



Further Sensitivities on the Proposed Revised Reference Set

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Summary

This paper reports certain sensitivity tests to the Proposed Revised Reference Set (“new” RS) for OMP testing that was put forward in WG/01/06/D:H:1. On the basis of the results obtained, it is recommended that the “new” RS be now adopted for this testing.

Introduction

In discussion of the Proposed Revised Reference Set (“new” RS) at the Task Group meeting on 20 January, certain questions were raised leading to requests that results of certain sensitivities be made available before a final decision be made on the RS to be used for OMP testing. These sensitivities related to:

- i) use of an age less than 15 for the plus-group;
- ii) whether changing the age of the plus-group gave rise to qualitatively different behaviour for variations in the central year assumed for the historic change from a primarily *M. capensis* to primarily *M. paradoxus* fishery; and
- iii) the effects of alternative selectivity assumptions for the longline fishery that become possible given the increase in the age of the plus-group.

This paper reports and then discusses the results of these sensitivities.

1. Different plus-group ages

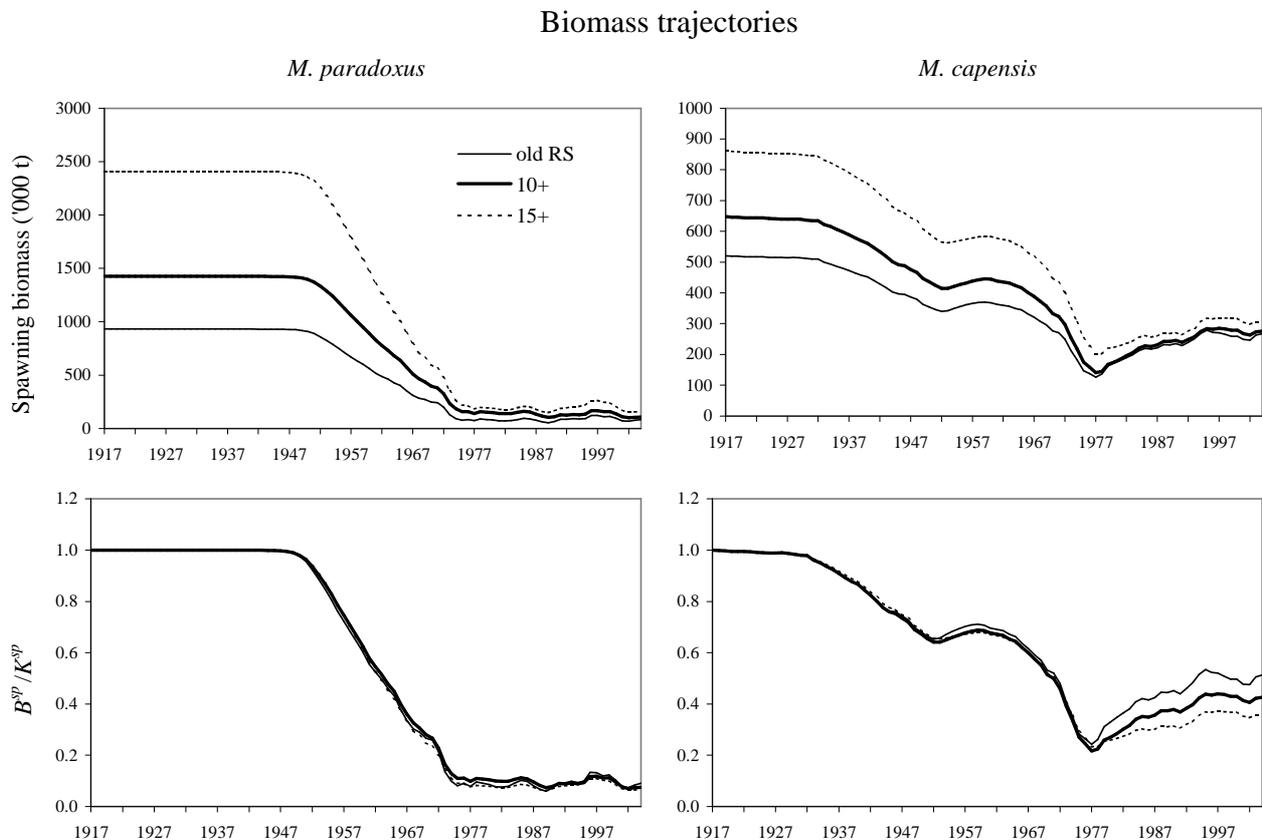


Fig. 1: Trajectories of resource abundance for one scenario of the proposed revised Reference Set (**M1-H1-C3-SR1**) for the “old” Reference Set (with plus-groups of age 5 and 7 for *M. paradoxus* and *M. capensis* respectively), for an assessment which extends the plus-group for both species to age 10 (“10+”) and for the proposed “new” Reference Set which extends the plus-group for both species to age 15 (“15+”). Resource abundance is expressed in terms of a) spawning biomass and b) of spawning biomass as a proportion of its pre-exploitation level.

