Stock Assessment Form
Demersal species

Nephrops norvegicus in GSA 5

Reference year: 2017

Reporting year: 2018

Norway lobster is OTB target. The status of the stock was assessed applying statistical catch at age (a4a) over the period 2009-2017. BALAR-MEDITS index was used for tuning. The stock is in high level of overfishing and overexploited with relative low level of biomass. A deterministic short term forecast was carried for years 2018 to 2020.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Please include your name*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
	Norway lobster	43
1st Geographical sub-area:	2nd Geographical sub-area:	3rd Geographical sub-area:
[GSA_5]		
4th Geographical sub-area:	5th Geographical sub-area:	6th Geographical sub-area:
1st Country	2nd Country	3rd Country
Spain		
4th Country	5th Country	6th Country
Stock assessment method: (direct, indirect, combined, none)		
Indirect		
Authors:		
STECF-18-12		
Affiliation:		
For more details please refer to https://stecf.jrc.ec.europa.eu/reports/medbs		

The ISSCAAP code is assigned according to the FAO 'International Standard Statistical Classification for Aquatic Animals and Plants' (ISSCAAP) which divides commercial species into 50 groups on the basis of their taxonomic, ecological and economic characteristics. This can be provided by the GFCM secretariat if needed. A list of groups can be found here:

http://www.fao.org/fishery/collection/asfis/en

Direct methods (you can choose more than one):

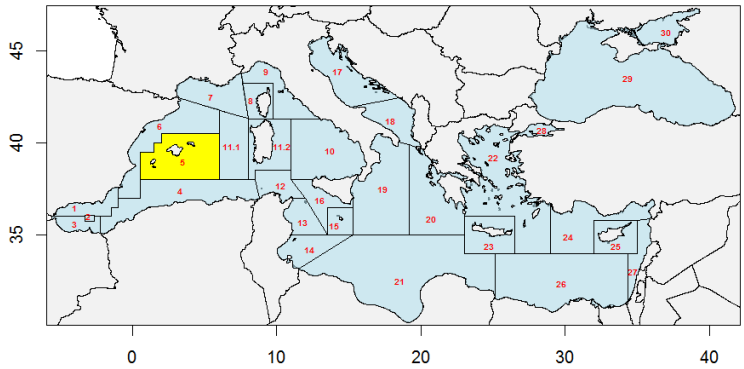
- Acoustics survey
- Egg production survey
- Trawl survey
- SURBA
- Other (please specify)

Indirect method (you can choose more than one):

- ICA
- VPA
- LCA
- AMCI
- XSA
- Biomass models
- Length based models
- Other (please specify)

Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify)

2 Stock identification and biological information



Due to the lack of information about the structure of the *N. norvegicus* population in the western Mediterranean, this stock was assumed to be confined within the GSA 5 boundaries. Generally managing Norway Lobster is considered to be a local small scale management issue, as stocks are linked to suitable benthic conditions, and occupy specific areas only.

2.1 Stock unit

The stock unit is represented by the GSA 5.

2.2 Growth and maturity

For *N. norvegicus*, males and females are known to have different growth, with males growing slower and reaching greater size than females. The DCF data did not include any information on the growth parameters by sex of in GSA 5. So although the sex ratio in the catches was available in the DCF, growth parameters for both sexes combined were taken from DCF.

Table 2.2-1: Maximum size, size at first maturity and size at recruitment.

Somatic magnitude measured (LT, LC, etc)				**Units**	
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	
Maximum size observed				**Recruitment season**	
Size at first maturity				**Spawning area**	
Recruitment size to the fishery				**Nursery area**	

Spawning is considered to occur through the year so spawning time was set at the mid-point of the year with 50% F and M occurring before spawning.

Natural mortality (M) was estimated according to Chen and Watanabe (1989).

Table 2-2.2: M vector and proportion of matures by size or age (combined)

Size/Age	Natural mortality	Proportion of matures
1	0.732	0.1
2	0.466	0.25
3	0.353	0.8
4	0.291	1
5	0.252	1
6	0.226	1
7	0.206	1

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	L_∞				86.1	
	K				0.126	
	t_0				0	
	Data source	DCF call 2018				
Length weight relationship	a				0.000229	
	b				3.25	
	M (scalar)					
	sex ratio (% females/total)					

3 Fisheries information

3.1 Description of the fleet

In the Balearic Islands (GSA 5), commercial trawlers employ up to four different fishing tactics (Palmer et al. 2009), which are associated with the shallow and deep continental shelf, and the upper and middle continental slope (Guijarro and Massutí 2006; Ordines et al. 2006). Vessels mainly target striped red mullet (*Mullus sumuletus*) and European hake (*Merluccius merluccius*) on the shallow and deep shelf respectively. However, these two target species are caught along with a large variety of fish and cephalopod species. The Norway lobster (*Nephrops norvegicus*) and the red shrimp (*Aristeus antennatus*) are the main target species on the upper and middle slope respectively. The Norway lobster is caught at the same time as a large number of other fish and crustacean species, but the red shrimp fishery is the only Mediterranean fishery that could be considered mono-specific (info taken from MUR_GSA_05_ESP, 2016).

