

6 Megrim and four-spot megrim in Cantabrian Sea and Atlantic Iberian waters

meg.27.8c9a and ldb.27.8c9a – *Lepidorhombus whiffiagonis* and *L. boscii* in divisions 8.c and 9.a

6.1 General

6.1.1 Ecosystem aspects

See Stock Annex^{1,2} for ecosystem aspects related to megrim assessment (both stock annexes were updated after the WKMEGRIM 2022 benchmark).

6.1.2 Fishery description

See Stock Annex for fishery description.

6.2 Summary of ICES advice for 2023 and management for 2022 and 2023

6.2.1 ICES advice for 2023 (as extracted from ICES advice on fishing opportunities, catch and effort 2022)

The two megrim species (*L. whiffiagonis* and *L. boscii*) are not completely separated in the landings. A single TAC covers both species and species-specific landings are estimated by ICES. ICES considers that management of the two megrim species under a combined TAC prevents effective control of the single-species exploitation rates and could lead to overexploitation of either species. Therefore, the advice since 2016 is based on the single-species F_{MSY} (ICES, 2022b, 2022c).

A mixed-fisheries analysis covering the stocks in Iberian waters of hake, megrim, four-spot megrim, and white anglerfish is provided in ICES (2022d).

ICES advise that when the EU multiannual plan (MAP; EU, 2019) for Western waters and adjacent waters is applied, catches in 2023 that correspond to the F ranges in the MAP are between 654 and 1456 t for *L. whiffiagonis* and between 1595 and 3421 t for *L. boscii*. According to the MAP, catches higher than those corresponding to F_{MSY} (968 t for *L. whiffiagonis* and 2282 t for *L. boscii*) can only be taken under conditions specified in the MAP, while the entire range is considered precautionary when applying the ICES advice rule.

¹ ICES. 2022. ICES Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop for selected megrim stocks (WKMEGRIM 2022).

² ICES. 2022. ICES Stock Annex: Four-spot megrim (*Lepidorhombus boscii*) in divisions 8.c and 9.a (south Bay of Biscay and Atlantic Iberian waters East). Produced by the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) and updated in August 2022 by the Benchmark workshop for selected megrim stocks (WKMEGRIM 2022).

6.2.2 Management applicable for 2022 and 2023

The agreed combined TAC for megrim and four-spot megrim in ICES divisions 8.c and 9.a was 2445 t in 2022 and 3250 t in 2023.

6.2.3 References

- EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. Official Journal of the European Union, L83: 1–17. <http://data.europa.eu/eli/reg/2019/472/oj>.
- ICES. 2022a. Benchmark workshop for selected megrim stocks (WKMEGRIM). ICES Scientific Reports. 4:53. <http://doi.org/10.17895/ices.pub.20069000>
- ICES. 2022b. Four-spot megrim (*Lepidorhombus boschii*) in divisions 8.c and 9.a (southern Bay of Biscay and Atlantic Iberian waters East). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, ldb.27.8c9a, <https://doi.org/10.17895/ices.advice.19448036>.
- ICES. 2022c. Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, meg.27.8c9a, <https://doi.org/10.17895/ices.advice.19448060>.
- ICES. 2022d. Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE). ICES Scientific Reports. 4:83. 229 pp. <https://doi.org/10.17895/ices.pub.21501414>
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6.3 Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a

6.3.1 General

See general section for both species.

6.3.2 Data

6.3.2.1 Commercial catches and discards

WGBIE estimates of landings, discards, and catches for the period 1986 to 2022 are given in Table 6.3.1. From 2011 to 2018, estimates of unallocated or non-reported landings were included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each *métier*. These estimates are considered the best information available at this time. In 2015, data revised for the period 2011–2013 were provided. This revision produced an improvement in the allocation of sampling trips and the revised data are used in the assessment. The total estimated international landings in divisions 8.c and 9.a for 2022 were 310 t. Landings reached a peak of 977 t in 1990, followed by a steady decline until 2002. Some increase in landings has been observed since then, but landings have again decreased annually from 2007 until 2010 to 83 t, the lowest value of the entire time-series. Since 2011, the stock increased again and has then remained stable. Historical landings for both species combined are

shown in Figure 6.3.1. The last period shows a decreasing trend since 2014 and in 2022, the international landings were 961 t.

Discards estimates were available from the Spanish “observers’ on board sampling programme” for the years displayed in Table 6.3.2(a). In 2020, discards data of the first semester were missing for the reasons previously mentioned and were estimated based on the discard per unit of effort of the second semester applied to the exerted effort in the first semester. Discards represent between 10–47% of the total catch, with the exception of the years 2007 and 2020 when discards were very low and in 2011 when the value observed was extremely high. Following the recommendations, during the WKSOUTH benchmark in 2014 (ICES, 2014), an effort was made to complete the time-series back until 1986 in years without samplings. Total discards, given in tonnes (Table 6.3.1) and numbers-at-age (Table 6.3.2b), were included in the assessment model. Figure 6.3.2 shows the proportion of discards-at-age.

Figures 6.3.3 (a, b and c) show the standardized catches, landings a discards proportion-at-age, where cohort tracking can be observed.

6.3.2.2 Biological sampling

Annual length compositions of total stock landings are provided in Figure 6.3.4 for the whole period and in Table 6.3.3a for 2022. The bulk of sampled specimens corresponds to individuals of 20–35 cm.

Sampling levels for both species are given in Table 1.4.

Mean lengths and mean weights in landings since 1990 are shown in Table 6.3.3b. The mean length and weight values observed in 2013 were the highest in the historic series.

Age compositions of catches are presented in Figure 6.3.5 and weights-at-age of catches from 1986 to 2022 is shown in Figure 6.3.6. These values were also used as the weights-at-age in the stock.

More biological information, the parameters used in the length-weight relationship, natural mortality and maturity ogive are provided in the Stock Annex, where the updates and new information approved in the last benchmark are shown (ICES, 2022).

6.3.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarized in Table 6.3.6.

Two Portuguese surveys, named “Crustacean” (PT-CTS-UWTV-FU28–29, G2913) and “October” (PtGFS-WIBTS-Q4, G8899), provide biomass and abundance indices. In 2012 and for the years, 2019 and 2020, these Portuguese Surveys were not carried out and surveys resumed in 2021 but has been performed in a new vessel

As noted in the Stock Annex, indices from these Portuguese surveys are not considered representative of the megrim abundance due to the very low catch rates. These surveys are not included in the assessment model.

Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) survey

The Spanish survey (SP-NSGFS-Q4, G2784) covers the distribution area and depth strata of this species in Spanish waters 8.c and 9.a. Total biomass and abundance indices from this survey were higher during the period 1988 to 1990, subsequently declining to lower mean levels, which were common throughout the rest of the time-series. There has been an overall declining trend in the abundance index after year 2000, with the values for 2008 and 2009 being the two lowest in the entire series. Since then, there is a general increasing trend with the highest value this year (Figure 6.3.7). In 2013, the survey was carried out in a new vessel. This year the abundance indices were high for flatfish and benthic species. Although there was an inter-calibration exercise

performed between both vessels, the results were not consistent with the results of the inter-calibration. Therefore, WGBIE decided not to include the abundance index value for that year in the assessment model. Since 2014, the gear used was similar to the gear used in the survey before 2013. A new inter-calibration exercise was conducted in 2014 and the index was considered suitable for inclusion in the assessment. In 2021, the second part of the survey was performed in a different vessels because of technical issues but the gear was the same. It has been assumed the possible effects are minor and the index is appropriate to use in the assessment.

The Spanish survey recruitment index for age 1 (Recruitment age) indicates an extremely weak year class in 1994, which improved in the following years. From 2000 to 2014, low values of year classes were observed except in 2010. However, since 2015, there was a considerable increase in age 1 with the highest value of the time-series in 2022 (Figure 6.3.8). Figure 6.3.8 displays a bubble plot of log (survey abundance-at-age), with each age standardised separately over the years. The figure indicates that the survey is quite good at tracking cohorts through time.

Figure 6.3.9 shows the internal consistency of the standardized index. The survey is a bit noisy for older ages, but still quite consistent.

Type	Name	Year range	Age range	Used in the assessment
Spanish Groundfish Survey	SpGFS-WIBTS-Q4 (G2784)	1983–present	1–6	Yes
Portuguese October Groundfish Survey	PtGFS-WIBTS-Q4 (G8899)	1990–present	Biomass index	No
Portuguese Crustacean Survey	PT-CTS -UWTV -FU 28-29 (G2913)	1997–present	1–6	No

6.3.2.4 Commercial catch-effort data

The commercial LPUE and effort data of the Portuguese trawlers fishing in Division 9.a and of two Spanish fishing ports operation in métier OTB_DEF_>=55_0_0 in 8.c and 9.a are available and cover the period 1986–2022. Figure 6.3.10 shows the LPUE series and the increasing trends in recent years.

The use of commercial LPUEs was rejected during the WKMEGRIM benchmark in 2022 (ICES, 2022) due to concerns about changes in efficiency, targeting behaviour, quota restrictions, technical measures, discarding and compliance. However, these trends can be used as supplementary information by WGBIE.

6.3.3 Assessment

An assessment was conducted, according to the Stock Annex specifications. Assessment years are from the period 1986–2022 and for ages 1–7+ individuals.

The a4a (Millar and Jardim, 2019) stock assessment model is selected and implemented for the assessment of the stock. It is a non-linear catch-at-age model implemented in R (R Core Team,

2022) and FLR (Kell *et al.*, 2007), and using ADMB (Fournier *et al.*, 2012), that can be applied rapidly to a wide range of situations with low parameterization requirements³.

6.3.3.1 Input data

Following the Stock Annex, discards and landed numbers-at-age were incorporated resulting in catch numbers-at-age as input data from 1986 to 2022 and the year 2022 was added to the Spanish SpGFS-WIBTS-Q4 (G2784) survey index.

6.3.3.2 Model

Model Specification

Software used: R package Fla4a (version 1.8.2) in R (version 4.1.2), (see Stock Annex for details):

The model structure is defined by submodels, which are the different parts that require structural assumptions. There are five submodels in operation:

1. model for F-at-age,
2. model for the initial age structure,
3. model for recruitment,
4. (list) of model(s) for abundance indices catchability-at-age,
5. list of models for the observation variance of catch-at-age and abundance indices.

These submodels were defined as:

```
fmodel: ~factor(replace(age, age > 6, 6)) + factor(year)
srmodel: ~factor(year)
n1model: ~factor(age)
qmodel: list(~I(1/(1 + exp(-age))))
vmodel:
catch: ~s(age, k = 3)
SpGFS-WIBTS-Q4: ~1
```

The F model is a separable model. The shape of the F-at-age pattern is independently estimated for each age except for ages 6 and 7+, which are assumed to have the same Fs. This F pattern is then independently scaled up and down for each year.

Stock–recruit model: Freely estimated for each year.

Catchability models:

For the SpGFS-WIBTS-Q4 (G2784) survey, catchability is assumed to increase asymptotically.

N1 model (population in the first year of the time-series): default value a4aSCA function (independently estimated for each age)

Vmodel (the shape of the observation variances): default value a4aSCA function: smooth function for the catch numbers-at-age and 'flat' for the index.

An FLStock object is needed and it was adapted from XSA (Shepherd, 1999) input data. This object includes catches, landings, discards, weights-at-age, natural mortality (M), maturity, harvest before spawning and mortality before spawning.

Model Settings

- F_{bar} is set to ages 2–4.

³ http://www.flr-project.org/doc/Statistical_catch_at_age_models_in_FLa4a.html

For more settings see the Stock annex.

Data screening

Figure 6.3.3a shows catch proportions-at-age where larger proportions can be observed for ages 1 to 3. Figure 6.3.3b shows landings proportions at age, indicating that the bulk of the landings consisted of ages 1 and 2 before 1994 then shifted mostly to ages 2 to 4 since the mid-1990s. The proportions-at-age decreases for ages 1 and 2 while increasing for the older ages. Some weak and strong cohorts can be observed in this figure, particularly around the mid-1990s and in the last period. In 2010, an increase in landings of older ages, especially ages 5 to 7+, was observed. In the last period, the high abundances of age 1 in the Spanish SpGFS-WIBTS-Q4 (G2784) survey in some years since 2010 can be tracked in the following years (Figure 6.3.8). Figure 6.3.3c shows discards proportions-at-age, being more abundant for age 1 from 2000 onwards. Before this year, discarding was higher for age 2 individuals.

Final run

The a4a framework (Millar and Jardim, 2019) was selected for use as in assessment model for the stock. Model description and settings are detailed in the Stock Annex.

6.3.3.3 Assessment results

Figure 6.3.11 shows the patterns in F-at-age and catchability estimated by the model. F is estimated to be low for age 1, then increases for age 5 and decreases again for ages 6 and 7+ (F is forced to be the same for ages 6 and 7+). The catchability (Q) of the Spanish (SpGFS-WIBTS-Q4, (G2784) survey increase along a logistic function.

The log residuals of catch and abundance index by age are shown in Figure 6.3.12. showing a slight trend in catch, overestimating catch in recent years.

The summary plots of the assessment are shown in Figure 6.3.13 and the summary results are presented in Table 6.3.5.

F decreases in the last year and although the general trend is decreasing, higher values have been observed in the last 10 years but still the lowest in the series. Catches show a slight increase with a value around the average of the last 10 years. The SSB values in 2001 and 2002 were the lowest in the series. Since 2017, values were significantly higher and there is an increasing trend especially in the most recent years. Since 2015, recruitment (age 1) has presented the highest values in the time-series.

The retrospective analysis shows a small but consistent pattern of SSB overestimation and F underestimation in recent years with Monn's Rho values of -0.463 for F, 0.734 for SSB and 0.127 for R (Figure 6.3.14).

6.3.4 Biological reference points

Biological reference points were established during the WKMEGRIM benchmark (ICES, 2022).

Methods

- Model used: Eqsim
- Software used: R packages msy (version 0.1.19), FLCore (version 2.6.18) in R (version 4.1.2) and icesAdvice (version 2.0.0)

	Type	Value	Technical basis
MSY approach	MSY B _{trigger}	725 t	B _{pa}

	Type	Value	Technical basis
	F_{MSY}	0.173	Stochastic simulations (<i>EqSim</i>) based on the recruitment period 1986–2020
	B_{lim}	532 t	B_{loss} , biomass in 2001 as estimated in 2022
Precautionary approach	B_{pa}	725 t	$B_{lim} \times \exp(1.645 \times 0.142)$
	F_{lim}	0.619	The F that results in long-term probability ($SSB < B_{lim}$) = 50%; calculated by stochastic simulation (<i>EqSim</i>) using a segmented regression with B_{lim} as the breakpoint and no error
	F_{pa}	0.45	$F_{p,0.5}$ with AR: The F that provides a 95% probability for SSB to be above B_{lim} .
EU Management plan (MAP; EU, 2019)	MAP $MSY B_{trigger}$	725 t	$MSY B_{trigger}$
	MAP B_{lim}	532 t	B_{lim}
	MAP F_{MSY}	0.173	F_{MSY}
	MAP range F_{lower}	0.112	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.284	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY

6.3.5 Short-term projections

Methods

- Model used: `stf()` and `fwd()` functions in R packages *FLasher* and *FLCore*.
- Software used: R packages *icesTAF* (version 3.6.0) and *FLasher* (version 0.6.7) in R (version 4.1.2)
- Settings and assumptions for Interim Year and for Forecast are described in the Stock Annex and have been followed to calculate the projections.
- Recruitment in last year was replaced by the geometric mean of 1998–2020
- Recruitment-at-age 1 assumed equal in intermediate year and all the projection as the geometric mean (GM) from 1998 to final assessment year minus 2.
- $F_{status\ quo}$: Average F_{bar} for the last three years.

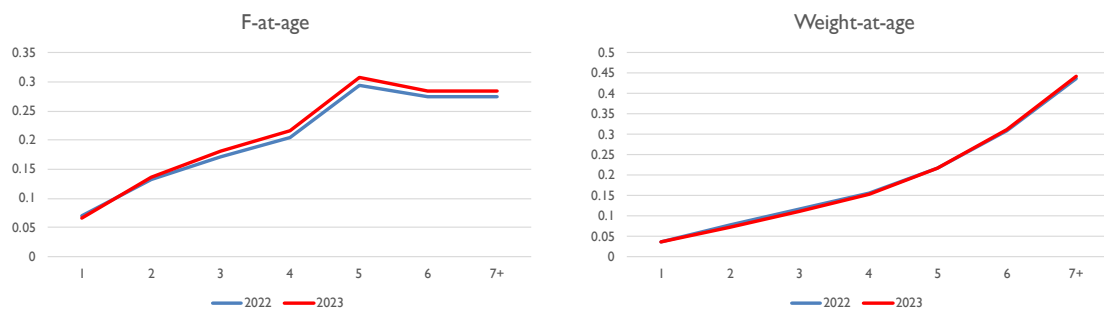
The values for the forecast and for the interim year, basis of the catch scenarios, are shown in Table 6.3.6. Management options for catch prediction are in Table 6.3.7.

Changes in advice

Current advice is 31% higher than last year advice. In order to explain the increase in advice, some comparison have been made. First, a matrix comparing the current estimates of numbers at age to the previous year's estimates to get a quick overview of how the estimate of stock size at age has changed. Also, two plots with selectivity and weight at age comparing the current and last year's selectivity/weights. Two tables with the values used in the interim year in the current and last year's assessments are also shown and finally, the Spanish survey abundance index (SpGFS-WIBTS-Q4 (G2784)) by age.

Age / length	2019	2020	2021	2022	2023
1	0.95	1.67	1.81	5.02	Na
2	0.81	0.94	1.65	1.80	Na
3	0.78	0.79	0.92	1.61	Na
4	0.82	0.75	0.76	0.89	Na
5	0.81	0.78	0.72	0.73	Na
6	0.80	0.76	0.73	0.68	Na
7	0.81	0.76	0.71	0.69	Na

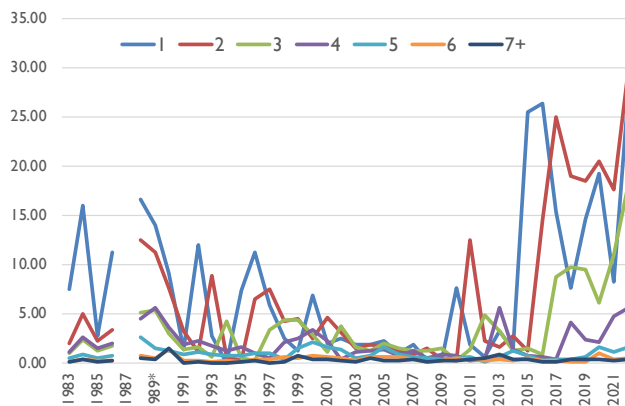
Number estimated in current assessment / number estimated previous assessment



Selectivity and weight at age of the current and last year's assessment.

2023		
Variable	Value	Notes
F[ages 2-4] (2023)	0.104	Fsq = average F (2020–2022).
SSB (2024)	6207	Short-term forecast (STF); in tonnes.
R[age 1] (2023, 2024)	3910	Geometric mean 1998–2020; in thousands.
Total catch (2023)	699	STF; in tonnes.
Projected landings (2023)	656	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	43	STF assuming average landings ratio at age 2018–2022; in tonnes.
2022		
Variable	Value	Notes
Fages 2–4(2022)	0.106	Fsq = average F (2019–2021).
SSB (2023)	4650	Short-term forecast (STF); in tonnes.
Rage 1 (2022–2023)	3760	Geometric mean 1998–2019; in thousands.
Total catch (2022)	553	STF using Fsq ; in tonnes.
Projected landings (2022)	531	STF assuming average landings ratio at age 2019–2021; in tonnes.
Projected discards (2022)	22	STF assuming average discards ratio at age 2019–2021; in tonnes.

The values for the forecast and for the interim year of the current and last year's assessment.



the Spanish survey abundance index (SpGFS-WIBTS-Q4 (G2784)) by age.

The advice for 2024 is 31% higher than the advice for 2023. The main reason for this is the increase in numbers at age [ages 1-4 in year 2022] estimated in current assessment. In addition, there is an increase in the abundance index from the Spanish survey, with the highest value of the time series. All ages contribute to this increase, especially the youngest. The comparison of the exploitation patterns and weights at age from the last assessment with the ones from the current assessment do not explain the increase in advice because there are no appreciable differences between them.

