

Update to the hake Reference Case Operating Model with inclusion of the 2024 commercial data

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Summary

Results for the 2025 RC update (which includes commercial CPUE, catch and catch-at-length data to 2024) are compared to those for the 2024 RC. As there were no surveys conducted in 2025, no further survey estimates are available. The results for the 2025 RC are consistent with those from before the update. The 2025 estimates suggest that the *M. paradoxus* stock continues the downward trend which it has shown since 2020, while the *M. capensis* resource is estimated to be continuing on an upward trajectory.

Keywords: South African hake, Reference Case update, 2025 data

Introduction

Results are provided for three iterations of the Reference Case (RC) Operating Model (OM).

Run1: The 2024 RC as reported in Ross-Gillespie and Butterworth (2024).

Run2: The 2024 RC with a correction to the post 2010 catches used in the model, after it was found that an incorrect version of the catch series had accidentally been used at the time.

Run3: An update of (2), with the 2024 commercial catch, CPUE and CAL data included in the model fit.

Table 1 lists the updated commercial catches for all the fleets from 1978 to 2024. Table 2 lists the updated GLM CPUE data used for Run3 and Table 3a and Table 3b list the survey abundance estimates used for all three runs (as no survey took place in 2025). The survey estimates for 2022 and 2023 reported in this Table have been scaled by the factor of 1.25 (Winker, 2018) to account for those surveys having been conducted by the industry vessel FV *Compass Challenger*.

Note that the full model specifications for this Ricker RC are given in Rademeyer *et al.* (2019). While this document needs updating, most of the specifications have stayed the same, apart from the natural mortality-at-age vectors which are updated periodically. The vectors currently in use are as reported in Ross-Gillespie and Butterworth (2022) and will be updated again ahead of the 2026 OMP revision.

Results

Table 4 lists key assessment outputs for the three runs, and Table 5 lists the negative log-likelihood components. Figure 1 - Figure 6 show various assessment outputs for the three model fits.

Discussion

The correction to the catches used for the 2024 RC has a negligible impact on the results (Run2 vs Run1). The results for the RC run with the 2025 updated data (Run3) are consistent with those from before the update. The 2025 update suggests that the *M. paradoxus* stock continues the downward trend which it has shown since

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2020. This downward trajectory is somewhat concerning, but hard to confirm further in the absence of the 2025 survey, given that the WC catch rates are up from last year, but the SC rates are lower than those from last year. The *M. capensis* resource is estimated to be continuing on an upward trajectory. Both species are still estimated to be above B_{MSY} , with *M. capensis* substantially higher ($B_{2025}/B_{MSY} = 3.00$), but *M. paradoxus* only slightly higher ($B_{2025}/B_{MSY} = 1.15$). The downward trend in the *M. paradoxus* resource warrants further discussion in the DWG in the lead up to the OMP revision next year.

References

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Table 1: Species-disaggregated catches (in thousand tons) by fleet of South African hake from the south and west coasts for the period 1978-present. Grey highlighting has been used to mark revised and new catch data (D. Durholtz *pers. comm.*).

