Data preparation before STECF EWG 25-09

Norway lobster: *Nephrops norvegicus* (NEP GSA06)

Summary

Amina Tifoura

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TERMS OF 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 NEP 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.

1.1 Stock identification and boundaries

spatial extent of the stock is assumed to coincide with the boundaries of GSA 6 (***Figure 1***) due to the lack of information on the stock structure for the Norway lobster *Nephrops norvegicus* in the Mediterranean Sea. Norway lobster is a benthic species of fossorial habits, with higher abundance in areas with muddy sediments. The species shows a wide bathymetric distribution in GSA 06, being present from 150 to 800 m depth with greatest abundance between 550 and 700 m depth over muddy bottoms. The highest abundances have been found in the GSA 06 North (Canyons of Palamos and Blanes) (Esteban & *al*., 2020, Tifoura & *al*., 2023).

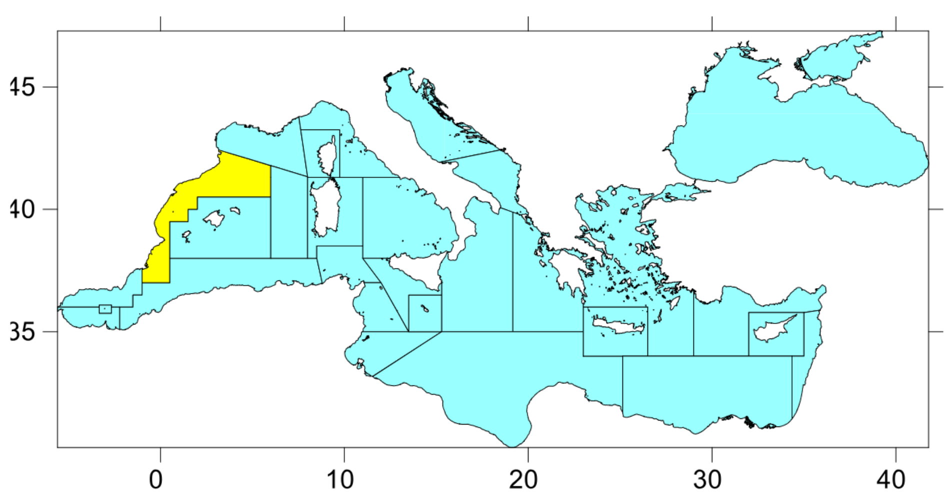


Figure 1: *Geographical location of GSA 6.*

1.2 Length, Age and growth

The Norway lobster is considered a long-lived species (Hillis 1979, Sardà 1985, Castro 1992), with slow growth rates ranging from 4 to 5 mm per year (Bianchini et *al.,* 1998, Vigo, et *al.,* 2024). The species 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 corresponds to both sexes combined (**Table 1**) as well as the parameters of the weight-at-length equation. It is also to highlight that the data in the DCF are not separated by sex.

Table 1: *Norway lobster in GSA 6: Parameters used for growth and weight at length.*

Growth model	$\mathbf{L_\infty}$	**k**	$\mathbf{t_0}$
Von Bertalanffy	86.1 mm CL	0.126 yr^{-1}	0
Weight at length	**a**	**b**	
$W = a\ Lb$	0.000481 g mm^{-1}	3.075	

1.3 Maturity and Spawning

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 (***Table 2***) (Orsi Relini et *al*., 1998; Aguzzi et *al*., 2004). Recent studies have observed a decline in the length at 50% maturity (***Table 3***). The (L50) which was previously about 30 mm has now decreased to approximately **25.3 mm** cephalothorax length as reported by Vigo, et *al.,* (2024). The same author report that the observed spawning period occurred in late summer (end of August or early September), while hatching was from December to February, as reported also by (Rotllant et al. 2005, Powell and Eriksson 2013).

Table 2: *Schematic reproductive cycle of female Norway lobster in GSA 6.*

Year t												Year t+1			
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	….
				Gonad maturity											
								Brooding							
												Hatching			

**Hatching corresponds to the release of eggs to the sea and it equivalent to spawning in fishes.*

Table 3: *Comparative of length at 50% maturity of Norway lobster in GSA 6.*

Year	**L50 (mm)**	**Reference**
1974-1977-1978	30-31	Sardà (1991)
1995	30	Orsi Relini et al. (1998)
2019-2021	25.3	Vigo, et al., (2024)

In difference of the last years, a new maturity ogive for the assessment of the Norway lobster was implemented during the last year (STECF, EWG 2410). This was necessary due to unrealistic results obtained with the previously employed maturity vector (prior to EWG 2410). It was also 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 4***). 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 previous reports prior to EWG 2410.

Table 4: *Maturity vector used as input for the assessment of Norway lobster in GSA 6.*

Ages	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Maturity vector	0.05	0.25	0.8	1.0	1.0	1.0	1.0	1.0	1.0

1.4 Feeding and essential fish habitats

The essential habitat for this species is the soft, muddy substrate that serves as a critical refuge from predators especially during the vulnerable moulting periods and safe nursery for egg-bearing females (Aguzzi and Sardà, 2008). The species presents a scavenging behaviour with a diet largely influenced by the availability and abundance of preys in their environment (Chiarini, 2022).

1.5 Natural mortality

Natural mortality was obtained by application of the Chen-Watanabe model. The vector used for the assessment is reported in the following table.

Table 5: *Natural mortality vector used as input for the assessment of Norway lobster in GSA 6.*

Ages	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
M: Chen Watanabe	0.732	0.466	0.353	0.291	0.252	0.225	0.206	0.192	0.181

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.

2.1 COMMERCIAL

2.1.1 Check landings and discards

Data on catches are available from 2002 to 2024 for GSA 6 (***Table 6***). 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 (***Figure 2***).

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 2024. The landings for 2024, for an amount of 166.1 t. Discards, reported since 2009, are negligible, normally below 5% of the catches, but note anomalously high value in 2012 (***Figure 3***). This unrealistic value has been reported on the DTMT sheet during the previous assessments but unfortunately it remains unresolved.

Table 6: *Norway lobster in GSA 6: landings, discards, catches and calculated proportion of discards.*

Year	Landings (t)	Discards (t)	Catches (t)	% discards
2002	187.50		187.50	0.00%
2003	381.81		381.81	0.00%
2004	321.72		321.72	0.00%
2005	351.99		351.99	0.00%
2006	390.18		390.18	0.00%
2007	409.40		409.40	0.00%
2008	393.77		393.77	0.00%
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	490.70	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	148.66	0.78	149.43	0.52%
2022	162.89	0.95	163.84	0.58%
2023	142.27	0.64	142.91	0.45%
2024	166.10	10.15	176.26	5.76%

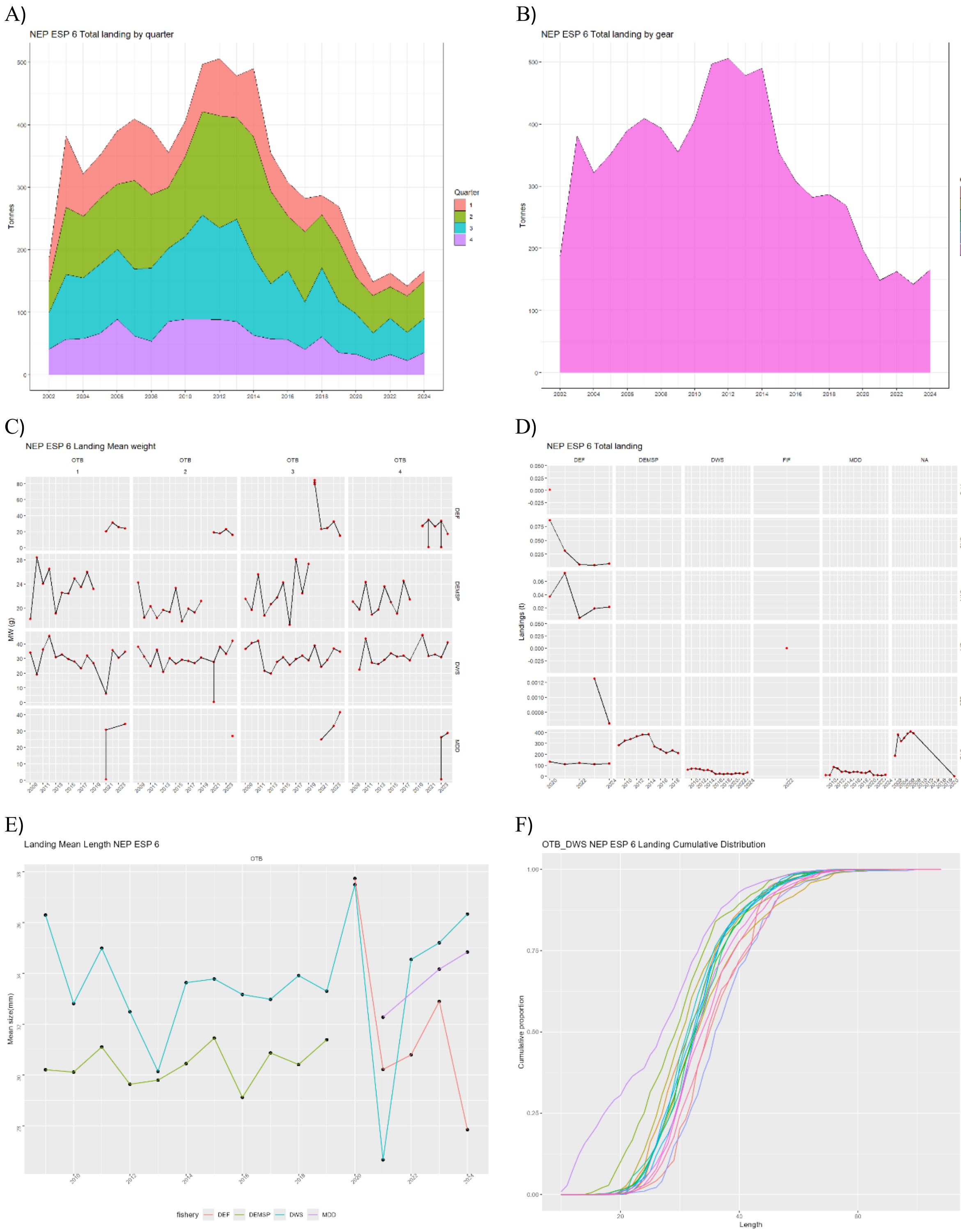


Figure 2: Total landings (t) per year, quarter, gear and mean weight and mean length.