6.3.6 Comments on the assessment

The use of the new a4a (Millar and Jardim, 2019) assessment model and the definition of new reference points, estimated following the standard ICES approach (ICES, 2021a), gave new relative values in relation to the reference points for SSB, F and R. Figure 6.3.15 shows historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. Last year's assessment is in orange while previous year's assessment results (ICES, 2021c) are in blue.

The model results have been accepted and although it shows a retrospective pattern with some peels which are out of bounds, the 2023 advice was drafted following the WKFORBIAS decision tree (ICES, 2020) as $SSB > MSY B_{trigger}$ and $F_{HCR} < F_{pa}$.

6.3.6.1 Interbenchmark proposal

In 2022 this stock was benchmarked during the WKMEGRIM (ICES, 2022) and the change of assessment model to the a4a (Millar and Jardim, 2019) model led to an improvement and progress due to the replacement of the XSA (Shepherd, 1999) deterministic assessment model which includes some uncertainties (ICES, 2021c). However, one of the problems that already existed in the deterministic model remains unsolved (ICES, 2021c). A strong retro bias (SSB overestimation and F underestimation) still remains despite the change in assessment method (ICES, 2022).

During the WKMEgrim benchmark (ICES, 2022), it was not possible to find a4a experts to participate during the meeting who may have provided guidelines or advice to resolve these issues. Due to this outstanding modelling problem, WGBIE still supports the organization of an inter-benchmark as soon as possible, with an objective of soliciting the participation of a4a experts in

order to explore, improve and validate other model configurations and obtain better and robust retrospective pattern fits.

6.3.7 Management considerations

Megrim, *L. whiffiagonis*, is caught in mixed fisheries. There is a common TAC for both megrim species (*L. whiffiagonis* and *L. boscii*), so the status of both stocks should be taken into consideration when formulating management advice. Megrim are caught as bycatch in mixed fisheries that generally target white fishes. Therefore, the F of megrims could be influenced by some restrictions imposed on demersal mixed fisheries that aim to preserve and rebuild the overexploited southern hake and *Nephrops* stocks.

This is a small stock (average stock SSB since 1986 is 1258 t). Fishery management geared on decreasing F of megrim stock to low values could cause serious difficulties for the exploitation of other stocks in the mixed fishery (i.e. choke species effect). Both Iberian megrim stocks are assessed separately but managed together, a situation that may produce inconsistencies when these stocks are considered in a mixed fisheries management approach. This effect was already observed in the results of the mixed fisheries analysis developed for Iberian stocks by the WGMIXFISH-ADVICE (ICES, 2021b). Of course, any F that will be applied for the management of megrim must conform with the precautionary approach.

WGBIE considered that this stock could be just “the tail” of a much larger megrim stock in ICES Subarea 7 and divisions 8.a, 8.b, and 8.d and suggested reconsidering the stock limits and its inclusion with the Northern megrim stock. This option was studied during the Stock Identification Methods Working Group (SIMWG) in 2015 and the conclusion was that SIMWG did not find any strong evidence to support the combination of the northern with southern area stock. Furthermore, SIMWG recommends that the current stock definition should be kept until more supportive and conclusive studies are developed (ICES, 2015).

6.3.8 References

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6.3.9 Tables and figures

Table. 6.3.1. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Landings, discards and catch in tonnes.

Year	Spain landings			Portugal landings	Unallocated	Total landings	Discards	Total catch
	8c	9a*	Total	9a				
1986	508	98	606	53		659	46	705
1987	404	46	450	47		497	40	537
1988	657	59	716	101		817	42	859
1989	533	45	578	136		714	47	761
1990	841	25	866	111		977	45	1022
1991	494	16	510	104		614	41	655
1992	474	5	479	37		516	42	558
1993	338	7	345	38		383	38	421
1994	440	8	448	31		479	13	492
1995	173	20	193	25		218	40	258
1996	283	21	305	24		329	44	373
1997	298	12	310	46		356	52	408
1998	372	8	380	66		446	36	482
1999	332	4	336	7		343	43	386
2000	238	5	243	10		253	35	288
2001	167	2	169	5		175	19	193
2002	112	3	115	3		117	19	137
2003	113	3	116	17		134	15	148
2004	142	1	144	5		149	11	159
2005	120	1	121	26		147	19	166
2006	173	2	175	35		210	16	226
2007	139	2	141	14		155	0.4	155
**2008	114	2	116	17		133	11	144
2009	74	2	77	7		84	11	94
2010	66	8	74	10		83	5	88
^2011	242	0	242	34	26	302	69	371
^2012	151	11	161	18	83	262	31	293
^2013	128	3	131	11	90	231	18	250
2014	225	5	231	30	116	377	23	399
2015	188	2	190	23	63	276	21	297
2016	171	1	172	15	48	235	63	298
2017	189	4	193	16	39	247	41	288
2018	227	8	234	7	74	315	37	352
2019	226	7	233	6		239	51	289
2020	278	26	305	10		315	5	320
2021	236	16	252	10		262	32	294
2022	261	25	285	24		310	40	350

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

*** Official data by country and unallocated landings

Table. 6.3.2a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discard/Total Catch ratio and estimated CV for Spain from on-board sampling.

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007	2008	2009
Weight Ratio	0.03	0.14	0.12	0.13	0.11	0.07	0.14	0.08	0.00	0.08	0.13
CV	50.83	32.23	33.4	48.41	19.93	29.24	43.17	31.62	55.01	58.8	52.9
Number Ratio	0.10	0.38	0.34	0.45	0.26	0.16	0.28	0.21	0.01	0.20	0.36

Year	2010	2011*	2012	2013	2014	2015	2016	2017	2018	2019	2020
Weight Ratio	0.06	0.23	0.12	0.07	0.06	0.07	0.21	0.14	0.10	0.17	0.02
CV	61.6	23.7	28.8	30.3	44.7	49.8	57.1	28.9			
Number Ratio	0.27	0.57	0.37	0.24	0.20	0.29	0.47	0.34	0.26	0.37	0.05

Year	2021	2022
Weight Ratio	0.11	0.11
CV		
Number Ratio	0.23	0.24

All discard data revised in WG2011

*Data revised in WG2013

Table. 6.3.2b. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discards in numbers-at-age (thousands) for Spanish trawlers.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	138	138	138	138	138	138	138	138	104	138	138	41	138	270	27
2	339	339	339	339	339	339	339	339	93	339	339	453	339	471	611
3	425	425	425	425	425	425	425	425	136	425	425	857	425	284	160
4	130	130	130	130	130	130	130	130	51	130	130	142	130	197	73
5	10	10	10	10	10	10	10	10	3	10	10	1	10	26	19
6	4	4	4	4	4	4	4	4	1	4	4	5	4	6	0
7	1	1	1	1	1	1	1	1	0	1	1	3	1	0	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	2012	2013	2014	2015
1	10	10	0	4	20	0	0	0	96	16	12	8	330	442	624
2	338	338	239	164	223	19	11	126	142	119	2044	808	53	94	10
3	82	82	57	28	61	108	0	86	21	6	346	85	13	16	4
4	31	31	12	6	38	115	0	8	15	1	1	41	5	2	1
5	9	9	4	5	11	28	0	5	7	2	2	2	0	0	0
6	1	1	0	3	4	13	0	2	7	0	0	1	0	0	0
7	1	1	0	2	1	4	0	0	3	1	0	1	0	0	0

	2016	2017	2018	2019	2020	2021	2022
1	1074	492	203	487	42	80	67
2	373	410	387	337	54	316	276
3	3	43	110	135	3	128	287
4	1	0	28	40	0	11	30
5	0	0	1	6	0	4	5
6	0	0	1	0	0	2	0
7	0	0	0	0	0	2	0

Table 6.3.3a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Annual length distribution of landings in 2022.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	766
17	104
18	9203
19	27445
20	103366
21	119220
22	201084
23	217144
24	226129
25	223890
26	185558
27	154243
28	144394
29	113522
30	98445
31	77544
32	66368
33	43562
34	36939
35	26900
36	17280
37	12694
38	12499
39	6102
40	4378
41	4134
42	2580
43	849
44	1356
45	701
46	593
47	602
48	206
49	96
50+	96
Total	2139993

Table 6.3.3b. Mean lengths and mean weights in landings since 1990.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Mean length (cm)	22.3	23.5	24.6	23.4	25.1	24.7	24.6	24.6	24.7	25.3	25.8	25.1	26
Mean weight (g)	105	108	129	108	124	121	120	118	119	127	134	124	137

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mean length (cm)	25.7	26.1	25.32	26.15	26.68	26.64	27.58	29.4	27.63	28.2	29.39	28.6	28.72
Mean weight (g)	134	137	127	137	148	146.8	163.2	187.4	159.5	163.2	187.5	170.7	172.3

Year	2016	2017	2018	2019	2020	2021	2022
Mean length (cm)	26.81	26.41	27.18	26.71	28.53	26.67	26.49
Mean weight (g)	145.7	134.1	147.8	139.9	169.1	147.3	144.8

Table 6.3.4. Megrim (*L. whiffiagonis*) divisions 8.c and 9.a. Biomass, Abundance and Recruitment indices from Portuguese and Spanish surveys.

Biomass Index					Abundance index					Recruitment index		
Portugal (k/h)					Spain (n/30 min)					At age I	At age 0	At age I
October	Crustaceans	s.e.	Mean	s.e.	Portugal (n/h)	s.e.	Mean	s.e.	Portugal (n)	Spain (n/30 min)	October	
1983			0.96	0.14	1983		14.0	2.45	1983		1.88	7.72
1984			1.92	0.34	1984		28.0	4.57	1984		0.32	16.08
1985			0.89	0.15	1985		9.0	1.34	1985		0.10	2.74
1986			1.65	0.2	1986		33.0	6.22	1986		13.78	11.19
1987			ns		1987		ns		1987		ns	ns
1988			3.52	0.64	1988		43.0	8.82	1988		0.65	16.60
1989			3.13	0.5332	1989		42.0	7.04	1989		2.90	13.96
1990	0.08		3.08	0.86	1990		28.0	5.5	1990	5	0.11	9.13
1991	0.11		1.22	0.17	1991		10.0	1.67	1991	5	1.26	1.38
1992	0.11		1.39	0.2	1992		18.0	3.35	1992	8	0.01	12.03
1993	0.04		1.46	0.24	1993		15.0	3.23	1993	1	0.00	2.76
1994	0.05		1.02	0.2	1994		8.0	1.87	1994 +		0.60	0.05
1995	0.01		1.03	0.16	1995		11.0	1.86	1995 +		0.41	7.38
A, 1996 +			1.64	0.22	A, 1996		21.0	3.6	A, 1996 +		0.45	11.26
1997 +		1.41	1.79	0.25	1997	7.22	20.0	3.26	1997 +		0.15	5.91
1998	0.01	0.20	1.47	0.23	1998	1.09	14.8	2.64	1998 +		0.02	2.56
A,B, 1999 +		0.11	1.59	0.29	A,B, 1999	0.57	15.5	3.05	A,B, 1999 +		0.56	1.26
2000 +		0.06	1.8	0.35	2000	0.27	19.4	4.46	2000 +		0.05	6.92
2001	0	0.04	1.45	0.28	2001	0.07	12.8	2.77	2001 +		0.19	1.97
2002	0.04	0.07	1.26	0.24	2002	0.21	12.1	2.65	2002 +		0.08	2.53
A, 2003	0.01	0.07	0.82	0.16	A, 2003	0.16	7.2	1.26	A, 2003	0.05	0.05	1.91
A, 2004	0.01	ns	1.08	0.2	A, 2004	ns	8.44	1.39	A, 2004 +		0.14	1.83
2005	0.01	0.37	1.29	0.21	2005	0.71	9.76	1.73	2005 +		0.08	2.21
2006	0.02	0.29	1.03	0.18	2006	0.43	6.38	1.16	2006		0.00	0.89
2007	0	0.15	1.13	0.24	2007	0.49	6.87	1.52	2007		0.01	1.87
2008	0	0.25	0.68	0.15	2008	1.49	4.33	1.07	2008		0.00	0.23
2009	0.00	*0.05	0.80	0.12	2009	*0.19	4.17	0.59	2009		0.19	0.20
2010	0.01	0.20	0.89	0.16	2010	0.56	10.15	1.97	2010		0.01	7.63
2011	0.00	0.84	1.83	0.35	2011	1.75	17.45	3.86	2011		0.00	1.94
2012	ns	ns	1.38	0.19	2012	ns	9.07	1.29	2012		0.03	0.58
**2013	0	0.20	2.44	0.39	2013	0.43	15.89	2.58	2013		0.02	3.24
2014	0.02	0.30	1.34	0.21	2014	0.81	9.04	1.26	2014		0.40	1.32
2015	0.06	0.27	1.86	0.26	2015	0.89	30.75	5.64	2015		0.28	25.46
2016	0.06	0.26	2.71	0.28	2016	0.90	43.10	5.35	2016		0.02	26.31
2017	0.06	0.21	3.75	0.39	2017	2.04	50.23	6.04	2017		0.00	15.42
2018	0.04	0.18	3.42	0.30	2018	1.49	41.45	4.37	2018		0.05	7.62
2019	ns	ns	3.93	0.43	2019	ns	46.19	5.86	2019		0.09	14.58
2020	ns	ns	3.79	0.49	2020	ns	51.00	6.34	2020		0.04	19.20
***2021	0.12	0.07	3.34	0.36	2021	0.18	43.48	5.06	2021		0.13	8.22
2022	0.09	0.39	5.78	0.73	2022	0.94	84.19	10.79	2022		0.09	27.72

+ less than 0.04

ns no survey

A Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)

B Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)

* Revised in WG2011

** Since 2013 new vessel for Spanish survey (Miguel Oliver)

*** From 2021 new vessel for Portuguese surveys (Mário Ruivo) with changes in the gear used in the October survey

Table 6.3.5. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Summary of catches and a4a results.

Summary

YEAR	LANDINGS	DISCARDS	CATCH	CatEst	TSB	SSB	SsbCv	RECRUITS	RecrCv	FBAR 2- 4	FbarCv
								Age I			
1986	659	46	705	667.29	2053.32	1478.05	0.077	7221.05	0.122	0.445	0.119
1987	497.1	39.9	537	369.32	1743.23	1176.48	0.075	8693.58	0.118	0.278	0.129
1988	816.5	41.5	858	651.36	2063.31	1442.28	0.069	8909.43	0.118	0.439	0.115
1989	713.6	47.4	761	657.87	2293.47	1562.54	0.067	10696.55	0.118	0.396	0.115
1990	977.3	44.7	1022	747.07	2218.72	1572.51	0.064	8492.75	0.115	0.483	0.116
1991	614.3	40.7	655	619.65	1753.36	1331.77	0.067	5550.58	0.116	0.487	0.115
1992	515.9	42.1	558	597.69	1750.90	1271.84	0.074	11541.50	0.113	0.474	0.109
1993	382.9	38.1	421	379.42	1568.67	1153.11	0.073	5055.48	0.115	0.302	0.121
1994	479.1	12.9	492	508.00	1294.40	1108.38	0.073	1663.57	0.112	0.512	0.108
1995	218.5	39.5	258	238.53	1169.56	784.46	0.083	7421.27	0.112	0.264	0.124
1996	329	44	373	288.48	1407.27	897.13	0.076	8037.57	0.111	0.261	0.119
1997	355.9	52.1	408	292.56	1372.13	982.37	0.072	6751.09	0.116	0.267	0.116
1998	445.9	36.1	482	517.82	1431.55	1144.37	0.072	4485.09	0.120	0.485	0.104
1999	342.7	43.3	386	393.25	1021.20	860.07	0.075	2316.29	0.117	0.485	0.115
2000	253.2	34.8	288	267.24	814.51	648.54	0.090	3431.02	0.116	0.400	0.124
2001	175.2	18.8	194	197.43	721.51	526.15	0.100	2928.67	0.112	0.340	0.143
2002	116.8	19.2	136	144.22	727.83	571.59	0.121	2324.89	0.109	0.221	0.147
2003	134.1	14.9	149	147.99	863.31	668.90	0.118	2768.59	0.110	0.192	0.145
2004	149.1	10.9	160	185.36	870.52	626.65	0.108	3560.90	0.112	0.257	0.145
2005	146.8	19.2	166	182.32	882.38	660.04	0.111	2597.73	0.115	0.241	0.138
2006	210.3	15.7	226	259.60	928.75	717.94	0.108	2449.45	0.116	0.341	0.129
2007	154.6	0.4	155	185.34	860.95	639.84	0.111	2544.52	0.111	0.254	0.140
2008	133.5	10.5	144	150.30	759.77	637.84	0.115	1443.89	0.109	0.206	0.143
2009	84.4	10.6	95	97.14	751.73	665.55	0.113	1225.97	0.106	0.124	0.140
2010	83.5	4.5	88	92.56	963.67	671.68	0.106	7159.14	0.108	0.104	0.135
2011	301.6	69.4	371	328.45	1204.38	884.56	0.084	3796.00	0.109	0.333	0.115
2012	262.2	30.8	293	327.75	1148.49	961.42	0.078	2267.52	0.114	0.351	0.116
2013	231.9	18.1	250	244.44	1043.65	884.73	0.079	2520.32	0.119	0.266	0.120
2014	376.2	22.8	399	375.85	958.56	816.11	0.079	1682.40	0.121	0.463	0.108
2015	276	21	297	321.86	958.36	596.98	0.086	8700.72	0.126	0.502	0.111
2016	234.8	63.2	298	264.17	1249.86	691.40	0.092	8474.40	0.128	0.320	0.131
2017	247.3	40.7	288	245.92	1523.62	1015.47	0.100	7397.38	0.140	0.220	0.145
2018	315.3	36.7	352	485.27	1773.99	1209.97	0.108	11026.19	0.160	0.399	0.175
2019	238.4	50.6	289	311.60	2345.40	1438.19	0.144	16258.92	0.196	0.177	0.195
2020	314.8	5.2	320	436.26	3955.97	2404.22	0.159	23795.21	0.255	0.147	0.230
2021	261.8	32.2	294	337.41	4022.28	3116.53	0.183	13083.24	0.375	0.092	0.228
2022	309.9	40.1	350	365.36	5348.79	4253.24	0.199	18895.82	0.795	0.071	0.229
2023*	NA	NA	NA	NA	NA	NA	NA	3909.99	NA	0.104	NA

Table 6.3.6. Megrim (*L. whiffiagonis*) in Div. 8c and 9a. The values for the forecast and for the interim year.

Variable	Value	Notes
F[ages 2-4] (2023)	0.104	Fsq = average F (2020–2022).
SSB (2024)	6207	Short-term forecast (STF); in tonnes.
R[age I] (2023, 2024)	3910	Geometric mean 1998–2020; in thousands.
Total catch (2023)	699	STF; in tonnes.
Projected landings (2023)	656	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	43	STF assuming average landings ratio at age 2018–2022; in tonnes.

Table 6.3.7. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Catch forecast: management options table.

