Results for an Illustrative Empirical Decision Rule for Hake Projections for C3 Scenarios in the Context of Alternative Options for Initial TAC Reduction Levels

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ABSTRACT

This paper reports further investigations of the performance of an illustrative EMPIRICAL decision rule (OMP) for the hake resource for C3 scenarios only because these reflect (on average) a current spawning biomass ratio for *M. capensis* compared to *M. paradoxus* of about 2:1, which is considered more plausible than the much higher corresponding ratios for the C1 and C2 scenarios. Initial annual reductions of 5000, 8000 and 10000 tons are considered for the first two years. After that initial period, TAC changes are restricted to a maximum of 5%, both up and down. Results for the C6 scenarios (C6 corresponds to C3 in the same way as C4 to C1 – reflecting a greater proportion of *M. capensis* in past offshore trawl catches) show a reduction of about 15000t in the annual TAC for similar final depletion statistics (the lower 5%ile being of primary importance as risk is the concern here) for *M. paradoxus*.

INTRODUCTION

At an MCM scientific meeting with the hake industry held on 9 November, it was agreed that further runs of an illustrative empirical decision rule (OMP) be conducted, based on the C3 scenarios, to assist the Working Group in finalising a recommendation for the hake TAC for 2006.

Fig. 1 shows the various hypotheses considered for the time series of the split of past offshore trawler commercial catches between *M. capensis* and *M. paradoxus* Reference Set (RS) Operating Models agreed earlier as the basis for OMP testing. Note that the various scenarios under the C3 heading correspond to a change to *M. paradoxus* prevalence in particularly west coast catches at a relatively early stage in the fishery. The reason to focus on the C3 scenarios is that they reflect (on average) a current spawning biomass ratio for *M. capensis* compared to *M. paradoxus* of about 2:1, which is considered much more plausible than the corresponding average ratios for the C1 and C2 scenarios of about 6:1 and 8:1 respectively. A particular reason for this plausibility evaluation is that the C3 scenarios yield much lower *M. capensis* spawning biomass estimates in absolute terms (see Fig. 2), which correspond to estimated multiplicative bias estimates for south coast research surveys which are reasonably close to 1 compared to the very low values for C1 and C2 scenarios.

Note that the assessment results for spawning biomass shown for C3 scenarios in Fig. 2 reflect somewhat poorer status for both the *M. capensis* and *M. paradoxus* resources relative to their pre-exploitation levels than was the case for the RS, which gave equal weighting to each of the C1, C2 and C3 sets of scenarios.

BASIS FOR UPDATED CALCULATIONS

The empirical control rule (OMP) detailed in Rademeyer *et al*. (2005, i.e. D:H:42(rev)) has been applied, with its control parameters tuned to give appropriate performance (steady recovery of the *M. paradoxus* resource and steady TAC trends after an initial fixed TAC reduction for the first two years – when each is considered in terms of its median). Initial annual reductions of 5000, 8000 and 10000 tons are considered for the first two years. After that initial period, annual TAC changes are restricted to a maximum of 5%, both up and down.

For improved precision of the results (as the C3 scenarios in isolation comprise only 16 assessment options in contrast to the 48 of the earlier RS which included C1 and C2 scenarios as well), 10 future projection replicates for each assessment were computed rather than 3 only as in the past.

The revised control parameter values selected for each initial TAC reduction option considered are listed in Table 1.

OMP1 vs OMP2

Previous poor performance in terms of risk to the *M. paradoxus* resource was driven primarily by results for the C4 scenarios in which the true proportion of *M. capensis* in the catch has been underestimated. Hence the Deep Sea Trawl Industry have indicated that they are planning additional sampling (such that in within three years data may become available to reliably inform on the "true" ratio of *M. paradoxus* : *M. capensis* in the offshore trawl catch). These data could suggest either that current assumptions remain valid or that these are flawed in some way.

This leads to two different classes of OMPs as follows:

	Species-aggregated TAC
1. Implemented in the first 3 years and thereafter if sampling indicates C3 species split is reasonably accurate	OMP 1
2. Default from 4th year if no sampling or if C6 are closer to the species-split indicated by sampling	OMP 2

The basic approach illustrated here is thus as follows:

i) OMP1 is implemented now, and

ii) after three years, if the requisite data have not been collected, or show a species-split of the offshore catch to be closer to C6 scenarios, OMP2 replaces OMP1.

RESULTS

Fig. 3 shows projections for spawning biomass for both *M. paradoxus* and *M. capensis* if the present TAC of 158 thousand tons is maintained unchanged into the future (and fishing patterns also remain the same). Clearly this is an unacceptable approach, as there is the possibility that this would lead to effective extermination of the *M. paradoxus* resource within a few years.

Figs. 4a-c show medians and 90% probability envelopes for the future TAC and the spawning biomasses of each of the two resources under initial TAC reductions of 5000, 8000 and 10000 tons respectively for the next two years, with the illustrative decision rule coming into play thereafter. Fig. 5 combines the medians on the same plots for ease of comparison.

