Data preparation STECF EWG 25-09

***Mullus barbatus* MUT GSA06**

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TERMS OR REFERENCE

The Data preparation before STECF EWG 25-09 addresses the TORs detailed below and the objective of this ad hoc contract is to update existing stock assessment input files for the stock/s MUT 6 in order for it to be ready for the assessment runs with the notable inclusion of 2024 relevant data stemming from the 2025 Med & BS DCF Data call.

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 as well as the standardized MEDITS Index for the longest time series available up to and including 2024, including length frequency distribution over time. To provide a complete and updated stock assessment input file in the format of those used in 2024.

1. Stock identification and boundaries

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.

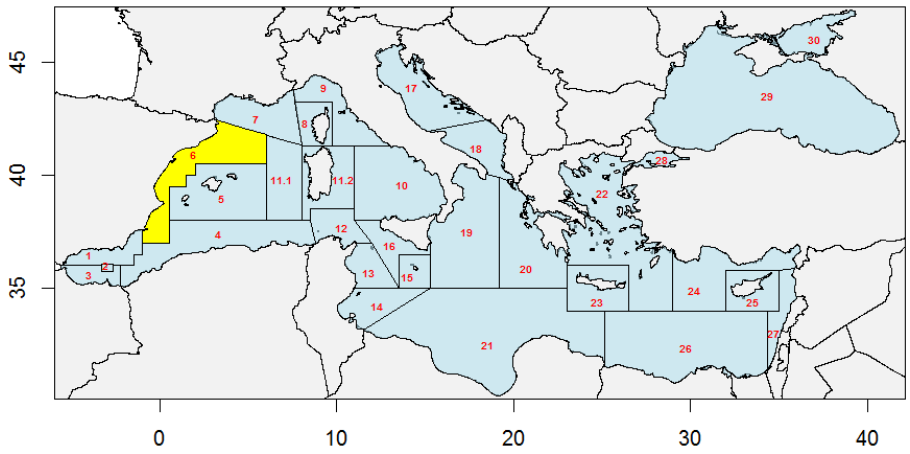

Figure 1: Location of GSA 6 in the Mediterranean Sea.

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) (**Figure 1**) and 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, García-Rodríguez et *al*., 2020).

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 (Voliani et *al.*, 1998).

2. 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 (**Table 1**).

Table 1: Maturity vector

Age	0	1	2	3	4
Proportion mature	0	1	1	1	1

3. 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 t0 values. EWG-21-02 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=0.34, t0=-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. In addition, and following the suggestions recommended last year, parameter by sex were tested using ELEFAN routine (**Table 2** and **Figure 2**)(Garcia Et al, 2024).

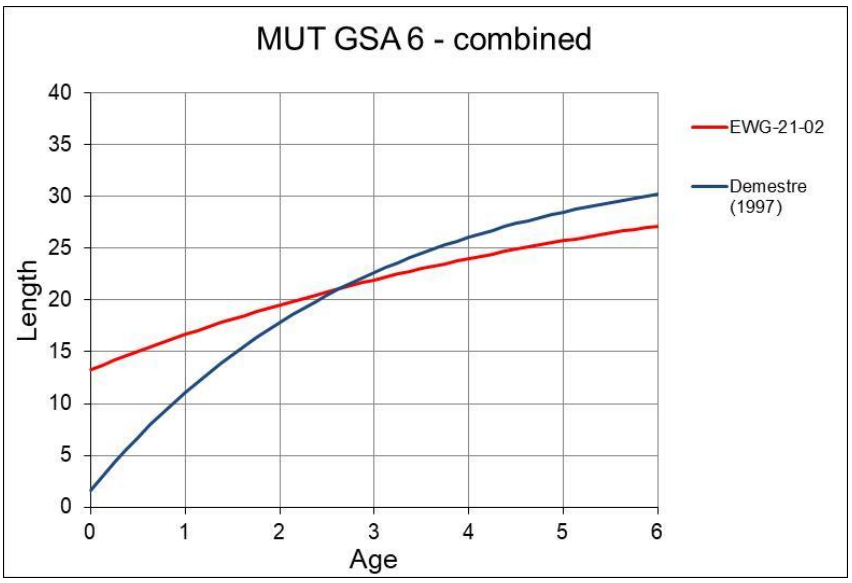

Figure 2: Growth curves according to the parameters used by EWG-21-02 and Demestre *et al.* (1997).

Table 2: Red Mullet growth parameters used

	Combined	**Males**	**Females**
L_∞ (cm)	34	25.5	31
k (yr^{-1})	0.134	0.365	0.33
t_0 (yr)	-0.143	-0.72	-0.4
a ($g\ mm^{-1}$)	0.0096	0.0085	0.0065
b	3.04	3.07	3.179

4. Natural mortality vector

Natural mortality vector was estimated with the method proposed by Chen and Watanabe (1989) (**Table 3**).

Table 3: Red Mullet Natural mortality vector

Age	0	1	2	3	4
M	1.74	0.8	0.57	0.48	0.43

5. Catch data (landings and discards)

Red mullet landings in GSA 6 come predominantly from OTB; a small amount is reported for small-scale fishing gears (trammel-net). Landings from small-scale gears other than entangling nets may be a mistake when coding the fishing gear (**Figure 3** and **Table 4**).

Landings

Table 4: Landings (t) by fishing gear over 2002-2024 (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).

	DRB	FPO	GNS	GTN	GTR	LA	LHM	LHP	LLS	LTL	OTB	PS	SV	Total Landings
2002					2.250						303.110			305.360
2003					19.010						1380.960			1399.970
2004					12.690						906.800			919.490
2005					17.940						977.090			995.030
2006					16.350						1371.430			1387.780
2007					12.450						1171.100			1183.550
2008					17.480						854.640			872.120
2009					11.720						509.170			520.890
2010					11.320						502.810			514.130
2011		0.870	1.520		136.970				0.620		923.080			1063.060
2012		0.620	0.130		76.050				0.430		992.660			1069.890
2013		1.540			98.610				1.160		1146.690			1248.000
2014			0.290		122.410				0.300		1186.190			1309.190
2015		0.870	0.780		129.690				0.800		1386.530			1518.670
2016		0.550			92.210				0.230		1580.910			1673.900
2017		0.630			109.760				0.530		1338.400			1449.320
2018					80.040						1200.660			1280.700
2019		0.701	0.808		111.592				0.528		1388.209			1501.838
2020		1.558	5.130	0.561	88.843			0.103	3.046		1347.024	0.021		1446.286
2021	0.032	0.545	1.877	0.059	71.702			0.001	1.136		981.728	0.033		1057.113
2022	0.574	3.281	1.616	0.244	127.606			0.005	1.337	0.010	1186.453	0.006		1321.131
2023	0.695	0.767	2.260	1.942	101.452	0.022			0.208		993.144	0.007	0.003	1100.498
2024	0.993	1.941	1.058	2.335	103.959		0.001	0.008	0.657	0.005	1179.257	0.012		1290.225

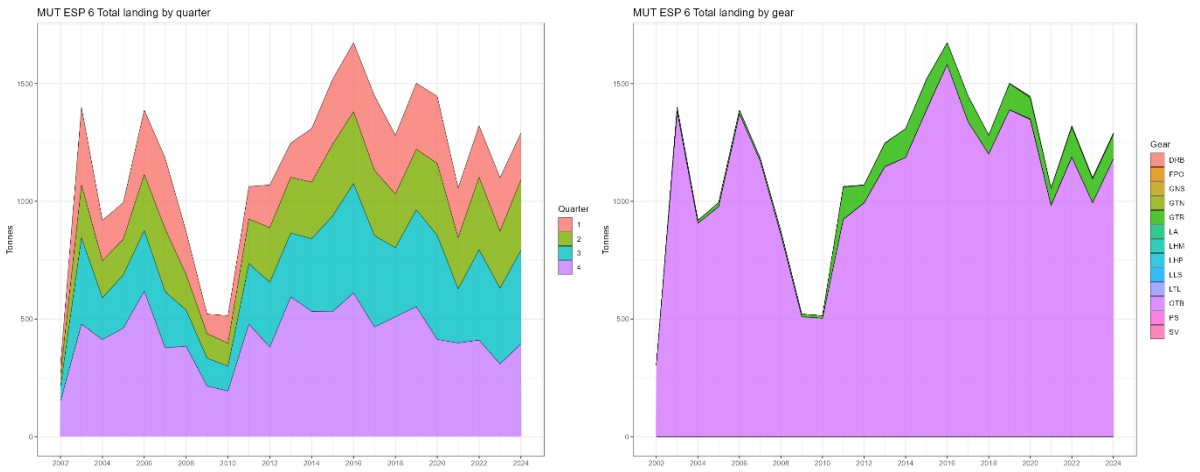

Figure 3: Landings (t) by quarter (left) and gear (right) over 2002-2024 data

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 2009-2024 were used. LFDs for the metier OTB_MDD (2009-2024) were reconstructed from the median OTB_DEMSP LFDs, applying SOP correction (**Figure 4** and **Figure 5**).