Basis	Total catch	Wanted catch	Unwanted catch	F[total]	F[wanted]	F[unwanted]	SSB	% SSB change
	2024	2024	2024	(ages 2-4) (2024)	(ages 2-4) (2024)	(ages 1-2) (2024)	2025	
MSY approach: F[MSY]	1271	1229	42	0.173	0.138	0.057	5575	-10.2
F=MAP F[MSY lower]	859	831	28	0.112	0.089	0.037	6070	-2.2
F=MAP F[MSY upper]	1915	1850	65	0.280	0.224	0.093	4809	-23
F=0	0	0	0	0.000	0.000	0.000	7102	14.4
F[pa]	2757	2660	97	0.450	0.360	0.149	3814	-39
F[lim]	3417	3292	124	0.619	0.494	0.204	3042	-51
SSB (2025)=B[pa]	5487	5250	237	1.771	1.415	0.585	725	-88
SSB(2025)=B[lim]	5677	5425	252	2.045	1.634	0.676	532	-91
SSB(2025)=MSY B[trigger]	5487	5250	237	1.771	1.415	0.585	725	-88
SSB(2024) = SSB (2025)	744	720	24	0.096	0.077	0.032	6207	0
F[2023]	799	773	26	0.104	0.083	0.034	6141	-1.05
Roll-over TAC	968	936	32	0.128	0.102	0.042	5938	-4.3

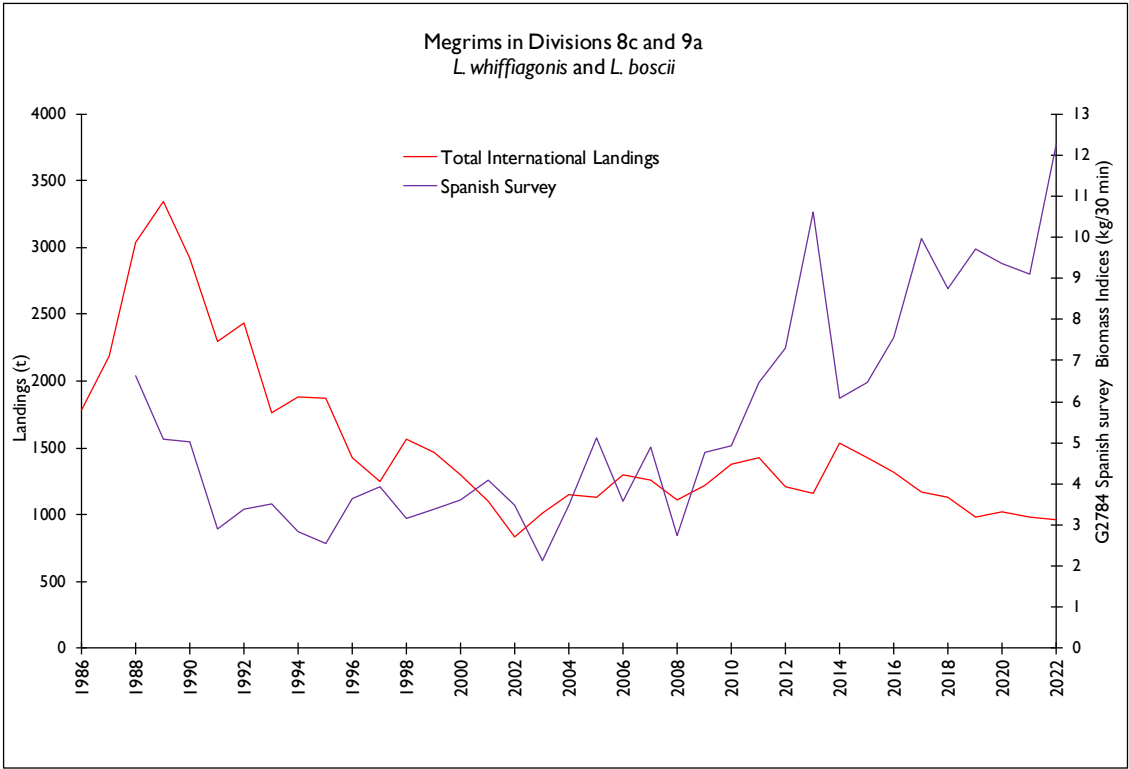


Figure 6.3.1. Historical landings and biomass indices of combined megrim stocks from the Spanish SpGFS-WIBTS-Q4 (G2784) survey.

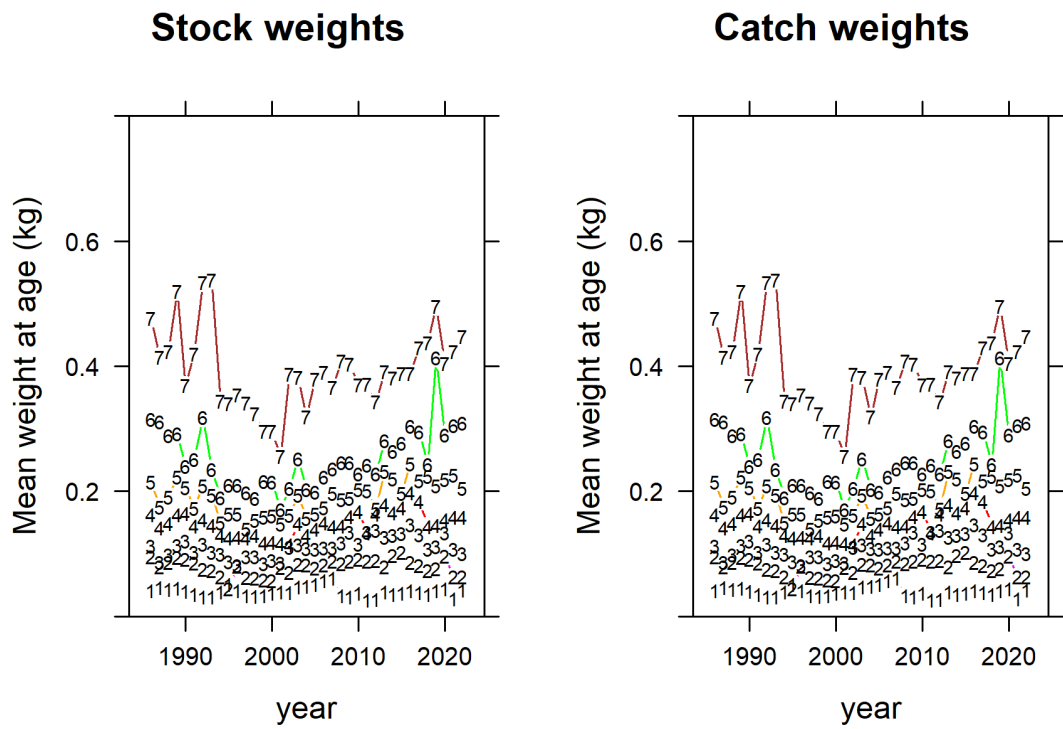


Figure 6.3.2. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Discards proportions-at-age.

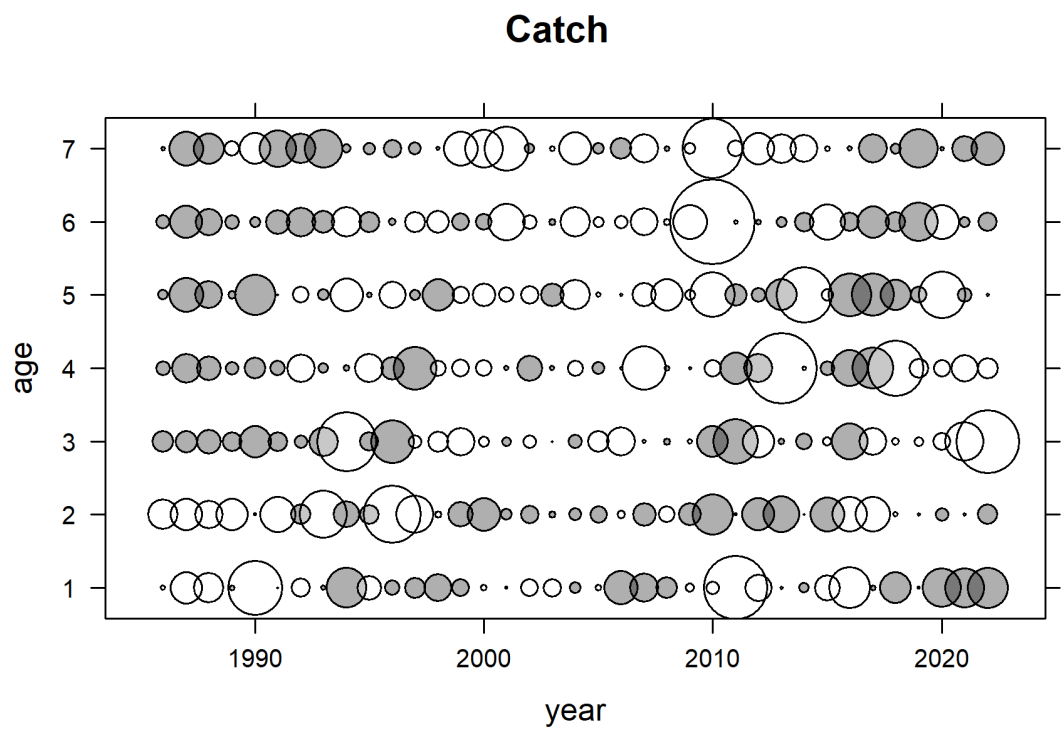


Figure 6.3.3a. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized catches proportions-at-age.

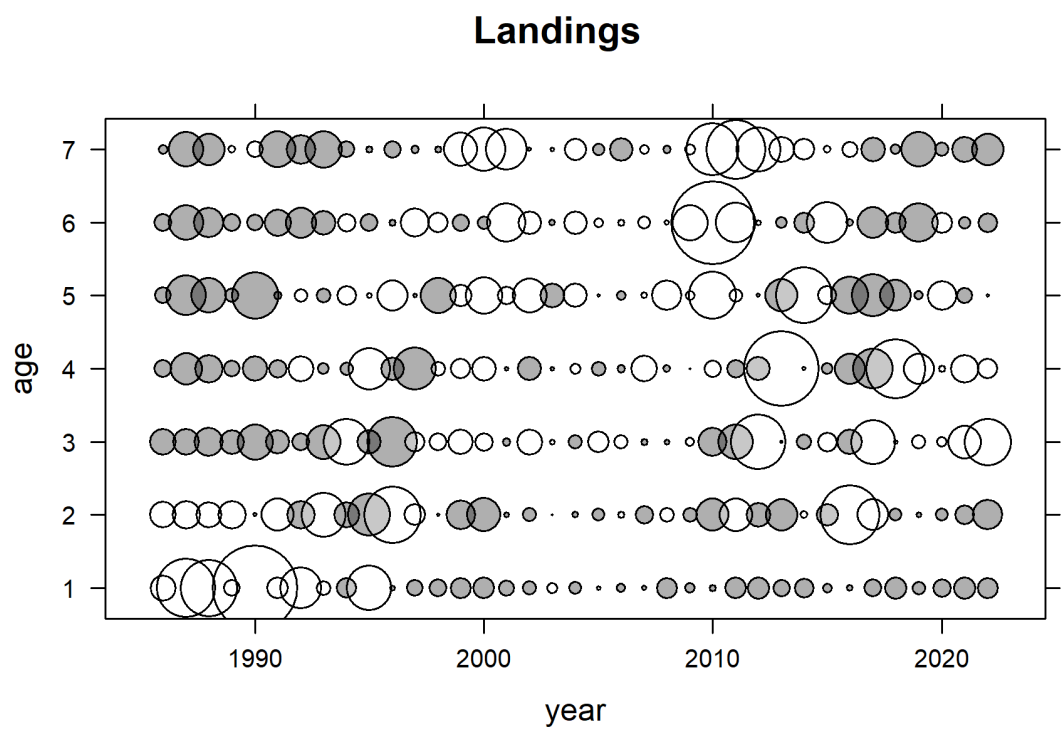


Figure 6.3.3b. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized landings proportions-at-age.

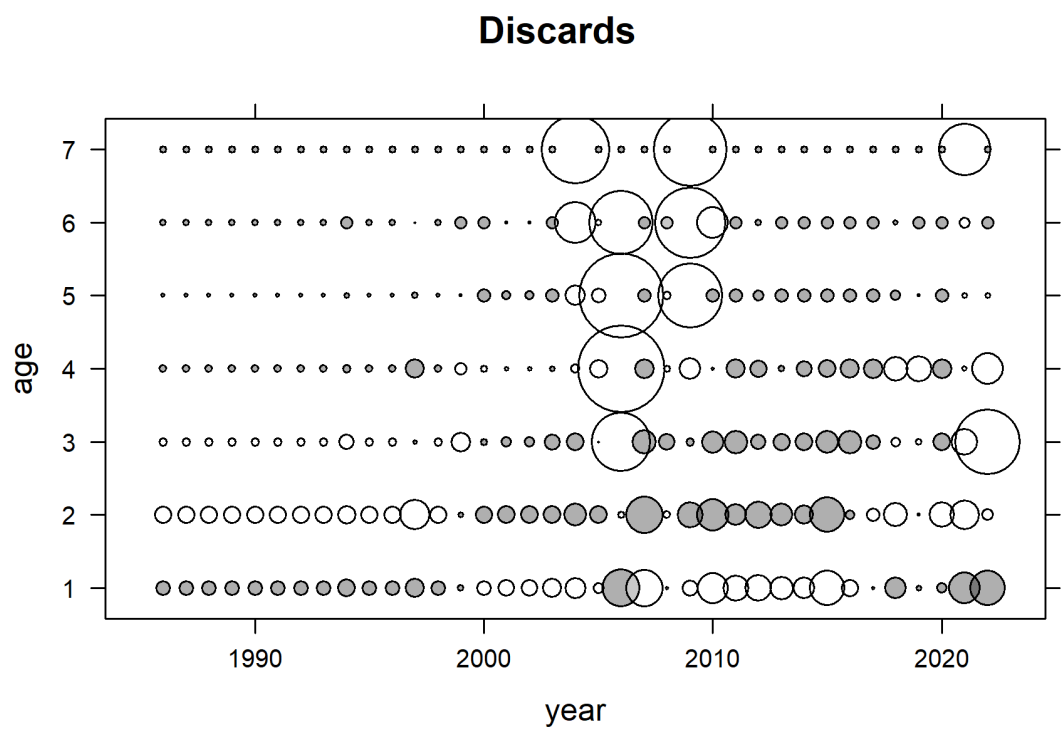


Figure 6.3.3c. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized discards proportions-at-age.

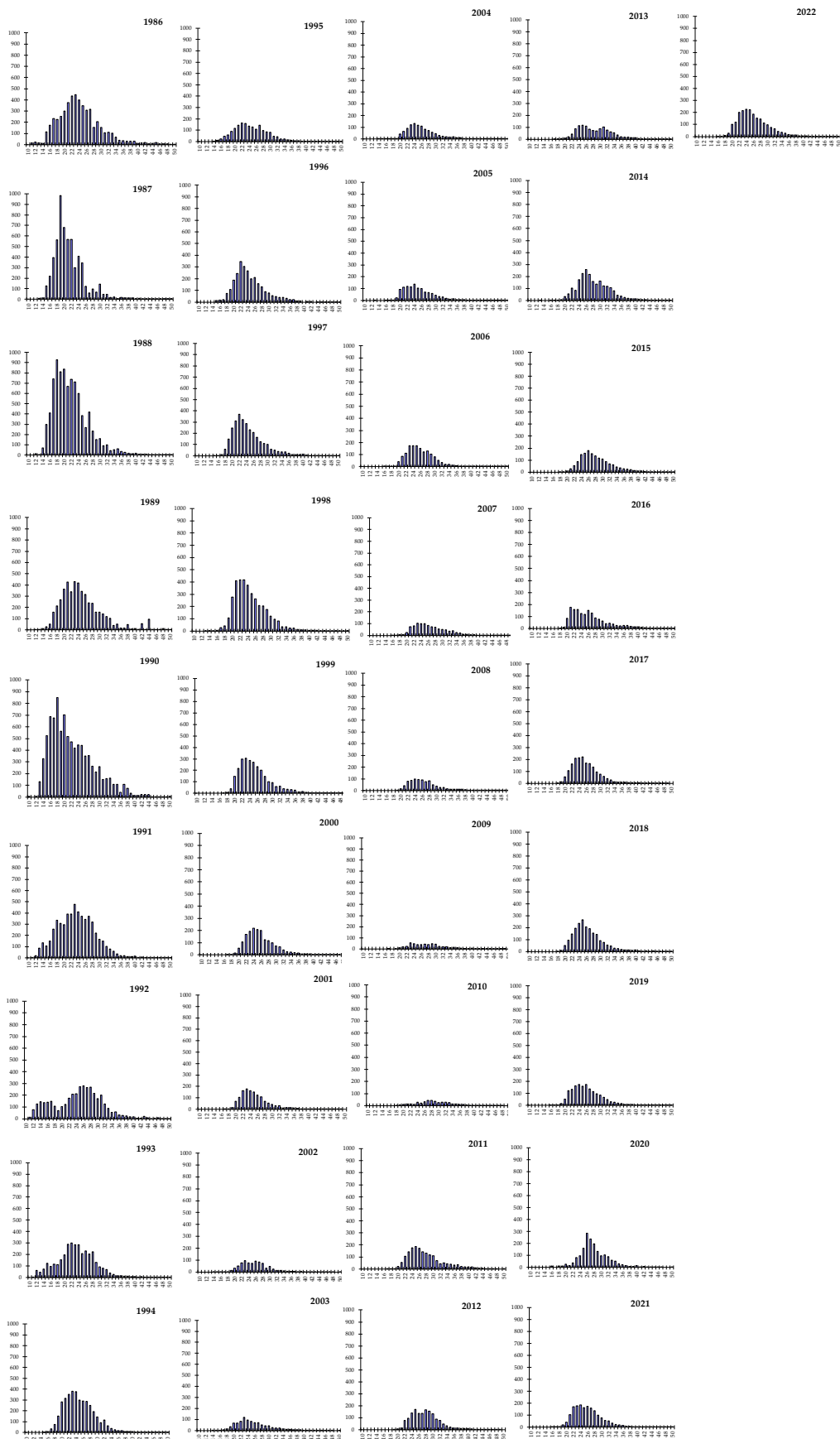


Figure 6.3.4. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Annual length compositions of landings ('000).

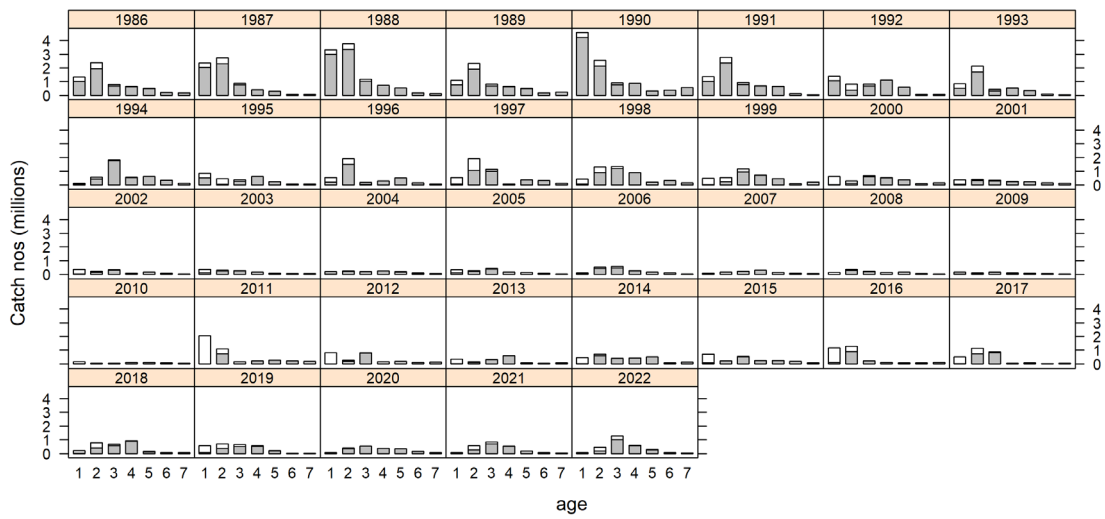


Figure 6.3.5. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Age composition of catches.

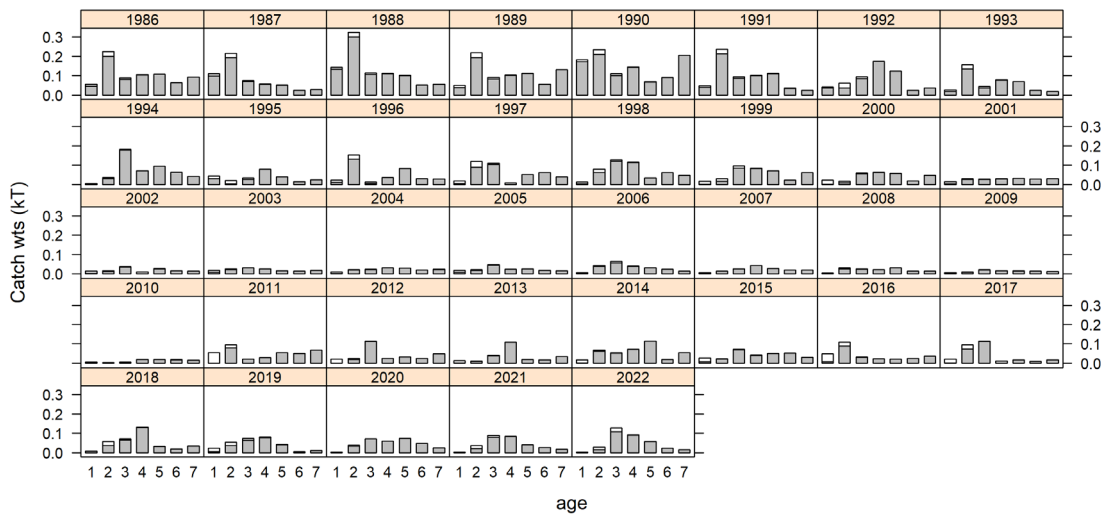


Figure 6.3.6. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Weights-at-age of catches.