2. Different catch series

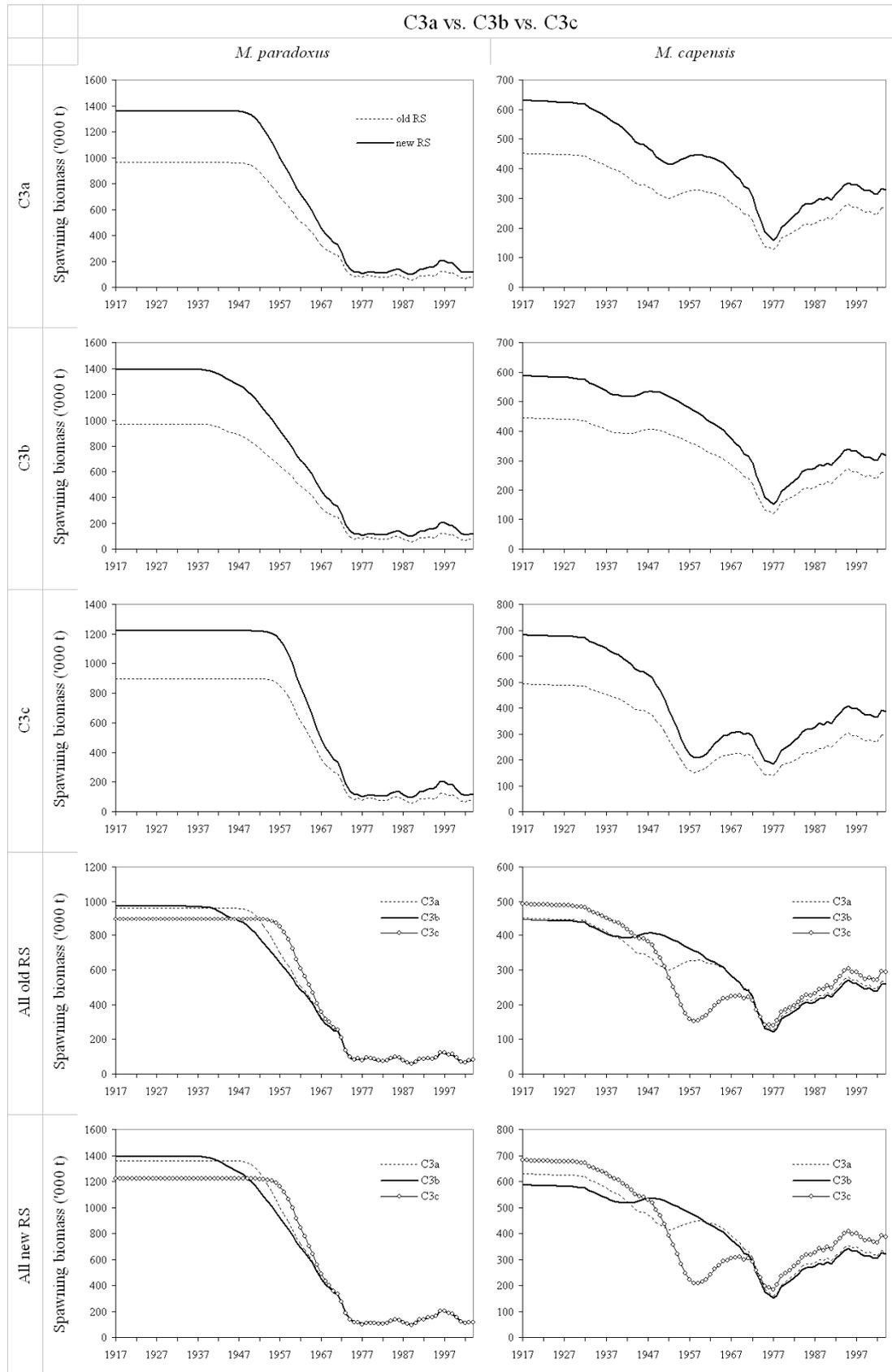


Fig. 2: Trajectories of resource abundance for one scenario of the proposed revised Reference Set (M4-H1-C3-SR1) for the C3a, b and c variants for the “old” Reference Set (5+ and 7+) and for the proposed “new” Reference Set (15+). Resource abundance is expressed in terms of a) spawning biomass and b) of spawning biomass as a proportion of its pre-exploitation level.

3. Different Longline Selectivity - Fixed

In the “Fixed longline selectivity”, the longline selectivity for *M. paradoxus* and *M. capensis* is fixed as shown in Fig. 3.

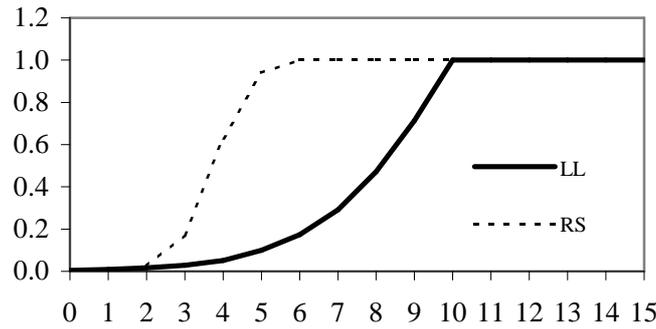


Fig. 3: Longline selectivity for the proposed “new” Reference Set (“RS”) and with fixed longline selectivity (“LL”) (see Appendix A). Note that the RS plot refers to *M. paradoxus*.

Four scenarios have been run:

M1-H1-C3a-SR1, M1-H4-C3a-SR1, M4-H1-C3a-SR1 and M4-H4-C3a-SR1).

Table 1: Results for four scenarios of the Reference Set and with fixed longline selectivity.

	Reference Set				Fixed longline selectivity				
	M1 C3 H1 SR1	M1 C3 H4 SR1	M4 C3 H1 SR1	M4 C3 H4 SR1	M1 C3 H1 SR1	M1 C3 H4 SR1	M4 C3 H1 SR1	M4 C3 H4 SR1	
-lnL total	-175.8	-159.7	-185.6	-178.2	-137.9	-121.2	-170.7	-156.5	
<i>M. paradoxus</i>	K^{sp}	2404	3278	1360	1080	2418	3283	1439	1068
	h	0.95	0.80	0.95	0.80	0.95	0.80	0.95	0.80