	<i>M. paradoxus</i>				<i>M. capensis</i>						Total
	Offshore		Longline		Offshore		Inshore	Longline		Handline	
	WC	SC	WC	SC	WC	SC	SC	WC	SC	SC	
1978	101.042	3.220	-	-	26.470	4.365	4.931	-	-	-	140.028
1979	94.331	1.924	-	-	39.192	4.995	6.093	-	-	-	146.535
1980	99.654	2.206	-	-	33.873	4.254	9.121	-	-	-	149.108
1981	88.883	0.910	-	-	32.048	4.575	9.400	-	-	-	135.816
1982	83.618	3.353	-	-	29.732	8.005	8.089	-	-	-	132.797
1983	71.238	4.723	0.126	-	23.195	7.792	7.672	0.104	-	-	114.850
1984	82.358	3.796	0.200	0.005	28.897	7.139	9.035	0.166	0.011	-	131.607
1985	94.428	8.059	0.638	0.091	30.642	11.957	9.203	0.529	0.201	0.065	155.813
1986	103.756	8.580	0.753	0.094	30.049	7.385	8.724	0.625	0.208	0.084	160.258
1987	93.517	7.460	1.952	0.110	24.008	8.225	8.607	1.619	0.243	0.096	145.837
1988	79.913	5.876	2.833	0.103	26.669	8.640	8.417	2.350	0.228	0.071	135.100
1989	82.230	6.182	0.158	0.010	25.029	12.730	10.038	0.132	0.022	0.137	136.668
1990	81.996	9.341	0.211	-	21.640	13.451	10.012	0.175	-	0.348	137.174
1991	87.093	12.448	-	0.932	19.357	9.626	8.206	-	2.068	1.270	141.000
1992	84.768	17.297	-	0.466	18.519	9.165	9.252	-	1.034	1.099	141.600
1993	102.125	9.880	-	-	15.940	4.380	8.870	-	-	0.278	141.473
1994	103.541	6.726	0.882	0.194	20.327	4.326	9.569	0.732	0.432	0.449	147.178
1995	100.268	4.004	0.523	0.202	20.629	3.146	10.630	0.434	0.448	0.756	141.040
1996	107.381	8.966	1.308	0.568	21.794	4.323	11.062	1.086	1.260	1.515	159.263
1997	100.654	10.509	1.410	0.582	16.500	5.327	8.834	1.170	1.290	1.404	147.680
1998	111.154	9.742	0.505	0.457	16.499	4.411	8.283	0.419	1.014	1.738	154.222
1999	88.581	11.420	1.532	1.288	15.179	3.926	8.595	1.272	2.856	2.749	137.398
2000	96.587	7.700	2.706	3.105	21.114	5.830	10.906	2.000	1.977	5.500	157.425
2001	101.247	7.850	1.417	0.084	16.349	8.306	11.836	2.394	1.527	7.300	158.310
2002	91.207	12.443	4.469	1.585	13.724	6.141	9.581	2.391	2.546	3.500	147.587
2003	93.711	17.397	3.305	1.252	11.665	7.636	9.883	2.526	3.078	3.000	153.453
2004	85.722	26.065	2.855	1.196	12.510	8.704	10.004	2.297	2.731	1.600	153.684
2005	85.869	21.778	3.091	0.472	9.398	7.468	7.881	2.773	3.270	0.700	142.700
2006	81.513	18.050	3.241	0.485	11.984	6.578	5.524	2.520	3.227	0.400	133.522
2007	92.724	13.488	2.512	3.021	16.145	3.757	6.350	2.522	2.522	0.400	143.441
2008	85.538	13.191	2.255	0.809	13.838	4.316	5.496	1.937	1.893	0.231	129.504
2009	68.202	10.895	2.410	1.069	12.296	4.806	5.639	2.828	2.520	0.265	110.930
2010	69.523	15.695	2.394	1.527	10.128	4.124	5.965	3.086	3.024	0.275	115.742
2011	75.804	18.590	2.522	0.140	15.520	4.242	6.437	3.521	3.047	0.186	130.009
2012	81.100	16.687	4.358	0.306	12.865	4.614	3.423	2.570	1.737	0.008	127.667
2013	75.112	29.155	6.056	0.060	8.858	4.502	2.920	2.606	1.308	0.000	130.577
2014	74.742	40.310	6.879	0.008	9.845	6.158	2.965	2.123	0.315	0.001	143.347
2015	79.943	30.865	5.205	0.023	13.119	3.924	3.082	3.025	0.069	0.001	139.257
2016	93.692	19.806	3.697	0.001	14.798	2.923	4.182	5.745	0.003	0.001	144.847
2017	72.695	30.888	5.300	0.025	15.345	4.469	2.813	2.813	0.126	0.004	134.479
2018	63.839	29.557	5.217	0.09	12.610	13.021	3.985	2.646	0.487	0.024	131.476
2019	72.954	23.017	5.328	0.034	14.657	9.765	4.743	3.623	0.299	0.009	134.427
2020	98.532	11.659	5.847	0.047	17.220	3.335	4.576	2.348	0.321	0.004	143.889
2021	95.816	12.317	5.892	0.018	22.094	8.098	5.439	2.932	0.194	0.010	152.811
2022	75.400	13.689	4.970	0.019	13.596	3.753	5.402	2.933	0.080	0.001	119.845
2023	71.986	14.747	5.042	0.007	12.544	3.610	3.700	2.364	0.034	0.007	114.040
2024	78.039	9.125	7.379	0.000	15.266	3.595	4.222	2.305	0.000	0.012	119.943

Table 2: GLM standardized CPUE data for *M. paradoxus* and *M. capensis* provided by D. Durholtz (*pers. comm.*).

Year	GLM CPUE (kg min ⁻¹)			
	<i>M. paradoxus</i>		<i>M. capensis</i>	
	West Coast	South Coast	West Coast	South Coast
1978	1.18	0.56	0.86	0.74
1979	1.19	0.48	1.18	0.83
1980	1.12	0.78	1.07	1.01
1981	1.09	0.54	1.11	0.88
1982	1.07	0.75	0.96	0.92
1983	1.18	0.76	1.19	1.08
1984	1.21	0.83	1.21	1.25
1985	1.41	1.07	1.36	1.58
1986	1.23	1.08	1.13	1.30
1987	1.03	1.00	0.96	1.19
1988	1.00	0.83	0.88	1.22
1989	1.08	0.86	0.93	1.35
1990	1.14	1.10	0.84	1.62
1991	1.27	1.20	1.02	1.46
1992	1.14	1.33	1.15	1.37
1993	1.15	1.12	1.12	1.01
1994	1.23	1.01	1.31	1.21
1995	1.10	0.79	1.26	1.11
1996	1.21	1.11	1.44	1.12
1997	1.07	1.19	1.22	0.95
1998	1.21	1.13	1.39	0.94
1999	1.01	1.31	1.24	1.02
2000	0.92	1.03	1.17	1.04
2001	0.74	1.02	0.84	0.84
2002	0.72	0.93	0.80	0.90
2003	0.83	1.06	0.72	0.96
2004	0.69	0.91	0.67	0.81
2005	0.67	0.80	0.52	0.69
2006	0.71	0.82	0.59	0.55
2007	0.85	0.85	0.61	0.54
2008	0.92	0.87	0.75	0.70
2009	0.95	1.02	1.08	1.20
2010	1.06	1.12	0.97	0.98
2011	0.83	1.26	0.58	1.12
2012	0.91	1.11	0.97	0.75
2013	0.80	1.24	0.78	0.75
2014	0.92	1.17	0.83	0.54
2015	0.99	1.10	0.80	0.58
2016	1.01	1.15	0.81	0.74
2017	1.07	1.28	1.03	0.98
2018	0.95	1.42	1.06	1.72
2019	0.87	1.11	1.04	1.29
2020	0.97	1.10	1.18	0.92
2021	0.99	1.15	1.38	0.83
2022	0.79	1.07	1.10	0.70
2023	0.72	0.83	0.90	0.73
2024	0.80	0.76	0.99	0.95

Table 3a: Survey abundance estimates and associated standard errors in thousand tons for *M. paradoxus* for the depth range 0-500m for the South Coast and for the West Coast (Fairweather, 2023). As the 2022 and 2023 surveys were conducted by the industry vessel *FV Compass Challenger*, the estimates shown here (marked with an asterisk) have already been multiplied by a factor of 1.25 to account for different catchability coefficients (Winker, 2018).

