.6	123.1	328	387	17.8	-39.9
	0.6	0.26	32335	0.44	204.9	224.6	142.4	328	363	10.5	-30.5
	0.7	0.31	32335	0.44	204.9	224.6	160.2	328	342	4	-21.8
	0.8	0.35	32335	0.44	204.9	224.6	176.8	328	323	-1.8	-13.7
	0.9	0.39	32335	0.44	204.9	224.6	192.2	328	306	-7	-6.2
	1.1	0.48	32335	0.44	204.9	224.6	220.1	328	276	-15.9	7.4
	1.2	0.53	32335	0.44	204.9	224.6	232.7	328	264	-19.7	13.6
	1.3	0.57	32335	0.44	204.9	224.6	244.6	328	252	-23.2	19.4
	1.4	0.61	32335	0.44	204.9	224.6	255.7	328	242	-26.3	24.8
	1.5	0.66	32335	0.44	204.9	224.6	266.2	328	232	-29.3	29.9
	1.6	0.7	32335	0.44	204.9	224.6	276.1	328	224	-31.9	34.8
	1.7	0.74	32335	0.44	204.9	224.6	285.5	328	215	-34.4	39.3
	1.8	0.79	32335	0.44	204.9	224.6	294.4	328	208	-36.7	43.7
	1.9	0.83	32335	0.44	204.9	224.6	302.8	328	201	-38.8	47.8
	2	0.88	32335	0.44	204.9	224.6	310.8	328	195	-40.8	51.7

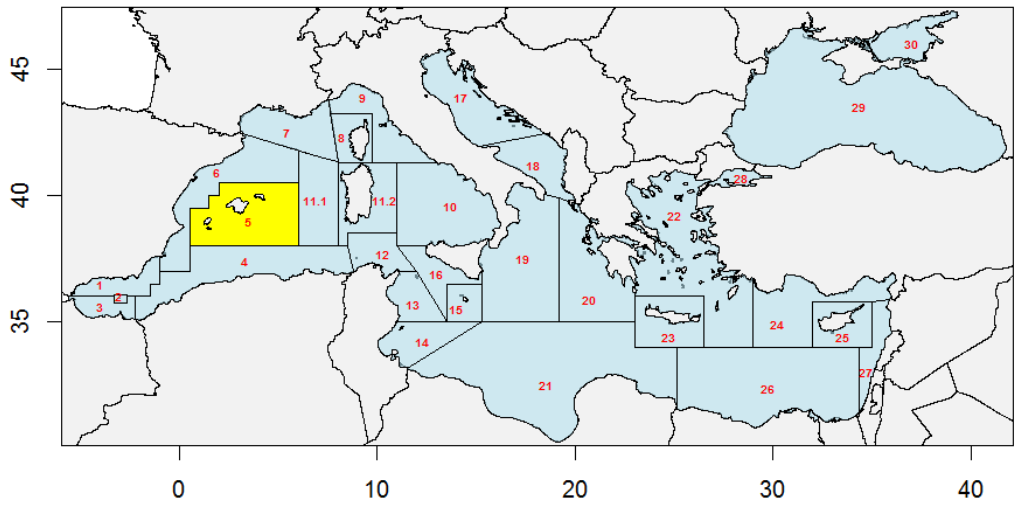
Source: own elaborations

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 **Figure 6.16.1.1.** Geographical localization of GSA 5.

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.

Source: own elaborations

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

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

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

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

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 24-10 through the Data Call. Data are available for the period 2002-2023 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, generally lower than 0.3 % of the total catch, so they were considered negligible and were not included in the assessment.

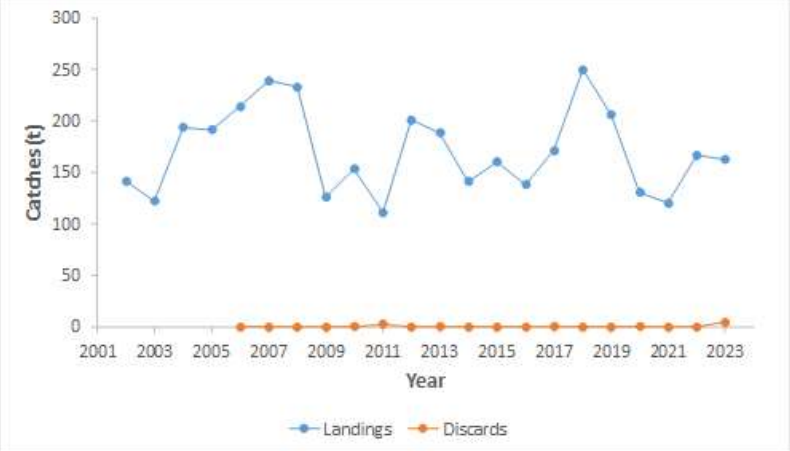
Table 6.16.2.2.1. Blue and red shrimp in GSA 5. Reported landings (t) and discards (t) from the DCF Data by all OTB metiers (2002-2023).

Year	SPAIN GSA5	Total landings	Total Effort * (Fishing Days)
2002	141.5	141.5	
2003	122.0	122.0	
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	120.1	120.1	6439
2022	166.7	166.7	
2023	162.6	162.6	

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

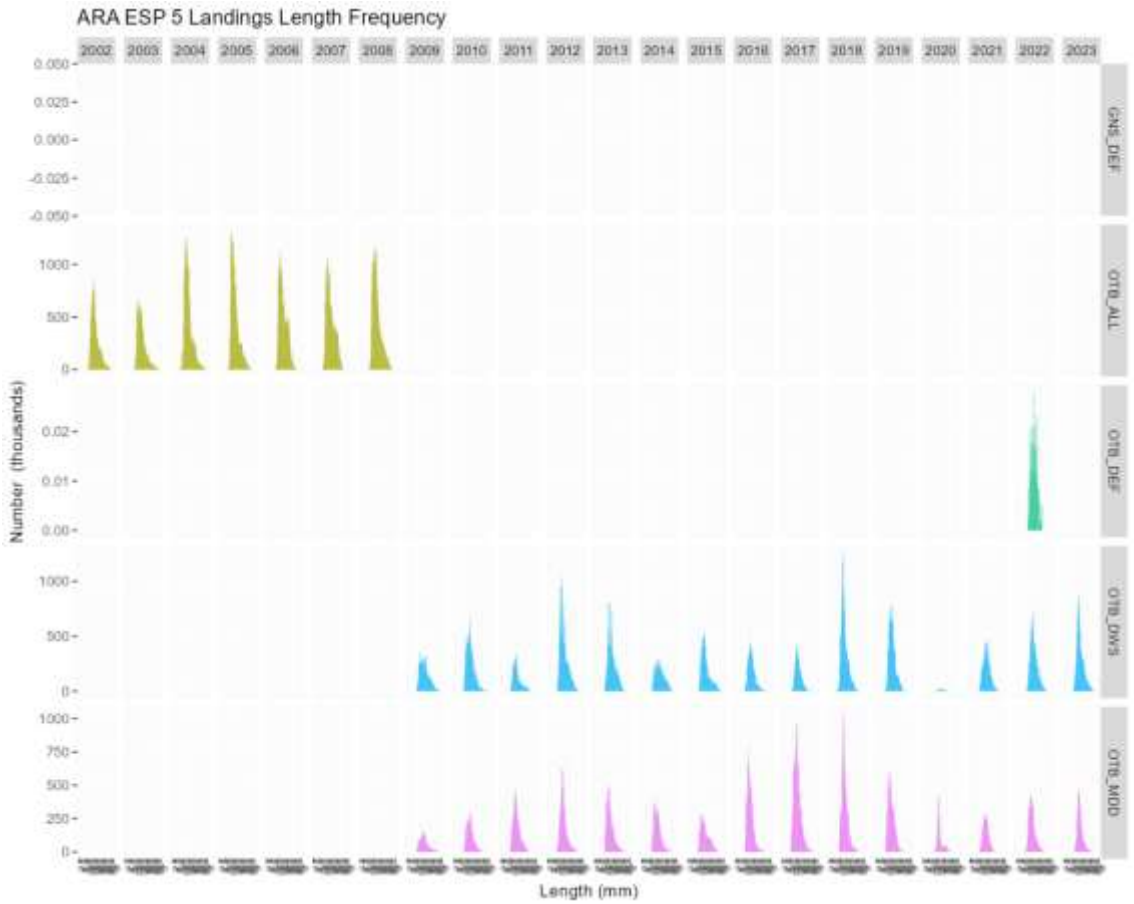
Figure 6.16.2.2.1. Blue and red shrimp in GSA 5. Reported landings (t) and discards (t) from the DCF Data by all OTB metiers (2002-2023).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

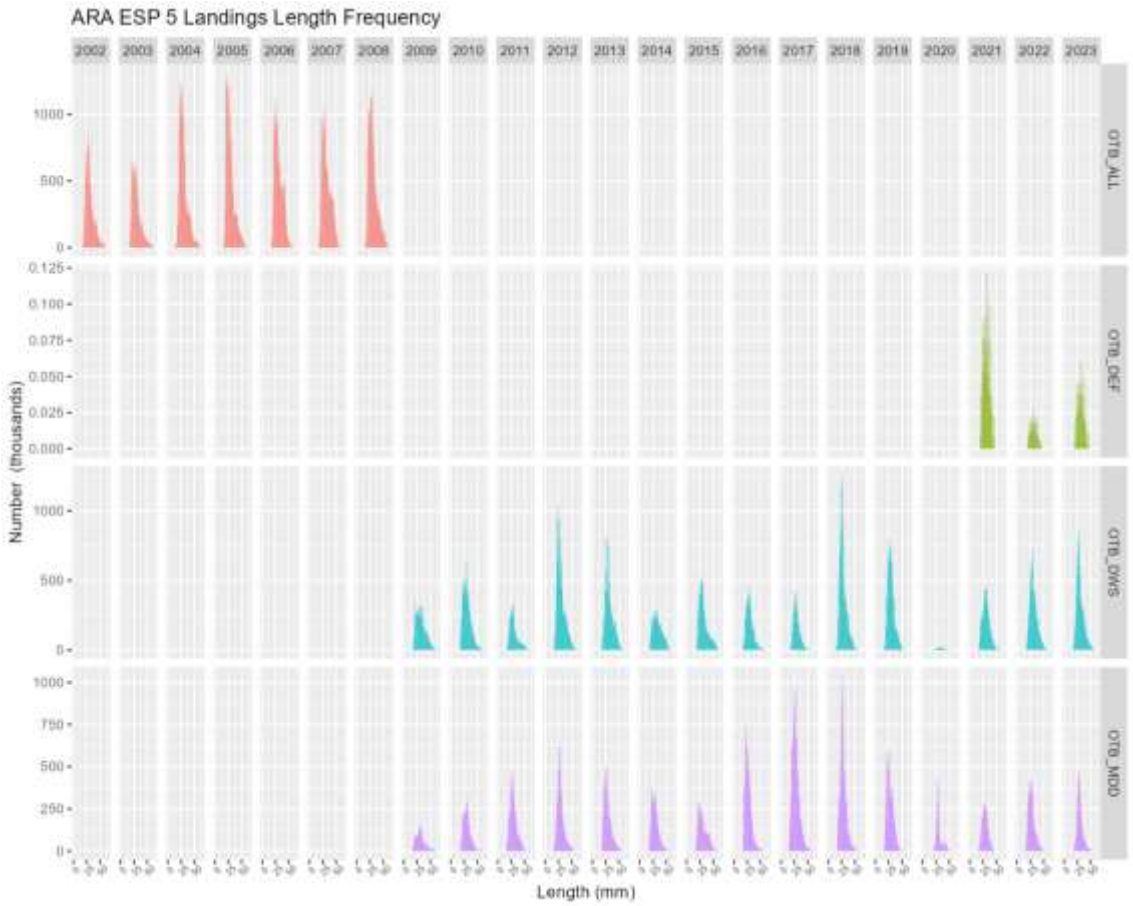
Length frequency distributions per gear, metier and year of landings from the DCF database (2002-2023) before reconstructions are presented in Figure 6.16.2.2.2. Length structure by gear, fishery and year (2002-2023) after reconstruction is shown in Figure 6.16.2.2.3. The percentage of total landings 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 (2002-2023).



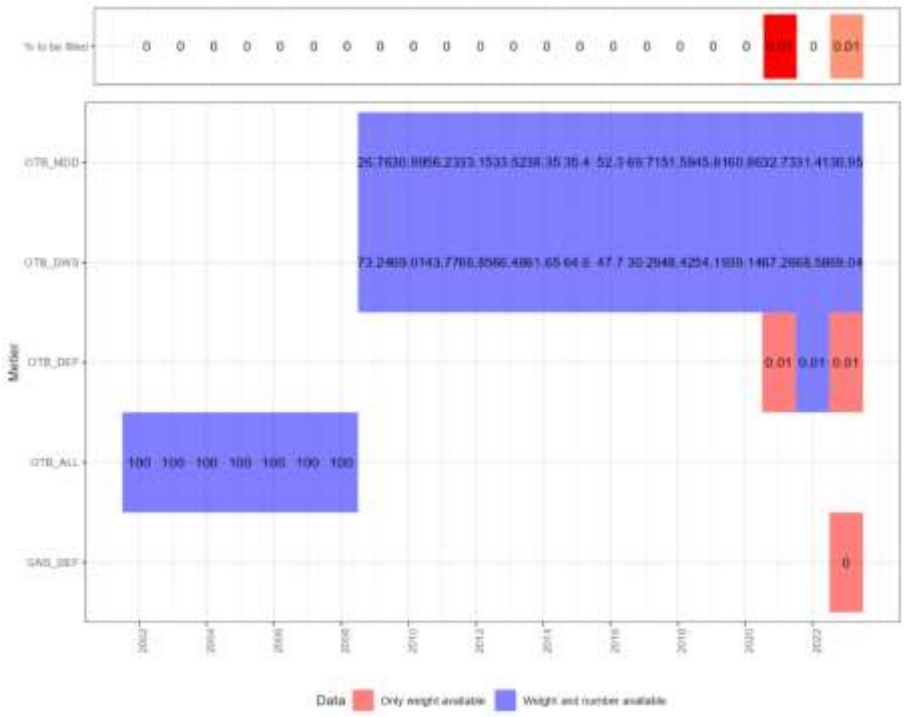
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.16.2.2.3. Blue and red shrimp in GSA 5. Length frequency distribution after reconstruction by fishing gear and fishery (2002-2023).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (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.



Source: own elaborations

6.12.2.2 EFFORT

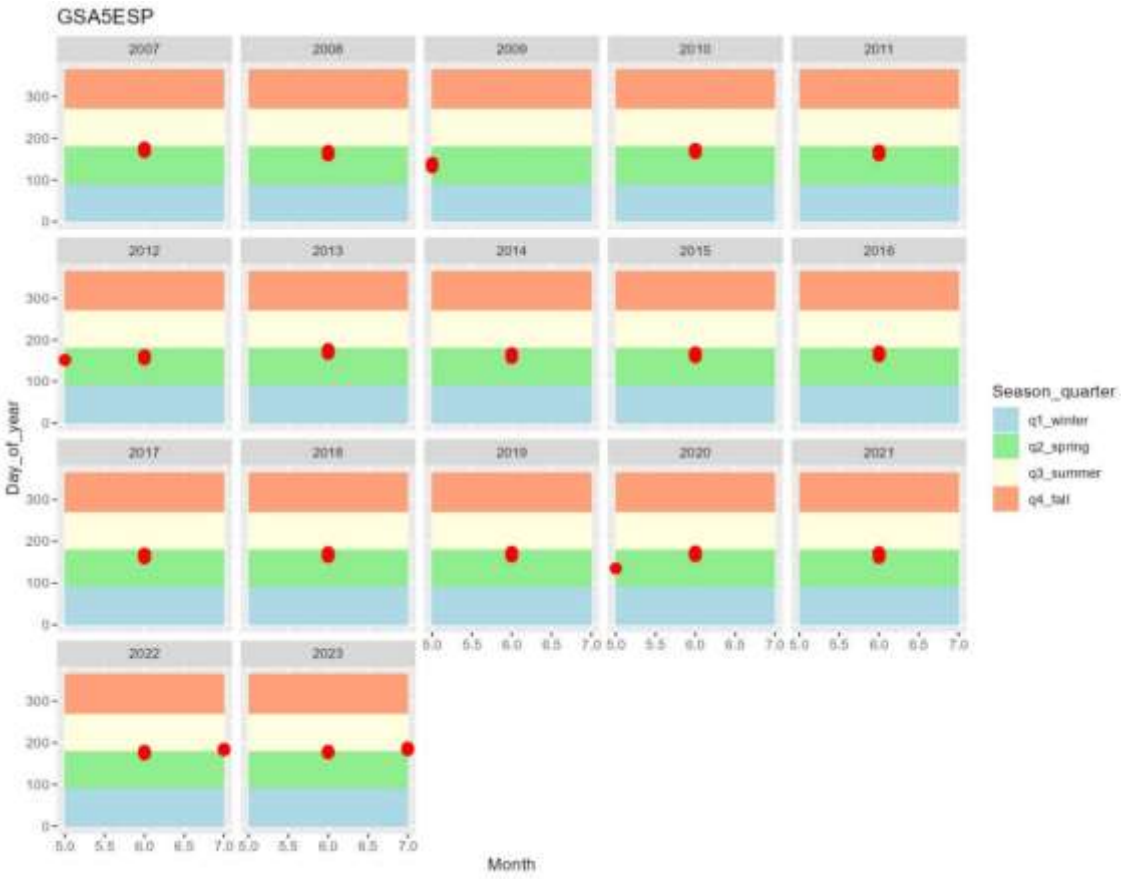
Fishing effort data for 2022 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

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).

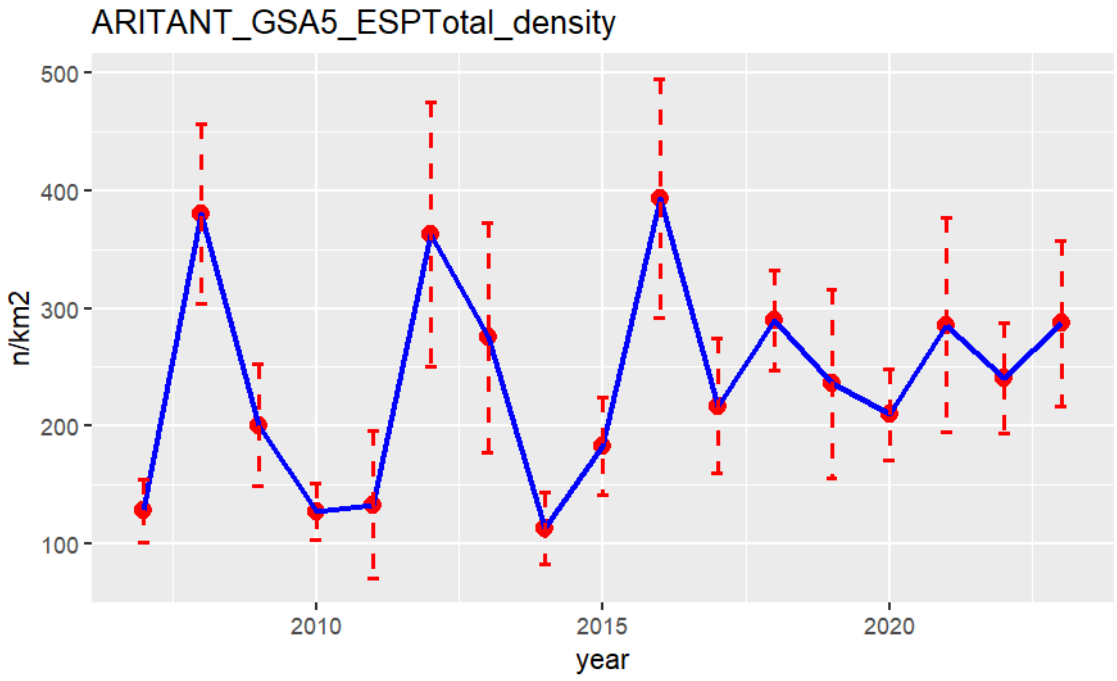
Figure 6.16.2.3.1 Year period when the hauls of MEDITS survey are being conducted in GSA 5.



Source: own elaborations

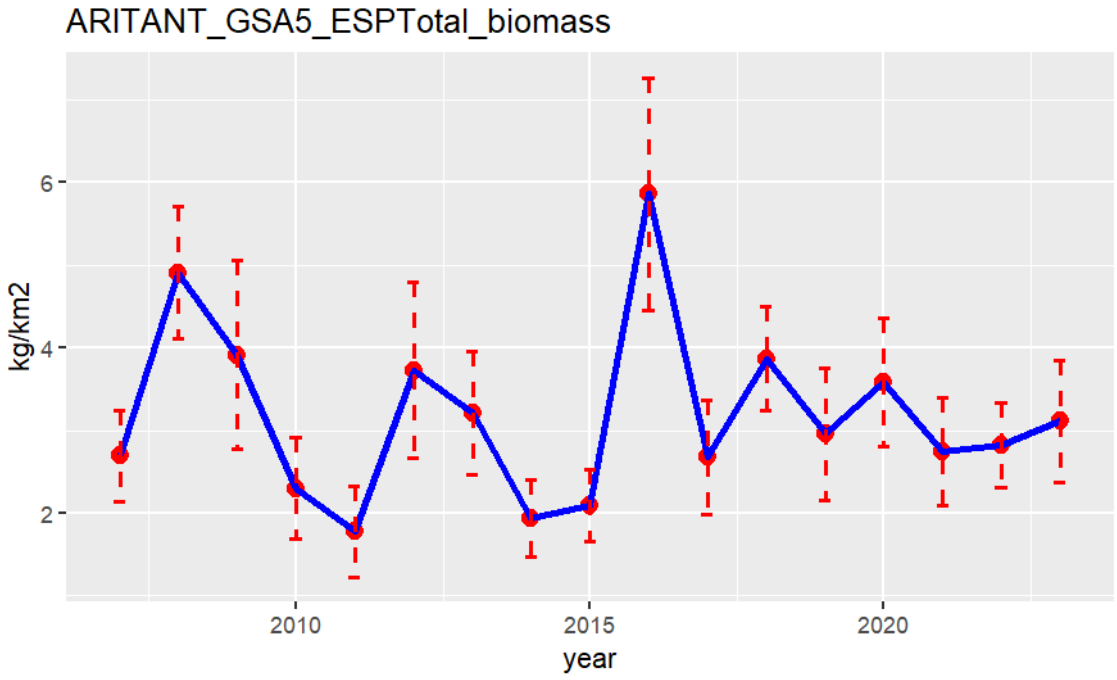
The time series of abundance and biomass indices of blue and red shrimp from MEDITS bottom trawl survey in GSA5 are shown in Figure 6.16.2.3.2 and 6.16.2.3.3. Large variations and no clearly discernible trends over the available period can be observed. Both estimated abundance and biomass indices show 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/km2) as reported by DCF (2007-2023).



Source: own elaborations

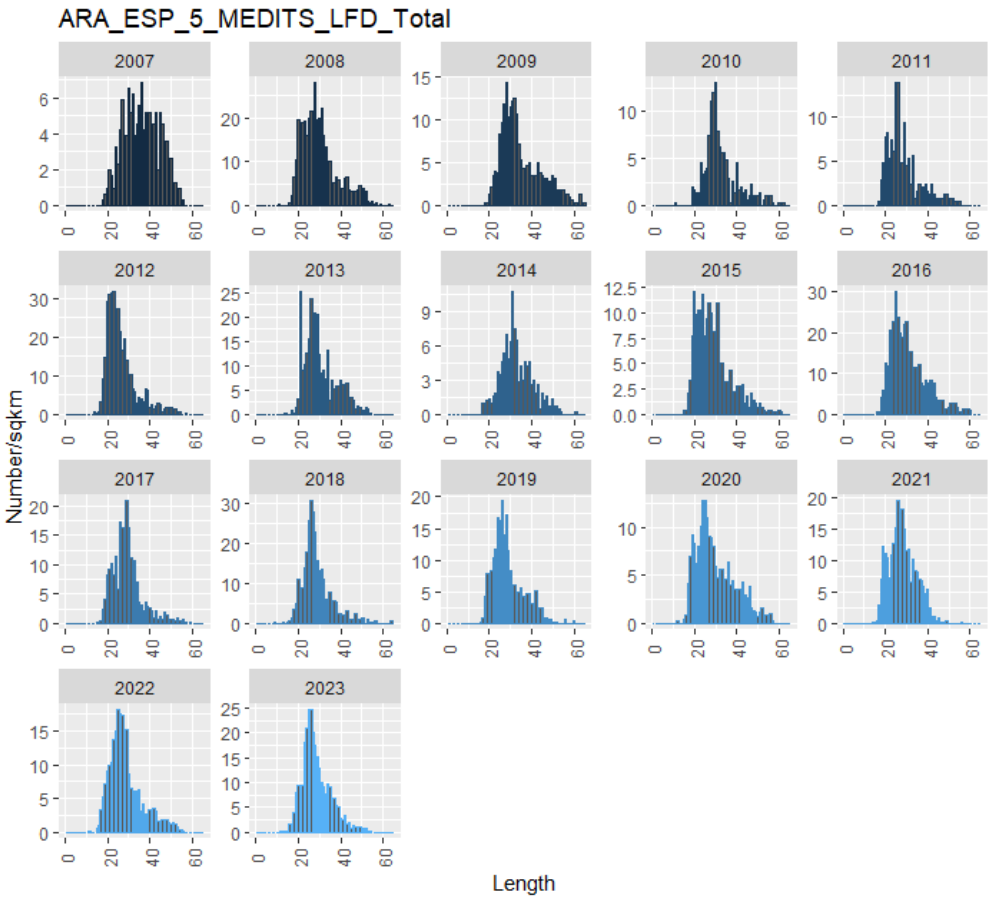
Figure 6.16.2.3.3 Blue and red shrimp in GSA 5. MEDITS survey biomass index (kg/km^2) as reported by DCF (2007-2023).



Source: own elaborations

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).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

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	3295.0	645.9	111.7	2.6
2003	7135.0	2623.3	562.3	127.3	12.1
2004	12279.0	4113.7	719.9	158.2	18.0
2005	12844.0	3933.6	908.0	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	11791.0	5246.0	1358.0	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	13019.0	4494.3	785.0	49.6	0.1
2013	10214.0	4735.7	849.0	27.6	0.1
2014	6135.4	3717.3	874.6	24.3	1.0
2015	7662.8	3591.0	970.2	108.9	0.1
2016	10967.0	3035.7	314.0	25.2	2.4
2017	13410.0	4015.2	335.8	31.8	0.5
2018	19872.0	5530.5	574.3	15.3	1.9
2019	14682.0	5346.4	374.8	7.9	0.1
2020	7463.6	2775.9	444.9	8.6	0.5
2021	6688.1	3837.0	201.3	4.2	0.1
2022	9692.9	4461.3	522.5	18.5	0.3

2023	9787.3	4030.9	506.0	20.6	0.1

Source: own elaborations

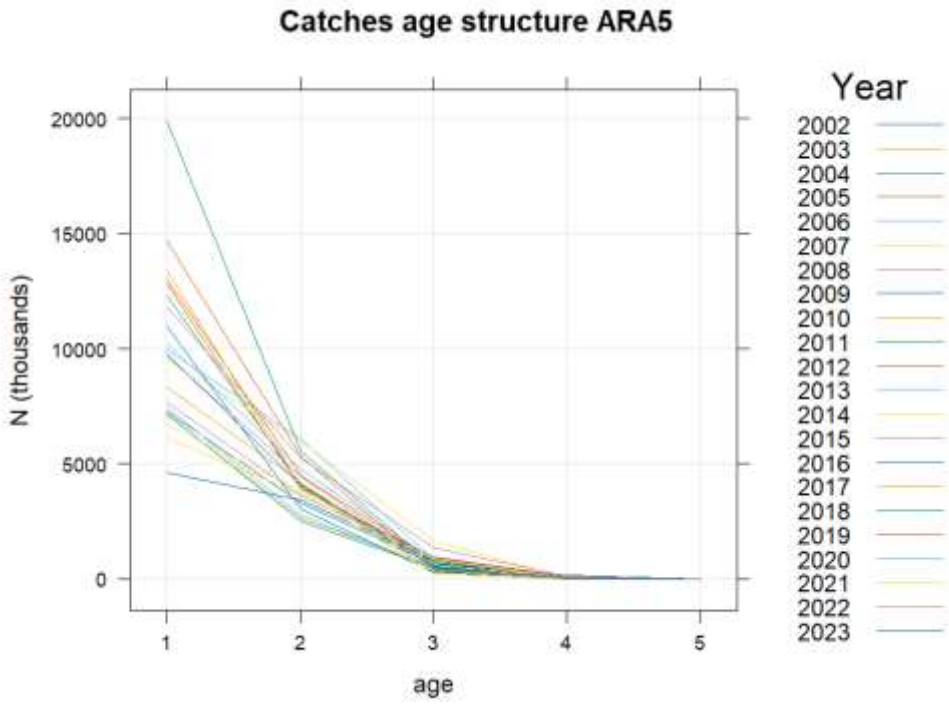
Table 6.16.3.2. Blue and red shrimp in GSA 5: Catch-at-age weights (kg) per year from the commercial fleet used in the assessment.

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	0.050	0.064
2007	0.007	0.018	0.033	0.049	0.070
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	0.050	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

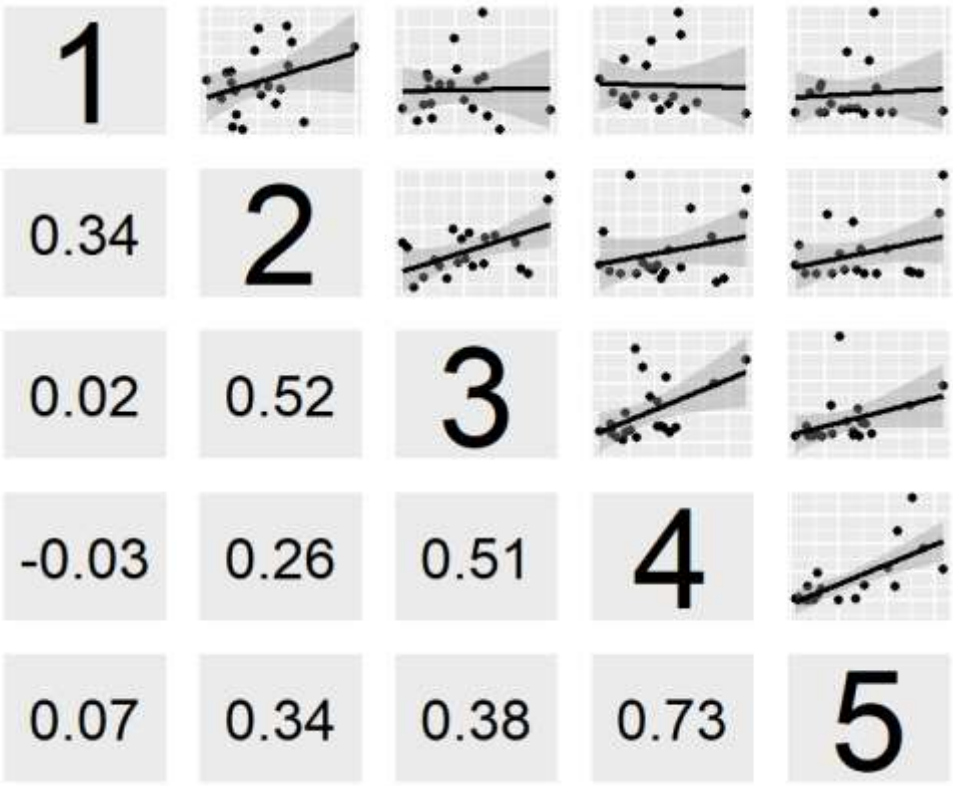
Source: own elaborations

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.



Source: own elaborations

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.



Source: own elaborations

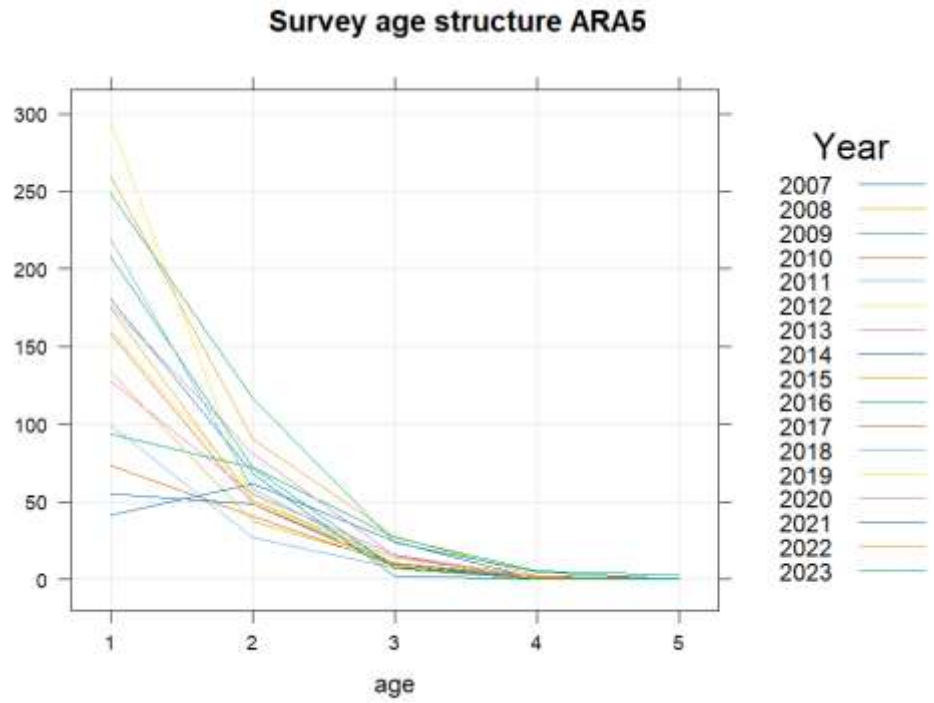
Table 6.16.3.3. Blue and red shrimp in GSA 5: Catch-at-age number (thousands) per year from MEDITS survey used in the assessment.

Year	1	2	3	4	5
2007	41.401	61.612	24.449	0.326	0.114
2008	259.464	90.468	27.367	2.246	0.321
2009	93.622	71.777	27.150	5.617	2.497
2010	73.376	40.619	9.500	2.293	0.655
2011	99.370	26.989	6.952	0.409	0.114
2012	295.055	50.275	10.714	0.412	0.114
2013	175.854	81.101	14.793	0.115	0.114
2014	54.732	48.391	9.631	0.115	0.235
2015	133.359	37.156	10.258	1.824	0.228
2016	248.785	116.581	23.436	4.807	0.114

2017	158.511	48.722	8.036	1.457	0.114
2018	219.434	58.153	9.740	1.432	0.573
2019	160.070	54.766	6.262	1.043	0.114
2020	127.436	55.241	15.701	1.526	0.114
2021	180.810	68.033	1.836	0.229	0.114
2022	174.881	50.724	13.795	0.637	0.114
2023	207.862	72.062	7.373	0.115	0.114

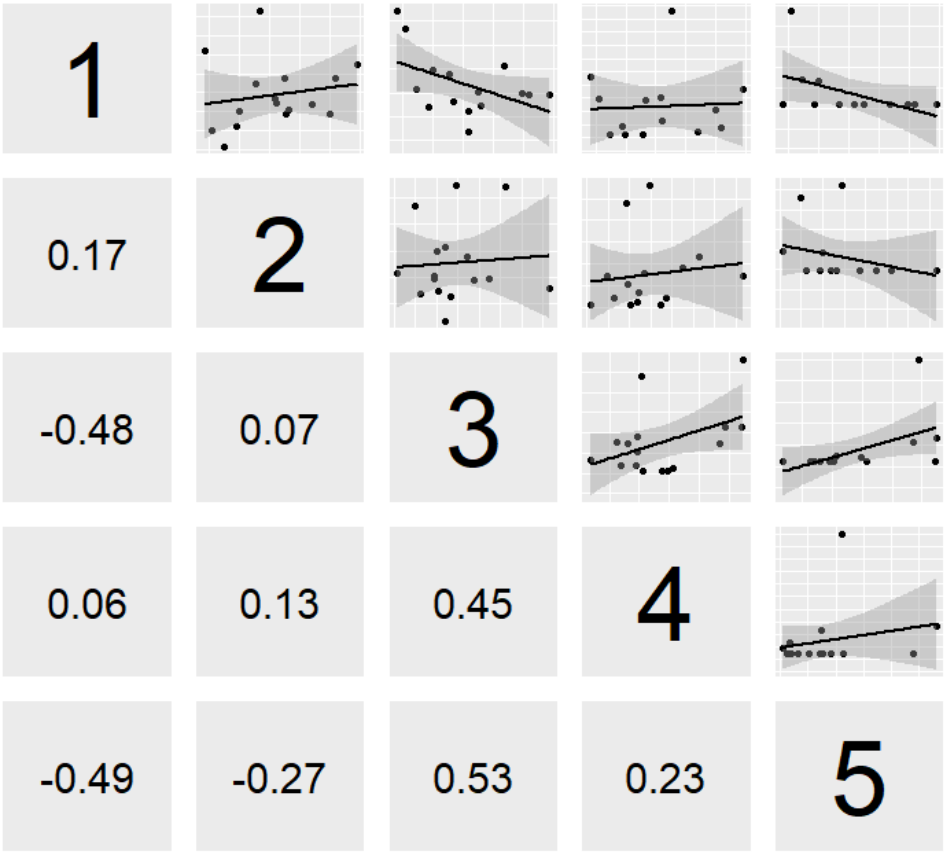
Source: own elaborations

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.



Source: own elaborations

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.



Source: own elaborations

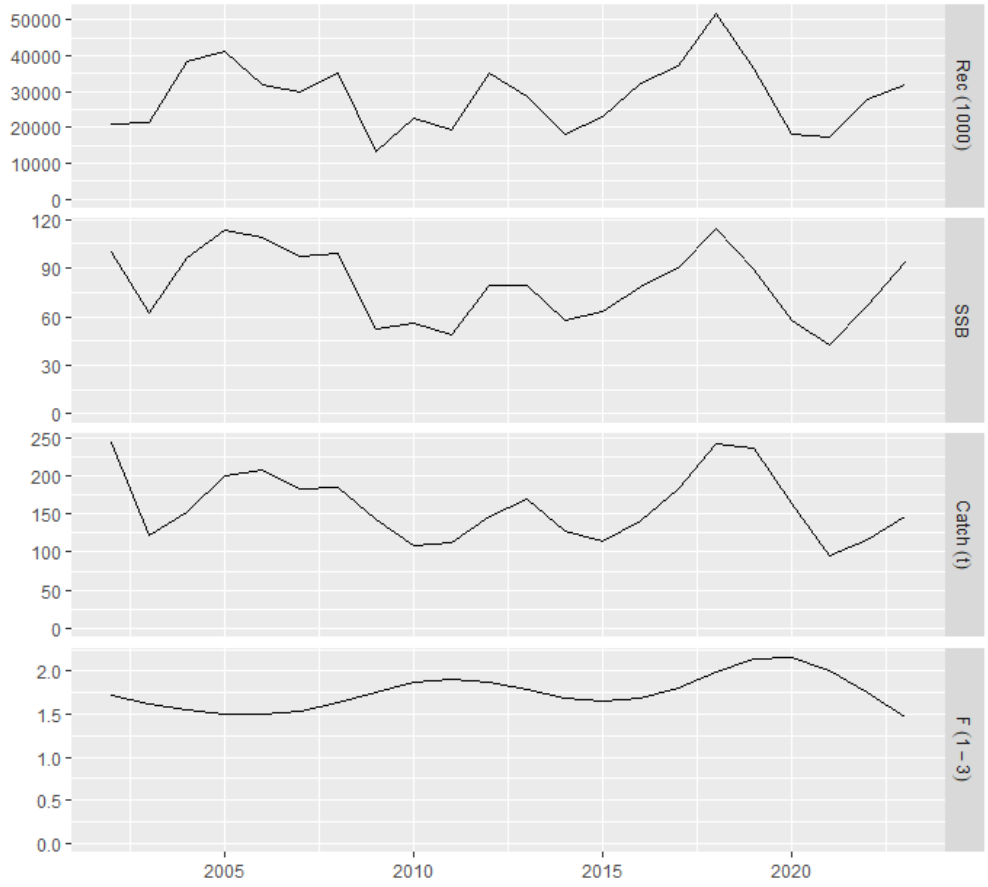
Assessment results

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. To verify the selected model, we studied how changing k affected the performance of the model, but no k seemed to show the best statistical support. The group decided to keep k=7 for the model because results showed the same trend in fishing mortality (F), recruitment (Rec), catches (Catch) and spawning stock biomass (SSB) expected for this stock was obtained as in previous years and all diagnostics were considered acceptable. 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)

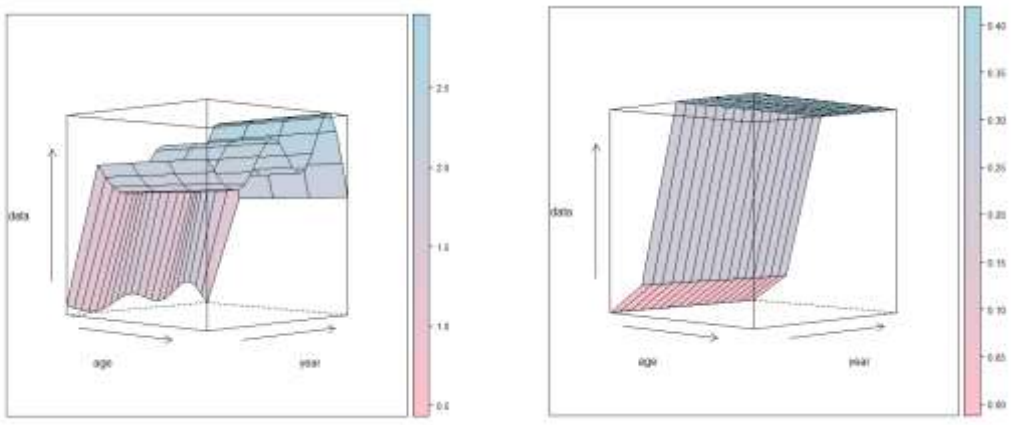
The general results of the a4a assessment, including the summary of the fitting of the model for all the parameters (Rec, SSB, Catch and F), the estimated fishing mortality and catchability for the survey, the residuals patterns, the fit vs. observed catch-at-age, the retrospective analysis and the performed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



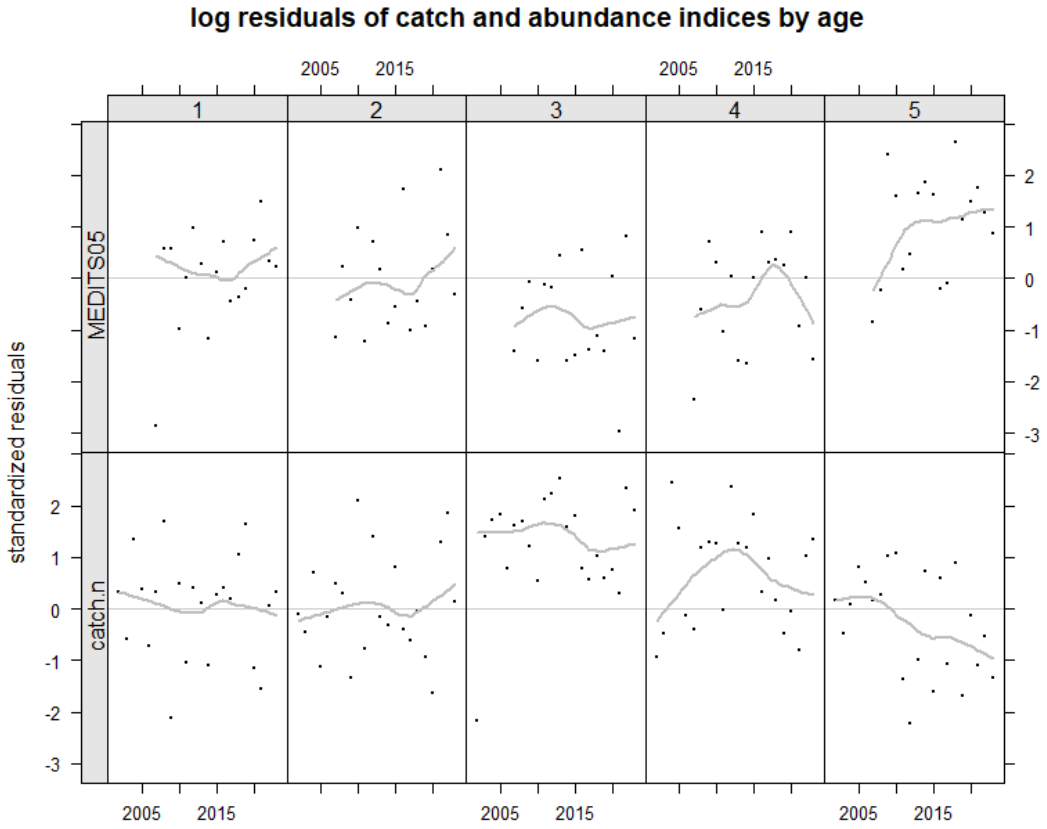
Source: own elaborations

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.

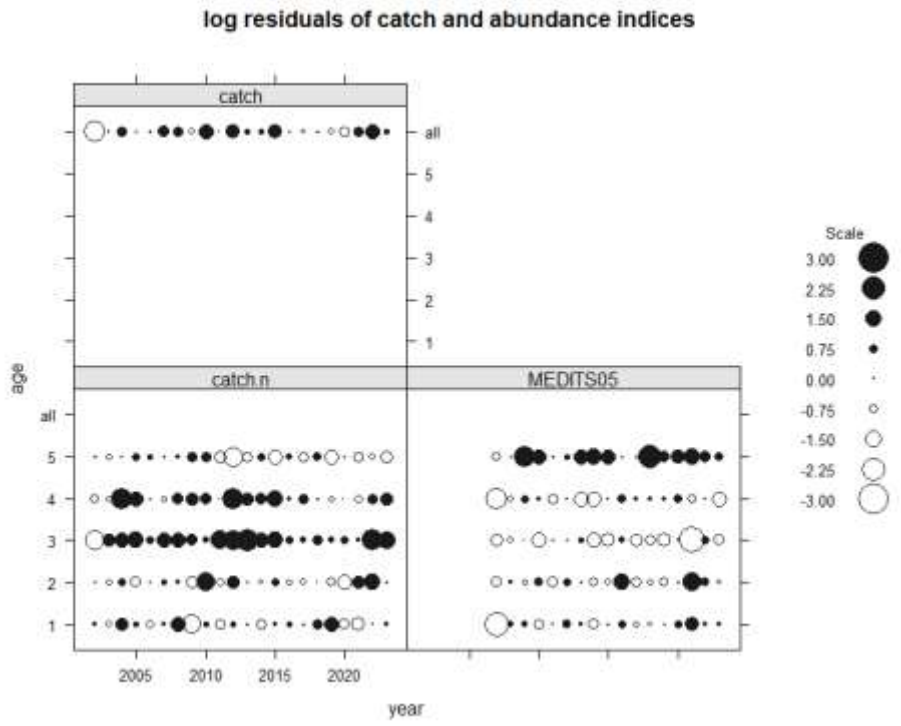


Source: own elaborations

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

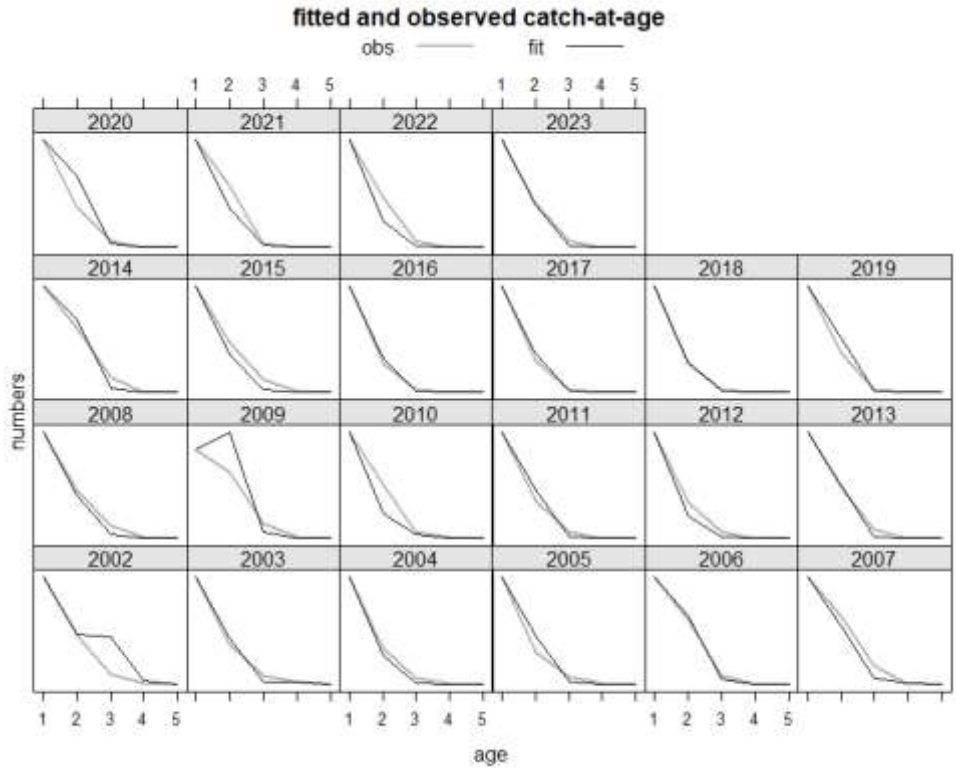


Source: own elaborations



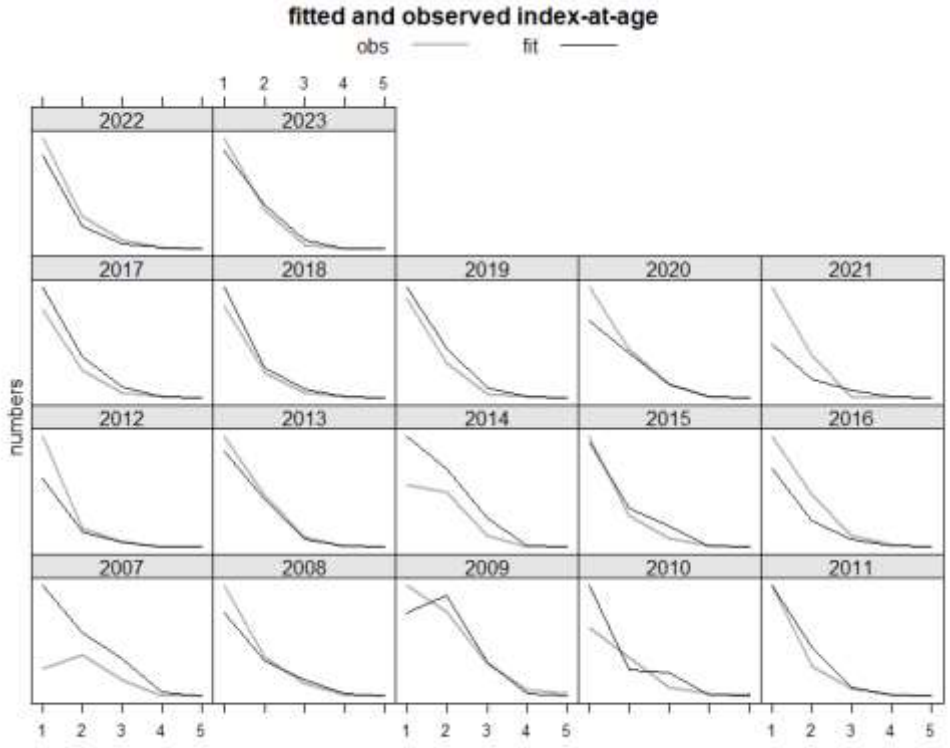
Source: own elaborations

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



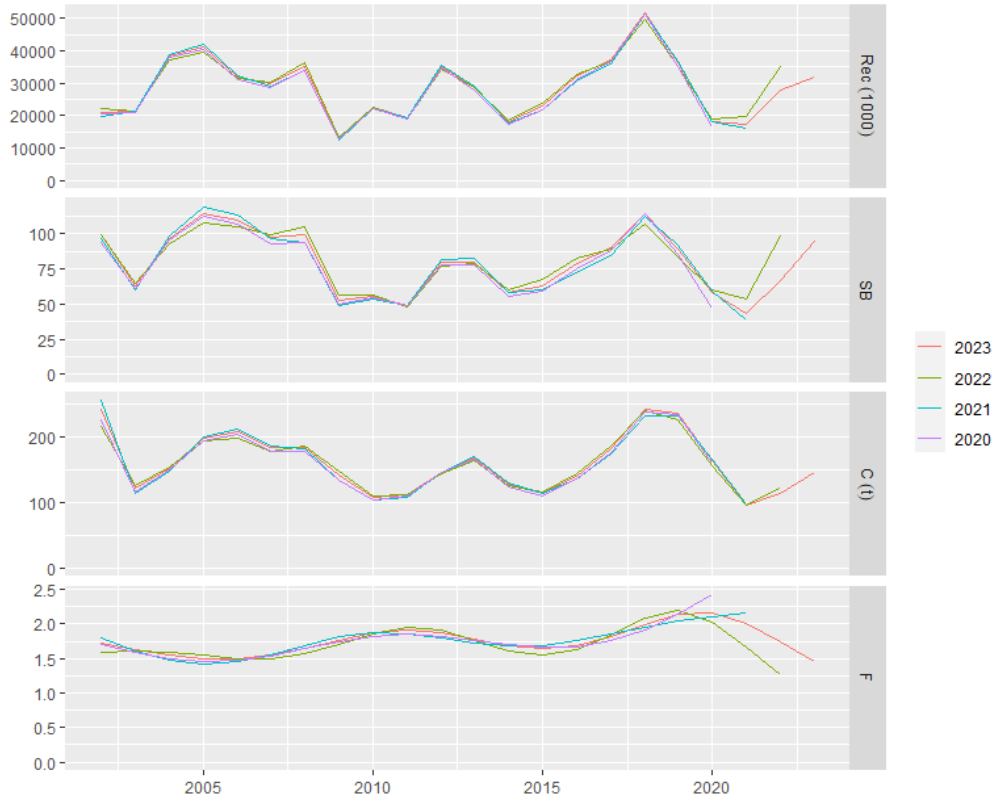
Source: own elaborations

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



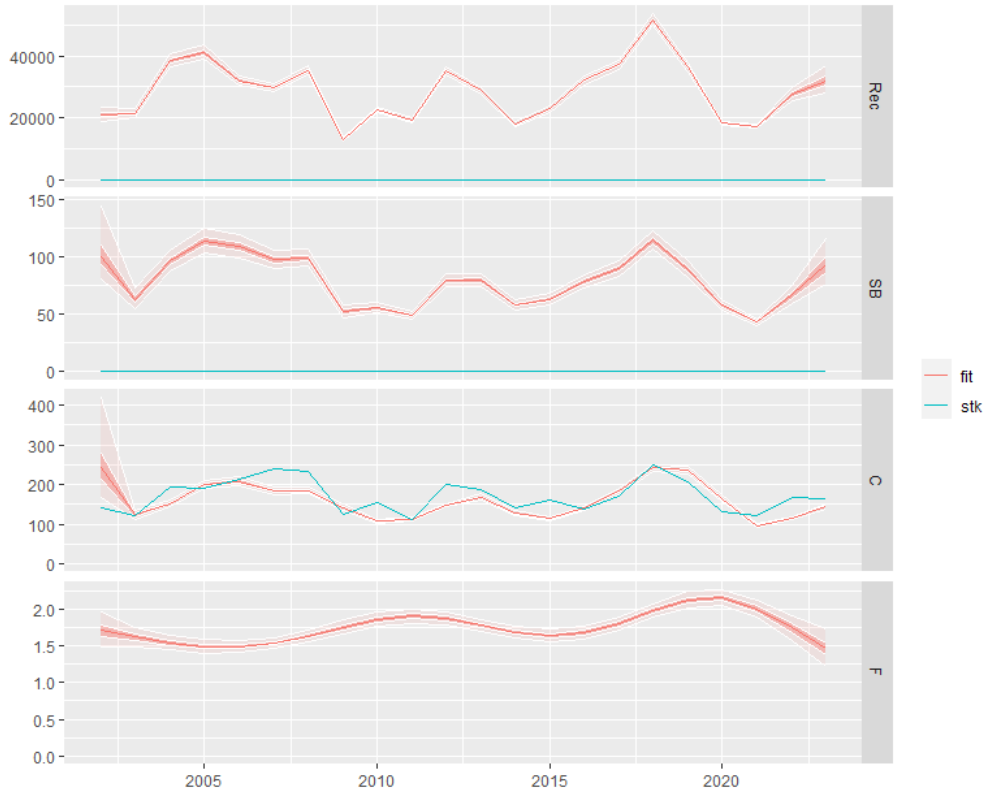
Source: own elaborations

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



Source: own elaborations

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



Source: own elaborations

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

fbar	ssb	rec
-0.02866373	0.06423617	0.03470405

Source: own elaborations

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	21017.0	4655.9	4228.0	360.4	2.9
2003	21481.0	4290.7	266.6	269.5	24.5
2004	38385.0	4555.7	277.9	19.2	22.4
2005	41143.0	8402.5	326.8	22.2	3.6

2006	32026.0	9183.2	641.7	27.8	2.3
2007	29813.0	7159.7	704.9	54.8	2.7
2008	35264.0	6536.2	516.1	56.6	4.9
2009	13078.0	7436.2	415.5	36.5	4.6
2010	22656.0	2625.2	403.3	25.1	2.6
2011	19186.0	4357.1	124.0	21.2	1.5
2012	35230.0	3623.4	194.1	6.1	1.2
2013	28673.0	6750.0	169.1	10.1	0.4
2014	17931.0	5701.5	355.1	9.9	0.6
2015	22838.0	3703.8	339.1	23.5	0.7
2016	32116.0	4801.2	233.1	23.8	1.8
2017	37241.0	6645.9	287.2	15.5	1.8
2018	51605.0	7327.0	337.8	16.2	1.0
2019	36251.0	9454.6	295.9	15.2	0.8
2020	18294.0	6255.5	314.7	11.0	0.6
2021	17216.0	3127.6	202.1	11.3	0.4
2022	27630.0	3122.5	122.3	8.8	0.5
2023	31959.0	5576.2	172.3	7.5	0.6

Source: own elaborations

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	21017	99.6	242.7	1.72
2003	21481	62.6	121.6	1.62

2004	38385	96.6	152.2	1.55
2005	41143	113.9	198.8	1.50
2006	32026	109.2	208.0	1.49
2007	29813	97.5	183.2	1.54
2008	35264	99.4	184.7	1.64
2009	13078	52.5	142.4	1.76
2010	22656	55.7	107.7	1.87
2011	19186	49.2	112.4	1.91
2012	35230	79.5	147.0	1.88
2013	28673	79.8	168.6	1.78
2014	17931	58.1	127.4	1.69
2015	22838	63.0	114.2	1.65
2016	32116	78.7	140.7	1.69
2017	37241	90.1	182.5	1.81
2018	51605	114.5	241.4	1.99
2019	36251	89.2	236.5	2.14
2020	18294	57.8	164.0	2.16
2021	17216	43.0	96.0	2.01
2022	27630	67.0	115.1	1.75
2023	31959	94.1	145.9	1.46

Source: own elaborations

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

Year	1	2	3	4	5

2002	0.69	2.23	2.23	2.23	2.23
2003	0.65	2.11	2.11	2.11	2.11
2004	0.62	2.01	2.01	2.01	2.01
2005	0.60	1.94	1.94	1.94	1.94
2006	0.60	1.94	1.94	1.94	1.94
2007	0.62	2.00	2.00	2.00	2.00
2008	0.66	2.13	2.13	2.13	2.13
2009	0.71	2.29	2.29	2.29	2.29
2010	0.75	2.43	2.43	2.43	2.43
2011	0.77	2.48	2.48	2.48	2.48
2012	0.76	2.44	2.44	2.44	2.44
2013	0.72	2.32	2.32	2.32	2.32
2014	0.68	2.20	2.20	2.20	2.20
2015	0.66	2.14	2.14	2.14	2.14
2016	0.68	2.19	2.19	2.19	2.19
2017	0.73	2.35	2.35	2.35	2.35
2018	0.80	2.58	2.58	2.58	2.58
2019	0.86	2.78	2.78	2.78	2.78
2020	0.87	2.81	2.81	2.81	2.81
2021	0.81	2.61	2.61	2.61	2.61
2022	0.70	2.27	2.27	2.27	2.27
2023	0.59	1.90	1.90	1.90	1.90

Source: own elaborations

The model is fitted with assumptions of flat selection at age 2 and above in the catch and flat q age 3 and above in the survey. Commercial catches showed better consistency than MEDITS survey index. However, the results of the assessment are a bit unstable, especially in terms of stability of residuals (both for commercial catches, especially in age class 3, as well as for MEDITS survey, in age classes 3 and 5). The retrospective analysis showed acceptable result

and also, all the diagnostics. Therefore, based on the a4a results, the main conclusions are that the stock of Blue and Red Shrimp in GSA5 shows a very variable pattern for all the variables, with no clear trends, along the entire time series. After a fluctuating trend since the beginning of the time series until 2014, catches, Rec and SSB showed a progressive increasing trend from 2014-2015 to 2018, where they reached a maximum peak. However, since then, they plummeted until 2021 for all of them, but since 2022 an increase in catches, Rec and SSB is observed. Fbar (1-3) shows a fluctuating trend along all the time series (between 1.46-2.11), but with a noticeable decrease since 2020 acquiring a value of 1.46 in 2023.