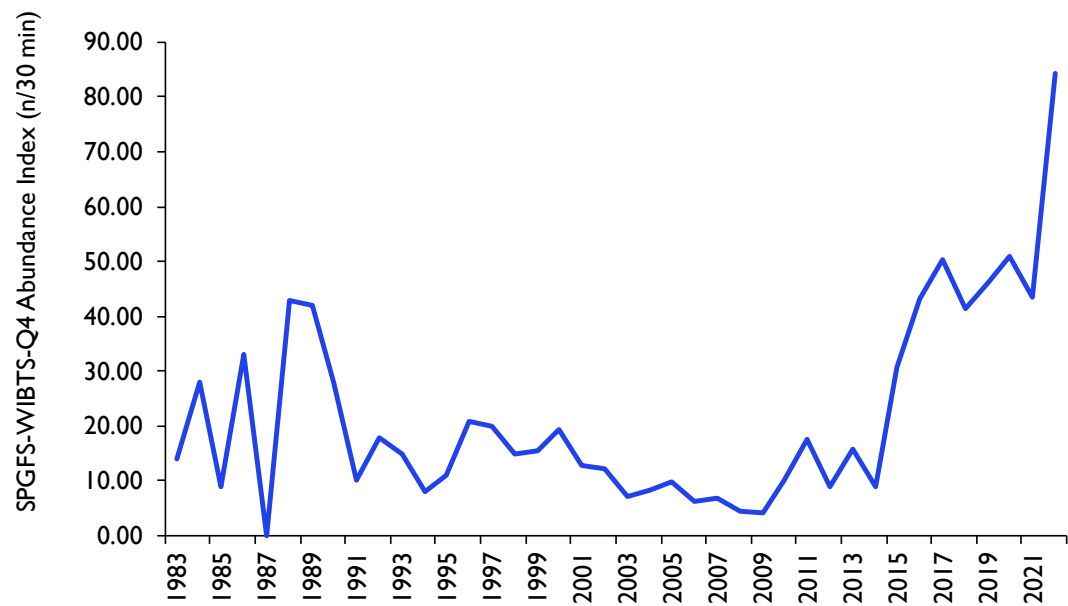


Figure 6.3.7. Megrim (*L.whiffiagonis*) in divisions 8.c and 9.a. Abundance Index from the SP-NSGFS-Q4 (G2784) survey.

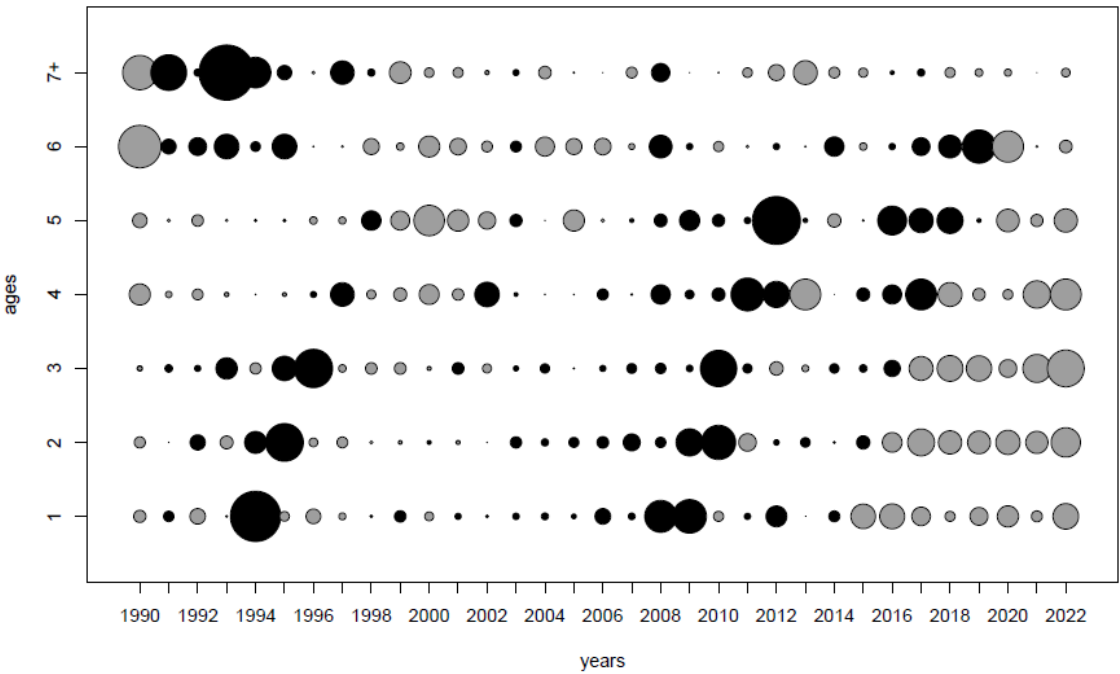


Figure 6.3.8. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from the SP-NSGFS-Q4 (G2784) survey.

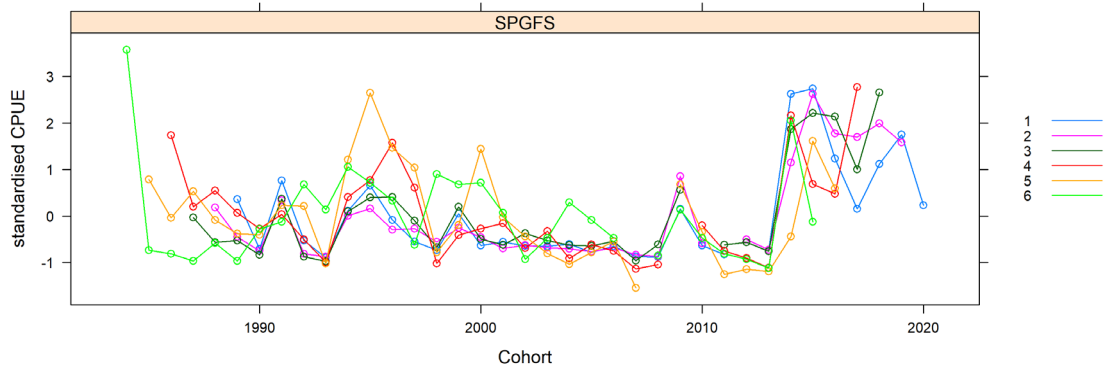


Figure 6.3.9. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Internal consistency of the standardized CPUE index from the SP-NSGFS-Q4 (G2784) survey.

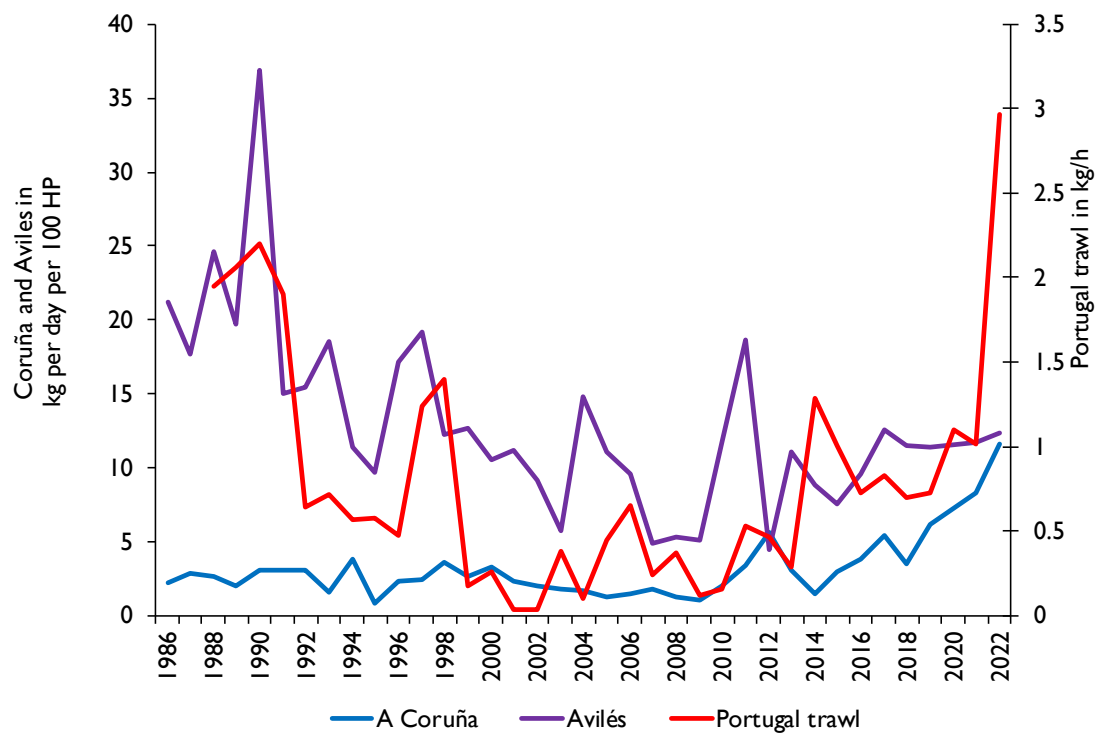


Figure 6.3.10. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. LPUE indices for Spanish and Portuguese commercial fleets.

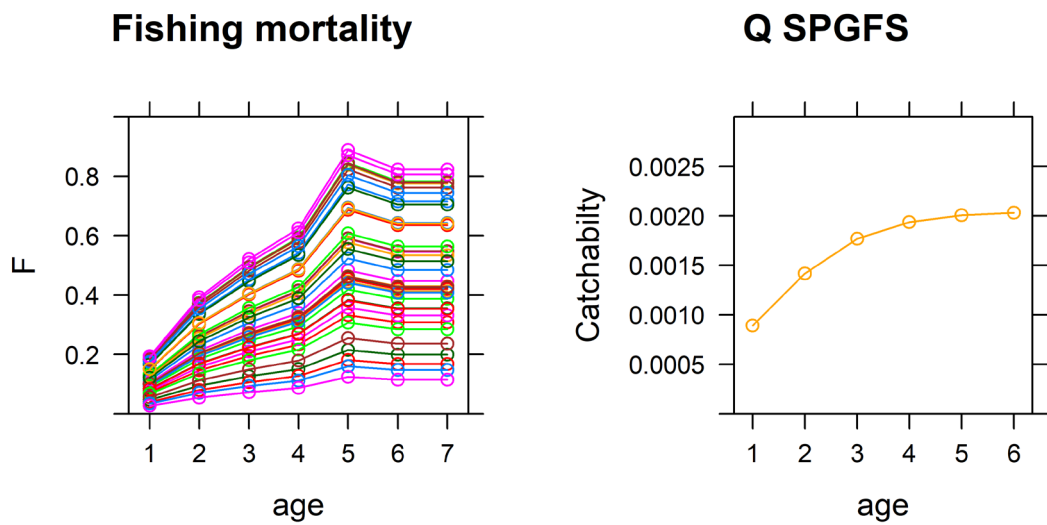


Figure 6.3.11. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. F-at-age (left; colours indicate years) and catchability-at-age (right) patterns of the SP-NSGFS-Q4 (G2784) survey.

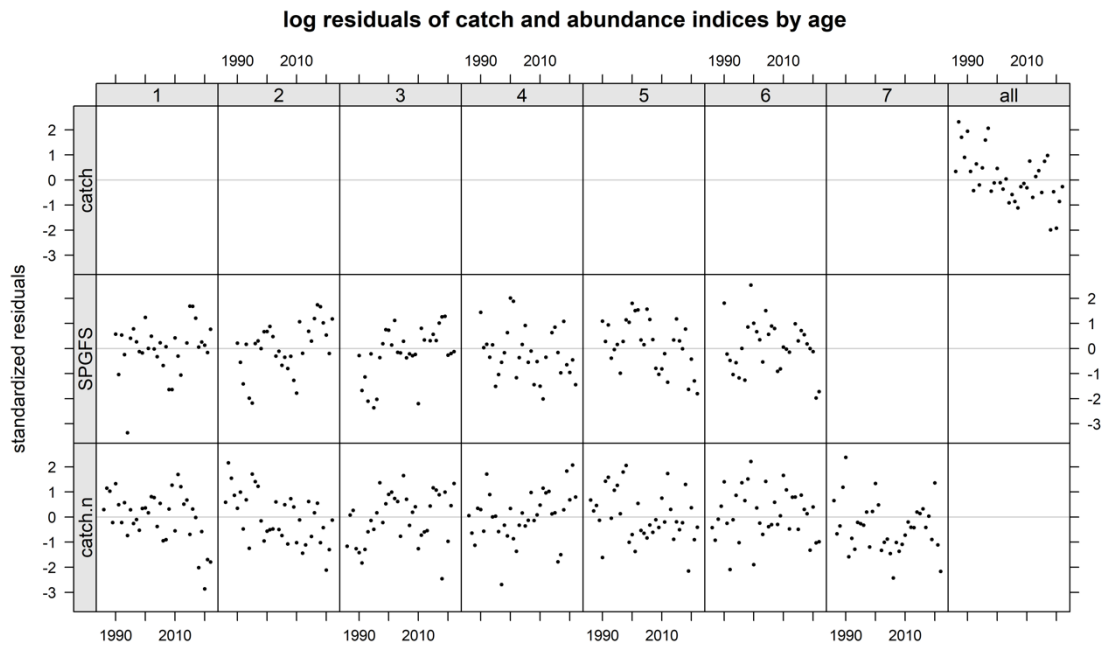


Figure 6.3.12. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Standardized residuals of the catch and the SP-NSGFS-Q4 (G2784) survey.

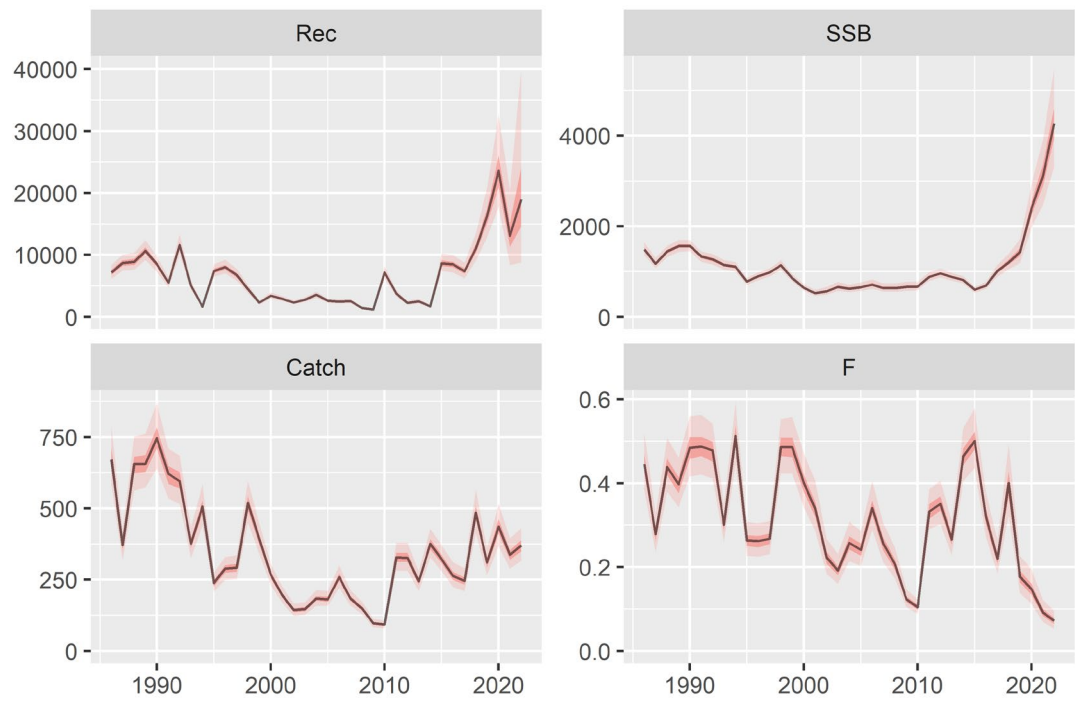


Figure 6.3.13. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Summary plots of the a4a assessment outputs.

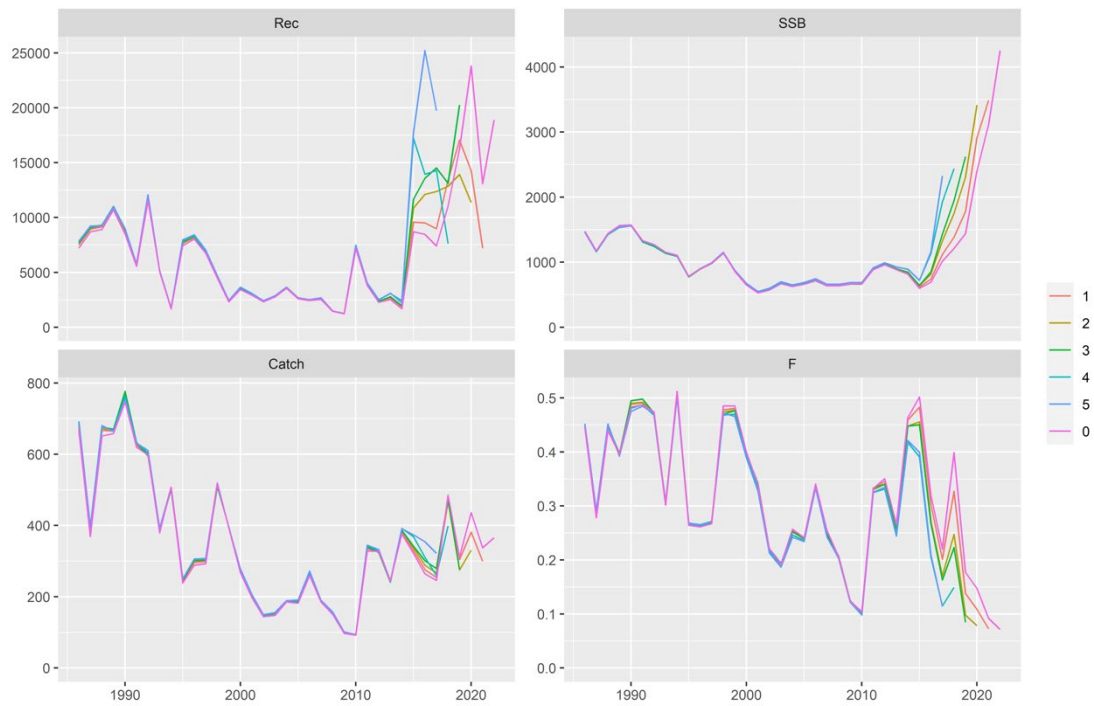


Figure 6.3.14. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Retro plots.

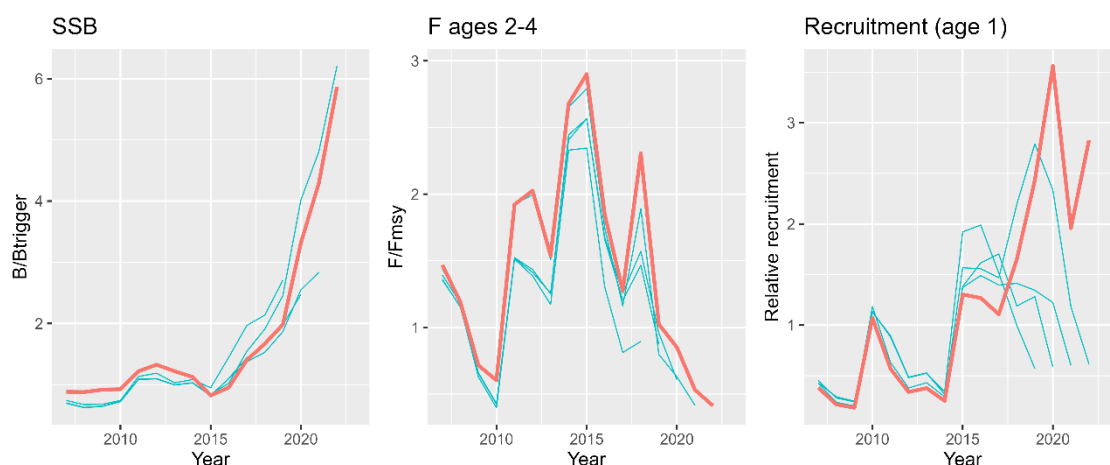


Figure 6.3.15. Megrim (*L. whiffiagonis*) in divisions 8.c and 9.a. Historical assessment results. Last year of geometric mean recruitment included. The assessment model and the reference points were revised in 2022 during the WKMEGRIM (ICES, 2022).