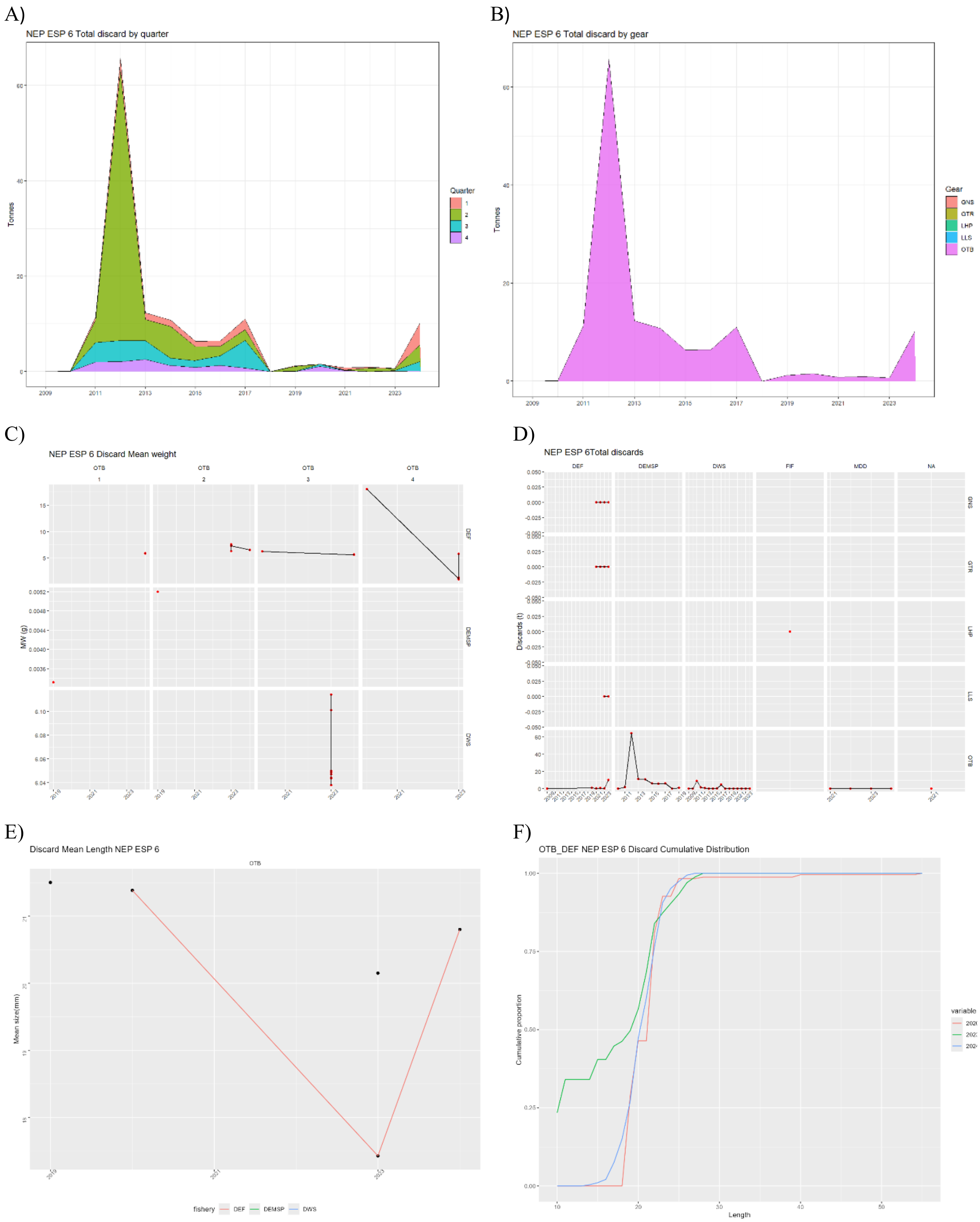


Figure 3: Discards (t) per year, quarter, gear and mean weight and mean length.

2.1.2 Quality checks

Comparison if the values reported in the catch at age file and landings/discards at length files are the same

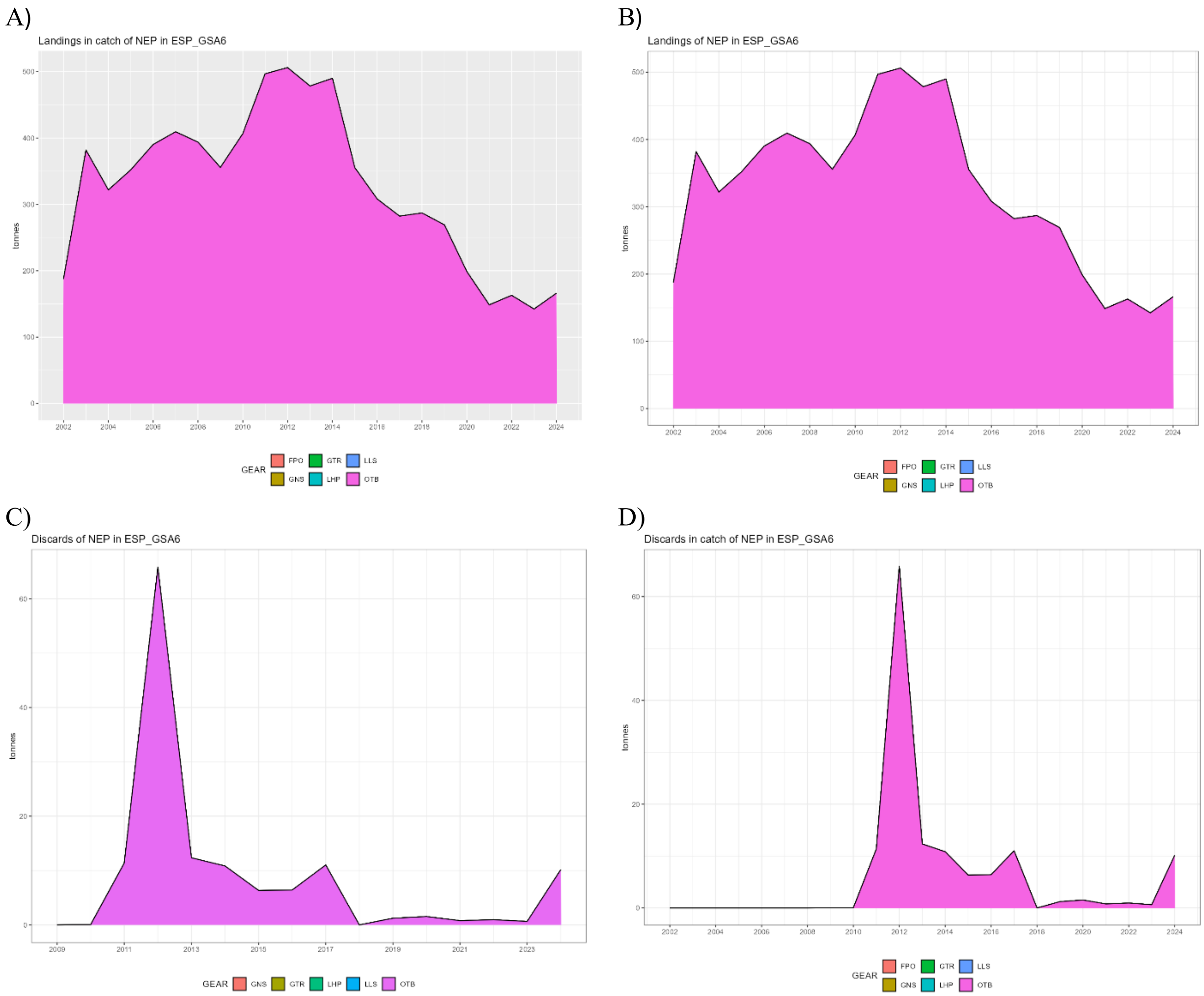


Figure 4: Landings and Discards (t) in weight by gear in catch at age and at length files.

2.1.1 Biological information reported in the DCF

Biological information reported by DCF was also checked as it is illustrated in ***Figure 5***, ***Figure 6***, ***Figure*** *7* and ***Figure 8***.