6.16.4 REFERENCE POINTS

The STECF EWG recommended to use $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the assessment.

Values of $F_{0.1}$ calculated by FLBRP package on the a4a assessment results is equal to 0.33. Current F values (2023), as calculated by model a4a, is 1.46 indicating that the stock is over-exploited (Fcurr/ $F_{0.1}$=4.406). SSB in 2023 is estimated to be above Blim, but is still below Bpa.

Estimation of biomass reference points

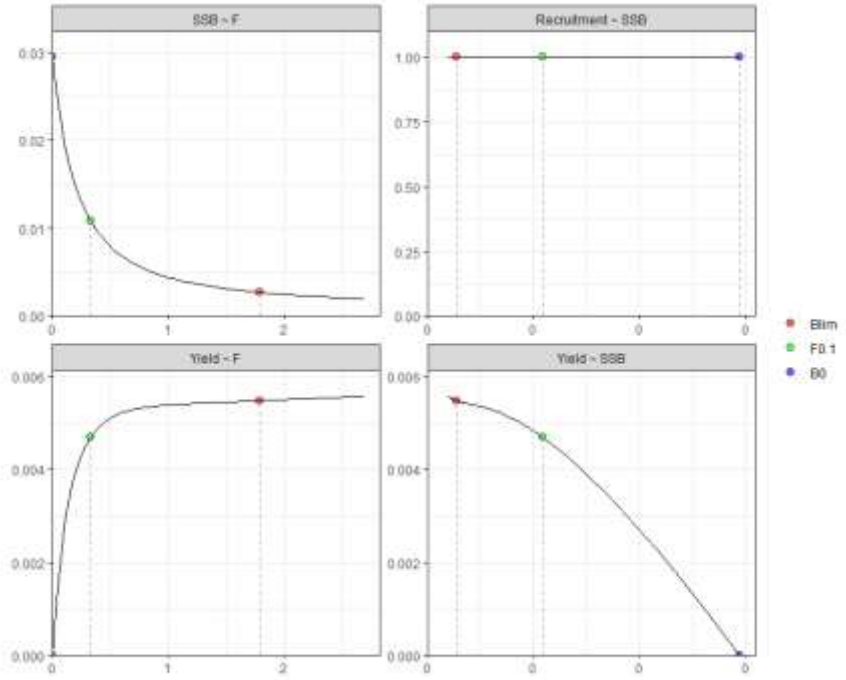
An exploratory per-recruit analysis was performed using the results of the a4a assessment. The per-recruit reference points of interest were computed from the stock object and are summarized in table 6.16.4.1 and figure 6.16.4.1.

Table 6.16.4.1 Blue and red shrimp in GSA 5. Per-recruit reference points.

EWG	$F_{0.1}$	B_{tgt}	B_{lim}	F_{lim}	Y_{eq}
EW 24-10	0.332	0.011	0.003	1.794	0.005

Source: own elaborations

Shows the trajectories of the assessment outputs relative to the per-recruit reference points B_{lim}, $F_{0.1}$ and B_0.



Source: own elaborations

Figure 6.16.4.1. Blue and red shrimp in GSA 5. Per-recruit reference points.

Initially four recruitment functions were explored, using the function ssrTBM in the package FLSRTMB:

1. Geometric Mean (model=geomean)
2. Hockey-Stick (model=segreg)
3. Beverton-Holt (model=bevholtSV)
4. Ricker (model=ricker)

The Hockey-Stick was constrained to search for solutions of the break-point so that it falls within a lower bound (lplim) and upper bound (uplim) of spawning ratio potential SRPlim = SPRlim/SPR_0. The initial bounds were chosen to be fairly on constrained for a range of SRPlim = SRP 0.1−20% by setting lplim=0.001 and uplim=0.2. In the initial fits of the Beverton-Holt and Ricker models steepness s and R_0 were estimated given the input SPR_0y.When testing the different S-R models (Geometric Mean, Hockey Stick, Beverton and Holt and Ricker models) the Hockey Stick model and the Geometric mean one coincided. Therefore, a jitter analysis was run to test if Hockey Stick models with a different slope would fit better the data.

Table 6.16.4.2. Blue and red shrimp in GSA 5. Summary of the four SR models.

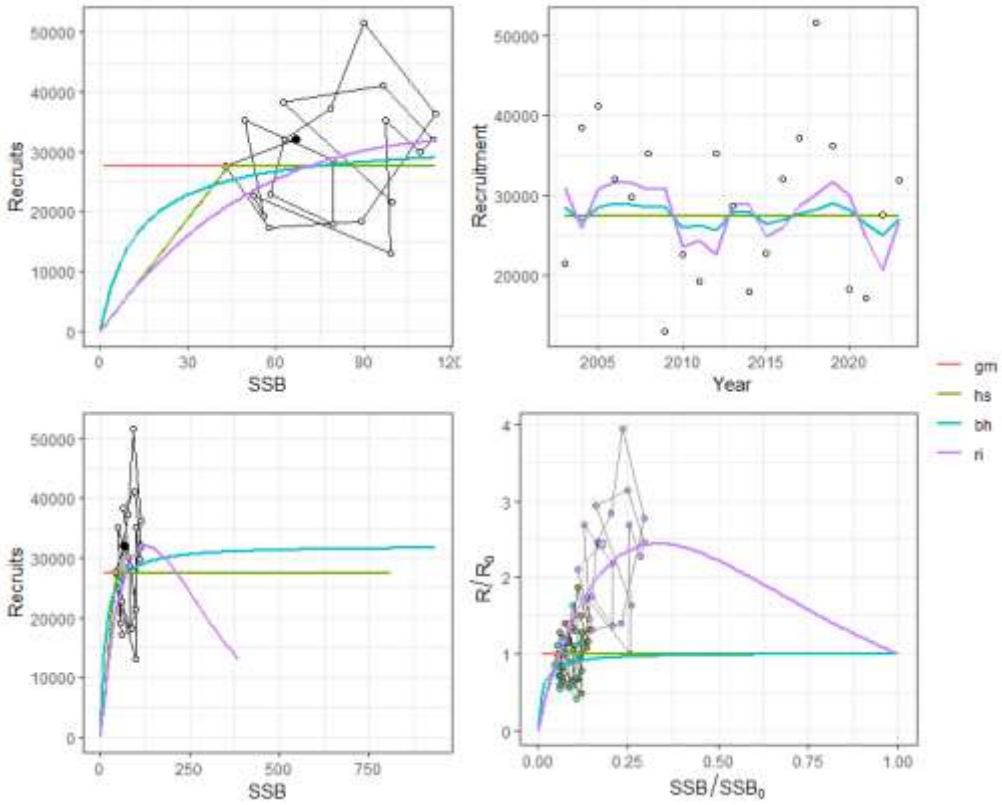
	s	sigmaR	R0	rho	B0

Hockey_Stick		0.34	27490.62	0.26	809.59
Beverton_Holt	0.95	0.34	31701.51	0.18	933.51
Geometric_mean		0.35	27491.15	0.26	809.53
Ricker	2.18	0.35	13077.93	0.06	385.10

Source: own elaborations

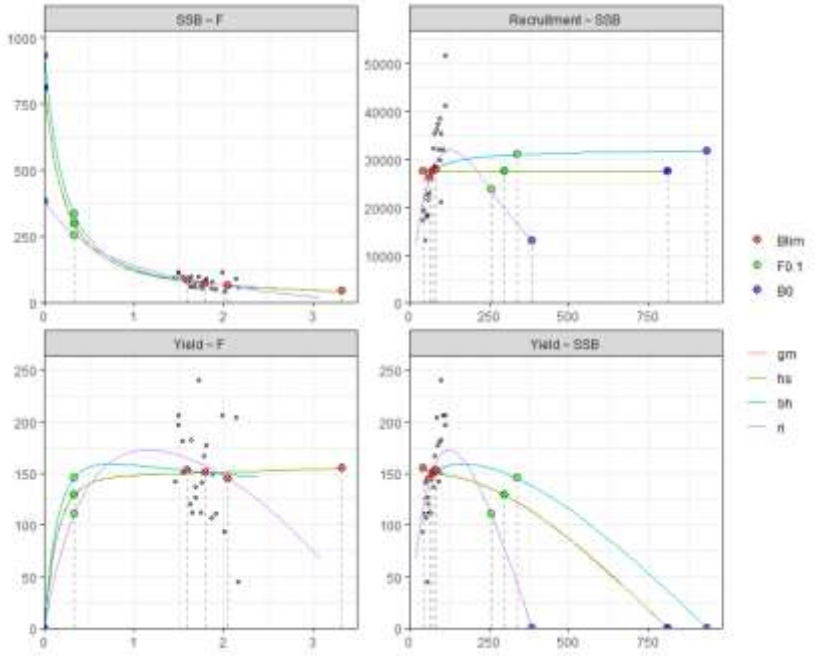
The observed SR data are sitting on the left side of the R-SSB plot, and the breakpoint estimated by the HS model is within the observed values.

Figure 6.16.4.2. Blue and red shrimp in GSA 5. Summary of the four SR models.



Source: own elaborations

Figure 6.16.4.3. Blue and red shrimp in GSA 5. Long term equilibrium evaluations for different S-R models.



Source: own elaborations

In the light of the outcomes of the exploratory analysis, it was decided to consider the Geometric mean approach the most appropriate to estimate the biomass reference points for the stock of blue and red shrimp in GSA 5. Table 6.16.4.3 summaries the reference point values based on the Geometric Mean model fitted to the data. B_{pa} is set to 2* Blim.

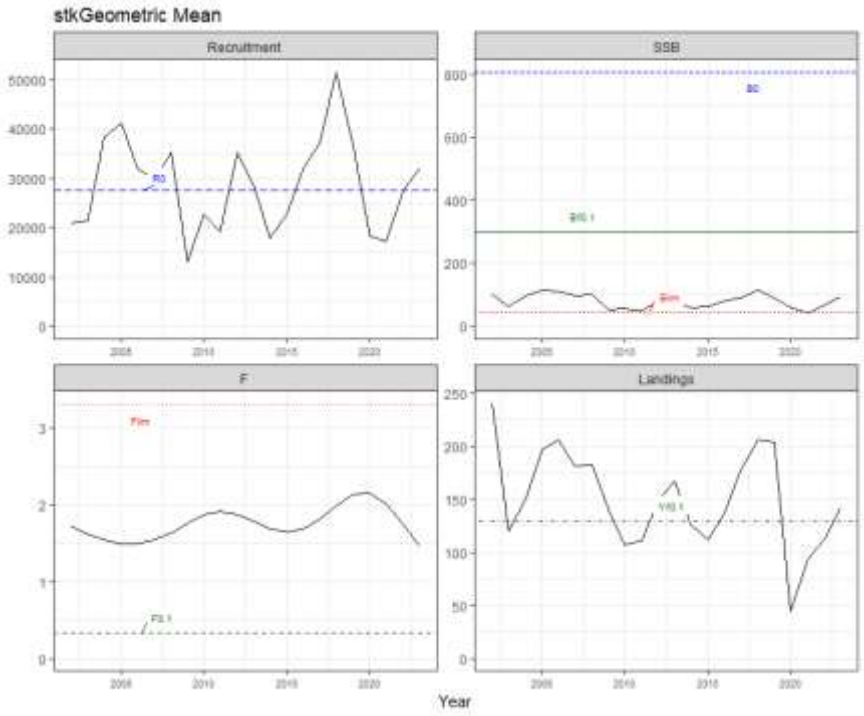
Table 6.16.4.3 Blue and red shrimp in GSA 5. Final reference points based on Geometric mean stock recruit model fitted to the data.

$F_{0.1}$	$B_{F0.1}$	B_{lim}	B_{pa}	F_{lim}	B_0	R_0
0.332	299	74.8	1.8	129	808	27500

Source: own elaborations

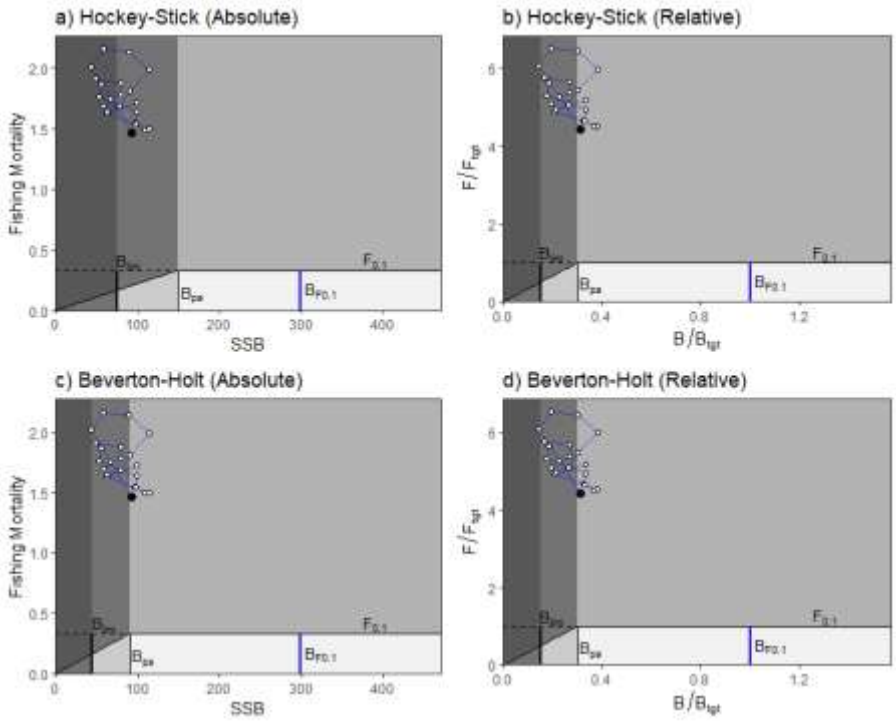
Figure 6.16.4.4-5 that SSB has fluctuated close to the B_{lim} and below the equilibrium biomass at $F_{0.1}$ ($B_{F0.1}$) to over time series, being above b_{lim} in 2023. However, despite the decrease of F from 2021 to 2023, F is still above $F_{0.1}$.

Figure 6.16.4.4. Blue and red shrimp in GSA 5. Status Advice plot showing stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Geometric Mean stock-recruitment relationship.



Source: own elaborations

Figure 6.16.4.5. Blue and red shrimp in GSA 5. Advice Rule plots, with B_{lim} fitted to the data and B_{pa} = 2 B_{lim}.



Source: own elaborations

6.16.5 SHORT TERM FORECAST AND CATCH OPTIONS

A deterministic short term prediction for the period 2023 to 2025 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age and maturity at age, while the F_{bar1-3} =1.46 (the last year's F estimated by the assessment model) was used for F in 2023, as F shows a declining trend. Recruitment is observed to increase over the period of the assessment, so the geometric mean across the entire time series (22 years) was used as an estimate of recruits in 2023.

Table 6.16.5.1. Blue and red shrimp in GSA 5. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1-3}$ (2023)	1.46	F current in the last year used to give F status quo for 2023
SSB (2023)	92.95	SSB intermediate year from STF output
R_{age1} (2023,2024)	28360	Catch intermediate year from STF output. Recruitment will be set as geometric mean of the last 6 years
Total catch (2023)	161.17	Catch intermediate year from STF output
Fbar (2019)	2.14	MAP base year fishing mortality from current assessment
a and b values	a=0 and b=1	Regression parameters from $F_{transition}$ regression line

Source: own elaborations

Biological parameters (maturity, natural mortality, mean weights) and fishery selection taken as mean of the last three years

Table 6.16.5.2. Blue and red shrimp in GSA 5. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_ 2024-2026(%)	Catch_change_ 2023-2025(%)
High long term yield (F0.1)	0.23	0.33	145.89	161.17	52.55	92.95	206.53	122.20	-63.98
F upper	0.31	0.46	145.89	161.17	68.63	92.95	184.10	98.07	-52.96
F lower	0.15	0.22	145.89	161.17	36.82	92.95	230.09	147.56	-74.76
FMSY transition	0.23	0.33	145.89	161.17	52.55	92.95	206.53	122.20	-63.98
F/Catch_option	0.14	0.21	145.89	161.17	34.42	92.95	233.83	151.58	-76.41
Zero catch	0.00	0.00	145.89	161.17	0.00	92.95	291.42	213.53	-100.00
Status quo	1.00	1.46	145.89	161.17	155.85	92.95	91.34	-1.73	6.83
Different Scenarios	0.10	0.15	145.89	161.17	25.05	92.95	248.76	167.64	-82.83
	0.20	0.29	145.89	161.17	47.07	92.95	214.56	130.84	-67.73

	0.30	0.44	145.89	161.17	66.52	92.95	186.95	101.13	-54.40
	0.40	0.58	145.89	161.17	83.78	92.95	164.51	76.99	-42.57
	0.50	0.73	145.89	161.17	99.16	92.95	146.14	57.23	-32.03
	0.60	0.88	145.89	161.17	112.93	92.95	130.99	40.93	-22.60
	0.70	1.02	145.89	161.17	125.30	92.95	118.39	27.38	-14.11
	0.80	1.17	145.89	161.17	136.48	92.95	107.84	16.03	-6.45
	0.90	1.31	145.89	161.17	146.62	92.95	98.93	6.44	0.50
	1.10	1.61	145.89	161.17	164.30	92.95	84.82	-8.74	12.61
	1.20	1.75	145.89	161.17	172.05	92.95	79.18	-14.81	17.93
	1.30	1.90	145.89	161.17	179.18	92.95	74.26	-20.10	22.82
	1.40	2.05	145.89	161.17	185.78	92.95	69.93	-24.76	27.34
	1.50	2.19	145.89	161.17	191.90	92.95	66.10	-28.88	31.53
	1.60	2.34	145.89	161.17	197.59	92.95	62.68	-32.57	35.43
	1.70	2.48	145.89	161.17	202.89	92.95	59.60	-35.88	39.07
	1.80	2.63	145.89	161.17	207.85	92.95	56.82	-38.87	42.47
	1.90	2.78	145.89	161.17	212.50	92.95	54.28	-41.60	45.66
	2.00	2.92	145.89	161.17	216.87	92.95	51.97	-44.09	48.65

Source: own elaborations

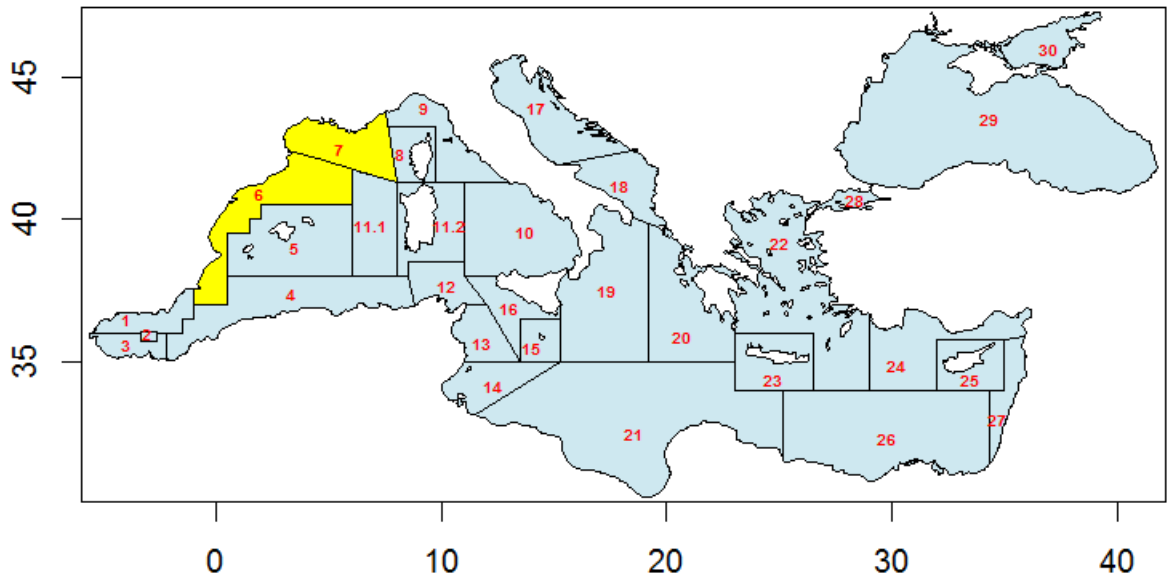
*$F_{MSY\ Transition}$ is based on a linear change in F from 2019 to F_{MSY} in 2025
*Fupper is not tested and is assumed not to be precautionary STECF does not advise fishing at F> F_{MSY}
^ % change in SSB 2024 to 2026
^^Total catch in 2025 relative to Catch in 2023.

6.17 BLUE AND RED SHRIMP IN GSA 6 AND 7

6.17.1 STOCK IDENTITY AND BIOLOGY

This stock was assessed for the last time in 2023 (STECF EWG 23-09) using a4a. No information was documented regarding stock delimitation of blue and red shrimp, *Aristeus antennatus* (Risso, 1816). It is assumed that the stock geographical distribution corresponds to GSA 6&7 (Figure 6.17.1.1).

Figure 6.17.1.1. Blue and red shrimp in GSA 6&7. Geographical location of the stock.



Source: own elaborations

The growth parameters used were taken from Garcia-Rodriguez (2003), just as in the previous assessment (STECF EWG 23-09); these are estimated from length frequency distributions analysis (Linf = 77.0 mm (carapace length); K = 0.38 year $^{-1}$; t0= -0.065 year).

This species shows sexual dimorphism, as females reach larger sizes compared to males, but only a combined set of growth parameters was available, and catch length data available were combined as well. Therefore, length frequency distributions from the Spanish OTB fleet as well as from survey data (MEDITS) were sliced to catch-at-age, using combined growth parameters.

The parameters of the length-weight relationship were taken from DCF data call 2017 (a= 0.0020; b= 2.5120) and corresponded to the ones used in the previous assessment (STECF EWG 22-09).

The proportion of mature individuals at age was available from the previous assessment report (STECF EWG 23-09, Table 6.17.1.1).

Table 6.17.1.1 Blue and red shrimp in GSA 6&7. Proportion of mature specimens (Pmat) at age.

Age	0	1	2	3	4	5+
Pmat	0.07863	0.7669	0.998	1	1	1

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

The natural mortality of blue and red shrimp in the present assessment was calculated as a vector using the Chen and Watanabe (1989) equation (Table 6.17.1.2).

Table 6.17.1.2 Blue and red shrimp in GSA 6&7. Natural mortality (M) at age Chen and Watanabe (1989).

Age	0	1	2	3	4	5+
M	1.967	0.848	0.610	0.512	0.461	0.432

Source: own elaborations

6.17.2 DATA

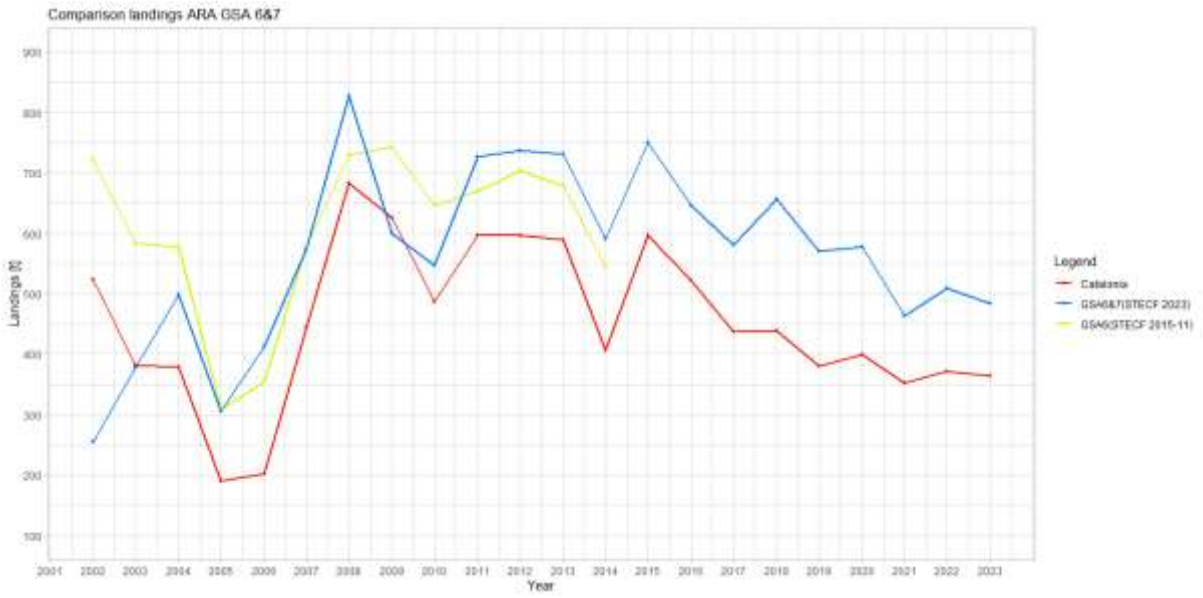
6.17.2.1 CATCH (LANDINGS AND DISCARDS)

General description of Fisheries

Blue and red shrimp is one of the most important crustacean species in catches and value of GSAs 6&7. It is a deepwater species caught exclusively by bottom trawl. The blue and red shrimp has a wide bathymetric distribution, between 80 and 3300 m depth (Sardà et al., 2004), although commercial fishing grounds are located between 450 and 900 m depth. Deeper areas may act as a refuge for the stock, especially for the juvenile fraction, as they are located far from the main fishing ports and below 1000 m of depth where the trawl fishing is banned (GFCM resolution 2005/1). Females predominate in the landings, representing nearly 80% of the total landings. Discards of the blue and red shrimp are practically null because of the high commercial value of the species and no minimum catch size. Other accompanying species of commercial value in the catches are large individuals of hake, greater forkbeard, Norway lobster and blue whiting. Exploitation is based on young age classes, mainly 1 and 2 years old. Figure 6.17.2.1 shows the landings by year, where a comparison is also presented with the landings reported by Catalonia (which produces around 70% of the total landings in GSAs 06 and 07) and the STECF 2015-11. As reported in EWG 22-03, there is a large discrepancy between landings in the first two years, which is why they were excluded from the assessment. The discarded component of the catch is small (Table 6.17.2.1), therefore catch and landings are considered as equal and the term catch will be used throughout this report. The total landings by metier (=catch as discards were negligible) is shown in Figure 6.17.2.2.

For both GSA 6 & 7, the LFD per year and metier before reconstruction are shown in Figure 6.17.2.3 Length structure of blue and red shrimp landed in GSA 6 & 7 by year and metier as reconstructed is shown in Figure 6.17.2.4.

Figure 6.17.2.1 Blue and red shrimp in GSA 6&7. Comparison of total landings reported in STECF 2015-11 (yellow), Catalonia (red) and EWG 23-10 (blue).



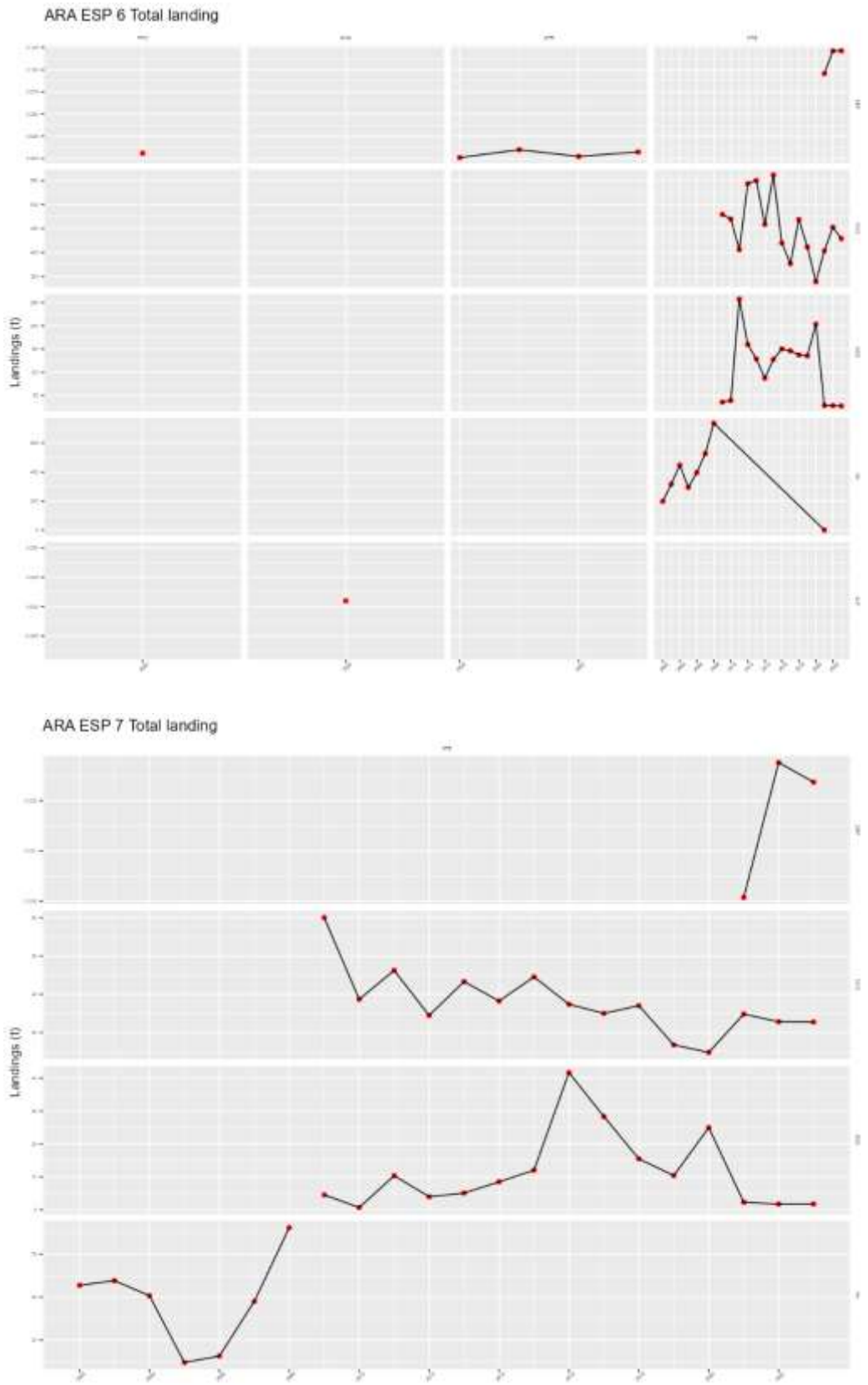
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.17.2.1 Blue and red shrimp in GSA 6&7. DCF landings (t) and discards (t) by OTB (all metiers).

Year	Landings(t)	Discards (t)
2004	498.80	0.00
2005	305.90	0.00
2006	411.70	0.00
2007	574.50	0.00
2008	827.50	1.14
2009	599.50	0.52
2010	547.11	1.31
2011	725.80	7.97
2012	735.90	15.10
2013	730.70	12.11
2014	591.00	0.60
2015	750.10	0.33
2016	646.50	3.38
2017	581.48	6.88
2018	655.60	0.04
2019	571.00	2.84
2020	577.60	0.49
2021	465.60	0.00
2022	507.80	0.221
2023	483.66	0.65

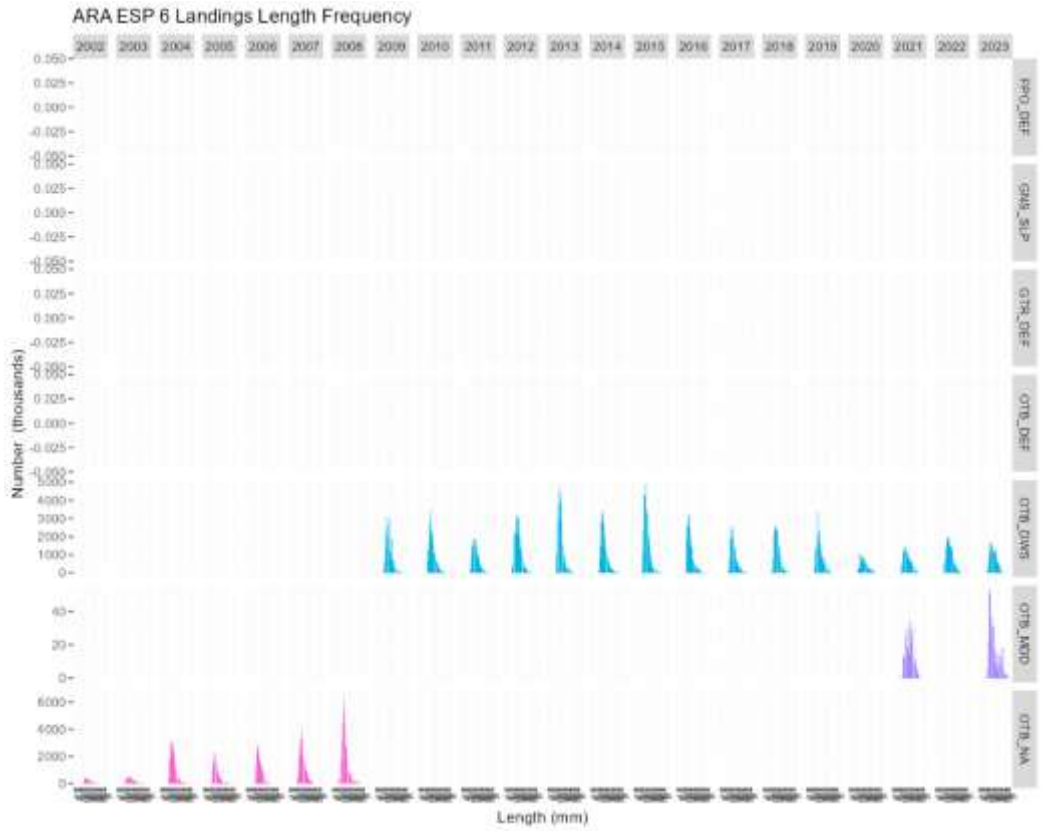
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.17.2.2 Blue and red shrimp in GSA 6&7. Total landing by gear and metier in GSA 6 and 7.

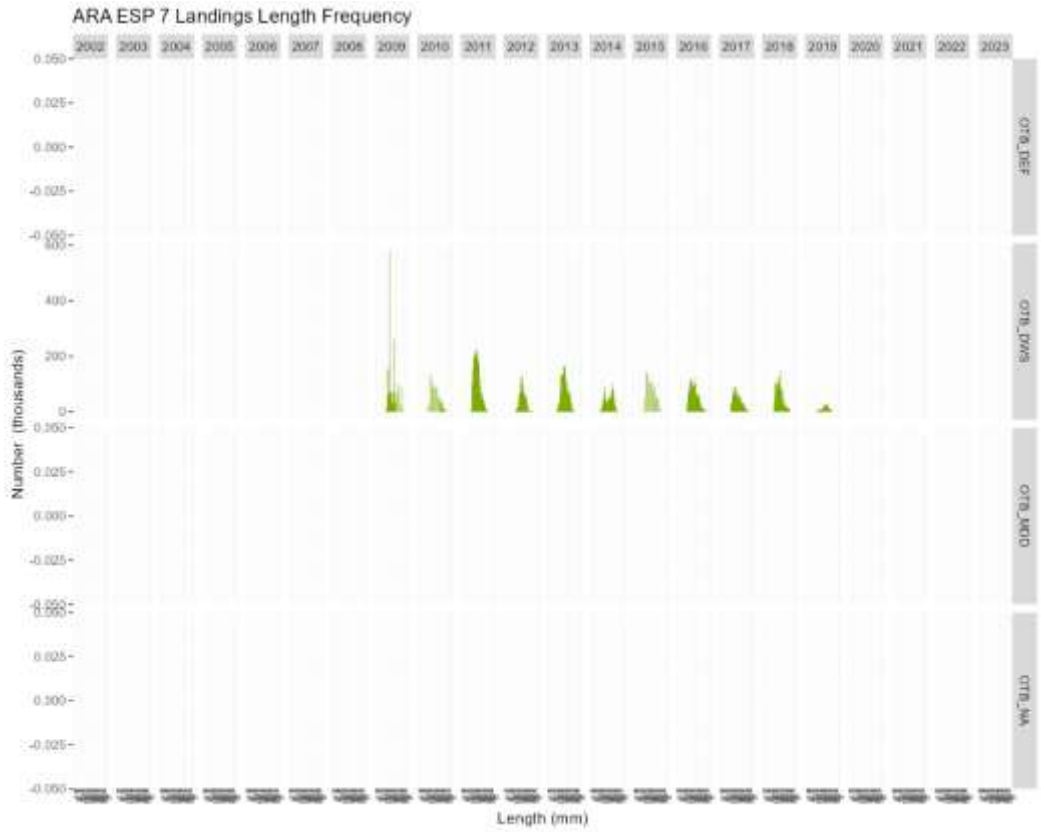


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.17.2.3 Blue and red shrimp in GSA 6&7. Length frequency distribution of landings by year and metier in GSA 6 and 7.

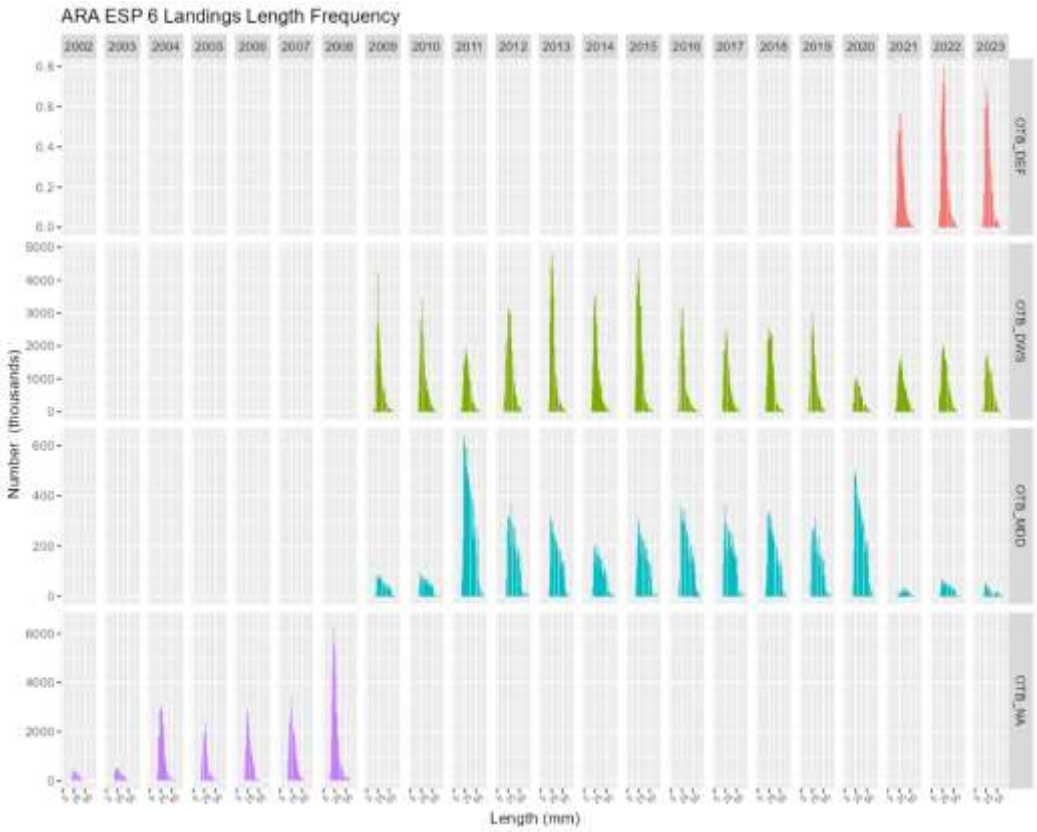


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

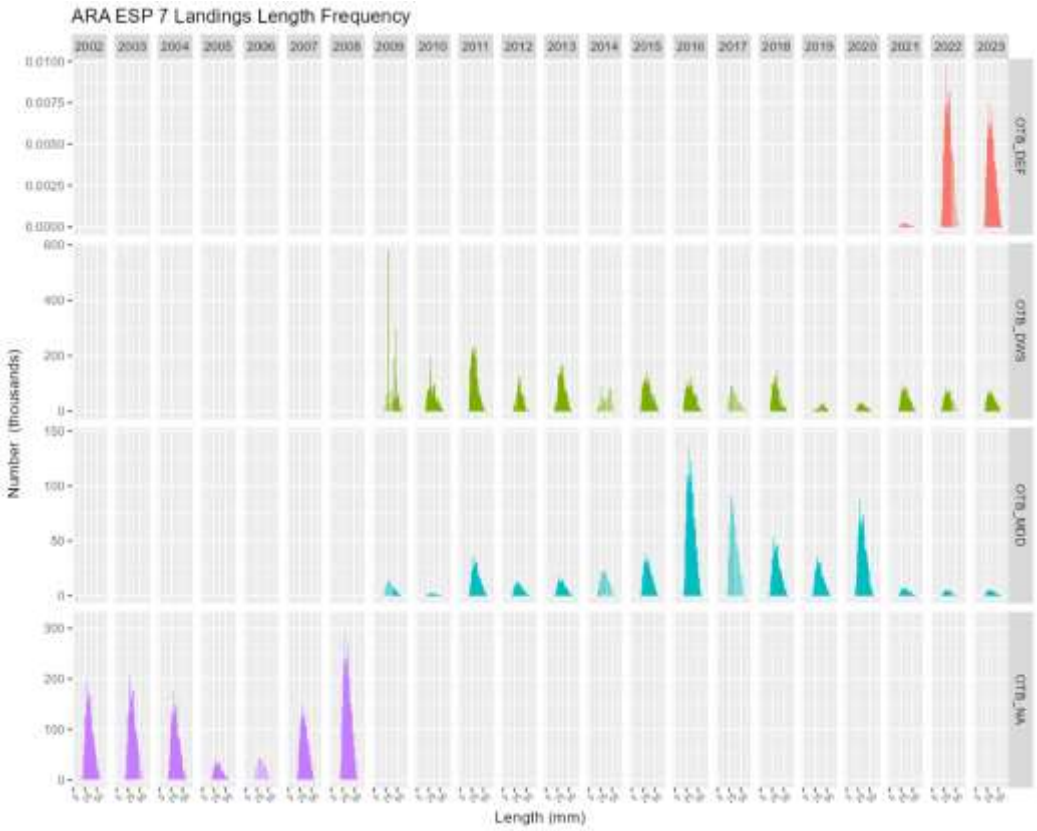


Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.17.2.4 Blue and red shrimp in GSA 6&7. Reconstructed length frequency distribution of catch by year and metier in GSA 6 and 7.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.17.2.2 EFFORT DATA

Fishing effort data were not made available to EWG 24-09. Fishing effort data up to 2023 will be reported to STECF EWG 24-12 through the FDI data call within the DCF framework.

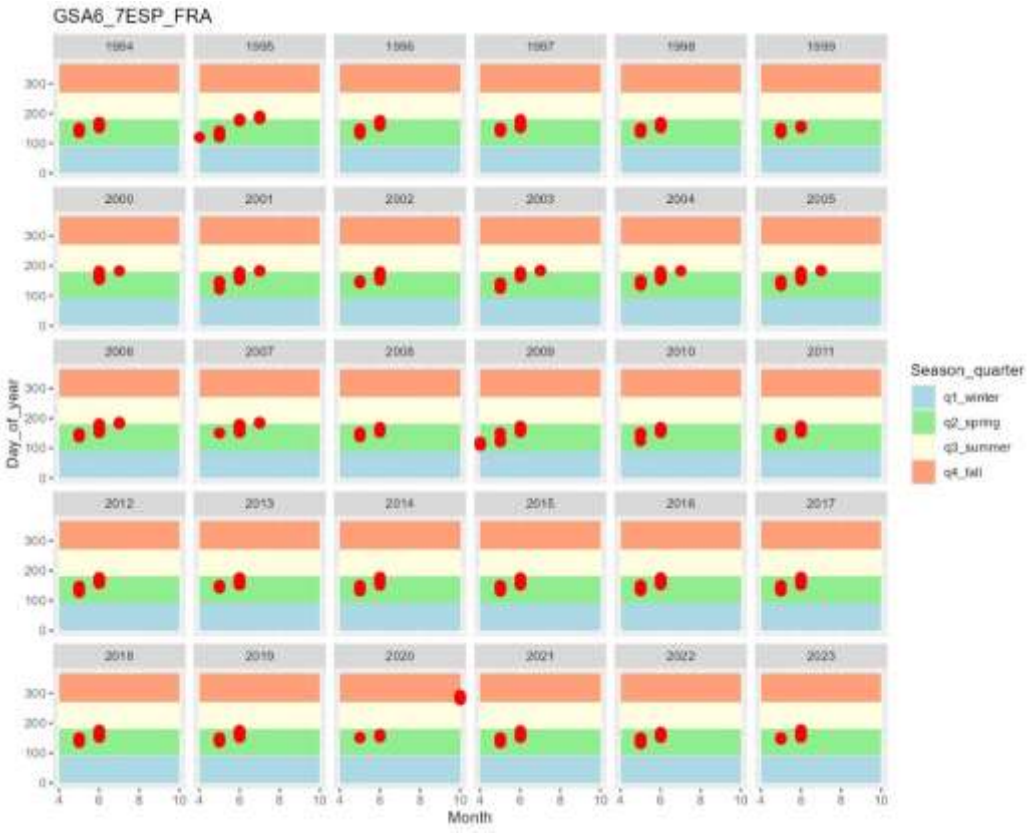
6.17.2.3 SURVEY DATA

6.17.2.2.1 Description and timing

The MEDITS surveys are carried mainly from May to July (Figure 6.17.2.7). Tables TA, TB, TC were provided according to the MEDITS protocol. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Data errors (e.g. length ranges) had been noted and were corrected prior to the analysis.

The abundance and biomass indices for GSA 6&7 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.

Figure 6.17.2.7 Blue and red shrimp in GSA 6&7. Month of the year when the MEDITS survey is conducted.



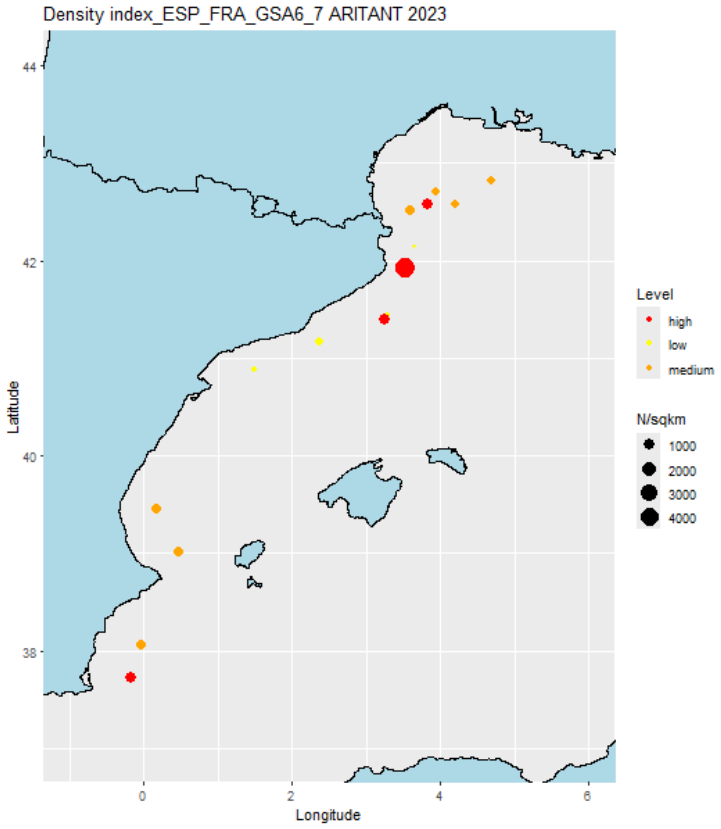
Source: own elaborations

The MEDITS survey data for the year 2020 was not included in the assessment, due to reduced coverage with only the Northern half of the area surveyed for the GSA 6.

6.17.2.2.2 Geographical distribution

The blue and red shrimp are mainly concentrated in the northern and southern parts of the region, while it is rare in the centre of the Spanish area where waters are shallower. The distribution did not show substantial variation across time (Figure 6.17.2.8).

Figure 6.17.2.8 Blue and red shrimp in GSA 6&7. Geographical distribution based on the density index of MEDITS survey in 2023.

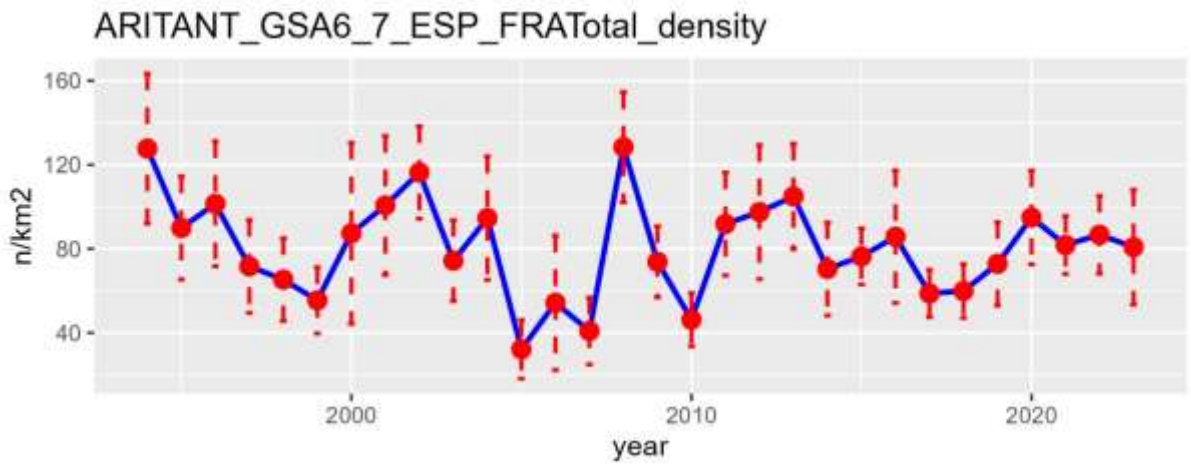


Source: own elaborations

6.17.2.2.3 Trends in abundance and biomass

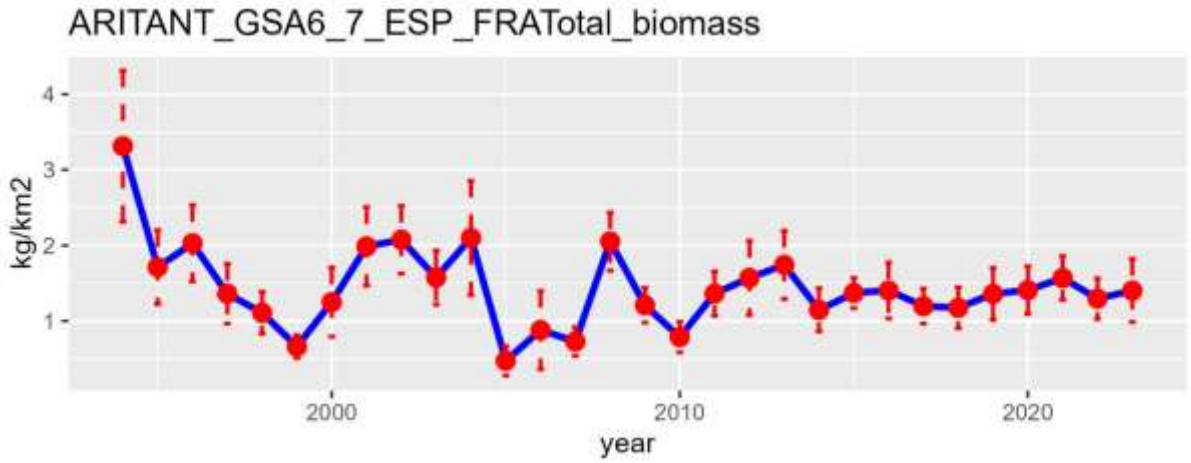
The time series of abundance and biomass indices of blue and red shrimp from MEDITS bottom trawl survey in GSAs 6&7 are available since 1994 as shown in the Figures 6.17.2.9 and 6.17.2.10, and Table 6.17.2.2.3. The density index shows an almost stable trend across the years while the biomass index shows a slight declining trend. The trends in abundance by length are shown on Figure 6.17.2.10.

Figure 6.17.2.9 Blue and red shrimp in GSA 6&7. MEDITS survey abundance index (n/km^2) of blue and red shrimp in GSA 6&7 as reported by DCF.



Source: own elaborations

Figure 6.17.2.10 Blue and red shrimp in GSA 6&7. MEDITS survey biomass index (kg/km^2) as reported by DCF.



Source: own elaborations

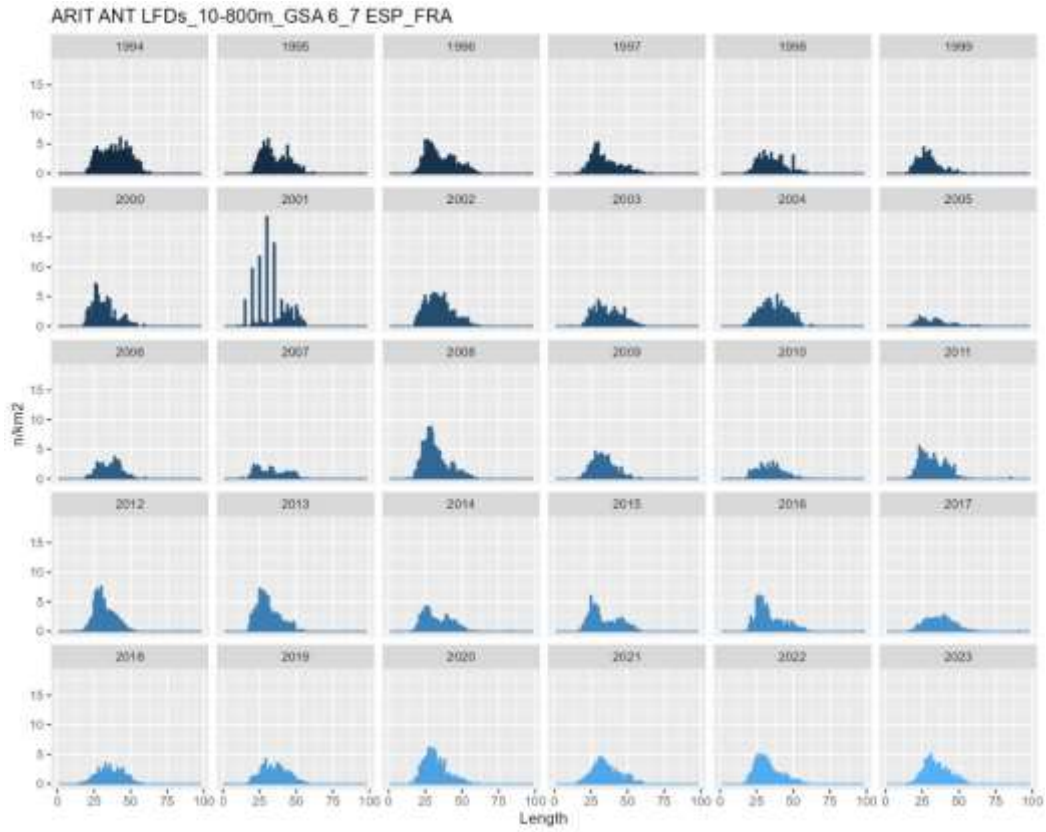
Table 6.17.2.2.3 Blue and red shrimp in GSA 6&7. MEDITS survey biomass index (kg/km^2) as reported by DCF. The survey is carried out from June to July.

Year	total_density	total_biomass
1994	127.71	3.31
1995	89.94	1.71
1996	101.43	2.03
1997	71.64	1.36
1998	65.35	1.11
1999	55.48	0.66

2000	87.39	1.25
2001	100.67	1.99
2002	116.31	2.08
2003	74.39	1.58
2004	94.62	2.10
2005	21.90	0.48
2006	54.33	0.88
2007	40.88	0.73
2008	128.38	2.05
2009	73.84	1.21
2010	46.28	0.79
2011	91.81	1.36
2012	97.51	1.57
2013	104.93	1.74
2014	70.43	1.15
2015	76.36	1.37
2016	85.76	1.41
2017	57.78	1.20
2018	59.93	1.18
2019	72.86	1.36
2020	84.67	1.41
2021	81.82	1.57
2022	86.69	1.30
2023	80.78	1.40

Source: own elaborations

Figure 6.17.2.11 Blue and red shrimp in GSA 6&7. Length frequency distribution of the MEDITS survey abundance index (n/km^2) as reported by DCF.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.17.3 STOCK ASSESSMENT

This is an update assessment of 2023 with rechecked data. Historical assessment a4a submodels were used for blue and red shrimp in GSA 6 and 7. The present assessment was carried out using also the statistical catch-at-age modelling framework – Assessment for all (a4a, Jardim et al., 2014) in FLR (http://www.flr-project.org/).

When slicing length to age for stocks with mid-year spawning and January to December assessment year it is necessary to ensure that growth to January (calendar year boundary) and growth to July (12 months of growth) are coherent with the slicing process (see Section 3). The slicing routine assigns age 0 to ages from 0 to 0.99 and age 1 to 1 to 1.99. If growth is defined on a birth date mid-year and the assessment is from January to December then slicing needs to occur at age 0 from 0 to 0.49 and age 1 from 0.5 to 1.5, this is arranged by adding 0.5 to t_0. When processing length frequency data here, 0.5 years was added to t_o in catch and survey data. This was necessary because without adding 0.5, there were large numbers of age 0 in both catch and particularly survey adjusted to the start of assessment year (January), which are not expected.

6.17.3.1. Input data

The growth parameters used to slice length frequency data from both, commercial and survey data, were Linf = 77 mm, k = 0.38 y^{-1}, t0 =-0.065, with the addition of 0.5 to t0 for purpose of aligning sizes appropriately with 1st of January for length slicing, same as the previous

assessment. SoP corrections were applied to catch numbers at age yearly (Table 6.15.3.1). The spawning of blue and red shrimp peaks during the summer, although continuous spawning throughout the year has been reported from some areas of the Mediterranean. Natural mortality (M) at age was estimated using the Chen-Watanabe (1989) model. Proportion of mature and M at age are shown in Tables 6.17.1.1 and 6.17.1.2. The MEDITS bottom trawl survey data (Table 6.17.2.9) were used for tuning of the a4a models.

Sum of Products (SoP) correction was applied in catch numbers at age to match the total catch by year reported in the DCF (Table 6.17.3.1)

Input data in terms of catch numbers and mean weight at age, and tuning data in terms of catch numbers from the MEDITS survey are shown in Figure 6.17.3.3.1 to Figure 6.17.3.3.4.

The plus group in the catch data was set to age 5, and ages 1-4 in MEDITS survey data were used to tune the assessment model. The age range of Fbar was set to age 1-2 as the majority of the catches were represented within these age classes.

Table 6.17.3.1. Blue and red shrimp in GSA 6 & 7. Sum of Products (SoP) correction array.

Year	SoP
2004	1.01
2005	1.00
2006	1.00
2007	1.01
2008	1.01
2009	1.01
2010	1.00
2011	1.01
2012	1.02
2013	1.02
2014	1.01
2015	1.01
2016	1.01
2017	1.02
2018	1.00
2019	1.01
2020	1.00
2021	1.00
2022	1.00
2023	1.00

Source: own elaborations

6.17.3.3 Stock assessment models and results

The same model settings were applied, as the ones used in EWG 23-09.