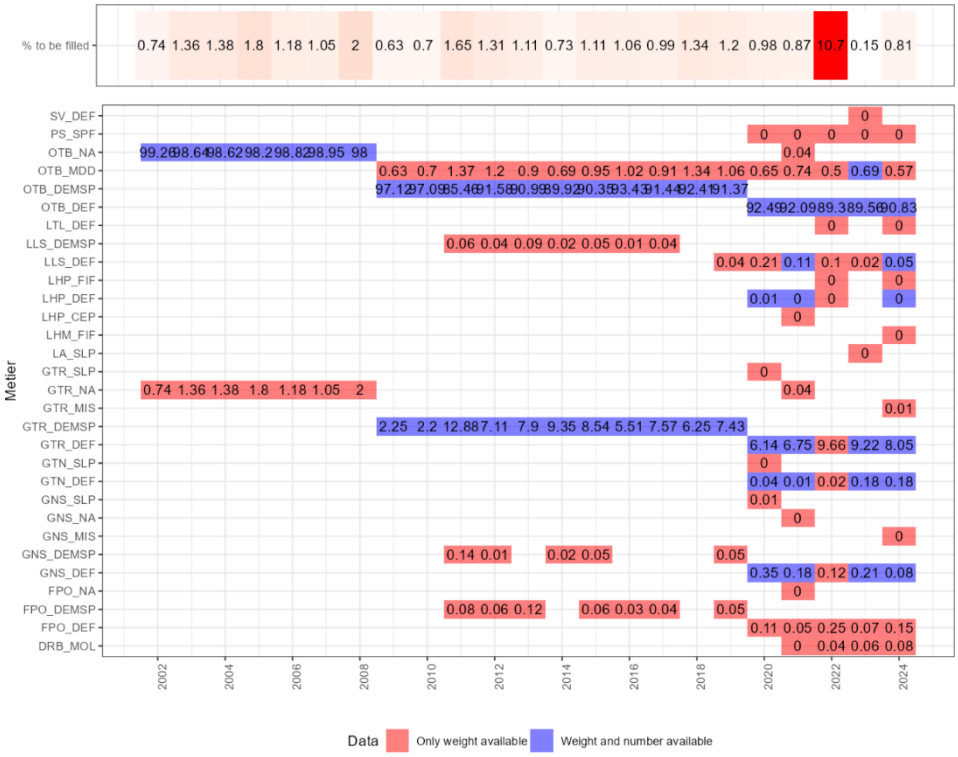

Figure 4: Summary of the reconstruction of landings data

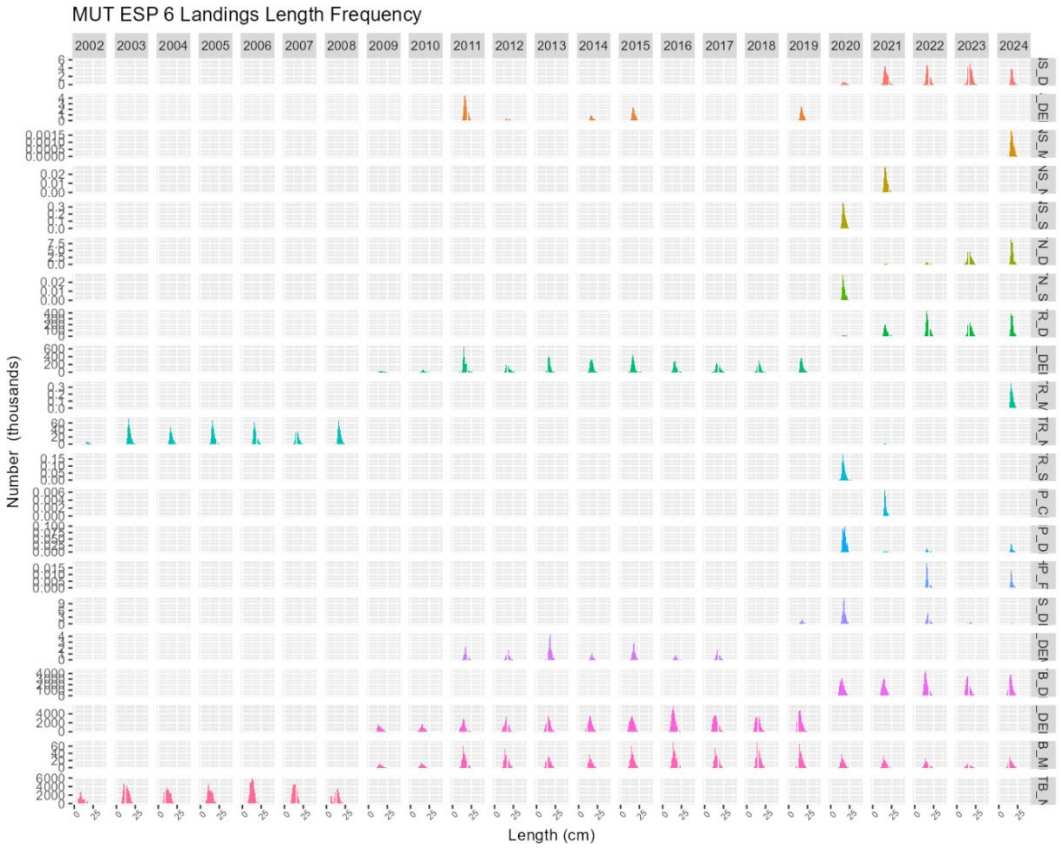

Figure 5: Landings length frequency distribution by gear and year (TL cm). LFDs until 2024 as reconstructed

Discards

Red mullet discards come mainly from OTB (**Table 5** and **Figure 6**).

Table 5:Discards (t) by fishing gear over 2002-2024 (tonnes; GNS=gillnet; GTR=trammel net; OTB=otter bottom trawl).

	GNS	GTR	OTB	Total Discards
2005			0.01	0.01
2007		0.02		0.02
2008			0.08	0.08
2009		0.00	0	0
2010		0.00	0.35	0.35
2011	0	0.00	5.44	5.44
2012	0	0.00	21.86	21.86
2013		0.00	14.22	14.22
2014	0	0.01	3.28	3.29
2015	0.01	0.00	51.45	51.46
2016		0.00	30.16	30.16
2017			14.72	14.72
2018			43.86	43.86
2019			1.76484	1.76484
2020			7.65	7.65
2021	0	0.00	9.66615	9.66615
2022	0	0.00	6.64001	6.64001
2023	0	0.00	14.87002	14.87002
2024	0	0.00	18.09001	18.09001

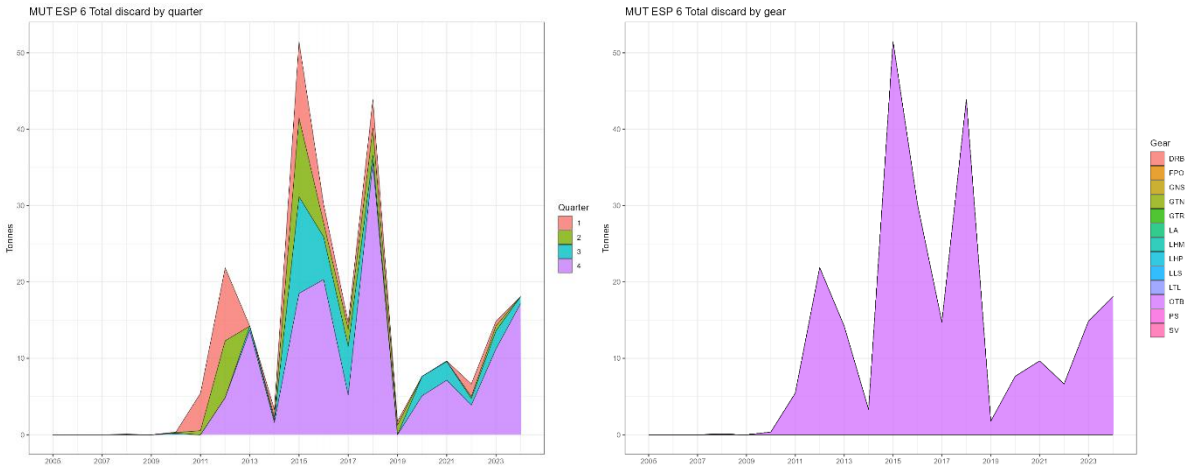

Figure 6: Discards (t) by quarter (left) and gear (right) over 2002-2024 data

LFDs were available for 2017-2024 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 7** and **Figure 8**).