Fig. 6 shows results for the 8000 ton initial decrease option for the C6 scenarios (C6 corresponds to C3 in the same way as C4 to C1 – see Fig. 1 – reflecting a greater proportion of *M. capensis* in past offshore trawl catches), and Fig. 7 compares the median in Fig. 6 with the corresponding result for the C3 scenarios.

Finally, Fig. 8 plots comparative performance statistics and Table 2 lists these performance statistics for all the decision rule variants investigated.

DISCUSSION

Although the C3 scenarios reflect distinctly poorer status for both resources in terms of absolute biomass and biomass relative to pre-exploitation than did the C1 and C2 scenarios, the differences in terms of projections are not as marked. The reason for this is that current resource productivity levels are better estimated from the available data than are absolute abundances. Note that the abundance and current status of the *M. paradoxus* resource are much better determined than those for *M. capensis*.

Median spawning biomass future trajectories for *M. paradoxus* show improved behaviour to those in D:H:42(rev), now reflecting continuing steady recovery. Consequently, although initial status is now estimated to be worse than for the earlier RS (C1, C2 and C3 combined), a greater degree of recovery is achieved, with even the lower 5%iles after 20 years well above the 2005 level (see Table 2).

The sharpish increase in the median TAC immediately following an initial reduction of 10000 tons for the first two years (see Fig. 4c) is not ideal. Given more time, control parameters for this case could perhaps have been modified to obtain improved performance in this respect. For an initial annual reduction of 5000 tons, further TAC reductions over the following decade would seem likely.

Results for the C6 scenarios show that there is the possibility to adjust future TACs in a non-disruptive manner in the future if direct sampling shows the current estimates of the species-split of the offshore trawler catch to be in error, but for the particular case examined this would in due course require future TACs to be lower by about 15000 tons.

LITERATURE CITED

Rademeyer, R. A., É. E. Plagányi and D.S. Butterworth. 2005. Yet further evaluations of candidate OMPs for the South African hake resource, including consideration of other management options. Marine and Coastal Management document WG/10/05/D:H:42(rev). 21 pp.

Table 1: Description of the illustrative empirical OMPs considered in this paper. δ_1, δ_2 and δ_3 are the parameters of the year-dependent tuning parameter, λ_y . Details of the decision rules are given in WG/09/05/D:H:42 (rev).

	Applied to cases	P	δ_1	δ_2	δ_3	*Yr_join*	*target paradoxus*	*target capensis*	max. increase and decrease	phase down
1	C3	5	0.1	5	2	10	3%	0	+-5%	2 x 5000t
2	C3	5	0.3	4	2	10	3%	0	+-5%	2 x 8000t
3	C3	5	0.6	2.5	2	10	3%	0	+-5%	2 x 10000t
4	C6	5	0.1	5	2	10	4%	0	+-5%	2 x 8000t

Table 2: Summary of performance statistics for 20-year projections for the illustrative OMPs presented in this paper. OMP1 variants are applied to the C3 scenarios of the RS and the OMP2 variant is applied to the C6 scenarios. All variants are tuned to the same 5%ile for *M. paradoxus* depletion in 2025.

		1	2	3	4
		C3 2x5000t	**C3 2x8000t**	**C3 2x10000t**	**C6 2x8000t**
	AvTAC				
	Median	146.3	151.1	151.1	134.3
	5%ile	134.4	134.0	134.0	115.5
	95%ile	157.4	163.9	163.9	146.8
	AAV				
	Median	3.1	4.1	4.1	3.3
	5%ile	2.2	3.1	3.1	2.6
	95%ile	4.1	4.7	4.7	4.2
M. paradoxus	B^{sp}_{2025}/K^{sp}				
	Median	0.31	0.28	0.28	0.33
	5%ile	0.15	0.16	0.16	0.15
	95%ile	0.50	0.47	0.47	0.57
	B^{sp}_{2025}/B_{2005}				
	Median	3.54	3.22	3.22	3.17
	5%ile	1.75	1.97	1.97	1.71
	95%ile	5.97	5.64	5.64	6.00
M. capensis	B^{sp}_{2025}/K^{sp}				
	Median	0.67	0.67	0.67	0.75
	5%ile	0.53	0.53	0.53	0.62
	95%ile	0.85	0.84	0.84	0.88
	B^{sp}_{2025}/B_{2005}				
	Median	1.26	1.25	1.25	1.37
	5%ile	1.01	1.02	1.02	1.08
	95%ile	1.54	1.48	1.48	1.61
M. p.	B^{sp}_{2005}/K^{sp}				
	Median	0.09	0.09	0.09	0.10
	5%ile	0.06	0.06	0.06	0.07
	95%ile	0.12	0.12	0.12	0.18
M. c.	B^{sp}_{2005}/K^{sp}				
	Median	0.54	0.54	0.54	0.56
	5%ile	0.42	0.42	0.42	0.47
	95%ile	0.69	0.69	0.69	0.64