Year	West coast				South coast			
	Summer		Winter		Spring (Sept)		Autumn (Apr/May)	
	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)
1985	168.989	(37.765)	290.281	(63.295)	-	-	-	-
1986	202.334	(37.745)	147.378	(21.667)	11.280	(3.111)	-	-
1987	284.434	(54.165)	180.158	(39.047)	16.381	(3.033)	-	-
1988	138.534	(20.303)	252.121	(71.246)	-	-	28.293	(8.673)
1989	-	-	434.092	(142.716)	-	-	-	-
1990	307.615	(87.841)	205.704	(43.607)	-	-	-	-
1991	331.177	(81.633)	-	-	-	-	27.570	(8.153)
1992	225.755	(33.711)	-	-	-	-	25.036	(6.650)
1993	340.079	(51.427)	-	-	-	-	162.375	(81.691)
1994	333.499	(56.259)	-	-	-	-	108.179	(38.369)
1995	317.104	(76.709)	-	-	-	-	70.890	(39.330)
1996	474.270	(92.744)	-	-	-	-	68.859	(19.929)
1997	543.615	(96.043)	-	-	-	-	121.707	(51.507)
1998	-	-	-	-	-	-	-	-
1999	542.830	(110.541)	-	-	-	-	263.256	(59.439)
2000	-	-	-	-	-	-	-	-
2001	-	-	-	-	16.668	(7.159)	-	-
2002	251.820	(32.690)	-	-	-	-	-	-
2003	386.321	(63.565)	-	-	98.434	(42.249)	185.345	(82.188)
2004	271.540	(55.710)	-	-	70.001	(22.156)	39.822	(22.153)
2005	296.065	(42.409)	-	-	-	-	26.691	(6.017)
2006	316.247	(57.332)	-	-	68.507	(18.283)	34.868	(5.843)
2007	407.377	(77.222)	-	-	66.267	(21.966)	102.195	(53.688)
2008	238.143	(37.018)	-	-	25.661	(8.324)	33.034	(9.340)
2009	310.760	(27.768)	-	-	-	-	45.030	(15.551)
2010	576.848	(88.202)	-	-	-	-	46.938	(12.160)
2011	380.185	(128.013)	-	-	-	-	21.054	(6.531)
2012	405.865	(59.099)	-	-	-	-	-	-
2013	136.260	(25.116)	-	-	-	-	-	-
2014	269.482	(37.492)	-	-	-	-	62.925	(24.802)
2015	207.583	(24.057)	-	-	-	-	111.411	(51.852)
2016	312.876	(33.250)	-	-	-	-	94.177	(51.731)
2017	319.024	(58.766)	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	243.560	(51.558)	-	-	-	-	-	-
2020	243.090	(43.989)	-	-	-	-	33.176	(15.444)
2021	-	-	-	-	-	-	50.060	(20.430)
2022	318.394*	(85.361)*	-	-	-	-	-	-
2023	127.575*	(17.346)*	-	-	-	-	20.409*	(4.931)*
2024	240.531	(50.557)	-	-	-	-	72.453	(25.329)

Table 3b: Survey abundance estimates and associated standard errors in thousand tons for *M. capensis* for the depth range 0-500m for the South Coast and for the West Coast (Fairweather, 2023). As the 2022 and 2023 surveys were conducted by the industry vessel *FV Compass Challenger*, the estimates here (marked with an asterisk) have already been multiplied by a factor of 1.25 to account for different catchability coefficients (Winker, 2018).

Year	West coast				South coast			
	Summer		Winter		Spring (Sept)		Autumn (Apr/May)	
	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)	Biomass	(s.e.)
1985	102.929	(18.888)	159.198	(18.982)	-	-	-	-
1986	113.154	(23.474)	115.218	(19.733)	96.768	(10.737)	-	-
1987	75.438	(9.709)	83.050	(10.306)	137.008	(13.057)	-	-
1988	66.365	(9.930)	48.046	(9.574)	-	-	154.548	(23.984)
1989	-	-	294.740	(67.495)	-	-	-	-
1990	400.142	(97.102)	156.337	(22.507)	-	-	-	-
1991	67.565	(9.656)	-	-	-	-	276.607	(25.274)
1992	95.401	(11.892)	-	-	-	-	124.495	(13.600)
1993	93.613	(14.390)	-	-	-	-	144.551	(12.379)
1994	124.497	(37.845)	-	-	-	-	153.790	(20.310)
1995	193.292	(24.270)	-	-	-	-	222.464	(31.245)
1996	87.969	(9.866)	-	-	-	-	222.176	(23.144)
1997	252.606	(42.721)	-	-	-	-	163.163	(17.274)
1998	-	-	-	-	-	-	-	-
1999	188.624	(31.362)	-	-	-	-	171.946	(13.330)
2000	-	-	-	-	-	-	-	-
2001	-	-	-	-	117.590	(20.093)	-	-
2002	105.093	(16.130)	-	-	-	-	-	-
2003	73.020	(12.518)	-	-	73.604	(9.142)	117.538	(17.192)
2004	194.294	(30.714)	-	-	96.933	(13.936)	92.796	(11.318)
2005	63.363	(11.498)	-	-	-	-	68.672	(5.302)
2006	73.655	(17.255)	-	-	92.831	(8.998)	116.298	(11.931)
2007	73.230	(9.306)	-	-	67.937	(6.553)	65.935	(5.303)
2008	52.577	(7.069)	-	-	87.836	(9.723)	102.169	(9.681)
2009	140.437	(26.486)	-	-	-	-	111.191	(10.832)
2010	162.402	(34.891)	-	-	-	-	170.261	(33.235)
2011	89.095	(23.574)	-	-	-	-	105.424	(10.688)
2012	84.746	(8.331)	-	-	-	-	-	-
2013	30.383	(4.575)	-	-	-	-	-	-
2014	219.756	(60.342)	-	-	-	-	63.389	(6.415)
2015	65.086	(9.178)	-	-	-	-	76.059	(6.873)
2016	115.058	(30.400)	-	-	-	-	83.197	(6.600)
2017	69.289	(14.486)	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	62.560	(7.697)	-	-	-	-	-	-
2020	109.983	(11.836)	-	-	-	-	132.099	(14.486)
2021	-	-	-	-	-	-	89.119	(10.798)
2022	175.716*	(37.074)*	-	-	-	-	-	-
2023	230.648*	(69.681)*	-	-	-	-	109.916*	(16.213)*
2024	295.141	(66.385)	-	-	-	-	114.403	(15.951)