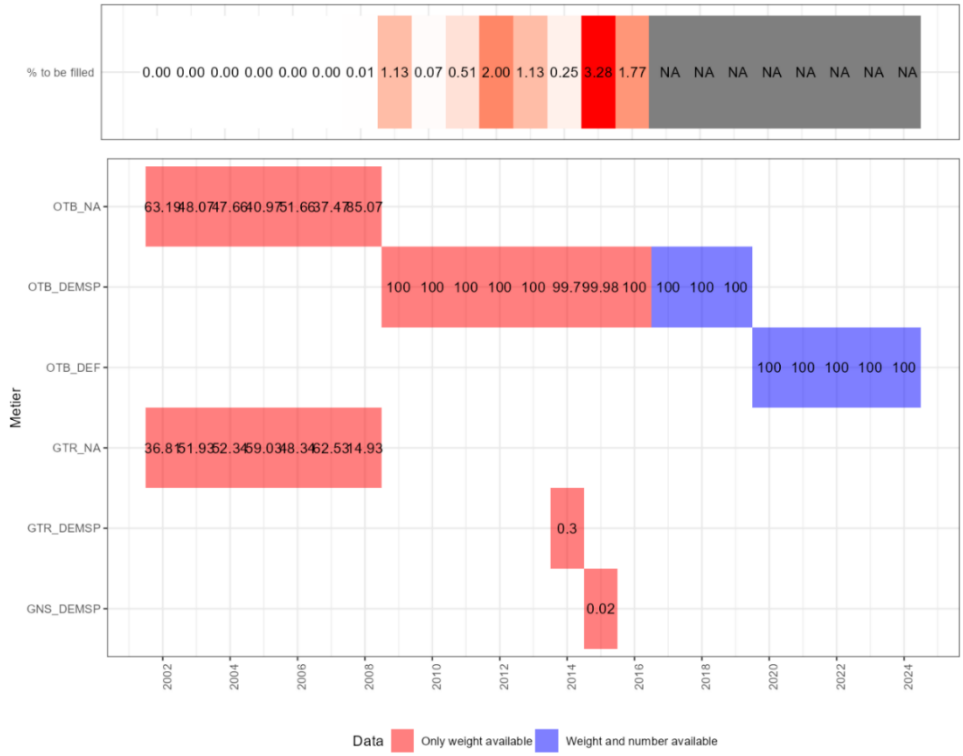

Figure 7: Summary of the reconstruction of discards data

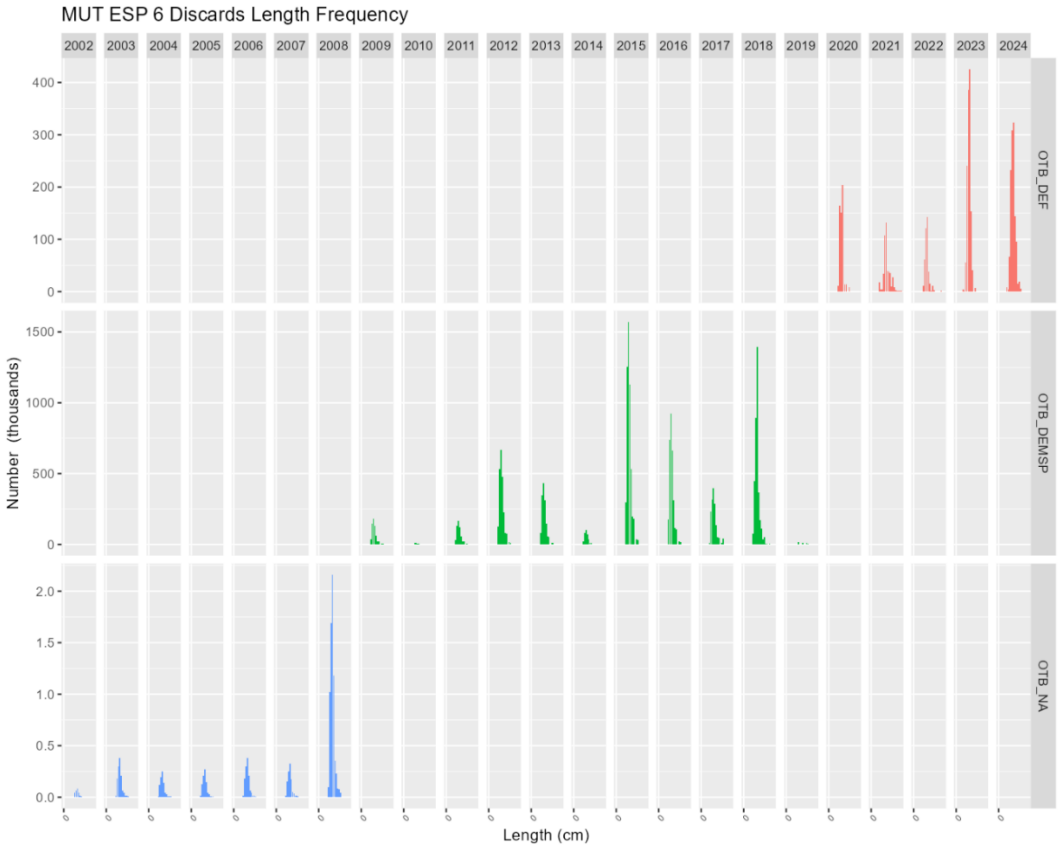

Figure 8:. Discards length frequency distribution, by year (TL cm). LFDs until 2024 as reconstructed

SoP correction

A SOP correction vector was applied to catch numbers at age (**Table 6**) 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:SoP correction

2002	**2003**	**2004**		**2005**	**2006**	**2007**	**2008**
1.1339625	1.1269589	1.1070072		1.1106927	1.1219262	1.1113399	1.1062482
2009	**2010**	**2011**		**2012**	**2013**	**2014**	**2015**
1.1486144	0.9607904	1.2773323		1.1430582	1.1505917	1.1549608	1.1336541
2016	**2017**	**2018**		**2019**	**2020**	**2021**	**2022**
1.1418441	1.1495692	1.0940196		1.0680326	1.5055704	1.1038023	1.1039939
2023	**2024**						
1.1081725	1.1018569						

Catch numbers at age

Table 7: Catch at age matrix by year

age	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
0	12277.696	10655.017	11960.911	9404.144	8796.17	3680.186	5103.957	1252.208
1	6682.843	29408.944	22718.788	24321.312	37567.614	31308.039	20521.888	9637.68
2	553.422	5689.527	2303.447	2654.853	2994.991	2934.258	2715.806	2540.078
3	33.509	178.677	37.075	87.754	57.917	49.715	74.912	120.241
4	0.572	13.188	0.516	4.809	7.129	6.042	1.7	4.679
age	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
0	360.387	2116.966	2462.487	1591.076	1488.441	6561.907	4593.801	4012.013
1	6943.323	20024.665	16664.149	20419.82	22207.397	25294.901	34549.618	27090.068
2	2782.269	4090.143	5346.823	6088.642	6542.668	7921.145	6879.735	6511.218
3	228.572	361.231	243.413	355.889	282.045	422.83	299.314	474.476
4	36.146	28.333	92.654	42.451	13.769	36.421	11.732	31
age	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
0	4293.359	327.41	2194.914	805.348	572.379	1312.223	751.66	
1	25340.722	29273.973	26750.713	18598.014	24409.981	20325.592	20875.532	
2	5445.78	6537.868	7056.839	4918.003	5968.307	4965.912	6138.194	
3	320.141	464.79	305.165	339.996	330.443	310.925	367.777	
4	31.809	17.807	7.834	36.256	23.68	10.684	42.011	