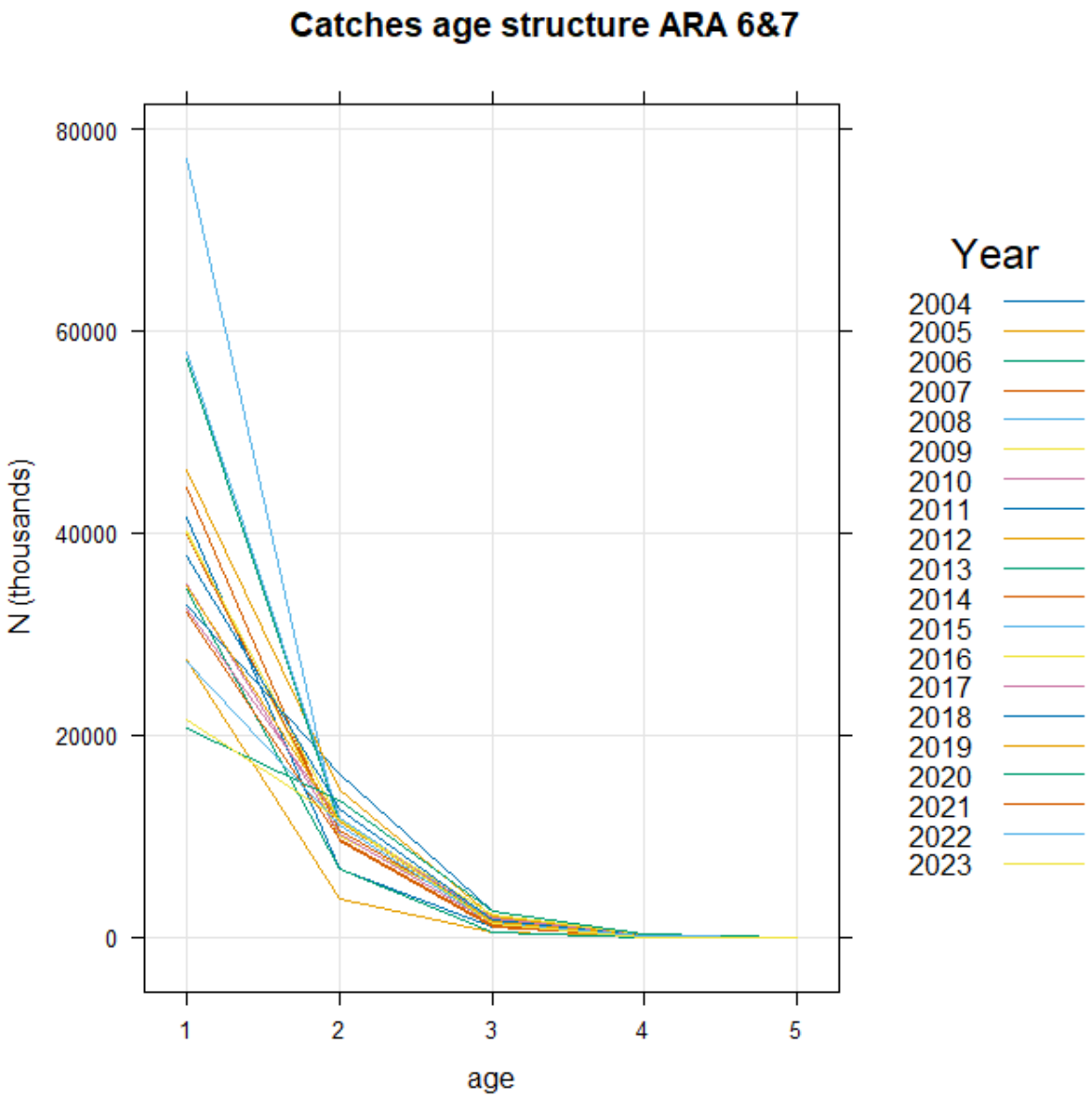
A4a submodels:

Fishing mortaliy: fmodel <- ~ s(year, k=8) + factor(replace(age,age>2,3))
Survey catchability: qmodel <- list(~factor(replace(age,age>3,3)))

Variance model:	vmodel	<- list(~s(age,k=3),~s(age, k=3))
Stock-recruit:	srmodel	<- ~ geomean(CV=0.25)

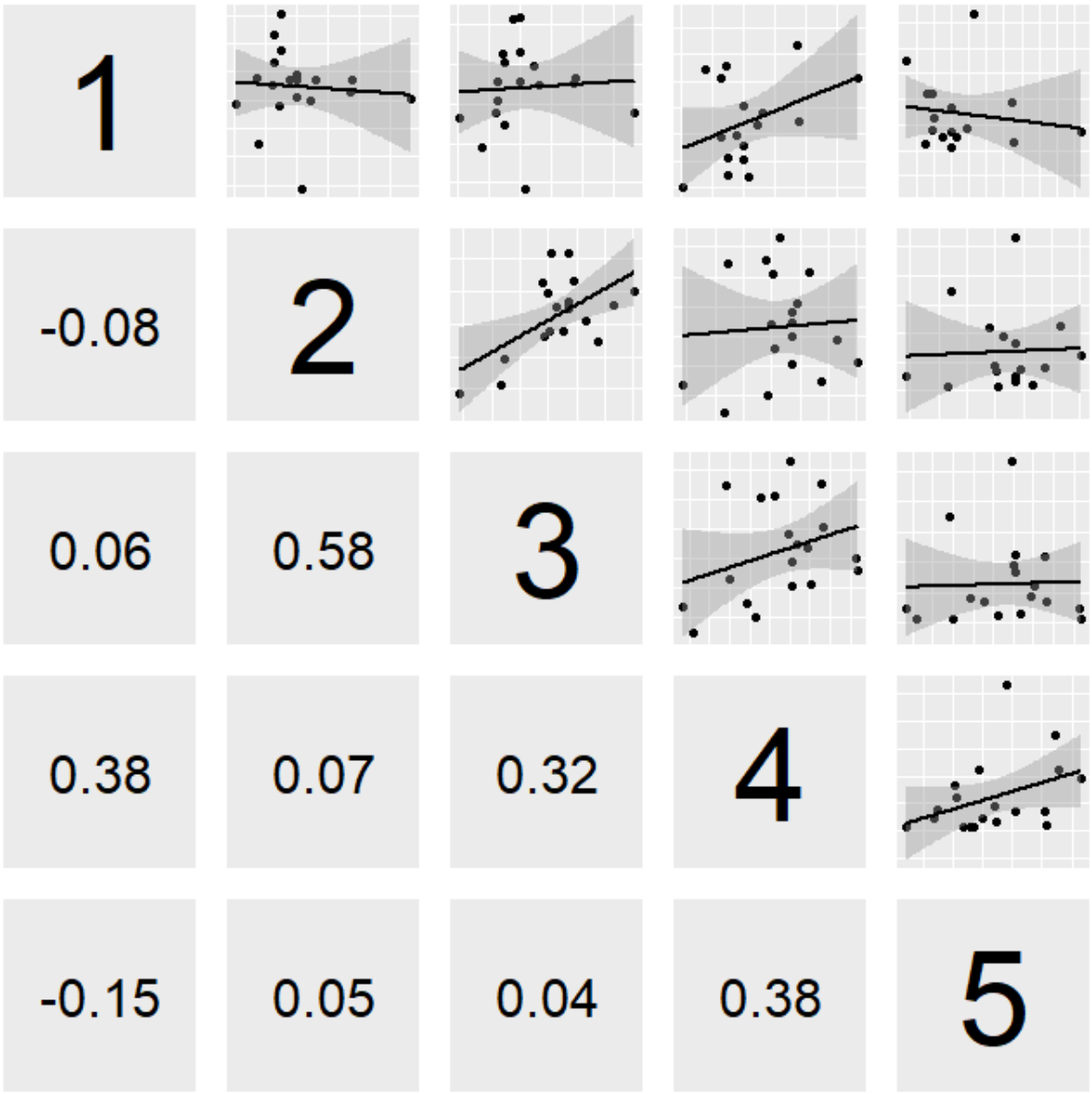
Figures (6.17.3.3.1 – 6.17.3.3.4) present catch-at-age and index-at-age input data for the stock assessment along with their cohort consistency plots. Consistency for the catch is poor between age 1 and 2 and moderate through the rest of the ages. Cohort consistency of the index is poor between age 1 and 2 and moderate through the rest of the ages

Figure 6.17.3.3.1 Blue and red shrimp in GSA 6&7. Blue and red shrimp number of individuals (thousands) at age of the catch in GSA 6&7 (2004-2023). Data from DCF.



Source: own elaborations

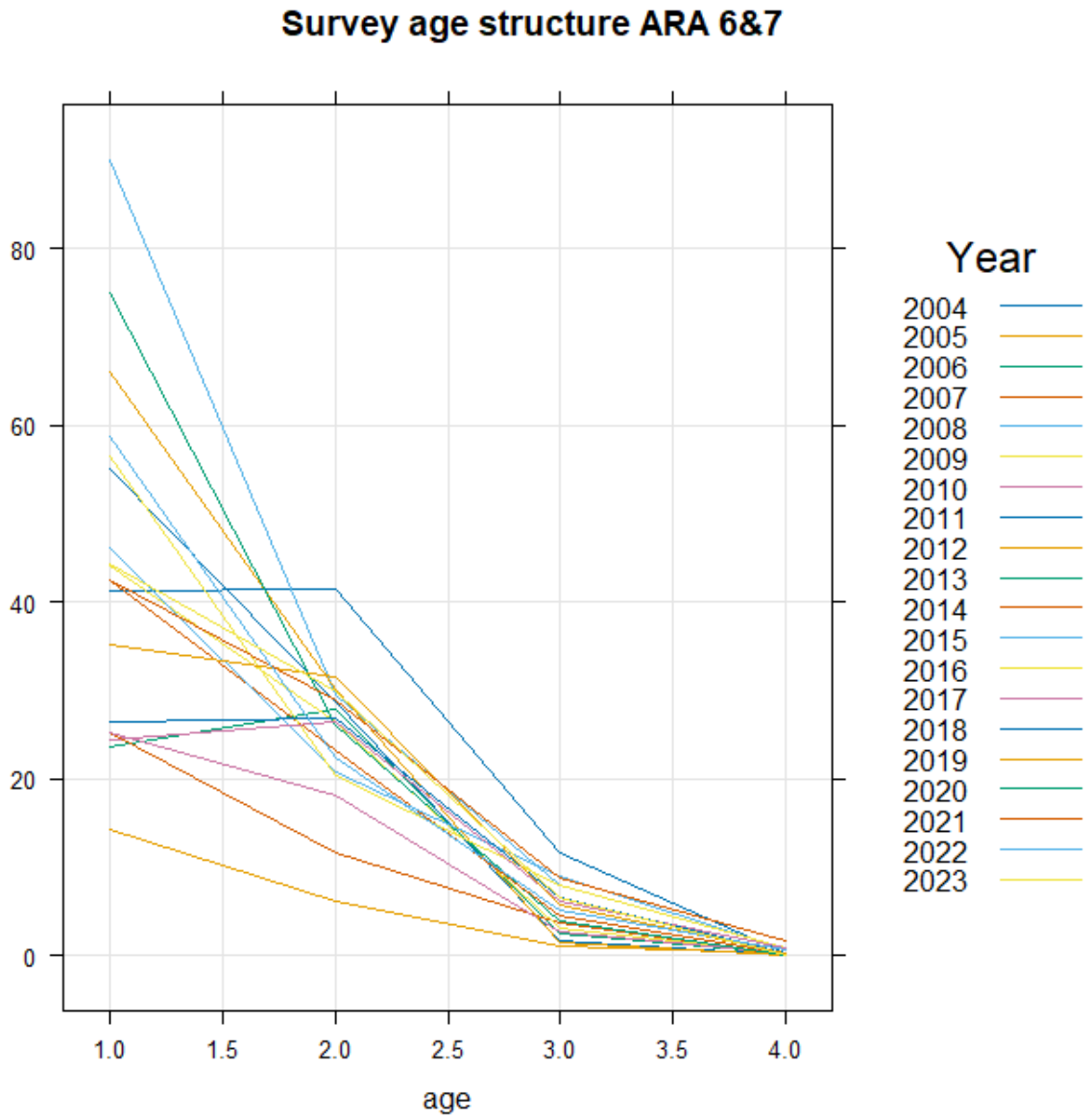
Figure 6.17.3.3.2 Blue and red shrimp in GSA 6&7. Cohort consistency in the catch.



Source: own elaborations

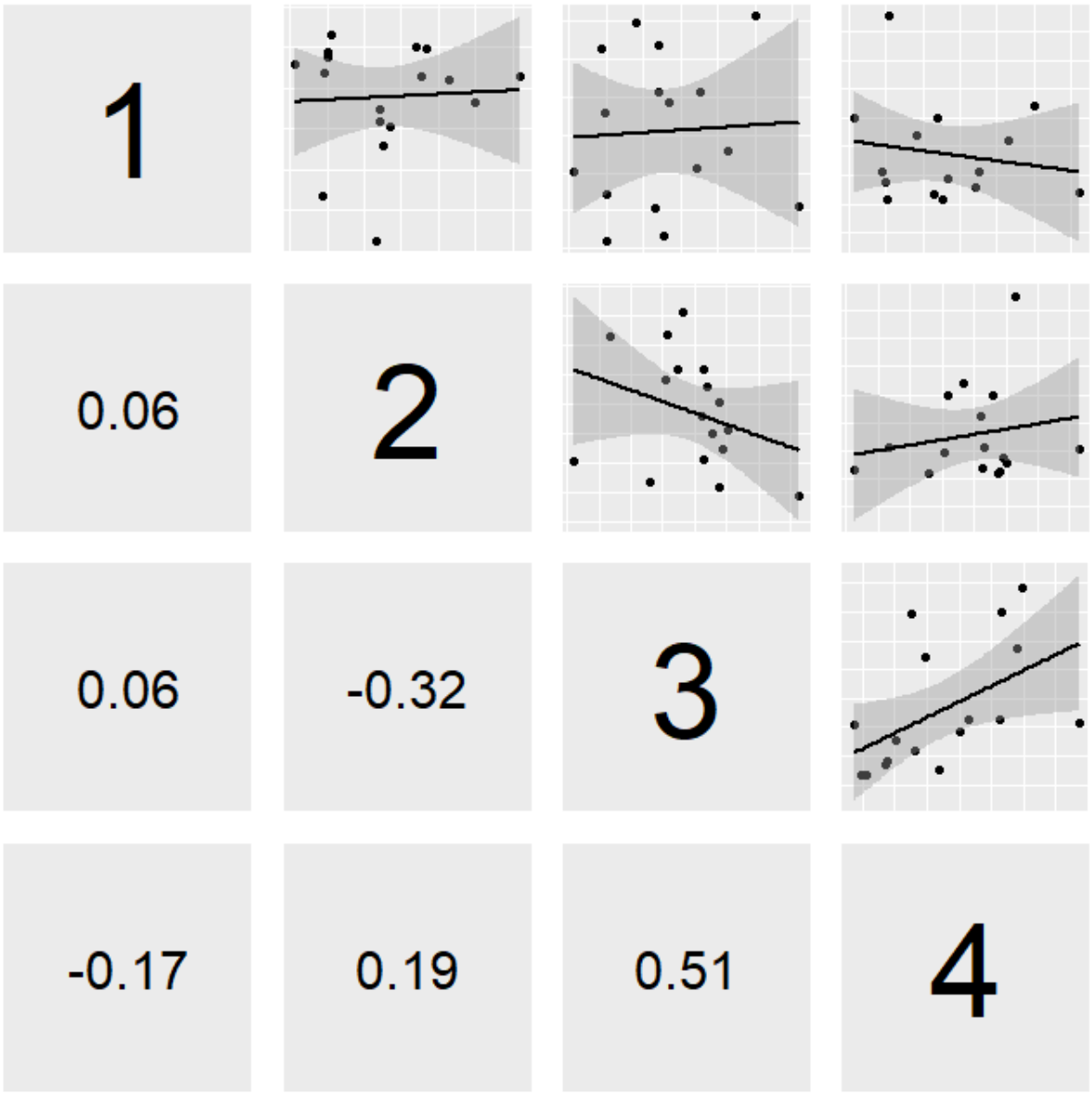
Source: own elaborations

Figure 6.17.3.3.3 Blue and red shrimp in GSA 6&7. Age composition of the MEDITS survey as reported by DCF.



Source: own elaborations

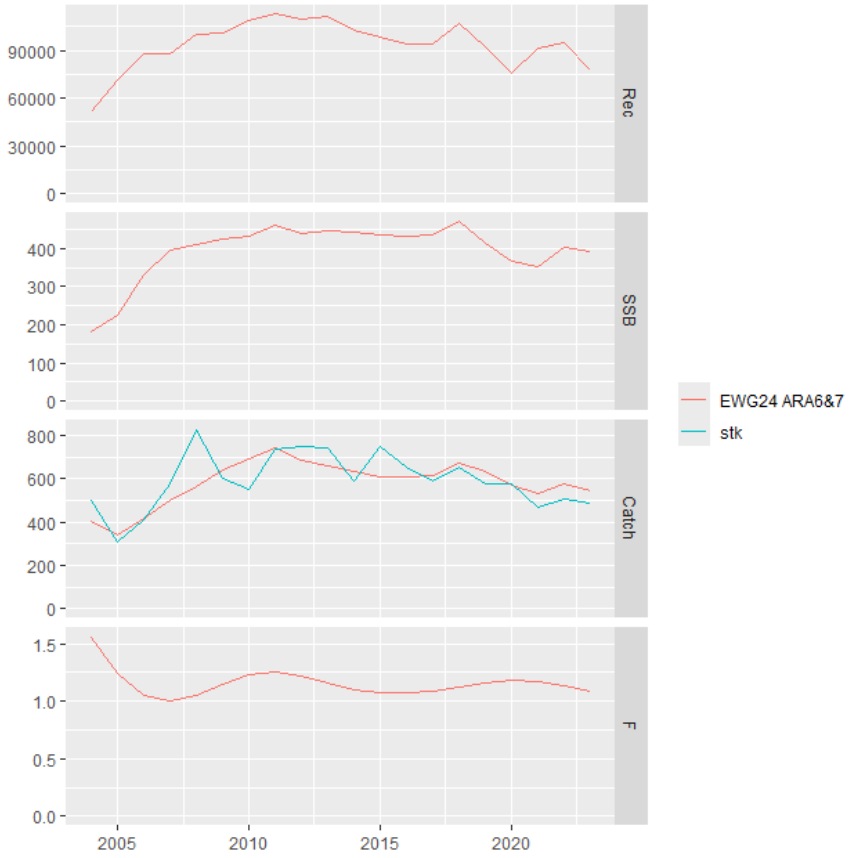
Figure 6.17.3.3.4 Blue and red shrimp in GSA 6&7. Cohort consistency of the index.



Source: own elaborations

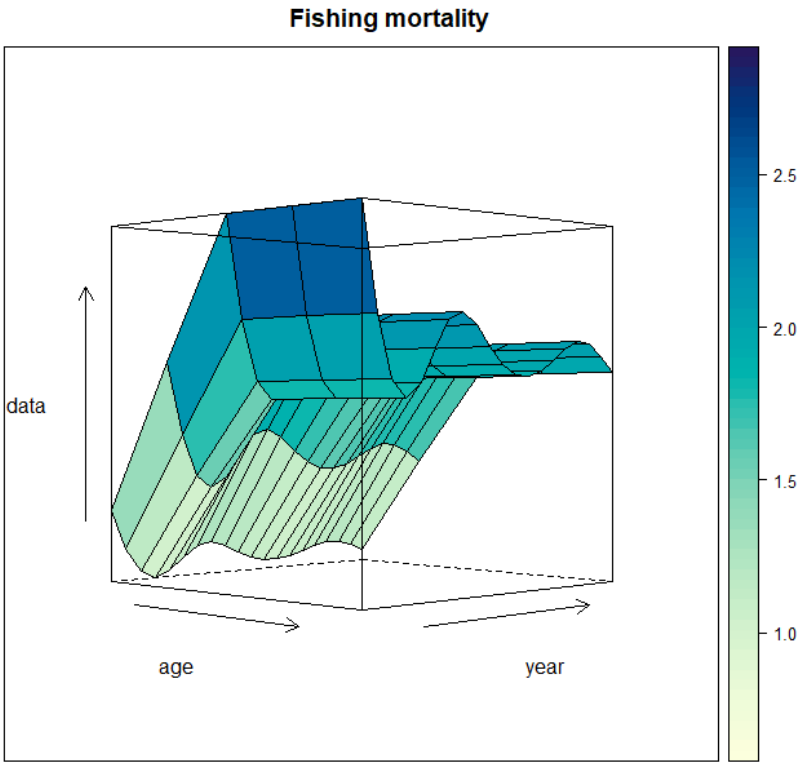
Figures (6.17.3.3.5 – 6.17.3.3.7) present stock assessment results, 3D plot of fishing mortality by age and year and 3D plot of catchability by age and year. The 3D plots of harvest and catchability reflect the assumption of constant F and q after age 3. The results were in line with the last year's assessment, but in both cases the assessments did not appear to follow appropriately the observed catches, and discrepancies were noted in some years.

Figure 6.17.3.3.5 Blue and red shrimp in GSA 6&7. Results of the stock assessment with 95% confidence limits and the observed catch.



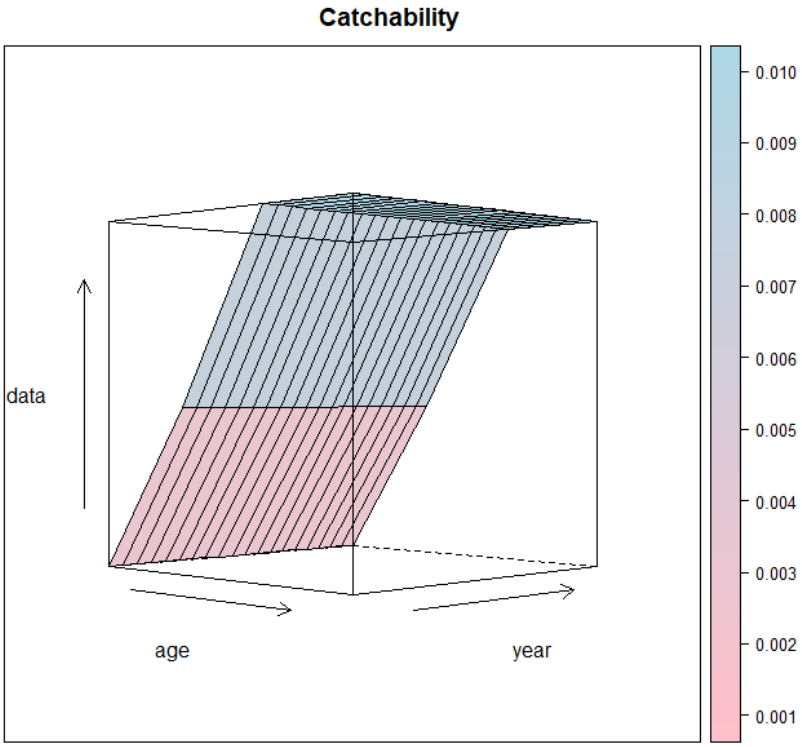
Source: own elaborations

Figure 6.17.3.3.6 Blue and red shrimp in GSA 6&7. 3D plot of fishing mortality by age and year.



Source: own elaborations

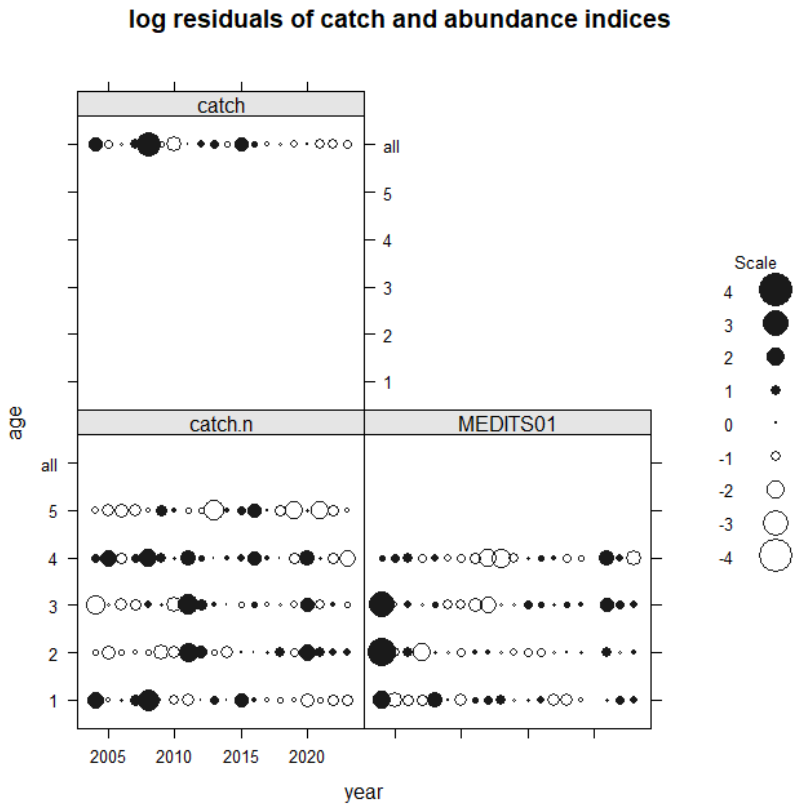
Figure 6.17.3.3.6 Blue and red shrimp in GSA 6&7. 3D plot of catchability by age and year.



Source: own elaborations

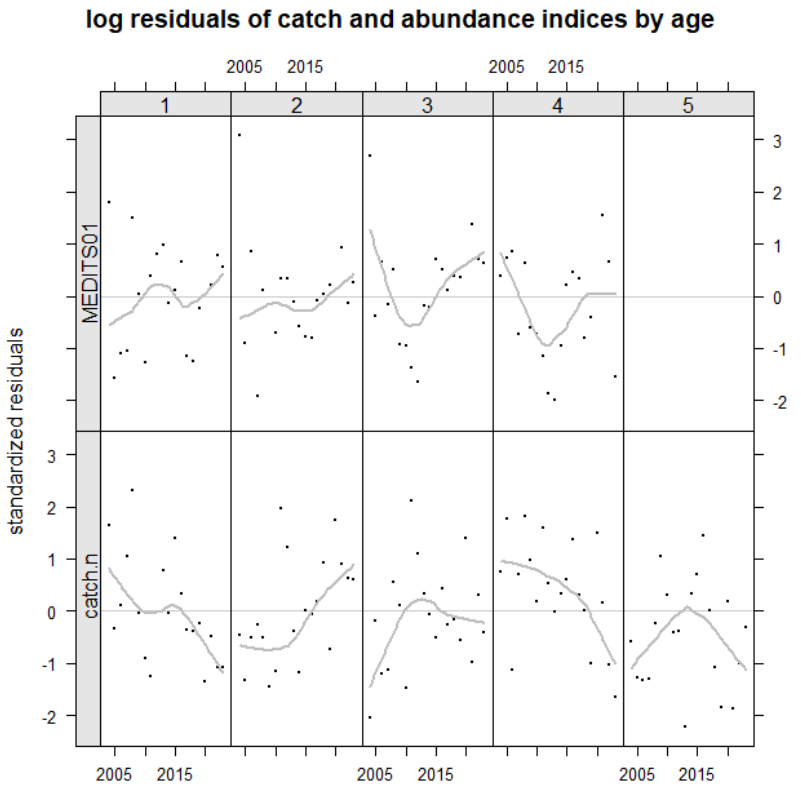
The Figures (6.17.3.3.7 – 6.17.3.3.11) present the diagnostics of the assessment. The total catch residuals did not show any particular pattern and the range of the standardized residuals values considered acceptable. The fitted versus observed catch at age was good, with some discrepancies for age 1 in years 2004, 2008, 2011, 2015 and 2020. The fitted versus observed index by age was poor in some cases especially in age 1 and the beginning of the time series. Retrospective plots were quite stable and the values of Mohn's rho for fbar, ssb and recruitment were inside of the suggested limits (-0.2 – 0.2).

Figure 6.15.3.7 Blue and red shrimp in GSA 6 & 7: Standardized residuals for abundance indices and for catch numbers.



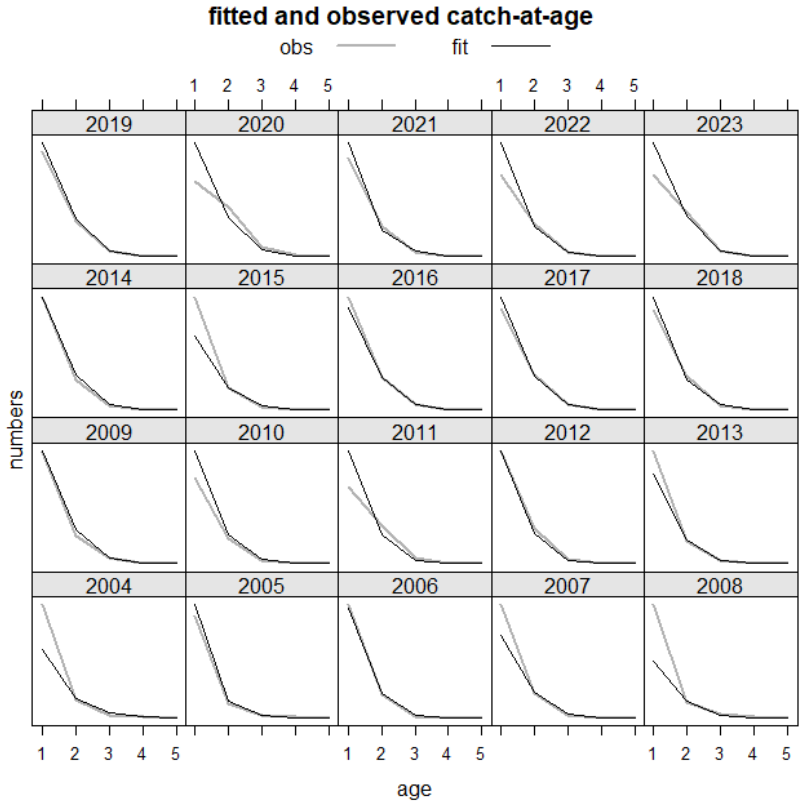
Source: own elaborations

Figure 6.17.3.3.8 Blue and red shrimp in GSA 6&7. Catch at age and Index by age residuals.



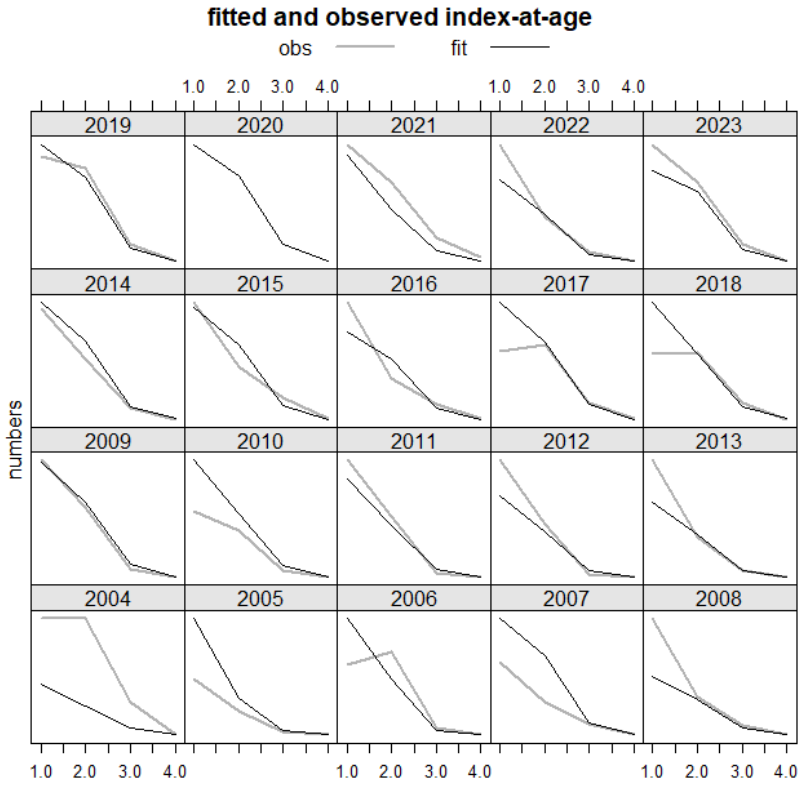
Source: own elaborations

Figure 6.17.3.3.9 Blue and red shrimp in GSA 6&7. Fitted versus observed catch by age and year.

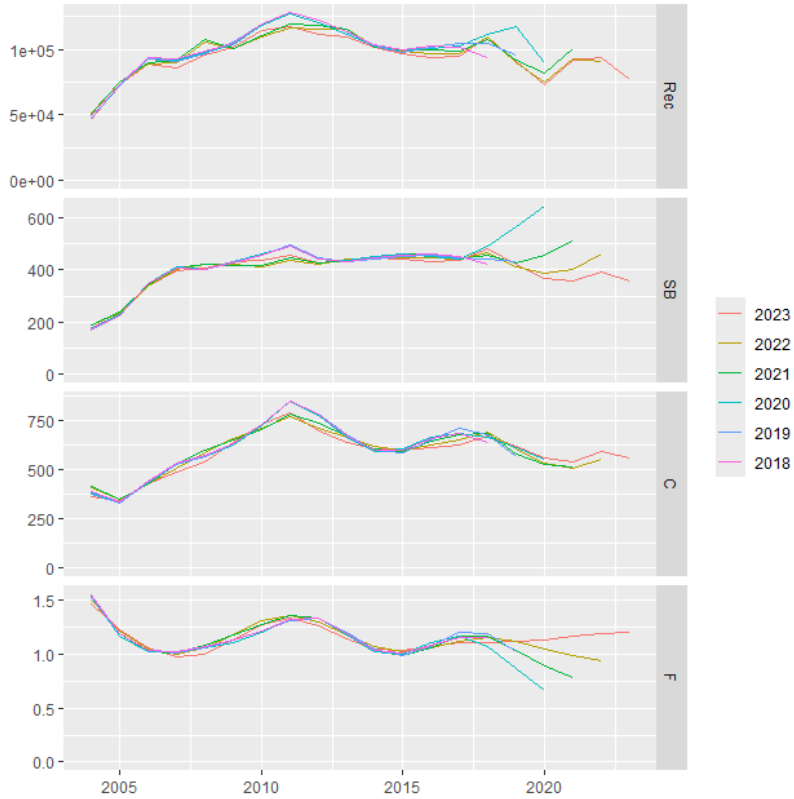


Source: own elaborations

Figure 6.17.3.3.10 Blue and red shrimp in GSA 6&7. Fitted versus observed index by age and year.



Source: own elaborations



Source: own elaborations

Table 6.17.3.3.1 Blue and red shrimp in GSA 6&7. Mohn's rho values for fbar, ssb and recruitment.

	Fbar	SSB	Recruitment
Mohn's rho	-0.150	0.233	0.042

Source: own elaborations

In the following tables the results of the a4a stock assessment are presented. F-at-age, Stock numbers by age, Recruitment, SSB estimated catch and Fbar.

Table 6.17.3.3.2 Blue and red shrimp in GSA 6&7. Fishing mortality by age as estimated through the a4a stock assessment

year	1	2	3	4	5+
2004	1.13	1.98	2.77	2.77	2.77
2005	0.90	1.58	2.21	2.21	2.21
2006	0.77	1.34	1.88	1.88	1.88
2007	0.73	1.27	1.78	1.78	1.78
2008	0.76	1.33	1.86	1.86	1.86
2009	0.83	1.46	2.04	2.04	2.04
2010	0.90	1.57	2.19	2.19	2.19
2011	0.91	1.60	2.24	2.24	2.24
2012	0.89	1.55	2.17	2.17	2.17
2013	0.84	1.47	2.06	2.06	2.06
2014	0.80	1.40	1.96	1.96	1.96
2015	0.78	1.36	1.91	1.91	1.91
2016	0.78	1.36	1.90	1.90	1.90
2017	0.79	1.38	1.93	1.93	1.93
2018	0.81	1.43	1.99	1.99	1.99
2019	0.84	1.47	2.06	2.06	2.06
2020	0.86	1.50	2.10	2.10	2.10
2021	0.85	1.50	2.09	2.09	2.09
2022	0.83	1.45	2.02	2.02	2.02
2023	0.79	1.38	1.93	1.93	1.93

Source: own elaborations

Table 6.17.3.3.2 Blue and red shrimp in GSA 6&7. Stock numbers by age as estimated through the a4a stock assessment

year	1	2	3	4	5+
2004	51068	10104	1941	121	2
2005	71588	7049	755	73	5
2006	87585	12447	789	50	5
2007	88135	17436	1766	72	5
2008	100400	18267	2655	179	8
2009	100610	20115	2621	248	18
2010	109150	18747	2542	205	22
2011	112930	19090	2120	170	16
2012	110040	19399	2092	136	13
2013	111530	19430	2231	143	11
2014	102630	20627	2423	171	12
2015	98525	19747	2757	205	16
2016	94265	19366	2740	245	21
2017	93832	18576	2699	245	25
2018	107210	18246	2529	234	25
2019	92118	20347	2381	207	22
2020	75892	17018	2532	182	18
2021	91076	13786	2057	186	16
2022	95106	16620	1679	153	16
2023	77677	17826	2122	133	14

Source: own elaborations

Table 6.17.3.3.3 Blue and red shrimp in GSA 6&7. Catch numbers by age as estimated through the a4a stock assessment.

year	1	2	3	4	5+
2004	25177	7150	1577	100	2
2005	30484	4515	572	56	4
2006	33307	7344	563	36	4
2007	32233	9989	1232	51	4
2008	37952	10729	1887	129	6
2009	40558	12389	1931	185	14
2010	46271	11972	1922	157	17
2011	48520	12307	1614	131	12
2012	46312	12325	1576	104	10
2013	45242	12022	1649	108	8
2014	40254	12452	1758	126	9
2015	37909	11752	1979	149	12
2016	36188	11506	1965	179	15
2017	36457	11136	1948	180	19
2018	42553	11112	1847	174	19
2019	37402	12597	1761	155	17
2020	31239	10641	1886	138	14
2021	37353	8598	1529	140	12
2022	38153	10200	1234	114	12
2023	30139	10675	1531	98	10

Source: own elaborations

Table 6.17.3.3.4 Blue and red shrimp in GSA 6&7. Stock summary: number of recruits, SSB, Fbar 1-2**,** estimated catch

Year	Recruitment (thousands)	SSB (t)	Fbar (1-2)	Catch (t)
2004	51068	182.42	1.56	404
2005	71588	224.7	1.24	341
2006	87585	328.77	1.05	418
2007	88135	395.51	1.00	497
2008	100398	411.5	1.05	563
2009	100606	426.25	1.15	639
2010	109146	431.03	1.23	692
2011	112928	460.93	1.26	742
2012	110037	438.34	1.22	687
2013	111527	445.49	1.16	661
2014	102631	442.31	1.10	632
2015	98525	434.22	1.07	607
2016	94265	431.93	1.07	606
2017	93832	436.68	1.09	617
2018	107207	470.11	1.12	670
2019	92118	414.1	1.16	631
2020	75892	364.97	1.18	572
2021	91076	352.23	1.17	531
2022	95106	403.09	1.14	578
2023	77677	390.87	1.08	547

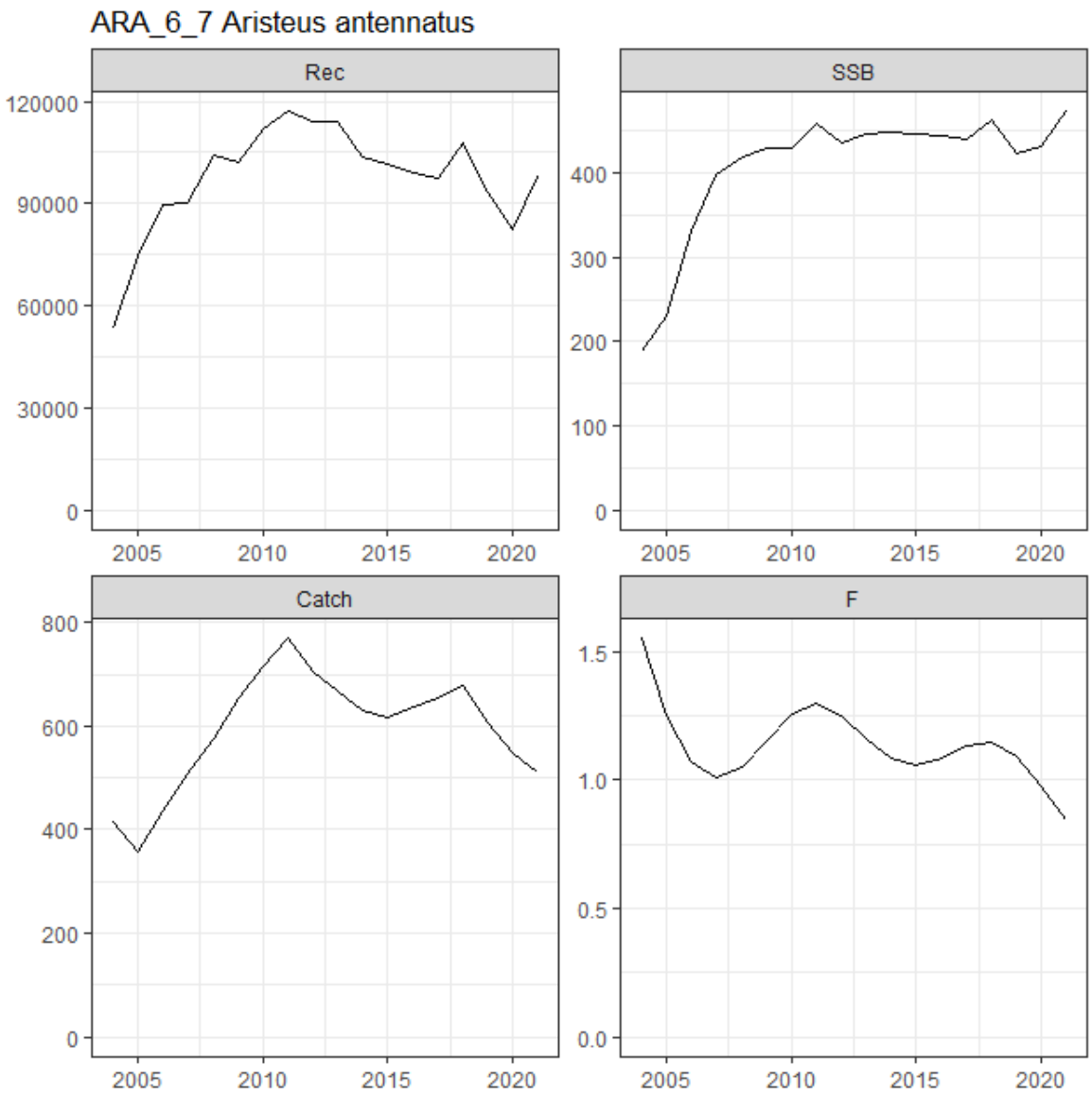
Source: own elaborations

6.17.4 REFERENCE POINTS

Reference points were re-calculated by EWG 24-10 for comparison with the outcomes of 22-09. Since no major difference was observed, the reference points estimated by EWG 22-09 were used, following the procedure agreed at STECF PLEN 22-03. This section is exactly the same as the previous report.

The time series is too short to fit a stock recruitment relationship. Therefore, reference points are based on equilibrium methods. The STECF EWG recommended using $F_{0.1}$ as a proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the a4a assessment.

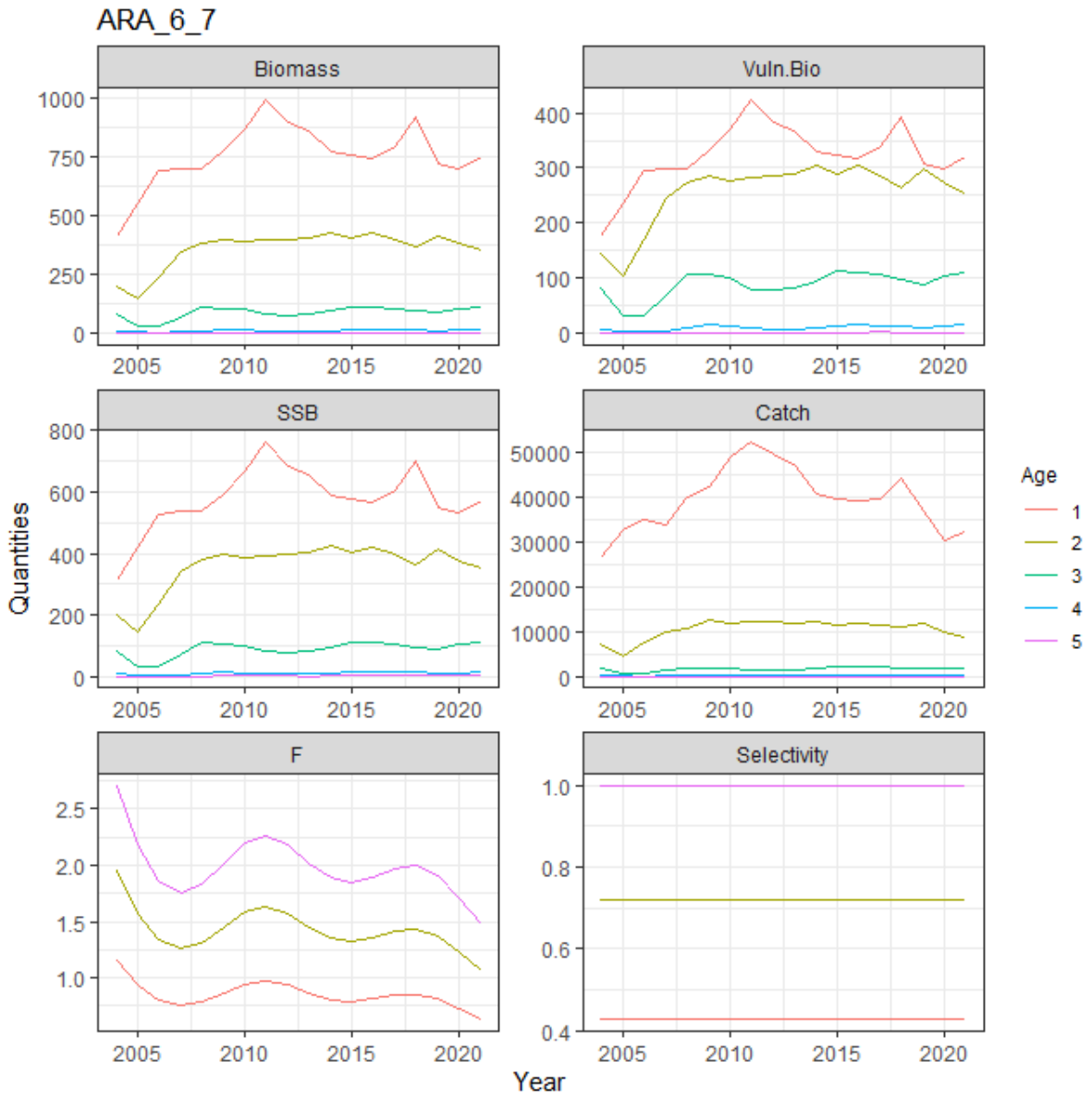
Figure 6.17.4.1 Blue and red shrimp in GSA 6&7. Stock summary from the final a4a model.



Source: own elaborations

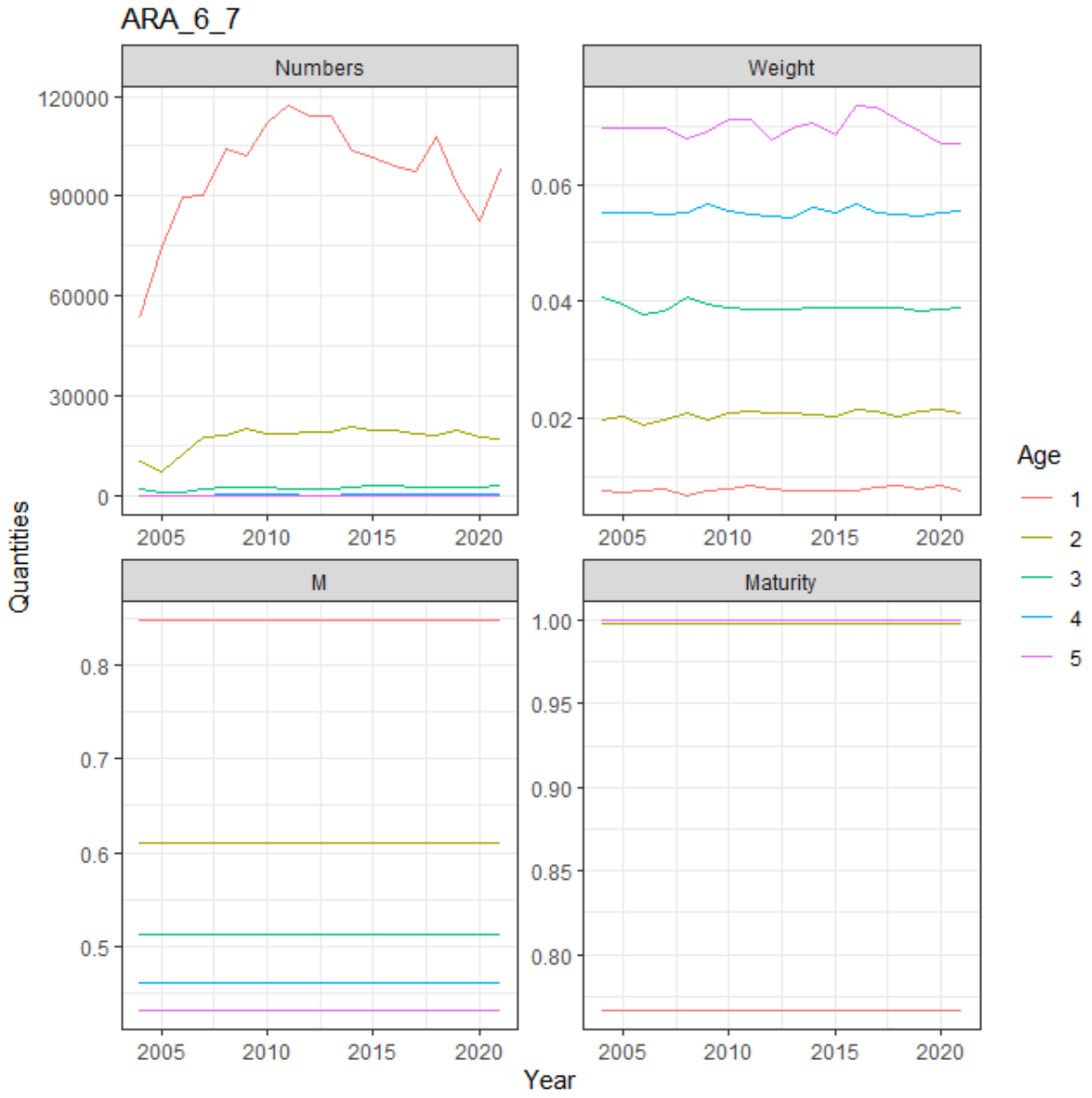
An overview of the input data used in the assessment and outcomes is provided in Figure 6.17.4.2 - 6.17.4.4.

Figure 6.17.4.2 Blue and red shrimp in GSA 6&7. Stock assessment trajectories at age.



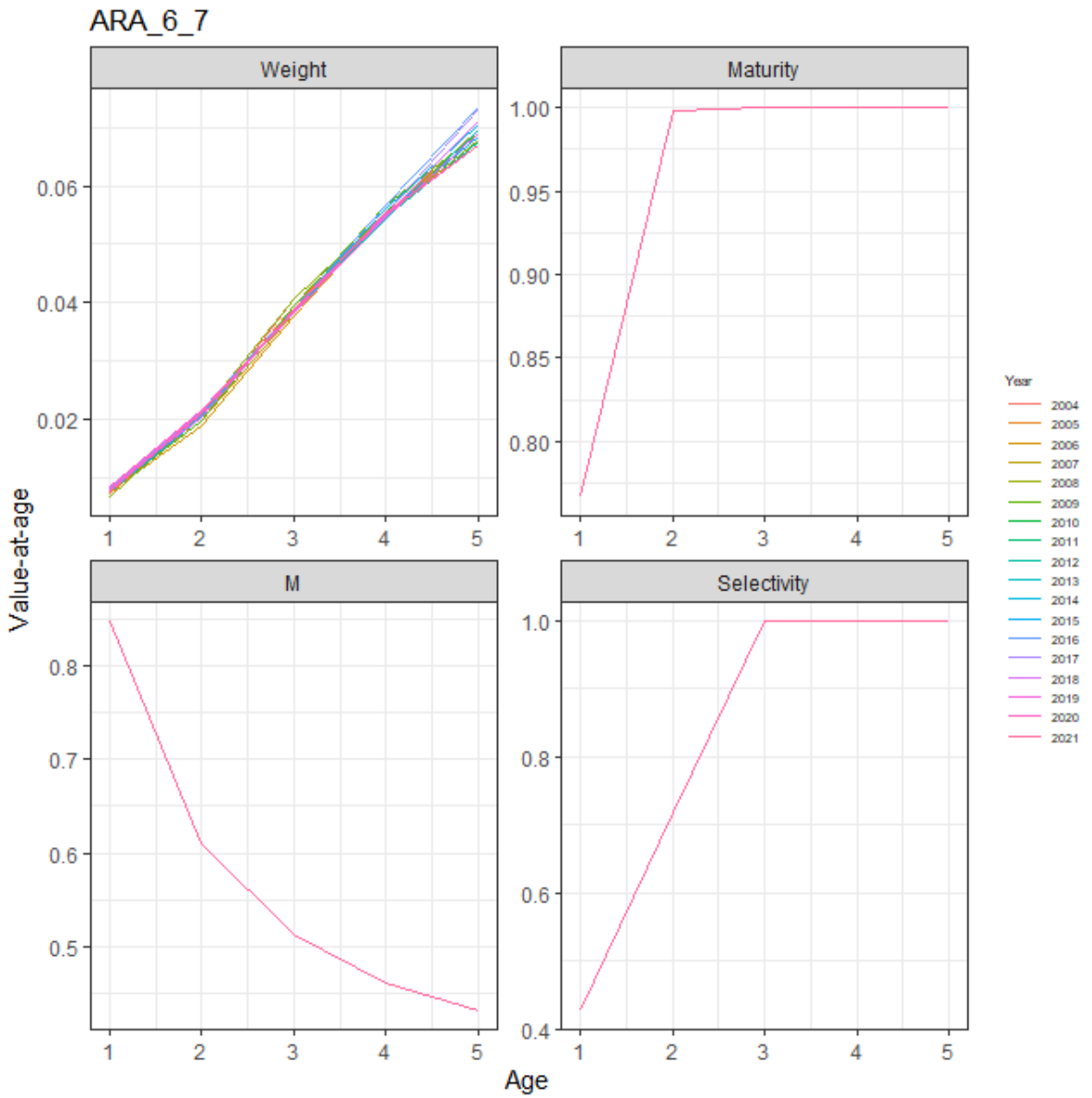
Source: own elaborations

Figure 6.17.4.3 Blue and red shrimp in GSA 6&7. Stock biology trajectories at age.



Source: own elaborations

Figure 6.17.4.4 Blue and red shrimp in GSA 6&7. Annual stock quantities at age: individual weights at age, fraction mature at age, natural mortality at age and selectivity at age in the fishery



Source: own elaborations

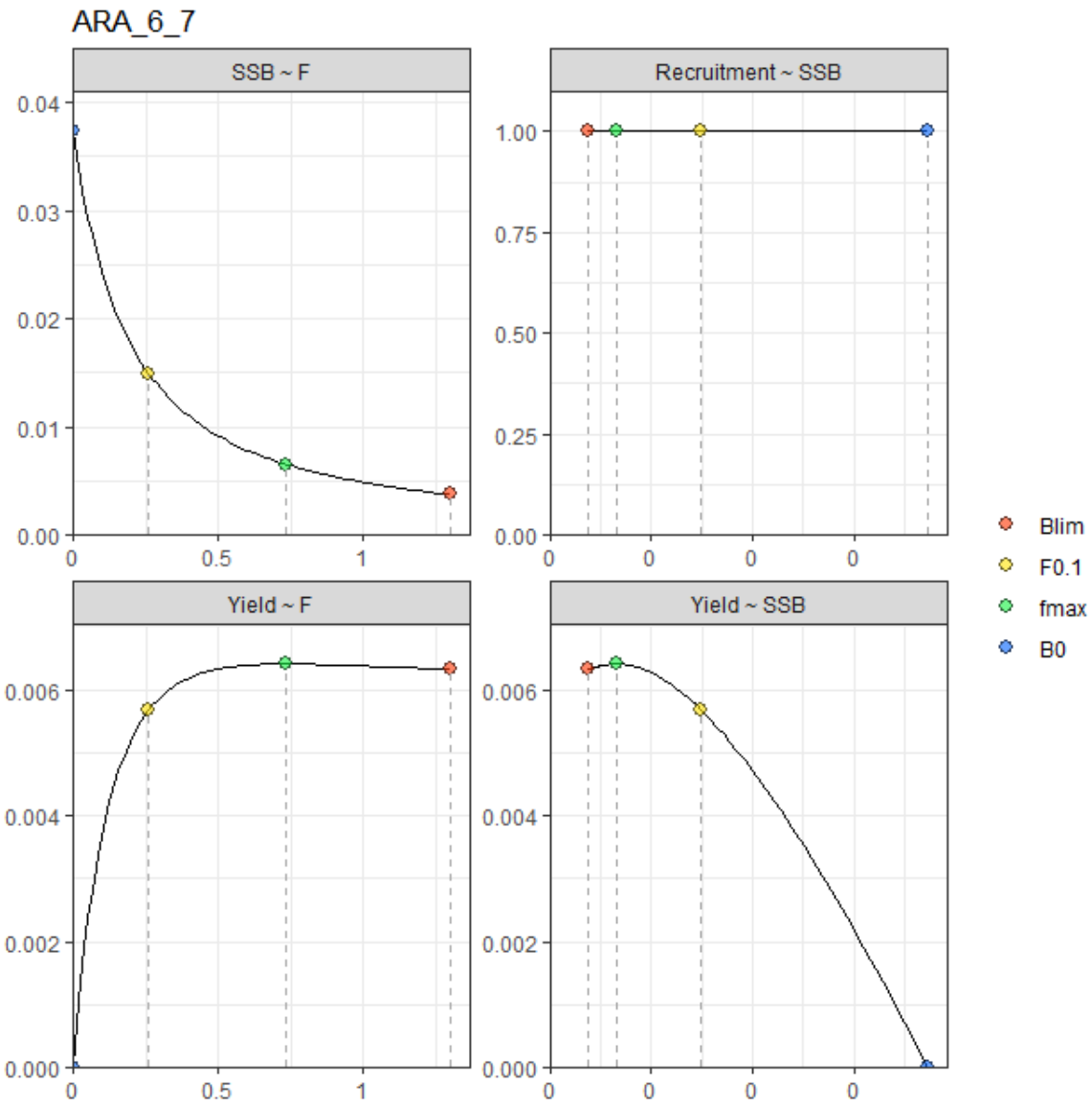
6.17.4.1 Exploratory analysis

An exploratory per-recruit analysis was performed using the stock object produced by EWG 22-09 containing the results of the a4a assessment. The per-recruit reference points of interest were computed from the stock object and are summarized in Table 6.17.4.1 and Figure 6.17.4.5.

Table 6.17.4.1 Blue and red shrimp in GSA 6&7. Per-recruit reference points.

F0.1	BF0.1	Blim	Flim	Yeq	B0
0.2604	0.0149	0.0037	1.3003	0.0057	0.0373

Figure 6.17.4.5 Blue and red shrimp in GSA 6&7. Per-recruit analysis.



