

## Contents

11	Megrim ( <i>Lepidorhombus</i> spp.) in Division 6.b (Rockall) .....	412
	Type of assessment in 2022 .....	412
	ICES advice applicable to 2023 .....	412
	General .....	412
	Stock description and management units .....	412
	Fishery in 2021 .....	413
	Landings.....	413
	Discards .....	414
	Surveys .....	414
	Historical stock development .....	414
	Final Assessment .....	414
	State of the stock.....	415
	Short-term projections .....	415
	MSY reference points .....	415
	Uncertainties and bias in assessment and forecast .....	415
	Recommendation for next Benchmark .....	417
	Management considerations.....	417
	References.....	417

## 11 Megrim (*Lepidorhombus* spp.) in Division 6.b (Rockall)

### Type of assessment in 2022

This stock was benchmarked in 2021 (ICES, 2021) and, as a result, the stock was changed from category 3 to category 2. The assessment, which is now based on Surplus Production in Continuous Time (SPiCT, Pedersen and Berg, 2017), includes revised assumptions and model priors. Reference points were also revised. These changes have resulted in a more reliable assessment and the methodology is appropriate to determine stock status and a short-term catch forecast.

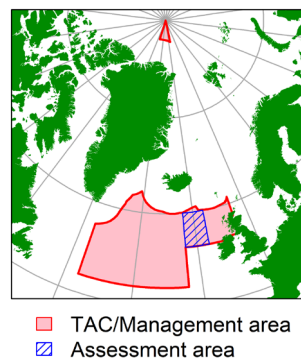
### ICES advice applicable to 2023

ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2023 should be no more than 1022 tonnes.

### General

#### Stock description and management units

Megrim stock structure is uncertain. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the west of Scotland,' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Gordon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. WKFLAT (2011) concluded that megrim in 6.b should continue to be considered as a separate stock until further information is available.



Management area (red box) and assessment area (blue hatched area).

TAC regulations for 2021 and 2022 are given below:

2021:

Species:	Megrim <i>Lepidorhombus</i> spp.	Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	526 <sup>(1)</sup>	Analytical TAC	
France	2 053 <sup>(1)</sup>	Article 8(2) of this Regulation applies	
Ireland	600 <sup>(1)</sup>		
Union	3 179 <sup>(1)</sup>		
United Kingdom	2 046 <sup>(1)</sup>		
TAC	5 225		
(1)	Special condition: of which up to 25 % may be fished in: United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).		

2022:

Species:	Megrim <i>Lepidorhombus</i> spp.	Zone:	6; United Kingdom and international waters of 5b; international waters of 12 and 14 (LEZ/56-14)
Spain	550 <sup>(1)</sup>	Analytical TAC Article 8(2) of this Regulation applies	
France	2 146 <sup>(1)</sup>		
Ireland	627 <sup>(1)</sup>		
Union	3 323 <sup>(1)</sup>		
United Kingdom	2 258 <sup>(1)</sup>		
TAC	5 581		
<sup>(1)</sup> Special condition: of which up to 25 % may be fished in United Kingdom and Union waters of 2a and 4 (LEZ/*2AC4C).			

## Fishery in 2021

Ireland had the highest catches in 2021 followed by the UK and Spain (Table 14.1). The majority of the landings and catches are from otter trawlers.

Catch	Landings		Discards
631 tonnes	Otter trawls 85%	Other gears 15%	Otter trawls 100%
	566 tonnes		65 tonnes

## Landings

Official landings data for each country together with Working Group best estimates of landings from 6.b are shown in Table 14.1 and Figure 14.1.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al.*, 1995; Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned by megrim species. Megrim are caught in association with anglerfish by some fleets and are area-misreported along with anglerfish. However, it is unknown whether misreporting from Division 6.b is an issue.

## Discards

Discard data for 2021 were available for Ireland, UK and Spain in InterCatch. Total discard estimates were available from 2005–2021. To estimate catches prior to 2005, for the SPiCT analysis; a catch over landing ratio of 1.2 was used (derived from that observed ratio between 2017–2020). In 2021, discards represented approximately 10% of catch; increasing to 65 from 59 tonnes (Table 14.1 and Figure 14.1).

## Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish. Sixteen years of survey data are available and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim, and as such was recommended by WKAGME (2008) as the main source of data of megrim relative biomass, for all megrim stocks in the Northern Shelf.

The survey index for 6.b is shown in Figure 14.2. Due to technical reasons the survey was unable to sample in Division 6.b, so the stock size is unknown for 2022. This value is also absent in 2020 due to the absence of the SCO-IV-VIAMISS-Q2 [G1794] survey cancellation due to Covid. Sensitivity trials showed the assessment to be robust to the missing data and it was decided by the group to use the updated assessment despite the missing input data. Details and outputs of the sensitivity trials are included below in the uncertainties section of the report.