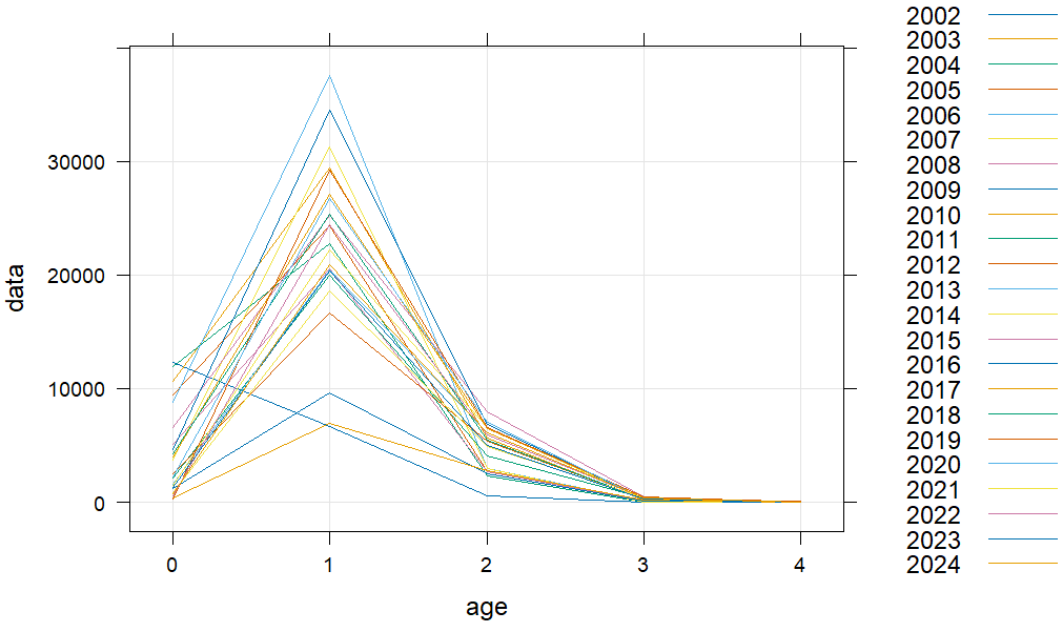

Figure 9: Catch at age structure

Internal consistency of the catch

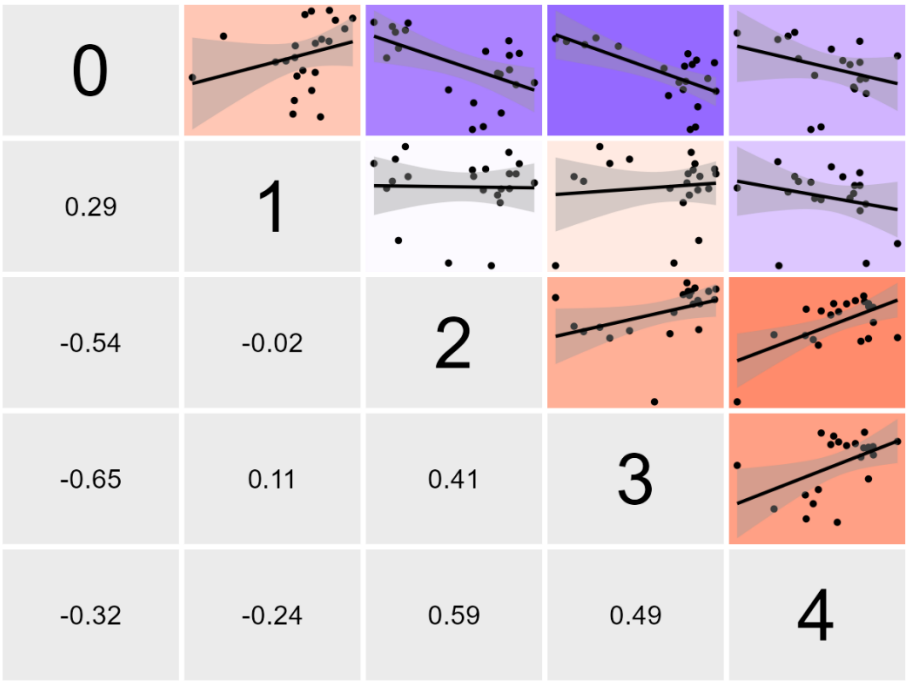

Figure 10: Internal consistency of the catch

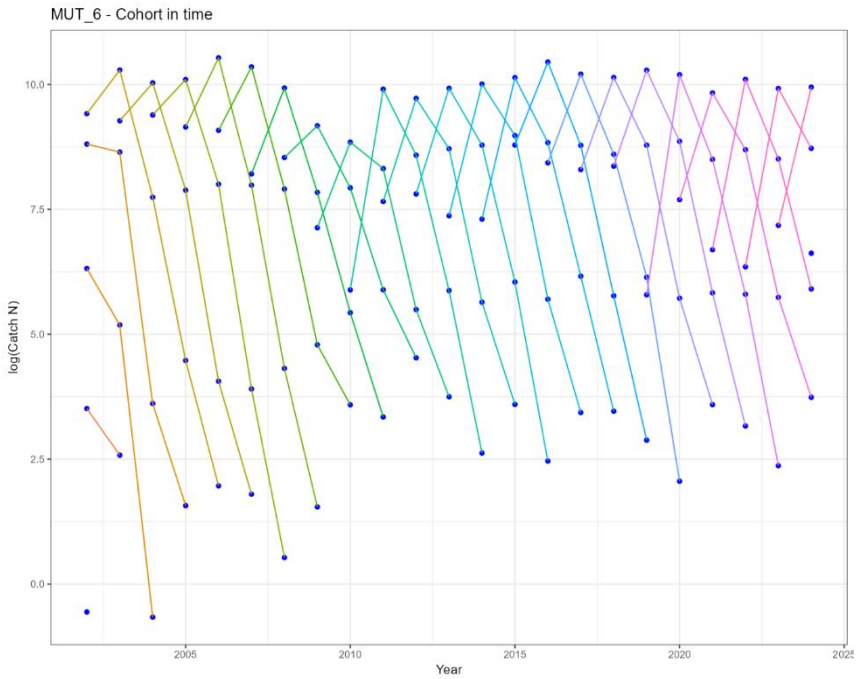

Figure 11: Cohorts internal consistency in the catch.

As recommended in previous EWGs, it has been tested the **internal consistency by sex (Figure 12** and **Figure 13)**