6.4 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a

6.4.1 General

See general section for both species.

6.4.2 Data

6.4.2.1 Commercial catches and discards

WGBIE estimates of four-spot megrim international landings, discards, and catches for the period 1986 to 2022 are given in Table 6.4.1. From 2011 to 2018, estimates of unallocated or non-reported landings were included in the assessment. These were estimated based on the sampled vessels (Spanish concurrent sampling) raised to the total effort for each métier. Currently, these estimates are considered the best information available for the stock. In 2015, revised data for the period 2011–2013 were provided. This revision produced an improvement in the allocation of sampling trips and, consequently, were used in the assessment. Landings reached a peak of 2629 t in 1989 and have generally declined since then to their lowest value of 720 t in 2002. There has been some increase observed in the following years. Landings in 2014 are 1531 t, the highest value after 1995. In 2022, a landings value of 644 t was observed and is the lowest of the whole time-series.

Discards estimates were available from the “observers’ on board sampling programme” for Spain in the years displayed in Table 6.4.2a. Discard / Total Catch ratio and CV are also presented, where discards represent between 21–67% of the total catch. Following the ICES recommendations in the advice sheet and using the same methodology described for *L. whiffiagonis* in section 6.3.2.1, discards missing data were also estimated for *L. boscii* in the WKSOUTH benchmark in 2014 (ICES, 2014). Spanish discards in numbers-at-age are shown in Table 6.4.2b that indicates that the bulk of discards (in numbers) is for ages 1 to 3. Total discards in tonnes) are summarized in Table 6.4.1 Figure 6.4.1 shows the proportion of discards-at-age.

Figures 6.4.2 (a, b, and c) show the standardized catches, landings a discards proportion-at-age, where cohort tracking can be observed.

6.4.2.2 Biological sampling

Annual length compositions of total stock landings are provided in Figure 6.4.3 for the period 1986–2022 and in Table 6.4.3a for the year 2022.

Mean length and mean weight in landings since 1990 are provided in Table 6.4.3b.

Age compositions of catches are presented in Figure 6.4.4. Weights-at-age of catches (given in Figure 6.4.5) were also used as weights-at-age in the stock. There are some variabilities of the weights-at-age through the historical time-series.

More information of the stock's biological data are provided in the Stock Annex, which includes in details the updates and new information approved in the WKMEGRIM benchmark (ICES, 2022a).

6.4.2.3 Abundance indices from surveys

Portuguese and Spanish survey indices are summarized in Table 6.4.4.

Two Portuguese surveys, named "Crustacean" (NepS (FU 28–29), G2913) and "October" (PtGFS-WIBTS-Q4, G8899), provide biomass and abundance indices. In 2012 and the years, 2019 and 2020, the Portuguese Surveys were not carried out and only resumed in 2021 but had been performed using a new vessel.

Portuguese "October" (PtGFS-WIBTS-Q4 (G8899)) survey

The October survey was conducted with a different vessel and gear in 2003 and 2004. Excluding these two years, the biomass index from this survey in 2021 was the highest observed since 1994, whereas the value in 2010 is the second-lowest in the series. Portuguese October index is not considered to be representative of the four-spot megrim abundance due to the very low catch rates.

Portuguese "Crustacean" (NepS (FU 28–29) (G2913)) survey

This survey covers part of the distribution of the four-spot megrim in Portuguese waters in the South of Division 9.a and was accepted as a survey series to be included in the assessment during the WKMEGRIM benchmark (ICES, 2022a). As the survey was performed using a new vessel since 2021, the continuity of the series must be analysed. Also to note a lower spatial coverage in 2021 (Moura, 2022; WD 05 in ICES, 2022b) and bad weather condition affecting the survey in 2022. For these reasons, these last two years of the survey were not included in the assessment. In 2018, both the biomass and abundance indices from the Crustacean NepS (FU 28–29) (G2913) survey were the highest values in the time-series. The abundance index from the Crustacean NepS (FU 28–29) (G2913) survey is shown in Figure 6.4.6. Age-length keys (ALKs) from the Spanish SP-NSGFS-Q4 (G2784) survey were applied for this survey, for which ages are not available. Figure 6.4.7 shows the bubble plot of log(abundance index at age) standardized by subtracting the mean and dividing by the standard deviation over the years (1997–2018) and where some cohorts can be identified. Figure 6.3.8 shows a "slight noise" in the internal consistency of the standardized indices of this survey and the Spanish (SP-NSGFS-Q4, G2784) one.

Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) survey

Total biomass, abundance and recruitment indices from the Spanish Groundfish Survey (SP-NSGFS-Q4 (G2784)) are also presented in Table 6.4.4. Total biomass indices from this survey generally remained stable after a maximum level from 1988 until 2003. In 2003, a very low value was obtained and as such, the 2003 index has been excluded from the assessment (as done in previous years) due to its significant contradiction with the rest of the time-series. Since then, this was followed by a period of higher values until the present days, with the exception of 2008. For the same reason as that for *L. whiffiagonis*, the abundance value of 2013 was not included in

the assessment model. In 2017, the survey presented the second-highest value in both biomass and abundance indices, remaining at high levels in 2019 and 2020. The abundance index is shown in Figure 6.4.9. In 2021, the second part of the survey was performed on a different vessel but with the same sampling gear as the standardly used vessel suffered some technical issues. It was assumed that this change in vessel would have an impact but was considered as minor which validated the use of the 2021 index as appropriate for use in the assessment. The recruitment indices for age 0 in 2005, 2009 and 2014 were very high. A value below average was estimated for the year 2022. The high indices in 2009 and 2014 applies to all ages and not just the recruitment (see Figure 6.4.10, which is a bubble plot of $\log(\text{abundance index at age})$ standardized by subtracting the mean and dividing by the standard deviation over the years). Since 2009, almost all ages appears to be above average. From Figure 6.4.10, the survey results appear to have been quite good in tracking cohorts during the last ten years and where the stronger cohorts for the years 2005, 2009 and 2014 can be followed, especially the last two.

Type	Name	Year range	Age range	Used in the assessment
Spanish Groundfish survey	SpGFS-WIBTS-Q4 (G2784)	1983-present	1–6	Yes
Portuguese October Groundfish survey	PtGFS-WIBTS-Q4 (G8899)	1990-present	Biomass index	No
Portuguese Crustacean survey	NepS (FU 28–29) (G2913)	1997-present	1–6	Yes

6.4.2.4 Commercial catch-effort data

The commercial LPUE and effort data of the Portuguese trawlers fishing in Division 9.a and of one Spanish fishing ports operation in *métier* OTB_DEF_>=55_0_0 in 8.c and 9.a are available and cover the period 1986–2022. Figure 6.4.11 show the LPUEs whose trends have been increasing till the last years where a decrease can be observed.

The use of commercial LPUEs was rejected during the WKMEGRIM benchmark in 2022 (ICES, 2022a) due to concerns about changes in efficiency, targeting behaviour, quota restrictions, technical measures, discarding and compliance. However, these trends can be used as supplementary information by WGBIE.

6.4.3 Assessment

An assessment was conducted according to the Stock Annex specifications. Assessment years are 1986–2022 and ages 0–7+.

The a4a (Millar and Jardim, 2019) stock assessment model is selected and implemented for the assessment of the stock. It is a non-linear catch-at-age model implemented in R (R Core Team, 2022) and FLR (Kell *et al.*, 2007), and using ADMB (Fournier *et al.*, 2012), that can be applied rapidly to a wide range of situations with low parameterization requirements⁴.

6.4.3.1 Input data

Following the Stock Annex, discards and landed numbers-at-age were incorporated resulting in catch numbers-at-age as input data from 1986 to 2022. The year 2022 was added to the index of

⁴ http://www.flr-project.org/doc/Statistical_catch_at_age_models_in_FLa4a.html

the Spanish SP-NSGFS-Q4 (G2784) survey and the index from the Portuguese Crustacean NepS (FU 28–29) (G2913) survey from 1997 to 2018 was included in the model.

6.4.3.2 Model

Model Specification

Software used: R package Fla4a (version 1.8.2) in R (version 4.1.2), (see Stock Annex for details):

The model structure is defined by submodels, which are the different parts that require structural assumptions. There are five submodels in operation:

1. model for F-at-age,
2. model for the initial age structure,
3. model for recruitment,
4. (list) of model(s) for abundance indices catchability-at-age,
5. list of models for the observation variance of catch-at-age and abundance indices.

These submodels were defined as:

```
fmodel: ~factor(replace(age, age > 6, 6)) + factor(year)
srmodel: ~factor(year)
n1model: ~factor(age)
qmodel: list(~I(1/(1 + exp(-age))))+s(replace(age, age > 5, 5), k = 5),
          ~I(1/(1 + exp(-age))))
vmodel:
catch:    ~s(age, k = 3)
SpGFS-WIBTS-Q4: ~1
PT-CTS-UWTV -FU 28–29: ~1
```

The F model is a separable model. The shape of the F-at-age pattern is independently estimated for each age except for ages 6 and 7+, which are assumed to have the same Fs. This pattern in F is then independently scaled up and down for each year.

Stock–recruit model: Freely estimated for each year.

Catchability models:

For the SpGFS-WIBTS-Q4 (G2784) survey, catchability is assumed to increase asymptotically but ages 5 and 6 are bound (i.e. same catchability for these two ages). This configuration was selected in order to solve a residuals issue in this survey.

For the NepS (FU 28–29) (G2913) survey, catchability is assumed to increase asymptotically.

N1 model (population in the first year of the time-series): default value a4aSCA function (independently estimated for each age)

Vmodel (the shape of the observation variances): default value a4aSCA function: smooth function for the catch numbers-at-age and 'flat' for the indices

An FLStock object is needed and it was adapted from the XSA (Shepherd, 1999) input data. This object includes catches, landings, discards, weights-at-age, natural mortality, maturity, harvest before spawning and mortality before spawning.

Model Settings

- F_{bar} is set to ages 2–4.

The preliminary runs showed a trend in the residuals of age 0 in catch. As the first period of the discards time-series was estimated, it was decided to set age 0 in the catch to NA for the early years.

```
stock@catch.n[0',as.character(1986:1998)] <- NA
```

Data screening

Figures 6.4.2a, b and c are bubble plots corresponding to standardized catch, landings and discards proportions-at-age, respectively. These are used to show which one corresponding to the landings is the best to follow cohorts. These plots clearly indicate that the bulk of the landings generally corresponds to ages 2 to 4 and the discards to ages 1–2. However, during the last years, there seems to be an increase in age 5 and a decrease in age 2. Very weak cohorts corresponding to year classes of 1993 and 1998 can be clearly identified from the standardized landing proportions-at-age matrix and stronger cohorts corresponding to year classes of 1991, 1992, 1995, 2005, 2009 and 2014 can also be tracked.

Final run

a4a model (assessment for all) was selected for use in this assessment. Model description and settings are detailed in the Stock Annex.

6.4.3.3 Assessment results

Figure 6.4.12 shows the patterns in F-at-age and catchability estimated by the model. F is estimated to be low for age 1, then increases over ages to age 5 then decreases again for ages 6 and 7+ (F is forced to be the same for ages 6 and 7+). The catchability (Q) of the Portuguese survey (NepS (FU 28–29), G2913) increases along a logistic function while the Q of the Spanish (SpGFS-WIBTS-Q4, G2784) survey is assumed to increase asymptotically but ages 5 and 6 are bound.

The log residuals of catch and abundance index by age are shown in Figure 6.4.13. Some patterns in the residuals of age 0 in the catch were removed and were set to NA the first years of discards data because they had been estimated. Total catch residuals show a trend to overestimate catches in recent years.

Assessment results are summarized in Table 6.4.5 and Figure 6.4.14.

SSB decreased gradually from 1989 to 2002, with the lowest value in the series, and has since gradually increased, accentuating in recent years. In 2022, the SSB was estimated at 13 957 t, the highest of the time-series.

Recruitment has fluctuated around 46 million fish during all the series. Very weak year classes were observed in 1993 and 1998. Since 2014, when the maximum value of the time-series was reached, the recruitment has been decreasing until this year, which shows a small increase.

Estimates of F values show two different periods: an initial one with higher values from 1986 to 2001 and a second period at a lower level, with oscillating values. Since 2015, F has been decreasing, with only a very small increase in the last year.

The retrospective analysis shows no particular worrying features with Monn’s Rho values of -0.035 for F, -0.050 for SSB and -0.348 for R (Figure 6.4.15).

AIC	BIC	Mohn's Rho	Mohn's Rho	Mohn's Rho
		(Retro_F)	(Retro_SSB)	(Retro_R)
1112.798	1540.195	-0.035	-0.050	-0.348

6.4.4 Biological reference points

Biological reference points were established during the WKMEGRIM benchmark (ICES, 2022a).

- Model used: Eqsim
- Software used: R packages msy (version 0.1.19), FLCore (version 2.6.18) in R (version 4.1.2) and icesAdvice (version 2.0.0)

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	2932 t	B_{pa}
Approach	F_{MSY}	0.176	Stochastic simulations (<i>EqSim</i>) based on the recruitment period 1986–2020
	B_{lim}	2321 t	B_{lossr} biomass in 2001 as estimated in 2022
Precautionary	B_{pa}	2932 t	$B_{lim} \times \exp(1.645 \times 0.142)$
Approach	F_{lim}	0.56	The F that results in long-term probability ($SSB < B_{lim}$) = 50%; calculated by stochastic simulation (<i>EqSim</i>) using a segmented regression with B_{lim} as the breakpoint and no error
	F_{pa}	0.46	$F_{p,05}$ with AR: The F that provides a 95% probability for SSB to be above B_{lim} .
EU Management plan (MAP; EU, 2019)	MAP MSY $B_{trigger}$	2932 t	MSY $B_{trigger}$
	MAP B_{lim}	2321 t	B_{lim}
	MAP F_{MSY}	0.176	F_{MSY}
	MAP range F_{lower}	0.119	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY
	MAP range F_{upper}	0.28	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY

6.4.5 Short-term projections

- Model used: stf() and fwd() functions in R packages FFlasher and FLCore.
- Software used: R packages ices TAF (version 3.6.0) and FFlasher (version 0.6.7) in R (version 4.1.2)
- Settings and assumptions for the interim year and for the forecasts are described in the Stock Annex and have been the basis for the calculation of the projections.
- Recruitment-at-age 0 is assumed equal in the intermediate year and all the projections used the GM from 1990 to final assessment year minus 2.
- F_{sq} : Average F_{bar} for the last three years.

The values for the forecast and for the interim year, basis of the catch scenarios, are shown in Table 6.4.6. Management options for catch prediction are in Table 6.4.7.

6.4.6 Comments on the assessment

The use of the new a4a (Milar and Jardim, 2019) assessment model and the definition of new reference points, estimated following the standard ICES approach (ICES, 2021a), gave new relative values in relation to reference points for SSB, F and R. Figure 6.4.16 shows historical assessment results (final-year recruitment assumptions included for each line) relative to each year's reference points for comparison. Last year's assessment is in orange while the previous year's assessment results (ICES, 2021c) is in blue.

6.4.7 Management considerations

As with *L. whiffiagonis*, it should be noted that four-spot megrim (*L. boscii*) is caught in mixed fisheries, and management measures applied to this species may have implications for other stocks. Both species of megrims are subject to a common TAC, so the joint status of these species should be taken into account when formulating management advice.

6.4.8 References

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6.4.9 Tables and figures

Table. 6.4.1 Four-spot megrim (*L. bosci*) in divisions 8.c and 9.a. Landings, discards and catch in tonnes.

Year	Spain landings			Portugal landings	Unallocated	Total landings	Discards	Total catch
	8c	9a*	Total	9a				
1986	799	197	996	128		1124	284	1408
1987	995	586	1581	107		1688	333	2021
1988	917	1099	2016	207		2223	363	2586
1989	805	1548	2353	276		2629	408	3037
1990	927	798	1725	220		1945	409	2354
1991	841	634	1475	207		1682	447	2129
1992	654	938	1592	324		1916	437	2353
1993	744	419	1163	221		1384	438	1822
1994	665	561	1227	176		1403	517	1920
1995	685	826	1512	141		1652	406	2058
1996	480	448	928	170		1098	368	1466
1997	505	289	794	101		896	308	1204
1998	725	284	1010	113		1123	378	1501
1999	713	298	1011	114		1125	317	1442
2000	674	225	899	142		1041	373	1414
2001	629	177	807	124		931	290	1221
2002	343	247	590	130		720	308	1028
2003	393	314	707	169		876	191	1067
2004	534	295	829	177		1006	348	1354
2005	473	321	794	189		983	375	1358
2006	542	348	891	201		1092	335	1427
2007	591	295	886	218		1104	292	1396
*2008	546	262	808	172		980	202	1182
2009	577	342	919	215		1134	279	1413
2010	616	484	1100	197		1297	265	1562
^2011	390	384	774	181	172	1128	269	1397
^2012	240	239	479	98	374	952	369	1321
^2013	338	283	621	80	230	931	496	1427
2014	427	313	739	142	273	1154	788	1942
2015	460	255	715	137	296	1148	597	1745
2016	403	276	679	105	303	1087	332	1419
2017	346	265	611	144	172	926	246	1173
2018	381	231	612	130	72	814	92	906
2019	385	240	625	118		742	201	943
2020	346	224	569	141		711	81	792
2021	368	222	590	132		723	109	831
2022	334	231	566	78		644	119	763

^Data revised in WG2015

*9a is without Gulf of Cádiz till 2016

** Data revised in WG2010

* Official data by country and unallocated landings

Table. 6.4.2a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discard/Total Catch ratio and estimated CV for Spain from on-board sampling.

Year	1994	1997	1999	2000	2003	2004	2005	2006	2007
Weight Ratio	0.30	0.28	0.24	0.29	0.21	0.30	0.32	0.27	0.25
CV	23.2	11.2	14.4	16.5	10.2	23.1	24.0	48.4	18.3
Number Ratio	0.50	0.63	0.59	0.61	0.47	0.55	0.55	0.42	0.47

Year	2008	2009	2010	2011*	2012	2013	2014	2015	2016
Weight Ratio	0.20	0.23	0.19	0.24	0.39	0.35	0.41	0.34	0.23
CV	22.6	21.1	18.8	16.0	15.5	23.2	17.8	20.1	16.4
Number Ratio	0.42	0.39	0.62	0.50	0.52	0.63	0.67	0.60	0.47

Year	2017	2018	2019	2020	2021	2022
Weight Ratio	0.21	0.10	0.21	0.10	0.13	0.16
CV	15.2					
Number Ratio	0.39	0.24	0.41	0.21	0.26	0.30

**All discard data revised in WG2011

*Data revised in WG2013

Table. 6.4.2b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discards in numbers-at-age (thousands) for Spanish trawlers.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	1289	1289	1289	1289	1289	1289	1289	1289	678	1289	1289	256	1289
1	3322	3322	3322	3322	3322	3322	3322	3322	2741	3322	3322	3273	3322
2	4322	4322	4322	4322	4322	4322	4322	4322	4134	4322	4322	6099	4322
3	2211	2211	2211	2211	2211	2211	2211	2211	2710	2211	2211	2108	2211
4	605	605	605	605	605	605	605	605	581	605	605	146	605
5	94	94	94	94	94	94	94	94	189	94	94	90	94
6	20	20	20	20	20	20	20	20	55	20	20	3	20
7	4	4	4	4	4	4	4	4	11	4	4	0	4

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
0	2933	354	208	208	238	33	10	1	100	202	2	2879	30
1	3954	6148	5673	5673	4479	6393	3515	1233	3248	2342	1525	10362	5132
2	2734	1207	1750	1750	989	3053	5482	2497	4541	2374	2490	1301	3595
3	1815	1888	1025	1025	495	693	609	1445	757	1384	1970	696	544
4	1088	1218	477	477	50	163	183	486	105	52	480	283	174
5	3	171	67	67	2	27	56	168	44	10	51	83	37
6	0	12	4	4	0		23	22	7	3	7	11	1
7	1	2	1	1			6	9	1	3		1	

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0	682	275	0	157	2	0	0	0	0	0	3
1	5313	5499	5645	2437	1606	526	209	717	180	79	118
2	2480	4379	11089	7061	5506	2116	1066	1183	628	872	677
3	1057	3030	2139	4588	785	2305	638	2192	622	891	854
4	15	707	582	532	232	363	297	446	252	258	455
5	5	39	161	26	70	29	16	86	34	62	116
6	2	12	11	4	30	1	3	1	2	5	5
7	0	2	0	0	1	0	0	0	0	1	5

Table 6.4.3a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Annual length distribution of landings in 2022.