The available data shows the stock abundance to have been stable since 2012 prior to which it displayed a largely increasing abundance and biomass trend since 2005. The area-stratified survey provides a minimum estimate of absolute biomass; survey catches are raised based on swept area and weighted by area. The survey assumes that all megrim in the trawl path are retained e.g.  $q=1$ . Assuming full retention is overly optimistic, therefore the minimum estimate of stock biomass was provided.

## Historical stock development

Prior to the benchmark in 2021, the stock was a category 3 stock that utilised a SPiCT assessment and the ratio of the mean of the last two SCO-IV-VIAMISS-Q2 index values.

## Final Assessment

Following on from the benchmark (ICES, 2021), the final assessment utilised a SPiCT model utilising the recommendations and developed settings. The catch data is shown in Figure 14.1 and combined the landings and discard estimates. The abundance index from the SCO-IV-VIAMISS-Q2 survey is shown in Figure 14.2. Following on from the sensitivity and robustness testing at the benchmark the following prior settings were applied:

- Surplus production curve fixed ( $n=2$ )
- Intrinsic growth rate ( $r$ ) 0.39 – modelled from FishLife
- An initial biomass depletion prior of 0.5
- Intermediate year catch – average of last 3 years' catch

The output of the model can be seen in Figure 14.3. The residuals are good (Figure 14.4) and the retrospective plots for the assessment show good agreement with all the peels (Figure 14.5). Final parameter estimates from the SPiCT run are given in Table 14.2.

## State of the stock

The summary plots can be seen in Figure 14.3 and they show fishing pressure on the stock is below  $F_{MSY}$  and biomass is above  $MSY B_{trigger}$  and  $B_{lim}$ .

## Short-term projections

Short term projections were conducted using a 2022 catch that was the average of the preceding 3 years, and the assumptions are shown below:

Variable	Value	Notes
$F(2022)/F_{MSY}$	0.62	F corresponding to <i>status quo</i> catch
$B(2023)/B_{MSY}$	1.31	Short term forecast (STF) with <i>status quo</i> catch
Catch (2022)	759	Status quo catch (average 2019-2021) ; in tonnes

Four management scenarios were explored and the catch and relative reference points estimated for 2023. Adopting the MSY approach (using the 35<sup>th</sup> percentile of predicted catch under  $F=F_{MSY}$ ) gave an estimated catch of 1022 tonnes, a  $F/F_{MSY}$  of 0.91 and a  $B/B_{MSY}$  of 1.26.

Basis	Total catch (2023)	$F_{2023}/F_{MSY}$	$B_{2024}/B_{MSY}$	% B change
MSY approach (35 <sup>th</sup> percentile of predicted catch distribution under $F = F_{MSY}$ )	1022	0.91	1.26	-3.67
$F_{MSY}$	1116	1.00	1.24	-5.17
$F_{2021}$	793	0.69	1.31	-0.06
$F=0$	0	0	1.47	12.4

## MSY reference points

The MSY reference points are calculated based on the relative reference points estimated by the SPiCT model, so will change when the assessment is updated. The reference points are calculated as:

Framework	Reference point	Value	Technical basis
MSY approach	$MSY B_{trigger}$	0.5 *	Relative value ( $B/B_{MSY}$ ) from the SPiCT assessment model. $B_{MSY}$ is estimated directly from the SPiCT model and changes when the assessment is updated.
	$F_{MSY}$	1 *	Relative value ( $F/F_{MSY}$ ) from the SPiCT assessment model. $F_{MSY}$ is estimated directly from the SPiCT model and changes when the assessment is updated.
Precautionary approach	$B_{lim}$	$0.3 \times B_{MSY}$	Relative value (equilibrium yield at this biomass is 50% of MSY).
	$F_{lim}$	$1.7 \times F_{MSY}$	Relative value (the F that drives the stock to $B_{lim}$ ).

## Uncertainties and bias in assessment and forecast

Due to the missing 2022 and 2020 survey data sensitivity analyses were conducted to determine the impact on the assessment. Comparisons between the 2021 assessment and the updated 2022

were conducted, and showed that the  $r$ ,  $K$  and  $q$  parameters (shown in the table below) estimated were very similar, with less than 3% change for each. There were some differences in the estimates states in the assessments, with lower fishing mortality and higher biomass states in 2022. This would be expected due to the catches being reduced by 31% in 2021.

Parameter <chr>	2021 Assessment <dbl>	2022 Assessment <dbl>	Percent.Change <dbl>
$r$	0.379	0.384	1.379
$K$	9421.813	9177.065	-2.598
$q$	0.615	0.618	0.440
B_2021.38	5903.066	5938.855	0.606
F_2021.38	0.156	0.105	-32.834
B_2021.38/Bmsy	1.259	1.301	3.321
F_2021.38/Fmsy	0.829	0.549	-33.732

Figure 14.6 compares the time series of the relative statuses as estimated by last year's assessment and the updated assessment. There is very good agreement up until 2022, at which point the assessment would be expected to diverge due to the large decrease in catches (31%) in 2021. The updated assessment produces a slight increase in advice from 2021 (<3%), based on these lower catches, and lower intermediate year catch assumptions.