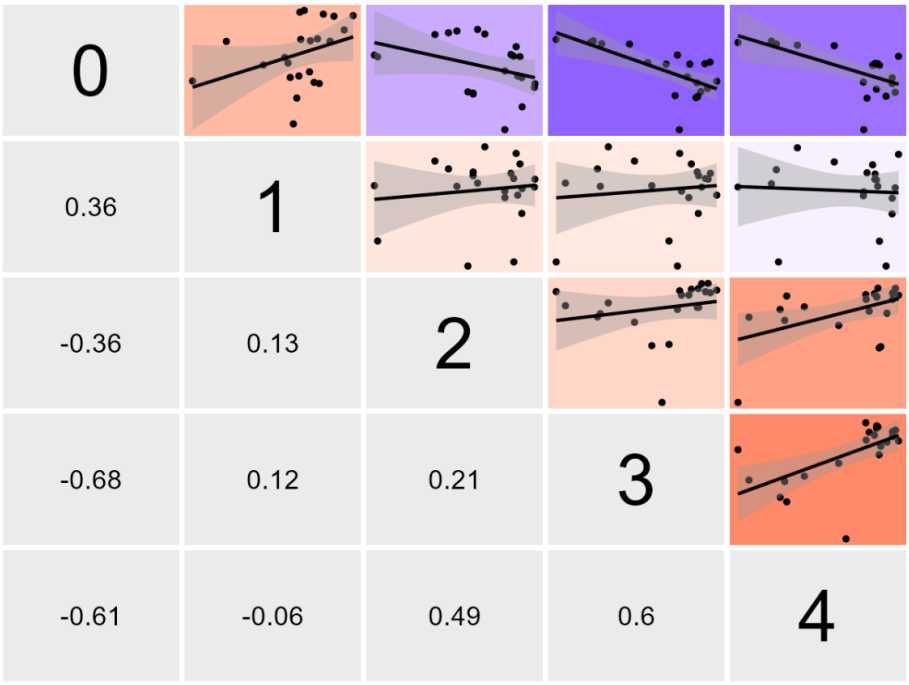

Figure 12: Internal consistency by sex of the catch

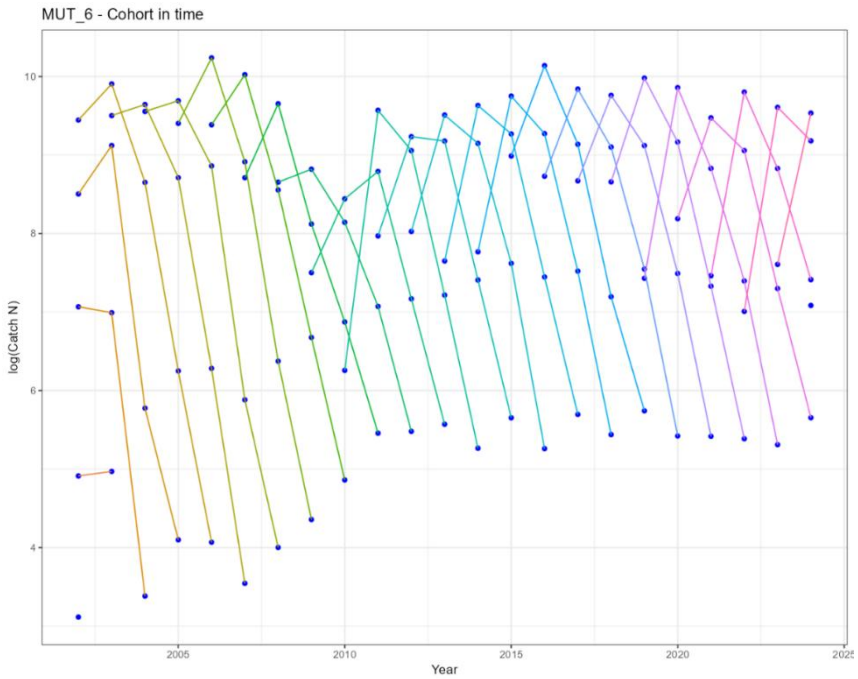

Figure 13: Cohorts internal consistency by sex in the catch

6. 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 1994-2024 (**Figure 14** and **Figure 15**). In 2024 the survey coverage was similar as that previous to 2020, when because of covid-19 half of the usual survey area was covered.

Figure 14: MEDITS survey period in GSA 6.

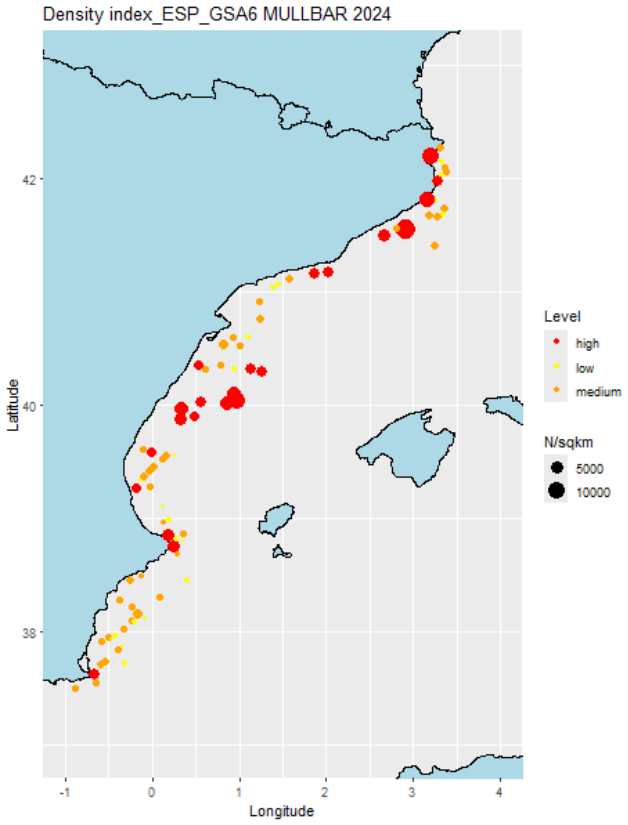

Figure 15: MEDITS survey in GSA 6 in 2024, hauls position.

Index number at age

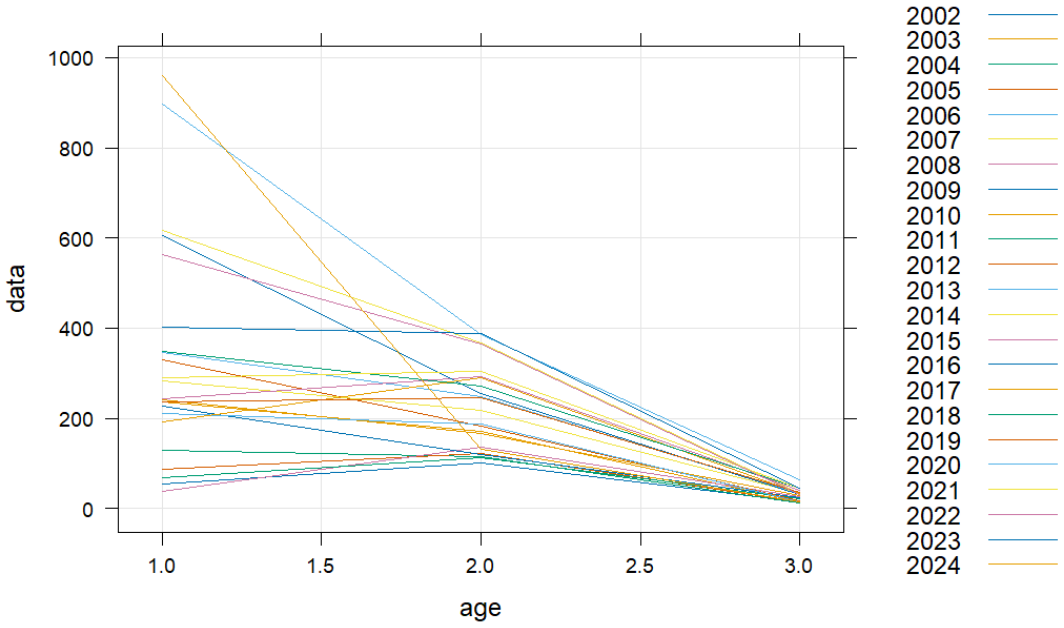

Figure 16: MEDITS catches at age structure in GSA 6.

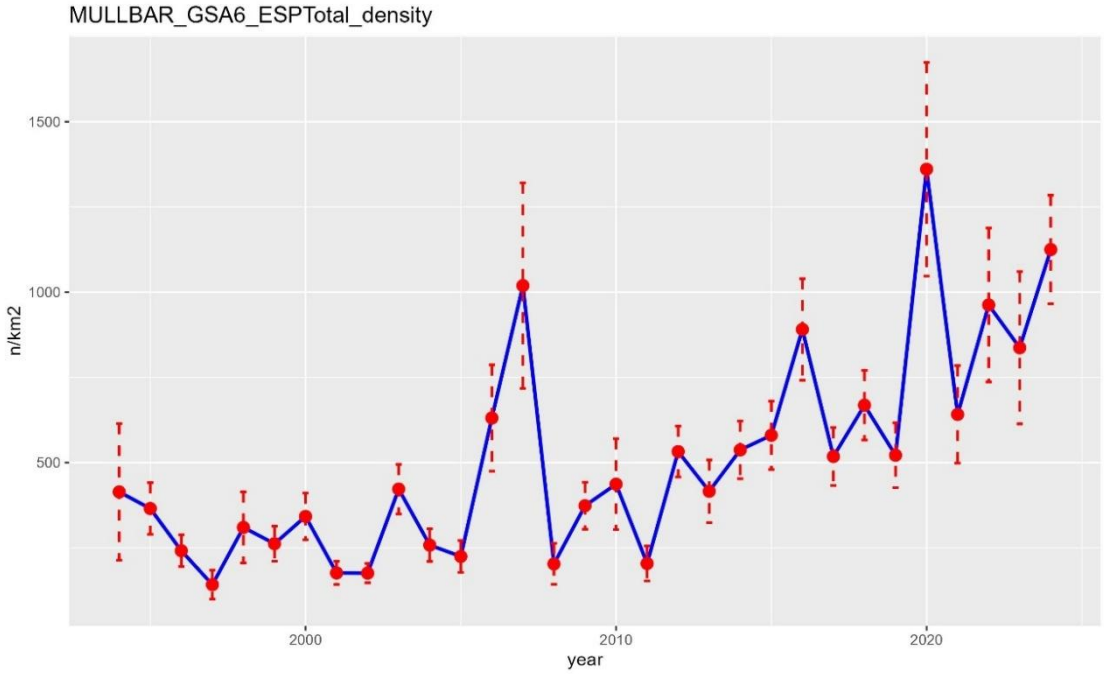

Figure 17: MEDITS abundance (n/km^2) over 1994-2024.