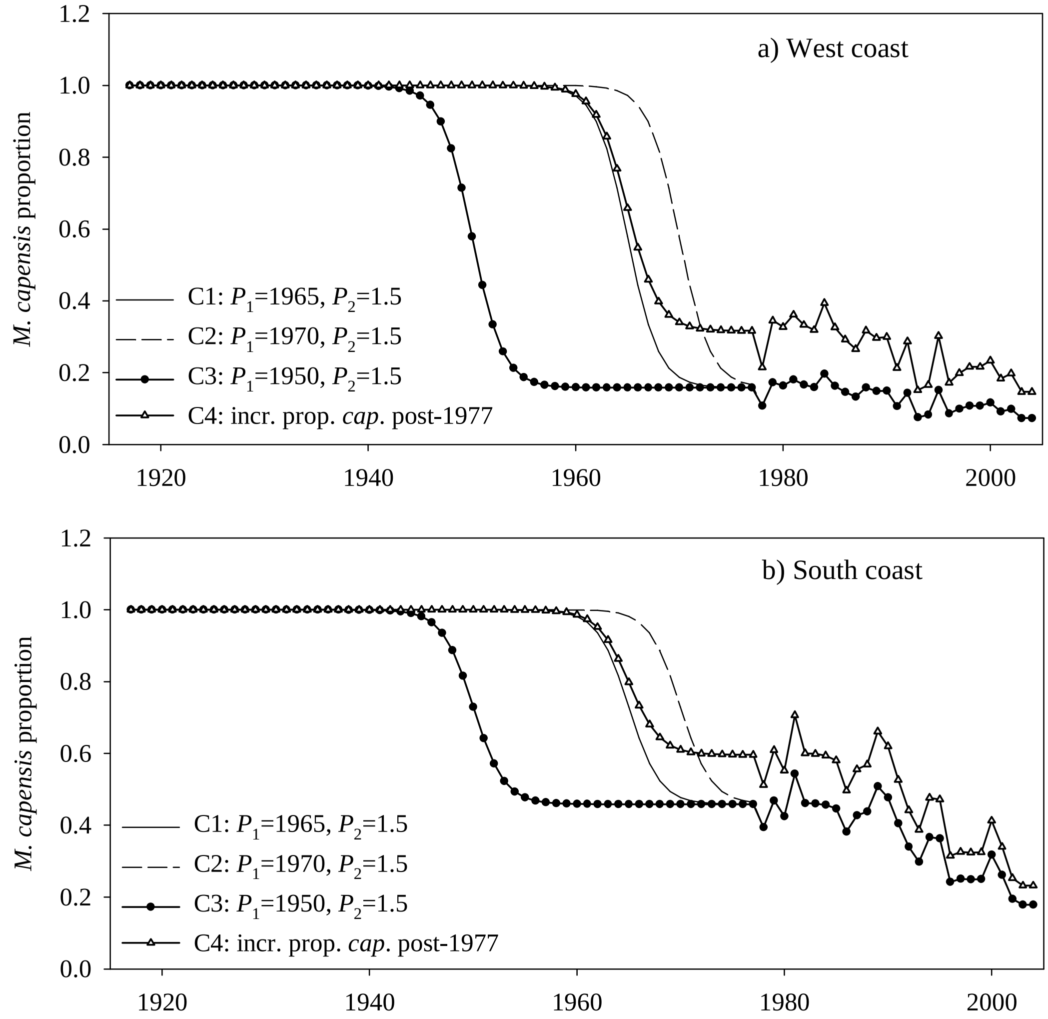


Fig. 1: Assumed proportion of *M. capensis* in the offshore catches for a) the west coast and b) the south coast for scenarios C1, C2, C3 and C4.

