6 STOCKS

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.

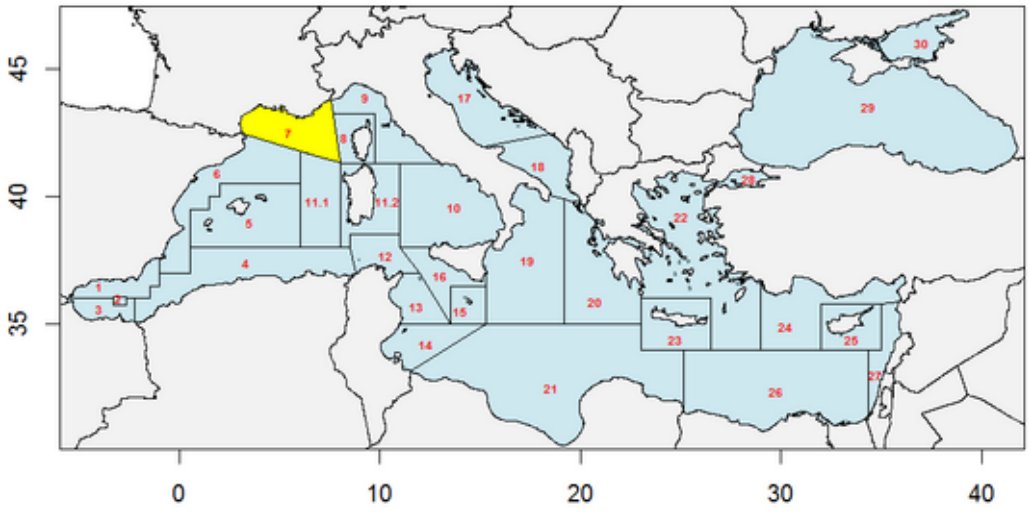

Fig. 6.6.1. Localisation of GSA 7 (in Yellow) in the Mediterranean Sea.

6.6.2 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).

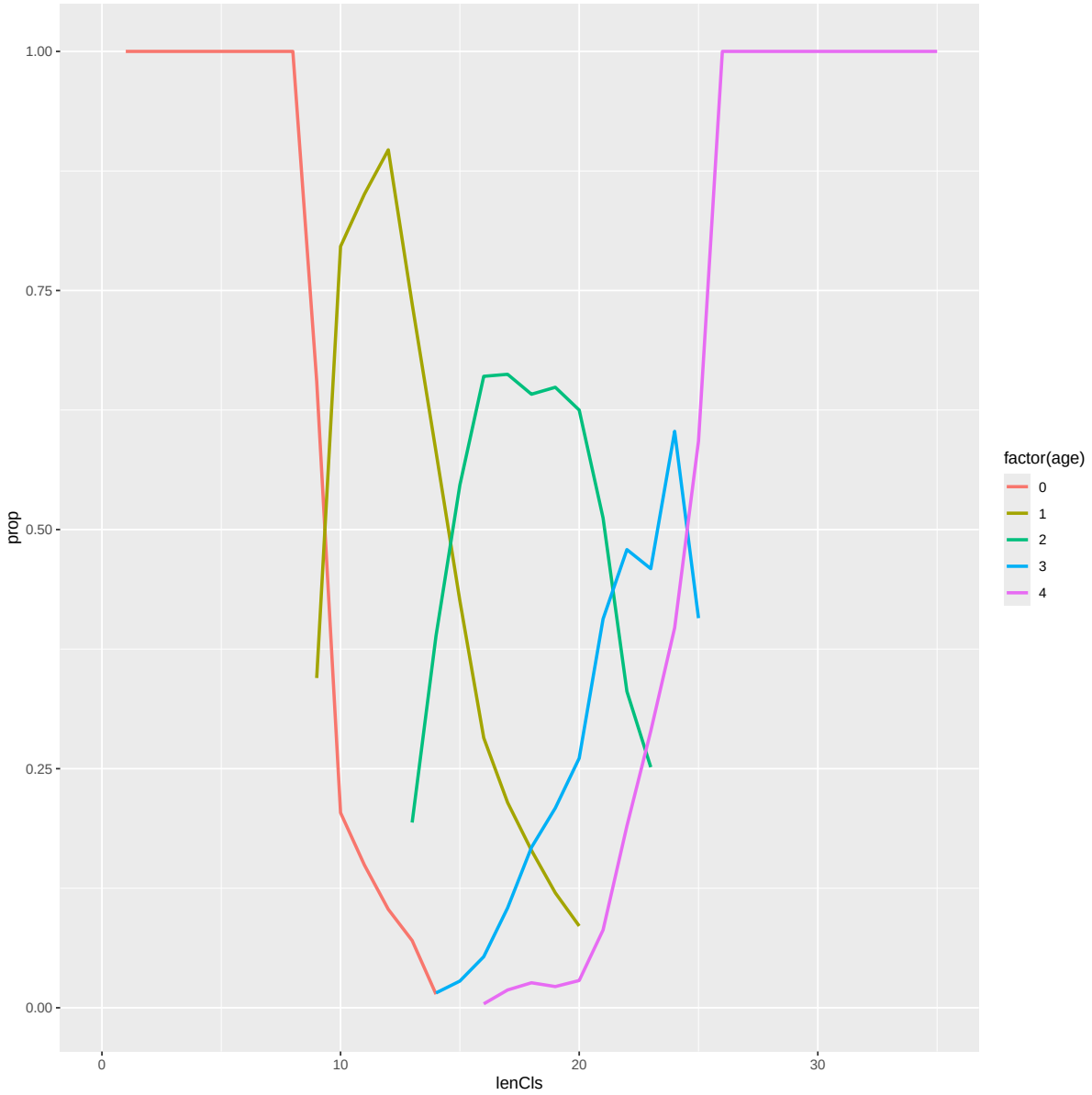

Fig. 6.6.2. Age-length Key derived from age-reading data. The purple line corresponds to age 4 or more.

6.6.3 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.

6.6.4 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.

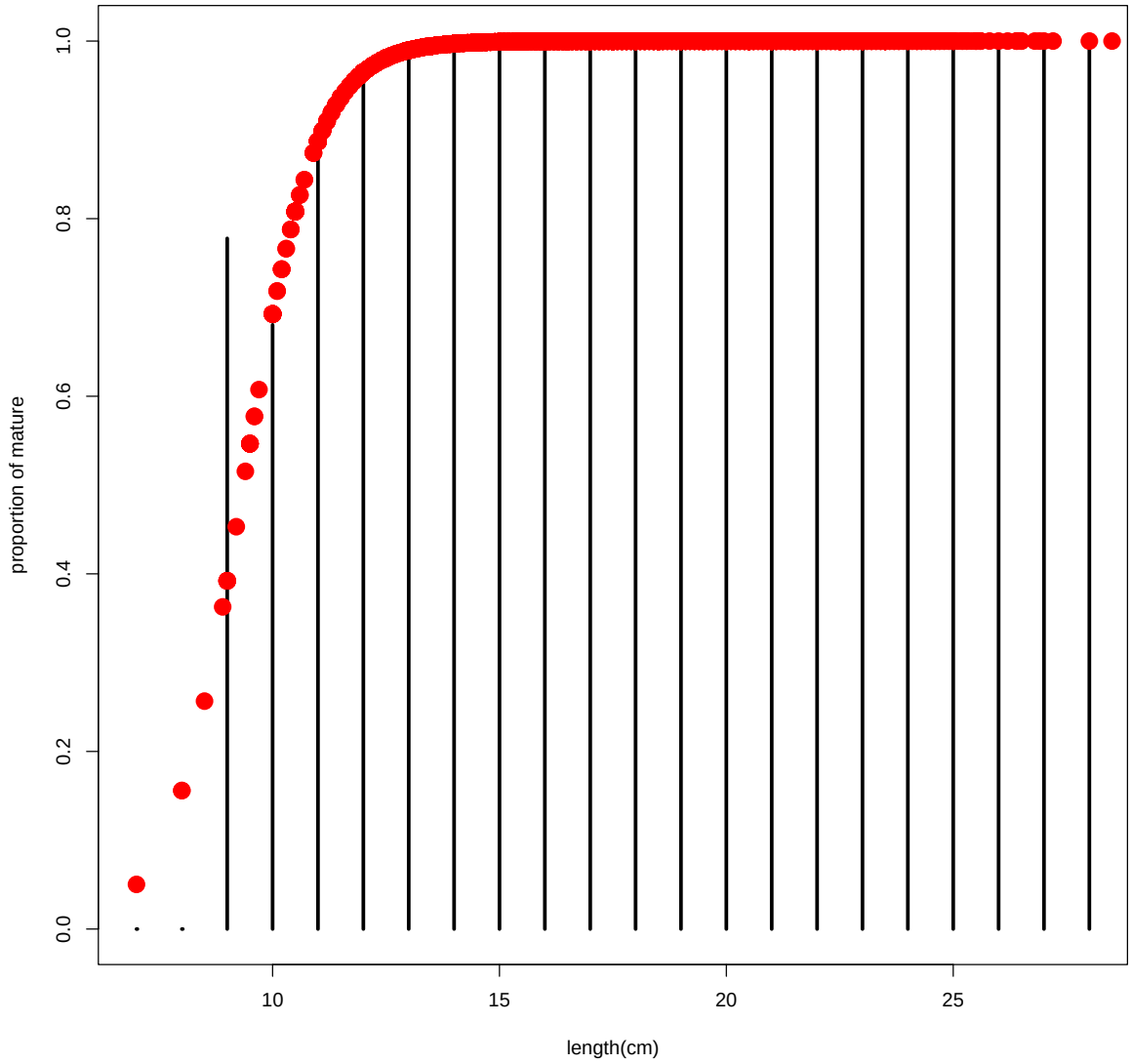

Fig. 6.6.3. Proportion of mature Red Mullet per length in GSA 7. The red line corresponds to the predicted proportion following a logistic regression model.

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.

6.6.5 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 (Fig. 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 Fig 6.6.4) and in the french data, MUR only accounts for 10-30% of landings (Fig 6.6.5).