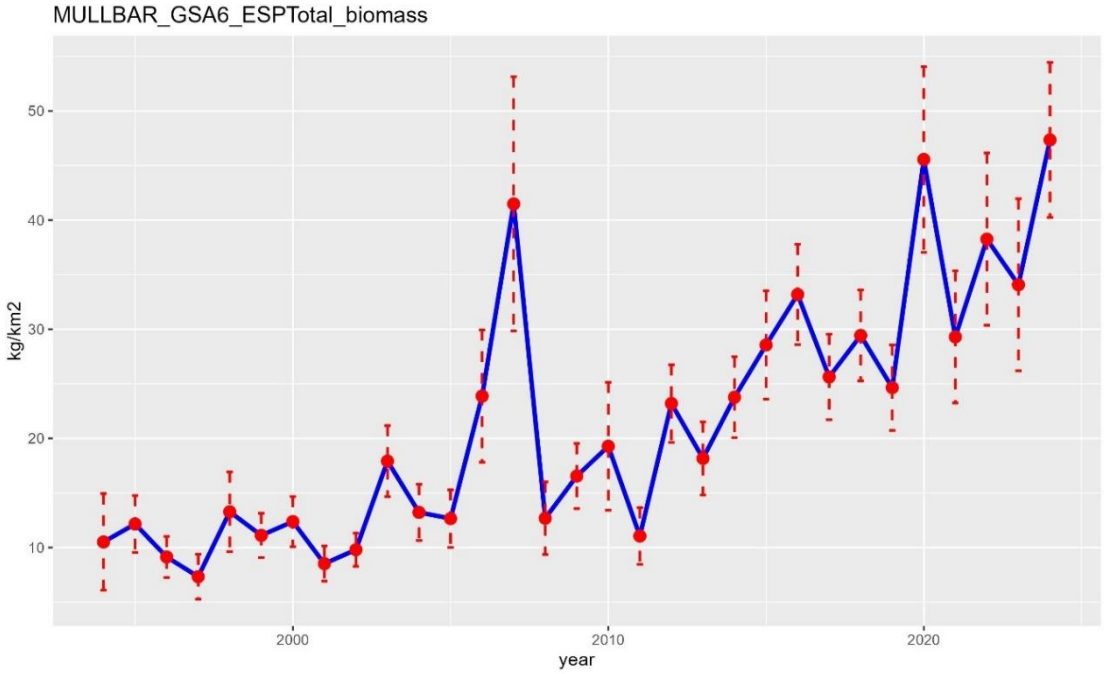

Figure 18: MEDITS biomass (kg/km^2) over 1994-2024.

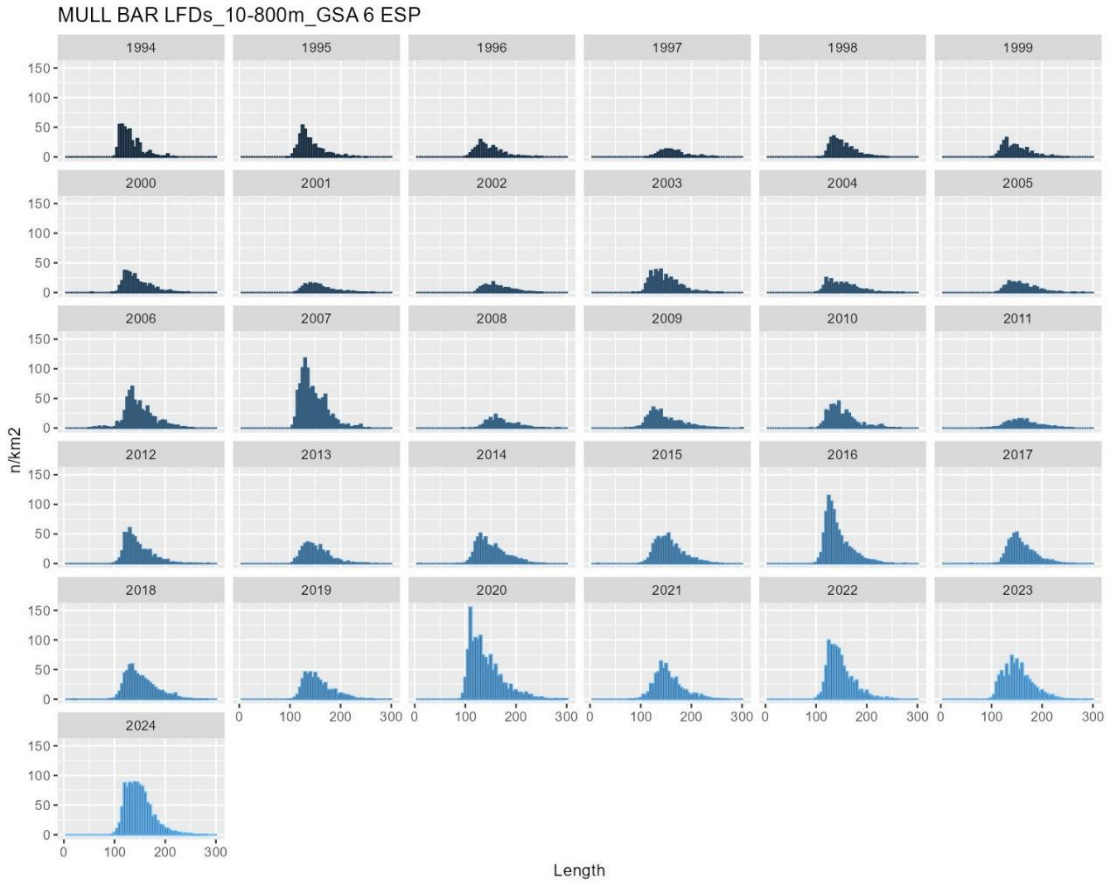

Figure 19: MEDITS total length frequency distribution n/km^2)

Table 8: MEDITS age structure

Age	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1	53.5	237.5	128.5	86.7	345.8	615.8	38.6	227.5
2	101.4	170.6	115.4	122.1	247.4	367.9	135.7	118.9
3	13.8	13.9	12.5	15.2	33.1	34.4	26.1	23.2
Age	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1	241.3	67.8	330.7	210.6	283.6	243.7	604.8	191.8
2	166.6	113.5	183.2	186.7	219	293.6	254.2	290.1
3	28.2	22.6	17.3	15.9	33	40.1	30.2	34.1
Age	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
1	349.5	236.8	896.8	289.8	562.3	401.7	960	
2	271.2	246.5	386.9	304.1	364.6	388.9	131.7	
3	44.6	35.8	64.9	44.7	32.2	44.8	15.2	