Table 4: Key assessment outputs for the three OMs. Biomass units are thousand tons.

<i>M. paradoxus</i>	Run1	Run2	Run3	<i>M. capensis</i>	Run1	Run2	Run3
K^{sp}	497	498	501	K^{sp}	227	227	228
B_{MSY}	79	79	76	B_{MSY}	59	59	58
B_{MSY} / K^{sp}	0.16	0.16	0.15	B_{MSY} / K^{sp}	0.26	0.26	0.25
MSY	130	131	136	MSY	84	84	84
B_{2024}^{sp}	101	102	98	B_{2024}^{sp}	175	174	170
B_{2024}^{sp} / K^{sp}	0.20	0.21	0.20	B_{2024}^{sp} / K^{sp}	0.77	0.77	0.74
B_{2024}^{sp} / B_{MSY}	1.29	1.30	1.29	B_{2024}^{sp} / B_{MSY}	2.95	2.95	2.92
B_{2025}^{sp}	-	-	88	B_{2025}^{sp}	-	-	174
B_{2025}^{sp} / K^{sp}	-	-	0.18	B_{2025}^{sp} / K^{sp}	-	-	0.76
B_{2025}^{sp} / B_{MSY}	-	-	1.15	B_{2025}^{sp} / B_{MSY}	-	-	3.00

Table 5: Negative log-likelihood values for the fits to the three OMs. The values for Run3 in grey text indicate that those negative log-likelihood components are not comparable to those from the 2024 RC on account of additional data.

Run	GLM CPUE	ICSEAF CPUE	Survey abun.	Comm. CAL	Survey CAL	Recruit. resid.	ALKs	Penalties	Total (w/o pen.)
Run1: 2024 RC	-252.79	-39.59	-40.49	-1616.51	-1805.61	12.28	128.78	0.02	-3613.93
Run2: 2024 RC, corrected	-252.80	-39.60	-40.49	-1616.44	-1805.67	12.29	128.79	0.02	-3613.93
Run3: 2025 data update	-259.55	-39.69	-40.91	-1625.98	-1807.72	13.44	128.76	0.01	-3631.65