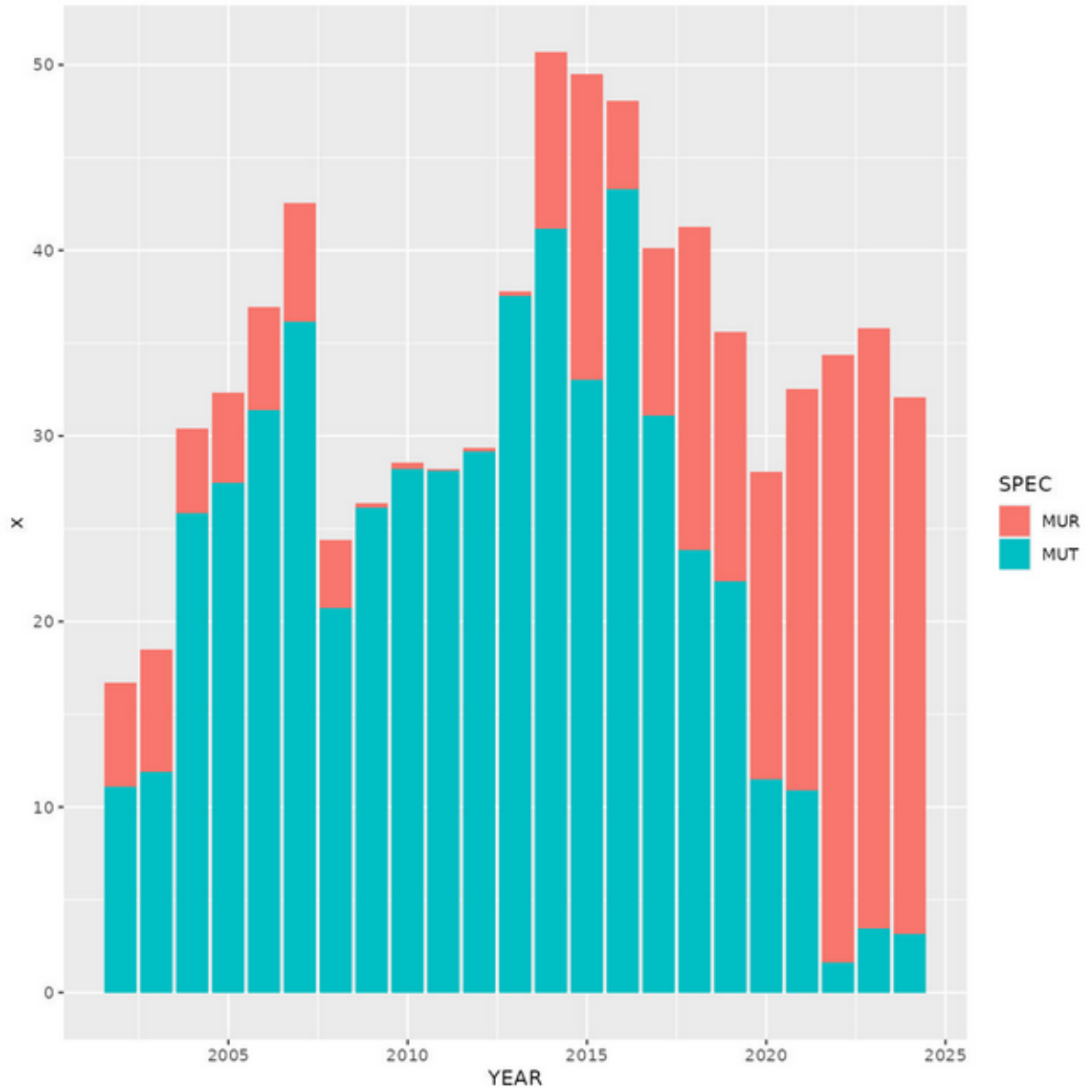

Fig. 6.6.4. MUT & MUR Landings by species provided by Spain in GSA 7

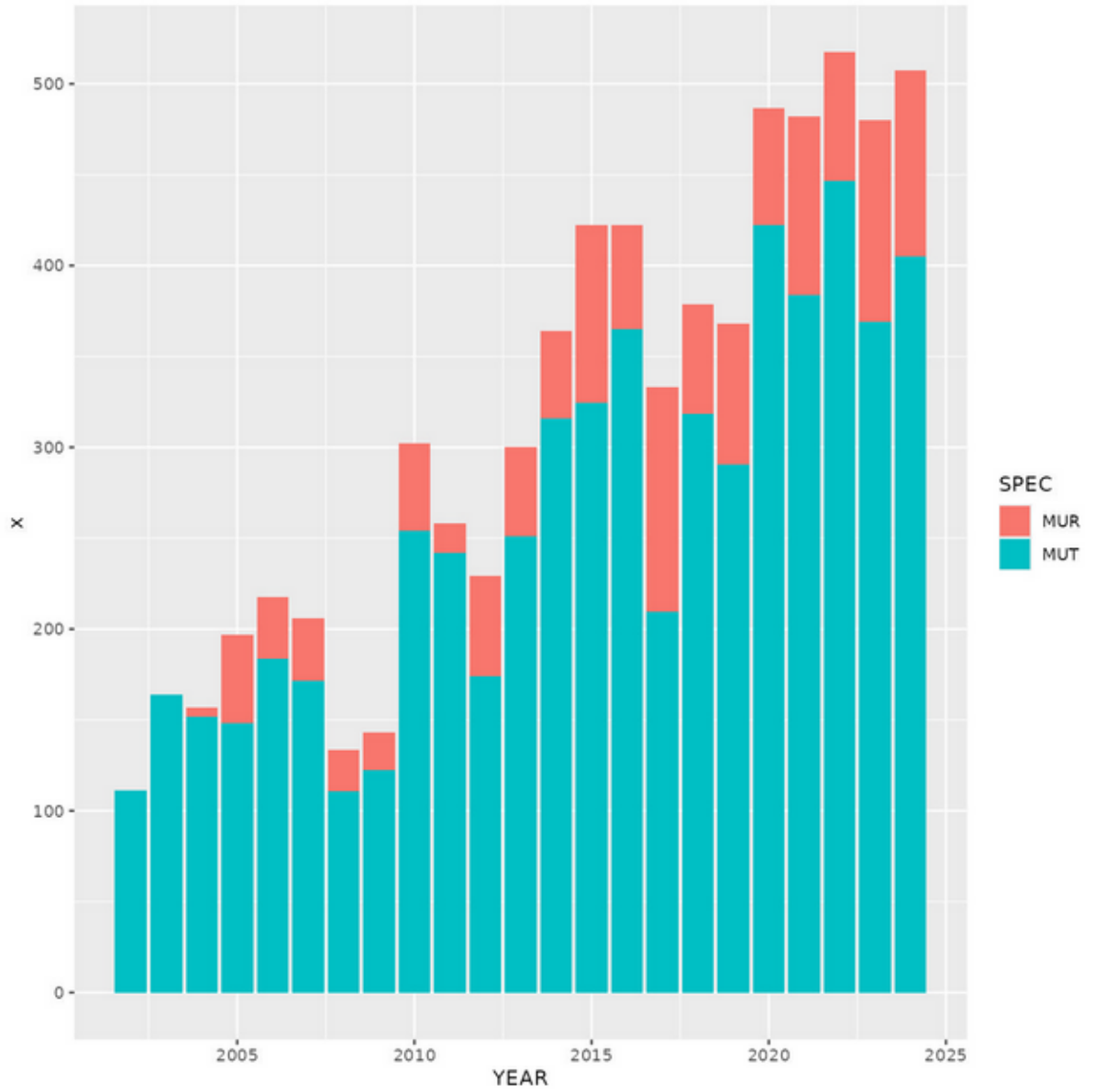

Fig. 6.6.5. MUT & MUR Landings by species provided by France in GSA 7

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 Fig. 6.6.6).

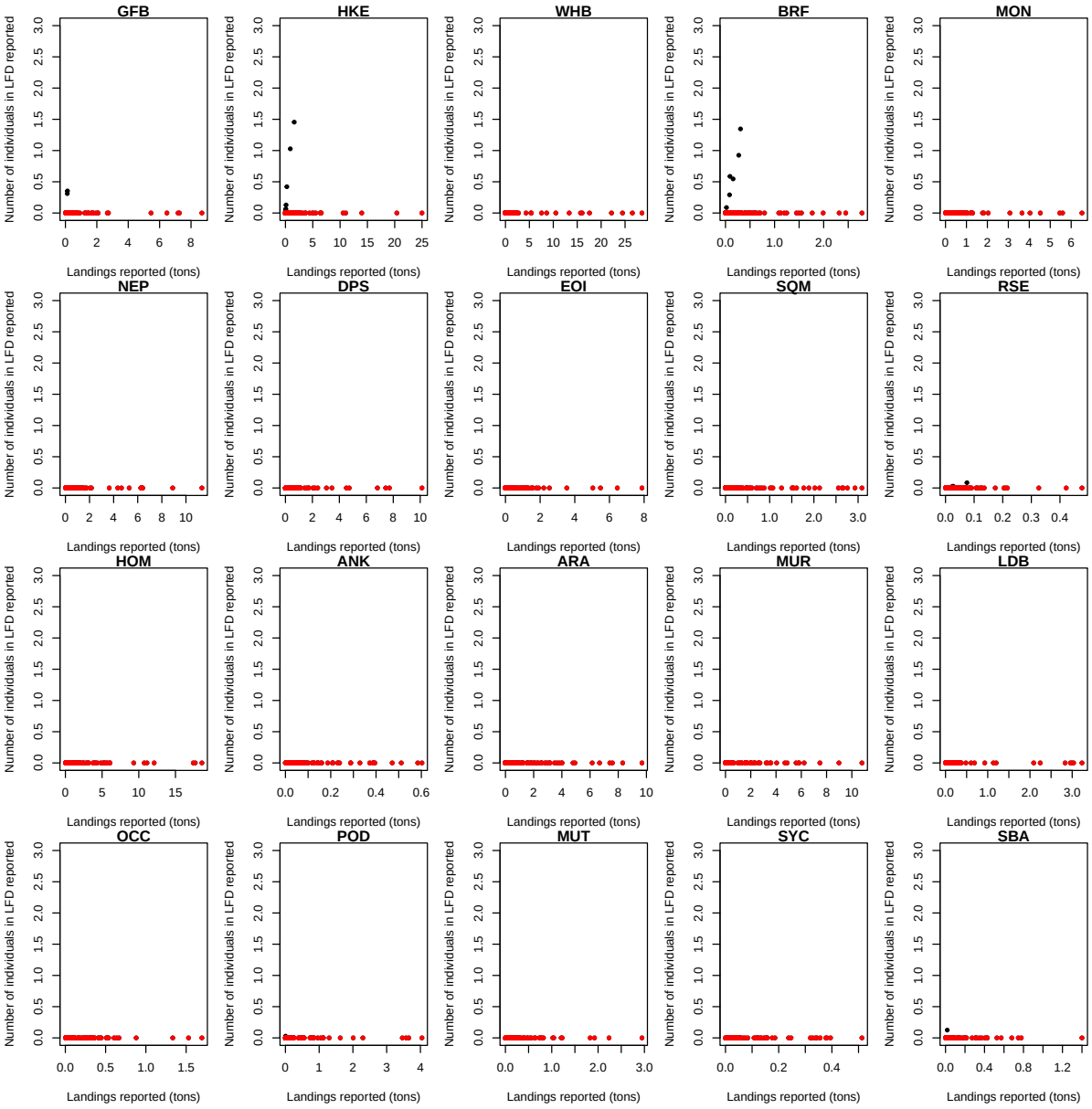

Fig. 6.6.6. reported landings (x-axis) versus numbers of individuals present in LFD (y-axis) in spanish data submitted to the MBS data call since 2020 in GSA 7. red dots corresponds to data point were landings are reported, but no size information is available.

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 (Fig. 6.6.7.)