Internal consistency of the survey

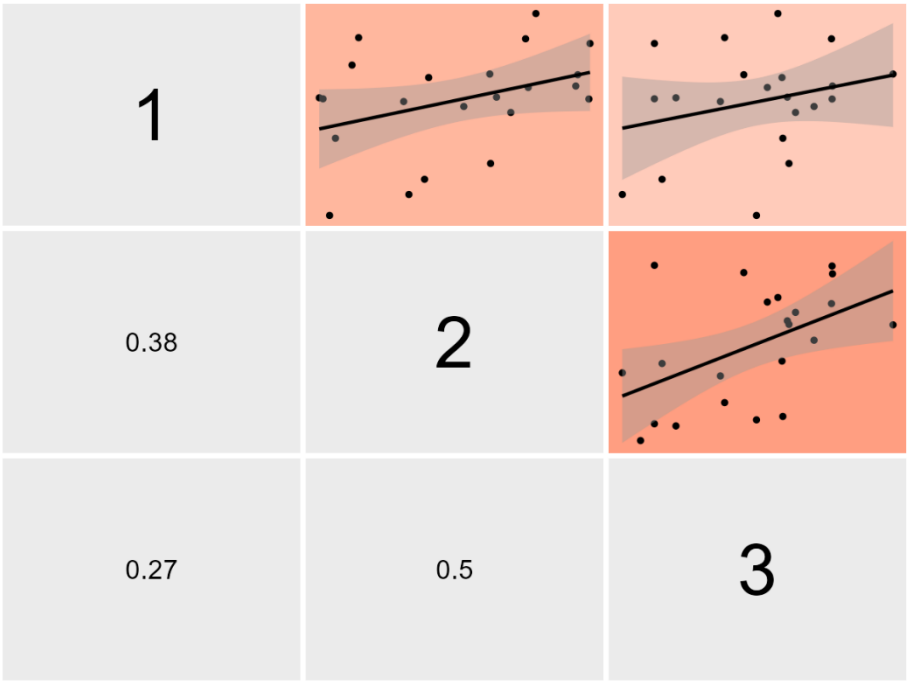

Figure 20: Cohorts internal consistency in MEDITS survey.

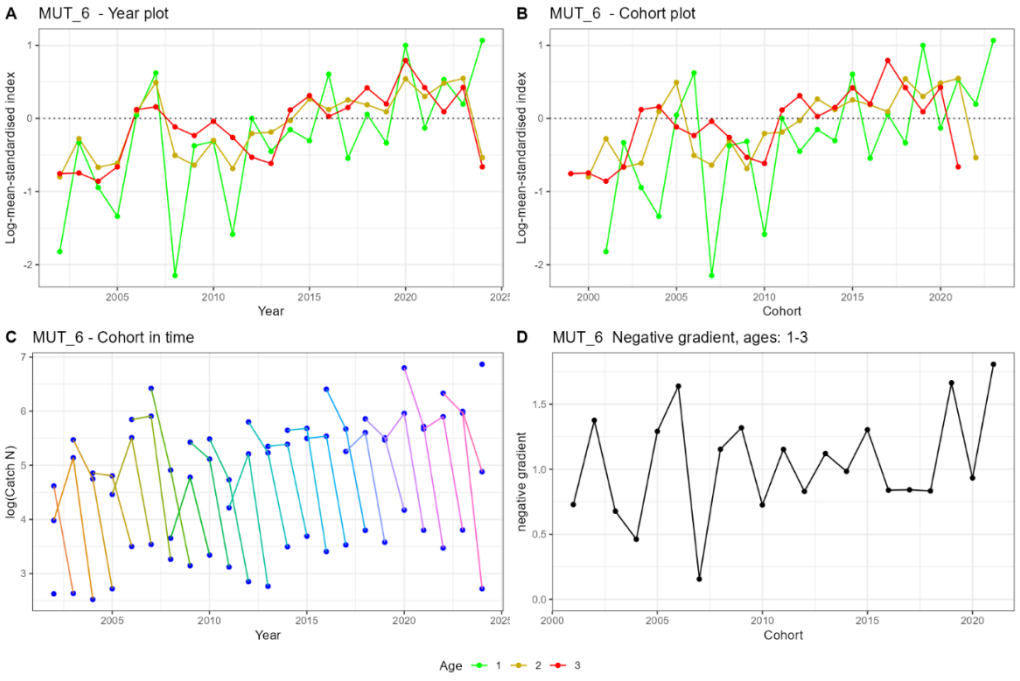

Figure 21: Summary of internal consistency in MEDITS survey.

Internal consistency of the survey by sex:

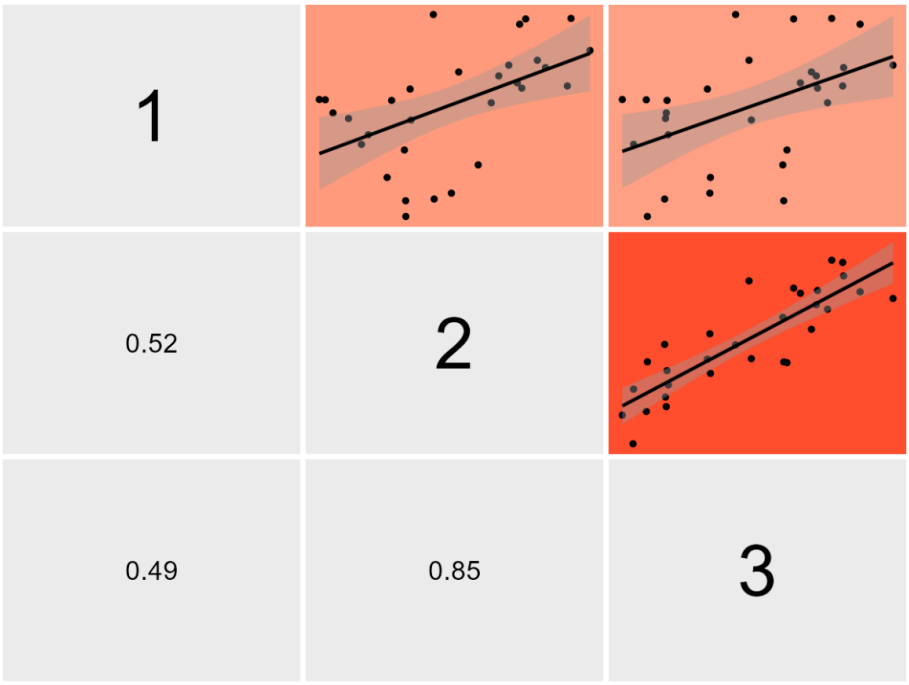

Figure 22 Cohorts internal consistency by sex in MEDITS survey.

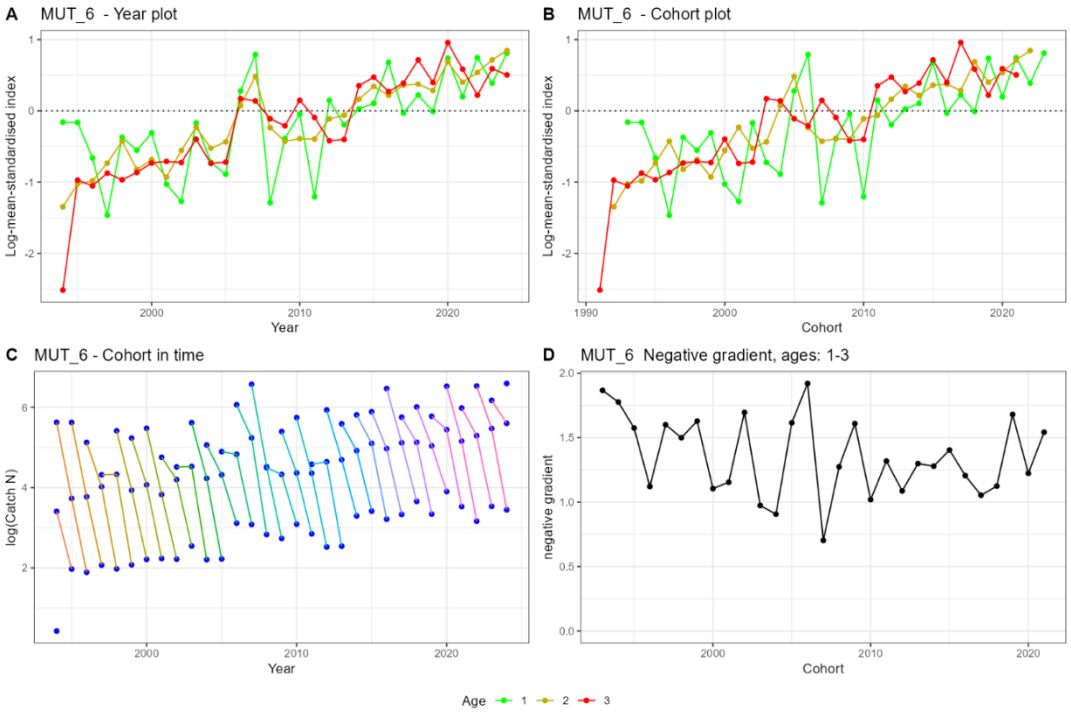

Figure 23: Cohorts internal consistency by sex in MEDITS survey.