	MSY	155	169	126	129	156	169	130	134
	B^{sp}_{2004}/K^{sp}	0.07	0.12	0.09	0.16	0.07	0.12	0.08	0.14
	$B^{sp}_{2004}/MSYL^{sp}$	0.34	0.47	0.54	0.68	0.33	0.47	0.48	0.64
	M 0	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	1	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	2	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
3	0.40	0.40	0.67	0.73	0.40	0.40	0.67	0.74	
4	0.34	0.34	0.47	0.57	0.34	0.34	0.47	0.59	
5+	0.30	0.30	0.34	0.47	0.30	0.30	0.34	0.48	
<i>M. capensis</i>	K^{sp}	861	1025	631	625	841	1021	560	600
	h	0.95	0.70	0.92	0.70	0.95	0.70	0.86	0.70
	MSY	61	57	75	67	59	57	73	65
	B^{sp}_{2004}/K^{sp}	0.35	0.40	0.52	0.48	0.32	0.40	0.29	0.27
	$B^{sp}_{2004}/MSYL^{sp}$	1.41	1.21	2.58	1.64	1.25	1.20	1.27	0.92
	M 0	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	1	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	2	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	3	0.40	0.40	0.72	0.75	0.40	0.40	0.75	0.75
	4	0.34	0.34	0.56	0.60	0.34	0.34	0.60	0.60
	5	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50
6	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50	
7+	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50	
SC survey q	1.05	0.86	0.74	0.76	1.14	0.87	3.71	3.22	
2004 $cap/para$ ratio B^{sp}	1.88	1.02	2.77	1.80	1.66	1.01	1.44	1.08	
B^{2+}	1.06	0.77	1.31	1.02	0.94	0.76	0.91	0.71	