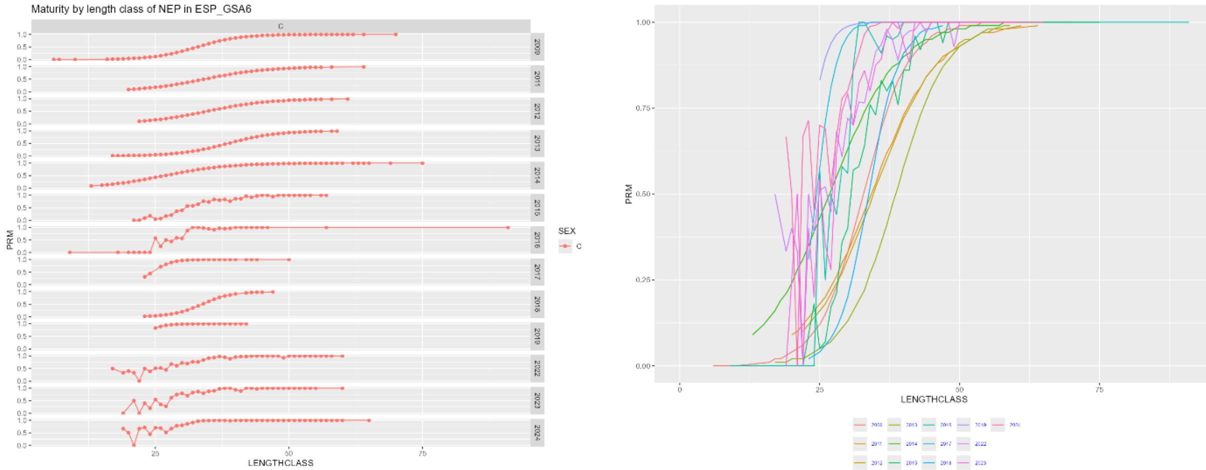


Figure 5: Maturity by length and year

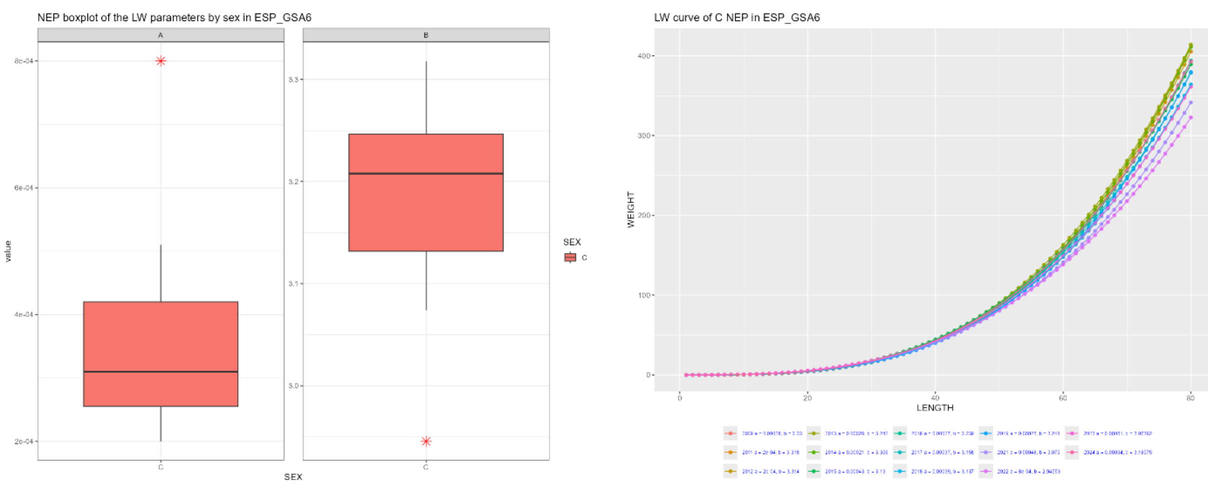


Figure 6: Length Weight relationships (LW)

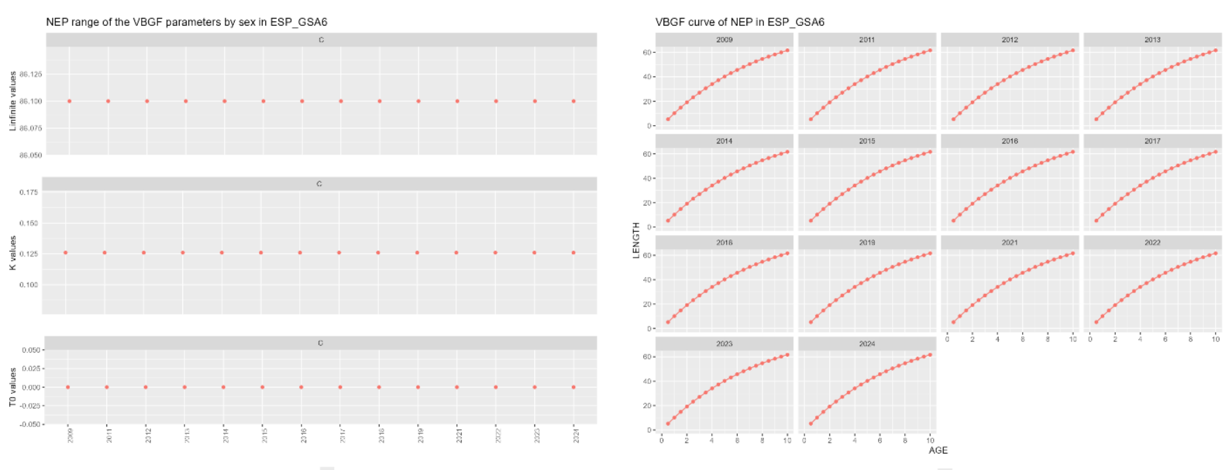


Figure 7: Von Bertalanffy Growth Functions (VBGF)

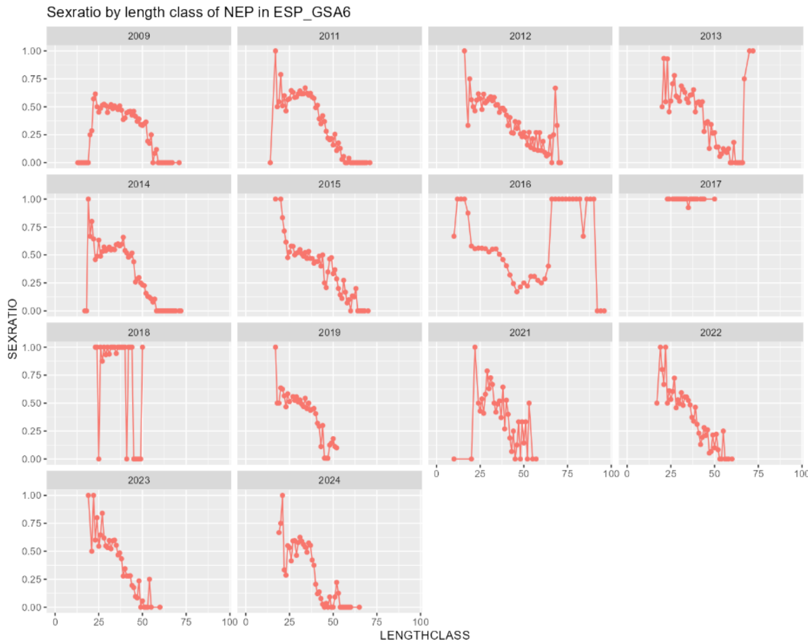


Figure 8: *Sex ratio by length*

2.1.2 Reconstructing Length Frequency Distributions

Information on the demographic structure of the exploited population is available as quarterly length frequencies from 2009 to 2024. Length frequency distribution for those years or métiers where no length frequencies were available in DCF MEDBS were filled-in (***Figure 9***). 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 until 2024 for the principal métier landing OTB_DEMSP, OTB_DEF (***Figure 10***).

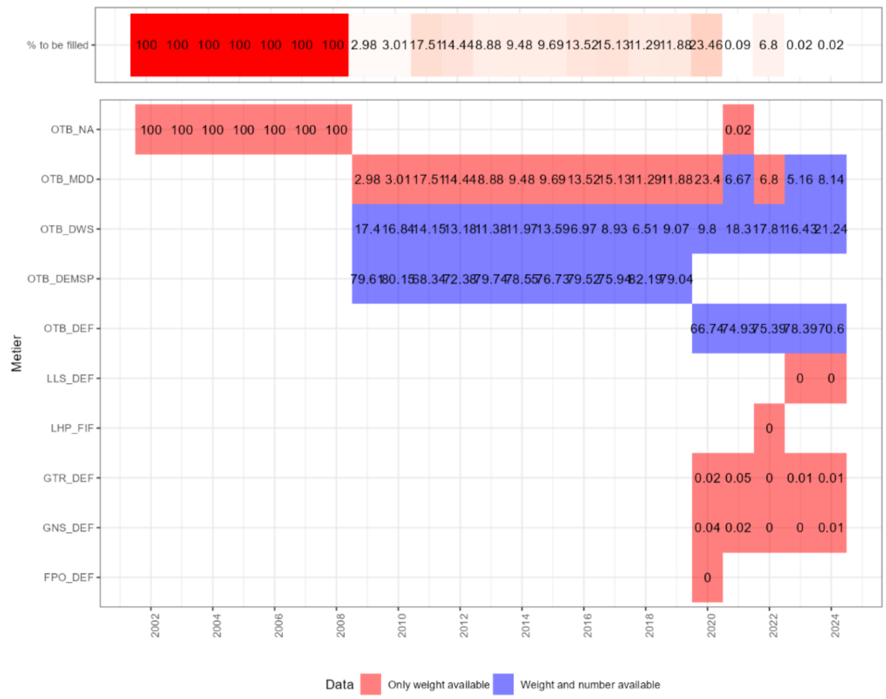


Figure 9: Available and reconstructed length frequencies for landings. Series of data with weight and length frequencies available in the DCF in blue; series with weight only for which length frequencies were reconstructed using median values in red.