To evaluate the assessments robustness to missing data, scenarios was recreating using the complete time series as used in 2019. Three assessments were compared:

- Full time series up to 2019
- Missing index in 2019
- Missing index in 2017 and 2019

The parameters and the state of the stock are very similar in all three scenarios. Comparing the full scenario and missing two index values found the  $r$  and  $k$  parameter estimates to be less than 1% different. The survey catchability parameter differed more (11%) but that might be expected to be more poorly estimated as the index time series becomes significantly shortened. The fishing mortality and biomass estimates differed approximately 5% between the assessments. Overall the time series of relative states show good agreement (Figure 14.7).

Paramater <chr>	Full <dbl>	Missing Last <dbl>	Missing Last and 2 <dbl>
$r$	0.374	0.375	0.377
$K$	9725.512	9525.894	9641.080
$q$	0.609	0.602	0.679
B_2019.38	6180.054	6109.830	5904.964
F_2019.38	0.156	0.159	0.165
B_2019.38/Bmsy	1.278	1.291	1.234
F_2019.38/Fmsy	0.836	0.853	0.880

The catch advice from these different assessment was also in good agreement, ranging from 1036 tonnes in the full assessment down to 992 with both missing data points.

Both these analyses provide reasonable reassurance that the current assessment is robust to missing survey data to the current extent. It also shows that the catch advice is unlikely to have been greatly impacted. There is some concern due to the large decrease in catch in 2021 when there is no available estimate of abundance to verify the health of the stock. It appears that this is partially due to decreased fishing effort in the area, although some decrease in  $l_{pue}$  is also noted.

Currently the assessment uses the SCO-IV-VIAMISS-Q2 survey to estimate biomass. It should be noted that the survey was specifically designed to catch angler fish. While this is not an issue when the biomass index is presented in the relative context, in the case of megrim; the raised

biomass calculation is based on full retention of megrim in the haul. The estimates are therefore considered as the minimum.

## Recommendation for next Benchmark

This stock was subject to benchmark in 2021.

## Management considerations

The TAC in 6 has not been fully utilised; the uptake rate is country-specific; partial quota by individual Member States may be an artefact of reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible.

## References

- Gordon, J.D. 2001. (co-ordinator) Distribution and biology of anglerfish and megrim in waters to the west of Scotland. Final Report of EC DGXIV Study Contract 98/096 XX.
- Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (West of Scotland). Final report EU FAR contract MA-2-520.
- ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39. 257 pp.
- ICES. 2021. Benchmark Workshop on the development of MSY advice for category 3 stocks using Surplus Production Model in Continuous Time; SPiCT (WKMSYSPiCT). ICES Scientific Reports. 3:20. 316 pp. <https://doi.org/10.17895/ices.pub.7919>.
- Pedersen, M. W. and Berg, C. W. 2017. A stochastic surplus production model in continuous time. Fish Fish, 18: 226–243. doi:10.1111/faf.12174.

**Table 14.1 Megrim in Division 6.b. History of catch and landings; official landings presented by country and ICES estimated catch. All weights are in tonnes.**

Year	France	Ireland	Spain	UK (England, Wales, & Northern Ireland)	UK (England & Wales)	UK (Scotland)	UK	Official landings	ICES Landings	ICES Discards
1991	-	240	587	14	-	204	-	1045	1045	
1992	-	139	683	53	-	198	-	1073	1073	
1993	-	128	594	56	-	147	-	925	925	
1994	-	176	574	38	-	258	-	1046	1046	
1995	-	117	520	27	-	152	-	816	816	
1996	-	124	515	92	-	112	-	843	843	
1997	-	141	628	76	-	164	-	1009	1009	
1998	-	218	549	116	-	208	-	1091	1091	
1999	-	127	404	57	-	278	-	866	866	
2000	4	167	427	57	-	309	-	964	964	
2001	< 0.5	176	370	42	-	236	-	824	824	
2002	< 0.5	87	120	41	-	207	-	455	455	
2003	-	83	93	74	-	382	-	632	632	
2004	-	43	71	42	-	372	-	528	528	
2005	-	68	88	19	-	207	-	382	382	87
2006	-	95	59	-	-	-	190	344	344	75
2007	-	87	19	-	-	-	188	106	106	22
2008	-	68	84	-	-	-	142	294	294	59
2009	-	48	46	-	-	-	165	226	226	44
2010	-	47	41	-	-	-	93	139	139	26
2011	-	72	28	-	-	-	69	155	155	7
2012	-	120	61	-	-	-	89	224	224	21
2013	-	181	-	-	-	-	58	278	278	15
2014	-	230	73	-	-	-	95	343	343	15
2015	-	256	190	-	-	-	130	453	453	85
2016	-	272	69	-	-	-	116	405	405	145
2017	-	358	215	-	-	-	180	586	586	233
2018	-	438	61	-	-	-	263	762	764	203
2019	25	76 †	94	-	-	-	229	791	757	34
2020*	41	467	112	-	-	-	246	866	861	59
2021*	1	293	71	-	-	-	212	577	566	65

\* Landing values are preliminary.