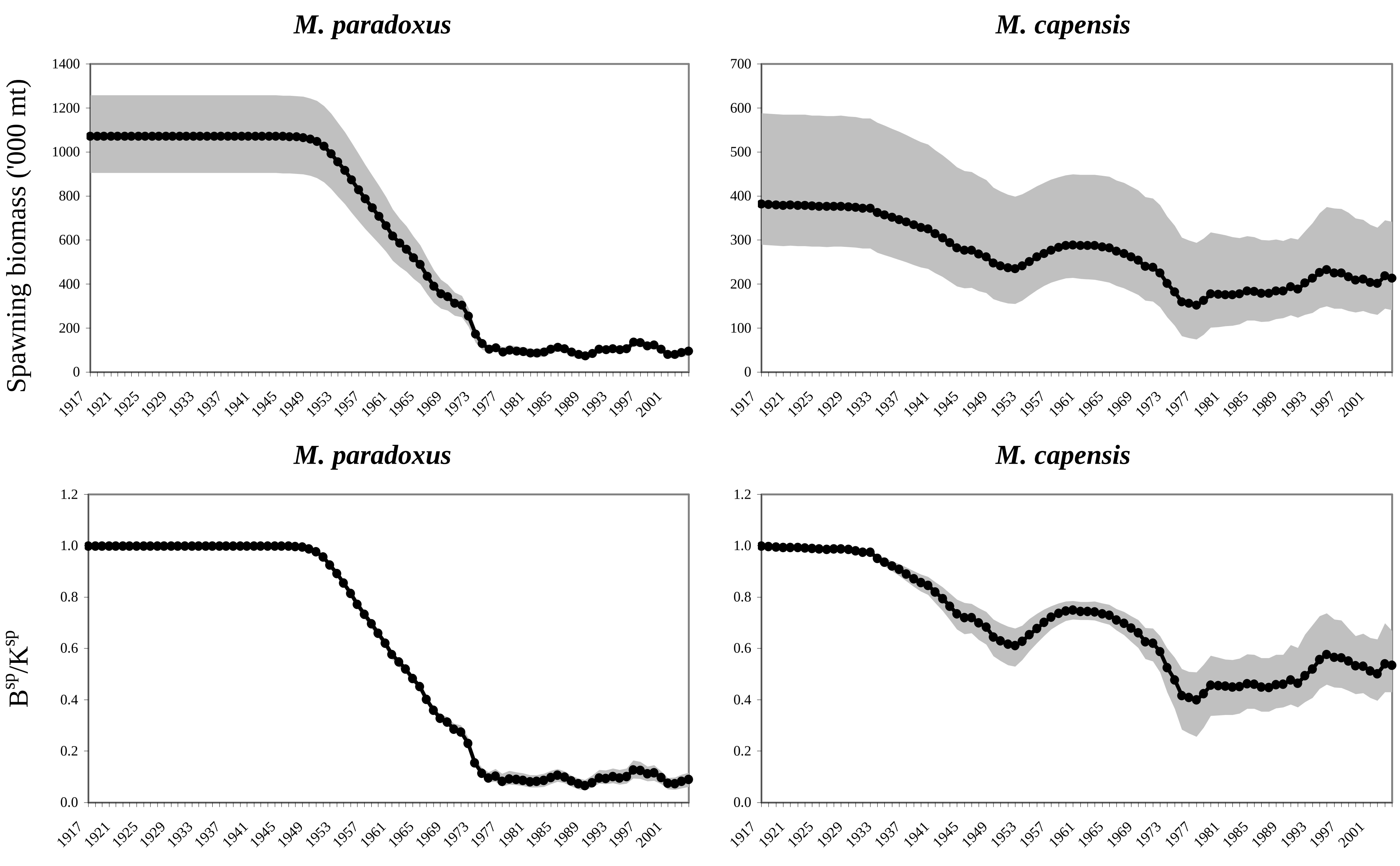


Fig. 2. Assessment medians and 90% probability envelopes for past spawning biomasses for the C3 scenarios of the Reference Set.