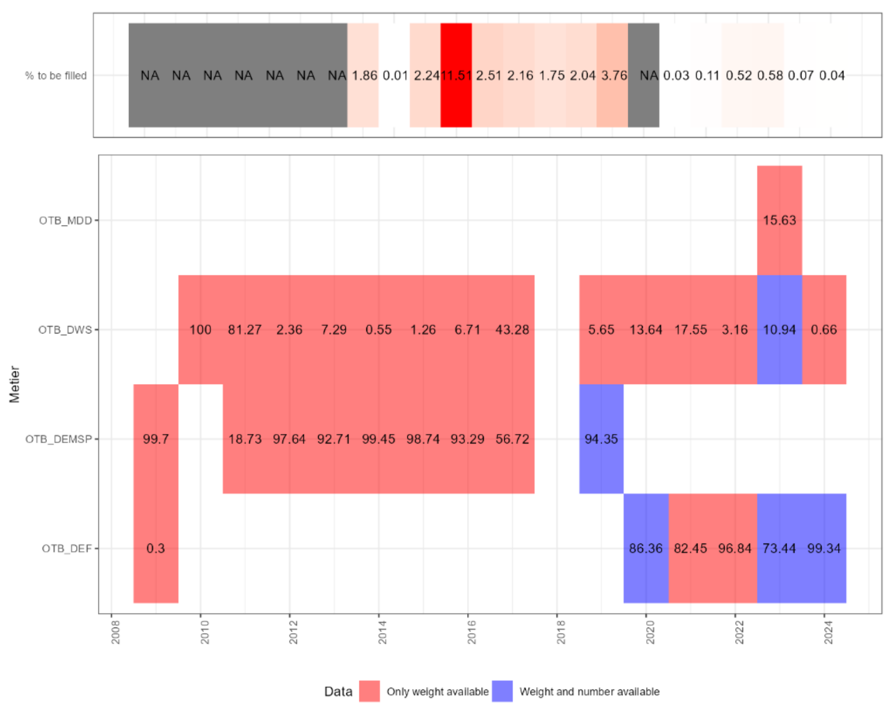


Figure 10: Available and reconstructed length frequencies for discards. Series of data with weight and length frequencies available in the DCF in blue; series with weight only for which length frequencies were reconstructed using median values in red.

The annual length frequencies by métier for the period 2002-2023 are shown in ***Figure 11*** and ***Figure 12***. Note the low number of individuals sampled in 2020 for métier DWS and the irregular size structure for métier DEF in 2020.

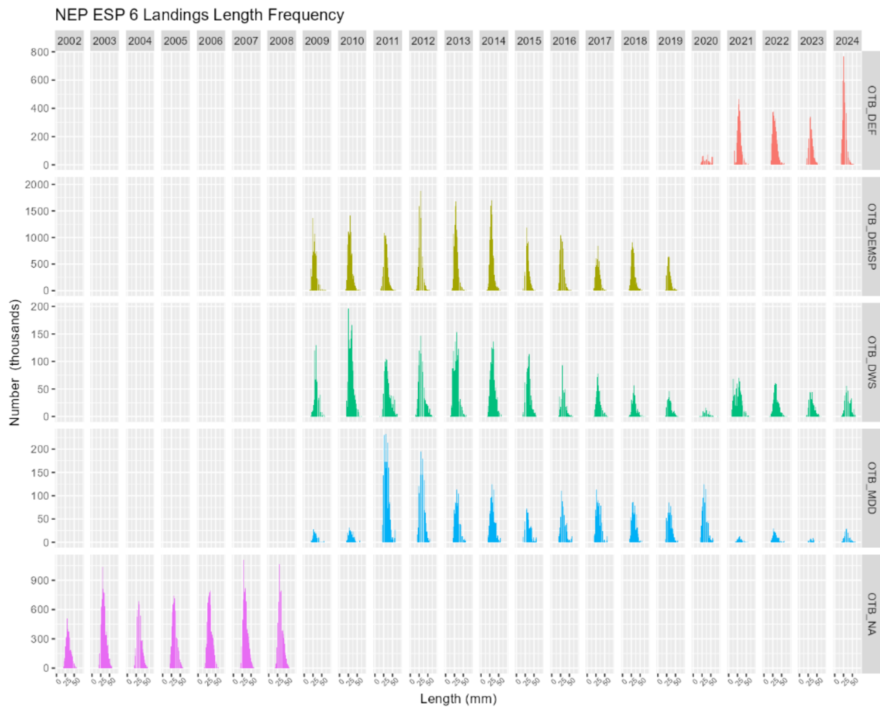


Figure 11: *Length frequency distribution of landings*

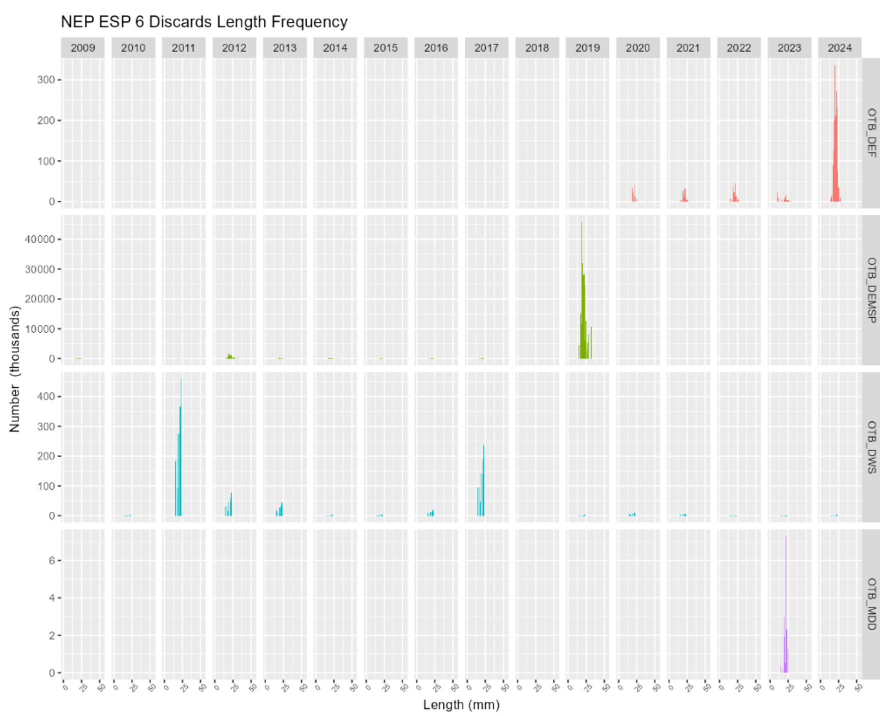


Figure 12: *Length frequency distribution of discards*

2.2 MEDITS Survey

The exploration of MEDITS data is performed using the script "*Script_MDTS_NEP6.R*". The results obtained are stored in the folder "*MEDITS_output*". The MEDITS trawl surveys carried out annually in GSA 6 in late spring since 1994 were used to derive a fisheries independent abundance index (***Figure 13***). Note that in 2020 only the northern half of GSA 6 could be covered by the survey (approximately northwards from 40 º latitude), but from the year 2021 experimental survey started to cover again the entire area.