† Incomplete/missing as a result of part of the data being unavailable under data confidentiality clauses.



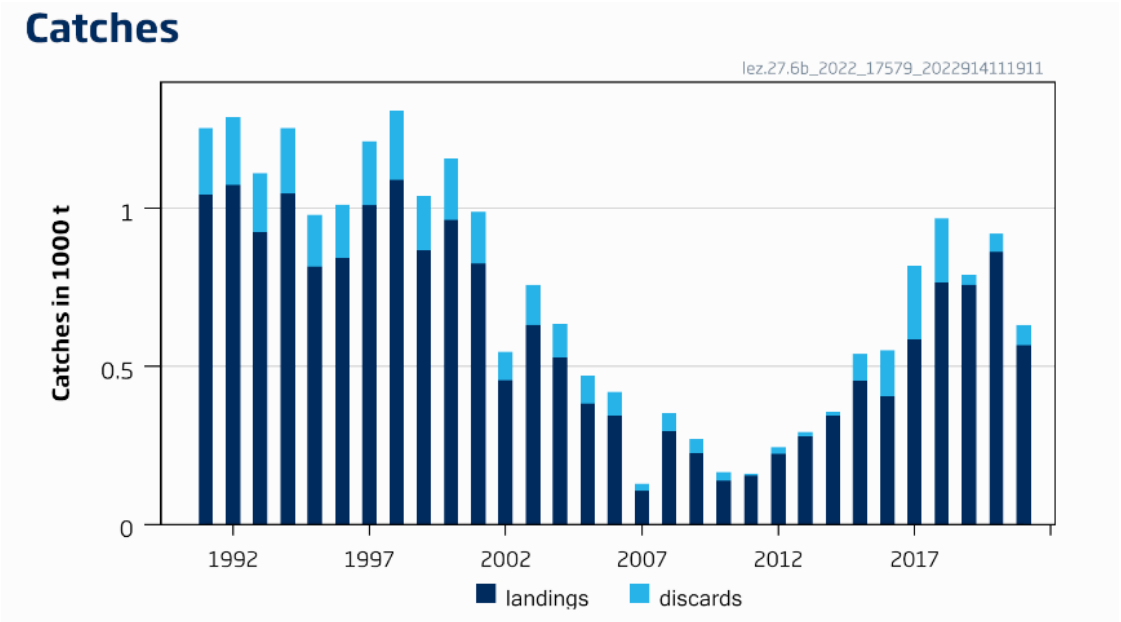


Figure 14.1. Lez.27.6b ICES estimated landings and discards. Discard data are only available since 2005; values prior to that are assumed to be 20% of landings based on the observed ratio from 2017 to 2020.

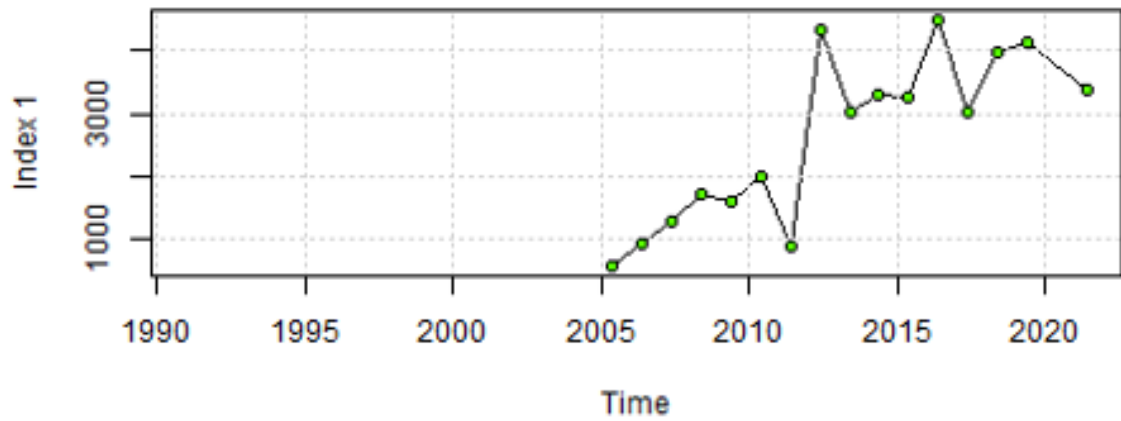


Figure 14.2. Survey data for lez.6b from SIAMISS (SCO-IV-VI-AMISS-Q2 [G1794])