Length (cm)	Total
10	
11	
12	
13	
14	
15	
16	1544
17	12720
18	64678
19	195938
20	564760
21	719347
22	745133
23	622820
24	567764
25	412137
26	347995
27	258157
28	188700
29	134004
30	92773
31	73154
32	48269
33	31398
34	20536
35	11884
36	16357
37	11092
38	6290
39	2607
40	4036
41	1594
42	73
43	2096
44	996
45	779
46	839
47	22
48	45
49	45
50+	43
Total	5160623

Table 6.4.3b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a Mean lengths and mean weights in landings since 1990.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mean length (cm)	23.1	23.5	23.8	24.2	23.3	22.3	23	23.3	23.3	23.5	24.2	23.8
Mean weight (g)	116	118	122	128	111	96	107	112	109	113	121	114

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Mean length (cm)	23.1	22.9	22.7	22.7	22.9	23.5	23.6	23.6	24.1	23.7	23.7	23.9
Mean weight (g)	105	101	98	97.0	99.4	109.1	109.7	110.7	118.4	112.2	112.0	114.0

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mean length (cm)	24.2	24.1	24.2	23.7	24.0	23.8	23.5	23.8	24.1
Mean weight (g)	117.8	117.4	118.6	111.8	115.6	112.5	110.6	118.9	124.6

Table 6.4.4. Four-spot megrim (*L. boscii*) divisions 8.c and 9.a. Biomass, Abundance and Recruitment indices from Portuguese and Spanish surveys.

										Recruitment index					
										At age 1		At age 0		At age 1	
										Portugal (n)		Spain (n/30 min)			
Biomass Index					Abundance index										
Portugal (k/h)				Spain (k/30 min)		Portugal (n/h)			Spain (n/30 min)						
October	SE	Crustacean	var	Mean	SE	Crustacean	var	Mean	SE	October					
1983				0.67	0.13	1983		11.80	1.80	1983	0.98	5.74			
1984				0.76	0.08	1984		15.80	2.00	1984	1.80	7.83			
1985				0.71	0.11	1985		14.00	1.74	1985	0.15	7.45			
1986				1.68	0.28	1986		32.60	3.82	1986	2.99	16.36			
1987				ns	-	1987		ns	-	1987	ns	ns			
1988				3.10	0.33	1988		59.20	6.49	1988	2.90	24.64			
1989				1.97	0.28	1989		40.75	6.24	1989	8.49	16.68			
1990	0.26			1.93	0.14	1990		40.30	3.00	1990	153	0.44	19.06		
1991	0.18			1.67	0.17	1991		27.70	2.62	1991	26	2.53	9.25		
1992	0.14			1.98	0.20	1992		49.10	5.20	1992	42	2.37	35.00		
1993	0.11			2.07	0.25	1993		43.30	5.39	1993	8	0.30	21.38		
1994	0.16			1.82	0.23	1994		26.90	3.63	1994	2	3.48	2.94		
1995	0.08			1.51	0.12	1995		32.30	2.78	1995	4	1.92	19.58		
A,1996	0.10			2.00	0.19	A,1996		44.80	4.05	A,1996	16	3.57	20.56		
1997	0.06		4.04	3.19	2.17	0.22	1997	41.77	251.67	43.50	3.84	1997	1	3.54	13.34
1998	0.04		2.62	0.28	1.80	0.20	1998	28.05	72.57	34.30	4.45	1998	+	0.27	9.57
A,B,1999	+		0.03	0.00	1.93	0.24	A,B,1999	0.66	0.03	29.30	3.22	A,B,1999	+	0.94	7.46
2000	0.08		1.15	0.11	1.89	0.28	2000	11.10	11.72	33.00	4.56	2000	16	1.07	13.96
2001	0.09		1.35	0.14	2.65	0.25	2001	14.22	13.01	42.70	3.35	2001	25	0.59	16.95
2002	0.02		2.63	0.30	2.21	0.22	2002	38.90	43.23	34.60	3.33	2002	1	1.04	9.95
A,2003	1.36		3.71	0.34	1.32	0.16	A,2003	60.82	98.16	16.90	1.54	A,2003	8	0.65	4.95
A,2004	1.27		2.79	0.35	2.40	0.24	A,2004	42.59	90.21	43.94	3.71	A,2004	5	1.19	21.10
2005	0.05		2.62	0.41	3.84	0.41	2005	31.72	71.08	62.89	6.16	2005	+	4.71	17.70
2006	0.10		1.82	0.07	2.56	0.24	2006	32.81	35.01	41.47	3.02	2006		0.59	14.70
2007	0.14	0.06	3.08	0.37	3.75	0.35	2007	46.74	69.87	51.10	4.30	2007		0.88	11.30
2008	0.07	0.03	3.08	0.25	2.08	0.22	2008	32.86	34.41	32.20	3.00	2008		0.37	8.13
2009	0.06	0.02	1.77	0.16	3.96	0.32	2009	14.68	14.68	52.83	3.97	2009		3.37	7.42
2010	0.03	0.01	4.91	0.93	4.04	0.38	2010	80.59	360.69	72.75	6.82	2010		0.65	34.22
2011	0.14	0.06	4.24	0.89	4.64	0.39	2011	65.44	182.87	69.26	5.72	2011		0.91	8.90
2012	ns	ns	ns	ns	5.92	0.47	2012	ns	ns	82.14	5.98	2012		1.71	11.58
**2013	0.10	0.03	2.37	0.47	8.17	1.13	2013	36.91	96.36	119.99	17.48	2013		1.32	25.86
2014	0.12	0.03	2.15	0.44	4.75	0.28	2014	32.40	123.72	67.42	3.72	2014		3.72	12.32
2015	0.13	0.04	2.22	0.06	4.62	0.48	2015	37.35	32.35	78.00	7.47	2015		1.12	33.18
2016	0.12	0.04	2.65	0.10	4.84	0.32	2016	53.47	19.96	86.70	5.19	2016		2.43	18.06
2017	0.22	0.07	2.82	0.67	6.21	0.96	2017	54.03	215.08	111.24	13.61	2017		1.03	23.69
2018	0.11	0.03	8.98	####	5.35	0.45	2018	146.28	6409.79	88.04	7.05	2018		0.46	6.36
2019	ns	ns	ns	ns	5.77	0.48	2019	ns	ns	102.03	8.21	2019		0.94	20.46
2020	ns	ns	ns	ns	5.56	0.49	2020	ns	ns	97.85	7.88	2020		1.42	15.66
***2021	1.20	0.24	2.33	1.18	5.75	0.50	2021	27.92	147.17	94.90	8.18	2021		0.53	11.42
2022	0.72	0.22	1.51	0.02	6.47	0.56	2022	26.83	3.65	97.14	7.90	2022		0.88	11.28

+ less than 0.04

ns no survey

A Portuguese October Survey with different vessel and gear (Capricórnio and CAR net)

B Portuguese Crustacean Survey covers partial area only with a different Vessel (Mestre Costeiro)

* Revised in WGHMM2011

** From 2013 new vessel for Spanish survey (Miguel Oliver)

*** From 2021 new vessel for Portuguese surveys (Mário Ruivo) with changes in the gear used in the October survey

Table 6.4.5. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Summary of catches and a4a results.

YEAR	LANDINGS	DISCARDS	CATCH	CatEst	TSB	SSB	SsbCv	RECRUITS Age 0	RecrCv	FBAR 2-4	FbarCv
1986	1124	284	1408	1397.28	5118.74	3088.18	0.068	63887.66	0.085	0.424	0.095
1987	1688	333	2021	1681.84	6941.16	3881.89	0.066	42536.24	0.088	0.383	0.092
1988	2223	363	2586	2309.90	7617.46	4907.07	0.067	54582.26	0.089	0.458	0.085
1989	2629	408	3037	2863.28	7754.52	5126.99	0.070	54738.08	0.086	0.588	0.082
1990	1945	409	2354	2116.48	6645.61	4457.22	0.079	35096.50	0.087	0.467	0.087
1991	1682	447	2129	2016.02	6894.58	4487.16	0.076	75412.74	0.092	0.440	0.087
1992	1916	437	2353	2715.96	7239.85	4692.70	0.083	65061.62	0.087	0.625	0.077
1993	1384	438	1822	2099.79	6458.11	4018.64	0.078	20482.47	0.091	0.500	0.083
1994	1403	517	1920	2085.74	6433.45	4045.35	0.067	49219.82	0.090	0.511	0.084
1995	1652	406	2058	1991.37	5792.75	3719.01	0.072	58179.04	0.085	0.564	0.081
1996	1098	368	1466	1519.36	4919.72	2853.93	0.083	44177.57	0.080	0.498	0.085
1997	896	308	1204	962.26	4120.61	2592.54	0.087	29039.39	0.085	0.343	0.094
1998	1123	378	1501	1598.87	5253.62	3734.28	0.080	18992.15	0.086	0.432	0.094
1999	1125	317	1442	1446.68	4734.92	3545.48	0.087	30309.53	0.088	0.414	0.093
2000	1041	373	1414	1313.77	4215.69	2897.75	0.095	34606.42	0.089	0.458	0.091
2001	931	290	1221	1370.46	4005.18	2543.25	0.110	30400.43	0.082	0.548	0.096
2002	720	308	1028	964.72	4287.73	2573.29	0.117	37973.20	0.082	0.345	0.106
2003	876	191	1067	997.93	5055.32	2953.13	0.104	42133.62	0.088	0.303	0.107
2004	1006	348	1354	1286.77	5178.24	3042.98	0.098	38300.50	0.088	0.388	0.103
2005	983	375	1358	1185.97	5167.80	3087.16	0.094	63677.56	0.087	0.353	0.107
2006	1092	335	1427	1493.25	6425.36	3754.17	0.101	54143.82	0.087	0.364	0.107
2007	1104	292	1396	1449.32	6257.81	3749.52	0.104	39068.97	0.089	0.346	0.122
2008	980	202	1182	1231.74	6946.78	4757.92	0.114	29060.10	0.090	0.232	0.120
2009	1134	279	1413	1554.61	7149.69	5298.19	0.121	59782.32	0.088	0.278	0.117
2010	1297	265	1562	1540.55	7359.18	5682.28	0.128	42750.50	0.087	0.255	0.119
2011	1128	269	1397	1456.70	7118.95	5145.03	0.136	47413.87	0.091	0.262	0.120
2012	952	369	1321	1375.41	8542.69	5505.51	0.130	60099.64	0.101	0.227	0.123
2013	931	496	1427	1631.39	7714.98	5586.74	0.136	48754.28	0.111	0.275	0.120
2014	1154	788	1942	1838.54	8366.17	5920.72	0.141	80539.73	0.117	0.290	0.122
2015	1148	597	1745	1928.55	9178.18	5963.35	0.151	58616.12	0.117	0.304	0.131
2016	1087	332	1419	1400.63	9732.96	6491.83	0.156	77433.83	0.117	0.188	0.149
2017	927	246	1173	1333.46	10421.22	7084.03	0.160	51214.20	0.117	0.164	0.151
2018	814	92	906	945.99	10454.76	8146.43	0.163	54743.91	0.127	0.101	0.155
2019	742	201	943	1250.22	12430.57	10294.20	0.164	51477.47	0.158	0.109	0.142
2020	711	81	792	1018.88	13470.16	11241.78	0.159	33962.36	0.245	0.080	0.138
2021	722	109	831	1224.23	15014.71	13100.08	0.157	22650.90	0.367	0.085	0.136
2022	644	119	763	1253.37	15556.48	13957.25	0.151	29913.87	0.620	0.084	0.146
2023*	NA	NA	NA	NA	NA	NA	NA	44431.04	NA	0.083	NA

Table 6.4.6. Four-spot megrim (*L. boscii*) in Div. 8c and 9a. The values for the forecast and for the interim year.

Variable	Value	Notes
F[ages 2-4] (2023)	0.083	Fsq = average F (2020–2022).
SSB (2024)	13130	Short-term forecast (STF); in tonnes.
R[age 0] (2023, 2024)	44431	Geometric mean 1990–2020; in thousands.
Total catch (2023)	1220	STF; in tonnes.
Projected landings (2023)	1136	STF assuming average landings ratio at age 2018–2022; in tonnes.
Projected discards (2023)	84	STF assuming average landings ratio at age 2018–2022; in tonnes.

Table 6.4.7. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a catch forecast: management options table.

Basis	Total catch 2024	Wanted catch 2024	Unwanted catch 2024	F[total] (ages 2-4) (2024)	F[wanted] (ages 2-4) (2024)	F[unwanted] (ages 0-2) (2024)	SSB 2025	% SSB change	Advice change
MSY approach: F[MSY]	2351	2186	165	0.176	0.113	0.049	11371	-13.4	3
F=MAP F[MSY lower]	1640	1526	114	0.119	0.076	0.033	12126	-7.6	3
F=MAP F[MSY upper]	3537	3284	253	0.280	0.179	0.078	10117	-23	3
F=0	0	0	0	0.000	0.000	0.000	13877	5.7	-100
F[pa]	5291	4902	389	0.460	0.295	0.129	8277	-37	132
F[lm]	6107	5651	456	0.560	0.357	0.156	7428	-43	168
SSB (2025)=B[pa]	10564	9677	886	1.430	0.914	0.400	2932	-78	360
SSB(2025)=B[lm]	11203	10238	965	1.660	1.060	0.460	2321	-82	390
SSB(2024) = SSB (2025)	699	651	48	0.049	0.031	0.013	13130	0	-69
SSB(2025)=MSY B[trigger]	10564	9677	886	1.430	0.914	0.400	2932	-78	360
F[2023]	1166	1085	81	0.083	0.053	0.023	12632	-3.8	-49
Roll-over TAC	2282	2122	160	0.170	0.109	0.048	11444	-12.8	0

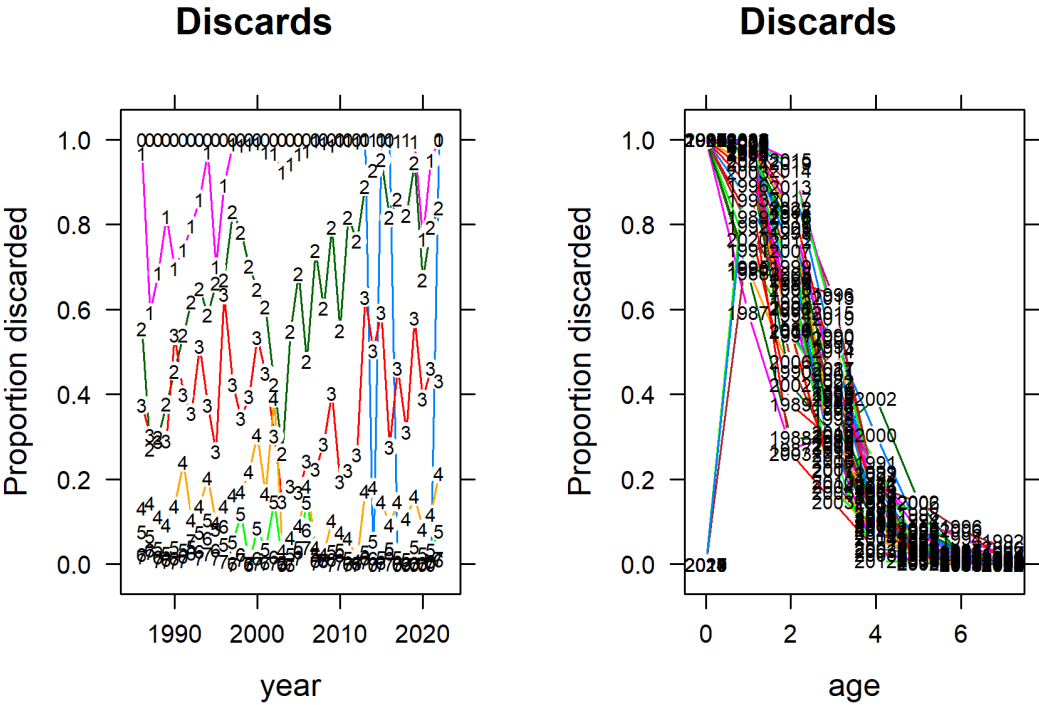


Figure 6.4.1. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Discards proportions-at-age.

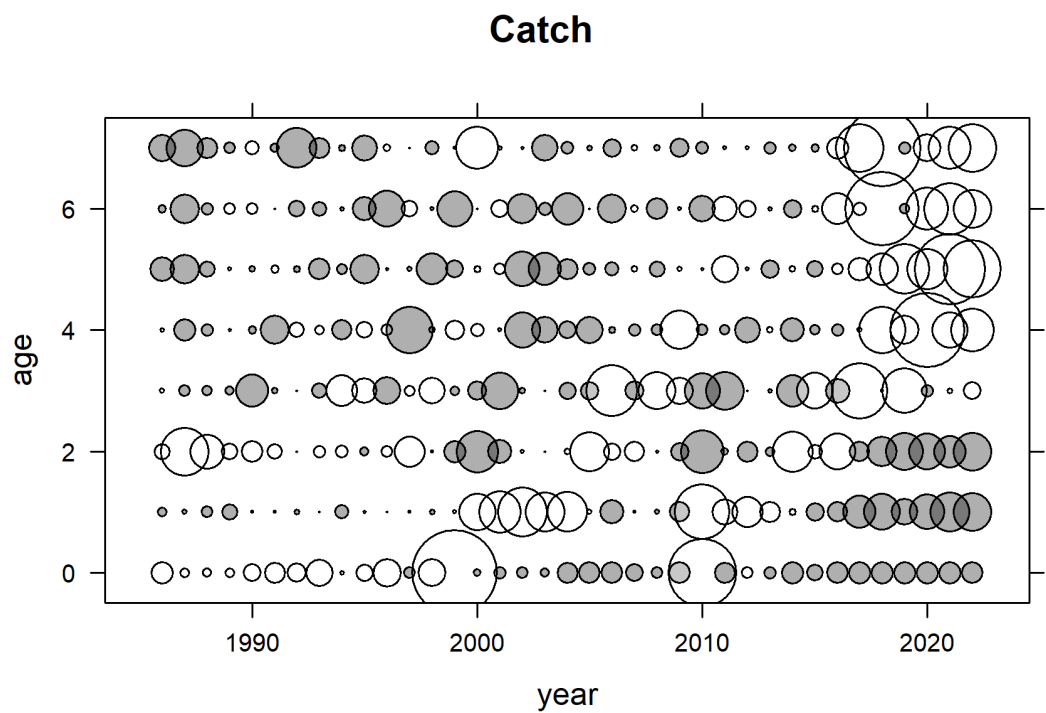


Figure 6.4.2a. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized catches proportions-at-age.