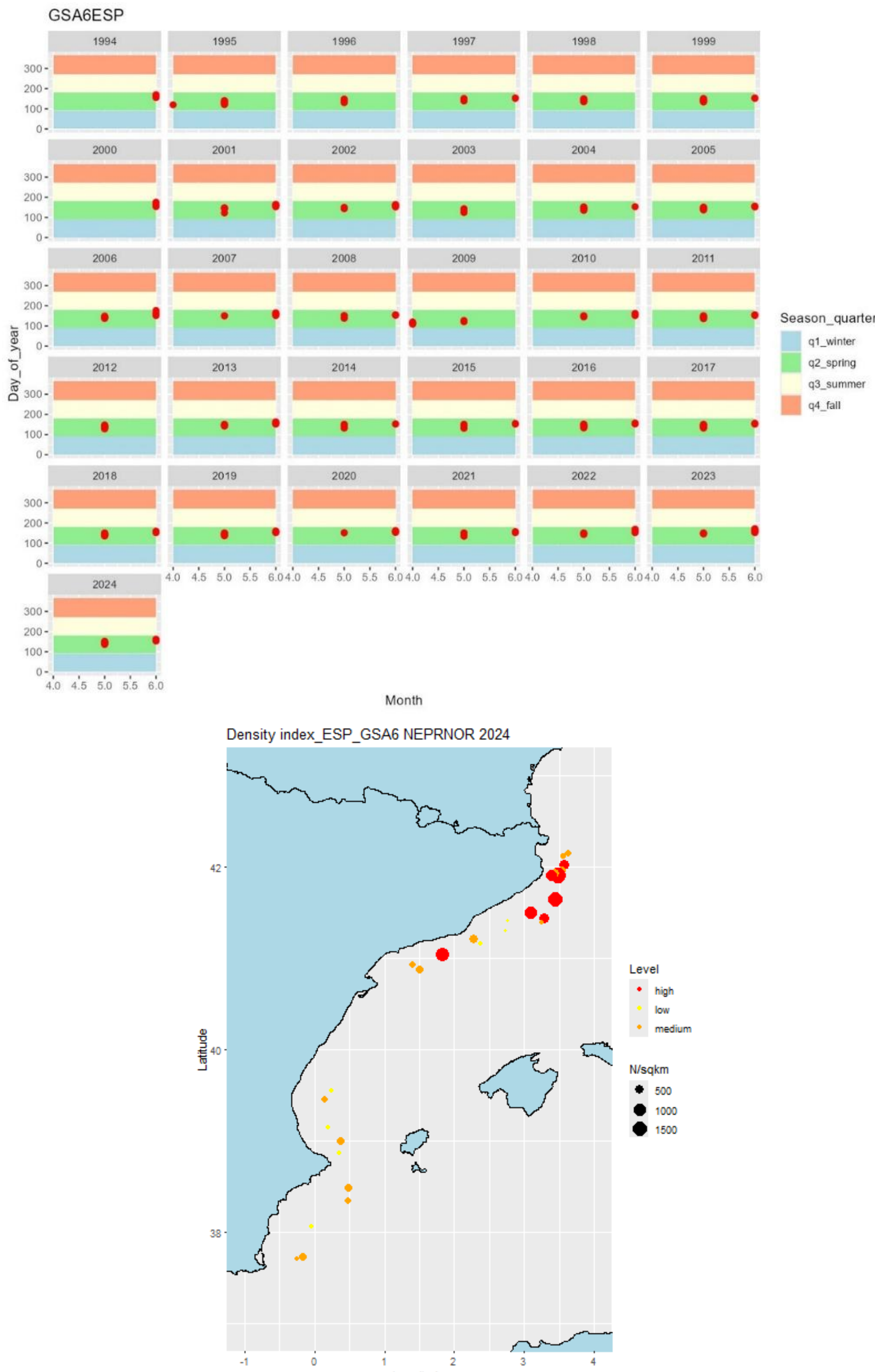


Figure 13: *Time of MEDITS surveys in GSA 6 and density index in 2024.*

The biomass and density index are estimated (**Figure 14** & **Figure 15**) and the length distribution LFDs, standardized by square kilometers for combined, immatures, males and females respectively (**Figure 16**, **Figure 17**, **Figure 18**, & **Figure 19**).