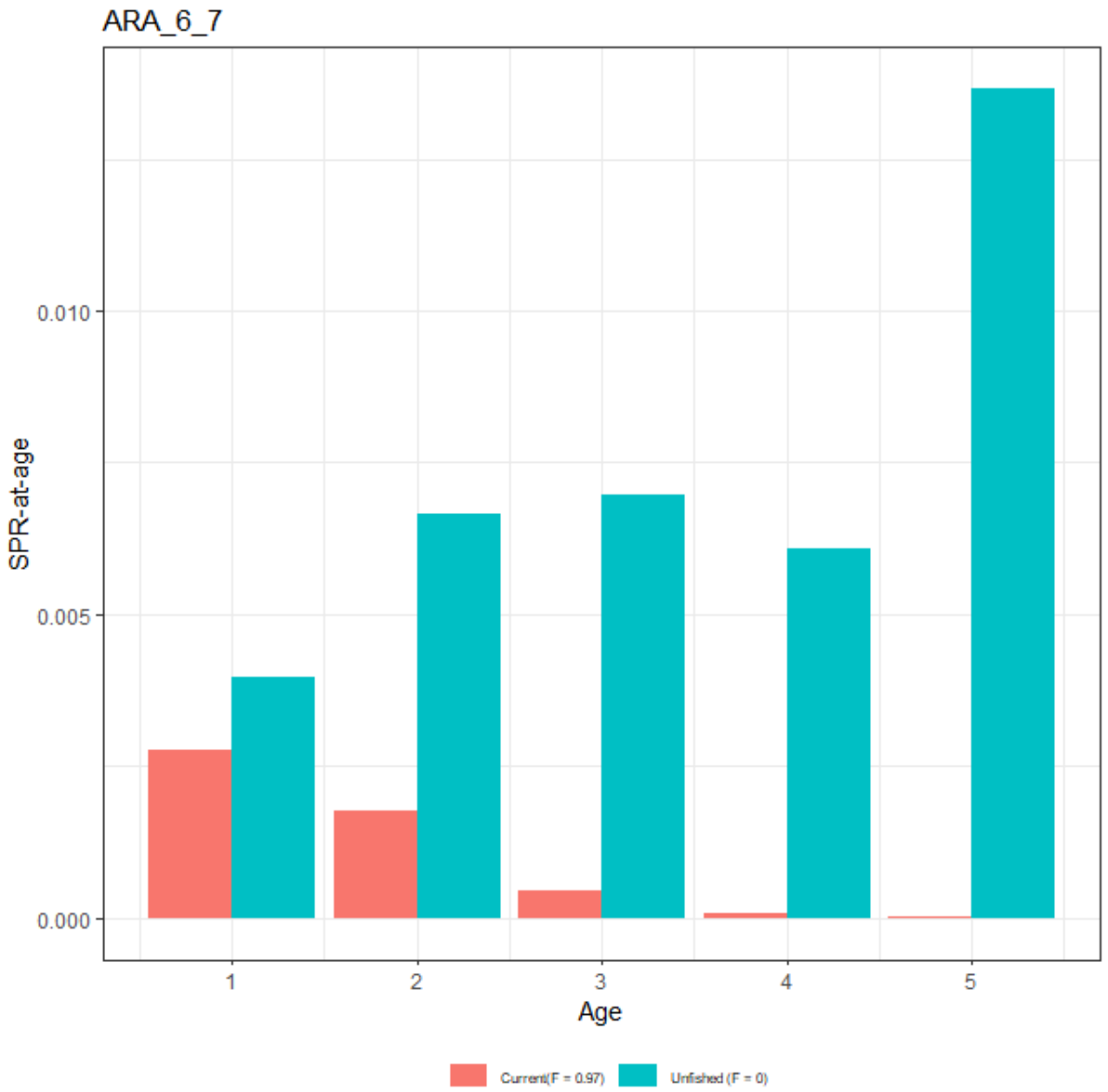
Source: own elaborations

Figure 6.17.4.6 Blue and red shrimp in GSA 6&7. Per-recruit analysis: outcomes of the a4a assessment relative to the per-recruit reference points.



Source: own elaborations

Figure 6.17.4.7 Blue and red shrimp in GSA 6&7. Comparison of the spawning biomass per recruit SPRF at current F (average of last 3 years) and SPR0 with F = 0.



Source: own elaborations

Initially four recruitment functions were explored, using the function ssrTBM in the package FLSRTMB:

1. Geometric Mean (model=geomean)
2. Hockey-Stick (model=segreg)
3. Beverton-Holt (model=bevholtSV)
4. Ricker (model=ricker)

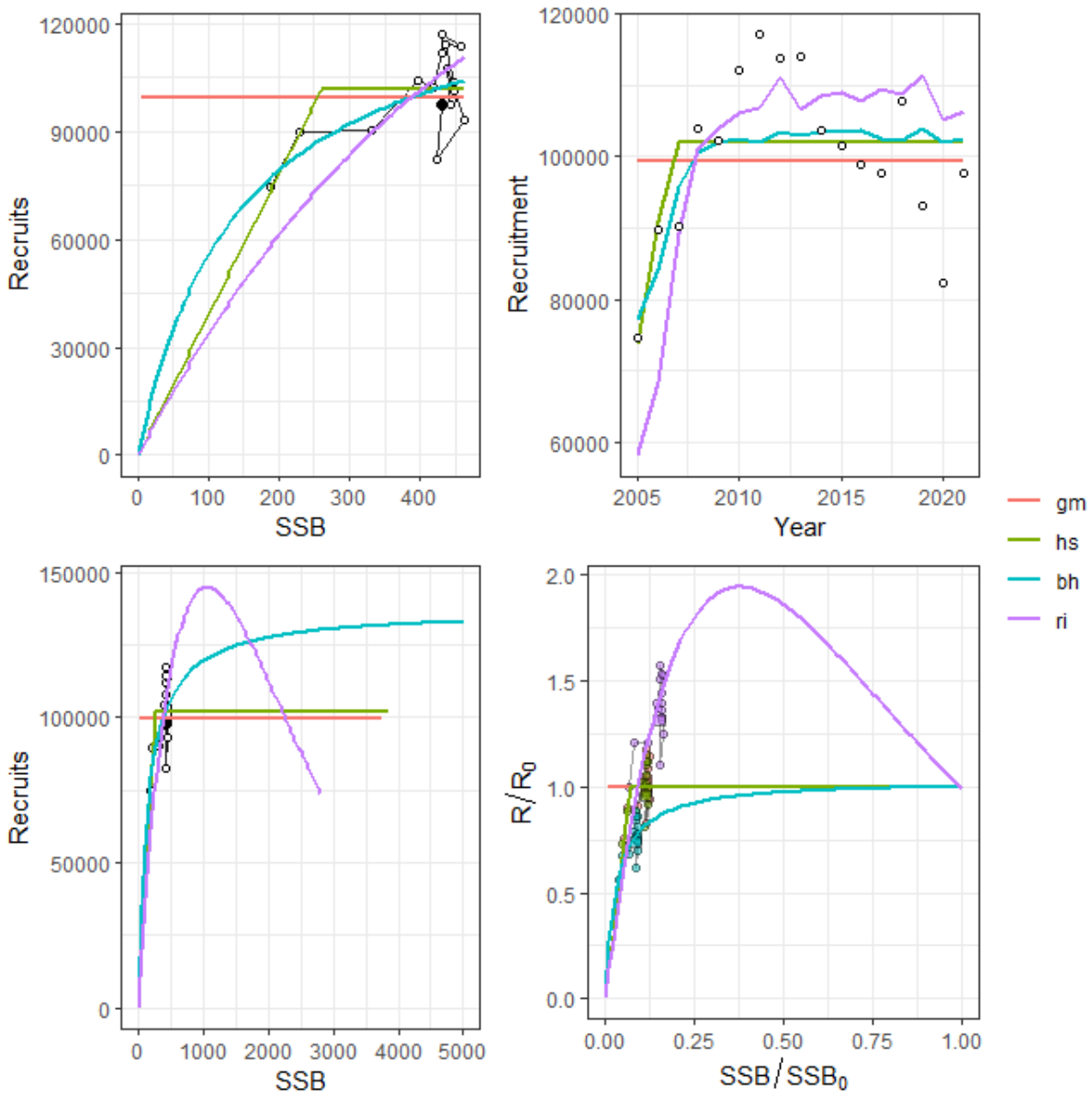
The Hockey-Stick was constrained to search for solutions of the break-point so that it falls within a lower bound (lplim) and upper bound (uplim) of spawning ratio potential SRPlim = SPRlim/SPR0. The initial bounds were chosen to be fairly on constrained for a range of SRPlim = SRP 0.1−20% by setting lplim=0.001 and uplim=0.2. In the initial fits of the Beverton-Holt and Ricker models steepness s and R0 were estimated given the input SPR0y.

Table 6.17.4.2 Blue and red shrimp in GSA 6&7. Stock summary from the final a4a model produced in STECF EWG 22-09.

	s	sigmaR	R_0	rho	B_0
Geometric mean	NA	0.12	99387.79	0.63	3744.79
Hockey-stick	NA	0.09	101991.60	0.50	3842.90
Beverton-Holt	0.90	0.09	132898.20	0.45	5007.41
Ricker	1.65	0.13	74620.87	0.67	2811.61

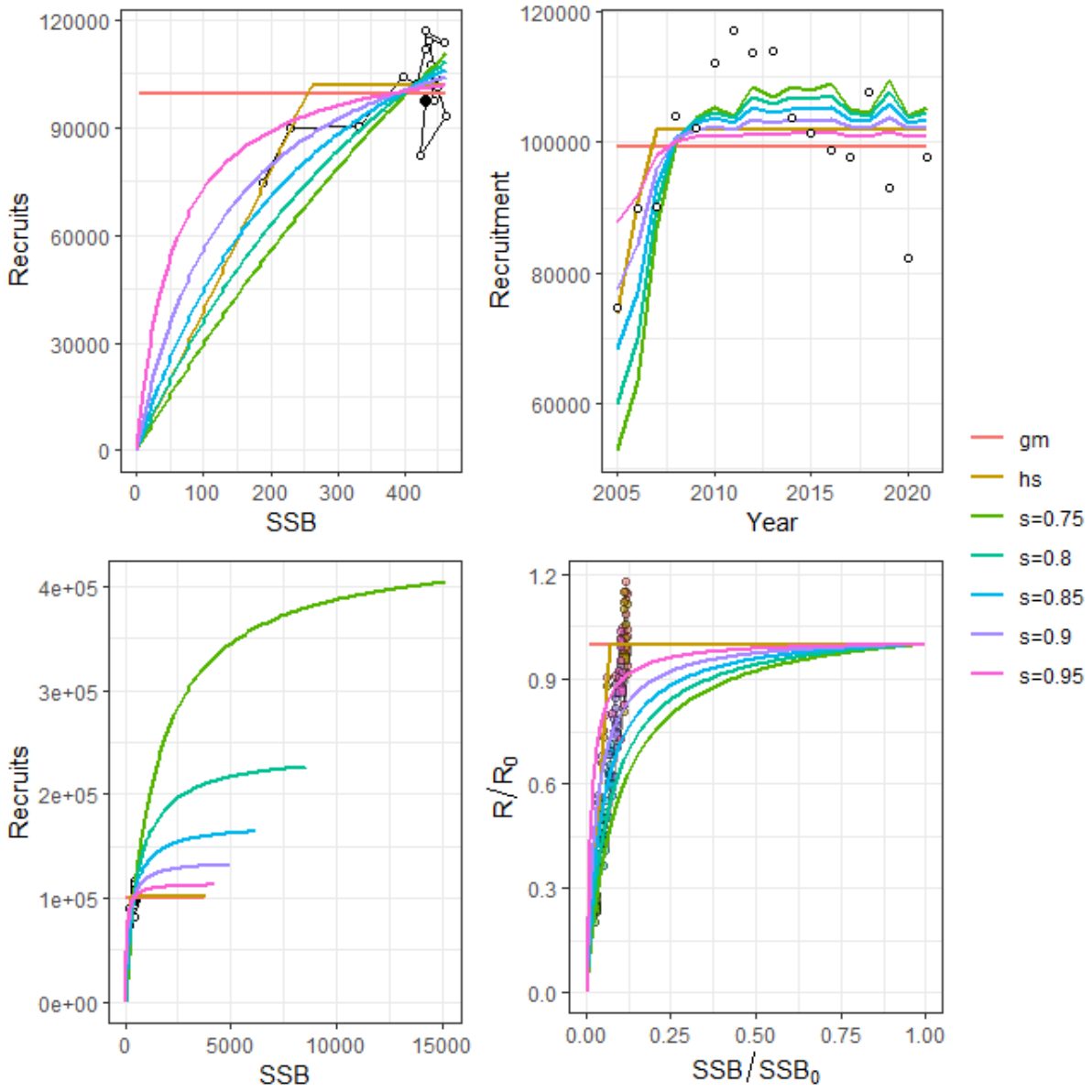
Source: own elaborations

Figure 6.17.4.8 Blue and red shrimp in GSA 6&7. Summary of the four SR models.



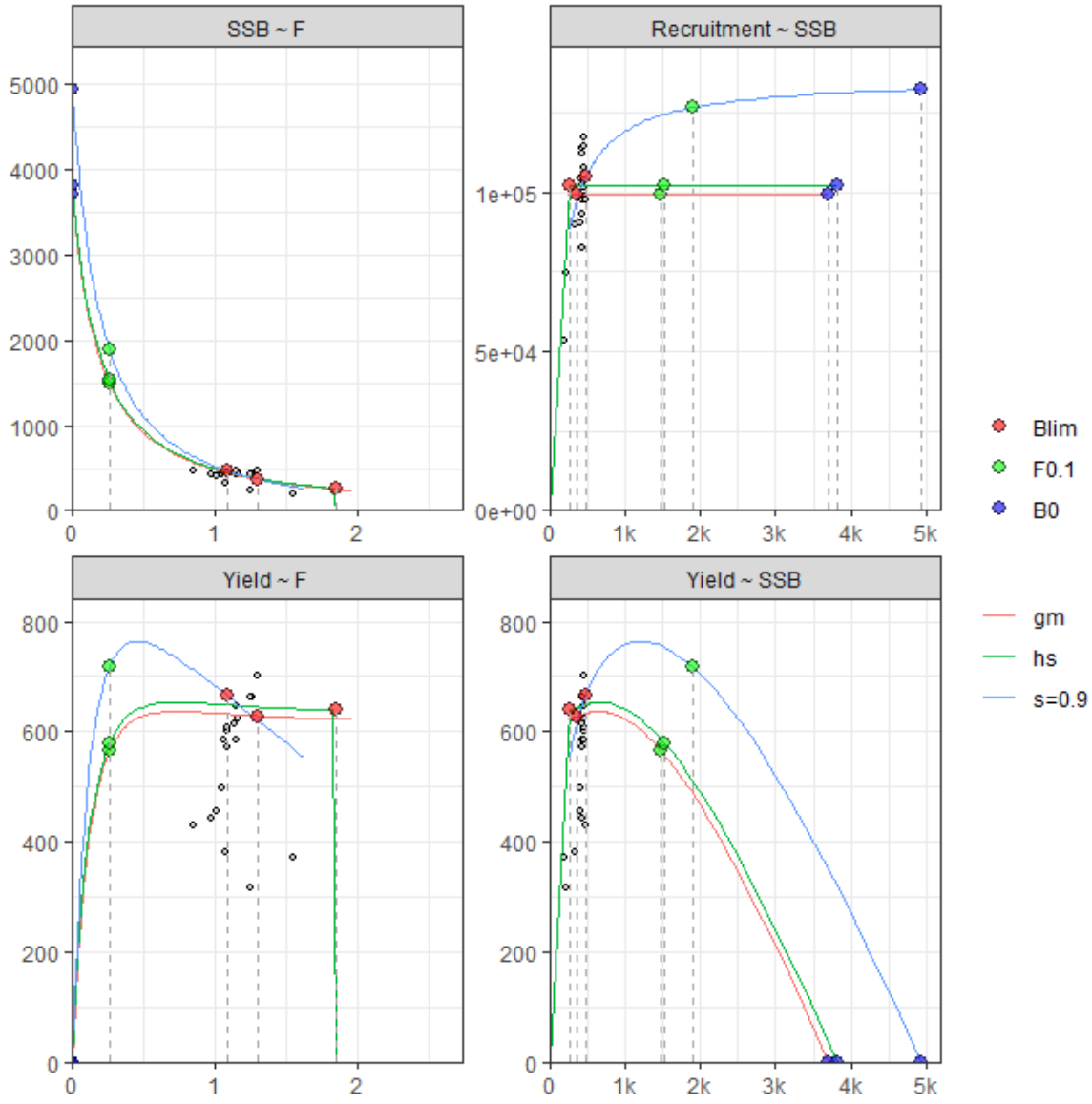
Source: own elaborations

Figure 6.17.4.9 Blue and red shrimp in GSA 6&7. Per-recruit analysis with different slope (s, steepness) scenarios for the Beverton-Holt model.



Source: own elaborations

Figure 6.17.4.10 Blue and red shrimp in GSA 6&7. Long Term equilibrium evaluations for different S-R models.



Source: own elaborations

6.17.4.3 Results

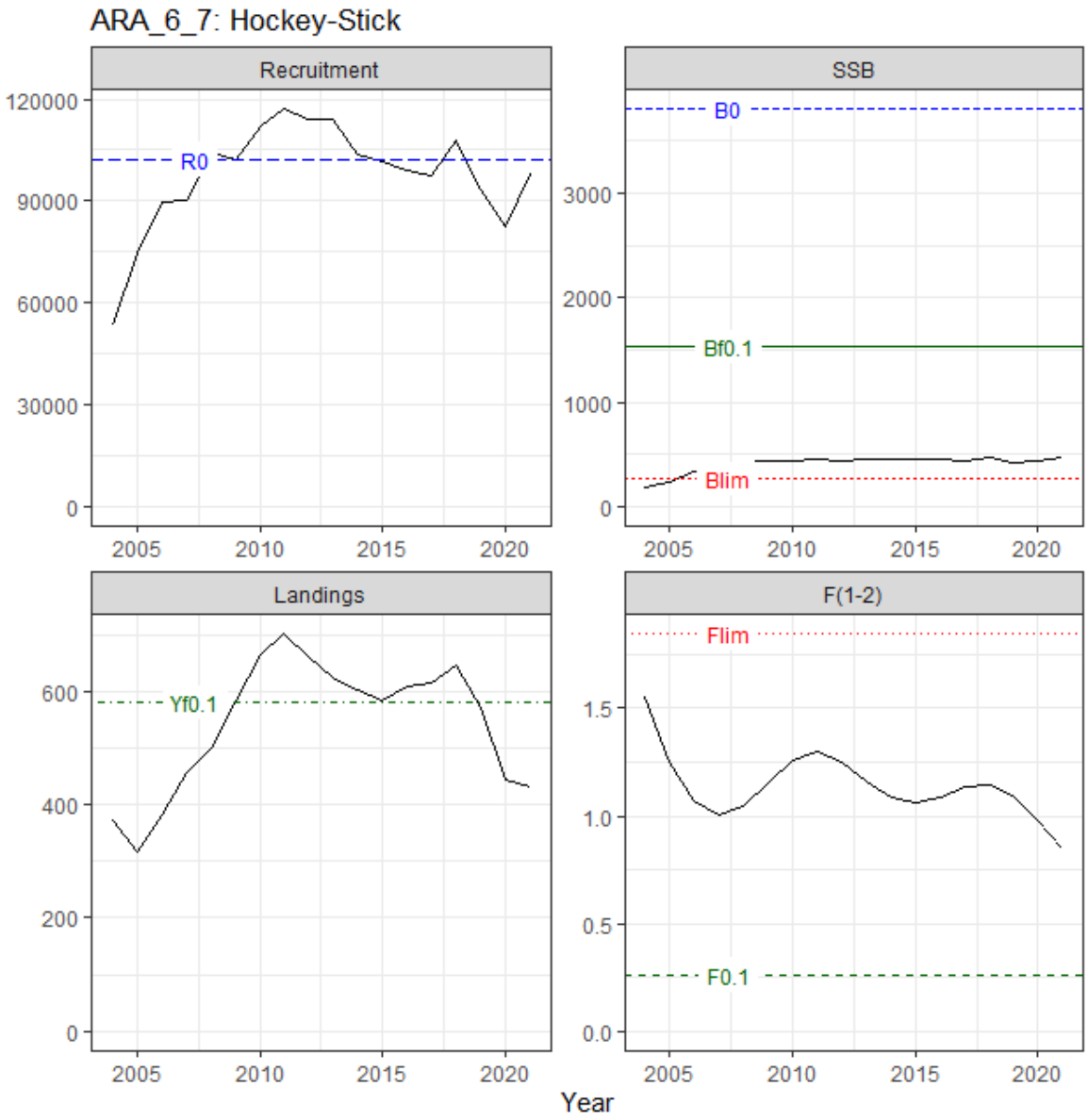
In the light of the outcomes of the exploratory analysis, it was decided to consider the HS model to provide reference points for the blue and red shrimp in GSA 6&7. Table 6.17.4.3 summaries the reference point values based on the Hockey-Stick model fitted to the data. Bpa is set to 2* BLim. Historic assessment information is shown in Figures 6.17.4.11 and 6.17.4.12.

Table 6.17.4.3 Blue and red shrimp in GSA 6&7. Final reference points based on Hockey-Stick stock recruit model fitted to the data.

$F_{0.1}$	B_{Lim}	B_{pa}	$B_{F0.1}$	B_0	Fpa
0.26	261	521	1520	3810	0.954

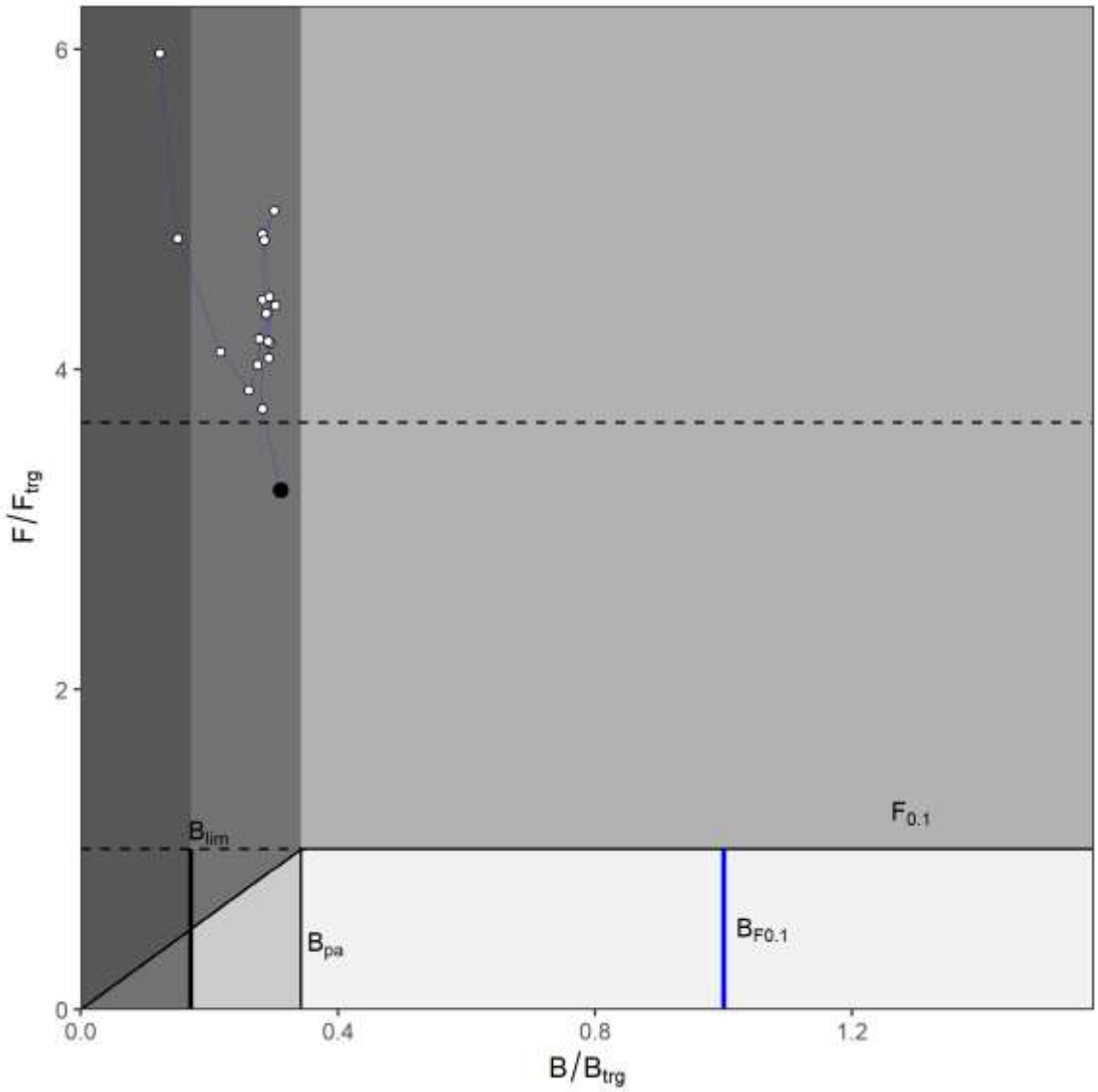
Source: own elaborations

Figure 6.17.4.11 Blue and red shrimp in GSA 6&7. Status Advice plot showing stock trajectories of Recruitment, SSB, F, Landings and Yield compared to the estimated reference points, based on a Hockey-Stick stock-recruitment relationship.



Source: own elaborations

Figure 6.17.4.12 Blue and red shrimp in GSA 6&7. Advice Rule plots, with BLim fitted to the data and Bpa = 2 BLim



Source: own elaborations

6.17.5 SHORT TERM FORECAST AND CATCH OPTIONS

6.17.5.1 Method

A deterministic short-term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age and maturity at age. while the $F_{bar1\text{-}2}$ =1.08 (the last year's F estimated by the assessment model) was used for F in 2023 as F shows a declining trend.

Table 6.17.5.1 Blue and red shrimp in GSAs 6 & 7: Assumptions made for the interim year and in the STF forecast.

Variable	Value	Notes
Default assumptions on biology	3	Number of years in which M, Mat, Mean weight, etc were averaged
Fages 1-2 (2024)	1.08	Fsq = F in the last year

SSB (2024)	428.9	SSB intermediate year from STF output
Rage1 (2024,2025)	102000	Recruitment will be set on Hockey Stick relationship
Total Catch (2024)	586.9	Catch intermediate year from STF output

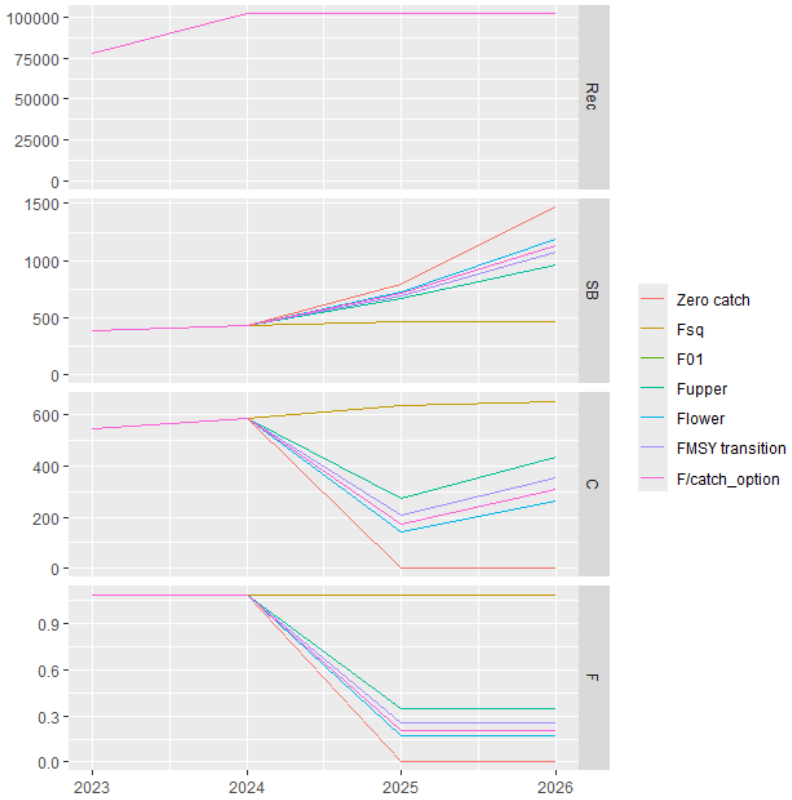
Source: own elaborations

6.17.5.2 Results

The results of the short-term forecasts for blue and red shrimp (GSA 6&7) are shown in Fig. 6.17.5.1. and Table 6.17.5.2.

The current level of fishing mortality (1.08) is more than 4 times the reference point F0.1, used as a proxy of FMSY (=0.26). This indicates that blue and red shrimp in GSA 6&7 is over exploited.

Figure 6.17.5.1 Blue and red shrimp in GSA 6&7. Annual catch scenarios and predictions of catch and SSB for blue and red shrimp (GSA 6&7).



Source: own elaborations

Table 6.17.5.2 Blue and red shrimp (ARA) in GSA 6&7. Short term forecast. Annual catch scenarios and predictions of catch and SSB. All weights are in tonnes.

Basis	Total catch* (2025)	F_{total}# (ages 1-2) (2025)	SSB (2026)	% SSB change***	% Catch change^
STECF advice basis					
F_{MSY}	208	0.25	1072	+150	-62
$F_{MSY\ Transition}$ ^^	208	0.25	1072	+150	-62
$F_{MSY\ Reduced}$ $B<B_{pa}$^^^	175	0.21	1130	+164	-68
$F_{MSY\ lower}$	145	0.17	1184	+176	-73
$F_{MSY\ upper}$**	275	0.35	959	+124	-50
Other scenarios					
Zero catch	0	0.00	1467	+242	-100
Status quo	637	1.08	468	+9	16
0.1	96	0.11	1276	+198	-83
0.2	182	0.22	1117	+161	-67
0.3	260	0.33	984	+129	-53
0.4	330	0.43	871	+103	-40
0.5	394	0.54	775	+81	-28
0.6	452	0.65	694	+62	-17
0.7	504	0.76	624	+46	-8
0.8	552	0.87	565	+32	+1
0.9	596	0.98	513	+20	+9
1.1	674	1.19	429	0	+23
1.2	707	1.30	395	-8	+29
1.3	739	1.41	365	-15	+35
1.4	767	1.52	338	-21	+40

*SSB at mid-year

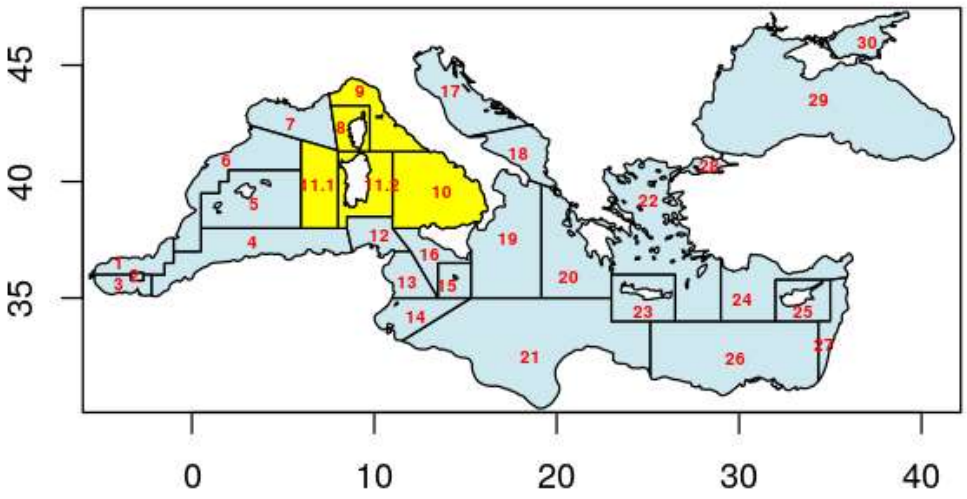
Source: own elaborations

6.18 BLUE AND RED SHRIMP IN GSAS 8, 9, 10 AND 11

6.18.1 STOCK IDENTITY AND BIOLOGY

STECF EWG 24-10 was asked to assess the state of Blue and red shrimp in the GSAs 8, 9, 10 and 11.

Figure 6.18.1.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Geographical location of GSAs 8, 9, 10 and 11.



Source: own elaborations

The growth of blue and red shrimp (*Aristeus antennatus*) has been studied in GSA9 using model progression analysis (Colloca et al. 1998; Orsi Relini and Relini 1998). Data on recruitment from the Ligurian Sea (Orsi Relini and Relini, 1998) and results of tagging studies (Relini et al. 2000, 2004) provided the basis for an interpretation of growth in which the possible life span of blue and red shrimp is 8-10 years.

The following sets of Von Bertalanffy growth parameters (VBGP) are available in the literature (Orsi Relini and Relini 1998) and have been used in the present assessment to comply with the previous ones (STECF EWG 19-10, STECF EWG 20-09, STECF EWG 21-11):

Females: L_∞= 76.9, K=0.21, t_0=-0.02 and

Males: L_∞= 46, K=0.21, t_0=-0.02.

These growth parameters were confirmed recently (Orsi Relini and Mannini, 2011; Orsi Relini et al., 2013) and are very close to the ones available in DCF biological dataset. STECF EWG 24-10 used the above set of growth parameters to convert catch in length into age (Figure 6.18.1.2).

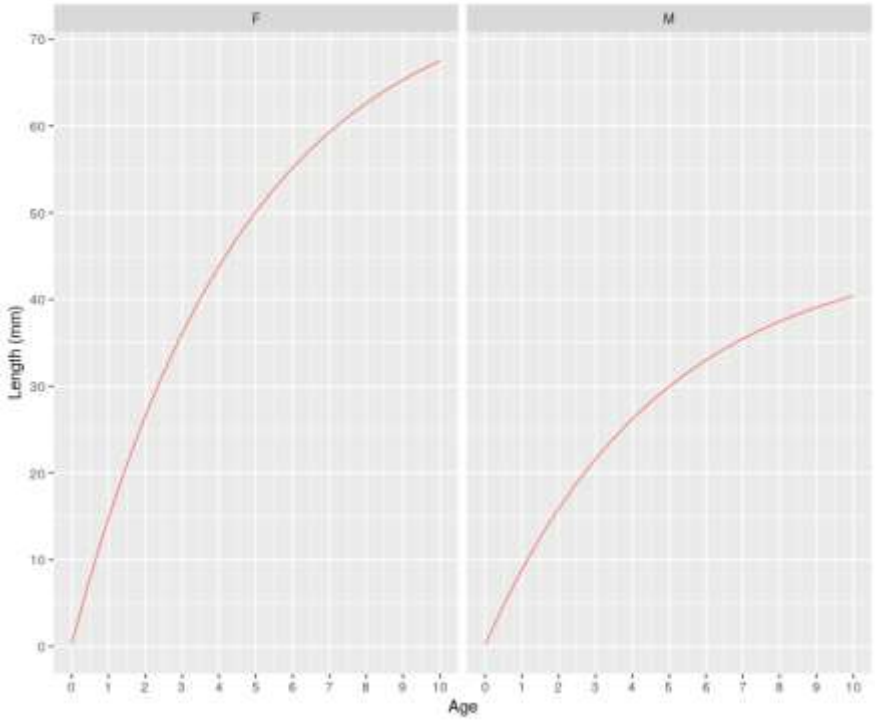
As in previous years as input for the assessment the median values of *a* and *b* from GSA9 (Figure 6.18.1.3) were used (STECF EWG 19-10, STECF EWG 20-09, STECF EWG 21-11).

The VBGF and LW relationship parameters used are summarized in the following Table (Tab. 6.18.1.1).

The spawning season, although with some regional differences in the Mediterranean Sea, is somewhat extended, starting in spring (April), peaking in summer (July-August), when most of

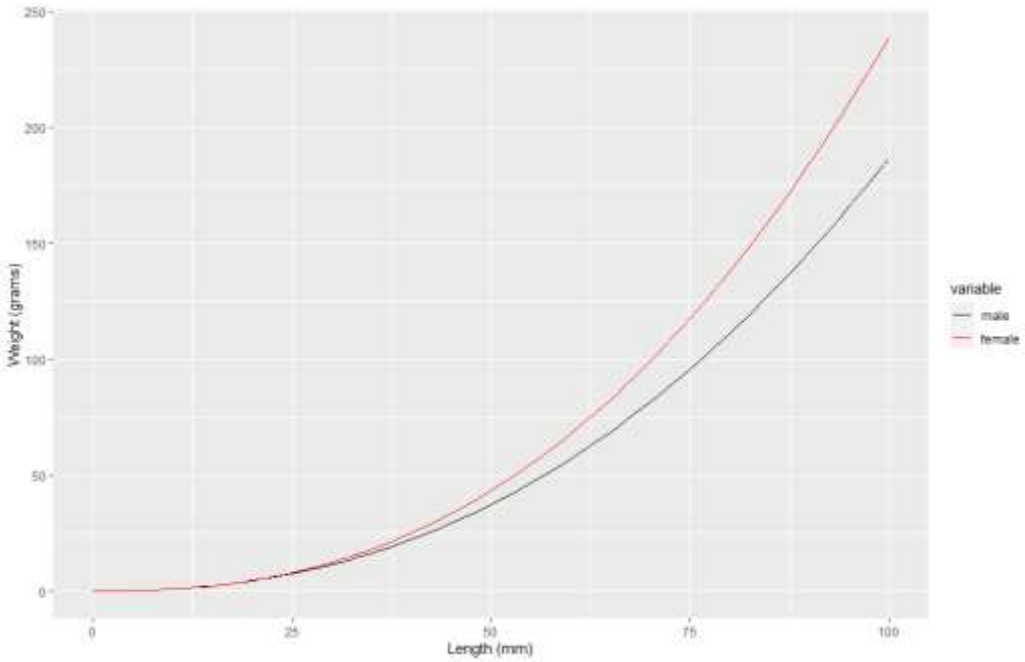
the females reach sexual maturity, and ending in autumn (October-November) (Orsi Relini and Relini, 1979; Orsi Relini and Pestarino, 1981; Colloca et al., 1998). Based on this, the proportions of F and M before spawning were set to 0.5 in the assessment model.

Figure 6.18.1.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Von Bertalanffy growth curves by sex used in the assessment (Orsi Relini and Relini, 1998).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.1.3. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length weight relationship by sex used in the assessment.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.18.1.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Growth parameters and length-weight relationship parameters used in the assessment.

GSA	Sex	L_{inf}	k	t_0	a	b
8_9_10_11	M	46.0	0.21	-0.02	0.0042	2.3237
	F	76.9	0.21	-0.02	0.0028	2.4652

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

The maturity vector was taken from previous year assessments (STECF EWG 19-10, STECF EWG 20-09, STECF EWG 21-11) (Table 6.18.1.2) and natural mortality vector was computed using Chen & Watanabe formula (Table 6.18.1.3) based on the same VBGF parameters reported above.

Table 6.18.1.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Maturity vector used in the assessment.

Maturity	0	1	2	3	4	5	6+
GSAs 8_9_10_11	0	0.204	0.786	0.983	0.999	1.000	1.000

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.18.1.3. Blue and red shrimp in GSAs 8, 9, 10 and 11. Natural mortality vectors used in the assessment.

M	0	1	2	3	4	5	6+
GSAs 8_9_10_11	2.023	0.768	0.511	0.402	0.342	0.301	0.281

Source: own elaborations

6.18.2 DATA

6.18.2.1 CATCH (LANDINGS AND DISCARDS)

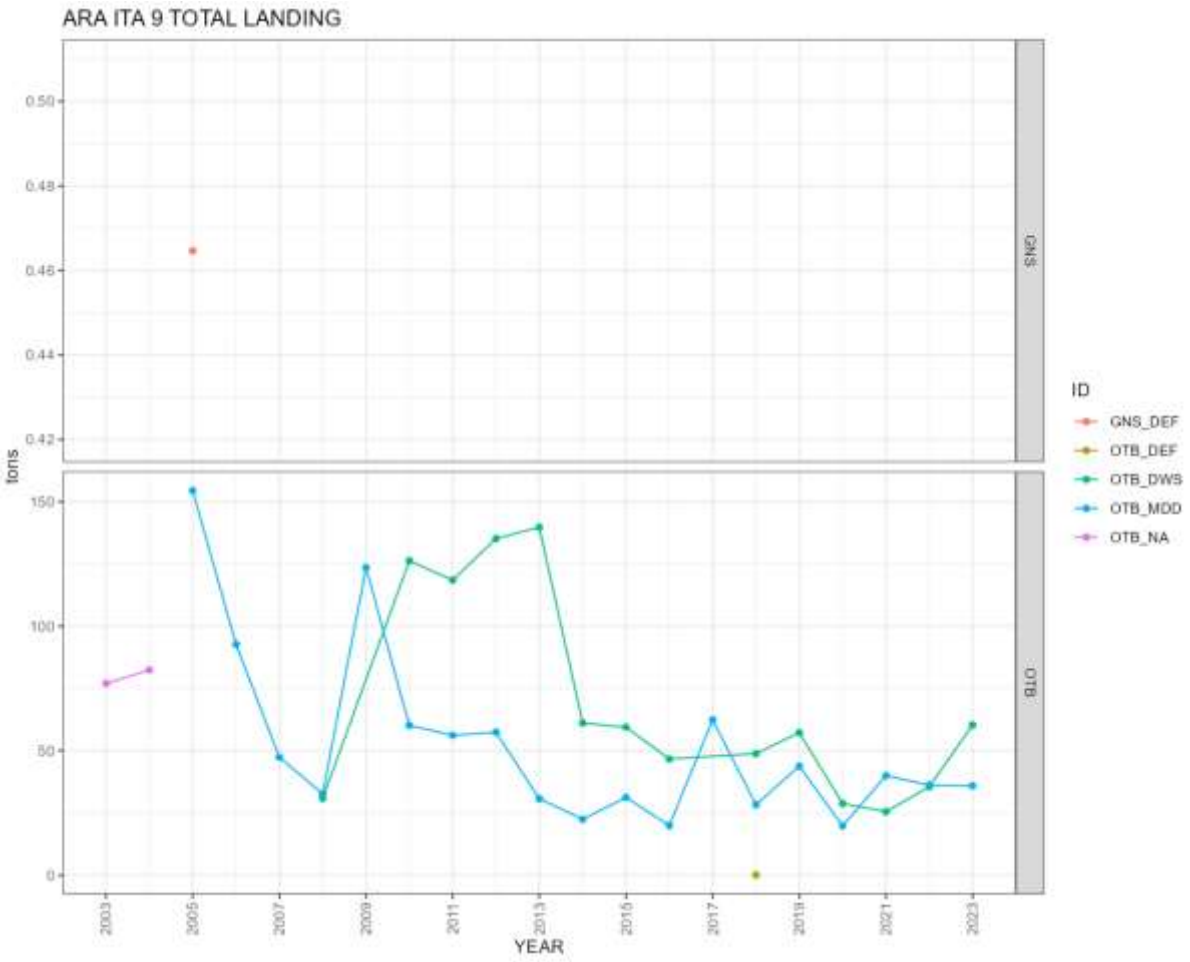
The blue and red shrimp is one of the most important target species of the fishery carried out on the muddy bottoms of the upper and middle slope. The species is almost exclusively exploited by bottom trawlers. In the past, in particular in GSA 10 there was a Gillnet fleet (GNS) targeting ARA associated with very low landings (less than 1.5 t). Sporadic landings are reported for FPO, GTR and OTM.

Landings

Landings data were reported to STECF EWG 24-10 through the DCF. Landings data by year, GSA and fleet are presented in Figures 6.18.2.1.1-3, total landings by year and GSA are presented in Table 6.18.2.1.1. In all GSAs most of the landings come from otter trawls. DCF data coming from other gear were considered inaccurate or sampled inconsistently; anyway, their catches were included in the stock assessment due to the low amounts. GSA 8 reported catches only in 2010, 2011, 2022 and 2023.

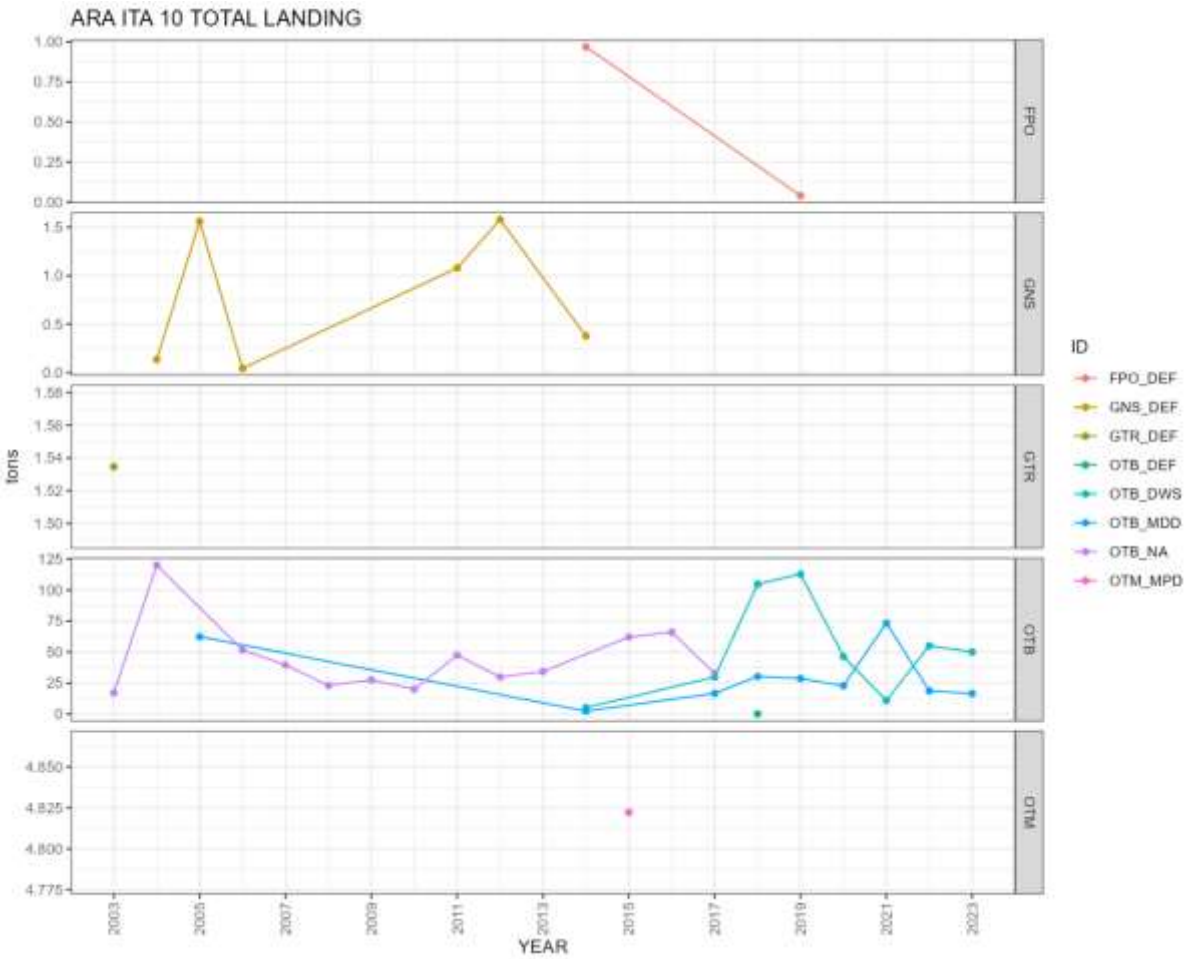
Data from GSA 10 in 2020 did not correspond between the MEDBS and the FDI datacall, therefore the values from the FDI datacall were used in the assessment process.

Figure 6.18.2.1.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Landings data in tonnes by year, area and fleet in GSA 9.



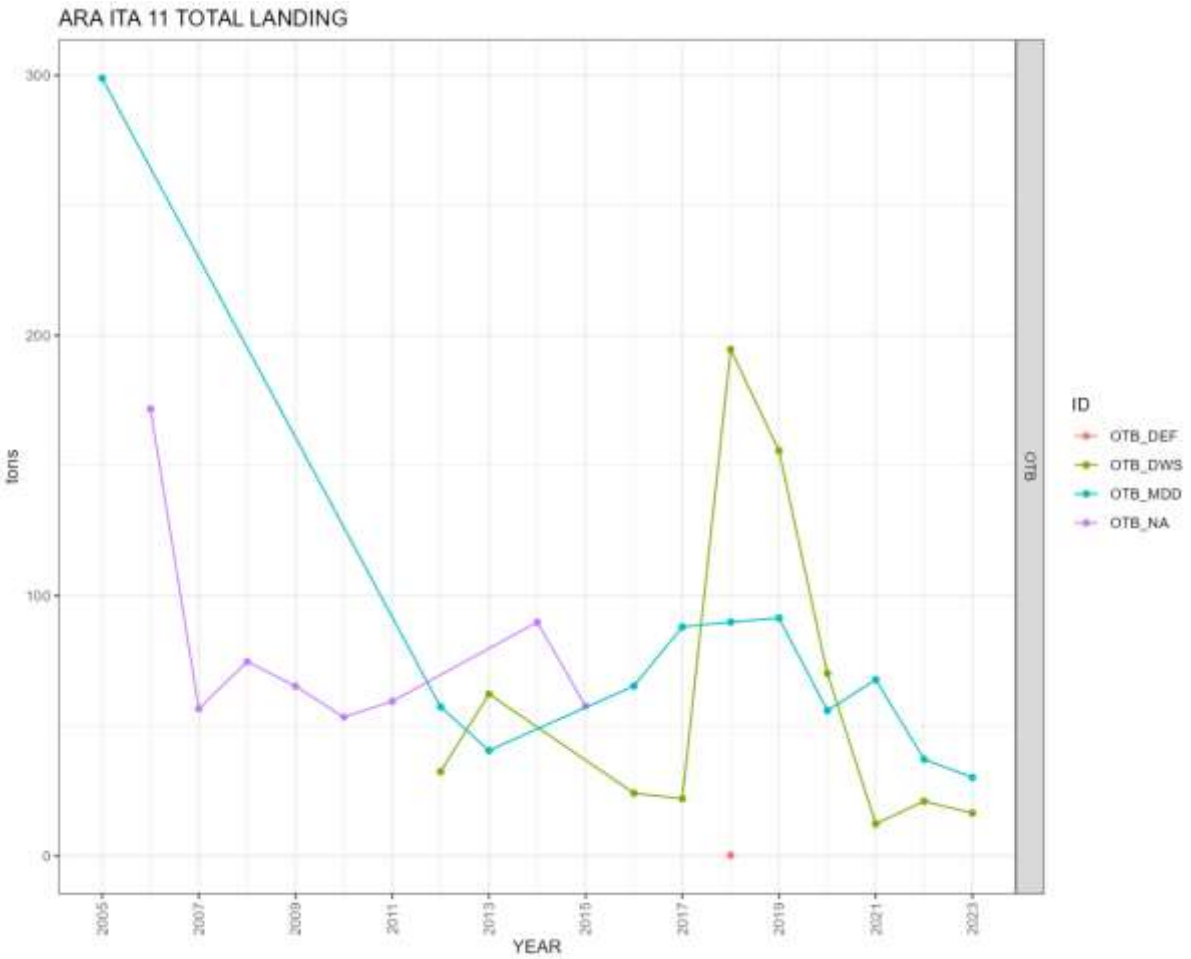
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.2.1.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Landings data in tonnes by year, area and fleet in GSA 10.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.2.1.3. Blue and red shrimp in GSAs 8, 9, 10 and 11. Landings data in tonnes by year, area and fleet in GSA 11.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.18.2.1.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Landings data in tonnes by year and GSA.

Year	FRANCE GSA8	ITALY GSA9	ITALY GSA10	ITALY GSA11	Total landings
2003	-	77	19	-	95**
2004	-	82	120	-	203**
2005	-	155	64	98	317
2006	-	93	52	172	316
2007	-	47	39	57	143
2008	-	63	23	75	161
2009	-	123	27	65	216
2010	3.5	186	20	53	263***
2011	4.3	175	48	59	287***
2012	-	193	31	57	281
2013	-	170	34	103	307

2014	-	84	9	90	182
2015	-	91	67	58	215
2016	-	67	66	89	222
2017	-	62	79	110	252
2018	-	77	135	285	497
2019	-	101	141	247	490
2020	-	49	83*	126	257
2021	-	65	84	80	230
2022	3.5	72	74	58	203***
2023	5.5	96	67	47	210***

* Data for 2020 from FDI data.

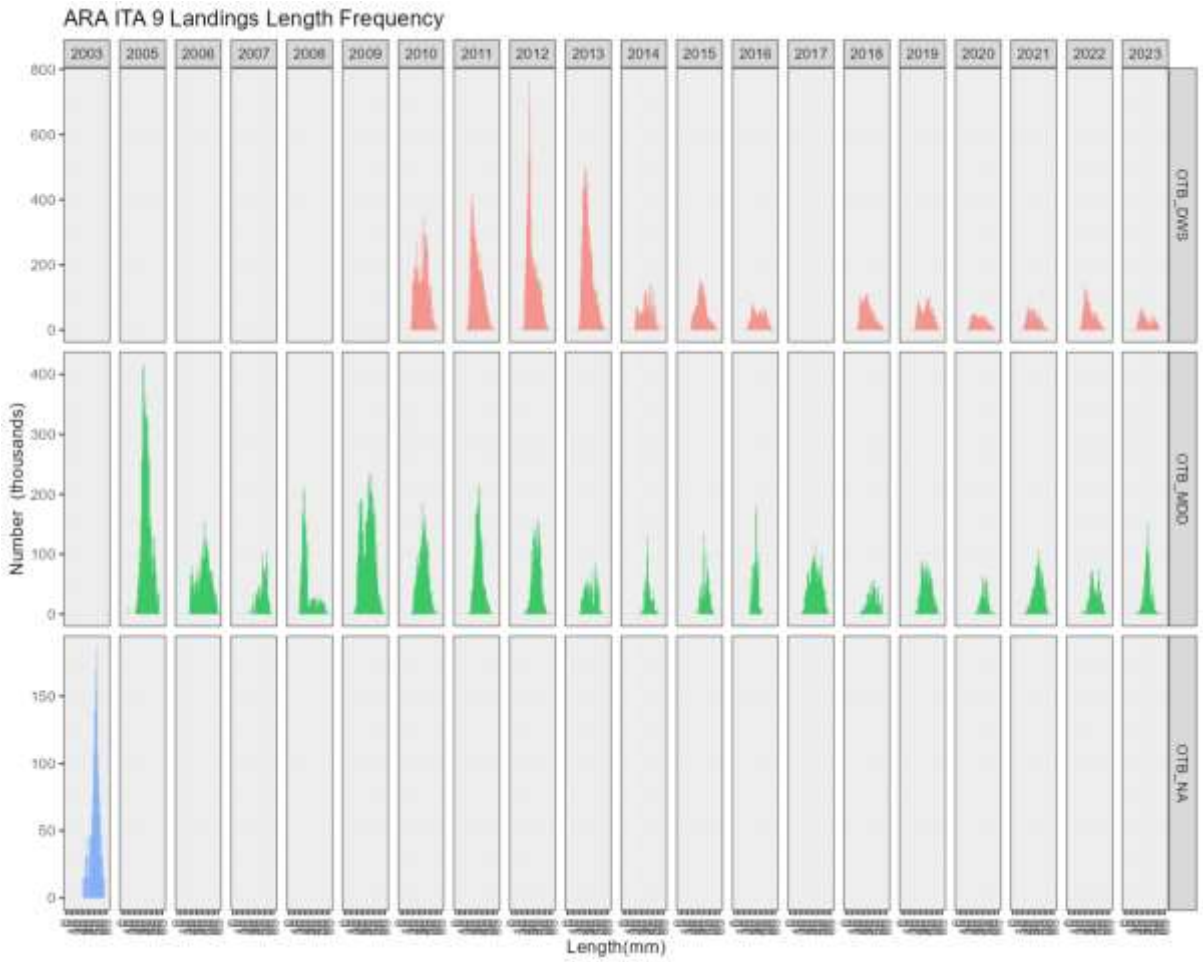
** Incomplete

*** Includes GSA 8

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Length frequency distribution of the landings by year, GSA and fleet from the DCF database are presented in Figures 6.2.1.2.1.4-6.

Figure 6.18.2.1.4. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution of the landings by year and fleet in GSA 9.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.2.1.5. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution of the landings by year and fleet in GSA 10.