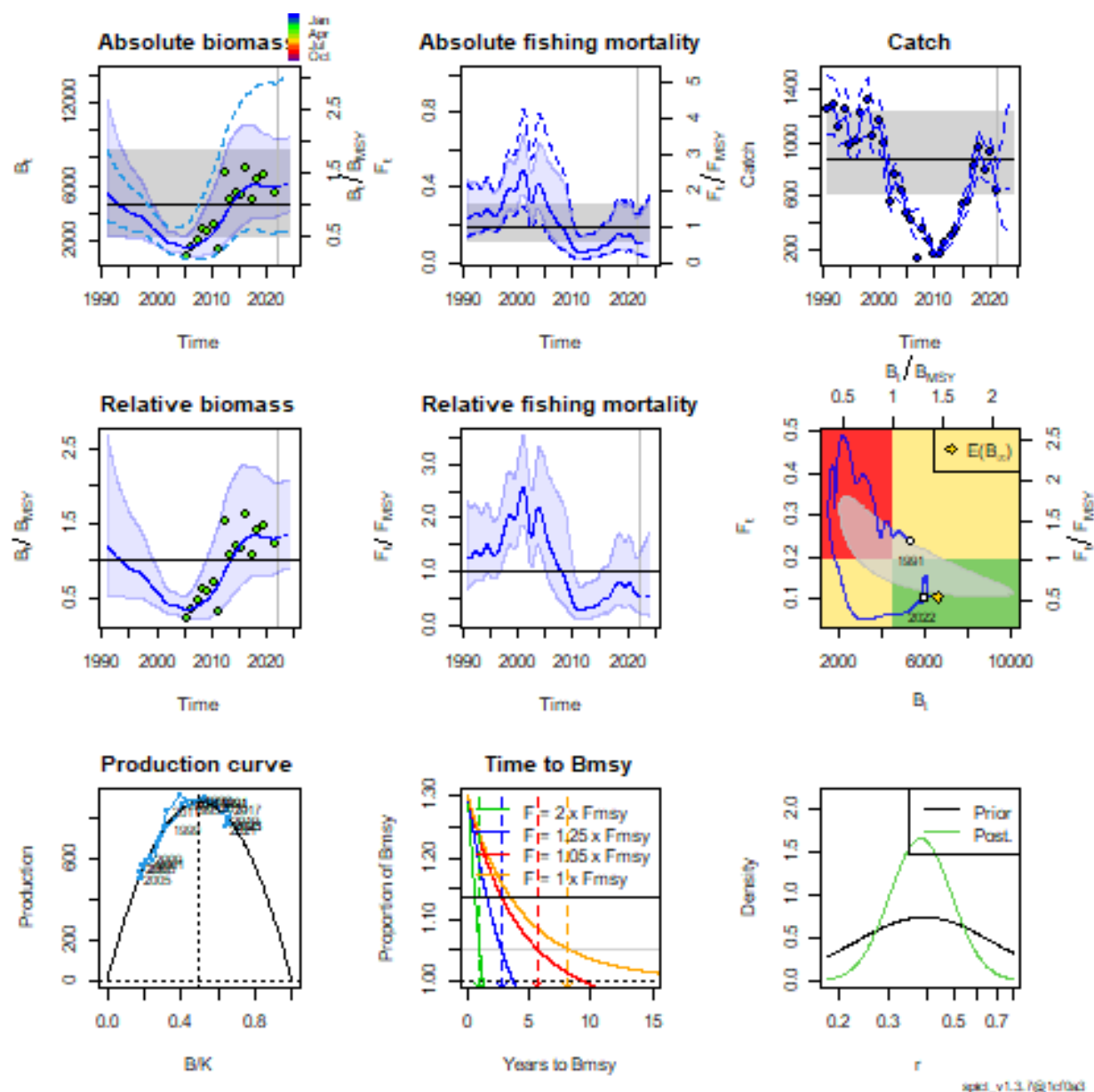


Figure 14.3. SPiCT model output for lez.27.6b. Top right: observed and fitted catch with 95 ci. Centre left: Biomass relative to  $B_{MSY}$ . Centre:  $F$  relative to  $F_{MSY}$ . Corresponding MSY quantities are shown in each plot as horizontal lines (0.5  $B_{MSY}$  in the case of the relative biomass plot). Centre right Kobe plot of stock trajectory.