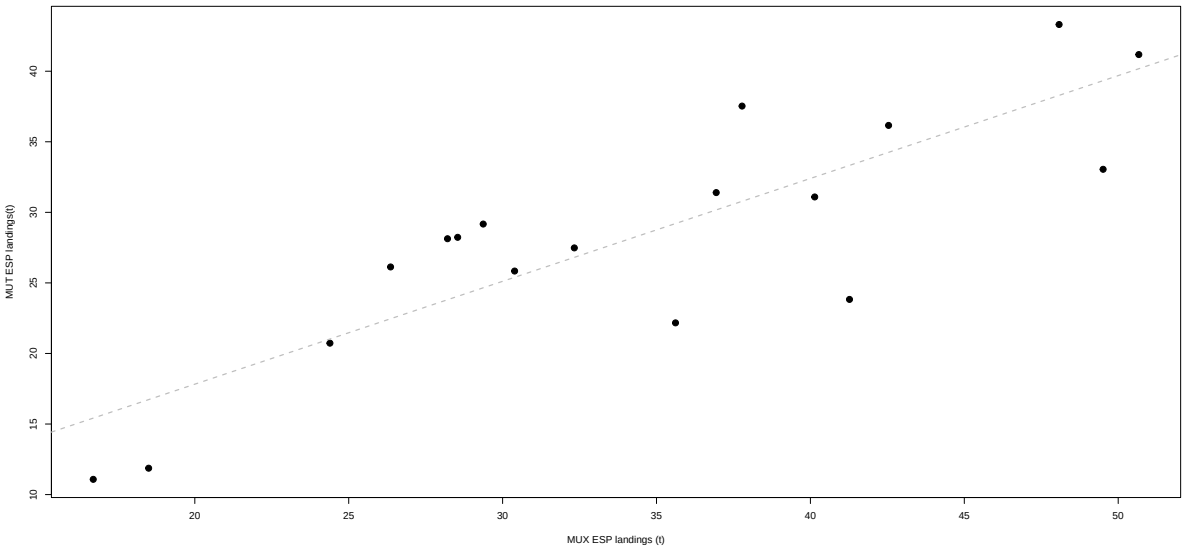

Fig. 6.6.7. linear regression between MUT and MUX spanish landings in GSA 7. The estimated linear regression has the following parameters: intercept = 3.25; slope = 0.73, and is significant (p = 1.21e-5) with a multiple R^2 = 0.708.

Then, the reconstructed spanish MUT landings were spread at length following the french documented LFD distribution.

6.6.5.1 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%, Fig. 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)

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
2024	405.05	26.64	431.69	25.165	456.855

Table 6.6.1. Total Landings per country, discards and total catch per year, in tons.

Year	Gillnet	Longline	OTB	Other	OTT
2002	0	0	111.424	0	0
2003	0	0	164.141	0	0
2004	0	0	151.646	0	0
2005	0	0	148.086	0	0
2006	0	0	183.478	0	0
2007	0	0	171.526	0	0
2008	0	0	110.494	0	0
2009	0	0	122.555	0	0
2010	0	0	249.644	0	4.193
2011	28.337	0	212.86	0	0.568
2012	33.395	0	140.522	0	0.021
2013	17.523	0	216.076	0	17.272
2014	15.363	0	276.182	0	24.33
2015	0	0	304.945	0	19.681
2016	19.787	0	252.886	0.561	91.894
2017	5.67	0	130.492	0.099	73.271
2018	19.385	0	180.213	0.17	118.58
2019	13.992	0	143.839	0.228	132.293
2020	24.409	0.004	186.546	0.498	210.622
2021	23.214	0.017	146.461	0.588	213.497
2022	43.848	0.037	161.699	0.852	239.772
2023	9.661	0.105	134.498	0.363	224.312
2024	16.941	0.049	141.868	0.145	246.046

Table 6.6.2. Red Mullet Landings per Year and Gear, French data

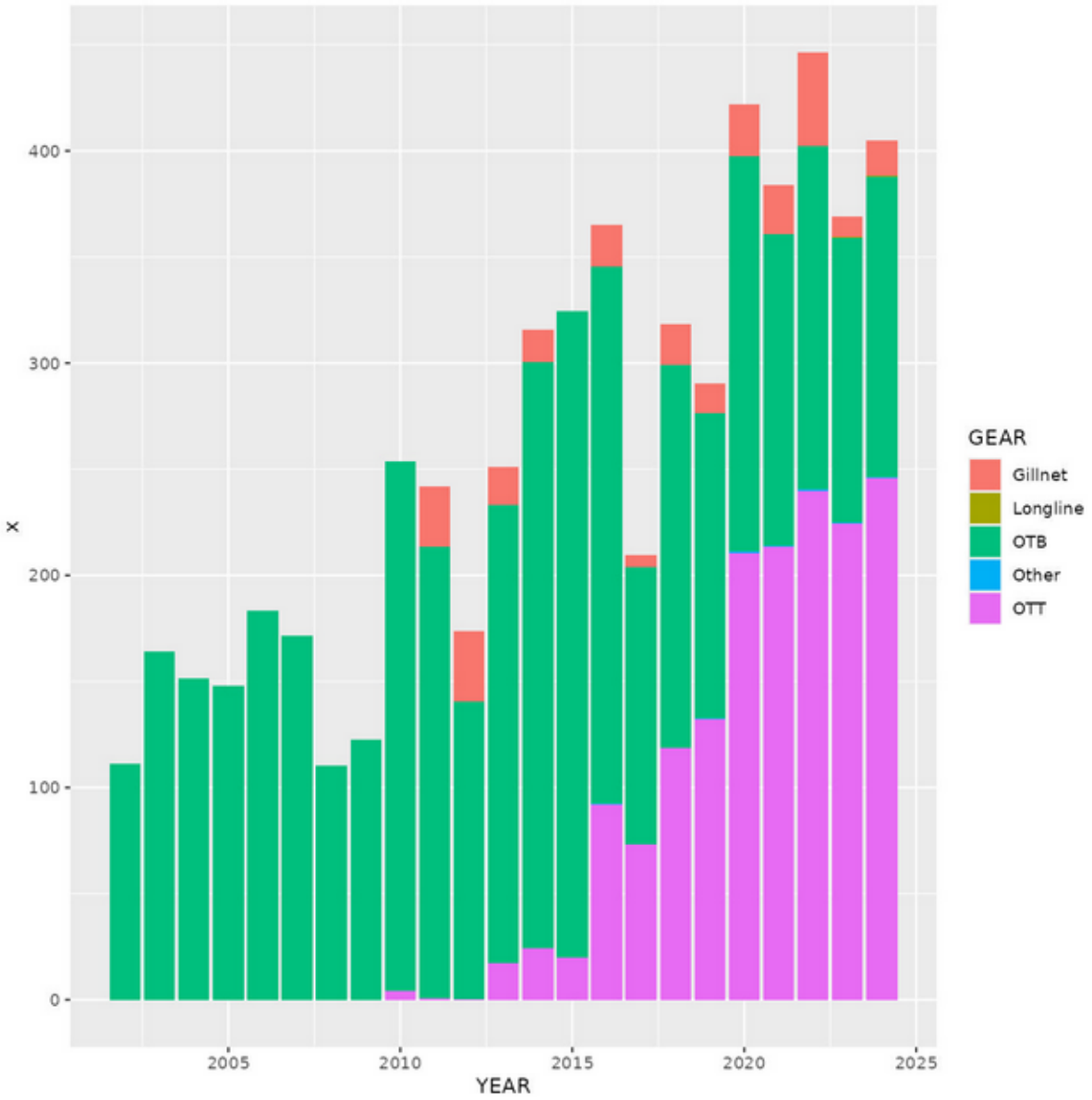

Fig 6.6.8. Red Mullet Landings per year and gear in GSA 7 (French fleet).

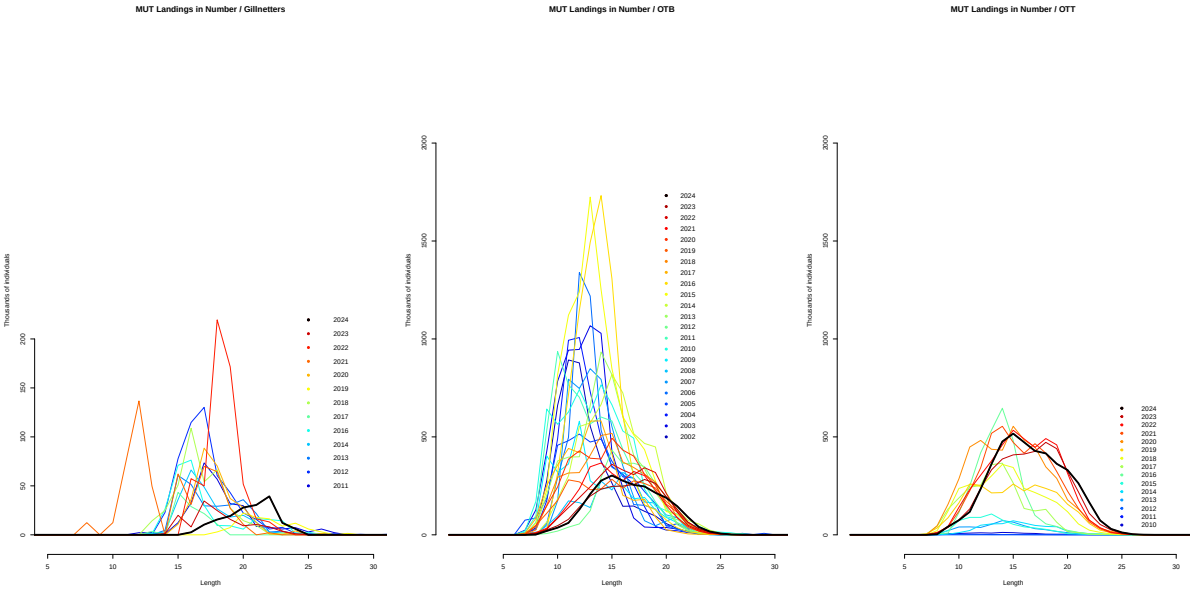

Fig 6.6.9. Size-Class distribution of Red Mullet french landings per year and mains gear. The thick black line corresponds to the most recent year (2024).