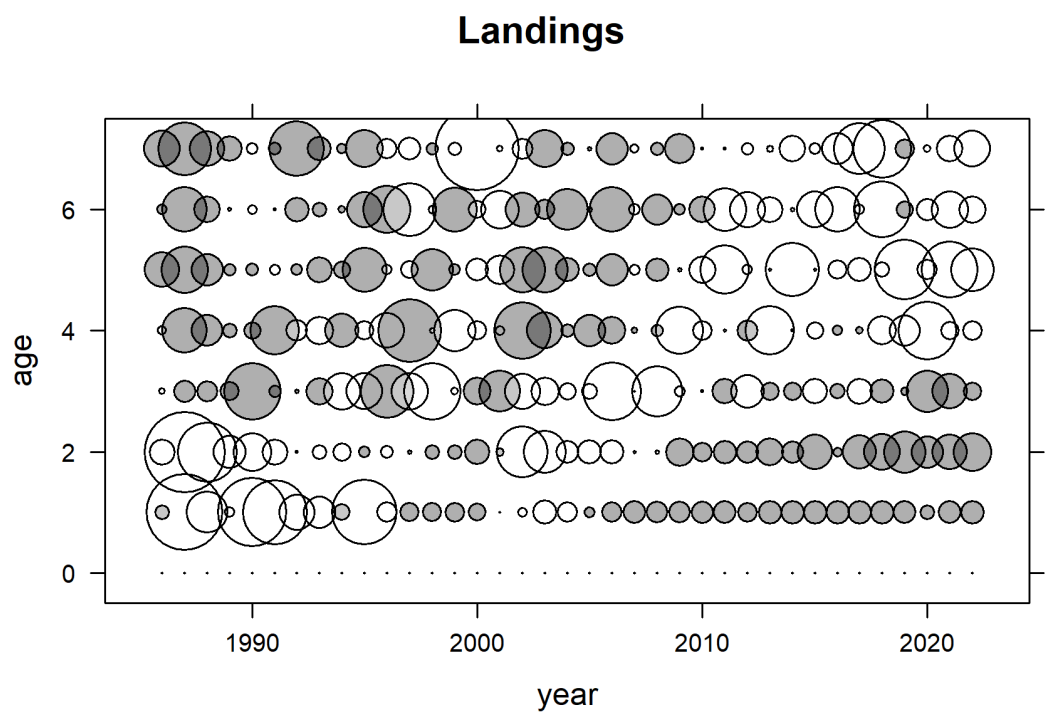


Figure 6.4.2b. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized landings proportions-at-age.

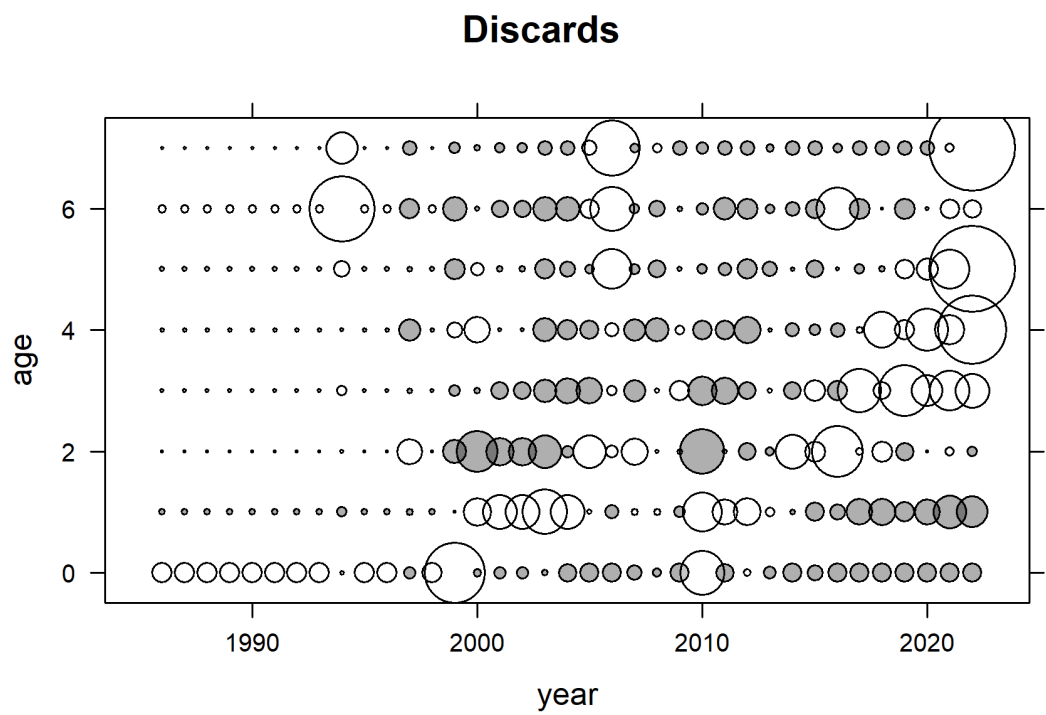


Figure 6.4.2c. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized discards proportions-at-age.

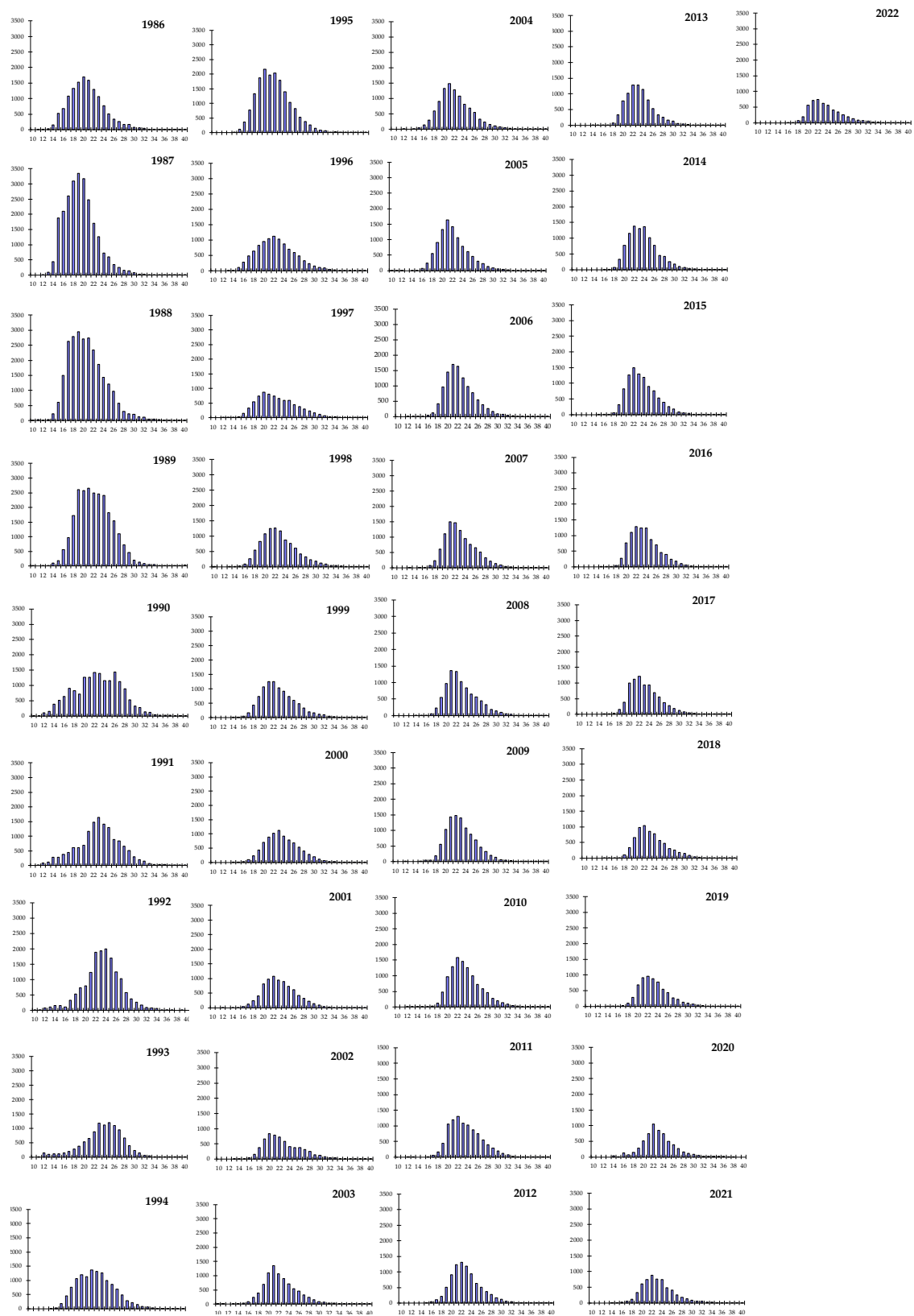


Figure 6.4.3. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Annual length compositions of landings ('000).

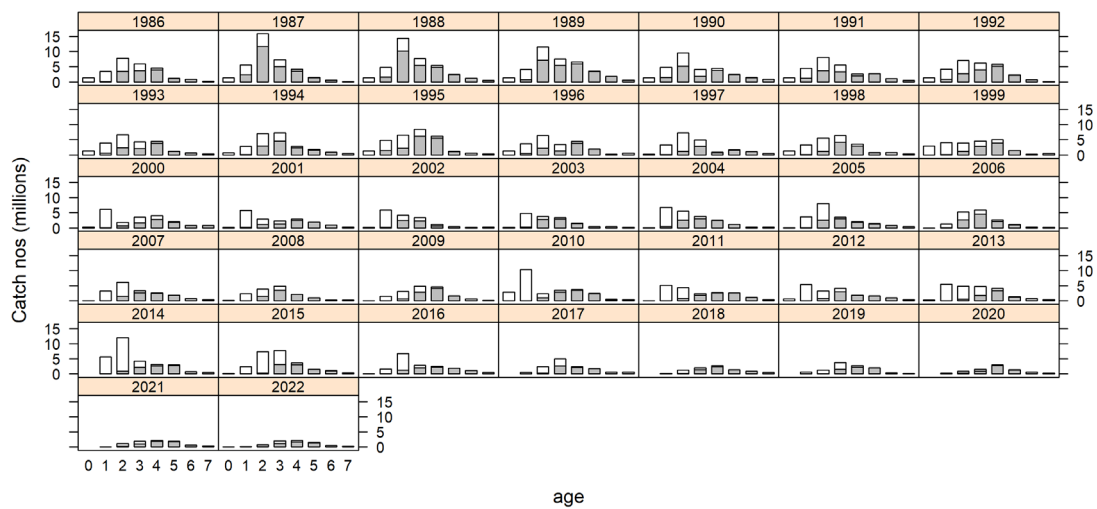


Figure 6.4.4. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Age composition of catches.

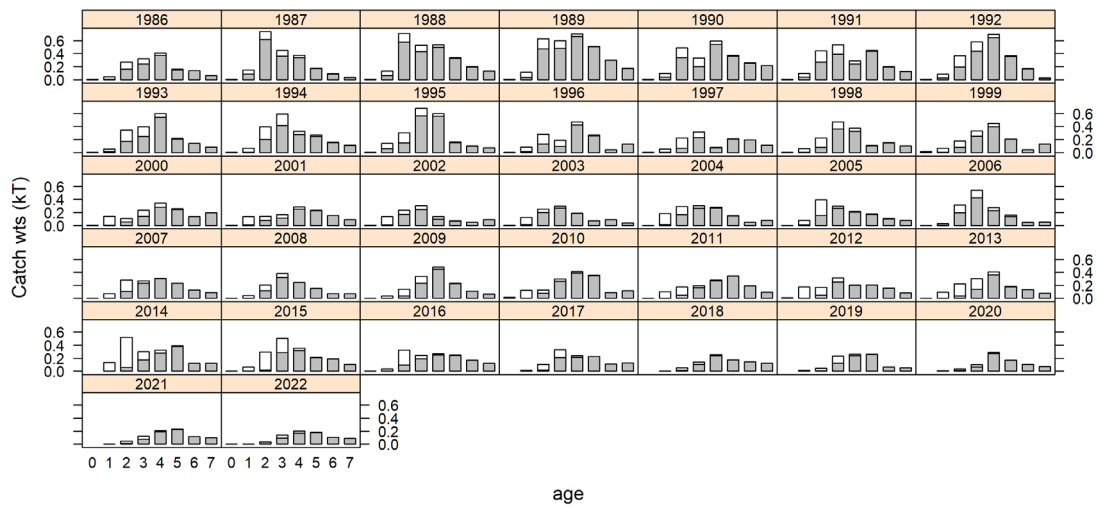


Figure 6.4.5. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Weights-at-age of catches.

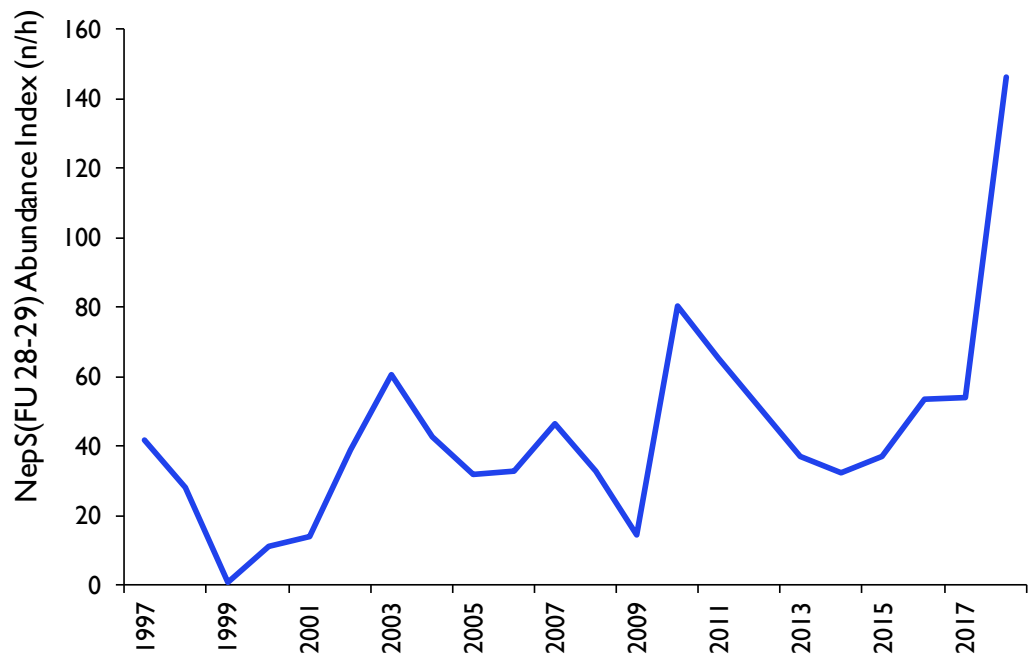


Figure 6.4.6. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Abundance Index from the portuguese NepS (FU 28–29) (G2913) survey for the years included in the assessment.

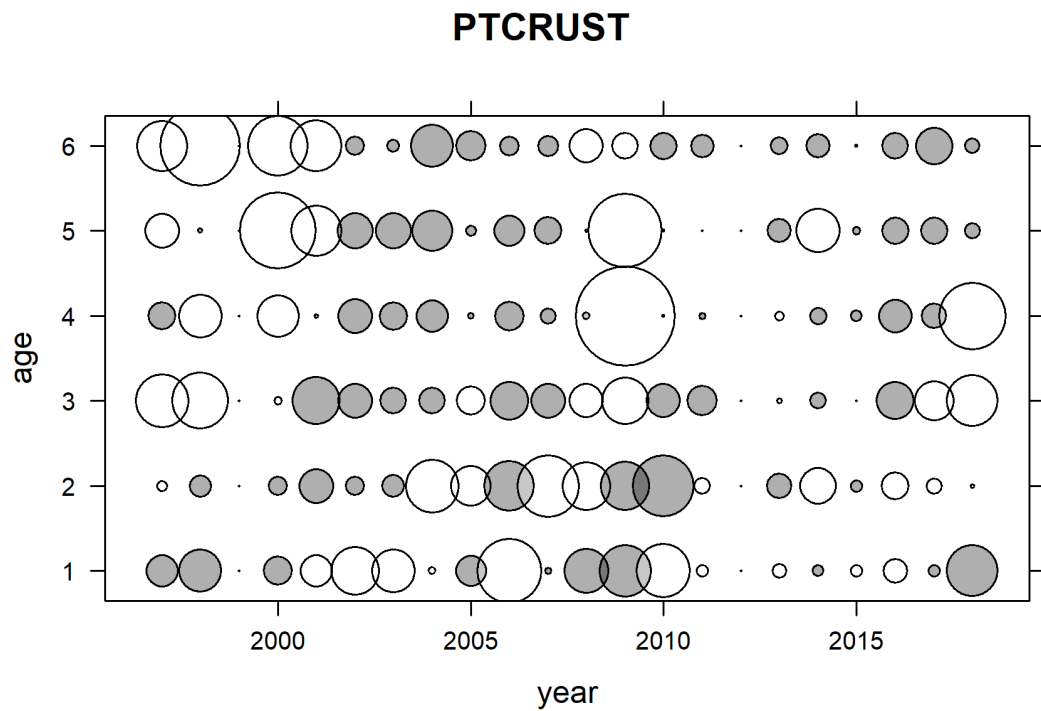


Figure 6.4.7. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from the portuguese NepS (FU 28–29) (G2913) survey.

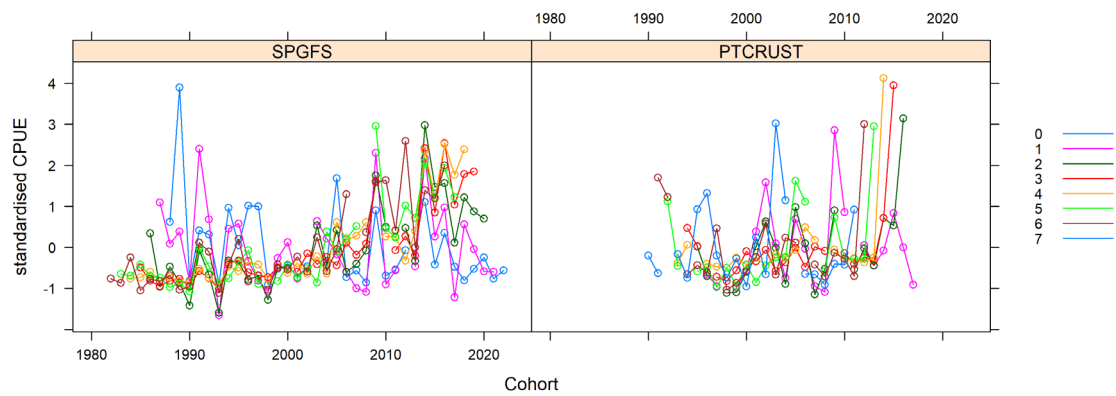


Figure 6.4.8. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Internal consistency of the standardized CPUE index from the SP-NSGFS-Q4 (G2784) and the NepS (FU 28–29) (G2913) surveys.

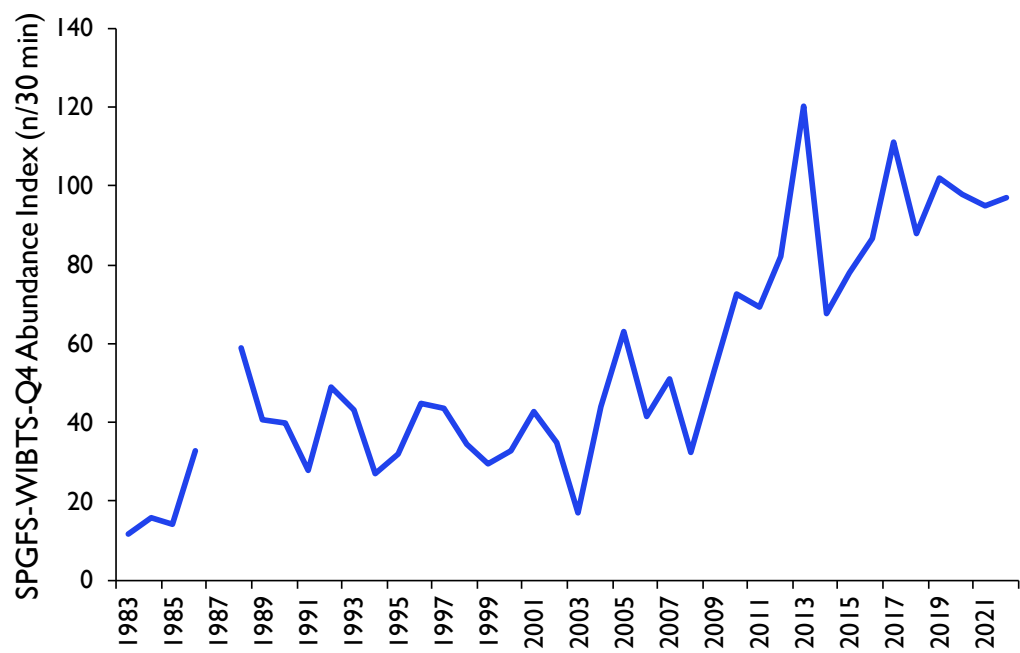


Figure 6.4.9. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Abundance Index from survey SP-NSGFS-Q4 (G2784).