Catch is dominated by bottom trawl, catch by other gears negligible. Below the information on the OTB fleet operating in GSA 5 as reported in the DCF (year 2017, 1st quarter taken as reference for the year).

year	quarter	vessel_lengt	gear	mesh_size_range	fishery	no_vessels
2017	1	VL1218	OTB	40D50	DEMSP	7
2017	1	VL1824	OTB	40D50	DEMSP	33
2017	1	VL2440	OTB	40D50	DEMSP	9
2017	1	VL1218	OTB	40D50	DWSP	1
2017	1	VL1824	OTB	40D50	DWSP	21
2017	1	VL2440	OTB	40D50	DWSP	10
2017	1	VL1218	OTB	40D50	MDDWSP	2
2017	1	VL1824	OTB	40D50	MDDWSP	26
2017	1	VL2440	OTB	40D50	MDDWSP	11

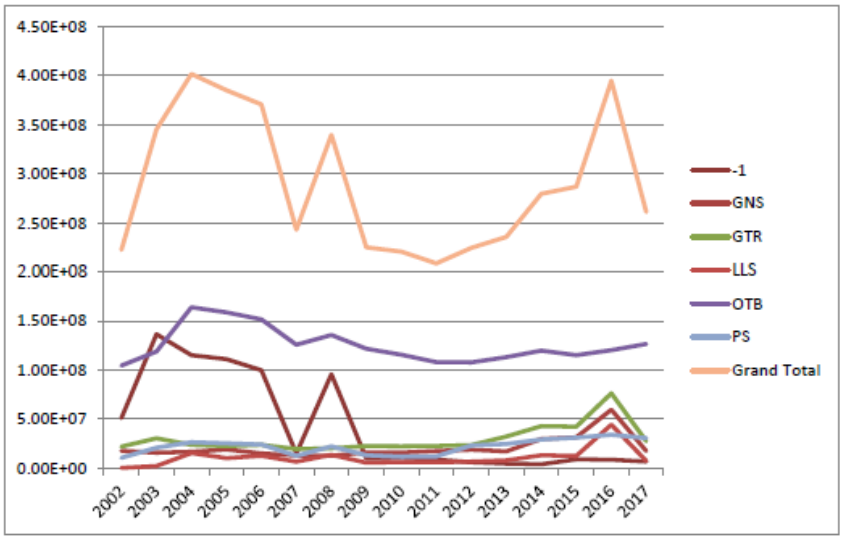
Table 3-1: Description of operational units exploiting the stock

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	Spain	GSA 5		OTB	[ISCAAP Group]	

Table 3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
[Operational Unit1]						
[Operational Unit2]						
[Operational Unit3]						
[Operational Unit4]						
[Operational Unit5]						
Total						

3.2 Historical trends



Nominal effort by fleet in GSA 5. Catch is dominated by bottom trawl, catches by other gears are negligible (DCF).

Norway lobster in GSA 5: total landings, discards and catch, in tonnes.

"year"	"landings"	"discards"	"total"
2002	17.32	0	17.32
2003	17.77	0	17.77
2004	25.09	0	25.09
2005	20.17	0	20.17
2006	21.27	0	21.27
2007	57.78	0	57.78
2008	89.63	0	89.63
2009	16.34	0.05	16.39
2010	16.19	0	16.19
2011	32.26	0.07	32.33
2012	29.5	2.11	31.61
2013	18.82	0	18.82
2014	30.8	0.03	30.83
2015	72.87	0.74	73.61
2016	28.33	0.02	28.35
2017	57.82	0.02	57.84

3.3 Management regulations

Trawl -

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: not fully observed

- Time at sea (12 hours per day and 5 days per week): fully observed

(info taken from MUR_GSA_05_ESP, 2016).

3.4 Reference points

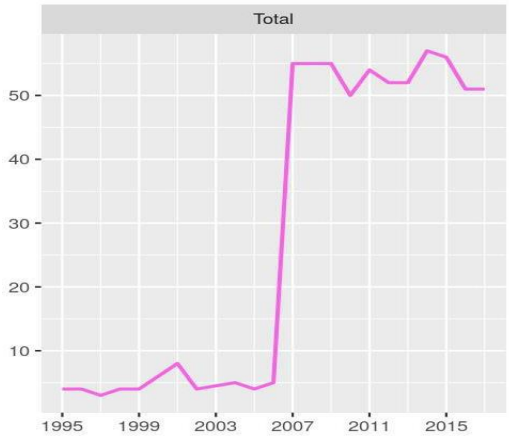
Table 3.3-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B					
SSB					
F			$F_{0.1}$	0.13	STECF-18-12
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 BALAR-MEDITS bottom trawl surveys

The MEDITS survey was conducted in a restricted way from 1995 to 2006, in 2007 the number of stations was increased greatly (Figure 6.9.2.3) and MEDITS was conducted consistently from 2007 to the present. The early data with very few hails per year was not considered suitable for a tuning index, given also that during most of that period only total catch would be available.



Number of MEDITS hauls per year 1995 to 2017, (increase in 2007).

4.1.1 Brief description of the direct method used

From 2001, the Spanish Institute of Oceanography has performed annual bottom trawl surveys following the same methodology and sampling gear described in the MEDITS protocol (BALAR surveys, Massutí and Reñones, 2005). Since 2007, this survey has been included in the MEDITS program (Bertrand et al., 2002). Mean stratified abundances and biomasses by km2 have been computed using the methodology described by Grosslein and Laurec (1982).