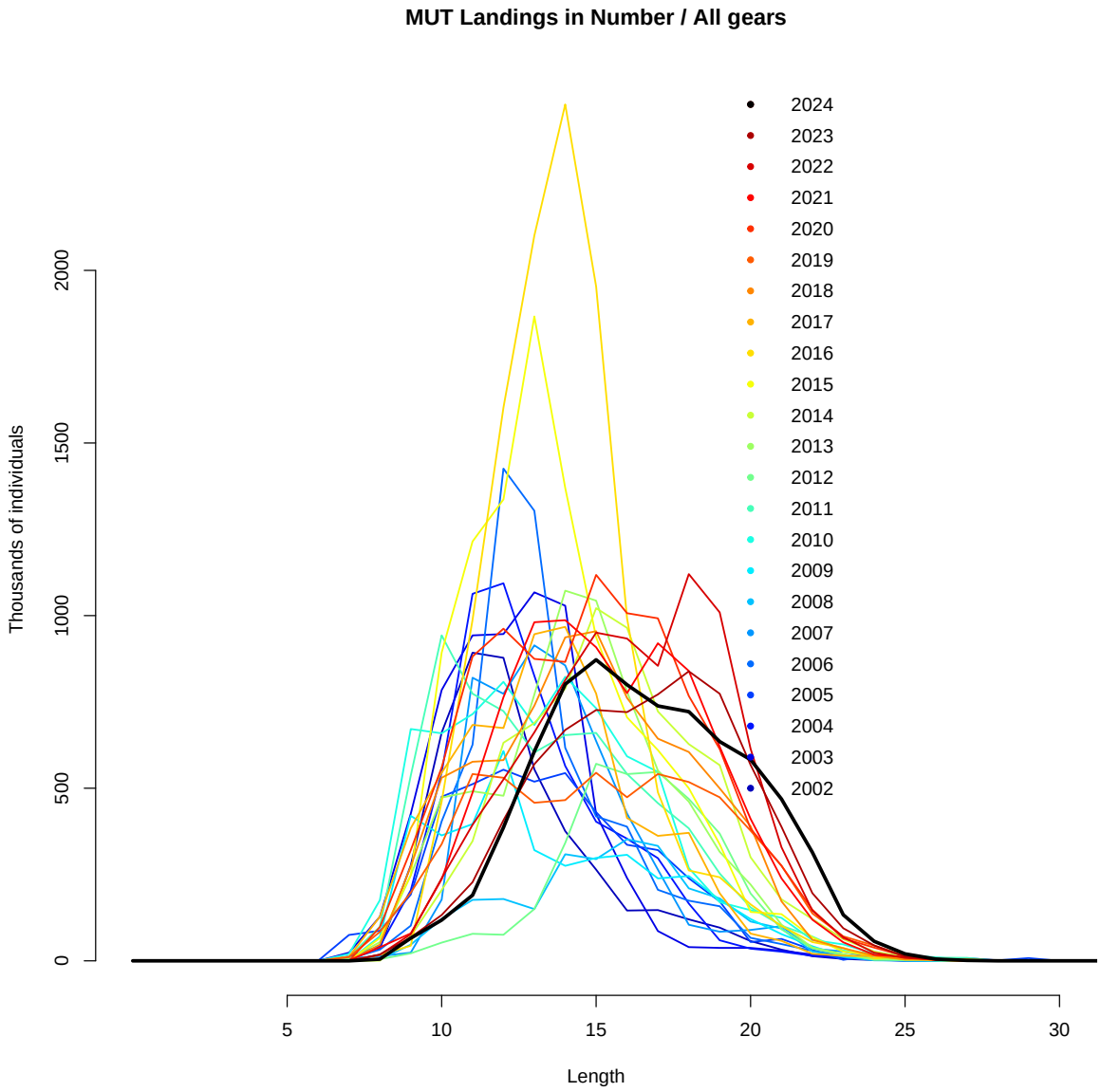

Fig 6.6.10. Size-Class distribution of Red Mullet total landings (including spanish reconstructed landings) per year. The thick black line corresponds to the most recent year (2024).

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 (Fig. 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 (Fig. 6.6.10).

Discards (Fig.6.6.11) 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.

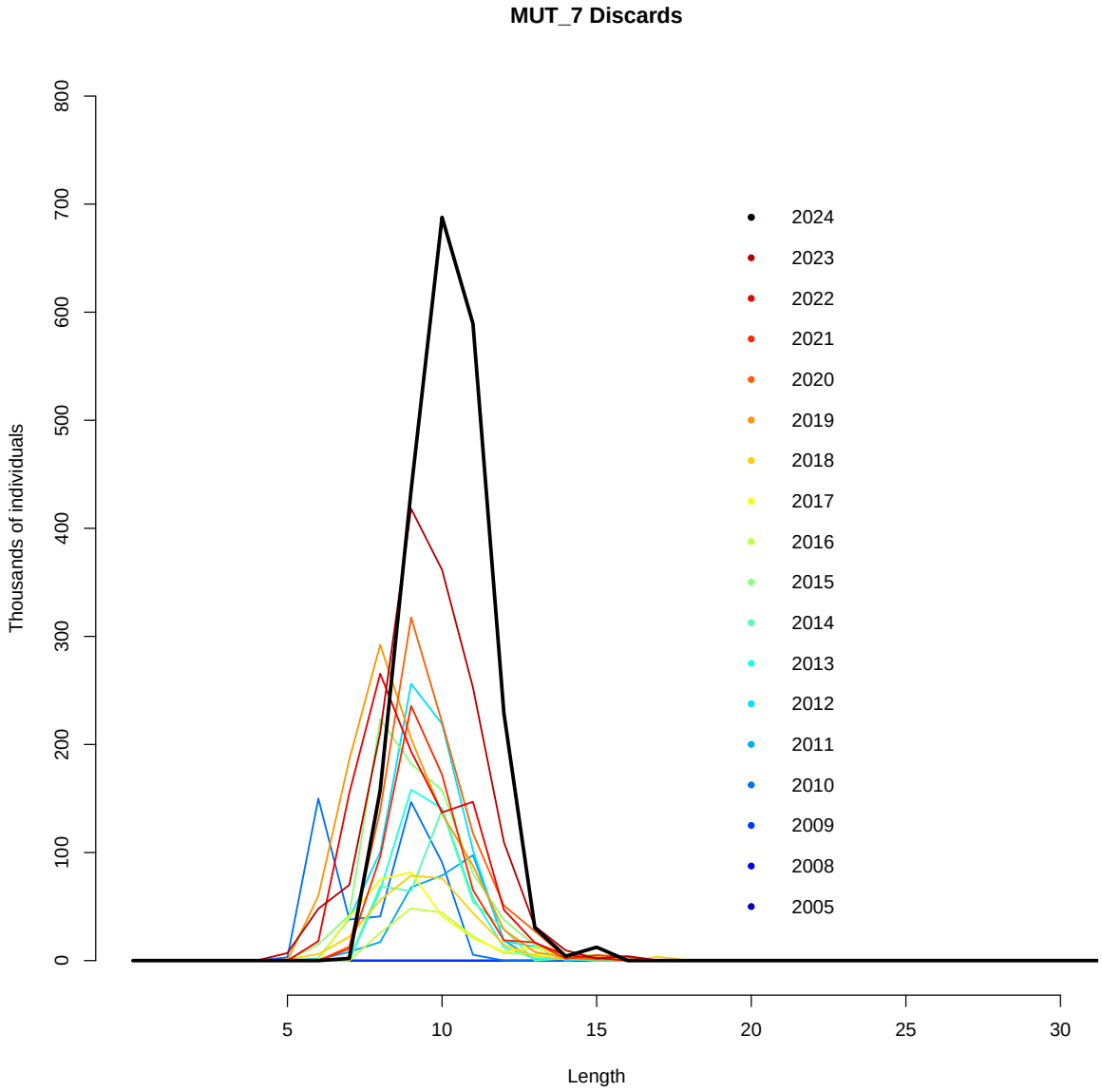

Fig. 6.6.11. Size-Class distribution of Red Mullet discards per year

6.6.5.2 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 (Fig. 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 Fig. 6.6.12.

Year	0	1	2	3	4+
2002	637.76	3079.909	805.771	117.768	18.961
2003	1041.512	4637.368	1306.067	114.434	17.776
2004	701.405	4071.49	1341.18	162.723	29.554
2005	608.64	2692.304	1434.463	235.75	64.245
2006	611.826	4478.199	1628.783	218.248	41.744
2007	399.537	3633.513	1776.764	244.883	45.671
2008	128.109	1149.488	1224.421	242.055	40.353
2009	598.784	2159.731	1156.934	237.77	43.608
2010	1133.276	4160.309	2306.908	401.04	102.915
2011	970.902	4015.401	2147.484	398.539	102.831
2012	66.61	1181.361	1980.764	393.319	72.569
2013	517.894	3468.295	2769.591	425.692	67.545
2014	267.138	3093.529	3239.541	653.895	134.725
2015	883.192	6085.222	3014.262	453.623	84.846
2016	628.451	6876.57	3881.939	422.715	71.125
2017	812.956	3909.373	2101.936	291.3	60.334
2018	551.499	3609.715	3066.252	590.064	102.127
2019	484.387	2630.215	2403.657	654.316	154.639
2020	731.242	4554.838	3802.383	805.785	169.081
2021	381.317	3724.487	3626.616	762.795	144.136
2022	288.42	3199.275	4145.872	991.795	184.588
2023	205.993	2348.609	3289.08	887.246	191.202
2024	189.14	2472.428	3448.923	981.09	237.481

Table 6.6.3. Landings at age (Thousands of individuals)

Year	0	1	2	3	4+
2002	0.013	0.021	0.049	0.077	0.097
2003	0.012	0.022	0.04	0.073	0.109
2004	0.014	0.022	0.046	0.073	0.103
2005	0.011	0.025	0.051	0.08	0.151
2006	0.016	0.024	0.047	0.078	0.114
2007	0.017	0.025	0.047	0.081	0.108
2008	0.015	0.031	0.057	0.08	0.095
2009	0.011	0.024	0.057	0.083	0.102
2010	0.011	0.025	0.052	0.085	0.128
2011	0.012	0.024	0.054	0.083	0.136
2012	0.016	0.04	0.058	0.078	0.125
2013	0.013	0.029	0.052	0.075	0.099
2014	0.017	0.032	0.057	0.084	0.112
2015	0.015	0.025	0.05	0.078	0.107
2016	0.019	0.027	0.044	0.073	0.122
2017	0.012	0.025	0.049	0.075	0.125
2018	0.013	0.029	0.056	0.081	0.102
2019	0.012	0.029	0.063	0.092	0.12
2020	0.013	0.028	0.058	0.085	0.112
2021	0.016	0.031	0.058	0.083	0.104
2022	0.016	0.034	0.062	0.084	0.109
2023	0.016	0.035	0.064	0.09	0.113
2024	0.017	0.035	0.064	0.094	0.118

Table 6.6.4. Average weight of landings at age (Kg)

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	386.044	141.699	0	0	0
2011	111.843	203.564	1.154	0.038	0
2012	384.092	388.53	4.042	0.085	0.002
2013	210.895	233.669	2.088	0.111	0.007
2014	152.641	208.502	0.818	0.033	0
2015	450.391	305.776	6.35	0.204	0.008
2016	70.234	86.362	6.267	0.243	0.002
2017	197.11	105.702	5.739	0.151	0
2018	162.285	145.895	5.253	0.474	0.067
2019	743.529	299.834	7.093	0.35	0.017
2020	432.936	456.555	7.741	0.136	0.005
2021	314.725	312.544	9.097	0.355	0.014
2022	622.515	359.974	6.58	0.15	0
2023	703.442	742.944	12.942	0.397	0.016
2024	681.093	1397.857	13.871	0.398	0

Table 6.6.5. Discards at age (Thousands of individuals)