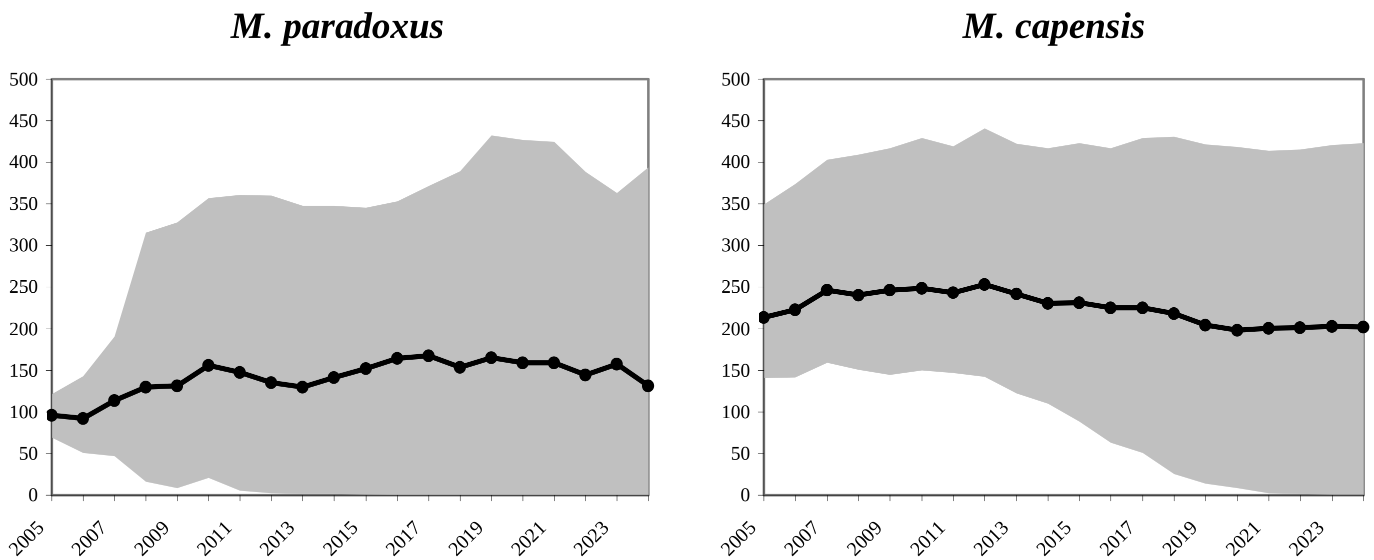
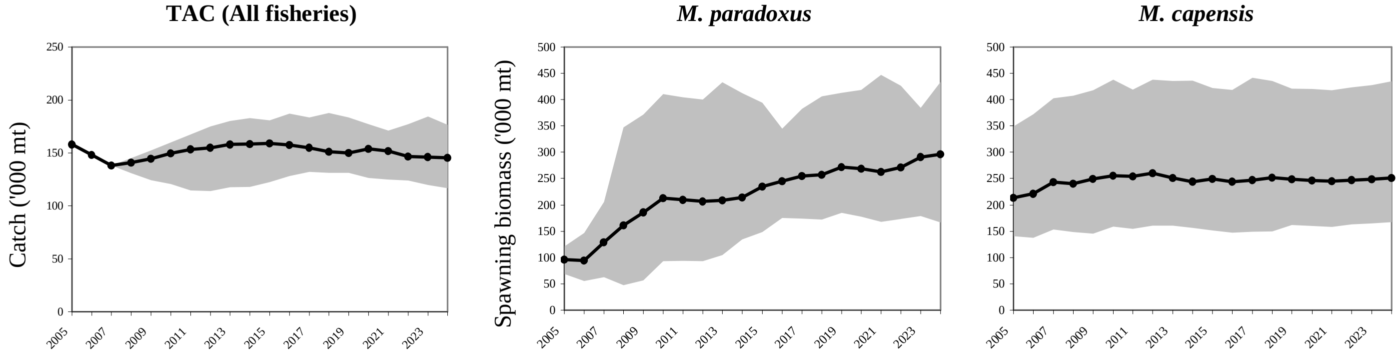
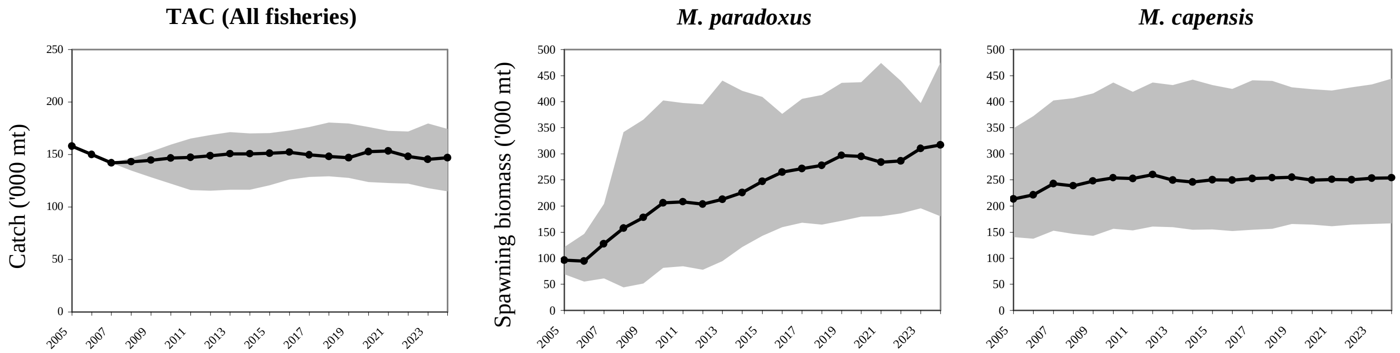


Fig. 3. Future trajectories for *M. paradoxus* and *M. capensis* resource spawning biomass for the C3 scenarios of the RS under the assumption that the TAC is maintained at the current level. Here and below, the median is shown as a dark dotted line and the shaded areas show 90% probability envelopes.