7. Issues

During the process of data exploration, some issues were found in survey data. Some years (2008, 2019, 2023) seems to have unrealistic values of sex ratio, lengths (to small) or maturity stages. This issue could be the result of a typing error of measurement units (typed in mm instead of cm) (**Figure 24** and **Figure 25**).

id	country	area	vessel	year	haul_num	codend_c	partit	genus	species	codlon	pfrac	pechan	sex	nbsex	length_cl	maturity	nblon	matsub	tf	month	day	catfau
50354323	ESP	6	MOL	2018	73	S	S	MULL	BAR	0	1406	1406	F	5	20	3	1	ND	TC	5	17	Ao
51316992	ESP	6	COR	2009	73	S	S	MULL	BAR	0	1732	1732	F	21	70	2	1	ND	TC	4	26	Ao
51370818	ESP	6	MOL	2014	117	S	S	MULL	BAR	0	770	770	M	15	10	3	1	ND	TC	5	23	Ao
51385790	ESP	6	MOL	2015	143	S	S	MULL	BAR	0	546	546	N	1	15	ND	1	ND	TC	5	29	Ao
51418947	ESP	6	MOL	2017	171	S	S	MULL	BAR	0	5073	5073	M	1	60	3	1	ND	TC	6	4	Ao

Another issue related to sex ratio assignation of age 0 which should be 0 instead of 1.

id	country	area	start_year	end_year	species	ageclass	sexratio	comment
232182	ESP	GSA 6	2024	2024	MUT	0	1	Macroscopically. Only reproductive months were taken into account.
232183	ESP	GSA 6	2024	2024	MUT	1	0.317	Macroscopically. Only reproductive months were taken into account.
232184	ESP	GSA 6	2024	2024	MUT	2	0.873	Macroscopically. Only reproductive months were taken into account.
232185	ESP	GSA 6	2024	2024	MUT	3	1	Macroscopically. Only reproductive months were taken into account.
232186	ESP	GSA 6	2024	2024	MUT	4	1	Macroscopically. Only reproductive months were taken into account.
232187	ESP	GSA 6	2024	2024	MUT	5	1	Macroscopically. Only reproductive months were taken into account.

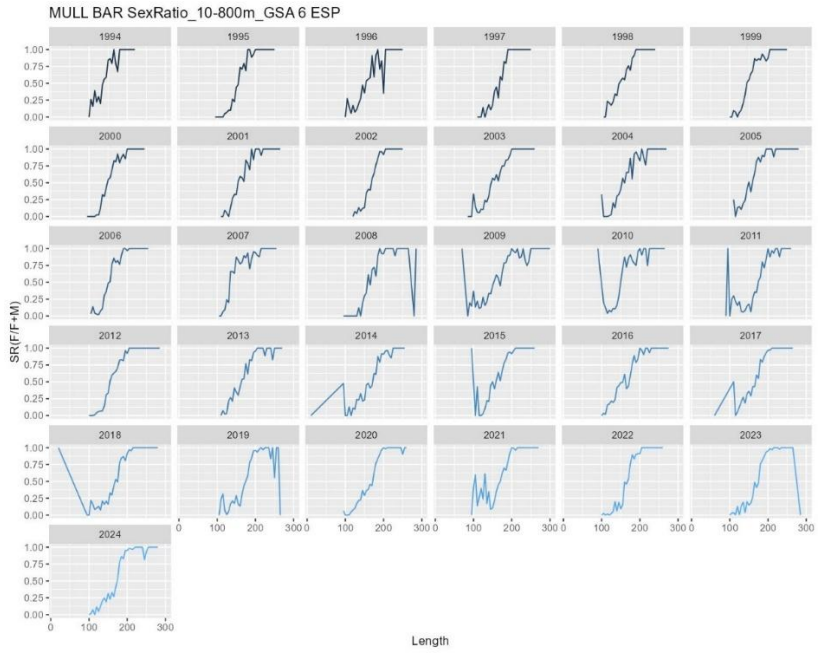

Figure 24: Original sex ratio from MEDITS survey

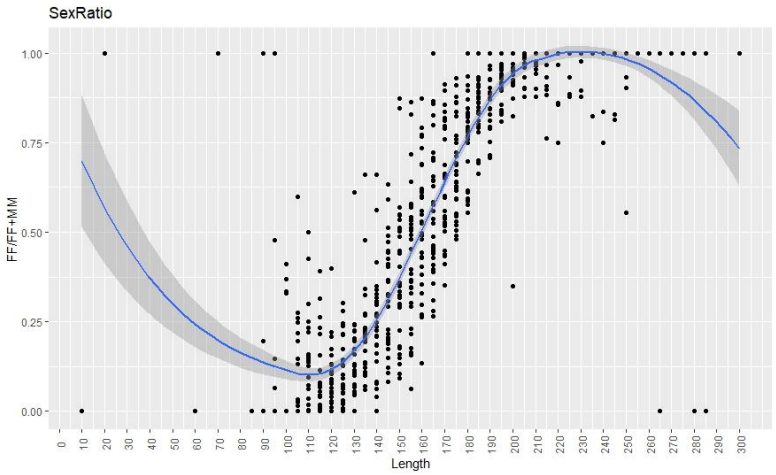

Figure 25: Original sex ratio modelled

The correction of the issue commented above is illustrated in **Figure 26** and **Figure 27**

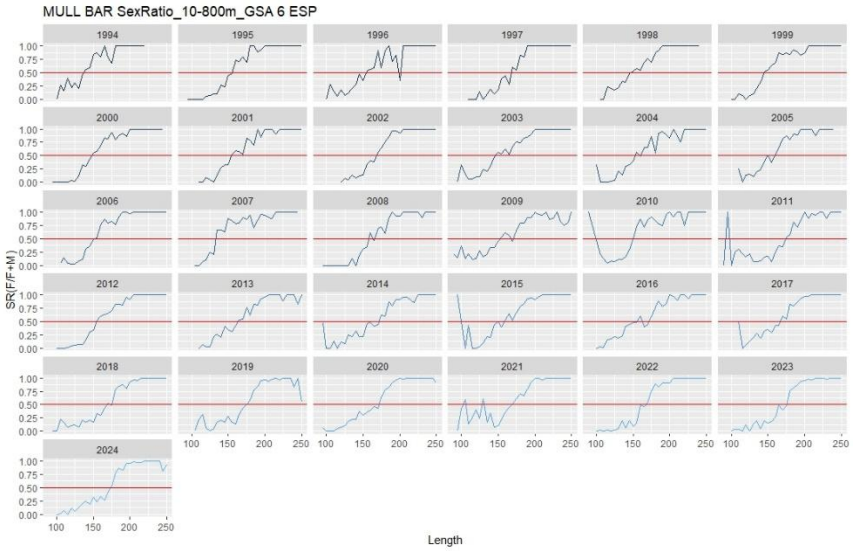

Figure 26: Corrected sex ratio

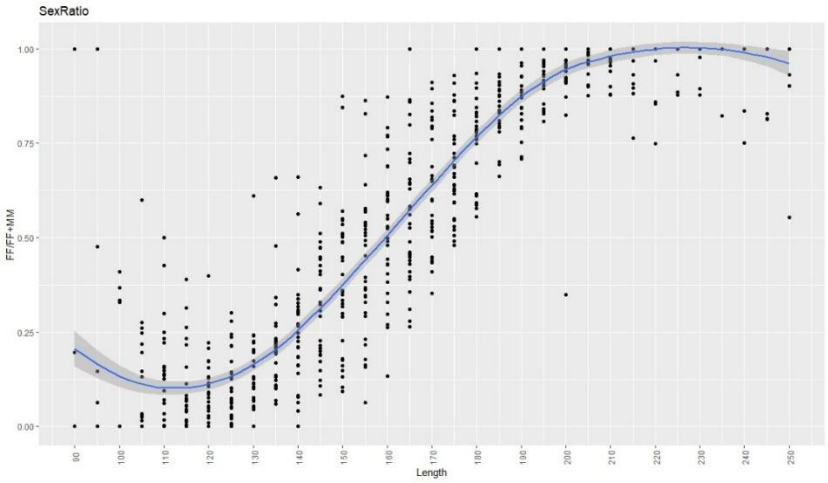

Figure 27: Corrected sex ratio modelled

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