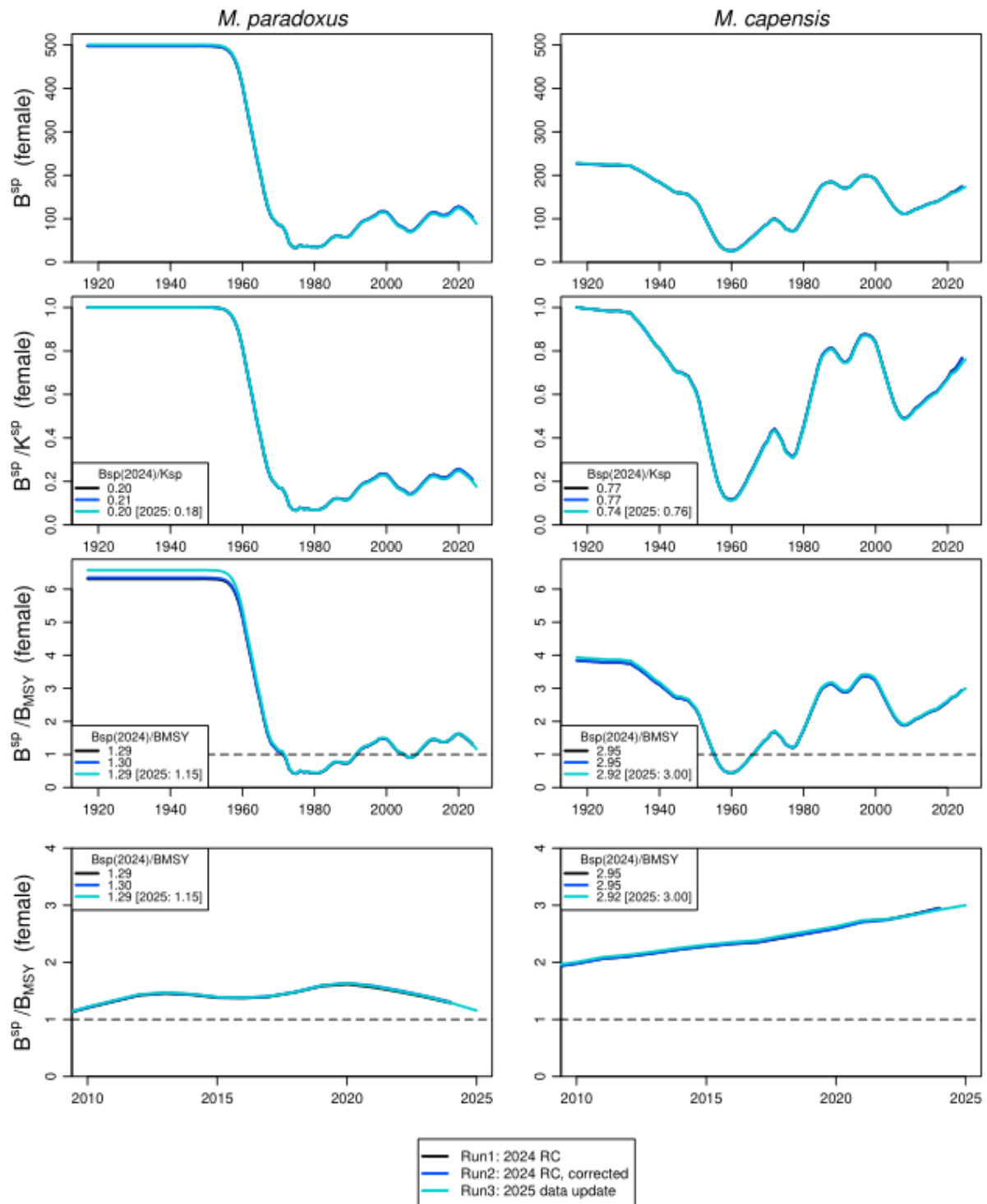


Figure 1: Female spawning biomass is shown for each species in absolute terms (top row), relative to pristine spawning biomass (second row), relative to B_{MSY} (third row) and relative to B_{MSY} but for the 2010-2025 time period only (fourth row). The depletion levels have been listed in the figure legends for the year 2024, with the 2025 values for Run3 included in square brackets.

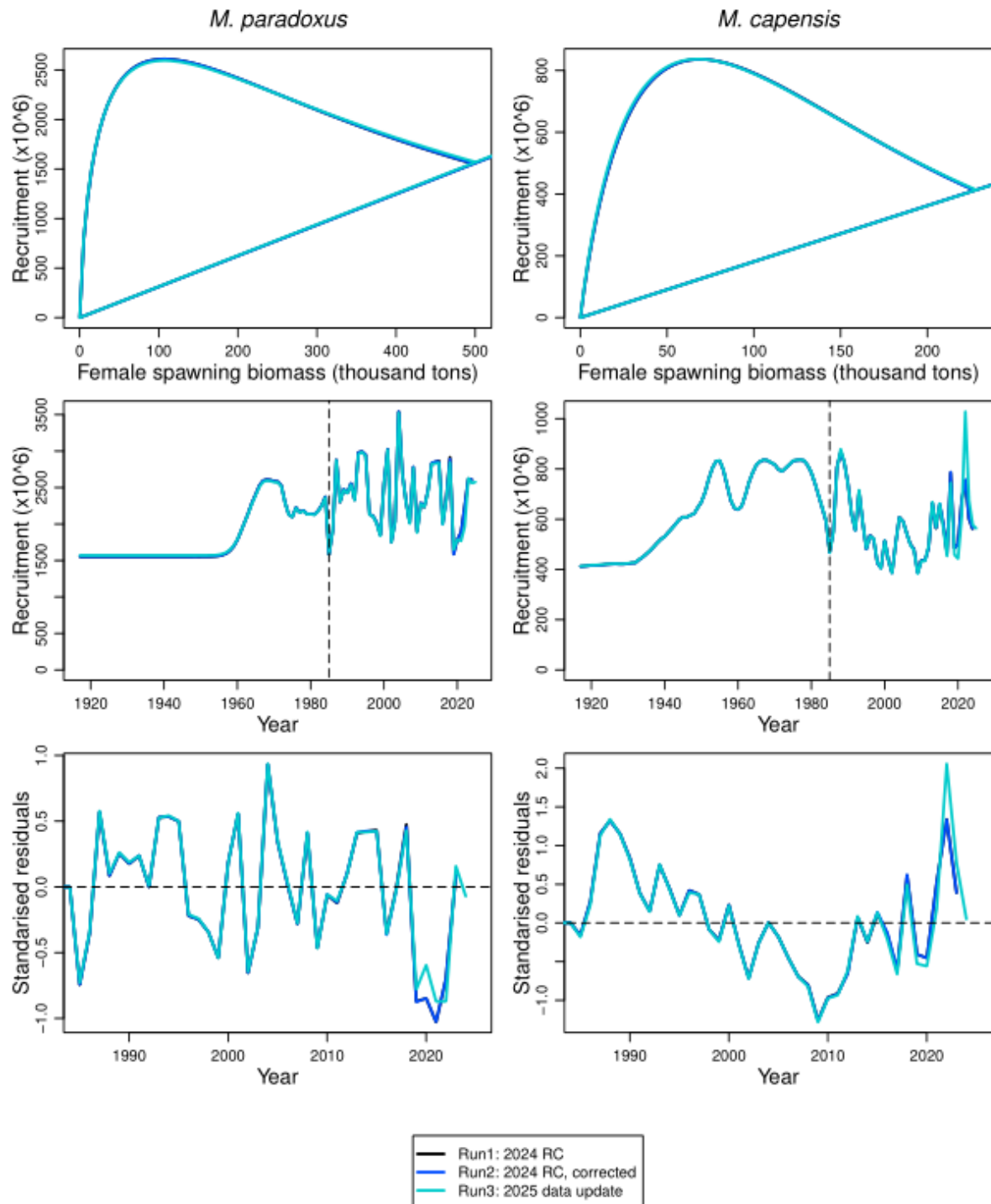


Figure 2: The top row shows the estimated recruitment-spawning biomass relationship for the two assessment models, while the second row shows the estimated recruitment time-series values and the bottom row the estimated standardized recruitment residuals.