Direct methods: trawl based abundance indices

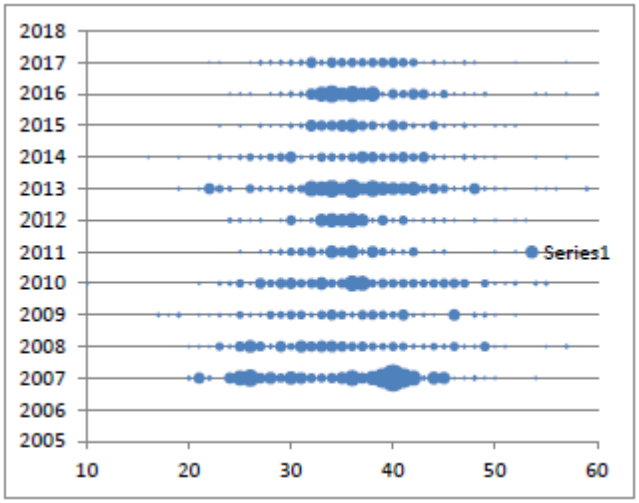
Table 4.1-1: Trawl survey basic information

Survey		**Trawler/RV**	
Sampling season			
Sampling design			
Sampler (gear used)			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			

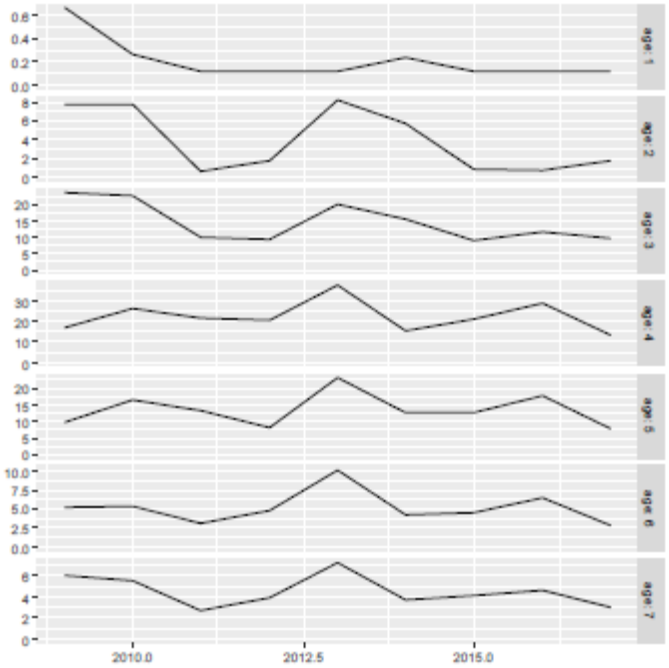
Table 4.1-2: Trawl survey sampling area and number of hauls

Stratum	Total surface (km^2)	Trawlable surface (km^2)	Swept area (km^2)	Number of hauls
Total (… – … m)				

Map of hauls positions



Norway lobster in GSA 5. MEDITS length frequencies distributions.



Norway lobster in GSA 5. MEDITS age composition as derived from slicing.

4.1.2 Spatial distribution of the resources

Include maps with distribution of total abundance, spawners and recruits (if available)

4.1.3 Historical trends

Time series analysis (if available) and graph of the observed trends in abundance, abundance by age class, etc. for each of the directed methods used.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

A list of protected species that can be potentially affected by the fishery should be incorporated here. This should also be completed with the potential effect and if available an associated value (e.g. bycatch of these species in T)

5.2 Environmental indexes

If any environmental index is used as i) a proxy for recruitment strength, ii) a proxy for carrying capacity, or any other index that is incorporated in the assessment, then it should be included here.

Other environmental indexes that are considered important for the fishery (e.g. Chl a or other that may affect catchability, etc.) can be reported here.

6 Stock Assessment

6.1 Statistical catch at age a4a (Jardim et al. 2015)

6.1.1 Model assumptions

6.1.2 Scripts

If a script is available which incorporates the stock assessment run (e.g. if using FLR in R) it should be provided here in order to create a library of scripts.

6.1.3 Input data and Parameters

Catch at age (thousands)

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	28.3	33.8	51.9	68.1	12.4	61.7	154.8	95.9	120.4
3	148.9	176.2	349.9	296.1	112.8	230.2	566.7	283.6	527.9
4	113.3	102.4	251.8	234.8	113.0	184.3	513.0	172.8	402.9
5	54.8	57.6	113.3	84.4	79.8	112.5	238.2	91.2	235.8
6	10.1	23.0	37.8	30.1	22.5	38.2	111.0	27.9	88.9
7	17.1	24.9	42.6	70.6	35.4	66.2	160.7	30.4	106.6

Stock and catch weight at age

age	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	0.0080	0.0077	0.0077	0.0077	0.0076	0.0080	0.0075	0.0073	0.0072
3	0.0155	0.0151	0.0156	0.0155	0.0162	0.0153	0.0154	0.0151	0.0157
4	0.0268	0.0274	0.0274	0.0272	0.0280	0.0275	0.0283	0.0268	0.0274
5	0.0434	0.0446	0.0439	0.0443	0.0450	0.0446	0.0439	0.0446	0.0447
6	0.0655	0.0649	0.0648	0.0653	0.0654	0.0647	0.0653	0.0651	0.0646
7	0.1122	0.1043	0.1061	0.1068	0.1041	0.1062	0.1163	0.1165	0.1102

Average spawning time set 0.5 (Ist July)
Catch 2009 to 2017 age range 2 to 7+
Fbar set 2 to 4

6.1.4 Tuning data

MEDITS tuning index of abundance, by age and year

age	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	7.769	7.765	0.629	1.742	8.138	5.667	0.917	0.802	1.790
3	23.641	22.639	9.956	9.363	20.017	15.569	9.164	11.761	9.722
4	17.195	26.513	21.517	20.615	37.710	15.325	21.287	29.038	13.563
5	9.744	16.412	13.193	8.299	23.116	12.732	12.590	17.677	7.849
6	5.161	5.328	3.145	4.721	10.071	4.239	4.580	6.450	2.826
7	6.011	5.511	2.735	3.897	7.238	3.769	4.114	4.678	3.035

6.1.5 Results

The stock assessment was based on the following models

fmodel: ~s(age, k = 4) + s(year, k = 4) (separable model smooth by age and year)

srmodel: ~factor(year) (recruitment independent by year)

n1model: ~s(age, k = 4)

qmodel: ~factor(replace(age, age > 5, 5)) (Q independent at age 2-4 5,6&7+ equal)

vmodel: catch: ~s(age, k = 3) (smooth catch model)