1) 2 x 10000t



2) 2 x 8000t



3) 2 x 5000t

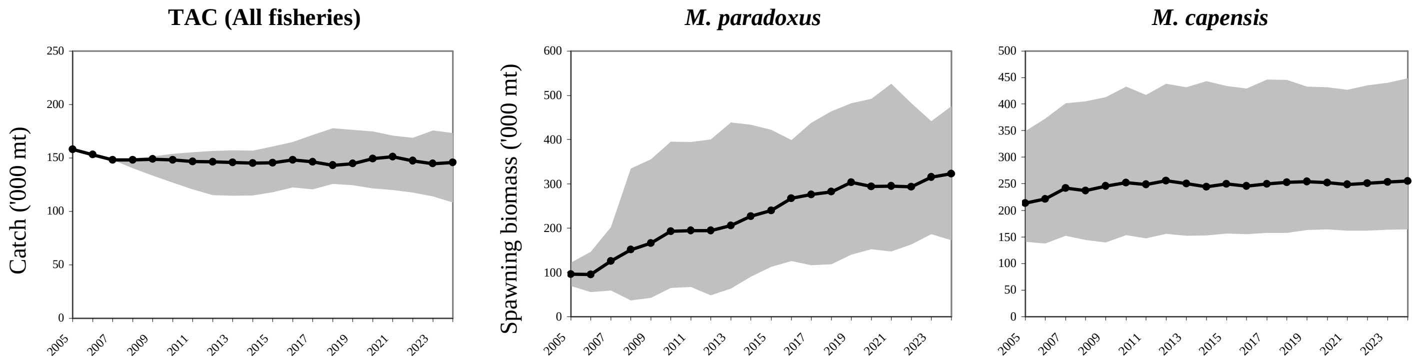


Fig. 4. Trajectories for future TACs and resource spawning biomasses from an application of illustrative OMP1 variants to the C3 scenarios of the RS (which assume the past catch split by species to be correct), shown under three different phase-down options for the TAC for the first two years.

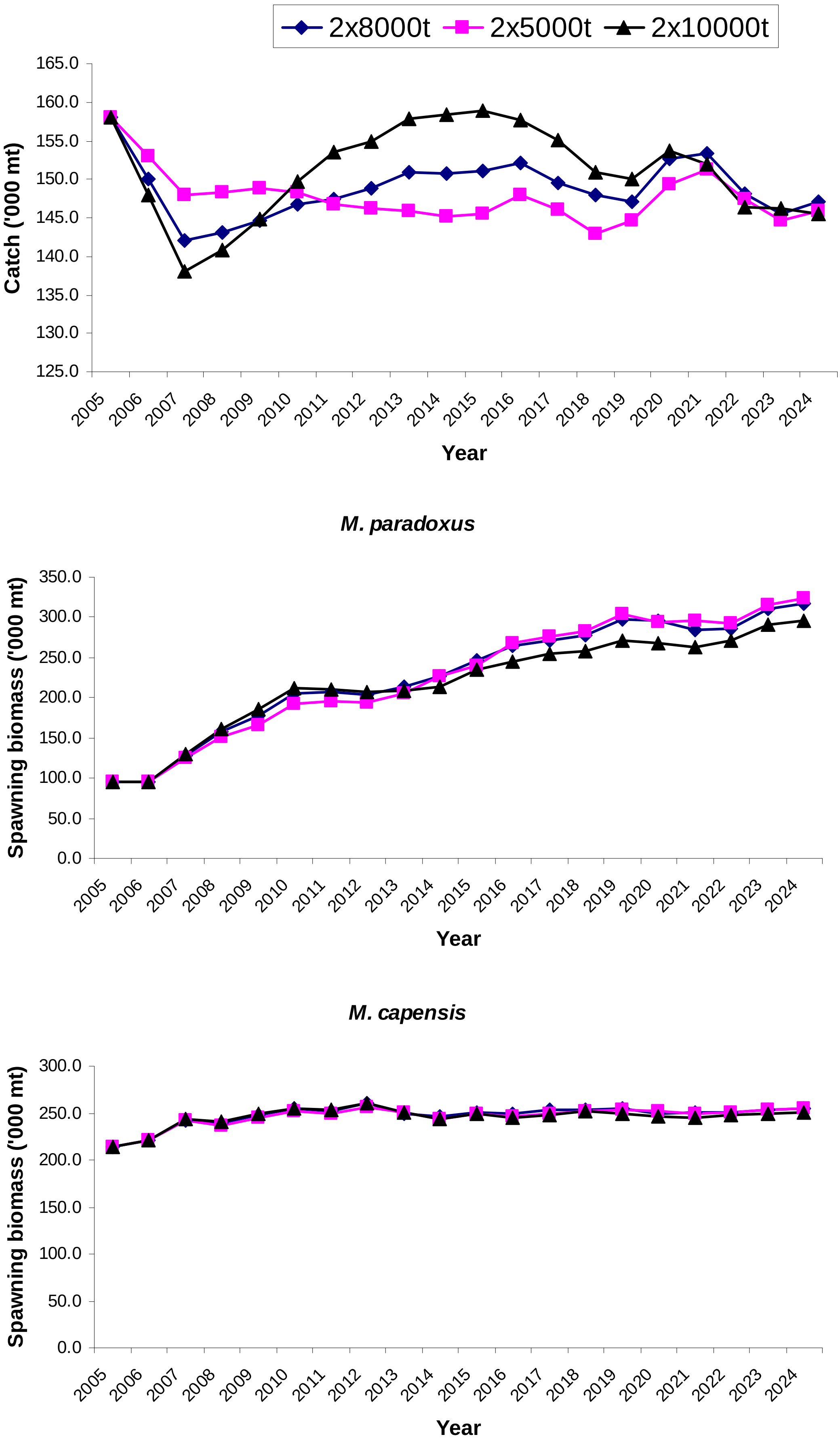


Fig. 5. Comparison of future trajectories for TACs and resource spawning biomasses (medians) for three variants of illustrative OMP1 (applied to C3 scenarios) under different phase-down options.