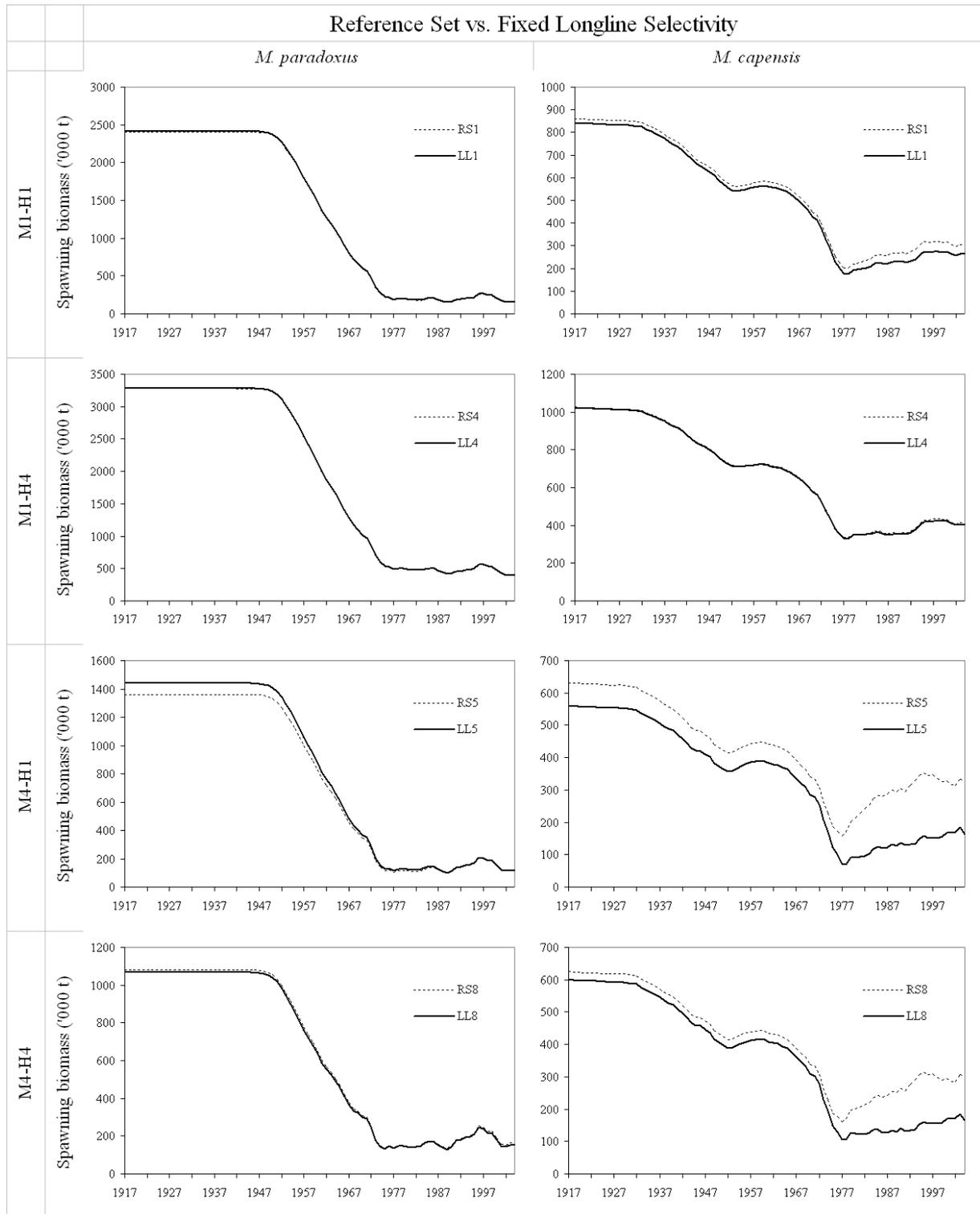


Fig. 4: Trajectories of resource abundance for four scenarios for the proposed “new” Reference Set (“RS”) and with fixed longline selectivity (“LL”). Resource abundance is expressed in terms of a) spawning biomass and b) of spawning biomass as a proportion of its pre-exploitation level.

4. Different Longline Selectivity - Estimated

Here the longline selectivity for *M. paradoxus* and *M. capensis* is estimated. As in the proposed Reference Set, it takes the form of a logistic function but instead of taken it to be flat from age 7, it flattens at age 10.

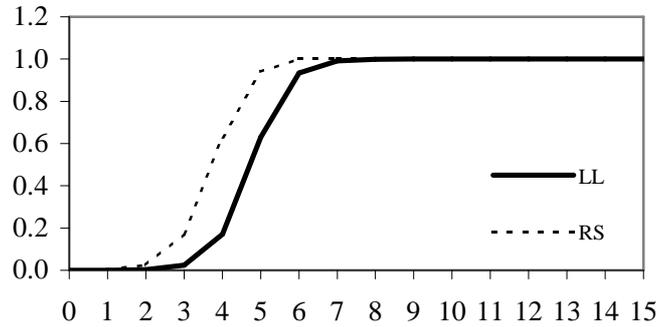


Fig. 5: Longline selectivity for the proposed “new” Reference Set (“RS”) and with estimated longline selectivity flattening at age 10 (“LL”) (see Appendix A).). Note that the RS plot refers to *M. paradoxus*.

Table 2: Results for four scenarios of the Reference Set and with estimated longline selectivity (flattening at age 10).

	Reference Set				Estimated longline selectivity (flat from age 10)				
	M1 C3 H1 SR1	M1 C3 H4 SR1	M4 C3 H1 SR1	M4 C3 H4 SR1	M1 C3 H1 SR1	M1 C3 H4 SR1	M4 C3 H1 SR1	M4 C3 H4 SR1	
-lnL total	-175.8	-159.7	-185.6	-178.2	-175.5	-159.5	-185.6	-177.9	
<i>M. paradoxus</i>	K^{sp}	2404	3278	1360	1080	2403	3272	1371	1089