IND: ~1 (One index)

Norway lobster in GSA 5: Stock number by age and by year in thousands

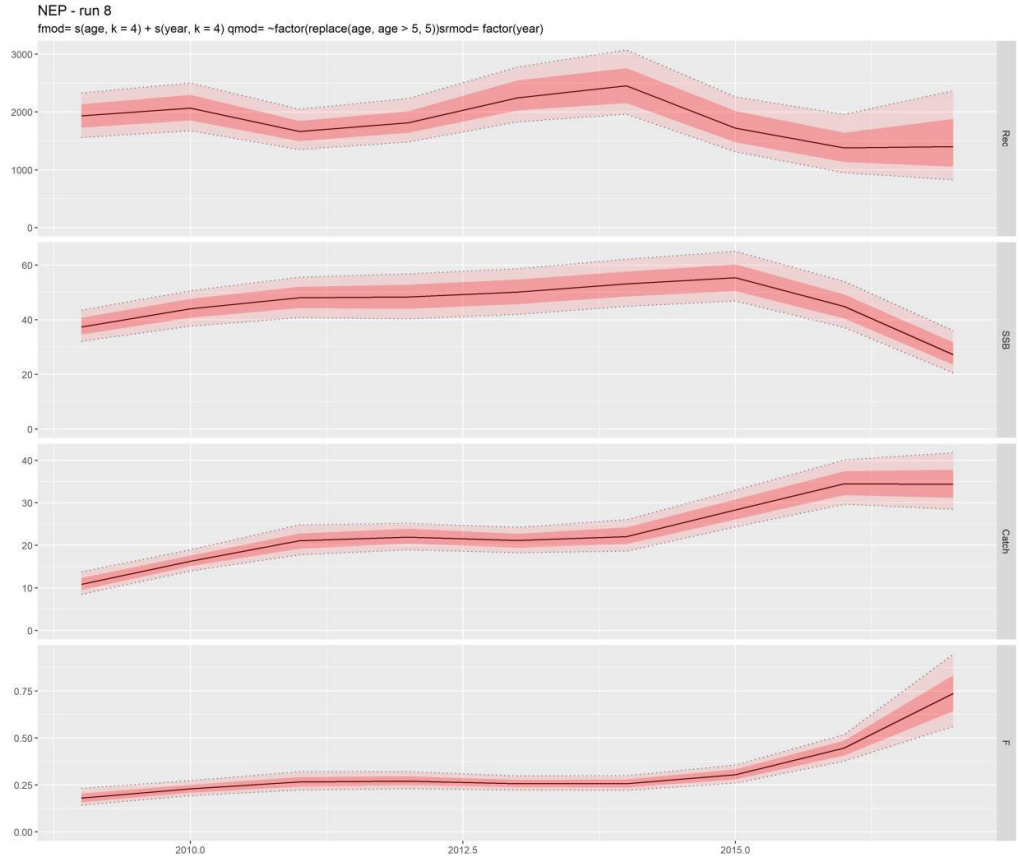
Age	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	1923.0	2061.4	1665.6	1819.4	2260.0	2451.7	1727.5	1363.2	1410.5
3	946.1	1176.4	1252.5	1006.7	1098.9	1367.7	1483.8	1038.5	803.8
4	445.3	567.0	675.2	695.7	556.6	615.3	766.1	796.6	493.5
5	161.6	233.2	269.6	298.3	304.1	250.4	277.0	313.6	248.0
6	80.4	92.1	122.2	132.5	145.3	151.8	125.1	127.4	113.6
7	81.1	93.9	99.0	111.0	120.9	135.6	146.2	125.3	91.8

Norway lobster in GSA 5: Fishing Mortality by age and by year

age	2009	2010	2011	2012	2013	2014	2015	2016	2017
2	0.0250	0.0320	0.0370	0.0380	0.0360	0.0360	0.0430	0.0620	0.1020
3	0.1590	0.2020	0.2350	0.2390	0.2270	0.2260	0.2690	0.3910	0.6440
4	0.3560	0.4520	0.5260	0.5360	0.5080	0.5070	0.6020	0.8760	1.4440
5	0.3100	0.3940	0.4580	0.4680	0.4430	0.4420	0.5250	0.7630	1.2590
6	0.2720	0.3470	0.4030	0.4110	0.3890	0.3880	0.4610	0.6710	1.1060
7	0.3820	0.4850	0.5640	0.5760	0.5450	0.5440	0.6460	0.9400	1.5500

Stock assessment summary table by year: Fishing morality, Recruitment (thousands) Spawing stock biomass (tonnes), Total Biomass (tonnes) and catch (tonnes)