C6 2 x 8000t

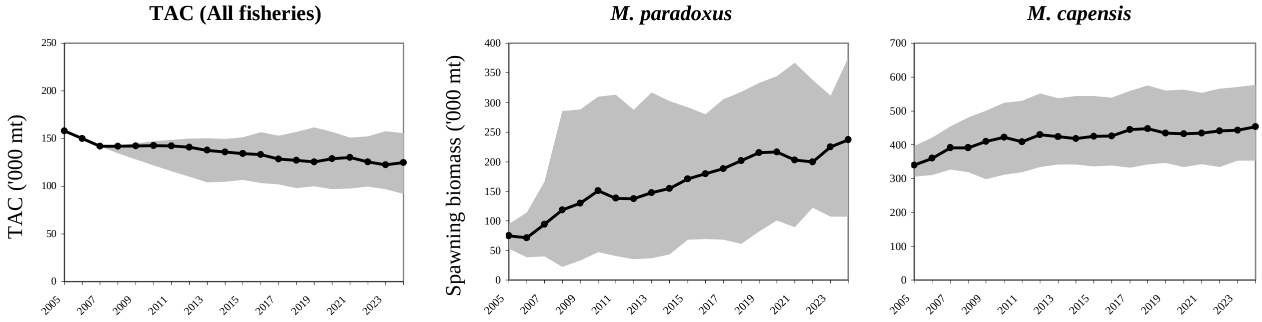


Fig. 6. Trajectories for future TACs and spawning biomasses from an application of an illustrative OMP2 (which assumes the past catch species split is NOT correct and should include more *M. capensis*) to the C6 scenarios shown under the 2x8000t phase-down option.