	h	0.95	0.80	0.95	0.80	0.95	0.80	0.95	0.80
	MSY	155	169	126	129	155	169	128	129
	B^{sp}_{2004}/K^{sp}	0.07	0.12	0.09	0.16	0.07	0.12	0.09	0.15
	$B^{sp}_{2004}/MSYL^{sp}$	0.34	0.47	0.54	0.68	0.34	0.47	0.52	0.68
	M 0	0.50	0.50	1.00	1.00	0.50	0.50	0.99	1.00
	1	0.50	0.50	1.00	1.00	0.50	0.50	0.99	1.00
	2	0.50	0.50	1.00	1.00	0.50	0.50	0.99	1.00
3	0.40	0.40	0.67	0.73	0.40	0.40	0.67	0.73	
4	0.34	0.34	0.47	0.57	0.34	0.34	0.47	0.57	
5+	0.30	0.30	0.34	0.47	0.30	0.30	0.34	0.47	
<i>M. capensis</i>	K^{sp}	861	1025	631	625	861	1028	589	624
	h	0.95	0.70	0.92	0.70	0.95	0.70	0.85	0.70
	MSY	61	57	75	67	61	57	76	67
	B^{sp}_{2004}/K^{sp}	0.35	0.40	0.52	0.48	0.35	0.40	0.54	0.48
	$B^{sp}_{2004}/MSYL^{sp}$	1.41	1.21	2.58	1.64	1.41	1.22	2.36	1.63
	M 0	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	1	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	2	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
	3	0.40	0.40	0.72	0.75	0.40	0.40	0.75	0.75
	4	0.34	0.34	0.56	0.60	0.34	0.34	0.60	0.60
5	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50	
6	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50	
7+	0.30	0.30	0.44	0.50	0.30	0.30	0.50	0.50	
SC survey q	1.05	0.86	0.74	0.76	1.05	0.86	0.71	0.77	
2004 <i>cap/para</i> ratio B^{sp}	1.88	1.02	2.77	1.80	1.89	1.05	2.72	1.79	
B^{2+}	1.06	0.77	1.31	1.02	1.06	0.79	1.36	1.02	