Year	0	1	2	3	4+
2002	0.013	0.021	0.049	0.077	0.097
2003	0.012	0.022	0.04	0.073	0.109
2004	0.014	0.022	0.046	0.073	0.103
2005	0.011	0.025	0.051	0.08	0.151
2006	0.016	0.024	0.047	0.078	0.114
2007	0.017	0.025	0.047	0.081	0.108
2008	0.015	0.031	0.057	0.08	0.095
2009	0.011	0.024	0.057	0.083	0.102
2010	0.005	0.01	0.052	0.085	0.128
2011	0.009	0.014	0.03	0.032	0.136
2012	0.008	0.012	0.031	0.042	0.047
2013	0.008	0.012	0.038	0.044	0.047
2014	0.008	0.013	0.032	0.032	0.112
2015	0.007	0.013	0.033	0.041	0.047
2016	0.008	0.014	0.034	0.037	0.047
2017	0.007	0.014	0.031	0.037	0.125
2018	0.007	0.013	0.044	0.053	0.057
2019	0.006	0.013	0.038	0.043	0.047
2020	0.008	0.013	0.029	0.041	0.047
2021	0.008	0.013	0.035	0.043	0.047
2022	0.007	0.014	0.03	0.035	0.109
2023	0.008	0.014	0.032	0.041	0.047
2024	0.01	0.014	0.032	0.038	0.118

Table 6.6.6. Average weight of discards at age (Kg)

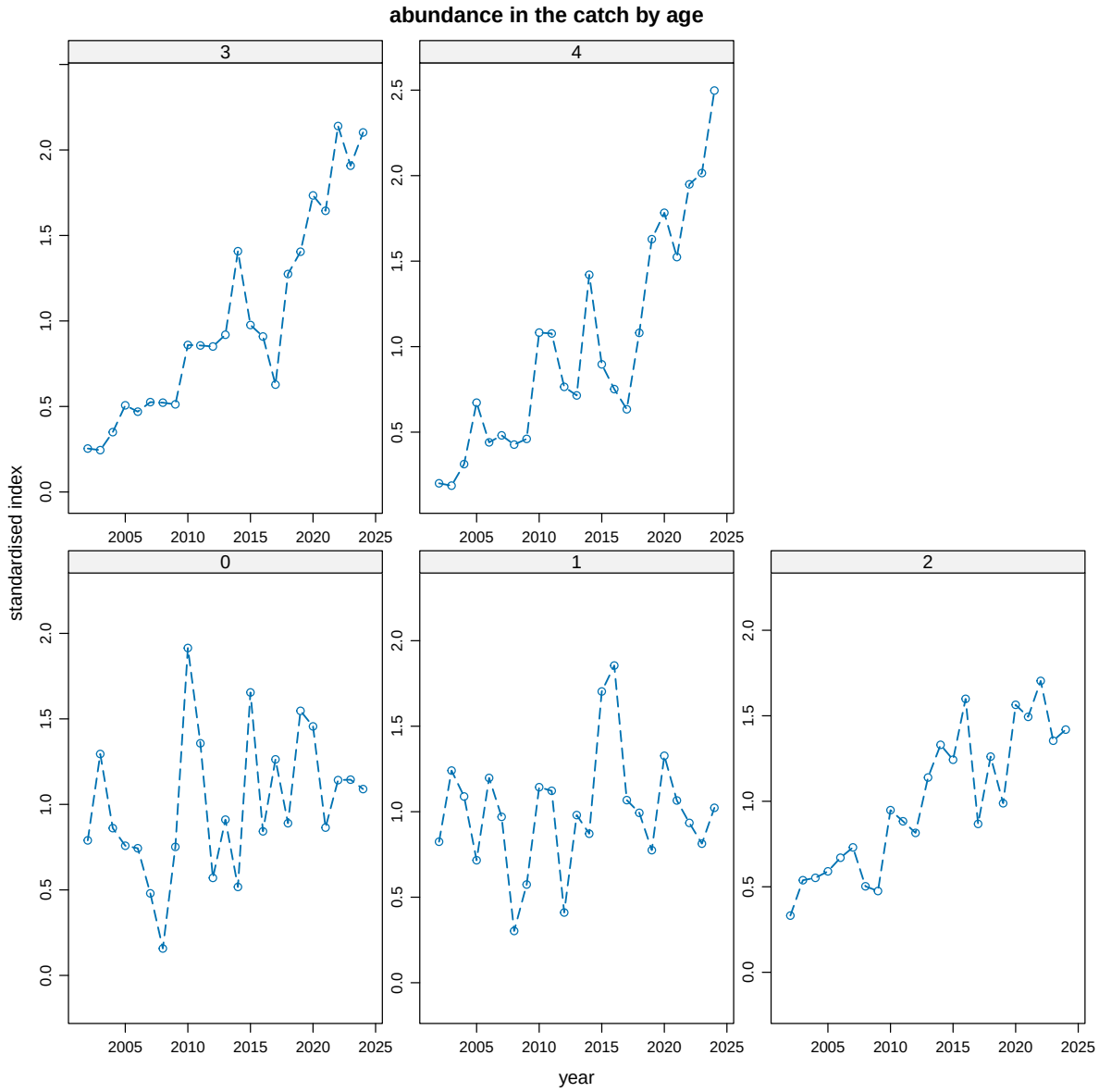

Fig. 6.6.12. Catch at age of Red Mulled in GSA 7. Y-axis is standardised.

6.6.6 Survey data

6.6.6.1 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.

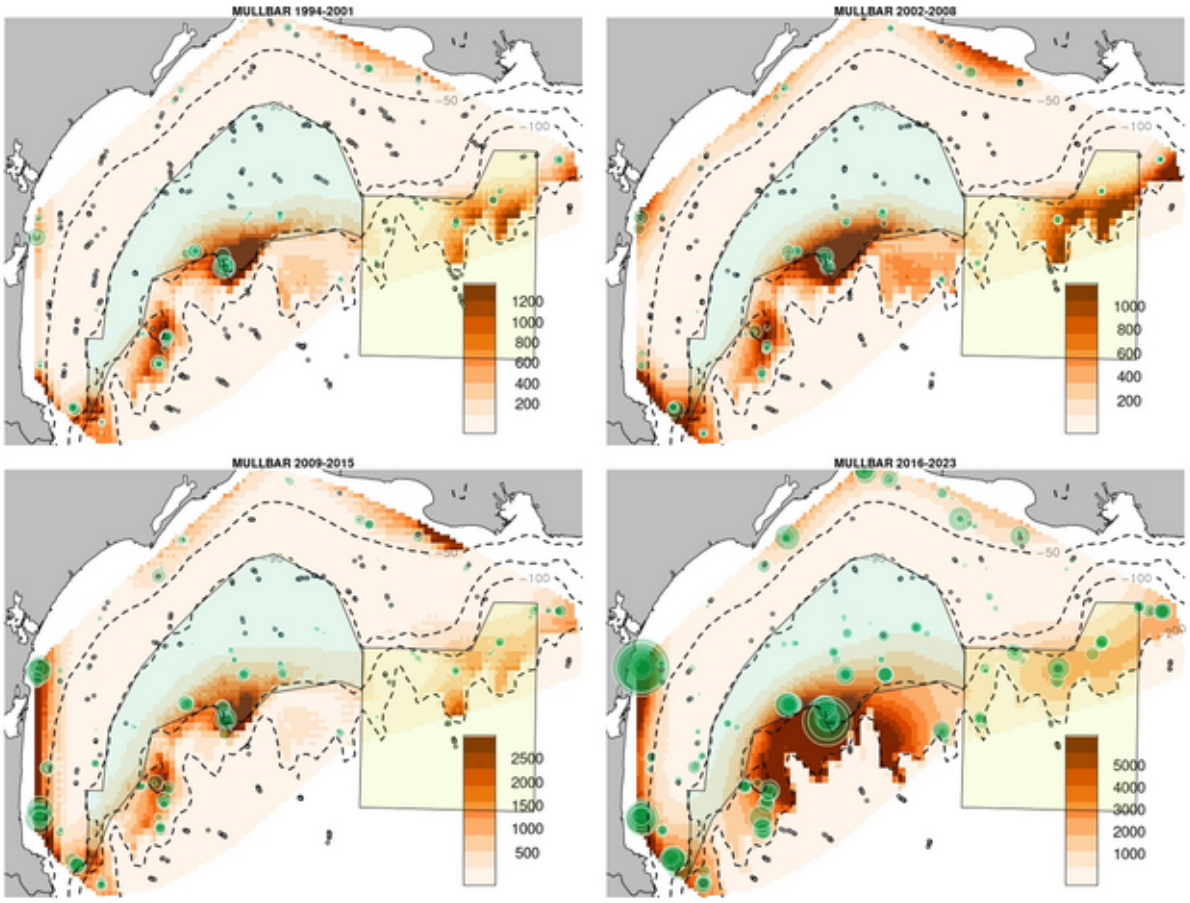

Fig. 6.6.13. Orange shades: Estimates of Red Mullet densities from MEDITS survey in N/km2. Green circles corresponds to trawls with red mullet, their size is proportional to densities. Coloured areas shows spatio-temporal closures, in blue the bathymetric area (closed from September to April) and in yellow the GFCM box (closed from November to April).

Fig. 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.

6.6.6.2 MEDITS index at length and age

The size range caught by the survey (Fig. 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.