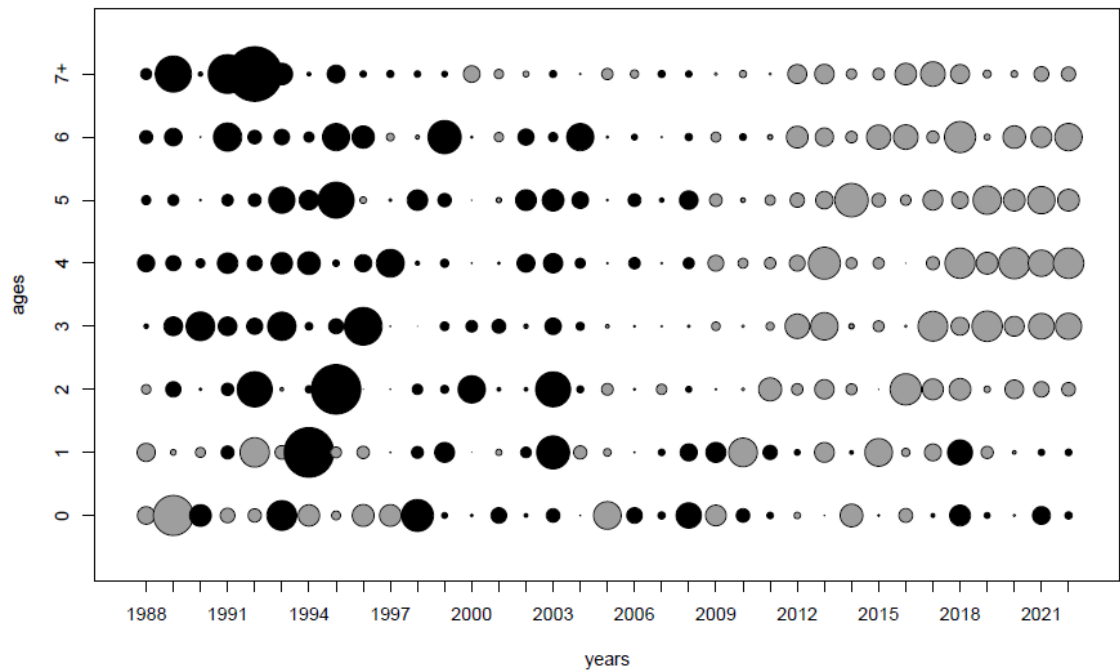


Figure 6.4.10. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized log (abundance index at age) from survey SP-NSGFS-Q4 (G2784) .

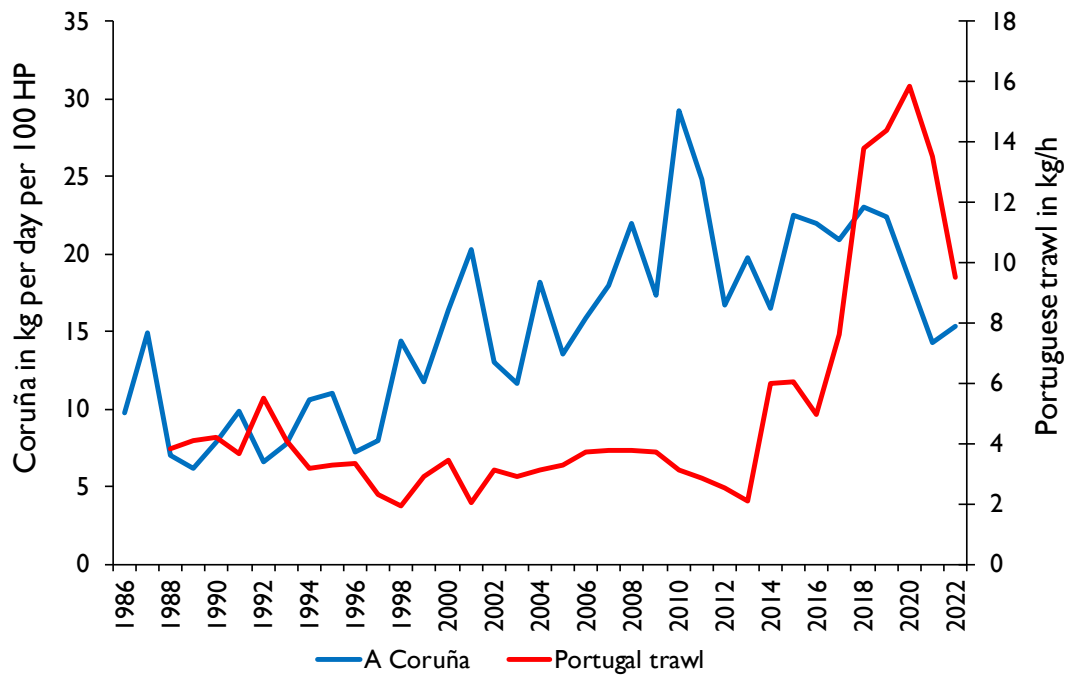


Figure 6.4.11. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. LPUE indices for Spanish and Portuguese commercial fleets.

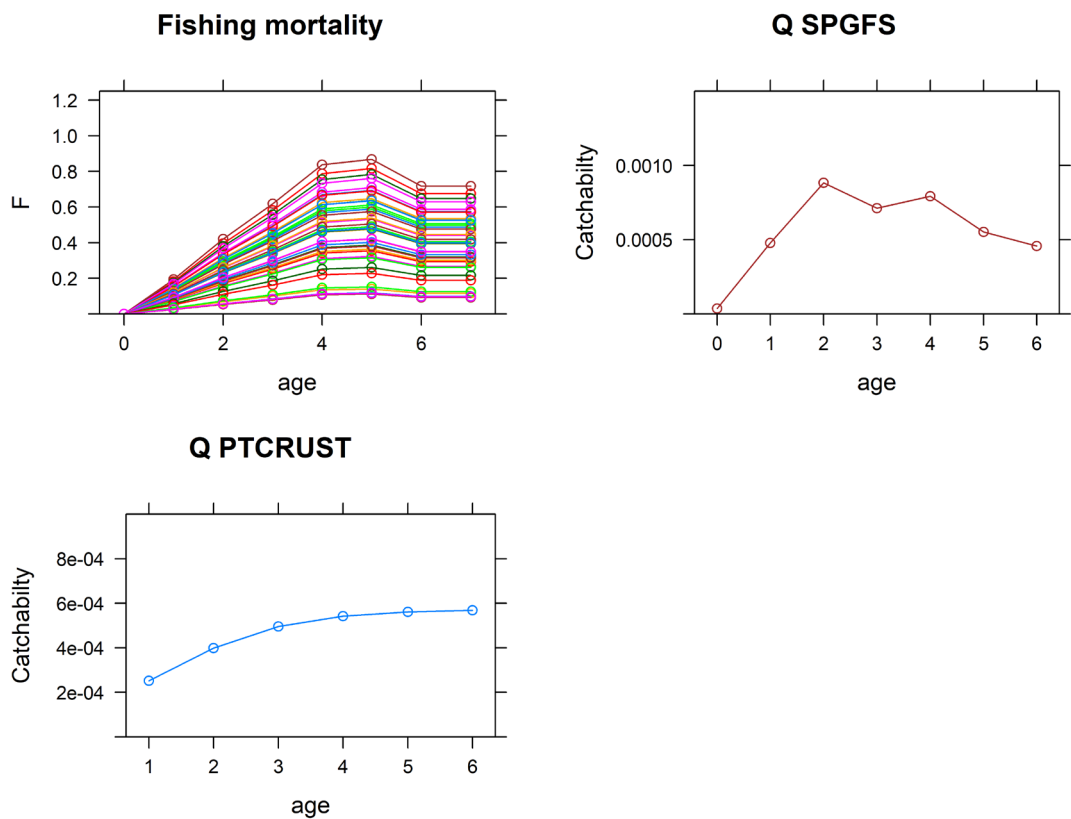


Figure 6.4.12. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. F-at-age (colours indicate years) and catchability-at-age pattern of the SP-NSGFS-Q4 (G2784) and PT-CTS UWTV-FU28–29 (G2913) surveys.

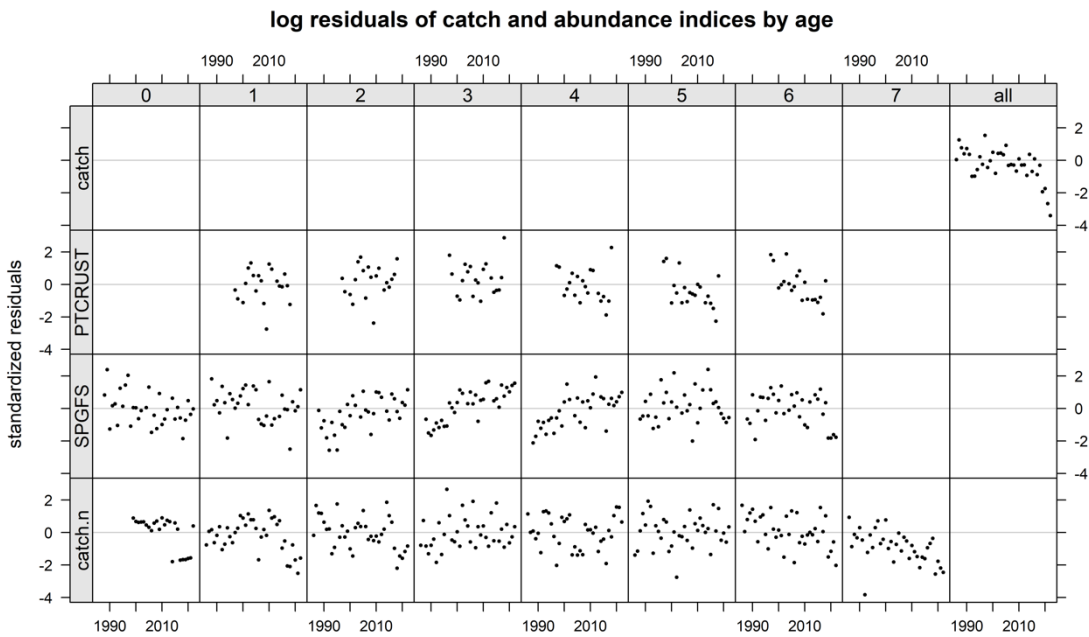


Figure 6.4.13. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Standardized residuals of the catch and the SP-NSGFS-Q4 (G2784) and PT-CTS UWTV-FU28–29 (G2913) surveys.

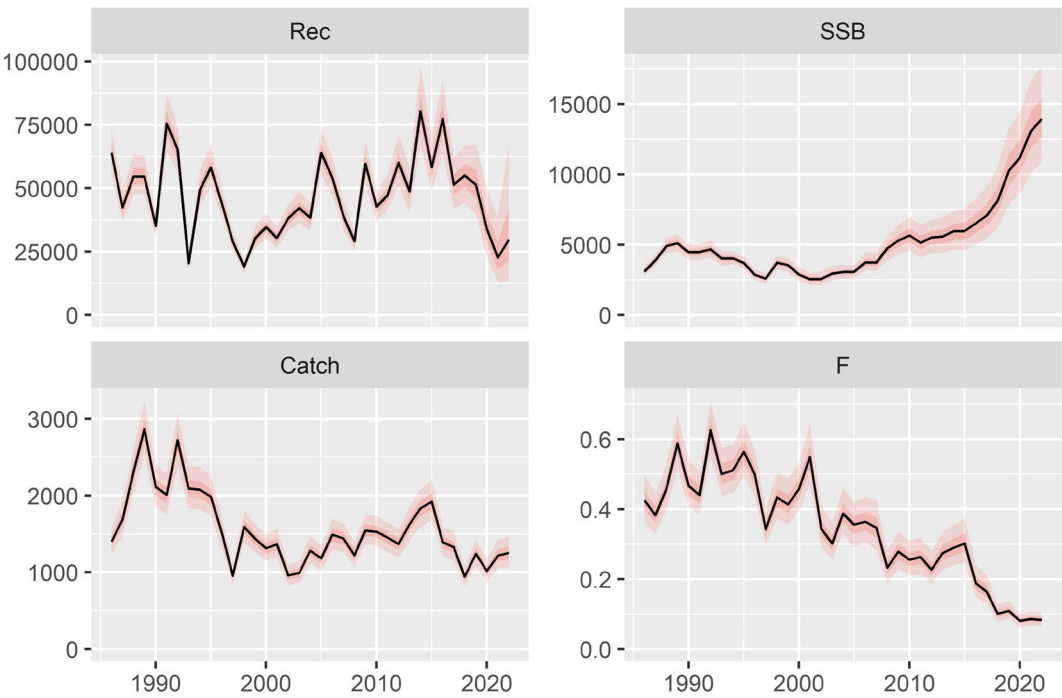


Figure 6.4.14. Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Summary plots of the a4a assessment outputs.

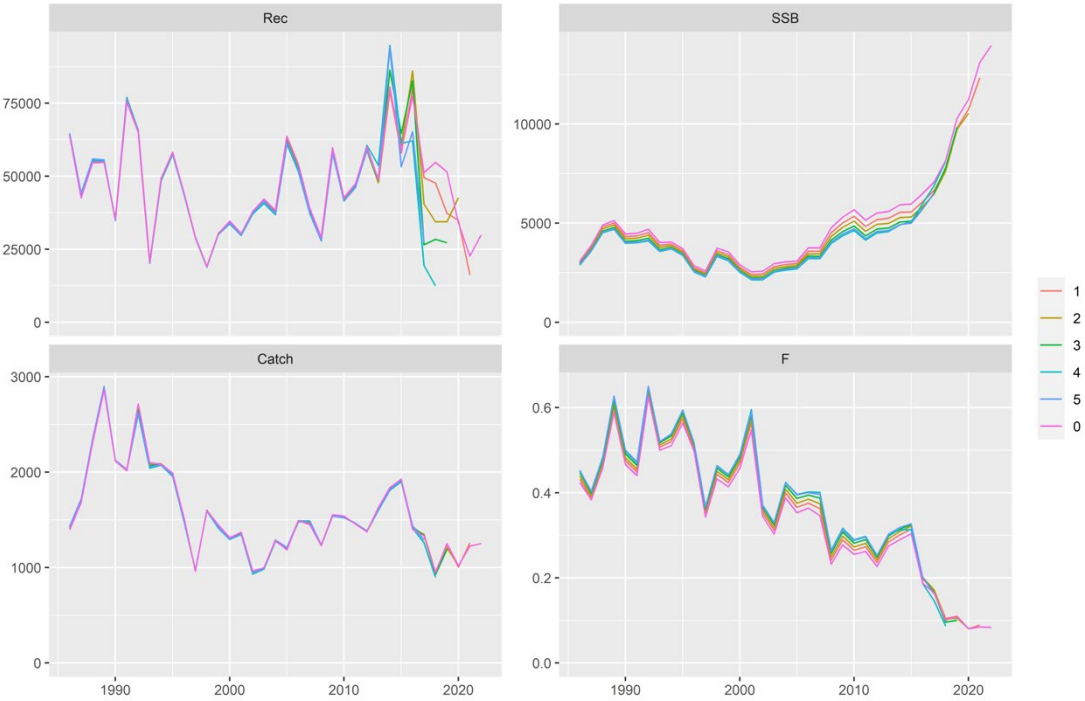


Figure 6.4.15 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Retro plots.



Figure 6.4.16 Four-spot megrim (*L. boscii*) in divisions 8.c and 9.a. Historical assessment results. Last year of geometric mean recruitment included. The assessment model and the reference points were revised in 2022 during the WKMEGRIM benchmark (ICES, 2022a).

6.5 Combined forecast for megrim stocks (*L. whiffiagonis* and *L. boscii*)

Figure 6.5.1 plots total international landings and estimated stock trends for both species of megrim in the same graph, in order to facilitate comparisons. The two species of megrims are included in the landings from ICES divisions 8.c and 9.a. Both are taken as bycatch in mixed bottom-trawl fisheries.

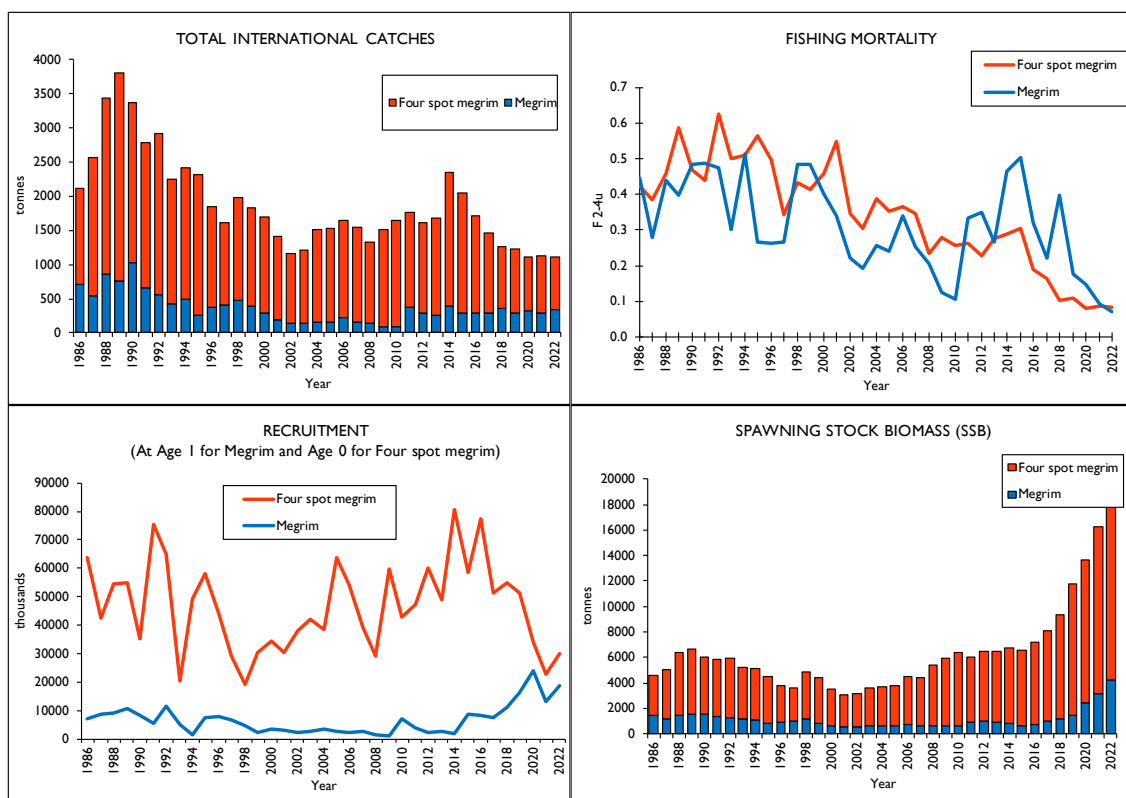


Figure 6.5.1. Stock trends for both stocks. Megrim and four-spot megrim in divisions 8.c and 9.a.

Contents

6	Megrim and four-spot megrim in Cantabrian Sea and Atlantic Iberian waters	238
6.1	General.....	238
6.1.1	Ecosystem aspects	238
6.1.2	Fishery description.....	238
6.2	Summary of ICES advice for 2023 and management for 2022 and 2023	238
6.2.1	ICES advice for 2023 (as extracted from ICES advice on fishing opportunities, catch and effort 2022)	238
6.2.2	Management applicable for 2022 and 2023.....	239
6.2.3	References	239
6.3	Megrim (<i>L. whiffiagonis</i>) in divisions 8.c and 9.a	239
6.3.1	General.....	239
6.3.2	Data.....	239
6.3.3	Assessment	241
6.3.4	Biological reference points	243
6.3.5	Short-term projections	244
6.3.6	Comments on the assessment.....	246
6.3.7	Management considerations.....	247
6.3.8	References	247
6.3.9	Tables and figures	249
6.4	Four-spot megrim (<i>L. boscii</i>) in divisions 8.c and 9.a	264
6.4.1	General.....	264
6.4.2	Data.....	264
6.4.3	Assessment	266
6.4.4	Biological reference points	269
6.4.5	Short-term projections	269
6.4.6	Comments on the assessment.....	270
6.4.7	Management considerations.....	270
6.4.8	References	270
6.4.9	Tables and figures	271
6.5	Combined forecast for megrim stocks (<i>L. whiffiagonis</i> and <i>L. boscii</i>).....	287