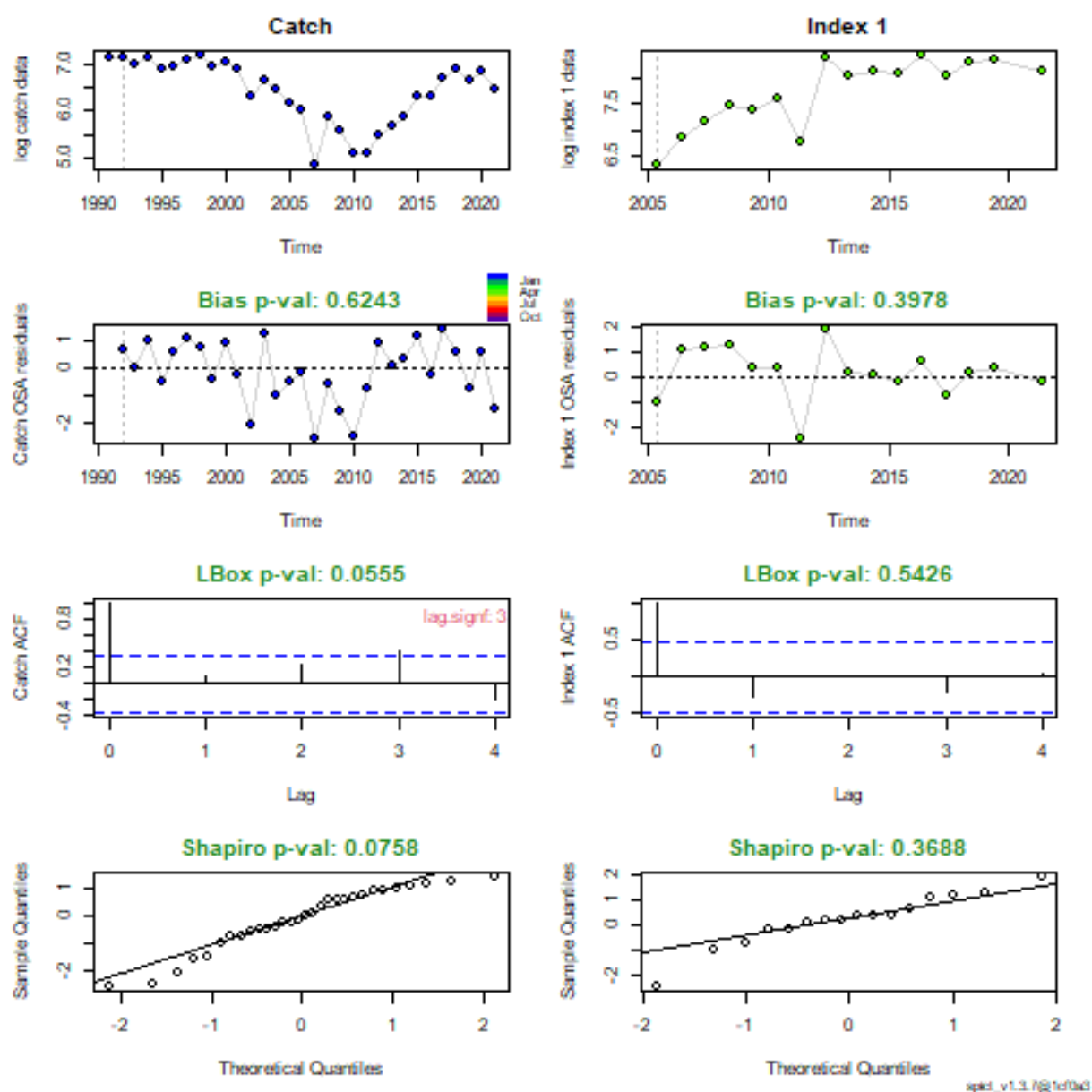


Figure 14.4. SPiCT model residual output for lez.27.6b

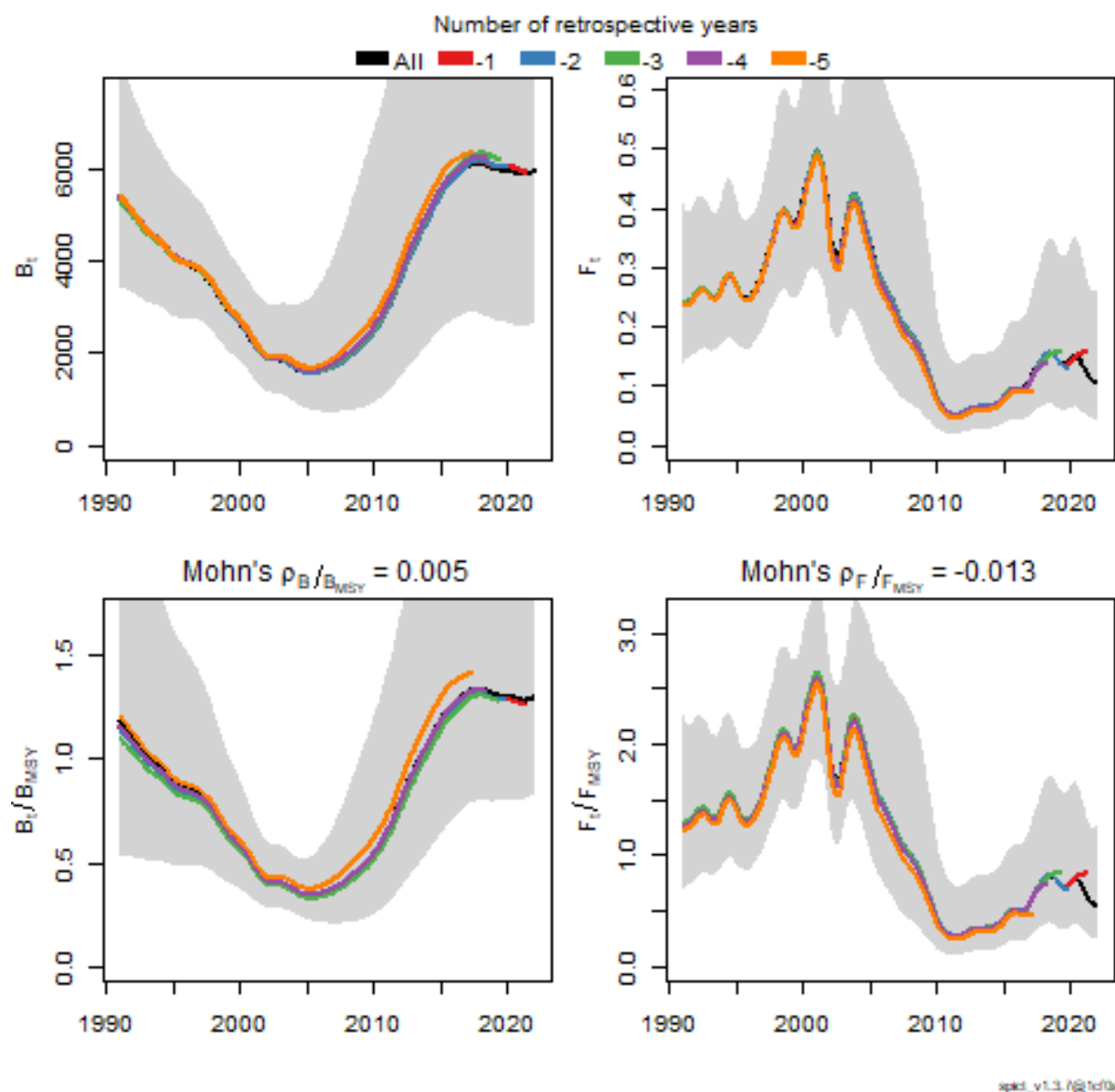


Figure 14.5. SPiCT model retrospectives for lez.27.6b

Table14.2. SPICT results for Lez.27.6b.

Model parameter estimates w 95% CI

	estimate	cilow	ciupp	log.est
alpha	5.9604221	0.7450337	4.768460e+01	1.7851413
beta	0.3342888	0.0982301	1.137625e+00	-1.0957499
r	0.3838002	0.2388906	6.166110e-01	-0.9576333
rc	0.3838002	0.2388906	6.166110e-01	-0.9576333
rold	0.3838002	0.2388906	6.166110e-01	-0.9576333
m	880.5398435	619.4560299	1.251663e+03	6.7805352
K	9177.0656892	4863.6232775	1.731601e+04	9.1244628
q	0.6176870	0.2677990	1.424715e+00	-0.4817734
sdb	0.0551011	0.0071406	4.251910e-01	-2.8985853
sdf	0.2790944	0.1823418	4.271848e-01	-1.2762053
sdi	0.3284259	0.2253436	4.786626e-01	-1.1134440
sdc	0.0932981	0.0363117	2.397173e-01	-2.3719552
pp	0.9615441	0.7651621	9.948154e-01	3.2190290
robfac	10.4473688	2.3561872	6.681155e+01	2.2457363

Deterministic reference points (Drp)

	estimate	cilow	ciupp	log.est
Bmsyd	4588.5328446	2431.8116387	8658.0034944	8.431316