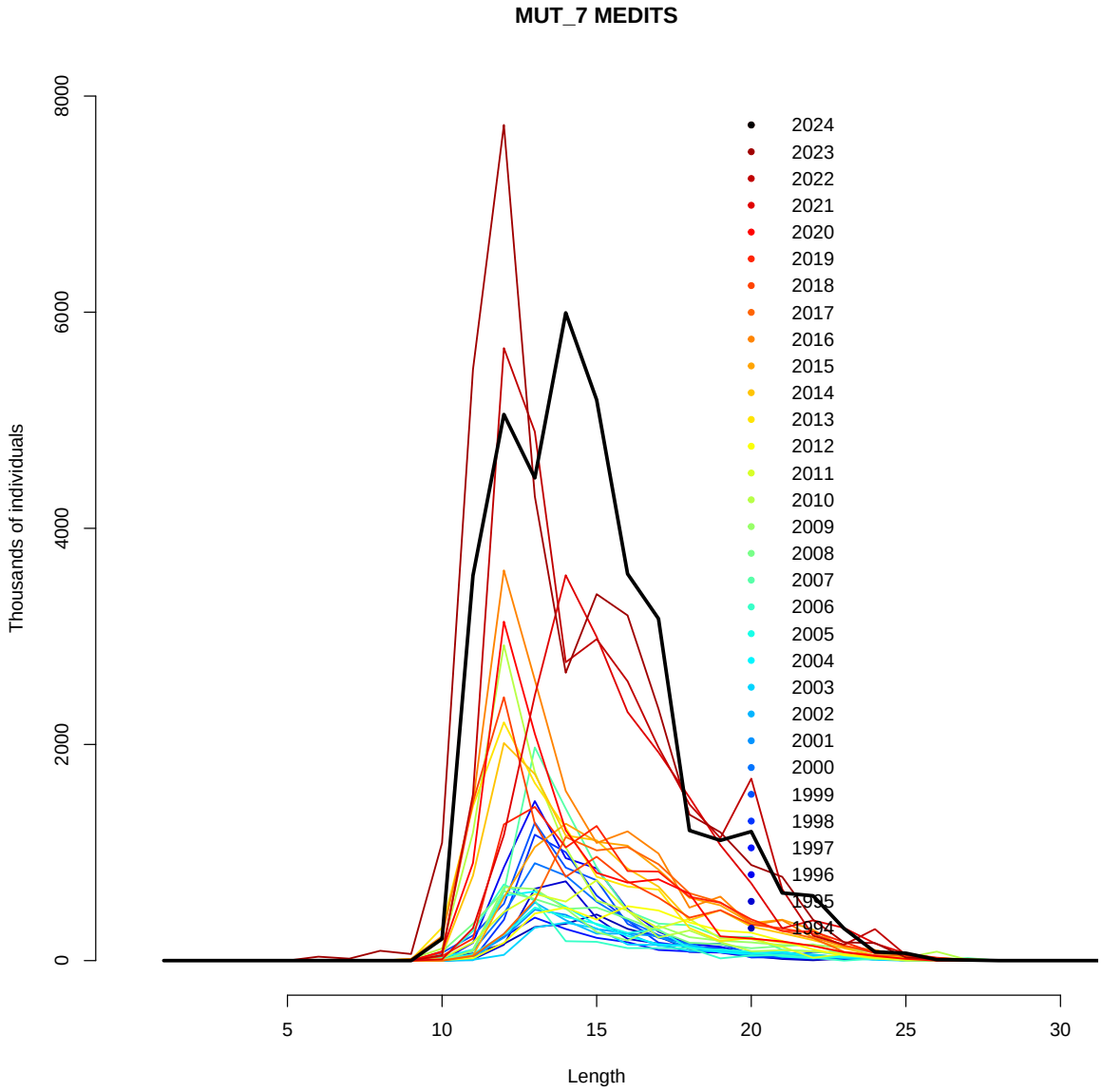

Fig 6.6.14. Length distribution of MEDITS abundance index over the years. The black thick line corresponds to 2024.

6.6.6.3 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 Fig. 6.6.15.

Year	0	1	2	3	4
2002	69.016	1082.995	889.933	195.689	74.534
2003	33.012	714.476	770.183	157.092	45.304
2004	134.864	1683.506	986.929	186.484	66.677
2005	75.318	1184.48	1022.484	183.612	51.615
2006	157.416	1544.067	576.687	119.656	54.866
2007	239.219	3593.195	2512.871	395.185	126.818
2008	180.896	2063.411	1409.183	333.606	110.181
2009	137.899	1767.032	1312.305	414.529	186.058
2010	647.955	6098.955	1933.913	321.882	186.692
2011	126.474	1948.991	1833.952	349.423	69.068
2012	58.718	1292.685	1830.406	451.154	138.51
2013	639.93	6114.528	2699.182	490.058	141.419
2014	472.82	5463.957	3368.08	688.961	180.82
2015	159.027	3210.126	3797.742	908.268	251.173
2016	851.972	8690.03	4354.33	902.667	250.166
2017	87.611	2456.384	3601.287	804.201	206.793
2018	586.039	5771.984	2978.128	763.153	255.046
2019	283.656	4127.974	3693.448	879.513	277.825
2020	639.455	6751.59	3119.118	567.616	133.431
2021	389.976	7962	8756.416	1687.015	425.445
2022	1206.367	14576.779	9827.935	2031.486	456.455
2023	2359.002	20473.965	10127.899	1938.423	422.794
2024	1491.938	18827.728	13324.107	2259.294	500.984

Table 6.6.7. MEDITS index at age (Numbers in thousands for the 13800 km² of the Gulf of Lion)

Year	0	1	2	3	4
2002	0.02	0.026	0.047	0.091	0.137
2003	0.02	0.027	0.045	0.079	0.127
2004	0.017	0.023	0.043	0.085	0.132
2005	0.018	0.026	0.044	0.081	0.124
2006	0.016	0.02	0.044	0.091	0.147
2007	0.019	0.024	0.04	0.075	0.13
2008	0.015	0.023	0.048	0.088	0.13
2009	0.019	0.025	0.054	0.098	0.147
2010	0.015	0.018	0.04	0.081	0.156
2011	0.017	0.026	0.046	0.073	0.095
2012	0.02	0.032	0.053	0.082	0.131
2013	0.015	0.02	0.044	0.082	0.118
2014	0.016	0.022	0.047	0.082	0.117
2015	0.019	0.028	0.048	0.082	0.112
2016	0.016	0.02	0.041	0.071	0.098
2017	0.02	0.032	0.049	0.078	0.111
2018	0.016	0.021	0.051	0.089	0.128
2019	0.017	0.024	0.046	0.08	0.115
2020	0.02	0.026	0.052	0.087	0.115
2021	0.018	0.027	0.043	0.072	0.102
2022	0.016	0.023	0.047	0.078	0.107
2023	0.013	0.019	0.043	0.071	0.095
2024	0.015	0.022	0.041	0.07	0.097

Table 6.6.8. MEDITS average weight at age.

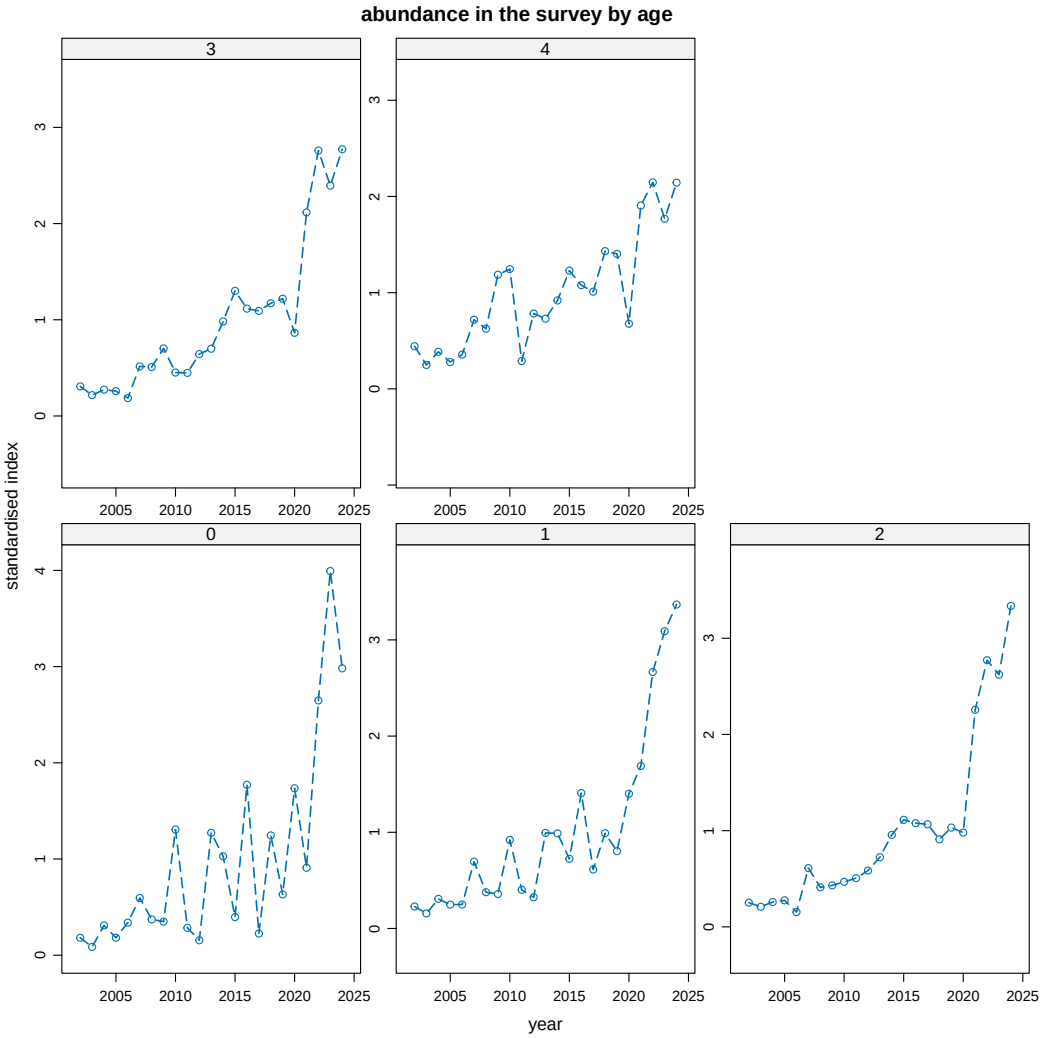

Fig. 6.6.15. MEDITS index at age of Red Mulled in GSA 7. Y-axis is standardised.

6.6.7 Stock assessment: a4a.

6.6.7.1 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)

6.6.7.2 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.

Year	Rec0	SSB	F03	Catch
2002	21035.77	127.727	0.774	114.961
2003	22078.47	144.658	0.742	127.054
2004	22572.08	167.202	0.711	145.856
2005	26045.28	201.28	0.684	166.802
2006	26099.43	215.613	0.661	170.874
2007	22472.42	240.877	0.643	186.73
2008	26236.98	272.002	0.63	211.889
2009	32291.56	250.191	0.623	191.826
2010	36612.82	291.763	0.621	212.162
2011	34091.38	333.642	0.622	251.138
2012	36126.74	418.748	0.627	310.35
2013	39171.16	370.345	0.631	277.569
2014	41747.52	437.242	0.633	324.79
2015	45807	387.98	0.629	294.58
2016	46196.56	438.198	0.618	314.769
2017	42266.11	454.865	0.598	323.543
2018	49537.44	502.855	0.568	352.671
2019	58956.76	577.56	0.529	368.662
2020	62700.52	668.116	0.485	384.229
2021	60484.69	817.153	0.438	428.745
2022	68780.71	957.173	0.39	454.525
2023	79622.93	1084.451	0.346	451.802
2024	70699.17	1260.875	0.305	466.172

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	0	1	2	3	4+
2002	0.039	0.561	1.345	1.151	0.509
2003	0.038	0.537	1.289	1.103	0.488
2004	0.036	0.515	1.236	1.057	0.468
2005	0.035	0.496	1.189	1.017	0.45
2006	0.034	0.479	1.149	0.983	0.435
2007	0.033	0.466	1.117	0.956	0.423
2008	0.032	0.457	1.095	0.937	0.415
2009	0.032	0.451	1.083	0.926	0.41
2010	0.032	0.45	1.079	0.923	0.408
2011	0.032	0.451	1.082	0.925	0.409
2012	0.032	0.454	1.089	0.931	0.412
2013	0.032	0.457	1.096	0.938	0.415
2014	0.032	0.459	1.1	0.941	0.416
2015	0.032	0.456	1.094	0.936	0.414
2016	0.031	0.448	1.074	0.919	0.407
2017	0.03	0.433	1.039	0.889	0.393
2018	0.029	0.411	0.987	0.844	0.374
2019	0.027	0.384	0.92	0.787	0.348
2020	0.025	0.351	0.843	0.721	0.319
2021	0.022	0.317	0.76	0.65	0.288
2022	0.02	0.283	0.678	0.58	0.257
2023	0.018	0.251	0.601	0.514	0.227
2024	0.016	0.221	0.531	0.454	0.201

Table 6.6.10. Fishing mortality at age resulting from the stock assessment model.