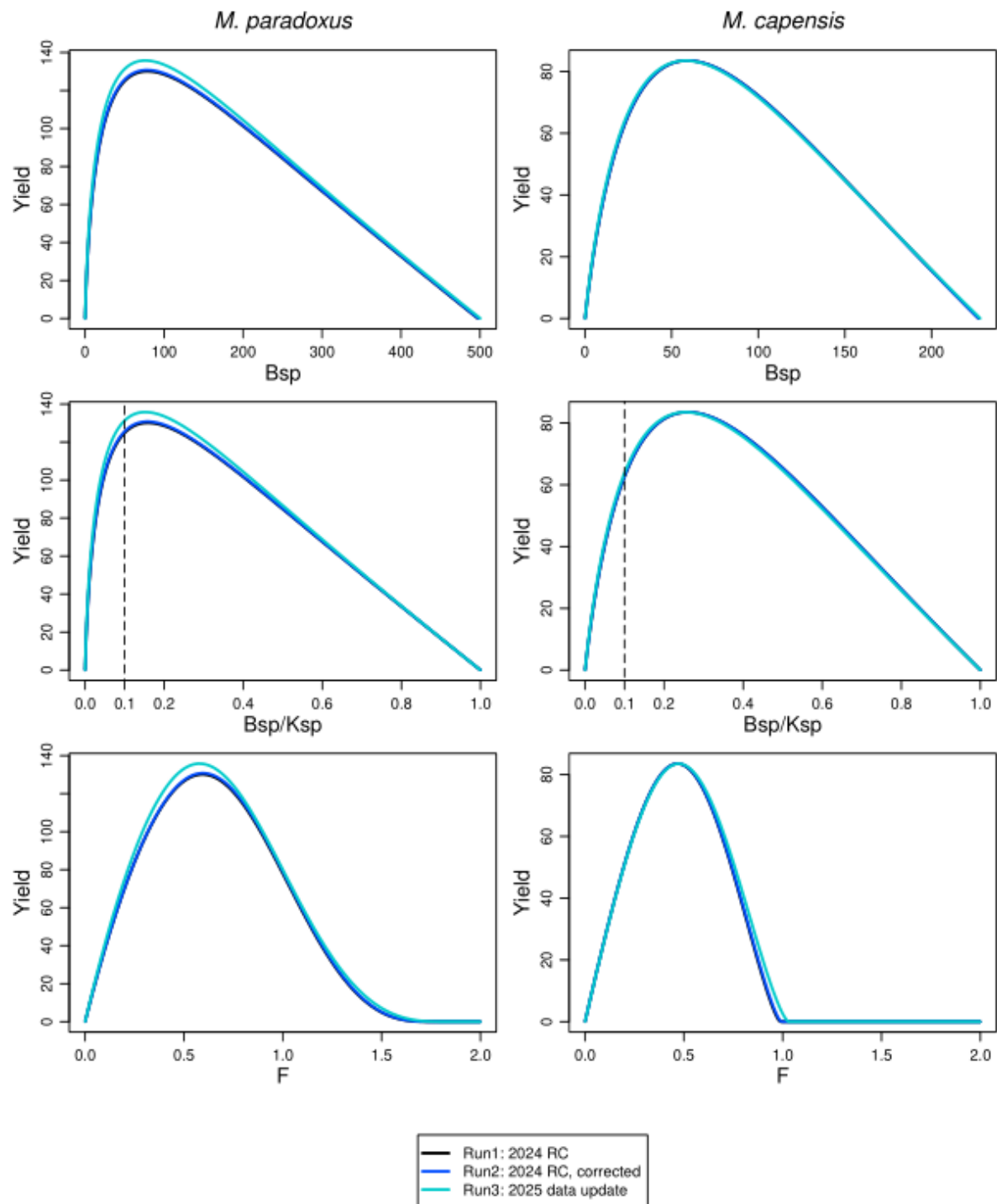


Figure 3: The estimated sustainable yield curve (yield in thousand tons) plotted against female spawning biomass (top panel), female spawning biomass relative to pristine levels (middle panel) and fishing mortality rate F (bottom panel).