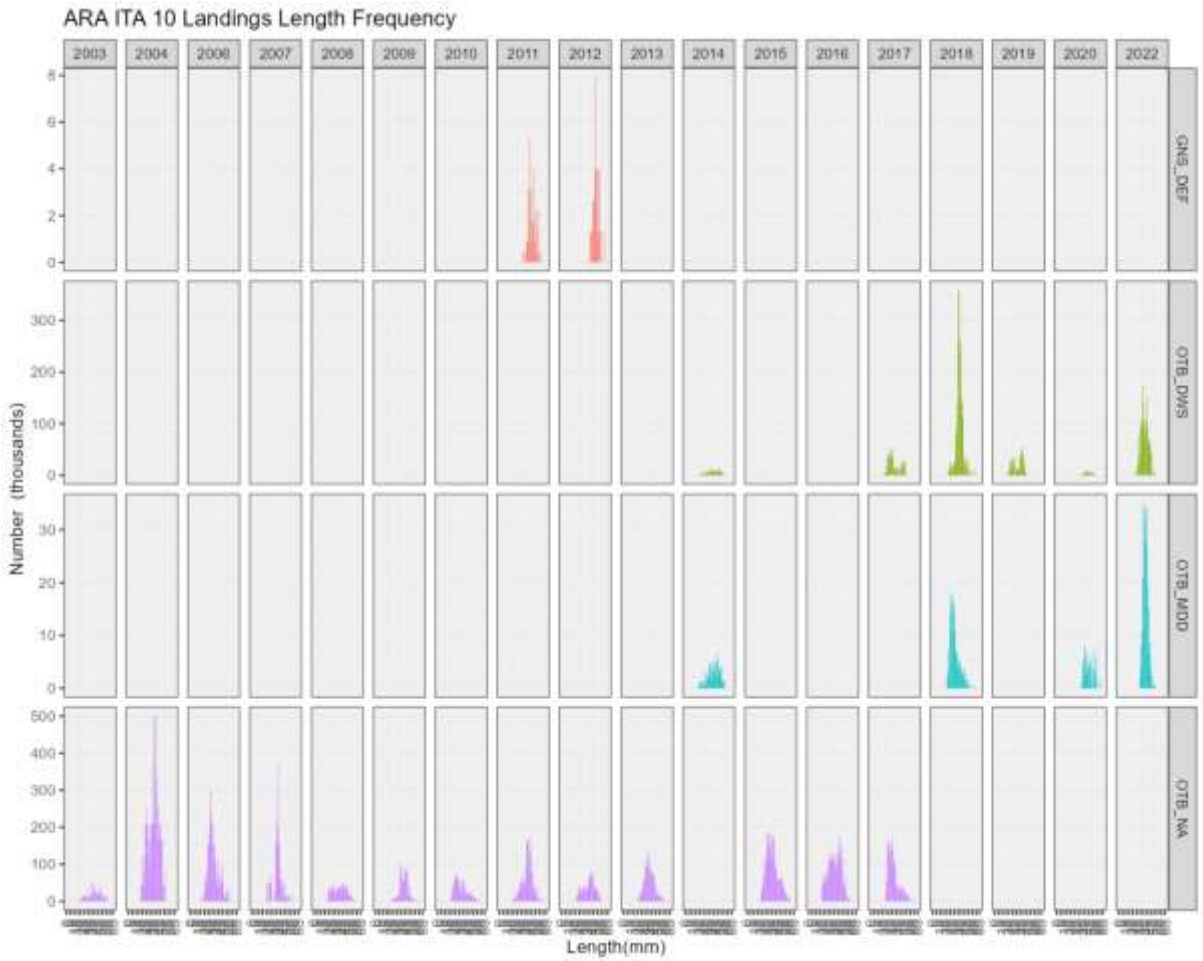
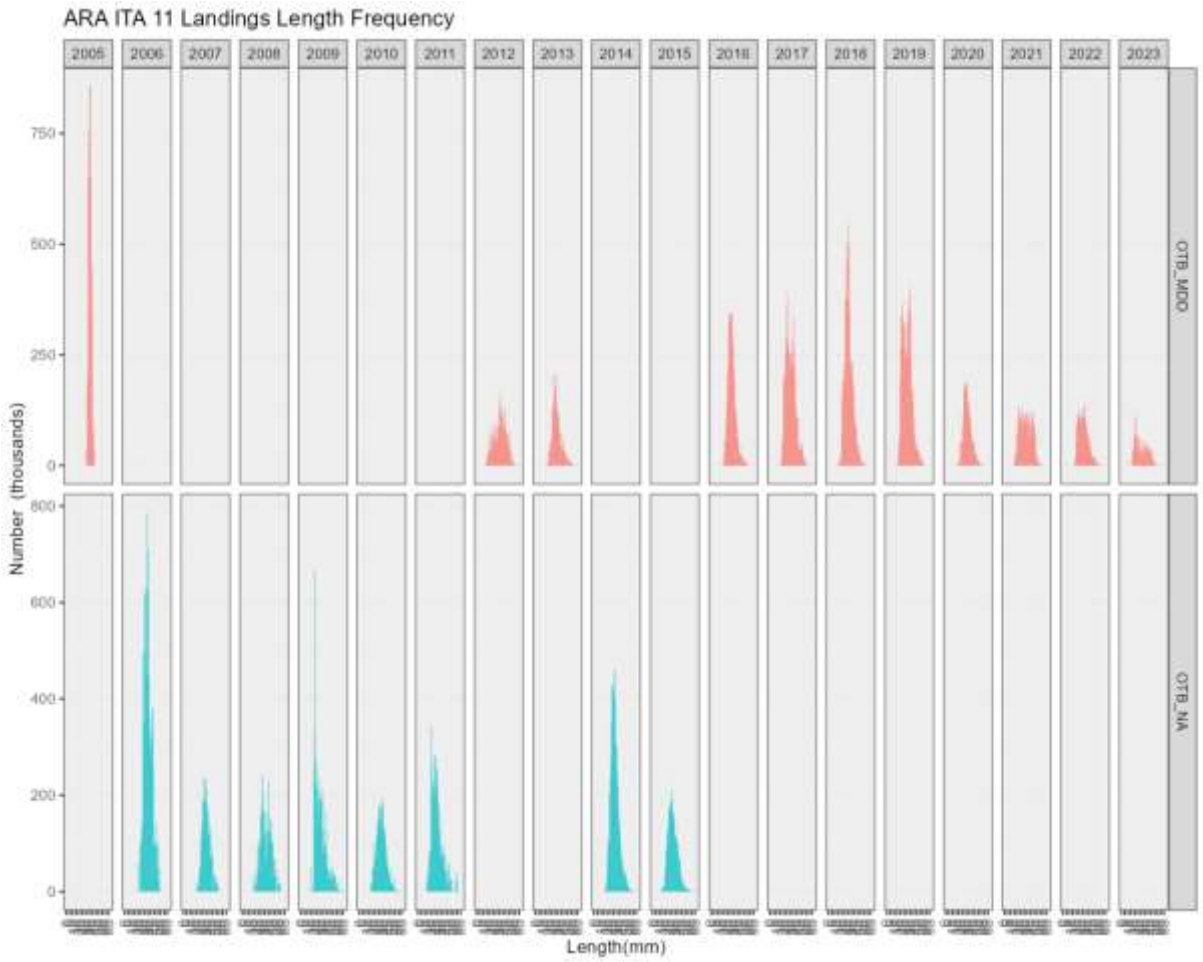


Figure 6.18.2.1.6. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution of the landings by year and fleet in GSA 11.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

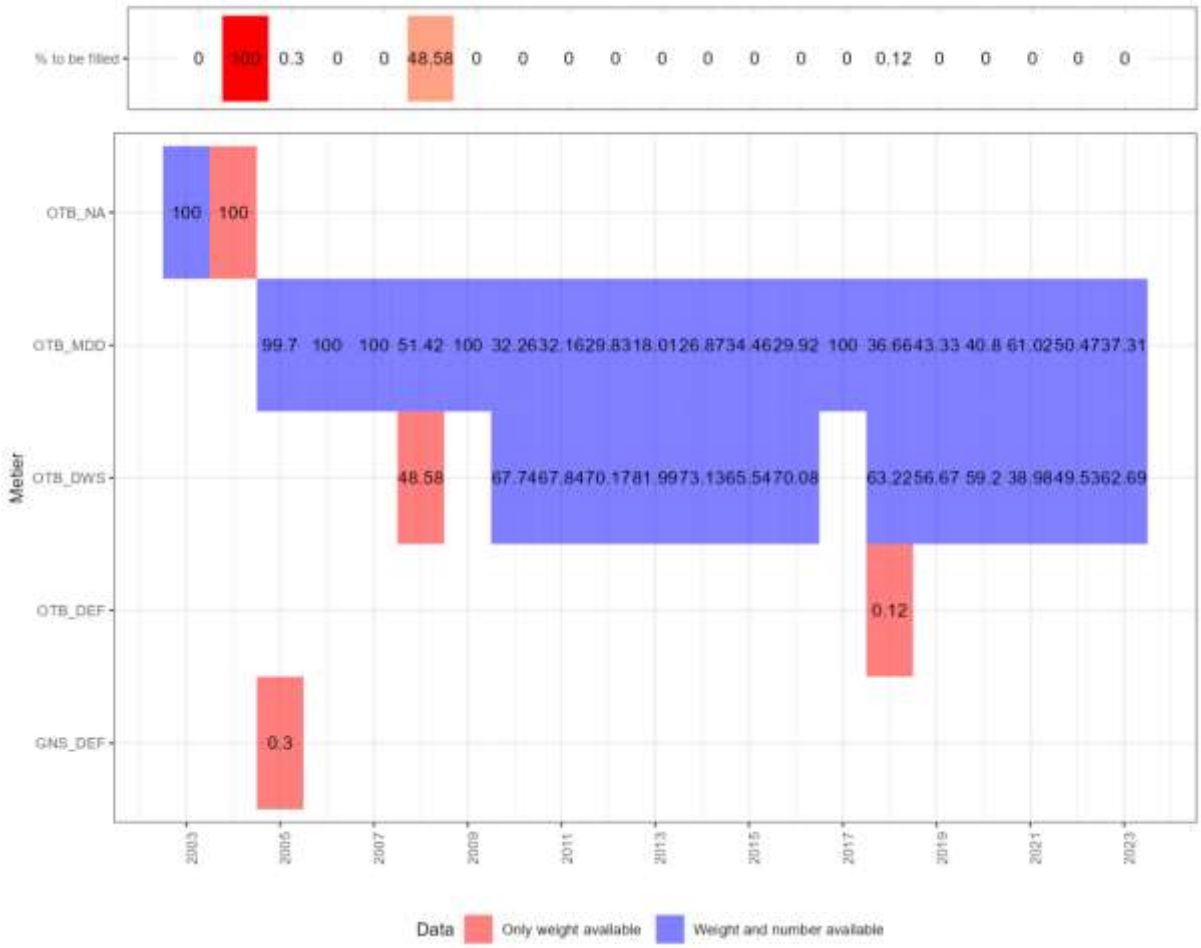
In GSA 9, length frequency distributions were not available for 2004.

In GSA 10, length frequency distributions were not available for 2003, 2005, 2021 and 2023. For the period 2018-2020 the length frequency distribution is provided for a very low percentage of the landings.

In GSA 11, length frequency distributions for OTB_DWS were not available for any year with landings associated.

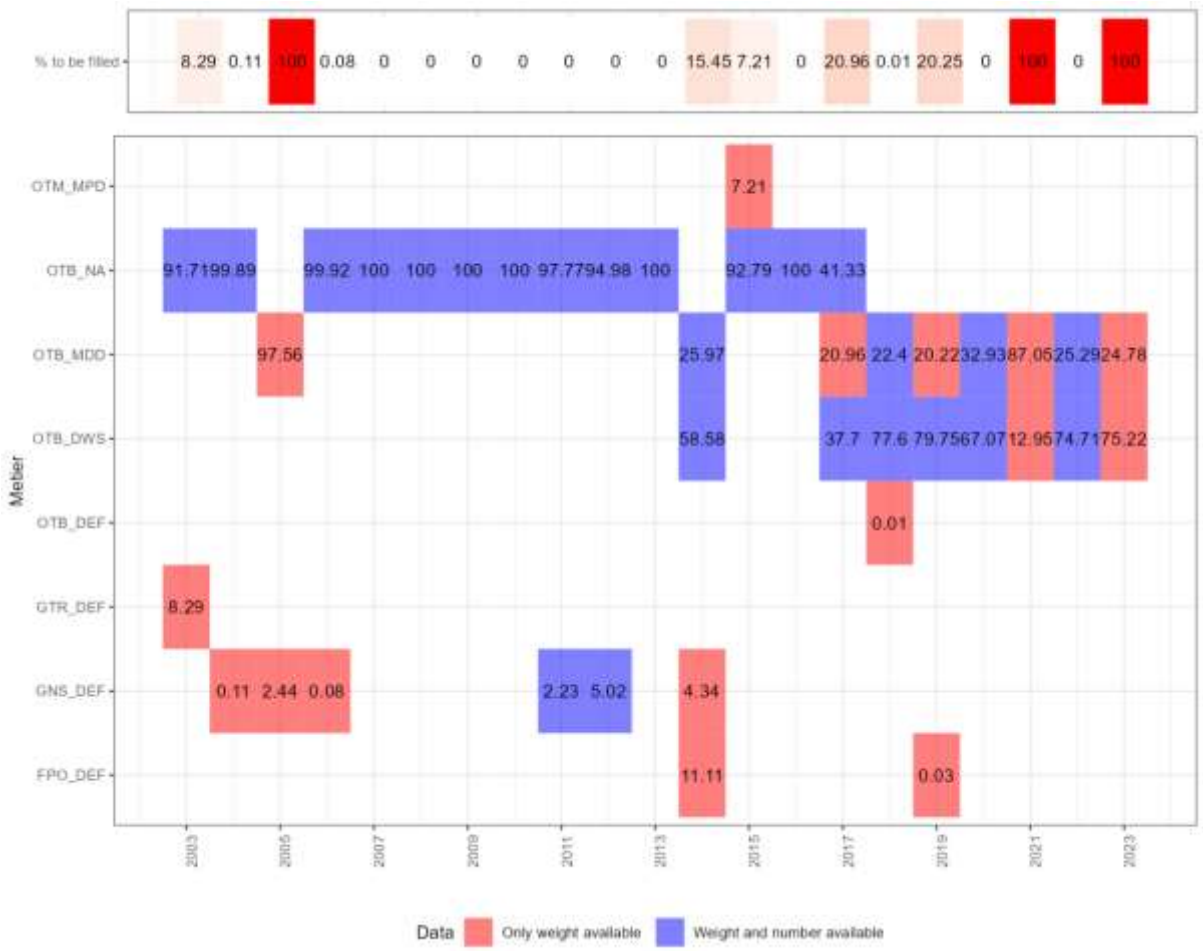
The group decided to fill the missing length frequency distributions for the metiers without any length information raising to the production instead of reconstructing LFDs. Raising of the landings from the metiers with partial length frequency distributions was performed together with the SOP correction. Missing length frequency distribution of the landings by year and fleet are presented in Figures 6.2.1.2.1.7-12.

Figure 6.18.2.1.7. Blue and red shrimp in GSAs 8, 9, 10 and 11. Missing length frequency distribution of the landings by year and fleet for GSA 9. The upper panel (single row) shows the total percentage of the weight to be reconstructed over total landings per year. The lower panel shows the percentage of the weight of each metier to be reconstructed over total landings per year.



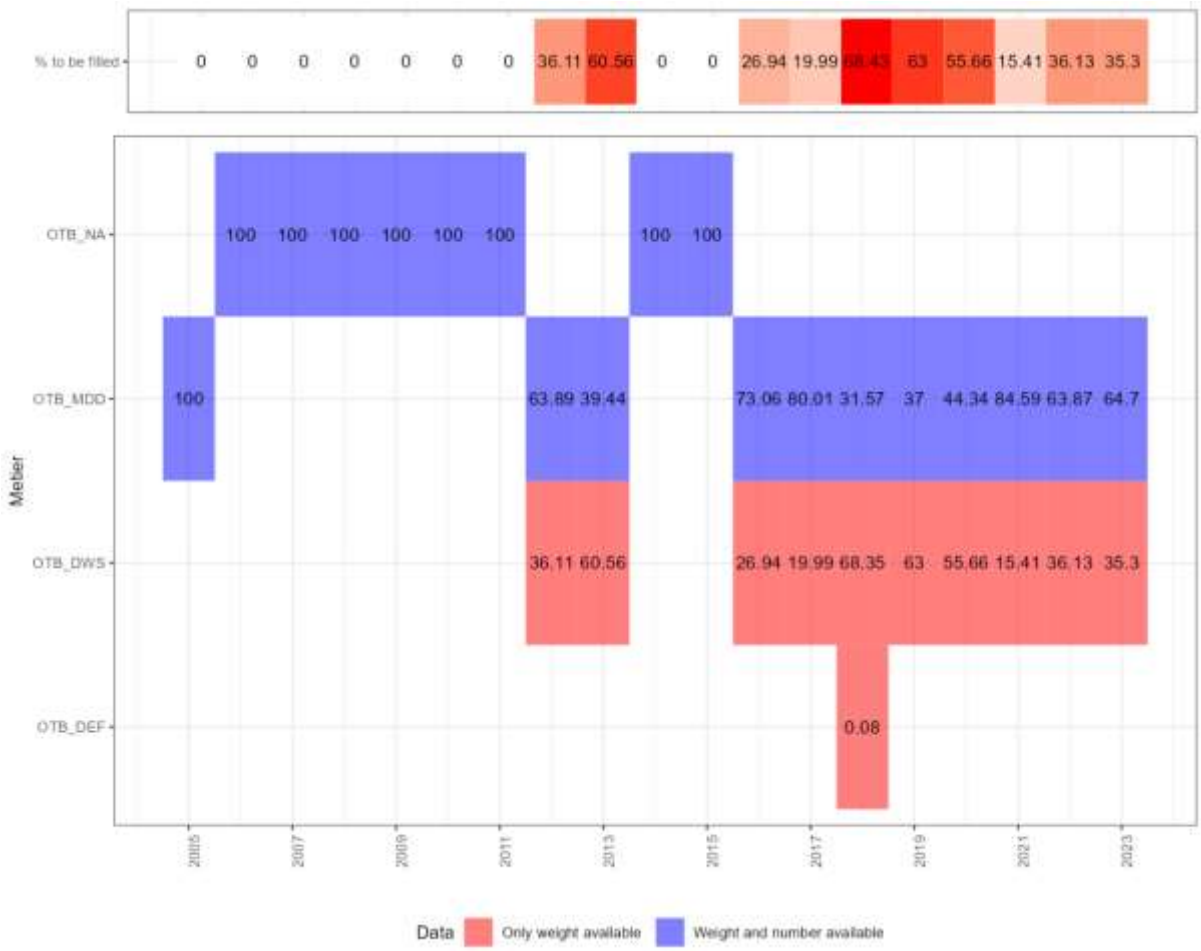
Source: own elaborations

Figure 6.18.2.1.8. Blue and red shrimp in GSAs 8, 9, 10 and 11. Missing length frequency distribution of the landings by year and fleet for GSA 10. The upper panel (single row) shows the total percentage of the weight to be reconstructed over total landings per year. The lower panel shows the percentage of the weight of each metier to be reconstructed over total landings per year.



Source: own elaborations

Figure 6.18.2.1.9. Blue and red shrimp in GSAs 8, 9, 10 and 11. Missing length frequency distribution of the landings by year and fleet for GSA 11. The upper panel (single row) shows the total percentage of the weight to be reconstructed over total landings per year. The lower panel shows the percentage of the weight of each metier to be reconstructed over total landings per year.



Source: own elaborations

Discards

Discards data were reported to STECF EWG 24-10 through the DCF. In general, blue and red shrimp is very rarely discarded. In the study area, very small quantities of blue and red shrimp were only discarded in 2011 and in 2021 in GSA 9; no discard data are reported for GSAs 8, 10 and 11. Total discard by year and GSA for the bottom trawl fishery is presented in Table 6.18.2.1.2. Due to the negligible amount of discards, no discard reconstruction was performed.

Table 6.18.2.1.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. OTB discards data in tonnes by GSA.

	Total Discard (tonnes)				
	GSA 8	**GSA 9**	**GSA 10**	**GSA 11**	**Total**
2003	-	-	-	-	-
2004	-	-	-	-	-
2005	-	-	-	-	-
2006	-	-	-	-	-
2007	-	-	-	-	-
2008	-	-	-	-	-
2009	-	-	-	-	-
2010	-	-	-	-	-
2011	-	0.403	-	-	0.403
2012	-	-	-	-	-
2013	-	-	-	-	-
2014	-	-	-	-	-
2015	-	-	-	-	-
2016	-	-	-	-	-
2017	-	-	-	-	-
2018	-	-	-	-	-
2019	-	-	-	-	-
2020	-	-	-	-	-
2021	-	0.007	-	-	0.007
2022	-	-	-	-	-
2023	-	-	-	-	-

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Discards were included in the stock assessment. Therefore, we will refer to catches as landings plus discards in the rest of the report.

6.18.2.2 EFFORT DATA

Effort data is not available to this EWG, the effort analysis is now carried out by STECF EWG 23-12, and effort results are available from that meeting.

6.18.2.3 SURVEY DATA

The MEDITS (Mediterranean International Trawl Survey) survey is an extensive trawl 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 maintained 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 timing of the survey is shown in Figure 6.18.2.3.1.

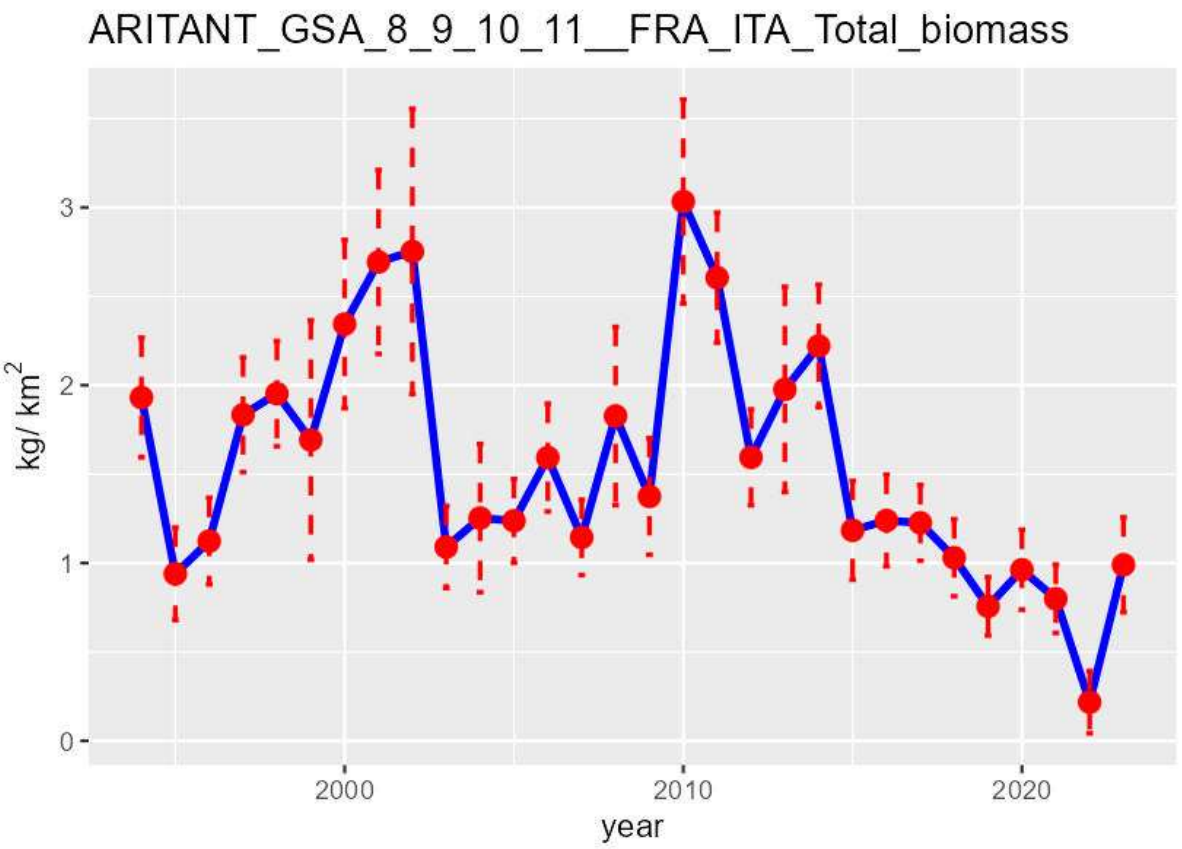
In the current assessment, combined MEDITS data for GSAs 8, 9, 10 and 11 from 2006 onwards were used, as commercial data were fully available for the four GSAs starting from that year. The combined MEDITS biomass and density indexes as well as the corresponding length frequency distributions were calculated using the script provided by JRC (Figures 6.18.2.3.2 and 6.18.2.3.3). MEDITS surveys in all four GSAs were delayed in 2020 and not performed in GSA 8. Additionally MEDITS survey in the Italian GSAs (9-10-11) was not performed in 2022 and was run in different periods in 2023. In the attempted analytical assessment the a4a model estimated the missing 2022 information through the model fit while the 2023 data were assumed to be held in the same period.

Figure 6.18.2.3.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Timing of the survey.



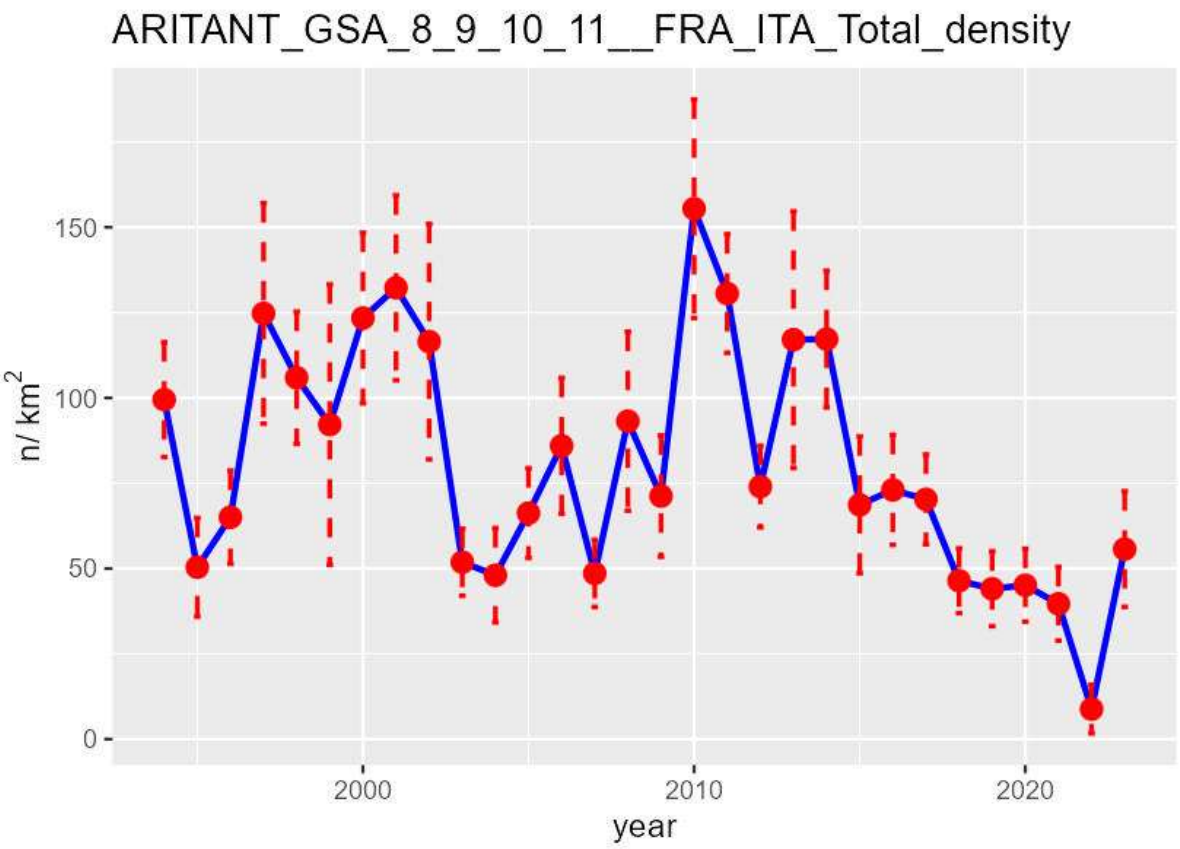
Source: own elaborations

Figure 6.18.2.3.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Estimated biomass indices from the MEDITS survey (kg/km^2). The survey was not held in 2022 therefore the 0 in the graph is not a true 0, but should be interpreted as missing information.



Source: own elaborations

Figure 6.18.2.3.3. Blue and red shrimp in GSAs 8, 9, 10 and 11. Estimated density indices from the MEDITS survey (n/km^2). The survey was not held in 2022 therefore the 0 in the graph is not a true 0, but should be interpreted as missing information.

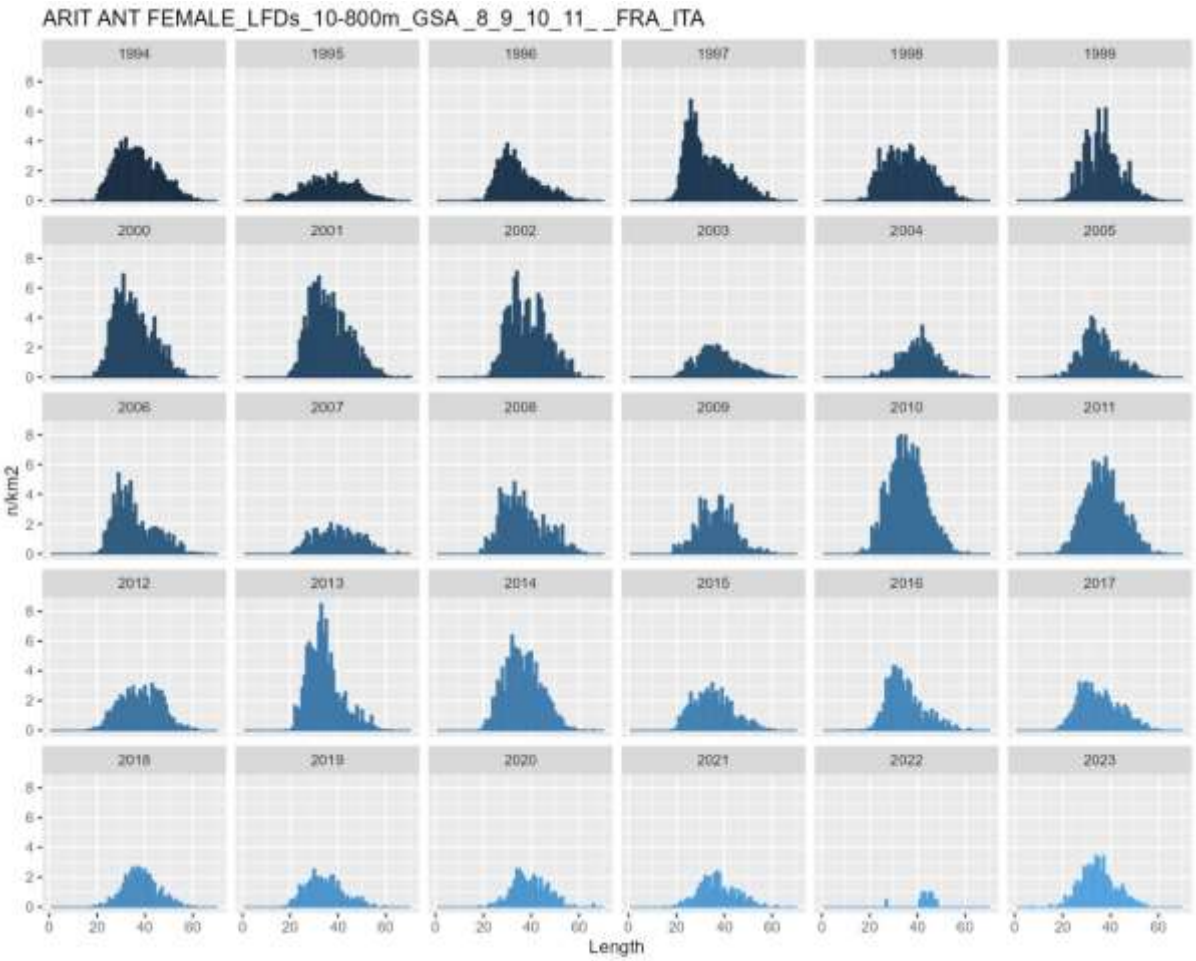


Source: own elaborations

Both estimated abundance and biomass indices show similar trends, with strong fluctuations throughout the time series and a clear declining trend since 2014. The biomass is now showing stability since 2018, while abundance shows a peak in 2023 to values higher than 2018.

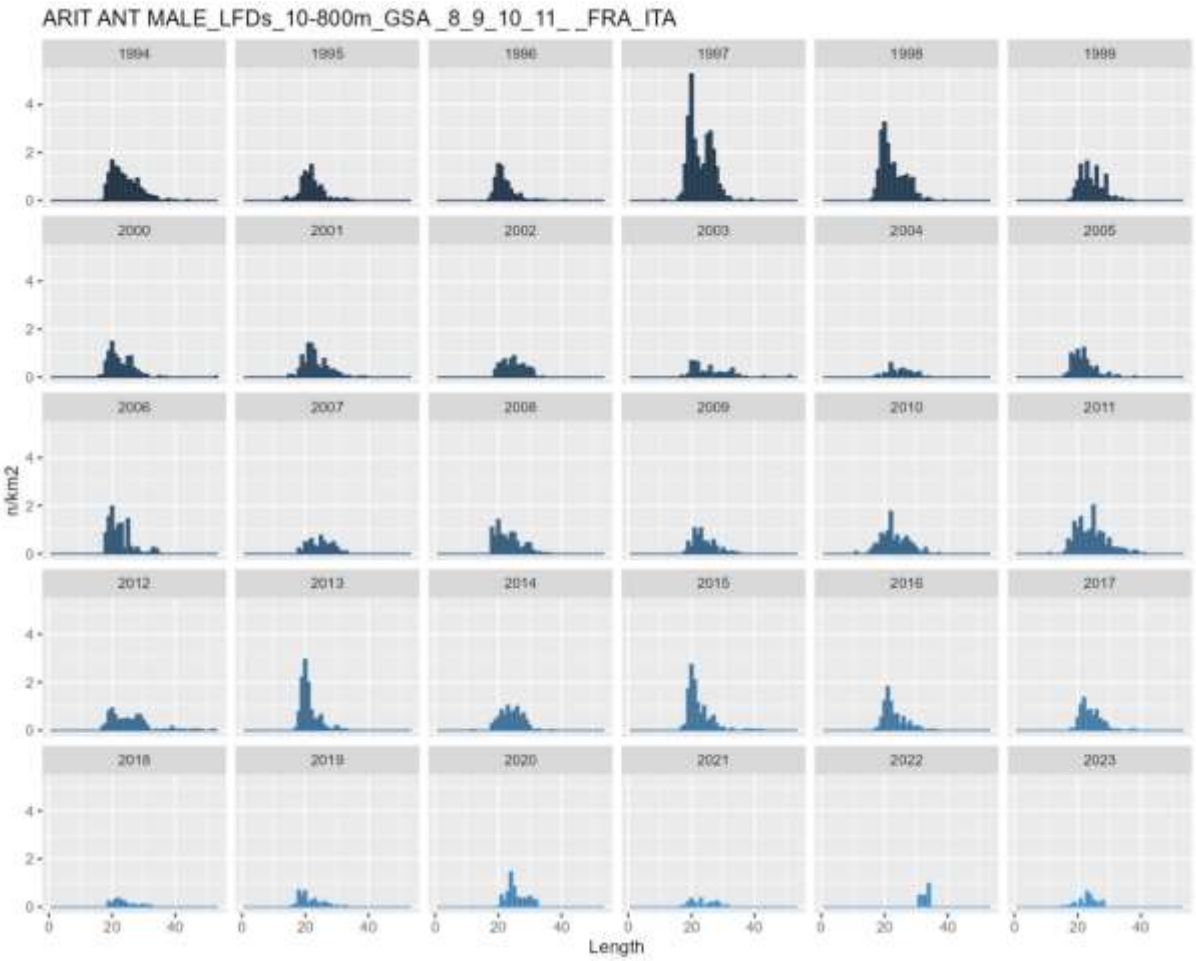
Length frequency distributions for male, female and sex combined are shown in Figures 6.18.2.3.4-6.

Figure 6.18.2.3.4. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution by year for females of MEDITS survey. The values in 2022 come solely from GSA 8.



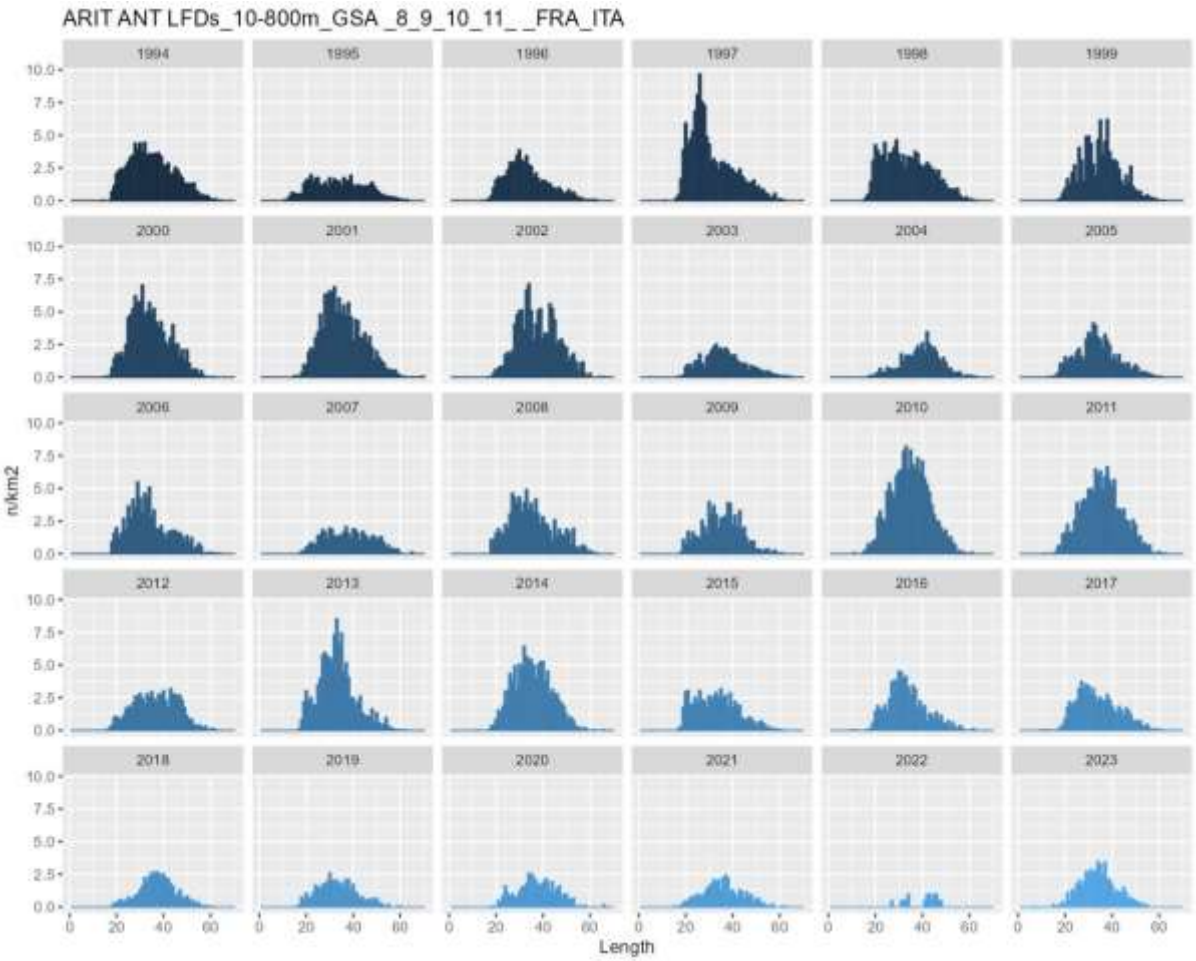
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.2.3.5. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution by year for males of MEDITS survey. The values in 2022 come solely from GSA 8.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.18.2.3.6. Blue and red shrimp in GSAs 8, 9, 10 and 11. Length frequency distribution by year for sexes combined of MEDITS survey. The values in 2022 come solely from GSA 8.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.18.3 STOCK ASSESSMENT

A statistical catch-at-age assessment was carried out for this stock, using the Assessment for All Initiative (a4a) method (Jardim et al. 2015). The a4a method utilizes catch-at-age data to derive estimates of historical population size and fishing mortality. However, unlike XSA, 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.

The model was fitted using as input data the period 2006-2023 for the catch data (landings + discards) and for the tuning index.

Both catch numbers at length and index number at length were sliced using the a4a age slicing routine in FLR, using for each GSA the same sex specific growth parameters. Catch at age by sex were obtained by splitting commercial total length distribution according to a sex-ratio vector model obtained from DCF available sex ratio vectors in the respective areas. The analyses were carried out for the ages 1 to 6+. Concerning the Fbar, the age range used was 2-5.

Input data

The growth parameters used for VBGF were the one reported in table 6.18.1.1.

Total catches and catch numbers at age were used as input data. SOP correction was applied to catch numbers at age per GSA before the creation of the aggregates stock object. Table 6.18.3.1 present the SOP correction vector applied per GSA. The SOP correction is high in GSA 10 from 2017 to 2023 due to partial or complete missing length frequency distributions in the catches of those years.

Table 6.18.3.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. SOP correction vector.

Year	SOP (GSA 9)	SOP (GSA 10)	SOP (GSA11)	SOP (total)
2006	0.96	0.97	0.94	1.00
2007	0.96	0.97	0.94	1.00
2008	1.93	0.97	0.93	1.00
2009	0.97	0.96	0.96	1.00
2010	0.98	1.00	0.95	1.02
2011	0.98	0.91	0.96	1.02
2012	0.98	0.92	1.46	1.00
2013	0.99	0.92	2.41	1.00
2014	0.97	1.08	0.96	1.00
2015	0.98	1.02	1.19	1.00
2016	0.99	0.96	1.32	1.00
2017	0.98	1.72	1.19	1.00
2018	1.01	2.31	3.05	1.00
2019	0.98	14.62	2.60	1.00
2020	0.96	10.97	2.82	1.05
2021	0.96	55.53	1.41	1.00
2022	1.03	1.74	1.59	1.02
2023	1.70	43.90	2.06	1.03

Source: own elaborations

Table 6.18.3.2 lists the input data for the a4a model, namely catches, catch number at age, weight at age, maturity at age, natural mortality at age, Proportion of M and F before spawning, and the tuning series at age.

Table 6.18.3.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Input data for the a4a model.

Catches (t)

2006	2007	2008	2009	2010	2011	2012	2013	2014
316.1	143.4	161.1	216.2	263.8	286.9	281.4	307.5	182.1
2015	2016	2017	2018	2019	2020	2021	2022	2023
215.1	222.1	251.5	496.9	489.6	257.0	229.7	206.9	214.8

Source: own elaborations

Catch numbers-at-age matrix (thousands)

age	2006	2007	2008	2009	2010	2011	2012	2013
1	792.3	239	1437.3	1810.1	1374.8	2226.1	1444.7	1720.9
2	6009.6	2135	2577.4	2930	3826.9	5028.4	4389.8	6896.8
3	4595	2272.1	2518.7	3496.6	4859.4	4907.9	4802.4	4485.6
4	2029.8	796.2	1424.3	1797.6	2186.5	2352.7	3340.8	2580.4
5	919.3	510.3	530.9	681.3	737.7	884.1	1130.8	1087.1
6+	475.3	217.4	289.6	348.8	410.7	539.1	425.3	464.4
age	2014	2015	2016	2017	2018	2019	2020	2021
1	913.1	1187.5	1136	2244.3	3520.3	5195.5	821.9	1371.3
2	3862.6	3887.8	5444.6	5258.7	12783.5	10509.9	4570.5	2282.4
3	2708.4	3518	3048.8	3917	9488	10299.3	3798	4802.8
4	1281.6	1579.3	1621.5	1963.3	2522.9	2604.5	1972.1	1679.8
5	551.1	590.5	651	712.2	883.2	915.5	724.8	627.9
6+	205.1	323.4	277.1	272.7	378.1	338	285.6	229.1
age	2022	2023						
1	1074.6	1421.3						

2	3915	2291.4						
3	3693.3	4481						
4	1421.6	1433.3						
5	493.2	660.1						
6+	200	356.1						

Source: own elaborations

Weights-at-age (kg)

age	2006	2007	2008	2009	2010	2011	2012	2013
1	0.007	0.007	0.007	0.006	0.007	0.007	0.007	0.007
2	0.014	0.014	0.012	0.012	0.013	0.013	0.013	0.013
3	0.023	0.022	0.019	0.02	0.022	0.021	0.022	0.021
4	0.03	0.032	0.027	0.03	0.028	0.026	0.027	0.025
5	0.039	0.045	0.038	0.04	0.035	0.031	0.034	0.03
6+	0.057	0.053	0.054	0.044	0.029	0.032	0.033	0.031
age	2014	2015	2016	2017	2018	2019	2020	2021
1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
2	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.013
3	0.022	0.022	0.022	0.019	0.021	0.02	0.023	0.023
4	0.029	0.029	0.027	0.027	0.024	0.024	0.03	0.029
5	0.038	0.037	0.034	0.038	0.031	0.037	0.04	0.041
6+	0.034	0.038	0.036	0.047	0.044	0.041	0.049	0.041
age	2022	2023						
1	0.007	0.006						
2	0.014	0.013						

3	0.022	0.022						
4	0.028	0.028						
5	0.035	0.039						
6+	0.033	0.035						

Source: own elaborations

Maturity, Natural mortality, proportion of M and F before spawning vectors.

Age	**1**	**2**	**3**	**4**	**5**	**6+**
Maturity	0.20	0.79	0.98	1	1	1
M	0.77	0.51	0.40	0.34	0.31	0.28
Prop M	0.5	0.5	0.5	0.5	0.5	0.5
Prop F	0.5	0.5	0.5	0.5	0.5	0.5

Source: own elaborations

MEDITS number (n/km^2) at age for GSA 8-9-10-11.

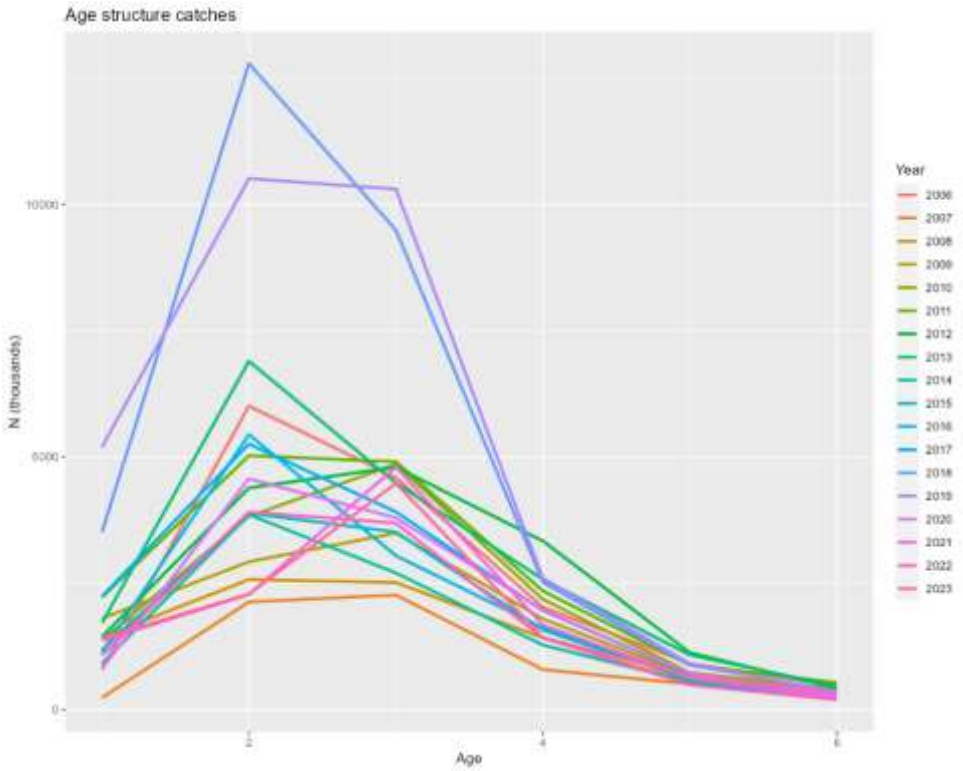
age	2006	2007	2008	2009	2010	2011	2012	2013
1	8.26	2.83	8.32	4.97	17.62	9.13	5.56	11.47
2	41.63	13.26	38.63	24.89	59.5	46.8	23.25	65.73
3	19.56	14.80	24.84	26.81	53.27	45.11	21.77	27.85
4	9.76	9.95	11.05	9.1	17.7	19.02	17.02	7.15
5	6.74	7.74	10.36	3.25	7.32	10.51	6.41	4.95
age	2014	2015	2016	2017	2018	2019	2020	2021
1	10.43	9.19	5.92	8.96	2.06	6.38	1.24	3.31
2	44.85	28.31	36.96	27.43	14.93	19.56	12.13	14.13
3	38.73	20.77	18.98	19.74	19.69	12.41	18.11	13.55
4	17.72	6.66	7.39	9.85	6.32	3.89	9.25	5.93
5	5.47	3.75	3.75	4.18	3.45	1.83	4.42	2.74
age	2022	2023						
1	NA	6.45						
2	NA	24.48						

3	NA	16.8						
4	NA	6.3						
5	NA	1.7						

Source: own elaborations

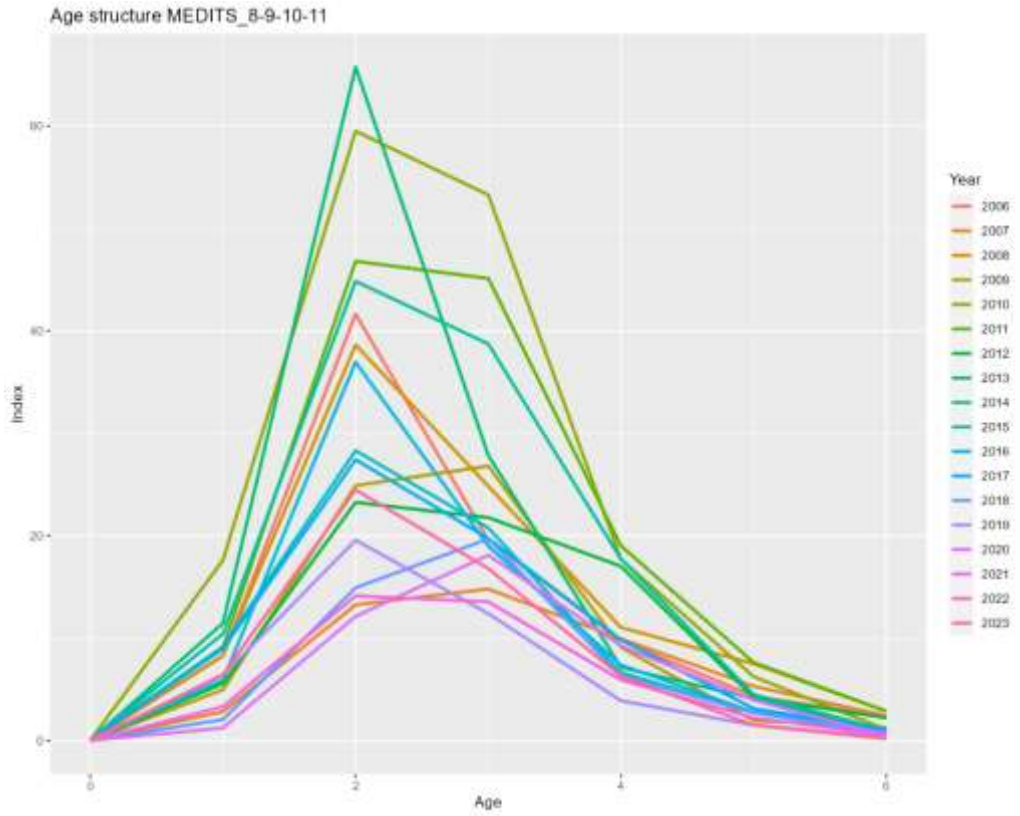
Figures 6.13.3.1-5 show the age structure of the catches, of the index, the weight at age matrix and the catch at age and MEDITS cohort consistency

Figure 6.18.3.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Age structure of the catches.



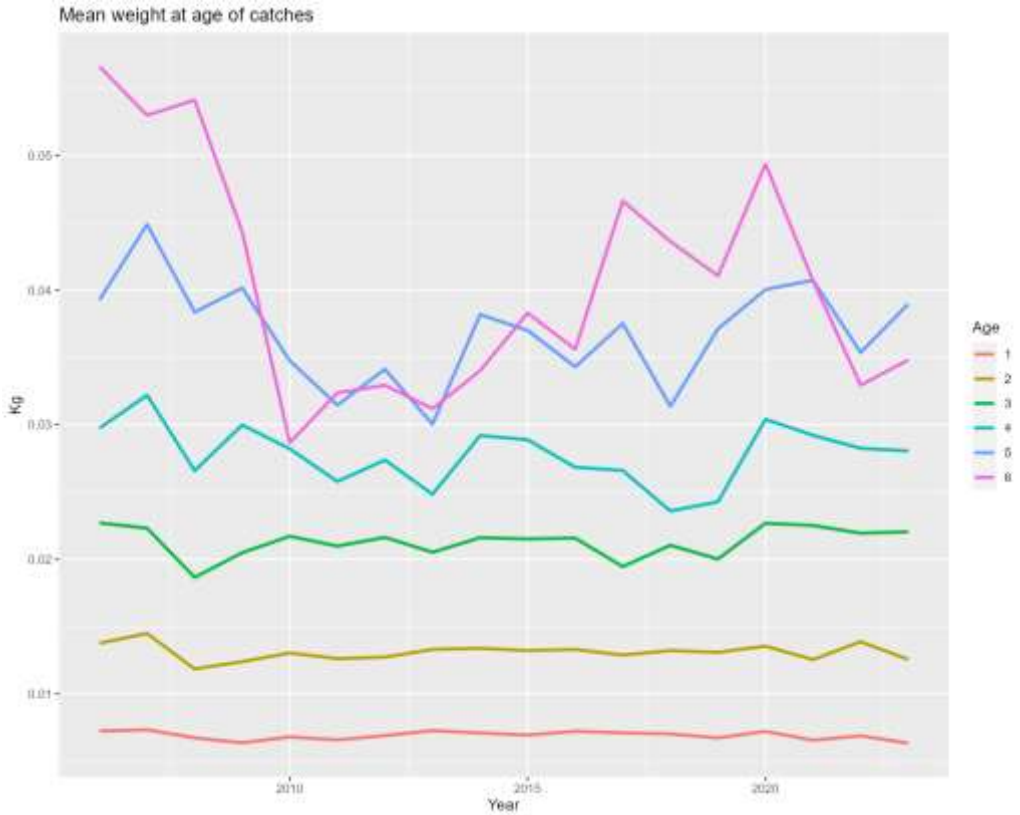
Source: own elaborations

Figure 6.18.3.2. Blue and red shrimp in GSAs 8, 9, 10 and 11. Age structure of the index.



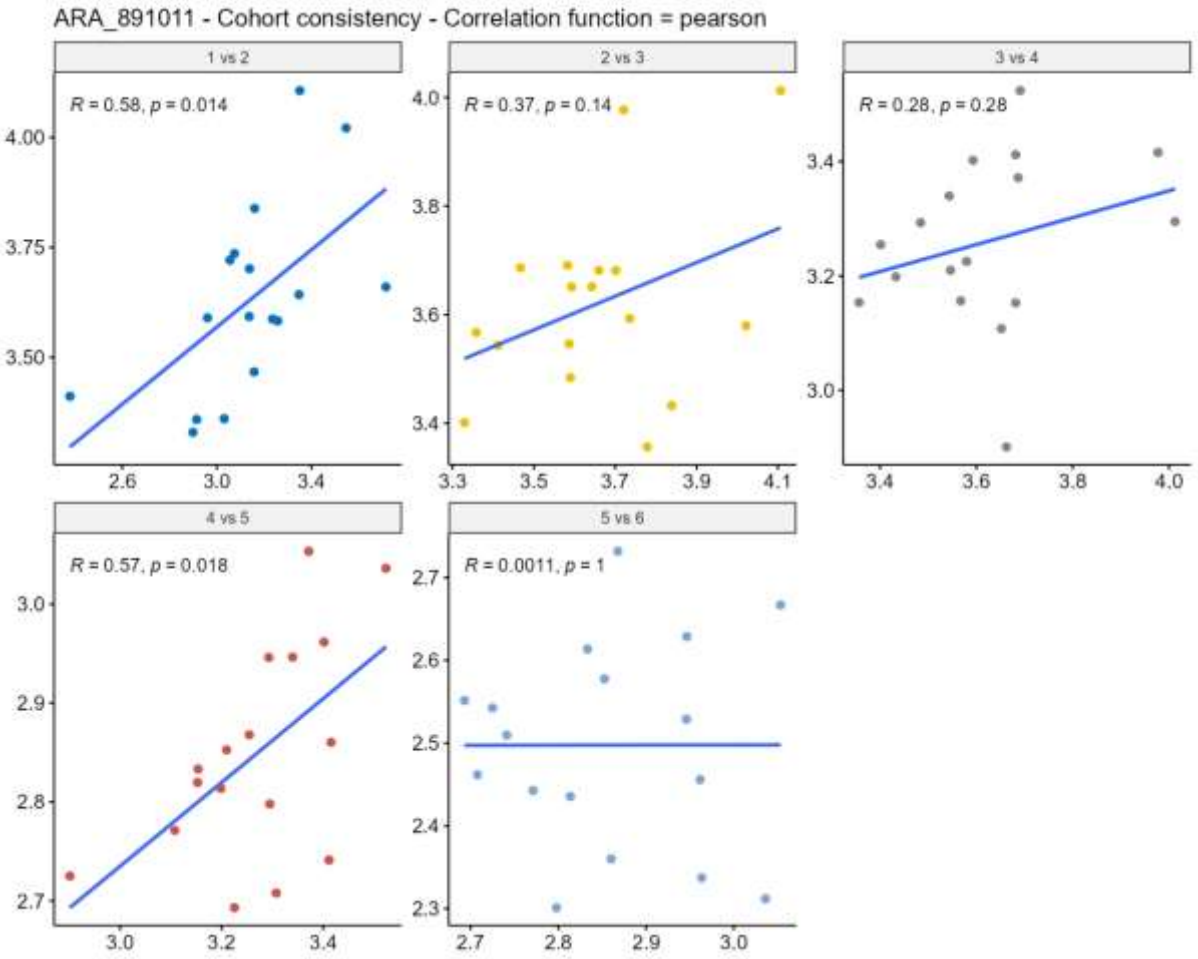
Source: own elaborations

Figure 6.18.3.3. Blue and red shrimp in GSAs 8, 9, 10 and 11. Weight at age matrix.



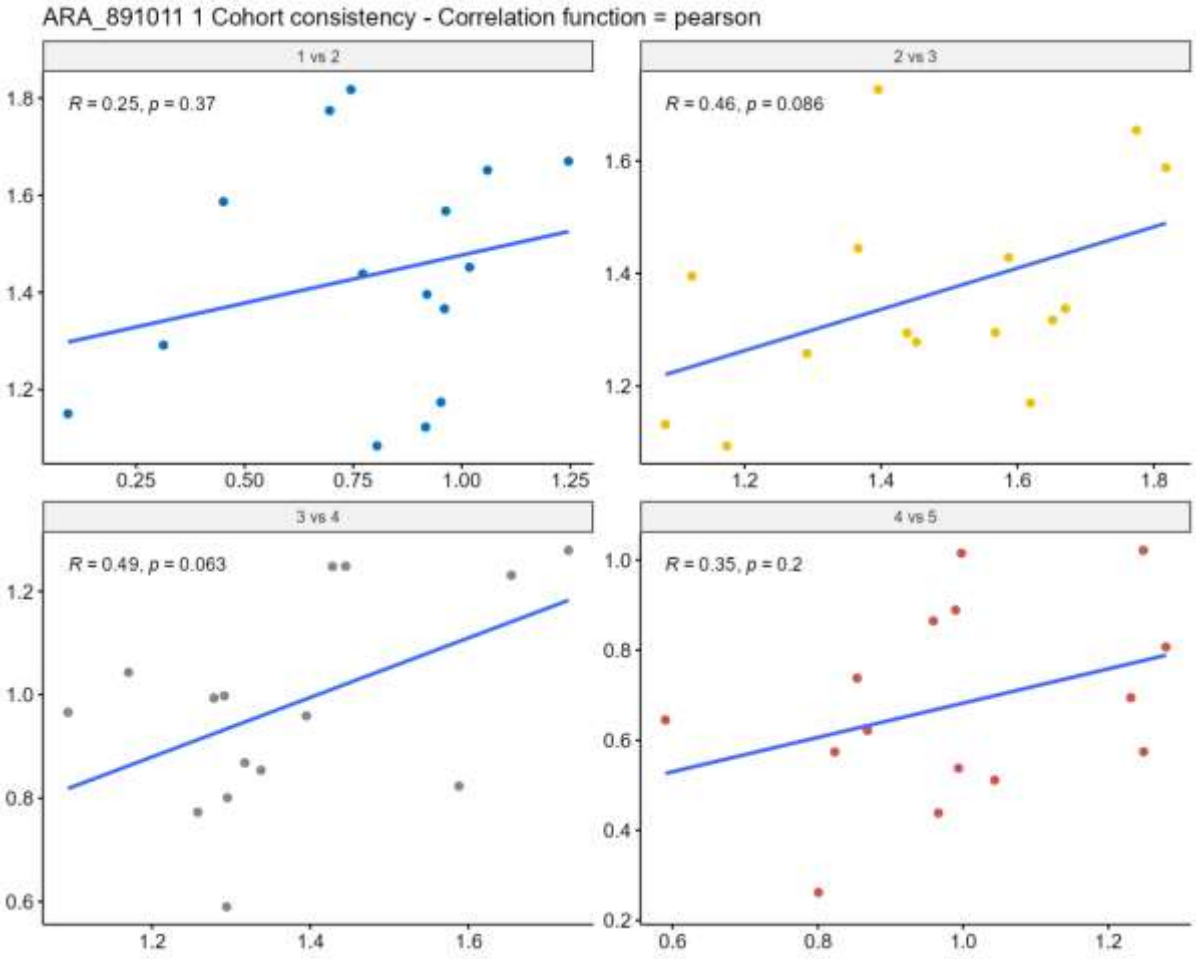
Source: own elaborations

Figure 6.18.3.4. Blue and red shrimp in GSAs 8, 9, 10 and 11. Catch at age cohort consistency.



Source: own elaborations

Figure 6.18.3.5. Blue and red shrimp in GSAs 8, 9, 10 and 11. Index at age cohort consistency.