Year	0	1	2	3	4
2002	21035.77	7751.185	1381.609	283.573	67.021
2003	22078.47	7884.62	2322.969	211.791	81.503
2004	22572.08	8289.109	2419.276	376.788	75.649
2005	26045.28	8487.516	2599.908	413.651	111.651
2006	26099.43	9807.063	2715.155	466.062	138.482
2007	22472.42	9838.956	3190.2	506.648	165.705
2008	26236.98	8479.42	3242.96	614.367	190.437
2009	32291.56	9906.301	2820.751	638.497	230.022
2010	36612.82	12196.874	3312.789	562.417	254.72
2011	34091.38	13830.605	4085.382	663.094	247.022
2012	36126.74	12876.956	4626.69	815.233	268.12
2013	39171.16	13642.946	4294.745	916.62	313.043
2014	41747.52	14789.349	4535.952	844.481	355.041
2015	45807	15760.585	4910.482	889.026	354.374
2016	46196.56	17296.125	5245.812	968.11	366.342
2017	42266.11	17453.008	5803.395	1054.367	395.762
2018	49537.44	15984.674	5943.327	1208.563	439.994
2019	58956.76	18763.203	5563.019	1303.998	516.365
2020	62700.52	22374.579	6714.544	1304.912	601.723
2021	60484.69	23849.125	8269.15	1701.579	673.672
2022	68780.71	23061.779	9122.026	2275.429	874.552
2023	79622.93	26287.788	9127.888	2724.765	1223.84
2024	70699.17	30500.734	10746.266	2946.048	1635.497

Table 6.6.11. Stock abundance (in thousands) at age estimated by the model

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 & Fig. 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.

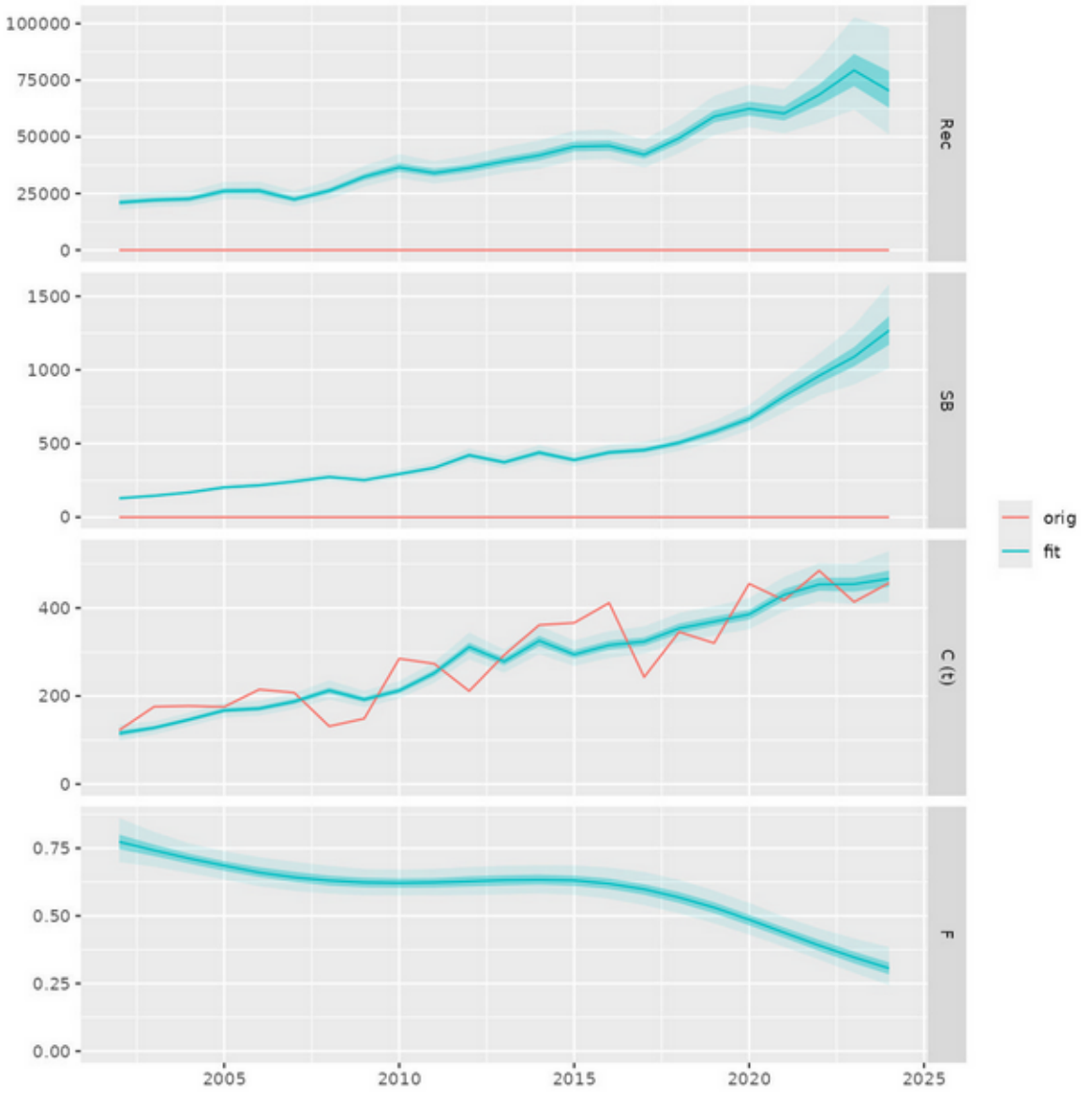

Fig 6.6.16. Time series and confidence intervals of Recruitment, SSB, Catch and Fbar estimated by the model, together with confidence intervals. The red line in the catch series corresponds to the observed catch.

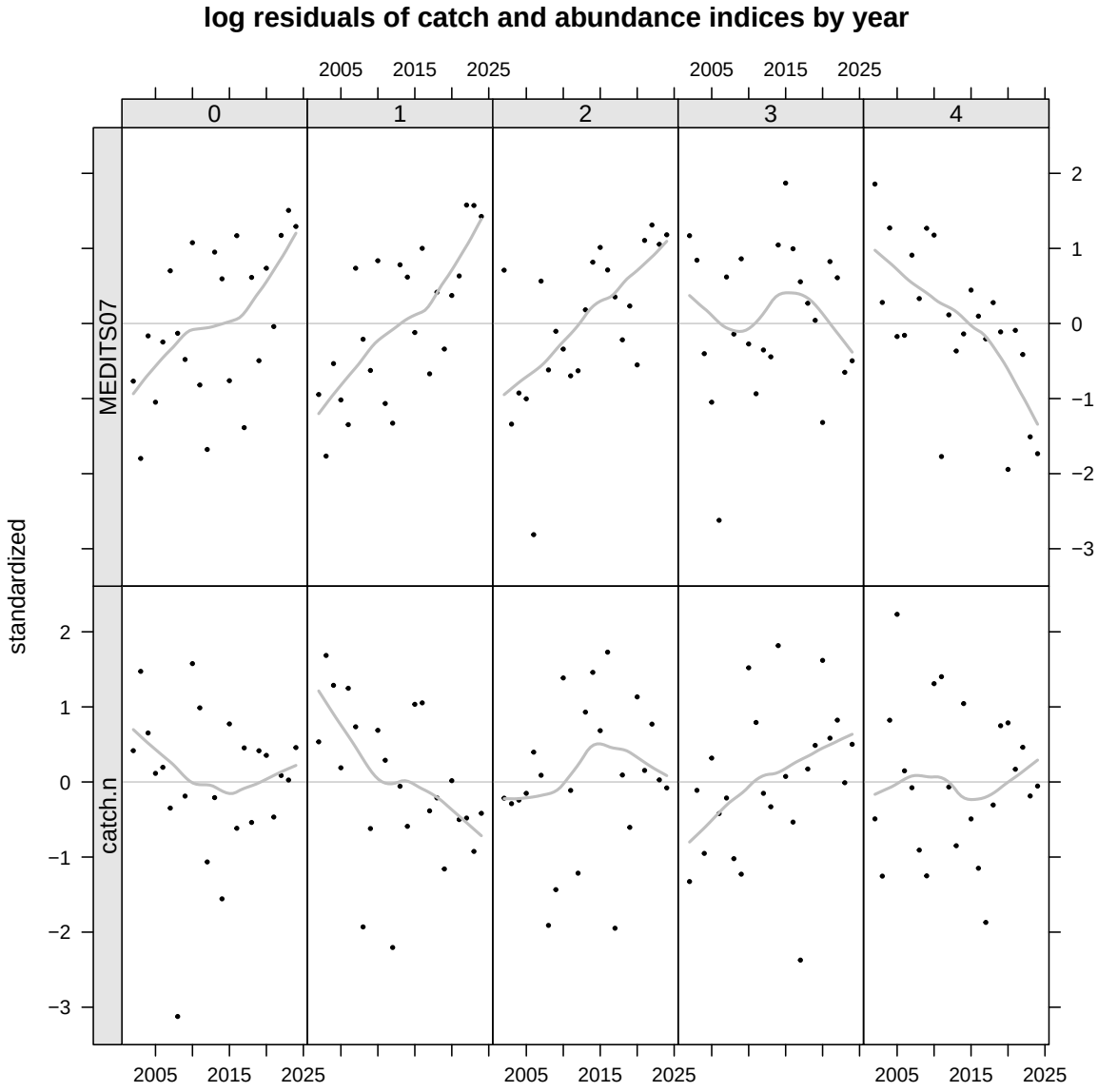

Fig 6.6.17. Log residuals from the stock assessment model.

As in previous years, Log-residuals (Fig. 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 (Fig 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 (Fig. 6.6.19) is assumed constant through the years, but increases with age up to age 3, in accordance with the catchability submodel specification.