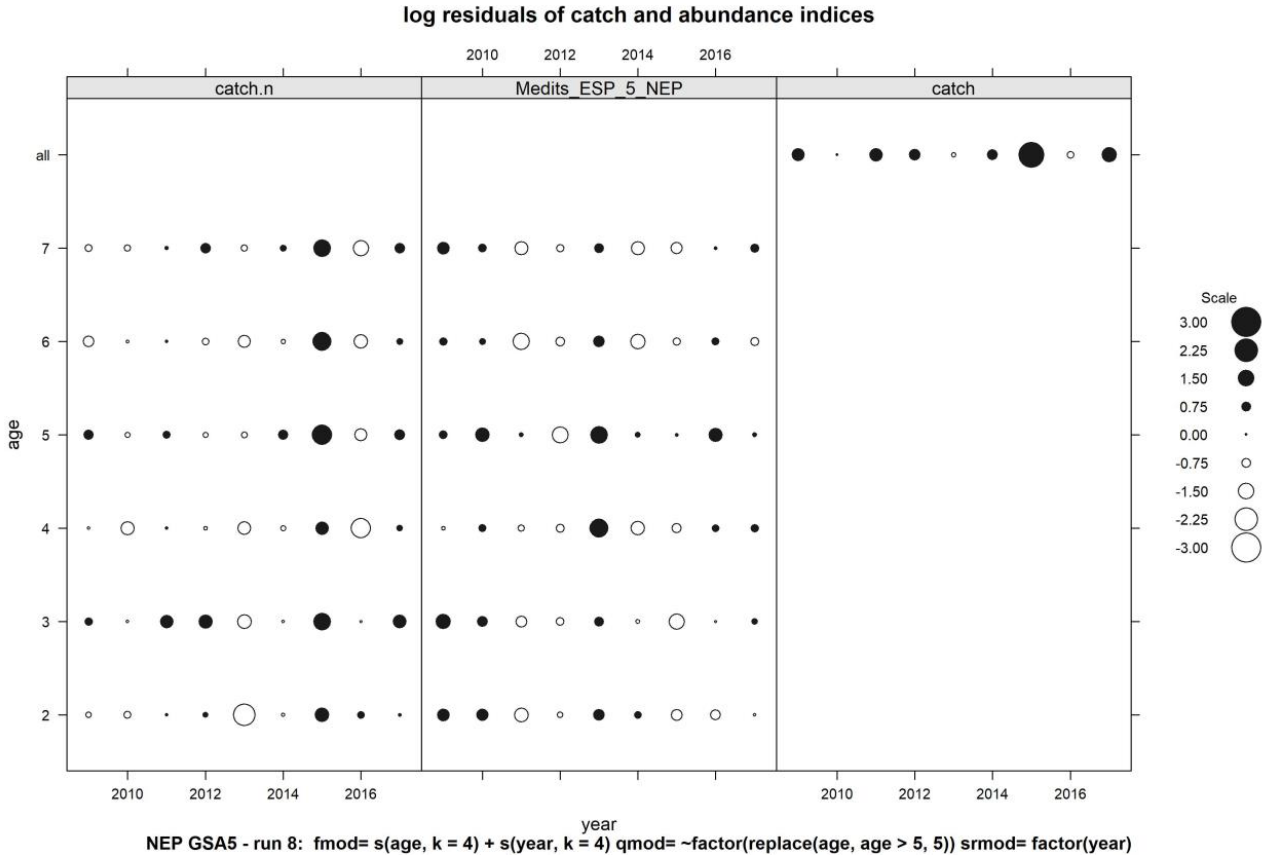
Year	Fbar	Recruitm	SSB	TB	Catch
2009	0.18	1923	37	63	11
2010	0.23	2061	43	75	16
2011	0.27	1666	48	81	21
2012	0.27	1819	48	82	22
2013	0.26	2260	50	86	21
2014	0.26	2452	53	93	22
2015	0.3	1728	55	95	28
2016	0.44	1363	44	84	34
2017	0.73	1410	27	65	34



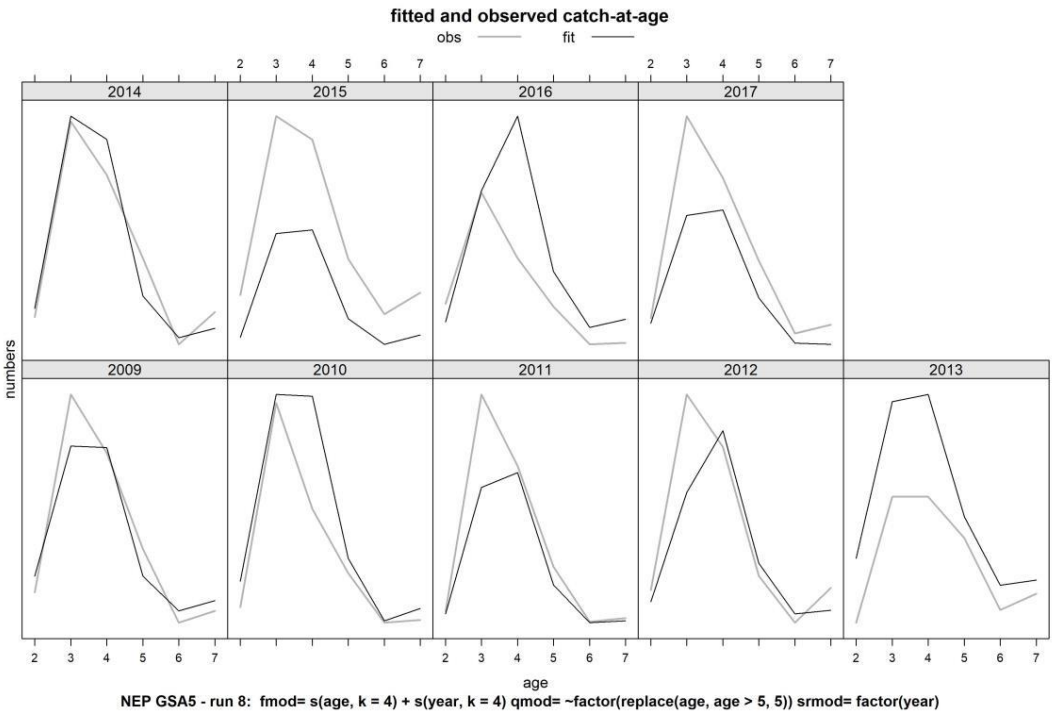
Norway lobster in GSA 5. Stock summary and 90% intervals 2009-2017: Recruitment, SSB, catch and F fishing mortality.