Source: own elaborations

Assessment results

Different a4a models were examined (combination of different f and q models). The best model (according to residuals and retrospective) was still the one selected during EWG 22-09:

Submodels:

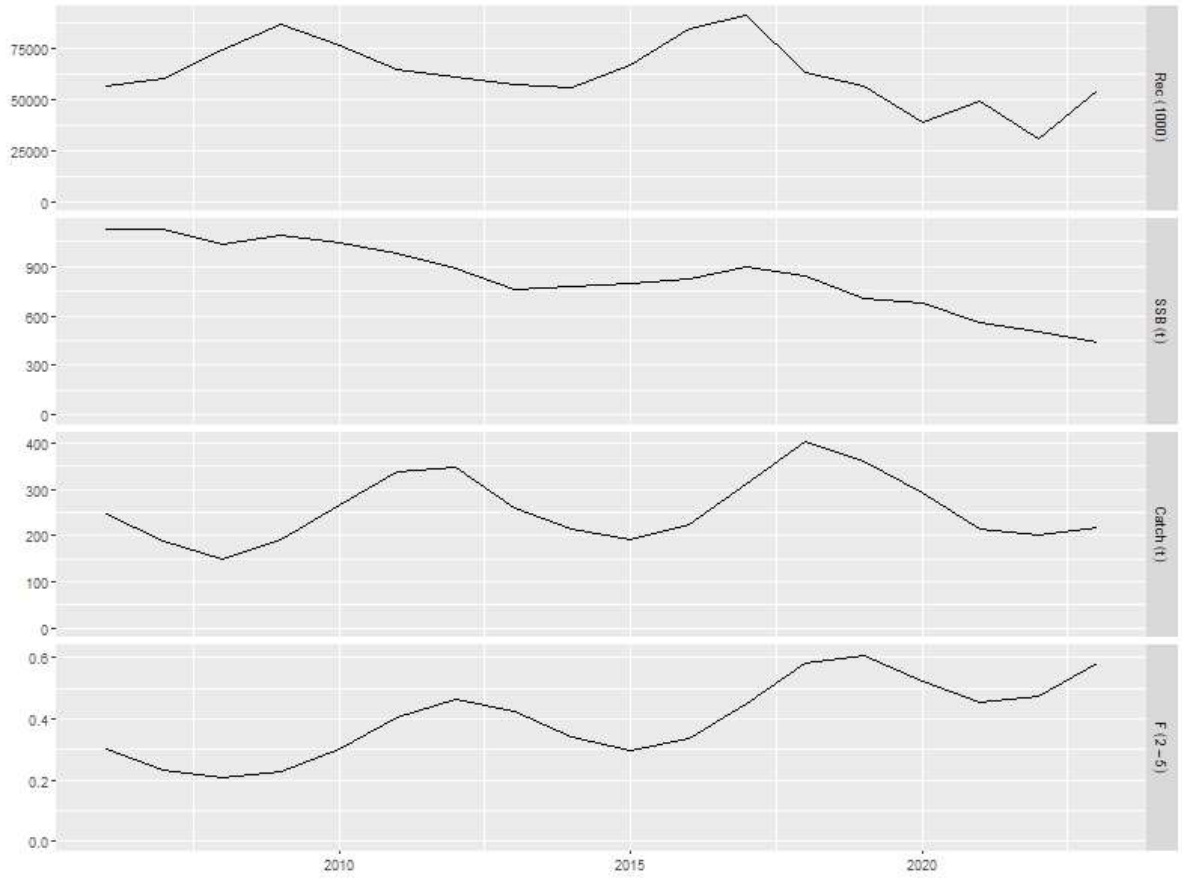
fmodel: ~ factor(age) + s(year, k=8)

srmodel: ~factor(year)

qmodel: MEDITS: ~factor(replace(age, age > 4, 4))

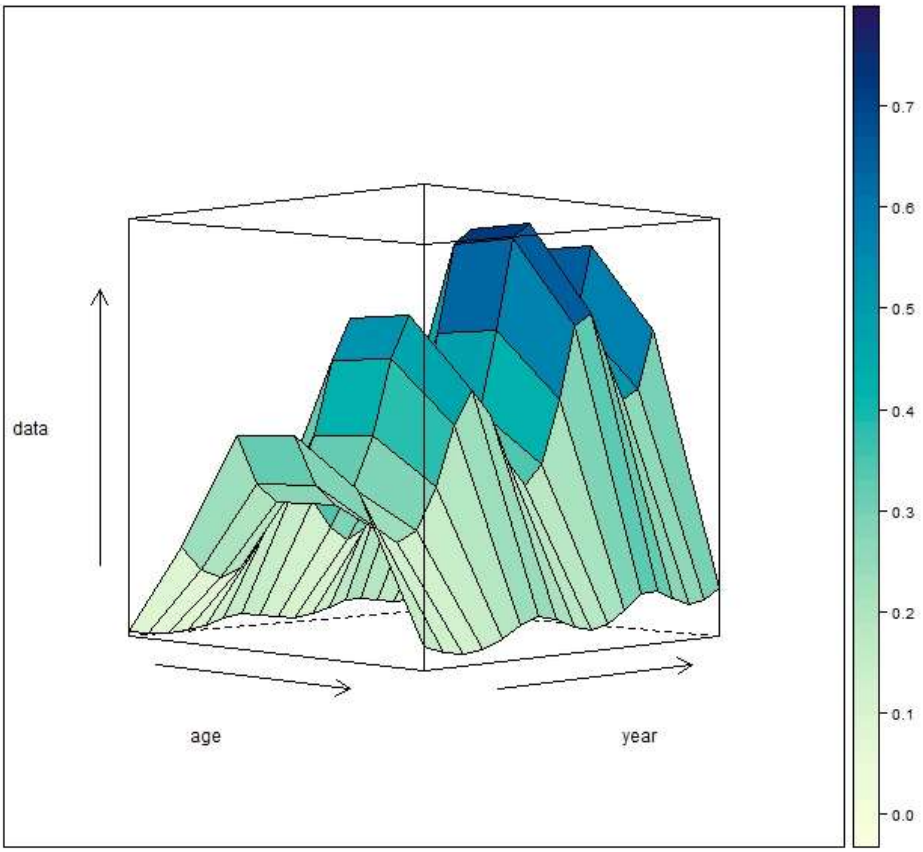
Assessment results are shown in Figures 6.18.3.3-6.18.3.9 and Tables 6.18.3.3- 6.18.3.6,

Figure 6.18.3.6. Blue and red shrimp in GSAs 8, 9, 10 and 11. Stock summary from the final a4a model. Recruits (Age 1), SSB (Stock Spawning Biomass), catch and harvest (fishing mortality for ages 2 to 5).



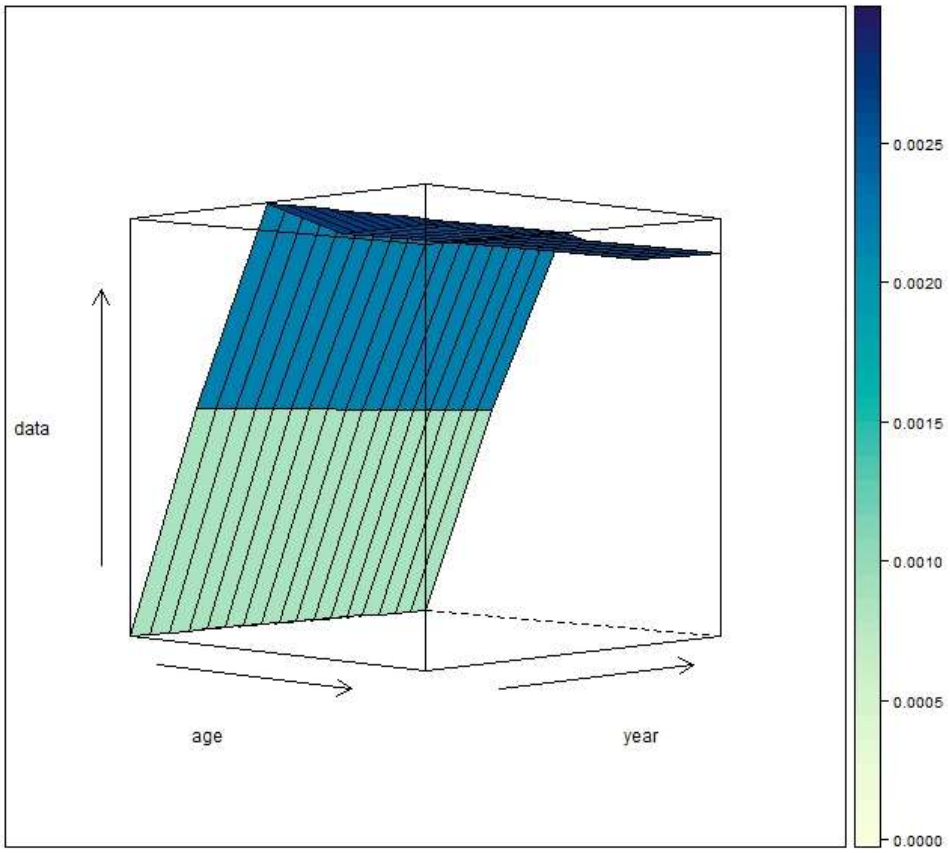
Source: own elaborations

Figure 6.18.3.7. Blue and red shrimp in GSAs 8, 9, 10 and 11. 3D contour plot of estimated fishing mortality at age and year.



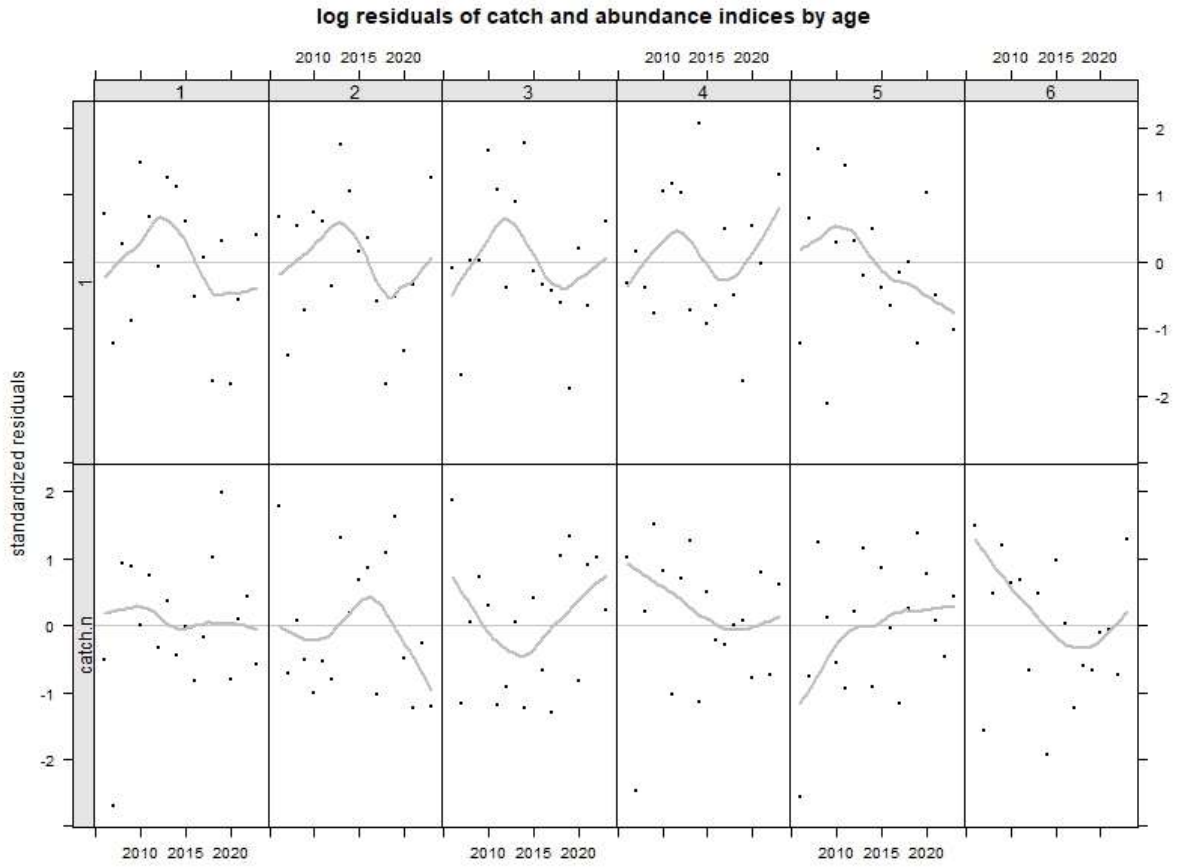
Source: own elaborations

Figure 6.18.3.8. Blue and red shrimp in GSAs 8, 9, 10 and 11. 3D contour plot of estimated catchability at age and year.



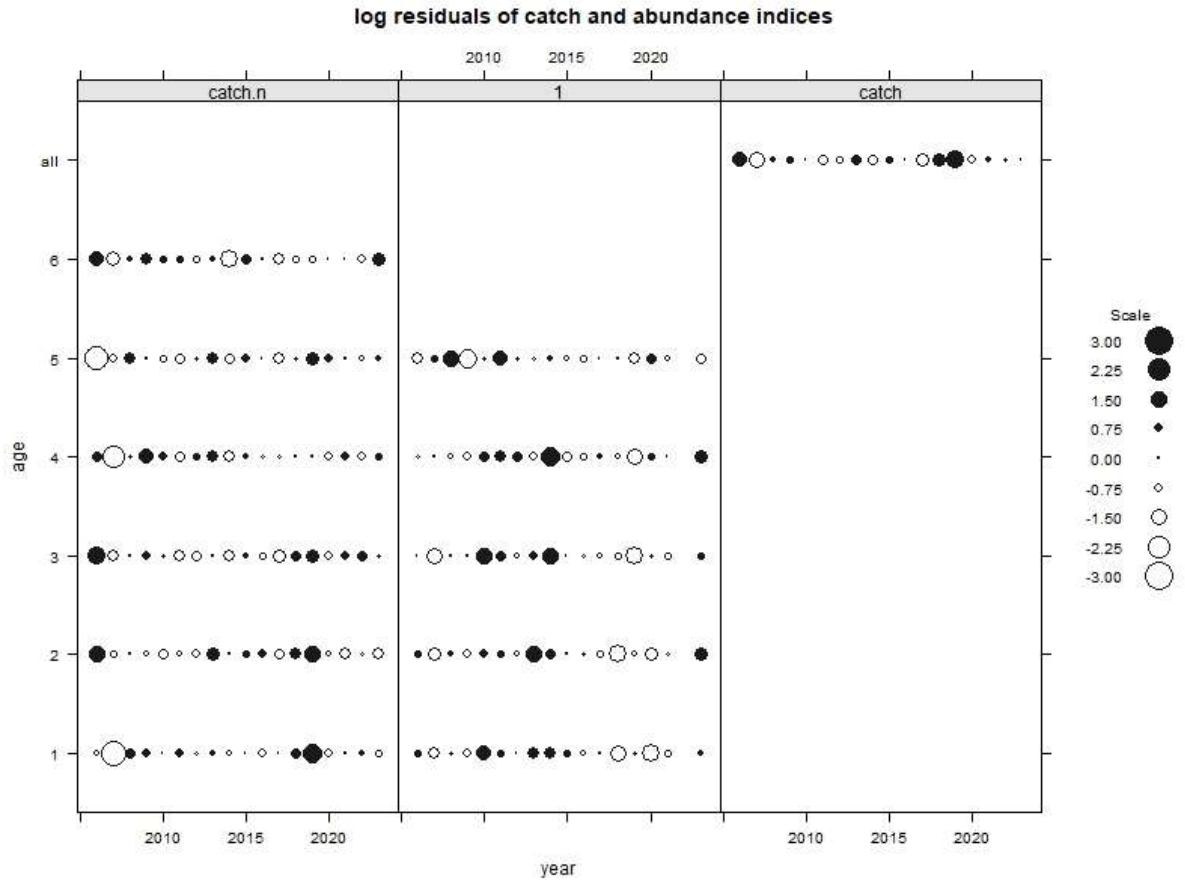
Source: own elaborations

Figure 6.18.3.9. Blue and red shrimp in GSAs 8, 9, 10 and 11. Standardized residuals for abundance indices and for catch numbers (catch.n). Each panel is coded by age class, dots represent standardized residuals and lines simple smoothers.



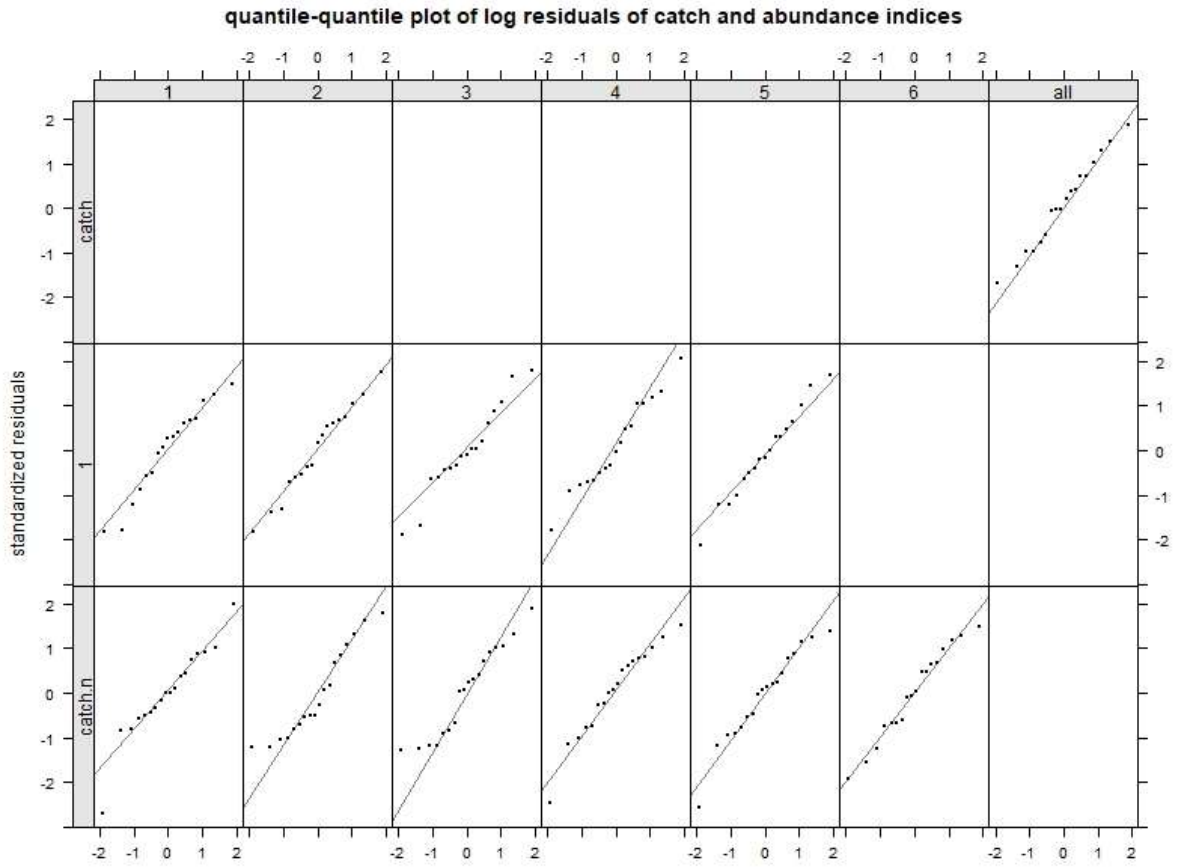
Source: own elaborations

Figure 6.18.3.10. Blue and red shrimp in GSAs 8, 9, 10 and 11. Standardized residuals for abundance indices and for catch numbers.



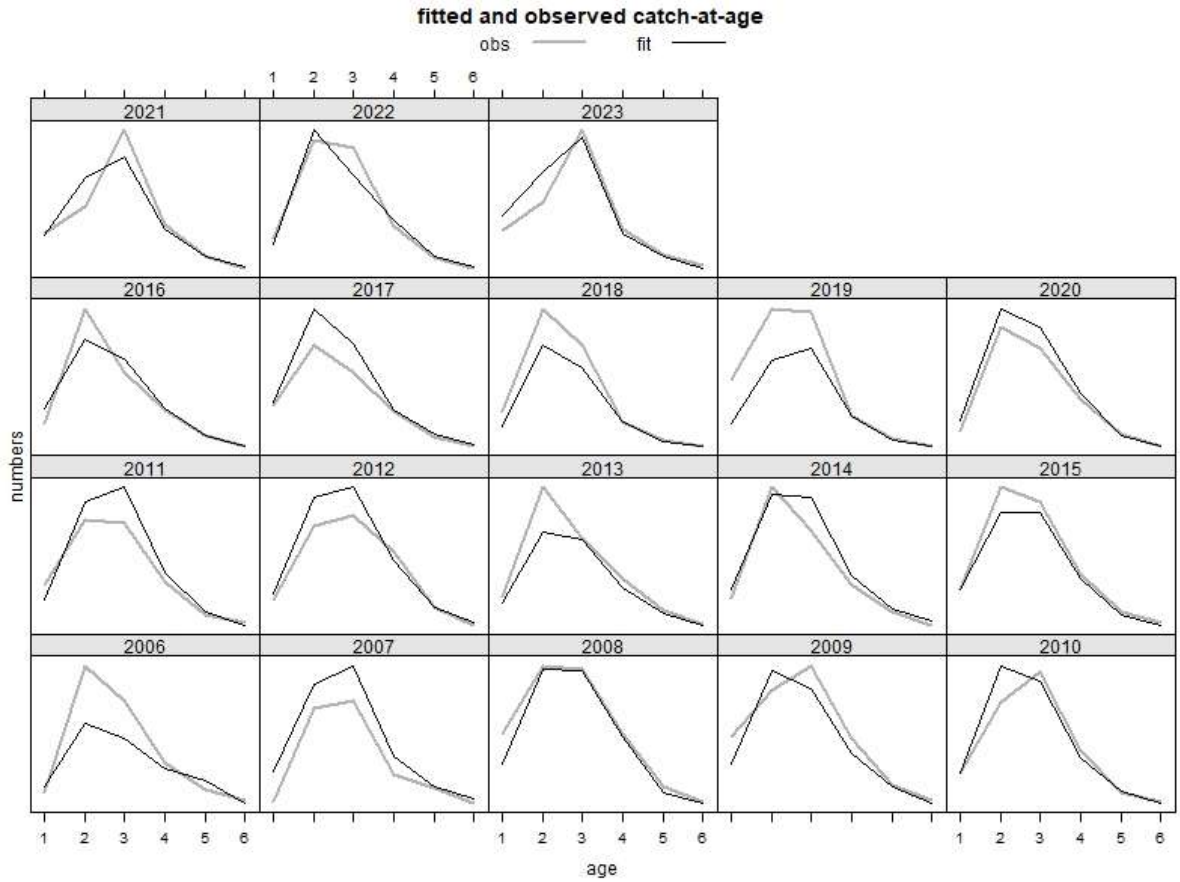
Source: own elaborations

Figure 6.18.3.11. Blue and red shrimp in GSAs 8, 9, 10 and 11. Quantile-quantile plot of standardized residuals for abundance indices and for catch numbers (catch.n). Each panel is coded by age class, dots represent standardized residuals and lines the normal distribution quantiles.



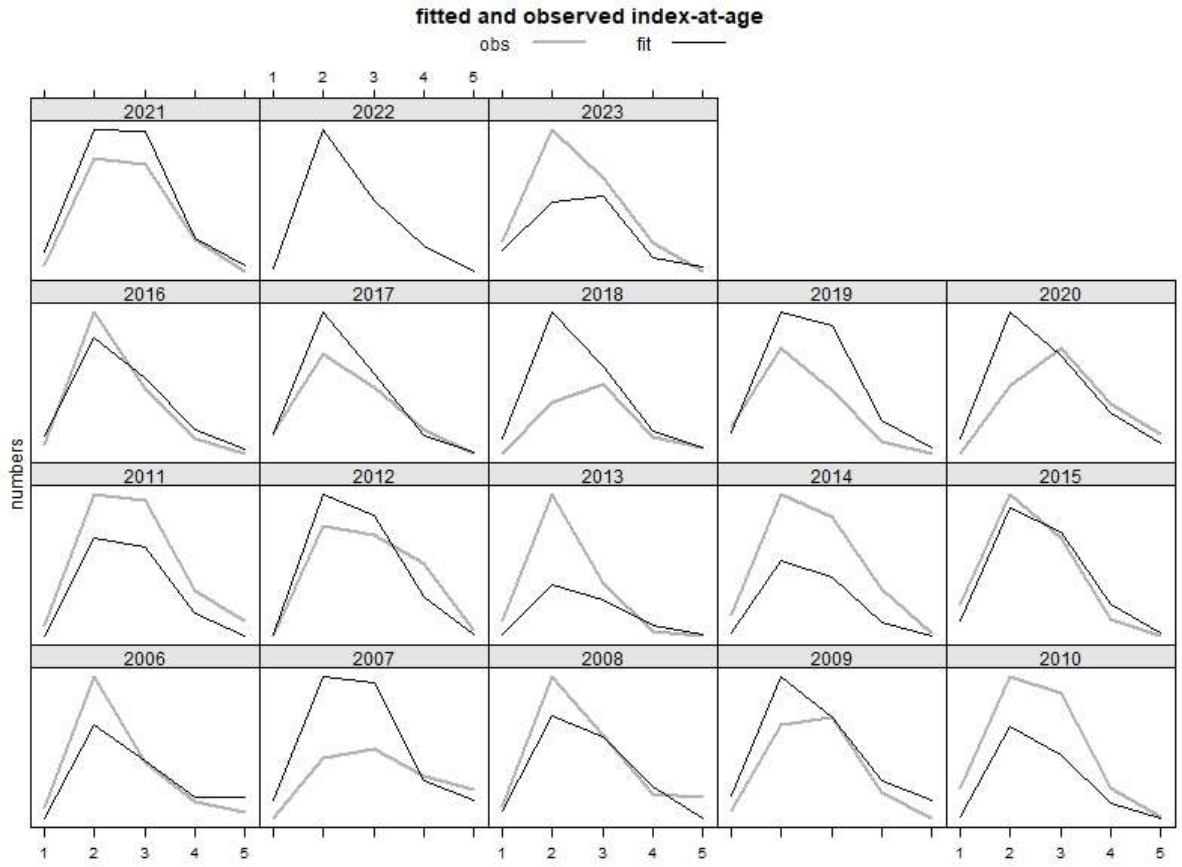
Source: own elaborations

Figure 6.18.3.12. Blue and red shrimp in GSAs 8, 9, 10 and 11. Fitted and observed catch at age.



Source: own elaborations

Figure 6.18.3.13. Blue and red shrimp in GSAs 8, 9, 10 and 11. Fitted and observed index at age.

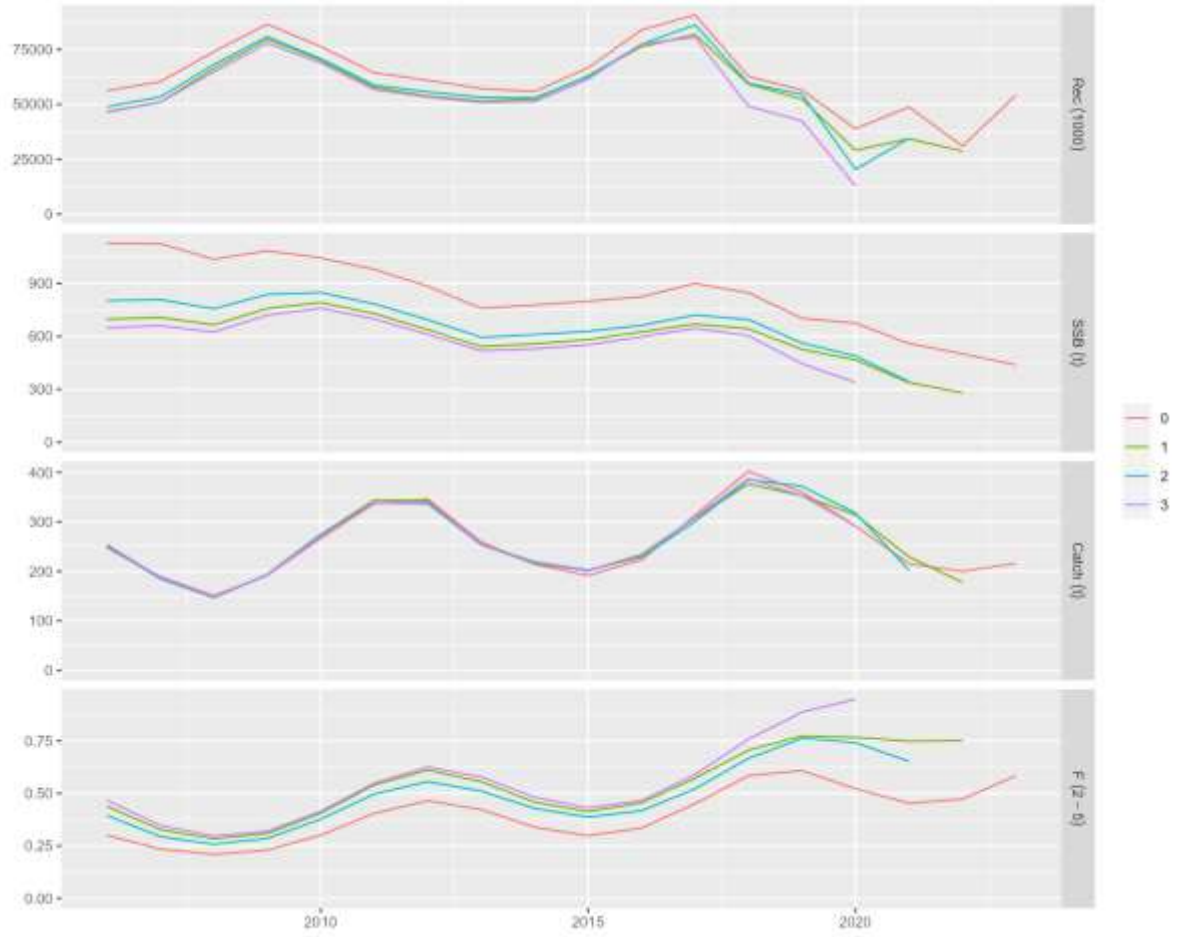


Source: own elaborations

Retrospective

The retrospective analysis was applied up 5 years back, but already after 3 years instability was highlighted. Model results were extremely unstable (Figure 6.18.3.14) and show a tendency to overestimate F and underestimate SSB for the whole time series.

Figure 6.18.3.14. Blue and red shrimp in GSAs 8, 9, 10 and 11. Retrospective analysis.



Source: own elaborations

Due to the model instability as shown by the retrospective analysis, the EWG 24-10 concluded that the output of this model was not suitable to provide the basis of the current status of the stock as already defined in 22-09.

The advice ran in 2022 based on Category 3 (ICES, 2022) methods could not be updated to the lack of MEDITS survey in 2022 for all Italian GSAs and the fact that MEDITS survey in 2023 was ran in different months between the three GSAs.

This stock was therefore downgraded to Category 5 (ICES, 2012) to give a catch advice for 2025, 2026 and 2027. Following the ICES guidelines the advice was calculated as the 80% of the 2023 catches, as reported in Section 6.18.5.

The group suggests anyway that next year an analytical assessment should be attempted anyway, potentially with a different analytical framework if time allows.

An additional analytical assessment was attempted building a stock and an index object considering only the female component of the population. During the data preparation though some data issues were observed, such as the lack of LFDs for GSA 10 (already highlighted when building the two sexes stock object) and the lack of sex ratio information for more than one year both in GSA 10 and 11 for some years. When the proportion of females was estimated using the sex ratio vectors available, in GSA 10 and 11, suggested that most of the samples would be represented by males. As these fisheries mainly targets females (being the biggest

individuals) and also comparing the sex ratio vector to the LFDs available the group agreed that a further data exploration should be held to evaluate if data estimated by sex could be used.

6.18.4 REFERENCE POINTS

No reference points were estimated.

6.18.5 SHORT TERM FORECAST AND CATCH OPTIONS

For stocks without information on abundance or exploitation rate, ICES considerd that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The precautionary buffer was never applied and has therefore been applied in 2023. Discards are null.

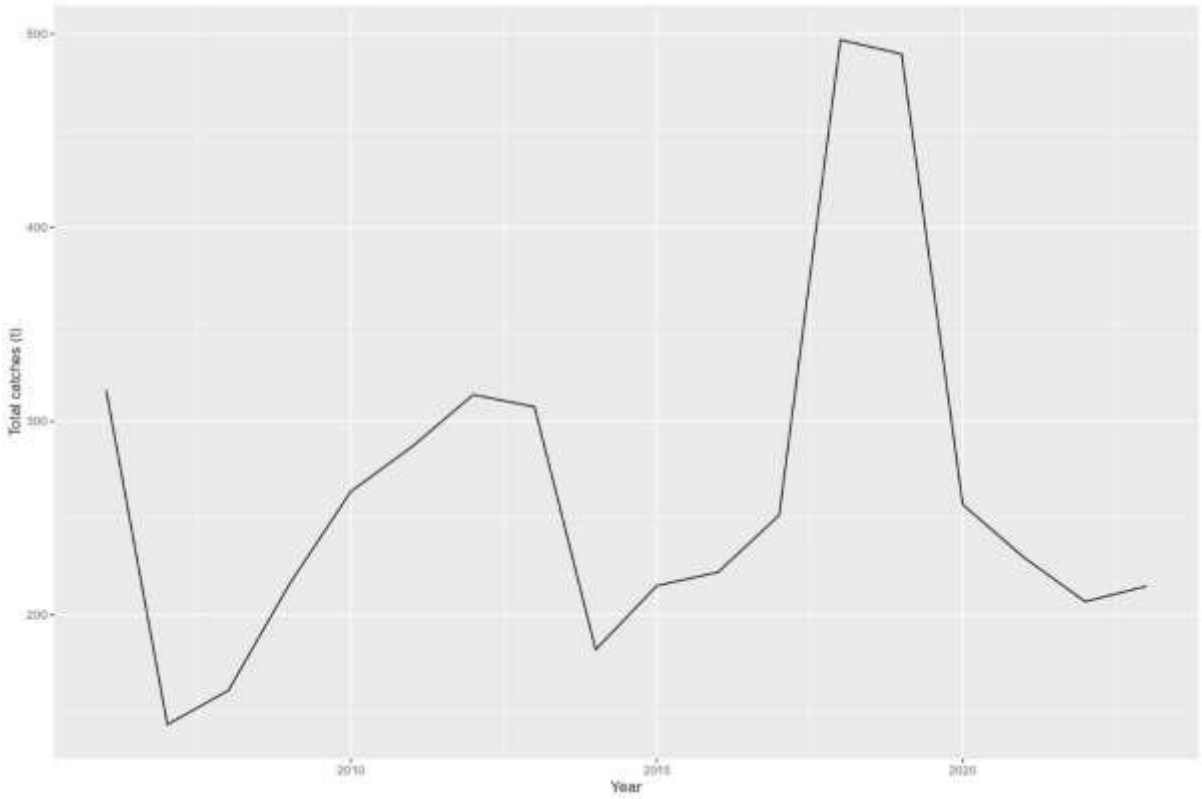
Table 6.18.1 Blue and red shrimp in GSAs 8, 9, 10 and 11: Basis for the catch scenarios. The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the tables.

Recent advised catches		127 tonnes
Discard rate		Negligible
Precautionary buffer	Applied	0.8
Catch advice		171.86 tonnes
% advice change**		-20%

* Advised catches for each of the years 2025, 2026, 2027.
** Advice value for 2025 relative to the catch in 2023 (215 tonnes).

Source: own elaborations

Figure 6.18.5.1. Blue and red shrimp in GSAs 8, 9, 10 and 11. Time series of total catches in tonnes



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

STECF EWG 24-10 advices that when the precautionary approach is applied catches should be no more than 172 tonnes in each of the years 2025, 2026 and 2027.

6.19 GIANT RED SHRIMP IN GSAS 8, 9, 10 & 11

6.19.1 STOCK IDENTITY AND BIOLOGY

In the Mediterranean, *Aristaeomorpha foliacea* (Risso, 1827) is a dominant species of bathyal megafaunal assemblages, and it is sympatric with *Aristeus antennatus*. Both species have considerable interest for fisheries.

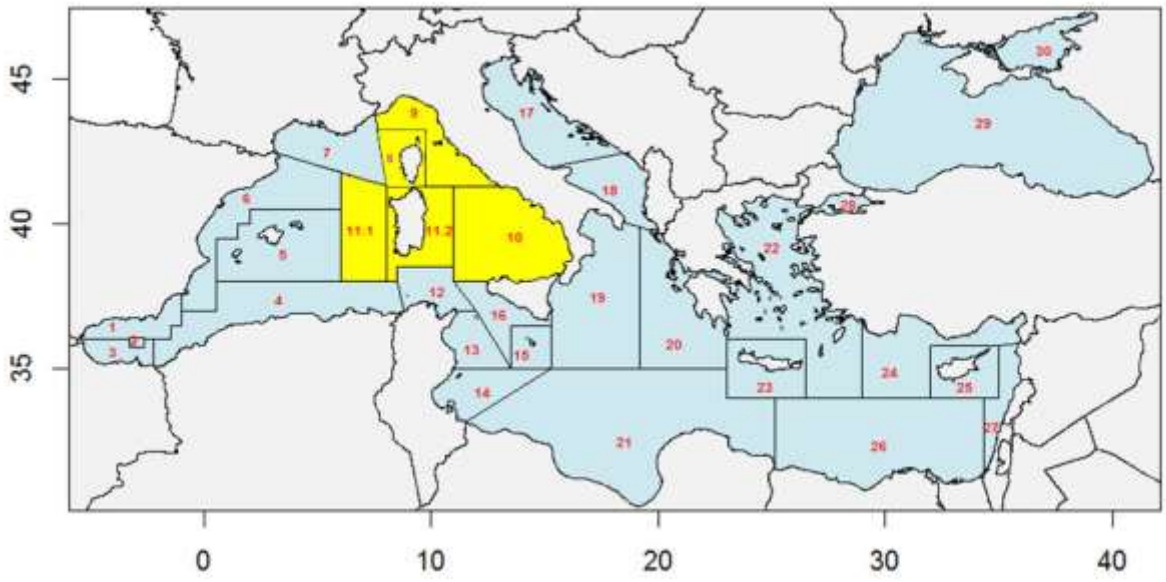
The giant red shrimp is mainly found in the epibathyal and mesobathyal waters of the Mediterranean. Due to a lack of enough information about the structure of giant red shrimp (*Aristaeomorpha foliacea*) in the western Mediterranean, this stock was assumed to be confined within the GSAs 8, 9, 10 and 11 boundaries (Figure 6.19.1.1).

In the GSA 9, *A. foliacea* is more abundant in the Tyrrhenian Sea, while lower concentrations are present in the Ligurian Sea, where the blue and red shrimp, *Aristeus antennatus*, is more abundant, and the giant red shrimp considerably decreased over time (Masnadi et al., 2018).

In GSA10, this species and the blue and red shrimp are characterised by seasonal variability and annual fluctuations of abundance (Spedicato et al., 1994), as reported for different geographical areas (e.g. Relini, 2007). The giant red shrimp is distributed beyond 350 m depth, but mainly in water deeper than 500 m.

The giant red shrimp shows high densities and well-structured populations with a clear multimodal size pattern in the GSA 11. Seasonal changes have been reported from southern Sardinia in both the vertical distribution and size-related spatial abundance of *A. foliacea*, with large females (preferentially) tending to move gradually deeper (to 650-740 m) from spring to summer (Mura et al., 1997).

Figure 6.19.1.1 Limit of Geographical Sub-Areas (GSAs) 8, 9, 10 & 11.



Source: own elaborations

Growth, maturity and natural mortality

Several sets of VBGF parameters have been reported in the DCF database for *A. foliacea*. VBGF curves by sex are available for the three main GSAs. However, being the VBGF parameters computed in GSA10 a good proxy of the average of the VBGF parameters provided

for the three main areas, it was decided to use those parameters, as in the previous assessments, to slice the size frequency distributions by sex. As done in the last assessments, the parameters were adjusted to shift length slicing by adding a value of 0.5 to the t_0 value.
For the Length-Weight relationship as well, several sets of parameters by sex are provided for the three main GSAs. The LW parameters used in the assessment to estimate mean weight at length and mean weight at age by sex are those from GSA 9 in 2019, chosen as good average values among all parameters.
The VBGF and LW relationship parameters used are summarized in the following table (Table 6.19.1.1).

Table 6.19.1.1 Giant red shrimp in GSAs 8, 9, 10 & 11: VBGF and LW relationship parameters.

		Units	Females	Males
VBGF parameters	**L_∞**	mm	73.0	50
	k	$years^{-1}$	0.438	0.40
	t_0	years	-0.10	-0.10
LW relationship	**a**	mm/g	0.00164	0.00127
	b	mm/g	2.58855	2.67574

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

A vector of proportion of mature by age was provided by the three main GSAs. The same weighed average of the vectors used in the previous assessment was used.
The natural mortality vector used was the one previously estimated last year by sex using the Chen and Watanabe equation and the growth parameters described above. A combined natural mortality vector was then computed as a weighted average of the vectors by sex.
The vector of proportion of mature and the natural mortality vector used in the assessment of giant red shrimp in GSAs 8, 9, 10 & 11 are shown in Table 6.19.1.2.

Table 6.19.1.2 Giant red shrimp in GSAs 8, 9, 10 & 11: natural mortality and proportion of mature vectors by age.

Age	Natural mortality	Proportion of matures
0	**1.89**	**0.00**
1	**0.86**	**0.40**
2	**0.62**	**1.00**
3	**0.53**	**1.00**
4+	**0.48**	**1.00**

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

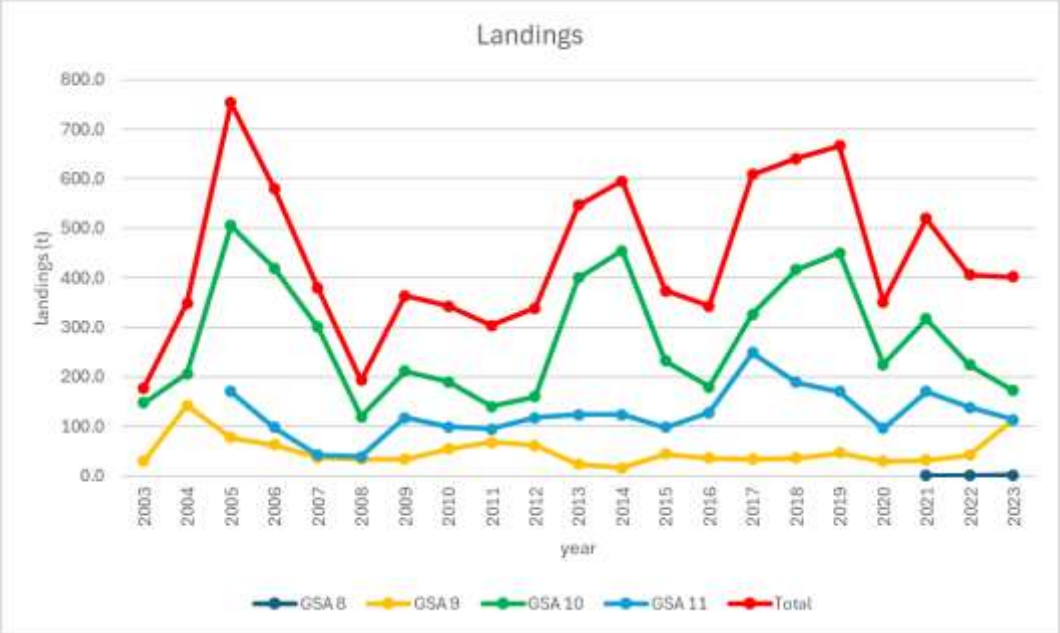
6.19.2 Data

6.19.2.1 Catch (Landings and Discards)

The annual total landings of giant red shrimp available in the DCF database are reported in Table 6.19.2.1.1 and Figure 6.19.2.1.1-6.10.2.1.1. Landings data are available in GSA 11 from 2005, and for GSA 8 they are available only from 2021 (Italian data); for GSAs 9 and 10 the time series are available from 2003. In general, landings show a fluctuating pattern along the time series, with peaks in 2005, 2014 and 2019. The landings coming from GSA 8, 9 and 11 are lower along all the time series in comparison to those from GSA 10. Data from 2020 have been resubmitted this year by Italy to be relative to operative GSA as requested, with the only exception of data for GSA 10 in 2020. However, this value has been retrieved from the FDI dataset.

The time series of landings by GSA and gear are shown in Figures 6.19.2.1.2-6.19.2.1.5.

Figure 6.19.2.1.1 Giant red shrimp in GSAs 8, 9, 10 & 11: landings by GSA and total landings.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.19.2.1.1. Giant red shrimp in GSAs 8, 9, 10 & 11: landings by GSA and gear.

	GSA 8	GSA 9		GSA 10		GSA 11
	OTB	OTB	Other gears	OTB	Other gears	OTB
2003	0.0	30.0	0.0	125.2	22.8	
2004	0.0	142.5	0.2	202.6	4.0	
2005	0.0	75.5	1.8	498.4	6.7	170.7
2006	0.0	62.6	0.0	411.8	7.9	98.1
2007	0.0	36.7	0.0	290.9	9.3	42.0

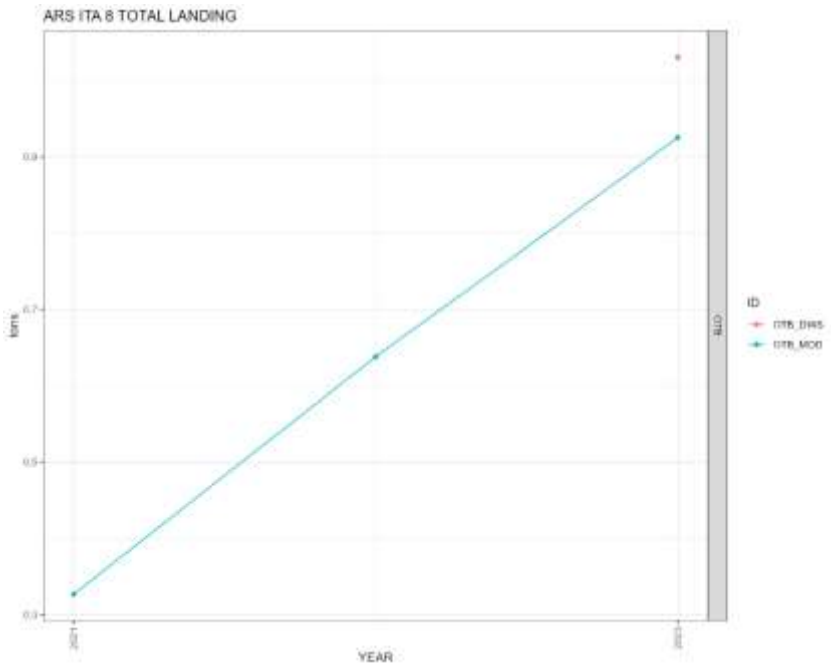
2008	0.0	33.1	0.7	112.8	7.3	38.6
2009	0.0	34.3	0.0	206.2	5.5	117.4
2010	0.0	54.6	0.0	189.3	1.0	98.6
2011	0.0	68.4	0.0	134.7	6.2	94.7
2012	0.0	60.7	1.2	151.6	8.2	117.3
2013	0.0	23.1	0.0	399.4	0.0	124.1
2014	0.0	16.8	0.0	449.3	4.8	123.9
2015	0.0	44.2	0.0	214.6	17.5	97.8
2016	0.0	35.8	0.0	179.1	0.0	127.6
2017	0.0	33.6	0.0	326.0	0.0	249.2
2018	0.0	36.4	0.0	416.2	0.0	188.4
2019	0.0	46.2	0.0	450.1	0.1	170.0
2020	0.0	30.2	0.0	224.6*	0.0	96.3
2021	0.3	31.3	0.0	317.1	0.0	170.6
2022	0.6	42.5	0.0	224.2	0.0	138.3
2023	2.0	113.6	0.0	172.8	0.0	113.3

*value for GSA 10 in 2020 has been corrected with the value reported in the FDI dataset.

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

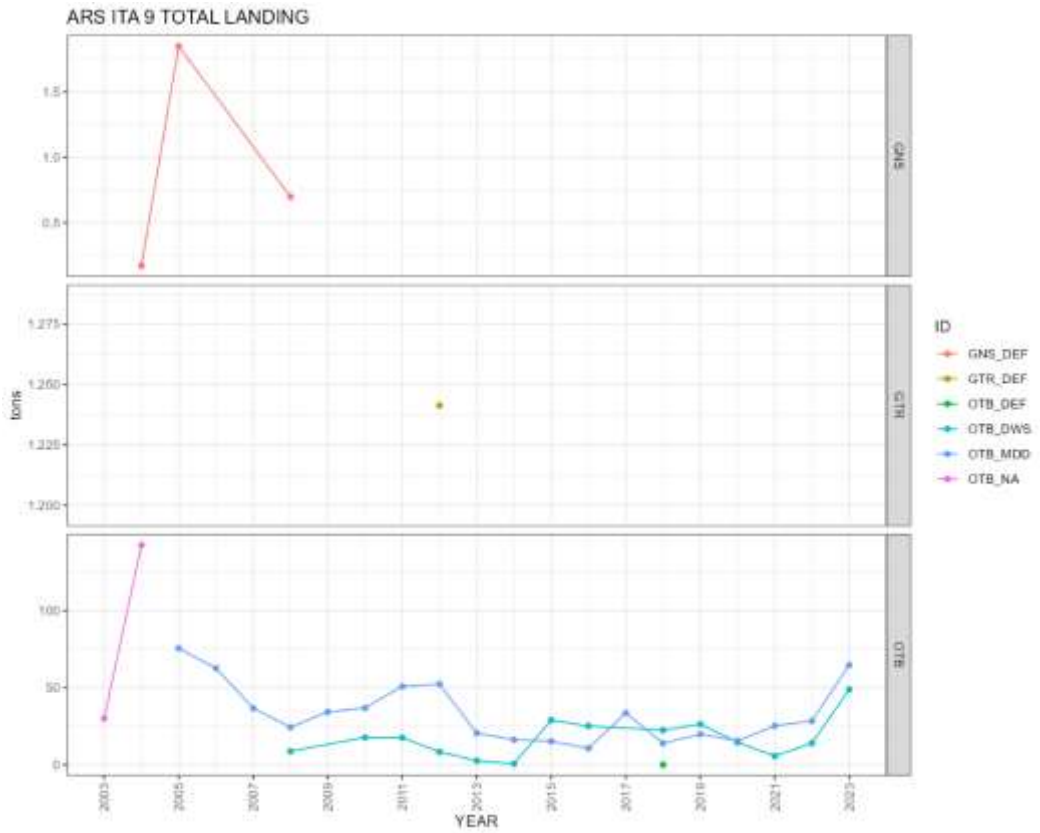
Although the bulk of the production in GSA 10 is coming from the trawl fisheries (mainly deep-water species and mixed demersal and deep-water species trawling), other fisheries (mostly gill nets) provided some contribution to the total production. In GSA 9, the contribution of GNS fisheries is negligible, while in GSA 11 and 8 the giant red shrimp is exploited exclusively by OTB.

Figure 6.19.2.1.2. Giant red shrimp in GSAs 8, 9, 10 & 11: landings trend by gear in GSA 8.



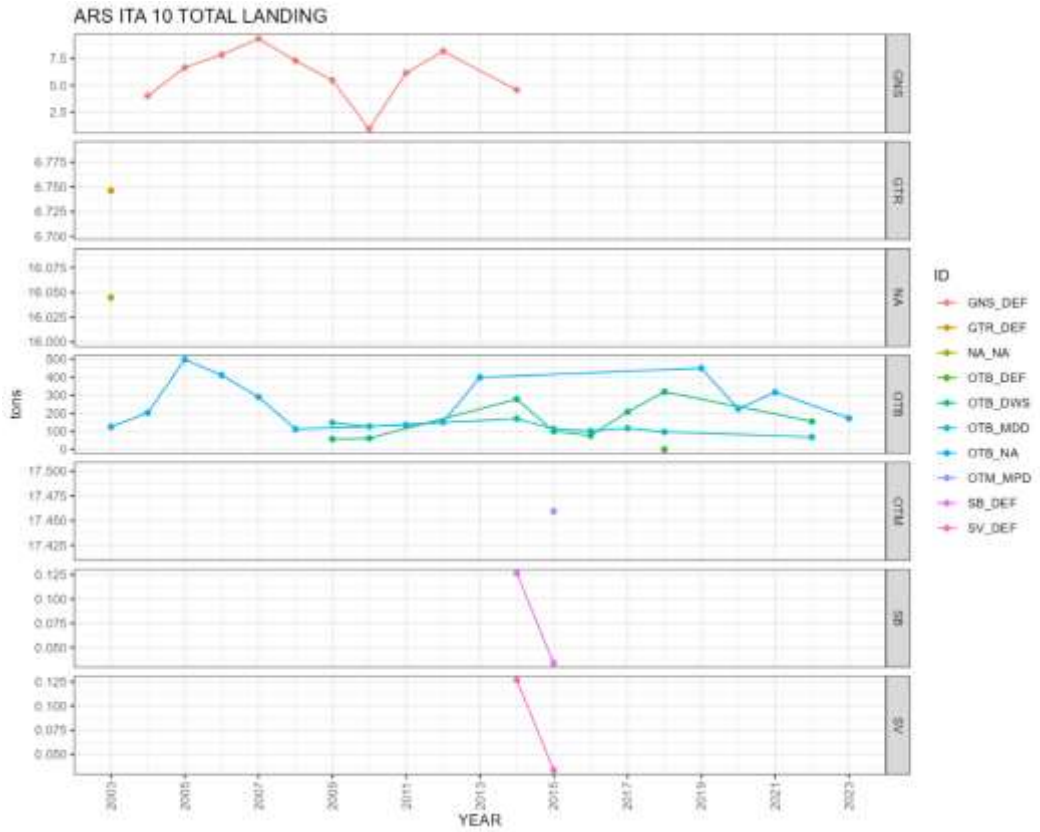
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.3. Giant red shrimp in GSAs 8, 9, 10 & 11: landings trend by gear in GSA 9 (ITA).



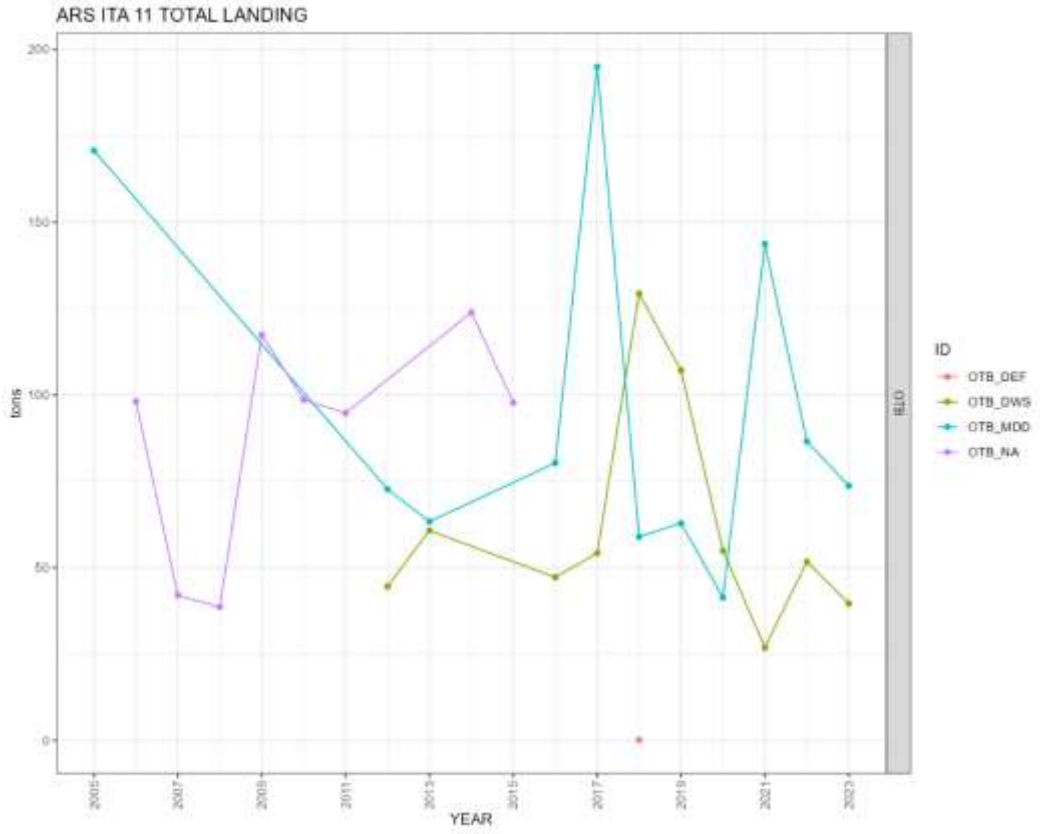
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.4. Giant red shrimp in GSAs 8, 9, 10 & 11: landings trend by gear in GSA 10.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.5. Giant red shrimp in GSAs 8, 9, 10 & 11: landings trend by gear in GSA 11 (ITA).



Discards of giant red shrimp are negligible. Low values of discards (from OTB) are reported only in GSA 9 and 10 for few years. The discards are summarized in Table 6.19.2.1.2 and were added to the landings for the assessment.

Table 6.19.2.1.2. Giant red shrimp in GSAs 8, 9, 10 & 11: Discards (t) by GSA.

year	GSA8	GSA9	GSA10	GSA11
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010		0.453		
2011			0.051	
2012			0.351	
2013				
2014				
2015				
2016				
2017			0.964	
2018				
2019				
2020		0.009		
2021				

2022				
2023				

Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Table 6.19.2.1.3. Giant red shrimp in GSAs 8, 9, 10 & 11: Annual catch (t) by GSA and fishing technique as provided through the official DCR-DCF database.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ITA_GSA 10_FPO_DEF										
ITA_GSA 10_GNS_DEF		4.0	6.7	7.9	9.3	7.3	5.5	1.0	6.2	8.2
ITA_GSA 10_GTR_DEF	6.7									
ITA_GSA 10_NA_NA	16.0									
ITA_GSA 10_OTB_DEF										
ITA_GSA 10_OTB_DWS							57.9	62.1		
ITA_GSA 10_OTB_MDD							148.3	127.2		
ITA_GSA 10_OTB_NA	125.2	202.6	498.4	411.8	290.9	112.8			134.7	151.6
ITA_GSA 10_OTM_MPD										
ITA_GSA 10_SB_DEF										
ITA_GSA 10_SV_DEF										
ITA_GSA 11_OTB_DEF										
ITA_GSA 11_OTB_DWS										44.5
ITA_GSA 11_OTB_MDD			170.7							72.7
ITA_GSA 11_OTB_NA				98.1	42.0	38.6	117.4	98.6	94.7	
ITA_GSA 9_GNS_DEF		0.2	1.8			0.7				
ITA_GSA 9_GTR_DEF										1.2
ITA_GSA 9_OTB_DEF										
ITA_GSA 9_OTB_DWS						8.7		17.7	17.6	8.3
ITA_GSA 9_OTB_MDD			75.5	62.6	36.7	24.4	34.3	36.9	50.8	52.4
ITA_GSA 9_OTB_NA	30.0	142.5								
ITA_GSA 8_OTB_DWS										
ITA_GSA 8_OTB_MDD										
MLT_GSA 11.2_OTB_MDD										
MLT_GSA 9_OTB_MDD										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
ITA_GSA 10_FPO_DEF							0.1				
ITA_GSA 10_GNS_DEF		4.6									
ITA_GSA 10_GTR_DEF											
ITA_GSA 10_NA_NA											
ITA_GSA 10_OTB_DEF						0.0					
ITA_GSA 10_OTB_DWS		278.5	101.0	76.8	208.1	319.2	360.5	141.0	60.9	155.2	109.3
ITA_GSA 10_OTB_MDD		170.7	113.6	102.3	117.9	96.9	89.5	61.4	256.2	69.1	63.5
ITA_GSA 10_OTB_NA	399.4										
ITA_GSA 10_OTM_MPD			17.5								
ITA_GSA 10_SB_DEF		0.1	0.0								
ITA_GSA 10_SV_DEF		0.1	0.0								
ITA_GSA 11_OTB_DEF						0.2					
ITA_GSA 11_OTB_DWS	60.8			47.2	54.3	129.3	107.1	55.0	26.9	51.7	39.6
ITA_GSA 11_OTB_MDD	63.3			80.3	194.9	59.0	62.9	41.3	143.7	86.5	73.7
ITA_GSA 11_OTB_NA		123.9	97.8								
ITA_GSA 9_GNS_DEF											
ITA_GSA 9_GTR_DEF											

ITA_GSA 9_OTB_DEF						0.0					
ITA_GSA 9_OTB_DWS	2.6	0.6	29.0	25.1		22.4	26.3	14.6	5.6	14.0	48.9
ITA_GSA 9_OTB_MDD	20.5	16.2	15.2	10.7	33.6	13.9	19.8	15.6	25.2	28.5	64.7
ITA_GSA 9_OTB_NA											
ITA_GSA 8_OTB_DWS											1.0
ITA_GSA 8_OTB_MDD									0.3	0.6	0.9
MLT_GSA 11.2_OTB_MDD									0.0		
MLT_GSA 9_OTB_MDD									0.5		

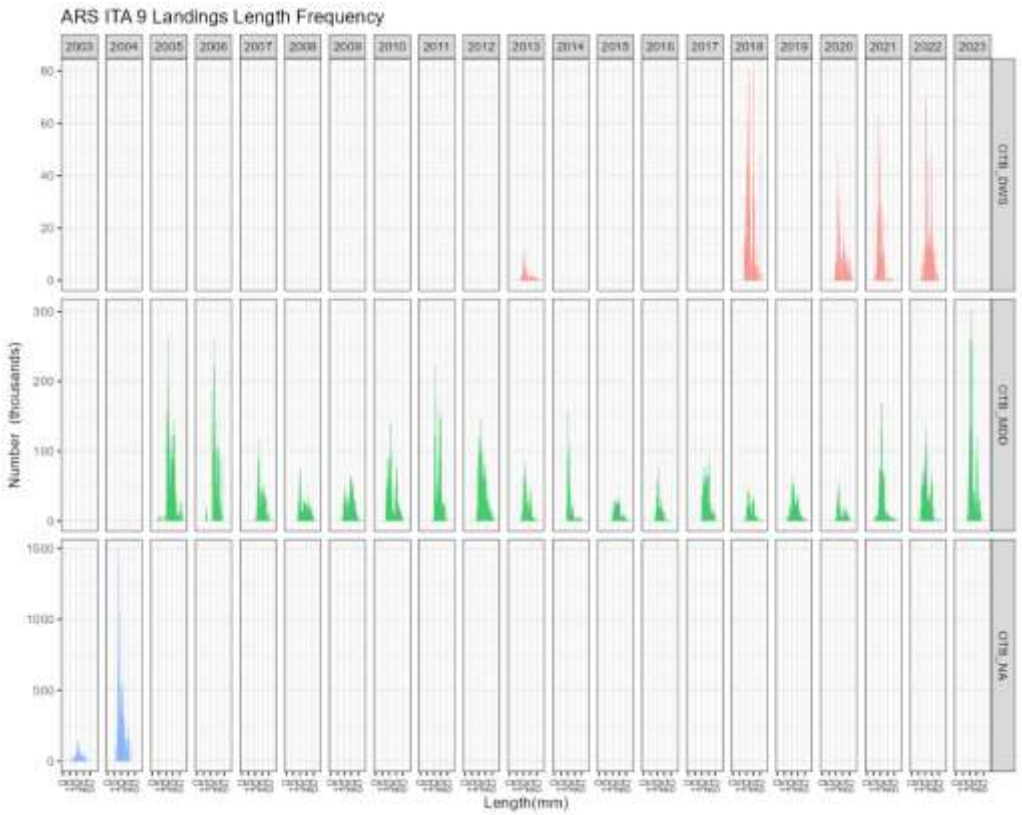
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Since the data from GSA 10 for the years 2019, 2020 and 2021 is derived from only a few quarters, and the length frequency distribution (LFD) for GSA 10 in 2023 is missing, the group decided to follow the approach used in previous assessments. It was then substituted the LFD data with the average of the LFD data from the same years from GSA 9 and 11, and then expanded it to match the production of GSA 10.