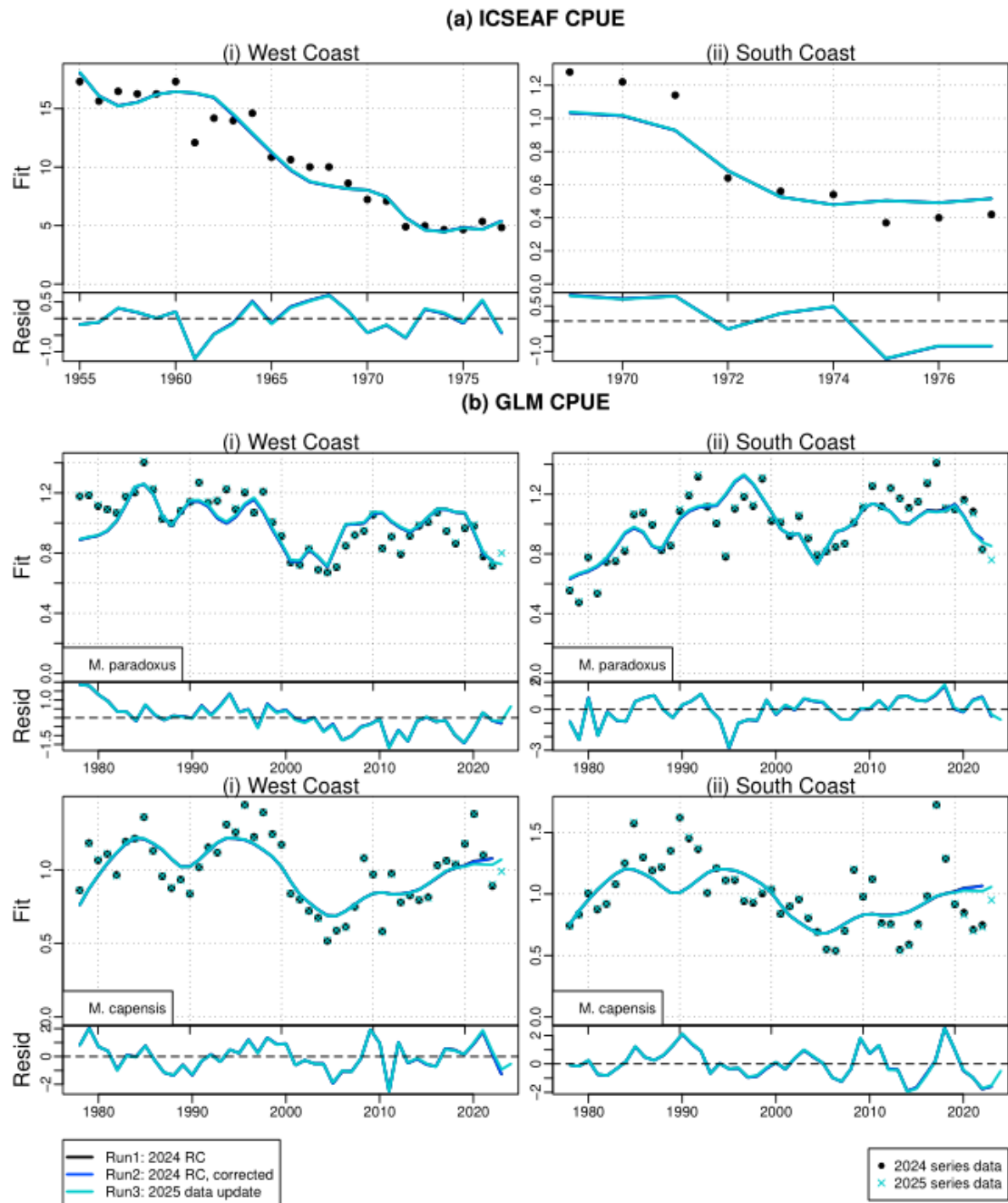


Figure 4: Fits to (a) the historical ICSEAF CPUE data and (b) the commercial GLM-standardized CPUE data are shown. Standardised residuals are also shown underneath each plot. The 2024 GLM series are shown by black dots and the updated 2025 GLM CPUE series by the light blue crosses.