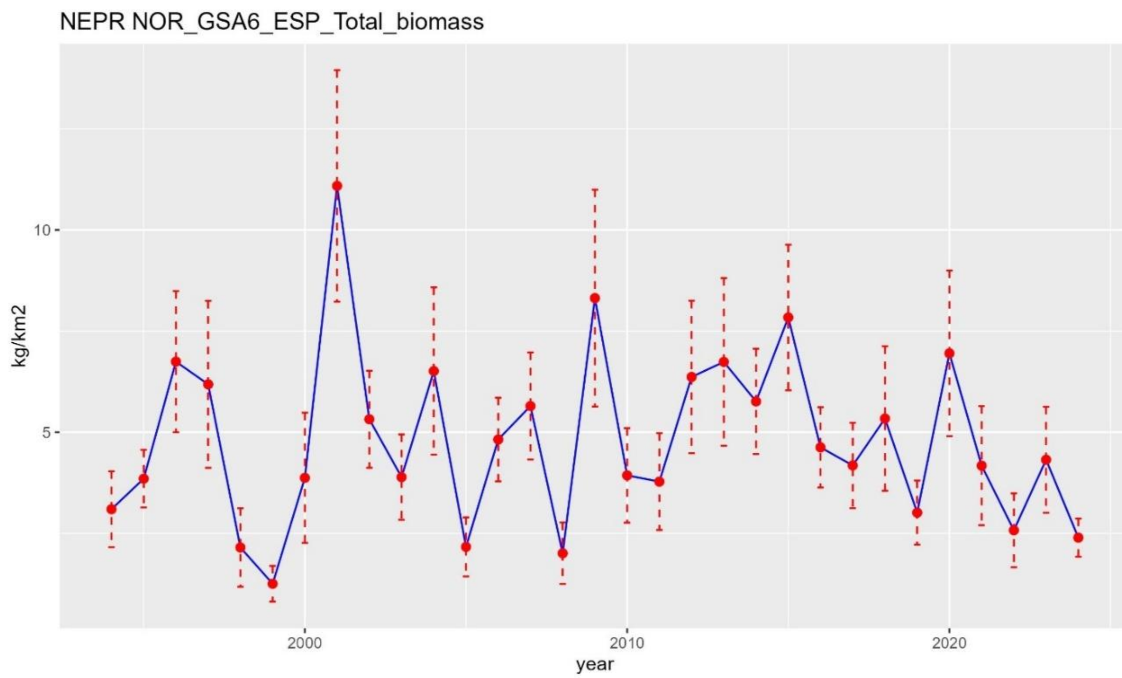


Figure 14: *Biomass index by square kilometer*

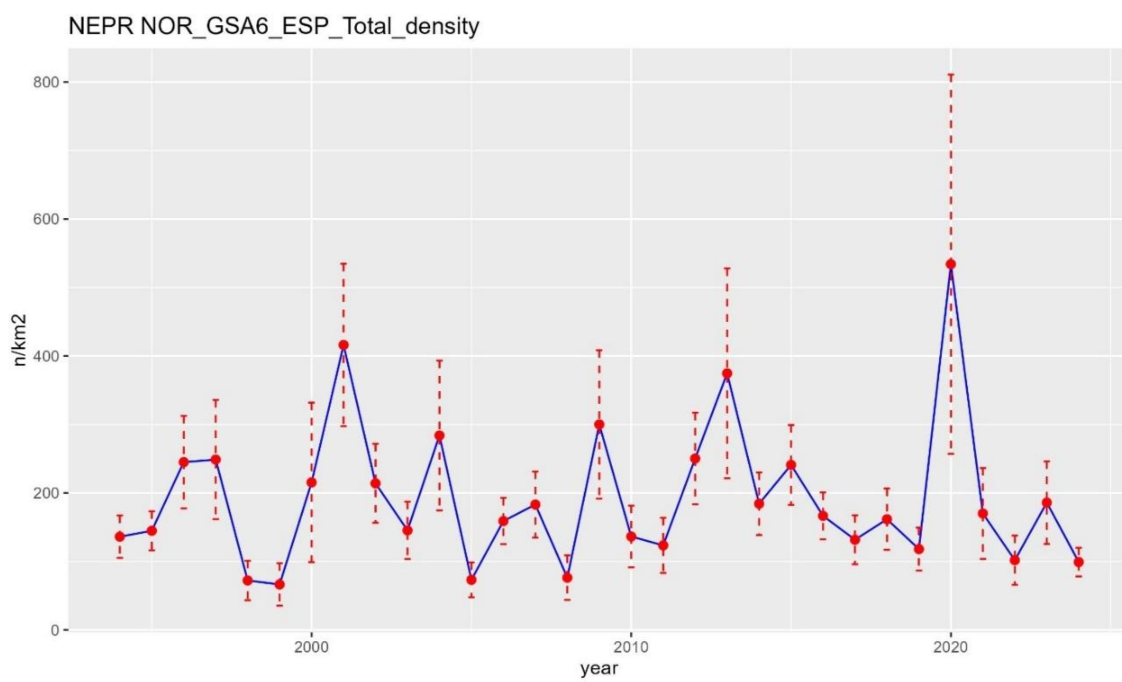


Figure 15: *Density index by square kilometer*

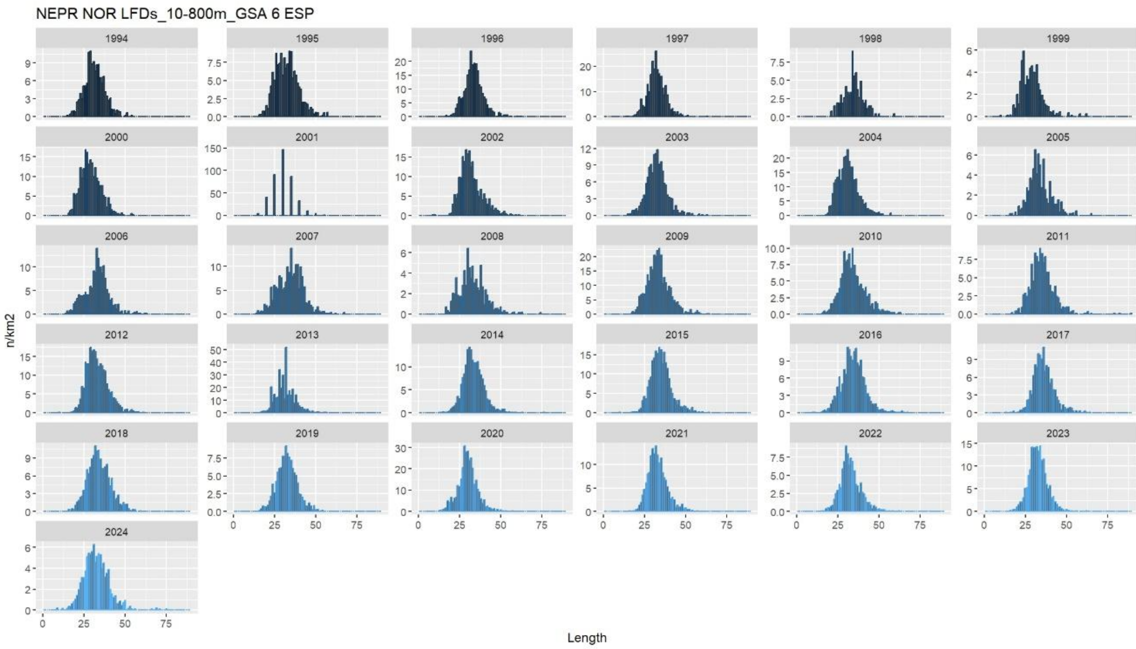


Figure 16: *Length frequency distributions standardized by square kilometer*

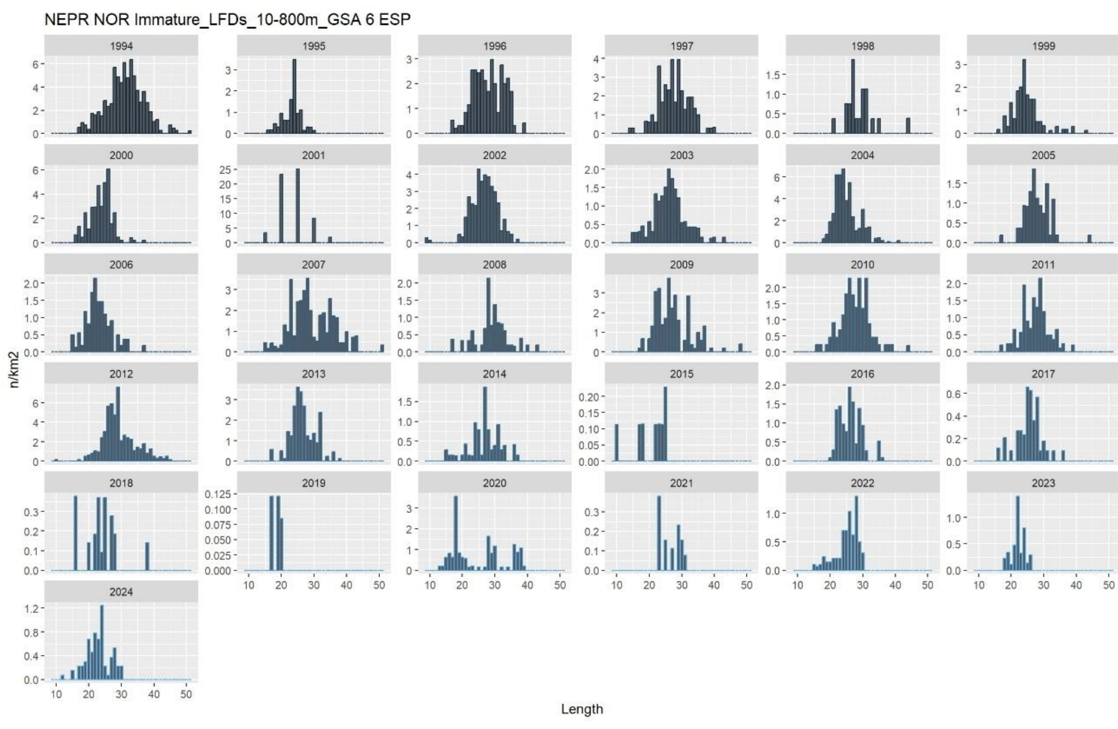


Figure 17: *Length frequency distributions standardized by square kilometer for immature*

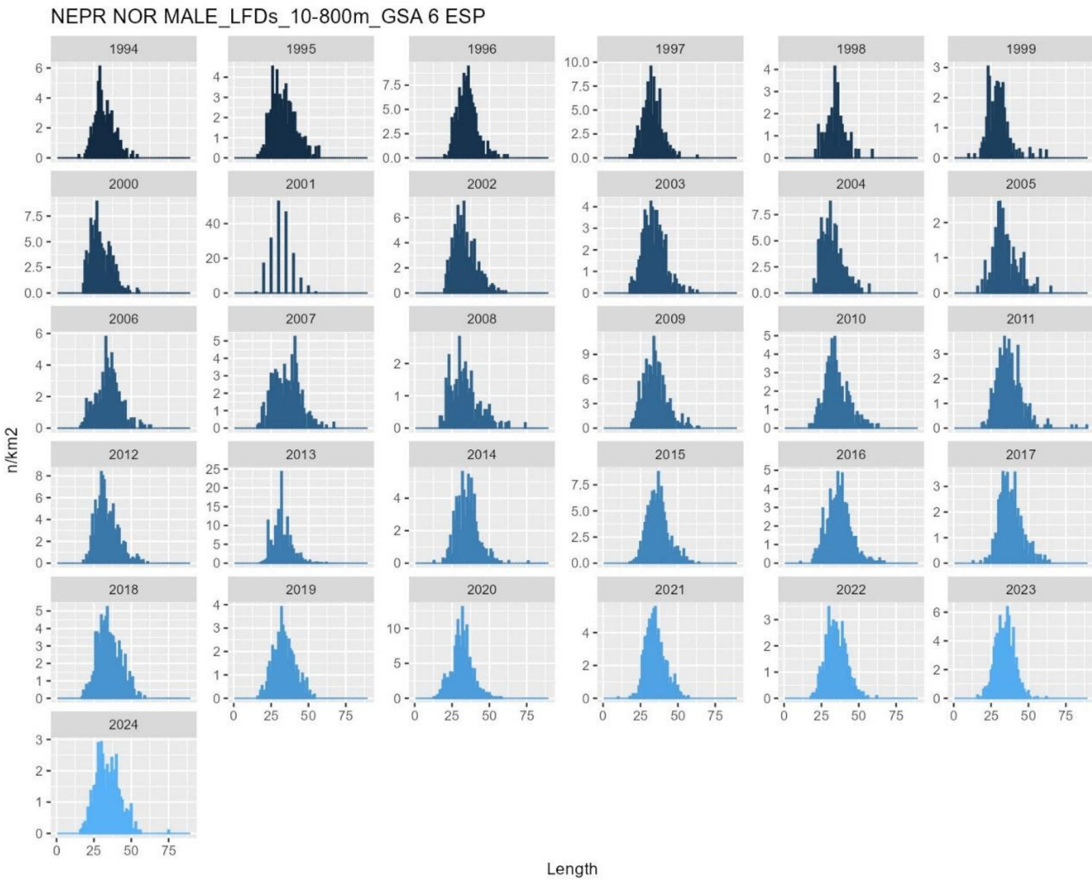


Figure 18: *Length frequency distributions standardized by square kilometer for males*

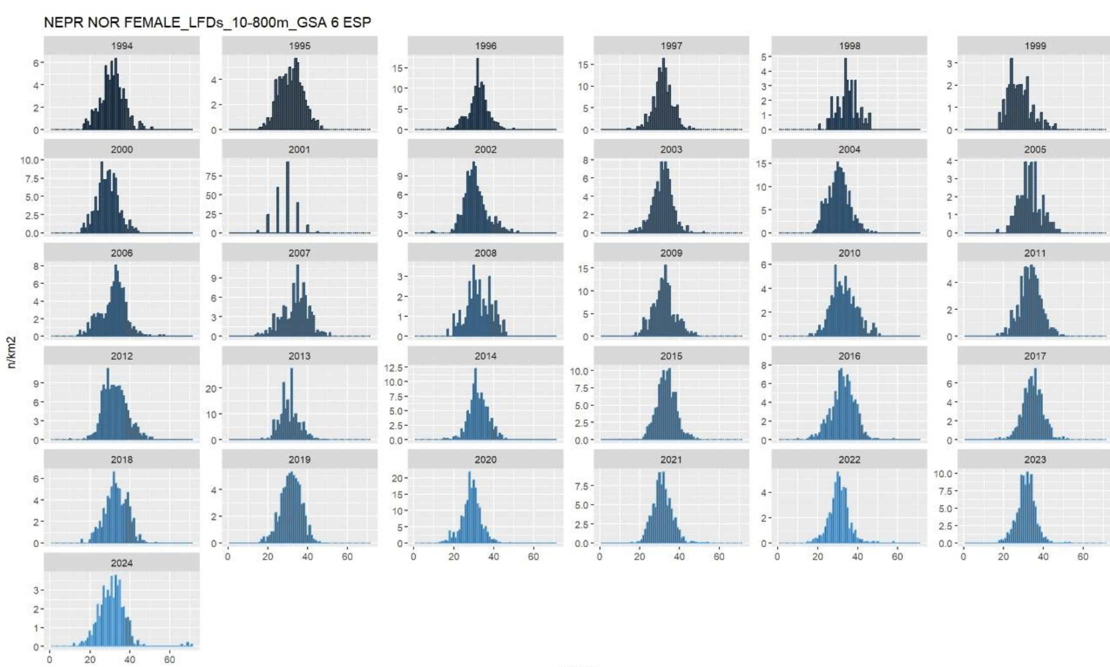
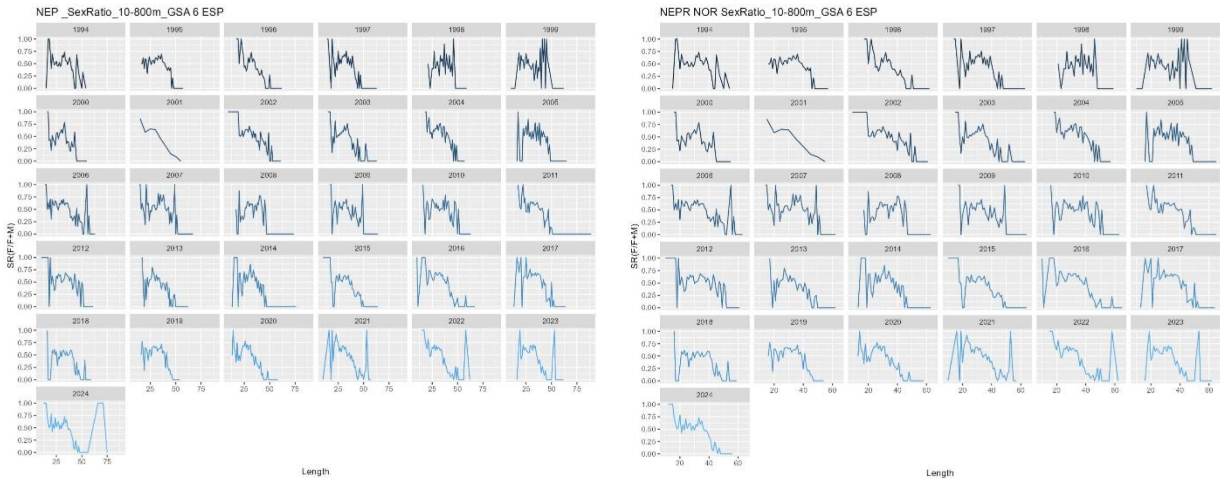