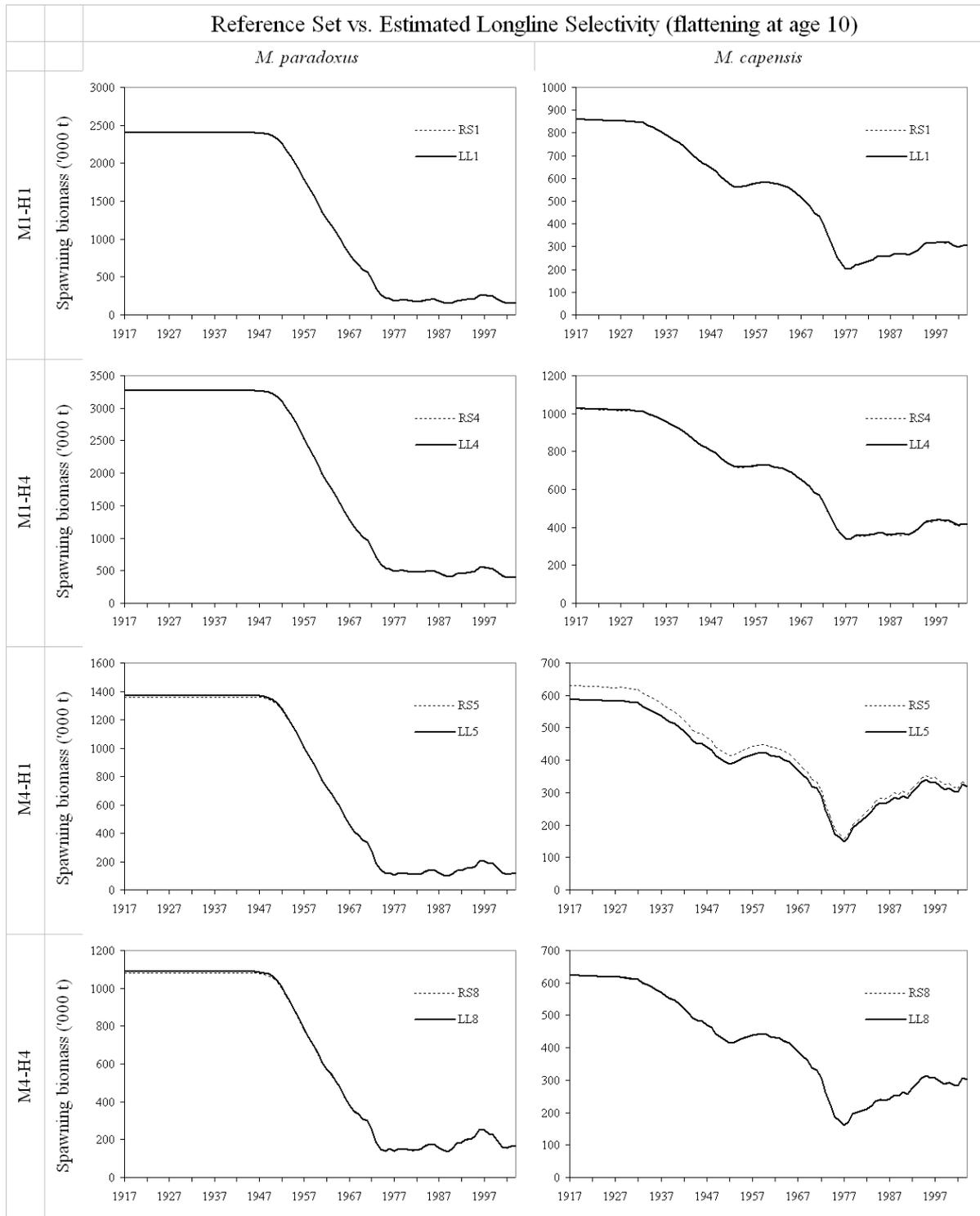


Fig. 6: Trajectories of resource abundance for four scenarios for the proposed “new” Reference Set (“RS”) and with estimated longline selectivity (“LL”).

Discussion

The plots in Fig. 1 show that an intermediate plus-group age of 10 gives results that are similarly intermediate between those for the original “old” RS and the age of 15 for the proposed “new” RS. The differences are appreciable in absolute terms, but less so when expressed relative to K for *M. capensis* and hardly at all for *M. paradoxus*. As motivated in WG/01/06/D:H:1, the proposal of 15 as the chosen age is considered the most appropriate on biological and computational practicality grounds. [Note that the request at the Task Group for results for the choice of 10 was motivated more to gain a sense of the impact on results than as a necessarily serious alternative RS candidate.]

Fig. 2 shows results for RS scenarios which cover the range of choice for the central year assumed for the historic change from a primarily *M. capensis* to primarily *M. paradoxus* fishery (the C3a, b and c variants) for both the “old” and the “new” RS. It is evident that the modification to the choice for the plus-group age, though changing absolute values of spawning biomass as expected, makes no qualitative difference to the variations in the biomass trajectories as the central year for the change in the fishery is varied across the range previously agreed.

The effects of changes to the longline selectivity depend on the manner the change is effected. For the “fixed” changes (Figs 3 and 4, and Table 1), appreciable differences in *M. capensis* spawning biomass trajectories are evident. However, when this selectivity is “estimated” given the greater flexibility admitted by increasing the plus-group age (Figs 5 and 6, and