The observed decreasing SSB since 2015 is simultaneous to the increase in the catch and F.

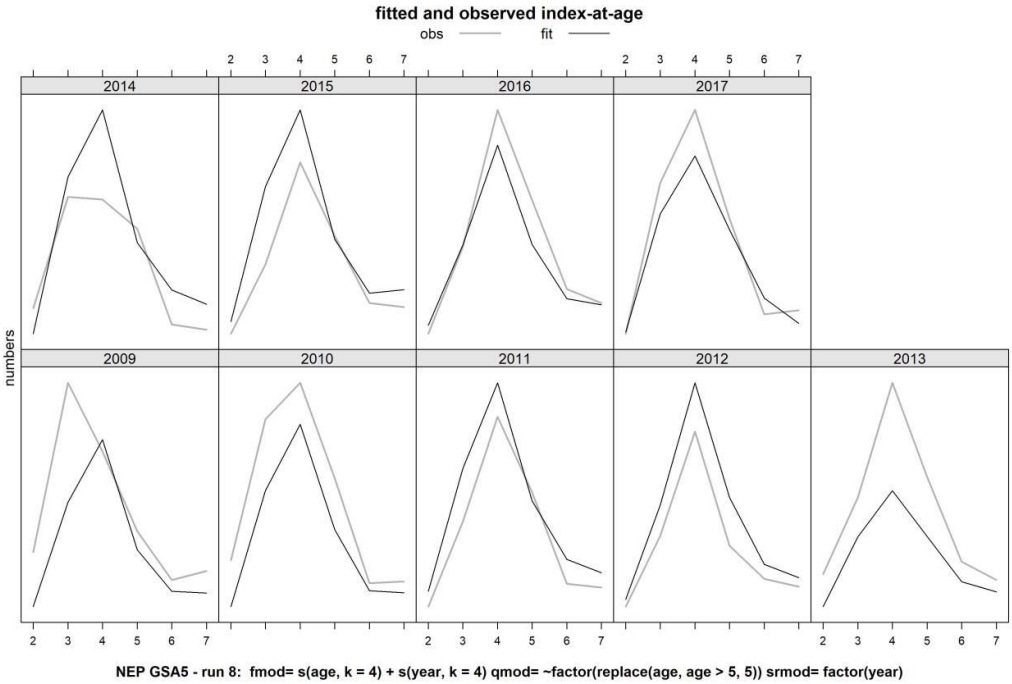
6.1.6 Robustness analysis



Norway lobster in GSA 5. Normalized log residuals for catch and abundance indices.

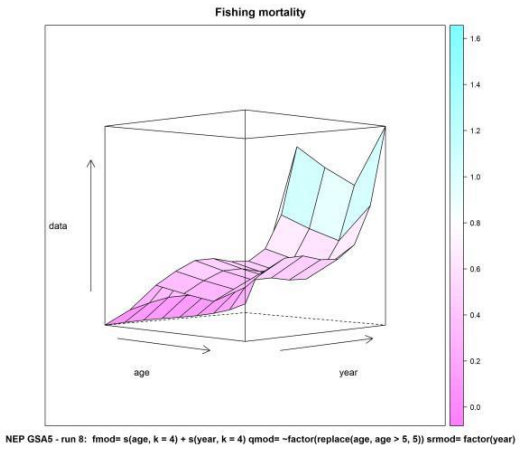


Norway lobster in GSA 5. Fitted and observed catch at age, by year.

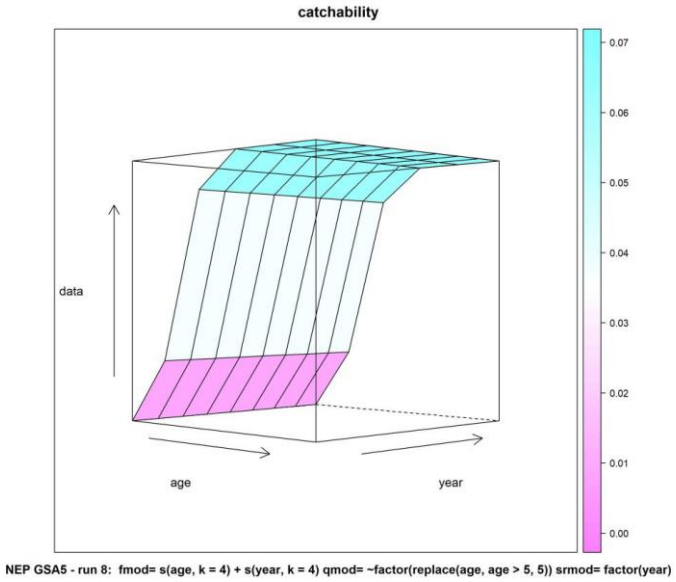


Norway lobster in GSA 5. Fitted and observed MEDITS index at age, by year.

Generally the residuals are moderate, with some year effects visible in both catch and survey indices, There is no indication of trend with age or year in catch and indices at age. Most of the catch residuals are positive, this was examined and it was observed that there was a small bias in the catch, but the residuals were normalised by a rather low variance resulting from the short time series. Catch and index observations and estimates are similar without major outliers but some mis-estimation in both data sets.