The used landings size structure by year, area and gear is shown in Figures 6.19.2.1.6-6.18.2.1.8.

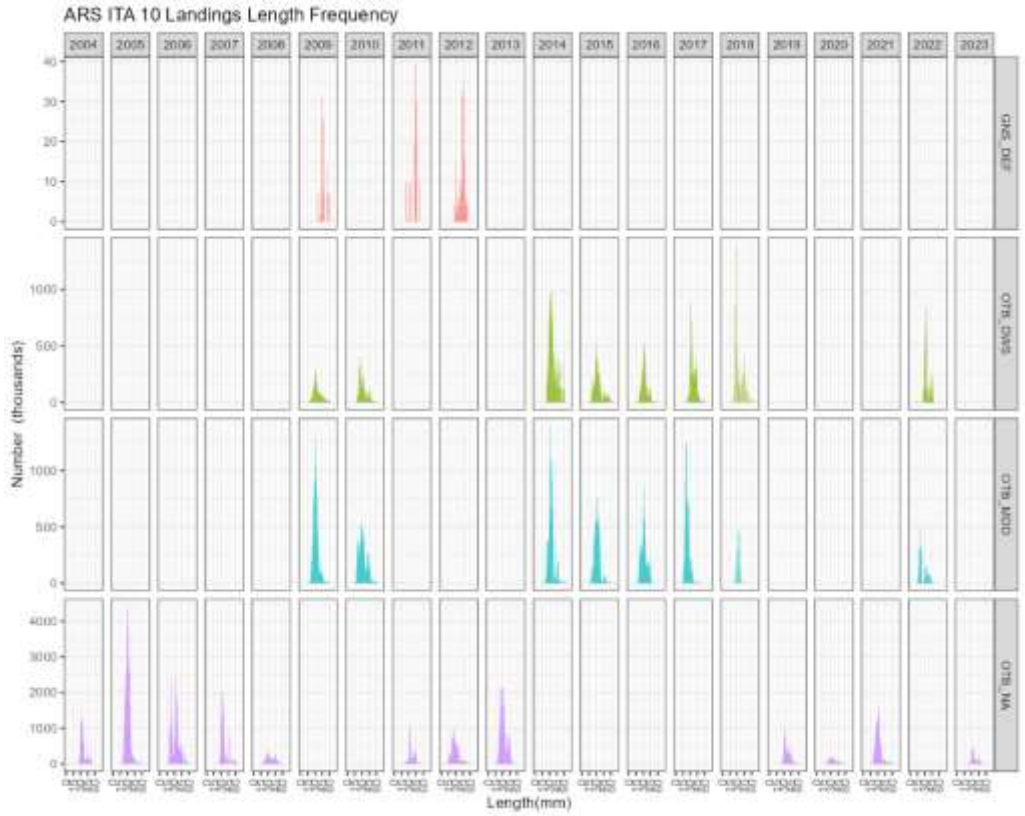
Despite the low values of discards, LFDs are available, and data were included into the stock assessment. LFDs of discards of giant red shrimp are shown in Figures 6.19.2.1.9 - 6.19.2.1.10.

Figure 6.19.2.1.6. Giant red shrimp in GSAs 8, 9, 10 & 11: LFDs of landings by year and gear of giant red shrimp in GSA 9.



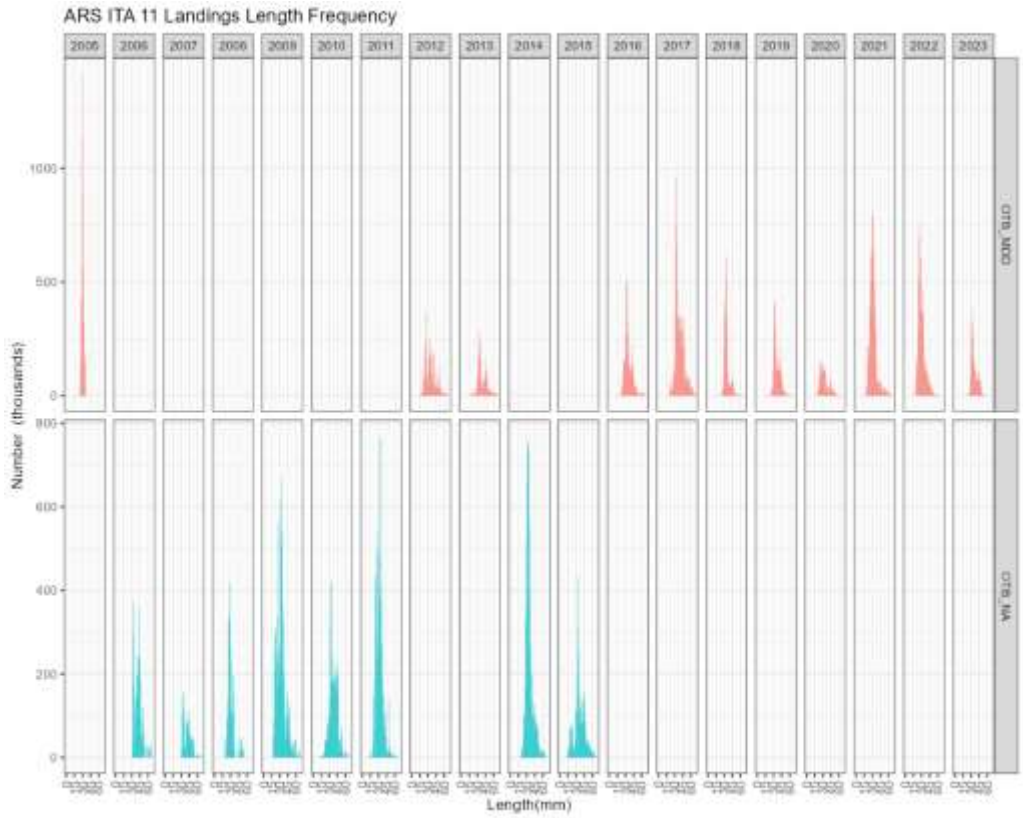
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.7. Giant red shrimp in GSAs 8, 9, 10 & 11: LFDs of landings by year and gear of giant red shrimp in GSA 10 (reconstructed data for 2019, 2020, 2021 and 2023).



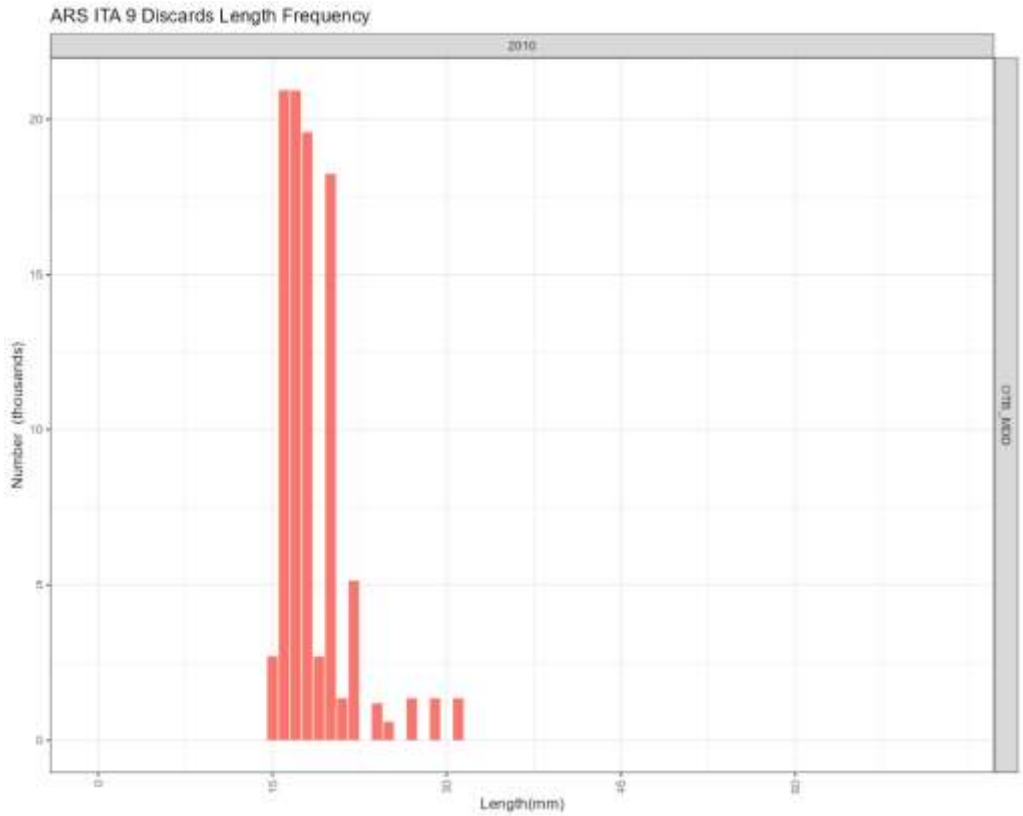
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.8. Giant red shrimp in GSAs 8, 9, 10 & 11: LFDs of landings by year and gear of giant red shrimp in GSA 11.



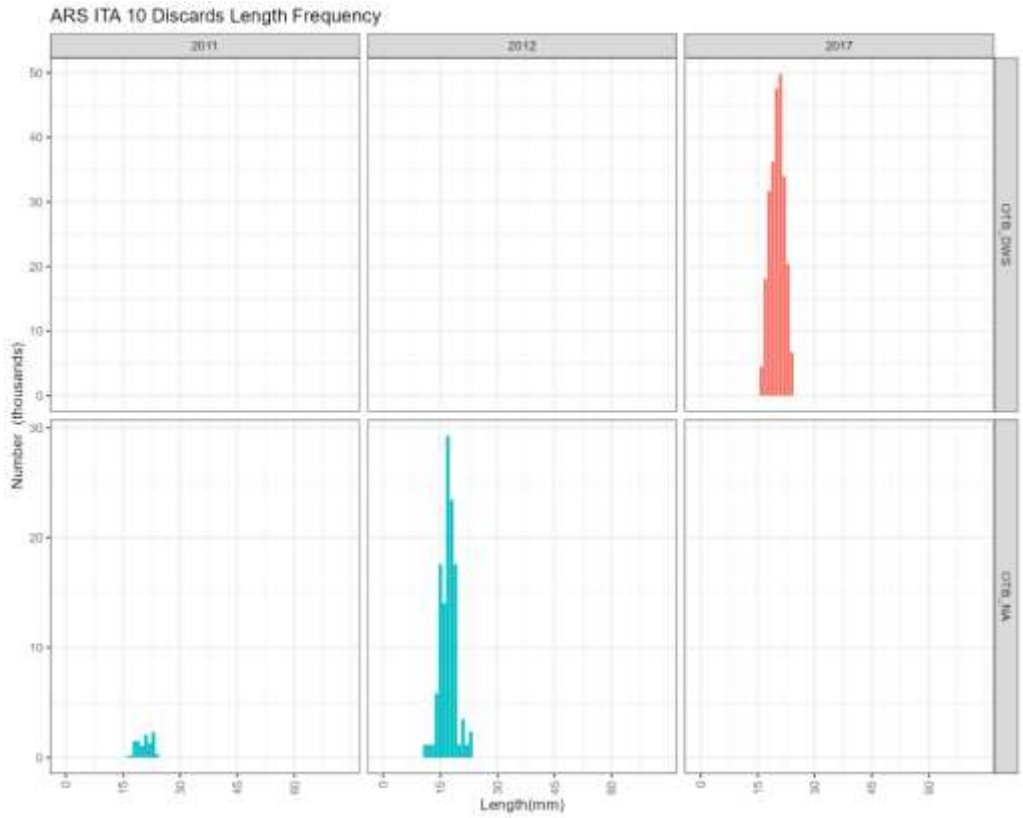
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.9. Giant red shrimp in GSAs 8, 9, 10 & 11: LFDs of discards of giant red shrimp in GSA 9



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.1.10. Giant red shrimp in GSAs 8, 9, 10 & 11: LFDs of discards of giant red shrimp in GSA 10.



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.19.2.2 Effort

6.19.2.3 Survey data

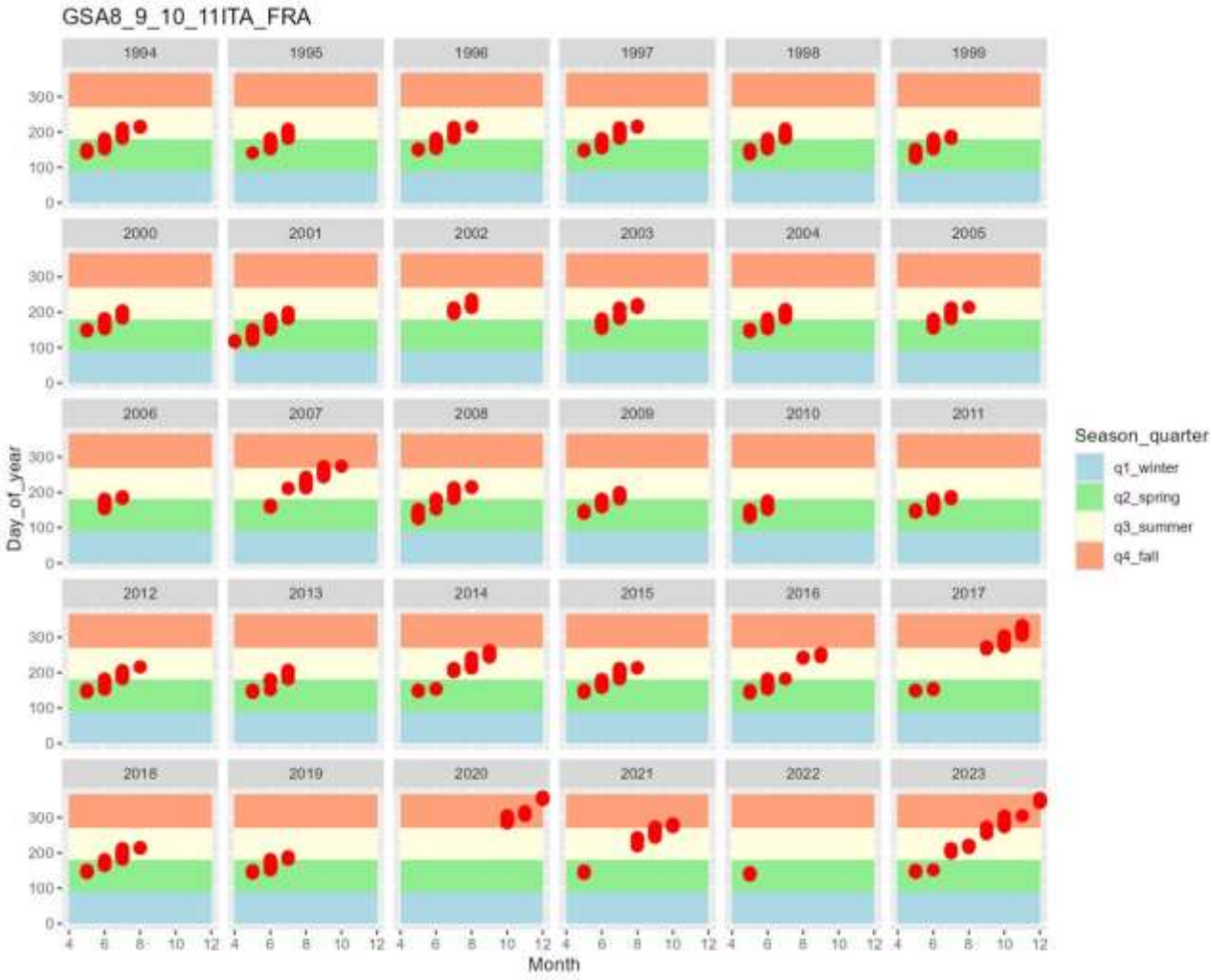
Since 1994, MEDITS trawl surveys had been regularly carried out each year (centred in the early summer). A random stratified sampling by depth (five strata with depth limits at 50, 100, 200, 500 and 800 m) is applied. Haul allocation was proportional to the stratum area. All the abundance data (number and total weight of fish per surface unit) are standardized to the km^2 using the swept area method.

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance) 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 three GSAs.

Medits has been regularly carried out since 1994 mainly during the spring-summer season. In some years (2017, 2020, 2021 and 2023) surveys were delayed in some GSAs (Figure 6.19.2.2.1). In 2023, in particular, in GSA 8 the survey was done in spring, in GSA 11 in summer, in GSA 9 in autumn while in GSA 10 at the end of autumn (and not all the hauls were performed). However, length frequency distributions observed are not noticeably different from the other years (Figure 6.19.2.2.6).

In 2002 and 2020 the survey was not carried out in GSA 8 while in 2022, the survey was not conducted in the Italian GSAs. Since the data for 2022 is derived only from GSA 8 (France), it was decided not to use this year's data in the stock assessment.

Figure 6.19.2.2.1 Giant red shrimp in GSAs 8, 9, 10 & 11: Suvery periods (MEDITS, 1994-2023) in GSAs 8, 9, 10 and 11.

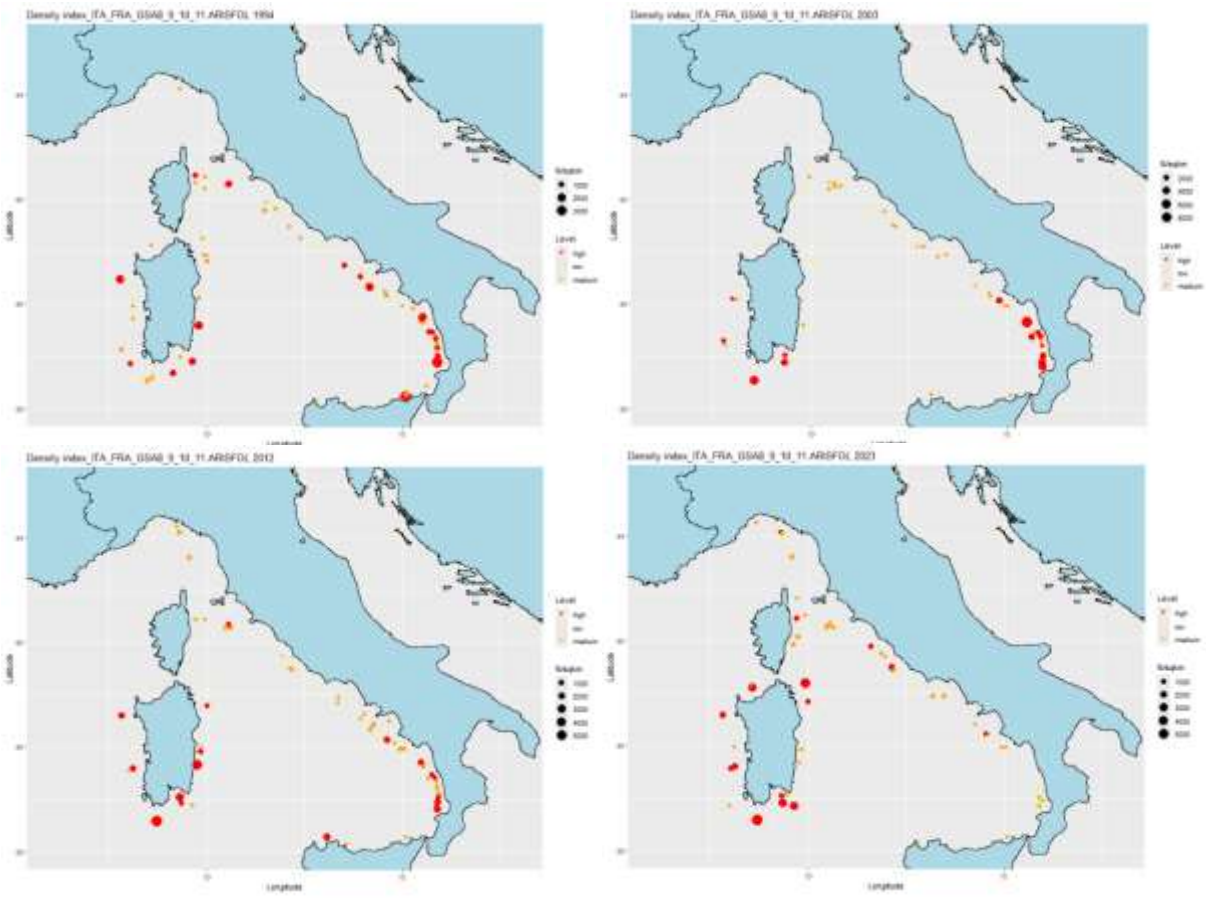


Source: own elaborations

Geographical distribution

The following maps show the density indices (n/km^2) by haul of the MEDITS survey. It is evident that the giant red shrimp is more abundant in GSAs 10 and 11 than in GSAs 8 and 9. Furthermore, in GSA 9 the species is mostly present in the southern part of the GSA (Masnadi et al., 2018).

Figure 6.19.2.2.2 Giant red shrimp in GSAs 8, 9, 10 & 11: distribution pattern in the period 1994-2023 (MEDITS survey). Maps for the years 1994, 2003, 2012 and 2023 are shown.



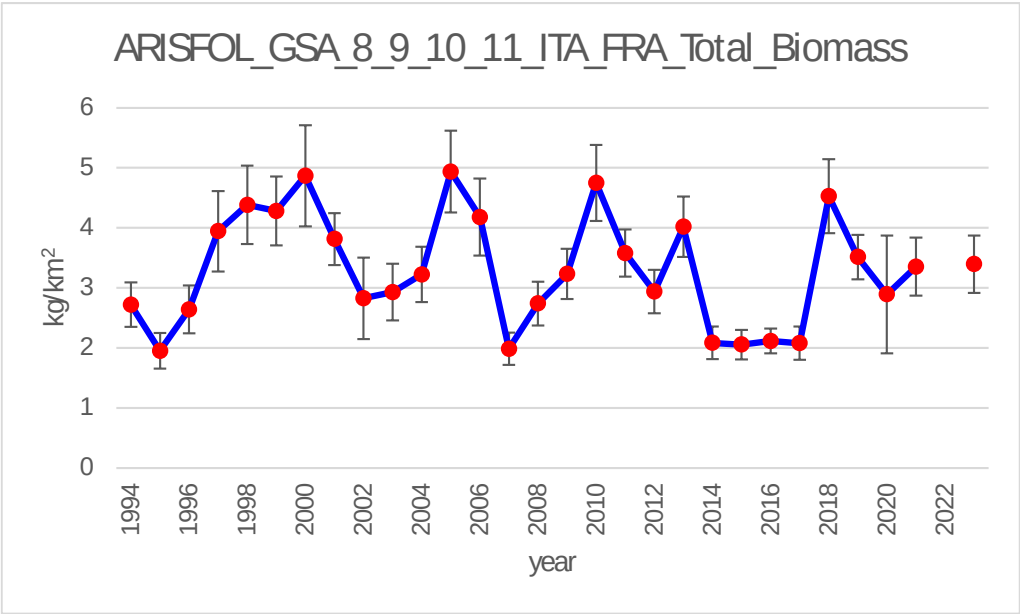
Source: own elaborations

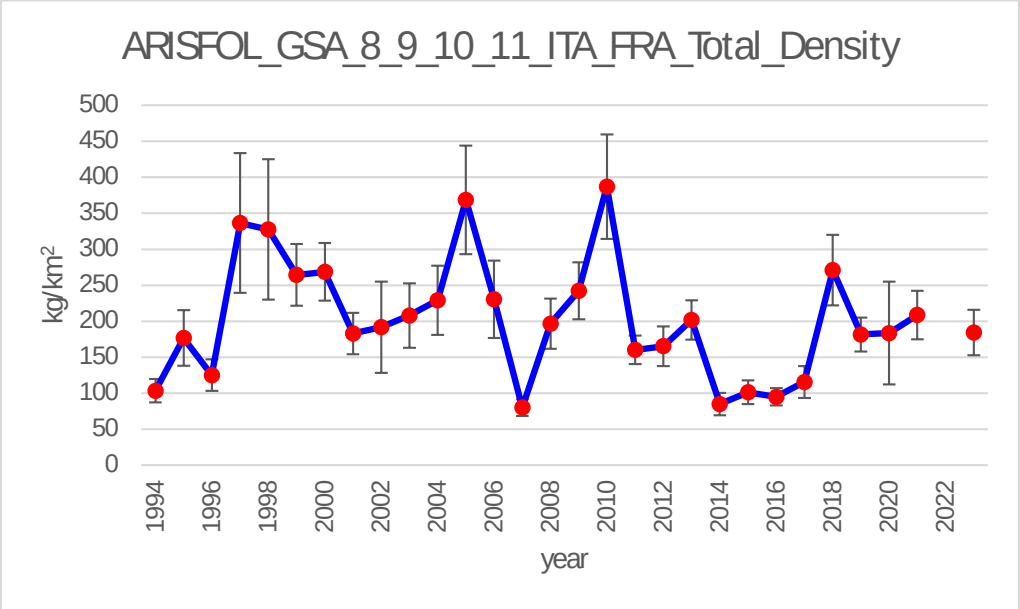
Trends in abundance and biomass

The trends of the MEDITS indices (biomass and density) computed on the GSAs combined are shown in Figure 6.19.2.2.3.

The time series of both indices are characterized by wide fluctuations with two main peaks in 2005 and 2010. An absence of a statistical trend can be observed for the two indices, with mean values along the time series of 3.3 kg/km^2 and 202 individuals/km^2.

Figure 6.19.2.2.3. Giant red shrimp in GSAs 8, 9, 10 & 11: MEDITS 1994-2023 standardized biomass and density indices (10-800 m).



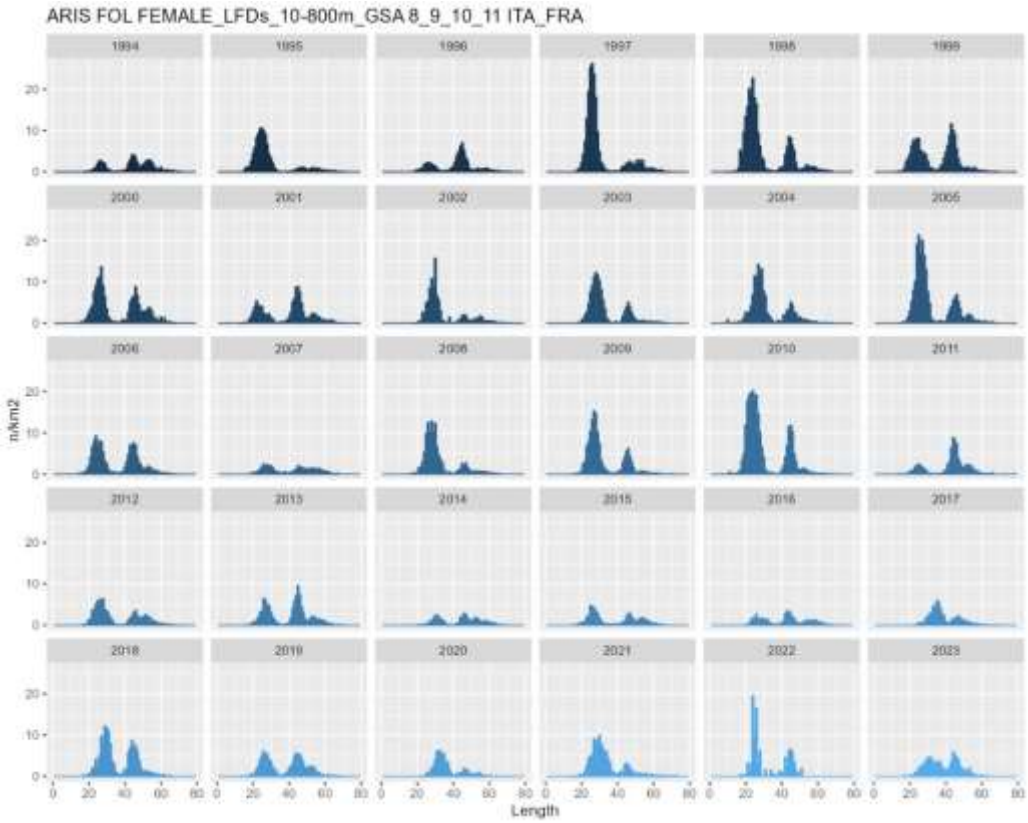


Source: own elaborations

Trends in abundance and biomass by length

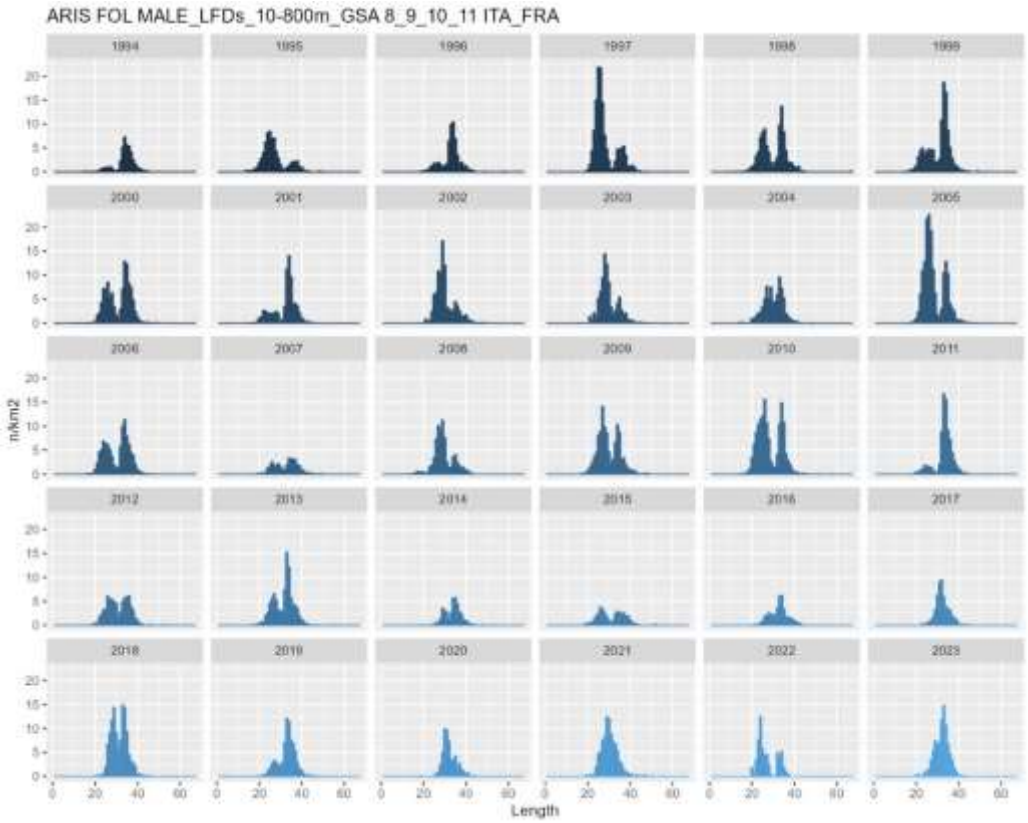
The stratified abundance indices by length (by sex and total) computed on the GSAs combined during the MEDITS surveys from 1994 to 2023 are shown in Figures 6.19.2.3.4-6.19.2.3.6.

Figure 6.19.2.3.4. Giant red shrimp in GSAs 8, 9, 10 & 11: stratified abundance indices by size for females, 1994-2023 (Data for 2022 is only from GSA 8 and was not considered in the assessment).



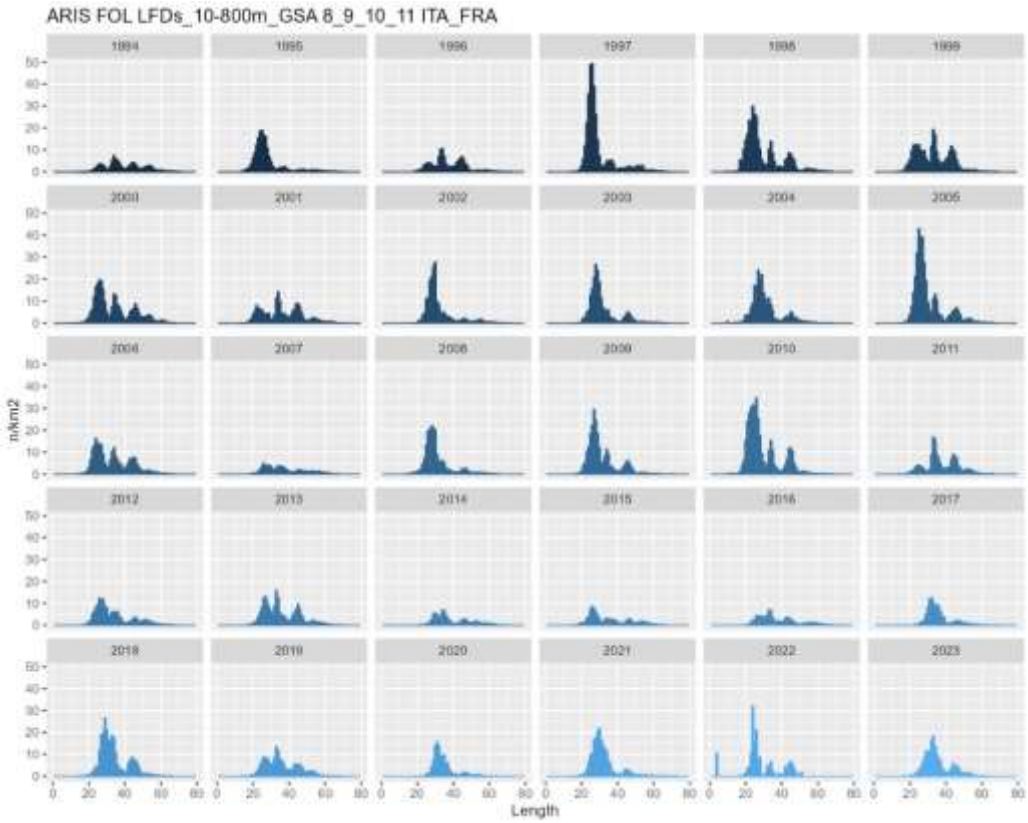
Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.3.5. Giant red shrimp in GSAs 8, 9, 10 & 11: stratified abundance indices by size for males, 1994-2023 (Data for 2022 is only from GSA 8 and was not considered in the assessment).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

Figure 6.19.2.3.6 Giant red shrimp in GSAs 8, 9, 10 & 11: total stratified abundance indices by size, 1994-2023 (Data for 2022 is only from GSA 8 and was not considered in the assessment).



Data source: MS data submission under the 2024 Mediterranean and Black Sea data call - MARE/D1/CO (2024)

6.19.3 Stock assessment

Input data

FLR libraries were employed in order to carry out a Statistical Catch-at-age (a4a) assessment.

The assessment by means of a4a was carried out using as input data the period 2005-2023 for the catch data and 2005-2023 for the tuning file (MEDITS indices).

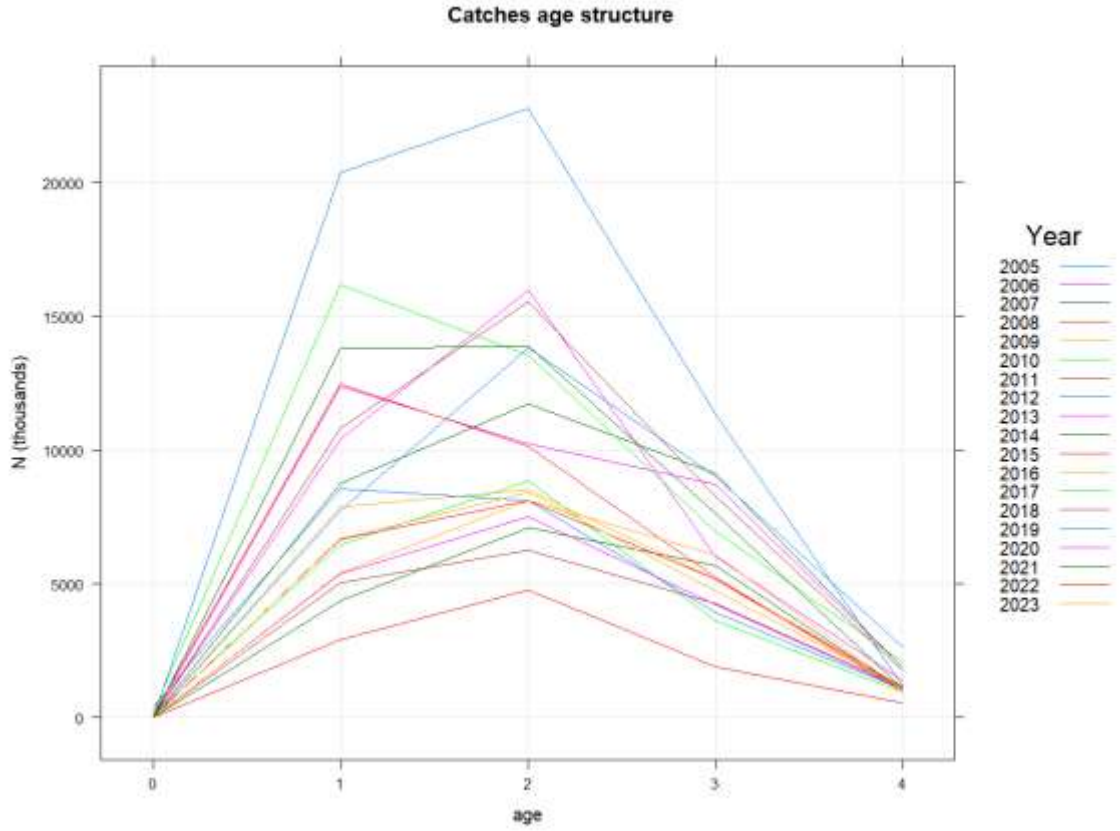
A natural mortality vector computed using Chen and Watanabe model was used in the assessment. Natural mortality vector and proportion of mature are described in section 6.19.1.1. Length-frequency distributions of commercial catches and surveys were split by sex and then transformed in age classes (plus group was set at age 4) using length-to-age slicing with different growth parameters by sex. A correction of 0.5 was applied to t_0 to align length slicing to assessment year to account for spawning at the middle of the year. The number of individuals by age relative to the catches was SOP corrected:

[SOP = catch / Σa (total catch numbers at age a x catch weight-at-age a)].

In both catches and survey, a plus group at age 4 was set. F_{bar} range was fixed at 1-3.

The final data input are shown in the tables and figures below (Figures 6.19.3.1-2, Tables 6.19.3.1-4).

Figure 6.19.3.1 Giant red shrimp in GSAs 8, 9, 10 & 11: catch-at-age distribution by year of the catches (2005-2023).



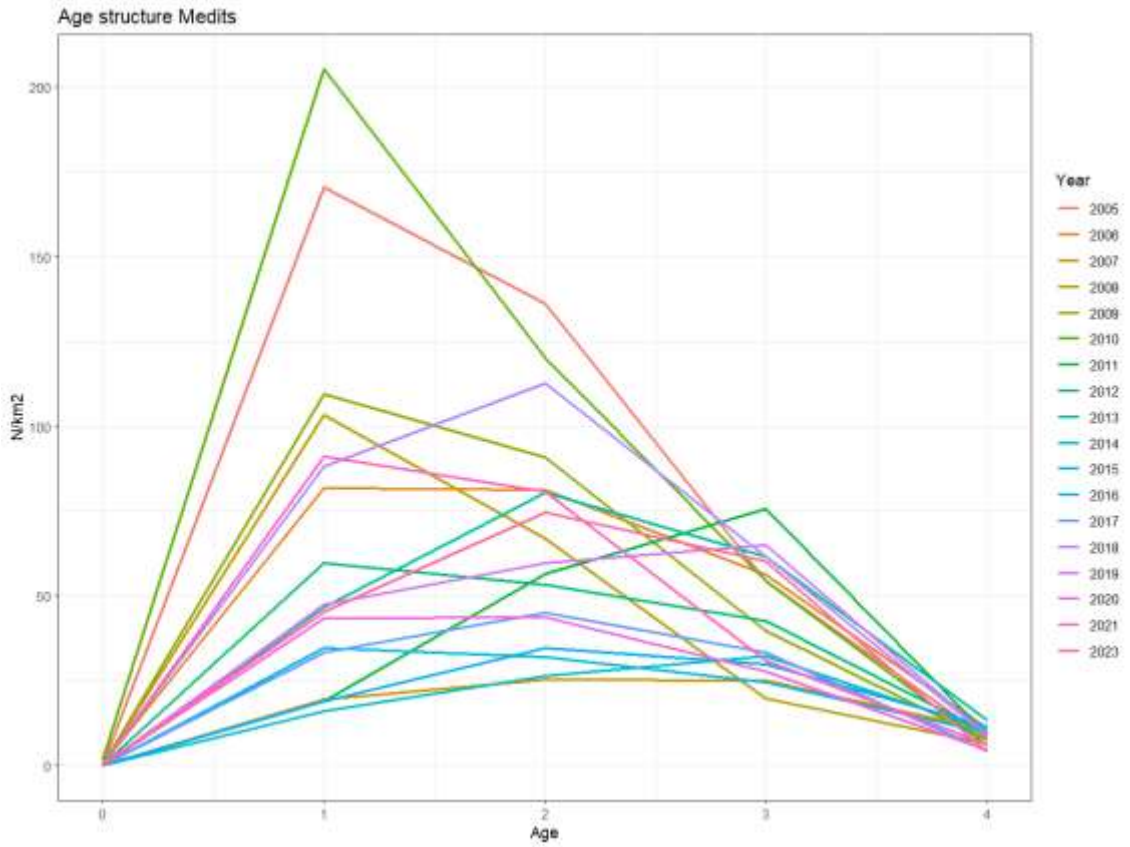
Source: own elaborations

Table 6.19.3.1. SOP correction vectors for the Giant red shrimp by GSAs in GSAs 9, 10 & 11.

	GSA 9	GSA 10	GSA 11
2005	1.0	1.0	2.6
2006	1.1	1.0	0.9
2007	1.1	1.0	0.9
2008	1.5	1.0	0.9
2009	1.1	1.0	0.9
2010	1.6	1.0	0.9
2011	1.5	1.0	0.9
2012	1.3	1.0	1.5
2013	1.1	1.0	1.9
2014	1.2	1.0	0.9
2015	2.9	1.0	1.2
2016	3.5	1.0	1.5
2017	1.0	1.7	1.2
2018	1.0	3.3	2.9
2019	2.4	2.5	2.5
2020	1.1	3.2	2.7
2021	1.1	1.3	1.4
2022	1.1	1.8	1.5
2023	2.3	2.1	2.0

Source: own elaborations

Figure 6.19.3.2 Giant red shrimp in GSAs 8, 9, 10 & 11: MEDITS index-at-age distribution by year (2005-2023).



Source: own elaborations

Table 6.19.3.2. Giant red shrimp in GSAs 8, 9, 10 & 11: Values of catch numbers at age per year used in the assessment (SOP applied).

Age	2005	2006	2007	2008	2009
0	16.83	1.04	1.03	1.32	1.27
1	20386.91	12383.09	4361.48	2912.07	7871.31
2	22773.74	10253.91	7088.70	4781.34	8526.99
3	11342.88	8707.29	5666.17	1887.43	5154.35
4+	1169.84	1856.57	1016.09	541.45	961.97
Age	**2010**	**2011**	**2012**	**2013**	**2014**
0	54.07	15.68	403.77	8.59	1.09
1	6445.16	5033.97	8562.66	10403.88	8737.67
2	8838.69	6258.41	8121.81	15994.68	11733.61
3	3630.47	4253.55	3904.83	6000.61	9118.39
4+	956.43	1124.12	1037.43	1398.28	1858.60
Age	**2015**	**2016**	**2017**	**2018**	**2019**
0	40.27	4.56	189.89	2.00	2.41
1	6660.53	6693.78	16188.29	10802.79	7738.95

2	8111.71	8416.27	13546.32	15553.50	13816.85
3	5184.02	4744.06	6968.22	8268.64	9032.67
4+	1153.88	1108.51	2069.89	1755.03	2630.24

Age	**2020**	**2021**	**2022**	**2023**
0	9.93	4.33	111.82	10.93
1	5382.72	13790.81	12462.94	5412.36
2	7495.56	13883.33	10126.20	8093.27
3	4218.17	7620.95	5232.68	6094.09
4+	1054.09	1071.34	1021.55	1022.35

Source: own elaborations

Table 6.19.3.3. Giant red shrimp in GSAs 8, 9, 10 & 11: Values of mean weight at age per year used in the assessment.

Age	2005	2006	2007	2008	2009
0	0.000	0.000	0.000	0.000	0.000
1	0.011	0.009	0.014	0.010	0.010
2	0.012	0.022	0.021	0.019	0.017
3	0.017	0.022	0.023	0.029	0.020
4+	0.038	0.030	0.041	0.035	0.037
Age	**2010**	**2011**	**2012**	**2013**	**2014**
0	0.000	0.000	0.000	0.000	0.000
1	0.009	0.011	0.008	0.010	0.013
2	0.019	0.022	0.017	0.018	0.019
3	0.022	0.018	0.024	0.018	0.021
4+	0.033	0.028	0.036	0.034	0.040
Age	**2015**	**2016**	**2017**	**2018**	**2019**
0	0.000	0.000	0.000	0.000	0.000
1	0.011	0.011	0.008	0.012	0.013
2	0.018	0.018	0.020	0.018	0.022
3	0.022	0.017	0.021	0.020	0.019
4+	0.037	0.033	0.035	0.037	0.031
Age	**2020**	**2021**	**2022**	**2023**	
0	0.000	0.000	0.000	0.000	
1	0.010	0.010	0.009	0.014	
2	0.019	0.013	0.018	0.023	
3	0.026	0.019	0.016	0.019	
4+	0.041	0.041	0.028	0.028	

Source: own elaborations

Table 6.19.3.4. Giant red shrimp in GSAs 8, 9, 10 & 11: Survey index (MEDITS) values of numbers at age per year used in the assessment.

Age	2005	2006	2007	2008	2009
0	0.169	0.360	0.028	0.043	0.092
1	170.351	81.718	19.556	103.310	109.360
2	135.982	81.132	25.368	66.989	90.897
3	54.246	56.310	24.943	19.729	39.706
4+	7.917	10.847	10.307	6.536	7.553
Age	**2010**	**2011**	**2012**	**2013**	**2014**
0	1.552	0.120	0.047	0.054	0.028
1	205.214	18.986	59.636	46.576	16.028
2	119.980	56.371	53.363	80.545	26.295
3	54.427	75.530	42.762	61.523	32.269
4+	5.898	9.199	9.556	13.233	10.363
Age	**2015**	**2016**	**2017**	**2018**	**2019**
0	0.095	0.028	0.028	0.157	0.125
1	34.721	19.047	33.258	88.095	47.307
2	32.034	34.569	45.072	112.704	59.765
3	24.635	29.886	33.218	61.464	65.053
4+	9.496	11.381	4.177	8.791	9.066
Age	**2020**	**2021**	**2022**	**2023**	

0	0.028	0.041	NA	0.028
1	43.521	91.173	NA	45.367
2	43.831	80.588	NA	74.510
3	27.625	30.861	NA	60.220
4+	4.533	6.054	NA	4.047

Source: own elaborations

Assessment results

The assessment was performed by sex combined. Given that the catches were composed mainly of individuals between 1 and 3 years, these ages were selected as F_{bar} range.

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

Fishing mortality sub-model: fmodel = factor(replace(age, age>3,3))+s(year, k=6)

Catchability sub-model: qmodel = list(~ factor(age))

SR sub-model: srmod = geomean(CV=0.2)

Model <- sca(stock = stk, indices = idx, fmodel, qmodel, srmod)

The n1model and vmodel used in the final fit are the default ones:

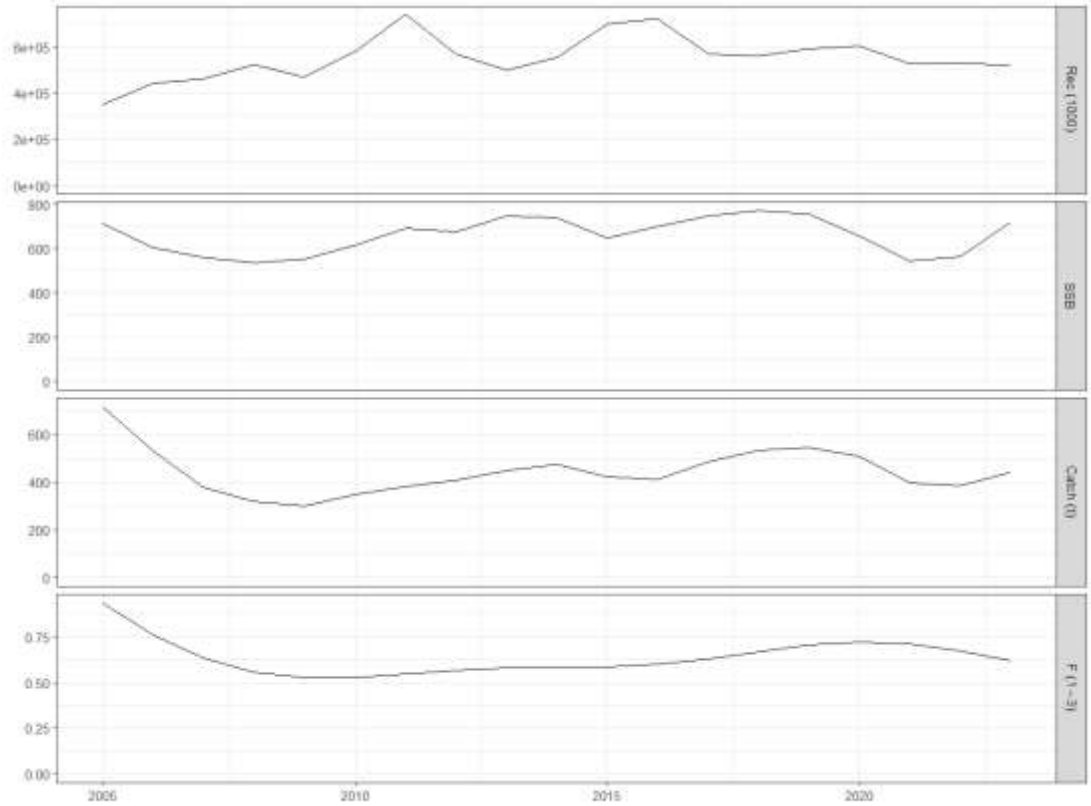
n1model <- ~s(age, k = 3)

vmodel <- list(~s(age, k=3), ~1)

The log residuals for both the catches and the survey are similar to the assessment from last EWG, and they do not show any particular issue. The fitting of the survey shows some problems (Figures 6.19.3.9), probably due to the poor internal consistency of the survey. Despite this, the diagnostics are considered acceptable and the a4a model is deemed suitable as a basis for advice.

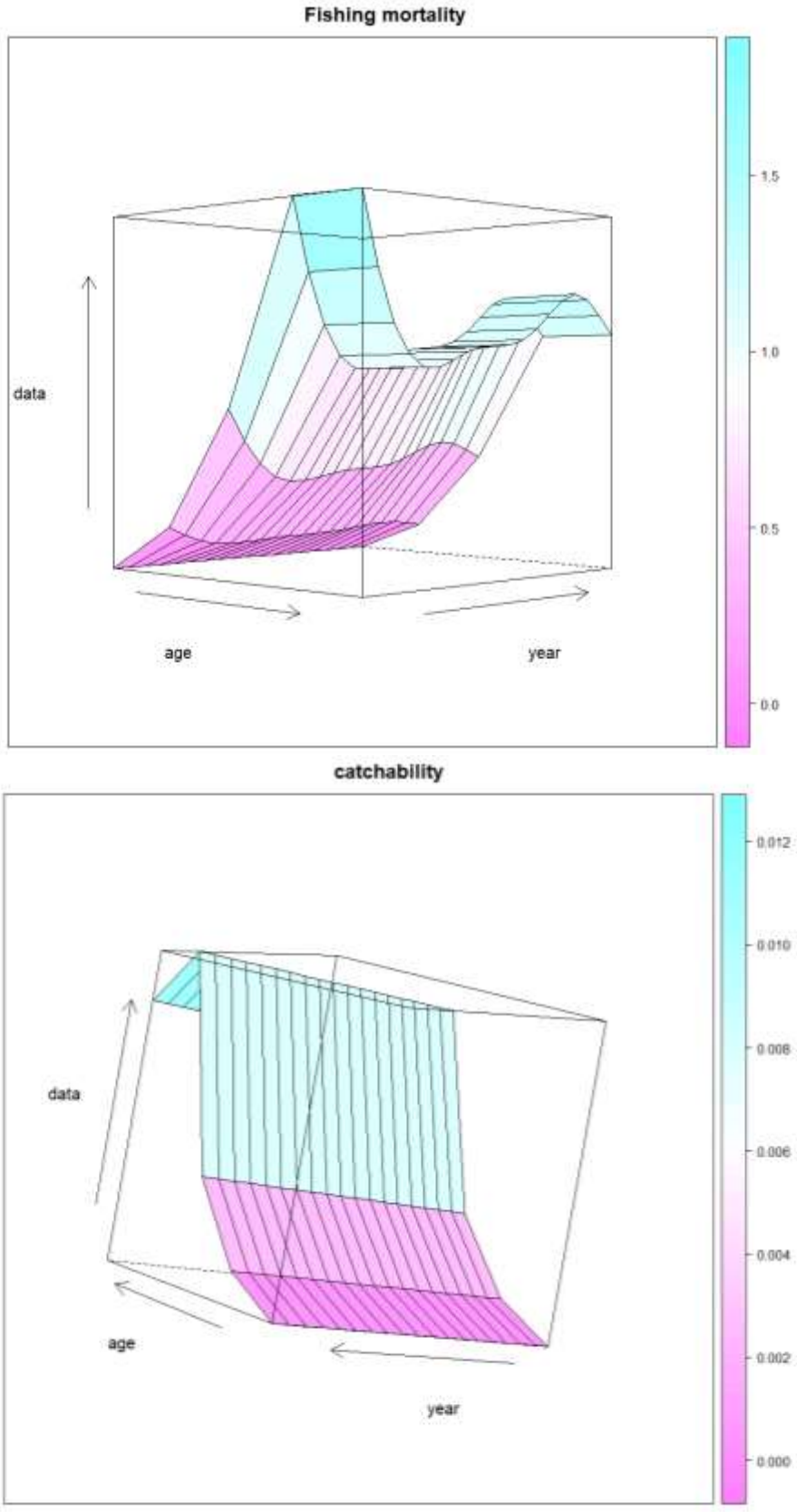
The effect of cryptic biomass was investigated, and did not show any relevant issue, as the biomass of the plus group (age 4+) is never higher than the 7% of the total SSB.

Figure 6.19.3.3. Giant red shrimp in GSAs 8, 9, 10 & 11. Stock summary from the final a4a model.



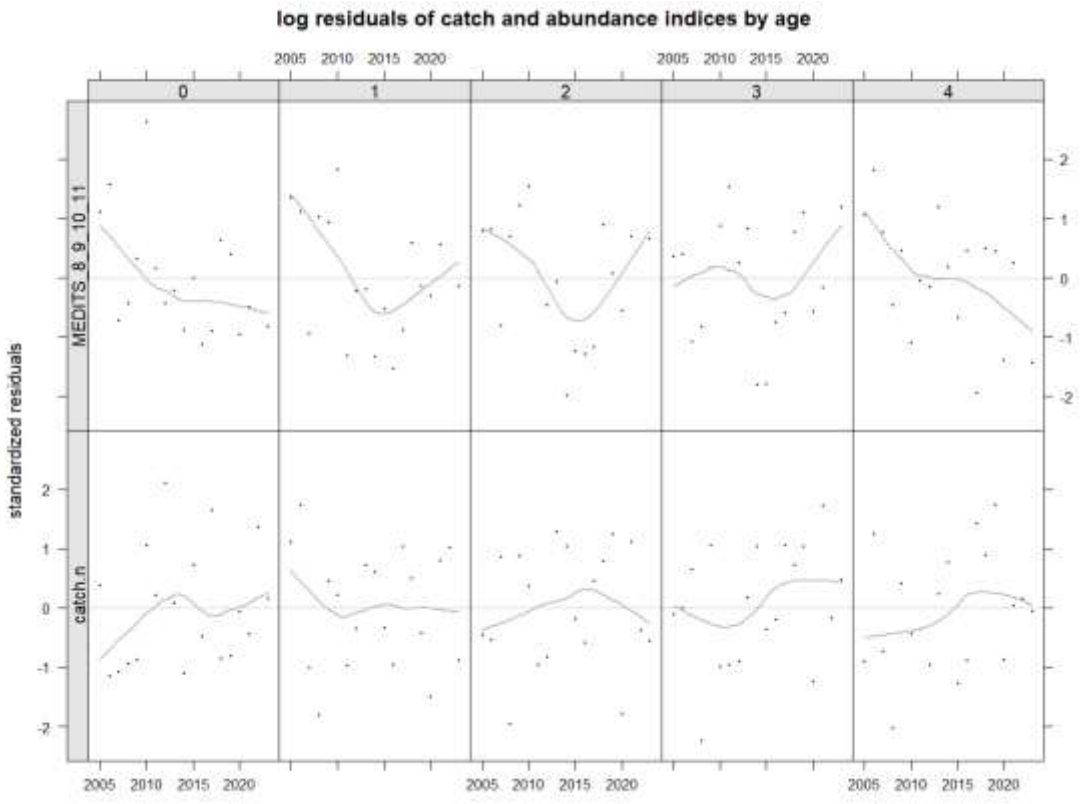
Source: own elaborations

Figure 6.19.3.4. Giant red shrimp in GSAs 8, 9, 10 & 11. 3D contour plot of estimated fishing mortality (top) and 3D contour plot of estimated survey catchability (bottom) at age and year.