Fmsyd	0.1919001	0.1194453	0.3083055	-1.650780
MSYd	880.5398435	619.4560299	1251.6633606	6.780535

Stochastic reference points (Srp)

	estimate	cilow	ciupp	log.est	rel.diff.Drp
Bmsys	4566.3266273	2423.0463927	8605.4228799	8.426464	-0.004863037
Fmsys	0.1911496	0.1189586	0.3071504	-1.654699	-0.003926166
MSYs	872.8348518	617.1145708	1234.5206457	6.771746	-0.008827548

States w 95% CI (inp\$msytype: s)

	estimate	cilow	ciupp	log.est
B_2021.94	5938.8541864	2620.3230175	1.346017e+04	8.6892715
F_2021.94	0.1050109	0.0420162	2.624536e-01	-2.2536909
B_2021.94/Bmsy	1.3005759	0.8310666	2.035333e+00	0.2628071
F_2021.94/Fmsy	0.5493651	0.2379788	1.268188e+00	-0.5989920

Predictions w 95% CI (inp\$msytype: s)

	prediction	cilow	ciupp	log.est
B_2024.00	6223.0147558	2763.9332488	1.401116e+04	8.7360098
F_2024.00	0.1050113	0.0314164	3.510072e-01	-2.2536875
B_2024.00/Bmsy	1.3628054	0.8951825	2.074704e+00	0.3095454
F_2024.00/Fmsy	0.5493670	0.1743656	1.730870e+00	-0.5989886
Catch_2023.00	647.0016731	324.4560955	1.290194e+03	6.4723489
E(B_inf)	6583.3951800	NA	NA	8.7923059