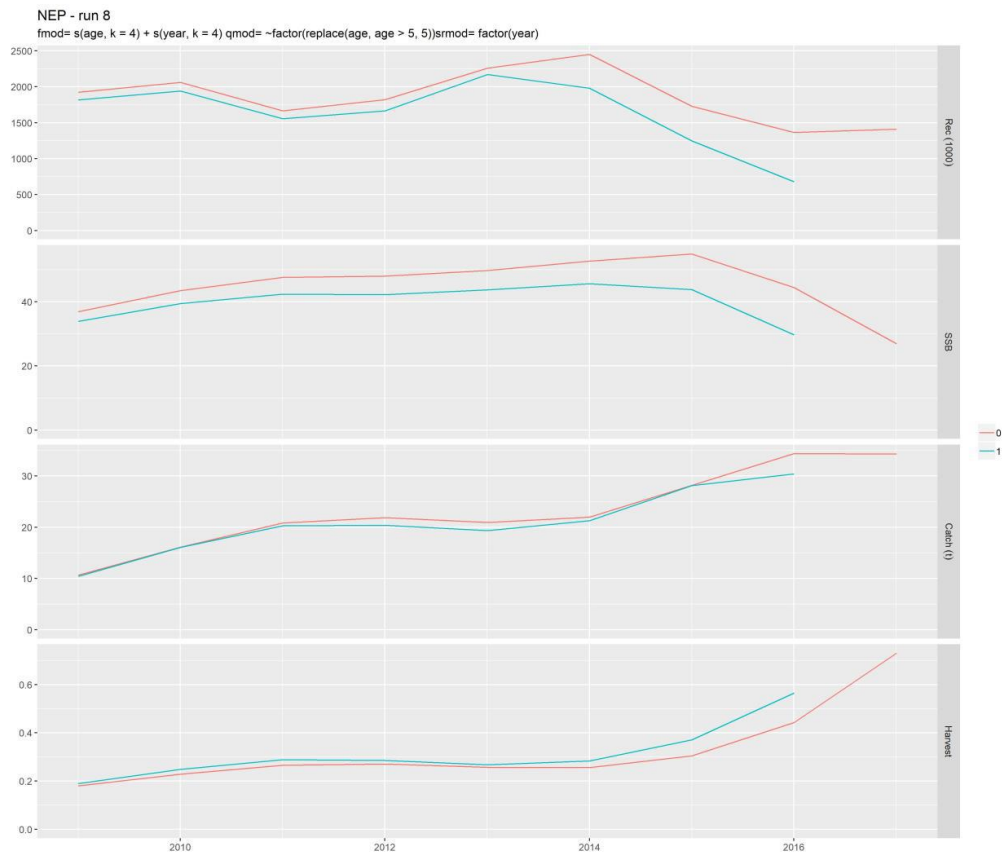


Nephrops in GSA 5. 3D contour plot of estimated fishing mortality at age and year.



Nephrops in GSA 5. Selection pattern for MEDITS index at age and year (flat age 5 and above).

6.1.7 Retrospective analysis, comparison between model runs, sensitivity analysis, etc.



Nephrops in GSA 5. Retrospective analysis 2009-2017: Recruitment, SSB, catch and Fishing mortality. Only one year is provided dur to the short time series.

6.1.8 Assessment quality

This assessment is considered to be poor but acceptable, the age sliced index has coherence from year to year and the assessment provides a coherent explanation of the trend in catches. Retrospective performance is marginal but acceptable for a very short time series of 8 years. The exploitation status of the stock (F>Fmsy) is unaffected in the retrospective evaluation.

There were no specific data deficiencies, however, sampling of catch appears to be at such a low level that catch at length appears noisy relative to catch at length in MEDITS.

7 Stock predictions

Norway Lobster in GSA 5 is decreasing and the stock is being overfished. Catches should be decreased at least 90% to reach F_{MSY} in 2019.

Reference points

The reference values were calculated based on input data from the mean of last three years Although this stock has a defined F max which gives a candidate value for Fmsy of 0.173, advice is given based on F0.1, which includes a precautionary aspect not included in Fmax.

Norway lobster in GSA 5. Reference points based on mean of last three years.

Refpt	harvest	yield	rec	ssb	biomass
Virgin	0.000	0.0000	1.000	0.15900	0.16500
Msy	0.173	0.0124	1.000	0.04060	0.04640
Crash	80.800	0.0071	1.000	0.00001	0.00002
f0.1	0.096	0.0115	1.000	0.06510	0.07100
Fmax	0.173	0.0124	1.000	0.04060	0.04640
spr.30	0.144	0.0124	1.000	0.04780	0.05360

7.1 Short term predictions

A deterministic short term forecast was carried using FLSTF for years 2018 to 2020.
For mean weights, maturity, natural mortality and selection pattern, the average values for the last three years were used. The recruitment in 2018 to 2020 was calculated as geometric mean of the series (1821 thousand).
Fishing at F0.1 in 2019 leads to an 18% rise in SSB and catches of 3.3 tonnes.

Norway lobster in GSA 5: Short term forecast results for 2017 to 2020 based on selection and biological parameters averaged over 3 years, and geometric mean recruitment from 2009 to 2017.

	Ffactor	Fbar	Catch2017	Catch2018	Catch2019	Catch2020	SSB2018	SSB2019	SSB2020	SSB_change_2018-2020(%)	Catch_change_2018-2019(%)
1	0	0.00	34.3	20.1	0.0	0.0	17.7	25.4	45.3	156.4	-100
2	0.1	0.07	34.3	20.1	2.6	4.7	17.7	24.3	40.0	126.4	-93
3	0.2	0.15	34.3	20.1	4.9	8.2	17.7	23.1	35.5	100.9	-86
4	0.3	0.22	34.3	20.1	7.0	10.8	17.7	22.1	31.7	79.1	-80
5	0.4	0.29	34.3	20.1	8.8	12.8	17.7	21.1	28.4	60.4	-74
6	0.5	0.37	34.3	20.1	10.5	14.2	17.7	20.2	25.5	44.4	-69
7	0.6	0.44	34.3	20.1	12.1	15.3	17.7	19.3	23.1	30.6	-65
8	0.7	0.51	34.3	20.1	13.5	16.0	17.7	18.4	21.0	18.6	-61
9	0.8	0.58	34.3	20.1	14.8	16.5	17.7	17.6	19.1	8.3	-57
10	0.9	0.66	34.3	20.1	16.0	16.8	17.7	16.9	17.6	-0.7	-53
11	1	0.73	34.3	20.1	17.0	17.0	17.7	16.2	16.2	-8.6	-50
12	1.1	0.80	34.3	20.1	18.0	17.1	17.7	15.5	14.9	-15.5	-47
13	1.2	0.88	34.3	20.1	18.9	17.2	17.7	14.9	13.9	-21.5	-45
14	1.3	0.95	34.3	20.1	19.8	17.1	17.7	14.3	12.9	-26.9	-42