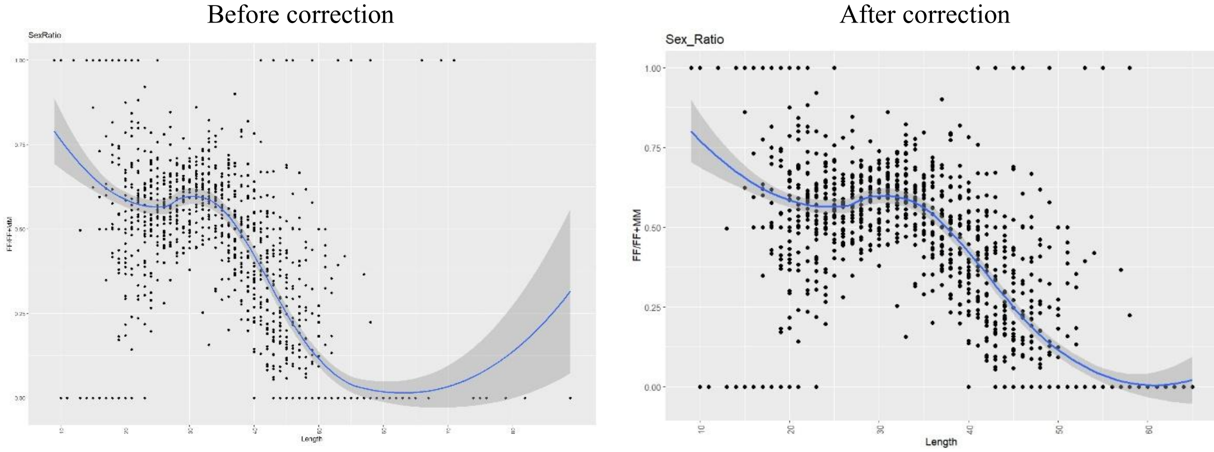
Figure 19: *Length frequency distributions standardized by square kilometer for females*

2.2.1 Sex ratio

The standardized length distribution by sex ratio vector is also computed as the ratio by each length classes between female and female plus male SR=FF/(FF+MM). The issues encountered are reported in the section "Issues" where some data were corrected to address the problem (***Figure 20***) .



Before correction After correction



Model before correction Model after correction

Figure 20: *sex ratio correction in the survey data.*

2.1.1 Updating objects

The objects related to the catch and the survey are created and updated by incorporating the information of the recent year (2024) are stored in the Workspace under the names NEP_6_STK.RDS and NEP_6_IDX.RDS. The catch number by age and index number by age are illustrated in ***Figure 21*** and ***Figure 22*** and respectively.

Table 7: *Catch in numbers by age and by year. Data for 2020 were excluded*

Age	2009	2010	2011	2012	2013	2014	2015	2016
2	4967.55	5491.56	6124.78	8972.26	8671.07	6201.28	3301.33	6946.82
3	6841.91	9549.44	10563.32	15750.93	13472.15	13665.67	8691.29	7950.8
4	3431.52	3497.85	4994.43	4033.73	3621.07	4339.97	3705.11	2509.08
5	1196.26	1150.18	1343.4	1284.76	1144.79	1155.32	1042.16	678.9
6	277.1	270.35	394.5	336.55	264.6	314.48	250.68	126.2
7	135.12	185.61	272.17	220.98	115.88	158.89	71.8	81.89
8	27.25	34.56	76.88	92.28	34.17	18.04	9.03	15.92
9	61.05	31.65	48.79	46.6	30.71	11.51	1.81	4.75

Age	2017	2018	2019	2020	2021	2022	2023	2024
2	5050.33	3361.38	2411.19	NA	1584.77	1827.2	679.72	5087.24
3	5749.7	7612.19	6558.71	NA	3559.15	3102.12	2629.7	3651.09
4	2870.75	2172.16	2609.26	NA	1332.53	1573.92	1572.97	1137.19
5	852.9	713.79	557.13	NA	440.26	567.07	524.91	451.12
6	147.15	221.82	250.56	NA	120.4	113.76	145.51	148.63
7	151.86	171.48	158.25	NA	57.31	103.99	71.27	82.06
8	19.46	24.52	9.91	NA	14.09	31.97	14.29	11.82
9	11.55	4.2	14.75	NA	4.71	4.87	5.14	2.99

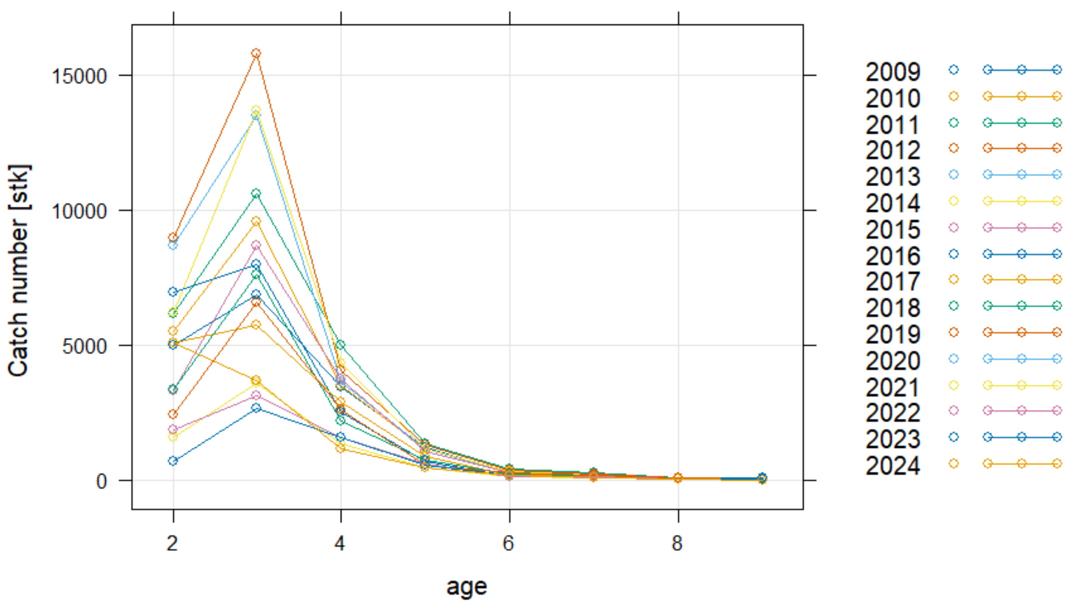


Figure 21: *Catch in numbers by age and by year*

Table 8: *Survey index in numbers by age and by year. Data for 2020 were excluded*

Age	2009	2010	2011	2012	2013	2014	2015	2016
2	41.5465	16.3344	10.7817	36.1799	62.9852	19.1495	13.997	21.7245
3	119.453	53.1978	41.8217	107.0185	172.6148	79.7167	83.0613	54.9977
4	85.4866	37.5372	43.8482	68.0863	79.6261	57.8306	85.5339	56.715
5	37.693	18.1322	18.5036	27.6969	21.723	19.6509	29.0167	24.8793
6	7.8458	5.6379	4.0697	6.0731	3.3188	3.3586	8.1509	5.3849
7	3.866	2.6885	2.9764	3.2178	1.8156	2.5038	4.9591	2.3773
8	1.8571	1.0562	0.1215	1.0879	0.6604	0.526	1.2332	0.6864
9	1.2417	0.8849	1.0933	0.4324	0.502	0.5468	0.5672	1.6212