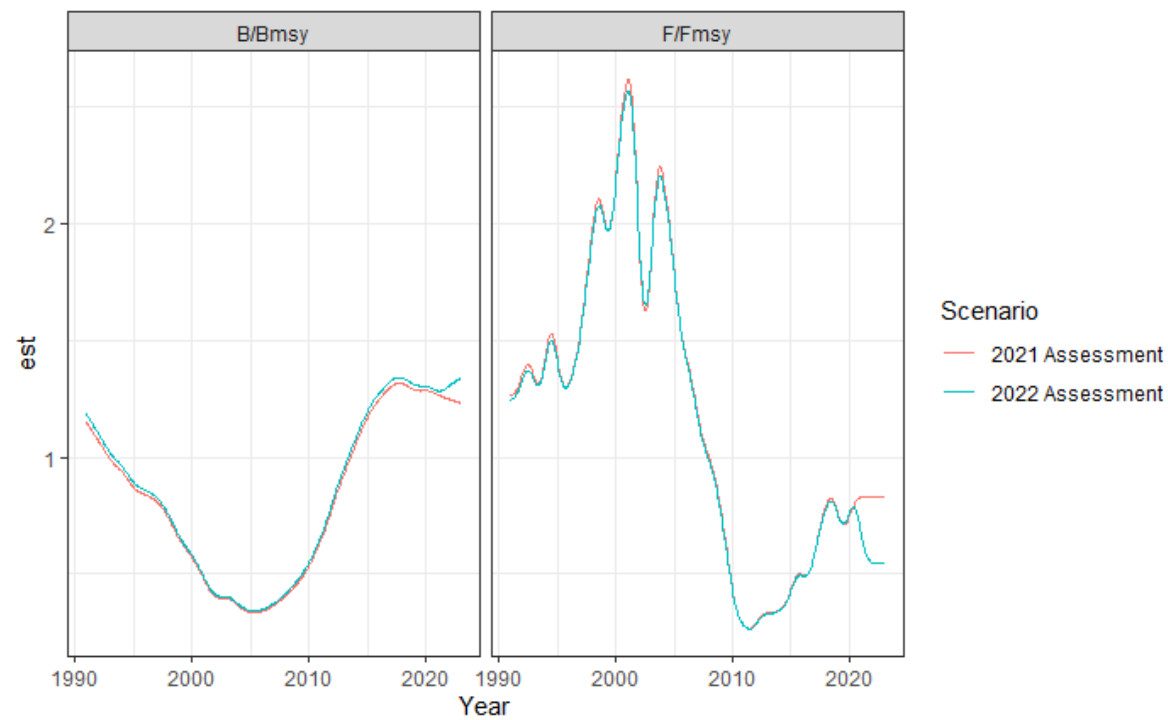


Figure 14.6. Comparison of relative time series from the SPiCT assessments for lez.27.6b in 2021 and 2022

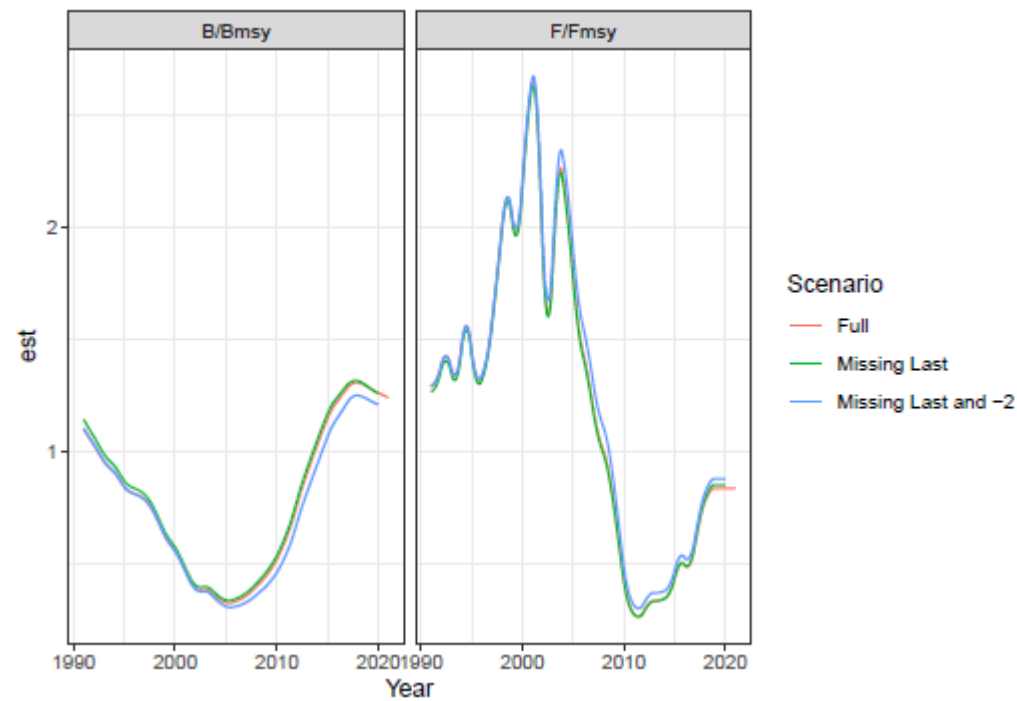


Figure 14.7. Sensitivity analyses comparing time series from the SPiCT assessments for lez.27.6b in with missing survey data points