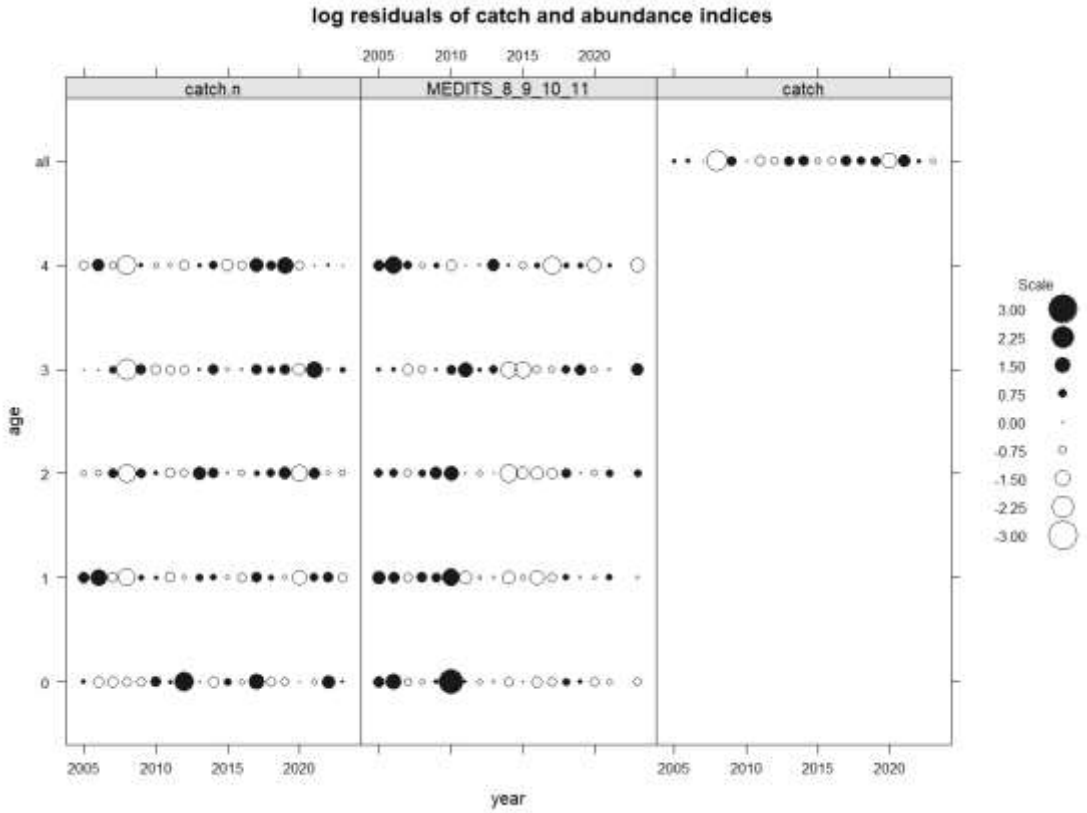
Source: own elaborations

Figure 6.19.3.5. Giant red shrimp in GSAs 8, 9, 10 & 11. log residuals for the catch-at-age data of the fishery and the survey.



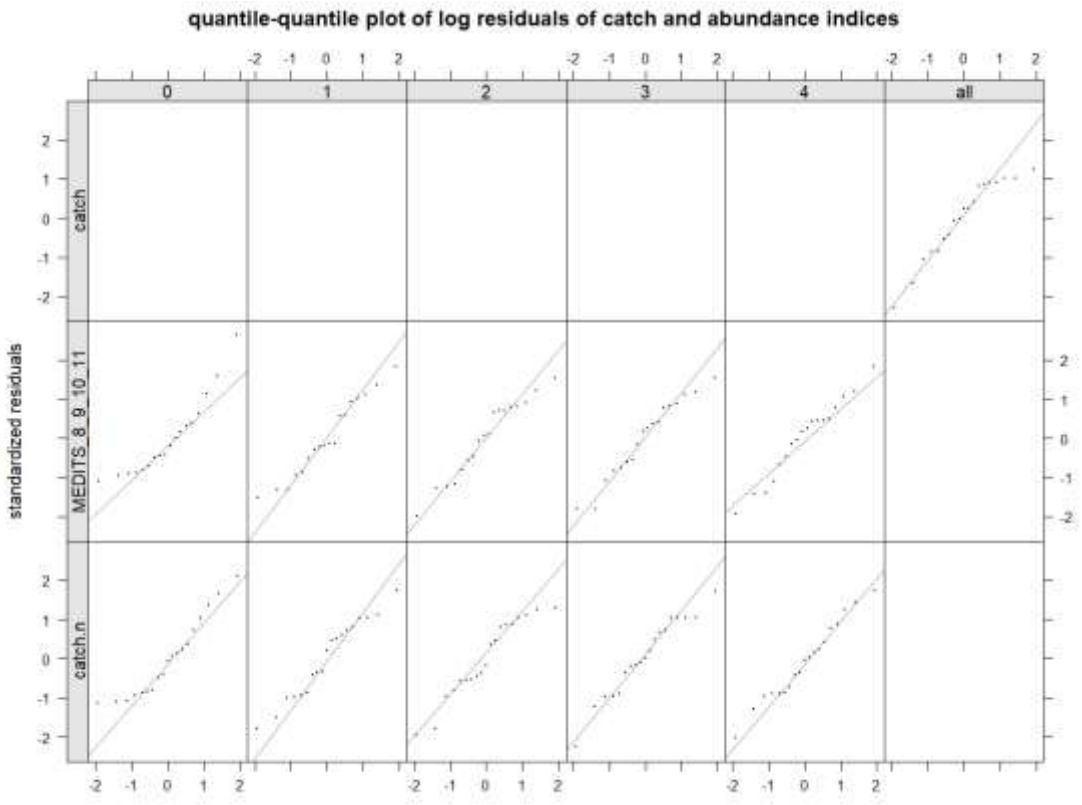
Source: own elaborations

Figure 6.19.3.6. Giant red shrimp in GSAs 8, 9, 10 & 11. Bubble plot of the log residuals for the catch-at-age data of the fishery and the survey.



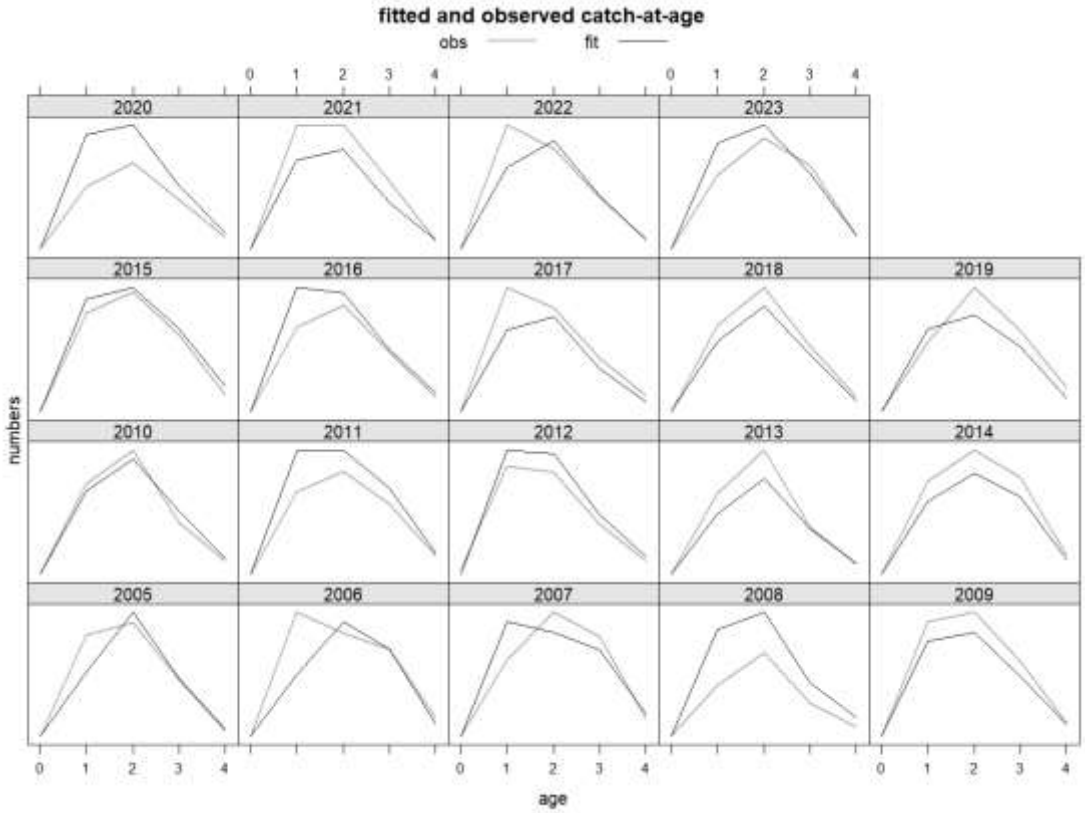
Source: own elaborations

Figure 6.19.3.7. Giant red shrimp in GSAs 8, 9, 10 & 11: QQ-plot of the log residuals for the catch-at-age data of the fishery and the survey.



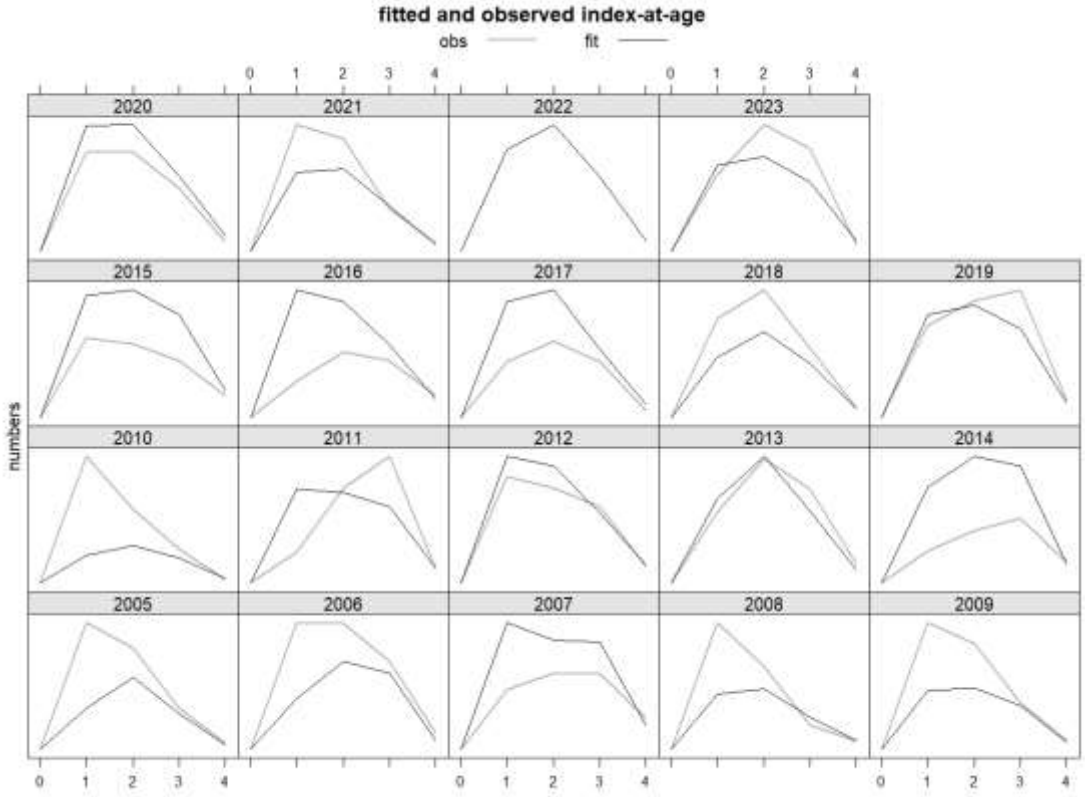
Source: own elaborations

Figure 6.19.3.8. Giant red shrimp in GSAs 8, 9, 10 & 11: fitted vs observed values by age and year for the catches.



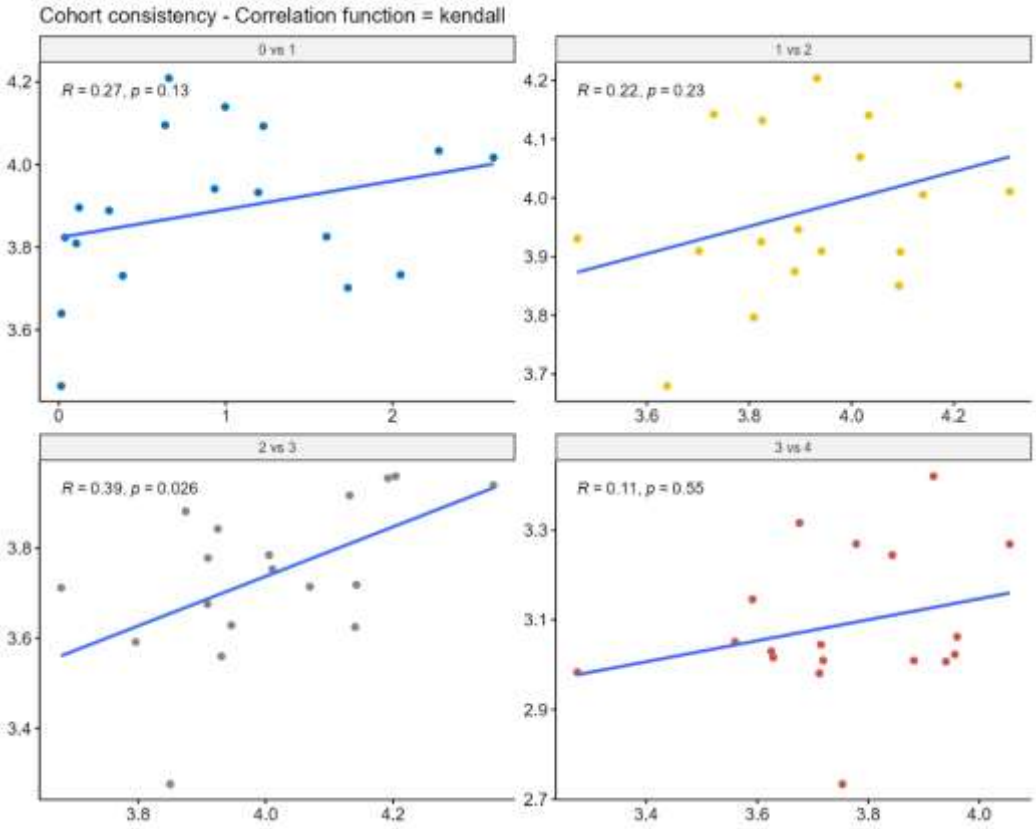
Source: own elaborations

Figure 6.19.3.9. Giant red shrimp in GSAs 8, 9, 10 & 11: fitted vs observed values by age and year for the survey.



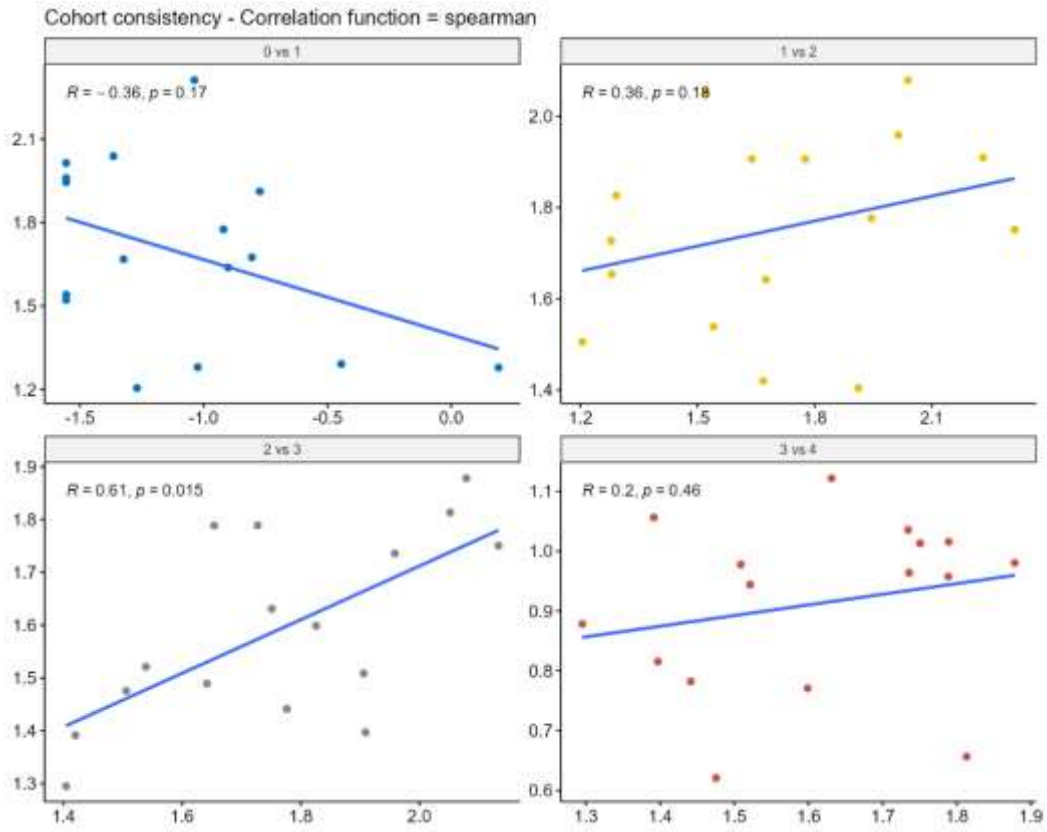
Source: own elaborations

Figure 6.19.3.10. Giant red shrimp in GSAs 8, 9, 10 & 11: internal consistency of the catch-at-age data.



Source: own elaborations

Figure 6.19.3.11. Giant red shrimp in GSAs 8, 9, 10 & 11: internal consistency of the catch-at-age data of the MEDITS survey.



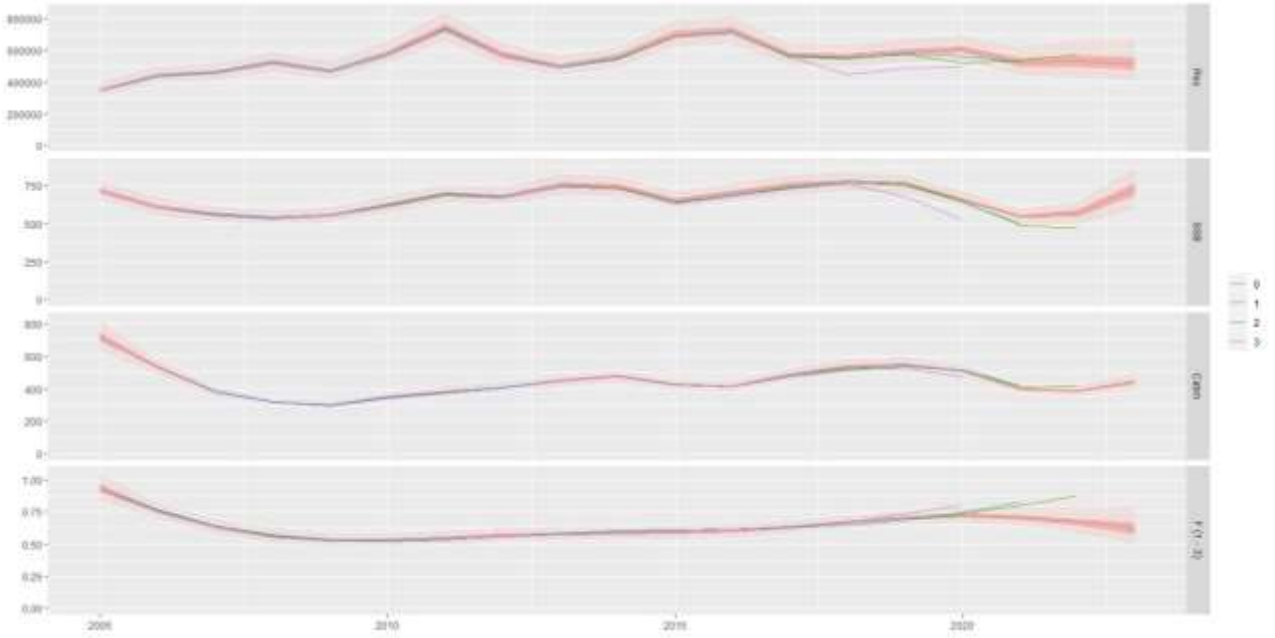
Source: own elaborations

Retrospective

The retrospective analysis was applied up to 3 years back. It shows that the assessment model is moderately stable. There is some evidence of retrospective bias, underestimation of F, probably linked to large negative and then positive residuals in survey data. The instability does not affect the conclusion $F>F_{MSY}$ in all years with F_{MSY} = 0. 48, F in 2023 is estimated as $F_{current}$=0.62.

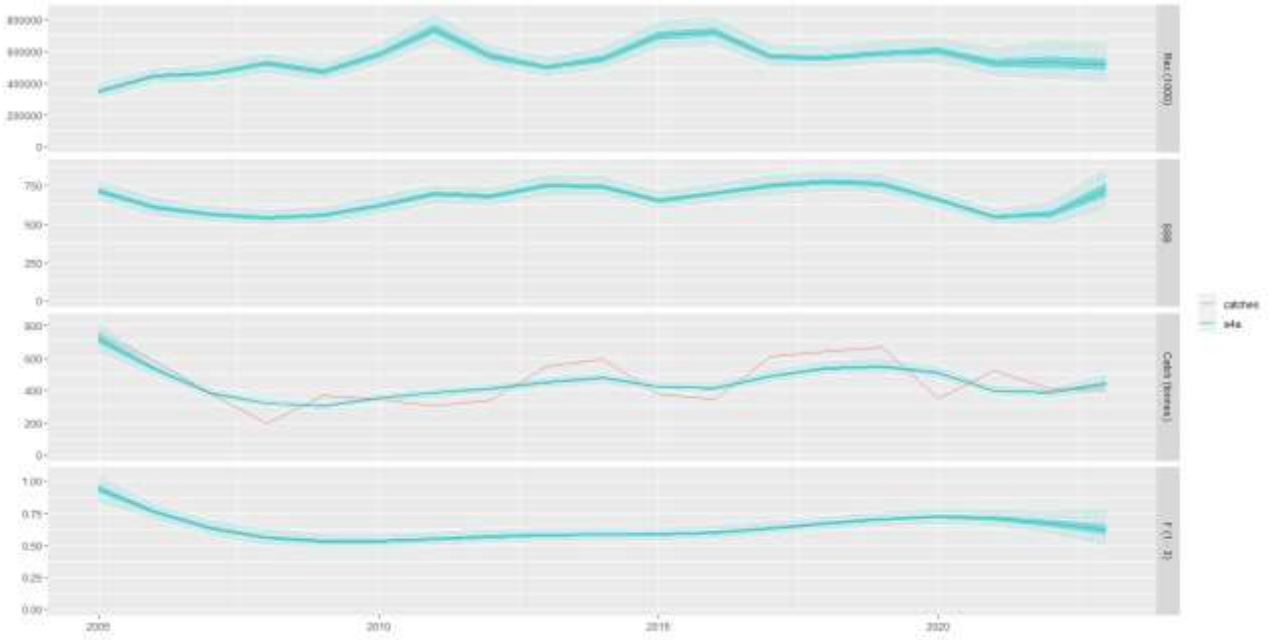
Based on the a4a results, the Giant red shrimp showed a slight increase in the SSB since 2021 (from 548 to 729 tons) and a decrease in F_{bar} (1-3) since 2020 which dropped from 0.72 in 2020 to 0.62 in 2023.

Figure 6.19.3.12. Giant red shrimp in GSAs 8, 9, 10 & 11. Retrospective analysis



Source: own elaborations

Figure 6.19.3.13. Giant red shrimp in GSAs 8, 9, 10 & 11. Simulations over summary results.



Source: own elaborations

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

Table 6.19.3.5. Giant red shrimp in GSAs 8, 9, 10 & 11. Stock numbers at age (thousands) as estimated by a4a.

	0	1	2	3	4+
2005	349204	92030	57862	16770	2241
2006	442226	52752	30920	13883	1925
2007	460984	66805	18521	8654	2242
2008	522380	69639	24193	5778	1968
2009	470531	78915	25681	8042	1611
2010	579832	71082	29317	8759	2115
2011	739607	87594	26399	9989	2380
2012	569816	111730	32388	8857	2618
2013	499486	86080	41113	10683	2344
2014	552771	75456	31582	13423	2596
2015	698767	83505	27657	10277	3166
2016	722196	105560	30579	8970	2647
2017	566924	109100	38527	9803	2229
2018	559310	85643	39542	12053	2184
2019	590325	84493	30741	11958	2396
2020	603388	89178	30051	9003	2253
2021	524951	91151	31580	8668	1712
2022	531014	79302	32380	9210	1614
2023	517108	80218	28441	9763	1809

Source: own elaborations

Table 6.19.3.6. Giant red shrimp in GSAs 8, 9, 10 & 11. Fishing mortality-at-age.

	0	1	2	3	4+
2005	0.00	0.23	0.81	1.77	1.77
2006	0.00	0.19	0.65	1.43	1.43
2007	0.00	0.16	0.54	1.19	1.19
2008	0.00	0.14	0.48	1.05	1.05
2009	0.00	0.13	0.46	1.00	1.00
2010	0.00	0.13	0.46	1.00	1.00
2011	0.00	0.13	0.47	1.03	1.03
2012	0.00	0.14	0.49	1.07	1.07
2013	0.00	0.14	0.50	1.09	1.09
2014	0.00	0.14	0.50	1.10	1.10
2015	0.00	0.14	0.51	1.11	1.11
2016	0.00	0.15	0.52	1.13	1.13
2017	0.00	0.15	0.54	1.19	1.19
2018	0.00	0.16	0.58	1.26	1.26
2019	0.00	0.17	0.61	1.33	1.33
2020	0.00	0.18	0.62	1.36	1.36
2021	0.00	0.17	0.61	1.34	1.34
2022	0.00	0.17	0.58	1.27	1.27

2023	0.00	0.15	0.54	1.17	1.17

Source: own elaborations

Table 6.19.3.7. Giant red shrimp in GSAs 8, 9, 10 & 11. a4a summary results.

	Fbar(1-3)	Recruitment (thousands)	SSB (t)	Catch (t)
2005	0.93	349559	715.5	719
2006	0.76	442393	607.2	531
2007	0.63	461833	563.7	382
2008	0.56	521306	540.4	320
2009	0.53	470211	555.7	302
2010	0.53	582107	618.5	350
2011	0.55	737882	696.4	383
2012	0.56	570048	676.6	409
2013	0.58	498382	750.2	448
2014	0.58	552309	743.4	476
2015	0.59	696119	653.1	422
2016	0.60	722200	703.9	413
2017	0.63	566200	751.9	488
2018	0.67	558325	774.3	539
2019	0.71	590672	760.8	549
2020	0.72	602407	656.9	508
2021	0.71	523373	547.5	397
2022	0.67	532031	568.7	385
2023	0.62	518361	729.0	441

Source: own elaborations

6.19.4 Reference Points

The time series is too short to produce meaningful stock recruitment relationship, so reference points are based on equilibrium methods. The STECF EWG recommended using $F_{0.1}$ as proxy of F_{MSY}. The library FLBRP available in FLR was used to estimate $F_{0.1}$ from the stock object resulting from the outputs of the assessment.

The value of $F_{0.1}$, chosen as proxy of F_{MSY}, is equal to 0.48. The current F, estimated as the F_{bar1-3} in the last year of the time series, 2023, is 0.62, above the $F_{0.1}$. This indicates that the giant red shrimps in GSAs 8, 9, 10 & 11 is overexploited.

Estimation of biomass reference points

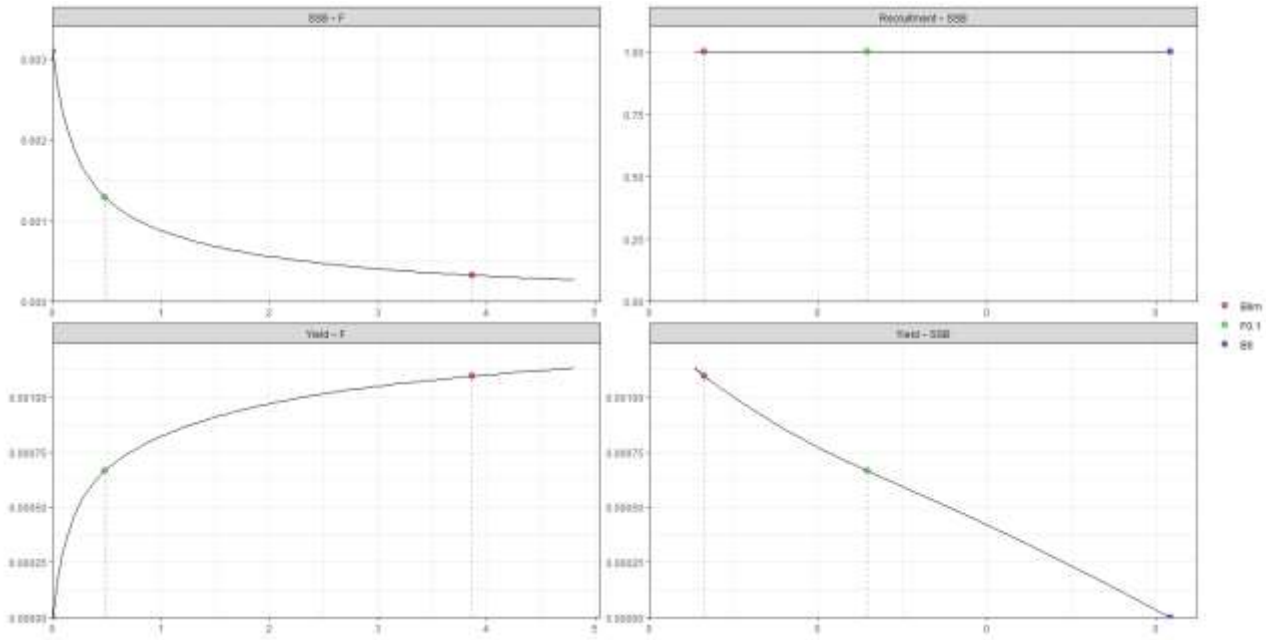
The biomass reference points were re-estimated by EWG 24-10 since in the new assessment data from GSA 8 was added. The procedure used for biomass reference points follows the methods set out in EWG 22-03 endorsed by STECF in July 2022. An exploratory per-recruit analysis was performed using the results of the a4a assessment. The per-recruit reference points of interest were computed from the stock object and are summarized in table 6.19.4.1 and figure 6.19.4.1. FLRef version 1.0.9 have been used.

Table 6.19.4.1. Giant red shrimp in GSAs 8, 9, 10 & 11. Per-recruit reference points.

$F_{0.1}$	$B_{F0.1}$	B_{lim}	F_{lim}	B_0
0.481	0.001290	0.000325	3.869916	0.003087

Source: own elaborations

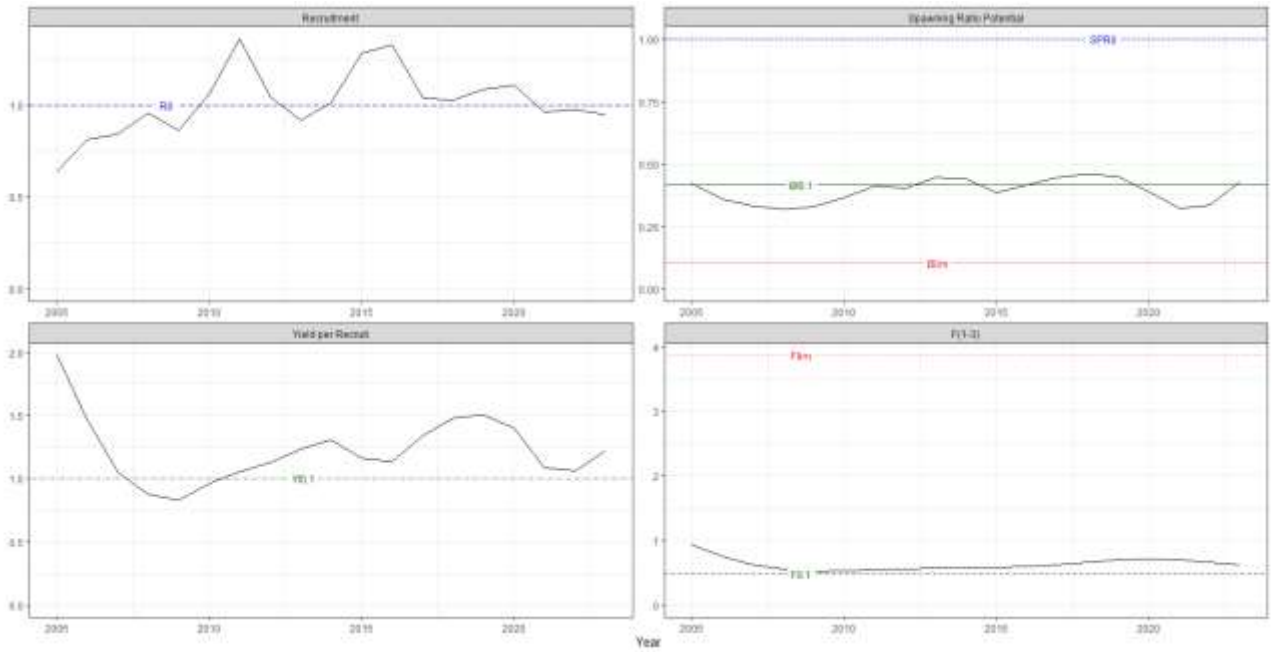
Figure 6.19.4.1: Giant red shrimp in GSAs 8, 9, 10 & 11. Per recruit analysis.



Source: own elaborations

Figure 6.19.4.2 is showing the trajectories of the assessment outputs against the per-recruit reference points. SSB has been fluctuating slightly below the biomass at $F_{0.1}$ ($B_{F0.1}$) and well above B_{lim}, with a gradual increase in the last years. At the same time, F has been slightly above $F_{0.1}$, though decreasing in the last years.

Figure 6.19.4.2. Giant red shrimp in GSAs 8, 9, 10 & 11. Per recruit analysis: outcomes of the a4a assessment compared against the per recruit reference points.



Source: own elaborations

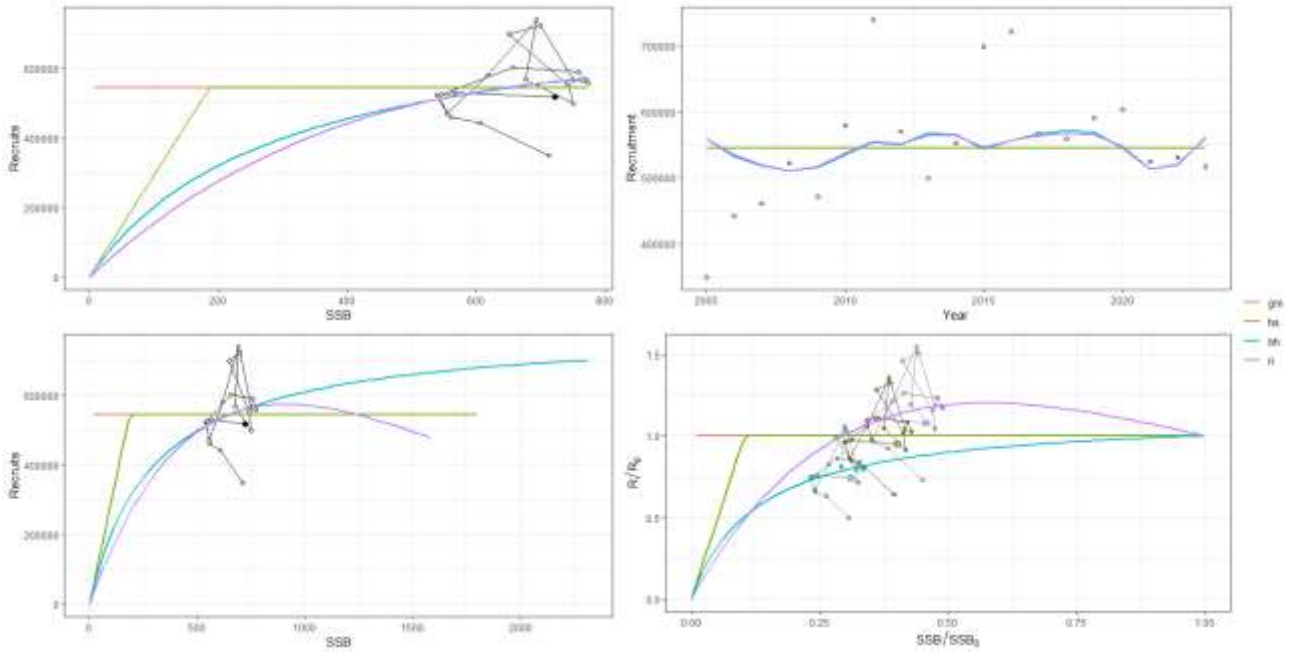
Following the procedure laid out in EWG 22-03 the Geometric Mean approach has been considered the most suitable to estimate the biomass reference points for the stock of giant red shrimp in GSAs 8, 9, 10 & 11, because the hockey Stick model fits the break point outside the data (Figure 6.19.4.3). The Beverton-Holt and Ricker models give higher biomasses, but these also lie outside the range of observations, making the GM a conservative option. Table 6.19.4.2 summaries the reference point values based on the default value of 25% of $B_{F0.1}$ for B_{lim} and Geometric Mean fitted to the data for R_0. B_{pa} is set to 2* B_{lim}. The stock is considered to be above B_{pa} and $B_{F0.1}$ in 2023.

The stock history relative to the reference points is illustrated over time (Figure 6.19.4.4) and as a Kobe plot in SSB and F (Figure 6.19.4.5).

Table 6.19.4.2. Giant red shrimp in GSAs 8, 9, 10 & 11. Final reference points based on Geometric mean stock recruit model fitted to the data and the default B_{lim}.

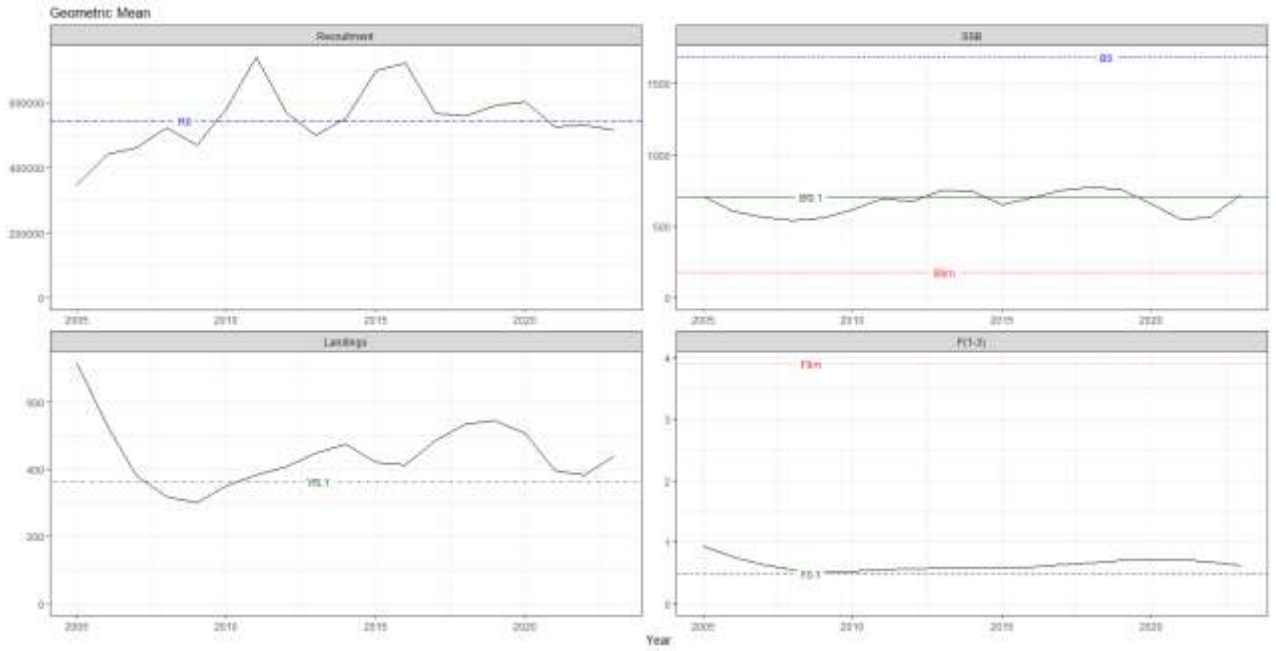
$F_{0.1}$	$B_{F0.1}$	B_{lim}	B_{pa}	B_0
0.481	702.902	175.72571	351.4514	1681.61809

Figure 6.19.4.3: Giant red shrimp in GSAs 8, 9, 10 & 11. Fit of S-R relationships to data. HS breakploint lies outside the data.



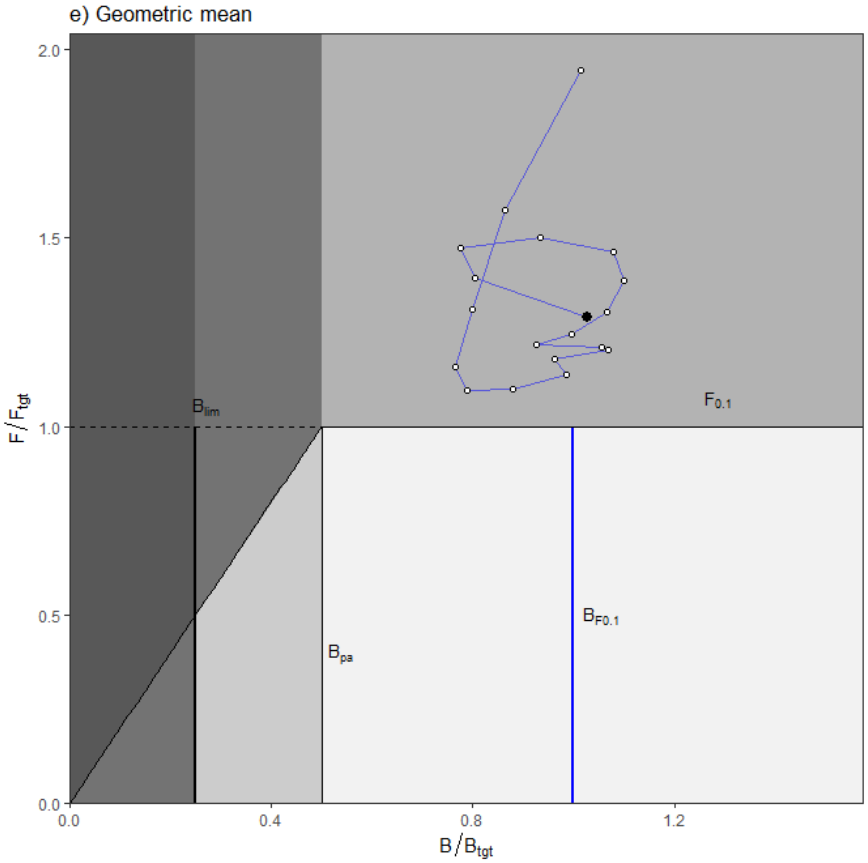
Source: own elaborations

Figure 6.19.4.4: Giant red shrimp in GSAs 8, 9, 10 & 11. History of the giant red shrimp stock relative to biomass points based on GM and 25% of $B_{F0.1}$.



Source: own elaborations

Figure 6.19.4.5: Giant red shrimp in GSAs 8, 9, 10 & 11. Kobe plot SSB and R with fitted reference points based on GM mean recruitment and breakpoint at 25% $B_{F0.1}$



Source: own elaborations

6.19.5 Short term Forecast and Catch Options

A deterministic short term prediction for the period 2024 to 2026 was performed using the FLR libraries and scripts, and based on the results of the a4a stock assessment.

An average of the last three years was used for weight at age, natural mortality and maturity at age, while the $F_{bar1\text{-}3}$ =0.62 (the last year's F estimated by the assessment model) was used for F in 2024, as F shows a decreasing trend in the last three years.
Recruitment (age 0) is observed to have no clear trend, for this reason the geometric mean of the whole time series (544684 thousand individuals, 19 years) has been used as an estimate of recruits in 2024-2025.

Table 6.19.5.1 Giant red shrimp in GSAs 8, 9, 10 & 11: Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 1\text{-}3}$ (2024)	0.62	Fsq = F in the last year
SSB (2024)	597	SSB intermediate year from STF output
R_{age0} (2024,2025)	544684	Recruitment will be set as geometric mean of the last 19 years
Total catch (2024)	379	Catch intermediate year from STF output

Source: own elaborations

Table 6.19.5.2 Giant red shrimp in GSAs 8, 9, 10 & 11. Short term forecast in different F scenarios.

Rationale	Ffactor	Fbar	Catch2023	Catch2024	Catch2025	SSB2024	SSB2026	SSB_change_2024-2026(%)	Catch_change_2023-2025(%)
High long term yield (F0.1)	0.77	0.48	441.49	379.02	311.98	596.90	682.14	14.28	-29.34
F upper	1.06	0.66	441.49	379.02	395.61	596.90	598.96	0.34	-10.39
F lower	0.52	0.32	441.49	379.02	223.52	596.90	779.47	30.59	-49.37
FMSY transition	0.77	0.48	441.49	379.02	311.98	596.90	682.14	14.28	-29.34
Zero catch	0.00	0.00	441.49	379.02	0.00	596.90	1072.25	79.64	-100.00
Status quo	1.00	0.62	441.49	379.02	379.63	596.90	614.22	2.90	-14.01
Different Scenarios	0.10	0.06	441.49	379.02	49.22	596.90	1001.77	67.83	-88.85
	0.20	0.12	441.49	379.02	95.34	596.90	938.86	57.29	-78.41
	0.30	0.19	441.49	379.02	138.62	596.90	882.53	47.85	-68.60
	0.40	0.25	441.49	379.02	179.30	596.90	831.94	39.38	-59.39
	0.50	0.31	441.49	379.02	217.61	596.90	786.34	31.74	-50.71
	0.60	0.37	441.49	379.02	253.73	596.90	745.11	24.83	-42.53
	0.70	0.43	441.49	379.02	287.83	596.90	707.72	18.57	-34.80
	0.80	0.50	441.49	379.02	320.09	596.90	673.70	12.87	-27.50
	0.90	0.56	441.49	379.02	350.65	596.90	642.65	7.66	-20.58
	1.10	0.68	441.49	379.02	407.16	596.90	588.11	-1.47	-7.78
	1.20	0.74	441.49	379.02	433.34	596.90	564.06	-5.50	-1.85
	1.30	0.81	441.49	379.02	458.28	596.90	541.85	-9.22	3.80
	1.40	0.87	441.49	379.02	482.06	596.90	521.28	-12.67	9.19
	1.50	0.93	441.49	379.02	504.76	596.90	502.17	-15.87	14.33
	1.60	0.99	441.49	379.02	526.47	596.90	484.39	-18.85	19.25
	1.70	1.06	441.49	379.02	547.24	596.90	467.79	-21.63	23.95
	1.80	1.12	441.49	379.02	567.15	596.90	452.26	-24.23	28.46
	1.90	1.18	441.49	379.02	586.24	596.90	437.71	-26.67	32.79
	2.00	1.24	441.49	379.02	604.58	596.90	424.03	-28.96	36.94

Source: own elaborations

7 DATA ISSUES

HKE 1-5-6-7

As concerns French data, MEDITS data seem being biased, in some years and hauls, because of a very high raising factor in TC that is reflected also in TB. Similar issues are occurring in commercial data too.

As regards Spanish data, MEDITS data seem being biased, in some years and hauls, because of a very high raising factor in TC that is reflected also in TB.

No length measurements were recorded for commercial data in GSA 7 in 2023.

As concerns MEDITS, new estimations of survey abundance index at age resulted in lower index values for the period 2007-2020. Due to time constraints, it was not possible to clarify the reason for those differences. It was agreed to use the abundance survey index by age time series from 2023 assessment, adding the last year of data (2023 MEDITS survey data).

DPS 1

Nothing to be reported

DPS 5-6-7

Data call Med and BS

Country	Data Requested	Issue	Issue Type	Severity	Recurrent Issue
Spain	GSA_5_DPS Maturity ogive at age (but available by length, sex combined)	not available	QUALITY	LOW	YES
Spain	GSA_5_DPS Growth parameters	not available by sex	QUALITY	LOW	YES
Spain	GSA_5_DPS Sex ratio at age	not available	QUALITY	LOW	YES
Spain	GSA_6_DPS Maturity ogive at age (but available by length, sex combined)	not available	QUALITY	LOW	YES
Spain	GSA_6_DPS Growth parameters	not available by sex	QUALITY	LOW	YES
Spain	GSA_6_DPS Sex ratio at age	not available	QUALITY	LOW	YES
France	GSA_7_DPS Landings and discards LFDs (catches are low)	not available	COVERAGE	LOW	YES
France	GSA_7_DPS Biological data	not available	COVERAGE	LOW	YES
Spain	GSA_6_DPS Discards numbers, check 2020 values duplicated	values duplicated	QUALITY	LOW	YES
Spain	GSA_6_DPS Discards numbers, check format 2019 to 2022, there are values that are text	format	QUALITY	LOW	YES

Nothing to be reported

MUT1

Commercial data

Although in 2002 a relevant portion of the size distributions had to be reconstructed, it has been considered appropriate to include this year in the assessment to use the entire historical series available.

Discard data

Some discards are reported in the last year only.

Survey data

Index for 2020 was not available.

MUR 5

Nothing to be reported.

MUT 6

MUT 6- gear coding. Red mullet landings from small-scale gears other than entangling nets may be misreported and should be checked (FPO=pots and traps; LHP= pole lines; LLS=longlines). This issue was already reported by EWG-21-11.

MUT landings in GSA6 - differences in red mullet (MUT) landings in GSA 6 were observed among the MEDBS, FDI and AER data calls.

country	year	GSA	species	landings	DataCall
ESP	2002	6	MUT	305.4	MEDBS
ESP	2003	6	MUT	1400.0	MEDBS
ESP	2004	6	MUT	919.5	MEDBS
ESP	2005	6	MUT	995.0	MEDBS
ESP	2006	6	MUT	1387.8	MEDBS
ESP	2007	6	MUT	1183.6	MEDBS
ESP	2008	6	MUT	872.1	MEDBS
ESP	2009	6	MUT	520.9	MEDBS
ESP	2010	6	MUT	514.1	MEDBS
ESP	2011	6	MUT	1063.1	MEDBS
ESP	2012	6	MUT	1069.9	MEDBS
ESP	2013	6	MUT	1248.0	MEDBS
ESP	2014	6	MUT	1309.2	MEDBS
ESP	2015	6	MUT	1518.7	MEDBS
ESP	2016	6	MUT	1673.9	MEDBS
ESP	2017	6	MUT	1449.3	MEDBS
ESP	2018	6	MUT	1280.7	MEDBS
ESP	2019	6	MUT	1501.8	MEDBS
ESP	2020	6	MUT	1446.3	MEDBS
ESP	2021	6	MUT	1056.7	MEDBS
FRA	2020	6	MUT	0.00361	MEDBS
FRA	2021	6	MUT	0.01059	MEDBS
ESP	2013	6	MUT	914.7	FDI
ESP	2014	6	MUT	826.6	FDI
ESP	2015	6	MUT	880.4	FDI

ESP	2016	6	MUT	1237.5 FDI
ESP	2017	6	MUT	1118.5 FDI
ESP	2018	6	MUT	1071.0 FDI
ESP	2019	6	MUT	1228.4 FDI
ESP	2020	6	MUT	1446.3 FDI
ESP	2021	6	MUT	1057.7 FDI
FRA	2020	6	MUT	0.004 FDI
FRA	2021	6	MUT	0.011 FDI
ESP	2008	6	MUT	544.5 AER
ESP	2009	6	MUT	586.3 AER
ESP	2010	6	MUT	600.9 AER
ESP	2011	6	MUT	695.9 AER
ESP	2012	6	MUT	790.3 AER
ESP	2013	6	MUT	788.2 AER
ESP	2014	6	MUT	560.9 AER
ESP	2015	6	MUT	846.9 AER
ESP	2016	6	MUT	1253.0 AER
ESP	2017	6	MUT	1129.8 AER
ESP	2018	6	MUT	1070.9 AER
ESP	2019	6	MUT	1228.4 AER

EWG-24-10 used the data of the MEDBS data call, since FDI and AER data match with the MEDBS along the time series and are similar in the most recent years. In addition, MEDBS data in 2009 and 2010 appear to be rather low when compared with the previous and the following years. MUT landings in GSA 6 in 2009 and 2010 should be checked.

MUT 7

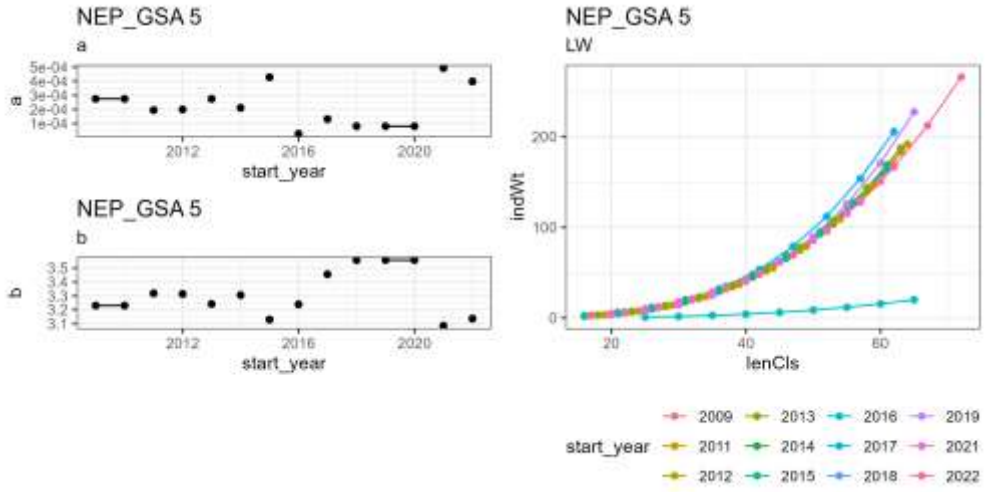
Nothing to be reported

NEP 5

Data from DCF 2023 as submitted through the Official data call in 2023 were used.

Commercial data

In growth parameters file, “gp.csv”, the length-weight parameters for 2016 give very lightweight individuals as shown in the plot below.



Discard data

In discards file provided to DCF 2023 Official data call there were some records with “-1” value in “discards” column. The record affected were the ones with following ids: 686594, 689386, 689729, 690857, 691831, 694903, 695789, 696485, 696841, 696955, 697214, 699323, 699499, 699879, 699993, 700155, 700380, 702007, 702244, 702661, 702977, 703482, 704678, 704752, 705082, 705143, 706359, 706551, 707689, 709891, 710164, 713396, 714563, 716107, 717514 and 721743.

Survey data

In the MEDITS data provided to DCF 2022 Official data call, haul number 150 of 2013 has four abundances values that are very high compared to the timeseries. In “medits_tc.csv” DCF 2022 Official data call file, these rows showed very high numbers in “pfrac” column affecting raise values. The data ids values are: 50229560, 50229561, 50229580 and 50229581.

Moreover, always in the “medits_tc.csv” file, in 2019 there are 52 rows reporting a length that isn’t coherent with the timeseries (eg. 580 mm). The involved ids are: 50398573, 50398574, 50398575, 50398576, 50398577, 50398578, 50398579, 50398580, 50398581, 50398582, 50398583, 50398584, 50398585, 50398586, 50398587, 50398588, 50398589, 50398590, 50398591, 50398592, 50398593, 50398594, 50398595, 50398596, 50398597, 50398598, 50398599, 50398600, 50398601, 50398602, 50398603, 50398604, 50398605, 50398606, 50398607, 50398608, 50398609, 50398610, 50398611, 50398612, 50398613, 50398614, 50398615, 50398616, 50398617, 50398618, 50398619, 50398620, 50398621, 50398622, 50398623 and 50398624.

Stock assessment

The Norway lobster is a crustacean species showing dimorphic growth, where females reach lower sizes than males, despite very similar growth rates. Providing biological data separated by sex should allow better stock assessment results.

NEP 6

The quality of the stock assessment is acceptable, despite some data deficiencies that were identified during the assessment process:

- The available landings and discards size frequencies for the year 2020 lead to inconsistent catch at age data for the year 2020, due to the limitations of commercial data sampling for that year (COVID pandemic). The issue is unlikely to be resolved. Removing the catch at age data for 2020 provided a better diagnostics.

- It is crucial to emphasize the necessity of correcting the discards data for the years 2012 and 2019, even though the changes in discards numbers do not impact significatively the final quality assessment.

- The growth parameters have been taken as the set of Linf, k, t0 from GSA 5, as done in previous assessments of Norway lobster in GSA 6, but this set was estimated in 2009-2010 and has been reused ever since. The member state might consider studying growth of Norway lobster in GSA 6.

- The Norway lobster is a crustacean species showing dimorphic growth, where females reach lower sizes than males, despite very similar growth rates. Providing biological data separated by sex should allow more robust results.

- Most of the issues are reported in the DTMT. Several corrections have been already made during the EWG 24-10. For instance, the correction of individuals carapace lengths above Linf as well as for individuals of 400 mm carapace length in the MEDITS TC has led to an improvement on the quality check data and the sex-ratio estimation.

HKE 8-9-10-11

No survey data are available for GSAs 9, 10 and 11 in 2022 and for GSA 8 in 2020.
In GSA 10, there is a recurring coverage issue in commercial data due to poor sampling in the last years (e.g. missing quarters, no LFDs available for most of the gears). This could have an impact on the stability of the model, even if the issue is partially covered by the availability of data coming from the other GSAs.

DPS 8-9-10-11

The 2020 landings data for GSA 10 are only partially available in the DCF MEDBS database. To complete the dataset for this assessment, additional data were sourced from the FDI database. A recurring issue with GSA 10's commercial data is insufficient sampling in recent years, leading to incomplete coverage (e.g., missing quarters, lack of LFDs for most gears). This data deficiency may affect the stability of the model, although the impact is mitigated to some extent by data availability from other GSAs.

Additionally, no MEDITS survey data were available for GSAs 9, 10, and 11 in 2022, and for GSA 8 in 2002 and 2020. Since the assessment dataset begins in 2009, only the 2022 data point is missing in the final model.

MUT 9

MEDITS was not performed in GSA 9 in 2022.

MUT 10

MEDITS was performed in December 2023 and only partially. It was not performed in GSA 10 in 2022. Less than half of the hauls were performed during the 2020 MEDITS survey.

No length samples are available for landings in 2022 and for 2023 only for OTB.

NEP 9

Nothing to be reported

NEP 11

Nothing to be reported

ARA1-2

For commercial data in GSA1, some high values at age-5 were found and fixed using the same values for weight at age as in GSA2. Different patterns in the residuals were found, and more data exploration will be needed in the following EWGs. Also, both parameters and the length-weight relationship by sex were unavailable, and the group decided to use the ones from the SAF of GFCM WGSAD 2023. MEDITS Index for 2020 was not available.

ARA 5

During the implementation of the MEDITS survey in GSA5 (2007-2020), hauls were carried out in the westernmost part of GSA5 (west of Ibiza and Formentera) only in some years along the time series. Also, since 2021, MEDITS survey has started covering all the area around west of Ibiza and Formentera. To maintain the consistency along the time series and remove their potential noise in the overall model procedure, these hauls were removed from the stock assessment analysis.

ARA 6-7

Nothing to be reported

ARA 8-9-10-11

Data from DCF 2023 as submitted through the Official data call in 2024 were used.

In GSA 9, length frequency distributions are not available for the first quarter of 2023.

In GSA 10, length frequency distributions are not available for 2003, 2005, 2021 and 2023. For the period 2018-2020, the length frequency distribution is provided for a very low percentage of the landings.

ARS 8-9-10-11

No survey data are available for GSAs 9, 10 and 11 in 2022 and for GSA 8 in 2002 and 2020. Since the assessment dataset begins in 2005, only the 2022 data point is missing in the final model.

Commercial data in GSA 10 suffers from a poor sampling in the last years; however, this has been covered by the availability of data coming from the other GSAs.

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[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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10 LIST OF ANNEXES

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11 LIST OF BACKGROUND DOCUMENTS

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