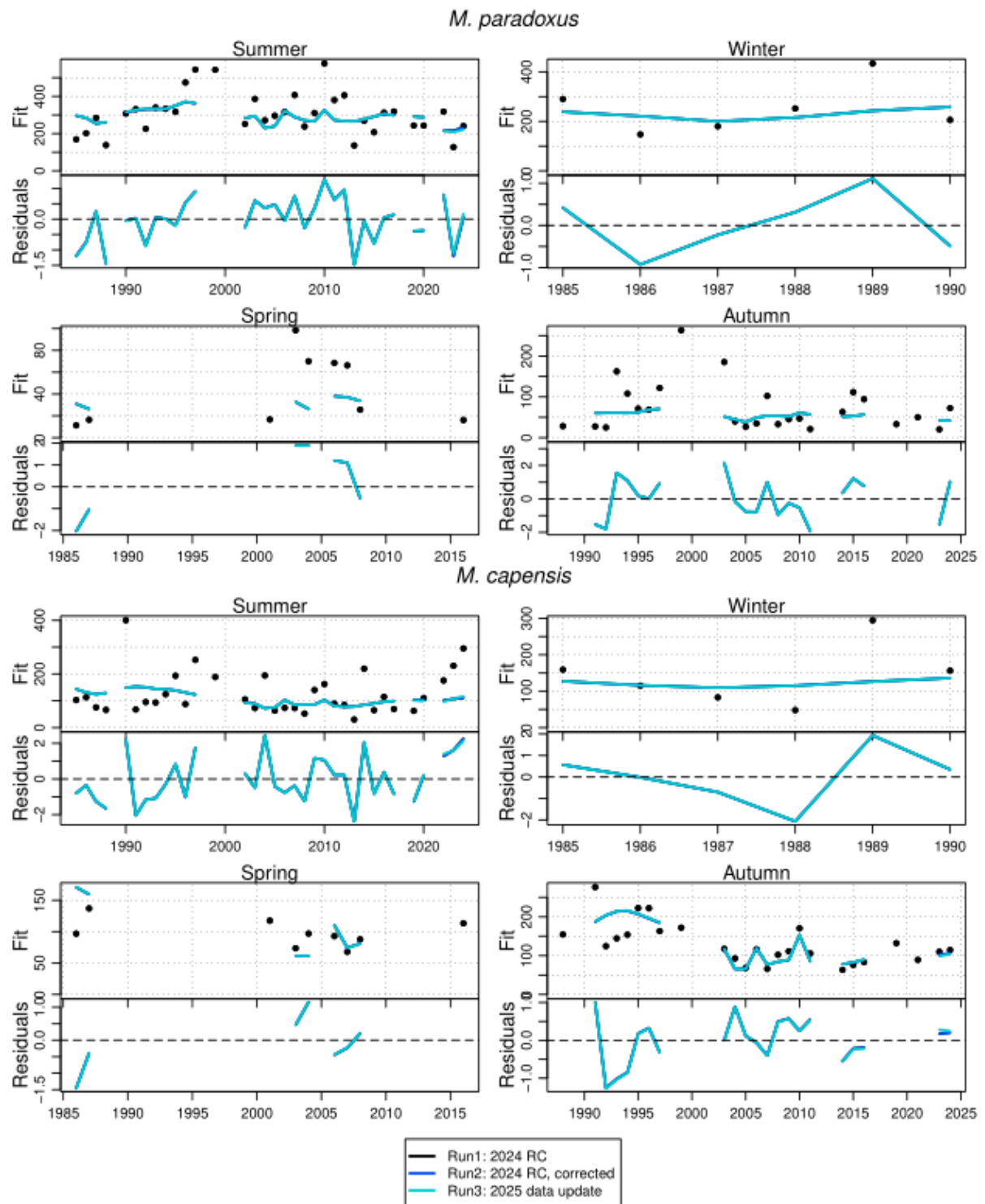


Figure 5: Fits to the survey relative abundance series are shown for the three OM. Standardised residuals are also shown underneath each plot. Note that at this level of resolution, the three fits can scarcely be distinguished.

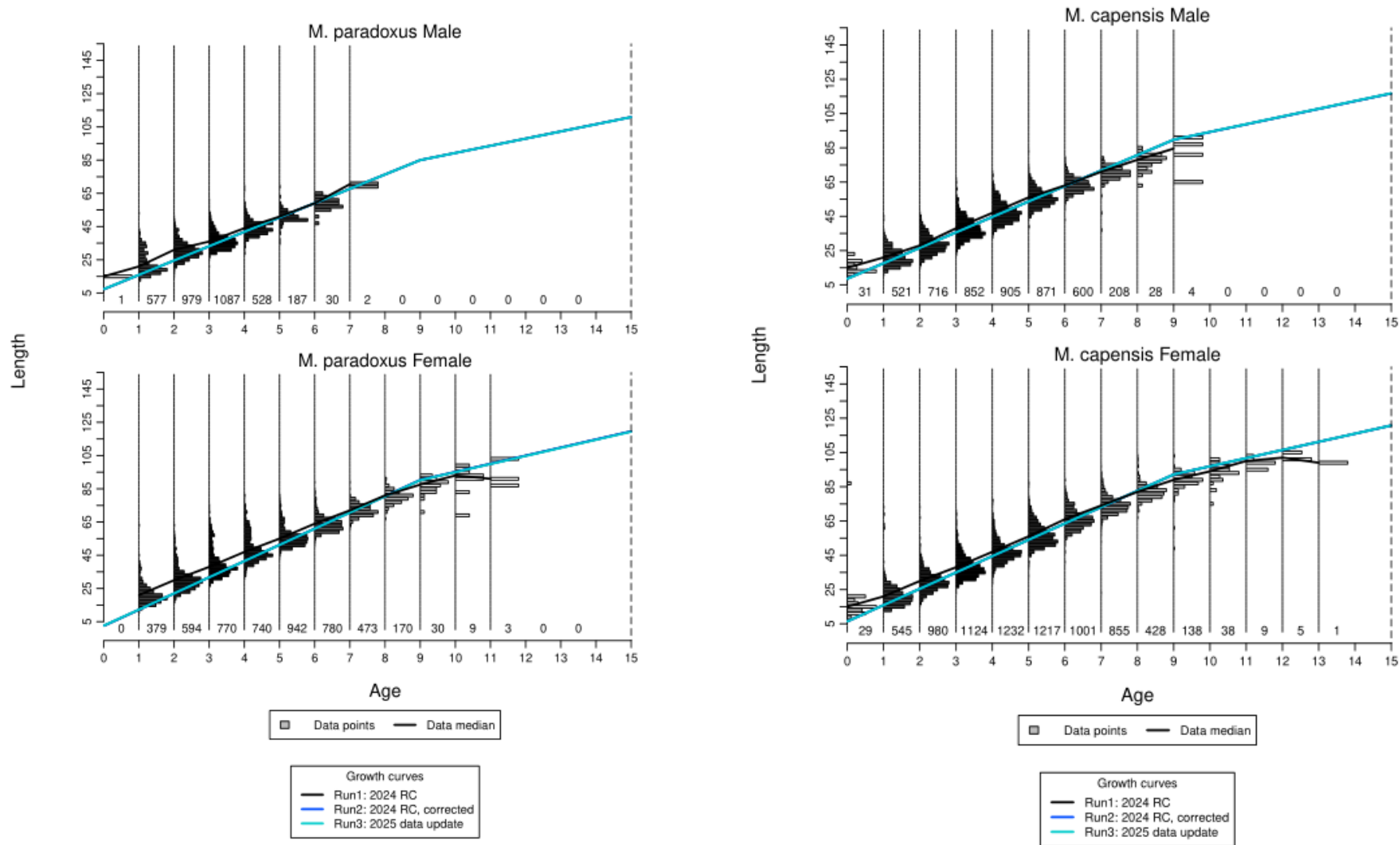


Figure 6: The estimated growth curves are superimposed on the length-at-age distributions derived from the age-length-key data. The numbers printed at the bottom of each age class indicate the number of data points available, and the shading of the bars is relative to these numbers, with darker shades indicating more data points.