Table 2), differences are hardly noticeable. It is important to note that the “fixed” option results in a severe deterioration to the overall model fit (related essentially to the likelihood for the longline catch-at-age data), so that the “fixed” results should be disregarded.

In summary, neither the effects of varying the year categorising the shift of the fishery towards *M. paradoxus*, nor changes to the longline selectivity that remain compatible with the data, result in meaningful modifications to estimated spawning biomass trends. Accordingly it is recommended that the “new” RS proposed in WG/01/06/D:H:1 be adopted without further modification for OMP testing. Note that details of robustness tests remain to be finalised, and further documentation in regard to them will be circulated in due course.

Appendix A

The longline selectivity-at-age for *M. paradoxus* and *M. capensis* is estimated in terms of a logistic curve given by:

$$S_a = \begin{cases} 0 & \text{for } a < 1 \\ \left[1 + \exp(-\delta^c (a - a^c))\right]^{-1} & \text{for } 1 \leq a \leq a_{flat} \\ S_{a-1} & \text{for } a \geq a_{flat} + 1 \end{cases} \quad (\text{A1})$$

where

a^c years is the age-at-50% selectivity,

δ^c year⁻¹ defines the steepness of the ascending limb of the selectivity curve.

The selectivity is then (re-)normalised so that the maximum selectivity is 1.

“Reference Set”:

a^c and δ^c are estimated and set equal for *M. paradoxus* and *M. capensis*. a_{flat} is set to 5 for *M. paradoxus* and 7 for *M. capensis*.

“Fixed longline selectivity”:

a^c and δ^c are fixed to $\frac{\ln 19}{5}$ and 10 respectively and a_{flat} is set to 10 for both species.

“Estimated longline selectivity (flattening at 10)”:

a^c and δ^c are estimated and set equal for *M. paradoxus* and *M. capensis*. a_{flat} is set to 10 for both species.