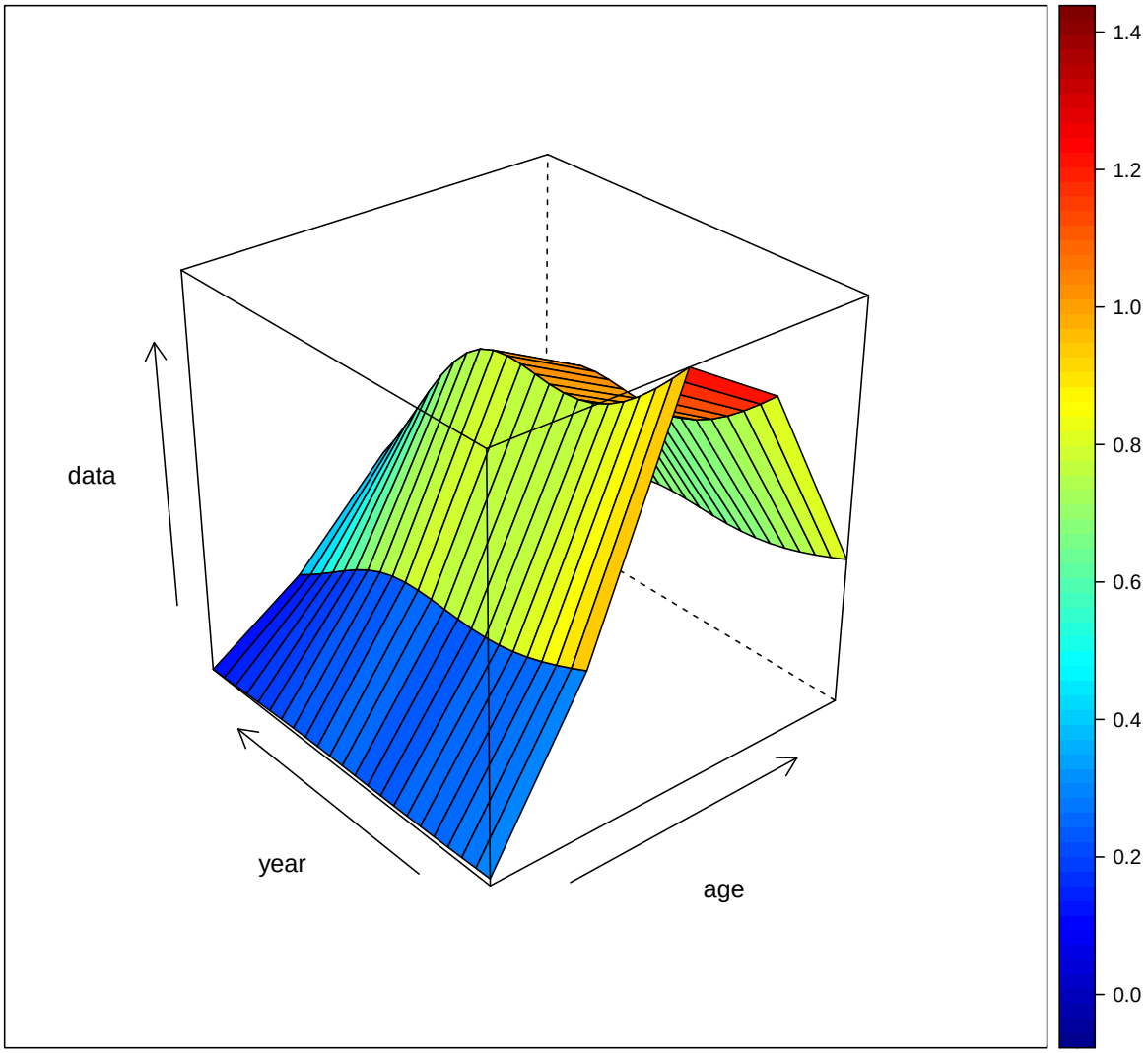

Fig. 6.6.18. Fishing mortality at age through the years

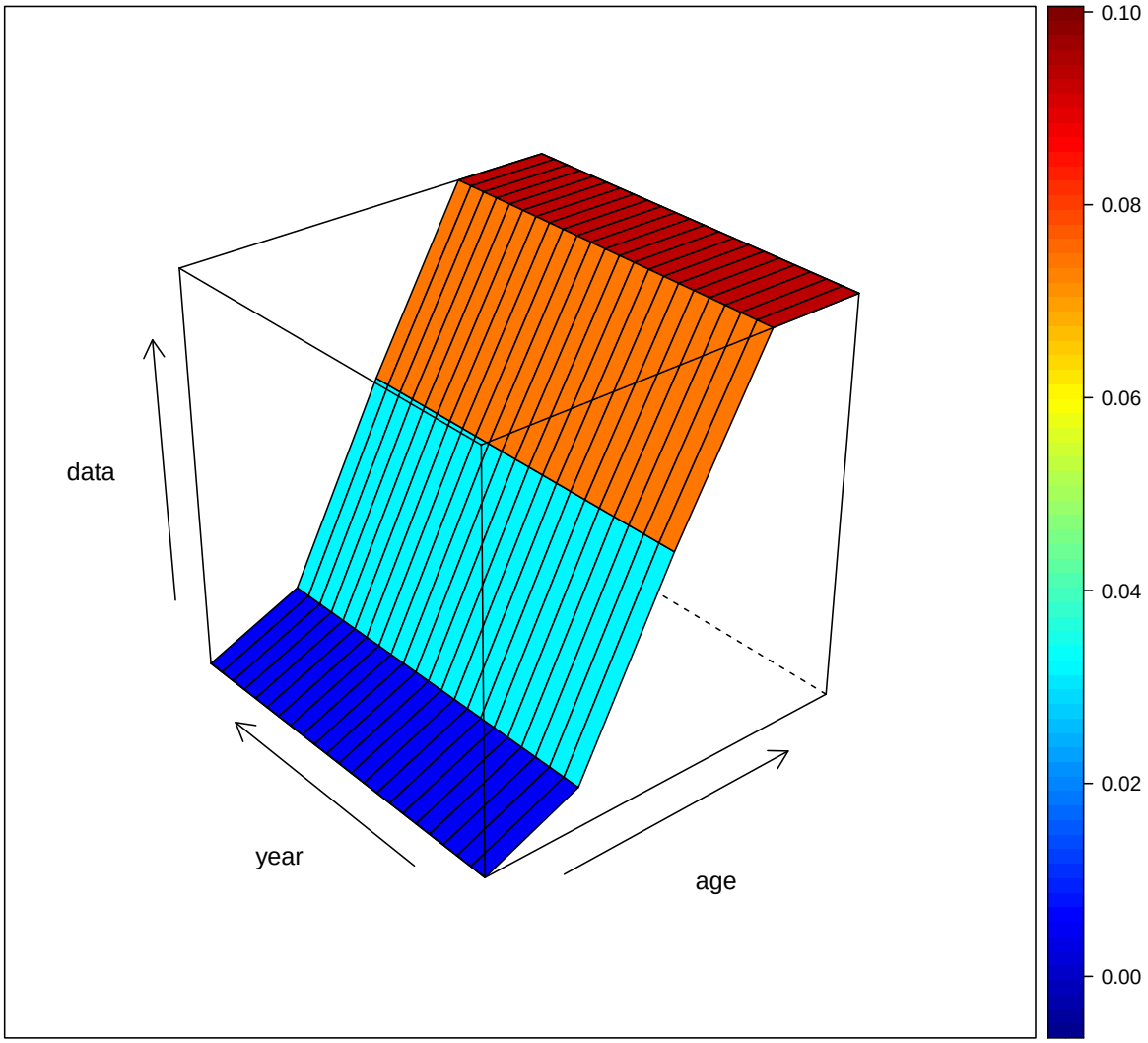

Fig. 6.6.19. Survey catchability at age through the years

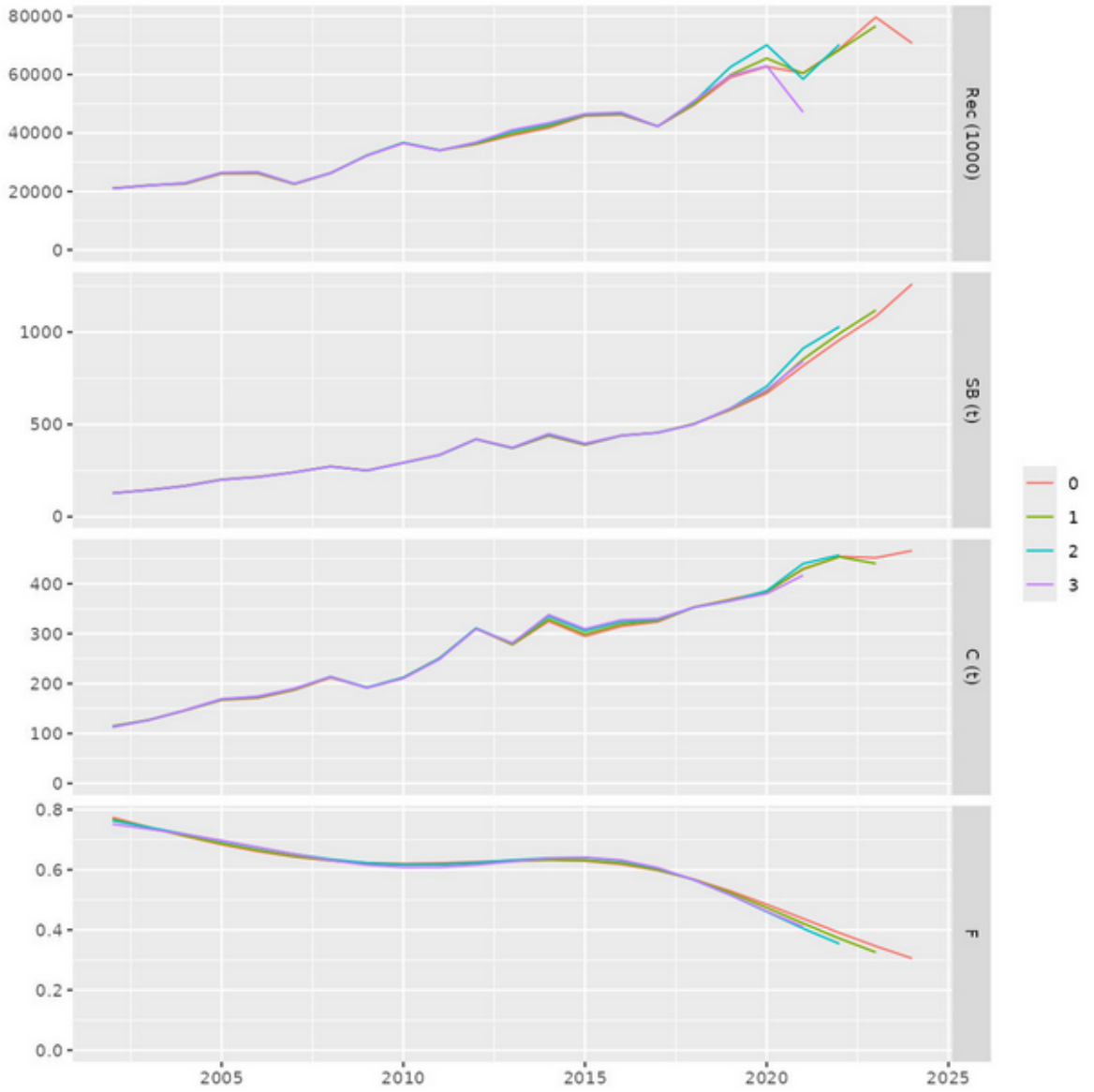

Fig. 6.6.20. Retrospective analysis carried out for the selected model.