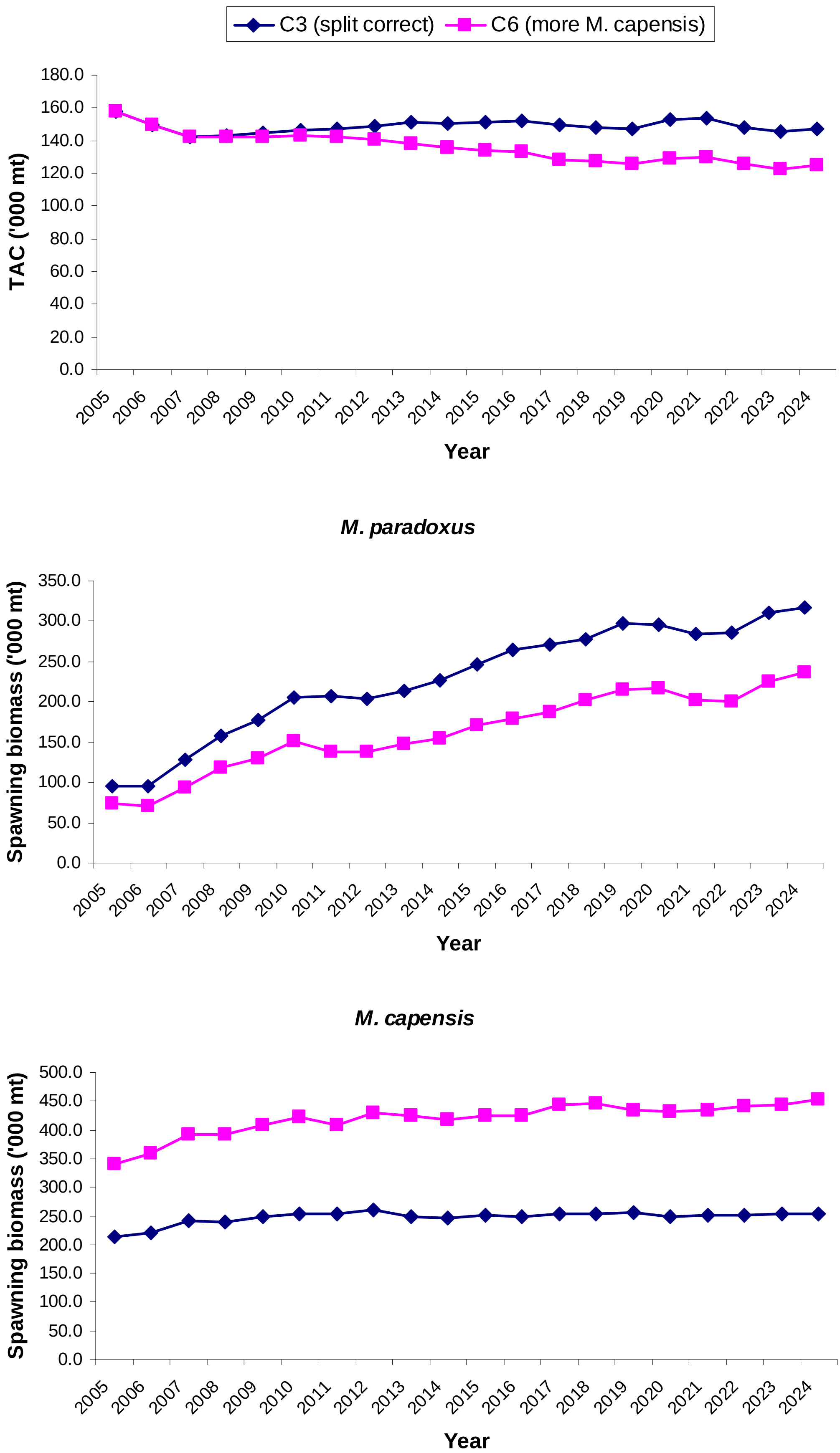


Fig. 7. Comparison of future trajectories for TACs and spawning biomasses (medians) for an application of an illustrative OMP1 to C3 and of an illustrative OMP2 to C6 scenarios, both under the 2x8000t TAC phase-down option, where the control rules are tuned to give the same lower 5%ile for *M. paradoxus* depletion in 2025.

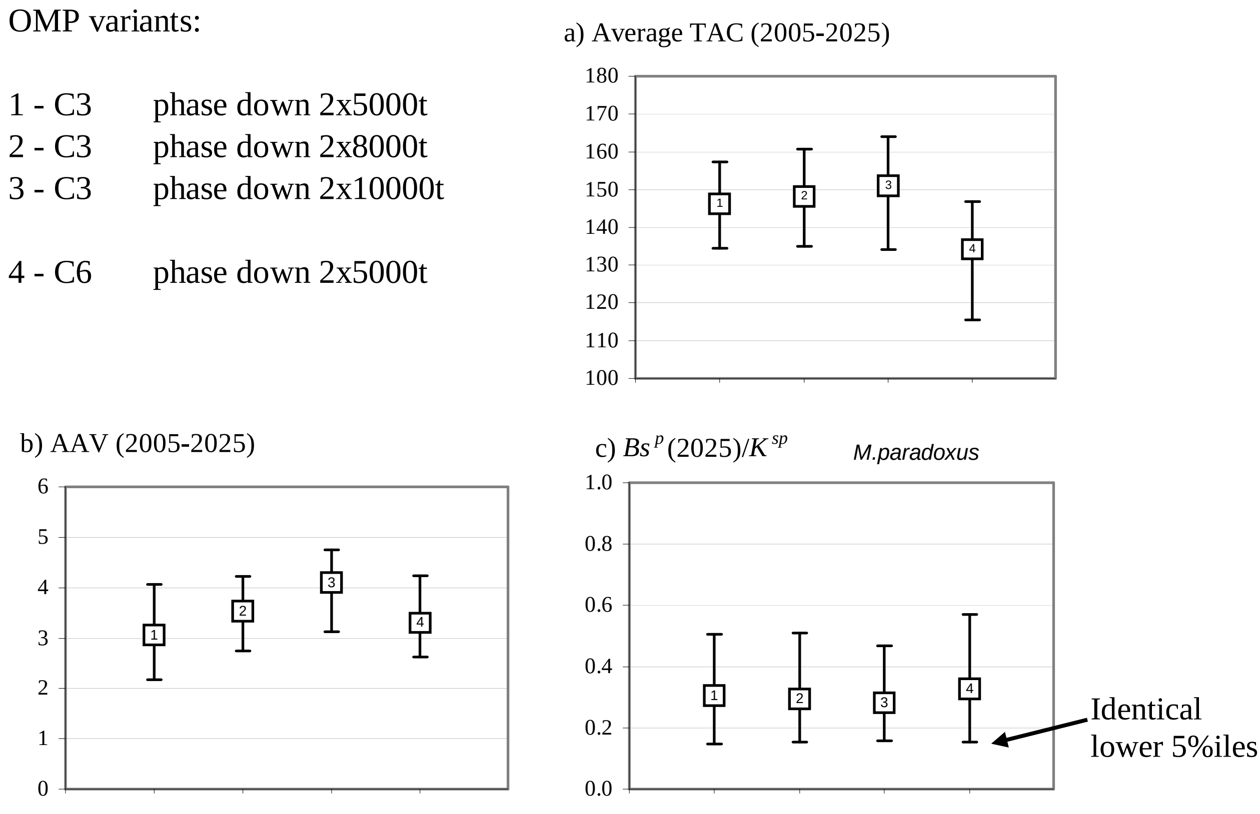


Fig. 8. Graphical summary of performance statistics for an illustrative OMP1 (applied to C3 scenarios only) with phase down options 2x5000t, 2x8000t and 2x10000t then max +-5%, and OMP2 which is applied to the C6 scenarios for the 2x8000t option.