15	1.4	1.02	34.3	20.1	20.5	17.1	17.7	13.7	12.1	-31.6	-40
16	1.5	1.10	34.3	20.1	21.2	17.0	17.7	13.2	11.3	-35.9	-38
17	1.6	1.17	34.3	20.1	21.9	16.9	17.7	12.7	10.7	-39.6	-36
18	1.7	1.24	34.3	20.1	22.5	16.7	17.7	12.2	10.1	-43.0	-34
19	1.8	1.31	34.3	20.1	23.1	16.6	17.7	11.7	9.5	-46.1	-33
20	1.9	1.39	34.3	20.1	23.6	16.5	17.7	11.3	9.0	-48.8	-31
21	2	1.46	34.3	20.1	24.1	16.4	17.7	10.9	8.6	-51.3	-30
F0.1	0.130	0.10	34.3	20.1	3.3	5.9	17.7	23.9	38.5	118.0	-90
Fupp	0.187	0.14	34.3	20.1	4.6	7.8	17.7	23.3	36.0	103.9	-87
Flow	0.091	0.07	34.3	20.1	2.3	4.3	17.7	24.4	40.5	129.0	-93

7.2 Medium term predictions

7.3 Long term predictions

8 Draft scientific advice

(Examples in blue)

Based on	Indicator	Analytic al reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Stock Status
Fishing mortality	Fishing mortality	$F_{0.1}$ = 0.13 F_{FMSY}= 0.173			I in the most recent yr	IO_H
	Fishing effort				OTB slightly increasing in the most recent yr	
	Catch				I	
Stock abundance	Biomass			33_{th} percentile		O_L
	SSB				D	
Recruitment					D	
Final Diagnosis		In high level of overfishing and overexploited with low level of biomass.				

The reference values were calculated based on input data from the mean of last three years Although this stock has a defined F max which gives a candidate value for Fmsy of 0.173, advice is given based on F0.1, which includes a precautionary aspect not included in Fmax.

For more details please refer to

https://stecf.jrc.ec.europa.eu/reports/medbs

8.1 Explanation of codes

Trend categories

1) N - No trend
2) I - Increasing
3) D – Decreasing
4) C - Cyclic

Stock Status

Based on Fishing mortality related indicators

1) **N - Not known or uncertain** – Not much information is available to make a judgment;
2) **U - undeveloped or new fishery** - Believed to have a significant potential for expansion in total production;
3) **S - Sustainable exploitation**- fishing mortality or effort below an agreed fishing mortality or effort based Reference Point;
4) **IO –In Overfishing status**– fishing mortality or effort above the value of the agreed fishing mortality or effort based Reference Point. An agreed range of overfishing levels is provided;

Range of Overfishing levels based on fishery reference points

In order to assess the level of overfishing status when $F_{0.1}$ from a Y/R model is used as LRP, the following operational approach is proposed:

- If $Fc^*/F_{0.1}$ is below or equal to 1.33 the stock is in **(O_L): Low overfishing**
- If the $Fc/F_{0.1}$ is between 1.33 and 1.66 the stock is in **(O_I): Intermediate overfishing**
- If the $Fc/F_{0.1}$ is equal or above to 1.66 the stock is in **(O_H): High overfishing**

*Fc is current level of F

5) **C- Collapsed**- no or very few catches;

Based on Stock related indicators

1) **N - Not known or uncertain:** Not much information is available to make a judgment
2) **S - Sustainably exploited:** Standing stock above an agreed biomass based Reference Point;
3) **O - Overexploited**: Standing stock below the value of the agreed biomass based Reference Point. An agreed range of overexploited status is provided;

Empirical Reference framework for the relative level of stock biomass index

- **Relative low biomass:** Values lower than or equal to 33rd percentile of biomass index in the time series **(O_L)**
- **Relative intermediate biomass:** Values falling within this limit and 66th percentile **(O_I)**
- **Relative high biomass:** Values higher than the 66th percentile **(O_H)**

4) **D – Depleted**: Standing stock is at lowest historical levels, irrespective of the amount of fishing effort exerted;
5) **R –Recovering:** Biomass are increasing after having been depleted from a previous period;

Agreed definitions as per SAC Glossary

Overfished (or overexploited) *- A stock is considered to be overfished when its abundance is below an agreed biomass based reference target point, like B0.1 or BMSY. To apply this denomination, it should be assumed that the current state of the stock (in biomass) arises from the application of excessive fishing pressure in previous years. This classification is independent of the current level of fishing mortality.*

Stock subjected to overfishing (or overexploitation) *- A stock is subjected to overfishing if the fishing mortality applied to it exceeds the one it can sustainably stand, for a longer period. In other words, the current fishing mortality exceeds the fishing mortality that, if applied during a long period, under stable conditions, would lead the stock abundance to the reference point of the target abundance (either in terms of biomass or numbers)*