Age	2017	2018	2019	2020	2021	2022	2023	2024
2	5.0084	18.7765	16.6593	67.5001	18.7867	13.6246	20.836	17.9963
3	41.2052	60.4441	50.9077	177.3754	80.3637	47.0743	87.3871	37.5613
4	52.7413	49.0354	35.3885	57.2747	49.2443	26.4685	56.8141	25.9942
5	23.0712	23.1175	9.8214	14.0557	14.7067	10.4221	16.7925	10.6594
6	4.2916	6.5697	3.0423	2.7972	4.3327	2.1188	2.2108	2.7443
7	3.4894	3.2677	0.8292	1.5622	2.0462	1.1755	0.9804	1.5622
8	0.4432	0.6746	0.0501	0.3914	0.232	0.1003	0.1122	0.1063
9	0.948	0.1422	0.0561	0.1736	0.0561	0.2005	0.1122	0.5316

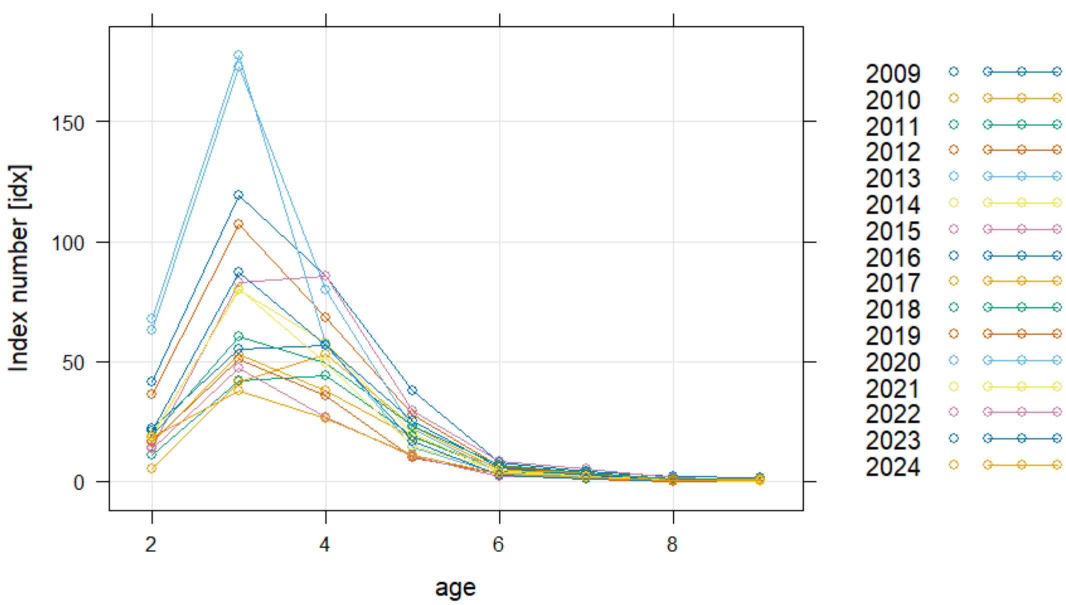


Figure 22: *Catch at age distribution in the MEDITS survey* samples (data for years before 2009 have been omitted for clarity)

2.1.2 Cohort consistency

After creating the objects, a cohort consistency check was performed for both catch and survey (***Figure 23*** and ***Figure 24***).

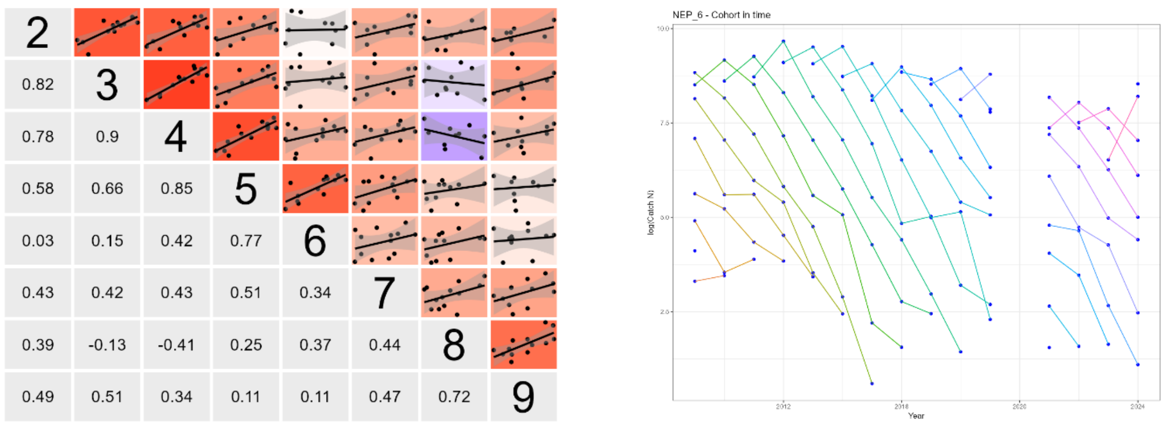


Figure 23: *Cohort consistency for catch*

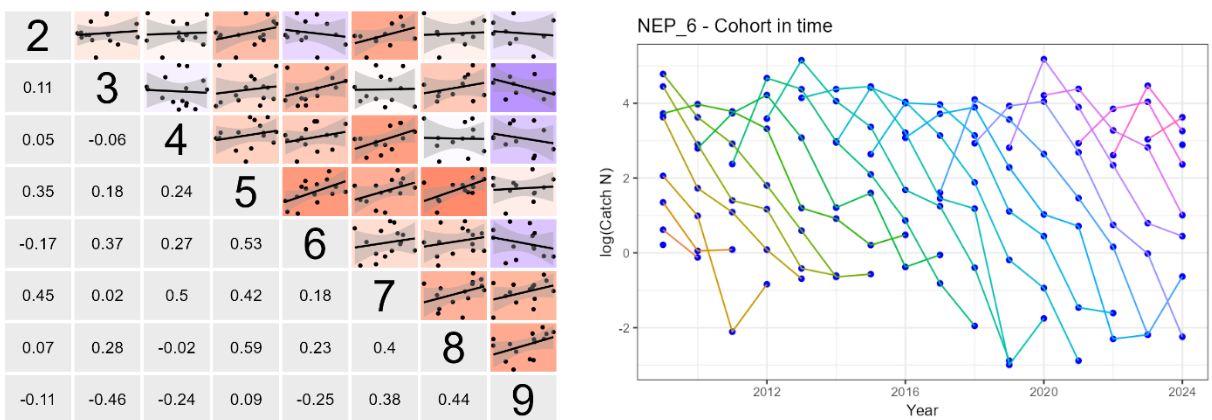


Figure 24: *Cohort consistency for MEDITS survey*

ISSUES

MEDITS:

- *Unrealistic length reported on the TC file: The issue was clearly a mistake in notation, and it has been resolved by adjusting the length by dividing it by 10.*

```
>          TCn[TCn$length_class>89,]
           id country area vessel year haul_number codend_closing partit genus species codlon pfrac pechan sex nbsex length_class maturity nblon matsub tf month day catfau upload_id
8568 51351090     ESP    6    COR 2013          53              S      S  NEPR     NOR      m   793    793   M    13          441        2     1     ND TC     5  23      B      5282
```

- *Non representativity among old individuals by sex while calculating the sex ratio (screen of some individuals from the TC file). Modeling the Sex ratio gets higher values for lengths over 65 mm. The discrepancy was addressed by excluding the individuals above this size.*

d	country	area	vessel	year	haul_numb	codend_cl	partit	genus	species	codlon	pfrac	pechan	sex	nbsex	length_cla	maturity	nblon	matsub	tf	month	day	catfau	upload_id
51330790	ESP	6	COR	2011	40	S	S	NEPR	NOR	m	103	103	M	2	79	2	1	ND	TC	5	17	B	5282
51331944	ESP	6	COR	2011	46	S	S	NEPR	NOR	m	4900	4900	M	48	82	2	1	ND	TC	5	18	B	5282
51331945	ESP	6	COR	2011	46	S	S	NEPR	NOR	m	4900	4900	M	48	89	2	1	ND	TC	5	18	B	5282

id	country	area	vessel	year	haul_numb	codend_cl	partit	genus	species	codlon	pfrac	pechan	sex	nbsex	length_cla	maturity	nblon	matsub	tf	month	day	catfau	upload_id
50508206	ESP	6	MOL	2022	80	S	S	NEPR	NOR	m	879	879	F	15	58	2	1	C	TC	5	25	B	4929
51394229	ESP	6	MOL	2016	96	S	S	NEPR	NOR	m	990	990	F	11	58	ND	1	ND	TC	5	17	B	5282
51474815	ESP	6	MOL	2024	83	S	S	NEPR	NOR	m	1884	1884	F	25	66	ND	1	ND	TC	5	17	B	5297
51474816	ESP	6	MOL	2024	83	S	S	NEPR	NOR	m	1884	1884	F	25	69	ND	2	ND	TC	5	17	B	5297
51474817	ESP	6	MOL	2024	83	S	S	NEPR	NOR	m	1884	1884	F	25	71	2	1	C	TC	5	17	B	5297

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